The District of Lake Country (District) invites Tenders for the construction of the Eldorado Treated Water Reservoir and Glenmore Booster Station. Work is spread over two sites and generally consists of:

- A 6,000 m³ cast-in-place concrete treated water reservoir at the Eldorado site
- Approximately 9.4 m x 18 m booster station at the Eldorado site
- Approximately 7.3 m x 15.1 m booster station at the Glenmore Road site
- Associated site piping, grading, and fencing
- Associated electrical work

There is a recommended site meeting on April 4, 2016, from 2:00pm pm to 3:00 pm. The meeting will be held at the District office at 10150 Bottom Wood Lake Road, Lake Country, BC. Following the meeting the project sites will be available for viewing.

Tenders are scheduled to close at:

- **Tender Closing Time:** 3:00:00 pm
- **Tender Closing Date:** April 13, 2017

Please notify the Contract Administrator to have your name added to the bidders list.

All inquiries should be directed in writing to the Contract Administrator:

Brett dewynter, P.Eng
AECOM
201-3275 Lakeshore Rd.
Kelowna, BC V1W 3S9
brett.dewynter@aecom.com
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DRAWINGS

The drawings, bound separately, form part of the Contract Documents. A Drawing List is provided at the front of the Drawings.

END OF SECTION
1.0 INTRODUCTION

1.1 The District of Lake Country, hereinafter called the "Owner," requests tenders from suitably qualified contractors for the construction of the Eldorado Treated Water Reservoir and Glenmore Booster Station.

These Instructions to Tenderers apply to and govern the submission of tenders for the Contract.

1.2 The Place of the Work for the Eldorado Treated Water Reservoir is at 5000 Beaver Lake Road, and the Glenmore Booster Station will be located adjacent to 9265 Seaton Road, both in Lake Country, BC.

2.0 INQUIRIES

2.1 All inquiries and requests for clarification regarding this Tender shall be directed in writing to:

AECOM
201-3275 Lakeshore Rd.
Kelowna, BC V1W 3S9

Attention: Brett deWynter, P.Eng.

Email: brett.dewynter@aecom.com

Fax: (250) 762-7789

3.0 SUBMISSION OF TENDERS

3.1 Tenders shall be submitted to:

District of Lake Country
10150 Bottom Wood Lake Road
Lake Country, BC V4V 2M1
Attention: Kiel Wilkie, Engineering Technician

no later than 3:00:00 p.m. local time April 13th, 2017 (the "Tender Closing Date").
INSTRUCTIONS TO TENDERERS

3.2 Tenders shall be submitted in a sealed envelope, with the Tenderer's name and Project name and number clearly identified on the outside as follows:

Tender for: Eldorado Treated Water Reservoir and Glenmore Booster Station  
Project No.: 60488627  
Submitted by: (Tenderer’s Name)  
Date: ____________________ Time: ____________________  
(To be stamped by the City)  

DO NOT OPEN PRIOR TO THE CLOSING DATE AND TIME

3.3 Telephone, telegraph, or facsimile tenders will NOT be accepted.

3.4 On or before the Tender Closing Date, the Owner may extend the Tender Closing Date for any reason and, in that event, shall, in writing, advise all parties registered as having received a copy of the Tender Documents of the revised Tender Closing Date. In the event of such an extension, the revised date shall thereupon be deemed to be the "Tender Closing Date."

3.5 The Owner will open the tenders in public and announce the names of the tenderers and their respective Tender Prices. All results at that time will be unofficial and will not constitute a Notice of Award.

3.6 Late tenders will NOT be accepted or considered, and will be returned unopened.

4.0 TENDER DOCUMENTS

4.1 The tender documents (the “Tender Documents”) which a tenderer must review to prepare a tender consist of the following documents (not in order of priority):

   Instructions to Tenderers, including Appendix A, appended.
   Form of Tender including Appendices, appended.
   The Agreement
   Definitions and General Conditions of Contract - (CCDC2 - 2008)
   Supplementary General Conditions
   General Requirements
   Specifications
   Drawings
   Exhibit
   Addenda, if issued

4.2 Any additional information made available to tenderers prior to the Tender Closing Date by the Owner, such as geotechnical reports or as-built plans, which is not expressly included in the Tender Documents, is not included in the Contract Documents. Such additional information is made available only for the assistance of tenderers, who must make their own judgement about its reliability, accuracy, or completeness, and neither the Owner nor any representative of the Owner gives any guarantee or representation that the additional information is reliable, accurate, or complete.
4.3 Tenderers should examine the tender documents immediately upon receipt and notify the Owner’s Contract Administrator in Section 2.1, no less than five (5) working days before Tender closing, of any errors, omissions, or ambiguities found in the documents. This will allow the Owner, at its discretion, to issue addenda to all tenderers prior to closing. There is no guarantee that any questions received less than 5 working days prior to the Tender Closing Date will be answered.

It is the responsibility of the tenderer to ensure receipt of a complete set of Tender Documents.

5.0 TENDER REQUIREMENTS

5.1 A tender must be on the Form of Tender provided and be signed by the authorized signatory(s) of the tenderer as follows:

.1 signature(s) must be in original handwriting;

.2 if the tenderer is a partnership or joint venture then the name of the partnership or joint venture and the name of each partner or joint venturer shall be included, and each partner or joint venturer shall sign; if a partner or joint venturer is a corporation then such corporation shall sign as indicated in paragraph 5.1.3 below;

.3 if the tenderer is a corporation then the full name of the corporation shall be included, together with the names and signatures of authorized signatories; and

.4 if the tenderer is a sole proprietor then the full name of the sole proprietor shall be included and their signature;

5.2 A tender must be accompanied by security (“Bid Security”) in an amount equal to ten (10) percent of the Tender Price and in the form of:

.1 a bid bond issued by a surety licensed to carry on the business of suretyship in British Columbia in a form reasonably satisfactory to the Owner.

5.3 A tender must include all the following completed forms and be submitted as a complete tender package at the time of close specified:

.1 Appendix 1 - Breakdown of Tender Price.

.2 Appendix 2 - List of Subcontractors.

5.4 Where in the Tender Form numbers are requested in both words and figures, in the case of discrepancy between the two, the amount in words shall govern.

5.5 Tender Evaluation
INSTRUCTIONS TO TENDERERS

Tenders will be evaluated based on the following criteria:

.1 Qualifications and related experience of the Tenderer, including senior staff and any subcontractors to perform the Work;

.2 Performance of the Tenderer and subcontractors on similar projects including without limitation, the Tenderer’s history with the respect to the quality of work, schedule, changes in the work and force account work;

.3 The Tenderer’s compliance and ability to comply with all statutes, regulations, bylaws and other enactments affecting the Tenderer’s work including its record of compliance and the record of compliance of any subcontractors;

.4 Overall cost to the Owner having the Work completed in accordance with the Contract Documents;

.5 The conformity of the Tender to the requirements set forth in these Instructions to Tenderers;

.6 Tenderer’s stated period of completion and compliance with any time requirements provided for in the contract Documents; and

.7 The ability of the Tenderer to provide full and continuous operations without delay once construction has commenced.

6.0 AWARD

6.1 The Owner has no obligation to accept the lowest or any tender and may, in its sole discretion and according to its own judgement of its best interest taking into account the criteria under which tenders will be evaluated:

.1 reject any or all tenders and reserves the complete right at any time to terminate the process under these Instruction to Tenderers;

.2 award the Contract to the tenderer whose tender the Owner considers to be in its best interest;

.3 consider and accept a tender which contains defects or deficiencies that, in the Owner’s opinion, are not material;

.4. reject tenders which, in the Owner’s opinion contain qualifications, omissions, irregularities, or informalities so as to make comparison with other tenders difficult.

Despite any other provision in the Tender Documents or any applicable statutory provisions, the Owner will not be liable for a tenderer’s costs of preparing a tender or for damages for any lost profit in the event that the tenderer’s tender is not accepted or that
the Owner breaches any contract between the tenderer and the Owner arising out of the tenderer’s submission of a tender in response to the Owner’s invitation to tender.

6.2 In the event a single bid is received, the Owner may open the bid privately without reference to the bidder. If the bid is opened and it is in excess of the Owner’s budget, the Owner reserves the right to re-issue the Tender Documents for new public re-bid without revisions being made to the Tender Documents and without disclosing the single Tender Price. The Owner reserves the right to accept or reject a single bid.

6.3 The Owner has the right to enter into over-budget negotiations with the lowest compliant bidder or a single bidder, without cancellation of all bids or consideration to other bidders and to require that bidder to negotiate with the Subcontractors named.

6.4 Award of this tender is when a Notice of Award is issued to the successful tenderer (if any).

6.5 The Owner may after issuance of any Notice of Award, negotiate changes to the scope of Work, the materials, the specifications, or any conditions with the successful tenderer without having any duty or obligation to advise any of the unsuccessful tenderers. The Owner shall have no liability to any unsuccessful tenderer as a result of such negotiations or modifications.

6.6 Pursuant to GC 3.7 of the Contract, the Owner reserves the right to object to any of the Subcontractors and suppliers listed in a tender. If the Owner objects to a listed Subcontractor(s) then the Owner will permit a tenderer to, within 5 days, propose a substitute Subcontractor(s) acceptable to the Owner. A tenderer will not be required to make such a substitution and, if the Owner objects to a listed Subcontractor(s), the tenderer may, rather than propose a substitute Subcontractor(s), consider its tender rejected by the Owner and by written notice withdraw its tender. The Owner shall, in that event, return the tenderer’s bid security.

7.0 KNOWLEDGE OF SITE

7.1 All tenderers, either personally or through a representative, are responsible to examine the Place of the Work before submitting a tender. A tenderer has full responsibility to be familiar with and make allowance in the tender for all conditions at the Place of the Work that might affect the tender, including any information regarding subsurface soil conditions made available by the Owner, the location of the Work, local conditions, topographical soil conditions, weather, and access. Unless otherwise specified in the Contract Documents, a tenderer is not required to do subsurface investigations. By submitting a tender, a tenderer represents that the tenderer has examined the Place of the Work, or specifically elected not to do so. No additional payments or time extensions shall be claimable or due because of difficulties relating to conditions at the Place of the Work which were reasonably foreseeable by a tenderer prior to submitting a tender.

8.0 APPROVED EQUALS
INSTRUCTIONS TO TENDERERS

8.1 No alternatives or equals to the specified products will be considered. Tenderers shall base their prices upon the specified products only.

9.0 INTERPRETATION OF CONTRACT DOCUMENTS

9.1 If a tenderer is in doubt as to the correct meaning of any provision of the Tender Documents, the tenderer may request clarification in writing from the person named in paragraph 2.1.

9.2 If a tenderer discovers any contradictions or inconsistencies in the Tender Documents or its provisions, the tenderer shall immediately notify the person in writing named in 2.1.

9.3 If the Owner considers it necessary, the Owner may issue written addenda to provide clarification(s) of the Tender Documents.

9.4 No oral interpretation or oral representations from the Owner or any representative of the Owner will affect, alter, or amend any provision of the Tender Documents.

10.0 PRICES

10.1 The Tender Price will represent the entire cost excluding GST to the Owner of the complete Work based on the Tender Documents. Without limiting the generality of the above, tenderers shall include in their Tender Price (and any unit prices, optional prices, or other forms of pricing) sufficient amount to cover:

   .1 the costs of labour, equipment, and material included in or required for the Work, including all items which, while not specifically listed, are included in the Work specifically or by necessary inference from the Tender Documents;

   .2 all assessments payable with respect to labour as required by any statutory scheme such as Workers’ Compensation, employment insurance, holiday pay, insurance, CPP, and all employee benefits;

   .3 all overhead costs, including head office and on-site overhead costs, and all amounts for the tenderer’s profit; and

   .4 the cost of complying with all applicable laws regarding trade or other qualifications of employees performing the Work.

11.0 TAXES AND DUTIES

11.1 The Tender Price and unit prices should include excise duties in force as of the date of the Tender Closing Date, except the Goods and Services Tax under the Excise Tax Act (Canada) (“GST”).
12.0 AMENDMENT OF TENDERS

12.1 A tenderer may amend or revoke a tender by giving written notice, delivered by hand, mail or email, to the Owner in accordance with paragraph 3.1 of these Instructions to Tenderers at any time up until the Tender Closing Date. An amendment or revocation that is received after the Tender Closing Date shall not be considered and shall not affect a tender as submitted.

12.2 An amendment or revocation of a tender must be signed by an authorized signatory of the tenderer in the same manner as provided by paragraph 5.1.

12.3 If an amendment discloses the Tender Price or other material element of the tender, the amendment must be sealed and marked in the same manner as the tender under 3.2 and must be delivered by hand or mail. Any amendment that expressly or by inference discloses the tenderer's Tender Price or other material element of the tender such that, in the opinion of the Owner, the confidentiality of the tender is breached, will invalidate the entire tender.

12.4 Tender amendments by facsimile will not be accepted. Prior to the Tender closing, tender amendments can be sent via email only to Kiel Wilkie at kwilkie@lakecountry.bc.ca. The Owner assumes no risk or responsibility whatsoever that any email will be received as required by paragraph 12.1 of this Section and shall not be liable to any tenderer if for any reason a email is not properly received.

13.0 DURATION OF TENDERS

13.1 Tenders shall remain open for acceptance by the Owner for a period of 60 calendar days after the Tender Closing Date.

14.0 QUALIFICATIONS OF TENDERERS

14.1 By submitting a tender, a tenderer is representing that it has the competence, qualifications, and relevant experience required to do the Work.

15.0 OPTIONAL WORK

15.1 If Appendix 1 – Breakdown of Tender Price requires the tenderer to submit prices for Optional Work, then tenderers must complete all the unit prices for such Optional Work. Such prices for Optional Work shall not include any general overhead costs, or other costs, or profit, not directly related to the Optional Work.

15.2 Notwithstanding that the Owner may elect not to proceed with the Optional Work, the tender prices for any Optional Work shall be included in the Tender Price for the purpose of any price comparisons between Tenders.
16.0 ADDENDA

16.1 The Owner may issue changes and clarifications to the Tender Documents and written Addendum to all parties registered as having received a copy of the Tender Documents and those Addenda shall then form part of the Tender Documents.

16.2 In the space provided in the Tender Form, a tenderer shall acknowledge receipt of all Addenda.

17.0 DEFINITIONS

17.1 In these Instructions to Tenderers and the Form of Tender, in addition to terms defined elsewhere in those documents:

“Bid Security” has the meaning set out in paragraph 5.2 of the Instructions to Tenderers;

“Contract” means the contract as set out and described in the Contract Documents;

“Contract Price” has the meaning set out in Article 4.1 of the Agreement;

“Contract Documents” has the meaning set out in Article 3.1 of the Agreement;

“Day” has a meaning of calendar day if not preceded by the adjective working;

“Notice of Award” means the award of a contract for the Work;

“Notice to Proceed” means a notice from the Owner to proceed with the Work;

“Optional Work” means the work described as such in Appendix 1 – Optional Work that may be included in the Work at the election of the Owner;

“Place of the Work” means the designated site or location where the Work products are to be finally or permanently constructed or installed;

“Project” means the project contemplated by paragraph 1.1 of the Instructions to Tenderers as more particularly described in the Tender Documents;

“Subcontractor” means a person, firm or corporation having a direct contract with the Contractor to perform a part or parts of the Work;

“Tender Price” means the price for which a tenderer offers to perform the Work as set out in paragraph 2.3 of the Form of Tender; and

“Work” means and includes anything and everything required to be done for the fulfillment and completion of the Project in accordance with the Contract.

END OF SECTION
FORM OF TENDER
PROJECT: ELDORADO TREATED WATER RESERVOIR AND GLENMORE BOOSTER STATION
PROJECT #: 60488627

TO: District of Lake Country
10150 Bottom Wood Lake Road
Lake Country, BC V4V 2M1
Attention: Kiel Wilkie, Engineering Technician

FROM: 
(Name of tenderer)

1.0 WE, THE UNDERSIGNED:

1.1 have received and carefully reviewed all of the Tender Documents, as listed in the Instructions to Tenderers, and the following Addenda (list all Addenda received if any):

1.2 have full knowledge of the Place of the Work, and the Work required;

1.3 have complied with the Instructions to Tenderers; and

2.0 ACCORDINGLY, WE HEREBY OFFER:

2.1 to perform and complete the Work and to provide all the labour, equipment and material all as set out in the Tender Documents, in strict compliance with the Tender Documents; and

2.2 to achieve Substantial Performance of the Work, on or before March 16, 2018; and

2.3 to do the Work for a fixed price of $____________________ dollars in Canadian funds (the “Tender Price”), which price includes duties in force at this date, but excludes the Goods and Services Tax (GST). Said Tender Price is comprised of the prices set out in Appendix 1 - Breakdown of Tender Price.

3.0 WE CONFIRM:

3.1 that the following are attached to and form a part of this tender:
FORM OF TENDER

.1 Appendices 1 and 2 inclusive as required by paragraph 5.3 of the Instructions to Tenderers; and

.2 the Bid Security as required by paragraph 5.2 of the Instructions to Tenderers.

4.0 WE AGREE:

4.1 that this tender will be irrevocable and open for acceptance by the Owner for a period of 60 days beginning on and including the day following the Tender Closing Date; and

.1 within ten (10) Working Days of receipt of a written Notice of Award to deliver to the Owner:

.1 a Performance Bond and a Labour and Material Payment Bond, each in the amount of 50 percent of the Contract Price, issued by a surety licensed to carry on the business of suretyship in the province of British Columbia, and in a form acceptable to the Owner. All bonds will name the Owner as the Obligee;

.2 a detailed Construction Schedule, as provided by GC 3.5;

.3 a “clearance letter” indicating that the Contractor is in WorkSafe BC compliance;

.4 a copy of the insurance policies as provided by GC 11.1 indicating that all such insurance coverage is in place;

.5 proof of Gold Seal enrollment for the Site Superintendent

.2 we will sign the Contract and deliver an executed copy to the Owner within 72 hours of receipt from the Owner; and

.3 within two Days of receipt of written “Notice to Proceed,” or such longer time as may be otherwise specified in the Notice to Proceed, commence the Work.

5.0 WE AGREE:

5.1 that, if we receive written Notice of Award of this Contract and, contrary to clause 4.0 of this Form of Tender, we:

.1 fail or refuse to deliver the documents as specified by paragraph 4.1.1 of this Form of Tender;

.2 fail to execute and deliver the Contract to the Owner within 72 hours of receipt of such document from the Owner; or

.3 fail or refuse to commence the Work as required by the Notice to Proceed,
then such failure or refusal will be deemed to be a refusal by us to enter into the Contract and the Owner may, on written notice to us, award the contract to another party. We further agree that, without limiting the Owner’s rights against the tenderer for compensation for any damages suffered by the Owner because of such failure or refusal, the Bid Security shall be forfeited to the Owner, in an amount equal to the lesser of:

.1 the face value of the Bid Security; and

.2 the amount by which our Tender Price is less than the amount for which the Owner contracts with another party to perform the Work.

6.0 OUR ADDRESS is as follows:

Telephone: ______________________ Facsimile: ______________________
Attention: ______________________

7.0 IN WITNESS WHEREOF this Tender is executed this ______________________ day of ______________________ 20_____. 
WHERE THE TENDERER IS A CORPORATION:

(Full Name of Corporation)  
Per: _______________________________ 
Authorized Signatory  
Per: _______________________________ 
Authorized Signatory  

FOR PARTNERSHIP:

(Full Name of Partnership)  
Per: _______________________________ 
Authorized Signatory  
Per: _______________________________ 
Authorized Signatory  

FOR SOLE PROPRIETORSHIP:

SIGNED  
______________________________  
(Doing business as)  
______________________________  
Address  
______________________________  
Occupation  
in the presence of:  
______________________________  
Witness
Pursuant to paragraph 2.3 of the Form of Tender, the Tender Price for the Work is comprised of the following components and the tenderer’s overhead and profit are included in each component:

<table>
<thead>
<tr>
<th>Component</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-selected electrical, instrumentation and control equipment (refer to Exhibit B for the scope of work)</td>
<td>$404,981.00</td>
</tr>
<tr>
<td>TOTAL Tender Price (GST excluded)</td>
<td>$</td>
</tr>
<tr>
<td>GST</td>
<td>$</td>
</tr>
</tbody>
</table>

The Contractor is to provide a complete breakdown of the Tender Price, within five days of the notice of award, which is to be used by the consultant to review the Contractor’s progress payments. Refer to Appendix 6 for requirements.
APPENDIX 2

LIST OF SUBCONTRACTORS

Pursuant to paragraph 5.3 of the Instructions to Tenderers, the following are the Subcontractors we propose to use for Divisions or Sections of Work listed hereunder:

<table>
<thead>
<tr>
<th>Division/Section of Work</th>
<th>Name of Subcontractor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Pursuant to Appendix 1 – Form of Tender, the Tender Price for the Work is comprised of the following components and the tenderer’s overhead and profit are included in each component:

<table>
<thead>
<tr>
<th>A</th>
<th>Eldorado Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>.1</td>
<td>Division 0 (Bonding and Insurance)</td>
</tr>
<tr>
<td>.2</td>
<td>Site Work and Servicing</td>
</tr>
<tr>
<td></td>
<td>Site Civil (Excavation and Grading)</td>
</tr>
<tr>
<td></td>
<td>Demolition</td>
</tr>
<tr>
<td></td>
<td>Buried/Site Piping</td>
</tr>
<tr>
<td>.3</td>
<td>Structural</td>
</tr>
<tr>
<td></td>
<td>Reservoir Structure</td>
</tr>
<tr>
<td></td>
<td>Reservoir Valve Room</td>
</tr>
<tr>
<td></td>
<td>Booster Station (Eldorado)</td>
</tr>
<tr>
<td></td>
<td>Metals (Hatches, etc.)</td>
</tr>
<tr>
<td>.4</td>
<td>Mechanical</td>
</tr>
<tr>
<td></td>
<td>Process Mechanical (piping main, bends, restraints, etc.)</td>
</tr>
<tr>
<td></td>
<td>Valves</td>
</tr>
<tr>
<td></td>
<td>HVAC</td>
</tr>
<tr>
<td>.5</td>
<td>Electrical and Instrumentation &amp; Control</td>
</tr>
<tr>
<td></td>
<td>Subtotal A (Eldorado)</td>
</tr>
</tbody>
</table>
# FORM OF TENDER

<table>
<thead>
<tr>
<th></th>
<th>Glenmore Site</th>
</tr>
</thead>
</table>
| .1| Division 0 (Bonding and Insurance)| $
| .2| Site Work and Servicing           |
|   | Site Civil (Excavation and Grading)| $
|   | Demolition                        | $
|   | Buried/Site Piping                | $
| .3| Structural                        |
|   | Booster Station (Glenmore)        | $
| .4| Mechanical                        |
|   | Process Mechanical (piping main, bends, restraints, etc.) | $
|   | Valves                            | $
|   | HVAC                              | $
| .5| Electrical and Instrumentation & Control | $
|   | Subtotal B (Glenmore)             | $

| Subtotal A (Eldorado)  | $
| Subtotal B (Glenmore)  | $
| TOTAL Tender Price (GST excluded) | $
| GST                   | $

END OF SECTION
BID BOND

No. ____________________________ Bond Amount $__________________________

as Principal, hereinafter called the Principal, and a corporation created and existing under the laws of ____________________________ and duly authorized to transact the business of Suretyship in ____________________________ as Surety, hereinafter called the Surety, are held and firmly bound unto ____________________________ Obligee, hereinafter called the Obligee, in the amount of ____________________________ Dollars ($__________________________) lawful money of Canada, for the payment of which sum the Principal and the Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally.

WHEREAS, the Principal has submitted a written bid to the Obligee, dated _________ day of ____________________________, in the year __________, for ____________________________ .

The condition of this obligation is such that if the Principal shall have the bid accepted within the time period prescribed in the Obligee’s bid documents, or, if no time period is specified in the Obligee’s bid documents, within ____________________________ (__________) days from the closing date as specified in the Obligee’s bid documents, and the Principal enters into a formal contract and gives the specified security, then this obligation shall be void; otherwise, provided the Obligee takes all reasonable steps to mitigate the amount of such excess costs, the Principal and the Surety will pay to the Obligee the difference in money between the amount of the bid of the Principal and the amount for which the Obligee legally contracts with another party to perform the work if the latter amount be in excess of the former.

The Principal and Surety shall not be liable for a greater sum than the Bond Amount.

It is a condition of this bond that any suit or action must be commenced within seven (7) months of the date of this Bond.

No right of action shall accrue hereunder to or for the use of any person or corporation other than the Obligee named herein, or the heirs, executors, administrators or successors of the Obligee.

IN WITNESS WHEREOF, the Principal and the Surety have Signed and Sealed this Bond dated _________ day of ____________________________, in the year __________ .

SIGNED and SEALED

in the presence of

ATTORNEY IN FACT

Principal

Signature

Name of person signing

Signature

Name of person signing

(CCDC 220 – 2002 has been approved by the Surety Association of Canada)

CCDC
Copyright 2002
Canadian Construction Documents Committee
PERFORMANCE BOND

No. __________________

__________________________ as Principal, hereinafter called the Principal, and
__________________________ a corporation created and existing under the laws
of ______________________ and duly authorized to transact the business of Suretyship in __________________ as Surety, hereinafter
called the Surety, are held and firmly bound unto __________________ as
Obligee, hereinafter called the Obligee, in the amount of ______________________ Dollars ($ __________________) lawful money of Canada, for the payment
of which the Principal and the Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally.

WHEREAS, the Principal has entered into a written contract with the Obligee, dated ______ day of __________, in the year ______
for ____________________________
hereinafter referred to as the Contract.

The condition of this obligation is such that if the Principal shall promptly and faithfully perform the Contract then this obligation shall be null and
void; otherwise it shall remain in full force and effect.

Whenever the Principal shall be, and declared by the Obligee to be, in default under the Contract, the Obligee having performed the Obligee’s
obligations thereunder, the Surety shall promptly:
1) remedy the default, or;
2) complete the Contract in accordance with its terms and conditions or;
3) obtain a bid or bids for submission to the Obligee for completing the Contract in accordance with its terms and conditions and upon determination
by the Obligee and the Surety of the lowest responsible bidder, arrange for a contract between such bidder and the Obligee and make available as
work progresses (even though there should be a default, or a succession of defaults, under the contract or contracts of completion, arranged under
this paragraph) sufficient funds to pay to complete the Principal’s obligations in accordance with the terms and conditions of the Contract and to
pay those expenses incurred by the Obligee as a result of the Principal’s default relating directly to the performance of the work under the
Contract, less the balance of the Contract price; but not exceeding the Bond Amount. The balance of the Contract price is the total amount
payable by the Obligee to the Principal under the Contract, less the amount properly paid by the Obligee to the Principal, or;
4) pay the Obligee the lesser of (1) the Bond Amount or (2) the Obligee’s proposed cost of completion, less the balance of Contract price.

It is a condition of this bond that any suit or action must be commenced before the expiration of two (2) years from the earlier of (1) the date of
Substantial Performance of the Contract as defined in the lien legislation where the work under the Contract is taking place, or, if no such definition
exists, the date when the work is ready for use or is being used for the purpose intended, or (2) the date on which the Principal is declared in default
by the Obligee.

The Surety shall not be liable for a greater sum than the Bond Amount.

No right of action shall accrue on this Bond, to or for the use of, any person or corporation other than the Obligee named herein, or the heirs,
executors, administrators or successors of the Obligee.

IN WITNESS WHEREOF, the Principal and the Surety have Signed and Sealed this Bond dated ______ day of __________, in the year ______

SIGNED and SEALED
in the presence of

ATTORNEY IN FACT

__________________________
Principal

__________________________
Signature

__________________________
Name of person signing
Surety

__________________________
Signature

__________________________
Name of person signing

CCDC Copyright 2002
Canadian Construction Documents Committee

(CCDC 221 – 2002 has been approved by the Surety Association of Canada)
LABOUR & MATERIAL PAYMENT BOND
(Trustee Form)

No. ____________________ Bond Amount $ ____________________

________________________________________ as Principal, hereinafter called the Principal, and
________________________________________ a corporation created and existing under the laws
of __________________________________ as Surety, hereinafter
called the Surety, are held and firmly bound unto __________________________________ as
Obligee, hereinafter called the Obligee, in the amount of

________________________________________ dollars ($ ____________________) lawful money of Canada, for the payment
of which sum the Principal and the Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally.

WHEREAS, the Principal has entered into a written contract with the Obligee, dated ______ day of _________, in the year ______

for __________________________________________________

in accordance with the Contract Documents submitted, and which are by reference made part hereof and are hereinafter referred to as the Contract.

The Condition of this obligation is such that, if the Principal shall make payment to all Claimants for all labour and material used or reasonably required for use in the performance of the Contract, then this obligation shall be null and void; otherwise it shall remain in full force and effect, subject, however, to the following conditions:

1. A Claimant for the purpose of this Bond is defined as one having a direct contract with the Principal for labour, material, or both, used or reasonably required for use in the performance of the Contract, labour and material being construed to include that part of water, gas, power, light, heat, oil, gasoline, telephone service or rental equipment directly applicable to the Contract provided that a person, firm or corporation who rents equipment to the Principal to be used in the performance of the Contract or under a contract which provides that all or any part of the rent is to be applied towards the purchase price thereof, shall only be a Claimant to the extent of the prevailing industrial rental value of such equipment for the period during which the equipment was used in the performance of the Contract. The prevailing industrial rental value of equipment shall be determined, insofar as it is practical to do so, by the prevailing rates in the equipment marketplace in which the work is taking place.

2. The Principal and the Surety, hereby jointly and severally agree with the Obligee, as Trustee, that every Claimant who has not been paid as provided for under the terms of its contract with the Principal, before the expiration of a period of ninety (90) days after the date on which the last of such Claimant’s work or labour was done or performed or materials were furnished by such Claimant, may as a beneficiary of the trust herein provided for, sue on this Bond, prosecute the suit to final judgment for such sum or sums as may be justly due to such Claimant under the terms of its contract with the Principal and have execution thereon. Provided that the Obligee is not obliged to do or take any act, action or proceeding against the Surety on behalf of the Claimants, or any of them, to enforce the provisions of this Bond. If any act, action or proceeding is taken either in the name of the Obligee or by joining the Obligee as a party to such proceeding, then such act, action or proceeding, shall be taken on the understanding and basis that the Claimants, or any of them, who take such act, action or proceeding shall indemnify and save harmless the Obligee against all costs, charges and expenses or liabilities incurred thereon and any loss or damage resulting to the Obligee by reason thereof. Provided still further that, subject to the foregoing terms and conditions, the Claimants, or any of them may use the name of the Obligee to sue on and enforce the provisions of this Bond.

3. It is a condition precedent to the liability of the Surety under this Bond that such Claimant shall have given written notice as hereinafter set forth to each of the Principal, the Surety and the Obligee, stating with substantial accuracy the amount claimed, and that such Claimant shall have brought suit or action in accordance with this Bond, as set out in sub-clauses 3 (b) and 3 (c) below. Accordingly, no suit or action shall be commenced hereunder by any Claimant:

a) unless such notice shall be served by mailing the same by registered mail to the Principal, the Surety and the Obligee, at any place where an office is regularly maintained for the transaction of business by such persons or served in any manner in which legal process may be served in the Province or Territory in which the subject matter of the Contract is located. Such notice shall be given.
i) in respect of any claim for the amount or any portion thereof, required to be held back from the Claimant by the Principal, under either the terms of the Claimant's contract with the Principal, or under the lien Legislation applicable to the Claimant's contract with the Principal, whichever is the greater, within one hundred and twenty (120) days after such Claimant should have been paid in full under the Claimant's contract with the Principal;

ii) in respect of any claim other than for the holdback, or portion thereof, referred to above, within one hundred and twenty (120) days after the date upon which such Claimant did, or performed, the last of the work or labour or furnished the last of the materials for which such claim is made under the Claimant's contract with the Principal;

b) after the expiration of one (1) year following the date on which the Principal ceased work on the Contract, including work performed under the guarantees provided in the Contract;

c) other than in a Court of competent jurisdiction in the Province or Territory in which the work described in the Contract is to be installed or delivered as the case may be and not elsewhere, and the parties hereto agree to submit to the jurisdiction of such Court.

4. The Surety agrees not to take advantage of Article 2365 of the Civil Code of the Province of Quebec in the event that, by an act or an omission of a Claimant, the Surety can no longer be subrogated in the rights, hypothec and privileges of said Claimant.

5. Any material change in the contract between the Principal and the Obligee shall not prejudice the rights or interest of any Claimant under this Bond, who is not instrumental in bringing about or has not caused such change.

6. The amount of this Bond shall be reduced by, and to the extent of any payment or payments made in good faith, and in accordance with the provisions hereof, inclusive of the payment by the Surety of claims made under the applicable lien legislation or legislation relating to legal hypothecs, whether or not such claim is presented under and against this Bond.

7. The Surety shall not be liable for a greater sum than the Bond Amount.

IN WITNESS WHEREOF, the Principal and the Surety have Signed and Sealed this Bond dated ____________ day of __________________, in the year ____________.

SIGNED and SEALED

Principal

in the presence of

ATTORNEY IN FACT

Signature

Name of person signing

Surety

Signature

Name of person signing

(CCDC 222 – 2002 has been approved by the Surety Association of Canada)
AGREEMENT TO BOND

Date: ____________________, 20____

“Name & Address of Surety Company”

District of Lake Country
10150 Bottom Wood Lake Road
Lake Country, BC, V4V 2M1

Gentlemen/Madams:

CONTRACT NO.:______________________________________________________________

Should the District of Lake Country (District) [hereinafter referred to as the “Owner”] accept the Tender of and execute an Agreement with _____________________________________ [hereinafter referred to as the “Tenderer”], we, the undersigned Surety Company, do hereby consent and agree to become bound to the Owner as Surety for the Tenderer in any of the following Bonds, on the standard format of the Canadian Construction Association.

1. Performance Bond for an amount equal to 50% of the Total Tender Price.

2. Labour and Material Payment Bond for an amount equal to 50% of the Total Tender Price.

We, the undersigned Surety Company, agree to furnish the Owner with the said Bonds within 7 days after written notification that the Owner has requested the said Bond or Bonds. We hereby further declare that our Company is legally entitled to do business in the Province of British Columbia.

Yours truly,

___________________________________
[Name of Surety Company]

___________________________________
[Address]

[Seal]

NOTE: This Agreement must be executed on behalf of the Surety Company by its authorized Officers under the Company’s corporate seal.

END OF SECTION
## FORM FOR CERTIFICATE OF INSURANCE

**PROOF OF LIABILITY INSURANCE WILL BE ACCEPTED ON THIS FORM ONLY**

**District of Lake Country**

### CERTIFICATE OF INSURANCE

<table>
<thead>
<tr>
<th>Contract Number</th>
<th>Description of Contract</th>
</tr>
</thead>
<tbody>
<tr>
<td>(if applicable)</td>
<td></td>
</tr>
</tbody>
</table>

**INSUREDS:**

(Contractor)

AND The District of Lake Country

AND All Sub-Contractors of either employed directly or in the work the work to be performed.

AND *

<table>
<thead>
<tr>
<th>POLICY</th>
<th>COMPANY &amp; POLICY NO.</th>
<th>DATE</th>
<th>LIMITS OF LIABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>GENERAL LIABILITY BODILY INJURY PROPERTY DAMAGE</td>
<td></td>
<td></td>
<td>Minimum Requirement</td>
</tr>
<tr>
<td>AUTOMOBILE LIABILITY</td>
<td></td>
<td></td>
<td>$5,000,000.00</td>
</tr>
<tr>
<td>OTHER (Describe)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**IMPORTANT:** This Certificate confirms that the Policies listed above are in full force and effect and that these Policies will not be amended to restrict coverage or cancelled without 30 days prior written notice being given The District of Lake Country and further that the General Liability Policy listed above includes all coverages outlined under (1) and (2) below and includes coverages under (3) as follows:

### GENERAL LIABILITY COVERAGE INCLUDES:

1) Cross Liability clause
2) Completed operations, which cover shall be maintained continuously in force for a period of not less than twenty-four months from the date of the Certificate of Total Performance of the Work.
   (i) Blanket Contractual Liability
   (ii) Contingent Employers Liability
   (iii) Non-owned automobile Liability
   (iv) Broad Form Property Damage
   (v) Excavation
3) where applicable, includes coverage for
   (i) Underpinning, Shoring
   (ii) Demolition
   (iii) Building Raising or Moving
   (iv) Blasting or the use of explosives
   (v) Tunneling
   (vi) Pile driving, caisson work
   (vii) Use of aircraft or watercraft, owned or non-owned

Date 20

NAME OF INSURANCE COMPANY (IES) (NOT BROKERS)

ADDRESS OF INSURANCE COMPANY OR BROKER (AUTHORIZED REPRESENTATIVE OR OFFICIAL)

* Enter name of Consulting Engineer, Architect, Construction or Project Management Firm, if applicable
END OF SECTION
District of Lake Country
Eldorado Treated Water Reservoir and Glenmore Booster Station
General Contract

Apply a CCDC 2 copyright seal here. The application of the seal demonstrates the intention of the party proposing the use of this document that it be an accurate and unamended form of CCDC 2 – 2008 except to the extent that any alterations, additions or modifications are set forth in supplementary conditions.
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2. Change Order
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7. Contract Price
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9. Contractor
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16. Provide
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The Canadian Construction Documents Committee (CCDC) is a national joint committee responsible for the development, production and review of standard Canadian construction contracts, forms and guides. Formed in 1974 the CCDC is made up of volunteer representatives from:

Public Sector Owners
Private Sector Owners
Canadian Bar Association (Ex-Officio)
* The Association of Canadian Engineering Companies
* The Canadian Construction Association
* Construction Specifications Canada
* The Royal Architectural Institute of Canada

*Committee policy and procedures are directed and approved by the four constituent national organizations.

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AGREEMENT BETWEEN OWNER AND CONTRACTOR
For use when a stipulated price is the basis of payment.

This Agreement made on the __________ day of ______ in the year ______.

by and between the parties

The District of Lake Country

hereinafter called the "Owner"

and

hereinafter called the "Contractor"

The Owner and the Contractor agree as follows:

ARTICLE A-1  THE WORK

The Contractor shall:

1.1 perform the Work required by the Contract Documents for

The District of Lake Country

located at

5000 Beaver Lake Road, and adjacent to 9265 Seaton Road, Lake Country, BC

for which the Agreement has been signed by the parties, and for which

AECOM

is acting as and is hereinafter called the "Consultant"

and

1.2 do and fulfill everything indicated by the Contract Documents, and

1.3 commence the Work by the __________ day of ______ in the year ______ and, subject to adjustment in Contract Time as provided for in the Contract Documents, attain Substantial Performance of the Work, by the 27th day of ______ in the year ______.

ARTICLE A-2  AGREEMENTS AND AMENDMENTS

2.1 The Contract supersedes all prior negotiations, representations or agreements, either written or oral, relating in any manner to the Work, including the bidding documents that are not expressly listed in Article A-3 of the Agreement - CONTRACT DOCUMENTS.

2.2 The Contract may be amended only as provided in the Contract Documents.
ARTICLE A-3 CONTRACT DOCUMENTS

3.1 The following are the Contract Documents referred to in Article A-1 of the Agreement - THE WORK:

- Agreement between Owner and Contractor
- Definitions
- The General Conditions of the Stipulated Price Contract

* Refer to Table of Contents in the District of Lake Country Eldorado Treated Water Reservoir and Glenmore Booster Station Issued for Tender for list of documents

- Drawings

* (Insert here, attaching additional pages if required, a list identifying all other Contract Documents e.g. supplementary conditions; information documents; specifications, giving a list of contents with section numbers and titles, number of pages and date; material finishing schedules; drawings, giving drawing number, title, date, revision date or mark; addenda, giving title, number, date)
ARTICLE A-4  CONTRACT PRICE

4.1 The *Contract Price*, which excludes *Value Added Taxes*, is:

\[ \text{\textdollar} \text{ /100 dollars } \text{ } \]

4.2 *Value Added Taxes* (of \[
\text{______
\text{\%}}\]) payable by the *Owner* to the *Contractor* are:

\[ \text{\textdollar} \text{ /100 dollars } \text{ } \]

4.3 Total amount payable by the *Owner* to the *Contractor* for the construction of the *Work* is:

\[ \text{\textdollar} \text{ /100 dollars } \text{ } \]

4.4 These amounts shall be subject to adjustments as provided in the *Contract Documents*.

4.5 All amounts are in Canadian funds.

ARTICLE A-5  PAYMENT

5.1 Subject to the provisions of the *Contract Documents*, and in accordance with legislation and statutory regulations respecting holdback percentages and, where such legislation or regulations do not exist or apply, subject to a holdback of \[
\text{\textdollar} \text{ /100 dollars } \text{ } \text{______
\text{\%}}\), the *Owner* shall:

.1 make progress payments to the *Contractor* on account of the *Contract Price* when due in the amount certified by the *Consultant* together with such *Value Added Taxes* as may be applicable to such payments, and

.2 upon *Substantial Performance of the Work*, pay to the *Contractor* the unpaid balance of the holdback amount when due together with such *Value Added Taxes* as may be applicable to such payment, and

.3 upon the issuance of the final certificate for payment, pay to the *Contractor* the unpaid balance of the *Contract Price* when due together with such *Value Added Taxes* as may be applicable to such payment.

5.2 In the event of loss or damage occurring where payment becomes due under the property and boiler insurance policies, payments shall be made to the *Contractor* in accordance with the provisions of GC 11.1 – INSURANCE.

5.3 Interest

.1 Should either party fail to make payments as they become due under the terms of the *Contract* or in an award by arbitration or court, interest at the following rates on such unpaid amounts shall also become due and payable until payment:

(1) 2\% per annum above the prime rate for the first 60 days.

(2) 4\% per annum above the prime rate after the first 60 days.

Such interest shall be compounded on a monthly basis. The prime rate shall be the rate of interest quoted by

\[ \text{\textdollar} \text{ /100 dollars } \text{ } \]

(Insert name of chartered lending institution whose prime rate is to be used) for prime business loans as it may change from time to time.

.2 Interest shall apply at the rate and in the manner prescribed by paragraph 5.3.1 of this Article on the settlement amount of any claim in dispute that is resolved either pursuant to Part 8 of the General Conditions – DISPUTE RESOLUTION or otherwise, from the date the amount would have been due and payable under the *Contract*, had it not been in dispute, until the date it is paid.
ARTICLE A-6  RECEIPT OF AND ADDRESSES FOR NOTICES IN WRITING

6.1 Notices in Writing will be addressed to the recipient at the address set out below. The delivery of a Notice in Writing will be by hand, by courier, by prepaid first class mail, or by facsimile or other form of electronic communication during the transmission of which no indication of failure of receipt is communicated to the sender. A Notice in Writing delivered by one party in accordance with this Contract will be deemed to have been received by the other party on the date of delivery if delivered by hand or courier, or if sent by mail it shall be deemed to have been received five calendar days after the date on which it was mailed, provided that if either such day is not a Working Day, then the Notice in Writing shall be deemed to have been received on the Working Day next following such day. A Notice in Writing sent by facsimile or other form of electronic communication shall be deemed to have been received on the date of its transmission provided that if such day is not a Working Day or if it is received after the end of normal business hours on the date of its transmission at the place of receipt, then it shall be deemed to have been received at the opening of business at the place of receipt on the first Working Day next following the transmission thereof. An address for a party may be changed by Notice in Writing to the other party setting out the new address in accordance with this Article.

Owner

District of Lake Country
Attention: Kiel Wilkie

10150 Bottom Wood Lake Road, Lake Country, BC V4V 2M1

Contractor

Consultant

AECOM (Canada) Ltd.
Attention: Brett deWynter

ARTICLE A-7  LANGUAGE OF THE CONTRACT

7.1 When the Contract Documents are prepared in both the English and French languages, it is agreed that in the event of any apparent discrepancy between the English and French versions, the English / French language shall prevail. Complete this statement by striking out inapplicable term.

7.2 This Agreement is drawn in English at the request of the parties hereto. La présente convention est rédigée en anglais à la demande des parties.

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ARTICLE A-8 SUCCESSION

8.1 The Contract shall enure to the benefit of and be binding upon the parties hereto, their respective heirs, legal representatives, successors, and assigns.

In witness whereof the parties hereto have executed this Agreement by the hands of their duly authorized representatives.

SIGNED AND DELIVERED in the presence of:

WITNESS          OWNER

__________________________
signature

__________________________
name of person signing

__________________________
signature

__________________________
name of person signing

District of Lake Country

__________________________
name of owner

__________________________
signature

__________________________
name and title of person signing

__________________________
name of owner

__________________________
signature

__________________________
name and title of person signing

__________________________
name of person signing

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signature

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name and title of person signing

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signature

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name and title of person signing

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name of person signing

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signature

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name and title of person signing

__________________________
name of person signing

__________________________
signature

__________________________
name and title of person signing

N.B. Where legal jurisdiction, local practice or Owner or Contractor requirement calls for:
(a) proof of authority to execute this document, attach such proof of authority in the form of a certified copy of a resolution naming the representative(s) authorized to sign the Agreement for and on behalf of the corporation or partnership; or
(b) the affixing of a corporate seal, this Agreement should be properly sealed.

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DEFINITIONS

The following Definitions shall apply to all Contract Documents.

1. Change Directive
   A Change Directive is a written instruction prepared by the Consultant and signed by the Owner directing the Contractor to proceed with a change in the Work within the general scope of the Contract Documents prior to the Owner and the Contractor agreeing upon adjustments in the Contract Price and the Contract Time.

2. Change Order
   A Change Order is a written amendment to the Contract prepared by the Consultant and signed by the Owner and the Contractor stating their agreement upon:
   - a change in the Work;
   - the method of adjustment or the amount of the adjustment in the Contract Price, if any; and
   - the extent of the adjustment in the Contract Time, if any.

3. Construction Equipment
   Construction Equipment means all machinery and equipment, either operated or not operated, that is required for preparing, fabricating, conveying, erecting, or otherwise performing the Work but is not incorporated into the Work.

4. Consultant
   The Consultant is the person or entity engaged by the Owner and identified as such in the Agreement. The Consultant is the Architect, the Engineer or entity licensed to practise in the province or territory of the Place of the Work. The term Consultant means the Consultant or the Consultant's authorized representative.

5. Contract
   The Contract is the undertaking by the parties to perform their respective duties, responsibilities and obligations as prescribed in the Contract Documents and represents the entire agreement between the parties.

6. Contract Documents
   The Contract Documents consist of those documents listed in Article A-3 of the Agreement - CONTRACT DOCUMENTS and amendments agreed upon between the parties.

7. Contract Price
   The Contract Price is the amount stipulated in Article A-4 of the Agreement - CONTRACT PRICE.

8. Contract Time
   The Contract Time is the time stipulated in paragraph 1.3 of Article A-1 of the Agreement - THE WORK from commencement of the Work to Substantial Performance of the Work.

9. Contractor
   The Contractor is the person or entity identified as such in the Agreement. The term Contractor means the Contractor or the Contractor's authorized representative as designated to the Owner in writing.

10. Drawings
    The Drawings are the graphic and pictorial portions of the Contract Documents, wherever located and whenever issued, showing the design, location and dimensions of the Work, generally including plans, elevations, sections, details, and diagrams.

11. Notice in Writing
    A Notice in Writing, where identified in the Contract Documents, is a written communication between the parties or between them and the Consultant that is transmitted in accordance with the provisions of Article A-6 of the Agreement – RECEIPT OF AND ADDRESSES FOR NOTICES IN WRITING.

12. Owner
    The Owner is the person or entity identified as such in the Agreement. The term Owner means the Owner or the Owner's authorized agent or representative as designated to the Contractor in writing, but does not include the Consultant.

13. Place of the Work
    The Place of the Work is the designated site or location of the Work identified in the Contract Documents.

14. Product
    Product or Products means material, machinery, equipment, and fixtures forming the Work, but does not include Construction Equipment.
15. Project
The Project means the total construction contemplated of which the Work may be the whole or a part.

16. Provide
Provide means to supply and install.

17. Shop Drawings
Shop Drawings are drawings, diagrams, illustrations, schedules, performance charts, brochures, Product data, and other data which the Contractor provides to illustrate details of portions of the Work.

18. Specifications
The Specifications are that portion of the Contract Documents, wherever located and whenever issued, consisting of the written requirements and standards for Products, systems, workmanship, quality, and the services necessary for the performance of the Work.

19. Subcontractor
A Subcontractor is a person or entity having a direct contract with the Contractor to perform a part or parts of the Work at the Place of the Work.

20. Substantial Performance of the Work
Substantial Performance of the Work is as defined in the lien legislation applicable to the Place of the Work. If such legislation is not in force or does not contain such definition, or if the Work is governed by the Civil Code of Quebec, Substantial Performance of the Work shall have been reached when the Work is ready for use or is being used for the purpose intended and is so certified by the Consultant.

21. Supplemental Instruction
A Supplemental Instruction is an instruction, not involving adjustment in the Contract Price or Contract Time, in the form of Specifications, Drawings, schedules, samples, models or written instructions, consistent with the intent of the Contract Documents. It is to be issued by the Consultant to supplement the Contract Documents as required for the performance of the Work.

22. Supplier
A Supplier is a person or entity having a direct contract with the Contractor to supply Products.

23. Temporary Work
Temporary Work means temporary supports, structures, facilities, services, and other temporary items, excluding Construction Equipment, required for the execution of the Work but not incorporated into the Work.

24. Value Added Taxes
Value Added Taxes means such sum as shall be levied upon the Contract Price by the Federal or any Provincial or Territorial Government and is computed as a percentage of the Contract Price and includes the Goods and Services Tax, the Quebec Sales Tax, the Harmonized Sales Tax, and any similar tax, the collection and payment of which have been imposed on the Contractor by the tax legislation.

25. Work
The Work means the total construction and related services required by the Contract Documents.

26. Working Day
Working Day means a day other than a Saturday, Sunday, statutory holiday, or statutory vacation day that is observed by the construction industry in the area of the Place of the Work.
GENERAL CONDITIONS OF THE STIPULATED PRICE CONTRACT

PART 1  GENERAL PROVISIONS

GC 1.1  CONTRACT DOCUMENTS

1.1.1 The intent of the Contract Documents is to include the labour, Products and services necessary for the performance of the Work by the Contractor in accordance with these documents. It is not intended, however, that the Contractor shall supply products or perform work not consistent with, not covered by, or not properly inferable from the Contract Documents.

1.1.2 Nothing contained in the Contract Documents shall create any contractual relationship between:
   .1 the Owner and a Subcontractor, a Supplier, or their agent, employee, or other person performing any portion of the Work.
   .2 the Consultant and the Contractor, a Subcontractor, a Supplier, or their agent, employee, or other person performing any portion of the Work.

1.1.3 The Contract Documents are complementary, and what is required by any one shall be as binding as if required by all.

1.1.4 Words and abbreviations which have well known technical or trade meanings are used in the Contract Documents in accordance with such recognized meanings.

1.1.5 References in the Contract Documents to the singular shall be considered to include the plural as the context requires.

1.1.6 Neither the organization of the Specifications nor the arrangement of Drawings shall control the Contractor in dividing the work among Subcontractors and Suppliers.

1.1.7 If there is a conflict within the Contract Documents:
   .1 the order of priority of documents, from highest to lowest, shall be
      – the Agreement between the Owner and the Contractor,
      – the Definitions,
      – Supplementary Conditions,
      – the General Conditions,
      – Division 1 of the Specifications,
      – technical Specifications,
      – material and finishing schedules,
      – the Drawings.
   .2 Drawings of larger scale shall govern over those of smaller scale of the same date.
   .3 dimensions shown on Drawings shall govern over dimensions scaled from Drawings.
   .4 later dated documents shall govern over earlier documents of the same type.

1.1.8 The Owner shall provide the Contractor, without charge, sufficient copies of the Contract Documents to perform the Work.

1.1.9 Specifications, Drawings, models, and copies thereof furnished by the Consultant are and shall remain the Consultant's property, with the exception of the signed Contract sets, which shall belong to each party to the Contract. All Specifications, Drawings and models furnished by the Consultant are to be used only with respect to the Work and are not to be used on other work. These Specifications, Drawings and models are not to be copied or altered in any manner without the written authorization of the Consultant.

1.1.10 Models furnished by the Contractor at the Owner's expense are the property of the Owner.

GC 1.2  LAW OF THE CONTRACT

1.2.1 The law of the Place of the Work shall govern the interpretation of the Contract.

GC 1.3  RIGHTS AND REMEDIES

1.3.1 Except as expressly provided in the Contract Documents, the duties and obligations imposed by the Contract Documents and the rights and remedies available thereunder shall be in addition to and not a limitation of any duties, obligations, rights, and remedies otherwise imposed or available by law.

1.3.2 No action or failure to act by the Owner, Consultant or Contractor shall constitute a waiver of any right or duty afforded any of them under the Contract, nor shall any such action or failure to act constitute an approval of or acquiescence in any breach thereunder, except as may be specifically agreed in writing.
GC 1.4 ASSIGNMENT

1.4.1 Neither party to the Contract shall assign the Contract or a portion thereof without the written consent of the other, which consent shall not be unreasonably withheld.

PART 2 ADMINISTRATION OF THE CONTRACT

GC 2.1 AUTHORITY OF THE CONSULTANT

2.1.1 The Consultant will have authority to act on behalf of the Owner only to the extent provided in the Contract Documents, unless otherwise modified by written agreement as provided in paragraph 2.1.2.

2.1.2 The duties, responsibilities and limitations of authority of the Consultant as set forth in the Contract Documents shall be modified or extended only with the written consent of the Owner, the Contractor and the Consultant.

2.1.3 If the Consultant’s employment is terminated, the Owner shall immediately appoint or reappoint a Consultant against whom the Contractor makes no reasonable objection and whose status under the Contract Documents shall be that of the former Consultant.

GC 2.2 ROLE OF THE CONSULTANT

2.2.1 The Consultant will provide administration of the Contract as described in the Contract Documents.

2.2.2 The Consultant will visit the Place of the Work at intervals appropriate to the progress of construction to become familiar with the progress and quality of the work and to determine if the Work is proceeding in general conformity with the Contract Documents.

2.2.3 If the Owner and the Consultant agree, the Consultant will provide at the Place of the Work, one or more project representatives to assist in carrying out the Consultant’s responsibilities. The duties, responsibilities and limitations of authority of such project representatives shall be as set forth in writing to the Contractor.

2.2.4 The Consultant will promptly inform the Owner of the date of receipt of the Contractor’s applications for payment as provided in paragraph 5.3.1.1 of GC 5.3 – PROGRESS PAYMENT.

2.2.5 Based on the Consultant's observations and evaluation of the Contractor's applications for payment, the Consultant will determine the amounts owing to the Contractor under the Contract and will issue certificates for payment as provided in Article A-5 of the Agreement - PAYMENT, GC 5.3 - PROGRESS PAYMENT and GC 5.7 - FINAL PAYMENT.

2.2.6 The Consultant will not be responsible for and will not have control, charge or supervision of construction means, methods, techniques, sequences, or procedures, or for safety precautions and programs required in connection with the Work in accordance with the applicable construction safety legislation, other regulations or general construction practice. The Consultant will not be responsible for the Contractor's failure to carry out the Work in accordance with the Contract Documents. The Consultant will not have control over, charge of or be responsible for the acts or omissions of the Contractor, Subcontractors, Suppliers, or their agents, employees, or any other persons performing portions of the Work.

2.2.7 Except with respect to GC 5.1 - FINANCING INFORMATION REQUIRED OF THE OWNER, the Consultant will be, in the first instance, the interpreter of the requirements of the Contract Documents.

2.2.8 Matters in question relating to the performance of the Work or the interpretation of the Contract Documents shall be initially referred in writing to the Consultant by the party raising the question for interpretations and findings and copied to the other party.

2.2.9 Interpretations and findings of the Consultant shall be consistent with the intent of the Contract Documents. In making such interpretations and findings the Consultant will not show partiality to either the Owner or the Contractor.

2.2.10 The Consultant’s interpretations and findings will be given in writing to the parties within a reasonable time.

2.2.11 With respect to claims for a change in Contract Price, the Consultant will make findings as set out in GC 6.6 – CLAIMS FOR A CHANGE IN CONTRACT PRICE.

2.2.12 The Consultant will have authority to reject work which in the Consultant's opinion does not conform to the requirements of the Contract Documents. Whenever the Consultant considers it necessary or advisable, the Consultant will have authority to require inspection or testing of work, whether or not such work is fabricated, installed or completed. However, neither the authority of the Consultant to act nor any decision either to exercise or not to exercise such authority shall give rise to any duty or responsibility of the Consultant to the Contractor, Subcontractors, Suppliers, or their agents, employees, or other persons performing any of the Work.
2.2.13 During the progress of the Work the Consultant will furnish Supplemental Instructions to the Contractor with reasonable promptness or in accordance with a schedule for such instructions agreed to by the Consultant and the Contractor.

2.2.14 The Consultant will review and take appropriate action upon Shop Drawings, samples and other Contractor's submittals, in accordance with the Contract Documents.

2.2.15 The Consultant will prepare Change Orders and Change Directives as provided in GC 6.2 - CHANGE ORDER and GC 6.3 - CHANGE DIRECTIVE.

2.2.16 The Consultant will conduct reviews of the Work to determine the date of Substantial Performance of the Work as provided in GC 5.4 - SUBSTANTIAL PERFORMANCE OF THE WORK.

2.2.17 All certificates issued by the Consultant will be to the best of the Consultant's knowledge, information and belief. By issuing any certificate, the Consultant does not guarantee the Work is correct or complete.

2.2.18 The Consultant will receive and review written warranties and related documents required by the Contract and provided by the Contractor and will forward such warranties and documents to the Owner for the Owner's acceptance.

**GC 2.3 REVIEW AND INSPECTION OF THE WORK**

2.3.1 The Owner and the Consultant shall have access to the Work at all times. The Contractor shall provide sufficient, safe and proper facilities at all times for the review of the Work by the Consultant and the inspection of the Work by authorized agencies. If parts of the Work are in preparation at locations other than the Place of the Work, the Owner and the Consultant shall be given access to such work whenever it is in progress.

2.3.2 If work is designated for tests, inspections or approvals in the Contract Documents, or by the Consultant's instructions, or by the laws or ordinances of the Place of the Work, the Contractor shall give the Consultant reasonable notification of when the work will be ready for review and inspection. The Contractor shall arrange for and shall give the Consultant reasonable notification of the date and time of inspections by other authorities.

2.3.3 The Contractor shall furnish promptly to the Consultant two copies of certificates and inspection reports relating to the Work.

2.3.4 If the Contractor covers, or permits to be covered, work that has been designated for special tests, inspections or approvals before such special tests, inspections or approvals are made, given or completed, the Contractor shall, if so directed, uncover such work, have the inspections or tests satisfactorily completed, and make good covering work at the Contractor's expense.

2.3.5 The Consultant may order any portion or portions of the Work to be examined to confirm that such work is in accordance with the requirements of the Contract Documents. If the work is not in accordance with the requirements of the Contract Documents, the Contractor shall correct the work and pay the cost of examination and correction. If the work is in accordance with the requirements of the Contract Documents, the Owner shall pay the cost of examination and restoration.

2.3.6 The Contractor shall pay the cost of making any test or inspection, including the cost of samples required for such test or inspection, if such test or inspection is designated in the Contract Documents to be performed by the Contractor or is designated by the laws or ordinances applicable to the Place of the Work.

2.3.7 The Contractor shall pay the cost of samples required for any test or inspection to be performed by the Consultant or the Owner if such test or inspection is designated in the Contract Documents.

**GC 2.4 DEFECTIVE WORK**

2.4.1 The Contractor shall promptly correct defective work that has been rejected by the Consultant as failing to conform to the Contract Documents whether or not the defective work has been incorporated in the Work and whether or not the defect is the result of poor workmanship, use of defective products or damage through carelessness or other act or omission of the Contractor.

2.4.2 The Contractor shall make good promptly other contractors' work destroyed or damaged by such corrections at the Contractor's expense.

2.4.3 If in the opinion of the Consultant it is not expedient to correct defective work or work not performed as provided in the Contract Documents, the Owner may deduct from the amount otherwise due to the Contractor the difference in value between the work as performed and that called for by the Contract Documents. If the Owner and the Contractor do not agree on the difference in value, they shall refer the matter to the Consultant for a determination.

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PART 3 EXECUTION OF THE WORK

GC 3.1 CONTROL OF THE WORK

3.1.1 The Contractor shall have total control of the Work and shall effectively direct and supervise the Work so as to ensure conformity with the Contract Documents.

3.1.2 The Contractor shall be solely responsible for construction means, methods, techniques, sequences, and procedures and for co-ordinating the various parts of the Work under the Contract.

GC 3.2 CONSTRUCTION BY OWNER OR OTHER CONTRACTORS

3.2.1 The Owner reserves the right to award separate contracts in connection with other parts of the Project to other contractors and to perform work with own forces.

3.2.2 When separate contracts are awarded for other parts of the Project, or when work is performed by the Owner's own forces, the Owner shall:
   .1 provide for the co-ordination of the activities and work of other contractors and Owner's own forces with the Work of the Contract;
   .2 assume overall responsibility for compliance with the applicable health and construction safety legislation at the Place of the Work;
   .3 enter into separate contracts with other contractors under conditions of contract which are compatible with the conditions of the Contract;
   .4 ensure that insurance coverage is provided to the same requirements as are called for in GC 11.1 - INSURANCE and co-ordinate such insurance with the insurance coverage of the Contractor as it affects the Work; and
   .5 take all reasonable precautions to avoid labour disputes or other disputes on the Project arising from the work of other contractors or the Owner's own forces.

3.2.3 When separate contracts are awarded for other parts of the Project, or when work is performed by the Owner's own forces, the Contractor shall:
   .1 afford the Owner and other contractors reasonable opportunity to store their products and execute their work;
   .2 cooperate with other contractors and the Owner in reviewing their construction schedules; and
   .3 promptly report to the Consultant in writing any apparent deficiencies in the work of other contractors or of the Owner's own forces, where such work affects the proper execution of any portion of the Work, prior to proceeding with that portion of the Work.

3.2.4 Where the Contract Documents identify work to be performed by other contractors or the Owner's own forces, the Contractor shall co-ordinate and schedule the Work with the work of other contractors and the Owner's own forces as specified in the Contract Documents.

3.2.5 Where a change in the Work is required as a result of the co-ordination and integration of the work of other contractors or Owner's own forces with the Work, the changes shall be authorized and valued as provided in GC 6.1 – OWNER'S RIGHT TO MAKE CHANGES, GC 6.2 - CHANGE ORDER and GC 6.3 - CHANGE DIRECTIVE.

3.2.6 Disputes and other matters in question between the Contractor and other contractors shall be dealt with as provided in Part 8 of the General Conditions - DISPUTE RESOLUTION provided the other contractors have reciprocal obligations. The Contractor shall be deemed to have consented to arbitration of any dispute with any other contractor whose contract with the Owner contains a similar agreement to arbitrate.

GC 3.3 TEMPORARY WORK

3.3.1 The Contractor shall have the sole responsibility for the design, erection, operation, maintenance, and removal of Temporary Work.

3.3.2 The Contractor shall engage and pay for registered professional engineering personnel skilled in the appropriate disciplines to perform those functions referred to in paragraph 3.3.1 where required by law or by the Contract Documents and in all cases where such Temporary Work is of such a nature that professional engineering skill is required to produce safe and satisfactory results.
3.3.3 Notwithstanding the provisions of GC 3.1 - CONTROL OF THE WORK, paragraphs 3.3.1 and 3.3.2 or provisions to the contrary elsewhere in the Contract Documents where such Contract Documents include designs for Temporary Work or specify a method of construction in whole or in part, such designs or methods of construction shall be considered to be part of the design of the Work and the Contractor shall not be held responsible for that part of the design or the specified method of construction. The Contractor shall, however, be responsible for the execution of such design or specified method of construction in the same manner as for the execution of the Work.

GC 3.4 DOCUMENT REVIEW

3.4.1 The Contractor shall review the Contract Documents and shall report promptly to the Consultant any error, inconsistency or omission the Contractor may discover. Such review by the Contractor shall be to the best of the Contractor’s knowledge, information and belief and in making such review the Contractor does not assume any responsibility to the Owner or the Consultant for the accuracy of the review. The Contractor shall not be liable for damage or costs resulting from such errors, inconsistencies or omissions in the Contract Documents, which the Contractor did not discover. If the Contractor does discover any error, inconsistency or omission in the Contract Documents, the Contractor shall not proceed with the work affected until the Contractor has received corrected or missing information from the Consultant.

GC 3.5 CONSTRUCTION SCHEDULE

3.5.1 The Contractor shall:
.1 prepare and submit to the Owner and the Consultant prior to the first application for payment, a construction schedule that indicates the timing of the major activities of the Work and provides sufficient detail of the critical events and their inter-relationship to demonstrate the Work will be performed in conformity with the Contract Time;
.2 monitor the progress of the Work relative to the construction schedule and update the schedule on a monthly basis or as stipulated by the Contract Documents; and
.3 advise the Consultant of any revisions required to the schedule as the result of extensions of the Contract Time as provided in Part 6 of the General Conditions - CHANGES IN THE WORK.

GC 3.6 SUPERVISION

3.6.1 The Contractor shall provide all necessary supervision and appoint a competent representative who shall be in attendance at the Place of the Work while work is being performed. The appointed representative shall not be changed except for valid reason.

3.6.2 The appointed representative shall represent the Contractor at the Place of the Work. Information and instructions provided by the Consultant to the Contractor’s appointed representative shall be deemed to have been received by the Contractor, except with respect to Article A-6 of the Agreement – RECEIPT OF AND ADDRESSES FOR NOTICES IN WRITING.

GC 3.7 SUBCONTRACTORS AND SUPPLIERS

3.7.1 The Contractor shall preserve and protect the rights of the parties under the Contract with respect to work to be performed under subcontract, and shall:
.1 enter into contracts or written agreements with Subcontractors and Suppliers to require them to perform their work as provided in the Contract Documents;
.2 incorporate the terms and conditions of the Contract Documents into all contracts or written agreements with Subcontractors and Suppliers; and
.3 be as fully responsible to the Owner for acts and omissions of Subcontractors, Suppliers and of persons directly or indirectly employed by them as for acts and omissions of persons directly employed by the Contractor.

3.7.2 The Contractor shall indicate in writing, if requested by the Owner, those Subcontractors or Suppliers whose bids have been received by the Contractor which the Contractor would be prepared to accept for the performance of a portion of the Work. Should the Owner not object before signing the Contract, the Contractor shall employ those Subcontractors or Suppliers so identified by the Contractor in writing for the performance of that portion of the Work to which their bid applies.

3.7.3 The Owner may, for reasonable cause, at any time before the Owner has signed the Contract, object to the use of a proposed Subcontractor or Supplier and require the Contractor to employ one of the other subcontract bidders.

3.7.4 If the Owner requires the Contractor to change a proposed Subcontractor or Supplier, the Contract Price and Contract Time shall be adjusted by the differences occasioned by such required change.
3.7.5 The Contractor shall not be required to employ as a Subcontractor or Supplier, a person or firm to which the Contractor may reasonably object.

3.7.6 The Owner, through the Consultant, may provide to a Subcontractor or Supplier information as to the percentage of the Subcontractor's or Supplier's work which has been certified for payment.

GC 3.8 LABOUR AND PRODUCTS

3.8.1 The Contractor shall provide and pay for labour, Products, tools, Construction Equipment, water, heat, light, power, transportation, and other facilities and services necessary for the performance of the Work in accordance with the Contract.

3.8.2 Unless otherwise specified in the Contract Documents, Products provided shall be new. Products which are not specified shall be of a quality consistent with those specified and their use acceptable to the Consultant.

3.8.3 The Contractor shall maintain good order and discipline among the Contractor's employees engaged on the Work and shall not employ on the Work anyone not skilled in the tasks assigned.

GC 3.9 DOCUMENTS AT THE SITE

3.9.1 The Contractor shall keep one copy of current Contract Documents, submittals, reports, and records of meetings at the Place of the Work, in good order and available to the Owner and the Consultant.

GC 3.10 SHOP DRAWINGS

3.10.1 The Contractor shall provide Shop Drawings as required in the Contract Documents.

3.10.2 The Contractor shall provide Shop Drawings to the Consultant to review in orderly sequence and sufficiently in advance so as to cause no delay in the Work or in the work of other contractors.

3.10.3 Upon request of the Contractor or the Consultant, they shall jointly prepare a schedule of the dates for provision, review and return of Shop Drawings.

3.10.4 The Contractor shall provide Shop Drawings in the form specified, or if not specified, as directed by the Consultant.

3.10.5 Shop Drawings provided by the Contractor to the Consultant shall indicate by stamp, date and signature of the person responsible for the review that the Contractor has reviewed each one of them.

3.10.6 The Consultant's review is for conformity to the design concept and for general arrangement only.

3.10.7 Shop Drawings which require approval of any legally constituted authority having jurisdiction shall be provided to such authority by the Contractor for approval.

3.10.8 The Contractor shall review all Shop Drawings before providing them to the Consultant. The Contractor represents by this review that:

.1 the Contractor has determined and verified all applicable field measurements, field construction conditions, Product requirements, catalogue numbers and similar data, or will do so, and

.2 the Contractor has checked and co-ordinated each Shop Drawing with the requirements of the Work and of the Contract Documents.

3.10.9 At the time of providing Shop Drawings, the Contractor shall expressly advise the Consultant in writing of any deviations in a Shop Drawing from the requirements of the Contract Documents. The Consultant shall indicate the acceptance or rejection of such deviation expressly in writing.

3.10.10 The Consultant's review shall not relieve the Contractor of responsibility for errors or omissions in the Shop Drawings or for meeting all requirements of the Contract Documents.

3.10.11 The Contractor shall provide revised Shop Drawings to correct those which the Consultant rejects as inconsistent with the Contract Documents, unless otherwise directed by the Consultant. The Contractor shall notify the Consultant in writing of any revisions to the Shop Drawings other than those requested by the Consultant.

3.10.12 The Consultant will review and return Shop Drawings in accordance with the schedule agreed upon, or, in the absence of such schedule, with reasonable promptness so as to cause no delay in the performance of the Work.

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GC 3.11 USE OF THE WORK

3.11.1 The Contractor shall confine Construction Equipment, Temporary Work, storage of Products, waste products and debris, and operations of employees and Subcontractors to limits indicated by laws, ordinances, permits, or the Contract Documents and shall not unreasonably encumber the Place of the Work.

3.11.2 The Contractor shall not load or permit to be loaded any part of the Work with a weight or force that will endanger the safety of the Work.

GC 3.12 CUTTING AND REMEDIAL WORK

3.12.1 The Contractor shall perform the cutting and remedial work required to make the affected parts of the Work come together properly.

3.12.2 The Contractor shall co-ordinate the Work to ensure that the cutting and remedial work is kept to a minimum.

3.12.3 Should the Owner, the Consultant, other contractors or anyone employed by them be responsible for ill-timed work necessitating cutting or remedial work to be performed, the cost of such cutting or remedial work shall be valued as provided in GC 6.1 – OWNER’S RIGHT TO MAKE CHANGES, GC 6.2 - CHANGE ORDER and GC 6.3 - CHANGE DIRECTIVE.

3.12.4 Cutting and remedial work shall be performed by specialists familiar with the Products affected and shall be performed in a manner to neither damage nor endanger the Work.

GC 3.13 CLEANUP

3.13.1 The Contractor shall maintain the Work in a safe and tidy condition and free from the accumulation of waste products and debris, other than that caused by the Owner, other contractors or their employees.

3.13.2 Before applying for Substantial Performance of the Work as provided in GC 5.4 – SUBSTANTIAL PERFORMANCE OF THE WORK, the Contractor shall remove waste products and debris, other than that resulting from the work of the Owner, other contractors or their employees, and shall leave the Place of the Work clean and suitable for use or occupancy by the Owner. The Contractor shall remove products, tools, Construction Equipment, and Temporary Work not required for the performance of the remaining work.

3.13.3 Prior to application for the final payment, the Contractor shall remove any remaining products, tools, Construction Equipment, Temporary Work, and waste products and debris, other than those resulting from the work of the Owner, other contractors or their employees.

PART 4 ALLOWANCES

GC 4.1 CASH ALLOWANCES

4.1.1 The Contract Price includes the cash allowances, if any, stated in the Contract Documents. The scope of work or costs included in such cash allowances shall be as described in the Contract Documents.

4.1.2 The Contract Price, and not the cash allowances, includes the Contractor’s overhead and profit in connection with such cash allowances.

4.1.3 Expenditures under cash allowances shall be authorized by the Owner through the Consultant.

4.1.4 Where the actual cost of the Work under any cash allowance exceeds the amount of the allowance, the Contractor shall be compensated for the excess incurred and substantiated plus an amount for overhead and profit on the excess as set out in the Contract Documents. Where the actual cost of the Work under any cash allowance is less than the amount of the allowance, the Owner shall be credited for the unexpended portion of the cash allowance, but not for the Contractor’s overhead and profit on such amount. Multiple cash allowances shall not be combined for the purpose of calculating the foregoing.

4.1.5 The Contract Price shall be adjusted by Change Order to provide for any difference between the amount of each cash allowance and the actual cost of the work under that cash allowance.

4.1.6 The value of the work performed under a cash allowance is eligible to be included in progress payments.

4.1.7 The Contractor and the Consultant shall jointly prepare a schedule that shows when the Consultant and Owner must authorize ordering of items called for under cash allowances to avoid delaying the progress of the Work.
GC 4.2 CONTINGENCY ALLOWANCE

4.2.1 The Contract Price includes the contingency allowance, if any, stated in the Contract Documents.

4.2.2 The contingency allowance includes the Contractor's overhead and profit in connection with such contingency allowance.

4.2.3 Expenditures under the contingency allowance shall be authorized and valued as provided in GC 6.1 – OWNER’S RIGHT TO MAKE CHANGES, GC 6.2 - CHANGE ORDER and GC 6.3 - CHANGE DIRECTIVE.

4.2.4 The Contract Price shall be adjusted by Change Order to provide for any difference between the expenditures authorized under paragraph 4.2.3 and the contingency allowance.

PART 5 PAYMENT

GC 5.1 FINANCING INFORMATION REQUIRED OF THE OWNER

5.1.1 The Owner shall, at the request of the Contractor, before signing the Contract, and promptly from time to time thereafter, furnish to the Contractor reasonable evidence that financial arrangements have been made to fulfill the Owner's obligations under the Contract.

5.1.2 The Owner shall give the Contractor Notice in Writing of any material change in the Owner's financial arrangements to fulfill the Owner's obligations under the Contract during the performance of the Contract.

GC 5.2 APPLICATIONS FOR PROGRESS PAYMENT

5.2.1 Applications for payment on account as provided in Article A-5 of the Agreement - PAYMENT may be made monthly as the Work progresses.

5.2.2 Applications for payment shall be dated the last day of each payment period, which is the last day of the month or an alternative day of the month agreed in writing by the parties.

5.2.3 The amount claimed shall be for the value, proportionate to the amount of the Contract, of Work performed and Products delivered to the Place of the Work as of the last day of the payment period.

5.2.4 The Contractor shall submit to the Consultant, at least 15 calendar days before the first application for payment, a schedule of values for the parts of the Work, aggregating the total amount of the Contract Price, so as to facilitate evaluation of applications for payment.

5.2.5 The schedule of values shall be made out in such form and supported by such evidence as the Consultant may reasonably direct and when accepted by the Consultant, shall be used as the basis for applications for payment, unless it is found to be in error.

5.2.6 The Contractor shall include a statement based on the schedule of values with each application for payment.

5.2.7 Applications for payment for Products delivered to the Place of the Work but not yet incorporated into the Work shall be supported by such evidence as the Consultant may reasonably require to establish the value and delivery of the Products.

GC 5.3 PROGRESS PAYMENT

5.3.1 After receipt by the Consultant of an application for payment submitted by the Contractor in accordance with GC 5.2 - APPLICATIONS FOR PROGRESS PAYMENT:

1. the Consultant will promptly inform the Owner of the date of receipt of the Contractor’s application for payment,
2. the Consultant will issue to the Owner and copy to the Contractor, no later than 10 calendar days after the receipt of the application for payment, a certificate for payment in the amount applied for, or in such other amount as the Consultant determines to be properly due. If the Consultant amends the application, the Consultant will promptly advise the Contractor in writing giving reasons for the amendment,
3. the Owner shall make payment to the Contractor on account as provided in Article A-5 of the Agreement - PAYMENT on or before 20 calendar days after the later of:
   - receipt by the Consultant of the application for payment, or
   - the last day of the monthly payment period for which the application for payment is made.
GC 5.4  SUBSTANTIAL PERFORMANCE OF THE WORK

5.4.1 When the Contractor considers that the Work is substantially performed, or if permitted by the lien legislation applicable to the Place of the Work a designated portion thereof which the Owner agrees to accept separately is substantially performed, the Contractor shall, within one Working Day, deliver to the Consultant and to the Owner a comprehensive list of items to be completed or corrected, together with a written application for a review by the Consultant to establish Substantial Performance of the Work or substantial performance of the designated portion of the Work. Failure to include an item on the list does not alter the responsibility of the Contractor to complete the Contract.

5.4.2 The Consultant will review the Work to verify the validity of the application and shall promptly, and in any event, no later than 20 calendar days after receipt of the Contractor's list and application:

.1 advise the Contractor in writing that the Work or the designated portion of the Work is not substantially performed and give reasons why, or

.2 state the date of Substantial Performance of the Work or a designated portion of the Work in a certificate and issue a copy of that certificate to each of the Owner and the Contractor.

5.4.3 Immediately following the issuance of the certificate of Substantial Performance of the Work, the Contractor, in consultation with the Consultant, shall establish a reasonable date for finishing the Work.

GC 5.5  PAYMENT OF HOLDBACK UPON SUBSTANTIAL PERFORMANCE OF THE WORK

5.5.1 After the issuance of the certificate of Substantial Performance of the Work, the Contractor shall:

.1 submit an application for payment of the holdback amount,

.2 submit CCDC 9A ‘Statutory Declaration’ to state that all accounts for labour, subcontracts, Products, Construction Equipment, and other indebtedness which may have been incurred by the Contractor in the Substantial Performance of the Work and for which the Owner might in any way be held responsible have been paid in full, except for amounts properly retained as a holdback or as an identified amount in dispute.

5.5.2 After the receipt of an application for payment from the Contractor and the statement as provided in paragraph 5.5.1, the Consultant will issue a certificate for payment of the holdback amount.

5.5.3 Where the holdback amount required by the applicable lien legislation has not been placed in a separate holdback account, the Owner shall, 10 calendar days prior to the expiry of the holdback period stipulated in the lien legislation applicable to the Place of the Work, place the holdback amount in a bank account in the joint names of the Owner and the Contractor.

5.5.4 In the common law jurisdictions, the holdback amount authorized by the certificate for payment of the holdback amount is due and payable on the first calendar day following the expiration of the holdback period stipulated in the lien legislation applicable to the Place of the Work. Where lien legislation does not exist or apply, the holdback amount shall be due and payable in accordance with other legislation, industry practice or provisions which may be agreed to between the parties. The Owner may retain out of the holdback amount any sums required by law to satisfy any liens against the Work or, if permitted by the lien legislation applicable to the Place of the Work, other third party monetary claims against the Contractor which are enforceable against the Owner.

5.5.5 In the Province of Quebec, the holdback amount authorized by the certificate for payment of the holdback amount is due and payable 30 calendar days after the issuance of the certificate. The Owner may retain out of the holdback amount any sums required to satisfy any legal hypothecs that have been taken, or could be taken, against the Work or other third party monetary claims against the Contractor which are enforceable against the Owner.

GC 5.6  PROGRESSIVE RELEASE OF HOLDBACK

5.6.1 In the common law jurisdictions, where legislation permits and where, upon application by the Contractor, the Consultant has certified that the work of a Subcontractor or Supplier has been performed prior to Substantial Performance of the Work, the Owner shall pay the Contractor the holdback amount retained for such subcontract work, or the Products supplied by such Supplier, on the first calendar day following the expiration of the holdback period for such work stipulated in the lien legislation applicable to the Place of the Work. The Owner may retain out of the holdback amount any sums required by law to satisfy any liens against the Work or, if permitted by the lien legislation applicable to the Place of the Work, other third party monetary claims against the Contractor which are enforceable against the Owner.
5.6.3 Notwithstanding the provisions of the preceding paragraphs, and notwithstanding the wording of such certificates, the Contractor shall ensure that such subcontract work or Products are protected pending the issuance of a final certificate for payment and be responsible for the correction of defects or work not performed regardless of whether or not such was apparent when such certificates were issued.

GC 5.7 FINAL PAYMENT

5.7.1 When the Contractor considers that the Work is completed, the Contractor shall submit an application for final payment.

5.7.2 The Consultant will, no later than 10 calendar days after the receipt of an application from the Contractor for final payment, review the Work to verify the validity of the application and advise the Contractor in writing that the application is valid or give reasons why it is not valid.

5.7.3 When the Consultant finds the Contractor's application for final payment valid, the Consultant will promptly issue a final certificate for payment.

5.7.4 Subject to the provision of paragraph 10.4.1 of GC 10.4 - WORKERS' COMPENSATION, and any lien legislation applicable to the Place of the Work, the Owner shall, no later than 5 calendar days after the issuance of a final certificate for payment, pay the Contractor as provided in Article A-5 of the Agreement - PAYMENT.

GC 5.8 WITHHOLDING OF PAYMENT

5.8.1 If because of climatic or other conditions reasonably beyond the control of the Contractor, there are items of work that cannot be performed, payment in full for that portion of the Work which has been performed as certified by the Consultant shall not be withheld or delayed by the Owner on account thereof, but the Owner may withhold, until the remaining portion of the Work is finished, only such an amount that the Consultant determines is sufficient and reasonable to cover the cost of performing such remaining work.

GC 5.9 NON-CONFORMING WORK

5.9.1 No payment by the Owner under the Contract nor partial or entire use or occupancy of the Work by the Owner shall constitute an acceptance of any portion of the Work or Products which are not in accordance with the requirements of the Contract Documents.

PART 6 CHANGES IN THE WORK

GC 6.1 OWNER'S RIGHT TO MAKE CHANGES

6.1.1 The Owner, through the Consultant, without invalidating the Contract, may make:
   .1 changes in the Work consisting of additions, deletions or other revisions to the Work by Change Order or Change Directive, and
   .2 changes to the Contract Time for the Work, or any part thereof, by Change Order.

6.1.2 The Contractor shall not perform a change in the Work without a Change Order or a Change Directive.

GC 6.2 CHANGE ORDER

6.2.1 When a change in the Work is proposed or required, the Consultant will provide the Contractor with a written description of the proposed change in the Work. The Contractor shall promptly present, in a form acceptable to the Consultant, a method of adjustment or an amount of adjustment for the Contract Price, if any, and the adjustment in the Contract Time, if any, for the proposed change in the Work.

6.2.2 When the Owner and Contractor agree to the adjustments in the Contract Price and Contract Time or to the method to be used to determine the adjustments, such agreement shall be effective immediately and shall be recorded in a Change Order. The value of the work performed as the result of a Change Order shall be included in the application for progress payment.

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GC 6.3 CHANGE DIRECTIVE

6.3.1 If the Owner requires the Contractor to proceed with a change in the Work prior to the Owner and the Contractor agreeing upon the corresponding adjustment in Contract Price and Contract Time, the Owner, through the Consultant, shall issue a Change Directive.

6.3.2 A Change Directive shall only be used to direct a change in the Work which is within the general scope of the Contract Documents.

6.3.3 A Change Directive shall not be used to direct a change in the Contract Time only.

6.3.4 Upon receipt of a Change Directive, the Contractor shall proceed promptly with the change in the Work.

6.3.5 For the purpose of valuing Change Directives, changes in the Work that are not substitutions or otherwise related to each other shall not be grouped together in the same Change Directive.

6.3.6 The adjustment in the Contract Price for a change carried out by way of a Change Directive shall be determined on the basis of the cost of the Contractor’s actual expenditures and savings attributable to the Change Directive, valued in accordance with paragraph 6.3.7 and as follows:

1. If the change results in a net increase in the Contractor’s cost, the Contract Price shall be increased by the amount of the net increase in the Contractor’s cost, plus the Contractor’s percentage fee on such net increase.
2. If the change results in a net decrease in the Contractor’s cost, the Contract Price shall be decreased by the amount of the net decrease in the Contractor’s cost, without adjustment for the Contractor’s percentage fee.
3. The Contractor’s fee shall be as specified in the Contract Documents or as otherwise agreed by the parties.

6.3.7 The cost of performing the work attributable to the Change Directive shall be limited to the actual cost of the following:

1. salaries, wages and benefits paid to personnel in the direct employ of the Contractor under a salary or wage schedule agreed upon by the Owner and the Contractor, or in the absence of such a schedule, actual salaries, wages and benefits paid under applicable bargaining agreement, and in the absence of a salary or wage schedule and bargaining agreement, actual salaries, wages and benefits paid by the Contractor, for personnel
   (1) stationed at the Contractor’s field office, in whatever capacity employed;
   (2) engaged in expediting the production or transportation of material or equipment, at shops or on the road;
   (3) engaged in the preparation or review of Shop Drawings, fabrication drawings, and coordination drawings; or
   (4) engaged in the processing of changes in the Work.
2. contributions, assessments or taxes incurred for such items as employment insurance, provincial or territorial health insurance, workers’ compensation, and Canada or Quebec Pension Plan, insofar as such cost is based on wages, salaries or other remuneration paid to employees of the Contractor and included in the cost of the Work as provided in paragraph 6.3.7.1;
3. travel and subsistence expenses of the Contractor’s personnel described in paragraph 6.3.7.1;
4. all Products including cost of transportation thereof;
5. materials, supplies, Construction Equipment, Temporary Work, and hand tools not owned by the workers, including transportation and maintenance thereof, which are consumed in the performance of the Work; and cost less salvage value on such items used but not consumed, which remain the property of the Contractor;
6. all tools and Construction Equipment, exclusive of hand tools used in the performance of the Work, whether rented from or provided by the Contractor or others, including installation, minor repairs and replacements, dismantling, removal, transportation, and delivery cost thereof;
7. all equipment and services required for the Contractor’s field office;
8. deposits lost;
9. the amounts of all subcontracts;
10. quality assurance such as independent inspection and testing services;
11. charges levied by authorities having jurisdiction at the Place of the Work;
12. royalties, patent licence fees and damages for infringement of patents and cost of defending suits therefor subject always to the Contractor’s obligations to indemnify the Owner as provided in paragraph 10.3.1 of GC 10.3 - PATENT FEES;
13. any adjustment in premiums for all bonds and insurance which the Contractor is required, by the Contract Documents, to purchase and maintain;
14. any adjustment in taxes, other than Value Added Taxes, and duties for which the Contractor is liable;
15. charges for long distance telephone and facsimile communications, courier services, expressage, and petty cash items incurred in relation to the performance of the Work;
16. removal and disposal of waste products and debris; and
17. safety measures and requirements.

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6.3.8 Notwithstanding any other provisions contained in the General Conditions of the Contract, it is the intention of the parties that the cost of any item under any cost element referred to in paragraph 6.3.7 shall cover and include any and all costs or liabilities attributable to the Change Directive other than those which are the result of or occasioned by any failure on the part of the Contractor to exercise reasonable care and diligence in the Contractor’s attention to the Work. Any cost due to failure on the part of the Contractor to exercise reasonable care and diligence in the Contractor’s attention to the Work shall be borne by the Contractor.

6.3.9 The Contractor shall keep full and detailed accounts and records necessary for the documentation of the cost of performing the Work attributable to the Change Directive and shall provide the Consultant with copies thereof when requested.

6.3.10 For the purpose of valuing Change Directives, the Owner shall be afforded reasonable access to all of the Contractor’s pertinent documents related to the cost of performing the Work attributable to the Change Directive.

6.3.11 Pending determination of the final amount of a Change Directive, the undisputed value of the Work performed as the result of a Change Directive is eligible to be included in progress payments.

6.3.12 If the Owner and the Contractor do not agree on the proposed adjustment in the Contract Time attributable to the change in the Work, or the method of determining it, the adjustment shall be referred to the Consultant for determination.

6.3.13 When the Owner and the Contractor reach agreement on the adjustment to the Contract Price and to the Contract Time, this agreement shall be recorded in a Change Order.

GC 6.4 CONCEALED OR UNKNOWN CONDITIONS

6.4.1 If the Owner or the Contractor discover conditions at the Place of the Work which are:

.1 subsurface or otherwise concealed physical conditions which existed before the commencement of the Work which differ materially from those indicated in the Contract Documents; or

.2 physical conditions, other than conditions due to weather, that are of a nature which differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents,

then the observing party shall give Notice in Writing to the other party of such conditions before they are disturbed and in no event later than 5 Working Days after first observance of the conditions.

6.4.2 The Consultant will promptly investigate such conditions and make a finding. If the finding is that the conditions differ materially and this would cause an increase or decrease in the Contractor's cost or time to perform the Work, the Consultant, with the Owner's approval, will issue appropriate instructions for a change in the Work as provided in GC 6.2 - CHANGE ORDER or GC 6.3 - CHANGE DIRECTIVE.

6.4.3 If the Consultant finds that the conditions at the Place of the Work are not materially different or that no change in the Contract Price or the Contract Time is justified, the Consultant will report the reasons for this finding to the Owner and the Contractor in writing.

6.4.4 If such concealed or unknown conditions relate to toxic and hazardous substances and materials, artifacts and fossils, or mould, the parties will be governed by the provisions of GC 9.2 - TOXIC AND HAZARDOUS SUBSTANCES, GC 9.3 - ARTIFACTS AND FOSSILS and GC 9.5 – MOULD.

GC 6.5 DELAYS

6.5.1 If the Contractor is delayed in the performance of the Work by an action or omission of the Owner, Consultant or anyone employed or engaged by them directly or indirectly, contrary to the provisions of the Contract Documents, then the Contract Time shall be extended for such reasonable time as the Consultant may recommend in consultation with the Contractor. The Contractor shall be reimbursed by the Owner for reasonable costs incurred by the Contractor as the result of such delay.

6.5.2 If the Contractor is delayed in the performance of the Work by a stop work order issued by a court or other public authority and providing that such order was not issued as the result of an act or fault of the Contractor or any person employed or engaged by the Contractor directly or indirectly, then the Contract Time shall be extended for such reasonable time as the Consultant may recommend in consultation with the Contractor. The Contractor shall be reimbursed by the Owner for reasonable costs incurred by the Contractor as the result of such delay.
6.5.3 If the Contractor is delayed in the performance of the Work by:
   .1 labour disputes, strikes, lock-outs (including lock-outs decreed or recommended for its members by a recognized contractors' association, of which the Contractor is a member or to which the Contractor is otherwise bound),
   .2 fire, unusual delay by common carriers or unavoidable casualties,
   .3 abnormally adverse weather conditions, or
   .4 any cause beyond the Contractor's control other than one resulting from a default or breach of Contract by the Contractor,

then the Contract Time shall be extended for such reasonable time as the Consultant may recommend in consultation with the Contractor. The extension of time shall not be less than the time lost as the result of the event causing the delay, unless the Contractor agrees to a shorter extension. The Contractor shall not be entitled to payment for costs incurred by such delays unless such delays result from actions by the Owner, Consultant or anyone employed or engaged by them directly or indirectly.

6.5.4 No extension shall be made for delay unless Notice in Writing of the cause of delay is given to the Consultant not later than 10 Working Days after the commencement of the delay. In the case of a continuing cause of delay only one Notice in Writing shall be necessary.

6.5.5 If no schedule is made under paragraph 2.2.13 of GC 2.2 - ROLE OF THE CONSULTANT, then no request for extension shall be made because of failure of the Consultant to furnish instructions until 10 Working Days after demand for such instructions has been made.

GC 6.6 CLAIMS FOR A CHANGE IN CONTRACT PRICE

6.6.1 If the Contractor intends to make a claim for an increase to the Contract Price, or if the Owner intends to make a claim against the Contractor for a credit to the Contract Price, the party that intends to make the claim shall give timely Notice in Writing of intent to claim to the other party and to the Consultant.

6.6.2 Upon commencement of the event or series of events giving rise to a claim, the party intending to make the claim shall:
   .1 take all reasonable measures to mitigate any loss or expense which may be incurred as a result of such event or series of events, and
   .2 keep such records as may be necessary to support the claim.

6.6.3 The party making the claim shall submit within a reasonable time to the Consultant a detailed account of the amount claimed and the grounds upon which the claim is based.

6.6.4 Where the event or series of events giving rise to the claim has a continuing effect, the detailed account submitted under paragraph 6.6.3 shall be considered to be an interim account and the party making the claim shall, at such intervals as the Consultant may reasonably require, submit further interim accounts giving the accumulated amount of the claim and any further grounds upon which it is based. The party making the claim shall submit a final account after the end of the effects resulting from the event or series of events.

6.6.5 The Consultant’s findings, with respect to a claim made by either party, will be given by Notice in Writing to both parties within 30 Working Days after receipt of the claim by the Consultant, or within such other time period as may be agreed by the parties.

6.6.6 If such finding is not acceptable to either party, the claim shall be settled in accordance with Part 8 of the General Conditions - DISPUTE RESOLUTION.

PART 7 DEFAULT NOTICE

GC 7.1 OWNER'S RIGHT TO PERFORM THE WORK, TERMINATE THE CONTRACTOR'S RIGHT TO CONTINUE WITH THE WORK OR TERMINATE THE CONTRACT

7.1.1 If the Contractor is adjudged bankrupt, or makes a general assignment for the benefit of creditors because of the Contractor's insolvency, or if a receiver is appointed because of the Contractor's insolvency, the Owner may, without prejudice to any other right or remedy the Owner may have, terminate the Contractor's right to continue with the Work, by giving the Contractor or receiver or trustee in bankruptcy Notice in Writing to that effect.

7.1.2 If the Contractor neglects to prosecute the Work properly or otherwise fails to comply with the requirements of the Contract to a substantial degree and if the Consultant has given a written statement to the Owner and Contractor that sufficient cause exists to justify such action, the Owner may, without prejudice to any other right or remedy the Owner may have, give the Contractor Notice in Writing that the Contractor is in default of the Contractor's contractual obligations and instruct the Contractor to correct the default in the 5 Working Days immediately following the receipt of such Notice in Writing.

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7.1.3 If the default cannot be corrected in the 5 Working Days specified or in such other time period as may be subsequently agreed in writing by the parties, the Contractor shall be in compliance with the Owner's instructions if the Contractor:
   .1 commences the correction of the default within the specified time, and
   .2 provides the Owner with an acceptable schedule for such correction, and
   .3 corrects the default in accordance with the Contract terms and with such schedule.

7.1.4 If the Contractor fails to correct the default in the time specified or in such other time period as may be subsequently agreed in writing by the parties, without prejudice to any other right or remedy the Owner may have, the Owner may:
   .1 correct such default and deduct the cost thereof from any payment then or thereafter due the Contractor provided the Consultant has certified such cost to the Owner and the Contractor, or
   .2 terminate the Contractor's right to continue with the Work in whole or in part or terminate the Contract.

7.1.5 If the Owner terminates the Contractor's right to continue with the Work as provided in paragraphs 7.1.1 and 7.1.4, the Owner shall be entitled to:
   .1 take possession of the Work and Products at the Place of the Work; subject to the rights of third parties, utilize the Construction Equipment at the Place of the Work; finish the Work by whatever method the Owner may consider expedient, but without undue delay or expense, and
   .2 withhold further payment to the Contractor until a final certificate for payment is issued, and
   .3 charge the Contractor the amount by which the full cost of finishing the Work as certified by the Consultant, including compensation to the Consultant for the Consultant's additional services and a reasonable allowance as determined by the Consultant to cover the cost of corrections to work performed by the Contractor that may be required under GC 12.3 - WARRANTY, exceeds the unpaid balance of the Contract Price; however, if such cost of finishing the Work is less than the unpaid balance of the Contract Price, the Owner shall pay the Contractor the difference, and
   .4 on expiry of the warranty period, charge the Contractor the amount by which the cost of corrections to the Contractor's work under GC 12.3 - WARRANTY exceeds the allowance provided for such corrections, or if the cost of such corrections is less than the allowance, pay the Contractor the difference.

7.1.6 The Contractor's obligation under the Contract as to quality, correction and warranty of the work performed by the Contractor up to the time of termination shall continue after such termination of the Contract.

GC 7.2 CONTRACTOR'S RIGHT TO SUSPEND THE WORK OR TERMINATE THE CONTRACT

7.2.1 If the Owner is adjudged bankrupt, or makes a general assignment for the benefit of creditors because of the Owner's insolvency, or if a receiver is appointed because of the Owner's insolvency, the Contractor may, without prejudice to any other right or remedy the Contractor may have, terminate the Contract by giving the Owner or receiver or trustee in bankruptcy Notice in Writing to that effect.

7.2.2 If the Work is suspended or otherwise delayed for a period of 20 Working Days or more under an order of a court or other public authority and providing that such order was not issued as the result of an act or fault of the Contractor or of anyone directly or indirectly employed or engaged by the Contractor, the Contractor may, without prejudice to any other right or remedy the Contractor may have, terminate the Contract by giving the Owner Notice in Writing to that effect.

7.2.3 The Contractor may give Notice in Writing to the Owner, with a copy to the Consultant, that the Owner is in default of the Owner's contractual obligations if:
   .1 the Owner fails to furnish, when so requested by the Contractor, reasonable evidence that financial arrangements have been made to fulfill the Owner's obligations under the Contract, or
   .2 the Consultant fails to issue a certificate as provided in GC 5.3 - PROGRESS PAYMENT, or
   .3 the Owner fails to pay the Contractor when due the amounts certified by the Consultant or awarded by arbitration or court, or
   .4 the Owner violates the requirements of the Contract to a substantial degree and the Consultant, except for GC 5.1 - FINANCING INFORMATION REQUIRED OF THE OWNER, confirms by written statement to the Contractor that sufficient cause exists.

7.2.4 The Contractor's Notice in Writing to the Owner provided under paragraph 7.2.3 shall advise that if the default is not corrected within 5 Working Days following the receipt of the Notice in Writing, the Contractor may, without prejudice to any other right or remedy the Contractor may have, suspend the Work or terminate the Contract.

7.2.5 If the Contractor terminates the Contract under the conditions set out above, the Contractor shall be entitled to be paid for all work performed including reasonable profit, for loss sustained upon Products and Construction Equipment, and such other damages as the Contractor may have sustained as a result of the termination of the Contract.
PART 8 DISPUTE RESOLUTION

GC 8.1 AUTHORITY OF THE CONSULTANT

8.1.1 Differences between the parties to the Contract as to the interpretation, application or administration of the Contract or any failure to agree where agreement between the parties is called for, herein collectively called disputes, which are not resolved in the first instance by findings of the Consultant as provided in GC 2.2 - ROLE OF THE CONSULTANT, shall be settled in accordance with the requirements of Part 8 of the General Conditions - DISPUTE RESOLUTION. Because of the nature of the disputes to which this Part applies, it is not necessary to accord the procedure hereinafter provided the status of a contractual dispute resolution procedure, and the parties may agree to any other procedure as they see fit.

8.1.2 If a dispute arises under the Contract in respect of a matter in which the Consultant has no authority under the Contract to make a finding, the procedures set out in paragraph 8.1.3 and paragraphs 8.2.3 to 8.2.8 of GC 8.2 - NEGOTIATION, MEDIATION AND ARBITRATION, and in GC 8.3 - RETENTION OF RIGHTS apply to that dispute with the necessary changes to detail as may be required.

8.1.3 If a dispute is not resolved promptly, the Consultant will give such instructions as in the Consultant's opinion are necessary for the proper performance of the Work and to prevent delays pending settlement of the dispute. The parties shall act immediately according to such instructions, it being understood that by so doing neither party will jeopardize any claim the party may have. If it is subsequently determined that such instructions were in error or at variance with the Contract Documents, the Owner shall pay the Contractor costs incurred by the Contractor in carrying out such instructions which the Contractor was required to do beyond what the Contract Documents correctly understood and interpreted would have required, including costs resulting from interruption of the Work.

GC 8.2 NEGOTIATION, MEDIATION AND ARBITRATION

8.2.1 In accordance with the Rules for Mediation of Construction Disputes as provided in CCDC 40 in effect at the time of bid closing, the parties shall appoint a Project Mediator.

8.2.2 A party shall be conclusively deemed to have accepted a finding of the Consultant under GC 2.2 - ROLE OF THE CONSULTANT and to have expressly waived and released the other party from any claims in respect of the particular matter dealt with in that finding unless, within 15 Working Days after receipt of that finding, the party sends a Notice in Writing of dispute to the other party and to the Consultant, which contains the particulars of the matter in dispute and the relevant provisions of the Contract Documents. The responding party shall send a Notice in Writing of reply to the dispute within 10 Working Days after receipt of such Notice in Writing setting out particulars of this response and any relevant provisions of the Contract Documents.

8.2.3 The parties shall make all reasonable efforts to resolve their dispute by amicable negotiations and agree to provide, without prejudice, frank, candid and timely disclosure of relevant facts, information and documents to facilitate these negotiations.

8.2.4 After a period of 10 Working Days following receipt of a responding party's Notice in Writing of reply under paragraph 8.2.2, the parties shall request the Project Mediator to assist the parties to reach agreement on any unresolved dispute. The mediated negotiations shall be conducted in accordance with the Rules for Mediation of Construction Disputes as provided in CCDC 40 in effect at the time of bid closing.

8.2.5 If the dispute has not been resolved within 10 Working Days after the Project Mediator was requested under paragraph 8.2.4 or within such further period agreed by the parties, the Project Mediator shall terminate the mediated negotiations by giving Notice in Writing to the Owner, the Contractor and the Consultant.

8.2.6 By giving a Notice in Writing to the other party and the Consultant, not later than 10 Working Days after the date of termination of the mediated negotiations under paragraph 8.2.5, either party may refer the dispute to be finally resolved by arbitration under the Rules for Arbitration of Construction Disputes as provided in CCDC 40 in effect at the time of bid closing. The arbitration shall be conducted in the jurisdiction of the Place of the Work.

8.2.7 On expiration of the 10 Working Days, the arbitration agreement under paragraph 8.2.6 is not binding on the parties and, if a Notice in Writing is not given under paragraph 8.2.6 within the required time, the parties may refer the unresolved dispute to the courts or to any other form of dispute resolution, including arbitration, which they have agreed to use.
8.2.8 If neither party, by Notice in Writing, given within 10 Working Days of the date of Notice in Writing requesting arbitration in paragraph 8.2.6, requires that a dispute be arbitrated immediately, all disputes referred to arbitration as provided in paragraph 8.2.6 shall be
.1 held in abeyance until
  (1) Substantial Performance of the Work,
  (2) the Contract has been terminated, or
  (3) the Contractor has abandoned the Work,
 whichever is earlier; and
  .2 consolidated into a single arbitration under the rules governing the arbitration under paragraph 8.2.6.

GC 8.3 RETENTION OF RIGHTS

8.3.1 It is agreed that no act by either party shall be construed as a renunciation or waiver of any rights or recourses, provided the party has given the Notice in Writing required under Part 8 of the General Conditions - DISPUTE RESOLUTION and has carried out the instructions as provided in paragraph 8.1.3 of GC 8.1 – AUTHORITY OF THE CONSULTANT.

8.3.2 Nothing in Part 8 of the General Conditions - DISPUTE RESOLUTION shall be construed in any way to limit a party from asserting any statutory right to a lien under applicable lien legislation of the jurisdiction of the Place of the Work and the assertion of such right by initiating judicial proceedings is not to be construed as a waiver of any right that party may have under paragraph 8.2.6 of GC 8.2 – NEGOTIATION, MEDIATION AND ARBITRATION to proceed by way of arbitration to adjudicate the merits of the claim upon which such a lien is based.

PART 9 PROTECTION OF PERSONS AND PROPERTY

GC 9.1 PROTECTION OF WORK AND PROPERTY

9.1.1 The Contractor shall protect the Work and the Owner's property and property adjacent to the Place of the Work from damage which may arise as the result of the Contractor's operations under the Contract, and shall be responsible for such damage, except damage which occurs as the result of:
  .1 errors in the Contract Documents;
  .2 acts or omissions by the Owner, the Consultant, other contractors, their agents and employees.

9.1.2 Before commencing any work, the Contractor shall determine the location of all underground utilities and structures indicated in the Contract Documents or that are reasonably apparent in an inspection of the Place of the Work.

9.1.3 Should the Contractor in the performance of the Contract damage the Work, the Owner's property or property adjacent to the Place of the Work, the Contractor shall be responsible for making good such damage at the Contractor's expense.

9.1.4 Should damage occur to the Work or Owner's property for which the Contractor is not responsible, as provided in paragraph 9.1.1, the Contractor shall make good such damage to the Work and, if the Owner so directs, to the Owner's property. The Contract Price and Contract Time shall be adjusted as provided in GC 6.1 – OWNER’S RIGHT TO MAKE CHANGES, GC 6.2 - CHANGE ORDER and GC 6.3 - CHANGE DIRECTIVE.

GC 9.2 TOXIC AND HAZARDOUS SUBSTANCES

9.2.1 For the purposes of applicable legislation related to toxic and hazardous substances, the Owner shall be deemed to have control and management of the Place of the Work with respect to existing conditions.

9.2.2 Prior to the Contractor commencing the Work, the Owner shall,
  .1 take all reasonable steps to determine whether any toxic or hazardous substances are present at the Place of the Work, and
  .2 provide the Consultant and the Contractor with a written list of any such substances that are known to exist and their locations.

9.2.3 The Owner shall take all reasonable steps to ensure that no person’s exposure to any toxic or hazardous substances exceeds the time weighted levels prescribed by applicable legislation at the Place of the Work and that no property is damaged or destroyed as a result of exposure to, or the presence of, toxic or hazardous substances which were at the Place of the Work prior to the Contractor commencing the Work.

9.2.4 Unless the Contract expressly provides otherwise, the Owner shall be responsible for taking all necessary steps, in accordance with applicable legislation in force at the Place of the Work, to dispose of, store or otherwise render harmless toxic or hazardous substances which were present at the Place of the Work prior to the Contractor commencing the Work.
9.2.5 If the Contractor
  .1 encounters toxic or hazardous substances at the Place of the Work, or
  .2 has reasonable grounds to believe that toxic or hazardous substances are present at the Place of the Work,
which were not brought to the Place of the Work by the Contractor or anyone for whom the Contractor is responsible and
which were not disclosed by the Owner or which were disclosed but have not been dealt with as required under paragraph
9.2.4, the Contractor shall
  .3 take all reasonable steps, including stopping the Work, to ensure that no person’s exposure to any toxic or hazardous
substances exceeds any applicable time weighted levels prescribed by applicable legislation at the Place of the Work, and
  .4 immediately report the circumstances to the Consultant and the Owner in writing.

9.2.6 If the Owner and Contractor do not agree on the existence, significance of, or whether the toxic or hazardous substances were
brought onto the Place of the Work by the Contractor or anyone for whom the Contractor is responsible, the Owner shall retain
and pay for an independent qualified expert to investigate and determine such matters. The expert’s report shall be delivered to the
Owner and the Contractor.

9.2.7 If the Owner and Contractor agree or if the expert referred to in paragraph 9.2.6 determines that the toxic or hazardous substances were
brought onto the place of the Work by the Contractor or anyone for whom the Contractor is responsible, the Owner shall promptly at the Owner’s own expense:
  .1 take all steps as required under paragraph 9.2.4;
  .2 reimburse the Contractor for the costs of all steps taken pursuant to paragraph 9.2.5;
  .3 extend the Contract time for such reasonable time as the Consultant may recommend in consultation with the Contractor
and the expert referred to in 9.2.6 and reimburse the Contractor for reasonable costs incurred as a result of the delay; and
  .4 indemnify the Contractor as required by GC 12.1 - INDEMNIFICATION.

9.2.8 If the Owner and Contractor agree or if the expert referred to in paragraph 9.2.6 determines that the toxic or hazardous substances were
brought onto the place of the Work by the Contractor or anyone for whom the Contractor is responsible, the Contractor shall promptly at the Contractor’s own expense:
  .1 take all necessary steps, in accordance with applicable legislation in force at the Place of the Work, to safely remove and
dispose the toxic or hazardous substances;
  .2 make good any damage to the Work, the Owner’s property or property adjacent to the place of the Work as provided in
paragraph 9.1.3 of GC 9.1 – PROTECTION OF WORK AND PROPERTY;
  .3 reimburse the Owner for reasonable costs incurred under paragraph 9.2.6; and
  .4 indemnify the Owner as required by GC 12.1 - INDEMNIFICATION.

9.2.9 If either party does not accept the expert’s findings under paragraph 9.2.6, the disagreement shall be settled in accordance with
Part 8 of the General Conditions - Dispute Resolution. If such disagreement is not resolved promptly, the parties shall act
immediately in accordance with the expert’s determination and take the steps required by paragraph 9.2.7 or 9.2.8 it being
understood that by so doing, neither party will jeopardize any claim that party may have to be reimbursed as provided by GC 9.2 –
TOXIC AND HAZARDOUS SUBSTANCES.

GC 9.3 ARTIFACTS AND FOSSILS

9.3.1 Fossils, coins, articles of value or antiquity, structures and other remains or things of scientific or historic interest discovered
at the Place or Work shall, as between the Owner and the Contractor, be deemed to be the absolute property of the Owner.

9.3.2 The Contractor shall take all reasonable precautions to prevent removal or damage to discoveries as identified in paragraph
9.3.1, and shall advise the Consultant upon discovery of such items.

9.3.3 The Consultant will investigate the impact on the Work of the discoveries identified in paragraph 9.3.1. If conditions are
found that would cause an increase or decrease in the Contractor’s cost or time to perform the Work, the Consultant, with the
Owner’s approval, will issue appropriate instructions for a change in the Work as provided in GC 6.2 - CHANGE ORDER or
GC 6.3 CHANGE DIRECTIVE.

GC 9.4 CONSTRUCTION SAFETY

9.4.1 Subject to paragraph 3.2.2.2 of GC 3.2 - CONSTRUCTION BY OWNER OR OTHER CONTRACTORS, the Contractor
shall be solely responsible for construction safety at the Place of the Work and for compliance with the rules, regulations and
practices required by the applicable construction health and safety legislation and shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the performance of the Work.

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GC 9.5 MOULD

9.5.1 If the Contractor or Owner observes or reasonably suspects the presence of mould at the Place of the Work, the remediation of which is not expressly part of the Work,
   .1 the observing party shall promptly report the circumstances to the other party in writing, and
   .2 the Contractor shall promptly take all reasonable steps, including stopping the Work if necessary, to ensure that no person suffers injury, sickness or death and that no property is damaged as a result of exposure to or the presence of the mould, and
   .3 if the Owner and Contractor do not agree on the existence, significance or cause of the mould or as to what steps need be taken to deal with it, the Owner shall retain and pay for an independent qualified expert to investigate and determine such matters. The expert’s report shall be delivered to the Owner and Contractor.

9.5.2 If the Owner and Contractor agree, or if the expert referred to in paragraph 9.5.1.3 determines that the presence of mould was caused by the Contractor's operations under the Contract, the Contractor shall promptly, at the Contractor’s own expense:
   .1 take all reasonable and necessary steps to safely remediate or dispose of the mould, and
   .2 make good any damage to the Work, the Owner’s property or property adjacent to the Place of the Work as provided in paragraph 9.1.3 of GC 9.1 - PROTECTION OF WORK AND PROPERTY, and
   .3 reimburse the Owner for reasonable costs incurred under paragraph 9.5.1.3, and
   .4 indemnify the Owner as required by GC 12.1 - INDEMNIFICATION.

9.5.3 If the Owner and Contractor agree, or if the expert referred to in paragraph 9.5.1.3 determines that the presence of mould was not caused by the Contractor’s operations under the Contract, the Owner shall promptly, at the Owner’s own expense:
   .1 take all reasonable and necessary steps to safely remediate or dispose of the mould, and
   .2 reimburse the Contractor for the cost of taking the steps under paragraph 9.5.1.2 and making good any damage to the Work as provided in paragraph 9.1.4 of GC 9.1 - PROTECTION OF WORK AND PROPERTY, and
   .3 extend the Contract Time for such reasonable time as the Consultant may recommend in consultation with the Contractor and the expert referred to in paragraph 9.5.1.3 and reimburse the Contractor for reasonable costs incurred as a result of the delay, and
   .4 indemnify the Contractor as required by GC 12.1 - INDEMNIFICATION.

9.5.4 If either party does not accept the expert’s finding under paragraph 9.5.1.3, the disagreement shall be settled in accordance with Part 8 of the General Conditions - DISPUTE RESOLUTION. If such disagreement is not resolved promptly, the parties shall act immediately in accordance with the expert’s determination and take the steps required by paragraphs 9.5.2 or 9.5.3, it being understood that by so doing neither party will jeopardize any claim the party may have to be reimbursed as provided by GC 9.5 - MOULD.

PART 10 GOVERNING REGULATIONS

GC 10.1 TAXES AND DUTIES

10.1.1 The Contract Price shall include all taxes and customs duties in effect at the time of the bid closing except for Value Added Taxes payable by the Owner to the Contractor as stipulated in Article A-4 of the Agreement - CONTRACT PRICE.

10.1.2 Any increase or decrease in costs to the Contractor due to changes in such included taxes and duties after the time of the bid closing shall increase or decrease the Contract Price accordingly.

GC 10.2 LAWS, NOTICES, PERMITS, AND FEES

10.2.1 The laws of the Place of the Work shall govern the Work.

10.2.2 The Owner shall obtain and pay for development approvals, building permit, permanent easements, rights of servitude, and all other necessary approvals and permits, except for the permits and fees referred to in paragraph 10.2.3 or for which the Contract Documents specify as the responsibility of the Contractor.

10.2.3 The Contractor shall be responsible for the procurement of permits, licences, inspections, and certificates, which are necessary for the performance of the Work and customarily obtained by contractors in the jurisdiction of the Place of the Work after the issuance of the building permit. The Contract Price includes the cost of these permits, licences, inspections, and certificates, and their procurement.

10.2.4 The Contractor shall give the required notices and comply with the laws, ordinances, rules, regulations, or codes which are or become in force during the performance of the Work and which relate to the Work, to the preservation of the public health, and to construction safety.
10.2.5 The Contractor shall not be responsible for verifying that the Contract Documents are in compliance with the applicable laws, ordinances, rules, regulations, or codes relating to the Work. If the Contract Documents are at variance therewith, or if, subsequent to the time of bid closing, changes are made to the applicable laws, ordinances, rules, regulations, or codes which require modification to the Contract Documents, the Contractor shall advise the Consultant in writing requesting direction immediately upon such variance or change becoming known. The Consultant will make the changes required to the Contract Documents as provided in GC 6.1 - OWNER’S RIGHT TO MAKE CHANGES, GC 6.2 - CHANGE ORDER and GC 6.3 - CHANGE DIRECTIVE.

10.2.6 If the Contractor fails to advise the Consultant in writing; and fails to obtain direction as required in paragraph 10.2.5; and performs work knowing it to be contrary to any laws, ordinances, rules, regulations, or codes; the Contractor shall be responsible for and shall correct the violations thereof; and shall bear the costs, expenses and damages attributable to the failure to comply with the provisions of such laws, ordinances, rules, regulations, or codes.

10.2.7 If, subsequent to the time of bid closing, changes are made to applicable laws, ordinances, rules, regulations, or codes of authorities having jurisdiction which affect the cost of the Work, either party may submit a claim in accordance with the requirements of GC 6.6 – CLAIMS FOR A CHANGE IN CONTRACT PRICE.

GC 10.3 PATENT FEES

10.3.1 The Contractor shall pay the royalties and patent licence fees required for the performance of the Contract. The Contractor shall hold the Owner harmless from and against claims, demands, losses, costs, damages, actions, suits, or proceedings arising out of the Contractor’s performance of the Contract which are attributable to an infringement or an alleged infringement of a patent of invention by the Contractor or anyone for whose acts the Contractor may be liable.

10.3.2 The Owner shall hold the Contractor harmless against claims, demands, losses, costs, damages, actions, suits, or proceedings arising out of the Contractor’s performance of the Contract which are attributable to an infringement or an alleged infringement of a patent of invention in executing anything for the purpose of the Contract, the model, plan or design of which was supplied to the Contractor as part of the Contract Documents.

GC 10.4 WORKERS’ COMPENSATION

10.4.1 Prior to commencing the Work, again with the Contractor’s application for payment of the holdback amount following Substantial Performance of the Work and again with the Contractor’s application for final payment, the Contractor shall provide evidence of compliance with workers’ compensation legislation at the Place of the Work, including payments due thereunder.

10.4.2 At any time during the term of the Contract, when requested by the Owner, the Contractor shall provide such evidence of compliance by the Contractor and Subcontractors.

PART 11 INSURANCE AND CONTRACT SECURITY

GC 11.1 INSURANCE

11.1.1 Without restricting the generality of GC 12.1 - INDEMNIFICATION, the Contractor shall provide, maintain and pay for the following insurance coverages, the minimum requirements of which are specified in CCDC 41 – CCDC Insurance Requirements in effect at the time of bid closing except as hereinafter provided:

.1 General liability insurance in the name of the Contractor and include, or in the case of a single, blanket policy, be endorsed to name, the Owner and the Consultant as insureds but only with respect to liability, other than legal liability arising out of their sole negligence, arising out of the operations of the Contractor with regard to the Work. General liability insurance shall be maintained from the date of commencement of the Work until one year from the date of Substantial Performance of the Work. Liability coverage shall be provided for completed operations hazards from the date of Substantial Performance of the Work, as set out in the certificate of Substantial Performance of the Work, on an ongoing basis for a period of 6 years following Substantial Performance of the Work.

.2 Automobile Liability Insurance from the date of commencement of the Work until one year after the date of Substantial Performance of the Work.

.3 Aircraft or Watercraft Liability Insurance when owned or non-owned aircraft or watercraft are used directly or indirectly in the performance of the Work

.4 "Broad form" property insurance in the joint names of the Contractor, the Owner and the Consultant. The policy shall include as insureds all Subcontractors. The “Broad form” property insurance shall be provided from the date of commencement of the Work until the earliest of:

(1) 10 calendar days after the date of Substantial Performance of the Work;

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on the commencement of use or occupancy of any part or section of the Work unless such use or occupancy is for construction purposes, habitational, office, banking, convenience store under 465 square metres in area, or parking purposes, or for the installation, testing and commissioning of equipment forming part of the Work;

(3) when left unattended for more than 30 consecutive calendar days or when construction activity has ceased for more than 30 consecutive calendar days.

.5 Boiler and machinery insurance in the joint names of the Contractor, the Owner and the Consultant. The policy shall include as insureds all Subcontractors. The coverage shall be maintained continuously from commencement of use or operation of the boiler and machinery objects insured by the policy and until 10 calendar days after the date of Substantial Performance of the Work.

.6 The “Broad form” property and boiler and machinery policies shall provide that, in the case of a loss or damage, payment shall be made to the Owner and the Contractor as their respective interests may appear. In the event of loss or damage:

(1) the Contractor shall act on behalf of the Owner for the purpose of adjusting the amount of such loss or damage payment with the insurers. When the extent of the loss or damage is determined, the Contractor shall proceed to restore the Work. Loss or damage shall not affect the rights and obligations of either party under the Contract except that the Contractor shall be entitled to such reasonable extension of Contract Time relative to the extent of the loss or damage as the Consultant may recommend in consultation with the Contractor;

(2) the Contractor shall be entitled to receive from the Owner, in addition to the amount due under the Contract, the amount which the Owner's interest in restoration of the Work has been appraised, such amount to be paid as the restoration of the Work proceeds in accordance with the progress payment provisions. In addition the Contractor shall be entitled to receive from the payments made by the insurer the amount of the Contractor's interest in the restoration of the Work; and

(3) to the Work arising from the work of the Owner, the Owner's own forces or another contractor, the Owner shall, in accordance with the Owner's obligations under the provisions relating to construction by Owner or other contractors, pay the Contractor the cost of restoring the Work as the restoration of the Work proceeds and as in accordance with the progress payment provisions.

.7 Contractors' Equipment Insurance from the date of commencement of the Work until one year after the date of Substantial Performance of the Work.

11.1.2 Prior to commencement of the Work and upon the placement, renewal, amendment, or extension of all or any part of the insurance, the Contractor shall promptly provide the Owner with confirmation of coverage and, if required, a certified true copy of the policies certified by an authorized representative of the insurer together with copies of any amending endorsements applicable to the Work.

11.1.3 The parties shall pay their share of the deductible amounts in direct proportion to their responsibility in regards to any loss for which the above policies are required to pay, except where such amounts may be excluded by the terms of the Contract.

11.1.4 If the Contractor fails to provide or maintain insurance as required by the Contract Documents, then the Owner shall have the right to provide and maintain such insurance and give evidence to the Contractor and the Consultant. The Contractor shall pay the cost thereof to the Owner on demand or the Owner may deduct the cost from the amount which is due or may become due to the Contractor.

11.1.5 All required insurance policies shall be with insurers licensed to underwrite insurance in the jurisdiction of the Place of the Work.

11.1.6 If a revised version of CCDC 41 – INSURANCE REQUIREMENTS is published, which specifies reduced insurance requirements, the parties shall address such reduction, prior to the Contractor’s insurance policy becoming due for renewal, and record any agreement in a Change Order.

11.1.7 If a revised version of CCDC 41 – INSURANCE REQUIREMENTS is published, which specifies increased insurance requirements, the Owner may request the increased coverage from the Contractor by way of a Change Order.

11.1.8 A Change Directive shall not be used to direct a change in the insurance requirements in response to the revision of CCDC 41 – INSURANCE REQUIREMENTS.

GC 11.2 CONTRACT SECURITY

11.2.1 The Contractor shall, prior to commencement of the Work or within the specified time, provide to the Owner any Contract security specified in the Contract Documents.
11.2.2 If the Contract Documents require surety bonds to be provided, such bonds shall be issued by a duly licensed surety company authorized to transact the business of suretyship in the province or territory of the Place of the Work and shall be maintained in good standing until the fulfillment of the Contract. The form of such bonds shall be in accordance with the latest edition of the CCDC approved bond forms.

PART 12 INDEMNIFICATION, WAIVER OF CLAIMS AND WARRANTY

GC 12.1 INDEMNIFICATION

12.1.1 Without restricting the parties’ obligation to indemnify as described in paragraphs 12.1.4 and 12.1.5, the Owner and the Contractor shall each indemnify and hold harmless the other from and against all claims, demands, losses, costs, damages, actions, suits, or proceedings whether in respect to losses suffered by them or in respect to claims by third parties that arise out of, or are attributable in any respect to their involvement as parties to this Contract, provided such claims are:

.1 caused by:
   (1) the negligent acts or omissions of the party from whom indemnification is sought or anyone for whose acts or omissions that party is liable, or
   (2) a failure of the party to the Contract from whom indemnification is sought to fulfill its terms or conditions; and

.2 made by Notice in Writing within a period of 6 years from the date of Substantial Performance of the Work as set out in the certificate of Substantial Performance of the Work issued pursuant to paragraph 5.4.2.2 of GC 5.4 – SUBSTANTIAL PERFORMANCE OF THE WORK or within such shorter period as may be prescribed by any limitation statute of the province or territory of the Place of the Work.

The parties expressly waive the right to indemnity for claims other than those provided for in this Contract.

12.1.2 The obligation of either party to indemnify as set forth in paragraph 12.1.1 shall be limited as follows:

.1 In respect to losses suffered by the Owner and the Contractor for which insurance is to be provided by either party pursuant to GC 11.1 – INSURANCE, the general liability insurance limit for one occurrence as referred to in CCDC 41 in effect at the time of bid closing.

.2 In respect to losses suffered by the Owner and the Contractor for which insurance is not required to be provided by either party in accordance with GC 11.1 – INSURANCE, the greater of the Contract Price as recorded in Article A-4 – CONTRACT PRICE or $2,000,000, but in no event shall the sum be greater than $20,000,000.

.3 In respect to claims by third parties for direct loss resulting from bodily injury, sickness, disease or death, or to injury to or destruction of tangible property, the obligation to indemnify is without limit. In respect to all other claims for indemnity as a result of claims advanced by third parties, the limits of indemnity set forth in paragraphs 12.1.2.1 and 12.1.2.2 shall apply.

12.1.3 The obligation of either party to indemnify the other as set forth in paragraphs 12.1.1 and 12.1.2 shall be inclusive of interest and all legal costs.

12.1.4 The Owner and the Contractor shall indemnify and hold harmless the other from and against all claims, demands, losses, costs, damages, actions, suits, or proceedings arising out of their obligations described in GC 9.2 – TOXIC AND HAZARDOUS SUBSTANCES.

12.1.5 The Owner shall indemnify and hold harmless the Contractor from and against all claims, demands, losses, costs, damages, actions, suits, or proceedings:

.1 as described in paragraph 10.3.2 of GC 10.3 – PATENT FEES, and

.2 arising out of the Contractor’s performance of the Contract which are attributable to a lack of or defect in title or an alleged lack of or defect in title to the Place of the Work.

12.1.6 In respect to any claim for indemnity or to be held harmless by the Owner or the Contractor:

.1 Notice in Writing of such claim shall be given within a reasonable time after the facts upon which such claim is based became known;

.2 should any party be required as a result of its obligation to indemnify another to pay or satisfy a final order, judgment or award made against the party entitled by this contract to be indemnified, then the indemnifying party upon assuming all liability for any costs that might result shall have the right to appeal in the name of the party against whom such final order or judgment has been made until such rights of appeal have been exhausted.
GC 12.2 WAIVER OF CLAIMS

12.2.1 Subject to any lien legislation applicable to the Place of the Work, as of the fifth calendar day before the expiry of the lien period provided by the lien legislation applicable at the Place of the Work, the Contractor waives and releases the Owner from all claims which the Contractor has or reasonably ought to have knowledge of that could be advanced by the Contractor against the Owner arising from the Contractor’s involvement in the Work, including, without limitation, those arising from negligence or breach of contract in respect to which the cause of action is based upon acts or omissions which occurred prior to or on the date of Substantial Performance of the Work, except as follows:

.1 claims arising prior to or on the date of Substantial Performance of the Work for which Notice in Writing of claim has been received by the Owner from the Contractor no later than the sixth calendar day before the expiry of the lien period provided by the lien legislation applicable at the Place of the Work;

.2 indemnification for claims advanced against the Contractor by third parties for which a right of indemnification may be asserted by the Contractor against the Owner pursuant to the provisions of this Contract;

.3 claims for which a right of indemnity could be asserted by the Contractor pursuant to the provisions of paragraphs 12.1.4 or 12.1.5 of GC 12.1 – INDEMNIFICATION; and

.4 claims resulting from acts or omissions which occur after the date of Substantial Performance of the Work.

12.2.2 The Contractor waives and releases the Owner from all claims referenced in paragraph 12.2.1.4 except for those referred in paragraphs 12.2.1.2 and 12.2.1.3 and claims for which Notice in Writing of claim has been received by the Owner from the Contractor within 395 calendar days following the date of Substantial Performance of the Work.

12.2.3 Subject to any lien legislation applicable to the Place of the Work, as of the fifth calendar day before the expiry of the lien period provided by the lien legislation applicable at the Place of the Work, the Owner waives and releases the Contractor from all claims which the Owner has or reasonably ought to have knowledge of that could be advanced by the Owner against the Contractor arising from the Owner’s involvement in the Work, including, without limitation, those arising from negligence or breach of contract in respect to which the cause of action is based upon acts or omissions which occurred prior to or on the date of Substantial Performance of the Work, except as follows:

.1 claims arising prior to or on the date of Substantial Performance of the Work for which Notice in Writing of claim has been received by the Contractor from the Owner no later than the sixth calendar day before the expiry of the lien period provided by the lien legislation applicable at the Place of the Work;

.2 indemnification for claims advanced against the Owner by third parties for which a right of indemnification may be asserted by the Owner against the Contractor pursuant to the provisions of this Contract;

.3 claims for which a right of indemnity could be asserted by the Owner against the Contractor pursuant to the provisions of paragraph 12.1.4 of GC 12.1 - INDEMNIFICATION;

.4 damages arising from the Contractor’s actions which result in substantial defects or deficiencies in the Work. “Substantial defects or deficiencies” mean those defects or deficiencies in the Work which affect the Work to such an extent or in such a manner that a significant part or the whole of the Work is unfit for the purpose intended by the Contract Documents;

.5 claims arising pursuant to GC 12.3 - WARRANTY; and

.6 claims arising from acts or omissions which occur after the date of Substantial Performance of the Work.

12.2.4 The Owner waives and releases the Contractor from all claims referred to in paragraph 12.2.3.4 except claims for which Notice in Writing of claim has been received by the Contractor from the Owner within a period of six years from the date of Substantial Performance of the Work should any limitation statute of the Province or Territory of the Place of the Work permit such agreement. If the applicable limitation statute does not permit such agreement, within such shorter period as may be prescribed by:

.1 any limitation statute of the Province or Territory of the Place of the Work; or

.2 if the Place of the Work is the Province of Quebec, then Article 2118 of the Civil Code of Quebec.

12.2.5 The Owner waives and releases the Contractor from all claims referenced in paragraph 12.2.3.6 except for those referred in paragraph 12.2.3.2, 12.2.3.3 and those arising under GC 12.3 – WARRANTY and claims for which Notice in Writing has been received by the Contractor from the Owner within 395 calendar days following the date of Substantial Performance of the Work.

12.2.6 “Notice in Writing of claim” as provided for in GC 12.2 – WAIVER OF CLAIMS to preserve a claim or right of action which would otherwise, by the provisions of GC 12.2 – WAIVER OF CLAIMS, be deemed to be waived, must include the following:

.1 a clear and unequivocal statement of the intention to claim;

.2 a statement as to the nature of the claim and the grounds upon which the claim is based; and

.3 a statement of the estimated quantum of the claim.

12.2.7 The party giving “Notice in Writing” as provided for in GC 12.2 – WAIVER OF CLAIMS shall submit within a reasonable time a detailed account of the amount claimed.
12.2.8 Where the event or series of events giving rise to a claim made under paragraphs 12.2.1 or 12.2.3 has a continuing effect, the detailed account submitted under paragraph 12.2.7 shall be considered to be an interim account and the party making the claim shall submit further interim accounts, at reasonable intervals, giving the accumulated amount of the claim and any further grounds upon which it is based. The party making the claim shall submit a final account after the end of the effects resulting from the event or series of events.

12.2.9 If a Notice in Writing of claim pursuant to paragraph 12.2.1.1 is received on the seventh or sixth calendar day before the expiry of the lien period provided by the lien legislation applicable at the Place of the Work, the period within which Notice in Writing of claim shall be received pursuant to paragraph 12.2.3.1 shall be extended to two calendar days before the expiry of the lien period provided by the lien legislation applicable at the Place of the Work.

12.2.10 If a Notice in Writing of claim pursuant to paragraph 12.2.3.1 is received on the seventh or sixth calendar day before the expiry of the lien period provided by the lien legislation applicable at the Place of the Work, the period within which Notice in Writing of claim shall be received pursuant to paragraph 12.2.1.1 shall be extended to two calendar days before the expiry of the lien period provided by the lien legislation applicable at the Place of the Work.

**GC 12.3 WARRANTY**

12.3.1 Except for extended warranties as described in paragraph 12.3.6, the warranty period under the Contract is one year from the date of Substantial Performance of the Work.

12.3.2 The Contractor shall be responsible for the proper performance of the Work to the extent that the design and Contract Documents permit such performance.

12.3.3 The Owner, through the Consultant, shall promptly give the Contractor Notice in Writing of observed defects and deficiencies which occur during the one year warranty period.

12.3.4 Subject to paragraph 12.3.2, the Contractor shall correct promptly, at the Contractor's expense, defects or deficiencies in the Work which appear prior to and during the one year warranty period.

12.3.5 The Contractor shall correct or pay for damage resulting from corrections made under the requirements of paragraph 12.3.4.

12.3.6 Any extended warranties required beyond the one year warranty period as described in paragraph 12.3.1, shall be as specified in the Contract Documents. Extended warranties shall be issued by the warrantor to the benefit of the Owner. The Contractor’s responsibility with respect to extended warranties shall be limited to obtaining any such extended warranties from the warrantor. The obligations under such extended warranties are solely the responsibilities of the warrantor.
CCDC 41

CCDC INSURANCE REQUIREMENTS

PUBLICATION DATE: JANUARY 21, 2008

1. General liability insurance shall be with limits of not less than $5,000,000 per occurrence, an aggregate limit of not less than $5,000,000 within any policy year with respect to completed operations, and a deductible not exceeding $5,000. The insurance coverage shall not be less than the insurance provided by IBC Form 2100 (including an extension for a standard provincial and territorial form of non-owned automobile liability policy) and IBC Form 2320. To achieve the desired limit, umbrella or excess liability insurance may be used. Subject to satisfactory proof of financial capability by the Contractor, the Owner may agree to increase the deductible amounts.

2. Automobile liability insurance in respect of vehicles that are required by law to be insured under a contract by a Motor Vehicle Liability Policy, shall have limits of not less than $5,000,000 inclusive per occurrence for bodily injury, death and damage to property, covering all vehicles owned or leased by the Contractor. Where the policy has been issued pursuant to a government-operated automobile insurance system, the Contractor shall provide the Owner with confirmation of automobile insurance coverage for all automobiles registered in the name of the Contractor.

3. Aircraft and watercraft liability insurance with respect to owned or non-owned aircraft and watercraft (if used directly or indirectly in the performance of the Work), including use of additional premises, shall have limits of not less than $5,000,000 inclusive per occurrence for bodily injury, death and damage to property including loss of use thereof and limits of not less than $5,000,000 for aircraft passenger hazard. Such insurance shall be in a form acceptable to the Owner.

4. "Broad form" property insurance shall have limits of not less than the sum of 1.1 times Contract Price and the full value, as stated in the Contract, of Products and design services that are specified to be provided by the Owner for incorporation into the Work, with a deductible not exceeding $5,000. The insurance coverage shall not be less than the insurance provided by IBC Forms 4042 and 4047 (excluding flood and earthquake) or their equivalent replacement. Subject to satisfactory proof of financial capability by the Contractor, the Owner may agree to increase the deductible amounts.

5. Boiler and machinery insurance shall have limits of not less than the replacement value of the permanent or temporary boilers and pressure vessels, and other insurable objects forming part of the Work. The insurance coverage shall not be less than the insurance provided by a comprehensive boiler and machinery policy.

6. "Broad form" contractors' equipment insurance coverage covering Construction Equipment used by the Contractor for the performance of the Work, shall be in a form acceptable to the Owner and shall not allow subrogation claims by the insurer against the Owner. Subject to satisfactory proof of financial capability by the Contractor for self-insurance, the Owner may agree to waive the equipment insurance requirement.

7. Standard Exclusions

7.1 In addition to the broad form property exclusions identified in IBC forms 4042(1995), and 4047(2000), the Contractor is not required to provide the following insurance coverage:
   - Asbestos
   - Cyber Risk
   - Mould
   - Terrorism
The Canadian Construction Documents Committee, Standard Construction Document CCDC 2 – Stipulated Price Contract, 2008, is hereby modified as follows:

**GC ARTICLE A-1**

Subsection 1.3 is deleted and replaced with the following:

“1.3 Subject to adjustment in Contract Time as provided for in the Contract Documents, attain Substantial Performance of the Work by the 16th day of March in the year 2018, and Total Performance of the Work by the 20th day of April in the year 2018.”

**GC ARTICLE A-5 PAYMENT**

Subsection 5.1 is revised to read:

“5.1 Subject to provisions of the *Contract Documents*, and in accordance with the Builders Lien Act (British Columbia), the *Owner* shall in Canadian funds:”

Add Subsection 5.1.4 as follows:

“.4 withhold ten percent (10%) of each progress payment.”

**GC ARTICLE A-9 NO DUTY OF CARE**

Add the following paragraph:

9.1 The Contractor acknowledges that the Owner, in the preparation of the Contract Documents, supply of oral or written information to Tenderers, review of Tenders or the carrying out of the Owner’s responsibilities under the Contract does not owe a duty of care to the Contractor and the Contractor waives for itself and its successors the right to sue the Owner in tort of any loss, including economic loss, damage, cost or expense arising from or connected with any error, omission or misrepresentation occurring in the preparation of the Contract Documents, supply of oral or written information to Tenderers, review of tenders or the carrying out of the Owner’s responsibilities under the Contract.
SUPPLEMENTARY GENERAL CONDITIONS

GENERAL CONDITIONS (GC)

GC DEFINITIONS

Add the following definitions:

.1 Addendum

“Addendum” means an addition to or a change in the Tender Documents that is issued by the Engineer prior to the tender closing.

.2 Final Acceptance

In addition to all other prior requirements, “Final Acceptance” will not occur until the successful completion of the warranty period and the Work has passed all inspections and testing requirements.

.3 Total Performance of the Work

“Total Performance of the Work” means when the entire Work, except those items arising from the provisions of GC 12.3 – WARRANTY, has been performed to the requirements of the Contract Documents and is so certified by the Engineer.

In addition to all prior requirements, Total Performance will not occur until the Work has passed all inspections and testing requirements.

.4 Engineer’s Representative

The “Engineer’s Representative” means any person authorized from time to time by the Engineer to perform the duties of the Engineer whose authority shall be notified in writing to the Contractor by the Engineer.

.5 Milestone Dates

Milestone Dates means any date specified in the Contract Documents for completion of the Work, or portion of the Work, including the date for Substantial Performance of the Work.

.6 Abnormally Adverse Weather

Abnormally Adverse Weather means temperature, precipitation, wind or other weather condition which, in a two week period, differs from the statistical average for that condition in that period by more than one standard deviation, calculated based on relevant data available from Environment Canada.
.7 Construction Schedule

Construction Schedule means a schedule of the Work prepared by the Contractor setting out the start and completion dates of the major elements of the Work including, but not limited to, mobilization, shop drawings, construction, installation, testing, commissioning, Substantial Performance of the Work, Owner occupancy and any other Milestone Dates, and may be amended from time to time in accordance with the Contract Documents.

Modify the following definitions:

.8 The definition of "Consultant" in definition 4 is deleted and replaced by the following:

"Consultant" - The Contract Administrator solely in charge of this Contract. The terms Consultant and Engineer have the same meaning.

.9 The definition of "Contractor" in definition 4 is deleted and replaced by the following:

"Contractor" – The Contractor is the person or entity identified as such in the Agreement. The term Contractor means the Contractor or the Contractor’s authorized representative as designated to the Owner in writing. The term General Contractor has the same meaning as Contractor.

.10 The definition of "Owner" in definition 4 is deleted and replaced by the following:

"Owner" – The Owner is the person or entity identified as such in the Agreement. The term Owner means the Owner or the Owner’s authorized agent or representative as designated to the Contractor in writing, but does not include the Consultant. The term City or District has the same meaning as Owner.

.11 The definition of "Subcontractor" in definition 19 is deleted and replaced by the following:

"Subcontractor" - A person, firm or corporation undertaking the execution of a part of the Work by virtue of an agreement with the Contractor, which has been approved by the Owner.

.12 The definition of "Substantial Performance of the Work" in definition 20 is deleted and replaced by the following:

(1) The Work is substantially performed:

1) when the Work, or a substantial part thereof has passed inspection and testing and is ready for use or is being used for the intended purposes, and:
SUPPLEMENTARY GENERAL CONDITIONS

2) when the work to be performed under the Contract is capable of completion or, where there is a known defect, correction is a cost of not more than

i) 3% of the first $500,000 of the Contract price,

ii) 2% of the next $500,000 of the Contract price, and

iii) 1% of the balance of the Contract price

(2) For the purposes of this Contract where the Work or a substantial part thereof is ready for use or is being used for the purposes intended and the remainder of the Work cannot be completed expeditiously for reasons beyond the control of the Contractor or, where the Owner and the Contractor agree not to complete the Work expeditiously, the price of the services or materials remaining to be supplied and required to complete the work shall be deducted from the Contract price in determining substantial performance.

GC 1.1 CONTRACT DOCUMENTS

Subsection GC 1.1.7 is deleted, and replaced by the following:

1.1.7 In the event of conflicts between the Contract Documents, the following shall apply:

(a) constructed works take precedence over drawing dimensions and details. Prior to fabrication of any item dependent upon accurate dimensions or details of the constructed works, the Contractor shall take field measurements of such constructed works,

(b) figured dimensions shown on a drawing shall govern even though they may differ from dimensions scaled on the same drawing,

(c) detailed drawings shall govern over general drawings,

(d) specifications shall govern over drawings,

(e) the Supplementary General Conditions shall govern over the General Conditions, and

(f) the executed agreement between the Owner and Contractor shall govern over all documents.

Notwithstanding the foregoing, documents of later date shall always govern those of an earlier date.
SUPPLEMENTARY GENERAL CONDITIONS

Replace GC 1.1.7.1 with the following:

1. The order of priority of documents, from highest to lowest, shall be:
   - Agreement
   - Addenda
   - Supplementary General Conditions
   - Definitions
   - General Requirements
   - General Conditions
   - Specifications
   - Drawings
   - Executed Form of Tender
   - Instructions to Tenderers

In GC 1.1.8. replace “sufficient copies” with “an electronic copy and two hard copies”.

GC 1.4 ASSIGNMENT

Amend by the addition of the following paragraph:

No assignment of this Contract in whole or in part shall be valid.

GC 2.3 REVIEW AND INSPECTION OF THE WORK

Add the following clause:

2.3.6 If the Engineer is required to make visits for the purpose of witnessing the testing of equipment or materials, or the factory inspection of equipment or materials on more than one occasion for the same piece of equipment or materials, by reason of delays of the Contractor, or malfunctioning of the equipment under test, or from whatever reason caused by the Contractor or his subcontractors, the Contractor shall pay to the Owner the additional fees and expenses incurred for the second and any such subsequent extra visits by the Engineer and charged by him to the Owner.

GC 3.1 CONTROL OF THE WORK

Section GC 3.1 shall be renamed “Contractor's Responsibility and Control of the Work” and is hereby amended by the addition of the following sections:

Add the following paragraph to 3.1.1 after “Contract Documents”:

“including the Construction Schedule.”

3.1.3 The Contractor shall commence the Work within 10 days after receiving Notice to Proceed from the Engineer. The Contractor will not commence the work until the Contract has been officially accepted by the Owner, the Insurance Certificates
and the Performance Bonds are satisfactory to the Owner, and the Contractor has received Notice from the Engineer to commence the work.

3.1.4 The Contractor shall provide for efficient drainage of all sections of the work during all stages of construction at his own expense. The Contractor will be held responsible for all damage which may be caused through his failure to provide proper drainage facilities. The Contractor shall restore any existing drainage works which are disturbed as a result of his construction activities.

3.1.5 In order to assist the Owner in inspecting the progress of the work, the Contractor shall prepare a Schedule of Work prior to starting the Contract and shall revise the schedule weekly for any changes throughout the Contract.

3.1.6 Prior to commencement of construction, the Engineer and the Contractor will locate on site those property bars, baselines and benchmarks which are necessary to delineate the Working Area and to lay out the Work, all as shown on the Contract Drawings.

3.1.7 The Contractor shall be responsible for the preservation of all property bars while the Work is in progress, except those property bars which must be removed to facilitate the Work. Any property bars disturbed, damaged or removed by the Contractor’s operations shall be replaced under the supervision of a British Columbia Land Surveyor, at no extra cost to the Owner.

3.1.8 The Contractor will give the Engineer at least 48 hours’ notice in writing before requiring any baselines or benchmarks in connection with the work. The Contractor shall clearly state in such notice the exact location where levels, lines, or stakes are required. The Contractor must satisfy himself before commencing any work as to the meaning and correctness of all stakes and marks, and no claim will be entertained by the Owner for or on account of any alleged inaccuracies, unless the Contractor notified the Engineer of such inaccuracies in writing before commencing the work.

The Contractor will be held responsible for the preservation of all stakes and marks in their proper positions, and where any of them are disturbed, lost or destroyed, it shall at once notify the Engineer in writing, and all expenses incurred in replacing such stakes or marks will be billed against the Contractor and if not paid by the Contractor will be deducted from any monies due the Contractor under the Contract.

All stakes and marks set will not in every case represent all the grades, levels, lines, angles or surfaces in the finished work and in this regard the Contractor shall ensure that such stakes and marks are read correctly and used in a manner consistent with the plans, details, specifications and directions of the Engineer. Should the Contractor discover or suspect any errors in stakes, lines, and grades which have been established for its use, the Contractor shall at once discontinue the work until such suspicions are investigated and any errors or misunderstanding
rectified, but no claims shall be made or allowed on this account, or because of any resulting delay.

The Contractor shall assume full responsibility for alignment, elevations, and dimensions of each and all parts of the Work, regardless of whether the Contractor's layout work has been checked by the Engineer.

The Contractor shall furnish the Engineer or any of his assistants with all reasonable help which may be required at any time in driving stakes or laying out the work. The Contractor will receive no additional compensation for this.

3.1.9 Maintaining Roadways and Detours

Where an existing Roadway is affected by construction, it shall be kept open to traffic, and the Contractor shall, except as otherwise provided in this subsection, be responsible for providing and maintaining for the duration of the Work, a road through the Work, including the road under construction, in accordance with the Manual of Uniform Traffic Control Devices (MUTCD).

The Contractor shall not be required to maintain a road through the Working Area until such time as the Contractor has commenced operations or on any part of the Contract that has been accepted in accordance with these General Conditions.

The Contractor will bear the cost of maintaining, in a satisfactory condition for traffic, a road through the working area. The road through the Work will include any detour constructed in accordance with the Contract Documents or required by the Engineer. Compensation for all labour, equipment and materials to do this work and to maintain the road, shall be considered to be included in the prices bid for the various tender items and no additional payment will be made.

Where work under the Contract is discontinued for any extended period including seasonal shutdown, the Contractor shall, when directed by the Engineer, open and place the roadway and detours in a passable, safe and satisfactory condition for public travel.

Where the Contractor constructs a detour which is not specifically provided for in the Contract Document or required by the Engineer, the construction of the detour and, if required, the subsequent removal shall be performed at the Contractor's expense. The detour shall be constructed and maintained to structural and geometric standards approved by the Engineer. Removal shall be performed as directed by the Engineer.

Compliance with the foregoing provisions shall in no way relieve the Contractor of obligations under General Conditions, Part 9, Protection of Persons and Property, dealing with the Contractor's responsibility for damage claims.
SUPPLEMENTARY GENERAL CONDITIONS

In order to satisfy the Owner that the Contractor has addressed concerns regarding traffic control and safety it will be required to submit a sketch indicating its proposed method of barricades and/or signage for each of the work sites included in the Contract. This information shall be available for review and approval by the Engineer at the Contract pre-construction meeting.

3.1.10 Residential and Commercial Access

The Contractor shall provide additional written notice to residents and businesses a minimum of one day prior to access restrictions. The content and form of the written notifications shall be reviewed and approved by the Engineer prior to delivery. Emergency access and pedestrian access to all properties shall be maintained at all times. Access for local traffic shall be maintained at all times except when work is proceeding immediately adjacent to a property. Suitable access shall have a minimum lane width of 3.0m and be defined as a bladed and comfortable driving surface, free of potholes and other impediments, sufficient to accommodate a standard two-wheel drive passenger vehicle at a speed of 30 km/h. Residents and businesses affected by watermain shutdowns must be notified, in writing, at least two days hours prior to a shutdown. Each customer should be impacted by a water shutdown no more than one time.

3.1.11 The Contractor shall arrange for public advertising of road closures and shall provide notification and coordination with all emergency and public services, including Transit, garbage collection, Canada Post, Ministry of Transportation, etc.

3.1.12 Notification of Ground Disturbance for Archaeological Monitoring

“The Contractor to notify the Owner in writing a minimum of 5 working days prior to performing any ground excavation within the limits of construction. All excavation and trenching of ground below the existing road structure (road structure to include the asphalt and road base) or existing topsoil is to be completed under the supervision of an archaeological monitor and in a total of twelve (12) eight (8) hour work days.”

GC 3.5 CONSTRUCTION SCHEDULE

In paragraph 3.5.1 sub-paragraph .1, delete “. . . prior to the first application for payment. . .” and replace with the following:

“within ten (10) working days after Notice of Award”;

Add paragraph 3.5.1.4:

3.5.1.4 If the Contractor submits a Construction Schedule or a revision to the Construction Schedule indicating that any Milestone Dates will not be met then receipt of such schedule by the Consultant will not relieve the Contractor of the obligation to meet the Milestone Dates as set out in the Contract Documents.
Add the following paragraph:

3.5.1.5 The Contractor shall immediately notify the Consultant in writing of any occurrence which, in the opinion of the Contractor has caused or which the Contractor anticipates may cause a delay to, or which will affect, the performance of the Work in accordance with the Construction Schedule. Such notice shall include complete details of the reason for the delay, the anticipated length of the delay and a revision to the Construction Schedule in accordance with the anticipated delay.

Add the following paragraphs 3.5.2, 3.5.3, 3.5.4, 3.5.5, 3.5.6 and 3.5.7:

3.5.2 The Contractor shall perform the Work in compliance with the Milestone Dates and the Construction Schedule. Any such failure to comply shall be deemed to be a default to which the provisions of GC 7.1.2 to GC 7.1.6 (inclusive) apply.

3.5.3 If the Consultant determines that, because of the Contractor’s own acts or omissions, the progress of the Work is behind the Construction Schedule, or the Contractor will not meet any particular Milestone Date then the Contractor shall, upon written notice from the Consultant and at the Contractor’s own cost, take all reasonable measures to accelerate the Work so as to conform to the Construction Schedule or meet the Milestone Date.

3.5.4 If the Consultant determines that, because of reasons other than the Contractor’s own acts or omissions, the progress of the Work is behind the Construction Schedule, or will not meet any particular Milestone Date, or if the Owner desires to accelerate the Work to achieve early completion of the Work, then on written notice from the Consultant the Contractor shall accelerate the Work as directed by the Consultant at the Owner’s cost, such acceleration to be a change to the Work to which the provisions of Part 6 shall apply.

3.5.5 If the Consultant has not directed the Contractor to accelerate the Work at the Owner’s cost, the Contractor shall not be entitled to claim any payment on account of acceleration costs unless the Contractor has given prior written notice within 5 working days to the Consultant setting out that the Contractor intends to claim such costs and the reasons for such claim, provided however that the giving of such notice shall not entitle the Contractor to payment of such costs.

3.5.6 If the Contractor accelerates the performance of the Work because of a notice given pursuant to GC 3.5.3, or for the Contractor’s own benefit, then the Owner may claim all reasonable additional costs incurred as a result of such acceleration.
3.5.7 If, for any reason, the Contractor deems it necessary to accelerate the Work then the Contractor shall provide written notice of its intention to accelerate the Work 5 Working Days prior to doing so and shall accelerate the Work at its own expense.

GC 3.6 SUPERVISION

Subsection GC 3.6.1 is deleted, and replaced with the following paragraph:

3.6.1 The Contractor shall be solely responsible for construction health and safety within the working areas and for compliance with the Occupational Health and Safety Act and Regulations. So as to avoid any misunderstanding as to the extent of the Contractor’s responsibility, the Contractor, by executing the Contract unequivocally acknowledges that the Contractor is the Constructor within the meaning of the Act and shall be assigned Prime Contractor.

Section GC 3.6 is amended by adding the following paragraph:

3.6.3 To co-ordinate the work, the Contractor or person(s) authorised to act for the Contractor will attend regular meetings with the Engineer or his representative during the period over which the work under the Contract is carried out, at a time and place to be decided by the Engineer.

Add the following paragraphs:

3.6.4 The Contractor shall employ a competent senior representative at the Place of the Work (the “Supervisor”) who shall have the responsibility to ensure that the Work is performed in compliance with the Contract Documents. The Contractor shall also employ any assistants to the Supervisor necessary for the Contractor to perform its obligations under this Agreement and the Supervisor and assistants shall be in attendance at the Place of Work while the Work is being performed.

3.6.5 The Supervisor shall represent the Contractor at the Place of the Work and instructions given to the Supervisor by the Consultant shall be deemed to have been given to the Contractor.

3.6.6 If the competence or performance of the Supervisor is not satisfactory to the Consultant then, on written request from the Consultant, the Contractor shall provide a replacement satisfactory to the Consultant. The Contractor shall not change the Supervisor without consent of the Consultant, such consent not to be unreasonably withheld.

GC 3.7 SUBCONTRACTORS AND SUPPLIERS

Add the following paragraph:
SUPPLEMENTARY GENERAL CONDITIONS

3.7.7 The Contractor shall, in respect of his Subcontractors, be held responsible for and shall ensure that said Subcontractors obtain and pay for all necessary permits, fees, licenses and certificates of inspection and insurance in connection with the Work as may be required by applicable statutes, regulations, by-laws and ordinances.

GC 3.8 LABOUR AND PRODUCTS

Section GC 3.8 is amended by the addition of the following paragraphs:

3.8.4 Contractor to keep Records which are to be Open for Inspection

The Contractor shall keep proper books and records showing the names, trades, addresses and hourly wage rates of all employees in his employ and the wages paid to and time worked by such employees both at regular wage rates and at overtime wage rates, and the books or documents containing such records shall be open for inspection by Officers of the Ministry of Labour, British Columbia, at any time it may be expedient to the Minister of Labour to have the same inspected.

3.8.5 If the Owner specifically authorizes, in writing, that the Contractor shall purchase any special tool, equipment, or other things at the expense of the Owner then such items shall become the property of the Owner. The Contractor shall bear the risk of loss or damage, normal wear and tear expected, to all such items for the time when such items are taken out of the possession and control of the Owner. Upon completion of the project, the Contractor shall deliver all such special tools, equipment and other things to the Owner.

GC 3.10 SHOP DRAWINGS

Add the following new subsection:

3.10.13 The Contractor shall submit all Shop Drawings, as-built drawings and any other drawings concerning the Work in triplicate and in reproducible, suitable, and usable electronic form.

GC 3.11 USE OF THE WORK

Section GC 3.11 is amended by the addition of the following subsections:

3.11.3 The Contractor shall maintain the Working Area in a tidy condition and free from the accumulation of debris.

3.11.4 The Contractor shall ensure that during night work the site of the Work is adequately floodlit to the Engineer's satisfaction.
SUPPLEMENTARY GENERAL CONDITIONS

3.11.5 Streets beyond the limits of the work and other construction areas shall be kept clean. Dusty materials shall be transported in covered haulage vehicles. Wet materials shall be transported in suitable watertight haulage vehicles.

3.11.6 The Contractor shall take such steps as may be required to prevent dust nuisance resulting from its operations either within the limits of the work or elsewhere or by public traffic where it is the Contractor's responsibility to maintain a roadway through the Work.

3.11.7 Where the Work requires the sawing of asphalt or the sawing or grinding of concrete, blades and grinders of the wet type shall be used together with sufficient water to prevent the incidence of dust, wherever dust would affect traffic or wherever dust would be a nuisance to residents of the area where the Work is being carried out.

3.11.8 Permitted dust control measures may include the application of calcium chloride, or water. More frequent applications of water should be employed in close proximity to watercourses.

3.11.9 The Contractor will obtain any Road Usage Permits required for Work within City Roadways.

3.11.10 The Contractor will submit a traffic management plan sealed by a professional engineer for approval by the Consultant showing how the Contractor will provide for safe and efficient access and exit of construction vehicles from Place of Work and the Contractor will ensure all work is conducted in accordance with the plan.

GC 3.13 CLEANUP

Add the paragraph 3.13.4 as follows:

3.13.4 The Contractor is responsible for dust control within the Place of the Work and roadways beyond the limits of the Place of the Work that have been affected during construction. While performing the Work the Contractor shall control dust originating from the Work and shall take immediate corrective action if directed by the Consultant. The Contractor will clean the Place of the Work and employ a street sweeper to clean affected roadways as directed by the Consultant. Dusty or loose materials shall be transported in covered haulage vehicles. Wet materials shall be transported in suitable watertight haulage vehicles.
SUPPLEMENTARY GENERAL CONDITIONS

The General Conditions are amended by the addition of the following section GC 3.14:

**GC 3.14 COMMUNICATIONS PROTOCOL**

3.14.1 All communications to and from the Contractor shall go through the Engineer. The Contractor shall not take any direction from Owner’s operation staff except under emergency situations.

**GC 5.2 APPLICATIONS FOR PROGRESS PAYMENT**

Section GC 5.2.1 is deleted, and replaced with the following:

5.2.1 Application for payment on account as provided in Article A-5 of the Agreement – PAYMENT may be made monthly as the work progresses, and in accordance with subsection GC 5.2.1.1 which follows:

5.2.1.1 Notwithstanding Paragraph GC 5.2.7 the Owner may withhold any or all payments to the Contractor or portions thereof in circumstances where the Contractor is considered by the Owner or Engineer to be unreasonable or in default of specified times for completion of the work.

Add the following paragraphs 5.2.8, 5.2.9, and 5.2.10 as follows:

5.2.8 As a condition to all payments, the Contractor shall submit to the Consultant a Statutory Declaration on the standard Canadian Construction Association (CCA) 9A 2001 declared before a notary public or commissioner for oaths for the Province of British Columbia stating that:

.1 all wages for the various classes of labour, and all accounts for purchase of materials, equipment, or for the rental of equipment employed in or about the Work, and amounts due to Subcontractors have been paid;

.2 there are no outstanding claims or liens relating to labour or services provided in connection with the Work; and

.3 all levies, assessments and sums due under any applicable Workers' Compensation laws or similar laws in force at the place of the Work have been fully paid.

As a further condition of payment, there shall be no liens registered against the Place of the Work, arising from or connected with the Work. In the event that a claim of builders lien relating to the Work has been registered against title to the Place of the Work, the Contractor shall be obligated, at its expense, to take all steps necessary, including making court application, to have the claim of lien immediately discharged from title to the Place of the Work and to indemnify the Owner for all costs, including court costs on a solicitor and own client basis, incurred as a result.
5.2.9 As a condition to all payments after the first progress payment, the Contractor shall also submit to the Consultant a Statutory Declaration for “Statement of Claims” on a form approved by the Owner, also declared before a notary public or a Commissioner for Taking Oaths for the Province of British Columbia stating:

.1 there are no outstanding claims for payment for Work, or changes to the Construction Schedule in respect of Work, performed beyond the scope of the Contract, or

.2 there are outstanding claims for payment for Work, or changes to the Construction Schedule in respect of Work, performed beyond the scope of the Contract which have been communicated to the Consultant in writing, but for which a Change Order or Change Directive has not yet been received; or

.3 there are outstanding claims for payment for Work, or changes to the Construction Schedule in respect of Work, performed beyond the scope of the Contract, including adjustments to the Construction Schedule, for which Change Orders or Change Directives have not been issued and which have not yet been communicated to the Consultant in writing.

5.2.10 Applications for payment on account may be made monthly as the Work progresses. The Contractor shall present to the Engineer two [2] copies of the estimate that he has certified to be correct. Two [2] copies of each progress payment certificate shall be delivered by the Engineer to the Contractor. Upon receipt of the progress payment certificate verified as aforesaid and upon its approval by the Engineer, the Owner will process the payment to the Contractor.

GC 5.3 PROGRESS PAYMENT

Notwithstanding the provisions of Article A5-Payment, GC 5.3.1.3 is deleted and replaced with the following:

5.3.1.3 The Owner shall make payment to the Contractor on account as provided in Article A-5 of the Agreement – payment no later than 30 days after the date of Certificate for Payment issued by the Consultant.

(a) The Contractor shall furnish the Engineer with satisfactory evidence in the form of a WorkSafe BC Certificate of Clearance that he has made suitable provision for meeting any liability under The Workers Compensation Act of British Columbia, prior to the release of any monthly progress payment.
SUPPLEMENTARY GENERAL CONDITIONS

(b) The Contractor shall furnish the Engineer with a Statutory Declaration that all liabilities incurred by the Contractor and its sub-Contractors in carrying out the Contract have been discharged and that all liens in respect of the Contract have expired or have been satisfied, discharged or provided for by payment. The Statutory Declaration shall be provided prior to all monthly progress payments except the first one.

GC 5.4 SUBSTANTIAL PERFORMANCE OF THE WORK

Add new paragraphs 5.4.4, 5.4.5 and 5.4.6 as follows:

5.4.4 Prior to or at the time of applying for a review under paragraph 5.4.1 to establish Substantial Performance of Work, the Contractor shall submit to the Consultant the following items:

.1 Letters of Assurance for professional design and review from those professionals engaged by the Contractor under the provisions of the Contract, including all applicable sealed shop drawings.
.2 All required manufacturer’s inspections, certifications, guarantees, warranties as specified in the Contract Documents.
.3 All maintenance manuals, operating instructions, maintenance and operating tools, replacement parts or materials as specified in the Contract Documents.
.4 Certificates issued by all permit issuing authorities indicating approval of all installations requiring permits.
.5 Certificates issued by all testing, commissioning, cleaning, inspection authorities and associations as specified in the Contract Documents.
.6 All Drawings and as-installed documents in the form specified in the Contract Documents.
.7 A certificate issued by Workers Compensation Board confirming that the Contractor has paid all assessments.

5.4.5 Prior to Substantial Performance of the Work and in addition to the lien holdback, a deficiency holdback shall be established for Work determined by the Consultant to be defective or incomplete (the “Deficiency Holdback”). The Consultant shall establish the amount of the Deficiency Holdback as twice the estimated cost to rectify defective work and finish incomplete Work using the services of another contractor or the Owner’s own forces. No part of the Deficiency Holdback shall become payable until all of the defective Work is corrected and all of the Work is complete. If the defective or incomplete Work is not corrected or completed within a reasonable time as determined by the Consultant, then all or a portion of the Deficiency Holdback as determined by
SUPPLEMENTARY GENERAL CONDITIONS

the Consultant may be retained by the Owner to be applied against the loss and damage suffered by the Owner to correct or complete the Work.

5.4.6 The Contractor’s application for the Certificate of Substantial Performance shall constitute a waiver and release by the Contractor of any and all claims arising out of or relating to the Contract up to the date of Substantial Performance of the Work. This waiver and release shall apply without limitation to claims that arise due to the negligence or breach of contract by the Owner, the Consultant, and their respective employees, agents, officers and consultants, but does not include claims made by the Contractor in writing prior to application for a certificate of Substantial Performance of the Work and delivered to the Consultant prior to the date of Substantial Performance of the Work and still unsettled.

GC 5.5 PAYMENT OF HOLDBACK UPON SUBSTANTIAL PERFORMANCE OF THE WORK

Replace Section 5.5.2 with the following paragraph:

5.5.2 “The Contractor shall furnish to the Owner a statutory declaration, dated not earlier than 7 days after expiry of the statutory lien period stating that no lien claim has been filed against title to the lands of the Owner or the lands of any other person and stating that all materials, labour, work, and services incurred directly or indirectly on account of the work have been paid for by the Contractor.”

Delete Section 5.5.3 in its entirety.

GC 5.7 FINAL PAYMENT

Replace Section 5.7.4 with the following paragraph:

5.7.4 “Subject to the provision of paragraph 10.4.1 of GC 10.4 – WORKERS’ COMPENSATION, and any lien legislation applicable to the Place of Work, the Owner shall, no later than thirty (30) days after the issuance of a final certificate for payment, pay the Contractor as provided in Article A-5 of the Agreement – PAYMENT.”

PART 6 CHANGES IN THE WORK

Throughout Part 6, Changes In The Work, “Change Directive” shall have the same meaning as “Field Order.”
SUPPLEMENTARY GENERAL CONDITIONS

GC 6.1 CHANGES

Section GC6.1 is amended by the addition of the following:

6.1.3 When the valuation of a change in the work is to be determined either by estimate and acceptance in a lump sum, or by cost and fixed, or, percentage fee, the valuation shall be in accordance with the following:

6.1.3.1 Mark Up

Cost of net increases or decreases to contract value due to changes in the work shall be marked up as follows:

Contractor’s Own Work: 10 percent of actual base costs;

Sub-contractor’s Own Work: 10 percent of actual base costs;

Sub-contractor’s Work: Contractor’s mark-up is 5 percent of actual base costs.

6.1.3.2 Substantiation

When requested, the Contractor shall submit details, quantities, prices, and fees together with substantiating documentation.

6.1.3.3 Time for Submission and Acceptance of Quotation

The Contractor shall co-operate in the pricing of changes by submitting quotations within 10 days of the Engineer's request. Quotations shall remain open for acceptance for 21 days from the date of submission.

6.1.4 Other Methods for the Valuation of Changes

The Engineer shall determine the amount, if any, to be added to, or deducted from, the sum named in the Tender, in respect of any changes ordered. All such work shall be valued at the prices set out in the Form of Tender and the Schedule of Additional Unit Prices if such are applicable in the opinion of the Engineer.

If this Contract does not contain any prices applicable to changes requested, then the Contractor and Engineer may agree on a price which shall be comparable to prices quoted on work of a similar nature.

Valuation methods presented in the construction documents are mutually exclusive in terms of their application.
6.1.5 The Contractor shall not be entitled to rely on any oral representation (except in an emergency in which GC 6.1.6 will apply), site meeting discussion, site meeting minutes, or other communication as approval that any Work is a Change. The Contractor must receive a Change Order or Change Directive before proceeding with a Change and the Contractor shall strictly comply with the requirements of this GC.

6.1.6 In an emergency, when it is impractical to delay a Change Directive, the Consultant may issue an oral direction which the Contractor shall follow. In such event, the Consultant shall issue a Change Directive at the first opportunity.

GC 6.2 CHANGE ORDER

Change the first part of paragraph 6.2.2 to read “When the Owner and the Contractor agree in writing…”

Add:

6.2.3. When the valuation of a change in the Work is to be determined either by estimate and acceptance in a lump sum, or by cost and fixed or percentage fee, the valuation shall be in accordance with the following:

.1 Work performed by the Contractor – Contractors direct field costs plus 10% mark-up for overhead and profit.

.2 Work performed by the Sub-Contractor – Sub-contractors will receive direct field costs plus 10% mark-up for overhead and profit. The General Contractor will receive an additional 5% markup on the actual cost evidenced by invoice to cover all overhead and profit.

GC 6.3 CHANGE DIRECTIVE

Subsection GC 6.3.6.1 is deleted and replaced with the following:

6.3.6.1 If the change results in a net increase in the Contractor’s cost, the Contract Price shall be increased by the amount calculated in accordance with Supplemental General Condition 6.1.3.

Subsection GC 6.3.6.2 is deleted and replaced with the following:

6.3.6.2 If the change results in a net decrease in the Contractor’s cost, the Contract Price shall be decreased by the amount calculated in accordance with Supplemental General Condition 6.1.3.
Delete and replace GC 6.3.6.3 with:

6.3.6.3 The Contractor's fee will cover all overhead and profit and will be calculated as follows:

.1 Work performed by the Contractor – Contractor's direct field costs plus 10% mark-up for overhead and profit.

.2 Work performed by the Sub-Contractor – Sub-contractors will receive direct field costs plus 10% mark-up for overhead and profit. The Contractor will receive a 5% markup on the Sub-contractor's actual cost evidenced by invoice to cover all of the Contractor's overhead and profit.

Section GC 6.3 is further amended by the addition of the following:

6.3.14 Upon receipt of a Change Directive, the Contractor may be directed, by either the Owner, or the Engineer, to proceed with extra work on the basis of daily force account sheets provided:

(i) Pre-approved, all inclusive, labour, material, and equipment rental charge out unit rates are on file with the Engineer.

(ii) Daily force account sheets outlining, as a minimum, the unit quantities used for the day, field instruction number, project name, and date, are provided to the Engineer for signature, and records, on a daily basis for work completed on the previous working day.

(iii) Work to proceed on the basis of daily force account sheets only after the Engineer has issued the Contractor a written, and numbered, change directive, or field instruction, to proceed with the extra work.

"Daily force account sheet" shall have the same meaning as "daily extra work order sheet", "daily work records", or, "daily time sheet."

Whenever extra work is being performed in accordance with GC 6.3.14 the Contractor shall submit daily force account sheets for approval to/by the Engineer showing the quantities of labour, materials and equipment used directly in carrying out each order for work on the preceding day, together with substantiating documentation. No claim for compensation for extra work will be considered in absence of such force account sheets. The Engineer will not allow any compensation for the cost of repairs to equipment or for damage to anything used in performing such extra work.

The Contractor shall not be entitled to interest on any bill for extra work on account of delay in its approval by the Engineer, or the Owner.
GC 6.4 CONCEALED OR UNKNOWN CONDITIONS

Add the following paragraphs 6.4.5 and 6.4.6:

6.4.5 Despite the rest of this GC, Contract Time will not be extended and the Contractor will not be entitled to any increase in the Contract Price due to conditions of the Place of the Work which the Consultant determines would have been reasonably foreseeable by the Contractor had the Contractor conducted a reasonable inspection of the Place of the Work, including the subsurface soil conditions of the Place of the Work.

6.4.6 Before commencing any Work at the Place of the Work, the Contractor shall be responsible to locate in three dimensions all underground utilities and structures indicated on the Contract Documents as being at the Place of Work. The Contractor shall also be responsible to consult with all utility providers that provide electricity, communication, gas, or other utility services in the area of the Place of the Work, to locate in three dimensions all underground utilities for which they have records. The Contractor shall also locate in three dimensions any other utilities or underground structures that are reasonably apparent in an inspection of the Place of the Work.

GC 6.5 DELAYS

Section GC6.5 is amended by the addition of the following:

6.5.6 In the case of an application for an extension due to abnormal inclement weather, the Contractor shall, with the Contractor's application, submit evidence from Environment Canada in support of such application. Extension of Contract Time will be granted in accordance with subsection GC 6.5.3.

6.5.7 If the Contractor's operations expose any items which may indicate an archaeological find, such as building remains, hardware, accumulations of bones, pottery, or arrowheads:

a) The Contractor shall immediately notify the Engineer and suspend operations within the area identified by the Engineer. Work shall remain suspended within that area until otherwise directed by the Engineer in writing.

b) Any delay in the completion date of the Contract that is caused by such a cessation of construction operations will be considered to be beyond the Contractor's control in accordance with Subsection GC6.5.3.

c) Any work directed or authorised by the Engineer with an archaeological find will be considered as Extra Work in accordance with Section GC6.5.3.
SUPPLEMENTARY GENERAL CONDITIONS

6.5.8 The Owner is not liable to pay Standby Time for any labour or equipment rental under this Contract.

6.5.9 The Contractor shall complete this Contract in its entirety by the completion date specified in the Tender Form.

If the time limit specified is not sufficient to permit completion of the Work by the Contractor working a normal number of hours each day or week on a single daylight shift basis, it is expected that additional and/or augmented daylight shifts will be required throughout the life of the Contract to the extent deemed necessary by the Contractor to ensure that the Work will be completed within the time limit specified. Any additional costs occasioned by compliance with these provisions will be considered to be included in the prices bid for the various items of Work and no additional compensation will be allowed therefore.

6.5.10 An extension of time may be granted in writing by the Engineer in his sole discretion in the event of the Work being delayed beyond the prescribed time for completion. Such extension shall be for such time as the Engineer may prescribe and the Engineer shall fix the terms on which such an extension may be granted. An application for an extension of time shall be made in writing by the Contractor to the Owner at least 15 days prior to the date of completion fixed by the Contract. The date of expiry of all Bonds and other Surety furnished to the Owner by the Contractor shall be extended at the expense of the Contractor.

6.5.11 Any extension of time that may be granted to the Contractor shall be so granted and accepted without prejudice to any rights of the Owner whatsoever under this Contract and all of such rights shall continue in full force and effect after the time limited in this Contract for completion of the work and whenever in this Contract, power or authority is given to the Owner or the Engineer or any person to take any action consequent upon the act, default, neglect, delay, breach, non-observance or non-performance by the Contractor in respect of the Work or Contract of any portion thereof, such powers or authorities may be exercised from time to time, and not only in the event of the happening of such contingencies before the time limited in this Contract for the completion of the Work but also in the event of the same happening after the time so limited in the case of the Contractor being permitted to proceed with the execution of the Work under an extension of time granted by the Owner. In the event of the Owner granting an extension of time, time shall continue to be deemed strictly of the essence of this Contract.

6.5.12 Immediately upon signing the Contract, the Contractor must review product requirements and anticipate foreseeable delivery delays in any items. If delays in deliveries of material, equipment, or articles are foreseeable, propose substitutions or other remedial action in ample time to prevent delay in performance of the Work.
SUPPLEMENTARY GENERAL CONDITIONS

If such proposal is not given to the Engineer by the Contractor, the Engineer reserves the right to substitute more readily available products later in order to prevent delays at no additional cost to the Owner.

No substitution of any item will be permitted unless the specified item cannot be delivered to the job site in time to comply with the Schedule and the Engineer has approved the substitutes.

To receive approval, proposed substitutes must equal or exceed the quality, finish, and performance of those products specified and/or shown, and must not exceed the space requirements allotted on the drawings. The Contractor must provide documentary proof of equality.

6.5.13 It is agreed by the Parties to the Contract that in case all the Work called for under the Contract is not finished by the completion date specified in the Tender Form or as amended by the Engineer, damage will be sustained by the Owner, and that it is and will be impracticable and extremely difficult to ascertain and determine the actual damage which the Owner will sustain in the event of and by reason of such delay. The Parties therefore agree that the Owner may deduct from monies owing to the Contractor the sum of $2,000 per day, or all direct out-of-pocket costs, such as safety, security, or equipment rental, reasonably incurred by the Owner as a direct result of such delay, for Liquidated Damages for each and every calendar day's delay in completing the Work beyond the date of completion prescribed and it is agreed that amount is an estimate of actual damage to the Owner which will accrue during the period in excess of the prescribed date of completion.

The Contractor shall not be assessed with Liquidated Damages for any delay caused by Acts of God, or of the Public Enemy, Act of the Owner, the Engineer, or of any Foreign State, Fire, Epidemics, Quarantine Restrictions,Embargoes, or Delays of Sub-Contractors due to such causes. If the Contractor is delayed by reason of alterations or changes made under GENERAL CONDITIONS OF THE STIPULATED PRICE CONTRACT, PART 6, GC 6.1 CHANGES, the time of completion shall be extended as determined by the Engineer in his sole discretion.

6.5.14 In the event of any delay the Contractor shall take all reasonable measures to minimize the effects and costs of the delay and (except where the delay is caused by the Owner or the Consultant or other cause reasonably outside of the control of the Contractor) the Contractor will be responsible for all costs relating to the delay.

6.5.15 The Contractor shall maintain and protect the Work during the period of delay in the performance of the Work.
SUPPLEMENTARY GENERAL CONDITIONS

GC 7.1 OWNER’S RIGHT TO PERFORM WORK OR STOP THE WORK OR TERMINATE CONTRACT

Subsections GC 7.1.2 and GC 7.1.3 are amended as follows:

7.1.2 Change reference from five (5) to three (3) working days.

7.1.3 Change reference from five (5) to three (3) working days.

Section GC 7.1 is amended by the addition of the following paragraphs:

7.1.7 The Engineer may stop any portion of the Work, if in his judgement the weather is such as to prevent the Work being properly done. No compensation of any kind will be made for such stoppage except an extension of time for the completion of the Work as provided in GC6.5.3

7.1.8 The Contractor shall, upon written notice from the Engineer, discontinue or delay any or all Work of base, foundation, or paving construction on any section of any road, if in the opinion of the Engineer, the foundation is not sufficiently compacted or settled for surfacing of the Work in question, and the Work shall not be resumed until the Engineer shall in writing so direct, and the Contractor shall not be entitled to any compensation for such stoppage or delay to the Work, other than an extension of time.

7.1.9 If the Owner decides for any reason not to proceed with the Project, the Owner may terminate this Agreement by giving thirty (30) days prior written notice to the Contractor. Upon receipt of such written notice, the Contractor shall perform no further services other than those reasonably necessary to close out the project. In such event, the Contractor shall be paid by the Owner for all services performed and all disbursements incurred pursuant to this Agreement and remaining unpaid as of the effective date of such termination.

GC 7.2 CONTRACTOR’S RIGHT TO STOP THE WORK OR TERMINATE CONTRACT

Delete entirely paragraph 7.2.3.1.

Replace paragraph 7.2.5 with the following:

“7.2.5 If the Contractor terminates the Contract under the conditions set out above, the Contractor shall be entitled to be paid for all work performed under the Contract including reasonable profit and will be entitled to no further compensation from the Owner.”
SUPPLEMENTARY GENERAL CONDITIONS

GC 8.2 NEGOTIATION, MEDIATION, AND ARBITRATION

Delete paragraph 8.2.1 and substitute the following:

8.2.1 In accordance with the latest edition of the Rules for Mediation of CCDC 40 - 2005 Rules for Mediation and Arbitration of Construction Disputes, the parties shall appoint a Project Mediator within 15 working days after both parties agree in writing that a Project Mediator be appointed.

Delete the paragraphs 8.2.6, 8.2.7 and 8.2.8 and replace with the following:

8.2.6 Upon termination of mediated negotiations, either party may refer the unresolved dispute to the courts or to any other form of dispute resolution, including arbitration, which the parties have agreed to use.

GC 9.1 PROTECTION OF WORK AND PROPERTY

Section GC 9.1 is amended by the addition of the following subsections:

9.1.5 When carrying out excavation work, the Contractor may encounter such underground utilities as sewers, gas mains, telephone cables, power cables, and watermains. The Contractor shall be fully responsible for any breakage or damage to such utilities, and the Contractor shall pay the full cost of repairing such damages and making good any losses or damages which are caused as a result of his operation in carrying out this Contract.

9.1.6 It shall be the Contractor's responsibility to obtain written permission and to make any required arrangements with the Owners of any adjacent properties which the Contractor may encroach.

9.1.7 The Contractor shall furnish and bear the cost of any watchman he may require for protection to perform this Contract except as provided in paragraph GC 10.2.6.

GC 9.4 CONSTRUCTION SAFETY

Delete paragraph 9.4.1 and replace with the following:

9.4.1 The Contractor shall be solely responsible for construction safety at the Place of the Work as and to the extent required by applicable legislation, regulations, and codes, including the Workers Compensation Act, applicable regulations, and good construction practice, and shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the performance of the Work.

GC 10.1 TAXES AND DUTIES

Add paragraph 10.1.3 as follows:
10.1.3 Any tax including, without limiting the generality of the foregoing, the Value-Added Tax or any government sales tax, customs, duty, or excise tax, whether paid or not, which is found to be inapplicable or for which exemption may be obtained is, the sole and exclusive property of the Owner. The Contractor agrees to cooperate with the Owner or his agent in the application for any refund of any such taxes, which cooperation shall include without limitation making or concurring in the making of application for any such refund or exemption and providing to the Owner or his agent copies, or where required, originals, or records, invoices, purchase orders and other documentation necessary to support such application for exemption or refund.

Add paragraph 10.1.4 as follows:

10.1.4 Where any invoices or other documents are required for tax and duty refund purposes, the Contractor shall provide the Owner with such invoices and other documents as may be necessary to substantiate the amount of taxes or duties paid during the performance of the Contract for which the Owner may rightfully claim redemption.

Add paragraph 10.1.5 as follows:

10.1.5 The Contractor agrees to provide the Owner with a signed statement, if requested by the Owner, in which is the Contractor confirms that the Contractor and all Subcontractors relinquish all claims to any refunds or reimbursements of any Federal or Provincial taxes paid by the Contractor relating to performance of the Contract for which the Owner may rightfully claim redemption and the Contractor hereby relinquishes all such claims.

GC 10.2 LAWS, NOTICES, PERMITS AND FEES

Subsection GC 10.2 is amended by the addition of the following paragraph:

10.2.8 The Contractor will notify, obtain inspections and approvals from, and co-operate with other organizations involved or affected by the Work, such as telephone, light and power, gas, railway companies, government agencies.

GC 10.4 WORKERS’ COMPENSATION

Add the following sentence to paragraph 10.4.1:

“The Contractor agrees that the Owner has the unfettered right to set off the amount of any unpaid premiums and assessments for WorkSafe BC coverage against any monies owing by the Owner to the Contractor.”
SUPPLEMENTARY GENERAL CONDITIONS

Add paragraph 10.4.3 as follows:

10.4.3 The Contractor shall indemnify and hold harmless the Owner from all manner of claims, demands, damages, costs, losses, penalties, actions, causes of action, and proceedings arising out of or in any way related to unpaid WorkSafe BC assessments owed by any person working on the Project or relating to the Work or arising out of or in any way related to the failure to observe safety rules, regulations, and practices of WorkSafe BC.

Add paragraph 10.4.4 as follows:

10.4.4 The Contractor will be the “Prime Contractor” for the Project under the Workers Compensation Act (British Columbia) and will fulfill all obligations of the “Prime Contractor” under that Act, including by ensuring that the activities of any employees, workers, and other persons at the Place of the Work relating to occupational health and safety are coordinated and by doing everything that is reasonably practicable to establish and maintain a system or process that will ensure compliance with the Workers Compensation Act and the regulations under that Act applicable to the Place of the Work.

GC 11.1 INSURANCE

Sub-subsection GC 11.1.1.1 is replaced by the following:

11.1.1.1 General Liability Insurance:

The Contractor shall obtain and maintain Comprehensive General Liability Insurance against Bodily Injury and Property Damage claims with respect to all work to be performed under this Contract. Such Insurance shall:

a) be in the joint names of the Contractor, the Owner, and the Engineer of the above employed directly or indirectly in the work to be performed.

b) contain a Cross Liability Clause;

c) include coverage for:

i) Completed Operations, which coverage shall be maintained continuously in force for a period of not less than 24 months from the date of the Certificate of Total Performance of the Work, and thereafter to be maintained for a further period of four (4) years

ii) Blanket Contractual Liability

iii) Contingent Employers Liability

iv) Non-owned Automobile Liability

v) Broad Form Property Liability

vi) Excavation
SUPPLEMENTARY GENERAL CONDITIONS

d) where applicable, include coverage for:
  
  i) Underpinning, shoring
  
  ii) Demolition
  
  iii) Building raising or moving
  
  iv) Blasting or the Use of Explosives
  
  v) Tunnelling
  
  vi) Pile driving, caisson work

e) Five-million dollars ($5,000,000.00) inclusive per occurrence.

Amend Subsection GC 11.1.1.6 by the addition of the following paragraph:

(4) Property and Boiler insurance is required.

Subsection GC 11.1.9 is added as follows:

11.1.9.1 It shall be the duty of the Contractor to fully comply with the terms and conditions of the Liability Insurance coverage, including, without limiting the generality of the foregoing, the requirement to promptly report claims to the Insurer.

11.1.9.2 The Contractor shall also promptly notify the Engineer of all such claims in writing.

11.1.9.3 If a claim is settled, the Contractor shall thereupon provide the Engineer with a copy of the Claimant's Release.

11.1.9.4 If a claim is rejected, the Engineer shall be notified at the time of rejection.

11.1.9.5 The Engineer shall be provided full information as to such claims at all times as the Engineer may require and in any event should 30 days elapse after the claim has been received by the Contractor and the Contractor is not able to report settlement or rejection of the claim, the Contractor will provide a full report to the Engineer as to the status of and steps being taken with respect to the claim.

Subsection GC 11.1.10 is added as follows:

11.1.10 All forms of insurance to be endorsed to provide the Owner with not less than thirty (30) days written notice in advance of any cancellation, change, or amendment restriction coverage. Prior to the commencement of any work under this Contract, the Contractor shall file with the Owner, to the attention of the Owner’s Clerk, Certificates evidencing full compliance with the above clauses, in accordance with the prescribed Certificate which is located after the “Tender Form” in the documents.
SUPPLEMENTARY GENERAL CONDITIONS

GC 11.2 BONDS

Section GC 11.2 is deleted and replaced by the following:

11.2.1 The Contractor, together with a surety company approved by the Owner and authorized by law to carry on business in the Province, shall furnish a 50% Labour and Materials Payment Bond to the Owner using CCDC Document(s) 222. The bond shall remain in effect until 12 months after the date the Engineer accepts the entire work.

11.2.2 The Contractor, together with a surety company, approved by the Owner and authorized by law to carry on business in the Province in which the work is to be performed, shall furnish a Performance Bond to the Owner using CCDC Document(s) 221 in the amount of 50% of the Contract price.

GC 12.1 INDEMNIFICATION

Delete GC 12.1.1 and 12.1.2 and replace with the following:

12.1.1 Without restricting the parties’ obligation to indemnify as described in paragraphs 12.1.4 and 12.1.5, the Owner and the Contractor shall each indemnify and hold harmless the other from and against all claims, demands, losses, costs, damages, actions, suits, or proceedings whether in respect to losses suffered by them or in respect to claims by third parties that arise out of, or are attributable in any respect to their involvement as parties to this Contract, provided such claims are:

.1 caused by:
the negligent acts or omissions of the party from whom indemnification is sought or anyone for whose acts or omissions that party is liable, or
a failure of the party to the Contract from whom indemnification is sought to fulfill its terms or conditions; and

.2 made by Notice in Writing within a period of 10 years from the date of Substantial Performance of the Work as set out in the certificate of Substantial Performance of the Work issued pursuant to paragraph 5.4.2.2 of GC 5.4 – SUBSTANTIAL PERFORMANCE OF THE WORK or within such territory of the Place of the Work.

12.1.2 The obligation of either party to indemnify as set forth in paragraph 12.1.1 shall be limited as follows:

.1 In respect to losses suffered by the Owner and the Contractor for which insurance is, or for which insurance is not, required to be provided by either party shall in no event be greater than $10,000,000.
.2 In respect to claims by third parties for direct loss resulting from bodily injury, sickness, disease or death, or to injury to or destruction of tangible property, the obligation to indemnify is without limit. In respect to all other claims for indemnity as a destruction of tangible property, the obligation to indemnify is without limit. In respect to all other claims for indemnity as a result of claims advanced by third parties, the limits of indemnity set forth in paragraphs 12.1.2.1 shall apply.

GC 12.3 WARRANTY

Subsection 12.3.1 is revised to read:

12.3.1 The warranty period with regard to the Contract is one (1) year from the date of Total Performance. Such approval shall not be unreasonably withheld.

Add the following sentence to paragraph 12.3.4:

“In effecting a correction of defects or deficiencies, the Contractor shall also bear all costs involved in removing, replacing, repairing, or restoring aspects of the Work that may be affected in the process of making the correction.”

Add the following subclauses to Clause 12.3:

12.3.7 Any defective item of equipment necessitating substantial repairs or replacement within the Warranty Period shall be subject to a further Warranty Period of 12 months from the time of repairing or replacement of same. The cost associated with the extended warranty shall be borne by the Contractor.

ADDITIONS TO THE GENERAL CONDITIONS

The following clauses are additional conditions of the Contract:

GC 13 RECORD DRAWINGS

13.1 The Contractor shall keep one set of Contract drawings on the site at all times. As the work progresses, he shall record, in a neat legible manner, all changes in the work. The following information shall be recorded for each change:

   i) Full Description of change
   ii) Date
   iii) Authority

13.2 At the completion of work, this set of drawings shall be forwarded to the Engineer for incorporation in a set of “RECORD” drawings for this project.
GC 14 FIELD ENGINEERING

14.1 The Contractor shall be responsible for field engineering survey services to measure and stake the Site and survey services to establish and confirm alignment and grade measurements for the Work. Unless otherwise stipulated in the Contract Documents, all Work is to be laid out by the Contractor. Layout will consist of horizontal and vertical baseline controls.

14.2 The field surveyor shall have a minimum of 3 years surveying experience on projects of similar or larger size. The Contractor shall submit a resume of the surveyor’s experience prior to commencement. If in the Contract Administrator’s opinion, the surveyor does not have sufficient experience and familiarity with the Work, the Contractor, at no extra cost to the Owner, shall provide a suitable alternate.

14.3 Existing base horizontal and vertical control points will be provided by the Contract Administrator. The Contractor’s surveyor is to locate, confirm and protect control points prior to starting site work and preserve permanent reference points during construction. No changes or relocations are permitted without prior written notice to Contract Administrator. Report to Contract Administrator when a reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.

14.4 Survey Requirements:

- Establish at least two additional permanent bench marks on Site, referenced to established bench marks by survey control points
- Establish lines and levels, locate and lay out, by instrumentation.
- Stake for excavation, pipe laying, road construction, etc.
- Provide cross sections for calculation and payment of road excavation.
- Provide completed cut sheets and grade sheets to the Contract Administrator at least 24 hours prior to the start of each section.
- Assist the Contract Administrator in checking layout surveys and grades of installed utilities as required.

14.5 Maintain a complete, accurate log of control and survey work as it progresses. On request of the Contract Administrator, submit documentation to verify accuracy of field engineering work.

14.6 Promptly notify the Contract Administrator in writing if subsurface conditions at the Place of the Work differ materially from those indicated in the Contract Documents, or a reasonable assumption of probable conditions based thereon. After prompt investigation, should Contract Administrator determine that the conditions do differ materially, instructions will be issued for changes in the Work as provided in the General Conditions.
14.7 The Contractor, upon entering the site for the purpose of beginning Work, shall locate all reference points and take all necessary precautions to prevent their destruction. The Contractor shall be charged with the cost of verifying or replacing any legal survey pins, monuments, or reference stakes damaged during construction operations. In the event that the Contractor requires the removal of any legal survey markers for the purpose of the Work, the cost of replacement will be borne by the Owner, provided the written consent of the Contract Administrator is first received and the pin has been adequately referenced by a BCLS. The Contractor shall provide and pay for all stakes, markers and tools.

END OF SECTION
Division 1
## GENERAL REQUIREMENTS

### INDEX FOR GENERAL REQUIREMENTS

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END OF INDEX
GENERAL REQUIREMENTS

1. DOCUMENTS

.1 This section forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts of the Contract Documents.

.2 The Specifications have been divided into approximate trade sections. However, the division of the Specifications into sections shall not operate to define or limit the responsibility of any Subcontractor.

2. COORDINATION AND COOPERATION

.1 The Contractor shall coordinate the work of his Subcontractors with efficient and continuous supervision and be fully aware of the Work requirements including, without limitation, those of the Specifications and Drawings.

.2 The Contractor is responsible for determining which Subcontractor shall perform Work. Differences in interpretation of the Specifications or Drawings as to which Subcontractor shall perform certain Work shall not be grounds for claims for extras.

.3 The Contractor shall coordinate the use of Products and Construction Equipment, including cranes, hoists, ladders, and scaffolds, and access to the Place of the Work, with the work of Subcontractors. The cost of use of Construction Equipment and Products by Subcontractors shall be governed by the agreements between the Contractor and the Subcontractors.

3. DAILY RECORD

.1 From the day of commencement of the Work, the Contractor shall maintain a careful daily record of the progress of the Work on his standard record form, with applicable trades listed. This record shall be open to the Consultant's and the Owner's inspections at all reasonable times. A copy of the record shall be turned over to the Consultant at weekly intervals.

.2 Contractor's diary shall record all pertinent data, such as:

.1 Daily weather conditions, including maximum and minimum temperatures.

.2 Commencement, progress, and completion of various portions of the Work.

.3 Dates of all site meetings.

.4 Dates of visits or inspections by government authorities, inspectors, and any other visitors to the Site.

.5 Record of work force employed and work performed thereby.
4. PERMITS AND FEES

.1 Pursuant to paragraph GC 10.2.2, the Owner will apply and pay for any required Development and Building Permits. Despite GC 10.2.3, the Contractor shall obtain and pay for all other permits and licenses required for the Work.

.2 The Contractor shall conform to the codes, ordinances, regulations, and orders of all authorities having jurisdiction over the performance of the Work. Should conflicts arise, the Contractor shall forthwith request clarification from the Consultant.

5. HOURS OF WORK

.1 The Work shall be carried out during permitted working hours under the applicable By-Law of the District of Lake Country.

.2 In the event it is necessary to perform work outside permitted working hours, the Contractor shall obtain any approvals or permits required under the applicable District of Lake Country By-Law, and shall submit a copy of such approvals or permits to the Owner and the Consultant.

6. SIGNS

.1 Signs or advertising shall not be placed on the Place of the Work without the written approval of the Owner. The Contractor shall be responsible for managing all signage on the Place of the Work in accordance with approvals and instructions of the Owner.

7. PUBLICITY

.1 All publicity relating to this Project and the Work is subject to the prior approval of the Owner, and no mention of the Project in advertising or articles in any publication will be permitted unless previously approved by the Owner. Publicity or advertising implying endorsement of the Contractor, a Subcontractor, or any product by the Owner will not be permitted without the written permission of the Owner.

8. WORK AREA

.1 The Work and the operation of vehicles and machinery, storage of equipment, materials and/or supplies must be contained within the Place of the Work.

.2 If revision of the boundaries of the Place of the Work is necessary, the Contractor shall contact the Consultant and shall not trespass or conduct any Work outside such boundaries (save in the case of emergency) without prior authorization by the Consultant.
9. SURVEY

.1 The Contractor shall engage qualified personnel approved by the Owner for any surveys required.

.2 The Contractor shall confirm the location of existing bench marks and survey control points established by the legal survey firm appointed by the Owner prior to commencement of the Work.

.3 The Contractor shall preserve permanent reference points during the Work and make no changes or relocations without the prior written consent of the Consultant.

.4 The Contractor shall report to the Consultant when a reference is lost or destroyed, or requires relocation because of necessary changes in grades or locations. The Contractor shall pay for any legal surveys required to re-establish lost or destroyed reference points.

.5 The Contractor shall submit to the Consultant a certificate signed by a registered surveyor licensed to practise in the Province of British Columbia certifying that elevations and locations of completed Work are in conformity with the Contract Documents.

10. PRECONSTRUCTION MEETING

.1 The Contractor shall attend a meeting with the Consultant, other consultants, Subcontractors, field inspectors, supervisors, and the Owner to discuss and resolve administrative procedures and responsibilities, and scheduling prior to commencing the Work.

.2 Items to be discussed at such meeting shall include, but shall not necessarily be limited to, the following:

.1 Confirmation of authorized representatives of the Owner, Consultant, other consultants, and the Contractor, and the name of the Contractor’s Construction Safety Officer.

.2 Schedule of Work.

.3 Site security.

.4 Construction safety program.

.5 Contemplated change notices, change orders, procedures, approvals required, and administrative requirements.

.6 Takeover procedures and acceptance.
GENERAL REQUIREMENTS

7. Monthly progress claims, administrative procedures, and holdbacks.

11. PROGRESS MEETINGS

.1 The Contractor shall hold weekly progress meetings at the Place of the Work throughout the duration of the Work.

.2 The Consultant, other consultants, the Contractor, and Subcontractors involved in the Work shall attend the weekly progress meetings.

.3 The Contractor will record minutes of weekly progress meetings and circulate same to attending parties and any relevant parties not in attendance within three (3) days of meeting.

12. CONSTRUCTION SAFETY

.1 The Contractor shall comply with the Workers' Compensation Prevention Regulations of British Columbia (latest edition) and provide all necessary safety requirements as prescribed by such regulations.

13. SECURITY

.1 The Contractor shall be responsible for security of the Work and at the Place of the Work.

.2 The Contractor and his Subcontractors shall make their own arrangements to ensure the security of their own equipment and materials.

.3 The Owner, the Consultant, or other consultants, and/or their respective representatives will not be liable for any loss or damage to materials, equipment, or other property of the Contractor, unless caused by their negligence.

14. EROSION AND DAMAGE

.1 The Contractor shall employ preventative measures to minimize erosion at the Place of the Work, ensure no disturbance and damage to and settlement of adjacent property, and to keep site drainage water flowing to approved connections to District sewers.

15. CLEANING STREETS

.1 The Contractor shall maintain streets and sidewalks affected by the Work in a clean and tidy condition as required by District By-Laws and minimize disruption to streets and sidewalks.

.2 The Contractor will be responsible for the cost of any cleaning or maintenance required due to breach of Section 16.1 of these General Requirements.
16. **NOISE ABATEMENT**

.1 The Contractor shall comply with the requirements of the District of Lake Country Noise By-Law (and any other applicable By-Laws) regarding noise abatement and take all necessary steps to ensure the generation and transmission of noise and vibration due to the Work do not exceed the level permitted by the By-Law.

.2 Any noise or vibration due to the Work that the Owner considers unreasonable given the nature of the Work shall be reduced, at no additional cost to the Owner and to the satisfaction of the Owner.

17. **OPERATING AND MAINTENANCE MANUALS**

.1 Upon Substantial Performance of the Work, the Contractor shall submit to the Consultant three (3) copies of Operating and Maintenance Manuals, containing pertinent information on maintenance, inspection, and emergency procedures, receipts, test reports, warranties, equipment, and finish schedules, and other Work information.

18. **PRODUCT MAINTENANCE MANUALS**

.1 The manual shall include but not necessarily be limited to:

.1 List of all contractors, subcontractors, manufacturers, suppliers, complete with addresses, telephone, and facsimile numbers.

.2 Hardware and paint schedules, complete with the actual manufacturer, supplier, and identification names and numbers.

.3 All manufacturers' equipment, materials, products, data, details, identification, schedules of maintenance, operational, and installation information as required in accordance with the specification.

.4 All extended warranties, maintenance bonds, certificates, letters of guarantees, registration cards, etc., as called for in the specification with the following information:

.1 Name and address of subject.

.2 Commencement date (Substantial Performance) of warranties.

.3 Duration and expiry date of warranties.

.4 Signature and seal of Contractor, installer, manufacturer, and/or supplier.

.5 Complete set of all final reviewed shop drawings.
.6 Certificates of inspection.

.7 Test reports and certificates.

.8 Confirmation letters stating that all extra replacement materials in accordance with the specifications have been handed over to the Owner in good order.

.9 Confirmation letters stating that all portable equipment, materials, (such as fire extinguishers, special tools, keys for all equipment, and/or panels, elevator pads/accessories, keys to millwork, casework, etc.) have been handed over to the Owner in good order.

19. AS-BUILT DRAWINGS

.1 The Contractor shall keep one set of current white prints of all Drawings and all addenda, revisions, clarifications, change orders, and reviewed shop drawings in the site office; and have them available at all times for inspection by the Consultant.

.2 As the Work proceeds, the Contractor shall record, clearly and indelibly in red pencil, as-built conditions wherever they deviate from the original directions of the Contract Documents.

.3 The Contractor shall present the as-built information for scrutiny at the project office and as may be required by the Consultant.

.4 At completion of the Work, the Contractor shall employ competent personnel to transfer all deviations, including those required by addenda, revisions, clarifications, shop drawings, change directive, and change order, to a set of white prints. Each as-built print shall bear the Contractor's identification, the date of record, and the notation, “We hereby certify that these drawings represent the work 'as-built'.” The Contractor's signature shall be placed below that notation.

.5 If required, by the Contract Documents, the Contractor will prepare as-built drawings on AutoCAD computerized drafting system compatible with that used by the Owner.

20. PROJECT TURNOVER DATE

.1 The date of Substantial Performance of the Work declared for the project will also be the date at which the Owner takes occupancy of the Project and assumes the following:

.1 Arranges and pays for all continuing utility services and costs.

.2 Arranges, pays for, and ensures that proper protection for fire, theft, property and/or building damages and liability insurance are in place for continuous coverage.
GENERAL REQUIREMENTS

.3 Arranges for a qualified maintenance person to operate and maintain all building systems and equipment.

.4 Receives all registered master keying from hardware supplier, arranges for removal of all construction keying, and replaces with own security master keying.

.5 Takes full control of security and access to the Project.

21. FINAL CLEANING

.1 Pursuant to clause GC 3.13 of the General Conditions, the Contractor shall:

.1 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris from time to time during the Work and at Substantial Performance of the Work.

.2 Clean and polish glass, mirrors, hardware, floor tile, wall tile, stainless steel, chrome, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched, or disfigured glass.

.3 Remove stains, spots, marks, and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, and floors.

.4 Vacuum clean and dust building interiors, behind grilles, louvres, and screens.

.5 Vacuum clean concrete floor surfaces below access flooring.

.6 Clean, vacuum or seal, or prepare floor finishes, as recommended by the manufacturer and as specified.

.7 Inspect finishes, fitments, and equipment and ensure specified workmanship and operation.

.8 Remove dirt and other disfigurations from exterior surfaces.

.9 Clean equipment and fixtures to a sanitary condition, and clean or replace filters of mechanical equipment.

.10 Clean off all marks and dirt from aluminium and clean and polish all glass.

.11 Clean up roofs, including spreading displaced gravel evenly and clearing of all drains.

.12 Clean grounds and exterior paved areas and leave these areas hosed down and swept and made ready for the Owner's use.
22. SYSTEMS DEMONSTRATION

.1 Prior to final inspection, the Contractor shall demonstrate operation of each system to the Owner and shall instruct personnel in operation, adjustment, and maintenance of equipment and systems, using data provided by operation and maintenance manuals as the basis for instruction.

23. PROJECT COMMISSIONING

.1 The Contractor shall:

.1 promptly correct deficiencies and defects identified by the Consultant.

.2 review maintenance manual contents (operation, maintenance instructions, as-built drawings, spare parts, materials) for completeness.

.3 submit required documentation such as statutory declarations, Workers' Compensation certificates, warranties, certificates of approval, or acceptance from regulating bodies.

.4 attend “end-of-work” testing and break-in or start-up demonstrations.

.5 review inspection and testing reports to verify that the findings conform to the intent of the documents and that changes, repairs, or replacements have been completed.

.6 review condition of equipment that has been used in the course of the Work to ensure turning over at completion in “as new condition” with warranties, dated and certified from time of Substantial Performance of the Work.

.7 arrange and coordinate instruction of Owner's staff in care, maintenance, and operation of building systems and finishes by suppliers or Subcontractors.

.8 when partial occupancy of uncompleted Project is required by the Owner, coordinate Owner's uses, requirements, and access with Contractor's requirements to complete Project.

.9 provide ongoing review, inspection, and attendance to building call back, and maintenance, and repair problems during the warranty periods.

24. RECORDS

.1 For at least one year after issuance of certificate of Substantial Performance, the Contractor shall keep all records, accounts, statements, and other documents relating to the performance of the Work, and shall permit representatives of the Owner to inspect and audit them at all reasonable times.
District of Lake Country
Eldorado Treated Water Reservoir &
Glenmore Booster Station
60488627

GENERAL REQUIREMENTS

END OF SECTION
SUMMARY OF WORK

1. GENERAL

1.1 Work Covered by Contract Documents

.1 The work to be performed under this Contract shall include the labour, equipment, and materials required to complete the construction of the Eldorado Treated Water Reservoir and Glenmore Booster Station project, as specified in the Contract Documents.

.2 The Scope of Work includes, but is not limited to, the following elements:

.1 Construction of a new 6,000 m³ concrete treated water reservoir approximately 60 m long by 27 m wide by 5.4 m high. The concrete structure includes a valve room.

.2 Booster stations at the Eldorado site (approximately 18 m x 9.4 m) and at the Glenmore site (15.1 m x 7.3 m).

.3 Siteworks, including excavation, grading, drainage, asphalt paving, fencing, and site restoration.

.4 Associated yard piping and electrical work.

.3 The Work shall not be deemed complete until the Work is accepted by the Owner. The Work, unless specifically stated otherwise, shall include the furnishing of all labour, supervision, management, materials, temporary works, supplies, services, Contractor’s Plant and Equipment, receiving and handling, transportation, foreign, federal, provincial, and municipal taxes and duties of whatsoever kind, permits and licenses and other things necessary for and incidental to the performance of all the Work. The Contractor shall advise the Engineer prior to applying for any permits or licenses.

.4 Any minor or incidental item of the Work not called for in the Specifications or shown on the Drawings but clearly required to meet the intent of design and normally provided for the proper operation of the Work shall be provided as if specifically called for in the Contract Documents. The intent is that the Contractor provides a complete Project.

.5 The Work of the Contract consists of the construction of all Work described and as shown in the Contract Documents and by implication.

.6 The Work may commence at the Site immediately following a Notice to Proceed. The Work is to be substantially complete by the date indicated in Section 01310 – Construction Schedule. The Contractor may be required to commence Work on Submittals after the Notice of Award, but prior to the Notice to Proceed.
SUMMARY OF WORK

.7 It is expressly required that the Contractor take a proactive approach to environmental protection in all aspects of the Work, including regularly supervising to ensure the Contractor meets all environmental performance requirements. Any compliancy issues by any Contractor may result in disciplinary action against such Contractors responsible for non-compliance. Refer to Section 01561 – Environmental Requirements.

.8 Among its other responsibilities, the Contractor will be totally responsible for developing and working in accordance with a comprehensive Quality Control Program. The Engineer will audit the Contractor to ensure compliance in a complementary Quality Assurance Program. Refer to Section 01450 – Quality Control.

1.2 Contract Method

.1 The Contractor shall construct the Work under a lump sum Contract.

1.3 Documents Required

.1 The Contractor shall maintain at the Site at least one (1) copy of each of the following:

.1 Contract Drawings and Tender Drawings
.2 Specifications
.3 Addenda
.4 Change Orders and correspondence from the Owner and Engineer
.5 Reviewed Submittals (e.g., shop drawings, erection/falsework drawings, product data, and samples)
.6 Field test reports
.7 Copy of all permits from authorities having jurisdiction
.8 Construction schedule
.9 Signed copy of the Contract
.10 WorkSafeBC Regulations
.11 Manufacturers’ installation and application instructions
.12 Manufacturers’ operations and maintenance instructions
.13 Contractor’s Safety Program
SUMMARY OF WORK

.14 Quality Control Program

.15 Environmental Protection Plan

.16 All other Submittals

.2 Refer to Section 01330 – Submittals

1.4 Coordination

.1 Cooperate and liaise with other contractors, utility agencies, the Owner’s employees, or their appointed representatives in order to make appropriate working arrangements to ensure satisfactory execution and timely completion of the work. The Contractor will not have exclusive rights to the construction area.

.2 Attend coordination meetings, as directed by the Engineer, when the Engineer considers that they are necessary for ensuring the sufficiency of the liaison and cooperation with other contractors. The Contractor shall be deemed to have allowed in his Tender Price for any interference to his operations which may result from any of the above. He must also take all precautions necessary to ensure that he does not hinder or delay in any way the progress of these other parties or cause damage to their completed work.

1.5 Sequence of Work

.1 Every effort shall be made in the scheduling of the work to ensure that existing water systems are disrupted as little as possible. With this in mind, a specified sequence of work is proposed.

.2 Refer to Section 01015 – Work Sequences and Tie-ins.

1.6 Contractor Use of Premises

.1 Generally restrict operations to the construction and laydown areas as indicated on the drawings or directed by the Engineer. Review the limits of work with the Engineer prior to commencing the work.

.2 Ascertain and abide by conditions pertaining to use of temporary working easements or rights-of-way.

.3 Obtain and pay for use of additional storage, access, or work areas needed for work under this Contract.

.4 The project site includes the existing Eldorado Reservoir. Operation of the existing works must be maintained with uninterrupted services unless specifically noted in the Contract Documents. Access for the Owner maintenance personnel must be provided throughout the project.
SUMMARY OF WORK

.5 The right-of-way at the Glenmore Booster Station is limited and is adjacent to busy streets. The storage of materials at this site is limited to the road right-of-way while ensuring the safety of the public traffic to the satisfaction of the Engineer.

1.7 Milestone Dates

.1 Time and all time limits stated in the Contract Documents are of the essence of the Contract. The Contractor shall perform his work expeditiously and with adequate forces to achieve the milestone dates.

1.8 Permits

.1 If required, it is the Contractor’s responsibility to obtain a demolition permit. All other required construction permits will be coordinated and paid for by the Owner.

2. PRODUCTS

Not Applicable.

3. EXECUTION

Not Applicable.

END OF SECTION
1. GENERAL

1.1 Continuity of Existing Water System Operation

.1 The existing water system needs to continuously deliver water to District customers. Do not interrupt functions except as specified herein. Coordinate the Work to avoid any interference with normal operations staff, equipment, and processes.

.2 Pay all penalties and costs including legal fees and other expenses imposed on the Owner as a result of the actions of the Contractor, its employees, or subcontractors.

.3 Ensure that access is maintained for all operation and maintenance requirements of the existing facilities at all times, housekeeping is maintained at the highest possible level to minimize interference, security requirements are fulfilled, and the existing facilities are maintained in weather-tight conditions.

.4 Complete all tie-ins to existing facilities in the shortest practical time frame and within the time limits specified in this Section. Scheduling must reflect the Contract milestone dates.

1.2 General Sequence of the Work

.1 The Contractor will be required to submit a detailed work plan including shut down times and anticipated length of time required to complete the work. Work plan shall be submitted to the Engineer for review and approval at least two (2) weeks prior to the work.

.2 Connections to the existing system can not be completed until after October 1st, 2017 and prior to the Contract completion date.

1.3 Work Sequence and Tie-Ins – Proposed

.1 The following is a proposed sequence of work and tie-in plan to provide the Contractor with information to develop a detailed plan for scheduling and constructing the Works. The Contractor is responsible for the work sequence and tie-ins and all costs associated with undertaking the Work. The below sequence of works is intended to provide the Contractor guidance and is not intended to be a prescriptive summary.

.2 Eldorado Site

1) Complete construction of the Treated Water Reservoir, valve chamber and the Low Lift Booster Station.

2) Complete the construction, leak testing, cleaning, flushing, disinfection and bacteriological testing of the Treated Water Reservoir.
WORK SEQUENCES AND TIE-INS

3) Complete the installation of the valves and piping. Following this complete the pressure testing, flushing, disinfection and bacteriological analysis.

4) Complete the construction of the Low Lift Booster Station. Once construction is complete all the process mechanical equipment shall be pressure tested, flushed and disinfected. Once this is complete the Low Lift Booster Station can be connected to the existing raw water pond for a raw water supply for testing, trial operation and commissioning of the booster station. The existing open reservoir will be drained to allow for the completion of the Low Lift Booster Station connection after 1-week notice is provided by the Contractor. The existing open reservoir can not be drained until the Glenmore Booster Station is commissioned and full accepted by the Owner.

5) Provide a temporary connection at the Treated Water Reservoir that allows the new chlorine dosing points to be trial tested while discharging the water back to the existing open raw water reservoir. The temporary connection shall be large enough to allow a single low lift booster station to run at 50% of the rated capacity. The discharge of the temporary connection shall be dechlorinated prior to being discharged to the existing raw water reservoir. All the controls shall be tested and fully operational prior to the starting the commissioning process.

6) Once the new Low Lift Booster Station, chlorine dosing points, and Treated Water Reservoir are trial tested and commissioned to the satisfaction of the Owner and the Engineer the buried piping connections can be completed.

7) After the buried pipe connections are completed the entire new system shall be performance tested to achieve the Form 104 acceptance of the new infrastructure on the Eldorado Reservoir site. Once this is completed and the reservoir is accepted, IHA will review documentation prior to final acceptance. The contractor should allow 2-weeks for this process.

.3 Glenmore Road Booster Station

1) Complete the construction of the new booster station without impacting the existing water system infrastructure.

2) Once construction is complete all the process mechanical pumps shall be pressure tested, flushed and disinfected. Once this is complete the Booster Station can be connected to the existing distribution system pipes for the purpose of a water supply for the trial operation of the pump station. The buried pipe network is part of the potable distribution network so all bacteriological testing must be completed to the satisfaction of the Engineer prior to the connections being completed.

3) The Booster Station is a second water source for the Treated Water Reservoir on the Eldorado site so the work (the treated water reservoir and
the associated piping) on the Eldorado Site needs to be completed and accepted prior to completing the commissioning and trial operation of the new booster station.

4) Complete all the piping modifications and performance testing of the pumps.

5) After the buried pipe connections are completed the entire new system shall be performance tested to achieve the Form 104 acceptance of the new infrastructure at the Glenmore Road Booster Station. Once this is completed and the booster station can be accepted. Once this is completed and the reservoir is accepted, IHA will review documentation prior to final acceptance. The contractor should allow 2-weeks for this process.

2. PRODUCTS
   Not Applicable

3. EXECUTION
   Not Applicable

END OF SECTION
1. GENERAL

1.1 Requirements Prior to Mobilization

.1 Prior to mobilizing to the Site and in addition to other submission requirements of other Specification Sections, the Contractor shall submit the following information to the Engineer for approval:

.1 List of survey equipment;
.2 Survey methodology;
.3 Layout surveys of the whole and various parts of the Work;
.4 Confirmation of surveyor’s qualifications.

1.2 Survey Reference Points and Legal Survey Markers

.1 The Owner will provide two sets of survey horizontal and vertical control points. One set contains one horizontal and one vertical control point.

.2 Locate, confirm and protect control points and legal survey markers prior to starting the Work. Preserve permanent reference points during construction.

.3 Replace legal survey markers lost or destroyed as a result of construction activities and re-establish survey control by a BC Land Surveyor at no cost to the Owner.

1.3 Survey Requirements

.1 Establish permanent benchmarks on the Site referenced to established benchmarks by survey control points. Record locations, with horizontal and vertical data, in Project record documents.

.2 Perform all surveying, establish lines and levels, locate and layout, by instrumentation.

.3 Perform all surveys, affecting the line and elevation under the direction of a qualified surveyor.

.4 Assist the Engineer with surveys, checking of layout, measurement of quantities and compilation of record data as required.

.5 Interim surveys as required to demonstrate compliance with design and upon which to base progress payments; final surveys for as-built record and upon which to base the final payment.
1.4 Records

.1 Maintain a complete, accurate log of control and survey work as it progresses.

1.5 Submittals for Information Only

.1 On request of the Owner or Engineer, submit documentation in accordance with Section 01330 – Submittals, to verify accuracy of field engineering work and to indicate compliance of installations with the Contract Documents.

2. PRODUCTS

Not Applicable

3. EXECUTION

Not Applicable

END OF SECTION
1. **GENERAL**

1.1 **Documents**

.1 This Section of the Specifications forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.

1.2 **Site Conditions/Limits**

.1 **Examination of Site**

.1 Prior to commencing actual construction work, inspect field conditions, obtain and confirm actual site dimensions, examine surface conditions as required to ensure correct execution of the Work.

.2 Maintain or arrange for the removal, relocation, and replacement as appropriate of any existing utilities which may be affected by the works, whether buried or surface utilities, signs, structures, or any other object which may be in conflict with the works.

.2 **Working on Site**

.1 The area of Works is located in close proximity to residents. Dust control practices will be required, refer to Section 01561.

.3 **Geotechnical Investigation**

.1 Copies of the geotechnical reports by Fletcher Paine Associates Ltd. (April 2016) for each project site are included in Exhibit A of the Contract Document.

.2 The soils investigation reports record properties of the soils and recommendations for the design of foundations and is prepared primarily for the use of the Engineer. The recommendations given shall not be construed as a requirement of the Contract unless contained in the Contract Document.

.3 The reports, by their nature, cannot reveal all conditions which exist or can occur on the project site. Should subsurface conditions be found to vary substantially from the Soils Investigation Reports, changes in the design and construction of foundations will be made with resulting credits or expenditures accruing to the Owner.
1.3 Documents/Instructions

.1 Documents Provided

.1 Upon award of the Contract, the Contractor will be provided with three full sets of the Contract Documents (including two sets of full size drawings). Additional sets, if required, can be produced by the Engineer, at the Contractor’s cost.

1.4 Changes to the Work

.1 Refer to the Contract General Conditions regarding changes to the Work. For this Contract, the management of change orders and change directives will be handled as defined in the Section 01280 Measurement and Payment.

2. PRODUCTS

Not Applicable

3. EXECUTION

Not Applicable

END OF SECTION
1. GENERAL

1.1 Preconstruction Meeting

.1 Within fifteen (15) days after award of Contract, the Engineer will request a project meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.

.2 Representatives of the Owner, Engineer, Contractor, and Major Subcontractors must be in attendance.

.3 Representatives of the Contractor and Subcontractors attending the preconstruction meeting must be qualified and authorized to act on behalf of the party each represents.

.4 After the time and location of this meeting has been established, the Contractor shall notify all parties concerned a minimum of ten (10) days before the meeting.

.5 The Engineer will arrange space and facilities for this meeting.

.6 The Engineer will chair and record discussions and decisions, and circulate the meeting notes to all parties concerned.

.7 Agenda to include the following:

.1 Appointment and notification of official representatives of participants in the Work.

.2 Schedule of the Work, progress scheduling.

.3 Schedule of shop drawing submissions.

.4 Schedule for the procurement and delivery of specified equipment.

.5 Plant orientation program.

.6 Requirements for temporary facilities, site signs, offices, storage sheds, utilities, hoarding, site access and use.

.7 Site security.

.8 Health and Safety issues.

.9 Modification procedures, Contemplated Change Notices and Change Order procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements (GC) as originated by the owner or in the case of a savings, by the Contractor.
.10 Product and tool storage.

.11 Weather protection.

.12 Record drawings.

.13 Operation and maintenance manuals.

.14 Commissioning, acceptance, and handover.

.15 Warrantees.

.16 Monthly progress claims, administrative procedures, photographs, holdbacks.

.17 Appointment of inspection and testing agencies or firms.

.18 Insurances and transcript of policies.

.19 Communications routing and logistics.

.20 Access to site and work areas.

.21 Survey.

.22 A schedule for progress meetings.

.23 Emergency telephone numbers.

.24 Other items as arise at the meeting.

1.2 Progress Meetings

.1 Schedule and administer progress meetings every two weeks during construction and every week during the final two months of construction and through the commissioning period.

.2 Provide input to the Engineer for the meeting agenda at least two days prior to the meeting.

.3 Representatives of the Owner, Engineer, Contractor, and Major Subcontractors must be in attendance. Arrange for the attendance of other subcontractors and suppliers as necessary to address issues on the agenda.

.4 Representatives of the Contractor, Subcontractors, and Suppliers attending meetings must be qualified and authorized to act on behalf of the party each represents.

.5 Agenda for Construction Progress Meetings to include the following:
.1 Review and approval of minutes of previous meeting.

.2 Field observations, problems, conflicts.

.3 Review submittal schedules: Expedite as required.

.4 Review of off-site fabrication and delivery schedule.

.5 Progress, schedule, during succeeding work period.

.6 Problems which impede construction schedule.

.7 Corrective measures and procedures to regain projected schedule.

.8 Revisions to construction schedule.

.9 Site coordination review.

.10 Maintenance of quality standards.

.11 Review of site cleanliness.

.12 Review of site safety and security.

.13 Review of temporary facilities.

.14 Review requests for information.

.15 Review of contemplated change notices, field orders, change orders, and field instructions.

.16 Review proposed changes for effect on construction schedule and on completion date.

.17 Review of progress payments.

.18 Outstanding action items.

.19 Date and location of next meeting.

.20 Other business.

.6 The Engineer will preside at the meetings.

.7 The Engineer will record notes of the project meetings, including significant proceedings, decisions, “Action By” parties, dates for completion of duties, etc.
1.3 Special Meetings

.1 Special meetings may be requested by the Owner, Engineer, or Contractor to discuss specific issues. Generally, three days' notice is required for special meetings. The agenda will be fashioned to suit the meeting. Minutes will be kept by the Engineer.

2. PRODUCTS

Not Applicable

3. EXECUTION

Not Applicable

END OF SECTION
1. GENERAL

1.1 Daily Record of Work Progress

.1 Maintain at the site a permanent written record of progress of the Work. Make the record available to the Engineer upon request and provide him with a copy if requested. Include in the record each day:

.1 The weather conditions with maximum and minimum temperatures.
.2 The conditions encountered during excavation.
.3 The commencement and the completion dates of the Work of each trade in each area of the Contract.
.4 The progress of each trade in each area of the work.
.5 The erection and removal dates of formwork in each area of the Contract.
.6 The dates, the quantities, and the particulars of each concrete pour.
.7 The dates, the quantities, and the particulars of building construction.
.8 The dates, the quantities, and the particulars of roofing installation.
.9 The numbers and classifications of the Contractor’s and the Subcontractor’s tradesmen working at the site and the numbers and classifications of construction machinery and equipment and the number of hours each is operated.
.10 The visits to the site by the Owner, the Engineer, the regulatory authorities, the testing companies, the subcontractors and the suppliers.

1.2 Progress Photographs

.1 When the Work commences at the site and at monthly intervals thereafter, provide the Engineer with each application for payment, digital photographic record of the Work from six different viewpoints.

.2 Photographs taken are to show the general extent of the Work by both exterior and interior views. The Engineer will select each viewpoint.

.3 Title each photograph at the bottom so no pertinent detail is obscured. Include in the title, the direction of view and the date when taken.

.4 Photographs shall be in digital format (JPEG) with 400 dpi resolution as a minimum.
2. PRODUCTS
   Not Applicable

3. EXECUTION
   Not Applicable

END OF SECTION
1. GENERAL

1.1 Measurement and Payment

.1 The Work, including any Materials, equipment and services, will be paid for in accordance with the prices set out in Appendix 1 – Tender Price Breakdown of Section 00310 – Form of Tender. The Section 00310 prices and any further breakdown do not limit the Work to the items listed therein. The Contractor has allowed for sufficient amounts to cover the cost of any Work or Materials not specifically listed in Section 00310, but included in the Drawings and Specifications by either direct mention or implication, by including all such amounts in the items to which they pertain most closely in Section 00310. Costs of a general nature that do not pertain to any one item have been distributed among all the items.

1.2 Applications for Payment

.1 Refer to Part 5 Payment – General Conditions (CCDC 2), and Section 00800 – Supplementary General Conditions.

.2 The Contractor shall use standard forms for submission of progress claims in the format agreed prior to the end of each month of Work.

.3 Show previous amount claimed and the amount claimed for the period ending. Show percentage of Work completed to date and holdback retained.

.4 For equipment items supplied by the Contractor payment will be as follows:

A payment claim of twenty percent (20%) of the Supply Contract will be paid upon receipt and approval of Submittals, less any amount the Owner is entitled to withhold pursuant to the Contract Documents.

A payment claim of sixty percent (60%) of the Supply Contract will be paid upon the delivery of the item of Goods at the Delivery Point, less any amount the Owner is entitled to withhold pursuant to the Contract Documents. Refer Section 01650 Form 100.

Upon successful Commissioning and Testing, the remaining twenty percent (20%) of the Supply Contract will be paid, less any amount the Owner is entitled to withhold pursuant to the Contract Documents. Refer to Section 01650 Form 103.

1.3 Changes in the Work

.1 Refer to Part 6 Changes in the Work – General Conditions (CCDC 2), and Section 00800 – Supplementary General Conditions.
.2 Changes to the work will be defined as below and be documented using the following forms:

.1 **Field Order** – Will be used when an instruction is given to the Contractor in the field, which may result in an adjustment to the Contract Price. A Field Order signed by the Engineer and the Owner is authorization to proceed with the Work on a Lump Sum, Unit Price or Force Account/Time and Material basis as stipulated on the Field Order form. Extra work shall not commence until the Contractor receives a copy of the Field Order signed by the Owner and the Engineer.

.2 **Field Memo** – Will be issued by the Engineer and be used as an instruction in situations where the change is not anticipated to result in an adjustment to the Contract Price.

.3 **Change Order** – Will be used for additions or deletions to the Work which originate in the form of revisions to Drawings and Specifications, and which may result in a change to the Contract Price. A Change Order signed by the Engineer and the Owner is authorization to proceed with the Work as stipulated in the Change Order. Extra work shall not commence until the Contractor receives a copy of the Change Order signed by the Owner and Engineer.

.3 Contemplated Changes in the Work

.1 Where a change in the Work is contemplated, the Engineer will give the Contractor written notice advising the Contractor of a contemplated change in the Work. Such notice requires that the Contractor submit either a lump sum quotation or an estimate based on unit prices and quantities, or labour and equipment rates in Schedule 2, to the Engineer within the time specified on the form. **Such notice is for information only and is not an instruction to execute changes, or to stop Work in progress.** The Contractor’s quotation shall:

.1 Make reference to the contemplated change order letter;

.2 Be set out in sufficient detail acceptable to the Engineer;

.3 Indicate the methodology and resources that the Contractor shall use to perform the extra work;

.4 Indicate the cost or credit to complete the extra work;

.5 Indicate the schedule to perform the extra work;

.6 Indicate any incremental cost impact included in quotation to maintain the Completion Date;
MEASUREMENT AND PAYMENT

.7 Indicate that quotation will remain open for acceptance by the Owner for thirty (30) days; and

.8 Submit all required back-up documents.

.2 The Engineer will review the Contractor’s quotations for contemplated changes in the Work to determine whether the quotation is acceptable, requires resubmittal or should be rejected. Support quotation with additional substantiating data if requested by the Engineer.

.3 When the quotation has been evaluated and is deemed acceptable to the Engineer, the Engineer will prepare and complete a Change Order entering the acceptable quotation adjustments to the Contract Price and Completion Date for the Owner’s signature. Once the Change Order is signed and fully executed by the Corporation, it will then be forwarded to the Contractor for signature. The Change Order, signed by the Owner, records and authorizes the Contractor to proceed with the Work.

.4 Methods for Valuing and Evaluating Changes on the Work

.1 Lump Sum Change Orders and Field Orders

.1 The content of Change Orders or Field Orders will be based on a prior quotation from the Contractor and agreed to by the Engineer and the Owner.

.2 The Contractor shall submit all necessary backup and the quotation shall be broken down as much as required by the Engineer.

.2 Unit Price Change Orders and Field Orders

.1 The content of Change Orders or Field Orders will be based on either prior agreed quantities or a survey of completed Work.

.2 The amounts of unit prices shall be those quoted in the Schedules to the Contract.

.3 When quantities can be determined prior to start of Work, the Engineer will prepare and complete a Change Order or Field Order describing the Work and entering the agreed confirmed unit prices, total quantities and total cost adjustments to the Contract Price and the construction schedule, for the Owner’s signature. Once the Change Order or Field Order is signed and fully executed by the Owner, it will then be forwarded to the Contractor for signature. The Change Order, signed by the Owner, records and authorizes the Contractor to proceed with the Work.
MEASUREMENT AND PAYMENT

.4 When quantities **cannot be determined** prior to start of Work, the Engineer will assign to the Contractor a Field Order signed by the Owner agreeing and authorizing the described Work to proceed immediately on the basis of the unit prices and an estimate mutually agreed upon. Upon completion of the changes involved, the Engineer will complete the Field Order entering the final total cost for the Work based on agreed confirmed unit prices and actual measured quantities support data submitted for the Owner’s signature to adjust the Contract Price and Completion Date as applicable.

.3 Force Account/Time and Material Change Orders and Field Orders

.1 When a change in the Work cannot be agreed upon by the Lump Sum and Unit Price methods, the Engineer may authorize the Work to be carried out on a Force Account/Time and Material basis.

.2 The Engineer will provide the Contractor with a Field Order, signed by the Owner agreeing and authorizing the described extra work to proceed immediately on a Force Account/Time and Material basis as reviewed on the Work Site.

.3 The Contractor shall support claims for changes determined by this method via numbered Daily Time Sheets (DTS) submitted the day following the Work with dates and times the Work was performed and by whom; time record, summary of hours worked and hourly rates paid; receipts and invoices for equipment used, listing dates and times of use; materials and products used, listings quantities; subcontracts.

.4 Upon completion of the changes, the Engineer will complete the Field Order entering the final approved total cost for the extra work involved, based on agreed confirmed time and material support data, invoices, time sheets and records submitted for the Owner’s signature to adjust the Contract Price and Completion Date as applicable.

.5 The percentage mark-up permitted for changes in the Work done on a Force Account basis is specified in the General Conditions.

.4 Quotations for changes in the Work shall show credits for work deleted from the Contract as a result of the change in the Work, if applicable.

.5 The mark-up on each change shall be applied to the net difference between credits and extras except in the case where the change results in a net credit to the Contract Price, in which case the Contractor is not entitled to charge mark-up on the net credit.

.6 Any dispute arising under this Section shall be governed by Part 8 Dispute Resolution – General Conditions (CCDC 2).
1.4 Provisional Sums

.1 The Owner has identified provisional sums by specific line items in the Tender Form, which are carried by the Contractor in the Contract Price.

.2 The expenditure of all or any portion of any provisional sum by the Contractor shall only be at the direction of the Owner.

.3 The Contractor has allowed in the Contract Price an appropriate sum to cover administration and handling of this potential Work.

.4 Except where covered by tendered unit prices or tendered lump sums, in the case of provisional sum allowances for Work done directly by the Contractor or subcontractor, payment to the Contractor shall be in accordance with Part 5 Payment – General Conditions (CCDC 2), and Section 00800 – Supplementary General Conditions.

2. PRODUCTS

Not Applicable

3. EXECUTION

Not Applicable

END OF SECTION
1. GENERAL

1.1 Description

1. The Engineer will operate an integrated system of overall project control for the Project of which this Contract forms a part. The Contractor shall develop and maintain a comprehensive project controls system. The construction schedule will provide a basis for determining the status of the Work of the Contract relative to the completion time, specific dates, and sequencing as noted in this Section and other sections of the Specifications in addition to determining the acceptability of the Contractor’s requests for payment.

2. Within one week of the Notice to Proceed, the Contractor shall meet with the Engineer to confirm the approach to scheduling on the Contract. In accordance with requirements noted in this Section, the purpose of this meeting will be to develop an agreed format, content and presentation of the construction schedule and other required project controls.

3. Prior to the Engineer’s approval for the Contractor to commence Work at the Site, the Contractor shall produce and submit a detailed Baseline Schedule, acceptable to the Engineer, which demonstrates the conformance to the requirements agreed to above and elsewhere in this Section. Once finalized and agreed to by the Engineer, this schedule will be deemed the Contract Schedule, to which the Contractor shall base all future updates and from which further detail will be developed.

4. Specifically, the Contract Schedule shall include, but not be limited to, a level of detail conforming to the following:

1. Be detailed to such a level that the sequence and interdependency of all Work will be demonstrated and make possible the coordination and control of all tasks required by the Work. Individual activities will not exceed 20 working days in duration or $100,000 in budget cost, unless agreed by the Engineer.

2. Employ activity identification codes that have been agreed in advance with the Engineer.

3. Clearly identify activity durations, sequencing, resources (e.g. labour, material and equipment), budget man-days and budget costs of every subcontractor and supplier.

4. Identify the work of other contractors that access the Site.

5. Include submission, review and approval of critical shop drawings, product data, samples, etc. The Contractor shall manage the cycle(s) of all other Submittals using a compatible spreadsheet or database program. Refer to Section 01330 – Submittals.
.6 Track all critical and significant material or equipment deliveries including the ordering, fabrication, delivery, and installation. Include Owner Supplied Materials.

.7 Include temporary and other construction works required on the Site.

.8 Include performance testing, verification, start-up, and demonstration procedures by the Contractor, allowing appropriate intervals for commissioning by third parties, and for integrated system certification.

.9 Detail general condition / general requirement activities.

.10 Include all critical or near critical change orders.

.11 Be electronically capable of comparing any given update of the Contract Schedule with at least two previous or subsequent schedule issues.

.12 Generate monthly progress claims, manpower histograms, and cash flow projections through detailed resource and cost loading of the schedule.

.5 The Contractor shall base the scheduled duration of each activity on the Work being performed during the work week established and agreed upon as of the date of the Notice of Award with allowances made for legal holidays and normal weather conditions.

.6 The Contractor shall show completion time as well as all specific dates and sequencing requirements described in Section 01015 – Work Sequences and elsewhere in the Specifications.

.7 The Contractor shall advise the Engineer within two (2) days of any problems anticipated by any activity shown in the Contract Schedule.

.8 The Contractor shall revise the schedule to reflect changes in the actual sequence and the future sequence of Work, should the actual sequence of Work performed by the Contractor deviate from the planned sequence indicated in the accepted Contract Schedule.

1.2 Submissions

.1 The Contractor shall provide Submittals in accordance with Section 01330 – Submittals and with the requirements noted herein.

.2 The Engineer’s acceptance of any schedule submission does not relieve the Contractor from any of its contractual responsibilities.

.3 For the initial submission of project controls documents, the Contractor shall submit one electronic copy of the following:
CONSTRUCTION SCHEDULE

.1 Written narrative describing the basis of the schedule and the scope of each activity or grouping of activities as agreed with the Engineer.

.2 Summary Schedule showing the full scope of the Work. Activities will be grouped and summarized by process area and then by trade or as agreed with the Engineer.

.3 Critical Path Schedule in bar chart and time scaled logic diagram formats.

.4 Eight Week Look Ahead Schedule identifying all activities planned to start and/or complete within eight weeks of the data date.

.5 Entire Contract Schedule grouped by process area then sub-area and sorted by early start.

.6 Manpower Histogram based on resource loading of detailed activities.

.7 Cash Flow projection covering all labour, material and equipment costs to directly support the plan for monthly progress claims.

.8 Days when the Contractor proposes to work more than the normal workweek established and agreed upon as of the date of Notice of Award.

.4 The Contractor shall submit monthly schedule status reports with the monthly progress claim consisting of five hard copies and one electronic copy of the following project control documents:

.1 Written narrative that describes the current status of the Contract Schedule and provides comments on deviations in the Current Schedule with respect to the accepted Contract Schedule and other more recent schedules as required, and highlights any critical or unusual elements of the Work.

.2 Summary Schedule update that groups and summarizes all activities by process area and then by trade.

.3 Update of Critical Path Schedule in bar chart and time scaled logic diagram formats.

.4 New Eight Week Look Ahead Schedule identifying all activities planned to start and/or complete within eight weeks of the data date.

.5 Update of entire schedule grouped by process area then sub-area and sorted by early start.

.6 Update of Manpower Histogram based on resource loading of detailed activities.
CONSTRUCTION SCHEDULE

.7 Updated Cash Flow projection covering all labour, material and equipment costs to directly support the current plan for monthly progress claims.

.8 Any changes to days when the Contractor proposes to work more than the normal workweek established and agreed upon as of the date of the Notice of Award.

.5 The Contractor shall indicate progress of each item or activity achieved from the date of Notice of Award up to the first day of the month for which the Contract Schedule and other project control documents are issued.

.6 The Contractor shall show the percentage of completion of each item or activity as projected for the last day of the month for which the schedule is issued. Modify the timing and duration of future activities to indicate current planning.

.7 The Contractor shall submit proposed revisions to the accepted Contract Schedule to the Engineer for review. Changes in timing for activities may be modified with agreement of the Contractor and Engineer. A change affecting the Contract Price, the completion time and sequencing of the Work (reference Section 01015 – Work Sequences) may be made only by approved Change Order.

.8 During the course of the Work, the Contractor shall produce more detailed schedules for any portion of the Work that may require specific detailed planning to facilitate such things as coordination with others, or to reflect a critical aspect of the Work being planned or performed.

1.3 Project Milestone Dates

.1 The Contractor shall schedule the Work in accordance with the following Project Milestone Dates:

   Substantial Completion by October 27, 2017
   Total Performance by November 27, 2017

2. PRODUCTS

   Not Applicable.

3. EXECUTION

   Not Applicable.

END OF SECTION
1. GENERAL

1.1 General Requirements

.1 Unless otherwise noted, make submittals to the Engineer for review.

.2 Make submittals with reasonable promptness and in an orderly sequence to avoid any delay in the Work. Failure to submit in ample time is not considered cause for an extension of Contract Time, and no claim for extension by reason of such default will be allowed.

.3 Do not proceed with Work affected by submittals until review is complete.

.4 The submittal reviews do not authorize changes in cost or time. Changes involving cost or time are authorized only by a signed change order.

1.2 Shop Drawings

.1 “Shop Drawings” mean custom drawings, specific product data, diagrams, illustrations, schedules, performance charts, brochures and other data, which are to be provided to illustrate details of a portion of the Work.

.2 Arrange for the preparation of clearly identified shop drawings as specified or as the Engineer may reasonably request. Shop drawings are to clearly indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of the Work. Where articles or equipment attach or connect to other articles or equipment, clearly indicate that all such attachments and connections have been properly coordinated, regardless of the trade under which the adjacent articles or equipment will be supplied and installed. Shop drawings must be submitted with the appropriate Specification Sections attached. Notify the Engineer in writing of any deviations in shop drawings from the requirements of the Contract Documents.

.3 Examine all shop drawings prior to submission to the Engineer to ensure that all necessary requirements have been determined and verified and that each shop drawing has been checked and coordinated with the requirements of the Work and the Contract Documents. Examination of each shop drawing shall be indicated by stamp, date and signature of a responsible person of the Subcontractor for supplied items and of the General Contractor for fabricated items. Shop drawings not stamped, signed and dated will be returned without being reviewed and stamped "Resubmit".

.4 Submit shop drawings with reasonable promptness and in an orderly sequence so as to cause no delay in the Work. Failure to submit shop drawings in ample time is not to be considered sufficient reason for an extension of Contract Time and no
claim for extension by reason of such default will be allowed. Jointly prepare a
schedule fixing the dates for submission and return of shop drawings.

.5 The Engineer will review and return shop drawings in accordance with the schedule
agreed upon or otherwise with reasonable promptness so as to cause no delay in
the Work. Allow sufficient time for review and consideration by the Engineer. Claims
for costs or contract extensions due to such review time will not be allowed.

.6 Submit a reproducible original or digital copy, minimum of two (2) hard copies of
white prints and two (2) copies of all fixture cuts and brochures. If the Contractor
needs more copies for his own distribution purposes, additional copies should be
submitted.

.7 Shop drawing review by the Engineer is solely to ascertain conformance with the
general design concept. Responsibility for approval of detail design inherent in shop
drawings rests with the Contractor and review by the Engineer shall not imply such
approval.

.8 Review of Shop Drawings by the Engineer shall not relieve the Contractor of his
responsibility for errors or omissions in shop drawings or for proper completion of
the Work in accordance with the Contract Documents.

.9 Responsibility for verification and correlation of field dimensions, fabrication
processes, techniques of construction, installation and coordination of all parts of the
Work rests with the Contractor.

.10 Shop drawings will be returned to the Contractor with one of the following notations:

.1 When stamped “REVIEWED”, distribute additional copies as required for
execution of the Work.

.2 When stamped “REVIEWED AS MODIFIED”, ensure that all copies for use
are modified and distributed, same as specified for “REVIEWED ONLY”. Resubmit for final records.

.3 When stamped “REVISE & RESUBMIT”, make the necessary revisions, as
indicated, consistent with the Contract Documents and submit again for
review.

.4 When stamped “REJECTED”, submit other drawings, brochures, etc. for
review consistent with the Contract Documents.

.5 Only shop drawings bearing “REVIEWED” or “REVIEWED AS MODIFIED”
shall be used on the Work unless otherwise authorized by the Engineer.
.6 It is understood that the following is to be read in conjunction with the wording on the Engineer’s shop drawing review stamp applied to each and every data sheet or drawing submitted:

“This review by the Engineer is for the sole purpose of ascertaining general conformance with the Contract design concept. This review does not mean that the Engineer approves the detail design inherent in the shop drawings, responsibility for which remains with the Contractor, and such review does not relieve the Contractor of the responsibility for errors or omissions in the shop drawing or of his responsibility for meeting all requirements of the Contract Documents. Be responsible for confirming and correlating dimensions at the Place of the Work, for information that pertains solely to fabrication processes or to techniques of construction and installation, and for coordination of the work of all subtrades.”

.11 After submittals are stamped “REVIEWED”, no further revisions are permitted unless re-submitted to the Engineer for further review.

.12 Any adjustments made on shop drawings by the Engineer are not intended to change the Contract Price. If it is deemed that such adjustments affect the Contract Price, clearly state as such in writing prior to proceeding with fabrication and installation of work.

.13 Make changes in shop drawings which the Engineer may require consistent with Contract Documents. When re-submitting, notify the Engineer in writing of any revisions other than those requested by the Engineer.

.14 Shop drawings indicating design requirements not included in the Contract Documents require the seal of a qualified Professional Engineer, registered in British Columbia.

.15 Only two reviews of a shop drawing will be made by the Engineer at no cost. Each additional review will be charged to the Contractor at the Engineer’s scheduled rates. The Engineer’s charges for additional work will be deducted from the Contractor’s Progress Certificates.

1.3 Product Data

.1 “Product Data” mean general diagrams, illustrations, brochures and other data, which are to be provided to illustrate items of construction materials, equipment, furnishings, and other elements of the work.

.2 Submit Product Data for the Engineer’s review as specified or as the Engineer may reasonably request. Reference Product Data to drawings and specifications.

.3 Where the submittal of Product Data is required, submit Product Data prior to arranging for delivery of Products to site.
.4 Submit Product Data with reasonable promptness and in orderly sequence. Failure to submit Product Data in ample time is not to be considered sufficient reason for an extension of Contract Time and no claim for extension by reason of such default will be allowed.

.5 Notify the Engineer in writing, at the time of submission, of any deviations in Product Data from requirements of Contract Documents.

.6 The Engineer will not review Product Data.

.7 Receipt of Product Data by the Engineer shall not relieve the Contractor of his responsibility providing the specified Products for incorporation in the Work in accordance with the Contract Documents.

.8 Submit a reproducible original or digital copy, minimum of five (5) hard copies of white prints and five (5) copies of all fixture cuts and brochures. The Engineer will keep two (2) copies, the original, two (2) copies will be forwarded to the Owner, and one (1) copy will be returned to the Contractor. If the Contractor needs more copies for his own distribution purposes, additional copies should be submitted.

1.4 Samples

.1 Submit, in duplicate, Samples for the Engineer's review as specified or as the Engineer may reasonably request. Clearly label samples as to origin and intended use in the Work. Reference samples to drawings and specifications.

.2 Submit Samples with reasonable promptness and in orderly sequence so as to cause no delay in the Work. Failure to submit samples in ample time is not to be considered sufficient reason for an extension of Contract Time and no claim for extension by reason of such default will be allowed.

.3 Notify the Engineer in writing, at the time of submission, of any deviations in Samples from requirements of Contract Documents.

.4 The Engineer's review of Samples will be for conformity of design concept and general arrangement only. Such review is not to be considered relief of responsibility for errors or omissions in Samples or of responsibility for meeting all requirements of the Contract Documents.

.5 Any adjustments made on Samples by the Engineer are not intended to change the Contract Price. If it is deemed that such adjustments affect the Contract Price, clearly state as much in writing prior to proceeding with fabrication and installation of the Work.

.6 Make changes in samples which the Engineer may require consistent with Contract Documents.
.7 Where changes or modifications of the Products for which samples are submitted are required, re-submit samples embodying the required changes or modifications.

.8 Where colour, pattern or texture is a criterion, submit a full range of samples.

.9 Reviewed samples will become the standard of workmanship and material against which the performed Work will be verified and accepted.

1.5 Record Drawings

.1 After award of the Contract the Engineer will provide a complete set of drawings for the purpose of maintaining Project record drawings. These drawings shall consist of a full size white paper copy.

.2 Record on the white prints on a daily basis, work constructed differently than shown on the Contract Documents. Record all changes in the Work caused by site conditions, or originated by the Owner, the Engineer, the Contractor, or a Subcontractor and by addenda, supplemental drawings, site instructions, supplementary instructions, change orders, correspondence, and directions of regulatory authorities. Do not use these drawings for daily working purposes and make the set available for periodic inspection by the Engineer.

.3 Accurately record the location of concealed mechanical services and electrical main feeders, junction boxes and pull boxes. Do not conceal critical Work until its location has been recorded.

.4 Dimension the installed locations of concealed service lines on the site or within the structure by reference from the centre line of the service to structure column lines or other main finished faces or other structural points easily identified and located in the finished Work.

.5 Make records in a neat and legibly printed manner with a non-smudging medium.

.6 Identify drawings as “Project Record Copy”. Maintain in good condition and make available for inspection on site by Engineer at all times.

.7 At completion of operational testing, neatly transfer notations to second set of prints and submit both sets of record drawings to Engineer.

.8 The record drawings will be reviewed monthly prior to acceptance by the Engineer of the monthly payment certificate. Failure to maintain the record drawings will result in a 10 percent reduction in payment to the Contractor for that month. The amount will be returned to the Contractor on the next payment as long as the record drawings are brought up to date.
.9 Failure to provide acceptable “Record Drawings” may delay acceptance of the project by the Owner. The Owner may assess against the Contract a sum based on their calculations of costs to prepare such plans.

1.6 Photographs and Publicity

.1 No press or publicity releases will be permitted without prior approval of the Engineer.

1.7 Procedures

.1 The Contractor shall, if required by the Engineer, submit for the review of the Engineer method statements which describe in detail, supplemented with drawings where necessary, the methods to be adopted for executing any portion of Work.

.2 These statements shall also include details of constructional plan and labour to be employed. Acceptance by the Engineer shall not relieve the Contractor of any of his responsibilities, nor shall reasonable refusal to approve entitle the Contractor to extra payment or an extension of time.

2. PRODUCTS

Not Applicable.

3. EXECUTION

Not Applicable.

END OF SECTION
1. **GENERAL**

1.1 **Permits/Inspections**

.1 The Owner shall obtain and pay for the Building Permit. The Contractor will support this application with the necessary submittal information and documentation. The Contractor will be responsible for coordinating the required inspections.

.2 The Contractor will obtain and pay for a demolition permit, if required.

.3 Refer to the General Conditions and Supplemental General Conditions for other requirements related to permits and other regulatory requirements.

.4 Arrange and pay for the regulatory submittals and inspections necessary for the completion of the Work in accordance with Federal, Provincial, and District laws, regulations, and by-laws.

.5 Within one week of receipt, provide one copy of all regulatory reports, permits, and other documents to the Engineer. Include any reports from the WCB related to Contractor operations on the site.

1.2 **Applicable Codes/Standards**

.1 Where specified codes/standards are not dated, conform to latest issue of specified codes/standards as amended and revised to the Tender closing date.

.2 Maintain one copy of all specified and applicable codes and standards at the job site for ready reference.

.3 Confine apparatus, the storage of Products and the operations of workers to limits indicated by laws, ordinances, and permits and by directions of the Engineer. Do not unreasonably encumber the premises with Products.

.4 In the event of discrepancies between codes, standards or other provisions, the most stringent shall apply.

.5 Conform to all Federal, Provincial, and District Codes, regulations and bylaws.

1.3 **Visitors**

.1 Make available four (4) “Visitor” safety helmets and safety glasses for authorized visitors.

.2 Ensure that visitors are provided safety orientation.
1.4 **Working Limits**

.1 Confine all deliveries and operations within the project property limits.

2. **PRODUCTS**

Not Applicable.

3. **EXECUTION**

Not Applicable.

END OF SECTION
REFERENCE STANDARDS

1. GENERAL

1.1 Latest Editions

.1 All references to specifications, standards, or methods of technical associations refer to the latest adopted revision, including all amendments, in effect on the date of submission of bids, except where a date or issue is specifically noted.

1.2 Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>AASHTO</td>
<td>American Association of State Highway and Transportation Officials</td>
</tr>
<tr>
<td>ACI</td>
<td>American Concrete Institute</td>
</tr>
<tr>
<td>AFBMA</td>
<td>Antifriction Bearing Manufacturers Association</td>
</tr>
<tr>
<td>AGA</td>
<td>American Gas Association</td>
</tr>
<tr>
<td>AGMA</td>
<td>American Gear Manufacturers Association</td>
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<tr>
<td>AISC</td>
<td>American Institute of Steel Construction</td>
</tr>
<tr>
<td>AMCA</td>
<td>Air Moving and Conditioning Association</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>API</td>
<td>American Petroleum Institute</td>
</tr>
<tr>
<td>ARI</td>
<td>Air-Conditioning and Refrigeration Institute</td>
</tr>
<tr>
<td>ASCE</td>
<td>American Society of Civil Engineers</td>
</tr>
<tr>
<td>ASHRAE</td>
<td>American Society of Heating, Refrigerating and Air Conditioning Engineers</td>
</tr>
<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
</tr>
<tr>
<td>AWMAC</td>
<td>Architectural Woodworkers Manufacturers Association of Canada</td>
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<tr>
<td>AWPA</td>
<td>American Wood Preservers Association</td>
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<tr>
<td>AWS</td>
<td>American Welding Society</td>
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<tr>
<td>AWWA</td>
<td>American Water Works Association</td>
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<tr>
<td>Abbreviation</td>
<td>Description</td>
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<tr>
<td>BCBC</td>
<td>British Columbia Building Code</td>
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<tr>
<td>CAN</td>
<td>Canadian National Standard</td>
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<tr>
<td>CBM</td>
<td>Certified Ballast Manufacturers</td>
</tr>
<tr>
<td>CBTIC</td>
<td>Clay Brick and Tile Institute of Canada</td>
</tr>
<tr>
<td>CEC</td>
<td>Canadian Electrical Code</td>
</tr>
<tr>
<td>CEMA</td>
<td>Canadian Electrical Manufacturers Association</td>
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<tr>
<td>CGA</td>
<td>Canadian Gas Association</td>
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<tr>
<td>CGRA</td>
<td>Canadian Good Roads Association</td>
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<tr>
<td>CGSB</td>
<td>Canadian General Standards Board</td>
</tr>
<tr>
<td>CISC</td>
<td>Canadian Institute of Steel Construction</td>
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<tr>
<td>CITC</td>
<td>Canadian Institute of Timber Construction</td>
</tr>
<tr>
<td>CLA</td>
<td>Canadian Lumbermen Association</td>
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<tr>
<td>CMAA</td>
<td>Crane Manufacturers Association of America</td>
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<tr>
<td>CMHC</td>
<td>Canada Mortgage and Housing Corporation</td>
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<tr>
<td>CPCA</td>
<td>Canadian Painting Contractors Association</td>
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<td>CPCI</td>
<td>Canadian Prestressed Concrete Institute</td>
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<td>CRCA</td>
<td>Canadian Roofing Contractors Association</td>
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<td>CRSI</td>
<td>Concrete Reinforcing Steel Institute</td>
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<td>CSA</td>
<td>Canadian Standards Association</td>
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<tr>
<td>CSSBI</td>
<td>Canadian Sheet Steel Building Institute</td>
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<tr>
<td>CUA</td>
<td>Canadian Underwriters Association</td>
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<tr>
<td>CWB</td>
<td>Canadian Welding Bureau</td>
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<tr>
<td>CWC</td>
<td>Canadian Wood Council</td>
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<tr>
<td>CSPI</td>
<td>Corrugated Steel Pipe Institute</td>
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</table>
## REFERENCE STANDARDS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEI</td>
<td>Edison Electric Institute</td>
</tr>
<tr>
<td>EEMAC</td>
<td>Electrical and Electronic Manufacturers of Canada</td>
</tr>
<tr>
<td>FFPC</td>
<td>Federal Fire Prevention Committee</td>
</tr>
<tr>
<td>FM</td>
<td>Factory Mutual Engineering Corporation</td>
</tr>
<tr>
<td>IAO</td>
<td>Insurers’ Advisory Organization</td>
</tr>
<tr>
<td>IBRM</td>
<td>Institute of Boiler and Radiator Manufacturers</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
</tr>
<tr>
<td>IEE</td>
<td>Institution of Electrical Engineers (U.K.)</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
</tr>
<tr>
<td>IES</td>
<td>Illuminating Engineering Society</td>
</tr>
<tr>
<td>IGMAC</td>
<td>Insulated Glass Manufacturers Association of Canada</td>
</tr>
<tr>
<td>IPCEA</td>
<td>Insulated Power Cable Engineers Association</td>
</tr>
<tr>
<td>ISA</td>
<td>Instrument Society of America</td>
</tr>
<tr>
<td>ISO</td>
<td>International Standardization Organization</td>
</tr>
<tr>
<td>LEMA</td>
<td>Lighting Equipment Manufacturers Association</td>
</tr>
<tr>
<td>LTIC</td>
<td>Laminated Timber Institute of Canada</td>
</tr>
<tr>
<td>MMA</td>
<td>Millwork Manufacturers Association</td>
</tr>
<tr>
<td>NAAMM</td>
<td>National Association of Architectural Metal Manufacturers</td>
</tr>
<tr>
<td>NBC</td>
<td>National Building Code of Canada</td>
</tr>
<tr>
<td>NEC</td>
<td>National Electrical Code</td>
</tr>
<tr>
<td>NESC</td>
<td>National Electric Safety Code</td>
</tr>
<tr>
<td>NFPA</td>
<td>National Fire Protection Association</td>
</tr>
<tr>
<td>NLGA</td>
<td>National Lumber Grade Authority</td>
</tr>
<tr>
<td>OECI</td>
<td>Overhead Electrical Crane Institute</td>
</tr>
</tbody>
</table>
REFERENCE STANDARDS

PCA  Portland Cement Association
PCI  Prestressed Concrete Institute
PMBC  Plywood Manufacturers Association of British Columbia
RCABC  Roofing Contractors Association of British Columbia
RLM  RLM Standards Institute
RTAC  Road and Transportation Association of Canada
SAE  Society of Automotive Engineers
SBI  Steel Boilers Institute
SJI  Steel Joist Institute
SSPC  Steel Structures Painting Council
TTMAC  Terrazzo, Tile and Marble Association of Canada
ULC  Underwriters' Laboratories of Canada
USFG  United States Federal Government
WCB  Workers' Compensation Board
WCLIB  West Coast Lumber Inspection Bureau

1.3  Conformance

.1  Conform to these standards, in whole or in part as specifically requested in Specifications.

.2  If there is question as to whether any product or system is in conformance with applicable standards, Owner reserves the right to have such products or systems tested to prove or disprove conformance.

.3  The cost for such testing will be borne by Owner in the event of conformance with Contract Documents or by Contractor in the event of non-conformance.

2.  PRODUCTS

Not Applicable.

3.  EXECUTION

Not Applicable.
REFERENCE STANDARDS

END OF SECTION
1. GENERAL

1.1 Codes and Standards

.1 In the case of a conflict or discrepancy between the Contract Documents and the governing standards, the more stringent requirements apply.

.2 Unless the edition number and date are specified, the reference to the manufacturer’s and published codes, standards, and specifications are to the latest edition published by the issuing authority, current at the date of tender closing.

.3 Reference standards and specifications are quoted in the Specifications to establish minimum standards. Work in quality exceeding these minimum standards conforms to the Contract.

.4 Where reference is made to a manufacturer’s direction, instruction, or specification it is deemed to include full information on storing, handling, preparing, mixing, installing, erecting, applying, or other matters concerning the Products pertinent to their use and their relationship to the Products with which they are incorporated.

.5 Where reference is made to regulatory authorities, it includes all authorities who have, within their constituted powers, the right to enforce the laws of the Place of Work.

1.2 References

.1 Quality tests shall be carried out in accordance with the requirements of the Specifications.

1.3 Requirements

.1 The Contractor shall conduct, at its own cost, all necessary quality control testing that is required to demonstrate that the materials, gradations and completed Work conform to the Contract Documents.

.2 The Contractor shall be responsible for all aspects of the quality of the Work, and shall put into place a suitable Quality Control Program to ensure that quality standards are met, and that the Work meets all the requirements and intent of the Contract Documents. Throughout the Contract Documents, any reference to quality control testing by the Contractor shall mean testing performed by the Contractor's independent certified laboratory.

.3 The Contractor shall subcontract quality control testing to a qualified CSA certified testing laboratory.
QUALITY CONTROL

.4 The Contractor shall provide equipment and qualified personnel to perform all quality control field and laboratory testing necessary to determine and monitor the characteristics of the materials produced and incorporated into the Work.

.5 The Owner may carry out quality assurance testing and inspection in order to provide the Owner with assurance that Work is generally in accordance with the Contract Documents and to verify the Contractor's quality control data.

.6 Testing and inspection by the Owner or Engineer will not relieve the Contractor of its responsibility to perform quality control testing and inspection.

.7 The cost of the Quality Control Program shall be included in the Contract Price.

1.4 Quality Control Program

.1 The Contractor shall develop a Quality Control Program. The program requires review by the Owner and Engineer.

.2 Prior to commencing Work at the Site, the Contractor shall submit to the Engineer for review and approval a Quality Control Program and list of independent inspection agencies. The Quality Control Program shall include but not be limited to the following:

.1 Conformance with Specifications.

.2 Qualification statements for all tradespersons.

.3 Concrete placement procedures.

.4 Materials testing procedures and frequency of tests.

.5 Welding procedures and related requirements

.6 Painting, Lining, and Protective Coating procedures.

.7 Document control.

.8 Non-conformance tracking and remediation.

.9 Compaction methods and testing procedures.

.3 The Contractor shall engage services of independent inspection and testing laboratory with facilities and personnel that are certified to CSA, ASTM and other specified test methods for the sampling and testing of materials.

.4 The Contractor shall prepare all test results in duplicate and provide copies of all tests to the Engineer for review.
QUALITY CONTROL

.5 All test results shall specify at least the following data:

.1 Type of test.

.2 Dates of sampling, testing and reporting.

.3 Personnel involved.

.4 Location of test (with sketch if required).

.5 Specified requirements.

.6 Test results.

.7 Remarks regarding conformance with Contract Documents.

.6 The Contractor shall provide written test results to the Engineer within twenty four (24) hours of tests. If the tests are completed on the Site, the Contractor shall provide the Engineer with a field memo summarizing results immediately following testing.

.7 Minimum testing requirements shall be in accordance with the requirements of the Specifications and all applicable laws, regulations, standards and codes.

.8 Test locations under this Section shall be determined by independent agencies working for the Contractor and shall be selected to test all aspects of the Work.

.9 The Contractor shall report, track, correct, and retest any deficient Work determined by the Quality Control Program or quality assurance program at no additional cost to the Owner.

.10 The Contractor's quality control testing will form the basis for acceptance of the Work, however the Owner may reject the Work based on its quality assurance testing.

2. PRODUCTS

Not Applicable

3. EXECUTION

3.1 Quality Control Manager

.1 The Contractor shall identify one person on staff to be responsible for quality control of the Work. This person shall be independent from the Contractor's production staff and shall report directly to the Contractor's senior management.
3.2 Procedures

.1 The Contractor shall notify the Engineer in advance of the requirement for tests, in order that attendance arrangements can be made.

.2 The Contractor shall provide labour and facilities to obtain and handle samples and materials at the Site. The Contractor shall provide sufficient space to store test samples.

.3 The Contractor shall submit copies of inspection and test reports to the Engineer in a timely manner.

END OF SECTION
1. GENERAL

1.1 Temporary Facilities

.1 Installation/Removal

.1 The Contractor shall:

.1 Provide temporary utilities for the Site as specified in Clause 1.2 and as specified elsewhere in the Contract Documents in order to execute the Work expeditiously.

.2 Make necessary applications to authorities having jurisdiction, obtain required permits, and pay all fees and related charges.

.3 Remove from the Site all such temporary utilities with the exception of those temporary utilities specified in the Contract Documents.

.4 Restore the Site to clean, sanitary condition.

.2 Maintenance of Public Utilities

.1 The Contractor shall:

.1 Arrange Work to avoid interruption of utilities serving the Owner and the public. Pay all penalties and costs including legal fees and other expenses imposed on the Owner as a result of actions of the Contractor, its employees, or subcontractors.

.2 Where interruption of public utilities is unavoidable, obtain prior approval for interruption from the responsible authority(ies).

.3 As required by the Owner authority(ies), establish and pay for temporary relocation of utilities during construction.

.4 Comply with requirements of the Owner authority(ies) by giving notice to users and the fire department prior to the interruption of service.

1.2 Site Requirements – General

.1 Sanitary Facilities

.1 The Contractor shall:

.1 Refer to Section 01561 – Environmental Requirements.
.2 Provide temporary portable toilet facilities for the use of the Contractor's, subcontractors' and Engineer's work forces.

.3 Disinfect facilities frequently.

.4 Dispose of sanitary wastes, in accordance with the applicable regulations.

.5 Contain all wastewater and later dispose of offsite at an approved facility at the Contractor's cost.

.6 Keep the Site and premises in a sanitary condition.

.7 Post notices and take such precautions as required by local health authorities or other public agency having jurisdiction.

.2 Construction Power

.1 The Owner will not guarantee an uninterrupted supply of power. Coordinate the supply of an electrical power supply for construction purposes with BC Hydro. Three phase power is available at the Site.

.2 The Contractor shall:

.1 Locate construction power at the designated location.

.2 Provide and distribute construction power and lighting as required for the execution of the Work.

.3 Pay for its power connection, routing, consumption and similar costs.

.4 Provide its own source of construction power to operate other equipment when or where necessary.

.5 Supply and pay for its own independent power for the Work.

.6 Install and maintain temporary facilities for power such as pole lines and underground cables to approval of local inspection authority.

.3 The Owner will pay for the power once permanent electrical power service is provided by BC Hydro.

.3 Heating and Ventilation

.1 Natural gas connection is not available at the Eldorado site.
.2 The Contractor shall:
   .1 Provide and pay for any propane or electrical heating for office or other facilities.
   .2 Provide and pay for all other temporary heating and ventilation, coverings, hoarding, enclosures as necessary to protect and perform the Work.

.4 Potable and Construction Water
   .1 Coordinate the installation of a temporary water supply with the Engineer. The Owner neither guarantees pressures at this connection nor the water as potable.
   .2 The Contractor shall furnish and install all necessary temporary piping and hoses required to distribute potable water from this connection and as necessary to complete the Work.

.5 Treated Water/Runoff
   .1 Treatment of runoff and water quality at the discharge points shall meet the requirements of Section 01561 – Environmental Requirements.

.6 Fire Protection
   .1 The Contractor shall:
       .1 Provide and pay all costs for temporary extinguishers and other fire protection equipment, adequate for fire protection of the Work and adjacent property.
       .2 Participate in firefighting training sessions.

.7 Contractor’s Field Offices
   .1 The Contractor shall:
       .1 Provide, maintain and subsequently remove any temporary field offices, lunch rooms and storage sheds necessary for the execution of the Work.
       .2 Pay all installation, monthly and other costs for the various supplies for the Contractor’s offices throughout the construction period.
       .3 Locate field offices where directed by the Engineer.
       .4 Connect and disconnect required services to the temporary field offices.
.8 Engineer’s Field Office

.1 The Contractor shall:

.1 Provide, maintain and subsequently remove a temporary engineer’s field office, including heating and ventilation, telephone and internet services.

.2 Pay all installation, monthly and other costs for the various supplies for the Contractor’s offices throughout the construction period.

.3 Locate field office where directed by the Engineer.

.4 Connect and disconnect required services to the temporary field office.

.9 First Aid

.1 The Contractor shall provide suitable first aid equipment, supplies and personnel during working hours.

.10 Materials, Owner Supplied Materials, Contractor’s Plant and Equipment Storage

.1 The Contractor shall:

.1 Locate materials, Owner Supplied Materials, Contractor’s Plant and Equipment storage where directed by the Engineer.

.2 Provide and maintain in a clean and orderly condition adequate lockable storage boxes, materials, Owner Supplied Materials, Contractor’s Plant and Equipment storage as required.

.3 Provide and maintain in a clean and orderly condition suitable weatherproof and lockable enclosures or sheds for storage and protection of materials, Owner Supplied Materials, Contractor’s Plant and Equipment storage which require such protection.

.4 The Owner will allocate storage/laydown areas at the Site for materials, Owner Supplied Materials, Contractor’s Plant and Equipment that do not require to be placed in weatherproof sheds. Maintain areas in a clean and orderly condition. Limit storage of materials, Owner Supplied Materials, Contractor’s Plant and Equipment to storage areas only.

.5 The Contractor shall not unduly encumber the Site with excess materials and Contractor’s Plant and Equipment. Storage will be limited to the materials and, Contractor’s Plant and Equipment required, and not for long-term storage.
TEMPORARY FACILITIES

.11 Scaffolding and Ladders

   .1 The Contractor shall:

      .1 Design, construct and dismantle ladders and scaffolding in accordance with CSA Standards and Workers' Compensation Board regulations governing scaffolding and ladders.

      .2 Erect scaffolding independent of walls and erect ladders so as not to damage finishes. Remove promptly when no longer required.

.12 Clean-Up

   .1 The Contractor shall:

      .1 Maintain the Site daily in a tidy condition, free from accumulation of waste products and debris.

      .2 Provide waste containers required for the Work and also properly load the bins for disposal.

      .3 Conduct cleaning and disposal operations to comply with local ordinances and regulations.

      .4 Remove waste material and debris from the Site and deposit in waste container at the end of each working day.

      .5 Contain lunchroom garbage to avoid wildlife being attracted to the Site.

      .6 Failure to maintain and clean the Site may result in the Owner arranging for others to clean and backcharge the Contractor.

2. PRODUCTS

   Not Applicable

3. EXECUTION

   Not Applicable

END OF SECTION
1. GENERAL

1.1 Installation/Removal

.1 Provide temporary access and parking areas as required.
.2 Remove from Site all such work after use.

1.2 Access Road

.1 Provide and maintain adequate access to Site.
.2 If authorized to use existing roads for access to Site, maintain such roads for duration of Contract and make good damage resulting from contractors’ use of roads.
.3 Access roads should not be used for storage of materials or equipment and must remain accessible at all times.
.4 Prior to final inspection, obtain and submit to Owner written signed releases from owners of all roads used for Site access, verifying that roads have been adequately restored and left in a satisfactory condition.
.5 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.

1.3 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.
.2 Provide and pay for bridges, walks, or other temporary facilities necessary to ensure that these controls or warning systems are free for use in their normal manner at all times during construction.

1.4 Construction Parking

.1 Parking will be permitted on Site in designated areas and provided it does not disrupt the performance of Work.

2. PRODUCTS

Not Applicable.

3. EXECUTION

Not Applicable.

END OF SECTION
TEMPOARY BARRICADES AND ENCLOSURES

1. GENERAL

1.1 Description

.1 The Contractor shall provide temporary barriers and enclosures required to protect the public against injury and damage.

.2 The Contractor shall install, remove, relocate and replace fencing and gates as required to perform the Work.

1.2 Guard Rails and Barricades

.1 The Contractor shall provide secure, rigid guard railings, and barricades around deep excavations and trenches as required by governing authorities having jurisdiction.

2. PRODUCTS

2.1 Temporary Fencing

.1 The Contractor shall design, supply, and install temporary fencing around excavations and trenches. The Contractor shall remove temporary fencing upon completion of the Work.

.2 Vinyl or wood "snow" fence will not be allowed as temporary fencing.

3. EXECUTION

3.1 Installation, Relocation, Removal and Maintenance

.1 The Contractor shall:

.1 Erect temporary fencing as soon as possible after mobilization.

.2 Maintain temporary and permanent fencing in good condition for the duration of the Work.

.3 Receive approval from the Engineer prior to removing or relocating any fencing or gates.

.4 Replace fencing as directed by the Engineer.

END OF SECTION
1. GENERAL

1.1 Site Working Areas

.1 Confine operations to limits of the site working area shown on Drawings.

.2 Provide access roads to the site working area and on the site in locations shown or otherwise acceptable to the Engineer.

.3 Install fencing to clearly define the working limits to the site working area, haul routes, parking areas, access routes, and maintenance areas to ensure all activity is confined to these areas.

1.2 Measurement for Payment

.1 The cost of environmental and aesthetic protection will not be paid for directly but shall be considered incidental to the contract tendered price.

1.3 Environmental Monitor

.1 All recommendations of the Environmental Monitor must be implemented in a timely fashion.

.2 The Environmental Monitor has the authority to halt work to remedy environmental risks and the Contractor must implement all recommendations made by the Environmental Monitor.

.3 In the event the Environmental Monitor is required to be on site, a 24-hour advance notice must be provided to the Environmental Monitor.

2. PRODUCTS

Not Applicable

3. EXECUTION

3.1 Disposal of Wastes

.1 Fires and burning of rubbish on site are not permitted.

.2 Do not bury rubbish and waste materials on site.

.3 Do not dispose of waste or volatile materials, such as mineral spirits, oil or paint thinner into waterways, storm or sanitary sewers.

.4 Remove all demolition, construction and trade waste from the site and dispose of at the designated trade waste landfill.
.5 No food, domestic garbage or hazardous wastes may be deposited in the trade waste site.

.6 Dispose of all hazardous wastes in conformance with the Environmental Contaminates Act and applicable Provincial regulations while observing the Code of Good Practice for Management of Hazardous and Toxic Wastes at Federal Establishments.

.7 Maintain the site in a tidy condition, free from the accumulation of waste products, debris and litter.

3.2 Drainage

.1 Provide temporary drainage and pumping as necessary to keep excavations and site free from water.

.2 Do not pump water containing suspended materials into waterways and drainage system.

.3 Control dispersal or run off of water containing suspended materials or other harmful substances in accordance with City Bylaw.

3.3 Contractor Operations

.1 Confine all operations to the work limits as staked or designated by the Engineer. No activities of any kind may be carried out beyond those work limits without the written permission of the Engineer.

.2 Do not store or stockpile construction materials in the trees bordering or being preserved on-site. Do not unreasonably encumber the site with projects.

.3 Equipment maintenance shall only be carried out in designated areas or as approved by the Engineer.

.4 Used oil, filter and grease cartridges, lubrication containers and other products of equipment maintenance shall be collected and disposed of at the nearest industrial waste facility.

.5 Provide sufficient sanitary facilities and maintain in a clean condition.

.6 Conduct operations at all times in such a manner as to preserve the natural features and vegetation in the area. Cut and fill slopes shall be blended with adjoining topography. Material from fill slopes will not be permitted to stuff or roll into surrounding tree cover or to bury any plant material designed to be retained.

.7 All equipment maintenance and refuelling shall be carried out so as to prevent the entry of petroleum products into the ground or watercourses at all times.
.8 The Contractor shall ensure the immediate availability of the products with which to affect 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.

.9 Maintain temporary erosion and pollution control features installed under this contract.

.10 Control noise emission from equipment and plant to local authorities’ noise emission requirements.

.11 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.

.12 When in the opinion of the Engineer, negligence on the part of the Contractor results in damage or destruction of vegetation, or other environmental or aesthetic features beyond the staked or designed work area, the Contractor shall be responsible, at his expense for complete restoration including the replacement of trees, shrubs, topsoil, grass, etc. to the satisfaction of the Engineer.

3.4 Pollution Control

.1 Maintain all temporary erosion and pollution control features installed under this contract.

.2 Control emissions from equipment and plant as required by specific sections of this specification.

.3 Prevent sandblasting, blasting and other extraneous materials from contaminating air beyond application area by providing suitable, temporary enclosures or mats.

.4 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads and on-site work as specified elsewhere.

3.5 Wildlife Protection

.1 The Environmental Monitor is to be notified of wildlife to remove them from the working area.

.2 If multiple occurrences are documented, silt or barrier fencing may be required.

.3 In the event that site clearing is required and will disturb birds, consult the Environmental Monitor for the need for bird surveys and an appropriate avian work window.

END OF SECTION
1. **GENERAL**

1.1 **Quality of Products**

.1 All products and installations to be in compliance with the District of Lake Country Subdivision and Development Servicing Bylaw 985, or the Approved Products list.

.2 Provide new materials, equipment, and articles incorporated in the Work, 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.

.3 Defective materials, equipment and articles whenever found may be rejected regardless of previous inspection. Inspection by the Engineer does not relieve the Contractor of his responsibility but is merely a precaution against oversight or error. Remove and replace defective materials at own expense and be responsible for all delays and expenses caused by rejection.

.4 Should any dispute arise as to the quality or fitness of materials, equipment or articles, the decision rests strictly with the Engineer based upon the requirements of the Contract Documents.

.5 Unless otherwise indicated in the specifications, maintain uniformity of manufacturer for any particular or like item throughout the building and other areas of the Work.

.6 Permanent labels, trademarks and nameplates on materials, equipment and articles are not acceptable in prominent locations except where required for operating instructions and when located in mechanical or electrical rooms.

1.2 **Availability of Products**

.1 Immediately upon signing the Contract, review Product requirements and anticipate foreseeable delivery delays in any items. If delays in deliveries of materials, equipment or articles are foreseeable, propose substitutions or other remedial action in ample time to prevent delay in performance of the Work.

.2 To receive approval, proposed substitutes must equal or exceed the quality, finish and performance of those specified and/or shown, and must not exceed the space requirements allotted on the drawings.

.3 If such proposal is not given to the Engineer, the Engineer reserves the right to substitute more readily available Products later in order to prevent delays at no additional cost to the Owner.

.4 No substitution of any item will be permitted unless the item cannot be delivered to the job site in time to comply with the Schedule.
1.3 Storage, Handling, and Protection of Products

.1 Handle and store products in a manner to prevent damage, contamination, deterioration and soiling and in accordance with manufacturer's recommendations when applicable.

.2 Store packaged or bundled products in original and undamaged condition with manufacturers' seals and labels intact. Do not remove from packaging or bundling until required in the Work.

.3 Products subject to damage from weather are to be stored in weatherproof enclosures. These enclosures are to be supplied and installed by the Contractor.

.4 Store cementitious materials clear of earth or concrete floors and away from walls.

.5 When used for grout or mortar materials, keep sand clean and dry. Store sand on polyethylene and cover with waterproof tarpaulins during inclement weather.

.6 Store sheet material, lumber and steel trusses, joists and members on flat, solid supports and keep clear of ground.

.7 Store and mix paints in a room assigned for this purpose. Keep room under lock and key at all times. Remove oily rags and any other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.

.8 Remove and replace damaged products at own expense.

1.4 Manufacturers' Directions

.1 Unless otherwise specified, install, or erect all products in accordance with manufacturers’ recommendations. Do not rely on labels or enclosures provided with products. Obtain instructions directly from manufacturers.

.2 Notify the Engineer, in writing, of any conflicts between the specifications and manufacturers' instructions so that the Engineer may establish the course of action to follow.

.3 Improper installation or erection of products due to failure in complying with these requirements authorizes the Engineer to require any removal and re-installation that may be considered necessary, at no increase in Contract Price.

.5 Provide documentary proof of equality, difference in price (if any) and delivery dates in the form of certified quotations from suppliers of both specified items and proposed substitutions.

.6 Include all costs in the difference in price (if any) for any required revisions to other structures and products to accommodate such substitutions.
1.5 **Protective Coating**

.1 Unless otherwise specified, ship each item of equipment to the Work Site with the manufacturer’s shop applied prime coating as specified.

1.6 **General Workmanship Requirements**

.1 Workmanship is to be of the best quality executed by workers fully experienced and skilled in their respective trades.

.2 At all times enforce discipline and good order among workers. Do not employ any unfit person or anyone unskilled in the duties assigned to him. The Engineer reserves the right to require the removal from site of workers deemed incompetent, careless, insubordinate or otherwise objectionable.

.3 Decisions as to the quality of or fitness of workmanship in cases of any dispute rests solely with the Engineer whose decision is final.

1.7 **Coordination**

.1 Coordinate the work of all Subcontractors.

.2 Ensure that all Subcontractors examine the drawings and specifications for other parts of the Work which may affect the performance of their work.

.3 Ensure that sleeves, openings, and miscellaneous foundations are provided as required for the Work.

.4 Ensure that items to be built in are supplied when required with all necessary templates, measurements, and shop drawings.

1.8 **Concealment**

.1 In finished areas conceal all pipes, ducts, and wiring except where indicated otherwise on drawings or in specifications.

.2 Before installation inform the Engineer if there is a contradictory situation. Install as directed.

1.9 **Location of Items**

.1 Consider the location of items indicated on drawings as approximate. The actual location of these items is to be as required or directed to site conditions at the time of installation and as is reasonable.

.2 Before installation inform the Engineer if there is a contradictory situation. Install as directed.
1.10 Cutting and Remedial Work

.1 Perform all cutting and remedial work that may be required to make the several parts of the Work come together properly. Coordinate and schedule the Work to ensure that cutting and remedial work are kept to a minimum.

.2 Remove and replace defective and non-conforming work.

.3 Where new work connects with existing work and where existing work is altered, cut, patch, and make good to match existing work.

.4 Do all cutting with power saws or core drilling equipment. Do not use pneumatic or impact tools. Make all cuts with clean, true, smooth edges.

.5 Do not cut, bore, or sleeve any load bearing structure without the written consent of the Engineer, unless specifically detailed on the Drawings. Submit details with each request for consent.

.6 Provide openings in non-structural elements of the Work for penetrations of mechanical and electrical work. Coordinate size and location of such openings with the trade involved.

.7 Fit construction tightly to ducts, pipes, conduits and similar products, to stop air movement completely. Where such work penetrates a fire separation element or wall of the building, pack the penetration around the duct, pipe, conduit or similar for the length of the openings with ULC listed fire stopping packing Product as part of the Work specified.

.8 Prepare the surfaces to receive patching and finishing.

.9 Refinish the surfaces to match the adjacent finishes. For continuous surfaces refinish to the nearest intersection, and for an assembly, refinish the entire unit.

.10 Employ specialists familiar with the materials affected in performing cutting and remedial work. Perform in a manner to neither damage nor endanger any portion of the Work.

1.11 Fastenings

.1 Provide the fasteners, anchors, braces, and supports required to maintain installations attached to the structure or to finished floors, walls and ceilings in a secure and rigid manner capable of withstanding the dead loads, live loads, superimposed dead loads, and any vibration of the installed Products.

.2 Use fasteners compatible with the structural requirements, finishes, and types of Products to be connected. Do not mix products subject to electrolytic action or corrosion where conditions are liable to cause such action.
.3 Where hangers are suspended from concrete slabs, install inserts before concrete is placed using inserts designed for the specific purpose.

.4 Where built-in inserts are inaccessible due to subsequent installation of ducts, pipes or other installations, use anchors appropriate to the load requirements. Locate anchors to avoid damage to reinforcing bars.

.5 Verify that the fasteners, anchors, braces and supports for suspended installations, and the structure to which they are to be secured are designed to support the load requirements, including safety factor.

.6 Where a fastener installation is suspect, have on-site tests of installed fasteners, performed by an independent testing laboratory acceptable to the Engineer, using properly engineered and calibrated force measuring meters.

.7 Where the floor, wall or ceiling construction is not suitable to support the loads, provide additional framing or special fasteners to ensure proper securement to the structure that is to support the Products.

.8 Provide reinforcing or connecting supports, where required, to distribute the loads on the structural components.

.9 Do not use wood plugs or hammer-impact fasteners. Anchoring to floor topping fills is not acceptable. Secure the anchors in floors to the floor structure.

.10 Where a performance requirement is specified, submit engineering calculations and written verification signed by a Registered Professional Engineer that the installation has been inspected and is structurally sound and in accordance with design requirements.

.11 Fastenings which cause spalling or cracking of the structure or Products to which anchorage is made are not acceptable.

.12 Obtain the Engineer’s consent for use of explosive-actuated fastening devices. If consent is given, comply with CSA A166-1975.

.13 Space the anchors within limits of load bearing or shear capacity and ensure they provide positive permanent anchorage.

.14 Provide metal fastenings and accessories in same texture, colour and finish as adjacent material unless otherwise specified.

.15 Prevent electrolytic action between dissimilar metals and materials.

.16 Use non-corrosive, non-staining fasteners and anchors for securing exterior work unless otherwise specified.
.17 Space anchors within their load limit or shear capacity and ensure that they provide positive permanent anchorage.

.18 Keep exposed fastenings to a minimum, space evenly and lay out neatly.

1.12 Protection of Work in Progress

.1 Adequately protect all work completed and in progress. Repair or replace all damaged work.

.2 Prevent overloading of any part of the Work.

1.13 Cleaning

.1 Remove waste materials and debris from the site at regular intervals. Do not burn waste materials and debris on site.

1.14 Local Workforce

.1 Give preference to the hiring of local workers, provided they are available and physically fit and qualified by training and experience to perform the Work. The foregoing does not apply to superintendent, timekeeper, foreman and construction equipment and machine operators, nor until ten days after the commencement of the Work. Make available at all reasonable times for examination by the Owner, the labour rolls for the determination of the domicile of the workers.

1.15 Metric Measurement

.1 Unless otherwise noted, this Project has been designed and is to be constructed in the S.I. metric system of measurements.

.2 During construction, when specified metric elements are unattainable at the time they are required to meet the Construction Schedule, the Contractor shall notify the Engineer in writing and suggest alternative substitutions. Costs due to these substitutions shall be borne by the Contractor.

2. PRODUCTS

Not Applicable.

3. EXECUTION

Not Applicable.

END OF SECTION
1. GENERAL

1.1 Description

.1 This Section describes the general requirements for the shipment, protection, and storage of the Goods.

.2 For pre-purchased equipment the Supply Contractor shall take responsibility for all shipment, protection and storage of the Goods up to and including delivery of the Goods to the Delivery Point.

1.2 Care

.1 Ship, handle, and store the Goods to prevent damage.

.2 Damaged items will not be permitted as part of the Goods except in cases of minor damage that have been satisfactorily repaired and are acceptable to the Owner.

1.3 Documents Required

.1 For each scheduled delivery, provide a written Notice of Shipment as specified herein.

.2 Each Notice of Shipment shall include legible copies of the approved Shipping Document as specified herein.

.3 Submit a Shipping Document for each shipment. The Shipping Document shall clearly state the manufacture, contract number, and shipment number. Where more than one shipment is made, the shipment number shall be “Shipment 1 of XX”, “Shipment 2 of XX”, etc. Each Shipping Document shall include a detailed packing list and bill of materials indicating weights of package of item(s) and special unloading and handling instructions.

.4 The Shipping Document shall include a description of all packing material such as wood pallets, plastic, Styrofoam, cardboard, or other indicating approximate weights of each material.

.5 Provide written instructions to the General Contractor clearly indicating proper handling, protection, and maintenance of the Goods while stored at the Delivery Point or the Site.

1.4 Transportation

.1 Pay all costs of transportation and insurance of the Goods to the Delivery Point.

.2 Provide protection against damage from moisture, dust, handling, or other cause during transport from manufacturer’s premises to the Delivery Point.
.3 Items or components of items with unique numbering systems such as mechanical and electrical equipment and instruments shall be clearly and securely tagged with such numbers.

.4 Use stiffeners where necessary to maintain shapes and to give rigidity.

.5 Deliver parts of the Goods in assembled or sub-assembled units to the maximum extent practicable.

.6 Wrap or otherwise seal bearing housings, vents and other types of openings to prevent contamination by grit and dirt.

.7 Correct any damage to conform to the requirements of the Contract before the Goods are incorporated into the facilities and pay the costs arising out of dismantling, inspection, and repair and reassemble as necessary.

1.5 Factory Applied Coatings

.1 Unless otherwise specified, ship each item of the Goods to the Delivery Point with the manufacturer’s shop applied finished coating.

2. PRODUCTS

Not Applicable.

3. EXECUTION

Not Applicable.

END OF SECTION
1. GENERAL

1.1 Intent

.1 This Section describes general requirements for all equipment supplied under the Contract and Owner-supplied equipment including: acceptance, equipment delivery, equipment installation training, equipment installation, and equipment performance testing.

.2 At least thirty (30) days prior to commencing equipment performance testing and process performance testing, the Contractor shall submit a detailed start-up plan to indicate the schedule and sequence of equipment installation checks and tests required for the Engineer's review and input. No testing work can commence until this plan has been discussed by all parties involved and accepted by the Engineer.

1.2 Definitions

.1 Equipment Manufacturer's representatives: An Equipment Manufacturer's representative is a trained serviceman (factory technician) empowered by the equipment supplier to provide:

.1 Installation training

.2 Witnessing of equipment installation

.3 Assistance in equipment performance testing

.4 Assistance in process performance testing.

.2 Major Equipment: for the purposes of this section, major equipment shall include (not limited to) all electrical and mechanical components of the systems as described in Section 01010. Technical sections, Divisions 02 to 17 (inclusive) will identify major equipment.

1.3 Expertise and Responsibility

.1 The Engineer recognizes the expertise of the Contractor.

.2 Should the Engineer issue a Contemplated Change Notice, Field Order, or Change Order to change the Work which would, in the opinion of the Contractor, compromise the success or safety of the Work, then it shall be incumbent on the Contractor to notify in writing the Engineer to this effect within two (2) days upon receipt.
1.4 Delivery of Equipment

.1 The Contractor will coordinate the date of major equipment delivery close to the time when the equipment will be installed (and within approved equipment delivery schedule time frame) to minimize the Equipment Manufacturer's representative attendance on site. A representative from each of the following groups will be in attendance at the time of delivery:

.1 The Contractor.

.2 The Supplier.

.3 The Owner (for Owner Supplied Equipment).

.2 Ensure that equipment is delivered to the construction site or other storage facility in as designated by the Contractor.

.1 When the Contractor and Supplier are satisfied that the equipment has been delivered in its entirety without damage complete the "Certificate of Equipment Delivery" (Form 100). Deliver the completed Form 100 to the Engineer prior to the departure of the Equipment Manufacturer's representative from the site.

.2 Off-loading and storage of the equipment at the job site will be the responsibility of the Contractor. Ensure suitable storage facilities.

.3 The equipment may have to be stored for an extended period of time before installation and equipment performance testing. Remove any protective coatings prior to installation and equipment performance testing in accordance with the Equipment Manufacturer's representative written instructions. In addition, adhere to any requirements by the Supplier outlined in documents included in the appendices regarding warranties and start-up requirements.

1.5 Installation Assistance

.1 Before commencing installation of all major pieces of equipment, the Contractor shall request from the Equipment Manufacturer's representative written instructions in the methods, techniques, precautions, and any other information relevant to the successful installation of the equipment.

.1 The Equipment Manufacturer's representative shall provide advice and instructions to the Contractor on the installation of the equipment but will not be responsible for the detailed supervision of the installation or the workers installing it.

.2 The Contractor shall notify the Engineer in writing immediately in the event of any disputes with the Contractor concerning installation of the equipment.
.2 When the Contractor and Equipment Manufacturer's representative are satisfied that the Contractor is aware of the installation requirements he and the Supplier shall so certify by completing the “Certificate of Equipment Installation” (Form 101).

.3 Installation of the equipment shall not commence until the Engineer has advised that he has accepted the completed Form 101.

.4 One copy of Form 101 shall be used for each major piece of equipment.

1.6 Installation

.1 If necessary, or if so directed by the Engineer during the course of installation, the Contractor shall contact the supplier to receive clarification of installation procedures, direction, or any other additional information necessary to continue or complete the installation in an appropriate manner.

.2 If it is found necessary, or if so directed by the Engineer, the Contractor shall arrange for the Equipment Manufacturer's representative to visit the site to provide assistance to the Contractor during installation, all at no cost to the Owner.

.3 Prior to completing installation, the Contractor shall inform the Equipment supplier and arrange for the attendance at the site of the Equipment Manufacturer's representative to verify successful installation.

1.7 Installation Verification

.1 Installation verification is led by the Contractor and the Equipment Manufacturer's representative; the Owner's Designated Staff should actively be involved to ensure they understand how each item of equipment is checked to ensure proper installation, alignment, or any other special requirements prior to start-up.

.2 The “Plan to Achieve Satisfactory Equipment Installation – Form P102 Sign-Off” at the end of this section is a guideline for the documentation and steps required to achieve equipment installation sign-off. Plan P102 shall be completed and submitted for each major piece of equipment.

.3 Prior to the start-up of any item of major equipment, the Contractor shall provide the Engineer with the Equipment Manufacturer's representative equipment installation check list. In addition, the Contractor shall ensure that a copy of the equipment specifications submitted during the shop drawing review process with the conformances and deviations identified by the Supplier is used by the Supplier to verify the equipment supply and installation.

.4 The Contractor shall provide the Engineer with the date of the Equipment Manufacturer's representatives installation check.
Prior to the start-up of any item of major equipment, the Equipment Manufacturer's representative will provide an on-site workshop to instruct the Owner's Designated Staff on the proper installation of the equipment. The Plan P102 prompts the Contractor, Engineer and Owner's Designated Staff to consider whether equipment T1 Training can be provided either before or after the installation has been verified. Refer to Section 01664 for details on equipment training requirements.

The Owner shall identify staff who shall attend the Equipment Manufacturer's representative workshop. When the commissioning team is satisfied that all the requirements necessary for proper installation of the equipment are understood, a standard checklist will be completed and signed by the Equipment Manufacturers Representatives representative, the Contractor, the Engineer and the Owner's Designated Staff.

When the installation of the equipment is essentially complete, the Equipment Manufacturer's Representative shall conduct a detailed inspection of the installation.

The Equipment Manufacturer's representative will identify any outstanding deficiencies in the installation and shall provide a copy of the Site Inspection Report to the Engineer and Contractor describing such deficiencies before the Equipment Manufacturer's representatives leaves the Site.

In addition, a Formal Inspection Report must be provided at a later date by the Equipment Manufacturer's representative.

The deficiencies shall be rectified by the Contractor and the Equipment Manufacturer's representative will be required to re-inspect the installation, at no cost to the Owner.

The “Certificate of Satisfactory Equipment Installation Form 102” can be signed off with the understanding that minor deficiencies are to be corrected prior to the start of the operation and performance verification (Form 103 stage).

Deliver the completed Form 102 to the Engineer prior to departure of the Equipment Manufacturer's representative from the site.

Tag the equipment with a 100 mm by 200 mm red card stating "Equipment Installation Checked. Do Not Run". Stenciled in large black letters. Sign and date each card.

One copy of Form 102 shall be used for each major piece of equipment.

Operation and Performance Verification

Equipment will be subjected to a demonstration, running test, and performance tests after the installation has been verified and any identified deficiencies have been remedied.
EQUIPMENT INSTALLATION

.2 A copy of the equipment operations manuals shall be provided a minimum of 30 days prior to commencement of the Equipment Performance Test.

.3 Equipment Performance verification is led by the Contractor and the Equipment Manufacturer's representative; the Owner's Designated Staff should actively be involved to ensure they understand how each item of equipment operates.

.4 The “Plan to Achieve Satisfactory Equipment Performance – Form P103 Sign-Off” at this end of this section is a guideline for the documentation and steps required to achieve equipment performance sign-off. Plan P103 shall be completed and submitted for each major piece of equipment.

.5 The Plan P103 also prompts the Contractor, Engineer and Owner’s Designated Staff to consider whether equipment T1 Training can be provided either before or after the equipment performance has been verified. Refer to Section 01664 for details on equipment training requirements.

.6 The Contractor shall provide the Engineer with the Equipment Manufacturer's operation check list. In addition, the Contractor shall ensure that a copy of the equipment specifications submitted during the shop drawing review process with the conformance and deviations identified by the Supplier is used by the Supplier to verify the equipment performance requirements.

.7 The Contractor shall submit a 3-Day test plan to the Engineer 21 working days in advance of conducting the tests.

.8 The Contractor shall inform the Engineer at least ten (10) working days in advance of conducting the tests and arrange for the attendance of the Equipment Manufacturer's Representative. The tests may be concurrent with the inspection of satisfactory installation if mutually agreed by the Contractor and the Engineer.

.9 Prior to commencement of the equipment startup inspection, a Pre-Start-Up meeting will be held on site with the Contractor, Equipment Manufacturer's representative, Engineer and Owner’s Designated Staff to confirm the 3-day test plan.

.10 The Contractor shall contact the Equipment Manufacturer's representative to conduct all necessary checks to the equipment and if necessary, advise the Contractor of any further work needed prior to confirming the equipment is ready to run.

.11 The Contractor shall then notify the Engineer of his readiness to demonstrate the operation of the equipment. The Engineer shall attend, as expeditiously as possible.

.12 The Contractor shall obtain the assistance of the Equipment Manufacturer's representative to demonstrate that any Form 102 deficiencies have been rectified. Alignment, piping connections, electrical connections, sample product, etc. will be checked and if appropriate, code certifications provided.
.13 The equipment shall then be run for one (1) hour. Local controls shall be satisfactorily verified by cycling the equipment through several start-stop operations, modulating its output, or some combination. Operating parameters such as temperature, pressure, voltage, vibration, etc., will be checked to ensure that they are within the specified or Equipment Manufacturer's representative's recommended limits, whichever is more stringent.

.14 On satisfactory completion of the one (1) hour demonstration, the equipment will be stopped and the Contractor shall recheck all critical parameters such as alignment.

.15 The equipment will be restarted and run continuously for three (3) days. During this period, as practicable, conditions will be simulated which represent maximum or most severe, average, and minimum or least severe conditions. These conditions will be mutually agreed by the Equipment Manufacturer's representative, the Contractor and the Engineer on the basis of the information contained in the Contract Documents, as well as the methods utilized to create the simulated conditions and the time periods allotted to each.

.16 Performance tests will be conducted either concurrent with or subsequent to the running test, as practicable and agreed between the Engineer, the Equipment Manufacturer's representative and the Contractor.

.17 Performance tests shall be as dictated in the technical specifications for each item of equipment or as reasonably required by the Engineer to prove adherence to the requirements listed in the specifications.

.18 The Contractor shall submit the results of the performance tests to the Engineer, documented and summarized in a format acceptable to the Engineer. (Refer to the Sample form at the end of this section for an example of the documentation required for the equipment performance test.) The Engineer reserves the right to request additional testing.

.19 Supply of water, chemicals, temporary power, heating, or any other ancillary services required to complete the initial demonstration, running test and performance tests are the responsibility of the Contractor.

.20 Provide the initial charges of oil, grease, and all materials necessary for the initial demonstration, running test and performance tests not provided under this contract, all to the satisfaction of the equipment manufacturer.

.21 The Equipment Manufacturer's representative will identify any outstanding deficiencies in the equipment performance and shall provide a written Site Inspection Report to the Engineer and Contractor describing such deficiencies before the Manufacturer's Representative leaves the Site.

.22 In addition, a Formal Inspection Report must be provided at a later date by the Equipment Manufacturer's representative.
.23 Should the initial demonstration, running test or performance tests reveal any defects, then those defects shall be promptly rectified and the demonstration, running tests, and/or performance tests shall be repeated to the satisfaction of the Engineer. Additional costs incurred by the Contractor, the Engineer, or the Owner, due to repeat demonstration, running tests, and/or performance tests shall be the responsibility of the Contractor.

.24 On successful completion of the demonstration, running test, and performance tests, including submittal of required data, the "Certificate of Satisfactory Equipment Performance" (Form 103) attached to this specification will be signed by the Equipment Manufacturer's representative, the Contractor, the Engineer and the Owner's representative. Form 103 can be signed off with the understanding that minor deficiencies are to be corrected prior to the start of the operation and performance verification (Form 104).

.25 No equipment shall be accepted and handed over to the Owner prior to the satisfactory completion of the Equipment Performance Test(s) and acceptance of the test reports by the Engineer.

.26 Tag the equipment with a 100 mm by 200 mm yellow card stating "Equipment Performance Checked. Do Not Run". Stencilled in large black letters. Sign and date each card.

.27 If the Client and Owner agree, the Process performance testing can commence as soon as the "Certificate of Satisfactory Equipment Performance" (Form 103) is completed. The relevant portion of the Supervisory Control and Data Acquisition System (SCADA) must be installed and Commissioned prior to commencement of the Process Performance Test.

.28 One copy of Form 103 shall be used for each major piece of equipment.

2. PRODUCTS

   Not Applicable

3. EXECUTION

   Not Applicable
CERTIFICATE OF EQUIPMENT DELIVERY
FORM 100

We certify that the equipment listed below has been delivered into the care of the Contractor. The equipment has been found to be in satisfactory condition. No defects in the equipment were found.

The Contractor will adhere to any requirements by the Equipment Manufacturer outlined in documents included in the appendices regarding warranties and start-up requirements.

PROJECT:

ITEM OF EQUIPMENT:

TAG NO:

REFERENCE SPECIFICATION:

Authorized Signing Representative of the Contractor

Date

Authorized Signing Representative of the Supplier

Date

Authorized Signing Representative of the Owner, signature required for Owner Supplied Equipment only

Date
CERTIFICATE OF EQUIPMENT INSTALLATION
FORM 101

I have familiarized the Contractor of the specific installation requirements related to the equipment listed below and am satisfied that he understands the required procedures.

PROJECT: ____________________________________________

ITEM OF EQUIPMENT: ____________________________________________

TAG NO: ____________________________________________

REFERENCE SPECIFICATION: ____________________________________________

(Authorized Signing Representative of the Supplier) ___________________________ Date ____________

I certify that I have received satisfactory installation instructions from the equipment Supplier.

(Authorized Signing Representative of the Contractor) ___________________________ Date ____________
CERTIFICATE OF SATISFACTORY EQUIPMENT INSTALLATION
FORM 102

I have completed my check and inspection of the installation listed below and confirm that it is satisfactory and that defects have been remedied to my satisfaction except any as noted below:

PROJECT: ____________________________________________

ITEM OF EQUIPMENT: ____________________________________________

TAG NO: ____________________________________________

REFERENCE SPECIFICATION: ____________________________________________

OUTSTANDING DEFECTS: ____________________________________________

(Authorized Signing Representative of the Supplier) __________________________ Date __________

(Authorized Signing Representative of the Contractor) __________________________ Date __________
CERTIFICATE OF SATISFACTORY EQUIPMENT PERFORMANCE
FORM 103

We certify that the equipment listed below has been continuously operated for at least three (3) consecutive days and that the equipment operates satisfactorily and meets its specified operating criteria. No defects in the equipment were found. The equipment is therefore classed as “conforming”.

PROJECT: ____________________________

ITEM OF EQUIPMENT: ____________________________

TAG NO: ____________________________

REFERENCE SPECIFICATION: ____________________________

(Authorized Signing Representative of the Supplier) Date

(Authorized Signing Representative of the Contractor) Date

(Authorized Signing Representative of the Engineer) Date

END OF SECTION
EQUIPMENT INSTALLATION

PLAN TO ACHIEVE SATISFACTORY EQUIPMENT INSTALLATION
FORM P102 SIGN-OFF

PROJECT: 

SYSTEM: 

EQUIPMENT: 

1.0 SCHEDULE
1.1 Date of Test: 
1.2 Duration of Test: 
1.3 T1 Training Available: YES NO N/A
   If Yes, Date of T1 Training: 

2.0 WORK PLAN
2.1 Supplier's Checklist Submitted: YES NO N/A
   If Yes, Date Submitted: 
2.2 Owner's Checklist Submitted: YES NO N/A
   Division 11 Specifications submitted as part of Shop Drawings with conformance and deviations noted by Supplier
   If Yes, Date Submitted: 

P:60488627\400-Tender Documents\Division 101650A Equipment Installation Form P102 Sign-Off.docx
### EQUIPMENT INSTALLATION

2.3 Pre Start-Up Meeting Date Scheduled: □ YES □ NO □ N/A
   If Yes, Date of Pre Start-Up Meeting: ____________________________

2.3.1 Attendees (provided by Owner Group)

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2.4 Site Inspection Report including deficiencies submitted: □ YES □ NO □ N/A

2.5 Formal Inspection Report including deficiencies submitted: □ YES □ NO □ N/A

2.6 Certificate of Satisfactory Equipment Installation Form 102 signed-off with the understanding that deficiencies are to be corrected prior to start of Form P103: □ YES □ NO □ N/A

2.7 Form 102 Tag (Red in Colour) is installed on Equipment signifying Form 102 signed-off: □ YES □ NO □ N/A

2.8 T1 Training Available: □ YES □ NO □ N/A
   If Yes, Date of T1 Training: ____________________________
EQUIPMENT PERFORMANCE

PLAN TO ACHIEVE SATISFACTORY EQUIPMENT PERFORMANCE
FORM P103 SIGN-OFF

PROJECT: 

SYSTEM: 

EQUIPMENT: 

1.0 SCHEDULE
1.1 Date of Test: 

1.2 Duration of Test: 3 Days 

1.3 T1 Training Available: □ YES □ NO □ N/A
   If Yes, Date of T1 Training: 

2.0 WORK PLAN
2.1 Supplier's Checklist Submitted: □ YES □ NO □ N/A
   If Yes, Date Submitted: 

2.2 Owner's Checklist Submitted: □ YES □ NO □ N/A
   Division 11 Specifications submitted as part of Shop Drawings with
   conformances and deviations noted by Supplier
   If Yes, Date Submitted: 

2.3 3-Day Test requirements provided: □ YES □ NO □ N/A 

2.4 Pre Start-Up Meeting Date Scheduled: □ YES □ NO □ N/A
   If Yes, Date of Pre Start-Up Meeting: 

### EQUIPMENT PERFORMANCE

2.4.1 Attendees (provided by Owner Group)

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2.4.2 Construction checklist complete and brought to meeting:  
- YES  - NO  - N/A

2.4.3 Form 102: Certificate of Satisfactory Installation deficiencies completed:  
- YES  - NO  - N/A

2.4.4 Can equipment be run fully using SCADA/PCS? (i.e. able to proceed to 14-Day test?)  
- YES  - NO  - N/A

2.5 Site Inspection Report including deficiencies submitted:  
- YES  - NO  - N/A

2.6 Formal Inspection Report including deficiencies submitted:  
- YES  - NO  - N/A

2.7 3-Day Test results attached to Form 103:  
- YES  - NO  - N/A

2.8 Deficiencies Review complete: Minor deficiencies signed off with Form 103 with understanding that deficiencies are to be corrected prior to start of 104. If deficiencies are major, Form 103 will not be signed-off and testing is rescheduled.  
- YES  - NO  - N/A

2.9 Form 103 sign-off complete:  
- YES  - NO  - N/A

If No, Date of Re-test: __________________________

2.10 Form 103 Tag (Yellow in Colour) is installed on Equipment signifying Form 103 complete:  
- YES  - NO  - N/A
### EQUIPMENT PERFORMANCE

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<td>2.11</td>
<td>T2 Training Available:</td>
<td>YES</td>
<td>NO</td>
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<td>If Yes,</td>
<td>Date of T2 Training:</td>
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<td></td>
<td>T2 Training procedures submitted:</td>
<td>YES</td>
<td>NO</td>
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1. GENERAL

1.1 Description

.1 This Section contains requirements for training the Owner's designated Operator Staff, 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 Refer to the equipment specifications for specific time periods.

.3 The intent is that the Operator Staff should receive sufficient training on the equipment system that they are going to operate and maintain. The Engineer shall have the authority to determine the duration and content of each training session required.

1.2 Quality Assurance

.1 Where required by the equipment specifications, provide on-the-job training of the Operator Staff. Training sessions will be conducted by qualified, experienced two (2) years minimum, factory-trained representatives of the various equipment suppliers. Training includes instruction of Operator Staff in equipment operation and preventive maintenance and instruction on mechanics, electronics, and instrumentation and communications equipment operators (technicians) in normal maintenance up to major repair.

.2 The trainer(s) proposed by the Contractor shall be experienced in "training" plant operators and shall have relevant experience in similar work.

1.3 Submittals

.1 Submit the following information in accordance with Section 01330. For phased testing and start-up activities, separate submittals can be prepared for equipment items or systems. The material will receive a "NO EXCEPTIONS TAKEN" or "MAKE NOTED CORRECTIONS" status by the Engineer no later than four (4) weeks prior to delivery of the training:

.1 Lesson plans and training manuals, handouts, visual aids, and other reference materials for each training session to be conducted by the Contractor's trainer(s).

.2 Date, time, and subject of each training session.

.3 Training schedule. Concurrent classes will not be allowed.
1.4 Location

1. Where specified, conduct training sessions for the Operator Staff, operation and maintenance personnel, on the operation, care, and maintenance of the equipment and systems installed under this Contract. Training will take place at Site and under the conditions specified herein.

2. Field training sessions will take place at the Site. Classroom training shall take place at the offices of the District. Alternatively, the Engineer may redirect the classroom training to take place at another suitable location.

1.5 Lesson Plans

1. Prepare formal written lesson plans for each training session and coordinate with the Engineer. Lesson plans to contain an outline of the material to be presented along with a description of visual aids to be utilized during the session. Each plan will contain a time allocation for each subject. Furnish ten (10) copies of necessary training manuals, handouts, visual aids and reference materials at least two (2) weeks prior to each training session.

1.6 Format and Content

1. Include time in the classroom and at the location of the equipment or system for each training session. As a minimum, cover the following topics for each item of equipment or system:

   1. Familiarization
   2. Safety
   3. Operation
   4. Troubleshooting
   5. Preventive maintenance
   6. Corrective maintenance
   7. Parts
   8. Local representatives

1.7 Video Recording

1. The Owner may record each training session. After taping, the material may be edited and supplemented with professionally produced graphics to provide a
permanent record for the Owner's use. Advise all suppliers providing training sessions that the training material may be videotaped.

1.8 Equipment Training

.1 General Requirements

.1 Conduct initial T1 training in conjunction with the Equipment Performance Testing periods. Schedule classes such that classroom sessions are interspersed with field instruction in logical sequence. Arrange to have the training conducted on consecutive days, with no more than four (4) hours of classes scheduled consecutively.

.2 Provide final Operating and Maintenance Manuals, as defined in Section 01330, for the specific equipment to the Owner at least four (4) weeks prior to the start of any training. Videotaping may take place concurrently with all training sessions.

.2 Operator Classroom Training

.1 As a minimum, classroom equipment training for operations personnel will include:

.1 The equipment's specific location in the plant and an operational overview. Use slides and drawings to aid discussion.

.2 Purpose and plant function of the equipment.

.3 The operating theory of the equipment.

.4 Start-up, shutdown, normal operation, and emergency operating procedures, including system integration and electrical interlocks, if any.

.5 Safety items and procedures.

.6 Routine preventive 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 for purposes such as operator inspection of equipment.
.3 Operator Hands-On Training

.1 As a minimum, hands-on equipment training for operations personnel will include:

.1 Identifying instrumentation: location of primary element; location of instrument readout; discuss purpose, basic operation, and information interpretation.

.2 Discussing, demonstrating, and performing standard operating procedures and daily visual inspection of system operation.

.3 Discussing and performing the preventive maintenance activities.

.4 Discussing and performing start-up and shutdown procedures.

.5 Performing the required equipment exercise procedures.

.6 Performing routine disassembly and assembly of equipment if applicable.

.7 Identifying and reviewing safety items and performing safety procedures, if feasible.

.4 Maintenance Classroom Training

.1 Classroom equipment training for the maintenance and repair personnel will include:

.1 Basic theory of operation.

.2 Description and function of equipment.

.3 Routine 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 replacement; and up to and including major
repairs such as replacement of major equipment part(s) with the use of special tools, bridge cranes, welding jigs, etc.

.5 Maintenance Hands-On Training

.1 Hands-on equipment training for maintenance and repair personnel will include:

.1 Locating and identifying equipment components.
.2 Reviewing the equipment function and theory of operation.
.3 Reviewing normal repair procedures.
.4 Performing routine start-up and shutdown procedures.
.5 Reviewing and performing the safety procedures.
.6 Performing Owner-approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.
.7 Reviewing and using Supplier’s manuals in the hands-on training.

1.9 Equipment and Systems Training

.1 General Requirements

.1 Conduct T2 training in conjunction with the Process Performance Testing periods. Schedule classes such that classroom sessions are interspersed with field instruction in logical sequence. Arrange to have the training conducted on consecutive days, with no more than four (4) hours of classes scheduled consecutively.

.2 Conduct a review of the Equipment Training T1 session.

.2 Provide training during the Equipment Performance Testing period for the following equipment and systems:

.1 All components of the above mentioned systems as described in Section 01010 and any identified equipment and systems in Divisions 02 to 17 (inclusive).

.3 Coordinate and finalize with the Engineer on training schedules and duration of each training session.
1.10 Training Completion Forms and Payment

.1 **Form T1**: To be completed for initial training either during Equipment Installation Verification or during Equipment Performance Testing.

.2 **Form T2**: To be completed for final training during the Process Performance Testing, once the Owner has had the opportunity to operate the equipment during the 14-day test period.

.3 A sample of **Forms T1** and **T2** are attached to this specification section.

.4 One copy of **Forms T1** and **T2** will be required for each major piece of equipment.

2. PRODUCTS

Not Applicable

3. EXECUTION

Not Applicable
CERTIFICATE OF SATISFACTORY TRAINING
FORM T1

We certify that the initial training for the equipment listed below has been provided as per the Specifications.

PROJECT: ________________________________

ITEM OF EQUIPMENT: ________________________________

TAG NO: ________________________________

REFERENCE SPECIFICATION: ________________________________

(Authorized Signing Representative of the Owner) ________________________________ Date ________________________________
CERTIFICATE OF SATISFACTORY TRAINING
FORM T2

We certify that the final training for the equipment listed below has been provided as per the Specifications.

PROJECT: ____________________________________________

ITEM OF EQUIPMENT: __________________________________

TAG NO: ____________________________________________

REFERENCE
SPECIFICATION: _______________________________________

(Authorized Signing Representative of the Owner) Date

END OF SECTION
1. GENERAL

1.1 Description

.1 This Section describes the Process Performance Teams for the satisfactory commissioning of the process, electrical, mechanical, and other systems to be installed as part of the Contract.

1.2 Definitions

.1 System: For the purpose of this Section, a System shall be defined as the equipment, piping, controls, ancillary devices, electrical power, etc. which together perform a specific function at the facility.

.2 Process Performance Testing: For the purpose of this Section, Process Performance Testing shall be defined as the successful operation of a system with water, wastewater, or other commodity, as agreed upon by the Engineer, Owner, and Contractor, in accordance with its design requirements for a period of fourteen (14) days, the last three (3) of which shall be consecutive, to prove that the equipment and controls are functioning properly and fully automated.

.3 Acceptance: For the purpose of this specification section, Acceptance shall occur after the end of successful Process Performance Testing of the system and the Supplier, Contractor, Engineer, and Owner have signed the "Certificate of Satisfactory Process Performance" (Form 104).

1.3 Process Performance Team

.1 Process Performance Testing will be conducted by a team comprised of personnel from the Contractor, the Supplier, the Engineer, and the Owner.

.2 The Engineer shall be responsible for the coordination of the Process Performance Testing effort and shall have ultimate authority.

.3 The Contractor shall provide personnel representing the appropriate trades, including electrical, control and instrumentation personnel during Process Performance Testing. These personnel shall be skilled workmen, able to expedite any minor repairs, adjustments, etc. as are required to complete process performance testing with as few delays as possible.

.4 The Contractor shall provide the Supplier's Representative who is experienced in onsite start-up and Process Performance Testing of similar equipment.

.5 The Owner shall be responsible for the daily routine equipment checks during the 14-day test.
1.4 Process Performance Testing Plan

.1 The Process Performance Testing Team shall develop a detailed methodology for the process performance testing of each system at least thirty (30) calendar days prior to planned start of process performance testing.

.2 The “Plan to Achieve Satisfactory Process Performance – Form P104 Sign-Off” at this end of this section is a guideline for the documentation and steps required to achieve process performance sign-off. **Plan P104** shall be used for each major piece of equipment.

.3 The **Plan P104** prompts the Contractor, Engineer, and Owner’s Designated Staff to ensure equipment **T2 Training** is provided. Refer to Section 01664 for details on equipment training requirements.

.4 The detailed methodology plan shall be prepared by the Contractor with input from the Supplier and Engineer and include the following:

   .1 Detailed Schedule of Events, including but not limited to the schedule for completion of testing of all component parts of the system in accordance with Section 01650 prior to process performance testing.

   .2 Method for introducing flow, disposing of partially treated effluent, and disposing of any sludge or other residual solids generated during the process performance testing procedure. The Contractor will take responsibility for implementation of these measures in a Greenfield plant. The Owner will take responsibility for the implementation of these measures in an existing plant.

   .3 Planned attendance schedule for the Supplier's Representative.

   .4 Contingency plans in the event of a process malfunction.

   .5 Drawings and sketches as required to illustrate the planned sequence of events.

   .6 List and details for all temporary equipment (pumps, etc.) required for process performance testing.

   .7 List of all personnel who the Contractor plans for process performance testing and hand-over with information indicating their qualifications for this work.

   .8 The Engineer shall provide the detailed equipment performance checks not verified during the equipment performance testing (**Form 103** Stage) along with the plant control system interlocks not yet verified.

   .9 The Engineer, with input from the Commissioning Team, shall provide the detailed daily routine check list for the Owner.
.5 The Contractor will organize a pre-start-up meeting to review the Process Performance Testing Plan, confirm testing requirements and roles. The Process Performance Testing Team will have to agree on the Plan prior to its implementation. The Engineer shall be the final arbiter.

1.5 Preparation

.1 All process, mechanical, electrical, control, and miscellaneous equipment related to a system shall be successfully installed and tested in accordance with Section 01650 and any specific requirements noted in other divisions. Form 103 shall be executed for each item.

.2 Initial staff training sessions shall be completed (Form T1).

.3 Temporary equipment will be installed and tested as necessary to ensure that it functions reliably and consistently through the process performance testing period.

.4 Operating and Maintenance manuals shall have been submitted and accepted.

.5 Piping, wiring, and other conduit systems shall be finished and tested.

.6 Electrical connections shall be completed and inspected to the satisfaction of the governing authorities.

1.6 Controls

.1 All controls, which are the responsibility of the Contractor, shall be installed and tested prior to process performance testing.

.2 The Engineer shall arrange for the simulation of the control sequences or shall allow for the operation of the system without the features included in the work of others. Every effort shall be made to ensure that the process performance testing period provides for the full and comprehensive operation of the equipment under all anticipated normal and adverse operating conditions.

1.7 Plant Utility Services

.1 The Contractor shall provide power as necessary to operate the plant through the process performance testing period. Provision of these services shall be limited to reasonable levels.

1.8 Manpower

.1 The Contractor shall supply competent staff capable of maintaining, repairing, and adjusting the equipment and controls to achieve the intended design functions during the process performance testing period.
1.9 Process Control Narratives

.1 Process Control Narratives (PCNs) or operating descriptions by the Engineer, where applicable, are in Division 17. To some degree, the intent of these have been included in the drawings and specifications. The Contractor, will review these descriptions and will make himself familiar with the requirements in order that Process Performance Testing can be completed in an appropriate manner.

1.10 Design Parameters

.1 Design parameters for the systems to be tested shall be as defined in the specifications and/or the operating descriptions, as modified by the Process Performance Testing Team. The Process Performance Testing Team will identify to the Contractor which parameters shall be modified prior to process performance testing and shall be responsible for any subsequent changes during the process performance testing period.

.2 Control systems shall be completed and the related control software deficiencies corrected prior to acceptance of the completed Process Performance Test.

1.11 Sequence

.1 Systems shall be process performance tested in a logical manner. Upstream components shall be tested first to the degree possible.

.2 The following sequence of events shall be followed:

.1 Draft Operating and Maintenance manuals shall be available at least eight (8) weeks prior to the Equipment Performance Testing. Submit final copies four (4) weeks before the Equipment Performance Testing period.

.2 Provide annotated Operating Descriptions two (2) weeks prior to testing. Make annotations to the appropriate portions of Division 11.

.3 Operator Final Training (T2) shall be undertaken during Equipment Performance Testing.

.4 Process and Utility streams shall be introduced to the system.

.5 Start and run system in manual mode.

.6 Turn separate items of equipment to automatic in a planned and logical manner. Ensure that the control system is operating the equipment in a manner which precludes damage of the equipment and which is consistent with the process operating requirements.
.7 Transfer the Equipment to the Owner and confirm that the Owner is aware that the equipment has been transferred. Tag the equipment with a 100 mm by 200 mm green card stating "Equipment Transferred to Owner for Commissioning". Stenciled in large black letters. Sign and date each card.

.8 Commence the process performance testing period of fourteen (14) days.

.9 The equipment shall operate continuously and successfully through the last three (3) days of a process performance testing period. Minor failures shall not void the process performance testing period. A minor failure is defined as one which does not present a safety hazard, does not impact overall process functioning and can be temporarily overcome by the use of available standby equipment. The last three (3) days of the process performance testing period shall be re-started if a critical failure occurs. A critical failure shall be deemed as one that prohibits the process from functioning successfully for an eight (8) hour period or one that creates a safety hazard.

.10 The Owner and Engineer shall collect the results of the performance tests and attach them to the Form P104. (Refer to the Sample form at the end of this section for an example of the documentation required for the equipment performance test.) The Engineer reserves the right to request additional testing.

.11 Upon successfully completing the process performance testing period and required documentation (refer to the Sample at end of section), the system shall be granted acceptance by the completion of the "Certificate of Satisfactory Process Performance" (Form 104). Form 104 can be signed off with minor deficiencies that do not prevent continued operation of the System.

1.12 Process Performance Testing

.1 Process and Utility streams will be introduced to the system in a manner which precludes the damage of any equipment or structures.

.2 Twice during the process performance testing period, plant component settings will be modified to ensure that the system is subjected to flows and loads as close to design conditions as possible. Where necessary to achieve this, flows to the area being tested will be augmented to exaggerate the naturally occurring flows and loads. Where it is necessary to modify settings outside the limits of this contract area within the plant, coordinate the changes with the Owner.

.3 The Contractor shall assist in the operation of the plant, as required to complete the Process Performance Test. Any such work must have prior approval from the Engineer and be made under the supervision of the Owner's Operating Forces or Owner designate. Obtain the Engineer's approval of any intention to conduct such work at least five (5) days in advance.
.4 All components and systems shall be operated in the automatic/manual and the remote/local modes as required to prove proper operation.

.5 The Contractor shall ensure all backup provisions function satisfactorily.

.6 All minor and major alarm conditions will be induced to ensure that the process reacts as intended, the applicable alarms are annunciated.

1.13 Acceptance

.1 An Acceptance Meeting must be held at the end of the fourteen (14) day test to confirm the status of each system.

.2 Upon acceptance and completion of Form 104, in black marker, write “Complete” across the green card stating "Equipment Transferred to Owner for Commissioning". Sign and date each card.

2. PRODUCTS

Not Applicable

3. EXECUTION

Not Applicable
CERTIFICATE OF Satisfactory Process Performance
FORM 104

We certify that the equipment listed below has been operated and tested as per the Specifications using wastewater for at least fourteen (14) days and that the equipment meets its Performance Testing Criteria, including fully automatic controls. The equipment is therefore classed as “conforming”.

PROJECT: ________________________________

ITEM OF EQUIPMENT: ________________________________

TAG NO: ________________________________

REFERENCE SPECIFICATION: ________________________________

(Authorized Signing Representative of the Supplier) ________________________________
Date ________________________________

(Authorized Signing Representative of the Contractor) ________________________________
Date ________________________________

(Authorized Signing Representative of the Engineer) ________________________________
Date ________________________________

(Authorized Signing Representative of the Owner) ________________________________
Date ________________________________

END OF SECTION
PROCESS PERFORMANCE

PLAN TO ACHIEVE SATISFACTORY PROCESS PERFORMANCE
FORM P104

PROJECT: 

SYSTEM: 

EQUIPMENT: 

1.0 SCHEDULE

1.1 Date of Test: 

1.2 Duration of Test: 14 Days

1.3 T2 Training Required:  YES  NO  N/A

If Yes, Date of T2 Training: 

T2 Training procedures submitted  YES  NO  N/A

If No, Explanation required: 

2.0 WORK PLAN

2.1 Form 102: Satisfactory Equipment Installation and Form 103: Satisfactory Equipment Performance completed  YES  NO  N/A

If No, Expected completion date: 

2.2 Sewage/Products required for 104 test  YES  NO  N/A

If Yes, Identify Sewage or list Products required: 

2.3 104 Checklist submitted to Commissioning Team (to be provided by AECOM)  YES  NO  N/A

2.4 SCADA complete (requires both Electrical Contractor and AECOM to confirm)  YES  NO  N/A
PROCESS PERFORMANCE

2.5 Pre Start-Up Meeting Date Scheduled  □ YES  □ NO  □ N/A
If Yes, Date of Pre Start-Up Meeting: __________________________

2.5.1 Owner Attendees (provided by Owner Group)

<table>
<thead>
<tr>
<th>NAME</th>
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2.6 Transfer of Equipment to Owner complete  □ YES  □ NO  □ N/A

2.7 104 Tag (Green in Colour) is installed on equipment signifying Equipment is to be operated by Owner  □ YES  □ NO  □ N/A

2.8 Owner has taken control of Equipment. Contractor in place to assist in 104 testing.  □ YES  □ NO  □ N/A

2.9 All major deficiencies corrected during first 11 days of 14-Day test  □ YES  □ NO  □ N/A

2.10 T2 Training complete  □ YES  □ NO  □ N/A
If No, Provide explanation: ____________________________________________

2.11 14-Day Test results attached to Form 104  □ YES  □ NO  □ N/A

2.12 Deficiencies Review complete. Minor deficiencies signed off with Form 104 with understanding that deficiencies are to be corrected as per attached. If deficiencies are major, Form 104 will not be signed-off and testing is rescheduled  □ YES  □ NO  □ N/A

2.3 Form 104 sign-off complete  □ YES  □ NO  □ N/A
If No, Date of Re-test: ____________________________________________
1. GENERAL

1.1 Description

.1 This section supplements the requirements for the provision of operation and maintenance manuals as described in Section 01330.

.2 Furnish complete operations manuals and maintenance information as specified in this section for installation check-out, operation, maintenance, and lubrication requirements for each unit of mechanical, electrical, and instrumentation equipment or system and each instrument.

.3 In some instances, this requirement is reinforced by additional references within individual technical specification sections, however, the inclusion or exclusion of additional references within the Contract shall not supersede or otherwise limit the generality of the foregoing and these requirements shall govern.

.4 Customize the operations manuals and maintenance information to describe the equipment actually furnished. Do not include extraneous data for models, options, or sizes not furnished. When more than one model or size of equipment type is furnished, show the information pertaining to each model, option, or size.

1.2 Submittals

.1 The submission and acceptance of the “Equipment Operating and Maintenance Instruction” manual is a condition precedent to the certification of substantial performance.

.2 Submit operation manuals and maintenance information in accordance with Section 01330. Submittals may be checked for general compliance with the requirements of this section.

.3 Submit complete operations manuals and maintenance information as soon as possible after review of project submittals but no later than 30 days before the Date of Substantial Performance.

.4 Submit a copy the operation and maintenance data in digital format. PDF file structure is suitable for this submittal.

1.3 Binders

.1 Submit the complete operations manuals in an identified three-post, hard-covered, plastic-jacketed binder equal to Grand and Toy No. L21-P5436 or equal.
OPERATION AND MAINTENANCE DATA

.2 For operations manuals and maintenance information smaller than the dimensions in Clause 1.3.1, remove, punch, and insert the contents in a binder with the required dimensions. The contents do not have to be changed to accommodate the size of the binder.

.3 Label each binder to designate the system or equipment enclosed with reference to the equipment number, and Specification Section. Provide each binder with a table of contents.

.4 Where more than one binder is required, label each binder “Vol. 1 of __”, “Vol. 2 of __”, etc.

1.4 General Requirements

.1 Punch all data for binding and composition. Arrange printing so that punching holes do not obliterate data.

.2 Provide materials suitable for photographic reproduction. If copies are used, they are to be of equal clarity and quality as the original.

.3 Provide drawings, diagrams, and manufacturer's literature which are legible. Provide drawings which are no larger than 280 mm x 432 mm bound into the documents as a fold out. Drawings which are larger than 280 mm x 432 mm shall be folded and inserted into pouches inside the manual and file folders.

.4 All instructions in these operations manuals and maintenance information to be in simple language.

.5 Mark manufacturer's standard documents to delete extraneous information not applicable to the equipment, assembly, subassembly or material supplied. Cross out or remove and eliminate any extraneous material for models, options, or sizes not furnished.

1.5 Operation Manual Contents and Organization

.1 Provide the manufacturer's standard operations and maintenance manuals for the equipment or instrument supplied. If the manufacturer's standard manuals do not contain all the required information, provide the missing information in supplementary documents and drawings inserted behind appropriate tabs in the manual binder. Separate maintenance information must also be provided as specified in Clause 1.6.

.2 When more than one piece of identical equipment or instruments are supplied, provide only one set of operations manuals.

.3 One set of operations manuals may be provided when more than one piece of similar equipment or instruments are supplied, such as different sizes of the same
model, and all similar pieces are covered in the same standard manufacturer's operations and maintenance manual.

.4 When similar equipment or instruments are provided by the same manufacturer, but are not covered in the same standard manufacturer's operations and maintenance manual, their specific manuals may be bound in the same 3-ring binder. Separate specific manuals with tab dividers labelled with the appropriate equipment numbers.

.5 Provide a cover sheet, bound as the first page of each manual, with the following information:

.1 Contract name and number.

.2 Functional title of the system, equipment, material, or instrument.

.3 Equipment number or, if more than one piece of equipment is provided, equipment numbers for equipment or instruments covered by the manual. Include functional description of equipment after each number.

.4 Relevant specification section number and drawing reference.

.5 Address and telephone number of the manufacturer and the nearest manufacturer's representative.

.6 Provide a table of contents listing the contents of the manual and identifying where specific information can be located.

.7 As a minimum, the operations manual must contain the following:

.1 Include the manufacturer's recommended step-by-step procedures for starting and stopping under normal and emergency operation. Include all specified modes of operation including recommended operation after the assembly or equipment has been in long-term storage.

.2 Provide control diagrams with data and information to explain operation and control of systems and specific equipment.

.3 Provide technical information on all alarms and monitoring devices provided with the equipment.

1.6 Maintenance Information Contents and Organization

.1 Provide specific maintenance information for each unit of mechanical, electrical, and instrumentation equipment or system and each instrument. Maintenance information provided under Clause 1.6 is in addition to any similar data which is included in standard manufacturer's manuals under Clause 1.5.1.
OPERATION AND MAINTENANCE DATA

.2 Provide a tab for each section as described in Clause 1.6.3. Insert the specific information described in Clause 1.6.3.

.3 Insert the specific information described below in file folders:

.1 Tab 1 - Equipment Data

.1 Insert completed Equipment and Instrumentation Data sheets for equipment supplied.

.2 Tab 2 - Maintenance Information

.1 Include the description and schedule for all manufacturer's recommended routine preventative maintenance procedures including specific lubrication recommendations. Indicate whether procedure is to be done daily, weekly, monthly, quarterly, semi-annually, annually, or fill in hours of operation.

.3 Tab 3 - Technical Data

.1 Insert manufacturer's technical specification and data sheets.

.2 Insert manufacturer's certified performance and calibration curves for the equipment and instruments.

.4 Tab 4 - Maintenance Instructions

.1 Provide requirements to set up and check out each system for use. Include all required and recommended step-by-step inspections, lubrications, adjustments, alignments, balancing, and calibrations. Include protective device settings and warnings and cautions to prevent equipment damage and to insure personnel safety.

.2 Provide manufacturer's description of routine preventive maintenance, inspections, tests, and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair.

.3 Provide manufacturer's recommendations on procedures and instructions for correcting problems and making repairs.

.4 Provide step-by-step procedures to isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.
.5 Provide step-by-step procedures and list special required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings, and adjustments required.

.5 Tab 5 - Assembly Drawings

.1 Provide drawings which completely document the equipment, assembly, subassembly, or material for which the instruction is written. Provide the following drawings as applicable: fabrication details, wiring and connection diagrams, electrical and piping schematics, block or logic diagrams, shop drawings, installation drawings, layout and dimension drawings, and electrical component fabrication drawings.

.2 Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number which will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies.

.6 Tab 6 - Bills of Materials

.1 Provide a clear, legible copy of the Bill of Materials that was shipped with the equipment. The Bill of Materials should list all equipment, instruments, components, accessories, tools, and other items that were shipped with the equipment.

.7 Tab 7 - Lubrication Data

.1 Provide a table showing recommended lubricants for specific temperature ranges and applications.

.2 Provide charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities.

.3 If the equipment or instrument is not lubricated, add a sheet under this Tab with the words "Not Applicable".

.8 Tab 8 - Warranties

.1 Provide a copy of all written warrants and guarantees required by the contract documents for the specific pieces of equipment or instruments and provide all additional manufacturer's standard warrants and
guarantees received by the contractor. Indicate the time frame of each warrant or guarantee.

1.7 Field Changes

.1 Following the acceptable installation and operation of an equipment item, modify and supplement the item's instructions and procedures to reflect any field changes or information requiring field data.

1.8 Other Warranties

.1 Provide in hard cover 3-ring binders for 215 mm x 280 mm paper labelled "Warranties" one copy of:

   .1 A list in Specification Section order of all warrants and guarantees required by the contract documents and all manufacturers' standard warrants and guarantees. Include the name and telephone number of the contact person. Indicate the time frame of each warrant or guarantee on the list.

   .2 Include, in Specification Section order, a copy of all other written warrants and guarantees not provided under Clause 1.6, but which are required by the contract documents. Include all additional standard warrants and guarantees received by the contractor that have not been specified or provided for under Clause 1.6.

2. PRODUCTS

Not Applicable

3. EXECUTION

Not Applicable

END OF SECTION
1. **GENERAL**

1.1 **Final Cleaning**

.1 In preparation for Certificate of Completion or Total Performance of the project, perform final cleaning.

.2 Prior to final review, remove surplus products, tools, construction machinery, and equipment.

.3 Remove waste products and debris other than that caused by Owner or other Contractors.

.4 Inspect finishes, fitments, and equipment and ensure specified workmanship and operation.

.5 Remove grease, dust dirt, stains, labels, fingerprints, and other foreign materials, from interior and exterior finished surfaces including glass and other polished surfaces.

.6 Clean lighting reflectors, lenses, and other lighting surfaces.

.7 Broom clean paved surfaces; rake clean other surfaces of grounds.

.8 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.

.9 Inspect valve boxes, manholes, and hydrants to check for debris and proper operation.

.10 Operate valves to ensure that no damage has occurred or debris accumulated, due to cleanup activities.

2. **PRODUCTS**

2.1 **Approved Products**

.1 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.

3. **EXECUTION**

Not Applicable

**END OF SECTION**
1. **GENERAL**

1.1 **General Requirements**

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, spare parts, and special tools not more than eight weeks in advance of operation testing of the associated system, and not later than the start of operational testing.

4. Deliver spare parts, maintenance materials, and special tools in boxes complete with packing list and identified by box tag number and store in designated areas as directed by the Engineer.

5. Assist the Engineer in checking and confirming delivery of maintenance materials, spare parts and special tools. Provide assistance for placing boxes on shelving. An Owner’s representative or appointee will be required for the acceptance of spare parts.

6. Prepare lists of maintenance materials, special tools, and spare parts for inclusion in operation and maintenance manuals as specified in Section 01735.

7. Do not use maintenance materials, special tools, and spare parts without Engineer permission. If authorized to do so, promptly replace.

1.2 **Submittals**

1. Prior to 65 percent Work completion or prior to delivery whichever is earlier, submit a spare parts and special tools list organized by specification section and equipment number.

2. Include a submittal transmittal form as appended to this section with each delivery of spare parts.

3. Two weeks prior to any delivery, submit a spare parts and special tools list complete with box tag numbers referencing spare parts box contents. The list is to be organized by Specification Section and equipment number.

1.3 **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 item is to be used.

1.4 Special Tools

.1 Assemble special tools as specified.

.2 Tag each tool with the manufacturers’ part number.

.3 Include instruction on intended use of tool with the tool when delivered.

1.5 Spare Parts

.1 Assemble spare parts as specified.

.2 Tag each spare part with the manufacturers’ part number.

.3 Include installation instructions as applicable with the spare part when delivered.

2. PRODUCTS

Not Applicable

3. EXECUTION

Not Applicable

END OF SECTION
CLOSE-OUT PROCEDURES

1. GENERAL

1.1 Description

.1 This section describes administrative procedures preceding preliminary and final inspections of Work.

1.2 Inspection and Declaration

.1 Contractor's Inspection: Contractor and all Subcontractors shall conduct an inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.

.1 Notify Engineer in writing of satisfactory completion of Contractor's Inspection and that corrections have been made.

.2 Request Engineer Inspection.

.2 Engineer Inspection: Engineer and Contractor will perform inspection of Work to identify obvious defects or deficiencies. Contractor shall correct Work accordingly.

.3 Completion: submit written certificate that following have 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, commissioned, and are fully operational.

.4 Certificates required by regulatory authorities have been submitted.

.5 Operation of systems have been demonstrated to Owner's personnel.

.6 Work is complete and ready for Final Inspection.

.4 Final Inspection: when items noted above are completed, request final inspection of Work by Owner, Engineer, and Contractor. If Work is deemed incomplete by Engineer, complete outstanding items and request re-inspection.

.5 Declaration of Substantial Performance: when Owner and Engineer consider deficiencies and defects have been corrected and it appears requirements of Contract have been substantially performed, make application for certificate of Substantial Performance. Refer to General Conditions Clause 5.4 - Substantial Performance of the Work.
CLOSE-OUT PROCEDURES

.6 Commencement of Lien Period: date of Owner’s acceptance of submitted declaration of Substantial Performance shall be date for commencement of lien period.

.7 Commencement of Warranty Period: date of completion of all acceptance tests shall be date for commencement of warranty period.

.8 Final Payment: When Owner and Engineer consider final deficiencies and defects have been corrected and it appears requirements of Contract have been totally performed, make application for final payment. Refer to General Conditions Clause 5.7 for specifics to application. If Work is deemed incomplete by Owner and Engineer, complete outstanding items and request re-inspection.

.9 Payment of Holdback: After issuance of certificate of Substantial Performance of Work, submit an application for payment of holdback amount in accordance with General Conditions Clause 5.5.

1.3 Warranty Inspection

.1 The Engineer will arrange and conduct with the Owner and the Contractor a warranty inspection at the site prior to expiration of the warranty period.

2. PRODUCTS

Not Applicable.

3. EXECUTION

Not Applicable.

END OF SECTION
Division 2
1. GENERAL

1.1 References

.1 Canadian Federal Legislation.

.2 Canadian Environmental Protection Act (CEPA).

.3 Canadian Environmental Assessment Act (CEAA).

.4 Transportation of Dangerous Goods Act (TDGA).

.5 Motor Vehicle Safety Act (MVSA).

1.2 Protection

.1 Perform all work in accordance with Section 01561 - Environmental Protection.

.2 Protect in accordance with Section 02315 - Excavating, Trenching, and Backfilling.

.3 Protect existing items designated to remain and items designated for salvage. In event of damage to such items, immediately replace or make repairs to approval of the Engineer and at no cost to the Owner.

.4 All designated for salvage to be delivered to the District yards at no cost to the Owner.

.5 In all circumstances, ensure that demolition work does not adversely affect adjacent watercourses, groundwater, and wildlife, or contribute to excess air and noise pollution.

.6 Do not pump water containing suspended materials into watercourses, storm, or sanitary sewers, or onto adjacent properties.

.7 Environmental:

.1 Remove contaminated or dangerous materials as defined by authorities having jurisdiction, relating to environmental protection, from site and dispose of in safe manner to minimize danger at site or during disposal.

.8 Control disposal or run off of water containing suspended materials or other harmful substances in accordance with local authorities.

.9 Protect trees, plants, and foliage on site and adjacent properties where indicated.
2. PRODUCTS

2.1 Silt Barrier Fence

.1 Silt fence to be manufactured from a woven, silt film geotextile material with a shiny to smooth surface texture designed to reduce velocity of runoff to a point that suspended particles settle out due to reduction of hydraulic energy.

.2 Minimum Requirements:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
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<tbody>
<tr>
<td>Grab Tensile</td>
<td>500 N</td>
</tr>
<tr>
<td>Mullen Burst</td>
<td>1900 kPa</td>
</tr>
<tr>
<td>Elongation at Break</td>
<td>25% Maximum</td>
</tr>
<tr>
<td>Opening</td>
<td>600 μm maximum</td>
</tr>
<tr>
<td>U.V. Rating at 500hrs</td>
<td>90% Retained</td>
</tr>
<tr>
<td>Efficiency</td>
<td>&gt;75% minimum</td>
</tr>
<tr>
<td>Construction</td>
<td>Woven (tape)</td>
</tr>
<tr>
<td>Texture</td>
<td>Smooth, shiny</td>
</tr>
<tr>
<td>Posts</td>
<td>4x4 cm, treated</td>
</tr>
<tr>
<td>Post Spacing (centres)</td>
<td>2 metre maximum</td>
</tr>
<tr>
<td>Permittivity</td>
<td>10 L/s/m²</td>
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Above values are "Minimum Average Roll Values"

3. EXECUTION

3.1 Preparation

.1 Inspect the site with the Engineer and verify extent and location of items designated for removal, disposal, and salvage.

.2 Locate utilities to be disconnected before start of work.

.3 Notify, coordinate with, and obtain approval of utility companies before starting demolition.

3.2 Sequences of Operation

.1 Remove items as indicated.

.2 Disposal of Material

.1 Dispose of materials not designated for salvage off-site.

.2 Do not disturb items designated to remain in place.
SITE DEMOLITION AND REMOVALS

3.3 Restoration

.1 Restore areas and existing works outside areas of demolition to match condition of adjacent, undisturbed areas.

3.4 Cleanup

.1 Upon completion of work, remove debris, trim surfaces, leave work site clean.

END OF SECTION
1. GENERAL

1.1 Definitions

.1 Clearing consists of cutting off trees and brush vegetative growth to not more than a specified height above ground and disposing of felled trees, previously uprooted trees and stumps, and surface debris.

.2 Grubbing consists of excavation and disposal of stumps and roots, boulders, and rock fragments of specified size to not less than a specified depth below existing ground surface.

1.2 Protection

.1 Prevent damage to fencing, trees, landscaping, natural features, bench marks, existing buildings, existing pavement, utility lines, Work Site appurtenances, water courses, and root systems of trees which are to remain.

.2 Do not commence tree cutting until the Owner confirms that any required permits have been received.

.3 Repair any damaged items to approval of Engineer.

.4 Replace any trees designated to remain, if damaged, as directed by Engineer.

.5 Surface Drainage: Provide suitable temporary ditches or other approved means of handling drainage prior to excavation and during construction to protect construction area and adjacent and other affected properties. Provide siltation controls to protect natural watercourses or existing drainage facilities.

1.3 Scope of Work

.1 Clear all vegetation as required to facilitate the scope of work shown on the design drawings.

.2 All vegetation shall be disposed by the Contractor. Disposal fees shall be the sole responsibility of the Contractor.

.3 All stripped topsoil shall be retained on-site and used for finish site restoration.

2. PRODUCTS

Not Applicable
CLEARING AND GRUBBING

3. EXECUTION

3.1 Preparation

.1 Inspect Work Site and verify with Engineer, items designated to remain.

.2 Locate and protect utility lines. Preserve in operating condition active utilities traversing Work Site.

.3 Notify utility authorities before starting clearing and grubbing.

3.2 Clearing

.1 Clear as indicated or as directed by Engineer, by cutting at a height of not more than 300 mm above ground. In areas to be subsequently grubbed, height of stumps left from clearing operations to be not more than 1000 mm above ground surface.

.2 Cut off branches, down trees overhanging area cleared as directed by Engineer.

.3 Cut off unsound branches on trees designated to remain as directed by Engineer.

3.3 Grubbing

.1 Grub out stumps and roots to not less than 200 mm below ground surface.

.2 Grub out visible rock fragments and boulders, greater than 300 mm in greatest dimension, but less than 0.5 m³.

3.4 Removal and Disposal

.1 Remove cleared and grubbed materials to approved off-site disposal area.

.2 Cut timber greater than 125 mm diameter and stockpile. Stockpiled timber becomes property of Owner.

3.5 Finished Surface

.1 Leave ground surface in condition suitable for immediate grading operations or stripping of topsoil.

END OF SECTION
1. GENERAL

1.1 Description

.1 This Section specifies requirements for supplying, producing, and placing crushed gravel or quarried stone as granular base to the lines, grades, and typical cross-sections as shown or directed by the Engineer.

2. PRODUCTS

2.1 Materials

.1 Granular base: Type 1 fill in accordance with Section 02315 – Excavating, Trenching, and Backfilling.

3. EXECUTION

3.1 Placing

.1 Construct granular sub-base to depth and grade in areas indicated.

.2 Ensure excavation is free of water prior to and during placement.

.3 Ensure no frozen material is placed.

.4 Place material only on clean unfrozen surface, free from snow or ice.

.5 Place granular sub-base materials using methods which do not lead to segregation or degradation.

.6 Place material to full width in uniform layers not exceeding 150 mm compacted thickness.

.7 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.

.8 Remove and replace portion of layer in which material has become segregated during spreading.

3.2 Compaction

.1 Compaction equipment is to be capable of obtaining required material densities.

.2 Compact to a density of not less than 100 percent maximum dry density in accordance with ASTM D698.
.3 Shape and roll alternately to obtain smooth, even, and uniformly compacted sub-base.

.4 Apply water as necessary during compaction to obtain specified density.

.5 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers.

.6 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.

### 3.3 Site Tolerances

.1 Finished sub-base surface to be within 10 mm of elevation as indicated but not uniformly high or low.

### 3.4 Protection

.1 Maintain finished sub-base in condition conforming to this section until succeeding base is constructed, or until granular sub-base is accepted by the Engineer.

**END OF SECTION**
1. GENERAL

1.1 Description

.1 This Section specifies requirements for supplying, producing, and placing crushed gravel or quarried stone as granular sub-base to the lines, grades, and typical cross-sections as shown or directed by the Engineer.

2. PRODUCTS

2.1 Materials

.1 Granular sub-base: Type 2 fill in accordance with Section 02315 – Excavating, Trenching, and Backfilling.

3. EXECUTION

3.1 Placing

.1 Construct granular sub-base to depth and grade in areas indicated.

.2 Ensure excavation is free of water prior to and during placement.

.3 Ensure no frozen material is placed.

.4 Place material only on clean unfrozen surface, free from snow or ice.

.5 Place granular sub-base materials using methods which do not lead to segregation or degradation.

.6 Place material to full width in uniform layers not exceeding 150 mm compacted thickness. The Engineer may authorize thicker lifts (layers) if specified compaction can be achieved.

.7 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.

.8 Remove and replace portion of layer in which material has become segregated during spreading.

3.2 Compaction

.1 Compaction equipment is to be capable of obtaining required material densities.

.2 Compact to a density of not less than 100 percent maximum dry density in accordance with ASTM D698.
GRANULAR SUB-BASE

.3 Shape and roll alternately to obtain smooth, even, and uniformly compacted sub-base.

.4 Apply water as necessary during compaction to obtain specified density.

.5 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers.

.6 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.

3.3 Site Tolerances

.1 Finished sub-base surface to be within 10 mm of elevation as indicated but not uniformly high or low.

3.4 Protection

.1 Maintain finished sub-base in condition conforming to this section until succeeding base is constructed, or until granular sub-base is accepted by the Engineer.

END OF SECTION
1. GENERAL

1.1 Description

.1 Section 02242 refers to those portions of the work that are unique to the supply and application of materials for dust control. This section must be referenced to and interpreted simultaneously with all other sections pertinent to the works described herein.

1.2 Delivery, Storage, and Handling

.1 Deliver calcium chloride to site in substantial and moisture-proof bags indicating name of manufacturer, name of product, net weight or mass, and percentage of calcium chloride guaranteed by manufacturer.

.2 Store bags of calcium chloride in weather-proof enclosures.

2. PRODUCTS

2.1 Materials

.1 Calcium chloride: to CGSB 15.1. Type 1-Regular (77%) or as liquid at 35% solution concentration.

.2 Magnesium chloride as 29 to 35% solution concentration.

.3 Water: to Contract Administrator’s approval.

.4 Aqueous magnesium chloride or calcium chloride may be used provided application is not in an environmentally harmful manner.

.5 Lignosulphonates may be used subject to conditions specified in Item 3.2.

.6 Used oil or “cut-back” bitumen products not permitted.

3. EXECUTION

3.1 Application

.1 Control dust at all times for duration of Contract.

.2 Apply aqueous solutions with distributors equipped with spray system that will ensure uniform application and with a means to turn off.

.3 Apply aqueous solutions at following rates:
DUST CONTROL

.1 Calcium chloride (25%) at 2.4 L/m$^2$ on roads not previously treated and 3.0 L/m$^2$ for road stabilization.

.2 Calcium chloride (35%) or magnesium chloride (30%) at 1.6 L/m$^2$ on roads not previously treated and 2.0 L/m$^2$ for road stabilization.

.4 Apply flake calcium chloride at rate of 1.00 kg/m$^2$.

3.2 Environmental Restrictions

.1 No application on slopes where precipitation may cause chemical to drain into watercourses.

.2 No application with 10 m minimum on either side of watercourses.

.3 No application of lignosulphonates in residential areas when air temperature exceeds 26ºC.

.4 No application of lignosulphonates when rain is imminent as minimum drying time of six hours is required.

END OF SECTION
1. GENERAL

1.1 Description

.1 Section 02271 refers to those portions of the work that are unique to the supply and placement of rip rap. This section must be referenced to and interpreted simultaneously with all other sections pertinent to the works described herein.

2. PRODUCTS

2.1 Rip Rap

.1 Hard, durable quarry stone, free from seams, cracks, or other structural defects, with specific gravity not less than 2.65, to meet following size distribution:

.1 Class 25:

.1 Class 25 Riprap refers to a 25 kg mean mass with the gradation of rock sizes such that 85 percent is greater than 2.5 kg, 50 percent is greater than 25 kg, and 15 percent is greater than 75 kg. Rocks generally shall be evenly graded and individual rocks shall have a thickness greater than one third their length and none shall have a mass greater than five times that of the specified class.

.2 Maximum dimension of any rip rap piece to not be more than 2.5 times its least dimension.

2.2 Cement Mortar

.1 Cement: to CAN3-A5 type 10.

.2 Sand for Mortar: to CSA A82.56.

.3 Mortar mix: 1 part cement to 3 parts sand, to consistency suitable for placement.

3. EXECUTION

3.1 Surface Preparation

.1 Where required, excavate trench at toe of slope to elevations and dimensions shown on Contract Drawings or as directed by Contract Administrator.

.2 Grade area to be rip rapped to uniform, even surface. Fill depressions with approved material and compact to provide firm bed.

.3 Grade out wave or surface water induced erosion of prepared bed prior to filter material and rip rap placement.
3.2 Placement

.1 Commence placing rip rap at toe of slope and continue placement working up slope.

.2 The nominal thickness is the thickness of the rock measured at right angles to the slope of placed rock.

.3 Do not drop rip rap if placed above water.

.4 Place rip rap in accordance with thickness, elevation, and surface tolerance details as shown on Contract Drawings.

.5 Dress all rip rap by reworking surface at least once so that voids are filled and rip rap surface is well keyed, dense and uniform.

.6 Hand placed rip rap:

.1 Use larger stones for lower courses and as headers for subsequent courses.

.2 Stagger vertical joints and fill voids with rock spalls or cobbles.

.3 Finish surface even, free of large openings and neat in appearance.

.7 Machine placed rip rap:

.1 Place rip rap using suitable equipment.

.2 Do not run equipment on finished rip rap surfaced.

.8 Mortar:

.1 Use mortar within one hour after water has been added. Do not add additional water after initial mixing.

.2 Commence applying mortar at bottom courses (above low water line) and work upwards completely filling voids and leaving out faces of stories exposed. Remove excess mortar to expose faces of stones.

.3 Cure and protect mortar in accordance with CAN3-A23.1 using absorptive mats or fabric kept continuously wet.

3.3 Finished Tolerances

.1 Ensure finished rip rap within +100 mm to -100 mm of specified grade.

.2 Ensure stone filter thickness within +50 mm to -50 mm of specified thickness.

.3 Ensure rip rap slope within +2 degrees to -2 degrees of specified slope in degrees.
RIP RAP

END OF SECTION
1. GENERAL

1.1 Protection

.1 Protect and/or transplant existing fencing trees, landscaping, natural features, bench marks, buildings, pavement, surface or underground utility lines which are to remain as directed by the Engineer. If damaged, restore to original or better condition unless directed otherwise.

.2 Maintain access roads to prevent accumulation of construction related debris on roads.

2. PRODUCTS

2.1 Materials

.1 Fill material: In accordance with Section 02315 - Excavating, Trenching, and Backfilling.

.2 Excavated or graded material existing on site may be suitable to use as fill for grading work if approved by the Engineer.

3. EXECUTION

3.1 Stripping of Topsoil

.1 Strip all organic material to specified limits and specified depth. Stockpile for re-use as shown in Contract Documents. Do not handle topsoil while in wet or frozen condition or in any manner in which soil structure is adversely affected. Remove all debris and unusable material as specified in the Contract Documents.

.2 Surface drainage: provide suitable temporary ditches or other approved means of handling drainage prior to excavation and during construction to protect construction area and adjacent and other affected properties. Provide siltation controls to protect natural watercourses or existing drainage facilities.

3.2 Grading

.1 Rough grade to levels, profiles, and contours allowing for surface treatment as indicated.

.2 Rough grade to following depths below finish grades:

.1 100 mm for grassed areas;

.2 100 mm for asphalt gravel paving or as shown on the design drawings for road gravels and asphalt.
.3 Slope rough grade away from building as directed.

.4 Grade ditches to depth as directed.

.5 Prior to placing fill over existing ground, scarify surface to depth of 150 mm. Maintain fill and existing surface at approximately same moisture content to facilitate bonding.

.6 Compact filled and disturbed areas to corrected maximum dry density to ASTM D 698, as follows:

   .1 85 percent under landscaped areas

   .2 95 percent under paved and walk areas

.7 Do not disturb soil within branch spread of trees or shrubs to remain.

3.3 Surplus Material

   .1 Remove and dispose of surplus material and material unsuitable for fill, grading, or landscaping off site.

END OF SECTION
1. GENERAL

1.1 Definitions

1. Rock is defined as all solid rock in form of bedrock, masses, ledges, seams, or layers and includes igneous rock of any sort, conglomerate, sandstone or shale, that requires breaking by continuous drilling and blasting before excavation and removal. Rock also includes rocks having individual volumes in excess of 1.0 m$^3$, removed by blasting or other means.

2 Common excavation: Excavation of materials of whatever nature, which are not included under definitions of rock excavation.

3 Unclassified excavation: Excavation of deposits of whatever character encountered in work.

4 Topsoil: Material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping, and seeding.

5 Waste material: Excavated material unsuitable for use in work or surplus to requirements.

6 Borrow material: Material obtained from locations outside area to be graded, and required for construction of fill areas or for other portions of work.

7 Unsuitable materials:

   1 Weak and compressible materials under excavated areas.

   2 Frost susceptible materials under excavated areas.

   3 Frost susceptible materials:

       1 Fine grained soils with plasticity index less than 10 when tested to ASTM D 4318, and gradation within limits specified when tested to ASTM D 422 and ASTM C 136: Sieve sizes to CAN/CGSB-8.1.

       2 Table:

       | Sieve Designation | % Passing |
       |-------------------|----------|
       | 2.00 mm           | 100      |
       | 0.10 mm           | 45 - 100 |
       | 0.02 mm           | 10 - 80  |
       | 0.005 mm          | 0 - 45   |

       3 Coarse grained soils containing more than 20 percent by mass passing 0.075 mm sieve.
.8 Unshrinkable fill: Weak mixture of Portland cement, concrete aggregates and water that resists settlement when placed in utility trenches, and capable of being readily excavated.

1.2 Protection of Existing Features

.1 Existing buried utilities and structures:

.1 Size, depth, and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.

.2 Prior to commencing excavation work, notify applicable corporation or authorities having jurisdiction, establish location, and state of use of buried utilities and structures. The corporations or authorities having jurisdiction are to clearly mark such locations to prevent disturbance during work.

.3 Confirm locations of buried utilities by careful test excavations.

.4 Maintain and protect from damage, water, sewer, gas, electric, telephone, and other utilities and structures encountered as indicated.

.5 Where utility lines or structures exist in area of excavation, obtain direction of the Engineer before excavating.

.6 Record location of maintained, re-routed, and abandoned underground lines.

.2 Existing buildings and surface features:

.1 Conduct, with the Engineer, condition survey of existing buildings, trees, and other plants, lawns, fencing, service poles, wires, rail tracks, pavement, survey bench marks, and monuments which may be affected by work.

.2 Protect existing buildings and surface features from damage while work is in progress. In event of damage, immediately make repair to the approval of the Engineer.

.3 Where required for excavation, cut roots or branches as approved by the Engineer.

1.3 Shoring, Bracing, and Underpinning

.1 Comply with applicable local regulations and protect existing features.

.2 Where required by Workers’ Compensation Board, engage services of qualified professional engineer who is registered in the Province of British Columbia to design and inspect shoring, bracing, underpinning, and temporary excavation slopes required for Work.
.3 At least 5 days prior to commencing Work, submit design and supporting data.

.4 Design and supporting data submitted to bear the stamp and signature of qualified professional engineer registered in the Province of British Columbia.

.5 Professional engineer responsible for design of temporary structures to submit proof of insurance coverage for professional liability except where engineer is employee of Contractor, in which case Contractor shall submit proof that work by professional engineer is included in Contractor's insurance coverage.

1.4 Samples

.1 At least 5 days prior to commencing Work submit to the Engineer gradation of the proposed fill materials.

.2 Submit samples in accordance with Section 01330 - Submittals.

1.5 Testing

.1 Refer to Section 01450 – Quality Control.

2. PRODUCTS

2.1 Fill and Backfill Materials

.1 All materials to be subject to Consultant’s approval.

.1 Crushed, pit run, or screened stone, gravel, or sand.

.2 Granular materials to be composed of sound, hard, uncoated particles, free from injurious quantities of clay, flaky particles, soft shale, friable materials, roots, vegetable matter, and frozen lumps.

.3 Grading of granular materials to show no marked fluctuations between opposite ends of extreme limits. Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.1.

.4 Type 1: select pit run gravel graded within the following limits:

<table>
<thead>
<tr>
<th>Sieve Size (Tyler)</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 mm sq. opening</td>
<td>100</td>
</tr>
<tr>
<td>75 mm sq. opening</td>
<td>60 – 100</td>
</tr>
<tr>
<td>25 mm sq. opening</td>
<td>60 – 80</td>
</tr>
<tr>
<td>4.75 mm (No. 4 sieve)</td>
<td>25 – 45</td>
</tr>
<tr>
<td>0.85 mm (No. 20 sieve)</td>
<td>10 – 20</td>
</tr>
<tr>
<td>0.425 mm (No. 40 sieve)</td>
<td>5 – 18</td>
</tr>
<tr>
<td>0.075 mm (No. 200 sieve)</td>
<td>0 - 6</td>
</tr>
</tbody>
</table>
.5 Type 2: crushed gravel graded within the following limits:

<table>
<thead>
<tr>
<th>Sieve Size (Tyler)</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mm sq. opening</td>
<td>100</td>
</tr>
<tr>
<td>20 mm sq. opening</td>
<td>95 – 100</td>
</tr>
<tr>
<td>10 mm sq. opening</td>
<td>60 – 80</td>
</tr>
<tr>
<td>4.75 mm sq. (No. 4 sieve)</td>
<td>40 – 60</td>
</tr>
<tr>
<td>2.36 mm sq. (No. 8 sieve)</td>
<td>28 – 48</td>
</tr>
<tr>
<td>0.6 mm sq. (No. 30 sieve)</td>
<td>13 – 29</td>
</tr>
<tr>
<td>0.3 mm sq. (No. 50 sieve)</td>
<td>9 – 21</td>
</tr>
<tr>
<td>0.15 mm sq. (No. 100 sieve)</td>
<td>6 – 15</td>
</tr>
<tr>
<td>0.075 mm sq. (No. 200 sieve)</td>
<td>0 – 6</td>
</tr>
</tbody>
</table>

At least 60 percent of material retained on 5 mm sieve to be fractured material.

.2 Type 3 fill: Selected material from excavation or other sources, approved by the Engineer for use intended, unfrozen and free from rocks larger than 75 mm, cinders, ashes, sods, refuse, or other deleterious materials.

.3 Type 4 fill: (Bedding and Pipe Surround) screened or crushed aggregate conforming to the following gradation limits when tested to sizes to ASTM C136:

<table>
<thead>
<tr>
<th>Sieve Designation</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>19 mm</td>
<td>100</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>60-100</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>40-80</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>30-60</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>30-45</td>
</tr>
<tr>
<td>0.075 mm</td>
<td>2-9</td>
</tr>
</tbody>
</table>

.4 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 0.02 MPa at 24 h

.4 Concrete aggregates: To CAN/CSA-A23.1

.5 Portland cement: Type 10

.6 Slump: 160 to 200 mm
EXCAVATING, TRENCHING, AND BACKFILLING

3. EXECUTION

3.1 Site Preparation

.1 Remove obstructions, ice, and snow from surfaces to be excavated within limits indicated.

.2 Cut pavement or sidewalk neatly along limits of proposed excavation in order that surface may break evenly and cleanly.

.3 Strip topsoil from within limits of the excavation and stockpile separately, for re-use.

.4 Dispose of unsuitable material offsite as directed by Engineer.

3.2 Stockpiling

.1 Stockpile fill materials in areas designated by the Engineer. Stockpile granular materials in manner to prevent segregation.

.2 Protect fill materials from contamination.

3.3 Shoring, Bracing and Underpinning

.1 Construct temporary works to depths, heights, and locations as indicated.

.2 During backfill operation:

   .1 Unless otherwise indicated or directed by the Engineer, remove sheeting and shoring from excavations.
   
   .2 Do not remove bracing until backfilling has reached respective levels of such bracing.
   
   .3 Pull sheeting in increments that will ensure compacted backfill is maintained at an elevation at least 500 mm above toe of sheeting.

.3 When sheeting is required to remain in place, cut off tops at elevations as indicated.

.4 Upon completion of substructure construction:

   .1 Remove shoring and bracing.
   
   .2 Remove excess materials from site as directed by the Engineer.

3.4 Dewatering

.1 Keep excavations free of water while work is in progress.
.2 Submit for the Engineer’s review, details of proposed dewatering or heave prevention methods, such as dikes, well points, and sheet pile cut-offs.

.3 Avoid excavation below groundwater table if quick condition or heave is likely to occur. Prevent piping or bottom heave of excavations by groundwater lowering, sheet pile cut-offs, or other means.

.4 Protect open excavations against flooding and damage due to surface run-off.

.5 Dispose of water in accordance with Section 01561 - Environmental Protection and in manner not detrimental to public and private property, or any portion of work completed or under construction.

3.5 Excavation

.1 Advise the Engineer at least 7 days in advance of excavation operations.

.2 Excavate material of whatever nature encountered to the depth shown on drawings or to such a depth as may be necessary to secure satisfactory bearing for all foundations, footings, slabs, underground utilities, etc. Where changes from the levels shown are required, additions or deductions shall be made at the agreed Unit Price basis prior to the work. Notwithstanding the foregoing, no additional compensation will be allowed for any changes necessitated by the deterioration of any excavation by activities or neglect or by over excavation on the part of the Contractor.

.3 Excavate to lines, grades, elevations and dimensions required for construction.

.4 Do additional excavation only by written authorization of the Consultant.

.5 Machine slope banks of all excavated areas.

.6 Hand trim and leave excavations free from loose or organic matter.

.7 Excavation must not interfere with normal 45 degrees splay of bearing from bottom of any footing.

.8 Do not disturb soil within branch spread of trees or shrubs that are to remain. If excavating through roots, excavate by hand and cut roots with sharp axe or saw.

.9 For trench excavation, unless otherwise authorized by the Engineer in writing, do not excavate more than 30 m of trench in advance of installation operations and do not leave open more than 15 m at end of day’s operation.

.10 Dispose of surplus and unsuitable excavated material offsite.

.11 Do not obstruct flow of surface drainage or natural watercourses.
.12 Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft, or organic matter.

.13 Notify the Engineer when bottom of excavation is reached.

.14 Obtain the Engineer’s approval of completed excavation.

.15 Remove unsuitable material from trench bottom to extent and depth as directed by the Engineer.

.16 Correct unauthorized over-excavation as follows:

.1 Fill under bearing surfaces and footings with Type 1 fill compacted to 100 percent of Standard Proctor Density, or with lean mix fill concrete.

.2 Fill under other areas with Type 2 fill compacted to not less than 100 percent of Standard Proctor Density.

.17 Hand trim, make firm, and remove loose material and debris from excavations. Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil. Clean out rock seams and fill with concrete mortar or grout to approval of the Engineer.

3.6 Fill Types and Compaction

.1 Prior to placement of structural grade fills under the mat foundation, and slab-on-grade, the exposed subgrade shall be proof rolled by a vibratory steel drum roller and compact to 100 percent SPD.

.2 Use fill of types as indicated or specified below. Compaction densities are percentages of maximum densities obtained from corrected maximum dry density.

.1 Underside of foundation: Use Type 1 fill to subgrade level and compact to 100 percent of Standard Proctor Density.

.2 Exterior side of perimeter walls: Use Type 3 fill to subgrade level. Compact to 95% of Standard Proctor Density.

.3 Within building area: Use Type 2 to underside of base course for floor slabs. Compact to 100 percent of Standard Proctor Density.

.4 Trench backfill in areas within untravelled areas: Use Type 3 fill to underside of granular sub-base.

.5 Trench backfill in areas within paved road surface: Use Type 2 fill to underside of granular sub-base.
.6 Bedding and pipe surrounding: Use Type 4 fill.

.7 Compaction of trench backfill: Compact bedding and immediate protective cover to 95 percent of Standard Proctor Density. Compact Type 2 fill to minimum 98 percent of Standard Proctor Density. In untravelled areas, compact Type 3 fill to at least 90 percent of Standard Proctor Density.

3.7 Bedding and Surround of Underground Services

.1 Place and compact granular material for bedding and surround of underground services as indicated.

.2 Place bedding and surround material in unfrozen condition.

3.8 Backfilling

.1 Do not proceed with backfilling operations until the Engineer has inspected and approved installations.

.2 Areas to be backfilled to be free from debris, snow, ice, water, and frozen ground.

.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. Within 1000 mm of structures, use light compacting equipment.

.5 Backfill around installations.

.1 Do not backfill around or over cast-in-place concrete within forty-eight (48) hours after placing of concrete.

.2 Place layers simultaneously on both sides of installed work to equalize loading. Difference not to exceed 1 m.

.3 Where temporary unbalanced earth pressures are liable to develop on walls or other structures:

.1 Permit concrete to cure for minimum seven (7) days at a minimum temperature of 10°C or until it has sufficient strength to withstand earth and compaction pressure and approval obtained from the Engineer.

.2 If approved by the Engineer, erect bracing or shoring to counteract unbalance, and leave in place until removal is approved by the Engineer.
3.9 Inspection and Testing

.1 Testing of materials and compaction will be the responsibility of the Contractor. Submit test report to Consultant for review.

.2 Refer to Section 01450 – Quality Control.

3.10 Restoration

.1 Upon completion of work, remove waste materials and debris, trim slopes, and correct defects.

.2 Replace topsoil. Refer to Section 02911- Planting Soil and Finish Grading.

.3 Reinstall pavement, curbs, and lawn to elevation which existed before excavation.

.4 Clean and reinstall areas affected by work as directed by the Engineer.

.5 Use temporary plating to support traffic loads over unshrinkable fill for initial twenty-four (24) hours.

END OF SECTION
1. GENERAL

1.1 Description

.1 Section 02498 refers to those portions of the work that are unique to the supply and installation of geosynthetic material. Geosynthetics include Geotextiles, Geogrids, Geocomposites, and Geomembranes. This section must be referenced to and interpreted simultaneously with all other sections pertinent to the works described herein.

.2 Geotextiles are typically of either a “slit-film, woven” variety or a “continuous filament” variety. Geotextiles may be used for separation, filtration, and reinforcement. Geogrids may be used for reinforcement. Geocomposites may be used for drainage and for separation / reinforcement or drainage / reinforcement. Geomembranes may be used for impermeable barriers.

.3 This section currently provides minimum specifications for geotextiles only. Requirements for geogrids, geocomposites, and geomembranes, if applicable, are shown on Contract Drawings and/or specified in Supplementary Specifications.

1.2 Material Certification

.1 Submit a “General Product Certification Sheet” clearly showing “Minimum Average Roll Values”, as governed by ASTM D4354, with tender documents. All values to meet or exceed specified requirements.

.2 At least two weeks prior to commencing work, and prior to material being accepted onsite, submit original manufacturer’s “Mill Certificates”, showing actual MINIMUM test values and clearly identifying roll and batch numbers. Any material arriving onsite which does not meet or exceed accepted “Minimum Average Roll Values” or that are not identified on original manufacturer’s mill certification documents to be removed at no cost to Owner.

.3 All rolls of geosynthetics arriving on-site to be clearly labelled identifying roll and batch number, original manufacturer’s product identification number, and width and length of material contained within roll.

1.3 Delivery and Storage

.1 Ensure each individual roll of geosynthetic is wrapped and covered to protect fabric from direct sunlight, ultraviolet rays, excessive heat, mud, dirt, debris, and rodents.

.2 Use equipment that does not contact material itself during loading, unloading, and handling. Slings or other lifting devices to provide adequate support without damaging material. Offload in a minimum of steps directly to storage or installation area.
.3 Store all rolls of geosynthetic on smooth, flat surfaces raised above ground that provide continuous support to rolls. Maintain additional protective cover if rolls are to be stored in excess of 30 days.

2. PRODUCTS

2.1 Geosynthetic

.1 Geosynthetic: See detailed specifications in Supplementary Specifications or as shown on Contract Drawings.

.2 Notwithstanding above, all specified properties represent “Minimum Average Roll Values” as governed by ASTM D4354.

.3 Sewn seams (geotextiles) to be constructed using a “j” configuration with 5 to 8 stitches per 25 mm in each of 2 lines of stitching separated by at least 12 mm. Stitches to be such that they will have an elongation at break equal to or greater than geosynthetic when tested in plane of seam. Ultimate grab strength perpendicular to seam to be equal to or exceed 90% of grab tensile strength of geosynthetic specified in Supplementary Specifications or on Contract Drawings.

.4 Thread for sewn seams (geotextiles) to have an equal or better resistance to chemical and biological degradation as that of geosynthetic. For inspection purposes, thread used to be of a colour that will contrast with original geosynthetic. Threads comprising of any organic fibres (such as cotton) or nylon will not be accepted.

.5 Seams for all other geosynthetics to be to manufacturer’s recommendations.

3. EXECUTION

3.1 Installation

.1 Where fabric seams are not sewn, ensure overlaps conform to Supplementary Specifications or as shown on Contract Drawings, but under no circumstances less than 600 mm.

.2 When placing fabric which incorporates a sewn seam, place seam “thread up” to facilitate inspection and repair.

.3 Place pins or staples, where used, at a maximum of 2 m intervals.

.4 Minimum granular thickness:

.1 Minimum lift thickness, prior to compaction with non-vibratory equipment to be 300 mm.
.2 Minimum base course thickness prior to further compaction with vibratory equipment to be 600 mm, pre-compacted as above.

3.2 Protection

.1 Do not permit passage of any vehicle directly on geosynthetic at any time. Place fill by end-dumping or long-reach equipment.

.2 Maximum drop height for fill directly onto geosynthetic to not exceed 1 m.

3.3 Repairs

.1 Repair seams which open, and tears and punctures, by removing fill and resetting fabric. Additional geosynthetic to be placed over area, extending beyond perimeter of failure a distance corresponding to lapping requirements for project. See 3.1.1. above. Where practical, repaired geosynthetic to be pinned, bonded, or stapled into place at intervals equal to or less than one-eighth perimeter of damage or 2 m, whichever is lesser.

END OF SECTION
1. GENERAL

1.1 Product Data

.1 Submit viscosity-temperature chart for asphalt cement showing either Saybolt Furol viscosity in seconds or Kinematic Viscosity in centistokes, temperature range 105 to 175°C at least five (5) days prior to commencing Work.

.2 Submit the manufacturer’s test data and certification that asphalt cement meets requirements of this section, upon request.

1.2 Samples

.1 Submit asphalt concrete mix design to Engineer for review prior to commencing Work.

2. PRODUCTS

2.1 Materials

.1 Asphalt cement: to CGSB 16-GP-3M, AC-6.

.2 Aggregate material to following requirements:

   .1 Crushed stone or gravel consisting of hard, durable, angular particles, free from clay lumps, cementation, organic material, frozen material, and other deleterious materials.

   .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>19mm</td>
<td>100</td>
</tr>
<tr>
<td>12.5mm</td>
<td>84-95</td>
</tr>
<tr>
<td>9.5mm</td>
<td>73-90</td>
</tr>
<tr>
<td>4.75mm</td>
<td>50-75</td>
</tr>
<tr>
<td>2.36mm</td>
<td>35-57</td>
</tr>
<tr>
<td>1.18mm</td>
<td>26-45</td>
</tr>
<tr>
<td>0.6mm</td>
<td>18-34</td>
</tr>
<tr>
<td>0.3mm</td>
<td>10-26</td>
</tr>
<tr>
<td>0.15mm</td>
<td>6-17</td>
</tr>
<tr>
<td>0.075mm</td>
<td>3-7</td>
</tr>
</tbody>
</table>

.3 Coarse aggregate is aggregate retained on 4.75mm sieve and fine aggregate is aggregate passing 4.75 mm sieve when tested to ASTM C136.

.4 Do not use aggregates having known polishing characteristics in mixes for surface courses.

.6 Magnesium Sulphate soundness: ASTM C88. Max percent loss by mass after five (5) cycles:
   .1 Coarse aggregate: 20.
   .2 Fine aggregate: 18.

.7 Los Angeles degradation Gradation B. ASTM C131. Max percent loss by mass:
   .1 Coarse aggregate: 35.

.8 Absorption: ASTM C127. Max percent by mass:
   .1 Coarse aggregate: 2.0.

.9 Loss by washing: ASTM C117. Max percent passing 0.075 mm sieve:
   .1 Coarse aggregate: 1.5.

.10 Lightweight particles: ASTM C123. Max percent by mass less than 1.95 relative density:
   .1 Coarse Aggregate: 1.5.

.11 Flat and elongated particles: (with length to thickness ratio greater than five (5)): Max percent by mass:
   .1 Coarse aggregate: 15.

.12 Crushed fragments: at least 70% of coarse aggregate particles by mass to have at least two (2) freshly fractured face.

.13 Regardless of compliance with specified physical requirements, fine aggregates may be accepted or rejected on basis of past field performance.

.3 Mineral filler:
   .1 Finely ground particles of limestone, hydrated lime, Portland cement or other approved non-plastic mineral matter, thoroughly dry and free from lumps.
   .2 Add mineral filler when necessary to meet job mix aggregate gradation or as directed to improve mix properties.
   .3 Mineral filler to be dry and free flowing when added to aggregate.
2.2 Mix Design

.1 Design of mix: by Marshall method to requirements below and as directed by Engineer.

.1 Compaction blows on each face of test specimens: 75.

.2 Mix physical requirements:
   .1 Voids in mineral aggregate: 14.
   .2 Air voids in compacted pavement: 3-5%.
   .3 Marshall load at 60°C:
      for 80-100: 7,000.
      for 150-200: 6,000.
      for 200-300: 6,000.
   .4 Index of retained stability: 75% minimum.

.3 Measure physical requirements as follows:
   .2 Compute void properties on basis of bulk specific gravity of aggregate (to ASTM C127 and ASTM C128). Make allowance for volume of asphalt absorbed into pores of aggregate.
   .3 Air voids: to ASTM D3203.

.4 Do not change job-mix without prior approval of Engineer. Should change in material source be proposed, new job-mix formula to be reviewed by Engineer.

3. EXECUTION

3.1 Equipment

.1 Pavers: To OPSS 310, mechanical self-powered pavers capable of spreading mix within specified tolerances, true to line, grade and crown indicated.

.2 Rollers: Sufficient number of type and weight to obtain specified density of compacted mix.

.3 Vibratory rollers, to OPSS 310:
HOT MIX ASPHALT CONCRETE

.1 Minimum drum diameter: 1,200 mm.

.2 Maximum amplitude of vibration (machine setting): 0.5 mm for lifts less than 40 mm thick.

.4 Haul trucks: Sufficient number and of adequate size, speed, and condition to ensure orderly and continuous operation and as follows:

.1 Boxes with tight metal bottoms.

.2 Covers of sufficient size and weight to completely cover and protect asphalt mix when truck fully loaded.

.3 In cool weather or for long hauls, insulate entire contact area of each truck box.

.4 Use only trucks which can be weighed in single operation on scales supplied.

.5 Hand tools:

.1 Lutes or rakes with covered teeth for spreading and finishing operations.

.2 Tamping irons having mass not less than 12 kg and bearing area not exceeding 310 cm² for compacting material along curbs, gutters, and other structures inaccessible to roller. Mechanical compaction equipment, when approved by the Engineer, may be used instead of tamping irons.

.3 Straight edges, 4.5 m in length, to test finished surface.

3.2 Preparation

.1 Reshape granular roadbed base to tolerances required.

.2 When paving over existing asphalt surface, clean pavement surface. When levelling course is not required, patch and correct depressions and other irregularities before beginning paving operations.

.3 Prior to laying mix, clean surfaces of loose and foreign material.

3.3 Transportation of Mix

.1 Transport the mix to the site in vehicles cleaned of foreign material.

.2 Paint or spray the truck beds with limewater, soap, or detergent solution, or non-petroleum based commercial product, at least daily or as required. Elevate the truck bed and thoroughly drain. No excess solution to remain in truck bed.

.3 Schedule delivery of material for placing in daylight, unless sufficient (50 lumens minimum) artificial light.
.4 Deposit mix from surge or storage silo to trucks in multiple drops to reduce segregation. Do not dribble mix into trucks.

.5 Deliver material to paver at uniform rate and in an amount within capacity of paving and compacting equipment.

.6 Deliver loads continuously in covered vehicles and immediately spread and compact. Deliver and place mixes at temperature within range compatible with mix design and paving equipment, but not less than 135°C.

3.4 Placing

.1 Obtain the Engineer's approval of base and existing surface and prior to placing asphalt.

.2 Place asphalt concrete to thicknesses, grades, and lines as indicated.

.3 Place asphalt concrete in compacted lift less than or equal to 50 mm.

.4 Where possible, do tapering and levelling where required in lower lifts. Overlap the joints by not less than 300 mm.

.5 On larger paved areas, commence spreading at high side of pavement or at crown and span crowned centerlines with initial strip.

.6 Spread and strike off mixture with self-propelled mechanical finisher.

.1 Construct longitudinal joints and edges true to line markings. Establish lines for paver to follow parallel to centerline of proposed pavement. Position and operate paver to follow established line closely.

.2 When using pavers in echelon, have first paver follow marks or lines, and second paver follow edge of material placed by first paver. Work pavers as close together as possible and in no case permit them to be more than 30 m apart.

.3 Maintain constant head of mix in auger chamber of paver during placing.

.4 If segregation occurs, immediately suspend spreading operation until cause is determined and corrected.

.5 Correct irregularities in alignment left by paver by trimming directly behind machine.

.6 Correct irregularities in surface of pavement course directly behind paver. Remove by shovel or lute excess material forming high spots. Fill and smooth indented areas with hot mix. Do not broadcast material over such areas.
.7 Do not throw surplus material on freshly screeded surfaces.

.7 When hand spreading is used:

.1 Use wood or steel forms, rigidly supported to assure correct grade and cross section. Use measuring blocks and intermediate strips to aid in obtaining required cross-section.

.2 Distribute material uniformly. Do not broadcast material.

.3 During spreading operation, thoroughly loosen and uniformly distribute material by lutes or covered rakes. Reject material that has formed into lumps and does not break down readily.

.4 After placing and before rolling, check surface with templates and straightedges and correct irregularities.

.5 Provide heating equipment to keep hand tools free from asphalt. Control temperature to avoid burning material. Do not use tools at higher temperature than temperature of mix being placed.

3.5 Compacting

.1 Do not change rolling pattern unless mix changes or lift thickness changes.

.2 Roll asphalt continuously to achieve required density of not less than 98% blow Marshall density in accordance with ASTM-D1559.

.3 General:

.1 Provide at least two (2) rollers and as many additional rollers as necessary to achieve specified pavement density. When more than two (2) rollers are required, one roller must be pneumatic tired type.

.2 Start rolling operations as soon as placed mix can bear weight of roller without excess displacement of material or cracking of surface.

.3 Operate roller slowly initially to avoid displacement of material. Do not exceed 5 km/hr for breakdown and intermediate rolling for static steel-wheeled and pneumatic tired rollers. Do not exceed 9 km/hr for finish rolling.

.4 Use static compaction for levelling coarse less than 25 mm thick.

.5 For lifts 50 mm thick and greater, adjust speed and vibration frequency of vibratory rollers to produce minimum of twenty-five (25) impacts per metre of travel. For lifts less than 50 mm thick, impact spacing not to exceed compacted lift thickness.
.6 Overlap successive passes of roller by minimum of 200 mm and vary pass lengths.

.7 Keep wheels of roller slightly moistened with water to prevent pick-up of material, but do not over-water.

.8 Do not stop vibratory rollers on pavement that is being compacted with vibratory mechanism operating.

.9 Do not permit heavy equipment or rollers to stand on finished surface before it has been compacted and has thoroughly cooled.

.10 After traverse and longitudinal joints and outside edge have been compacted, start rolling longitudinally at low side and progress to high side. Ensure that all points across width of pavement receive essentially equal numbers of passes of compactors.

.11 When paving in echelon, leave unrolled 50 to 75 mm of edge which second paver is following and roll when joint between lanes is rolled.

.12 Where rolling causes displacement of material, loosen affected areas at once with lutes or shovels and restore to original grade of loose material before re-rolling.

.4 Breakdown rolling:

.1 Commence breakdown rolling with static steel wheeled roller vibratory roller immediately following rolling of transverse and longitudinal joint and edges.

.2 Operate rollers as close to paver as necessary to obtain adequate density without causing undue displacement.

.3 Operate breakdown roller with drive roll or wheel nearest finishing machine. When working on steep slopes or super-elevated sections use operation approved by the Engineer.

.4 Employ only experienced roller operators.

.5 Finish rolling:

.1 Accomplish finish rolling with two-axle or three-axle tandem steel wheeled rollers while material is still warm enough for removal of roller marks. If necessary to obtain desired surface finish, use pneumatic-tired rollers as directed by the Engineer.

.2 Conduct rolling operations in close sequence.
.6 Dust entire area of sheet asphalt pavements with hydrated lime immediately after rolling to eliminate tendency to pick-up under traffic.

3.6 Joints

.1 General:

.1 Remove surplus material from surface of previously laid strip. Do not deposit on surface of freshly laid strip.

.2 Paint contact surfaces of existing structures such as manholes, curbs or gutters with bituminous material prior to placing adjacent pavement.

.2 Transverse joints:

.1 Offset transverse joint in succeeding lifts by at least 600 mm.

.2 Cut back to full depth vertical face and tack face with thin coat of hot asphalt prior to continuing paving.

.3 Compact transverse joints to provide smooth riding surface. Use methods to prevent rounding of compacted surface at joints.

.3 Longitudinal joints:

.1 Offset longitudinal joints in succeeding lifts by at least 150 mm.

.2 Cold joint is defined as joint where asphalt mix is placed, compacted and left to cool below 100°C prior to paving of adjacent lane.

.1 If cold joint cannot be avoided, cut back by saw cutting previously laid lane, by at least 150 mm, to full depth vertical face, and tack face with thin coat of hot asphalt of adjacent lane.

.3 Overlap previously laid strip with spreader by 25 to 50 mm.

.4 Before rolling, carefully remove and discard coarse aggregate in material overlapping joint with lute or rake.

.5 Roll longitudinal joints directly behind paving operation.

.6 When rolling with static or vibratory rollers, have most of drum width ride on newly placed lane with remaining 150 mm extending onto previously placed and compacted lane.

.4 Construct feather joints so that thinner portion of joint contains fine graded material obtained by changed mix design or by raking out coarse aggregate in mix. Place
and compact joint so that joint is smooth and without visible breaks in grade. Location of feather joints as indicated.

.5 Construct butt joints as indicated.

3.7 Finish Tolerances

.1 Finished asphalt surface to be within 5 mm of design elevation but not uniformly high or low.

.2 Finished asphalt surface not to have irregularities exceeding 5 mm when checked with 4.5 m straight edge placed in any direction.

3.8 Defective Work

.1 Correct irregularities which develop before completion of rolling by loosening surface mix and removing or adding material as required. If irregularities or defects remain after final compaction, remove surface course promptly and lay new material to form true and even surface and compact immediately to specified density.

.2 Repair areas showing checking, rippling, or segregation.

.3 Adjust roller operation and screed settings on paver to prevent further defects such as rippling and checking of pavement.

END OF SECTION
1. **GENERAL**

1.1 **Material Certification**

.1 Products having CSA certification to be used where readily available. Certification by Standards Council of Canada approved independent third body that products conform to CSA standards is acceptable in lieu of CSA certification.

.2 Submit manufacturer's test data and certification that pipe materials meet requirements of this section at least two (2) weeks prior to commencing work. Include manufacturer's drawings, information, and shop drawings where pertinent.

2. **PRODUCTS**

2.1 **Materials**

.1 Cement: to CAN/CSA-A5, type 10.

.2 Concrete mix design to produce 21 MPa minimum compressive strength at 28 days and containing 25 mm maximum size coarse aggregate.

.3 Precast manhole units: to ASTM C 478M, complete with ladder rungs. Top sections eccentric cone or flat slab top type with opening offset for vertical ladder installation.

.4 Precast catch basin sections: to ASTM C 478M.

.5 Joints: to be made watertight using rubber rings, bituminous compound, epoxy resin cement or cement mortar.

.6 Mortar:

.1 Aggregate: to CSA A82.56.

.2 Cement: to CAN/CSA-A8.

.7 Ladder rungs:

.1 To conform to ASTM C-947, C-478 load test.

.2 No.25M billet steel deformed bars conforming to ASTM A615, hot dipped galvanized to CAN/CSA G164. Rungs to be safety pattern (drop step type).

.3 20 mm Aluminum Alloy #6351-T6, complete with polyethylene anchor insulating sleeves and installed in 25 mm precast or drilled holes in manhole sections.

.4 Distance from top of manhole cover to top rung to be maximum 500 mm where no handhold provided. Maximum 650 with handhold.
.8 Adjusting rings: to ASTM C 478M.

.9 In compliance with all requirements of Workers’ Compensation Board.

.10 Frames, gratings, and covers to dimensions as indicated and following requirements:

.1 Metal gratings and covers to bear evenly on frames. A frame with grating or cover to constitute one unit. Assemble and mark unit components before shipment, with foundry identification.

.2 Gray iron castings: to ASTM A 48, for H20 loading.

.11 Granular bedding shall conform with the requirements for Granular Base – Section 02233.

3. **EXECUTION**

3.1 **Excavation and Backfill**

.1 Excavate and backfill in accordance with Section 02315 – Excavating, Trenching, and Backfilling and as indicated.

.2 Obtain approval of Engineer before installing manholes or catch basins.

3.2 **Installation**

.1 Construct units in accordance with details indicated, plumb and true to alignment and grade.

.2 Complete units as pipe laying progresses. Maximum of three units behind point of pipe laying will be allowed.

.3 Dewater excavation to approval of Engineer and remove soft and foreign material before placing concrete base.

.4 Cast bottom slabs directly on undisturbed ground or set precast concrete base on drain rock base or compacted granular bedding.

.5 Precast Manhole units:

.1 Set bottom section of precast unit in bed of cement mortar and bond to concrete slab or base. Make each successive joint watertight with Engineer approved rubber ring gaskets, bituminous compound, cement mortar, epoxy resin cement, or combination thereof.

.2 Clean surplus mortar and joint compounds from interior surface of unit as work progresses.
MANHOLES AND CATCH BASINS

.3 Plug lifting holes with concrete plugs set in cement mortar or mastic compound.

.4 All manhole to have required stamps from manufacturer.

.6 Catch Basins:

.1 Catch basins shall be constructed as shown on the drawings.

.2 Place minimum of 100 mm compacted bedding gravel under base.

.3 Trapping hood to be installed on all CB leads.

.7 For sewers:

.1 Place stub outlets and bulkheads at elevations and in positions indicated.

.2 Bench to provide a smooth U-shaped channel. Side height of channel to be full diameter of sewer. Slope adjacent floor at 1 in 20. Curve channels smoothly. Slope invert to establish sewer grade.

.8 Compact granular backfill to 100% Modified Proctor density to ASTM D1557.

.9 Installing units in existing systems:

.1 Where new unit is to be installed in existing run of pipe, ensure full support of existing pipe during installation, and carefully remove that portion of existing pipe to dimensions required and install new unit as specified.

.2 Make joints watertight between new unit and existing pipe.

.3 Where deemed expedient to maintain service around existing pipes and when systems constructed under this project are ready to be put in operation, complete installation with appropriate break-outs, removals, redirection of flows, blocking unused pipes or other necessary work.

.10 Set frame and cover to required elevation on no more than 3 courses of brick or concrete riser rings. Make brick joints and join brick to frame with cement mortar. Parge and make smooth and watertight.

.11 Clean units of debris and foreign materials. Remove fins and sharp projections. Prevent debris from entering system.
3.3 Leakage Test

.1 Install watertight plugs or seals on inlets and outlets of each new sewer manhole and fill manhole with water. Leakage not to exceed 0.3% per hour of volume of manhole.

.2 If permissible leakage is exceeded, correct defects. Repeat until acceptable to Engineer.

.3 Engineer will issue Test Certificate for each manhole passing test.

END OF SECTION
1. **GENERAL**

1.1 **Material Certification**

.1 Submit manufacturer’s test data and certification that pipe materials meet requirements of this Section at least five (5) days prior to commencing Work. Include manufacturer’s drawings, information, and shop Drawings where pertinent.

1.2 **Shop Drawings**

.1 Submit shop Drawings in accordance with Section 01330 - Submittals.

.2 Provide data to produce record Drawings, including directions for operating valves, list of equipment required to operate valves, details of pipe material, location of valves, hydrant details, maintenance and operating instructions in accordance with Section 01735 – Operation and Maintenance Data.

1.3 **Scheduling of Work**

.1 See Section 01015 – Work Sequences and Tie-Ins

2. **PRODUCTS**

2.1 **Piping Identification**

.1 The Drawings designate the size and line service specification of all pipe and fittings to be supplied by the Contractor in the following manner.

.1 Line Identification is place on each line in the following manner:

750 – RW – ST
Line Size: 750
Commodity: RW
Pipe Material: ST

eg. 750 mm line size, raw water, steel pipe.

.2 Commodity Symbols for Line Identification:

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>COMMODITY</th>
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<tbody>
<tr>
<td>CLS</td>
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<tr>
<td>SAM</td>
<td>Sample</td>
</tr>
<tr>
<td>TW</td>
<td>Treated Water</td>
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</tbody>
</table>
2.2 Piping Material, Joints and Fittings

.1 PVC (Gravity Service)

.1 Polyvinyl chloride pipe up to 1,200 mm in diameter, DR35. Pipe to have minimum pipe stiffness (F/Y) of 320 kPa at 5.0% deflection, ASTM D2412. Pipe to be manufactured to specifications for pipe size ranges as follows:

.1 100 mm dia. – 375 mm dia. To ASTM D3034

.2 450 mm dia. – 1200 mm dia. to ASTM F679

.2 Pipes to be certified by Canadian Standards Association to standards for pipe size ranges below.

.1 100 mm dia. – 1,200 mm dia. To CSA B182.2

.3 Joints: To conform to ASTM D3212; pipe to include integral bell and spigot ends with stiffened wall section and formed groove for a rubber gasket; elastomeric gaskets to ASTM F477.

.4 Normal pipe length joint to joint to be 4.0 m.

.5 Maximum installed deflection not to exceed 7.5% of the base inside diameter.

.2 Stainless Steel Pipe – refer to Section 15.

.3 Polyvinyl Chloride (PVC) Pressure Pipe:

.1 Pipe:

.1 Pipe to be manufactured to specifications for pipe size ranges as follows:

.1 Pipes 100 mm to 300 mm dia. - AWWA C900

.2 Pipes 350 mm to 1,200 mm dia. - AWWA C905

AWWA C900 pipe to Pressure Class or AWWA C905 pipe to pressure rating specified in Contract Documents.

.2 Pipes to be certified by Canadian Standards Association for pipe size ranges below:

.1 Pipes 100 mm to 1,200 mm dia. – CSA B137.3

.3 ULC listed.
.4 Cast iron pipe equivalent outside diameter.

.5 To be compatible with specified mechanical joint and push-on joint fittings and valves without use of special adapters.

.2 Joints: Push-on integrally thickened bell and spigot type to ASTM D3139 with single elastomeric gasket to ASTM F477.

.4 High Density Polyethylene Pipe:

.1 Pipe:

.1 To AWWA C906 pressure class specified in Contract Documents.

.2 Iron pipe size equivalent outside diameter.

.3 To be compatible with specified mechanical joint fittings and valves without special adapters.

.2 Joints: Heat butt fusion to ASTM F2620 and in accordance with manufacturer's recommendations.

.3 Fittings:

.1 Fabricated HDPE mitred fittings to AWWA C906 suitable for pressure rating specified in Contract Documents.

.2 Moulded HDPE fittings to ASTM 3261 suitable for pressure rating specified and fusion to main pipe, dimensions as specified in Contract Documents.

.3 Flanged joints to AWWA C906 flat faced stub end and loose hot-dip galvanized ductile iron (ASTM A536) backup ring drilling to ANSI B16.1, ANSI B16.5, or AWWA C207, class suitable for pressure rating specified in Contract Documents.

.4 Nuts and bolts as specified for “Fittings” in this section.

.5 Steel Pipe:

.1 Size and Location: as shown on Contract Drawings.

.2 Material: To AWWA C200 (minimum wall thickness 9.5 mm) as specified in Contract Drawings electrically welded. Steel to ASTM A36.

.3 Joints and Fittings:

.1 Steel pipe nominal size 914 – 1525 mm:
1 Pipe Joints: Pipe ends prepared for lap joints for field welding, prepared in accordance with AWWA C200.

2 Fittings to: field and/or shop fabricated mitred fittings to AWWA C208; reinforcement in accordance with AWWA M11.

Steel pipe nominal size 508 – 762 mm:

1 Pipe Joints: to ANSI/AWWA C200 butt weld.

2 Fittings to: field and/or shop fabricated mitred fittings to AWWA C208; reinforcement in accordance with AWWA M11.

4 Flanges: Steel pipe flanges to AWWA C207. Dimensions for fabricated steel water pipe fittings to AWWA C208.

5 Finishes: Exterior and interior: hot applied coal tar enamel to AWWA C203 or liquid epoxy coating to AWWA C210.

6 Ductile iron pipe:

1 Pipe: To AWWA C151, to Pressure Class or Special Thickness Class specified in Contract Documents, and standard cement mortar lined to AWWA C104.

2 Joints: Single rubber gasket for push-on bell and spigot type joint and/or mechanical piep joints: to AWWA C111 Tyton.

7 Fittings:

1 Gray-iron (cast iron) fittings to ANSI/AWWA C110/A21.10-93 suitable for 1035 kPa minimum pressure rating or higher as specified in Contract Documents. Where specified in Contract Documents, to be cement mortar lined and externally seal coated, both to AWWA C104.

2 Ductile iron fittings to AWWA C110 suitable for pressure rating of 2415 kPa, cement mortar lined to AWWA C104.

3 Compact ductile iron fittings to ANSI/AWWA C153/A21.53-94 suitable for pressure rating of 2415 kPa, cement mortar lined to AWWA C104.

4 PVC injection-molded fittings shall be C900, DR18, Class 150 conforming to AWWA C907 and CAN/CSA-B137.3-93.

5 PVC extruded fittings shall be Class 150, DR 18 conforming to AWWA C900-89.
.6 Single rubber gasket for push-on bell and spigot type joint and/or mechanical pipe joints: to AWWA C111. All push-on joint hubs to be equipped with tie-rod lugs.

.7 Flanged Joints:
   .1 Flat faced conforming to the face dimension and drilling of ANSI B16.1, Class 125.
   .2 On AWWA C110 fittings to AWWA C110 with minimum pressure rating 1035 kPa or higher as specified in Contract Documents.
   .3 On AWWA C153 fittings to AWWA C153 with minimum pressure rating of 1723 kPa or higher as specified in Contract Documents.

.8 Flange gaskets to be manufactured from black natural rubber 3.175mm thick with layer of cotton on both sides.

.9 Bolts and nuts:
   .1 Bolts to be carbon steel, Grade B to ASTM A307, heavy hex style, zinc plated to ASTM B633 or cadmium plated to ASTM B766. Bolt sizes to AWWA C110.
   .2 Nuts and washers: Nuts to be carbon steel, Grade A to ASTM A563. Washers to be flat hardened steel to ASTM F436. Nuts and washers to be zinc plated to ASTM B633 or cadmium plated to ASTM B766.

.10 Tie rods and nuts:
   .1 Tie rods to be continuous threaded, quenched and tempered alloyed steel to ASTM A354, Grade BC. To be zinc plated to ASTM B633 or cadmium plated to ASTM B766. Tie rod sizes to be minimum 19 mm diameter or greater as shown on the Drawings.
   .2 Nuts and internally threaded couplings to be heavy hex finish to ASTM A563. Washers to be flat hardened steel to ASTM F436. All to be zinc plated to ASTM B633 or cadmium plated to ASTM B766.

.11 Fabricated steel pipe fittings: AWWA C208 and AWWA C207 if flanged, interior and exterior protected with hot applied coal tar enamel to AWWA C203 or liquid epoxy coating to AWWA C210.

.12 Couplings and Flanged Coupling Adapters:
   .1 General Requirements:
      .1 Suitable for pressure class specified in Contract Documents.
.2 Flanges and full face flange gaskets where applicable to Clauses 2.2.4.7 and 2.2.4.8 of this Section.

.3 To AWWA C219.

.4 Anti-corrosion coating of interior and exterior centre sleeve and end rings to AWWA C219, AWWA C213, AWWA C210, or AWWA C550 as specified in Contract Documents.

.5 Compression gaskets to AWWA C219.

.6 Bolts and nuts high strength low alloy steel to AWWA C111, stainless steel to ASTM F593 or F738 for bolts and ASTM F594 or F836M for heavy flex nuts, as specified in Contract Documents. Rolled threads, fit and dimensions to AWWA C111.

.7 Ductile iron castings to ASTM A536, Grade 65-45-12.

.2 Plain end or transition couplings as specified in Contract Documents.

.3 Flanged coupling adapters as specified in Contract Documents.

.13 Joint Restraint Devices:

.1 General Requirements:

.1 Ductile iron castings to ASTM A536.

.2 Anti-corrosion coating of ductile iron castings to AWWA C219, AWWA C210, C213 or C550 as specified in Contract Documents.

.3 Bolts and nuts high strength low alloy steel to AWWA C111 or as specified in Contract Documents, stainless steel to ASTM F593 or F738 for bolts and ASTM F594 or F836 for heavy hex nuts. Rolled threads, fit and dimensions to AWWA C111.

.4 Tie rods to Clause 2.2.7.10 of this Section.

.5 Restrainers for ductile iron pipe with mechanical joint fittings as specified in Contract Documents.

.6 Restrainers for PVC pipe to Clause 2.2.7. of this Section with mechanical joint fittings as specified in Contract Documents.

.7 Restrainers for ductile iron pipe with push-on joint fittings with tie rod lugs as specified in Contract Documents.
.8 Restrainers for PVC to Clause 2.2.7 of this Section with push-on joint fittings with tie rod lugs as specified in Contract Documents.

.9 Restrainers for mechanical joints or push-on joints in ductile iron pipe as specified in Contract Documents.

.10 Restrainers for bell joints in PVC pipe to Clause 2.2.7 of this Section.

.11 Joint restraint devices for PVC watermain to be Underwriter Laboratories of Canada (UL) or Factory Mutual (FM) approved.

2.3 Pipe Bedding and Surround Material

.1 Type 4 granular fill material to Section 02315 - Excavating, Trenching, and Backfilling.

.2 Concrete mixes and materials required for bedding cradles, encasement, supports, trench dams, thrust blocks: to Section 03300 - Cast-in-Place Concrete.

2.4 Backfill Material

.1 Type 2 fill material under traveled surfaces, in accordance with Section 02315 - Excavating, Trenching, and Backfilling.

.2 Type 3 fill material under un-traveled surfaces in accordance with Section 02315 - Excavating, Trenching, and Backfilling.

2.5 Couplings

.1 Flexible coupling plain end: Dresser style 38 or approved equal.

.2 Flange / flexible coupling: Dresser style 128 or approved equal.

.3 Coat couplings with petroleum tape, mastic and paste.

2.6 Coatings

.1 Interior coating: liquid epoxy coating to AWWA C210.

.2 Exterior coating: hot applied Coal Tar enamel to AWWA C203.

.3 Outer Wrap: Bonded Coal Tar Coated Fiberglass Felt.

.4 Finish: Kraft Paper.

2.7 Valve and Valve Box

.1 Valves to open counter clockwise.
2. Butterfly valves:

   .1 Material: to ANSI/AWWA C504, short body, buried service condition, manual gear box, with combination handwheel, 50 mm square operating nuts, actuator to AWWA torques with position indicator, end flanges suitable to mating to ANSI B16.5 Class 150 flange joints.

   .2 Size: as specified.

   .3 Cast iron valve boxes: to Owner’s standards.

   .4 Air Release, Air/Vacuum and Combination Air Valves

      .1 Gray cast iron or ductile iron body

      .2 Threaded or flanged connections

      .3 Maximum working pressure 2070 kPa

      .4 To AWWA C512

2.8 Bolts and Nuts

   .1 Bolts and nuts to ASTM A307, Grade B Steel, hex head. Coat exposed fasteners with petroleum tape, mastic, and paste.

2.9 Pipe Disinfection

   .1 Sodium hypochlorite or calcium hypochlorite to ANSI/AWWA B300 to disinfect water mains.

   .2 All material that will come in contact with the potable water will be inspected and approved by the Utility.

2.10 Valve and Large Meter Chambers

   .1 Applicability for mainline butterfly valves or mainline gate valves 400 mm and larger and for meters 200 mm and larger.

   .2 As specified in Contract Documents, valve chambers for pressure reducing valves, air release valves, meters, and backflow prevention devices may have special and additional requirements and features.

   .3 Concrete and reinforcing steel: Section 03200 – Concrete Reinforcement and Section 03300 – Cast-in-Place Concrete.
.4 Precast concrete sections to ASTM C478M. Ladder rungs be cast integral with unit; field installation not permitted. Precast concrete lids to H-20 loading conditions.

.5 Jointing materials:

.1 Manufacturer’s rubber ring gaskets,
.2 Mastic joint filler,
.3 Cement mortar or,
.4 Combination of above types.

.6 Mortar: aggregate to CAN/CSA A82.56, masonry cement to CAN/CSA A8.

.7 Ladder rungs for valve chambers: minimum 20 mm diameter, for 76 mm minimum embedment in precast or cast-in-place concrete, minimum rung length 150 mm, minimum projection 100 mm, maximum vertical spacing 300 mm, minimum design liveload 1334N, cold rolled steel to CAN/CSA G164 or aluminum alloy #6061-T6 to CAN3-S157 and NBC 1990. Rungs to be safety pattern. Hand holds at top entry to conform to minimum design liveload and dimensions.

.8 Valve chamber frames and covers: as specified in Contract Documents.

.9 Mechanical and Electrical: as specified in Contract Documents.

3. EXECUTION

3.1 Preparation

.1 Clean pipes, fittings, valves, hydrants, and appurtenances of accumulated debris and water before installation. Carefully inspect materials for defects to approval of Engineer. Remove defective materials from site as directed by Engineer.

.2 Carry out sedimentation control in runoff in accordance with Section 02315 - Excavating, Trenching, and Backfilling.

3.2 Trenching

.1 Trenching Work in accordance with Section 02315 - Excavating, Trenching, and Backfilling.

.2 Trench depth to provide cover over pipe of not less than 1.5 m from finished grade or as indicated.
3.3 **Concrete Bedding and Encasement**

.1 Do concrete Work in accordance with Section 03300 - Cast-in-Place Concrete. Place concrete to details as indicated or as directed by Engineer.

.2 Pipe may be positioned on concrete blocks to facilitate placing of concrete. When necessary, rigidly anchor or weight pipe to prevent flotation when concrete is placed.

.3 Do not backfill over concrete within twenty-four (24) hours after placing.

3.4 **Granular Bedding**

.1 Place granular bedding material in uniform layers not exceeding 150 mm compacted thickness to depth as indicated.

.2 Do not place material in frozen condition.

.3 Shape bed true to grade to provide continuous uniform bearing surface for pipe.

.4 Shape transverse depressions in bedding as required to suit joints.

.5 Compact each layer full width of bed to minimum 95% Standard Proctor density in compliance with ASTM D698.

.6 Fill authorized or unauthorized excavation below design elevation of bottom of specified bedding in accordance with Section 02315 - Excavating, Trenching, and Backfilling.

3.5 **Pipe Surround**

.1 Upon completion of pipe laying and after Engineer has inspected Work in place, surround and cover pipes as indicated.

.2 Hand place surround material in uniform layers not exceeding 150 mm compacted thickness as indicated. Do not dump material within 2 m of pipe.

.3 Place layers uniformly and simultaneously on each side of pipe.

.4 Do not place material in frozen condition.

.5 Compact each layer from pipe invert to mid height of pipe to minimum 95% Standard Proctor Density in compliance with ASTM D698.
.6 Compact each layer from mid height of pipe to underside of backfill to minimum 95% Standard Proctor Density in compliance with ASTM D698.

3.6 Pipe Installation

.1 Handle pipe in accordance with manufacturer’s recommendations. Do not use chains or cables passed through pipe bore so that weight of pipe bears upon pipe ends.

.2 Lay and join pipes to manufacturer’s instructions and specifications except as noted otherwise herein.

.3 Horizontal tolerances: plus or minus 50 mm from specified alignment. Vertical tolerances: plus or minus 10 mm from specified grade. Reverse grade is not acceptable.

.4 Lay pipes on prepared bed, true to line and grade. Ensure barrel of each pipe is in contact with shaped bed throughout its full length.

.5 Commence laying at outlet and proceed in upstream direction with socket ends of pipe facing upgrade.

.6 Pipes on curved alignments:
   .1 Concrete pipe and ribbed profile PVC plastic pipe. Do not exceed permissible joint deflection recommended by pipe manufacturer.

.7 Keep jointing material installed pipe free of dirt, water and other foreign materials. Whenever work is stopped, install removable watertight bulkhead at open end of last pipe laid to prevent entry of water and foreign materials.

.8 Cut pipes as required, as recommended by pipe manufacturer, without damaging pipe and leave smooth end at right angles to axis of pipe.

.9 Joints:
   .1 Install gaskets as recommended by manufacturer.

   .2 Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.

   .3 Align pipes carefully before joining.

   .4 Maintain pipe joints free from mud, silt, gravel and other foreign material.

   .5 Avoid displacing gasket or contaminating with dirt or other foreign material. Remove disturbed or dirty gaskets; clean, lubricate and replace before joining is attempted.
.6 Complete each joint before laying next length of pipe.

.7 Minimize joint deflection after joint has been made to avoid joint damage.

.8 Apply sufficient pressure in making joints to ensure that joint is complete as outlined in manufacturer’s recommendations.

.10 Ensure completed joints are restrained by compacting bedding material alongside and over installed pipes or as specified otherwise.

.11 When any stoppage of Work occurs, restrain pipes in an approved manner to prevent “creep” during down time.

.12 Plug lifting holes with approved prefabricated plugs, to pipe supplier’s recommendations for sealing methods.

.13 Make watertight connections to manholes. Use shrinkage compensating grout when suitable gaskets are not available. Core neat circular holes in walls of existing manholes. Do not hammer or chip except as approved by Engineer.

3.7 Connections to Existing Mainline Pipes

.1 Use prefabricated saddles or approved field connection materials and techniques to connect service pipes to existing mainline sewer pipes. Ensure joint structurally sound and watertight without encroachment into inner circle of mainline sewer pipe.

.2 Where feasible, make connections to existing non-reinforced or reinforced concrete mainline pipe by coring or sawing circular holes in existing pipe walls. Where not feasible, make as follows:

.1 Break in to pipe by drilling small diameter holes, spaced at approximately 50 mm along pipe axis, using a drill or chipping gun. Use hammer to strike concrete adjacent to centre holes to create small core, and similarly expand core to suit outside dimensions of stub.

.2 Core dimensions to allow maximum 20 mm clearance around stub at any point.

.3 Trim stub to conform closely to shape of pipe interior when installed.

.4 Insert stub into core, ensuring that no portion of stub protrudes beyond interior of pipe.

.5 Prepare non-shrink, fast-setting cementitious grout to “dry pack” consistency. Pack grout tightly into void between stub and pipe.

.6 Hand finish interior and exterior grout surfaces to smooth surface.
.7 Allow sufficient time for strength development of grout prior to installation of connecting pipe or trench backfill.

.3 For new connections to existing PVC mainline sewers, drill hole in mainline to exact dimension of new connection. Use saddle or insertable tee for connections more than two (2) sizes smaller than mainline. Insertable tees may be used for all types of gravity mains provided insertable tee designed for applicable pipe thickness is used.

.4 For new connections to existing ribbed PVC pipe mainline sewers use preformed tee or wye fitting when connection is up two (2) sizes smaller than mainline pipe. For these pipes, in-situ installations of tees or wyes involving cutting across pipe ribs not permitted. For connections more than two sizes smaller than mainline pipe, an insertable tee for ribbed PVC pipe is permitted. When an insertable tee is used, hole cut into mainline pipe to cut as few ribs as possible.

3.8 Backfill

.1 Place and compact backfill material in accordance with Section 02315 - Excavating, Trenching, and Backfilling.

3.9 Valve Installation

.1 Install valves to manufacturer’s recommendations at locations shown on Drawings.

.2 Support valves located in valve boxes by means of either concrete or pressure treated and end treated wood blocks, located between valve and solid ground. Maximum length of pipe on each end of valve to be 1 m. Valves not to be supported by pipe.

.3 Support valves located in valve chambers by means of either concrete blocks or fabricated steel pipe stands as shown on Contract Documents.

.4 Valves to be installed in vertical position with actuating stem plumb.

3.10 Valve Chambers

.1 Use cast-in-place or precast units as shown on Drawings. Precast units to be in accordance with Section 02631 – Manholes and Catch Basins. Cast-in-Place units to be in accordance with Section 03200 – Contract Reinforcement and Section 03300 – Cast-in-Place Concrete.

.2 Construct units as shown on Drawings, plumb and with valve chamber openings centered over valve nut, true to alignment and grade. Valve chambers not to rest on pipe.

.3 Place reinforcing steel and miscellaneous metals required to be embedded in concrete to details shown on Drawings and in accordance with Section 03300 – Cast-in-Place Concrete.
.4 Cast bottom slabs for precise units directly on undisturbed ground where shown on Drawings, set precast concrete slab on 100 mm minimum of compacted granular material.

.5 Set bottom section of precast unit in bed of cement mortar and bond to bottom slab. Make each successive joint watertight with approved rubber ring gaskets, mastic joint filter, cement mortar, or combination thereof.

.6 Clean surplus mortar and joint compounds from interior surface of valve chamber as work progresses.

.7 Plug lifting holes with precast concrete plugs set in non-shrink non-staining grout or non-shrink, non-staining mortar.

.8 Set frame and cover to required elevation on at least two and not more than four courses of brick or precast concrete riser rings. Make brick or riser ring joints and join brick or riser rings to frame with cement mortar, parge and trowel smooth.

.9 Cover to be marked as specified in Contract Documents.

.10 Clean valve chambers of debris and foreign materials; remove fins and sharp projections.

.11 Set valve boxes centrally over valve nut. Set valve boxes and any other boxes around appurtenances and complete backfill with twenty-four (24) hours of setting appurtenances.

.12 Install sump drainer assemblies where shown on Drawings.

3.11 Under Crossing

.1 Excavate working pit to dimensions shown on Drawings, outside right-of-way to be crossed.

.2 Excavate working pit to not less than 0.6 m below lowest invert of encasing pipe.

.3 Dewater excavation.

.4 Dewater area of under-crossing.

.5 Install heavy timber or steel frame backstop.

.6 Place encasing pipe to exact line and grade shown on Drawings. Encasing pipe to cross under obstruction at angle shown on Drawings.

.7 Install encasing pipe by jacking, boring or tunneling methods approved by Engineer.

.8 Encasing pipe not to be in tension.
.9 Joints for encasing pipe to be welded to AWWA C206.

.10 Submit shop drawings showing proposed method of installation of carrier pipe.

.11 For ductile iron carrier pipe only, install continuous zinc strip sacrificial anode electrically bonded to carrier pipe shown on Drawings. Install sacrificial anodes for encasing pipe as shown on Drawings.

.12 Insert carrier pipe into encasing pipe, in end with largest open area, after placing leveling pad.

.13 Use approved chromated copper arsenate salt treated blocking method or fabricated high density polyethylene casing spacers to maintain carrier pipe in true alignment and uniform separation from encasing pipe.

.14 Clearance between blocks or casing spacers and encasing pipe to be maximum 15 mm when carrier pipe is in position.

.15 Join carrier pipe one length at a time outside encasing pipe. Push or pull carrier pipe into position.

.16 Couplings of carrier pipe not to rest on leveling pad when carrier pipe is in position.

.17 Place 20 MPa concrete cradle around carrier pipe after it is positioned. Cradle to be minimum of 225 mm and maximum of 300 mm above leveling pad.

.18 Fill open annular space at each end of encasing pipe with burlap bags filled with 20 MPa.

3.12 Corrosion Protection

.1 Where specified, provide corrosion protection measures as shown in Contract Documents.

3.13 General Procedure Flushing, Testing and Disinfection

.1 Perform all tests in presence of Engineer. Notify Engineer twenty-four (24) hours in advance of proposed test.

.2 Where any section of system is provided with concrete thrust blocks, do not conduct tests until at least five (5) days after placing concrete or two (2) days if high early strength concrete is used.

.3 Obtain municipal approval prior to discharging flushing water to municipal sewers or drainage ditches.

.4 Provide Engineer with all required approvals.
3.14 Cleaning and Preliminary Flushing

.1 Before flushing and pressure testing, ensure waterworks system is completely finished except tie-ins to existing watermains and make arrangements with Engineer for scheduling of testing and disinfection of mains. Testing and disinfection to be witnessed by Engineer.

.2 Isolation of existing water system where required will be performed by Owner. Do not operate any existing valves without authorization of Engineer.

.3 Water may be supplied from municipal fire hydrants upon application for a Hydrant Use Permit and presentation of valid test certificate for reduced pressure principle backflow prevention device conforming to AWWA C511.

.4 Remove foreign material from pipe and related appurtenances by flushing with water. Main to be flushed at water velocities as high as can be obtained from available water sources. Minimum velocity to be 0.8 m/s and/or in accordance with AWWA C651. Continue flushing at least until flow from most distant point has reached discharge point and until water discharged is clean and clear.

3.15 Field Testing

.1 Testing of lines to be carried out in presence of Engineer.

.2 Strut and brace caps, bends and tees, to prevent movement when test pressure is applied.

.3 Expel air from lines, by slowly filling lines water. High points to be drilled and tapped and suitable cocks installed to vent air and to be shut when pressure is applied. Remove cocks after satisfactory completion of test and seal holes with tight fitting plugs.

.4 Apply hydrostatic test pressure of 200 kPa for main process lines and 750 kPa for non-potable water line.

.5 No leakage permitted for welded steel lines and non-potable water lines.

.6 Apply pressure for one (1) hour for pressure test and two (2) hours for leakage test.

.7 Examine exposed pipe, joints and fittings while system is under pressure.

.8 Remove defective joints, pipe and fittings and replace with new sound material.

.9 Define leakage as amount of water supplied from meter in order to maintain test pressure for two (2) hours.

.10 Do not exceed allowable leakage as defined in ANSI/AWWA C600.
.11 Locate and repair defects if leakage is greater than amount specified in Article 3.9.10.

.12 Repeat test until leakage is within specified allowance.

.13 Complete backfill.

.14 Repeat test after completing backfill. Locate and repair defects and backfill. Repeat tests, repairs and backfills as needed until leakage is less than amount specified in Article 3.9.10.

3.16 Flushing and Disinfection

.1 Do not use granular hypochlorite for disinfection of PVC pipe with solvent welded joints, as there is an explosive reaction potential.

.2 Retain water containing not less than 25 mg/L free chlorine in water system for a period of at least twenty-four (24) hours, in accordance with AWWA C651, Continuous Feed Method. Submit outline of proposed disinfection procedure accompanied by marked up schematic drawing to Engineer for approval forty-eight (48) hours in advance of commencement of disinfection.

.3 Allow water from existing distribution system, isolated by reduced pressure principle backflow prevention device or other approved source of supply, to flow at constant, measured rate into newly laid watermain.

.4 At a point not more than 3 m downstream from beginning of new main, ensure water entering new main receives dose of chlorine fed at a constant rate such that the water will have not less than 25 mg/L free chlorine. To assure that this concentration is provided, measure chlorine concentration at regular intervals as specified in AWWA C651.

.5 Allow flow of water containing chlorine to continue until entire main, all service connections, extremities and hydrants to be treated are filled with 25 mg/L chlorine solution. To ensure that this concentration has been attained throughout, measure free chlorine residual at a number of points and extremities along main. Retain chlorinated water in main for at least twenty-four (24) hours. During this time operate all valves, curb stops and hydrants in section treated in order to disinfect them thoroughly.

.6 At the end of this twenty-four (24) hour period, treated water to contain no less than 10 mg/L free chlorine throughout main. If chlorine content is less than 10 mg/L, repeat chlorination procedure until specifications are met.

.7 After completion of chlorination, flush chlorinated water from system, hydrants and services until chlorine concentration in remaining water is less than 0.3 mg/L chlorine residual.
.8 Upon completion of disinfection and flushing, Contractor to remove test and bleed point apparatus and backfill and complete any other work required for placing of waterworks system in service.

END OF SECTION
1. GENERAL

1.1 Related Work

.1 Section 02231 - Clearing and Grubbing

.2 Section 02311 - Site Grading

.3 Section 02315 - Excavating, Trenching and Backfilling

.4 Section 02911 - Planting Soil and Finish Grading

1.2 References

.1 CSA G30.5-M, Welded Steel Wire Fabric for Concrete Reinforcement.


1.3 Submittals

.1 Submit product information for chemicals and fertilizers used in accordance with Section 01330 – Submittals.

1.4 Scheduling

.1 Obtain approval from Engineer for schedule indicating commencement of Work.

2. PRODUCTS

2.1 Materials

.1 Fill:

.1 Type (A): clean, natural river sand and gravel material, free from silt, clay, loam, friable or soluble materials, and organic matter.

.2 Type (B): excavated pervious soil, free from roots, rocks larger than 75 mm, building debris, and toxic ingredients (salt, oil). Excavated material to be approved by Engineer before use as fill.

.2 Coarse washed river stones: 35-75 mm diameter clear, round hard stone.

.3 Draintile: 100 mm diameter corrugated plastic perforated tubing complete with snap couplings to CGSB 41-GP-31M.

.4 Peatmoss:
.1 Derived from partially decomposed species of Sphagnum Mosses.
.2 Elastic and homogeneous.
.3 Free of wood and deleterious material which could prohibit growth.
.4 Shredded minimum particle size: 5 mm.
.5 Fertilizer:
  .1 To Canada "Fertilizer Act" and "Fertilizers Regulations".
  .2 Complete, commercial, slow release with 35 percent of nitrogen content in water-insoluble form.
.6 Anti-dessicant: commercial, wax-like emulsion.
.7 Filter Cloth:
  .1 Type 1: 100 percent non-woven needle punched polyester, 2.75 mm thick, 240 g/m² mass.
  .2 Type 2: biodegradable burlap.
.8 Wood posts: 38 x 89 x 2400 mm length, untreated wood.
.9 Welded wire fabric (WWF): 100 x 100 mm, 1500 mm high, to CSA G30.5.
.10 Vinyl snow fence or equivalent (1500 mm high).

3. EXECUTION

3.1 Identification and Protection

.1 Identify plants and limits of root systems to be preserved to satisfaction of Engineer.
.2 Protect plant and root systems from damage, compaction, and contamination resulting from construction to satisfaction of Engineer.

3.2 Root Curtain System

.1 Identify limits for required construction excavation to satisfaction of Engineer.
.2 Hand dig trench minimum 500 mm wide x 1500 mm deep, along perimeter of excavation limits, prior to construction excavation.
.3 Prune exposed roots cleanly at side of trench nearest plants to be preserved. Pruned ends to point obliquely downwards.
.4 Install wooden posts and welded wire fabric or vinyl snow fence against construction edge of trench. When depth of excavation for walls, foundations, and footings exceeds 1500 mm, provide additional support for posts and curtain as required.

.5 Securely attach Type 2 filter fabric on plant side of wire mesh.

.6 Prepare homogeneous mixture of fertilizer, parent material, and organic matter. Add organic matter to mixture to achieve 7-9 percent organic matter content by weight. Incorporate with mixture grade 2:12:8 ratio fertilizer (dry) at rate of 1.5 kg/m³.

.7 Backfill with homogeneous mixture between curtain wall and plants to be preserved in layers not exceeding 150 mm in depth. Compact each layer to 85 percent Standard Proctor Density.

.8 Protect root curtain from damage during construction operations.

.9 Water plants and root curtain sufficiently during construction to maintain optimum soil moisture condition until backfill operations are complete.

.10 Protect root curtain during backfill operations. Ensure root curtain is cut down to 300 mm below finished grade and remove cut material.

3.3 Air Layering System

.1 Using manual methods, carefully remove turf, plants, leaves, and organic matter in area of root system and slightly loosen topsoil surface. Avoid damage to root system.

.2 Lay horizontal system of perforated drain pipe on surface of existing grade. Slope drain tile minimum 3 percent for drainage away from trunk of tree. Connect system with general Work Site drainage system or drain to low point on Work Site.

.3 Install plastic "vent" pipes vertically over joints in horizontal pipe system or where indicated. Top of vent pipe to be 20 mm above finished grade of fill. Keep top of vent pipe covered during construction.

.4 Cover joints with Type 1 filter fabric and place coarse washed stone around joints and vertical pipes to secure their position.

.5 Construct drywell around trunk of tree. Ensure open ends of horizontal pipe system, vertical vent pipes are left exposed for air circulation to root system. Protect openings from blockage during construction. Install protective caps on exposed horizontal openings.

.6 Place 200 mm depth of coarse washed stone on surface of original ground and horizontal pipe system to limits.

.7 Place Type 1 filter fabric over surface of granular layer.
.8 Place Type A fill over filter fabric to required depth without disturbing or damaging drain pipe system. Avoid damage to filter fabric.

.9 Complete topsoil and hydraulic seeding over area of sub-surface system within one week of placing fill.

.10 Remove temporary protective covering from vent pipe openings. Install protective caps flush with finished grade.

3.4 Trenching and Tunneling for Underground Services

.1 Centre line location and limits of trench/tunnel excavation to be approved by Engineer prior to excavation. Tunnel excavation to extend 2000 mm from edge of trunk on either side.

.2 Excavate manually within zone of root system. Do not sever roots greater than 40 mm diameter except at greater than 500 mm below existing grade. Protect roots, and cut roots cleanly with sharp disinfected tools.

.3 Excavate tunnel under centre of tree truck using methods and equipment approved by Engineer.

.4 Backfill for tunnel and trench to 85 percent Standard Proctor Density. Avoid damage to trunk and roots of tree.

.5 Complete tunneling and backfilling at tree within two (2) weeks of starting Work.

3.5 Lowering Grade around Existing Tree

.1 Commence Work in accordance with schedule approved by Engineer.

.2 Cut slope not less than 500 mm from tree trunk to new grade level.

.3 Excavate to depths as indicated. Protect from damage root zone which is to remain.

.4 Cut roots with sharp tools when severing roots at excavation level.

.5 Cultivate excavated surface manually to 15 mm depth.

.6 Prepare homogeneous soil mixture consisting by volume of:

   .1 60 percent excavated soil cleaned of roots, plant matter, stones, debris.

   .2 25 percent coarse, clean sterile sand.

   .3 15 percent organic matter.

   .4 Grade 2:12:8 fertilizer at rate of 1.5 kg/m².
.7 Place soil mixture over area of excavation to finished grade level. Compact to 85 percent Standard Proctor Density.

.8 Water entire root zone to optimum soil moisture level.

.9 Install surface cover of hydro seeding, sodding in accordance with Section 02922 - Hydroseeding.

3.6 Maintenance during Warranty Period

.1 Perform following maintenance operations from time of acceptance by Engineer to end of warranty period:

.1 Apply pesticides in accordance with Federal, Provincial, and Municipal regulations as and when required to control insects, fungus, and disease. Obtain product approval from Engineer prior to application.

.2 Apply fertilizer in early spring at rate of 0.025 kg of nitrogen/m².

.3 Remove dead, broken, or hazardous branches from plant material.

.4 Submit monthly written reports to Engineer identifying:

.1 Maintenance work carried out.

.2 Development and condition of plant material.

.3 Preventative or corrective measures required which are outside Contractor's responsibility.

.2 Ensure relocated plant materials are watered for minimum one (1) month following installation as part of maintenance operations.

3.7 Pruning

.1 Prune crown to compensate for root loss while maintaining general form and character of plant.

3.8 Anti-Dessicant

.1 Apply anti-dessicant to foliage where applicable and as directed by Engineer.

END OF SECTION
1. GENERAL

1.1 Documents

.1 This section of the Specifications forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.

1.2 Source Quality Control

.1 Advise the Engineer of sources of planting soil to be utilized 7 days in advance of starting work.

.2 Contractor is responsible for soil analysis and requirements for amendments to supply planting soil as specified. Provide soil analysis report for the proposed soil to the Engineer for approval.

2. PRODUCTS

2.1 Planting Soil (Top Soil)

.1 Planting soil for seeded areas: mixture of mineral particulates, micro-organisms, and organic matter which provides suitable medium for supporting intended plant growth.

.1 Soil texture based on The Canadian System of Soil Classification, to consist of 50-70 percent sand and contain 3-8 percent organic matter by weight.

.2 Fertility: major soil nutrients present in following ratios:

.1 Nitrogen (N): 20-40 micrograms of available N per gram of topsoil.

.2 Phosphorus (P): 10-20 micrograms of phosphate per gram of topsoil.

.3 Potassium (K): 80-120 micrograms of potash per gram of topsoil.

.4 Calcium, magnesium, sulphur, and micro-nutrients present in balanced ratios to support germination and/or establishment of intended vegetation.

.3 pH value >8.0.

.4 Contain no toxic elements or growth inhibiting materials.
PLANTING SOIL AND FINISH GRADING

.5 Free from:

.1 Debris and stones over 30 mm diameter such that 85-100 percent pass a 9.5 mm sieve.

.2 Course vegetative material 10 mm diameter and 100 mm length, occupying more than 2 percent of soil volume.

.3 Crabgrass, couchgrass, equisetum, or noxious weeds or seeds or parts thereof.

.6 Consistency: friable when moist.

.7 Planting soil and amendments to be mixed off-Site prior to placement.

2.2 Soil Amendments

.1 Peat moss:

.1 Horticultural grade.

.2 Derived from partially decomposed species of Sphagnum mosses.

.3 Elastic and homogeneous, brown in colour.

.4 Free of wood and deleterious material which could prohibit growth.

.5 Shredded particle minimum size 5 mm with 95-100 percent passing a 9.5 mm sieve.

.6 pH value not less than 3.5 and not greater than 4.5.

.7 Organic content to be no less than 90 percent based on dry weight as determined by ash analysis.

.2 Sand - washed coarse silica sand, medium to coarse texture:

.3 Limestone:

.1 Ground agricultural limestone containing minimum calcium carbonate equivalent of 85 percent.

.2 Gradation requirements - percentage passing by weight, 90 percent passing 1.0 mm sieve, 50 percent passing 0.125 mm sieve.
PLANTING SOIL AND FINISH GRADING

.4 Fertilizer:

.1 Lime to include coarse (60 mesh) dolomite lime.

.2 Fertilizer to be of uniform composition, free flowing and dry, granular, drill form, or pelleted commercial product with 50 percent of total nitrogen derived from natural organic material in a slowly available form.

.5 Mulch - to be ‘Glenmore Grow’ by City of Kelowna Landfill operations, free of all soil, stones, sticks, roots or other extraneous matter.

3. EXECUTION

3.1 Preparation of Existing Grade

.1 Verify that grades are correct. If discrepancies occur, notify the Engineer and do not commence Work until instructed by the Engineer.

.2 Grade soil, eliminating uneven areas and low spots, ensuring positive drainage, and dispersion of surface flow of water, preventing concentration of flow and potential erosion. The Contractor is responsible for prevention and/or repair of areas eroded by surface water flow, including regrading, placing riprap, sediment control fencing, straw mat, hay bales, and the like placed to the satisfaction of the Engineer.

.3 Remove debris, roots, branches, stones in excess of 50 mm diameter and other deleterious Materials. Remove soil contaminated and petroleum products. Remove debris which protrudes more than 75 mm above surface. Dispose of removed material off-site or to a disposal site within the watershed area designated by the Engineer.

.4 Coarse cultivate entire area which is to receive topsoil to depth of 100 mm. Cross-cultivate those areas where equipment used for hauling and spreading has compacted soil.

.5 Provide proper water management and drainage of site during construction. Include silt traps, erosion control measures, temporary water collection ditches, as well as maintenance during construction period.

3.2 Placing and Spreading of Planting Soil

.1 Place planting soil after the Engineer has accepted sub-grade.

.2 Spread planting soil in uniform layers not exceeding 100 mm, over unfrozen sub-grade free of standing water.

.3 Spread planting soil as indicated to following minimum depths after settlement and 80 percent compaction:
PLANTING SOIL AND FINISH GRADING

.1 100 mm for lawn areas.

.2 150 mm for ground cover areas.

.3 300 mm for shrub areas.

.4 225 mm for sides of root ball for tree pits.

.4 Manually spread planting soil around trees, shrubs and obstacles. Provide 450 mm planting soil depth for shrubs.

.5 Place mulch immediately after all planting is complete and finish grading approved by Engineer. Ensure minimum depth of mulch is 75 mm after settlement.

3.3 Finish Grading

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

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

3.4 Acceptance

.1 The Engineer will inspect and test topsoil in place and determine acceptance of Materials, depth of topsoil and finish grading. Approval of topsoil Materials subject to soil testing and analysis.

3.5 Restoration of Stockpile Sites

.1 Restore stockpile sites acceptable to the Engineer.

3.6 Surplus Material

.1 Dispose of materials not required off-site.
1. GENERAL

1.1 Scope of Work

.1 Furnish all labour, products, and equipment required for grass hydroseeding of disturbed and finished project area.

1.2 Related Work

.1 Section 02911 - Planting Soil and Finish Grading.

1.3 Scheduling

.1 Schedule hydroseeding to coincide with preparation of soil surface and as designated by the Engineer.

1.4 Delivery, Storage and Protection

.1 Protect all seeded areas against trespassing and from damage at all times. Repair seeded area that are damaged, as required by the Owner.

.2 Protect existing Work Site features against damage or contamination due to Work of this Section. Make good damage or contamination which occurs.

.3 Deliver seeds, mulch, fertilizers, tackifier, and other products to the Work Site in manufacturer's original containers, clearly identified.

.4 Store in weatherproof storage areas. Protect from water damage.

.5 Repair any damage to the satisfaction of the Engineer.

2. PRODUCTS

2.1 Materials

.1 Granular Fertilizer: standard approved brands delivered in original containers, bearing manufacturer's guaranteed analysis, dry and free-flowing, organic base, conforming to the applicable Provincial Fertilizer Laws, not less than 3 percent Nitrogen, 15 percent Phosphoric Acid and 6 percent Potash (3-15-6).

.2 Slow-Release Turf Starter Fertilizer: Not less than 16 percent Nitrogen, 32 percent Phosphate, 6 percent Potash. (16-32-6). Recommended - Pro (16-32-6) 50 percent P.S.C.U.

.3 Slow Release Maintenance Fertilizer: Not less than 23 percent Nitrogen, 3 percent Phosphate, and 23 percent Potash. (23-3-23).
HYDROSEEDING

.4 Grass Seed: Mixed and supplied by a recognized seed house and delivered in original containers clearly showing:

.1 Name of supplier.
.
.2 Analysis of seed mixture.
.
.3 Percentage of pure seed.
.
.4 Year of production.
.
.5 Net weight (mass).
.
.6 Date and location of bagging.
.
.5 Seed to be in accordance with Federal and Provincial seed laws having a minimum germination of 75 percent and minimum purity of 97 percent.
.
.6 Grass Seed Mixture by weight for Landscaped Areas:

60% Bluebunch wheatgrass
25% Idaho Fescue
10% Sandburg bluegrass
4% Junegrass
1% Canada bluegrass
.
.
.7 The Engineer may test seed for purity and germination.
.
.8 Hydroseeded areas into which any other varieties of grass have been introduced will not be accepted.
.
.9 Hydroseeding Mulch: Provide hydroseeding solution containing a mulch of wood cellulose fibre specifically designed for hydraulic seeding containing no growth or germination inhibiting factors, and dyed green for visual metering during application.
.
.10 Tackifier: Provide a dry powdered muciloid designed for hydroseeding.
.
.11 Dolomite Lime: Provide finely ground dolomite lime, containing not less than 90 percent calcium carbonate.
3. EXECUTION

3.1 Soil Preparation

.1 Grades:

.1 Complete Work Site grading in accordance with Section 02911 – Planting Soil and Finish Grading and approval of Engineer prior to hydroseeding.

.2 Restore all areas to be seeded which are misshapen or eroded to specified condition, grade, and slope as directed just prior to seeding. Minor adjustment and refinement of finish grade to be made as directed by the Engineer.

.3 Obtain approval of the Engineer of finish grading prior to proceeding.

.2 Clearing:

.1 Remove all weeds, briars, debris, and other material detrimental to the growth of the grass.

3.2 Application

.1 Scheduling: Carry out seeding of grass during periods which are most favourable for the establishment of a healthy stand of grass.

.2 All seeding to be done during calm weather and on soil that is free of frost, snow, and standing water.

.3 One week prior to seeding, apply dolomite lime uniformly over the area at a rate necessary to bring the pH to a minimum level of 6.5. Work well into top 50 mm of soil.

.4 Seeding Procedure:

.1 Apply with equipment designed for hydraulic seeding, a uniform solution in water of:

.1 Grass seed rate:

.1 224 kg/ha (2.24 kg/100 m²).

.2 Fertilizer rate:

.1 448 kg/ha (4.48 kg/100 m²).
.3 Fibre Mulch rate:
  .1 2240 kg/ha (22.4 kg/100 m²).

.4 Tackifier rate:
  .1 134 kg/ha (1.34 kg/100 m²).

.5 Ensure uniform distribution of the solution over the area.

.5 Germination:
  .1 Follow up hydroseeding with all maintenance procedures as required to maintain the approved grades and obtain uniform germination. These shall include:
    .1 Spray as required by weather conditions to maintain seed and mulch in a moist condition.
    .2 Reseed areas damaged or having inadequate germination.

.6 Clean up:
  .1 Remove from the Work Site all surplus material and other debris resulting from seeding operations.
  .2 Flush all walks and paved areas clean to the satisfaction of the Engineer.

3.3 Maintenance during Establishment Period

.1 Perform following operations for one (1) growing season from time of seed application, or until acceptance by Engineer:

  .1 Grass Mixture:
    .1 Repair and reseed dead or bare spots to allow establishment of seed prior to acceptance.
    .2 Mow grass to 40 mm whenever it reaches height of 60 mm. Remove clippings which will smother grass.
    .3 Fertilize seeded areas after first cutting ten (10) weeks after germination provided plants have mature true leaves in accordance with fertilizing program. Spread half of required amount of fertilizer in one direction and remainder at right angles.
.4 Eliminate weeds by manual, mechanical or chemical means on a regular basis.

.1 Comply with Federal, Provincial, and Municipal control regulations if chemical means are used.

.5 Water seeded area to maintain optimum soil moisture level for germination and continued growth of grass. Control watering to prevent washouts.

3.4 Acceptance

.1 Seeded areas will be accepted by Engineer provided that:

.1 Seeded areas are free of rutted, eroded, bare, or dead spots and free of weeds.

.2 Areas have been fertilized.

END OF SECTION
Division 3
1. GENERAL

1.1 Work Included

.1 Forms and supporting falsework design.

.2 Wood or steel forms for all cast-in-place concrete.

.3 Special forms for architectural concrete formed finished.

.4 Tubular column forms.

.5 Void forms.

.6 Shoring, bracing and anchorage.

.7 Taping of form joints for special finishes.

.8 Form openings for other trades.

.9 Coordinate installation of concrete accessories.

.10 Set anchor bolts, anchors, sleeves, frames and other items supplied by other trades.

.11 Clean erected formwork prior to concrete placement.

.12 Remove forms and supporting falsework.

.13 Reshoring.

1.2 Related Work

.1 Concrete Reinforcement: Section 03200

.2 Concrete Accessories: Section 03250

.3 Cast-in-Place Concrete: Section 03300

1.3 Reference Standards

.1 Design, construct and erect supporting falsework in accordance with the current National Building Code of Canada, CSA CAN3-A23.1M, ACI 347 and applicable construction safety regulations.

.2 CAN/CSA-S269.3, Concrete Formwork.
CONCRETE FORMWORK AND FALSEWORK

.3 CSA S269.1 Falsework for Construction Purposes.
.4 CSA-A23.1, Concrete Materials and Methods of Concrete Construction.
.5 CAN/CSA-O86.1, Engineering Design in Wood (Limit States Design).
.6 CSA O121, Douglas Fir Plywood.
.7 ACI 347 Recommended Practices for Concrete Formwork.
.8 Design to be done by a Professional Structural Engineer registered in the Province of British Columbia. Same Engineer to inspect the erected falsework and formwork and certify, in writing, that it is in accordance with the design.

1.4 Shop Drawings

.1 Submit falsework and formwork shop drawings for review in accordance with Section 01330.
.2 Clearly indicate sizes, methods of construction, materials, arrangement of joints, ties and shores, location and size of falsework, schedule of erection and stripping.
.3 Shop drawings and design briefs are to bear the seal of a professional structural engineer registered in the Province of British Columbia.

2. PRODUCTS

2.1 Materials

.1 For exposed surfaces: square-edged, smooth surfaced panels true in plane, free of holes, surface markings or defects.
.2 Formwork Materials: to CSA-A23.1.
.3 Steel forms: to be free from irregularities, dents, sags, rust, and materials which would discolour the concrete.
.4 For unexposed surfaces: square-edged T&G lumber, plywood, or other material suitable to retain concrete without leakage or distortion.
.5 Architectural Finish: fabricated form adequate to achieve the architectural finishes as marked on drawings and architectural specifications.
.6 Do not use aluminum for formed surfaces in contact with concrete.
.7 Wood Materials:
CONCRETE FORMWORK AND FALSEWORK

.1 Plywood: Douglas Fir, conforming to CSA 0121-M, solid one side select sheathing - tight face grade. Sound, undamaged sheets with clean true edges.

.2 Lumber: conforming to CSA 0141-M.

.3 Nails, Spikes and Staples: galvanized or phosphatized; conforming to CSA B111.

.8 Prefabricated Forms:

.1 Steel Type: minimum 1.6 mm steel thickness; well matched, tight fitting and adequately stiffened to support the weight of concrete without deflection detrimental to structural tolerance and appearance of finished concrete surface.

.2 Tubular Column Type: round, spirally wound laminated fibre material, internally treated with release agent; sizes indicated on the Drawings.

.3 Void Forms: moisture resistant treated paper faces; bio-degradable; structurally sufficient to support weight of wet concrete mix until initial set; 150 mm thick.

.9 Accessories:

.1 Form Release Agent: colourless mineral oil which will not stain concrete or impair natural bonding or colour characteristics of coating intended for use on concrete. Form release agent shall be non-toxic.

.2 Corner or Chamfer Fillets: extruded plastic or mill finish pine, 20 mm width, maximum possible lengths, mitre ends.

.3 Sealing Tape: reinforced, self-adhesive polyvinyl-chloride.

3. EXECUTION

3.1 Examination

.1 Before starting this work examine work done by others which affects this work.

.2 Rectify all conditions which would prejudice proper completion of this work.

.3 Commencement of work implies acceptance of existing conditions.
3.2 Erection

.1 Verify lines, levels, and centers before proceeding with formwork. Ensure dimensions agree with the Drawings.

.2 Construct formwork and falsework in accordance with CSA S269.1, and CSA-S269.3, to meet design and regulatory requirements and to produce finished concrete conforming to surfaces, shapes, lines, and dimensions indicated on the Drawings. Ensure visible lines of the curbs, walls, and walks follow a smooth profile both vertically and horizontally.

.3 Construct forms to produce finished concrete conforming to shape, dimensions, locations, and levels indicated within tolerances required by CAN3-A23.1.

.4 Where concrete is exposed to view, arrange forms so that joints are kept to a minimum and aligned in a symmetrical arrangement. Ensure joints are taped and are watertight.

.5 Arrange and assemble formwork to permit removal without damage to concrete. Set shores supporting forms for beams, slabs and other horizontal members on wedges or other approved adjustable supports.

.6 Do not weld formwork to steel superstructure.

.7 Align joints and make watertight to prevent leakage of cement paste and disfiguration of concrete. Keep form joints to a minimum. Where joints are shown on drawings, Contractor shall ensure that joint layout matches drawings. Tape form joints as necessary.

.8 Do not use earth surfaces to form concrete without written approval of Consultant.

.9 Arrange forms to allow removal without removal of principal shores where these are required to remain in place.

.10 Obtain the Engineer’s permission before framing openings in concrete slabs, beams and columns not shown on drawings.

.11 Provide falsework to ensure stability of formwork. Prop or strengthen all previously constructed parts liable to be overstressed by construction loads.

.12 Position form joints to suit any expressed lines required in exposed concrete. Arrange form board panels in a regular symmetrical pattern to the approval of the Consultant.

.13 Provide 25 mm chamfer on all internal and external corners and edges of exposed concrete.
CONCRETE FORMWORK AND FALSEWORK

.14 Form chases, slots, openings, drips, and recesses as detailed on the Drawings.

.15 Set screeds with top edge level to required elevations.

.16 Check and re-adjust formwork to required lines and levels during placing of concrete.

.17 If form sheathing is to be re-used, remove nails and clean surfaces in contact with concrete before re-using.

.18 Clean formwork in accordance with CAN3-A23.1, before placing concrete.

3.3 Tolerances

.1 Construct formwork, falsework and all supporting or bracing members to provide concrete with dimensions, lines and levels within tolerances specified in CAN/CSA A23.1, latest edition.

.2 If tolerances are exceeded, remove, replace or modify placed concrete as directed by the Consultant at no cost to the Owner.

.3 Provide for settlement, closure of joints and elastic shortening of forms and shoring. Camber slabs and beams as shown on the Drawings. Maintain beam depth and slab thickness from cambered surface.

3.4 Construction Joints

.1 Locate joints not indicated on the Drawings so as to least impair the strength of the structure. Obtain the Consultant's approval before proceeding.

.2 Construct joints in accordance with CSA CAN3-A23.1-M. Provide waterstops for full length of joint.

.3 Roughen surface of hardened concrete and thoroughly clean of any foreign matter and laitance. Wet surface with water and ensure forms are tight against face of hardened concrete. Epoxy bonding agent to be used where shown on drawings or as indicated by the Consultant.

3.5 Inserts / Embedded Items / Openings

.1 Provide formed openings where required for pipes, conduits, sleeves and other work to be embedded in and passing through concrete members.

.2 Accurately locate and set in place items which are to be cast directly into concrete.
CONCRETE FORMWORK AND FALSEWORK

3.6 Form Ties

.1 Submit tie patterns form tie specifications to the Consultant for review prior to construction. Arrange ties in a uniform pattern; horizontally and vertically.

.2 Ties to be metal with no metal within 38 mm of concrete surfaces when forms have been removed.

.3 For exposed concrete fit ties with cones approximately 20 mm diameter and not longer than 40 mm. Coat ties with cup grease or other approved material if ties are to be removed. Loosen ties twenty four hours after concrete has been placed. Ensure sufficient numbers of ties remain to hold form in place. Cutting ties back from the face of the wall is not permitted.

.4 For all non-exposed concrete, fill all holes left by withdrawal of rods or holes left by removal of tie ends with solid mortar as outlined in the concrete section.

.5 Remove all cones from both interior and exterior concrete surfaces. If surface is to be sandblasted, leave cones in place until after sandblasting is complete. Fill cone holes with small amount of grey sealant to cover metal rod.

.6 In water retaining structures, channels, tunnels or surfaces requiring waterproofing of removable ties; all ies-holes shall be treated as per the waterproofing admixture manufactures written instructions.

.7 The holes left by withdrawal of rods or the holes left by removal of ends of ties shall be filled solid with mortar after first being thoroughly wetted. For holes passing entirely through the wall a plunger-type pressure gun or other device shall be used to force the mortar through the wall starting at the back face. A piece of burlap or canvas shall be held over the hole on the outside and when the hole is completely filled, the excess mortar shall be struck off with the cloth flush with the surface. Holes not passing entirely through the wall shall be filled with a
small tool that will permit packing the hole solid with mortar. Any excess mortar at the wall shall be struck off flush with the surface.

.1 Form ties: removable or snap-off metal ties, fixed or adjustable length, of a type that no metal will be within 40 mm of the concrete surface when forms have been removed. Use tapered plastic cones at faces of concrete to allow for grouting or filling with precast concrete plugs. Use waterstop flange at mid length of single wire tie for watertight and below grade structures. Multiple strand ties are not permitted.

.2 Provide a neoprene waterstop plug installed at centreline of hole with adhesive. Fill holes on each side of waterstop to within 40 mm of surface with non shrink grout. Pack 40 mm depth to surface with crystalline waterproofing. Submit cleaning and installation procedure for review by Engineer.

3.7 Embedded Items

.1 Provide formed openings where required for pipes, conduits, sleeves, and other work to be embedded in and passing through the concrete members.

.2 Accurately locate and set in place items which are to be cast directly into concrete.

.3 Coordinate the work of other sections and cooperate with trades involved in forming openings, slots, recesses, chases and setting sleeves, bolts, anchors, and other inserts.

.4 Coordinate installation of concrete accessories specified in Section 03250 – Concrete Accessories.

.5 Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

.6 Close temporary ports or openings with tight fitting panels, fit flush with inside face of forms, neatly fitted so no leakage occurs and to provide uniform surface on exposed concrete.

.7 Set anchor bolts, sleeves, and inserts accurately at the positions designated. Secure in position by means of wooden templates and ties to prevent shifting and floating during concrete placement.

.8 Do not set anchor bolts, sleeves, and inserts into placed concrete.

.9 Core holes and grout anchor bolts for bearings.
CONCRETE FORMWORK AND FALSEWORK

3.8 Quality Control

.1 Inspect and check complete formwork, falsework, shoring, and bracing to ensure that the work is in accordance with formwork design and that supports, fastenings, wedges, ties, and parts are secure.

.2 Inform Engineer when formwork is complete and has been cleaned to allow for inspection. Engineer's inspection will be for verification that forms are clean and free from debris.

.3 For all exposed concrete surfaces do not patch formwork.

.4 Allow the Engineer to inspect each section of formwork prior to reuse. Formwork may be re-used if approved by the Engineer.

3.9 Cleaning

.1 Clean forms as erection proceeds to remove foreign matter. Remove cuttings, shavings and debris from within the forms. Flush completely with water to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.

.2 During cold weather, remove ice and snow from within the forms. Do not use de-icing salts. Do not use water to clean out completed forms unless formwork and concrete construction proceed within a heated enclosure. Use compressed air or other means to remove foreign matter.

3.10 Preparation

.1 Apply form release agent in accordance with the manufacturer's recommendations prior to placing reinforcing steel, anchoring devices and embedded parts. Any embedded item to be cast in concrete, on which form release agent has been applied, shall be thoroughly cleaned prior to placing concrete.

.2 Do not apply form release agent where concrete surfaces are to receive special finishes or applied coverings which are affected by the agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces moist prior to placing the concrete.

3.11 Form Removal

.1 Remove falsework and formwork in accordance with CSA-A23.1.

.2 Notify Consultant prior to removing formwork.
CONCRETE FORMWORK AND FALSEWORK

.3 Falsework shall be left in place until the concrete has attained sufficient strength to support its own weight adequately together with construction loads likely to be imposed.

.4 The following Table is to be used as a guide for the removal of forms and supports:

<table>
<thead>
<tr>
<th>Minimum Period of Time</th>
<th>Minimum Concrete Strength (based on 28 Day Strength)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beams and slabs</td>
<td>14 days</td>
</tr>
<tr>
<td>Columns</td>
<td>3 days</td>
</tr>
<tr>
<td>Walls and critical vertical faces</td>
<td>2 days</td>
</tr>
<tr>
<td>Footings</td>
<td>1 day</td>
</tr>
</tbody>
</table>

.5 Remove falsework progressively in accordance with regulatory requirements and ensure that no shock loads or imbalanced loads are imposed on the structure.

.6 In Winter Concreting: the forms for walls and suspended slabs shall remain in place for a minimum for seven days after placing concrete. The concrete must be wetted down immediately and be covered tightly with a 10 mil polyethylene sheet or suitable new tarpaulin. If the temperature differential between the concrete and ambient air is greater than 10°C, the forms shall be in place until the temperature differential is less than 10°C.

.7 Loosen forms carefully. Do not apply tools to exposed concrete surfaces.

.8 Leave forms loosely in place for protection until complete removal is approved by the Consultant.

.9 Store removed forms for exposed architectural concrete in a manner that surfaces to be in contact with fresh concrete will not be damaged. Marked or scored forms will be rejected.

.10 Removal of forms subject to approved on-going curing procedures.

3.12 Reshoring

.1 Prepare a schedule of reshoring and submit to the Consultant for review.

.2 Reshore structural members where required due to design requirements or construction conditions, or where subject to additional loads during construction.

.3 Install reshoring as required to permit progressive construction.

END OF SECTION
1. **GENERAL**

1.1 **References**

.1 American Concrete Institute (ACI)

.2 American National Standards Institute/American Concrete Institute (ANSI/ACI)
   .1 ANSI/ACI 315, Details and Detailing of Concrete Reinforcement.

.3 American Society for Testing and Materials (ASTM)
   .1 ASTM A775/A775M, Specification for Epoxy-coated Reinforcing Steel Bars.
   .2 ASTM A1044/A1044M, Specification for Steel Stud Assemblies for Shear Reinforcement of Concrete.

.4 Canadian Standards Association (CSA)
   .1 CAN/CSA A23.1, Concrete Materials and Methods of Concrete Construction.
   .2 CSA A23.2, Methods of Test for Concrete
   .3 CAN3 A23.3, Design of Concrete Structures for Buildings
   .4 CSA G30.3, Cold Drawn Steel Wire for Concrete Reinforcement
   .5 CSA G30.5, Welded Steel Wire Fabric for Concrete Reinforcement
   .6 CSA G30.15M, Welded Deformed Steel Wire for Concrete Reinforcement
   .7 CAN/CSA G30.18, Billet Steel Bars for Concrete Reinforcement
   .8 CSA W47.1-97, Certification of Companies for Fusion Welding of Steel Structures
   .9 CAN/CSA G40.21, Structural Quality Steels
   .10 CSA W186, Welding of Reinforcing Bars in Reinforced Concrete Construction

1.2 **Submittals For Review**

.1 Submit bar bending schedules and shop drawings including placing of reinforcement in accordance with Section 01330.
CONCRETE REINFORCEMENT

.2 Inform the Owner’s Representative of proposed source(s) of products to be supplied.

.3 A certified copy of each null test report shall be submitted for all steel supplied, showing the designated physical representation and chemical analyses and yield strengths upon request.

.4 All reinforcement shall be of the grade specified on the drawings. Reinforcement without rolled-in grade identification shall be otherwise identified to the satisfaction of the Designated Representative.

.5 The yield strength shall correspond to that determined by tests on full size bars unless an alternative test method is shown to correlate with tests on full size bars.

.6 All bars for concrete reinforcement shall be deformed bars, except that plain bars may be used for spiral or helical ties. Plain bars no larger than 10 mm in diameter may be used for stirrups or ties.

.7 Indicate on shop drawings, bar bending details, lists, quantities, or reinforcement, sizes and spacing, with identifying code marks to permit correct placement without reference to structural drawings. Indicate sizes, spacings, and locations of chairs, spacers, and hangers. Prepare reinforcement drawings in accordance with Reinforcing Steel Manual of Standard Practice by Reinforcing Steel Institute of Canada.

.8 Detail lap lengths and bar development lengths to CSA-A23.3. Provide tension lap splices where indicated. Splices to be as shown on Drawings, or minimum CSA A23.3, Class B.

.9 Use large scale details for area of congested reinforcement.

.10 Support and placing details of reinforcing to ACI 350 and RISC.

.11 Review of the shop drawings by the Engineer is intended to assist the Contractor and does not relieve the Contractor of responsibility for the completeness and accuracy of the Work and its conformance with the contract drawings and specifications.

.12 Fabrication that commences prior to shop drawing review by the Engineer is at risk of the Contractor.

1.3 Work Included

.1 Reinforcing steel bars, welded steel wire fabric or fabricated steel bar for cast-in-place concrete, complete with tie wire and epoxy coating where shown on the drawings.
.2 Support chairs, bolsters, bar supports and spacers for reinforcing.

1.4 Related Work

.1 Cast-in-place Concrete: Section 03300

1.5 Quality Assurance


.2 Submit two certified copies of mill test report of reinforcement supplied, indicating physical and chemical analysis.

.3 Submit samples and specifications of accessory materials prior to use.

1.6 Shop Drawings

.1 Concrete reinforcement will be inspected “in place”. Shop drawings for concrete reinforcement are not to be submitted to the Engineer for review.

1.7 Delivery and Storage

.1 Deliver, handle and store reinforcement in a manner to prevent damage and contamination.

.2 Deliver bars in bundles, clearly identified in relation to bar lists.

2. PRODUCTS

2.1 Materials

.1 Substitute different size bars only if permitted in writing by Engineer.

.2 Reinforcing steel: billet steel, grade 400W, deformed bars to CAN/CSA G30.18, unless indicated otherwise.

.3 Cold drawn annealed steel wire ties: to CSA G30.3.

.4 Welded steel wire fabric: to CSA G30.5. Provide in flat sheets only.

.5 Chairs, bolsters, bar supports, spacers: to CAN/CSA A23.1.

.6 Do not use materials with loose, scaly rust, dirt, oil, paint, or other bond-breaking coatings.
2.2 Fabrication

.1 Fabricate reinforcing steel in accordance with CAN/CSA A23.1, and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada.

.2 Obtain Engineer’s approval for locations of reinforcement splices other than those shown on placing drawings.

.3 Upon approval of the Designated Representative, weld reinforcement in accordance with CSA W186. Do not weld reinforcement at the bend in a bar.

.4 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.

.5 Store reinforcing steel above ground on platforms, skids, or racks and protect from prolonged exposure to weather.

2.3 Source Quality Control

.1 Upon request and in accordance with Section 01330, provide Engineer with certified copy of mill test report of reinforcing steel, showing physical and chemical analysis, minimum two (2) weeks prior to commencing reinforcing work.

.2 Upon request inform Engineer of proposed source of material to be supplied.

2.4 Accessory Materials

.1 Tie Wire: minimum 1.6 mm diameter annealed type, plastic coated for epoxy-coated reinforcement.

.2 Chairs, Bolsters, Bar Supports, Spacers: adequately sized for strength and support of reinforcing steel during construction and meeting cover requirements.

.3 Concrete Bricks: acceptable for support of bottom layer of bars in slabs on grade. Broken concrete blocks and wood supports are NOT acceptable.

.4 Dowel Bar Splicer: shall develop at least 150 percent of the specified yield strength of the bars, conforming to CSA A23.3M, ACI 318, ACI 349, complete with temporary cap, sizes as shown on drawings, as manufactured by Richmond Screw Anchor Co. or approved equal. Splicers which require threads to be cut into the bar are not allowed.

3. EXECUTION

3.1 Examination

.1 Before starting this work, examine work done by others which affects this work.
.2 Review any conditions which would prejudice proper completion of this work.

.3 Commencement of work implies acceptance of existing conditions.

3.2 Fabrication

.1 Fabricate reinforcing steel in accordance with CAN / CSA-A23.1 latest edition and Drawings.

.2 Locate reinforcing splices not indicated on drawings at points of minimum stress. Lap splices are calculated in accordance with A23.3 summarized in the table on contracts drawings.

.3 Fabricate within the following tolerances:
   .1 Sheared length: ±25 mm.
   .2 Depth of truss bars: plus 0, minus 10mm.
   .3 Stirrups, ties and spirals: ±10mm.
   .4 Other bends: ±25mm.

.4 Welding of reinforcing bar is not permitted.

.5 All bending shall be done cold with a suitable machine accurately producing all lengths, depths and radii shown on the bending details.

.6 After initial fabrication, reinforcing steel shall not be re-bent or straightened unless so indicated on the drawings.

.7 Heating of reinforcing steel will not be permitted.

3.3 Placing Reinforcement

.1 Place reinforcing steel in accordance with reviewed placing drawings and CAN / CSA-A23.1. Chair slab reinforcing not further apart than 1.2 m in either direction.

.2 Adequately support reinforcing, and secure against displacement within tolerances permitted.

.3 Unless noted otherwise on the drawings, place reinforcing steel to provide concrete cover, as follows:
   .1 Surfaces in cast against earth: 75 mm
   .2 Principal Reinforcing: 50 mm
.3 Ties and Stirrups: 40mm

.4 Maintain alignment within the tolerances noted in CAN / CSA-A23.1.

.5 Do not disturb or damage vapour barrier while placing reinforcing steel.

.6 Prior to placing concrete, obtain Engineer’s approval of reinforcing material and placement.

.7 Engineer to be informed minimum forty-eight (48) hours prior to concrete placing.

.8 Protect projecting dowels from damage and cold bending.

3.4 Splicing

.1 Splices shall be done only as permitted by the Engineer. Splice reinforcement at locations shown on the drawings. Do not splice reinforcement at other locations except with approval of the Engineer.

.2 Welded splices will not be permitted.

3.5 Cleaning

.1 Ensure concrete reinforcing is clean and free from oil and deleterious matter.

.2 Remove all loose scale, loose rust and other deleterious matter from surfaces of reinforcing.

END OF SECTION
CONCRETE ACCESSORIES

1. GENERAL

1.1 Work Included

.1 Premoulded joint fillers.
.2 Waterstops.
.3 Inserts.
.4 Joint sealants.
.5 Vapour barrier under floor slabs on fill.
.6 Sealing compounds.

1.2 Reference Standards

.1 Conform to the following reference standards:
   .1 CGSB 41-GP-35M, Polyvinyl Chloride Waterstop
   .2 ASTM D1752, Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

1.3 Related Work

.1 Concrete Formwork: Section 03100
.2 Cast-in-place Concrete: Section 03300

1.4 Submittals For Information Only

.1 Submit the following information in accordance with Section 01330:
   .1 Waterstops
   .2 Inserts
   .3 Sealants
   .4 Epoxy Bonding Agent
2. PRODUCTS

2.1 Materials

.1 Bearing pads and gaskets: commercial grade neoprene, Durometer 60 with thicknesses and areas specified on drawings.

.2 Waterstops: to CGSB 41 GP 35M as shown on standard drawings. Acceptable products: Sternson Durajoint Type 300; Greenstreak 701.

.3 Expanding waterstops: Water-swelling rubber elastic type sealant. Acceptable products; Adeka Ultrasel P201, Volclay waterstop RX by American Colloid Company.

.4 Resilient joint filler: to ASTM D1752 Type I, (sponge rubber) size and thickness shown.

.5 Backer rod: closed vinyl with 90% recovery after 50% compression. Size and thickness shown.

.6 Inserts: malleable iron, galvanized steel or stainless steel to AISI Type 304 or Type 316. Type, Sizes and number as shown.

.7 Anchor bolts: refer to Section 05501.

.8 Epoxy bonding agent: a two component epoxy resin. Acceptable product: Sikadur 32 Hi-Mod by Sika Products; Bonding Agent ST433 by Sternson; Concressive Standard Paste by Master Builders; Duralbond by Tamms.

.9 Grout for dowels: a component epoxy resin. Acceptable product (overhead or horizontal): Sikadur 31 Hi-Mod Gel; Duralcrete Gel by Tamms – (vertical) Sikadur 31 or 35; Bonding Agent ST433 by Sternson; Concressive Standard Paste by Master Builders; Duralcrete LV by Tamms.

.10 Stair nosing: Aluminium with integrally cast abrasive for slip resistance and concealed integral anchors. Acceptable product: Alumogrit Safety Tread Type 101 by Wooster Products Inc.; Surefoo Style No. 1004 by Globe Foundry Ltd.

.11 Polymer modified patching material: A two component cementitious mortar for horizontal and vertical concrete repair. Acceptable product: Masterpatch by Master Builders; Sikatop by Sika.

2.2 Premoulded Joint Fillers

.1 Asphalt-impregnated vegetable or cane fibreboard, conforming to ASTM D1751, sizes indicated on drawings, W. R. Meadows Sealtight Fibre Expansion Joint, Sternson Flexcell.
2.3 Backer Rod for Joint Sealant

.1 Backer Rod: closed cell vinyl foam.

2.4 Waterstops

.1 PVC Waterstops: conform to CSGB 41-6P-35M polyvinylchloride hollow tube at mid-width, sizes indicated on drawings. Waterstop intersections, such as tees, crosses, and L’s shall be factory made fabrications. Product and manufacturer identification to be printed at minimum 3 m intervals.

.2 Minimize number of site-welded joints. Premanufacture joints for right angled intersections. Joints to be fully watertight, permanently flexible, and retain not less than 50% of the mechanical strength of the parent section.

.3 Handle waterstops carefully and place in correct locations.

.4 Internal waterstops are required in all joints of watertight concrete.

.5 Install expanding waterstops in accordance with manufacturer’s instructions.

.6 Provide adequate temporary support to waterstops to prevent misalignment during placement. Do not puncture with nails.

.7 Retrofit waterstop and tear web waterstop.

.8 PVC Waterstop Physical Properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>TEST *ASTM</th>
<th>NOMINAL VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water absorption</td>
<td>*D570</td>
<td>0.043</td>
</tr>
<tr>
<td>Tear resistance</td>
<td>*D624</td>
<td>395 lb./in.</td>
</tr>
<tr>
<td>Ultimate elongation</td>
<td>*D638</td>
<td>365%</td>
</tr>
<tr>
<td>Min tensile strength</td>
<td>*D638</td>
<td>16 MPa</td>
</tr>
<tr>
<td>Low temperature brittleness</td>
<td>*D746</td>
<td>Passed @ -37°C</td>
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<tr>
<td>Stiffness in flexure</td>
<td>*D747</td>
<td>5 MPa</td>
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<tr>
<td>Specific gravity</td>
<td>*D792</td>
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<tr>
<td>Ozone resistance</td>
<td>*D1149</td>
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<tr>
<td>Volatile loss</td>
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<td>Hardness Shore A15</td>
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<td>Accelerated extraction</td>
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<tr>
<td>* Tensile strength</td>
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<td>370%</td>
</tr>
<tr>
<td>* Elongation</td>
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<td></td>
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<tr>
<td>Effect of Alkali</td>
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<tr>
<td>* Weight change</td>
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<tr>
<td>* Hardness change</td>
<td></td>
<td>-1 point</td>
</tr>
</tbody>
</table>
2.5 Inserts

.1 Dovetail Anchor Slots: minimum 0.8 mm thick galvanized steel, conforming to CSA A37OM; foam filled; release tape sealed slots; stiffening lips minimum 3mm wide, neck 13 mm, depth 25 mm; securable to formwork, manufactured by Superior Concrete Accessories Ltd.; Drew Brown Ltd.; Burke Industries.

.2 Flashing Reglets: 0.032 mm extruded aluminum, longest possible lengths; complete with alignment splines for joints; securable to formwork; Superior or Fry Reglet.

.3 Structural Inserts: stainless steel inserts for bolts, sizes and locations as indicated on the drawings. All inserts to be Hilti products unless otherwise noted.

2.6 Sealants


.2 Interior Saw Cut Joint or Control Joint Sealant: Sternson Loadflex, Sealtight Bondflex, Concrete Chemicals 903B Flexible Sealant, Allied Coatings AC-1210 Flexible Epoxy Sealant, Sikaflex 1A.

.3 Exterior Saw Cut Joint or Control Joint Sealant: self levelling polyurethane, Sternson Uraflex 2, PRC 270, Sikaflex 1A.

.4 Water retaining structure exterior and interior faces: Sikaflex 2C/NS for vertical joints and Sikaflex 2C/SL for horizontal joints. As recommended by the waterproofing admixture manufacture’s written instructions.

.5 Primers: as supplied by sealant manufacturers.

2.7 Vapour Barrier

.1 Vapour Barrier: 0.15 mm clear polyethylene film, unreinforced, with self-adhesive polyethylene tape for joints, suitable for use below grade.

2.8 Sealing Compounds

.1 Colourless silane sealer and chloride ion protective coating; Sikagard 71 or equal.

2.9 Epoxy Bonding Agent

.1 Sikadur 32 Hi-Mod.
3. **EXECUTION**

3.1 **Examination**

.1 Before starting this work, examine work done by others which affects this work.

.2 Review any conditions which would prejudice proper completion of this work.

.3 Commencement of work implies acceptance of existing conditions.

3.2 **Installation**

.1 Coordinate work of this Section with other construction.

.2 Install all concrete accessories in accordance with drawings and manufacturer's recommendations; straight, level, and plumb.

.3 Install vapour barrier under interior floor slabs on grade. Lap joints 150 mm (minimum) and tape full length of joints.

.4 Construction joints shall be placed in accordance with drawings.

.5 Ensure embedded items are not disturbed during concrete placement.

.6 Install waterstops continuous without displacing reinforcement. All PVC waterstop mitred tees, crosses, and L’s shall be shop welded by manufacturer. Butt splices can be welded on site but should be strictly in accordance with manufacturer’s recommendations. Secure in place to prevent dislodgement during placing of concrete. Splices in Volclay or Ultraseal waterstops shall be installed as per manufacturers’ recommendations.

.7 When installing sealants, clean contact surfaces free from dirt, water, oil, rust, frost, and any other loose foreign matter. When recommended by manufacturer, prime contact surfaces of concrete.

.8 Install protective boards over joint covers when potentially damaging construction activities are not complete. Protect wall joint sealants from bituminous dampproofing with a fibreboard protection board, minimum 300 mm wide.

3.3 **Sealing Saw Cut Joints and Expansion Joints**

.1 Saw cutting of control and construction joints in slabs on grade as per Section 03300 – Cast-in-Place Concrete.

.2 Not less than 7 days after concrete placement, blow out joints with compressed air.

.3 Remove all loose particles, dust, laitance and curing compounds from joints.
.4 Install PVC, polyurethane or polyethylene foam rope joint filler, same distance below concrete surface as joint width.

.5 If joint surfaces are damp, dry and apply primer as recommended by manufacturer.

.6 Install sealant in joints in accordance with manufacturer's directions.

3.4 Sealing Compounds

.1 After concrete has been allowed to dry, apply sealer to specified locations. Concrete shall be at least 28 days old.

.2 Apply at least two (2) coats of the sealer. Apply sealer until a residual film of epoxy resin starts to form on the surface (approximately 4m² per litre). Confirm proper amounts of sealer required by testing over a 2m by 2m area.

.3 Apply all coats within 1½ hours of preceding application.

END OF SECTION
1. GENERAL

1.1 References

This Section incorporates by reference the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of a listed document, the requirements of this Section prevail.

BCBC 2012 - British Columbia Building Code.


ACI 350 - Code requirements for Environmental Engineering Concrete Structures.

CSA A23.1 - Concrete Materials and Methods of Concrete Construction.

CSA A23.2 - Methods of Test for Concrete.

CSA A23.3 - Design of Concrete Structures for Buildings.

CSA-A23.5 – Supplementary Cementing Materials.

CSA-A3001 – Cementitious Materials for Use in Concrete.

CAN/CSA A5 - Portland Cement.


CAN/CSA G30.18 - Billet Steel Bars for Concrete Reinforcement.

CAN/CSA S269.3 – Concrete Formwork.

CAN/CSA G164 - Hot Dip Galvanizing of Irregularly-Shaped Articles.

ASTM C260 - Specification for Air Entaining Admixtures for Concrete.

CAN 3-A266.1 – Air Entaining Admixtures for Concrete.

ASTM C494 - Specification for Chemical Admixtures for Concrete.

ASTM C1017 – Standard Specification for Chemical Admixtures or Use in Producing Flowing Concrete.

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ASTM C1751 – Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).

American Concrete Institute (ACI) where noted.

American Society for Testing and Materials (ASTM) where noted.

Concrete Reinforcing Steel Institute (CRSI) where noted.

Reinforcing Steel Institute of Canada (RISC) - Manual of Standard Practice, Metric Supplement where noted.

Provincial safety standards where applicable.

Conform to applicable safety regulations for erection, maintenance, and removal of formwork.

1.2 Submittals For Review

.1 Submit the following documents in accordance with Section 01330.

.2 Four weeks prior to commencing concrete work, the manufacturer’s test data and certification by a qualified independent inspection and testing laboratory for the following materials shall be submitted for the Designated Representative and Engineer’s approval:

.1 Portland Cement
.2 Admixtures
.3 Aggregates
.4 Water
.5 Supplementary Cementing Materials
.6 Curing Compounds
.7 Binding Agents

.3 Submit shrinkage test results for liquid retaining structures.

.4 Submit data sheets for all proposed pre-mixed grouts to the Engineer for review.

.5 Submit samples of fine and coarse aggregate and all admixtures proposed for concrete mixes to the testing firm’s laboratory if requested by the Engineer.

.6 Submit data on all concrete accessories specified or proposed.
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.7 Submit data sheets for mass concrete.

.8 Admixtures – when use of admixtures in mass concrete is desired, submit data on proposed admixtures.

.9 Cementitious Materials – submit brand names, manufacturer’s certifications, and test data on heat of hydration.

.10 Submit complete shop drawings for material, fabrication, and construction sequence/procedures for all hinge and slide joints shown on the design drawings. Submittal details shall depict all facets of the hinge and slide joints, including concrete dimensions, reinforcing, waterstops, neoprene, sealant, waterproofing membrane and adhesive, prefabricated waterstop and waterproofing membrane corner and tee-intersections, steel plates and anchors, and void form blockouts. Include data showing that void form blockout material can withstand concrete pressures associated with the planned height of the pour. Submittal shall be a complete submittal containing all facets of the hinge and slide joints because it is critical that all parts of the joint construction be coordinated properly for acceptable behavior of the joints. Piecemeal submittals will be rejected.

.11 Submit proposed methods of protection of concrete when air temperatures are expected to be above 25°C or below 5°C.

.12 Submit responses to all site review reports stating that all reported defects and deficiency items were corrected or stating what action was taken.

1.3 Work Included

.1 All plain and reinforced cast-in-place concrete shown on drawings.

.2 Setting anchors, inserts, frames, sleeves, and other items supplied by other Sections.

.3 Repairing concrete imperfections.

.4 Finishing formed concrete surfaces.

1.4 Related Work

.1 Concrete Formwork and Falsework - Section 03100

.2 Concrete Reinforcement - Section 03200

.3 Concrete Accessories - Section 03250

.4 Disinfection of Structures and Piping - Section 15950
1.5 Quality Assurance

.1 All concrete inspection and testing shall be carried out by an inspection and testing organization retained by the contractor. All test results shall be submitted to the Designated Representative for approval.

.2 Provide access for sampling of aggregates, Portland Cement, and each type of supplementary cementing material.

.3 Failure to comply with the requirements of this Section will result in the structure being considered potentially deficient.

.4 Strength evaluation tests and analysis:

.1 The Engineer may order an independent testing firm to obtain cores, x rays, or similar non destructive tests where evidence points to a potentially deficient structure.

.2 The Engineer may order a load test and/or analysis, as defined by CSA A23.3, if the non destructive tests are impractical or inconclusive.

.5 Pay all costs for the evaluation tests and additional engineering analysis required:

.1 To demonstrate the adequacy of a structure that does not meet the requirements of these specifications or the drawings.

.2 For a structure that has been placed before formwork and reinforcing have been made available for review and accepted by the Engineer.

.6 Reinforce by additional construction or replace as directed by the Engineer at Contractor’s expense concrete that is judged inadequate by structural analysis or by results of load tests.

.7 Revise mix design proportions as required for the remainder of the Work.

.8 Cast-in-place concrete to conform to CAN / CSA-A23.1 latest Edition and ACI 350 M-01.

.9 Testing shall conform to CAN/CSA-A23.2.

1.6 Inspection and Testing

.1 Inspect complete formwork and concrete reinforcement prior to closing of forms or pouring concrete. Record inspections on Concrete Pour Release Form.

.2 Allow ample time for inspection and corrective work, if required, before scheduling concrete placement.

.3 Provide free access to all portions of work.
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.4 Submit proposed mix design of each class of concrete for review at least 2 weeks prior to commencement of work.

.5 Tests of cement and aggregates may be performed to ensure conformance with requirements stated herein.

.6 Concrete sampling, inspection, and testing is to be performed by an independent inspection and testing firm appointed and paid by the Contractor.

.7 Three concrete test cylinders will be taken for every 50 m$^3$ or less of each class of concrete placed.

.8 At least three test cylinders will be taken daily for each class of concrete placed. Atmospheric and concrete temperatures shall be recorded.

.9 One additional test cylinder will be taken during cold weather concreting, and be cured on job site under same conditions as concrete it represents.

.10 One slump test and one air content test will be taken for each set of test cylinders taken. These tests shall be performed before the concrete from which the sample was taken is allowed to be incorporated into the work.

.11 Verify quality of concrete with additional slump tests as required.

.12 Test concrete in accordance with CAN/CSA-A23.2 latest edition. Test results will be issued to the Contractor, the Supplier, the Consultant, and the Owner.

.13 Pay costs for required retesting due to results indicating defective materials or workmanship regardless of the results of the restarting.

1.7 Delivery, Storage, and Handling

.1 Procedure: Section 01650

.2 Deliver all materials to the site in bundles easily identified and properly marked.

.3 Store and handle all materials on site in a manner to prevent damage and contamination.

.4 Do not straighten or re-bend any reinforcement.

.5 Do not use any reinforcement that has been kinked or bent on site.

2. PRODUCTS

2.1 Cementing Materials

.1 Portland cement: to CAN/CSA A5, Type GU and MS - The cement is not to contain a total sodium oxide equivalent in excess of 0.6% by mass and the tricalcium aluminate content is to be between 6% and 10%.
2.2 Supplementary Cementing Material

.1 Fly ash is to be a Type F pozzolan and is to meet the requirements identified in CAN/CSA-A3001 with the following additional requirements:
  .1 Minimum SiO₂ and A₁₂O₃ and Fe₂O₃ content: 70%
  .2 Maximum retained on 45 NM sieve: 20%
  .3 Maximum loss of ignition: 4%
  .4 Maximum Na₂O equivalent: 3%
  .5 Maximum CaO content: 8%

.2 Ground Granulated Blast Furnace Slag (GGBFS)
  .1 GGBFS shall conform to ACI 233 and CAN CSA A3000.
  .2 Maximum GGBFS content shall be limited to 50% of the total cementitious material weight. Maximum total combined GGBFS plus fly ash shall be limited to 50% of the total cementitious weight.

2.3 Aggregates

.1 For all concrete mix types, the fine aggregate is to conform to the requirements identified in CSA A23.1 for the specified exposure class.

.2 For all concrete mix types, the coarse aggregate is to conform to the requirements identified in CSA A23.1 for the specified exposure class. The aggregate is to meet the Group 1 gradation requirements listed in Table 2 of CSA A23.1.

.3 Aggregates are not to react with alkalis in the cement to an extent that results in excessive expansion of concrete.

.4 The source of the aggregate and the method of manufacture or production, including the type of equipment used, are not to be altered for the duration of the project following the acceptance of the aggregate.

2.4 Water

.1 Water for use in concrete production and curing is to be clean and free from injurious amounts of oil, acid, alkali, soluble chlorides, organic matter, sediment, or any other deleterious substances as per CSA A23.1.
2.5 Admixtures

.1 Air-entraining admixtures are to conform to the requirements of ASTM C260 and CAN 3-A266.2. The admixture is to be of uniform consistency and quality within each container and from shipment to shipment.

.2 Water-reducing admixtures are to conform to the requirements of ASTM C494, Type A or D. The admixture is to be of uniform consistency and quality within each container and from shipment to shipment.

.3 Superplasticizers (high-range water reducers), if approved by the Engineer, are to conform to the requirements of ASTM C494, Type F.

.4 Concrete Waterproofing Admixture by Crystallization to maximum 2% of cementitious material and shall be suitable for portable water application and approved by NSF 61. Approved products: Xypex Admix C-500 or Krystal Internal Membrane K300 by Kryton.

.5 Concrete Waterproofing Admixture: Shall be a Permeability Reducing Admixture for Hydrostatic Conditions (PRAH) as indicated by ACI 212.3R and be able to seal cracks up to 0.4 mm in width. Dosage rate will be based on manufacturer's written recommendations and the actual concrete mix design. Krystal Internal Membrane (KIM) by Kryton International, Inc.

.1 Xypex Admix C-500 by Xypex Chemical Corporation

2.6 Accessories

.1 Epoxy Bonding Agent: two component epoxy resin, Sika Sikadur Hi-Mod, Concrete Chemicals 901B, Adhesive Engineering Company Concrese 1001 LPL, Allied Coatings AC 01201 Epoxy Bonding Agent.

.2 Curing Compound: for exterior slabs and walls only, conforming to ASTM C309 Type 1 - clear or translucent. All concrete in contact with soil and water shall be moist-cured in conformance with CAN / CSA-A23.1, clause 21.1.6.1(a) to (h), inclusive.

.3 Moisture Retention Film: Master Builders Confilm or approved equal, for curing of slabs-on-grade only.

.4 Epoxy adhesive: Hilti HIT RE 500, UCAN Poly-All epoxy, or Sika Sikadur Injection Gel.

2.7 Concrete Mixes

.1 The Contractor is to design all concrete mixes and is to pay for all costs associated with the development of the mix designs.
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.2 The Contractor is to supply concrete in accordance with CSA A23.1, Clause 4.1.2, Table 5, Alternative 1, except that the additional requirements of this specification are also to apply.

.3 Only such materials or blends of materials that will result in a uniform colour of exposed surfaces are to be used.

.4 Concrete mixes that will be placed by concrete pump are to be designed for pumping.

.5 In the event that slump and/or air content are outside the specified tolerance range as determined by the inspection and testing firm appointed by the Owner, the Engineer may, at his sole discretion, accept a proposal for one adjustment of the deficient condition as an alternate to rejection.

.6 The maximum placement temperature of 18°C is specified to ensure that concrete temperatures do not exceed 60°C during curing, that temperature gradients do not exceed 20°C total, and temperature rise or drop does not exceed a maximum heating and cooling rate of 2°C/hour. The maximum placement temperature may be increased to 25°C provided the above temperature requirements are met.

.7 Supply concrete in accordance with CSA A23.1 with properties as noted in the following table:

<table>
<thead>
<tr>
<th>Type Location</th>
<th>28 Day Strength (MPa)</th>
<th>Cement Type</th>
<th>Aggreg. Max (mm)</th>
<th>Slump at Point of Discharge (mm)(Range)</th>
<th>Total Air % (Range)</th>
<th>Max. Water/Cement Ratio</th>
<th>Exposure Class</th>
<th>Fly Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) A: Liquid Retaining Structures, Struct. Walls</td>
<td>35</td>
<td>GU</td>
<td>20</td>
<td>75 to 125</td>
<td>5 to 8</td>
<td>0.45</td>
<td>A2</td>
<td>Maximum 25% of total cementing material</td>
</tr>
<tr>
<td>(2) Slab (interior)</td>
<td>35</td>
<td>GU</td>
<td>20</td>
<td>75 to 125</td>
<td>&lt;3</td>
<td>0.40</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>(3) Foundation Footings &amp; Beams &amp; Columns &amp; Walls &amp; exposed walls &amp; slabs</td>
<td>35</td>
<td>GU</td>
<td>20</td>
<td>75 to 125</td>
<td>5 to 8</td>
<td>0.40</td>
<td>F2</td>
<td></td>
</tr>
</tbody>
</table>
.8 Do not change concrete mix without prior approval of the Designated Representative. Should change in material source be proposed, new mix design to be approved by Designated Representative.

.9 Uses:

.1 Type A: Liquid retaining structures and below-grade walls and slabs.
.2 Type B: Structural slabs, beams, walls and columns.
.3 Type C: Foundation – Footings & walls and Exposed walls & slabs

.10 Aggregate size specified is maximum nominal allowance. Contractor may use smaller nominal size to ease placing in the vicinity of the PVC waterstop and other congested areas approved by the Engineer. Air content may have to be increased for smaller aggregate to meet exposure class requirements.

.11 Minimum cement content:

.1 335 kg/m$^3$ (total cementitious material) for Type A to E.

.12 Fly ash content as a percentage of the total cementitious material

.1 Concrete with exposure classes C1 and C2: fly ash is not allowed.
.2 Concrete with exposure classes A2, F1, F2, and N: Minimum 15% fly ash, maximum 25% fly ash.

.13 Slump: No slumps outside the range of maximum or minimum will be permitted without written permission of the Engineer. Slump is to be measured before addition of superplasticizer.

.14 Air Content: All mix types with exposure classifications to be air-entrained in accordance with the above table and CSA A23.1. Except floors to be steel troweled finish.

.15 Use a water-reducing agent in Type A concrete mix.

.16 Use accelerating admixtures in cold weather only when approved by the Engineer. If approved, the use of admixtures will not relax cold weather placement requirements.

.17 Do not use calcium chloride or admixtures containing calcium chloride.

.18 Use set-retarding admixtures during hot weather with written approval of the Engineer.

.19 Shrinkage:
Liquid retaining structures are intended to be watertight. For concrete mixes at liquid retaining structures, the Contractor shall provide test results for the concrete mix meeting the following requirement: drying shrinkage limit of 0.032 percent in the laboratory at 35 days (7 days moist cure and 28 days drying) as tested by ASTM C157 with the following modifications.

Wet cure specimens for a period of 7 days (including the period of time the specimens are in the mold). Wet cure may be achieved either through storage in a moist cabinet or room in accordance with ASTM C 511, or through storage in lime saturated water.

Slump of concrete for testing shall match job requirements and need not be limited to restrictions as stated in ASTM C 157 section 8.4.

Report results in accordance with ASTM C 157 at 0, 7, 14, & 28 days of drying.

Concrete shall not be placed in the field prior to acceptance of the concrete mix. It is recommended that a shrinkage reducing admixture (see Part 2 paragraph above for Shrinkage Reducing Admixture products) be considered for use in concrete for liquid retaining structures to meet the drying shrinkage limit.

Use all admixtures in strict accordance with the manufacturer's recommendations.

Do not use non-specified admixtures unless approved in writing by the Engineer. Where superplasticizers are thus approved, ensure mix designs are correctly adjusted for placement, strength, durability, and air content requirements.

### 2.8 Storage and Handling of Materials

Cement to be stored in a suitable weather-tight building that will protect these materials from dampness. Cement to be free from lumps at all times during use in the Work. Cement stored for a length of time resulting in the hardening or formation of lumps is not to be used in the Work.

All aggregates are to be handled so as to prevent segregation and to obtain uniformity of materials. The separated aggregates and the aggregates secured from different sources are to be piled in separate stockpiles. The site of the stockpiles is to be cleaned of all foreign materials and is to be reasonably level and firm. If the aggregates are placed directly on the ground, material is not to be removed from the stockpile within 150 mm of the ground level. This material is to remain undisturbed to avoid contaminating the aggregate with the ground material.
2.9 Epoxy for Crack Injection

.1 Epoxy for crack injection shall be a two component, moisture insensitive, high modulus, injection grade, 100 percent solids, blend of epoxy-resin compounds. The consistency shall be as required to achieve complete penetration in hairline cracks and larger. Material shall conform to ASTM C881 Type 1 Grade 1. Acceptable products include Sika Corporation “Sikadur 2”; Adhesives Technology Corporation “Crackbond SLV302”; or approved alternate. Epoxy grout shall be used for structural non-movement cracks in liquid-containing concrete. The Engineer shall determine whether a crack is classified as structural movement or non-movement.

2.10 Chemical Grout for Crack Injection

.1 Chemical (Glycolmethacrylate) grout shall be used at the Engineer's discretion for sealing structural movement cracks in structures intended to be watertight. Acceptable products include Tricosal Inject 215 Duroseal Acrylate Resin, or approved alternate by the Engineer.

2.11 Grout Mixes

.1 Conform to specification Section 03600 – Grout

2.12 Placing

.1 Placing temperatures — Unless otherwise permitted or specified, the temperature of concrete when deposited at the point of placement shall not exceed 25°C, or be less than 2°C. Use the following for maximum limits based on thickness of sections.

.1 Less than 300mm, 32°C
.2 Greater or equal to 300mm, but less than 1,000mm, 30°C
.3 Greater or equal to 1,000mm, but less than 2,000mm, 25°C
.4 High performance concrete limit is 25°C

.2 Slump — Slump of the concrete when placed shall meet the tolerances of CAN/CSA A23.1.

.3 Consolidation — Place concrete in layers not more than 600 mm thick. Extend vibrator heads into the previously placed layer of plastic concrete.

.4 Curing and protection

.1 Preservation of moisture — Cure mass concrete for the minimum curing period specified in CAN/CSA A23.1.
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.1 When a specific curing method is not specified in Contract Documents, preserve the moisture either by maintaining the forms in place or, for surfaces not in contact with forms, by applying one of the procedures specified.

.5 Cold weather concrete placement — Protect the concrete from freezing and moisture loss for the required curing period in accordance with CAN/CSA A23.1. Do not use steam or other curing methods that will add heat to the concrete.

.6 Hot weather concrete placement — Keep forms and exposed concrete continuously wet during the curing period whenever the surrounding air temperature is above 32°C.

.7 Control of concrete surface temperature — Unless otherwise specified, cool the concrete gradually so that the drop in concrete surface temperature during and at the conclusion of the specified curing period does not exceed 11°C in any 24-hour period.

.8 Control of internal concrete temperature — Internal concrete temperature during the curing period shall not exceed 71°C. When the adiabatic temperature rise indicates that the expected internal temperature will exceed 71°C and when required, provide thermal instrumentation. Take temperature readings at the center of the placement and within 100 mm of each plane surface.

3. EXECUTION

3.1 Field Quality Control

.1 Procedures: Sections 01450

.2 Inspection and Testing of Concrete

.1 Test all concrete by a testing firm certified in accordance with CSA A283, retained and paid for by the Contractor and approved by the Engineer in accordance with Section 01450.

.2 Provide casual labour to the testing firm’s field personnel for the purpose of obtaining and handling sample materials. Provide free access to all portions of the Work, and cooperate with the testing firm.

.3 Advise testing firm 48 hours in advance of concrete placement.

.4 The Contractor is to provide properly designed temperature-controlled storage boxes for test cylinders, as specified in CSA A23.2, for a period of at least 24 hours and further protection from adverse weather and mishandling until removed from the site. The Contractor is to provide a max/min thermometer for each storage box. Storage in a portable building that will be used by the Contractor’s personnel or the Engineer during the first 24 hour
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storage period will not be permitted. Storage facilities are to be provided, installed, checked, and approved before any concrete may be placed.

.5 Secure sufficient 3- and 7-day test cylinders for testing of concrete to ensure quality control and sufficient strength for application of construction loads and stripping. Cost for these additional tests to be borne by the Contractor. 3-day test is required only if contractor requests to have early form stripping or to place heavy construction loads on top of the structure.

.6 Testing firm to conduct all tests in accordance with CSA A23.2.

.7 Samples of concrete to be taken as close to the point of final deposit in the form as possible, at end of pipe when pumping is used.

.8 Testing firm to take a minimum of five test cylinders for a strength test and not less than one strength test for each 40 m$^3$, of concrete, or portion thereof, for each type of concrete placed and not less than one test for each type of concrete placed in any one day.

.9 Testing firm to moist cure and test one cylinder at 7 days and to moist cure and test the remaining two cylinders at 28 days. The remaining two cylinders shall be tested at 56 days if strength is low at 28 days.

.10 Testing firm is to take one additional test cylinder during cold weather concreting and cure on job site under same conditions as the concrete it represents.

.11 Testing firm is to take at least one slump test and one entrained air test for each set of test cylinders taken.

.12 Testing firm is to report results of tests immediately to the Contractor. The Contractor is responsible for ensuring that the concrete meets the requirements of the specifications. Report adverse test results to the Engineer immediately.

.13 Testing firm is not authorized to revoke, relax, enlarge, or release any requirements of the specification, nor to approve or disapprove any portion of the Work.

.14 Testing firm is to advise placing crews to halt placing of adverse concrete immediately, and thereafter notify Contractor to reject the concrete. The execution, or lack of execution, of this request is to be recorded.

.15 Testing firm is to submit to the Engineer and Contractor certified copies of test results. Include the following information with the results:

.1 Name of project.

.2 Date of sampling.
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.3 Mix design, specified strength, slump, and air content.
.4 Name of supplier, truck, and ticket number.
.5 Time batched and time placed.
.6 Identification of sampling and testing technician.
.7 Cement type and admixtures used.
.8 Exact location in the structure of the concrete sampled.
.9 Ambient air and concrete temperatures.
.10 Nominal aggregate size.
.11 Water added and personnel authorizing additional water.
.12 Concrete density.
.16 Testing firm to certify, in writing, that all concrete meets the specified requirements.
.17 Reject and do not place concrete with slumps greater than maximum specified, air content lower than minimum specified, and concrete over 2 hours from batch time.

3.2 General

.1 Perform cast-in-place concrete work in accordance with requirements of CSA A23.1 unless indicated otherwise on the drawings.

3.3 Inserts/Embedded Parts/Openings

.1 Provide formed openings where required for pipes, conduits, sleeves, and other work to be embedded in and passing through concrete members.
.2 Refer to mechanical, electrical, and process drawings for sleeves and openings required through structural components. These are not to reduce the structural capacity. Locations and sizes not shown on the structural drawings are to be approved in writing by the Engineer.
.3 Maximum size of electrical conduit in structural slabs is 1/5 of solid portion of the slab thickness, and where more than two are adjacent to each other, they are to be spaced 100 mm apart. Conduit is to be placed in the middle third of the slab unless otherwise specified or approved in writing by the Engineer.
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.4 Provide recesses in top of foundation walls at all doors and openings to allow slab to bear on walls.

.5 Accurately locate and set in place items that are to be cast directly in concrete.

.6 Coordinate work of other sections and cooperate with the trade involved in forming and/or setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts. Do not perform work unless specifically indicated on drawings or approved prior to installation.

.7 Do not place anchor bolts, sleeves, and inserts into freshly placed concrete. Tie firmly into place prior to placing concrete.

.8 Install all concrete accessories in accordance with drawings and manufacturer’s recommendations, straight, level, and plumb. Ensure adequate support to prevent movement during concrete placement.

.9 Install waterstops continuous without displacing reinforcement. Do not nail through waterstops. Heat seal all joints watertight.

.10 Wire all waterstops to reinforcing to prevent folding during concrete placement.

3.4 Placing Concrete

.1 Notify Engineer and testing firm a minimum of 48 hours prior to commencement of any concrete placement. Allow time for corrective work for areas of unusual formwork and congested reinforcement.

.2 Notify geotechnical Engineer to inspect and verify all soil conditions and bearing pressures of all foundations prior to placing concrete for foundations.

.3 Do not place concrete against frozen ground, frozen concrete, or frosted forms.

.4 Concrete shall be handled, deposited, and vibrated in accordance with CSA-A23.1.

.5 Place concrete in accordance with CSA A23.1, Clause 19 and as specified herein.

.6 Ensure all hardware and all other items to be cast into concrete are placed securely and will not cause undue hardship in placing concrete.

.7 Ensure reinforcement, inserts, embedded parts, formed expansion, and contraction joints and other critical items are not disturbed during concrete placement.
.8 Revise, re-seat, and correct improperly positioned reinforcing hardware and other embedded items immediately before concrete placement.

.9 Ensure specified concrete cover around reinforcing is maintained.

.10 Do not place concrete older than 2 hours from batch time.

.11 Do not add water after batching unless in strict accordance with CSA A23.1, Clause 18.4.3 and such that concrete conforms to the specified mix design parameters.

.12 Place concrete and screed in accordance with the lines and levels indicated on the drawings.

.13 Place concrete in approximate horizontal layers such that each lift can be vibrated into the previous lift.

.14 Maximum vertical free fall of concrete is not to exceed 1200 mm in unexposed work or 800 mm in exposed work. Confine concrete with a suitable vertical drop pipe to prevent segregation.

.15 Place concrete directly into its final position in forms. Do not spread concrete with vibrators.

.16 Compact concrete thoroughly by mechanical vibrators. Ensure concrete is worked around reinforcement, embedded items, and into all areas and corners of forms.

.17 Use internal vibrators in all sections that are sufficiently large, and supplement with external type in the event that satisfactory surfaces cannot be obtained.

.18 Check and re-adjust formwork to required lines and levels during placement of concrete.

.19 Place concrete as a continuous operation, stopping only at construction joints.

.20 Allow a minimum of three days for slabs and five days for walls between adjacent concrete placements.

.21 Consolidate and screed floors and slabs on grade level in accordance with CSA A23.1, Clause 22, maintaining surface flatness as required for final floor finish. Pitch to drains 20 mm per metre nominal or as indicated on the drawings.

.22 Place slabs on grade as one continuous placement between construction joints indicated on drawings or as limited in Section 03100 if not shown on drawings. For slab on grade less than 250 mm in thickness, sawcut control
joints for each placement by sawing a continuous minimum 25 mm deep slot or 1/4 of the slab thickness at maximum 4.5 m centres each way unless otherwise indicated on the drawings. Sawcut as soon as the concrete has sufficiently hardened to prevent raveling of the edges, but in no case later than 24 hours after the concrete has been placed.

.23 Use cold weather concreting methods in accordance with CSA A23.1, Clause 21 when the mean daily temperature falls below 5°C, and use hot weather methods when the mean temperature rises above 25°C.

.24 Maintain accurate records of concrete placement. Record date, location of placement, quantity, air temperature, and test samples taken.

.25 Before placing or curing concrete during adverse weather, obtain the Designated Representative’s approval of the proposed method of protection.

3.5 Finishing Flatwork

.1 Finish flatwork in accordance with timing and procedures outlined in CSA A23.1, Clause 22.

.2 Flatness and levelness to be in accordance with CSA A23.1, Table 16, Class A.

.3 Float finish: For all concrete slabs to receive insulation board, final finish surface with a power float to a true plane not exceeding a 10 mm gap under a three metre straight edge placed in any direction.

.4 Steel trowel: For all interior concrete slabs to be left exposed, final finish surface with a power trowel to a true plane not exceeding a 5 mm gap under a three metre straight edge placed in any direction.

.5 Broomed finish: For all exterior concrete slabs, final finish surface after trowelling with fine broom finish.

.6 Repair all surfaces with unacceptable finishes or excessive variation by grinding and/or filling as approved by the Engineer at Contractor’s expense.

.7 Floor hardeners: Apply in strict accordance with the manufacturer’s recommendations.

.8 Floor sealer: Apply in strict accordance with the manufacturer’s recommendations.

3.6 Construction and Contraction Joints

.1 Joints shall be located as indicated on Drawings or as approved by the Designated Representative.
.2 Where additional joints are required for construction, they shall be located and designed so that the strength and appearances of the structure are least impaired.

3.7 Curing and Protection

.1 Cure and protect concrete in accordance with CSA A23.1, Clause 21.

.2 Initial curing: Keep concrete surfaces continuously moist and cure at a minimum temperature of 10°C for three days or for the time required to obtain 35 percent of the required 28 day strength.

.3 Final curing: Immediately following initial curing and before the concrete has dried, maintain curing to ensure required strengths and durability are obtained. Moist cure the following concrete at a minimum temperature of 10°C for the times noted or for the time required to obtain 70 percent of the 28 day strength.

.1 Foundation concrete exposed to be continuously moist cured for a minimum of seven days.

.2 Exterior exposed concrete to be continuously moist cured for a minimum of seven days.

.4 Protect concrete from sudden temperature changes as noted in CSA-A23.1, Table 15.

.5 Acceptable curing methods:

.1 Ponding or continuous sprinkling.

.2 Absorptive mat or fabric kept continuously wet.

.3 Continuous steam vapour mist bath not exceeding 70°C.

.4 Curing compounds approved by the Engineer for type and rate of application.

.5 Waterproof paper or plastic film.

.6 Watertight forms left in place. Wood forms are not considered watertight unless coated or sealed to prevent moisture absorption.

.7 Other moisture-retaining method approved by the Engineer.

.6 Where curing compounds are approved, apply in two applications at right angles to each other.
CAST-IN-PLACE CONCRETE

.7 Do not use curing compounds on concrete surfaces to receive topping, hardener, protective coatings, or other type of bonded finish unless approved by the Engineer. Confirm that the coatings and curing compound are compatible.

.8 Protect freshly placed and consolidated concrete against damage or defacement from curing methods or adverse weather conditions.

.9 Exterior concrete to be protected and allowed to air dry for 30 days prior to application of de-icing chemicals.

.10 Exposed concrete walking surfaces not to receive an integral hardener: Coat with curing compound of type that provides permanent seal.

.11 Do not use water curing during freezing weather.

.12 During hot weather, begin curing process immediately after finishing. Use continuous water or absorptive mats. Cure and protect freshly placed concrete in accordance with CAN / CSA-A23.1, ACI 350M as specified.

.13 For formed concrete surfaces keep absorbent wood forms wet until they are removed. If the formwork is removed or loosened (so as to allow moisture to escape from the concrete surface) in less than 7 days, the concrete shall receive moist curing in conformance with CAN / CSA-A23.1 until 7 days have elapsed since the concrete was placed.

.14 Water/sewage holding structure slabs wet cure for a minimum of 7 days.

.15 All other concrete cure in accordance with CAN /CSA-A23.1

.16 No concreting will be allowed until all materials required for curing are on-site and ready for use.

3.8 Form Removal

.1 Comply with CSA S269.1 for dismantling all falsework.

.2 Do not remove forms, shores, and bracing until concrete has gained sufficient strength to carry its own weight, construction loads, and the design loads that are liable to be imposed upon it.

.3 Remove forms not directly supporting weight of concrete as soon as stripping operations will not damage concrete but not before a minimum of three days from final concrete placement to prevent rapid loss of moisture from concrete.
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.4 Arrange forms to allow removal without removal of principal shores where these are required to remain in place.

.5 Retain shores and forms under structural members for a minimum of 14 days or until the concrete has attained 75 percent of the required 28 day strength, whichever occurs later.

.6 Verify strength by field cylinders or insert type tests in accordance with ASTM C900 T.

.7 Remove formwork progressively and in accordance with code requirements so that no shock loads or unbalanced loads are imposed on structure.

.8 Loosen forms carefully. Do not damage concrete by wedging pry bars, hammers or tools against concrete surfaces.

.9 Re-shore structural members as required for design or construction conditions. Construction is to be re-shored to carry all future anticipated construction loading unless otherwise approved in writing by the Engineer.

3.9 Defective Concrete

.1 Immediately after removing forms, all concrete surfaces are to be inspected, and any imperfect joints, voids, stone pockets, or other defective areas as specified are to be reported to the Engineer at once and repaired before the concrete is thoroughly dry. Defective areas are to be chipped away to a depth of not less than 25 mm with the edges perpendicular to the surface. The area to be repaired and a space at least 150 mm wide entirely surrounding it is to be wetted to a saturated surface dry condition to prevent absorption of water from the repair material.

.2 The repair is to be made of the same material and of the same proportions as used for the concrete, except that the coarse aggregate is to be omitted and cement added to match the colour of the surrounding concrete. The amount of mixing water is to be as little as consistent with the requirements for handling and placing. The mortar is to be re-tempered without the addition of water by allowing it to stand for a period of one hour, during which time it is to be mixed with a trowel to prevent setting.

.3 The repair material is to be thoroughly compacted into place and screeded off to leave the repair slightly higher than the surrounding surface. It is then to be left undisturbed for a period of one to two hours to permit initial shrinkage before being finally finished. The repair is then to be finished to match the adjoining surface and cured to the requirements noted in this specification.

.4 Report any shapes and lines outside the specified tolerances and repair or correct as directed by the Engineer.
3.10 Finish Formed Surfaces

.1 Finish concrete in accordance with CSA A23.1, Clause 24. Ensure all concrete finishes are uniform.

.2 Rough-Form Finish: Concrete surfaces not exposed to view. Seal tie holes with non-shrink grout, repair defects, and remove fins exceeding 5 mm.

.3 Smooth-Form Finish: Concrete surface to be painted to view including ceilings and soffits. Smooth form finish also applies to all below grade surfaces to receive a waterproofing coating or membrane. Surfaces to be smooth, hard, and uniform texture free from raised grain, torn surfaces, worn edges, patches, dents, or other defects impairing the texture. Seal tie holes and surface cavities (bugholes) exceeding 5 mm in any dimension with non-shrink grout or where concrete is to be watertight with cementitious waterproofing, repair defects, and remove all fins.

.4 Sack-Rubbed Finish: Interior and exterior unpainted concrete exposed to view. Seal all tie holes and surface cavities (bugholes) with non-shrink grout or where concrete is to be watertight with cementitious waterproofing. Repair defects and remove all fins. Rub wetted surface with carborundum stone and mortar within six hours of removing forms to obtain a uniform colour and texture. Sack-rubbed finish shall not be provided at concrete surfaces receiving a coating.

3.11 Repair of Damaged Concrete, Cracking

.1 Acceptance of Concrete: Completed cast-in-place concrete work shall conform to the applicable requirements of ACI 301 and the Contract Documents. Concrete work that fails to meet the requirements of ACI 301 or the Contract Documents shall be repaired as approved by the Engineer to bring the concrete into compliance. Concrete that cannot be brought into compliance by approved repair methods will be rejected. Rejected concrete work shall be removed and replaced. Repair methods shall be in accordance with ACI standards, including ACI 503.7, and are subject to the approval of the Engineer. The cost of repairs and replacement of defective concrete shall be borne by the Contractor.

.2 Repair Methods: Damaged concrete or concrete with crack widths exceeding 0.10 mm at liquid-containing and conveying structures or crack widths exceeding 0.15 mm for other structures unless noted otherwise shall be repaired by one of the following methods as approved by the Engineer. Where crack widths exceed the maximum allowable widths listed above, the Engineer in their sole discretion may determine that the crack does not require repair. For liquid-containing and conveying structures, meeting the crack width criteria defined above does not relieve the Contractor from meeting the leakage criteria in Section 15950 and performing crack injection repairs as needed to meet the leakage criteria.
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.1 Repair Method 1: Fill the joint or crack by drilling holes to the affected area, install injection ports, and force epoxy or chemical grout into the joint under pressure. The material type, whether epoxy or chemical grout shall be approved by the Engineer. After injection and curing, ports, sealing mix, and surface generally shall be cleaned and worked to match the specified finish.

.2 Repair Method 2: Fill cracks with low viscosity epoxy, applied by pouring/flooding crack zone until cracks are filled. Prepare surface, install, and cure according to manufacturer's recommendations. At a minimum, prepare surface to result in a clean, dry surface and with no visible detrimental material in cracks to be filled. Conform to temperature limitations for epoxy to be used. Finish to match adjacent areas.

.3 Repair Method 3: Cut a bevel groove 10 to 12 mm width and depth, and caulk with sealant in accordance with manufacturer’s instructions. This repair method is only to be used where expressly allowed by the Engineer. Groove and caulk shall be applied on wet or hydrostatic pressure side of surface where occurs.

.3 Repair Method Use:

.1 Repair Method 1 shall be used for all cracks in walls, surfaces sloped 1:1 or greater, beams, columns, slabs, overhead surfaces, and generally for liquid retaining surfaces. Need for repair depends upon crack width, location, and surface conditions under service conditions. Epoxy grout shall be used for repair of structural non-movement cracks and chemical grout shall be used for repair of structural movement cracks at liquid-containing structures. The Engineer shall determine whether a crack is classified as structural movement or non-movement.

.2 Repair Method 2 may be utilized in lieu of Method 1 for slabs which receive a raked finish. Method 2 may also be used with Engineer’s approval for exposed troweled and broomed finishes after review of conditions, degree of exposure to public, and proposed repair product and installation. Finish shall substantially match adjacent surfaces.

.3 Repair Method 3 shall be limited to dry-surface slabs, walls subject to less than three feet of liquid pressure, or as specifically directed by the Engineer. Method 3 is not an equivalent repair method to Methods 1 or 2, which shall be considered the standards.

3.12 Grout

.1 Conform to Section 03600 – Grout.
CAST-IN-PLACE CONCRETE

3.13 Vapour Barrier

.1 Refer to drawing design notes for extent of vapour barrier.

.2 Place vapour barrier on prepared subgrade as shown on drawings. Lap each sheet minimum 150 mm, and seal with mastic cement.

.3 Fix punctures or tears with patches at least 150 mm larger, and seal with mastic cement.

3.14 Joint Sealant

.1 All exposed concrete floors on grade subjected to pedestrian and vehicular traffic: Use a two-component self-levelling polyurethane sealant to CAN/CGSB 19.24 M90, Type 1, Class B, colour grey, shore hardness 40 to 50 in strict accordance with manufacturer’s recommendations.

.2 Seal base of all form tie holes in exposed concrete surfaces using approved sealant.

3.15 External Fastening and Coring

.1 Do not core without prior written approval of the Engineer.

.2 Do not drill inserts or drive power actuated fasteners into structural concrete without prior written approval of the Engineer.

3.16 Testing of Watertightness of Concrete Structures

.1 Do not proceed with the watertightness test until the concrete structure is completed and the concrete has attained the specified strengths. Refer to Section 15950.

.2 Locate and repair all leaks at Contractor’s expense.

.3 Plug and make completely watertight all visible leaks in items requiring nil leakage at Contractor’s expense.

.4 Remedy all leaks in excess of maximum specified at Contractor’s expense. Re-test structure at Contractor’s expense after repairing until leakage is less than maximum specified.

.5 Do not apply waterproofing or place sealants until after all requirements for watertightness have been met. Test in compliance with ACI 350.1 and as specified below.

.6 On completion of construction of water retaining structures, conduct leakage tests. Test structures prior to backfilling. Test each cell and chamber independently.
.7 Fill the structure to the maximum liquid level shown on the Drawings and keep it filled for an absorption period of 3 days, by the addition of water as required. Use only potable water for testing.

.8 Repair visible leaks.

.9 If repairs require the water level to be lowered, carry out a further 3-day absorption period after the water level has been raised again to the maximum level.

.10 At the expiration of the absorption period, record the level of the water surface and record further measurements 24 hours, 48 hours, 72 hours and 96 hours thereafter. For open structures, place an evaporation tray in the open in a protected location during this period. The structures will be deemed watertight and acceptable if, after due allowance for evaporation and rainfall, the total leakage does not exceed 0.1% of the water volume per 24-hour period.

3.17 Finishing Walks, Curbs, Ramps, Steps

.1 Finish edges to smooth radius.

.2 On walks, platforms, and ramps, tool control joints across at 1.8 m o.c., unless otherwise noted in these Specifications or on the drawings.

.3 Broom finish surface of platforms, steps, walks, curbs, and ramps.

.4 Apply curing compound to manufacturer’s directions.

3.18 Cleaning

.1 Repair, remove, and clean all drips and smears resulting from the work of this section on exposed, finished surfaces, or surfaces to be subsequently finished.

3.19 Defective Concrete

.1 Concrete not meeting the requirements of the Specifications and Drawings shall be considered defective concrete.

.2 Concrete not conforming to the lines, details, or grades specified herein or as shown on the drawings shall be modified or replaced. Finished lines, dimensions, and surfaces shall be correct and true within tolerances specified herein and in Section 03100 of these Specifications.

.3 Concrete placed which results in excessive honeycombing or other defect in critical areas of stress shall be repaired or replaced.
CAST-IN-PLACE CONCRETE

.4 To conform to the strength requirements, the average of all tests shall exceed the specified strength. When five or more tests of the same class of concrete are available, the average of any five consecutive tests shall be equal to, or greater than, the specified strength, and no strength test shall fall more than 3.5 MPa below the specified strength. Implement corrective measures if tests are below specified strength:

.1 Changes in mix proportions for the remainder of the work, for which Mix Designs shall be submitted in accordance with these Specifications.

.2 Cores drilled and tested from the areas in question in accordance with CAN / CSA-A23.2-2000. The test results shall be indicative of the strength of the in-place concrete.

.3 Load testing of the structural elements. The changes in the mix proportions and the testing shall be at the Contractor’s expense.

.5 Concrete failing to meet the strength requirements of this specification shall be repaired or replaced.

3.20 Patching

.1 Inspect concrete surfaces immediately upon removal of all formwork.

.2 Patch imperfections when concrete is green.

.3 Remove all exposed metal form ties, nails, and wires, break off fins, and remove all loose concrete.

.4 Thoroughly wet all form tie pockets and patch with patching mortar followed by proper curing.

.5 Chip away honeycombed and other defective surfaces to depth of not less than 25 mm with the edges perpendicular to the surface. Thoroughly wet and patch with patching mortar followed by proper curing.

3.21 Water-tightness Test Exposed Roofs Slab

.1 Leak test concrete roof over occupied spaces exposed to rain or earthen cover:

.1 RAS Pump Station

.2 Tunnels

.2 On completion of construction of the exposed roof structure, conduct leakage tests.
.1 Keep roof structure either submerged or continuously wet using a sprinkler system for a minimum of 24 hours.

.2 Roof shall be considered to pass the leakage test if no leaks or damp patches show on the soffit.

.3 If roof fails the leakage test, the contractor shall repair leaks in the roof structure, and retest roof after remedial work has been complete.

.3 Water-tightness Test

.1 Test in compliance with ACI 350.1 and as specified below.

.2 On completion of construction of water retaining structures, conduct leakage tests. Test structures prior to backfilling. Test each cell and chamber independently.

.3 Fill the structure to the maximum liquid level shown on the Drawings and keep it filled for an absorption period of 3 days, by the addition of water as required. Use only potable water for testing.

.4 Repair visible leaks.

.5 If repairs require the water level to be lowered, carry out a further 3-day absorption period after the water level has been raised again to the maximum level.

.6 At the expiration of the absorption period, record the level of the water surface and record further measurements 24 hours, 48 hours, 72 hours and 96 hours thereafter. For open structures, place an evaporation tray in the open in a protected location during this period. The structures will be deemed watertight and acceptable if, after due allowance for evaporation and rainfall, the total leakage does not exceed 0.1% of the water volume per 24-hour period.

END OF SECTION
1. GENERAL

1.1 Scope of Work

.1 Cleaning of the reservoir.

.2 Leak testing of the reservoir.

1.2 Related Section

.1 Cast-in-Place Concrete - Section 03300

.2 Disinfection of Structures and Piping - Section 15950

2. PRODUCTS

.1 Water: Potable water for testing to be provided by the Contractor.

3. EXECUTION

3.1 Clean-Up and Inspection

.1 Remove all construction debris, forms, lumber, water, and other materials from reservoir interior.

.2 Sweep and hose down all interior concrete surfaces.

.3 The Contractor shall inspect all interior surfaces of the reservoir for cracks, honeycombing, surface disintegration, opening of joints, or other abnormalities. Any or all of such abnormalities shall be suitably repaired and sealed, prior to hydraulic testing.

3.2 Repair

.1 Repair as outlined in concrete specifications.

3.3 Testing

.1 The reservoir shall not be backfilled until the leakage test has been successfully completed.

.2 The reservoir shall be filled with clean, potable water to the maximum operating level, and maintained for two (2) days.

.3 The test will begin at this time and continue for three (3) full days.
.4 The Contractor shall measure the leakage during the 3-day period and the measured leakage, including evaporation losses and changes in volume due to temperature, shall not exceed 5 mm in water level. All measurements must be witnessed by the Engineer.

.5 If there are persistent damp areas on exterior surfaces, visible leaks, or the leakage exceeds the above limit, the Contractor shall be responsible to find the causes and repair them to the satisfaction of the Engineer and the above process shall be repeated.

.6 Water from final test may be retained for disinfection purposes.

.7 The reservoir roof slab shall be ponded with 100 mm depth of water and maintained for two (2) days.

.8 The test will begin at this time and continue for three (3) full days.

.9 If there are persistent damp areas on the underside of the roof slab or visible leaks, the Contractor shall be responsible to find the causes and repair them to the satisfaction of the Engineer and the above process shall be repeated.

.10 All liquid retaining or conveying concrete structures must meet maximum leakage criteria set forth in ACI 350.1 as follows:

<table>
<thead>
<tr>
<th>Structure Type</th>
<th>Tightness Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>.1 Tank</td>
<td>0.050% of Volume per day</td>
</tr>
<tr>
<td>.2 Channels</td>
<td>0.100% of Volume per day</td>
</tr>
</tbody>
</table>

3.4 Disinfection

.1 Disinfection of water storage reservoir only shall be done upon completion of a satisfactory test as outlined above and shall be carried out in accordance with AWWA C652, latest edition, as summarized below.

.2 Follow procedure in Section 15950 – Disinfection of Structures and Piping for disinfection, including bacteriological testing.

3.5 Disposal

.1 See Section 15950 – Disinfection of Structures and Piping for disposal of chlorinated water.
1. GENERAL

1.1 Work Included

.1 Finish concrete floors.
.2 Non-metallic concrete hardener.
.3 Liquid concrete hardener.
.4 Curing compound and sealer on finished floors.

1.2 Related Work

.1 Section 03250 – Concrete Accessories
.2 Section 03300 – Cast-in-Place Concrete

1.3 Quality Assurance

.1 Perform work to requirements of CAN/CSA-A23.1 and ACI 117 - Proposed Floor Flatness and Levelness Specification.
.2 Tests for surface flatness and levelness to be performed in accordance with ASTM Committee E6.21.10 to ensure conformance with specified tolerances. Cost of testing to be borne by Owner.
.3 A qualified representative of the floor hardener manufacturer shall be present prior to and during initial installation of the hardener to advise on the correct use of the product under prevailing job conditions.

1.4 Qualification

.1 Concrete finishing is to be done by an established firm having at least 5 years of proven, satisfactory experience in this trade and employing skilled personnel.
.2 Submit proof of qualifications in writing to the Engineer.

2. PRODUCTS

2.1 Curing Compound

.1 Curing Compound: moisture retention requirements to conform to ASTM C309, clear Sternson Florseal or Master Builders Masterseal.
3. **EXECUTION**

3.1 **Examination**

.1 Before starting the Work, examine work done by others which affects the Work.

.2 Notify the Engineer of any conditions which would prejudice proper completion of the Work.

.3 Commencement of work implies acceptance of existing conditions.

3.2 **Bull Floating**

.1 Immediately after screeding, bull float floor surfaces to remove ridges and fill voids.

.2 Complete bull floating before any excess moisture or bleed water is visible on surface.

3.3 **Mechanical Floating**

.1 Mechanical float floor surfaces when bleed water has disappeared and surfaces are sufficiently hard to prevent working excess mortar to surface.

.2 Continue floating as necessary to produce surfaces of uniform texture, free from hollows, bumps and screed marks.

.3 For surfaces to be trowelled, continue floating as necessary to embed coarse aggregate particles firmly below surface mortar.

.4 Hand float in restricted areas, corners, etc.

3.4 **Trowelling**

.1 Trowel floor surfaces with mechanical trowelling machines fitted with steel blades.

.2 Commence trowelling when surfaces are sufficiently hard to prevent working excess fine material to surface.

.3 Perform additional trowelling at intervals so final trowelling is done just before concrete becomes so hard that further trowelling is ineffective.

.4 Finished trowelled surfaces to be hard, dense and free from blemishes and other imperfections.

.5 Hand trowel in restricted areas, corners, etc.

.6 Cure concrete as specified under Section 03300 – Cast-in-Place Concrete.
.7 Protect, all hardened floors from damage during construction.

3.5 Liquid Hardened Floors

.1 Ensure concrete is at least 28 days old before applying liquid hardener.

.2 Remove all laitance, dirt, dust, debris, grease and other substances from concrete surfaces.

.3 Prepare hardener in accordance with manufacturer's directions.

.4 Apply hardener in two consecutive applications, using quantities and coverage to manufacturer's directions.

3.6 Curing Compound

.1 Apply curing compound on all concrete floors shown to receive resilient flooring and carpet.

.2 Coverage to be 0.1 L/m² using short nap rollers, brushes or low pressure spray equipment.

.3 Apply after final trowelling when concrete surfaces are sufficiently hardened to prevent marring, and before surfaces start to dry.

3.7 Floor Finish Tolerances

.1 Surfaces of finished suspended floor slabs shall conform to design grade as follows:

Final elevation to fall between:

\[
\text{Elevation D} \geq d + 10 \text{ mm}
\]

\[
\text{and elevation D} \leq d - 10 \text{ mm}
\]

where

\[
D = \text{the design elevation of the finished floor surface}
\]

\[
d = \text{deflection of the base at the point of measurement occurring as a consequence of the slab's (or topping's) dead weight.}
\]

The alternative Straight Edge Method in A23.1 provides that the gap at any point under a 3m straight edge shall not exceed:

<table>
<thead>
<tr>
<th>Finish Type</th>
<th>Gap (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>12</td>
</tr>
<tr>
<td>Moderately Flat</td>
<td>8</td>
</tr>
<tr>
<td>Flat</td>
<td>5</td>
</tr>
<tr>
<td>Very Flat</td>
<td>3</td>
</tr>
</tbody>
</table>

.2 Finished floor slabs on grade to conform to 3 mm in 3 m and be within + 10 mm of design grade.
.3 Finished floors not meeting the specified requirements will be rejected and must be repaired.

END OF SECTION
1. **GENERAL**

1.1 **Construction Tolerances**

.1 Tolerance of precast elements to CSA-A23.4.

.2 Length of precast elements not to vary from design length by more than plus or minus 13 mm.

.3 Cross sectional dimensions of precast elements not to vary from design dimensions by more than plus or minus 5 mm.

.4 Deviations from straight lines not to exceed 3 mm in 3 m.

.5 Precast elements not to vary by more than plus or minus 0.5% from true overall cross sectional shape as measured by difference in diagonal dimensions.

1.2 **Action and Informational Submittals**

.1 Submit shop drawings in accordance with CSA-A23.3 and CSA-A23.4 and include following items:

.1 Detail fabrication and installation of architectural precast concrete units. Indicate member locations, plans, elevations, dimensions, shapes, and cross sections. Indicate aesthetic intent including joints, reveals, and extent and location of each surface finish. Indicate details at building corners.

.2 Indicate separate face and backup mix locations, and thicknesses.

.3 Indicate welded connections by AWS standard symbols. Detail loose and cast-in hardware, and connections.

.4 Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.

.5 Indicate locations, extent, and treatment of dry joints if two-stage casting is proposed.

.6 Indicate plans, and/or elevations showing unit location, and sequence of erection for special conditions.

.7 Indicate location of each architectural precast concrete unit by same identification mark placed on panel.

.8 Indicate relationship of architectural precast concrete units to adjacent materials.
PRECAST CONCRETE

.9 Indicate locations and details of brick units and joint treatment.

.10 Design Modifications:

.1 If design modifications are necessary to meet the performance requirements and field conditions, submit design calculations and drawings. Do not adversely affect the appearance, durability, or strength of units when modifying details or materials and maintain the general design concept.

.2 Shop Drawings: Each document submitted shall bear the signature and stamp of a qualified Professional Engineer registered in the province of British Columbia. Submit BCBC Schedule S-B and S-C, for design and field review and compliance to the Architect.

.3 Samples: Design reference samples for initial verification of design intent, approximately 300 x 300 x 50 mm, representative of finishes, color, and textures of exposed surfaces of architectural precast concrete units for Architects approval prior to fabrication.

.1 When back face of precast concrete unit is to be exposed, show samples of the workmanship, color, and texture of the backup concrete as well as the facing.

1.3 Design Requirements

.1 Meet or exceed the National Energy Code of Canada for Buildings 2015 (NECB).

1.4 Quality Assurance

.1 Sample Panels: After sample approval and before fabricating architectural precast concrete units, produce a sample panel approximately 1200mm x1200mm in size for review by Architect. Incorporate full scale details of architectural features, finishes, textures, transitions, and caulk joints in the sample panels.

.1 Damage part of an exposed-face surface for each finish, color, and texture, and demonstrate adequacy of repair techniques proposed for repair of surface blemishes.

.2 After acceptance of repair technique, maintain one sample panel at the manufacturer’s plant and one at the project site in an undisturbed condition as a standard for judging the completed Work.

.3 Demolish and remove sample panels when directed.
1.5 Delivery, Storage, and Handling

.1 Store units with adequate dunnage and bracing and protect units to prevent contact with soil, staining, and to prevent cracking, distortion, warping, or other physical damage.

.2 Store units, unless otherwise specified, with non-staining, resilient supports.

.3 Place stored units so identification marks are clearly visible, and product can be inspected.

.4 Deliver all architectural precast concrete units to the project site in such quantities and at such times to assure compliance with the agreed project schedule and proper setting sequence so as to limit unloading units temporarily on the ground.

.5 Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses which would cause cracking or damage.

.6 Lift and support units only at designated points shown on the Shop Drawings.

.7 Place non-staining resilient spacers of even thickness between each unit.

.8 Support units during shipment on non-staining shock absorbing material.

1.6 Warranty

.1 Contractor warrants that precast element will not spall or show visible evidence of corrosion of embedded steel and cracking, except for normal hairline shrinkage cracks, in accordance with General Conditions (GC) - CCDC GC 12.3, but for 5 years.

.2 Contractor warrants that precast elements will not spall or show visible evidence of cracking, except for normal hairline shrinkage cracks, in accordance with subsection GC 32.1 of General Conditions "C", but for 12 months warranty period, which is extended to 60 months.

2. PRODUCTS

2.1 Mold Materials

.1 Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that will provide continuous and true precast concrete surfaces within fabrication tolerances indicated; non-reactive with concrete and suitable for producing required finishes.

.2 Form Liners: Units of face design, texture, arrangement, and configuration indicated and to match precast concrete design reference sample. Provide solid backing and form supports to ensure that form liners remain in place during concrete placement.
Use with manufacturer’s recommended liquid-release agent that will not bond with, stain, or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.

2.2 Mold Fabrications

.1 Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement and vibration operations and temperature changes and for pre-stressing and de-tensioning operations. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and pre-stressing tendons by release agent.

.1 Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during placing of concrete. Coat form liner with form-release agent.

.2 Maintain molds to provide complete architectural precast concrete units of shapes, lines and dimensions indicated, within fabrication tolerances specified.

.1 Form joist are not permitted on faces exposed to view in the finished work.

.2 Edge and corner treatment: uniformly chamfered 13mm x 13mm.

2.3 Materials

.1 Portland Cement:

.1 to ASTM C150, Type I or III.

.2 to CAN/CSA-A3001.

.2 Reinforcing steel: to CAN/CSA-G30.18.

.3 Prestressing steel tendons and bars: to CAN/CSA-S6.

.4 Welded wire fabric: to ASTM A185/A185M.

.5 Hardware and miscellaneous materials: to CSA-A23.1/A23.2.

.6 Forms: to CSA-A23.4.

.7 Anchors and supports: to CAN/CSA-G40.21.

.8 Welding materials: to CSA W48.

.9 Welding electrodes: to CSA W48.
.10 Galvanizing: hot dipped galvanizing with minimum zinc coating of [610] g/m² to CAN/CSA-G164.

.11 Epoxy coating: to ASTM A775/A775M.

.12 Steel primer: to CAN/CGSB-1.40 and MPI #23.

.13 Zinc-rich primer: to CAN/CGSB-1.181 and MPI #18.

.14 Insulation: polystyrene to CAN/ULC-S701.

2.4 Finishes

.1 Panel faces shall be free of joint marks, grain, and other obvious defects. Corners, including false joints shall be uniform, straight and sharp. Finish exposed-face surfaces of architectural precast concrete units to match approved sample panels and as follows:

.1  As-Cast Surface Finish: Provide surfaces free of excessive air voids, sand streaks, and honeycombs.

.2  Weathered random boards: Impart by form liners to provide surfaces free of excessive air voids, sand streaks, and honeycombs. Board widths between 89mm and 286mm. No more than two (2) of the same width side by side.

.3  Metal panel form liner: 19mm recessed from weather random boards.

.2 Finish exposed exterior back surfaces of architectural precast concrete units to match face-surface finish.

.3 Finish exposed and unexposed interior back surfaces of architectural precast concrete units by smooth steel-trowel finish.

2.5 Source Quality Control

.1 Provide Consultant with certified copies of quality control tests related to this project as specified in CSA-A23.4 and CSA-G279.

.2 Inspect pre-stressed concrete tendons in accordance with CSA-G279.

.3 Provide records from in-house quality control programme based upon plant certification requirements to Consultant for inspection and review.
3. EXECUTION

3.1 Preparation

.1 Deliver anchorage devices that are embedded in or attached to the building structural frame or foundation before start of such work. Provide locations, setting diagrams, and templates for the proper installation of each anchorage device.

3.2 Examination

.1 Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

.2 Do not install precast concrete units until supporting cast-in place concrete building structural framing has attained minimum allowable design compressive strength or supporting steel or other structure is structurally ready to receive loads from precast.

3.3 Erection

.1 Install loose clips, hangers, bearing pads, and other accessories required for connecting architectural precast concrete units to supporting members and backup materials.

.2 Erect architectural precast concrete level, plumb and square within the specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment of units until permanent connections are completed.

.1 Install temporary steel or plastic spacing shims or bearing pads as precast concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.

.2 Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.

.3 Remove projecting lifting devices and use sand-cement grout to fill voids within recessed lifting devices flush with surface of adjacent precast concrete surfaces when recess is exposed.

.4 Unless otherwise shown provide for uniform joint widths of 19mm.

.3 Connect architectural precast concrete units in position by bolting, welding, grouting, or as otherwise indicated on approved Erection Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and/or grouting are completed.
.1 Disruption of roof flashing continuity by connections is not permitted; concealment within roof insulation is acceptable.

.4 Welding: Comply with applicable AWS D1.1 and AWS D1.4 requirements for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.

.1 Protect architectural precast concrete units and bearing pads from damage by field welding or cutting operations and provide noncombustible shields as required.

.2 Welds not specified shall be continuous fillet welds, using not less than the minimum fillet as specified by AWS.

.3 Clean weld affected metal surfaces with chipping hammer followed by brushing then apply a minimum 0.004 inch (100 μm) thick coat of galvanized repair paint to galvanized surfaces in conformance with ASTM A780.

.4 Clean weld affected metal surfaces with chipping hammer followed by brushing then re-prime damaged painted surfaces in accordance with manufacturer’s recommendations.

.5 Visually inspect all welds critical to precast connections. Visually check all welds for completion and remove, re-weld, or repair all defective welds, if services of AWS-certified welding inspector are not furnished by Owner.

.5 At bolted connections, use lock washers, tack welding, or other acceptable means to prevent loosening of nuts after final adjustment.

.1 Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot. For friction connection apply specified bolt torque and check 25 percent of bolts at random by calibrated torque wrench.

3.4 Erection Tolerances

.1 Erect architectural precast concrete units level, plumb, square, and true, without exceeding the following noncumulative erection tolerances.

.1 Plan Location from Building Grid Datum: Plus or Minus 13 mm.

.2 Plan Location from Centerline of Steel: Plus or Minus 13 mm.

.3 Top Elevation from Nominal Top Elevation: As follows:

.1 Exposed Individual Panel: Plus or Minus 6 mm.

.2 Nonexposed Individual Panel: Plus or Minus 13 mm.
.3 Exposed Panel Relative to Adjacent Panel: 6 mm.

.4 Nonexposed Panel Relative to Adjacent Panel: 13 mm.

.4 Support Elevation from Nominal Support Elevation: As follows:

.1 Maximum Low: 13 mm.

.2 Maximum High: 6 mm.

.5 Maximum Plumb Variation over the Lesser of Height of Structure or 100 Feet (30 m): 1 inch (25 mm).

.6 Plumb in Any 10 Feet (3 m) of Element Height: 1/4 inch (6 mm).

.7 Maximum Jog in Alignment of Matching Edges: 1/4 inch (6 mm).

.8 Joint width (Governed over Joint Taper): Plus or Minus 1/4 inch (6 mm).

.9 Maximum Joint Taper: 3/8 inch (10 mm).

.10 Joint Taper in 10 Feet (3 m): 1/4 inch (6 mm).

.11 Maximum Jog in Alignment of Matching Faces: 1/4 inch (6 mm).

.12 Differential Bowing or Camber, as Erected, between Adjacent Members of Same Design: 1/4 inch (6 mm).

.13 Opening Height between Spandrels: Plus or Minus 1/4 inch (± 6 mm).

3.5 Repairs

.1 Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 6 m.

.2 Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.

.3 Remove and replace damaged architectural precast concrete units when repairs do not meet requirements.

3.6 Cleaning

.1 Clean all surfaces of precast concrete to be exposed to view, as necessary, prior to shipping.
.2 Clean mortar, plaster, fireproofing, weld slag, and any other deleterious material from concrete surfaces and adjacent materials immediately.

.3 Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.

.1 Perform cleaning procedures, if necessary, according to precast concrete fabricator’s recommendations. Clean soiled precast concrete surfaces with detergent and water, using stiff fiber brushes and sponges, and rinse with clean water. Protect other work from staining or damage due to cleaning operations.

.2 Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION
1. GENERAL

1.1 Description

.1 This section specifies Portland cement based grout for general applications such as equipment bases, and which are not specified in other Sections.

1.2 Reference Standards

.1 Conform to the following reference standards:

.1 CAN/CSA A23.1, Concrete Materials and Methods of Concrete Construction.
.2 CAN/CSA A5, Portland Cement.
.3 CAN/CSA A23.5, Supplementary Cementing Materials.
.4 CAN3 A266.2, Chemical Admixtures for Concrete.

2. PRODUCTS

2.1 Acceptable Products

.1 For equipment bases: Masterflow 713 or 928 by Masterbuilders; M-Bed grout by Sternsons; Horngroup by Tamms; Sikagroup 212 HP by Sika Products.

.2 For general use: Set grout by Masterbuilders M-Bed Standard by Sternsons.

2.2 Materials

.1 Cement: to CAN/CSA A5 Type 10.
.2 Supplementary cementing materials to CAN/CSA A23.5.
.3 Water to CAN/CSA A23.1.
.4 Chemical admixtures to CAN3 A266.2.

.5 Shrinkage compensating grout. Premixed compound consisting of non-metallic aggregate, Portland cement, water reducing and plasticizing agents. Compressive strength to be minimum 35 MPa at 7 days.
3. **EXECUTION**

3.1 **Preparation**

.1 Maintain surfaces and ambient air temperature of minimum 10°C for a minimum period of 24 hours prior to, during, and 72 hours after application.

.2 If grouting in exposed conditions, provide and maintain temporary weatherproof enclosures from inclement weather during preparation, grouting and curing.

3.2 **Mixing**

.1 Mix grout dry and add water to bring mix to the correct consistency in a mechanical rotary mixer.

.2 Mix premix grout in accordance with manufacturer's instructions.

3.3 **Inspection**

.1 Notify Engineer 24 hours before commencing grouting operations.

3.4 **Placing**

.1 Roughen and clean contact surfaces and thoroughly wet with water prior to grouting.

.2 Prepare grout no earlier than 10 minutes before use and place in final position within 30 minutes.

.3 Ram dry pack against suitable back-up blocker.

.4 Grout using procedures in accordance with manufacturer's recommendations which results in 100% contact over grouted area.

.5 Grout under base plates to be installed to provide for full bearing. Remove all air pockets.

.6 Finish and tool grout exposed to view in a workmanlike manner consistent with the finish of adjacent materials.

.7 Continuously moist cure at temperature above 5°C for seven days and in accordance with manufacturer's recommendations.

END OF SECTION
Division 5
STRUCTURAL STEEL

1. GENERAL

1.1 Work Included

.1 All structural steel frames as indicated on the Drawings.

.2 Baseplates for columns complete with anchor bolts.

.3 Joist design, steel joists, bridging.

.4 Bearing plates, angles with anchors and anchor bolts for joists.

.5 Structural supports around openings in metal deck over 450 mm in any dimension.

.6 Welds, bolts, washers, nuts, shims, and miscellaneous steel items.

.7 Shear connectors.

.8 Galvanized structural steel members.

.9 Field touch up of galvanized surfaces.

1.2 Related Work

.1 Grouting bearing baseplates - Section 03600

.2 Placement of anchor bolts, bearing plates, and miscellaneous metal in concrete - Section 03300

.3 Placement of anchor bolts, bearing plates, and angles in masonry - Section 04220

.4 Structural supports around openings in metal deck up to 450 mm in any dimension - Section 05311

.5 Connectors through metal deck - Section 05311

.6 Metal Fabrications - Section 05500

1.3 Design Standards, Code Requirements

.1 Conform to requirements of CAN/CSA S16.1, the Canadian Institute of Steel Construction (CISC) and the Provincial Construction Safety Act.

Contractor is responsible for structural steel connection design. All structural steel connections are to be designed by a Contractor's Engineer registered in the Province of British Columbia.

Perform all welding in accordance with requirements of CSA W59.

Design joists to support their own weight and design loads shown with not more than allowable deflection.

Joists and joists connections are to be designed by a joist supplier's Engineer, registered in the Province of British Columbia.

1.4 Qualifications

All work is to be performed by a firm certified by the Canadian Welding Bureau to the requirements of CSA W47.1 in Division 1 or Division 2.1.

All welders employed for erection are to possess valid "S" Classification Class "O" certificates issued by the Canadian Welding Bureau.

1.5 Inspection and Testing

Shop and field inspection and testing is to be performed by an Inspection and Testing Firm appointed by Utility and paid by the Contractor.

Provide free access to all portions of work in the shop and in the field and cooperate with appointed firm.

Pay all additional costs for inspection and re-inspection due to defective workmanship or materials.

If requested by the Engineer, submit 4 copies of mill test reports, properly correlated to materials actually used.

Radiographic and magnetic particle inspection of welds is to be performed by the Inspection and Testing Firm, in accordance with CSA W59 and ASTM E109, when required by the Engineer.

Welds are to be considered defective if they fail to meet quality requirements of CSA W59.

Additionally, all welds are to be visually inspected.

High Tensile bolted connections are to be inspected and tested in accordance with CAN/CSA S16.1.
1.6 **Shop Drawings, Submittals**

.1 Provide a fabrication and erection schedule to the Engineer prior to commencement of shop fabrication and field erection, in ample time to allow proper scheduling of inspection and testing.

.2 Submit details of typical connections and special connections for review prior to preparation of shop drawings.

.3 Shop drawings and design briefs are to bear the seal of a Professional Structural Engineer, registered in the Province of British Columbia.

.4 Submit shop drawings for review in accordance with Section 01330.

.5 Clearly indicate profiles, sizes, spacing and locations of structural members, connections, attachments, reinforcing, anchorage, framed openings, size and type of fasteners, cambers and loads, accessories, column anchor bolt locations, setting details.

.6 Include erection drawings, elevations and details.

.7 Indicate welded connections using welding symbols in compliance with CISC Welding Standards. Clearly indicate net weld lengths.

.8 Shop drawing review by the Engineer is solely to ascertain conformance to the general design concept.

.9 Responsibility for approval of detail design inherent in shop drawings rests with the Contractor and review by the Engineer shall not imply such approval.

.10 Review shall not relieve the Contractor of his responsibility for errors or omissions in shop drawings or for proper completion of the Work in accordance with the Contract Documents.

.11 Responsibility for verification and correlation of field dimensions, fabrication processes, techniques of construction, installation and coordination of all parts of the Work rests with the Contractor.
2. PRODUCTS

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>General Construction Steel</td>
</tr>
<tr>
<td>W</td>
<td>Weldable Steels</td>
</tr>
<tr>
<td>T</td>
<td>Weldable Low Temperature Steels</td>
</tr>
<tr>
<td>R</td>
<td>Atmospheric Corrosion Resistant Structural Steel</td>
</tr>
<tr>
<td>A</td>
<td>Atmospheric Corrosion Resistant Structural Steel With Improved Low Temperature Properties</td>
</tr>
<tr>
<td>Q</td>
<td>Quenched and Tempered Low Alloy Steel Plate</td>
</tr>
</tbody>
</table>

2.1 Materials

.1 All materials are to be new.

.2 Structural Steel: conforming to CAN/CSA G40.21, Type W with yield strength of 350 MPa.

.3 Hollow Structural Sections: conforming to CAN/CSA G40.21, Type W, yield strength of 350 MPa, Class C.

.4 All structural steel to be hot dip galvanized after fabrication.

.5 Bolts, Nuts and Washers: conforming to ASTM A325; finished to match members to which they attach.

.6 Anchor Bolts: fabricated from material conforming to CAN/CSA G40.21, Type W, yield strength 300 MPa; nuts and washers to be of equal or greater strength than bolts.

.7 Welding Materials: conforming to CSA W59.

.8 Stud Shear Connectors: conforming to ASTM A108; grades 1020.

.9 Galvanizing: conforming to CSA G164; minimum 610 g/m² coating.

2.2 Fabrication

.1 Fabricate structural steel members in accordance with CAN/CSA S16.1 and CAN/CSA S136.

.2 Verify all drawing dimensions prior to commencing fabrication.

.3 Openings are not allowed through any structural members unless approved by Engineer in writing. If approved, openings shall not be larger than 30 mm. Reinforce openings with steel plates sized and welded in place, to restore members to original...
design strength. Locate holes so as to cause no appreciable reduction in strength of members.

.4 Provide connections for loads shown.

.5 Provide connections as detailed.

.6 All shop connections are to be welded.

.7 Provide CISC double angle header connections wherever possible.

.8 Accurately cut and mill column ends and bearing plates to assure full contact of bearing surfaces prior to welding.

.9 Close and weatherproof all gaps, butt joints and connections exposed to exterior of building. Grind all exposed welds flush with surface of welded members.

.10 Weld shear studs in place with stem perpendicular to member, in full fusion weld.

.11 Where indicated on Drawings, extend bottom chords of joists to support columns.

.12 Design and detail connections for structural steel so that corrosion potential is minimized. Cap and seal weld all exposed ends of HSS sections.

2.3 Hot Dip Galvanizing

.1 Clean all members, remove all loose mill scale, rust, oil, dirt and other foreign matter. Prepare surfaces according to SSPC SP 6 after fabrication.

.2 Hot-dip all structural steel conforming to CSA G164 with minimum 610 gm per square metre coating.

3. EXECUTION

3.1 Examination

.1 Before starting erection, take field measurements and examine other work may affect this Work.

.2 Notify the Engineer of any conditions which would prejudice proper installation of this Work.

.3 Commencement of this Work implies acceptance of existing conditions.

3.2 Damaged Members

.1 Repair or replace members damaged during transit or erection, before securing in position.
3.3 Erection

.1 Erect structural steel in accordance with CAN/CSA S16.1 and Drawings.

.2 All field connections are to be bolted, as shown on drawings.

.3 Field weld connection can only be performed when approved by Engineer. Do not field weld wet surfaces or during rain unless under cover.

.4 Do not weld at temperature below 5°C except with express permission of the Engineer.

.5 Conform to requirements of CSA W59 for minimum preheat and interpass temperatures.

.6 Make adequate provision for all erection loads, and for sufficient temporary bracing to maintain structure safe, plumb and in true alignment until completion of erection and installation of necessary permanent bracing.

.7 Set column bases and other vertical members to design elevations on leveling nuts or steel wedges. Do not use wood wedges.

.8 Use only light drifting to draw parts together. Enlarge holes for bolted connections with reamers or twist drill only. Do not burn to form holes, enlarge holes or match unfair holes.

.9 Erection error is not to exceed requirements of CAN/CSA S16.1.

.10 Obtain Engineer's written permission prior to field cutting or altering structural members.

.11 After erection touch up damage to galvanized coating with 3 coats of Zinc rich paint conforming to CGSB1-GP-178a.

END OF SECTION
1. GENERAL

1.1 Work Included

.1 Metal roof deck complete with cover plates, closures, flashing, and fastenings.

.2 Bearing plates and angles complete with required anchorage.

.3 Angle framing around openings up to 450 mm maximum in any dimension.

.4 Cut openings through deck.

1.2 Related Work

.1 Building in bearing plates and angles in masonry - Section 04220

.2 Supply of bearing plates and angles - Section 05120

1.3 Shop Drawings

.1 Submit shop drawings in accordance with Section 01330.

.2 Clearly indicate decking plan, deck profile dimensions and thicknesses, anchorage, supports, projections, openings and reinforcement, closures, flashings, applicable details, and accessories.

.3 Shop drawings and design briefs are to bear the seal of a Professional Structural Engineer registered in the Province of British Columbia.

.4 Supply and install metal deck as specified on the Drawings and this Specification.

2. PRODUCTS

2.1 Materials

.1 Metal: galvanized sheet steel conforming to ASTM A653M, Grade 230 as shown in manufacturers' current literature. Z275 zinc coating.

2.2 Deck and Related Accessories

.1 Roof Deck: 1.52 mm nominal thickness base sheet steel, Grade 230, 38 mm deep flutes with spacing at 150 mm centre to centre. Deck shall be galvanized conforming to ASTM A653M with zinc thickness corresponding to Z275, laid in 3 span continuously.
METAL DECK

<table>
<thead>
<tr>
<th>Approved Products</th>
<th>Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canam Joist and Steel Deck</td>
<td>P3606 Type 16</td>
</tr>
<tr>
<td>Vic-West</td>
<td>RD938</td>
</tr>
</tbody>
</table>

.2 Closure Strips, Flashing, Cover Plates: 1.52 mm minimum thickness base sheet steel, Z275 zinc coating, profiles and sizes as shown on drawings.

.3 Stud Shear Connectors: conforming to ASTM A108, grades 1020

2.3 Fabrication

.1 Fabricate metal deck in accordance with requirements of CAN/CSA S136, Canadian Sheet Steel Building Institute (CSSBI) Standards and Drawings.

.2 Fabricate to generally span over 3 or more supports unless shown otherwise on the Drawings.

3. EXECUTION

3.1 Examination

.1 Before starting erection, take field measurements and examine other work which may affect this work.

.2 Notify the Engineer of any conditions which would prejudice proper installation of this work.

.3 Commencement of this work implies acceptance of existing conditions.

3.2 Damaged Members

.1 Repair or replace sections damaged during transit or erection, before securing in position.

3.3 Installation - General

.1 Erect metal deck in accordance with requirements of CSSBI and the Drawings. Align and level deck on structural supports.

.2 Locate all end joints over supports.

.3 Lap all end joints with a minimum of 50 mm.

.4 Maintain minimum end bearing on steel supports of 75 mm.
.5 Maintain minimum end bearing on masonry supports of 150 mm.

.6 Lay out lines of supporting steel on top surface of deck to produce accurate welds and prevent burns through deck from improper weld location.

.7 Cut all holes required in deck for drains, vents, mechanical equipment, ducts, and conduits.

.8 Reinforce openings up to 450 mm in any dimension with 75 x 75 x 6 mm steel angles. Place angles at right angles to ribs, extend out two ribs each side and weld.

.9 Immediately after installation, touch up welds, burned areas and damaged areas of zinc coating with primer paint.

3.4 Roof Deck Installation

.1 Fasten roof deck to all supports as indicated on the Drawings.

.2 Mechanically fasten sidelaps as indicated on the Drawings.

.3 Install angle or channel closures full length on all deck edges at perimeter, walls, and openings.

END OF SECTION
1. GENERAL

1.1 Related Sections

.1 Section 06100 - Rough Carpentry – Short Form.

1.2 General

.1 Supply and install all miscellaneous metal items indicated on the drawings and/or specified herein.

1.3 Site Dimensions

.1 Check dimensions for all miscellaneous metal items on site.

1.4 Action and Informational Submittals

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature, and data sheets for sections, plates, pipe, tubing, bolts, and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Shop Drawings:

.1 Submit shop drawings for Architects approval prior to fabrication. Shop drawings shall show complete details including all connections, locations, and elevations of miscellaneous metal. Clearly indicate design criteria used and loads.

.2 Shop drawings to include for member, assembly and anchorage design sealed by a Professional Engineer, registered in the Province of British Columbia in accordance with the British Columbia Building Code. Drawings indicate minimum sizes for architectural appearances.

.3 Each document submitted shall bear the signature and stamp of a qualified Professional Engineer registered in the province of British Columbia. Submit BCBC Schedule S-B for design compliance to the Architect.

1.5 Delivery, Storage, and Handling

.1 Deliver, store, and handle materials in accordance with Common Product Requirements and 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 in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for recycling.

1.6 Field Inspection

.1 The B.C. professional engineer responsible for design or a designated representative responsible to this engineer shall inspect the joists after erection, prior to closing in, and provide written confirmation to the Structural Engineer of Record that they have been erected in accordance with code requirements and erection drawings.

.2 Letter of Assurance: Registered Professional Engineer who signed and sealed shop drawings shall perform sufficient field reviews in order to allow him to provide a letter of professional assurance after completion of the Work, giving assurance that the Work has been installed in general conformance with the sealed shop drawings. Approved form is British Columbia Building Code Schedule S-B and S-C, Assurance of Professional Design and Field Review and Compliance. Written inspection reports of field reviews shall be submitted to Consultant promptly as the field reviews are made.

1.7 Design Criteria

.1 Comply with the most restrictive requirement noted below.

.1 Design to withstand, calculated in accordance with British Columbia Building Code and applicable local regulations or as shown on the drawings.

.2 Design systems to allow for thermal movement of the components caused by ambient temperature range of -15°C to +40°C without causing deterioration of the system or its supports.

.3 Specified support system distributed and point loading capacities.

1.8 Work with Other Trades

.1 Co-operate with other trades, make connection to and adjustments for other work.

.2 Deliver and set in place miscellaneous metal items to be built into adjoining work.

2. PRODUCTS

2.1 Materials

.1 All materials shall be new, best quality, clean to dimensions indicated, and free from distortions and defects.

.2 Steel sheet shall be cold rolled, stretcher levelled.
.3 Steel plate shall be hot rolled, open hearth carbon steel, carbon content between 0.10 and 0.30.

.4 Steel angles shall be galvanized stock steel angles.

.5 Bar Mill Products shall be mild steel, merchant bar quality, with low carbon quality for cold bending and hot formed.

.6 Steel pipe shall be hollow pipe of dimension specified and/or detailed. Hot dip galvanized where specified or detailed.

.7 Screws shall be socket head or Phillips type, machine screws, same as parent metal, galvanized for exterior, plated for interior of adequate size, countersunk.

.8 Fasteners, expansion shields, etc., shall be of proper type, size and location for purpose intended. All exterior component fasteners shall be 316 stainless steel.

.9 Exterior exposed steel

.1 surface preparation to SSPC#6 commercial blast cleaning

.2 hot dipped galvanized, to CSA G164, minimum zinc coating of 600 g/m² (0.123 lb/ft²). Galvanizing Zinc Rich touch-up paint: "Galvicon" or approved equal.

.10 Interior steel

.1 Refer to Specification Section 09900 – Interior Painting.

.11 Stainless steel bolts to AISI steel products manual No.13.

.12 Bituminous paint to CGSB 1.GP.108M Type 1.

2.2 Multi-Plate Structure

.1 Multi-Plate sheet and plate fabricated in accordance with CSA G401 Corrugated Steel Pipe Products.

.2 Each Multi-Plate sheet to be hot dip galvanized in accordance with CSA G164 with a zinc mass as specified in CSA G401.

.3 Manufacturer: Armtec

2.3 Grating and Components

.1 Grating type: Steel press-locked bar grating.

.2 Bearing bar spacing: 30mm, horizontal.

.3 Bearing bar depth: 25mm.

.4 Bearing bar thickness: 3mm.
.5 Cross bar Spacing: 100mm, vertical.

.6 Top surface: Smooth.

.7 Finish: Hot dipped galvanized.

.8 Fasting system: As recommended by manufacturer.

.9 Fabricate cut-outs in grating for penetrations as shown on the drawings.

2.4 Fabrication

.1 Fabricate work square, true, straight and accurate to required size, with joints closely fitted and properly secured.

.2 Use self-tapping shake-proof flat round oval headed screws on items requiring assembly by screws or as indicated.

.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.

2.5 Finishes

.1 Galvanizing: hot dipped galvanizing with zinc coating 600 g/m² to CAN/CSA-G164.

.2 Shop coat primer: MPI-INT EXT 5.1A MPI-INT EXT 5.1B in accordance with chemical component limits and restrictions requirements and VOC limits of CCD-047a CCD-048 GS-11.

.3 Zinc primer: zinc rich, ready mix to MPI-INT EXT 5.2C in accordance with chemical component limits and restrictions requirements and VOC limits of CCD-047a CCD-048 GS-11.

2.6 Shop Painting

.1 Primer: VOC limit 250 g/L maximum to GS-11 CCD-047a CCD-048.

.2 Apply one shop coat of primer to metal items, with exception of galvanized or concrete encased items.

.3 Use primer unadulterated, as prepared by manufacturer. Paint on dry surfaces, free from rust, scale, grease. Do not paint when temperature is lower than 7 degrees C.

.4 Clean surfaces to be field welded; do not paint.
METAL FABRICATIONS

3. EXECUTION

3.1 Examination

.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for metal fabrications installation in accordance with manufacturer’s written instructions.

.1 Visually inspect substrate.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 Workmanship

.1 Fabricate and assemble all items in shop where possible, cut fit, and adjust on site when necessary.

.2 Fabricate and install to best trade practice, jointing shall be true to line and plane, tight, with adequate fastening. Conform to detail and dimensions, grind all edges smooth with no shop projections, adequately reinforce, wedge and anchor in place.

.1 The compliance to the requirements of this Clause shall be judged from the closest in service reviewing distance.

.2 All sections shall be true, straight, and not contain dents, bends or other noticeable damage.

.3 Connection details designed by the contractor shall meet, in addition to the structural requirements, the aesthetic requirements of the architect.

.4 The workmanship for all connections shall respect the exposed nature of the element. All weld passes shall be continuous with uniform bead size. Protect surrounding steel from damage due to weld spatter. Grind all welds to a smooth uniform surface to the approval of the architect.

.3 Weld using neat full continuous fillet or butt welds, grind smooth and level with parent metal, fill and finish with hand file where exposed.

.4 Fix items with concealed fastening where possible, to best trade practice to give permanent stability and good appearance.

.5 Weld heavy anchors to items where required, at spacing to ensure stability.

.6 After fabrication prepare metal for primer as described above.
3.3 **Erection**

.1 Do welding work in accordance with CSA W59 unless specified otherwise.

.2 Erect metalwork square, plumb, straight, and true, accurately fitted, with tight joints and intersections.

.3 Provide suitable means of anchorage acceptable to Departmental Representative DCC Representative Consultant such as dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.

.4 Exposed fastening devices to match finish and be compatible with material through which they pass.

.5 Supply components for work by other trades in accordance with shop drawings and schedule.

.6 Make field connections with bolts to CSA S16 or Weld field connection.

.7 Deliver items over for casting into concrete and building into masonry together with setting templates to appropriate location and construction personnel.

.8 Touch-up rivets, field welds, bolts and burnt or scratched surfaces with primer after completion of:

   .1 Primer: maximum VOC limit 250 g/L to GS-11.

.9 Touch-up galvanized surfaces with zinc rich primer where burned by field welding.

   .1 Primer: maximum VOC limit 250 g/L to GS-11.

**3.4 Cleaning**

.1 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

**3.5 Protection**

.1 Protect installed products and components from damage during construction.
.2 Repair damage to adjacent materials caused by metal fabrications installation.
1. GENERAL

1.1 Related Sections

.1 Section 03300 – Cast-in-Place Concrete

.2 Section 05500 – Metal Fabrications

1.2 Reference Standards

.1 ASTM A53-90b, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

.2 ASTM A307-92a, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile.

.3 ASTM A325M-92a, Specification for High-Strength Bolts for Structural Steel Joints.

.4 ANSI/NAAMM MBG 531-88, Metal Bar Grating Manual.

.5 CAN/CGSB-1.40-M89, Primer, Structural Steel, Oil Alkyd Type.


.7 CAN/CSA-G40.21-98, General Requirements for Rolled or Welded Structural Quality Steel.

.8 CAN/CSA-G164-M92 (R1998), Hot Dip Galvanizing of Irregularly Shaped Articles.


1.3 Design Requirements

.1 Design metal ladders and railings construction and connections to NBCC for vertical and horizontal live load requirements.

.2 Detail and fabricate stairs to NAAMM Metal Stairs Manual.

1.4 Design Requirements

.1 Submit shop drawings in accordance with Section 01330.

.2 Indicate construction details, sizes of steel sections and thickness of steel sheet.
METAL STAIRS AND RAILINGS

.3 Submit shop drawing bearing stamp of a qualified professional engineer registered in the Province of British Columbia.

2. PRODUCTS

2.1 Materials

.1 Steel sections: to CAN/CSA-G40.21, Grade 300W.

.2 Steel plate: to CAN/CSA-G40.21, Grade 260W, pattern per architectural drawings.

.3 Steel pipe: to ASTM A53, standard weight, schedule 40, seamless black.

.4 Metal bar grating: to ANSI/NAAMM MBG 531, as per architectural drawings, designed to meet loads per structural drawings.

.5 Welding materials: to CSA W59.

.6 Bolts: to ASTM A307.

.7 High strength bolts: to ASTM A325M.

2.2 Fabrication

.1 Fabricate to NAAMM, Metal Stair Manual.

.2 Weld connections where possible, otherwise bolt connections. Countersink exposed fastenings, cut off bolts flush with nuts. Make exposed connections of same material, colour and finish as base material on which they occur.

.3 Accurately form connections with exposed faces flush; mitres and joints tight. Make risers of equal height.

.4 Grind or file exposed welds and steel sections smooth.

.5 Shop fabricate stairs in sections as large and complete as practicable.

2.3 Ladders

.1 Provide and install metal ladders in locations where indicated on the drawings and to height required.

.2 Metal ladders shall be 600 mm wide and constructed with 50 mm x 9 mm flat bar stringers with 16 mm diameter rungs at 300 mm o.c. and shall be welded to stringers.

.3 Ladders shall be complete with steel angle clips bolted to floor and welded to stringers. Secure to walls at maximum 900 mm o.c. with angle brackets and 12 mm
diameter anchor bolts anchored into walls. Anchor types to be appropriate for floor/wall assembly.

### 2.4 Pipe or Guards and Railings

.1 Supply and install metal railings and guards on roof and railings on stairs and footrail at glazing on second floor as shown on drawings.

.2 Construct balusters and handrails from steel pipe or steel tubing.

.3 Cap and weld exposed ends of balusters and handrails.

.4 Terminate at abutting wall with end flange.

### 2.5 Finishes

.1 Galvanizing: hot dipped galvanizing with zinc coating 600 g/m² to CAN/CSA-G164.

.2 Shop coat primer: to CAN/CGSB-1.40.

.3 Zinc primer: zinc rich, ready mix to CAN/CGSB-1.181.

### 2.6 Shop Painting

.1 Clean surfaces in accordance with Steel Structures Painting Council SSPC-SP2.

.2 Apply one coat of shop primer except interior surfaces of pans.

.3 Apply two coats of primer of different colours to parts inaccessible after final assembly.

.4 Use primer as prepared by manufacturer without thinning or adding admixtures. Paint on dry surfaces, free from rust, scale, grease; do not paint when temperature is below 7°C.

.5 Do not paint surfaces to be field welded.

### 3. EXECUTION

#### 3.1 Installation of Stairs

.1 Install in accordance with NAAMM, Metal Stair Manual.

.2 Install all ladders and railings plumb and true in exact locations, using welded connections wherever possible to provide rigid structure. Provide anchor bolts, bolts and plates for connecting stairs to structure.
METAL STAIRS AND RAILINGS

.3 Hand items over for casting into concrete or building into masonry to appropriate trades together with setting templates.

.4 Do welding work in accordance with CSA W59 unless specified otherwise.

.5 Touch up shop primer to bolts, welds, and burned or scratched surfaces at completion of erection.

END OF SECTION
1. GENERAL

1.1 Work Included

.1 Access hatches, frames, and covers.
.2 Ladders and rungs in concrete.
.3 Frames, gratings, and checker plate covers.
.4 Ships ladder and platforms and all required supports and anchors.
.5 Stainless steel anchor bolts.
.6 Stainless steel bolts for bolted connections.
.7 Stainless steel anchor bolts and anchorages for all aluminum equipment supplied.

1.2 Related Work

.1 Section 03300 – Cast-in-Place Concrete
.2 Section 05500 – Metal Fabrications

1.3 Standards

.1 Complete aluminum work to CAN3-S157-M83.
.2 Welding to CSA W47.2 and CAN3-S157-M83.

1.4 Shop Drawings

.1 Submit Shop Drawings for review in accordance with Section 01330 - Submittals.
.2 Clearly indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners and accessories.
.3 Include erection drawings, elevations, and details where applicable.
.4 Indicate welded connections using CISC standard welding symbols. Clearly indicate net weld lengths.
2. PRODUCTS

2.1 Materials

.1 Aluminum to CSA Standard HA, 6351-T6 Alloy unless specified otherwise.

.2 Nuts, bolts, and fastening devices connecting aluminum parts to aluminum, concrete, or other materials: stainless steel with appropriate isolation device.

.1 Stainless steel bolts to conform to ASTM A193, Gr. B8, 550 MPa minimum yield strength. Nuts to conform to ASTM A194, Gr.8.

.3 Bituminous Paint: to CGSB 1-GP-108b.

.4 Aluminum Grating & Plate: Design to carry a live load and maximum deflection as indicated on the Drawings.

2.2 General Fabrication

.1 Verify all dimensions on site prior to fabrication.

.2 Connect bearing bars in a panel with a bending bar of same height as bearing bars and minimum thickness 5 mm.

.3 Finish openings requiring the cutting of 4 or more bearing bars in the same manner as the ends of panels.

.4 Fabricate adjacent panels with bars lined up to preserve a continuous appearance.

.5 Band all ends and openings for each grating panel.

3. EXECUTION

3.1 Examination

.1 Before starting erection, examine the Work done under other sections which may affect the Work of this section.

.2 Rectify all conditions which would prejudice proper installation of the Work of this section.

3.2 Erection

.1 Obtain Engineer's permission prior to site cutting or making adjustments which are not part of the Work.

.2 Install items plumb, square, and level, fit accurately, and maintain free from distortion or defects detrimental to appearance and performance.
ALUMINUM FABRICATIONS

.3 Make provision for erection stresses and temporary bracing. Keep work in alignment at all times.

.4 Replace items damaged in course of installation.

.5 Perform required field welding. Grind all visible field welds smooth.

.6 Perform necessary cutting and altering for the installation of the Work of other sections, and as indicated on the Drawings. No additional cutting is to be done without the approval of the Engineer.

.7 Perform all field assembly bolting and welding to match standard of shop bolting and welding. Bolts and screws are to be concealed whenever possible.

.8 Clip adjacent grating panels edges together at 1500 mm maximum spacing to prevent differential vertical movement.

.9 Provide two hold down clips at each end of the panels if not detailed on the Drawings. Clips shall not fall from panels when panels are moved or loosened.

.10 Provide anchors required for setting in concrete, minimum 100 mm embedment.

.11 Paint aluminum surfaces in contact with concrete with two thorough coats of alkali-resistant bituminous paint.

.12 Prevent electrolytic action between aluminum and dissimilar metals if in contact.

END OF SECTION
Division 6
ROUGH CARPENTRY – SHORT FORM

1. GENERAL

1.1 Related Sections

.1 Section 05500 – Metal Fabrications
.2 Section 07620 – Sheet Metal Flashing and Trim
.3 Section 08111 – Metal Doors and Frames
.4 Section 09110 – Non Structural Metal Framing

1.2 References

.1 Canadian Standards Association (CSA International)
  .2 CAN/CSA-G164-M92 (R1998), Hot Dip Galvanizing of Irregularly Shaped Articles.
  .4 CAN/CSA-O141-91 (R1999), Softwood Lumber.
  .5 CSA O151-M1978 (R1998), Canadian Softwood Plywood.
  .6 CAN/CSA-O325.0-92 (R1998), Construction Sheathing.

.2 National Lumber Grades Authority (NLGA)
  .1 Standard Grading Rules for Canadian Lumber 2014.

1.3 Quality Assurance

.1 Plywood identification: by grade mark in accordance with applicable CSA standards.

1.4 Waste Management Disposal

.1 Separate and recycle waste materials.
.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
2. PRODUCTS

2.1 Lumber Material

.1 Lumber: unless specified otherwise, softwood, S4S, moisture content 19% or less in accordance with following standards:

   .1 CAN/CSA-O141.

   .2 NLGA Standard Grading Rules for Canadian Lumber.

.2 Blocking:

   .1 Board sizes: "Standard" or better grade.

   .2 Dimension sizes: "Standard" light framing or better grade.

2.2 Panel Material

.1 Douglas fir plywood (DFP): to CSA O121, standard construction.

2.3 Accessories

.1 Nails, spikes and staples: to CSA B111.

.2 Bolts: 12.5 mm diameter unless indicated otherwise, complete with nuts and washers.

.3 Proprietary fasteners: toggle bolts, expansion shields and lag bolts, screws and lead or inorganic fibre plugs, explosive actuated fastening devices, recommended for purpose by manufacturer.

2.4 Finishes

.1 Galvanizing: to CAN/CSA-G164, use galvanized fasteners for all interior work.

3. EXECUTION

3.1 Installation

.1 Comply with requirements of current edition of the British Columbia Building Code, drawing details as applicable, and as supplemented by the following paragraphs.

.2 Install blocking as required to space-out and support casework, cabinets, counter tops, grab bars, sliding door hardware, accessories, ceiling lifts, wall and ceiling finishes and other work as required.

.3 Align and plumb faces of furring and blocking to tolerance of 1:600.
3.2 Erection

.1 Frame, anchor, fasten, tie, and brace members to provide necessary strength and rigidity.

.2 Countersink bolts where necessary to provide clearance for other work.

END OF SECTION
FIBREGLASS REINFORCED PLASTIC GRATING

1. GENERAL

1.1 Scope

.1 This section refers to all fibreglass reinforced plastic grating including: design, detailing, fabrication, and installation of the fiberglass grating and support structure.

1.2 Submittals for Review

.1 Provide Engineer with copies of product testing and manufacturer's established minimum quality requirements. Published technical information must be substantiated with data gathered from large scale testing. Manufacturer and erector to demonstrate a minimum of five years in industrial construction.

.2 Submit structural design calculation for the grating and support structures in accordance with Section 01330 – Submittals.

.3 Submit shop Drawings in accordance with Section 01330 – Submittals.

.4 Indicate material, thicknesses, finishes, connections, joints, method of anchorage, supports, details, and accessories. On erection Drawings indicate member size, base plate elevation, location, and information necessary for assembly.

.5 All submitted Drawings and Calculations to bear the signature of a professional engineer registered in the Province of British Columbia for all fabricator designed assemblies, components, and connections.

1.3 Reference Standards

.1 Reference Standards for properties of Pultruded FRP products: ASTM D638, D695, D790, D953, D2344, D732, D256, D2583, D570, D792, D696, D495, D149, and D150.

.2 The dimensional tolerances of pultruded shapes shall be as specified in ASTM 3917, Standard Specifications for Dimensional Tolerances of Thermosetting Glass Reinforced Plastic Pultruded Shapes.

2. PRODUCTS

2.1 Materials

.1 38 mm deep fibreglass (FRP) pultruded grating Dura Grid Style I 4000 as manufactured by Strongwell, or approved alternate.

.2 Pultruded FRP curb angle at all perimeter supports. Support beams: pultruded FRP I beams, 6x3x3/8 – Extran 525 by Strongwell, or approved alternate.
.3 Glass fibre reinforcement to be continuous and oriented in two directions. Glass content to be a minimum 60% by weight.

.4 Resin to be Isophthalic Polyester.

.5 Use 316L stainless steel clips, brackets, bolts, and anchors, epoxy coated.

2.2 Fabrication

.1 Fabricate materials in accordance with approved Drawings.

.2 All materials to be factory fabricated. Field modifications are not permitted without manufacturer's and Engineer's written consent.

.3 All cut edges and holes to be sealed with general purpose polyester resin or equal to prevent corrosive attack.

3. EXECUTION

3.1 Inspection

.1 Verify alignment of primary frames and supports.

.2 All bearing surfaces must be clean.

.3 Place on supports and adjust into final position with proper bearing, joint alignment laps, and supports before fastening.

3.2 Handling

.1 Protect surfaces of FRP units from cuts, scratches, gouges, abrasions, and impact. If any damage does occur, manufacturer must be contacted prior to any attempted repair.

.2 Keep all FRP materials covered. Store materials in a dry location, off the ground and well ventilated.

END OF SECTION
Division 7
1. GENERAL

1.1 Section Includes

.1 Cold applied asphalt bitumen damp proofing.

1.2 Quality Assurance

.1 Perform work in accordance with NRCA Waterproofing Manual.

1.3 Environmental Requirements

.1 Apply materials in environmental conditions specified in manufacturer’s literature.

.2 Do not apply in rainy weather.

.3 Maintain ambient temperatures above 5 degrees C for 24 hours before and during application until membrane has cured.

.4 Store solvent based materials away from excessive heat and open flame.

2. PRODUCTS

2.1 Manufacturers

.1 Bakor Inc. Type 810-07 Non-fibered asphalt foundation coating.

.2 Substitutions: Refer to Section 01600.

2.2 Cold Asphaltic Materials

.1 Asphalt Emulsion: Conforming to ASTM D3747.

.2 Asphalt Primer: ASTM D41, compatible with substrate.

.3 Asphalt Cement: ASTM D2822 Type I.

3. EXECUTION

3.1 Examination

.1 Verify substrate surfaces are durable, free of matter detrimental to adhesion or application of damp proofing system.

.2 Verify items that penetrate surfaces to receive damp proofing are securely installed.
3.2 Preparation

.1 Protect adjacent surfaces not designated to receive damp proofing.

.2 Clean and prepare surfaces to receive damp proofing in accordance with manufacturer's instructions.

.3 Do not apply damp proofing to surfaces unacceptable to manufacturer or applicator.

.4 Apply mastic to seal penetrations, small cracks, or minor honeycomb in substrate.

.5 Patch form tie holes and finish flush with adjacent surfaces. Allow patching to cure prior to application of damp proofing.

.6 Seal exterior joints between foundation walls and footings, joints between concrete floor slab and foundation, and around penetrations through damp proofing with sealing compound.

3.3 Application

.1 Prime surfaces in accordance with manufacturer's instructions.

.2 Apply cold bitumen by brush.

.3 Apply bitumen in one coat, continuous and uniform, at a rate of 0.068 L/sq m per coat.

.4 Apply from 50mm below finish grade elevation to and including top of footings.

.5 Apply two additional coats of damp proofing to vertical corers and construction joints for a minimum width of 250mm on each side and 250mm all around for pipes passing through walls.

.6 Seal items projecting through damp proofing surface with mastic. Seal watertight.

.7 Allow to cure and dry prior to commencement of backfilling.

END OF SECTION
1. **GENERAL**

1.1 **Related Requirements**

.1 Cast-in-place Concrete - Section 03300

1.2 **References**

.1 Canadian General Standards Board (CGSB)

 .1 CAN/CGSB-51.34-M86, Vapour Barrier, Polyethylene Sheet, for Use in Building Construction.

2. **PRODUCTS**

2.1 **Sheet Vapour Barrier**

.1 Polyethylene film: to CAN/CGSB-51.34, 0.15 mm thick.

2.2 **Accessories**

.1 Joint sealing tape: air resistant pressure sensitive adhesive tape, type recommended by vapour barrier manufacturer, 50 mm wide for lap joints and perimeter seals, 25 mm wide elsewhere.

.2 Sealant: compatible with vapour retarder materials, recommended by vapour retarder manufacturer. To Section 07900 - Joint Sealants.

3. **EXECUTION**

3.1 **Installation**

.1 Ensure services are installed and inspected prior to installation of retarder. Install sheet vapour retarder below slab on grade assemblies prior to placing concrete form continuous retarder.

.2 Use sheets of largest practical size to minimize joints.

.3 Inspect for continuity. Repair punctures and tears with sealing tape before work is concealed.

3.2 **Exterior Surface Openings**

.1 Cut sheet vapour retarder to form openings and ensure material is lapped and sealed to penetration.
VAPOUR RETARDERS

3.3 Perimeter Seals

.1 Seal perimeter of sheet vapour barrier as follows:
   .1 Apply continuous bead of sealant to substrate at perimeter of sheets.
   .2 Lap sheet over sealant and press into sealant bead.
   .3 Ensure that no gaps exist in sealant bead. Smooth out folds and ripples occurring in sheet over sealant.
   .4 Tape all joints.

3.4 Lap Joint Seals

.1 Seal lap joints of sheet vapour barrier as follows:
   .1 Attach first sheet to substrate.
   .2 Apply continuous bead of sealant over solid backing at joint.
   .3 Lap adjoining sheet minimum 150 mm and press into sealant bead.
   .4 Ensure that no gaps exist in sealant bead. Smooth out folds and ripples occurring in sheet over sealant.
   .5 Tape all joints.

3.5 Penetrations

.1 Seal penetrations to vapour barrier as follows:
   .1 Wrap with film sheet providing minimum 300 mm perimeter lap flange.
   .2 Apply sealant or tape to seal edges of flange to main vapour barrier and seal penetrations.

END OF SECTION
1. GENERAL

1.1 Related Sections

1. Cast-in-place Concrete - Section 03300
2. Precast Concrete - Section 03410

1.2 References

1. American Society for Testing and Materials International (ASTM)

1.3 Submittals

1. Product data:
   1. Submit manufacturer's printed product literature, specifications, and data sheet in accordance with Section 01330 - Submittals.

2. Manufacturer's Instructions:
   1. Submit manufacturer's installation instructions.

1.4 Delivery, Storage, and Handling

1. Store packaged material in original containers with manufacturer's labels and seals intact.
2. Prevent damage to materials during handling and storage. Keep materials under cover and free from damp conditions.

1.5 Environmental Requirements

1. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.
.2 Do not start work until conditions are satisfactory. Commencement of work signifies acceptance of conditions.

.3 Consult other trades in advance and make provisions for work of other trades to avoid cutting and patching.

.4 Protect surrounding surfaces from damage.

1.6 Sequencing

.1 Sequence work to ensure air barrier and vapour retarder materials are in place before beginning the Work of this section.

1.7 Waste Management and Disposal

.1 Separate waste materials for recycling.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

2. PRODUCTS

2.1 Insulation

.1 Under slab perimeter Insulation: Closed Cell Polyisocyanurate

   .1 Compressive strength: Minimum 35 psi.

   .2 Thermal Resistance: Minimum R of 5.0/inch.

   .3 Total thickness: 51mm.

2.2 Accessories

.1 Foundation Sealing Compound: Bitumen sealing compound.

.2 Adhesive: All-purpose construction adhesive in accordance with insulation manufacturer’s written recommendations.

3. EXECUTION

3.1 Manufacturer’s Instructions

.1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
3.2 Examination

.1 Verification of Conditions: Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for insulation installation in accordance with manufacturer's written recommendations.

.2 Verify substrate surface is flat, free from irregularities and materials, or substances that may impede adhesive bond.

.3 Start of insulation installation indicates installer’s acceptance of substrate installation conditions.

3.3 Installation – Foundation Perimeter

.1 Follow directives of surface preparation required in the manufacturer's literature.

.2 Apply adhesive in three (3) continuous beads per board length to full bed 3mm thick. Daub adhesive tight to protrusions. Mechanically fasten panels to framing.

.3 Install boards on foundation wall perimeter.

.4 Place boards in a method to maximize contact bedding.

.5 Stagger joints.

.6 Butt edges and ends tight to adjacent board and to protrusions.

.7 Cut and fit insulation tight to protrusions or interruptions to the insulation plane.

.8 Install next layer of insulation perpendicular to first layer.

3.4 Protection

.1 Protect installed products and accessories from damage during construction.

.2 Repair damage to adjacent materials caused by insulation installation.
1. GENERAL

1.1 Related Sections

.1 Section 06100 - Rough Carpentry-Short Form
.2 Section 08111 - Metal Doors and Frames
.3 Section 09110 - Non-Structural Metal Framing

1.2 References

.1 American Society for Testing and Materials International (ASTM)


.2 Underwriters Laboratories of Canada (ULC)


2. PRODUCTS

2.1 Insulation

.1 Acceptable Material: ROXUL INC., ROXUL COMFORTBATT™.

3. EXECUTION

3.1 Manufacturer’s Instructions

.1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.2 Insulation Installation

.1 Install insulation to maintain continuity of thermal protection to building elements and spaces.

.2 Fit insulation closely around electrical boxes, pipes, ducts, frames and other objects in or passing through insulation.

.3 Do not compress insulation to fit into spaces.
.4 Keep insulation minimum 75 mm from heat emitting devices such as recessed light fixtures, and minimum 50 mm from sidewalls of CAN/ULC-S604 Type A chimneys and CAN/CGA-B149.1 and CAN/CGA-B149.2 Type B and L vents.

.5 Do not enclose insulation until it has been reviewed by Consultant.

END OF SECTION
1. GENERAL

1.1 Related Requirements

.1 Section 07120 – Bituminous Damp Proofing
.2 Section 07212 – Board Insulation
.3 Section 07213 – Blanket Insulation
.4 Section 07410 – Preformed Metal Siding
.5 Section 07620 – Sheet Metal Flashing and Trim
.6 Section 08111 – Metal Doors & Frames

1.2 References

.1 Underwriters Laboratories of Canada (ULC)
   .1 CAN/ULC – S741-08(R2016), Standard for Air Barrier Materials.
   .2 CAN/ULC – S742-11(R2016), Standard for Air Barrier Assemblies.

1.3 Action and Informational Submittals

.1 Product data:
   .1 Submit manufacturer's printed product literature, specifications, and datasheet, and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Quality Assurance Submittals: submit the following in accordance with Section 1450 - Quality Control.
   .1 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.

1.4 Quality Assurance

.1 Qualifications:
   .1 Applicator: company specializing in performing work of this section.

.2 Mock-Up:
   .1 Construct mock-up in accordance with Section 01450 - Quality Control.
.2 Construct typical exterior wall panel, 3 m wide by height of wall, incorporating door frame, insulation, building corner condition, junction with roof system; illustrating materials interface and seals.

.3 Locate where directed.

.4 Mock-up may remain as part of finished work.

.5 Allow 48 hours for inspection of mock-up by Consultant before proceeding with air/vapour barrier Work.

1.5 Delivery, Storage, and Handling

.1 Deliver, store, and handle materials in accordance with manufacturer’s written instructions.

1.6 Ambient Conditions

.1 Install solvent curing sealants and vapour release adhesive materials in open spaces with ventilation.

.2 Ventilate enclosed spaces in accordance with manufacturers’ requirements.

.3 Maintain temperature, and humidity recommended by materials manufacturers before, during, and after installation.

1.7 Sequencing

.1 Sequence work in accordance with Construction Progress Schedule.

.2 Sequence work to permit installation of materials in conjunction with related materials and seals.

1.8 Warranty

.1 Warranty: include coverage of installed sealant and sheet materials which:

.1 Fail to achieve air tight and watertight seal.

.2 Exhibit loss of adhesion or cohesion.

.3 Do not cure.

2. PRODUCTS

2.1 Air Barrier (Air/Vapour Barrier) Assembly

.1 Materials:
AIR BARRIERS

.1 Membrane: 3M™ Self-Adhered Air and Vapor Barrier Membrane 3015
  .1 Description: Tan colored, semi-transparent proprietary film with acrylic adhesive and silicone coated release liner.
  .2 Weight: 464 g/m2
  .3 Total membrane thickness: ASTM D3652, 0.25 mm.

.2 Accessory Materials:
  .1 Sealant: 3M™ Polyurethane Sealant 540; a one component, moisture curing sealant
    .1 ASTM C920, Type S, Grade NS, Class 25
    .2 Tack free: 60-90 minutes at 73° F at 50% relative humidity
  .2 Sealant: 3M™ Polyurethane Construction Sealant 525; a one component, moisture curing sealant
    .1 ASTM C920, Type S, Grade NS, Class 25
    .2 Tack free: 90-150 minutes at 73° F at 50% relative humidity
  .3 Flashing: 3M™ Self-Adhered Air and Vapor Barrier Membrane 3015 in detail widths
    .1 Description: Tan colored, semi-transparent proprietary film with acrylic adhesive and silicone coated release liner.
    .2 Total membrane thickness: ASTM D3652, 0.25 mm.
  .4 Primer: recommended by sealant manufacturer, appropriate to application.

3. EXECUTION

3.1 Manufacturer’s Instructions
  .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage, and installation instructions and data sheets.

3.2 Examination
  .1 Verify that surfaces and conditions are ready to accept work of this section.
AIR BARRIERS

.2 Ensure surfaces are clean, dry, sound, smooth, continuous, and comply with air barrier manufacturer's requirements.

.3 Report unsatisfactory conditions to Consultant in writing.

.4 Do not start work until deficiencies have been corrected.

   .1 Beginning of Work implies acceptance of conditions.

3.3 Preparation

.1 Remove loose or foreign matter, which might impair adhesion of materials.

.2 Ensure substrates are clean of oil or excess dust; masonry joints struck flush, and open joints filled; and concrete surfaces free of large voids, spalled areas or sharp protrusions.

.3 Ensure substrates are free of surface moisture prior to application of self-adhesive membrane and primer.

.4 Ensure metal closures are free of sharp edges and burrs.

.5 Prime substrate surfaces to receive adhesive and sealants in accordance with manufacturer's instructions.

3.4 Installation

.1 Install materials in accordance with manufacturer's instructions.

.2 Cut membrane to length and wind up into a roll. Fold the starting edge back over itself to crease the paper release liner. Peel back the liner to expose the 75mm starting strip of the membrane. Do not contaminate the starting strip with dust or debris before applying it to the intended surface.

.3 Stagger all vertical joints if membrane installed in “weatherboard” or “shingle fashion”. Stagger all horizontal joints if membrane installed in vertical strips.

.4 Align and set the membrane in place, rolling the product back against the exposed adhesive. Simultaneously unwind the roll pulling the release liner, maintaining pressure against the substrate to tack the membrane in place. Wipe the membrane down with a feathering motion from the middle outward to obtain a smooth surface.

.5 Lap a minimum of 50mm on sides and ends. Roll the membrane with a rubber roller to ensure a tight seal against the wall and between overlapped edges.

.6 Install 150mm wide membrane at inside and outside vertical corners and construction joints, lapping a minimum of 50mm on either side.
AIR BARRIERS

.7 Carefully execute detail work to ensure a continuously sealed building envelope.

.8 Through-wall flashings: Seal top edge of through-wall flashing with air barrier sealant. Lap membrane over sealed through-wall flashing top edge minimum 50mm.

.9 Transitions to adjacent systems: See the Drawings for project specific detailing of transitions to the roof, foundation waterproofing, and door systems.

.10 Repair all wrinkles and fish mouths extending within 50mm of the membrane edge with a repair membrane piece extending 150mm beyond the defect.

.11 Window, Door and Louver Openings:

.1 Wrap rough openings as detailed in the Drawings with either flashing or membrane material in detail widths.

.2 Install sealant at each inside corner of the window sill, jamb, and head.

.3 Apply detail strips of membrane at each inside corner extending the full depth of the sill and a minimum 50mm onto the face.

.4 Install detail strips at the sill, jambs, and head in lengths beyond window opening extending the full depth of the sill.

.5 Apply reinforcing piece cut into a football, bowtie, or butterfly shape at each corner.

.6 Install membrane in “weatherboard” or “shingle fashion” with a minimum 50mm overlap at all detail strips.

.12 Penetrations:

.1 Seal all penetrations with sealant. Install flashing or membrane material cut to length to allow installation around the full circumference of penetration.

.2 Masonry Ties or Anchors:

.1 Post-applied: Install backplate of tie or anchor over the air barrier with self-tapping screws. Apply sealant over the screw heads.

.2 Knife plate: Cut a one piece membrane to overlap minimum 50mm in each direction of the knife plate. Cut a slot for the knife plate and apply the membrane over. Apply sealant at the knife plate penetration perimeter.

.13 Utilities, Pipes, Conduit, and Duct Penetrations:

.1 Apply sealant between the penetration and the exterior wall.
AIR BARRIERS

.2 Apply membrane to allow continuous 2 inch overlap onto vent/pipe penetration and cut “fingers” to transition to the exterior wall.

.3 Install a narrow membrane collar strip around the circumference of the penetration perimeter, lapping onto the penetration and substrate.

.4 Install one piece membrane with penetration shape cut out on to the substrate. Apply over “fingers” on the substrate and extend a minimum of 2 inches beyond the penetration perimeter.

.5 Apply sealant at the penetration perimeter and cut edge of the one piece membrane.

.14 Substrate transitions and building joints: See Drawings for project specific detailing with backer rod, sealant, and membrane.

.15 Repairs: Apply membrane 150mm larger than test or damage area. Seal leading cut edges of membrane with sealant.

3.5 Protection of Work

.1 Protect air barrier materials from damage during installation and the remainder of the construction period.

.2 Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction and acceptable to the air barrier assembly manufacturer.

.3 Ensure finished work is protected from climatic conditions.

END OF SECTION
1. GENERAL

1.1 Action and Informational Submittals

.1 Shop Drawings:
   .1 Submit shop drawings in accordance with Section 01330 - Submittals.
   .2 Indicate dimensions, profiles, attachment methods, schedule of wall elevations, trim and closure pieces, soffits, fascia, metal furring, and related work.

.2 Samples:
   .1 Submit samples in accordance with Section 01330 - Submittals.
   .2 Submit duplicate 300 x 300 mm samples of siding material, of colour and profile specified.

.3 Manufacturer’s Instructions:
   .1 Submit manufacturer's installation instructions.

2. PRODUCTS

2.1 Steel Cladding and Components

.1 Prefinished Cladding
   .1 VicWest AD 300R.
      .1 Minimum CSSBI/MGS 0.760 mm, design (nominal) base thickness.
      .2 Finish substrate: WeatherXL finish to exposed side. Contractor shall allow for two (2) colours.

2.2 Accessories

.1 Exposed trim: inside corners, outside corners, cap strip, drip cap, undersill trim, starter strip and window/door trim of same material, colour and gloss as cladding.

2.3 Fasteners

.1 Same material as sheet metal, to CSA B111, ring thread flat head roofing nails of length and thickness suitable for metal flashing application.

.2 Washers of same material as sheet metal, 1 mm thick with rubber packings.
3. EXECUTION

3.1 Manufacturer's Instructions

.1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.2 Installation

.1 Install cladding in accordance with CGSB 93.5, and manufacturer's written instructions.

.2 Install continuous starter strips, inside and outside corners, edgings, soffit, drip, cap, sill flashings as indicated.

.3 Install outside corners, fillers and closure strips with carefully formed and profiled work.

.4 Maintain joints in exterior cladding, true to line, tight fitting, hairline joints.

.5 Attach components in manner not restricting thermal movement.

END OF SECTION
1. **GENERAL**

1.1 **Related Requirements**

.1 Section 05500 – Metal Fabrications

.2 Section 07620 – Sheet Metal Flashing and Trim

.3 Section 09110 – Non-Structural Metal Framing

.4 Section 09250 – Gypsum Board Assemblies

1.2 **References**

.1 Roofing Contractors Association of British Columbia (RCABC).


1.3 **Action and Informational Submittals**

.1 Provide submittals in accordance with Section 01330 - Submittals.

.2 Product Data:

.1 Provide technical roofing components data sheets describing materials' physical properties and include product characteristics, performance criteria, physical size, finish, fasteners, adhesives, and limitations.

.3 Provide shop drawings:

.1 Indicate flashing, control joints, tapered insulation details.

.2 Provide layout for tapered insulation.

.4 Each shop drawing submitted shall bear the signature and stamp of a qualified Professional Engineer registered in the province of British Columbia. Submit permit Schedules B-1, B-2, and field review and compliance Schedule C-B to the Architect. Indicate design criteria used (BCBC, RCABC/RGC, ULC FM, Manufacturer or specify other), values used and limiting factor (interfacing material, attachment method, attachment spacing, substrate or specify other).

.5 Design Criteria: Design roofing system to withstand design criteria loads. Comply with the most restrictive requirement noted below.

.6 Comply with snow (S), wind (W) and earthquake (E) requirements resulting from BCBC 2012 Specified Loads and Effects 4.1.2, Sentence 4.1.2.1(3), Table 4.1.2.1 Importance Categories for Buildings: Importance Category: Normal.
.7 Specified support system distributed and point loading capacities.

.8 Supporting materials and system interfacing materials load capacities with proposed attachment systems.

.9 Submit applicable CAN/ULC S-107M Class C roof membrane listings.

1.4 Close Out Submittals

.1 Provide submittals in accordance with Section 01770 – Close-out Procedures.

.2 Product Data:

.1 Provide technical roofing components data sheets describing materials' physical properties and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Provide confirmation of fastening to CSA A123.21.04 for mechanical fastened systems.

.3 Provide manufacturer's standard material warranties, minimum ten (10) years.

1.5 Quality Assurance

.1 Installer qualifications: company or person specializing in application of modified bituminous roofing systems with five (5) years documented experience and approved by manufacturer.


1.6 Delivery, Storage, and Handling

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions and Section 01606 – Shipment, Protection, and Storage.

.2 Storage and Handling Requirements:

.1 Deliver and store materials in original containers with manufacturer's labels and seals intact.

.2 Safety: comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of asphalt, sealing compounds, primers and caulking materials.

.3 Provide and maintain dry, off-ground weatherproof storage.
1.7 **Site Conditions**

.1 Ambient Conditions:

.1 Temperature, relative humidity, moisture content.

.1 Apply TPO membrane only when surfaces and ambient temperatures are within manufacturers' prescribed limits.

.2 Do not install TPO membrane when temperature remains below +5 degrees C, or when wind chill gives equivalent cooling effect.

.3 Install TPO membrane on dry substrate, free of snow and ice. Use only dry materials and apply only during weather that will not introduce moisture into system.

2. **PRODUCTS**

2.1 **Performance Criteria**

.1 Compatibility between components of roofing system is essential. Provide written declaration to Consultant stating that materials and components, as assembled in system, meet this requirement. If materials are not compatible, contractor shall propose an equivalent system and no additional cost to the Owner.

.2 Roofing System: to CSA A123.21 for wind uplift resistance.

2.2 **Deck Covering**

.1 Glass Mat, in accordance with Section 09250 – Gypsum Board Assemblies
2.3 Deck Primer
   .1 Roll or spray applied deck primer.
   .1 Carlisle CCW 702 Primer.

2.4 Vapour Retarder
   .1 1.016mm thick composite consisting of 0.9mm Self-adhering rubberized asphalt membrane laminated to an 0.127mm UV resistance poly film with an anti-skid surface.
   .1 Carlisle 725TR Air and Vapour Barrier.

2.5 Polyisocyanurate Insulation
   .1 Closed-cell polyisocyanurate foam insulation board laminated on both sides with a non-organic (type 3) facer, mechanically fastened, R 5.7 per inch to meet R20, tapered insulation as required to slope to drains.
   .1 Carlisle SecurShield Polyisocyanurate

2.6 Membrane
   .1 Reinforced Thermoplastic Polyolefin (TPO) membrane:
   .1 Carlisle Sure-Weld Gray TPO, 1.524mm thick

2.7 Primers, Adhesive, Sealants, and Cleaners
   .1 As recommended by the membrane manufacturer and approved by RCABC.

2.8 Accessories
   .1 Flashings, cover strips, pre-molded corners, pipe seals, tubing wraps, sealant pockets, termination strips, distribution plates as recommended by membrane manufacturer.

3. EXECUTION

3.1 Quality of Work
   .1 Do examination, preparation and roofing Work in accordance with manufacturers written recommendations and RCABC Roofing Specification Manual, particularly for fire safety precautions.
3.2 Examination of Roof Decks

.1 Verification of Conditions:

.1 Inspect with deck conditions including parapets, construction joints, roof drains, plumbing vents and ventilation outlets to determine readiness to proceed.

.2 Evaluation and Assessment:

.1 Prior to beginning of work ensure:

.1 Decks are firm, straight, smooth, dry, free of snow, ice or frost, and swept clean of dust and debris. Do not use calcium or salt for ice or snow removal.

.2 Curbs have been built.

.3 Roof drains have been installed at proper elevations relative to finished roof surface.

.4 Sheathing has been installed to deck, walls and parapets as indicated.

.5 Confirm deck is reviewed by structural engineer and deficiencies corrected.

.6 Confirm deck meets Specification requirements.

.7 Confirm vapour retarder membrane has been installed below curbs and is suitable for continuity tie-in with roof vapour retarder membrane.

.8 Ensure membrane substrate is rigid, dry, smooth, compatible, free of fins and sharp edges, and clean of all debris and foreign matter.

.3 Do not install roofing materials during rain or snowfall.

3.3 Deck Sheathing

.1 Mechanically fasten to steel deck Glass Mat Gypsum Board with screws to steel deck's upper rib surfaces, spaced 400 mm on centre each way and aligned.

.2 Place with long axis of each sheet transverse to steel deck ribs, with end joints staggered and fully supported on ribs.

3.4 Priming Deck

.1 Apply deck primer to deck substrate at the rate recommended by manufacturer.
3.5 Vapour Retarder

.1 Adhere vapour retarder using solvent based adhesive as per manufacturer's instructions.

3.6 Protected Membrane Roofing (PMR) Application

.1 Insulation application: fully adhered, adhesive application:
   .1 Adhere insulation using solvent-based adhesive.
   .2 Place boards in parallel rows with ends staggered, and in firm contact with one another.
   .3 Cut end pieces to suit.

.2 Membrane
   .1 Install fully adhered membrane and flashing in accordance with ASTM D4434 and manufacturer's written instructions.
   .2 Separation sheet.
   .3 Install separation sheet loosely laid over insulation.
   .4 Overlap edges 300 mm minimum.
   .5 Slit separation sheet to fit over penetrations. Cut out around drains and other openings.

.3 Flashings
   .1 Install TPO membrane flashings in accordance with manufacturer's written instructions.

.4 Roof penetrations
   .1 Install roof drain pans, vent stack covers and other roof penetration flashings and seal to membrane in accordance with manufacturer's recommendations and details as indicated.

3.7 Cleaning

.1 Progress Cleaning: clean in accordance with Section 01741 – Final Cleaning.
   .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 Section 01741 – Final Cleaning.

.3 In areas where finished surfaces are soiled caused by work of this section, consult manufacturer of surfaces for cleaning advice and complying with their documented instructions.

.4 Check drains to ensure cleanliness and proper function, and remove debris, equipment and excess material from site.

.5 Repair or replace defaced or disfigured finishes caused by work of this section.

END OF SECTION
1. GENERAL

1.1 Related Requirements

.1 Section 05500 – Metal Fabrications
.2 Section 07620 – Sheet Metal Flashing and Trim
.3 Section 09110 – Non-Structural Metal Framing
.4 Section 09250 – Gypsum Board Assemblies

1.2 References

.1 Roofing Contractors Association of British Columbia (RCABC).

1.3 Action and Informational Submittals

.1 Provide submittals in accordance with Section 01330 - Submittals.

.2 Product Data:
   .1 Provide technical roofing components data sheets describing materials' physical properties and include product characteristics, performance criteria, physical size, finish, fasteners, adhesives, and limitations.

.3 Provide shop drawings:
   .1 Indicate flashing, control joints, tapered insulation details.
   .2 Provide layout for tapered insulation.

.4 Each shop drawing submitted shall bear the signature and stamp of a qualified Professional Engineer registered in the province of British Columbia. Submit permit Schedules B-1, B-2, and field review and compliance Schedule C-B to the Architect. Indicate design criteria used (BCBC, RCABC/RGC, ULC FM, Manufacturer or specify other), values used and limiting factor (interfacing material, attachment method, attachment spacing, substrate or specify other).

.5 Design Criteria: Design roofing system to withstand design criteria loads. Comply with the most restrictive requirement noted below.

.6 Comply with snow (S), wind (W) and earthquake (E) requirements resulting from BCBC 2012 Specified Loads and Effects 4.1.2, Sentence 4.1.2.1(3), Table 4.1.2.1 Importance Categories for Buildings: Importance Category: Normal.
VEGETATED PROTECTED MEMBRANE ROOFING

.7 Specified support system distributed and point loading capacities.

.8 Supporting materials and system interfacing materials load capacities with proposed attachment systems.

.9 Submit applicable CAN/ULC S-107M Class C roof membrane listings.

1.4 Close Out Submittals

.1 Provide submittals in accordance with Section 01770 – Close-out Procedures.

.2 Product Data:

.1 Provide technical roofing components data sheets describing materials' physical properties and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Provide confirmation of fastening to CSA A123.21.04 for mechanical fastened systems.

.3 Provide manufacturer's standard material warranties, minimum ten (10) years.

1.5 Quality Assurance

.1 Installer qualifications: company or person specializing in application of modified bituminous roofing systems with five (5) years documented experience and approved by manufacturer.


1.6 Delivery, Storage, and Handling

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions and Section 01606 – Shipment, Protection, and Storage.

.2 Storage and Handling Requirements:

.1 Deliver and store materials in original containers with manufacturer's labels and seals intact.

.2 Safety: comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of asphalt, sealing compounds, primers, and caulking materials.

.3 Provide and maintain dry, off-ground weatherproof storage.
.4 Store rolls of felt and membrane in upright position. Store membrane rolls with salvage edge up.

.5 Remove only in quantities required for same day use.

.6 Store membrane rolls in heated enclosures prior to use where climatic conditions warrant and as recommended by manufacturer; bring only enough rolls for immediate use to work area.

.7 Store combustible materials away from heat and open flame.

.8 Place plywood runways over completed Work to enable movement of material and other traffic.

.9 Store sealants at +5 degrees C minimum.

.10 Store insulation protected from daylight and weather and deleterious materials.

1.7 Site Conditions

.1 Ambient Conditions:

.1 Do not install roofing when temperature remains below -18 degrees C for torch application, or -5 degrees C and to manufacturers’ recommendations for mop application.

.2 Minimum temperature for solvent-based adhesive is -5 degrees C.

.2 Install roofing on dry deck, free of snow and ice. Use only dry materials and apply only during weather that will not introduce moisture into roofing system.

2. PRODUCTS

2.1 Performance Criteria

.1 Compatibility between components of roofing system is essential. Provide written declaration to Consultant stating that materials and components, as assembled in system, meet this requirement. If materials are not compatible, contractor shall propose an equivalent system and at no additional cost to the Owner.

.2 Roofing System: to CSA A123.21 for wind uplift resistance.

2.2 Deck Covering

.1 Glass Mat, in accordance with Section 09250 – Gypsum Board Assemblies.
VEGETATED PROTECTED MEMBRANE ROOFING

2.3 Deck Primer

.1 Roll or spray applied deck primer.

.1 Elastocol Stick.

2.4 Vapour Retarder

.1 Self-adhesive membrane composed of SBS modified bitumen, with a surface screen made of high-density polyethylene laminated between two layers of polyethylene films.

.1 Sopravap'R by Soprema.

2.5 Polyisocyanurate Insulation

.1 Closed-cell polyisocyanurate foam insulation board laminated on both sides with a non-organic (type 3) facer, mechanically fastened, R 5.7 per inch to meet R20, tapered insulation as required to slope to drains.

.1 Sopra-Iso Plus by Soprema.

2.6 Overlay Board

.1 Protection board: asphaltic core between asphalt saturated fibreglass facers to CAN/CSA-A247-M, Type1, square edges, 4.8 mm thick, as recommended by the membrane manufacturer and approved by RCABC.

.1 Sopraboard by Soprema.

2.7 Membrane

.1 Base sheet:

.1 Sopraply Base 520 by Soprema.

.2 Cap sheet:

.1 Sopraply Traffic Cap 560 by Soprema.

2.8 Root Barrier

.1 Polyethylene 30 mil completes the protection against roots.

.1 Polyethylene 30 mil by Soprema
2.9 Drainage Panel

.1 High-strength drainage panel consisting of a polypropylene core with a factory-laminated geotextile.

.1 Sopradrain 10-G by Soprema

2.10 Primers, Adhesive, Sealants, and Cleaners

.1 As recommended by the membrane manufacturer and approved by RCABC.

2.11 Sleeves

.1 Sleeves for mechanical and electrical piping and conduits, guardrail post sleeves: “Thaler New Standard Stack jack Flashings”, aluminum, insulated liner, EPDM pressure grommet seal top and bottom, diameter and height to suit application.

2.12 Growing Medium

.1 Description: Growing medium consisting of an unconsolidated mixture of organic matter and mineral aggregates with a particle size under 16 mm. The composition must be specially formulated by the vegetated roofing system manufacturer for extensive or semi-intensive systems, to provide optimal water retention, permeability, structural stability and density.

.2 Non-irrigated extensive systems, with plants with low water needs: sedums, perennials and some grasses.

.3 Specified Product: SOPRAFLOR X by SOPREMA.

2.13 Vegetation

.1 Meadow seed mix composed of perennials and grasses like surrounding existing vegetation.

3. EXECUTION

3.1 Quality of Work

.1 Do examination, preparation, and roofing Work in accordance with manufacturers’ written recommendations and RCABC Roofing Specification Manual, particularly for fire safety precautions.

3.2 Examination of Roof Decks

.1 Verification of Conditions:
VEGETATED PROTECTED MEMBRANE ROOFING

.1 Inspect with deck conditions including parapets, construction joints, roof drains, plumbing vents and ventilation outlets to determine readiness to proceed.

.2 Evaluation and Assessment:

.1 Prior to beginning of work ensure:

.1 Decks are firm, straight, smooth, dry, free of snow, ice or frost, and swept clean of dust and debris. Do not use calcium or salt for ice or snow removal.

.2 Curbs have been built.

.3 Roof drains have been installed at proper elevations relative to finished roof surface.

.4 Sheathing has been installed to deck, walls and parapets as indicated.

.5 Confirm deck is reviewed by structural engineer and deficiencies corrected.

.6 Confirm deck meets Specification requirements.

.7 Confirm vapour retarder membrane has been installed below curbs and is suitable for continuity tie-in with roof vapour retarder membrane.

.8 Ensure membrane substrate is rigid, dry, smooth, compatible, free of fins and sharp edges, and clean of all debris and foreign matter.

.3 Do not install roofing materials during rain or snowfall.

3.3 Deck Sheathing

.1 Mechanically fasten to steel deck Glass Mat Gypsum Board with screws to steel deck's upper rib surfaces, spaced 400 mm on centre each way and aligned.

.2 Place with long axis of each sheet transverse to steel deck ribs, with end joints staggered and fully supported on ribs.

3.4 Priming Deck

.1 Apply deck primer to deck substrate at the rate recommended by manufacturer.

3.5 Vapour Retarder

.1 Adhere vapour retarder using solvent based adhesive as per manufacturer's instructions.
VEGETATED PROTECTED MEMBRANE ROOFING

3.6 (Exposed) Conventional Membrane Roofing (CMR) Application

.1 Insulation: fully adhered, adhesive application:
   .1 Adhere insulation to steel deck laminated vapour barrier using solvent-based adhesive.
   .2 Place boards in parallel rows with ends staggered, and in firm contact with one another.
   .3 Cut end pieces to suit.
   .4 Apply adhesive in continuous ribbons at 300 mm on centre.
   .5 Separate the membrane and insulation with a drainage layer or slipsheet.

.2 Overlay Board: adhesive application
   .1 Install overlay board in accordance with shop drawings, membrane manufacturer’s and RCABC standards.
   .2 Adhere overlay board to insulation.
   .3 Place boards in parallel rows with end joints staggered. Cap joints approximately 25 mm.
   .4 Cut ends to suit and apply adhesive in continuous ribbons at 300 mm on centre.

.3 Flashings
   .1 Complete installation of flashing base sheet stripping prior to installing membrane base and cap sheet.
   .2 Cut membrane in 1 m wide, the roll width, by the length required to suit detail.
   .3 Prime substrates.
   .4 Extend membrane base flashing minimum 100 mm out onto roof from toe of cant, up interior vertical surface of parapet, across top of parapet, and down outside face of parapet 75mm minimum under cap flashing.
   .5 Stagger side laps in membrane base flashing minimum 300 mm from side and end laps in roof membrane cap sheet.
   .6 Install adhesive membrane base flashing according to membrane manufacturer’s written instruction and RCABC/RGC requirements.
VEGETATED PROTECTED MEMBRANE ROOFING

.7 Properly secure flashings to their support, without sags, blisters, fishmouths or wrinkles.

.8 Do work in accordance with manufacturer's recommendations Section 07620 - Sheet Metal Flashing and Trim.

.4 Base sheet application:

.1 Starting at low point of roof, perpendicular to slope, unroll base sheet, align and reroll from both ends.

.2 Unroll and embed base sheet in uniform coating of adhesive.

.3 Unroll and torch base sheet onto substrate taking care not to damage membrane or its reinforcement or substrate.

.4 Lap sheets 75 mm minimum for side and 150 mm minimum for end laps.

.5 Application to be free of blisters, wrinkles and fishmouths.

.5 Cap sheet application:

.1 Starting at low point on roof, perpendicular to slope, unroll cap sheet, align and reroll from both ends.

.2 Unroll and embed cap sheet in uniform coating of adhesive.

.3 Unroll and torch cap sheet onto base sheet taking care not to damage membrane or its reinforcement.

.4 Lap sheets 75 mm minimum for side laps and 150 mm minimum for end laps. Offset joints in cap sheet 300 mm minimum from those in base sheet.

.5 Application to be free of blisters, fishmouths and wrinkles.

.6 Do membrane application in accordance with manufacturer's recommendations.

.7 Press firmly into place using a damp cloth; remove air pockets.

.6 Roof penetrations

.1 Install roof drain pans, vent stack covers and other roof penetration flashings and seal to membrane in accordance with manufacturer's recommendations and details as indicated.

3.7 Cleaning

.1 Remove bituminous markings from finished surfaces.
.2 In areas where finished surfaces are soiled caused by work of this section, consult manufacturer of surfaces for cleaning advice and complying with their documented instructions.

.3 Repair or replace defaced or disfigured finishes caused by work of this section.

END OF SECTION
1. GENERAL

1.1 Related Requirements

.1 Section 07540 – Thermoplastic Polyolefin Roofing
.2 Section 07560 – Vegetated Protected Membrane Roofing
.3 Section 07900 – Joint Sealants
.4 Section 08111 – Metal Doors & Frames
.5 Section 09110 – Non-Structural Metal Framing

1.2 References

.1 Roofing Contractors Association of British Columbia (RCABC).
.2 Sheet Metal and Air Conditioning Contractors’ National Association (SMACNA)

1.3 Action and Informational Submittals

.1 Provide submittals in accordance with Section 01330 - Submittals.
.2 Product Data:
   .1 Submit manufacturer’s printed product literature for sheet metal flashing systems materials, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
.3 Samples:
   .1 Submit 200 x 50 mm samples of each type of sheet metal material, finishes, and colours.

1.4 Quality Assurance

.1 Qualifications:
   .1 Applicator: company specializing in performing work of this section.
2. PRODUCTS

2.1 Sheet Metal Materials

.1 Prefinished Sheet Material:
   .1 Minimum CSSBI/MGS 0.610 mm (24 gauge), design (nominal) base thickness.
   .2 Aluminum zinc coated, commercial grade A to AZM165/AZ55 sheet steel.

.2 Heavy Gauge Prefinished Sheet Material:
   .1 Minimum CSSBI/MGS 1.6 mm (16 gauge), design (nominal) base thickness.
   .2 Aluminum zinc coated, commercial grade A to AZM165/AZ55 sheet steel.

.3 Finish coating:
   .1 Kynar 500, Hylar 5000 PVDF or WeatherXL finish both sides to match metal siding finish coating.
   .2 Allow for three colours.

2.2 Accessories

.1 Isolation coating: alkali resistant bituminous paint.

.2 Plastic cement: to CAN/CGSB 37.5.
   .1 Maximum VOC limit 50 g/L.

.3 Underlay for metal flashing: dry sheathing to CAN/CGSB-51.32 3.6.

.4 Sealants: one part polysulfide to 19_GP_13, colour to match adjacent surface.
   .1 Maximum VOC limit 50.

.5 Cleats: of same material, and temper as sheet metal, minimum 50 mm wide. Thickness same as sheet metal being secured.

.6 Fasteners: of same material as sheet metal, to CSA B111, ring thread flat head roofing nails of length and thickness suitable for metal flashing application.

.7 Washers: of same material as sheet metal, 1 mm thick with rubber packings.

.8 Solder: to ASTM B32, 50% tin and 50% lead.
.9 Flux: rosin, cut hydrochloric acid, or commercial preparation suitable for materials to be soldered.

.10 Touch-up paint: as recommended by prefinished material manufacturer.

.1 Maximum VOC limit 50 g/L to Standard GS-11.

2.3 Fabrication

.1 Fabricate metal flashings, gutters and other sheet metal work to applicable RCABC and SMACNA specifications as indicated.

.2 Form pieces in 2400mm maximum lengths.

.1 Make allowance for expansion at joints.

.3 Hem exposed edges on underside 12 mm.

.1 Mitre and seal corners with sealant.

.4 Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.

.5 Apply isolation coating to metal surfaces to be embedded in concrete or mortar.

.6 Provide standing seam joints on non-vertical portions of roof flashings.

2.4 Metal Flashings

.1 Form flashings, copings and fascias to profiles indicated of prefinished sheet steel unless noted otherwise on details and in specification.

.2 Exterior and interior corners shall be preformed.

2.5 Pans

.1 Form pans to receive roofing plastic from galvanized steel sheet metal with minimum 75 mm up stand above finished roof and 100 mm continuous flanges with no open corners. Solder joints.

.1 Make pans minimum 50 mm wider than member passing through roof membrane.

2.6 Cap Flashings

.1 Form metal cap flashing from prefinished steel sheet metal in accordance with RCABC standards and recommendations and as detailed.
2.7 Scuppers

.1 Form scuppers from prefinished steel sheet metal.

.2 Sizes and profiles in accordance with RCABC standards and recommendations and as detailed.

.3 Provide necessary fastenings.

3. EXECUTION

3.1 Manufacturer’s Instructions

.1 Compliance: comply with manufacturer’s written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 Installation

.1 Install sheet metal work in accordance with RCABC and SMACNA standards and as detailed.

.2 Use concealed fastenings except where approved before installation.

.3 Counter flash flashings at intersections of roof with vertical surfaces and curbs.

.1 Flash joints using standing seams forming tight fit over hook strips, unless noted otherwise.

.4 Lock end joints and caulk with sealant.

.5 Insert metal flashing under cap flashing to form weather tight junction.

.6 Caulk flashing at cap flashing with sealant.

.7 Install pans and scuppers where shown around items projecting through roof membrane to RCABC details. Fill voids with plastic cement.

.8 Where flashings do not overlay roof membranes provide underlayment of self-adhesive waterproof membrane.

END OF SECTION
1. GENERAL

1.1 Section Includes

.1 Materials, preparation, and application for caulking and sealants.

.2 Related to other various Sections containing sealant or caulking specifications.

1.2 Related Sections

.1 Sheet Metal Flashing and Trim - Section 07620

.2 Metal Doors and Frames - Section 08111

1.3 References

.1 American Society for Testing and Materials International (ASTM)

.1 ASTM C919-08, Standard Practice for Use of Sealants in Acoustical Applications.

.2 Canadian General Standards Board (CGSB)


.4 CAN/CGSB-19.17-M90, One-component Acrylic Emulsion Base Sealing Compound.

.5 CAN/CGSB-19.24-M90, Multi-component, Chemical Curing Sealing Compound.

.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.4 Action and Informational Submittals

.1 Product data:
JOINT SEALANTS

.1 Submit manufacturer's instructions, printed product literature and data sheets for joint sealants and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Colours of sealants to be selected by the Consultant from the range of manufacturer’s standard colours.

1.5 Project Conditions

.1 Environmental Limitations:

.1 Do not proceed with installation of joint sealants under following conditions:

.1 When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 5 degrees C.

.2 When joint substrates are wet.

.2 Joint-Width Conditions:

.1 Do not proceed with installation of joint sealants where joint widths are less or more than those allowed by joint sealant manufacturer for applications indicated.

.3 Joint-Substrate Conditions:

.1 Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

1.6 Environmental Requirements

.1 Conform to manufacturer's recommended temperatures, relative humidity, and substrate moisture content for application and curing of sealants including special conditions governing use.

1.7 Warranty

.1 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer. Include coverage for installed sealants and accessories which fail to achieve air tight seal or water tight, or other failure, exhibit loss of adhesion or cohesion, staining adjacent surfaces or do not cure.
2. **PRODUCTS**

2.1 **Sealant Materials**

1. Do not use caulking that emits strong odours, contains toxic chemicals or is not certified as mould resistant in air handling units.

2. Where sealants are qualified with primers use only these primers.

2.2 **Sealant Material Designations**

1. Type 1: Multi-component, polyepoxide urethane sealant. To meet specified requirements of CGSB specification CAN/CGSB-19.24-M90, Type 2, Class B. Acceptable product, Dymeric 240, Dymeric 240 FC by Temco Ltd., Sikafles II, Vulkem. Use at all locations, except where another type is specified.

2. Type 2: Mildew resistant, one component neutral cure silicone sealant. Meeting the specified requirements of specification CGSB-19GP22M. Tremsil 600 by Tremco Ltd. Use on fixtures and vanity tops (white at white fixtures, clear elsewhere), between glazed tiles, junction of washroom fixtures to floors, junction of vanities to walls and between finished resilient base and door frames.

3. Type 4: One component, paintable acrylic latex sealant. Meeting the specified requirements of specification CGSB-19-GP-17M. Tremflex 834 by Tremco Ltd. Use in interior non-moving joints that may be painted.

2.3 **Joint Cleaner**

1. Non-corrosive and non-staining type, compatible with joint forming materials and sealant recommended by sealant manufacturer.

2. Primer: as recommended by manufacturer.

3. Joint Backing: ASTM D1056; round, foam rod; oversized 30 to 50 percent larger than joint width.

4. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

3. **EXECUTION**

3.1 **Examination**

1. Verify that substrate surfaces and joint openings are ready to receive work.

2. Verify that joint backing and release tapes are compatible with sealant.
3.2 Protection

.1 Protect installed Work of other trades from staining or contamination.

3.3 Surface Preparation

.1 Examine joint sizes and conditions to establish correct depth to width relationship for installation of backup materials and sealants.

.2 Clean bonding joint surfaces of harmful matter substances including dust, rust, oil grease, and other matter which may impair Work.

.3 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings unless tests have been performed to ensure compatibility of materials. Remove coatings as required.

.4 Ensure joint surfaces are dry and frost free.

.5 Prepare surfaces in accordance with manufacturer's directions.

3.4 Priming

.1 Where necessary to prevent staining, mask adjacent surfaces prior to priming and caulking.

.2 Prime sides of joints in accordance with sealant manufacturer's instructions immediately prior to caulking.

3.5 Backup Material

.1 Apply bond breaker tape where required to manufacturer's instructions.

.2 Install joint filler to achieve correct joint depth and shape, with approximately 30% compression.

3.6 Application

.1 Sealant

.1 Apply sealant in accordance with manufacturer's written instructions.

.2 Mask edges of joint where irregular surface or sensitive joint border exists to provide neat joint.

.3 Apply sealant in continuous beads.

.4 Apply sealant using gun with proper size nozzle.
.5 Use sufficient pressure to fill voids and joints solid.

.6 Form surface of sealant with full bead, smooth, free from ridges, wrinkles, sags, air pockets, embedded impurities.

.7 Tool exposed surfaces before skinning begins to give slightly concave shape.

.8 Remove excess compound promptly as work progresses and upon completion.

.2 Curing

.1 Cure sealants in accordance with sealant manufacturer's instructions.

.2 Do not cover up sealants until proper curing has taken place.

.3 Cleanup

.1 Clean adjacent surfaces immediately and leave Work neat and clean.

.2 Remove excess and droppings, using recommended cleaners as work progresses.

.3 Remove masking tape after initial set of sealant.

END OF SECTION
1. GENERAL

1.1 Related Requirements

.1 Section 06100 – Rough Carpentry – Short Form
.2 Section 07270 – Air Barriers
.3 Section 07900 – Joint Sealants
.4 Section 08710 – Door Hardware
.5 Section 08800 – Glazing

1.2 References

.1 Canadian Steel Door Manufacturers’ Association (CSDMA)
   .3 CSDMA, Recommended Specifications for Commercial Steel Door and Frame Products, 2006.

1.3 Action and Informational Submittals

.1 Provide product data: in accordance with Section 01330 - Submittals.
   .1 Indicate each type of door, material, steel core thicknesses, mortises, reinforcements, location of exposed fasteners, openings, glazed, louvered, arrangement of hardware and fire rating and finishes.
   .2 Indicate each type frame material, core thickness, reinforcements, glazing stops, location of anchors and exposed fastenings, reinforcing and fire rating.
   .3 Include schedule identifying each unit, with door marks and numbers relating to numbering on drawings and door schedule.

2. PRODUCTS

2.1 Materials

.1 Hot dipped galvanized steel sheet: to ASTM A653M, ZF75, minimum base steel thickness in accordance with CSDMA Table 1 - Thickness for Component Parts.
.2 Reinforcement channel: to CSA G40.20/G40.21, Type 44W, coating designation to ASTM A653M, ZF75.

2.2 Door Core Materials

.1 Doors 1.2 mm minimum base thickness commercial grade cold rolled roller sheet steel to ASTM A653, CS, Type B, coating designation ZF75 (A25) minimum. Minimum thickness to be increased to suit Appendix 1 of CSDMA, manufacturing requirements and Labeling Authorities requirements.

.2 Stiffened: face sheets welded, uninsulated, or insulated core.

.1 Insulation: Fibreglass or mineral wool, type to suit manufacturing and labeling authorities’ requirements.

2.3 Adhesives

.1 Honeycomb cores and steel components: heat resistant, spray grade, resin reinforced neoprene/rubber (polychloroprene) based, low viscosity, contact cement.

.2 Lock-seam doors: fire resistant, resin reinforced polychloroprene, high viscosity, sealant/adhesive.

2.4 Primer

.1 Touch-up prime CAN/CGSB-1.181.

2.5 Accessories

.1 Door silencers: single stud rubber/neoprene type.

.2 Exterior and interior top caps: steel.

.3 Fabricate glazing stops as formed channel, minimum 16 mm height, accurately fitted, butted at corners and fastened to frame sections with counter-sunk oval head sheet metal screws.

.4 Metallic paste filler: to manufacturer’s standard.

.5 Make provisions for glazing as indicated and provide necessary glazing stops.

.1 Provide removable stainless steel glazing beads for use with glazing tapes and compounds and secured with countersunk stainless steel screws.

.2 Design exterior glazing stops to be tamperproof.
2.6 Frames Fabrication General

.1 Fabricate frames in accordance with CSDMA specifications.

.2 Frames 1.6 mm base thickness steel.

.3 Floor anchors, channel spreaders and wall anchors, minimum 1.6 mm base thickness steel.

.4 Guard boxes, minimum 0.72 mm base thickness steel.

.5 Fabricate frames to profiles and maximum face sizes as indicated.

.6 Exterior and interior frames: 1.6 mm welded type construction.

.7 Blank, reinforce, drill and tap frames for mortised, templated hardware, and electronic hardware using templates provided by finish hardware supplier. Reinforce frames for surface mounted hardware.

.8 Protect mortised cutouts with steel guard boxes.

.9 Conceal fastenings except where exposed fastenings are indicated.

.10 Provide factory applied touch up primer at areas where zinc coating has been removed during fabrication.

.11 Insulate exterior frame components with polyurethane insulation.

2.7 Frame Anchorage

.1 Provide appropriate anchorage to floor and wall construction.

.2 Locate each wall anchor immediately above or below each hinge reinforcement on hinge jamb and directly opposite on strike jamb.

.3 Provide 2 anchors for rebate opening heights up to 1520 mm and 1 additional anchor for each additional 760 mm of height or fraction thereof.

.4 Locate anchors for frames in existing openings not more than 150 mm from top and bottom of each jambs and intermediate at 660 mm on centre maximum.

2.8 Frames: Welded Type

.1 Welding in accordance with CSA W59.

.2 Accurately mitre or mechanically joint frame product and securely weld on inside of profile.
.3 Cope accurately and securely weld butt joints of mullions, transom bars, centre rails and sills.

.4 Grind welded joints and corners to a flat plane, fill with metallic paste and sand to uniform smooth finish.

.5 Securely attach floor anchors to inside of each jamb profile.

.6 Weld in 2 temporary jamb spreaders per frame to maintain proper alignment during shipment.

2.9 Door Fabrication General

.1 Doors: swing type, flush, with provision for glass and/or louvre openings as indicated.

.2 Exterior and interior doors: insulated construction with internal stiffeners.

.3 Fabricate doors with longitudinal edges locked seam and welded. Seams: grind welded joints to a flat plane, fill with metallic paste filler and sand to a uniform smooth finish.

.4 Blank, reinforce, drill doors and tap for mortised, templated hardware and electronic hardware.

.5 Reinforce doors where required, for surface mounted hardware. Provide flush steel top caps to all doors. Provide factory applied touch up primer at areas where zinc coating has been removed during fabrication.

.6 Provide fire labeled doors for those openings requiring fire protection ratings, as scheduled. Test such products in conformance with CAN4-S104 or NFPA 252 and list by nationally recognized agency having factory inspection service and construct as detailed in Follow Up Service Procedures/Factory Inspection Manuals issued by listing agency to individual manufacturers.

3. EXECUTION

3.1 Manufacturer’s Instructions

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage, and installation instructions and data sheets.

3.2 Installation General

.1 Install labeled steel fire rated doors and frames to NFPA 80 except where specified otherwise.
3.3 Frame Installation

.1 Set frames plumb, square, level and at correct elevation.

.2 Secure anchorages and connections to adjacent construction.

.3 Brace frames rigidly in position while building-in. Install temporary horizontal wood spreader at third points of door opening to maintain frame width. Provide vertical support at centre of head for openings over 1200 mm wide. Remove temporary spreaders after frames are built-in.

.4 Make allowances for deflection of structure to ensure structural loads are not transmitted to frames.

.5 Maintain continuity of air barrier.

3.4 Door Installation

.1 Install doors and hardware in accordance with hardware templates and manufacturer's instructions and Section 08710 - Door Hardware.

.2 Provide even margins between doors and jambs and doors and finished floor and thresholds as follows.

.1 Hinge side: 3.0 mm.

.2 Latchside and head: 3.5 mm.

.3 Finished floor, noncombustible sill and thresholds: 12 mm.

.3 Adjust operable parts for correct function.

3.5 Finish Repairs

.1 Touch up with primer finishes damaged during installation.

3.6 Glazing

.1 Install glazing for doors in accordance with Section 08800 - Glazing.

END OF SECTION
1. GENERAL

1.1 Related Sections

.1 Section 08111 – Metal Doors & Frames

1.2 References

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and data sheet in accordance with Section 01330 - Submittals.

.2 Hardware List:

.1 Submit contract hardware list in accordance with Section 01330 - Submittals.

.2 Indicate specified hardware, including make, model, material, function, size, finish and other pertinent information.

.3 Manufacturer's Instructions:

.1 Submit manufacturer's installation instructions.

.4 Closeout Submittals

.1 Provide operation and maintenance data for hardware for incorporation into manual specified in Section 01770 - Closeout Procedures.

1.3 Delivery, Storage, and Handling

.1 Packing, Shipping, Handling and Unloading:

.1 Deliver, store, handle and protect materials in accordance with Section 01606 – Shipment, Protection, and Storage.

.2 Package each item of hardware including fastenings, separately or in like groups of hardware, label each package as to item definition and location.

.2 Storage and Protection:

.1 Store finishing hardware in locked, clean and dry area.
DOOR HARDWARE - GENERAL

2. PRODUCTS

2.1 Hardware Items

.1 Use one manufacturer's products only for similar items.

2.2 Door Hardware

.1 Locks and latches:

.1 Schlage, L9000 Series.

.1 Lever handles: 03.

.2 Latch Set: L9010.

.3 Lock Set: Storeroom lock L9080P 06B

.4 Finishes: US32D.

.2 Electrical Strike:

.1 Von Durpin 6211 FSE

.1 For single leaf door.

.2 Von Durpin EL98/99 Series

.1 For double door with one active leaf, locking hardware is to be Electric Strike or Retracting Panic Grade 1 Panic Bar with Electrical latch and contact.

.3 Transfer Hinge:

.1 Von Durpin EPT10 or,

.2 Stanley CS series

.4 Butts and hinges:

.1 Interior doors: Stanley RPFBB191 or Hager BB1191

.2 Exterior doors: Stanley RPFBB191 (Non removable Pin) or Hager BB1191 (Non removable Pin)

.5 Flush Bolt:

.1 Hager 282D
.6 Self-closing device:
   .1 LCN 4110 series
      .1 Covers: 4110-72MC
      .2 Arms: 4110-3049SCNS

.7 Astragal:
   .1 By metal door supplier.

.8 Kick Down Door Holder:
   .1 Hager 270C.

.9 Door Plate: 762 mm high, 1mm thickness, all edges beveled, aluminum, mechanically fastened, US32D finish.
   .1 Hager 194S

.10 Door position switch:
   .1 Schlage 679-05M or,
   .2 Honeywell 7939 WG

.11 Thresholds:
   .1 Pemko 2716A

.12 Weather stripping:
   .1 Head and jamb seal: Pemko 29310 CPK
   .2 Door bottom seal: Pemco 234 APK

.13 Rain drip:
   .1 Pemko 346C

.14 Access Control System: By Chubb Edwards

2.3 Fastenings
   .1 Supply screws, bolts, expansion shields and other fastening devices required for satisfactory installation and operation of hardware.
.2 Exposed fastening devices to match finish of hardware.

.3 Where pull is scheduled on one side of door and push plate on other side, supply fastening devices, and install so pull can be secured through door from reverse side. Install push plate to cover fasteners.

.4 Use fasteners compatible with material through which they pass.

3. EXECUTION

3.1 Manufacturer’s Instructions

.1 Compliance: comply with manufacturer’s written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

.2 Furnish door and frame manufacturers with complete instructions and templates for preparation of their work to receive hardware.

.3 Furnish manufacturers’ instructions for proper installation of each hardware component.

3.2 Installation

.1 Install hardware to standard hardware location dimensions in accordance with Canadian Metric Guide for Steel Doors and Frames (Modular Construction) prepared by Canadian Steel Door and Frame Manufacturers’ Association.

.2 Use only manufacturer’s supplied fasteners. Failure to comply may void manufacturer’s warranties and applicable licensed labels. Use of “quick” type fasteners, unless specifically supplied by manufacturer, is unacceptable.

.3 Remove construction cores when directed by Departmental Representative; install permanent cores and check operation of locks.

3.3 Adjusting

.1 Adjust door hardware, operators, closures and controls for optimum, smooth operating condition, safety and for weather tight closure.

.2 Lubricate hardware, operating equipment and other moving parts.

.3 Adjust door hardware to provide tight fit at contact points with frames.

END OF SECTION
1. **GENERAL**

1.1 **Related Requirements**

.1 Section 08111 – Metal Doors & Frames

1.2 **References**

.1 Canadian General Standards Board (CGSB)

   .1 CAN/CGSB-12.1-M90, Tempered or Laminated Safety Glass.

   .2 CAN/CGSB-12.2-M91, Flat, Clear Sheet Glass.

   .3 CAN/CGSB-12.8-97, Insulating Glass Units.

   .4 CAN/CGSB-12.8-97 (Amendment), Insulating Glass Units.

   .5 CAN/CGSB-12.12-M90, Plastic Safety Glazing Sheets.

1.3 **Action and Informational Submittals**

.1 Submit in accordance with Section 01330 - Submittals.

.2 Product Data:

   .1 Submit manufacturer's instructions, printed product literature and data sheets for glass, sealants, and glazing accessories and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 **Delivery, Storage, and Handling**

.1 Deliver, store and handle materials in accordance with Section 01606 – Shipment, Protection, and Storage and 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 and protect glazing and frames from nicks, scratches, and blemishes.

   .2 Replace defective or damaged materials with new.

1.5 **Warranty**

.1 Provide warranty for sealed units.
2. PRODUCTS

2.1 Materials

.1 Flat Glass:


.2 Laminated safety glass: to CAN/CGSB-12.1, transparent.

.1 Type 1-laminated.

.2 Class B-float.

.3 Polished edge treatment where exposed

.3 Tempered safety glass: to CAN/CGSB-12.1, transparent.

.1 Type 2-tempered.

.2 Class B-float.

.3 Polished edge treatment where exposed.

.4 Category II 540 J impact resistance.

.5 Complete with heat soaking.

.6 6mm minimum thickness unless noted otherwise.

.4 Plastic glazing: to CAN/CGSB-12.12, clear, 8 mm thick.

.1 Material: Polycarbonate.

.2 Category: 2.

.3 Light Transmission: minimum 80%.

.2 Insulating Glass Units:

.1 Insulating glass units: to CAN/CGSB-12.8, double unit, 25mm overall thickness.

.1 Inter-cavity space thickness: 13mm between inner and outer lights with low conductivity spacers.

.2 Glass coating: surface number 2, low "E".
.3 Inert gas fill: argon.

.3 Primer, sealers, and cleaners: Dow Corning® 999 A Silicone Building and Glazing Sealant.

.1 VOC limit 250 g/L maximum.

2.2 Accessories

.1 Setting blocks and spacers: neoprene, size and thickness as required by glass size and weight.

.2 Glazing tape: As supplied by glazing and window system manufacturer and specified in each glazing and window system section.

.3 Glazing compound: Sealant colour shall be black.

.4 Glazing clips: manufacturer's standard type.

.5 Primer, sealers, and cleaners: Refer to Section 07900 Joint Sealants for VOC content limitations. Dow Corning® 999_A Silicone Building and Glazing Sealant.

3. EXECUTION

3.1 Examination

.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for glazing installation in accordance with manufacturer's written instructions.

.1 Verify that openings for glazing are correctly sized and within tolerance.

.2 Verify that surfaces of glazing channels or recesses are clean, free of obstructions, and ready to receive glazing.

3.2 Glazing Preparation

.1 Clean contact surfaces with solvent and wipe dry.

.2 Seal porous glazing channels or recesses with substrate compatible primer or sealer.

.3 Prime surfaces scheduled to receive sealant.

3.3 Installation

.1 Refer to drawings for glass type locations note noted herein.
.2 Manufacturer’s Instructions: comply with manufacturer’s written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

.3 Install glass with glazing materials, specified in accordance with manufacturers' recommendations for each type of installation. All installations to be permanently air and water tight under all conditions.

.4 Refer to frame elevations and window elevations.

END OF SECTION
Division 9
1. GENERAL

1.1 Scope

.1 The work of this Section shall include the supply and installation non-load bearing steel stud framing, and associated accessories.

.2 All drawing and specification references to steel framing, steel studs, z-bars, hat track sections, and framing channels, furring channels, angles and similar descriptions all refer to this Section implies all forms of such framing.

1.2 Related Requirements

.1 Section 07410 – Preformed Metal Siding
.2 Section 07620 – Sheet Metal Flashing and Trim
.3 Section 08111 – Metal Doors & Frames
.4 Section 09250 – Gypsum Board Assemblies

1.3 References

.1 ASTM C645-07a Standard Specification for Non-structural Steel Framing Members.
.3 ASTM C955-06 Standard for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases.
.4 ASTM C1007-04 Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories.

1.4 Design Criteria

.1 Design Engineer by this Section. Comply with the most restrictive requirement noted below:

.1 Comply with earthquake (E) requirements resulting from BCBC 2012 Specified Loads and Effects 4.1.2, Sentence 4.1.2.1(3), Table 4.1.2.1 Importance Categories for Buildings: Importance Category Normal.

.2 Design wall systems and installation to withstand imposed axial loads, and lateral loads
.3 Calculate in accordance with British Columbia Building Code and applicable local regulations or as shown on the drawings.

.4 Deflection of the systems under live loading shall not exceed 1/240th of the span at 360 Pa.

.5 Design wall system to prevent structural system deflection transferring vertical loads to walls using double deflection tracks under structure or slide clips between structure and wall.

.6 Exterior stud partitions thickness after galvanizing to be design base steel thickness 0.478 mm (25 ga) minimum.

1.5 Quality Assurance

.1 All materials and installation shall comply with the most restrictive requirement noted below or elsewhere in the Section:

.1 Current Association of Wall and Ceiling Contractors of B.C. (AWCC) Specification Standards Manual, together with authorized additions and amendments shall be used as a reference standard and shall form part of this project specification.

.2 Current Canadian Sheet Steel Building Institute Technical Bulletins and Guide Specifications.

.3 CAN/CSA-S136-0, CAN/CGSB-7.1-98 for interior walls.

1.6 Delivery, Storage, and Handling

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions and Common Product Requirements.

.2 Storage and Handling Requirements:

.1 Store packaged material in original containers with manufacturers’ seals and labels intact.

.2 Prevent damage to materials during handling and storage. Keep materials under cover and free from dampness.

2. PRODUCTS

2.1 General

.1 Conform to CSA136.
NON-STRUCTURAL METAL FRAMING

2.2 Steel Framing Members

.1 Knurled faces, pre-punched pass through holes and hemmed edges to flange returns and lips.

.2 Flange depth shall be 32 mm minimum, stud widths 41 mm, 64 mm, 92 mm, 100, and 152 mm as shown on drawings.

.3 Steel studs shall be colour coded for gauge.

2.3 Furring Channels

.1 Hat shaped sections, knurled faced roll formed, 68.2 mm wide with 35 mm face, 22 mm deep.

.2 Interior: minimum 0.46 mm material

2.4 Sheet Steel Angles and Plates

.1 Sheet steel angles and bent plates as detailed shall be formed of .939 mm galvanized sheet steel.

2.5 Proprietary Connectors

.1 Manufactured specialty connectors for stud to steel or concrete structural framing including deflection capable clips between exterior wall studs and structural members.

3. EXECUTION

3.1 Coordination

.1 Coordinate work with related Sections.

.2 Provide additional vertical and horizontal members at corners, deflection joints, openings and finish changes.

3.2 Workmanship

.1 Steel studs and steel furring shall be erected by mechanics skilled in this trade and as follows.
.2 Finished work shall be rigid, secure, square, level or plumb, framed and erected to maintain the finish wall line dimensions and contours indicated.

3.3 Installation of Steel Stud

.1 Install steel stud as indicated on drawings.

.2 Coordinate sequence of installation with various trades whose materials and/or services are being installed within the partitions.

.3 Fix studs to runners by screws or by crimping.

.4 Unless noted otherwise install steel studs vertically at 400 mm OC maximum and not more than 50 mm from abutting construction, openings and each side of corners and termination with dissimilar materials.

.5 Splice interior studs only where necessary by boxing and lap minimum four (4) times the width of steel studs. Fasten with two screws or rivets per stud flange located not more than 25 mm from ends of splice.

.6 Reinforce all 64 mm steel studs with flat strip bridging at 1200 mm OC maximum.

.7 Reinforce double steel stud walls exceeding 2700mm in height by connecting between double studs with 64mm stud horizontal tie at quarter points and mid point.

.8 Where horizontal runs of service lines are to be installed and if standard openings in studs are too small for service lines, splice studs together as necessary, splice piece to be minimum 300 mm longer than height of the cutout; splice as specified above.

.9 Reinforce and frame all openings in steel stud partitions to adequately carry loads, by the use of additional framing members.

3.4 Installation of Furring

.1 Install all vertical and horizontal furring as indicated and as required, complete with metal furring steel studs and/or furring channels. Secure to structure.

.2 Steel stud furring members shall be spaced 400 OC maximum. Where board is applied to one side only brace horizontally at 1200 mm OC.

.3 Set furring studs in track, top and bottom.

.4 Shim furring studs level as required.

.5 For furring installed horizontally, attach a furring stud not more than 100 mm from both floor and ceiling lines. For furring installed vertically, attach a furring stud not more than 100 mm from abutting walls.
.6 Secure with hardened nails, power actuated fasteners or equivalent fastenings. Maximum spacing 600 mm alternating to opposite flanges.

END OF SECTION
1. GENERAL

1.1 Related Requirements

1.2 References

1.3 Delivery, Storage, and Handling

2. PRODUCTS

2.1 Materials
3. EXECUTION

3.1 General

.1 Do not apply glass mat sheathing until bucks, anchors, blocking, insulation, vapour barrier, electrical and mechanical work which will be concealed after gypsum board application are approved by Owners Consultants.

.2 Install wallboard by mechanics skilled in this trade in accordance with the following application standards to produce a first class job.

.3 The work shall be properly co-ordinated with the work of other trades.

3.2 Exterior Glass Mat Sheathing Application

.1 Apply Exterior Glass Mat Sheathing to exterior steel stud framing for walls, parapets, fascia and soffits.

.2 Boards to be installed with tight butt joints and free of broken edges, corners or other damage.

.3 Replace any boards installed with over driven screws damaging the exterior facing.

.4 Confirm screws are penetrating through framing and achieving full capacity.

.5 Screws found not to be penetrating framing are to be left in place and covered with a self adhesive membrane patch 100mm x 100mm.

END OF SECTION
1. **GENERAL**

1.1 **Related Work**

.1 Section 03300 – Cast-in-Place Concrete

1.2 **Submittals**

.1 Submit in accordance with Division 1.

.2 Submit sample of floor coating on plywood for review by the consultant.

1.3 **Qualifications**

.1 Applicators: factory trained with a minimum of two (2) years proven experience for projects of similar size and complexity and approved by the manufacturer.

.2 Manufacturer: use products and materials from same source for entire project.

1.4 **Quality Assurance**

.1 Manufacturer: provide an experienced technical representative to review installation procedures and to regularly inspect the work during installation to verify compliance with specifications and details.

.2 To ensure a high degree of quality control, representatives from the contractor, installer, manufacturer and the consultant convene a pre-installation conference at the job site to review material selections, substrate preparations, joint conditions and installation procedures.

.3 Prior to commencement of work, the floor coating manufacturer’s representative shall inspect and certify:

.1 That the surfaces on which the floor coating is to be applied are in good condition and suitable for the application of membrane;

.2 That environmental conditions for application of coating are within limits prescribed by the manufacturer; and

.3 That materials to be applied conform in all respects with the requirements of these specifications.

1.5 **Delivery, Storage, and Handling**

.1 Deliver materials to the site in original containers with labels and seals intact and store in accordance with manufacturer’s printed instructions and Section 01500 – Temporary Facilities.
.2 Store liquid membrane at temperatures prescribed by the manufacturer. Keep liquid away from open flames or excessive heat.

1.6 Environmental Conditions

.1 Environmental conditions for installation: within the limits prescribed by the manufacturer.

.2 Provide forced air circulation during curing period for enclosed applications to control dangerous vapour buildup, odours and fumes.

1.7 Job Mock-Up

.1 Prepare in accordance with Section 01330 – Submittals.

.2 Do first 10 m² or one day’s work location as directed by Engineer. Do not proceed further without approval of Engineer.

2. PRODUCTS

2.1 Materials

.1 High build epoxy coating to the following properties for the cured resin:

<table>
<thead>
<tr>
<th>Description</th>
<th>Test Method</th>
<th>Results</th>
</tr>
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<tbody>
<tr>
<td>Compressive strength</td>
<td>astm d695</td>
<td>24000 psi min.</td>
</tr>
<tr>
<td>Impact resistance</td>
<td>mil d 3134 Sec. 4.7.3</td>
<td>Passes 16 ft/lbs</td>
</tr>
<tr>
<td>Taber abrasion</td>
<td>astm d4060</td>
<td>24.7 mg.</td>
</tr>
<tr>
<td>Adhesion to concrete</td>
<td>aci 403</td>
<td>breaks concrete</td>
</tr>
<tr>
<td>Tensile strength &amp; break</td>
<td>astm d638</td>
<td>3700 psi.</td>
</tr>
<tr>
<td>Elongation &amp; break</td>
<td>astm d638</td>
<td>25.1%</td>
</tr>
<tr>
<td>Flexural strength</td>
<td>astm d790</td>
<td>3180 psi.</td>
</tr>
<tr>
<td>Flexural modules</td>
<td>astm d790</td>
<td>57.7 x 103 psi.</td>
</tr>
<tr>
<td>Shore d hardness</td>
<td>stm d2240</td>
<td>78.5</td>
</tr>
<tr>
<td>Water absorption (24 hr)</td>
<td>astm d570</td>
<td>0.2%</td>
</tr>
<tr>
<td>Fungus &amp; bacteria resistance</td>
<td>mil-f-52505</td>
<td>no support of growth under Tt-p-34.</td>
</tr>
</tbody>
</table>

.2 Chemical resistant urethane top coat to the following properties:

<table>
<thead>
<tr>
<th>Description</th>
<th>Test Method</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile</td>
<td>astm d412</td>
<td>5,000 psi</td>
</tr>
<tr>
<td>Elongation</td>
<td>astm d412</td>
<td>10%</td>
</tr>
<tr>
<td>Abrasion resistance</td>
<td>astm c501</td>
<td>.025 mg loss/1000 rev-cs17 wheel.</td>
</tr>
<tr>
<td>Hardness</td>
<td>astm d2240</td>
<td>95+</td>
</tr>
<tr>
<td>Gloss</td>
<td></td>
<td>90+</td>
</tr>
<tr>
<td>Volume solids</td>
<td>calculated</td>
<td>52.5%</td>
</tr>
</tbody>
</table>
.3 Acceptable product: Stonhard Stonkote GS4, or approved equal.

.4 Colour: as selected by the consultant from manufacturer’s complete range of available colours.

.5 Acceptable primers: Stoncrest GS3 or HT primer by Stonhard, or approved equal.

.6 Acceptable installers for floor coating: Stonhard.

3. EXECUTION

3.1 Examination

.1 Examine surfaces to receive coating to ensure they are smooth, dry, and free from conditions that will adversely affect execution, permanence, or quality of work.

.2 Install coating after other work, which penetrates membrane, has been completed.

.3 Allow concrete to cure a minimum of 28 days and take moisture tests to determine if substrate moisture content is acceptable for application of materials.

3.2 Preparation

.1 Prepare surfaces to receive epoxy coating in accordance with manufacturer’s instructions.

.2 Steel shot blast the concrete surface to remove surface contaminants.

.3 Vigorously scrub surfaces contaminated with oil or grease with a power broom and a strong, non-sudsing detergent. Thoroughly wash, clean, and dry.

.4 Seal cracks using materials approved by the manufacturer.

3.3 Installation

.1 Apply primer at rate as recommended by the manufacturer.

.2 Apply membrane with a rubber squeegee at a rate not to exceed 12 m² per 4.55 litres or as recommended by manufacturer.

.3 Back roll wet material with a high quality, short napped phenolic core roller to ensure even coverage.

3.4 Temporary Protection

.1 Provide temporary barriers to protect topping membrane during curing period.

END OF SECTION
1. **GENERAL**

1.1 **Related Requirements**

   .1 Section 04 05 12 – Concrete Unit Masonry
   
   .2 Section 06 20 00 – Finish Carpentry
   
   .3 Section 07 92 10 – Joint Sealing
   
   .4 Section 08 11 14 – Metal Doors & Frames

1.2 **References**

   .1 The latest edition of the following reference standards shall govern all painting work:

       .1 Architectural Painting Specification Manual by the Master Painters Institute (MPI), including Identifiers, Evaluation, Systems, Preparation and Approved Product List. (hereafter referred to as the MPI Painting Manual) as issued by the local MPI Accredited Quality Assurance Association having jurisdiction.

1.3 **Quality Assurance**

   .1 Only qualified journeypersons, as defined by local jurisdiction shall be engaged in painting and decorating work. Apprentices may be employed provided they work under the direct supervision of a qualified journeyperson in accordance with trade regulations.

   .2 Materials, preparation and workmanship shall conform to requirements of the latest edition of the Architectural Painting Specification Manual by the Master Painters Institute (MPI) (hereafter referred to as the MPI Painting Manual) as issued by the local MPI Accredited Quality Assurance Association having jurisdiction.

   .3 Paint manufacturers and products used shall be as listed under the Approved Product List section of the MPI Painting Manual

1.4 **Action and Informational Submittals**

   .1 Submit in accordance with Section 01330 - Submittals.

   .2 Samples:

       .1 Submit duplicate 200 x 300 mm sample panels of each paint, stain, clear coating, and special finish with specified paint or coating in colours, gloss/sheen and textures required to MPI Painting Specification Manual standards.
1.5 **Delivery, Storage, and Handling**

.1 Deliver, store and handle materials in accordance with Section 01606 – Shipment, Protection, and Storage and with manufacturer's written instructions.

1.6 **Site Conditions**

.1 **Temperature, Humidity and Substrate Moisture Content Levels:**

.1 Apply paint finishes when ambient air and substrate temperatures at location of installation can be satisfactorily maintained during application and drying process, within MPI and paint manufacturer's prescribed limits.

.2 Test concrete, masonry and plaster surfaces for alkalinity as required.

.3 Apply paint to adequately prepared surfaces, when moisture content is below paint manufacturer's prescribed limits.

.2 **Additional application requirements:**

.1 Apply paint finish in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.

.2 Apply paint in occupied facilities during silent hours only. Schedule operations to approval of Consultant such that painted surfaces will have dried and cured sufficiently before occupants are affected.

2. **PRODUCTS**

2.1 **Materials**

.1 **Volatile Organic Compound (VOC) Content:**

.1 Provide coatings that comply with the most stringent requirements specified in the following:


.2 Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.
.2 Compatibility: Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

.3 Acceptable Manufacturer:
   .1 Benjamin Moore and Co.
   .2 Dulux.

2.2 Colours
   .1 Consultant will provide Colour Schedule.
   .2 Colour schedule will be based upon selection of three (3) base colours and three (3) accent colours.
   .3 Selection of colours will be from manufacturer’s full range of colours.
   .4 Where specific products are available in restricted range of colours, selection will be based on limited range.
   .5 Second coat in three coat system to be tinted slightly lighter colour than top coat to show visible difference between coats.

2.3 Interior Painting Systems
   .1 Concrete vertical surfaces:
      .1 INT 3.1L WB Light Industrial G3– MPI # 3 (Primer, Alkali Resistant, Water Based) & MPI # 151 (Light Industrial Coating, Interior, Water Based G3),
   .2 Concrete horizontal surfaces: floors:
      .1 INT 3.2G – MPI # 99 (Sealer, Water Based, for Concrete Floors)
   .3 Structural steel and metal fabrications: columns, beams, joists:
      .1 INT 5.1B WB Light Industrial G5– MPI # 107 (Primer, Rust-Inhibitive, Water Based) & MPI # 153 Light Industrial Coating, Interior, Water Based G5)
   .4 Galvanized metal: doors, frames, railings, misc. steel, pipes, overhead decking, and ducts.
      .1 INT 5.3K WB Light Industrial G5– MPI # 107 (Primer, Rust-Inhibitive, Water Based) & MPI # 153 (Light Industrial Coating, Interior, Water Based G5)
   .5 Bituminous coated surfaces: cast iron pipe, concrete, etc.:
PAINTING

.1 INT 10.2A G5 – MPI # 107 (Primer, Rust-Inhibitive, Water Based) & MPI # 54 Latex, Interior G5)

2.4 Exterior Painting Systems

.1 Concrete vertical surfaces:

.1 EXT 3.1C WB Light Industrial G3– MPI # 3 (Primer, Alkali Resistant, Water Based) & MPI # 161 (Light Industrial Coating, Exterior, Water Based G3),

.2 Concrete horizontal surfaces: floors:

.1 EXT 3.2H – MPI # 99 (Sealer, Water Based, for Concrete Floors)

.3 Structural steel and metal fabrications: columns, beams, joists:

.1 EXT 5.1M WB Light Industrial G5– MPI # 107 (Primer, Rust-Inhibitive, Water Based) & MPI # 163 Light Industrial Coating, Exterior, Water Based G5)

.4 Galvanized metal: doors, frames, railings, misc. steel, pipes, overhead decking, and ducts.

.1 EXT 5.3J WB Light Industrial G5– MPI # 107 (Primer, Rust-Inhibitive, Water Based) & MPI # 163 (Light Industrial Coating, Exterior, Water Based G5)

.5 Bituminous coated surfaces: cast iron pipe, concrete, etc.:

.1 EXT 10.2A G5 – MPI # 107 (Primer, Rust-Inhibitive, Water Based) & MPI # 11 Latex, Exterior G5)

3. EXECUTION

3.1 General

.1 Compliance: comply with manufacturer’s written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheets.

.2 Perform preparation and operations for interior painting in accordance with MPI - Architectural Painting Specifications Manual and MPI - Maintenance Repainting Manual except where specified otherwise.

3.2 Examination

.1 Investigate existing substrates for problems related to proper and complete preparation of surfaces to be painted. Report to Consultant damages, defects, unsatisfactory or unfavourable conditions before proceeding with work.
.2 Conduct moisture testing of surfaces to be painted using properly calibrated electronic moisture meter, except test concrete floors for moisture using simple "cover patch test". Do not proceed with work until conditions fall within acceptable range as recommended by manufacturer.

3.3 Preparation

.1 Protection of in-place conditions:

.1 Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore surfaces as directed by Consultant.

.2 Protect items that are permanently attached such as Fire Labels on doors and frames.

.3 Protect factory finished products and equipment.

.2 Surface Preparation:

.1 Remove electrical cover plates, light fixtures, surface hardware on doors, bath accessories and other surface mounted equipment, fittings and fastenings prior to undertaking painting operations. Identify and store items in secure location and re-installed after painting is completed.

.2 Move and cover furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.

.3 Place "WET PAINT" signs in occupied areas as painting operations progress.

.4 Clean and prepare surfaces in accordance with MPI - Architectural Painting Specification Manual and MPI - Maintenance Repainting Manual specific requirements and coating manufacturer's recommendations.

.5 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint, or pretreatment as soon as possible after cleaning and before deterioration occurs.

.6 Where possible, prime non-exposed surfaces of new wood surfaces before installation. Use same primers as specified for exposed surfaces.

.1 Apply vinyl sealer to MPI #36 over knots, pitch, sap and resinous areas.

.2 Apply wood filler to nail holes and cracks.

.3 Tint filler to match stains for stained woodwork.
.7 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 1000 mm.

.8 Clean metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with MPI requirements.

.9 Touch up of shop primers with primer as specified.

3.4 Application

.1 Use method of application approved by Consultant.

.1 Conform to manufacturer’s application recommendations.

.2 Apply coats of paint in continuous film of uniform thickness.

.1 Repaint thin spots or bare areas before next coat of paint is applied.

.3 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.

.4 Sand and dust between coats to remove visible defects.

.5 Finish surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as tops of interior cupboards and cabinets and projecting ledges.

.6 Finish top, bottom, edges and cutouts of doors after fitting as specified for door surfaces.

.7 Mechanical/Electrical Equipment:

.1 Do not paint over nameplates.

.2 Paint disconnect switches for fire alarm system and exit light systems in red enamel.

END OF SECTION
Division 11
1. GENERAL

1.1 Description

.1 Unless otherwise specified, this section specifies general requirements common to all process and mechanical equipment included in Division 11 to Division 15, inclusive.

.2 Comply with all laws, ordinances, rules, regulations, codes, and orders of all authorities having jurisdiction relating to this work.

1.2 Definitions and Interpretations

.1 Where the term “Provide” is used herein, it shall be understood to include labour, materials, and services necessary to supply items or work referenced.

.2 Where the terms “Instructions” or “As Instructed” or “Where Instructed”, are used herein, they shall be understood to mean as instructed by the Engineer including supplementary instruction notices and all comments made regarding submittals of shop drawings and samples for review.

.3 Where the term “Listed” is used herein, it shall be understood to mean that the materials or equipment have been tested in accordance with applicable standards and methods, have been approved and listed for the intended use by a testing authority which itself has been approved by the authorities having jurisdiction.

.4 Where the terms “Approved”, or “Approval”, are used herein, they shall be understood to mean approved by Authorities having jurisdiction as conforming to Codes, Standards, Bylaws, etc.

.5 Where the terms “Acceptable”, or “Acceptance”, are used herein, they shall be understood to mean acceptable to the Engineer as generally conforming to the requirements of the contract documents.

.6 Where the term “Submit for Review” is used herein, it shall be understood to mean submit to the Engineer.

.7 Where the term “Subject to Review” etc. is used herein, it shall be understood to mean work shall be laid out for review by the Engineer. No work shall proceed until instructions have been obtained from the Engineer. Submit further information, shop drawings, samples, etc. as specified and/or as may be reasonably requested by the Engineer.

.8 Where the term “Accessible” is used herein, it shall be understood to mean readily approachable by person or tools as required and where obstacles may be removed and replaced without cutting or breaking out materials.
.9 Where working pressure or pressure ratings are specified or shown on the drawings for valves, piping, fittings, equipment, etc., these items shall be suitable for operating at specified pressures and corresponding temperature unless noted otherwise.

1.3 Shop Drawings

.1 Refer to Section 01330 – Submittals for the general requirements for shop drawings.

.2 In addition to the requirements of Section 01330, submit the following specific information with shop drawings.

   .1 Assembly drawings showing details of connections and termination of equipment for connection by others.

   .2 List of materials of construction, detailing the component parts and reference specifications (ASTM, CSA, ANSI, etc.).

   .3 Motor operating data, including motor and insulation ratings, start-up and operating current ratings, operating voltage and amperage tolerances, and description of construction, complete with illustrative drawings.

   .4 Gearbox and drive data, including AGMA/ABFMA ratings for components, materials of construction, tolerances, and description of construction.

   .5 Control schematics, text, and wiring diagrams as required to describe control operations. Where large instrumentation and control schematics are required as part of the submission, submit samples of the drawings prior to the full submission.

   .6 Required ancillary services including but not limited to electrical, non-potable water, and drains.

   .7 Installation instructions indicating assembly and mounting requirements, alignment and assembly tolerances, and points of connection for ancillary services.

   .8 Start-up instructions including lubricant requirements, electrical requirements, etc.

   .9 Details of coating systems to be applied.

   .10 Details of insulation provided to prevent galvanic corrosion between mating surfaces constructed of dissimilar metals.

   .11 A copy of the Contract Document mechanical layout drawings, control diagrams, and process and instrumentation diagrams, with addenda updates, that apply to the equipment marked to indicate special changes necessary for
GENERAL PROCESS PROVISIONS

the supplied equipment. If no changes are required, mark the drawing(s) “no changes required”.

.12 A copy of the related specification section with addenda updates, and all referenced sections with addenda updates, with each paragraph check marked to show specification compliance or marked to show deviations.

1.4 Temporary Usage

.1 Temporary usage by the Owner of any process device, apparatus, machinery, or equipment prior to interim or final inspection is not to be construed as acceptance.

1.5 Owner Supplied Equipment

.1 Where indicated in the drawings or noted in the specifications, install, test, and commission equipment provided by the Owner.

.2 Review all information available for the Owner-supplied equipment and become familiar with requirements for storage, installation, testing, and commissioning.

.3 Hand over Owner-supplied equipment according to a schedule agreed upon by the Contractor, the Engineer, and the Owner.

.4 Upon handover, fully inspect the item of equipment in the presence of the Engineer. Where the equipment requires modification or repair to properly function, these items will be identified to and confirmed by the Engineer.

1.6 Design Standards, Acceptable Products and Acceptable Manufacturers

.1 Equipment lists included in the specifications may be in two parts. The first part is the “Design Standard” equipment items. The second part of the list is comprised of “Acceptable Manufacturers” if the equipment of a specific vendor is specified.

.2 The design has been based on the Design Standard. Quality of workmanship, dimensions, operating protocol, basic materials, and ancillary services have been defined on this basis and incorporated in the design.

.3 Where Acceptable Products or Acceptable Manufacturers have been listed after a Design Standard, these products or ranges of products have been accepted as being capable of meeting the basic functional requirements of the equipment, but may not be the same as the Design Standard in detail. Provide all ancillary services, material upgrades, etc. as necessary to satisfy the quality requirements defined by the Design Standard. Make all minor changes in arrangement, piping, and/or electrical connections, etc. as necessary to suit the requirements of the Acceptable Products or Acceptable Manufacturers.
.4 Where Acceptable Products or Acceptable Manufacturers have been listed, but no Design Standard is listed, these products or ranges of products have been accepted as being capable of meeting the basic functional requirements of the equipment. Provide all ancillary services and minor modifications to arrangement, piping, and/or electrical connections, etc. as necessary to suit the functional requirements of the equipment.

.5 No additional payment will be made for revisions or alterations made to accommodate the equipment supplied.

1.7 Coordination

.1 Coordinate the requirements of the equipment supplied with piping, structural supports, drainage, ventilation/cooling, electrical service, instrumentation and control interface, and other ancillaries specified in other Divisions.

1.8 Shipment, Protection, and Storage

.1 Ship and store equipment in accordance with Section 01606 – Shipment, Protection, and Storage unless otherwise specified.

.2 Prior to installation, protect all equipment stored on- or off-site against corrosion. Provide blanks, plugs, packing grease, special covering, moisture absorbing material, and/or other appurtenances necessary to preclude moisture from equipment interior spaces. Take special care with electrical and control panels.

.3 During storage, turn shafts as required, run as necessary, and/or undertake all other special maintenance activities required to ensure that rotating equipment bearings are not subjected to excess wear.

1.9 Tagging Instructions

.1 Tag loose items associated with a particular unit with the equipment number. Make tagging materials of aluminum or stainless steel (no plastic) and securely attach to each item.

1.10 Abbreviations

.1 The following abbreviations are found in the Process Specifications:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABFMA</td>
<td>American Bearing Fabrication and Manufacturer's Association</td>
</tr>
<tr>
<td>AGMA</td>
<td>American Gear Manufacturer's Association</td>
</tr>
<tr>
<td>AISI</td>
<td>American Iron and Steel Institute</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
</tr>
<tr>
<td>AWS</td>
<td>American Welding Society</td>
</tr>
<tr>
<td>BS</td>
<td>British Standard</td>
</tr>
</tbody>
</table>
2. PRODUCTS

2.1 Spare Parts

.1 Supply spare parts as required in the various specification sections. The lists in these sections are intended to include all parts which normally would be required within a single year for normal preventative maintenance and where fabrication requirements for special parts would delay delivery and could keep an item of equipment out of service for an extended period.

.2 Identify any special spare parts not listed. Include a price list.

.3 Provide a list of all spare parts, not including lubricants, which normally would be required through the first five (5) years of operation. Provide prices for each part, guaranteed for six (6) months.

.4 Replenish any spare parts used in the initial year of operation at the end of the maintenance period for the related item(s) of equipment.

2.2 Flanges and Pipe Threads

.1 Provide flanges on cast iron equipment and appurtenances that conform in dimension and drilling to ANSI B16.1, Class 125 and flanges on steel equipment and appurtenances that conform in dimension and drilling to ANSI B16.5, Class 150 otherwise specified.

.2 Provide pipe threads that conform in dimension and limits of size to ANSI B1.1, coarse thread series, Class 2 fit.

.3 Provide flange assembly bolts that are heavy pattern, hexagonal head, carbon steel machine bolts with heavy pattern, hot pressed, hexagonal nuts conforming to ANSI B18.2.1 and B18.2.2. Provide threads that conform to Unified Screw Threads, Standard Coarse Thread Series, Class 2A and 2B, ANSI B1.1.
2.3 **Bearings**

.1 Unless otherwise specified, provide oil or grease lubricated, ball or roller type equipment bearings, designed to withstand the stresses of the service specified. Rate each bearing in accordance with ABFMA Methods of Evaluating Load Ratings of Ball and Roller Bearings.

.2 Generally, use oil lubrication systems for bearings on rotating equipment with a drive over 15 kW. Also use oil lubrication for large, slowly rotating bearings such as clarifier and thickener drives.

.3 Provide equipment bearings that have a minimum L-10 rating life of 50,000 hours, as determined using the maximum equipment operating speed, unless otherwise specified.

.4 Fit grease lubricated bearings, except those provided factory sealed and lubricated, with easily accessible grease supply, flush, drain, and relief fittings. Use extension tubes where necessary. Provide standard type grease supply fittings.

.5 Ensure that all grease fittings on the project are the same size, North American standard, and compatible with plant standards.

.6 Extend grease fittings to an accessible location.

.7 Equip oil lubricated bearings with either a pressure lubricating system or a separate oil reservoir type system. Provide each oil lubrication system to be of sufficient size to absorb the heat energy generated in the bearing under a maximum ambient temperature of 40°C.

.8 For pressure lubricating systems or oil reservoirs, provide a filler pipe and an external level indicator gauge. Provide a cap, complete with retention chain, for the oil inlet.

2.4 **Critical Speed**

.1 For rotating equipment, ensure that operating speed is no more than 80 percent of the first critical speed unless otherwise specified.

2.5 **V-Belt Assemblies**

.1 Select belt for not less than 150 percent of rated driver power. Where two sheave sizes are specified, ensure belt sizing is appropriate for both sets.

.2 Except where specified otherwise, use cog belt anti slip type belts.

.3 Use anti-static belts on explosion-proof equipment.
.4 Statically balance sheaves and bushings. Where sheaves and bushings are to operate at peripheral speeds greater than 1,650 m/min, dynamically balance the assembly.

.5 Separately mount sheaves on their bushings by means of three pull-up grub or cap tightening devices. Key seat bushings to the drive shaft.

2.6 Couplings

.1 For equipment with drives over 0.375 kW and less than 120 kW, and where the driver is directly connected to the driven unit, provide a flexible coupling. Couplings shall accommodate angular misalignment, parallel misalignment, and end float and shall cushion shock loads and dampen torsional vibrations.

.2 The flexible member of flexible couplings shall consist of a tire, with synthetic tension members bonded together in rubber. Attach the flexible member to flanges by means of clamping rings and cap screws, and attach the flanges to the stub shaft by means of taperlock bushings. Provide the equivalent of a shrunk-on fit. There will be no metal-to-metal contact.

.3 For larger couplings, provide continuous sleeve flexible gear type, forged steel couplings.

.4 Size each coupling as recommended by the coupling manufacturer for the specific application, considering applied power, speed of rotation, type of service, and other pertinent details.

2.7 Guards

.1 On moving parts, provide three-sided sheet steel guards in accordance with workplace safety regulations. Fabricate of galvanized 14 gauge steel.

.2 Paint guards after fabrication to the same standard as the attached equipment.

.3 Guards shall be removable to facilitate maintenance of moving parts.

.4 Make provision for extension of lubrication fittings through the guards.

2.8 Equipment Identification

.1 Provide nameplates for all equipment in accordance with Section 11910 - Identification.

.2 Provide nameplates for all electrical and control panels supplied with equipment, in accordance with Section 11910 - Identification and Division 16 requirements.
2.9 Caution Signs

.1 For caution signs, use vinyl stick-on type decals placed onto clean, smooth surface of equipment to be posted.

.2 Where insufficient space exists, use decal applied to galvanized mild steel, fibreglass, or plastic sheet fastened to equipment.

.3 Provide signs that read “CAUTION - AUTOMATIC EQUIPMENT MAY START AT ANY TIME”.

.4 Make letters 25 mm in height, red on a white background.

.5 Provide mounting posts and hardware and mount close to guarded moving parts.

2.10 Gauge Connections and Test Plugs

.1 Provide weld-o-lets for gauges on the suction and discharge side of pumps, blowers, and compressors.

.2 Install gauges at each location indicated.

.3 Provide weld-o-lets at locations indicated in the drawings and as required to practically complete testing of piping and equipment.

2.11 Concrete Pads

.1 Coordinate location of concrete pads for equipment.

.2 Ensure that, unless otherwise shown, concrete pads are a minimum of 300 mm above finished floor elevation and extend a minimum of 100 mm outside of the equipment base.

.3 Ensure that pads drain away from base.

.4 Ensure that conduit, drains, piping, etc. required for the equipment, rise through the pad.

2.12 Equipment Bases

.1 Structural Steel Bases

.1 Make bases of structural steel shapes with thickened steel pads for dowelling.

.2 Fabricate bases in a rectangular pattern. "T" and "L" patterns may be used where required to accommodate the equipment drive and accessories.
GENERAL PROCESS PROVISIONS

.3 Make perimeter members of structural beams with a minimum depth equal to 0.10 of the longest dimension of the base. Beam depth need not exceed 350 mm provided that the deflection and misalignment is kept within the manufacturer's recommended limits.

.4 Provide grout holes where vibration isolation is not specified.

.2 Cast Iron Bases

.1 Seal in accordance with the requirements of Sections 11900 – Field Applied Protective and Maintenance Coatings and 11901 – Factory Applied Protective and Maintenance Coatings for bleeding surfaces, prior to grouting.

.2 Terminate fasteners requiring connection to the base by nuts welded to the bottom of the base and plugged with cork, plastic plugs or grease, or acorn nuts.

2.13 Anchor Bolts

.1 For all permanently or intermittently submerged services and for all exterior mounting locations, provide AISI 316 stainless steel anchor bolts conforming to ASTM A320.

.2 For all other anchor bolts, provide AISI 316 stainless steel anchor bolts conforming to ASTM A320, unless noted otherwise.

.3 Provide nuts and washers of the same material and of equal or greater strength than bolts. Use tapered washers where the mating surface is not square with the nut.

.4 For rotating equipment over 35 kW, provide anchor bolts with sleeves and washers to permit adjustment during installation of the equipment.

.5 Do not use drilled expansion or adhesive anchors for anchor bolts unless submitted and reviewed by the Engineer.

.6 Where stainless steel anchor bolts are required, double bolt all connections or use nylon locking bolts.

2.14 Equipment Base Templates

.1 For rotating equipment where shown in the drawings or specifically called for in the specifications for that equipment, provide an equipment base template for location of equipment anchor bolts to be embedded in concrete.

.2 Manufacture the equipment base template of structural steel with stops or holes placed for the anchor bolts.
GENERAL PROCESS PROVISIONS

.3 Shop finish the templates in accordance with Section 11901 – Factory Applied Protective and Maintenance Coatings for items to be embedded in concrete.

.4 Provide access holes for the placement of grout or concrete, as applicable.

2.15 Jacking Screws

.1 On all base mounted rotating equipment larger than 7.5 kW, provide jacking screws for the driver and the driven end to facilitate alignment.

.2 Provide jacking screws consisting of a 12 mm nut welded to the frame of the equipment with the hole in a horizontal plane.

.3 Provide a 12 mm bolt that fits through the nut and extend to the mounting feet.

.4 Two jacking screws are required at each end of the equipment, one parallel to the axis of the equipment and one perpendicular.

3. EXECUTION

3.1 Operator Training

.1 Allow adequate time for operator training for each piece of equipment or system supplied. Scheduling of training is to be arranged with the Engineer and the Owner.

.2 Refer to the specific equipment specifications for training requirements.

.3 Training will be by the Manufacturer’s Representative and/or the Installer Trades and will include maintenance procedures, troubleshooting, and repair procedures for all electrical and mechanical components.

END OF SECTION
1. GENERAL

1.1 Description

.1 Installation, including the supply of anchor bolts, and testing of equipment supplied by others and supplied under other sections in Division 11.

1.2 Definitions and Interpretations

.1 Testing: In this Division, testing is defined as the operation of a specific item of equipment under actual and/or simulated conditions for the purpose of ensuring the equipment satisfies its basic design criteria. Testing shall be conducted by the Contractor. All materials, labour, power and equipment required to conduct the tests shall be the Contractor's responsibility. The Manufacturer is to provide technical assistance to the Contractor for the installation, testing, start-up and commissioning of the equipment supplied.

.2 Commissioning: In this Division, commissioning is defined as the operation of equipment systems under actual and/or simulated conditions for the purpose of ensuring the system performs its intended functions.

1.3 Submissions

.1 Check all the shop drawings relative to the equipment and materials, dimensions, measurements, size of members, type of materials, controls, list of equipment being supplied, names of manufacturers, and other details to affirm that they are correct and conform to the requirements and intent of the Contract.

.2 Where the shop drawings are submitted with coordination information missing, such as dimensions of structures, the Engineer will return the submission as soon as practicable marked “Revise & Resubmit.”

2. PRODUCTS

2.1 Equipment Schedule

.1 Unless indicated otherwise, supply and install all equipment listed on the Equipment Schedule, detailed on the equipment specification sheets, or shown on the drawings.

.2 Determine the extent of equipment to be supplied from the specifications, list of equipment and materials and manufacturer's drawings covering the equipment. Furnish and install all additional materials necessary to complete the installation.

.3 Incorporate all ancillary devices in the installation including those providing for cooling water, seal water, lubricant supply, process drains, electrical connection, and instrumentation and control requirements.
PROCESS EQUIPMENT INSTALLATION

2.2 Mounting Requirements

.1 Provide all supports, anchorage, and mounting of all equipment in accordance with the manufacturer’s recommendations, the NBC, and industry standard requirements, unless otherwise specified.

.2 Design and provide all elements required to resist the calculated forces described herein or required by the element manufacturer.

.3 Design anchorage for all equipment bases, supports, and foundations in accordance with NBC (Za = 6, Zv = 6, V = 0.4).

.4 For rotating equipment, where specified, submit design notes and calculations for anchorage, signed and sealed by a Professional Engineer.

3. EXECUTION

3.1 Coordination

.1 Coordinate the work specified under this Section with the work of other Sections to produce a complete and workmanlike job.

.2 Coordinate the placement of equipment bases and housekeeping pads with Division 3.

.3 Coordinate the routing of ancillary piping with Division 15 – Process Mechanical.

.4 Coordinate the routing of electrical and control wiring and conduit with Division 16.

3.2 Preparation

.1 Before commencing installation of the work, inspect and take field measurements and ensure that work conducted previously in the area is not prejudicial to the proper installation of the works.

.2 Refer to the equipment specifications and specification sheets for assistance in determining the form in which equipment is to be shipped and the extent of field assembly required.

.3 Dimensions shown on the Contract Documents for equipment bases, piping connections, etc., are approximate and must be corrected by the Contractor to suit the exact dimensions of the equipment provided for each application. Arrange any necessary modifications to piping connections, pipework, or other ancillaries at no cost and after acceptance by the Engineer.

.4 Schedule the visits to the site of the manufacturer’s representative for the times and periods specified in other sections. Cooperate in his supervision of the installation and start-up. Follow all reasonable instructions of the manufacturer’s representative.
Should the Contractor require the manufacturer's representative to attend for longer or more frequent periods he shall arrange this, at his own expense, with the manufacturer.

### 3.3 Installation of Equipment

.1 Install all equipment specified in other sections, detailed on the equipment specification sheets, or shown on the drawings.

.2 Dimensions shown on the Contract Documents for equipment bases, piping connections, etc., are approximate. Correct to suit the exact dimensions of the equipment provided for each application. Arrange any necessary modifications to piping connections, pipework, or other ancillaries at no cost and after acceptance by the Engineer.

.3 Supply and install all necessary shims, gaskets, etc., required to complete the installation.

.4 Provide for the use of all necessary lifting and loading equipment and all tools required to complete the installation.

.5 Comply with the specific requirements for installation noted in other sections of this specification and with the instructions of the Manufacturer. Where there is a conflict in these requirements, identify the conflict to the Engineer and proceed as directed.

### 3.4 Equipment Bases and Anchorage

.1 Equipment will be mounted on housekeeping pads that are a minimum of 300 mm high.

.2 For rotating equipment of 7.5 kW or above and for equipment requiring structural锚oring, set anchor bolts in advance. Where required, set anchor bolts in sleeves to permit minor adjustment during installation. Use machine base templates where shown. Tie anchor bolts to reinforcing steel to resist tensile forces, as shown.

.3 Prepare grout as specified in Division 3 and provide full contact with the equipment bases unless otherwise recommended by the equipment manufacturer and accepted by the Engineer. Neatly bevel, form or trim the grout.

.4 Where equipment is supplied with a plate steel base, provide access holes in the top of the plate and use a pour grade, non-shrink, non-metallic grout as specified in the structural concrete specifications to fill the entire void under the base.

### 3.5 Alignment

.1 Set and align all rotating equipment in accordance with the more stringent requirements of either the manufacturer’s requirements or the following:
.1 Level base, use machinists level on all machined bases.

.2 Align couplings to satisfy the following criteria:

<table>
<thead>
<tr>
<th>Coupling Speed</th>
<th>Allowable Angular Misalignment</th>
<th>Allowable Parallel Misalignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 100 rpm, below 50 hp</td>
<td>4’00”</td>
<td>0.25 mm</td>
</tr>
<tr>
<td>Under 100 rpm, 50 hp and over</td>
<td>3’00”</td>
<td>0.12 mm</td>
</tr>
<tr>
<td>100 to 600 rpm</td>
<td>2’00”</td>
<td>0.12 mm</td>
</tr>
<tr>
<td>600 to 1800 rpm</td>
<td>1’00”</td>
<td>0.10 mm</td>
</tr>
<tr>
<td>1800 to 3600 rpm</td>
<td>0’35”</td>
<td>0.05 mm</td>
</tr>
</tbody>
</table>

.3 Check for soft foot, maximum permissible 0.002 mm.

.2 Where equipment undergoes a substantial differential temperature rise (30°C between driver and driven unit), provide precision benchmarks in foundation and on equipment and perform alignment at operating temperatures.

.3 Demonstrate to the Owner, Engineer, and Manufacturer’s Representative the final alignment.

3.6 Lubricants

.1 Extend any inaccessible lubrication points and lubricant drains to convenient locations.

.2 Remove storage lubricant and provide the initial fill of new lubricants for the equipment. Lubricant grade to be as recommended by the Manufacturer.

3.7 Vibration Survey

.1 Conduct a vibration survey under normal operating conditions for all equipment with a motor size exceeding 37 kW and for smaller units where specified.

.2 Use a calibrated vibration sensor, accepted by the Engineer, and capable of measuring unfiltered vibration velocities and peak to peak amplitudes. Select a sensor capable of measuring velocities at a precision of 0.1 mm/s and an accuracy of plus or minus 0.2 mm/s.

.3 Monitor vibration in all three dimensions at the head and tail end of both the driver and driven units, at intermediate bearing points, and at other critical locations which may be identified by the Engineer.

.4 Record the vibration velocities for each item of equipment and submit a report to the Engineer detailing the findings. Include a description of the measuring equipment, identification of equipment on which vibration monitoring was completed, description
of conditions under which the test was conducted, and a listing of all of the collected data.

.5 Unless specified otherwise, use unfiltered velocities as the vibration criteria. Unfiltered velocities less than 2 mm/sec shall be considered acceptable. Undertake corrective action where unfiltered velocities exceed 4 mm/sec.

3.8 Noise Survey

.1 Conduct a noise survey for all equipment over 37 kW and for smaller units where specified.

.2 Use a calibrated noise meter, accepted by the Engineer, and capable of measuring noise in the A Scale at a precision of 0.5 dBA and an accuracy of 1.0 dBA.

.3 Measure noise levels at an elevation similar to the major noise emitter from the equipment (bearing housing, muffler, etc.) and at a horizontal distance of 1.0 metres.

.4 Record the noise levels for each item of equipment and submit a report to the Engineer detailing the findings. Include a description of the measuring equipment, identification of equipment on which noise level monitoring was completed, description of conditions under which the test was conducted, and a listing of all of the collected data.

.5 The general requirement for any item of equipment shall be that it operates at a noise level less than 85 dBA, when measured in free field at 1.0 metre. Noise requirements may be more stringent in areas where more than one item of process equipment is intended to operate concurrently. Specific requirements for equipment that differ from 85 dBA are listed in the sections related to those items of equipment.

.6 Noise abatement features (acoustic panels, acoustic insulation, etc.) are specified in other sections.

.7 In any process area, recommend whatever measures necessary to maintain a composite noise level below 90 dBA. Where directed by the Engineer, undertake those corrective actions.

3.9 Quality Assurance Forms

.1 Test all process equipment to ensure the equipment operates in accordance with the basic design criteria listed in the specification sections or equipment specification sheets. Complete the series of forms that attest to the proper installation and functioning of the equipment. Refer to Section 01650 for the Forms.

END OF SECTION
1. GENERAL

1.1 Description

.1 This section specifies alternating current induction motors, 150 kW or less, to be provided with the driven equipment.

.2 This Section does not specify medium voltage (2300 V and greater) and specialty motors such as submersible motors, valve operator motors or torque rated motors.

.3 Unless specified otherwise, electric motors to be provided by the manufacturer of the driven equipment, as an integral component of the driven equipment, as specified in Section 11005 – General Process Provisions.

.4 Motors suitable for driving centrifugal pumps, fans, blowers, compressors, gears, progressive cavity pumps or other loads fed via the variable frequency drive or connected across-the-line.

1.2 Reference Standards

.1 Conform to the following reference standards:

.1 CSA C22.2 No. 100, Motors and Generators.

.2 CSA C22.2 No. 145, Motors and Generators for Use in Hazardous Locations.

.3 CSA C390, Energy Efficient Test Methods for Three Phase Induction Motors.

.4 EEMAC M1-7, Motors and Generators.

.5 NEMA Std. MG1, Motors and Generators.

.6 IEEE 112, Polyphase Induction Motors and Generators - Testing.

.7 IEEE 114, Single Phase Induction Motors - Testing.

1.3 Submittals

.1 Shop Drawings: Submit with the related items of equipment in accordance with Section 01330 - Submittals and Section 11005 – General Process Provisions. In addition, submit the following details: Provide the specified information for each typical size or type of motor driven equipment.

.1 Shop drawings and product data in accordance with Division 16.

.2 Overall dimensions of motor.
.3 Shaft centreline to base dimension.
.4 Shaft extension diameter and keyway, coupling dimensions and details.
.5 Fixing support dimensions.
.6 Terminal box location and size of terminals.
.7 Arrangement and dimensions of accessories.
.8 Diagram of connections.
.9 Speed/torque characteristic.
.10 Weight of motor.
.11 Installation data.
.12 Rotation direction.
.13 Starting restrictions (time between starts).
.14 Terminal leads marking.
.15 Bearing data (including part numbers).
.16 Recommended lubricant.
.17 Design ambient temperature and temperature rise ratings.
.18 Torque characteristics including rated starting torque and breakdown torque.
.19 The ABFMA L-10 rated life for the motor bearings.
.20 The nominal efficiency for all motors.
.21 Class, division, group and UL frame temperature limit code for explosion-proof motors.

1.4 Service Conditions

.1 Unless specified otherwise, provide motors suitable for continuous operation at an elevation of 30 m above sea level.

.2 Provide motors suitable for continuous operation in a 40°C ambient temperature.
1.5 Coordination

.1 For motors fed via variable frequency drives, communicate motor requirements to
   and comply with drive requirements of the manufacturer of the VFD in accordance
   with Division 16.

1.6 Quality Assurance

.1 Build motors in accordance with CSA C22.2 No. 100, CSA C22.2 No. 145, NEMA
   Standard MG1, and to the requirements specified.

1.7 Shipment, Protection, and Storage

.1 Ship, protect and store equipment in a manner that prevents damage or premature
   aging.

.2 Handle motors with suitable lifting equipment.

.3 Store motors in heated, dry, weather-protected enclosure.

2. PRODUCTS

2.1 Acceptable Manufacturers

.1 Baldor

.2 General Electric

.3 GEC Alsthom

.4 Reliance

.5 Siemens

.6 Toshiba

.7 U.S. Motors

.8 Westinghouse

2.2 Materials

.1 Motors: to EEMAC M1-6.

.2 Lead markings: to EEMAC M2-1.

.3 Unless specified otherwise, provide all motors with:
.1 Cast iron frame
.2 Cast metal fan blades and shrouds
.3 Stainless steel hardware
.4 Non-hygroscopic windings

2.3 Components

.1 Bearings
   .1 Provide sealed ball bearing type on motors less than 37.5 kW.
   .2 Bearings on 37.5 kW motors or larger to be greasable ball bearing type, rated for a minimum L-10 life of 100,000 hours at the ambient temperature specified herein.

.2 Provide adequately sized, diagonally split, gasketted, EEMAC 4 terminal boxes complete with threaded hub for conduit entry for ODP and TEFC motors and adequately sized, diagonally split, gasketted EEMAC 7 terminal boxes complete with threaded hub for conduit entry for explosion-proof motors.

.3 Provide a ground connection and lifting eyes or lugs.

.4 Motors are to be aligned and balanced with the related equipment in the shop to minimize vibration and undue stresses.

.5 Where specified, equip motors with anti-condensation heaters suitable for connection to 120 V, single phase, 60 Hz.

.6 Current Imbalance
   .1 Do not exceed the values tabulated below when the motor is operating at any load within its service factor rating and is supplied by a balanced voltage system:
      .1 Under 37.5 kW: 25 percent
      .2 37.5 kW and above: 10 percent
   .2 Base imbalance criteria upon the lowest value measured.

.7 Winding Over-temperature Protection
   .1 Provide stator winding over-temperature protection on all motors rated 45 kW and larger. Motors rated less than 45 kW to have stator winding over-
temperature protection when required by the specific equipment specification section or if recommended by the driven equipment manufacturer.

.2 Over-temperature protection for motors rated 45 kW and larger and other motors, where specified, to be NEMA MG1-12.53, Type 1, winding running and locked rotor over-temperature protection. One detector to be provided per phase. Detectors to be positive thermal protection (PTC) thermistor type, with leads brought out to a terminal strip in a NEMA 4 enclosure in Type 2 motors and a NEMA 7C or 9 enclosure for Type 3 motors.

2.4 Motor Efficiency

.1 Use high efficiency motors with efficiencies that comply with the minimum requirements of EPACT and NRCAN.

.2 Use vertical motors with efficiency within 0.5 percent of minimum values stated for horizontal motors.

.3 Test motor efficiency in accordance with CSA C390 and NEMA MG1, accounting for stray load losses, measured indirectly based on the IEEE method.

2.5 Motors Smaller than 0.25 kW

.1 General

.1 Unless otherwise specified, motors 0.25 kW and smaller to be squirrel cage, single phase, capacitor start, induction run type with copper windings.

.2 Construction features listed in this section may be as normally supplied by the equipment manufacturer.

.3 Single phase motors to have Class F insulation.

.4 Small fan motors may be split-phase or shaded pole type.

.5 Provide copper windings.

.2 Rating

.1 Unless specified otherwise, motors to be rated for operation at 115/1/60 VAC, and continuous-time rated in conformance with NEMA Standard MG1, paragraph 10.35.

.3 Enclosures

.1 Unless otherwise specified, provide motors with totally enclosed fan cooled or totally enclosed non-ventilated enclosures.
.2 Provide explosion-proof motors bearing the UL label for Class I, Division 1, Group D hazardous locations.

.3 Provide an over-temperature device in the enclosure to detect and automatically de-energize the motor.

.4 Motors 0.25 kW to 150 kW

.1 General

.1 Unless otherwise specified, motors 0.25 kW to 150 kW to be 3-phase, squirrel cage, full voltage start, high efficiency induction type with copper windings.

.5 Rating

.1 Provide all motors which run continuously for heavy duty service, rated high efficiency, and TEFC unless otherwise specified.

.2 Squirrel cage induction type, with a service factor of 1.15 at 40°C ambient, Class F insulation and non-hygroscopic windings unless otherwise specified.

.3 Provide motors with EEMAC Design B torque characteristics. Size motors to satisfy the driven equipment’s starting torque requirements. For special high torque applications such as sweep arm drives, motors with Design C characteristics may be specified or provided subject to the Contract Administrator’s approval.

.4 Rated for 600/3/60 VAC service unless otherwise specified.

.5 Design motors for full voltage starting, capable of running successfully when terminal voltage is from +10 percent to -10 percent of nameplate voltage.

.6 Motors with a service factor of 1.0 to operate at no more than 90 percent of their nameplate current rating and motors with a service factor of 1.15 to operate at not more than 100 percent of their nameplate current rating.

.7 Capacity sufficient to operate the driven load and associated devices under all conditions of operation without overloading.

.6 Enclosure and Insulation

.1 Classify motors as:

.1 Type 1 (General Duty)

.2 Type 2 (Process)
.3 Type 3 (Explosion-proof)

.2 Enclosures and insulation systems are specified in the following clauses. Temperature rise for all motor types not to exceed that permitted by Note II, paragraph 12.42, NEMA MG1.

.3 Insulation to be non-hygroscopic.

.4 Type 1 Motors (General Duty): Unless specified otherwise, TEFC enclosures with Class F insulation.

.5 Type 2 Motors (Process): TEFC, with Class F insulation, suitable for moist and corrosive environment. Motors rated 7.5 kW and larger to have Class F insulation with Class B temperature rise. All internal surfaces to be coated with an epoxy paint. Aluminum frame motors are permitted. Steel frame motors are permitted for motors with frames 184 and smaller.

.6 Type 3 Motors (Explosion-proof): Motors to be rated for operation in a Class 1, Division 1, Group D hazardous location in accordance with CSA C22.1. The motor to have a Class F insulation. Steel frame motors are not permitted. Provide an approved breather/drain device to be provided in the motor drain hole.

2.6 Motors for Variable Frequency Drives

.1 Comply with the characteristics of the intended variable frequency drives. Ensure that the variable frequency drives are rated for 690 V/3-phase/60 Hz VAC service.

.2 Select premium efficiency units, inverter duty rated, in conformance with NEMA MG1.

.3 Use Type 2 or Type 3 motors.

.4 Insulation: Class F insulation with Class B temperature rise, suitable for moist and corrosive environments and in accordance with NEMA MG1 Part 30 and Part 31.

.5 Design motors for variable frequency systems so that they are not required to deliver more than 80 percent of the motor’s power rating by any load imposed by the driven machine at any specified operating condition or any condition imposed by the driven machine’s performance curve at maximum operating speed.

.6 Ensure motors have adequate cooling capacity when operating through the entire speed range capacity of the drive.

.7 Enclosure and other insulation requirements are the same as required for constant speed motors.
2.7 **Vertical Motors**

.1 Unless otherwise specified, provide full voltage vertical motors with a Type P base specifically designed for vertical installation.

.2 Universal position motors are not acceptable.

.3 Provide vertical motors with solid shafts unless specified otherwise.

.4 Provide thrust bearing rating compatible with the loads imposed by the driven equipment.

2.8 **Two Speed Motors**

.1 Provide two speed motors with separate windings. Single winding two speed motors are not acceptable.

2.9 **Power Factor Correction Capacitor Sizing**

.1 The motor vendor to confirm the maximum capacitor size which may be connected to motors 18 kW and larger, on constant speed drives.

2.10 **Motor Mounting**

.1 Where equipment is specified to include C-Flange mounting, make motors compatible with this joining and alignment technique.

2.11 **Finishes**

.1 In accordance with Division 16.

2.12 **Equipment Identification**

.1 Provide equipment identification in accordance with Division 11 and Division 16.

.2 **Nameplates**

.1 Provide motor nameplates on engraved or stamped stainless steel. Include information enumerated in NEMA Standard MG1, paragraph 10.37, 10.38 or 20.60, as applicable.

.2 Additionally, indicate:

.1 The ABFMA L-10 rated life for the motor bearings for motors 37.5 kW and larger.

.2 The nominal efficiency for all motors.
.3 Class, division, group and UL frame temperature limit code for explosion-proof motors.

.4 Permanently fasten nameplates to the motor frame and position to be easily visible for inspection.

2.13 Spare Parts

.1 Provide maintenance materials and spare parts in accordance with Section 01750 – Spare Parts and Maintenance Materials.

3. EXECUTION

3.1 Installation

.1 Dry motor if dampness present, in accordance with manufacturer’s recommendations.

.2 Install or ensure the motor is properly installed to provide satisfactory service.

.3 Make connections as indicated. Use liquid-tight PVC jacketed flexible conduit between rigid conduit and motor.

.4 Make flexible conduit long enough to permit movement of motor over entire length of slide rails, when applicable.

.5 Check for correct direction of rotation, with motor uncoupled from driven equipment.

.6 Align and couple motor to driven machinery to manufacturers’ instructions, using only correct parts such as couplings, belts, sheaves, as provided by manufacturer.

.7 Install anchor devices and setting templates in accordance with Division 3.

3.2 Testing

.1 Perform tests and document results in accordance with Division 16.

END OF SECTION
1. **GENERAL**

1.1 **Description**

.1 This section defines the general requirements for the supply and supervision of installation and commissioning of all pumps required for this project.

1.2 **Definitions**

.1 Definitions:

.1 Efficiency: Pump efficiency is calculated as the delivered hydraulic power divided by the electrical power at the inlet box of the pump. Take full account of mechanical and electrical losses.

.2 Performance Curve: The performance curve is a graph of the flow delivered (L/s, x-axis) in relation to the discharge head (metres, y-axis). It generally denotes efficiencies as isopleths and may include NPSH requirements as a function of the flow.

.3 BEP: The BEP (Best Efficiency Point) is the point in the pump performance curve where the pump operates at its highest efficiency.

.4 Rating Point: The pump rating point is the combination of discharge head and flow that the pump must satisfy. It typically is determined on the basis of all duty pumps (one or more, depending on the service) operating simultaneously against the worst system conditions (typically maximum headloss, minimum suction head, maximum discharge head, etc.). This condition is listed in the detailed pump specification and must be satisfied by the pump supplied.

.5 Low Head Point: The low head point is the combination of head and flow that corresponds to the least head the pump might operate against. It is determined on the basis of only one duty pump operating against the system conditions which would produce the least discharge pressure (typically minimum headloss, maximum suction head, minimum discharge head, etc.). The minimum system head is shown or described for each pump. The manufacturer must ensure that the pump can operate satisfactorily, without cavitation in the pump casing or over-stressing of the motor, at the intersection of the pump curve and the minimum head curve, or low head point.

.6 Low Speed Point: The minimum flow and head conditions against which a variable speed pump is expected to operate.

.7 NPSH (Net Positive Suction Head): The total pressure (atmospheric) at the pump suction. The available NPSH is the pressure available at the pump suction and is a function of site atmospheric pressure and suction piping
losses. Required NPSH is the pressure required at the pump suction to ensure cavitation due to water column separation does not occur. Required NPSH shall be defined by the pump supplier at the pump inlet connection whether that be at the casing or at the face of a suction reducer/elbow supplied as an integral part of the pump.

1.3 Submittals

.1 Shop Drawings: Submit in accordance with Section 01330 – Submittals and Section 11005 – General Process Provisions. For all pump shop drawings, in addition to the requirements of Section 11005 – General Process Provisions, include the following specific details:

.1 Performance curve for the pumping unit(s) superimposed on the system curve for the particular pumping application. Where the system curve is not included in the specifications, request this information from the Engineer when required. With the performance curve, include efficiency isopleths and NPSHR variation with flow. Where required in the specific pump sections, the performance curve should be certified in accordance with Hydraulic Standards.

.2 Motor operating data, including motor and insulation ratings, start-up and operating current ratings, operating voltage and amperage tolerances, description of construction complete with illustrative drawings, and any other pertinent information.

.3 List of materials of construction, detailing the component parts of the pump(s), their materials of construction, and reference specifications for those materials.

.4 Required ancillary services including, but not limited to electrical, seal water, and drains. The sizes, ratings, and any other pertinent information related to these services.

.5 Installation instructions indicating assembly and mounting requirements, alignment and assembly tolerances, and points of connection for ancillary services (electrical, seal water, drains, etc.).

.6 Start-up instructions including lubricant requirements, electrical requirements, etc.

.2 Operating and Maintenance Data: Provide for incorporation in operation and maintenance manual as specified in Section 01735 – Operation and Maintenance Materials. Include the following:

.1 Complete description of operation

.2 General arrangement and detailed drawings
.3 Wiring diagrams for power and control schematics

.4 Parts catalogues with complete list of repair and replacement parts with section drawings, illustrating the connection and the parts manufacturer’s identifying numbers.

.3 Number of weeks prior to shipment that Engineer will be required to supply final conditions of flow and head for trimming the impeller. Manufacture casings to the conditions given on the system head curves, but complete final trim of the impellers according to the flow and head supplied for this pump on or before a date agreed on between Contractor and the Engineer.

1.4 Coordination

.1 Coordinate with other Divisions to ensure there are no conflicts in the work.

1.5 Shipment, Protection, and Storage

.1 Ship pre-assembled to the degree that is possible. Inform installer of any site assembly requirements.

.2 Securely fasten heavy wood blanks to the pump flanges. Use blanks that are larger diameter than the flange. Protect machined surfaces against rusting. Protect threaded connections with threaded plugs or caps. Protect open, plain pipe ends with caps.

.3 Where pumps are to be stored on-site for any period of time exceeding one (1) week, instruct site staff of specific requirements to ensure there is no uneven wear or distortion of pump component parts.

.4 Identify any special storage requirements.

2. PRODUCTS

2.1 Pump Performance Requirements

.1 Provide pumps that are suitable for continuous duty.

.2 Select impellers for fixed speed pumps that permit operation at an efficiency within five (5%) percent of the efficiency at the Best Efficiency Point.

.3 For variable speed pumps, select pump speed and impeller diameter which allow operation from the Rating Point to the Low Speed Point at efficiencies within ten (10%) percent of efficiency at the Best Efficiency Point.

.4 Ensure that motors are sufficiently sized to drive pumps at a maximum speed when the head is as defined for the low head point.
.5 Where the motor speed is greater than the required pump speed, and would require increasing the motor size with a direct coupled configuration, the Contractor can, only with the Engineers approval, to provide a V-belt overhead mount configuration or a gear reduction. This clause overrides clause 2.9.1.

2.2 Pressure Sensing

.1 Supply a means of measuring inlet and outlet pressure with each pump, except as noted.

.2 For centrifugal pumps handling sewage, clean water, etc., provide gauges for the outlet of each pump. Provide a connection for a pressure gauge on the pump inlet.

.3 For submersible pumps, provide only one gauge for mounting on the discharge of the pump on a weldolet installed outside, but within 2 metres of the wetwell.

.4 Gauges.

.1 Supply gauges that are 60 mm diameter, 6.35 mm bottom connection, complete with shutoff cock with stainless steel movement and Bourdon tube.

.2 Use metric units of measurement (kPa or Pa), clearly indicated on the face of the gauge.

.3 Calibrate the gauges to read pressure ranges approximately as follows:

<table>
<thead>
<tr>
<th>Actual Pressure</th>
<th>Gauge Pressure Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suction</td>
<td></td>
</tr>
<tr>
<td>-50 kPa to 50 kPa</td>
<td>-50 kPa to 350 kPa</td>
</tr>
<tr>
<td>50 kPa to 200 kPa</td>
<td>0 kPa to 350 kPa</td>
</tr>
<tr>
<td>200 kPa to 700 kPa</td>
<td>0 kPa to 1000 kPa</td>
</tr>
<tr>
<td>Discharge</td>
<td></td>
</tr>
<tr>
<td>50 kPa to 350 kPa</td>
<td>0 kPa to 700 kPa</td>
</tr>
<tr>
<td>350 kPa to 700 kPa</td>
<td>0 kPa to 1000 kPa</td>
</tr>
<tr>
<td>700 kPa to 1500 kPa</td>
<td>0 kPa to 2000 kPa</td>
</tr>
</tbody>
</table>

.4 Acceptable manufacturers: Ashcroft, Dwyer, H.O. Trerice.

.5 Pressure Sensors

.1 Refer to Division 17.

2.3 Pump Seals

.1 Provide single mechanical seals, as scheduled, unless otherwise noted in the pump data sheets. Provide cartridge style single mechanical seals, as scheduled, unless noted otherwise in the pump specification section or the pump data sheet.
.2 Provide non-destructive, self-aligning seals of the stationary design with require no wearing sleeve for the shaft.

.3 Material of construction:

<table>
<thead>
<tr>
<th>Type of Service</th>
<th>Metal Parts</th>
<th>Spring(s)</th>
<th>O-Rings</th>
<th>Faces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potable water</td>
<td>316 or 317L Stainless Steel</td>
<td>316 or Hastelloy C</td>
<td>Buna-N or Viton</td>
<td>Silicone Carbide on Carbon</td>
</tr>
</tbody>
</table>

.4 Design standard John Crane, Safematic, Chesterton or approved alternate

2.4 Bearings

.1 Refer to Section 11005 – General Process Provisions.

2.5 Protective Guards

.1 Provide a protective guard for all couplings and keys, drive belts, or other exposed rotating devices. As a minimum, conform to the requirements of Section 11005 – General Process Provisions.

2.6 Couplings

.1 For all pumps other than submersible and where noted otherwise in the detailed specifications, provide flexible, double disc, spacer type couplings between the pump shaft and driver shaft conforming with Section 11005 – General Process Provisions.

.2 Design couplings so that the pump unit can be disassembled without disturbing face piping.

2.7 Shafts

.1 Design shafts to absorb 1.15 times the rated power of the motors required to drive the pumps when the pump is fitted with maximum size impellers.

2.8 V-Belt Drives

.1 Do not use V-belt drives unless specified or shown on the drawings.

.2 Conform to the requirements of Section 11005 – General Process Provisions.

2.9 Spare Parts

.1 For each pump, provide for one spare mechanical seal or packing kit (as applicable) and one set of pump bearings.
.2 For each centrifugal pump type and size, provide a single impeller, wear plate, suction ring (if replaceable), one pump shaft, and nut.

.3 Meet additional spare parts requirements as stated in detailed equipment specification sections.

2.10 Factory Performance Testing

.1 Where required for specific pumps, as noted in the sections related to those pumps, factory performance test all pumps.

.2 Conduct factory performance testing in compliance with the Hydraulic Institute Standards.

.3 Inform the Engineer at least three weeks prior to the factory testing to allow for the Engineer’s attendance.

.4 Certify test results and summarize findings in a short report. Submit report within three weeks of completing factory tests.

.5 Where the pump(s) does not satisfy the specified performance requirements within the tolerances specified by the Hydraulics Institute, redesign, modify, and retest the pump(s), all at no additional cost.

.6 Do not ship the pump(s) until the test result report has been submitted to the Engineer.

2.11 Finishes

.1 Factory prime and coat all pumps in accordance with Division 11.

.2 All substances, materials or compounds (e.g. pipes, coatings, filter media, solders, valves, gaskets, lubricants, resins, process equipment, etc.) that may come in contact with water in the waterworks being treated to be potable and water that is potable shall conform to the requirements of the NSF 61 Standard.

3. EXECUTION

3.1 General

.1 Comply with the requirements of the specific sections for the pumps to be provided.

3.2 Installation

.1 Comply with the requirements of Section 11020 – Process Equipment Installation and any special requirements listed in the specific sections related to each pump.
3.3 Testing

.1 Field test all pumps to verify performance.

.2 Provide temporary connections, flow monitoring, pressure monitoring, ammeters, and temporary tankage required for the performance of the tests.

.3 Flow Metering

   .1 Where possible, use fill and draw techniques to determine the amount of flow conveyed during the test period. Ensure that the volumes are sufficient for at least five (5) minutes of pump operation at the flows that are to be tested, other than run-out.

   .2 Where permanent flow meters are installed on the downstream piping, they may be used to measure the flow during testing when accepted by the Engineer. Ensure that the permanent flow meters are calibrated to within five percent of the rated flow of the pump to be tested prior to testing.

   .3 Temporary metering may be used if accepted by the Engineer. Temporary meters must have an accuracy of plus or minus five (5%) percent, at the rated flow of the pump, to be acceptable.

   .4 Where other methods are not possible or where directed, use dye testing to determine the flow during the test periods. Dye testing is to be conducted by an agency acceptable to the Engineer. Measured flows during the testing will be certified by a qualified Engineer to be within five percent of the actual flows.

.4 Pressure Monitoring

   .1 Do not use permanent gauges for pressure monitoring during tests. Temporary test gauges can be connected to the permanent gauge taps.

   .2 Use gauges with sufficient accuracy to measure anticipated pressures on pump discharges within two point five (2.5%) percent. Where pump suction draws from an open tank or wet well, test gauge must be capable of measuring pressure at pump suction within 1.0 kPa.

   .3 Provide evidence of pressure gauge calibration within three (3) months of conducting tests.

.5 Test pump(s) at a minimum of three flow conditions, typically corresponding to the rating point flow, seventy-five (75%) percent of that flow, and one hundred and twenty (120%) percent of that flow. At each test point, measure flow, pressure, and amperage. In addition, verify run-out conditions.
.6 For variable speed pumps, conduct the tests at three speeds, typically one hundred (100%) percent of the design speed, seventy (70%) percent of the design speed and thirty (30%) percent of the design speed. The pump vibration must be 50% of the Hydraulic Institute standard at all three test speeds.

.7 Field Test Report

.1 Compile field test results into a report for submittal to the Engineer.

.2 Describe test set-up and measurement devices used to conduct the tests.

.3 For each pump, list the specified performance requirements and field test results. Show field test results (flow, pressure, power draw) superimposed on the performance curve provided with the submission.

.4 For pump installation certification, the pump supplier technician is to certify that no additional weight has been transferred to the pump from connecting piping that would otherwise transmit undue forces that could be detrimental to the pump operation and cause premature failure of components such as bearings, seals, shafts, etc.

.8 Where field tests do not verify compliance with specified performance requirements, investigate cause for noncompliance, undertake remedial work as required to bring pump into compliance, or replace the pump and all necessary ancillaries, and retest to prove compliance. All work required to bring the pump into compliance is the responsibility of the Contractor.

END OF SECTION
1. **GENERAL**

1.1 **Work Included**

.1 This Section specifies the supply, verification of the on-site equipment installation, testing, commissioning, and training of horizontal, frame-mounted end suction centrifugal pumps.

1.2 **Reference Specifications**

The following specifications shall apply to this specification:

- Section 01330 Submittals
- Section 01735 Operating and Maintenance Data
- Section 11005 General Process Provisions
- Section 11020 Process Equipment and Installation
- Section 11205 Process Motors Less than 150 kW

.2 Conform to the current standards of Hydraulic Institute.

1.3 **Submittals**

.1 Submittals in accordance with Section 01330, as well as those specified in Section 11205.

.2 Shipment, Protection, and Storage

.3 Ship pre-assembled to the degree that is practical.

.4 Identify special storage requirements. Store on site until ready for incorporation into the work using methods recommended by the manufacturer to prevent damage, undue stress or weathering.

1.4 **Unit Responsibility**

.1 Assign unit responsibility to the Pump Supplier for providing a fully functioning and operable system in accordance with the performance specification of this Section.

.2 Pump Manufacturer takes responsibility to ensure the compatibility between the pump motor and the variable speed drive (VFD), including sizing and power requirement of the drive.
2. **PRODUCTS**

2.1 **Detailed Pump Specification Sheets**

.1 Specific pumps are listed in detailed Specification sheet – Section 11301a and 11301b – Detailed Pump Specification. Required performance data are presented.

2.2 **Approved Manufacturers**

.1 Flowserve/ Ingersoll-Dresser

.2 Goulds Pump

.3 Hayward Gordon

.4 Grundfos

.5 Aurora

.6 Approved others may be accepted. Pump vendors shall submit their pump selections during the Tender period for review and acceptance. All pumps shall be manufactured by the same company.

2.3 **Impellers**

.1 Provide open or semi-open impeller, statically and dynamically balanced.

.2 Fabricate impellers of stainless steel type 316, ASTM A743, Gr.CF-8M.

2.4 **Casings**

.1 Fabricate casing of one piece ASTM A395 ductile iron or equivalent.

.2 Provide a flanged end suction inlet and a flanged vertical centreline discharge outlet.

.3 Pressure test casings at 1.5 times the pressure developed by the pump at shut off head.

.4 Provide tapped and plugged holes for priming and draining.

.5 Make the casing bore large enough to permit back pullout of the impeller without disturbing the casing or suction and discharge piping.

2.5 **Shafts**

.1 Fabricate pump shafts of American Iron Steel Institute (AISI) C1045 carbon steel or equivalent
.2 For shaft sleeve, use series 400 stainless steel.

.3 Make the shaft of sufficient diameter to assure rigid support of the impeller and to transmit loads without slip, vibration or undue deflection at operating loads. Designed for max 0.002 inch deflection at sealing face at max load.

.4 Key the impeller to the shaft, and secure by an impeller bolt. Design the assembly to prohibit loosening of the connection due to torque developed during operation. Design the assembly to allow a smooth flow path without causing the accumulation of stringy material.

.5 Provide a renewable shaft sleeve to protect the shaft through the sealing box area.

2.6 Wearing Rings

.1 Fit the casing with a Stainless Steel 316 wear ring to minimize abrasive and corrosive wear. Provide a radial type wear ring, press fitted into the casing.

2.7 Flexible Coupling

.1 Connect the pump shaft and the motor shaft with a flexible coupling. Refer to Section 11005 – General Process Provisions.

2.8 Motors

.1 Motor types, voltages, service conditions, and power ratings are indicated in the detailed pump Specification sheets.

.2 Comply with the provisions of Section 11205 – Process Motors under 150 kW.

2.9 Bases

.1 Manufacture frame- mounted pump bases of cast iron or fabricated steel with drain pan.

.2 Provide grouting holes, a minimum of one (1) at the centre and one (1) at each corner, of sufficient size to allow for the pouring of grout into the annular space.

.3 Bases are to have square corners in all three (3) directions, with parallel surfaces.

2.10 Protective Coatings

.1 All wetted parts require NSF 61 coatings.

.2 Provide coatings in accordance with approved factory standard.
3. EXECUTION

3.1 Manufacturer’s Representative

.1 The Manufacturer shall arrange for a technically qualified Manufacturer’s Representative to attend the installation work, train Owner’s Designated Staff and undertake the testing of the system for sufficient periods to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer’s requirements and specifications.

.2 The minimum periods of site attendance are identified in the following table along with the Form to be completed on each of these trips. A “day” is defined as eight working hours on site.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>No. of Days per Trip</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equipment Delivery</td>
<td>0.5</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>Installation Assistance (combined with Item 1)</td>
<td>0.5</td>
<td>101</td>
</tr>
<tr>
<td>3</td>
<td>Witnessing of Equipment Installation</td>
<td>1</td>
<td>102</td>
</tr>
<tr>
<td>4</td>
<td>Operator and Maintenance Training (combined with Item 3)</td>
<td>1</td>
<td>T1</td>
</tr>
<tr>
<td>5</td>
<td>Equipment Performance Testing</td>
<td>1</td>
<td>103</td>
</tr>
<tr>
<td>6</td>
<td>Process Performance Testing</td>
<td>1</td>
<td>104</td>
</tr>
</tbody>
</table>

.3 The total number of trips will depend on the Contractor’s schedule. The cost of additional trips, to be determined by the Engineer, will be borne by the Contractor.

3.2 Installation Assistance

.1 The Manufacturer’s Representative shall verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.

.2 The Manufacturer’s Representative shall instruct the Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractors’ understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.
3.3 Installation Witnessing

.1 The Contractor shall ensure the equipment is installed plumb, square and true within the tolerances specified by the Manufacturer and as indicated in the Contract Documents.

.2 The Contractor shall ensure that the equipment is installed as required to provide satisfactory service.

.3 The Manufacturer's Representative shall cooperate with the Contractor to deliver a successful installation as documented by Form 102 illustrated in Section 01650 – Equipment Installation.

3.4 Equipment Performance Testing

.1 The Manufacturer's Representative shall ensure the equipment, including all component parts and control systems, operates as intended.

.2 The Manufacturer’s Representative shall cooperate with the Contractor to test the equipment as documented by Form 103, illustrated in Section 01650 – Equipment Installation.

3.5 Process Performance Testing

.1 The Manufacturer's Representative shall attend the commissioning of the process system that includes the equipment specified in this Section to ensure the equipment functions as intended. The Manufacturer’s Representative shall cooperate with the Process Performance Testing Team in the development of the Commissioning Plan for this equipment and cooperate with the Contractor in the commissioning of the equipment as documented by Form 104, illustrated in Section 01670 – Commissioning.

3.6 Training

.1 The Manufacturer’s Representative shall provide training to the Owner’s Designated Staff in the proper operation and maintenance of the equipment as documented by Forms T1 and T2, illustrated in Section 01664 – Training.

END OF SECTION
## 1. GENERAL DESCRIPTION

<table>
<thead>
<tr>
<th>Pump name</th>
<th>Glenmore Booster Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment number</td>
<td>P-110, P-105</td>
</tr>
<tr>
<td>Quantity</td>
<td>2</td>
</tr>
<tr>
<td>Duty</td>
<td>Duty, Duty</td>
</tr>
<tr>
<td>Drive</td>
<td>Variable Speed</td>
</tr>
<tr>
<td>Ambient environment</td>
<td>Indoors</td>
</tr>
<tr>
<td>Ambient temperature (°C)</td>
<td>5-30</td>
</tr>
<tr>
<td>Ambient average relative humidity (percent)</td>
<td>20-100</td>
</tr>
<tr>
<td>Fluid service</td>
<td>Chlorinated Water</td>
</tr>
<tr>
<td>Fluid temperature (°C)</td>
<td>2-20</td>
</tr>
<tr>
<td>Fluid Specific Gravity (at 15°C)</td>
<td>1.0</td>
</tr>
<tr>
<td>Site Elevation (m)</td>
<td>470.0 m</td>
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<tr>
<td>Atmospheric pressure (kPaA)</td>
<td>101.5</td>
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<tr>
<td>Minimum available NPSH (m)</td>
<td>Pump Manufacturer to confirm NPSHa &gt; NPSHr</td>
</tr>
<tr>
<td>Design flow capacity (L/s)</td>
<td>100</td>
</tr>
<tr>
<td>Acceptable Manufacturer</td>
<td>Refer to Item 2.2 of Section 11301</td>
</tr>
<tr>
<td>Rated TDH (m)</td>
<td>101.2</td>
</tr>
<tr>
<td>Design pump speed (r/min)</td>
<td>1750</td>
</tr>
<tr>
<td>Design motor speed (r/min)</td>
<td>1800</td>
</tr>
<tr>
<td>Minimum motor size (hp)</td>
<td>200</td>
</tr>
<tr>
<td>Motor Enclosure Type</td>
<td>TEFC, Premium Efficiency</td>
</tr>
<tr>
<td>Discharge flange rating ANSI (psi)</td>
<td>125</td>
</tr>
<tr>
<td>Discharge size (mm)</td>
<td>200</td>
</tr>
<tr>
<td>Suction size (mm)</td>
<td>200</td>
</tr>
<tr>
<td>Pump Accessories</td>
<td></td>
</tr>
<tr>
<td>Propeller</td>
<td>Stainless Steel type 316, ASTM A743, Gr. CF-8M</td>
</tr>
<tr>
<td>Mounting</td>
<td>Frame Mounted</td>
</tr>
<tr>
<td>Coatings</td>
<td>Epoxy coat all ferrous wetted parts.</td>
</tr>
</tbody>
</table>
# GENERAL DESCRIPTION

<table>
<thead>
<tr>
<th>Pump name</th>
<th>Eldorado Low Lift Pump Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment number</td>
<td>P-200, P-201, P-202</td>
</tr>
<tr>
<td>Quantity</td>
<td>3</td>
</tr>
<tr>
<td>Duty</td>
<td>Duty, Duty, Standby</td>
</tr>
<tr>
<td>Drive</td>
<td>Variable Speed</td>
</tr>
<tr>
<td>Ambient environment</td>
<td>Indoors</td>
</tr>
<tr>
<td>Ambient temperature (°C)</td>
<td>5-25</td>
</tr>
<tr>
<td>Ambient average relative humidity (percent)</td>
<td>20-100</td>
</tr>
<tr>
<td>Fluid service</td>
<td>Raw Water</td>
</tr>
<tr>
<td>Fluid temperature (°C)</td>
<td>2-20</td>
</tr>
<tr>
<td>Fluid Specific Gravity (at 15°C)</td>
<td>1.0</td>
</tr>
<tr>
<td>Site Elevation (m)</td>
<td>614.20 m</td>
</tr>
<tr>
<td>Atmospheric pressure (kPaA)</td>
<td>101.5</td>
</tr>
<tr>
<td>Minimum available NPSH (m)</td>
<td>Pump Manufacturer to confirm NPSHa &gt; NPSHr</td>
</tr>
<tr>
<td>Design flow capacity (L/s)</td>
<td>375</td>
</tr>
<tr>
<td>Acceptable Manufacturer</td>
<td>Refer to Item 2.2 of Section 11301</td>
</tr>
<tr>
<td>Rated TDH (m)</td>
<td>9.8 (maximum, refer to pump curve provided below)</td>
</tr>
<tr>
<td>Design pump speed (rp/min)</td>
<td>900</td>
</tr>
<tr>
<td>Design motor speed (r/min)</td>
<td>900</td>
</tr>
<tr>
<td>Minimum motor size (hp)</td>
<td>100</td>
</tr>
<tr>
<td>Motor Enclosure Type</td>
<td>TEFC, Premium Efficiency</td>
</tr>
<tr>
<td>Discharge flange rating ANSI (psi)</td>
<td>150</td>
</tr>
<tr>
<td>Discharge size (mm)</td>
<td>300</td>
</tr>
<tr>
<td>Suction size (mm)</td>
<td>400</td>
</tr>
<tr>
<td>Pump Accessories</td>
<td>All stainless steel wetted parts</td>
</tr>
<tr>
<td>Propeller</td>
<td>Stainless Steel type 316, ASTM A743, Gr. CF-8M</td>
</tr>
<tr>
<td>Mounting</td>
<td>Frame Mounted</td>
</tr>
<tr>
<td>Coatings</td>
<td>Epoxy coat all ferrous wetted parts</td>
</tr>
</tbody>
</table>
Eldorado Low Lift Booster Station - System Curve

- Single Pump Duty Point, 375 L/s
- Two Pump Duty Point, 750 L/s

Total Dynamic Headloss (metres)

Flow (L/s)

END OF SECTION
1. GENERAL

1.1 Work Included

.1 Provide, apply, and maintain the specified field applied protective and maintenance coating systems. Coatings are required on all process and mechanical equipment, vessels, and pipes unless otherwise specified.

.2 Refer to Drawings and Schedules herein for the type, location, and extent of coatings required and included for all field coating necessary to complete all the work shown, specified or scheduled.

1.2 Delivery and Storage

.1 Deliver all coating materials to the site in sealed containers properly labelled to indicate the manufacturer's name, type, and colour of contents, date of manufacture, batch number, and storage requirements.

.2 Provide adequately heated and ventilated storage for all materials and ensure compliance with fire prevention regulations.

2. PRODUCTS

2.1 Manufacturers

.1 All constituents of each coating system are to be provided by the same manufacturer.

.2 Acceptable Manufacturers: Amercoat Canada, General Paint, Carboline, Cloverdale, Devoe Coatings, Valspar, Sherwin Williams, Benjamin Moore.

2.2 Schedule of Surface Treatments

.1 The Schedule of Surface Treatments defines the components of the protective coating system.
Schedule of Protective Systems

2.3 The schedule of protective systems defines the combination of surface treatments required in each system and the sections of the plant to which it is to be applied. The systems have been grouped into three categories as follows:

.1 Category A: Immersed Service, equipment, or material fully, partially, or intermittently immersed in water during routine plant operation.

.2 Category B: Exposed Service, equipment, or material exposed to the normal range of atmospheric conditions and conditions common to water and wastewater treatment facilities (high humidity, etc.)

.3 Category C: Indoor Service, equipment, or materials inside buildings or other ventilated spaces.
2.4 Category A

.1 All Category A systems will be tested by the Owner’s representative using a wet sponge holiday detector set at 67.5 V. Touch up will be required at points where the detector is grounded.

.2 Schedule:

<table>
<thead>
<tr>
<th>System</th>
<th>Surface Treatments</th>
<th>Typical Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>A, D, L, L</td>
<td>Equipment or piping delivered with inorganic zinc primer, e.g. clarifier mechanics, mixers, etc.</td>
</tr>
<tr>
<td>A2</td>
<td>A, F, J, L, L</td>
<td>Equipment or piping delivered uncoated or with coatings not compatible with epoxy, e.g. ductile iron, cast iron, or steel pipe and pipe sleeves inside treatment units. External Surfaces at valves, fabricated pipe supports, brackets, etc.</td>
</tr>
<tr>
<td>A3</td>
<td>A, G, M</td>
<td>Aluminum surfaces in contact with concrete, e.g. access cover frames.</td>
</tr>
<tr>
<td>A4</td>
<td>A, E</td>
<td>Ferrous metal surface cast into concrete, e.g. penstocks, pipe sleeves.</td>
</tr>
<tr>
<td>A5</td>
<td>A</td>
<td>Stainless steels, plastics, and fibreglass products.</td>
</tr>
</tbody>
</table>

2.5 Category B

.1 Schedule:

<table>
<thead>
<tr>
<th>System</th>
<th>Surface Treatments</th>
<th>Typical Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>A, B, R, R</td>
<td>Equipment or piping delivered with inorganic zinc primer, e.g. motors, flocculator gearbox &amp; motor, valve headstocks, piping above ground, &amp; outside treatment units, hydrants, etc.</td>
</tr>
<tr>
<td>B2</td>
<td>A, B, J, R, R</td>
<td>Equipment or piping delivered but not applied with an inorganic zinc prime coat or with a prime coat not compatible with an inorganic zinc overcoat.</td>
</tr>
<tr>
<td>B3</td>
<td>A, B, H, R, R</td>
<td>Galvanized or cadmium plated goods, e.g. pipe supports or brackets, mountings for electrical or control equipment (Unistrut, etc.).</td>
</tr>
<tr>
<td>B4</td>
<td>A</td>
<td>Stainless steel or aluminum products, e.g. insulation recovering.</td>
</tr>
</tbody>
</table>
FIELD APPLIED
PROTECTIVE AND MAINTENANCE COATINGS

2.6 Category C

.1 Schedule

<table>
<thead>
<tr>
<th>System</th>
<th>Surface Treatments</th>
<th>Typical Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>A, B, K, K</td>
<td>Equipment or piping delivered c/w factory finished coatings. Coated for system identification and maintenance. Surface temperature during operation not exceeding 100°C, e.g. pumps, air handling units, valves, etc.</td>
</tr>
<tr>
<td>C2</td>
<td>A, G, K, K</td>
<td>Equipment or accessories fully primed. Surface temperatures not exceeding 100°C, e.g. pumps, steel piping.</td>
</tr>
<tr>
<td>C3</td>
<td>A, C, I, N, N</td>
<td>Equipment or accessories as C1 or C2 but with operating surface temperatures between 100°C and 150°C, e.g. air compressors, blowers.</td>
</tr>
<tr>
<td>C4</td>
<td>E, J, O</td>
<td>Equipment or accessories as C1 or C2 but with operating surface temperatures between 150°C and 400°C, e.g. boiler fittings.</td>
</tr>
<tr>
<td>C5</td>
<td>B, P, K, K</td>
<td>Piping or valves with bituminous or tar coatings. Surface temperatures not exceeding 100°C, e.g. cast iron &amp; ductile iron pipe, valves.</td>
</tr>
<tr>
<td>C6</td>
<td>A, K, K</td>
<td>PVC pipe, fittings, or accessories coated for identification only.</td>
</tr>
<tr>
<td>C7</td>
<td>A, H, K, K</td>
<td>Aluminum insulation recovering coated for identification only.</td>
</tr>
<tr>
<td>C8</td>
<td>A, Q, G, N, N</td>
<td>Canvas insulation recovering.</td>
</tr>
</tbody>
</table>

**NOTE:**

(1) Surface preparation G-abrasion has not been fully scheduled but is to be carried out between all coatings.

(2) No bare ferrous metal surfaces are permitted. Pipe hanger rods etc., unless zinc or cadmium plated, are to be at least prime coated. Cut ends of plated surfaces (Uni-strut, etc.) are to be spot primed.

2.7 Colour Coding

.1 Refer to Section 11910 for pipe and equipment identification color coding.

3. EXECUTION

3.1 Quality Assurance

.1 Apply all paints and coatings strictly in accordance with the manufacturer's directions.

.2 Pay particular attention to ensure the compatibility of each surface treatment with the preceding and subsequent surface treatments and coatings. Ensure the compatibility of all surface treatments and coatings.
3.2 Environmental Conditions

.1 Do not apply a coating when the ambient or surface temperature is below 10°C or less than 3°C above the dew point.

.2 Provide adequate ventilation and sufficient heating to maintain temperatures above 7°C for 24 hours before coatings are applied. Continue heating to maintain 10°C during application and for 48 hours after application.

.3 Provide a minimum of 300 lux illumination on surface to be treated.

.4 Do not apply coatings where dust is being generated.

3.3 Protection

.1 Provide sufficient drop cloths, shields, and protective equipment to prevent spray or droppings from fouling surfaces not being painted. Make good any damage resulting from inadequate or unsuitable protection.

.2 Maintain all coated surfaces until completion of the works. Damage to coatings, occurring at any time, shall be made good within seven days.

.3 Place cotton waste, cloths, and material which may constitute a fire hazard in closed metal containers and remove from the site at suitable intervals.

.4 Remove and, after painting, replace or adequately mask all grease nipples, bright metal surfaces, identification plates, and other items not to be painted. Do not use solvent that may remove permanent lacquer finishes.

3.4 Condition of Surfaces

.1 Thoroughly examine all surfaces to be treated or coated prior to commencement of work. Report, in writing, to the Engineer any condition or defect that may affect the integrity or quality of the finished coating. Do not commence work on any section until all such defects in that section have been corrected.

.2 On all factory primed or coated equipment, touch up defects prior to the application of subsequent coatings.

.3 Be responsible for the condition of surfaces and for correcting defects and deficiencies in the surface.

END OF SECTION
1. GENERAL

1.1 Documents

.1 This Section of the Specifications forms part of the Contract Documents and are to be read, interpreted, and coordinated with all other parts.

1.2 Work Included

.1 Supply and application of all factory applied prime coats or factory applied finish coats.

1.3 Submissions

.1 With the shop drawings, submit details of the coating systems to be applied.

1.4 Quality Assurance

.1 This specification is intended to be a minimum reference standard. The Supply Contractor may submit for review alternative coating systems for specific items which provide equal or better corrosion protection and maintenance service than those specified herein.

2. PRODUCTS

2.1 Surface Preparation

.1 Immersion Service: After degreasing, dry blast all ferrous components to a white metal finish in accordance with SSPC-SP5 to a degree of cleanliness in accordance with NACE #1 and obtain a 50 micron blast profile.

.2 Non-immersion Service: After degreasing, dry blast all ferrous components to a near white metal finish in accordance with SSPC-SP10 to a degree of cleanliness in accordance with NACE #3 and obtain a 50 micron blast profile.

2.2 Prime Coating

.1 Prime coat all ferrous surfaces before the blasted surfaces deteriorate.

.2 Coat ferrous surfaces with inorganic zinc primer, containing a minimum of 50% solids by volume, applied to a minimum dry film thickness of 75 microns.

2.3 Finish coats

.1 Apply finish coats in conformance with Section 11900 for service, coating types, and application rates.
2.4 Assembly

.1 For items which are to be bolted together before shipment, clean surfaces and coat before the parts are assembled.

.2 Continuous weld all welded connections, sealing the mating surface completely. On completion of the welding and fettling, treat all weld seams with phosphoric acid solution. Rinse and thoroughly dry before the prime is applied.

.3 Where dissimilar metals are mated insulate the mating surfaces from one another to provide protection against corrosion. Insulate bolts, nuts, washers, and rivets in a similar manner.

.4 Use 304 stainless steel or better for all nuts, bolts, washers, and similar fittings for immersion service. For non-immersion service, use 304 stainless or zinc or cadmium plated nuts, bolts, washers, and similar fittings. Clean and coat the inner face of non-threaded bolt holes as required for other surfaces.

3. EXECUTION

3.1 Inspection

.1 Notify the Engineer two weeks before commencing the protective coating to permit the inspection by the Engineer of the surface preparation and protective coating application.

3.2 Protection

.1 Protect all coated equipment adequately against damage, dust, moisture, and scratching during shipment, off-loading, and storage on-site. If, in the opinion of the Engineer, the coating is damaged during shipment to the extent that touch up would not be satisfactory, return and re-coat the equipment at the Supply Contractor’s cost.

.2 Make good damage to coatings occurring at any time prior to the application of any further coatings.

3.3 Application Conditions

.1 Apply all factory applied coatings under controlled conditions, in a dust-free atmosphere at a temperature of between 10°C and 20°C, and a relative humidity that should not exceed 80%.

END OF SECTION
IDENTIFICATION

1. GENERAL

1.1 Work Included

.1 Identification of equipment, motors, vessels, valves, ferrous, non-ferrous, and insulated piping.

2. PRODUCTS

2.1 Equipment Manufacturer's Nameplates

.1 Provide metal nameplate on each piece of equipment, mechanically fastened with raised or recessed letters.

.2 Provide Underwriters’ Laboratories and/or CSA registration plates, as required by respective agency.

.3 Manufacturer’s nameplates to indicate size, equipment model, manufacturer’s name, serial number, voltage, cycle, phase, and power of motors.

2.2 Equipment - Project Identification Nameplates

.1 Supply and install white lamacoid identification plates, with black lettering, for all equipment installed under this contract. Provide identification plates that are engraved with the unit name and equipment number in 12 mm high lettering and electrical characteristics, if applicable, in 6 mm high lettering.

.2 Example: Dissolved Air Flotation Clarifier 1...... 12 mm lettering DAF-210...........................................12 mm lettering

.3 Submit list of plates for review prior to engraving.

2.3 Valves

.1 Provide all valves with a white lamacoid tag, with 12 mm black engraved names and numbers.

.2 Number valves as directed by the Engineer or as shown on the drawings.

.3 Attach tags to valves using fasteners. Adhesive mounts are not acceptable.
2.4 Piping

.1 For all carbon steel and PVC piping installed under this Contract, use pipe markers designating the pipe service and the direction of flow. Do not paint stainless steel piping.

.2 Stencil marking directly onto pipe or use pre-printed pipe markers. For pre-printed pipe markers, use self-adhesive, plastic coated cloth labels. In addition to its adhesive, secure each label with a full tape band at each end of the label.

.3 Make direction arrows 150 mm long by 50 mm wide for piping with an outer diameter 75 mm or larger, including insulation. Use 100 mm long by 20 mm wide arrows for smaller diameter piping. Provide double headed arrows where appropriate.

.4 Use block capital letters for names, 50 mm high for piping with an outer diameter 75 mm or larger, including insulation. Use 20 mm high letters for smaller diameters. Identify the pipe commodity codes using the abbreviations detailed on the drawings or identified in Section 15055 – Detailed Process Piping Specification Sheets.

.5 Use brass tags for pipes and tubing with an outer diameter 20 mm and smaller.

2.5 Colour Coding

.1 Use a colour coded identification system on the following items:

.1 All piping and valves – paint the piping using Sherwin Williams Pro Industrial DTM Acrylic Semi-gloss. Paint all valves medium blue other than valves on fire protection systems. Paint the valves on fire protection systems red.

.2 All motors – paint all motors using General Paint 10-052 7856A.

.2 Identification shall consist of the following:

.1 Banding of pipes to the colour of the medium being conveyed.

.2 Finish valve handles, chain wheels, and similar appurtenances in blue.
IDENTIFICATION

.3 Select identification colours in accordance with the colour scheme as outlined in the following table:

<table>
<thead>
<tr>
<th>Process Commodity</th>
<th>Colour</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorine Solution</td>
<td>Yellow</td>
<td>CLS</td>
</tr>
<tr>
<td>Drain</td>
<td>Dark Gray</td>
<td>DRA</td>
</tr>
<tr>
<td>Overflow</td>
<td>Same colour as overflow line</td>
<td>OF</td>
</tr>
<tr>
<td>Raw Water</td>
<td>Dark Blue</td>
<td>RW</td>
</tr>
<tr>
<td>Sample</td>
<td>Same colour as line being sampled</td>
<td>SAM</td>
</tr>
<tr>
<td>Treated Water</td>
<td>Dark Blue</td>
<td>TW</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mechanical Commodity</th>
<th>Colour</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Cold Water</td>
<td>Dark Blue</td>
<td>DCW</td>
</tr>
<tr>
<td>Domestic Hot Water</td>
<td>Dark Blue/Orange Band</td>
<td>DHW</td>
</tr>
<tr>
<td>Utility Water</td>
<td>Dark Blue</td>
<td>UW</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other</th>
<th>Colour</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical (motors, etc.)</td>
<td>French Grey</td>
<td></td>
</tr>
<tr>
<td>H/V Air Ducts</td>
<td>Light Brown</td>
<td></td>
</tr>
</tbody>
</table>

3. EXECUTION

3.1 Equipment Manufacturer’s Nameplates

.1 Locate nameplates so that they are easily read. Do not insulate or paint over plates.

3.2 Equipment Project Identification Nameplates

.1 Attach plates to the equipment with sheet metal screws or nuts and bolts (adhesive will not be accepted).

.2 Fasten plates in conspicuous locations. Where plates cannot be mounted on hot or cold surfaces, provide standoffs.

3.3 Valves

.1 Attach tags to all valves with sheet metal screws or nuts and bolts. Ensure tags are easily accessible from operator location and do not conflict with valve operation.

3.4 Piping

.1 On completion of protective coatings or finish painting, neatly stencil direction flow arrows and the commodity abbreviation on the pipe. Alternatively, attach pre-printed labels.
IDENTIFICATION

.2 Stencil or attach pipe markers in readily visible locations. Identify piping at the following locations:

.1 At each valve

.2 On both sides of wall penetrations

.3 At floor and roof penetrations

.4 On each leg of branches

.5 Every 15 metres along continuous runs.

END OF SECTION
Division 15 –
Building Mechanical
1. GENERAL

1.1 Intent

.1 Provide complete, fully tested and operational mechanical systems to meet the requirements described herein and in complete accord with applicable codes and ordinances.

.2 Contract Documents and Drawings of this Division are diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are not detailed installation instructions.

.3 Follow Manufacturers’ recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.

.4 Install equipment generally in locations and routes shown. Run piping and ductwork close to building structure, parallel to building lines to maximize headroom and with minimum interference with other services and free space. Remove and replace improperly installed equipment to satisfaction of the Consultant at no extra cost.

.5 Install equipment to provide access and ease of maintenance.

.6 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the Owner as shown on the drawings or listed herein. Uncrate equipment, move in place and install complete; start-up and test.

.7 Install valves, dampers, thermal wells, and other devices on piping and ducts, furnished by Controls Contractor.

.8 Furnish a written guarantee stating that all work executed in this Contract will be free from defective workmanship and materials for a period of one (1) year from the date of Substantial Performance. The Contractor shall, at his own expense, repair and replace any work which fails or becomes defective during the term of the guarantee/warranty, providing such work is not due to improper usage. The period of guarantee specified shall not in any way supplant any other guarantees of a longer period but shall be binding on work not otherwise covered.

.9 If the equipment is used during construction, the guarantee or guarantee period shall not be shortened or altered.

.10 ‘Provide’ shall mean ‘supply and install’.

.11 Consultant shall mean AECOM Canada Ltd. Designated Representative.

1.2 Coordination of Work

.1 Cooperate and coordinate with other trades on the project.

.2 Make reference to electrical, mechanical, structural and architectural drawings when setting out work. Consult with respective Divisions in setting out locations for ductwork, equipment, and piping, so that conflicts are avoided and symmetrical even spacing is maintained. Jointly work out all conflicts on site before fabricating or installing any materials or equipment.
.3 Where dimensional details are required, work with the applicable architectural and structural Drawings.

.4 Full-size and detailed drawings shall take precedence over scale measurements from Drawings. Drawings shall take precedence over Specifications.

.5 Any areas indicated as space for future materials or equipment shall be left clear.

1.3 Permits

.1 All work shall comply with provincial, municipal, by-laws and authorities having jurisdiction.

.2 Obtain all permits and pay all fees applicable to the work.

.3 Contractor shall arrange for inspections of the work by the authorities having jurisdiction and shall provide certificates indicating Final Approval.

1.4 Examination of Site

.1 Before submitting Tender, visit and examine the site and note all characteristics and features affecting the work. No allowances will be made for any difficulties encountered or any expenses incurred because of any conditions of the site or item existing thereon, which is visible or known to exist at the time of Tender.

1.5 Quality of Work

.1 All work shall be by qualified tradesmen with valid Provincial Trade Qualification Certificates. Spot checks will be made by the Consultant.

.2 Work which does not conform to standards accepted by the Consultant and the trade may be rejected by the Consultant. The Contractor shall redo rejected work to the accepted standard at no cost to the Owner.

1.6 References


1.7 Metric Conversion

.1 All units in this Division are expressed in SI units.

.2 Equivalent Nominal Diameters of Pipes - Metric and Imperial:

   .1 Where pipes are specified with metric dimensions and imperial sized pipes are available, provide equivalent nominal Imperial sized pipe as indicated in the table, and provide at no extra cost adapters to ensure compatible connections to all metric sized fittings, equipment and piping.

   .2 When CSA approved SI Metric pipes are provided, the Contractor shall provide at no extra cost adapters to ensure compatible connections between the SI Metric pipes and all new and existing pipes, fittings, and equipment.
GENERAL MECHANICAL PROVISIONS

### Metric Duct Sizes:

- The Metric duct sizes are expressed as 25 mm = 1 inch.

<table>
<thead>
<tr>
<th>mm (in. NPS)</th>
<th>mm (in. NPS)</th>
<th>mm (in. NPS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 (1/8)</td>
<td>65 (2½)</td>
<td>375 (15)</td>
</tr>
<tr>
<td>6 (1/4)</td>
<td>65 (2½)</td>
<td>450 (18)</td>
</tr>
<tr>
<td>10 (3/8)</td>
<td>75 (3)</td>
<td>500 (20)</td>
</tr>
<tr>
<td>15 (1½)</td>
<td>100 (4)</td>
<td>600 (24)</td>
</tr>
<tr>
<td>20 (3/4)</td>
<td>125 (5)</td>
<td>750 (30)</td>
</tr>
<tr>
<td>25 (1)</td>
<td>150 (6)</td>
<td></td>
</tr>
<tr>
<td>30 (1¼)</td>
<td>200 (8)</td>
<td></td>
</tr>
<tr>
<td>40 (1½)</td>
<td>250 (10)</td>
<td></td>
</tr>
<tr>
<td>50 (2)</td>
<td>300 (12)</td>
<td></td>
</tr>
</tbody>
</table>

1.8 **Alternate Materials and Equipment**

- The price submitted for this Contract shall be based on the use of materials and equipment as specified or as contained within the Acceptable Manufacturers List.

- Requests for approval for tendering purposes of equivalent materials or equipment shall be submitted to the Consultant no later than seven (7) working days prior to the closing date of Tender for mechanical trade, complete with all applicable technical data, including performance curves and physical details, and highlighting all areas indicating conformance with the material, technical and performance specification. The Contractor shall submit all requests in the same SI units stated in the Tender Documents, or with converted values were SI units are not available. Submit original pdf files or original printed documents. Photocopied, faxed, or scanned documents or documents submitted in Imperial units will not be reviewed. Approval of requests shall only be given by addendum.

- The Contractor shall, in his quotation, indicate the degree of approval obtained from the Consultant. In the event that the product has been approved as “Alternate Only”, this shall be stated in the quotation, and the Contractor shall bear any and all costs for design/system modifications to accommodate the “alternate” equipment.

- Approved equivalents and/or alternatives to specified products shall be equal to the specified product in every respect, operate as intended, and meet the space, capacity, and noise requirements outlined.

- The Contractor shall be fully responsible for any additional work or materials required by the trades or other Contractors to accommodate use of other than specified materials or equipment. Extras will not be approved to cover such work.

1.9 **Drawings and Specifications**

- Drawings and Specifications are complementary each to the other, and what is called for by one shall be binding as if called for by both.

- Should any discrepancy appear between Drawings and Specifications which leaves the Contractor in doubt as to the true intent and meaning of the plans and specifications, obtain
a ruling from the Consultant, before submitting a Tender. If this is not done, it will be assumed that the most expensive alternate had been included.

.3 Examine all Contract Documents, including all Drawings and Specifications, and work of other trades to ensure that work is satisfactorily carried out without changes to building.

1.10 Shop Drawings

.1 Provide one (1) electronic copy or two (2) printed copies, for all scheduled equipment and as specified in specific equipment sections of this Specification. Submit electronic copies in pdf format using original documents or create the pdf. Scanned copies shall be rejected. For printed submittals, submit original printed documents. Photocopied or faxed documents will be rejected.

.2 Submit all Shop Drawings and maintenance manuals in SI units. On all Shop Drawings use the same SI units as stated in the Specification or in the schedules or both. Where information is not produced in the same SI units as stated in the Specification or in the schedules or both, the Contractor will provide converted values. Shop Drawings not presented in the same SI units as stated in the Specification or in the schedules or both or without converted values will be rejected.

.3 Clearly mark each Shop Drawing with the Specification Section number together with the clause number or schedule number and the item tag number (where applicable) to which it refers.

.4 Identify materials and equipment by manufacturer, trade name and model number. Include applicable brochure or catalogue material. Do not assume applicable catalogues are available in the Consultant's office. Maintenance and operating manuals are not suitable submittal material.

.5 Clearly mark submittal material using arrows, underlining or circling to show differences from specified, e.g. ratings, capacities and options being proposed. Cross out non-applicable material. Specifically note on the submittal specified features such as special tank linings, pumps seals materials or painting.

.6 Include weights, dimensional, and technical data sufficient to check if equipment meets requirements. Include wiring, piping, and service connection data and motor sizes. Provide centre of gravity diagrams for the use of the seismic consultant.

.7 Installed materials and equipment shall meet specified requirements regardless of whether or not Shop Drawings are reviewed by the Consultant.

.8 Do not order equipment or material until the Consultant has reviewed and returned Shop Drawings.

.9 Prior to submission to the Consultant, the Contractor shall review all Shop Drawings. By this review, the Contractor certifies that he has determined and verified all field measurements, field construction criteria, materials, catalogue numbers and similar data, and certifies that he has checked and coordinated each Shop Drawing with the requirements of the work of the Contract Documents. The Contractor's review of each Shop Drawing shall be indicated by stamp, date and signature of the Contractor's designated project manager.
GENERAL MECHANICAL PROVISIONS

.10 Contractor’s responsibility for errors and omissions in submissions is not relieved by Consultant review of submittals.

.11 Contractor’s responsibility for deviations in submission from requirements of Contract is not relieved by the Consultant review of submittals.

.12 Retain one (1) copy of reviewed Shop Drawings on site for review.

1.11 Salvage

.1 Remove from site all equipment, ducting or piping which is no longer required because of work under this Contract.

.2 Turnover to and deliver to the Owner’s storage area all items which have been determined to have salvage value and has been removed due to the Work.

1.12 Cutting, Patching and Coring

.1 Provide holes and sleeves, cutting and fitting required for mechanical work.

.2 Drill for expansion bolts, hanger rods, brackets, and supports.

.3 Obtain written approval from the Structural Consultant before cutting or burning structural members.

.4 Provide openings and holes required in precast members for mechanical work. Cast holes 100 mm or larger in diameter. Field-cut smaller than 100 mm.

.5 Patch building where damaged from equipment installation, improperly located holes etc. Use matching materials as specified in the respective section.

1.13 Outdoor Piping Sealant

.1 Unless otherwise noted, all outdoor openings around pipe penetrations shall have the gap filled with an adhesive/sealant to provide a weatherproof seal.

.2 Adhesive/sealant shall be polyurethane based, temperature range of -40°C to 93°C, paintable with the use of primer, sandable, and has high UV resistance.

.3 Acceptable adhesive/sealant: Silaprene Solid Seal from Faucher Industries (Model: 642-2256, White)

.4 Acceptable adhesive/sealant: Silaprene Solid Seal from Faucher Industries (Model: 642-2263, Grey)

.5 Acceptable adhesive/sealant: Silaprene Solid Seal from Faucher Industries (Model: 642-2270, Black)

1.14 Excavation and Backfill

.1 Refer to requirements of Division 2.
1.15 **Installation of Equipment**

.1 Pipe all equipment drains to building drains.

.2 Unions and flanges shall be provided in piping or ductwork to permit easy removal of equipment.

.3 Maintain permanent access to equipment for maintenance.

1.16 **Fire-Stopping**

.1 The Contractor is solely responsible for fire-stopping all openings cast, cored or cut, pertaining to his work and the work of his subcontractors.

.2 Fire-stop all pipe, duct, conduit and wire penetrations through floors and walls, designated as fire and/or smoke separations. The Contractor is required to coordinate with the Architectural Drawings to contractual rated wall types and installation details.

.3 Fire-stopping materials to meet ULC CAN 2S115. Acceptable Materials: "Tremco" or "National Firestopping", or Hilti CP680 Cast-in-Place Firestopping System.

.4 Preparation of surfaces and installation of fire-stopping materials shall be carried out as per Manufacturer's instructions.

1.17 **Connections to Existing Services**

.1 Maintain liaison with the Owner and provide a schedule to interrupt, re-route or connect to existing systems, with minimum interruption of services.

.2 Major services shall not be interrupted before all preparatory work is completed and all required materials are on site. Provide a minimum of five (5) working days written notice for each service shutdown.

.3 Interruptions and shutdowns of existing services shall be by the building/plant maintenance staff.

1.18 **Equipment and Materials**

.1 Materials and equipment installed shall be new, full weight and of quality specified.

.2 Each major component of equipment shall bear Manufacturer’s name, address, catalogue and serial number in a conspicuous place.

.3 Where two or more products of the same type are required, products shall be of the same manufacturer.

.4 Make known in writing to the Consultant ten (10) days prior to the Tender closing date any materials specified that are required to complete the work which are not currently available or will not be available for use as called for herein. Failing to do so, it will be assumed that the most expensive alternate has been included in the tender price.
GENERAL MECHANICAL PROVISIONS

1.19 Equipment Protection and Clean-Up

.1 Protect equipment and materials in storage on site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

.2 Protect equipment with polyethylene covers and crates.

.3 Operate, drain and flush out unsealed bearings and refill with new change of oil, before final acceptance.

.4 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances.

.5 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.

.6 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

1.20 Electrical Motors

.1 Supply mechanical equipment complete with electrical motors.

.2 Provide motors designed, manufactured, and tested in accordance with the latest edition of the following codes and standards: NEMA, EEMAC, CSA, CEC Part 1, IEEE and ANSI. All motors to be CSA labelled. All motors to be approved for use in the designated area classification by the Provincial Electrical Protection Branch.

.3 All motors intended for use with a variable speed drive (variance frequency drive) shall be inverter only rated. Variable speed drive shall be matched to motor. Coordinate with Division 16.

.4 Two speed motors shall have separate winding for each speed.

.5 Unless specified otherwise, provide motors designed for full voltage starting, EEMAC Design B. Motors driving high torque or high inertia loads may be EEMAC Design C or D.

.6 Provide motors rated for continuous duty with 1.15 service factor unless specified otherwise in the driven equipment specifications. Provide all motors with thermal overload protection.

.7 Motors less than 0.38 kW shall be 120 V, 60 Hz, 1 phase. Motors 0.38 kW and larger shall be 3-phase at the indicated voltage.

.8 All motors shall be 1800 rpm except where indicated.

.9 Provide motors with grease or oil lubricated anti-friction type ball or roller bearings.

.10 Provide motors designed with Class F insulation for totally enclosed motors.

.11 Refer to Electrical Specifications, Division 16, for voltage, frequency, and phase data. This shall take precedence over any reference in Division 15.
.12 Where motor power is stated in watts or kilowatts, nominal motor horsepower multiplied by 746 or 0.746 respectively, has been used as the conversion factor.

1.21 Access Doors

.1 Provide access doors for maintenance or adjustment purposes for all mechanical system components including:

.1 Valves
.2 Volume and splitter dampers
.3 Cleanouts and traps
.4 Controls, coils and terminal units
.5 Expansion joints
.6 Filters
.7 Strainers

.2 Steel frame access panel with stainless steel piano-type hinge, channel reinforced steel door panel, three "Symmons" fasteners per door. Provide acoustic gasket between door panel perimeter and steel frame. Rated access doors shall be UL-listed.

.3 Sizes to be 200 mm x 200 mm for cleanout, 300 mm x 300 mm for hand 600 mm x 600 mm for body access minimum.

1.22 Miscellaneous Metals

.1 Provide all necessary miscellaneous metals to hang or support materials, equipment and provide access for work under this contract.

.2 All miscellaneous metals shall be prime painted.

.3 Miscellaneous metals shall include but are not limited to:

.1 Hangers for equipment, piping and ductwork.
.2 Support for equipment.
.3 Access platforms and catwalks.

1.23 Escutcheon and Plates

.1 Provide escutcheon and plates on piping and ductwork passing through finished walls, floors and ceilings.

.2 Escutcheons shall be split type, stainless or chrome plated steel.
1.24 Painting and Identification

.1 Colour code mechanical equipment, piping and exposed ductwork. Refer to colour coding schedule below.

.2 Legend and direction of flow arrows shall consist of adhesive backed labels, yellow colour, with minimum 20 mm high black lettering equal to Brady System B-500, vinyl cloth labels for non-insulated surfaces; and Brady B 946 for insulated surfaces.

.3 Identify piping with labels, colour bands, and flow arrows. Provide identification at 3 m maximum intervals, before and after pipes pass through walls, at all sides of tees, behind access doors and in equipment rooms as required.

.4 Apply colour bands at both ends of the label with primary colour bands used to secure both ends of individual labels. Refer to colour schedule at end of this Section.

.5 Provide 20 mm diameter brass, with metal photo black numbers, or white lamacoil with black engraved numbers, secured to valve stem with key chain. Provide neat, typewritten directories, giving valve number, services and location. Frame one copy under glass for wall mounting as directed, second copy to be forwarded to Owner. Include copies in O&M Manuals.

.6 Tag automatic controls, instruments and relays and match/key to Control Shop Drawing identification numbers. Tag all equipment and control panels.

.7 Identify electric starting switches, thermostats controlling motors, remote push button stations, and controls equipment supplied under this Division with lamacoil plates having 6 mm (1/4 inch) minimum letter size. Identification to state equipment controlled.

.8 Identify the usage of duct access panels with self-adhesive Brady stick-on coloured labels. Apply labels conforming to the following schedule.

<table>
<thead>
<tr>
<th>Colour</th>
<th>Letters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaning and service access</td>
<td>yellow</td>
</tr>
<tr>
<td>Controls, including heat sensors</td>
<td>black</td>
</tr>
<tr>
<td>Dampers (backdraft, balance &amp; control)</td>
<td>blue</td>
</tr>
</tbody>
</table>

Note: Provide black lettering for yellow or white background, white for all other colours.

.9 Identify the location of the following items of equipment which are concealed above a ceiling with Avery "Data Dots". Place identification dots on the access panel. The colours shall conform to the following schedule:

<table>
<thead>
<tr>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concealed equipment and cleaning access</td>
</tr>
<tr>
<td>Control equipment, including control dampers and valves, and heat sensors</td>
</tr>
<tr>
<td>Fire, smoke, and sprinkler equipment including dampers</td>
</tr>
<tr>
<td>Pipe mounted equipment with the exception of fire, smoke, sprinkler and control equipment</td>
</tr>
</tbody>
</table>
GENERAL MECHANICAL PROVISIONS

Balancing Dampers blue

When T-bar ceilings are installed, adhere "Data Dots" on T-bar framing adjacent to panel to be removed.

1.25 Colour Coding Schedule

.1 Colour numbers are called for in Federal Standard 595B. Colours assigned from CGSB 1-GP-12c for colour code identification.

MECHANICAL PRIMARY COLOURS FOR PIPE LINES/EQUIPMENT

1. Yellow - 13538
2. Light Blue - 15200
3. Green - 14115
4. Orange - 12473
5. Brown - 10055
6. Red - 11120
7. White - 17925
8. Aluminum - 17178
9. Purple - 17100
10. Grey - 16360

SECONDARY COLOURS FOR BANDS

1. Red - 11120
2. Orange - 12473
3. Blue - 15200

BANDING

1. Red - to indicate extremely hazardous material
2. Orange - to indicate mildly hazardous material
3. Blue - to indicate non-hazardous material

.2 Identification Symbols and Colour for Piping

<table>
<thead>
<tr>
<th></th>
<th>Pipe Colour</th>
<th>Stripe Colour</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Cold Water</td>
<td>Light Blue</td>
<td>None</td>
<td>Dom. Cold Wat.</td>
</tr>
<tr>
<td>Domestic Hot Water</td>
<td>Green</td>
<td>Orange</td>
<td>Dom. Hot Wat.</td>
</tr>
<tr>
<td>Domestic Hot Water</td>
<td>Green</td>
<td>Blue</td>
<td>Dom. Hot Wat. R.</td>
</tr>
<tr>
<td>Drains</td>
<td>Aluminum</td>
<td>Red/Orange</td>
<td>Drain</td>
</tr>
<tr>
<td>Heating Hot Water Return</td>
<td>Yellow</td>
<td>Orange</td>
<td>Heat Wat. R.</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>Orange</td>
<td>Red</td>
<td>Nat.Gas</td>
</tr>
</tbody>
</table>
GENERAL MECHANICAL PROVISIONS

.3 Mechanical Control Systems

.1 Conduit pull boxes, terminal boxes and junction boxes - GREY Covers - GREY with black ‘C’.

.2 Main and secondary control panels, factory finish acceptable - Control Contractor to install company label to identify.

.4 Ductwork

All ductwork to be identified as follows, complete with directional arrows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return Air</td>
<td>R.A.</td>
</tr>
<tr>
<td>Supply Air</td>
<td>S.A.</td>
</tr>
<tr>
<td>Mixed Air</td>
<td>M.A.</td>
</tr>
<tr>
<td>Combustion Air</td>
<td>Comb. Air</td>
</tr>
<tr>
<td>Relief Air</td>
<td>Relief Air</td>
</tr>
<tr>
<td>Exhaust Air</td>
<td>Exh. Air</td>
</tr>
</tbody>
</table>

1.26 Temporary Heat

.1 Do not use the permanent system for temporary heating purposes without written permission from the Consultant. The Contractor shall in writing, seek written permission from the Consultant at least twenty (20) working days in advance of the anticipated date for the requirements of temporary heat.

.2 Where written permission is given by the Consultant, the Contractor shall

.1 Within five (5) workings days of the anticipated date for the requirement of temporary heat, provide the Consultant with a written statement and plan outline acceptance with the conditions listed below and providing details of how the criteria will be met. The Consultant reserves the right to reject the statement and plan should non compliance with the below criteria exist.

.2 Thoroughly clean and overhaul permanent equipment used during the construction period, replace worn or damaged parts before final inspection.

.3 Operate heating systems under conditions which ensure no temporary or permanent damage. Operate with proper safety devices and controls installed and fully operational. Operate systems only with treated water as specified. Comply with the requirements of the Manufacturer’s printed instructions. Comply with all relevant Codes, Statutes and By-Laws.

.4 Provide an alarm indicating a system failure. Connect alarm to independent alarm company system.

.5 Replace mechanical seals, regardless of condition, with new mechanical seals on all permanent pumps used for temporary heating.

.3 Where written permission is given by the Consultant,

.1 The use of permanent systems for temporary heat shall not modify terms of warranty.
.2 Any and all damaged caused to the heating system shall be rectified to the satisfaction of the Consultant, replacing complete system components as required.

.3 The use of permanent systems for temporary heat shall be solely at the Contractor’s risk.

.4 The Contractor shall make restitution for any and all damages to the building structure, and any consequential damages as a result of a failure of the temporary heating system.

.4 Air systems shall not be used for temporary heating.

1.27 Temporary or Trial Usage

.1 Temporary or trial usage by the Owner or Consultant of mechanical equipment supplied under Contract shall not represent acceptance.

.2 Repair or replace permanent equipment used temporarily.

.3 Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.

1.28 Substantial and Total Performance

.1 Prior to requesting an inspection for Substantial Performance, provide a complete list of items which are deficient.

.2 A certificate of Substantial Performance will not be granted unless the following items are completed:

   .1 Heating air conditioning, plumbing systems have been commissioned and are capable of operation with alarm controls functional and automatic controls in operation. Commissioning checklists must be submitted prior to the request by the Contractor to have a Substantial Completion Inspection.

   .2 The necessary tests on equipment and systems including those required by authorities have been completed with certificates of approval.

   .3 Air systems have been balanced with draft report submitted to the Consultant.

   .4 Valve tagging and equipment identification is complete.

   .5 Warranty forms have been mailed to the Manufacturer. Provide copy of original warranty for equipment which has warranty period longer than one year.

   .6 Systems have been pressure tested, flushed and cleared of all debris, foreign oils, moisture, water or condensation. Provide report from Manufacturer's Representative to confirm status of treatment.

   .7 Draft O&M Manuals have been submitted.

   .8 Operating and Maintenance demonstrations have been provided to the Owner.
.9 Written inspection report by Manufacturer’s Representative has been submitted for noise and vibration control devices and flexible connections.

.10 Record Drawings have been submitted.

.11 Fan plenums have been cleaned, and temporary filters have been replaced with permanent filters.

.12 All previously identified deficiencies have been corrected.

.3 The following shall be an outline checklist of the minimum requirements to be met by the Contractor prior to the Consultants’ Substantial Performance by the Contractor.

Inspection:

- Complete Commissioning Checklists
- Final Plumbing Inspection Certificate from local plumbing inspector
- Final Gas Inspection Certificate from local gas inspector
- Final Backflow Prevention test reports for all backflow devices
- Controls Commissioning, Checklist and 15 day trend logs for all major equipment (AHU’s, Chiller/Boiler Plants, selected space sensors)
- Fire Alarm Test Certificate (via Division 16)
- Fire Stopping Test Letter
- Vibration isolation supplier’s inspection report
- Potable water main’s flushing and chlorination test certificate
- Sound level tests reports (as required)
- Major equipment – suppliers start-up test sheets and letters certifying start up. (packaged equipment)
- Medical gas test certificates
- Final As-Built Drawings ready for review
- Maintenance and operation manuals, ready for review

.4 Prior to Total Performance Inspection provide declaration in writing that deficiencies noted at time of Substantial Performance Inspection have been corrected and the following items completed prior to the Total Performance Inspection:

.1 Submit final air balance reports.
.2 Submit final O&M Manuals.

.3 Submit final "As Constructed" Drawings.

.4 Complete final calibration.

.5 Submit warranty certificate(s).

.5 The Consultant shall provide one (1) visitation for the purpose of Substantial Performance Inspection, and one (1) visitation for the purpose of Total Performance Inspection. Subsequent visitations if required shall be at the expense of the Contractor.

.6 The Contractor shall provide qualified personnel in appropriate numbers to operate the facility until Substantial Performance is declared.

1.29 Acceptable Manufacturers/Suppliers and Agencies

.1 The following listed manufacturers are acceptable for their ability to meet the general design intent, quality and performance characteristics of the specified product. The list does not endorse the acceptability of all products available from the listed manufacturers/suppliers.

.2 It remains the responsibility of the Contractor to ensure the products supplied are equal to the specified products in every respect, operate as intended, and meet the performance specifications and physical dimensions of the specified product.

.3 The Contractor shall be fully responsible for any additional work or materials, to accommodate the use of equipment from the acceptable manufacturers and suppliers list.

.4 Submit within fourteen (14) days of Contract award a copy of the list underlining the name of the manufacturer whose price was carried in the tender. If no Manufacturer’s names are submitted, it will be assumed that the price carried in the tender was that of the specified manufacturer or where the specified product is generic, the first acceptable manufacturer listed for each item and equipment.

.5 List of Acceptable Manufacturers/Suppliers and Agencies:

.1 Access Doors                                      Maxam, Acudor, Milcor, Can.Aqua, Mifab
.2 Air Terminals – Grilles, Registers, Diffusers     E.H. Price, Greenheck, Titus, Anemostat, Nailor, Kruger
.3 Air Valves - Mixing, Constant                     E.H. Price, Titus, Trane

                           Volume and VAV
.4 Air Vents                                              Hoffman, Maid-O-Mist, Taco, B&G
.5 Backflow Preventers                                   Febco, Watts, Hersey, Singer, Ames, Wilkins
.6 Balancing Agents                                     AMS, AHS, DFC, Airdronics
### GENERAL MECHANICAL PROVISIONS

| .7 | Coils - Heating and Cooling | Trane, Aerofin, Engineered Air, Colmac, McQuay, Heatcraft |
| .8 | Condensing Units and Fan Coil Units | Trane, Mitsubishi, Dunham Bush, York |
| .9 | Controls Contractors and/or Suppliers | Barber Coleman, Barcol, BSD Solutions, Delta, Honeywell, Johnson Controls, Siemens |
| .10 | Dampers – Backdraft | Airolite, Greenheck, Vent-Aire, Penn, T.A. Morrison |
| .11 | Dampers – Balancing | Maxam, Ruskin, Greenheck |
| .12 | Dampers – Control | Ruskin, Tamco, Greenheck |
| .13 | Drains - Floor, Roof, Cleanouts, Trap Primers, Water Hammer Arrestors, Trench Drains | Zurn, Ancon, PPP, J.R. Smith, Watts, ACO |
| .14 | Expansion Compensators | Flexonics, Tube Turn, Hyspan, Hydroflex, Metraflex, United Flexible, Mason |
| .17 | Fans - Axial (Variable Pitch in Motion) | Woods, Joy |
| .18 | Fans - Bathroom Exhaust | ACME, Broan, Penn Zephyr, Reversomatic, Nutone, Broan |
| .19 | Fans - Centrifugal | Greenheck, Buffalo, Twin City, Trane, Chicago, Barry Blower, Northern |
| .20 | Fans - In-Line Centrifugal | Greenheck, Jenn Air, Ammerman, ILG, Cook, Penn, Twin-City, Carnes |
| .21 | Fans - In-Line Centrifugal (Tubular) | Chicago, Greenheck, Twin-City, Barry/CML, Northern Blower |
| .22 | Fans - Propeller | Greenheck, Cook, Penn, Jenn Air, ACME, Powerline, Joy |
| .23 | Fans - Roof and Wall Mounted | Greenheck, Ammerman, Powerline, ACME, Loren Cook, Penn, Jenn Fan, ILG, Carnes, Twin City, Aerovent |
| .24 | Filters | Cambridge, AAF, Pacific, FARR |
| .25 | Filters (Final) | FARR Durafil ES |
| .26 | Fire Hose Cabinets, Valves and | NFE, Grigor, Wilson & Cousins, Flag |
### GENERAL MECHANICAL PROVISIONS

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Brands</th>
</tr>
</thead>
<tbody>
<tr>
<td>.27</td>
<td>Flexible Connectors - Ducting</td>
<td>Thermaflex, G.I. Industries Type IHP</td>
</tr>
<tr>
<td>.28</td>
<td>Flexible Connectors - Piping</td>
<td>Flexonics, Tube Turn, Atlantic, Hyspan, Hydroflex, Metraflex, United Flexible, Mason, Twin City Hose</td>
</tr>
<tr>
<td>.29</td>
<td>Flexible Duct</td>
<td>Thermaflex, Wiremold, GI Industries Type H.P.</td>
</tr>
<tr>
<td>.30</td>
<td>Gauges - Pressure</td>
<td>Trerice, Marsh, Ashcroft, Weiss, Mijoco</td>
</tr>
<tr>
<td>.31</td>
<td>Grooved Mechanical Pipe Joints</td>
<td>Victaulic, Mech Line (only where permitted)</td>
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<tr>
<td>.32</td>
<td>Heat Exchangers - Plate</td>
<td>Alpha Laval, Tranter, Armstrong, APV</td>
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<tr>
<td>.33</td>
<td>Hose Bibbs</td>
<td>Jenkins, Dahl, Crane, Toyo, Kitz, Mifab, Zurn, Chicago Faucets, Watts</td>
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<tr>
<td>.34</td>
<td>Insulation - Piping and Duct</td>
<td>Fibreglass Canada, Manson, Knauf Fibreglass, Plasti-Fab, Manville</td>
</tr>
<tr>
<td>.35</td>
<td>Louvres</td>
<td>Price/Airolite, Penn, Airstream, West Vent, Nailor, Ruskin, Ventex</td>
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<tr>
<td>.36</td>
<td>Pipe Restraints</td>
<td>Trelleborg</td>
</tr>
<tr>
<td>.37</td>
<td>Piping Hangers and Saddles</td>
<td>Grinnell, Myatt</td>
</tr>
<tr>
<td>.38</td>
<td>Plug Cocks</td>
<td>DeZurik, Newman-Milliken</td>
</tr>
<tr>
<td>.39</td>
<td>Plumbing Brass</td>
<td>Crane, American Standard, Cambridge Brass, Waltec, Kohler, Symmons, Bradley Zurn, Sloan, OS&amp;B</td>
</tr>
<tr>
<td>.40</td>
<td>Plumbing Fixtures</td>
<td>Crane, American Standard, Kohler</td>
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<tr>
<td>.41</td>
<td>Plumbing Fixtures - Prefab FRP</td>
<td>Aquarius, Acrylic Tubs, Hytec</td>
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<td>.42</td>
<td>Pumps - Sump</td>
<td>Monarch, Barnes, Hydromatic, Myers, Zoeller</td>
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<tr>
<td>.43</td>
<td>Pumps - Vertical In-Line and Base Mounted</td>
<td>Armstrong, B &amp; G, Taco, Leitch, Grundfos</td>
</tr>
<tr>
<td>.44</td>
<td>Radiation - Wall</td>
<td>Engineered Air, Trane, Slant/Fin, Rosemex, Dunham Bush, Stelrad, Buderus</td>
</tr>
<tr>
<td>.45</td>
<td>Sinks - Mop</td>
<td>Fiat, Crane, American Standard</td>
</tr>
<tr>
<td>.46</td>
<td>Sinks - Stainless Steel</td>
<td>KIL, American Standard, Elkay</td>
</tr>
</tbody>
</table>
1.30 **Scope**

.1 Provide rough-in for and make all connections to equipment supplied by others.

1.31 **Related Work in Other Sections**

.1 Refer to other Specification Sections to complete list of equipment supplied by others.

1.32 **Installation**

.1 Make all mechanical connections to equipment supplied by others under this Contract. This shall include all water, drain, gas, exhaust, traps, ductwork and similar connections required.

.2 Change to rough-in of services or final equipment connections due to a change in the make of equipment from that specified shall be made at no extra cost to the Owner, provided that proper Shop Drawings are available for rough-in. Prior to commencing installation of rough-in for the equipment, coordinate with the final reviewed equipment Shop Drawings and with the Manufacturer.

.3 Exposed piping shall be painted as per Consultant’s instructions.

.4 Arrange piping connections to allow for equipment removal.
2. PRODUCTS

2.1 Counter Flashing Materials

.1 Not Applicable.

3. EXECUTION

.1 Not Applicable.

END OF SECTION
1. GENERAL

1.1 Scope

.1 Operating and Maintenance Manuals.

.2 Record Drawings.

1.2 Quality Assurance

.1 Work specified in this Section shall be performed by the Contractor and paid for by the Contractor.

2. PRODUCTS

2.1 Operating and Maintenance Manuals

.1 Refer to Division 1.

.2 Secure and assemble all necessary literature describing the operation and maintenance of all equipment provided. Complete and transmit documentation for review to Consultant two (2) months prior to final inspection.

.3 Provide four (4) 216 mm x 280 mm capacity, expanding spine catalogue binders, bound with heavy fabric, hot stamped lettering front and spine.

.4 Index binder according to the following system:

Tab-1.0 Mechanical Systems:

Title page with clear plastic protection cover.

Tab-1.1 List of Mechanical Drawings:

Tab-1.2 System Descriptions:

Provide complete description of the operating sequence for all systems. Include detailed system description with individual components described, and an explanation of how components interface with others and to the complete system, and locations of thermostats, controllers or operating variances, and controller operating setpoints.

Tab-1.3 Operating Division:

Provide complete and detailed operation of major components and systems. Provide information on location of components, how to energise switches and controls, how components interface with other components, operation of controls including operational sequence, operational changes for summer and winter operation, how to accomplish the changeover, complete trouble shooting sequence, emergency operating sequences in event of major component failure, and safeguards to indicate if equipment goes off-line.
Tab-1.4 Maintenance and Lubrication Division:

Provide general maintenance and lubrication schedule for major components to include daily, weekly, monthly, semi-annual and yearly checks and tasks. Explain how to execute maintenance tasks required for typical equipment such as bearings, drives, motors, and filters. Compile this information for equipment and separate from Shop Drawings.

Tab-1.5 List of Equipment Suppliers and Contractors:

Provide list of equipment suppliers and contractors, including address and telephone number. Outline procedures for purchasing parts and equipment.

Tab-Certification (2.0, 2.1 ...):

Include copy of test data on hydrostatic or air tests performed on piping systems, equipment alignment certificates, copy of balancing data for air, copy of valve tag identification and pipe colour code, inspection approval certificates for plumbing system, heating and ventilation systems.

Tab-Shop Drawings and Maintenance Bulletins (3.0, 3.1 ...):

Provide materials received in compliance with clause "Shop Drawings".

.5 The divider tabs shall be laminated Mylar plastic and coloured according to Section. The colouring is as follows: Mechanical Systems - 1.0 - 1.5 Orange; Certification - 2.0 - 2.4 Green; Shop Drawings & Maintenance - 3.0 - 3.17 Yellow. Plastic tabs with typewritten card insertions will not be accepted.

2.2 Record Drawings

.1 Refer to Division 1 for general requirements.

.2 The Contractor shall keep on site, available to the Consultant at all times and particularly for each regularly scheduled site meeting, a complete set of prints, edge bound, that are to be updated daily showing any and all deviations and changes from the Contract Drawings. This set of Drawings is to be used only for this purpose, and must not be used as the daily general reference set.

.3 Provide Record Drawings which identify location of dampers, access doors, tagged valves, and equipment and control devices. As well, deviations that are to be recorded shall include in general, items that are significant or are hidden from view and items of major importance to future operations and maintenance, and to future alterations and additions including cleanouts and isolation valves.

3. EXECUTION

3.1 General

.1 Submit documents to the Consultant for approval prior to transmitting to the Owner.
3.2 Record Drawings

.1 Enter dimensions from building line to all installed services.

.2 Service connections to sewer lines entering a building shall be recorded as to horizontal dimension from a convenient building element with suitable depth elevations relating to main floor level and sea level datum.

.3 Sewer lines which are placed beneath floor slabs shall be located such that each point of entry, change in direction, and irregularity is located by dimension from column grid lines on the as-built drawings. Depth below slabs shall be given.

.4 The Contractor shall provide the consultant with red-line mark-up drawings prior to substantial completion.

END OF SECTION
1. GENERAL

1.1 General

.1 This Section describes the commissioning of the mechanical system and outlines the duties and responsibilities of the team.

.2 The commissioning of the mechanical system shall be in accordance with the Code of Practice for Commissioning Mechanical Systems in Buildings, The National Fire Code of Canada, and as described in this Section.

.3 The commissioning process shall be applied to all products, equipment and systems provided under this Division.

.4 Work specified in this Section shall be performed by the Contractor and paid by the Contractor.

.5 The Contractor shall appoint a Commissioning Coordinator upon award of Contract.

1.2 Scope

.1 Demonstration of equipment and systems operations.

.2 Instruction seminars for Owner's personnel.

1.3 Quality Assurance

.1 Work specified shall be performed by the Contractor.

2. THE COMMISSIONING PROCESS

2.1 The Commissioning Team

.1 The Commissioning Team shall be formed and consist of:

.1 The Commissioning Coordinator

.2 The Contractor.

.3 The Consultant’s Representative.

.4 The Owner's Staff Representative.
2.3 Duties of the Team

.1 The duties of the team are summarised below:

.1 The Commissioning Coordinator shall plan, organize and implement the commissioning process and shall within one (1) month of the award of the Contract submit the name and address of the Commissioning Coordinator.

.2 The Commissioning Coordinator shall provide a complete description of the systems operation, performance and flow data to the Consultant for review.

.3 The Commissioning Coordinator shall prepare the commissioning plan and provide demonstration and instructions to the Owner's staff over a period of time to enable the staff to become familiar with the systems.

2.4 Commissioning Schedule

.1 Within one (1) months of commencing with the project work the Commissioning Coordinator shall review design intent and intended commissioning procedures with the Consultant. Three (3) months prior to the date of scheduled Substantial Performance, submit a detailed plan identifying the orderly progression of the pre-start commissioning check and subsequent commissioning performance check of each sub-system, leading up to the ultimate commissioning of entire systems.

.2 Submit a schedule for the commissioning phase of the work. This schedule shall show:

.1 Completion dates for each trade in each major section of the building.

.2 Timing of the various phases of the commissioning, testing, balancing and demonstration process.

.3 Submission dates for the various documents required prior to verification of commissioning by the Consultant.

.4 Prepare a commissioning statement in which each of the four (4) phases that the process is perceived to be worked through. In sequence, the phases are expected to be:

Phase 1 - System Readiness.

Phase 2 - System Start-up, Testing, Balancing, etc.

Phase 3 - Verification of System Commissioning.

Phase 4 - Demonstration and Instruction.

.3 With the commissioning schedule noted above, submit a copy of all commissioning worksheets to be used during the commissioning process.

.4 Each phase is applicable to each major and separate system making up the work in Division 15 including controls and Division 16 interface as applicable.
2.5 Commissioning Phases

.1 Phase 1 - Before starting any of the separate systems, provide written verification stating that the specific system is ready for start-up and the following conditions have been met:

.1 Copies of all test and certificates have been submitted to the Consultant.
.2 All safety controls installed and fully operational (dry run test).
.3 Flushing, strainer cleaning (as required), priming with fluid (as required), are complete.
.4 Equipment lubrication and pre-start checks are complete.
.5 Air system cleaning complete.
.6 Filter systems installed and sealed in place.
.7 Adjusting vibration isolation completed.
.8 Alignment of drives (direct and belt) completed.
.9 Control functional checks, including all alarms performed.
.10 Start-up verification checks by Manufacturer’s Representatives completed.
.11 All deficiencies to be recorded, reviewed by the commissioning team and, subsequently corrected before proceeding to the next phase, Phase 2.

.2 Phase 2 - System Commissioning shall include but not necessarily be limited to:

.1 Activation of all systems.
.2 Testing and adjustment of all systems.
.3 As in the case of the System Readiness Phase, all deficiencies are to be recorded, reviewed by the commissioning team and, subsequently, corrected. The process at the point of the deficiency shall be repeated before proceeding forward.
.4 Phase 2 is concluded when the installation is in full working order and acceptable for use. The work will include the following:

.1 Position all balance dampers in ductwork.
.2 Make provisions for testing air pressures and flow rates.
.3 Set up air diffusers, registers and grilles.
.4 Set up all automatic temperature control devices.
.5 Set up constant volume and variable volume fans.
COMMISSIONING

.6 Plug all air pressure and flow measuring holes.

.7 Adjust vibration isolators as necessary.

.8 Air balance is complete.

.5 Fine Tuning:

.1 Setting up automatic controls for accurate response and precise sequencing.

.2 Correction of problems revealed by Balancing Agency and change of fan speed and pitch as necessary.

.6 Testing:

.1 The Commissioning Coordinator shall perform a detailed check of the following:

.1 All items and functions to be later demonstrated to the Owner’s Representatives.

.2 Systems operation in the presence of the authorities having jurisdiction.

.3 Phase 3 - Verification of Commissioning.

.1 Verification of commissioning by the Consultant shall not commence until the commissioning process, Phase 2, has been totally completed. Submit test procedure completion test certificates at the time of requesting the commencement of the verification procedure. The verification process will include the demonstration of the following:

.1 Location of and opening and closing of all access panels.

.2 Operation of all automatic control dampers and automatic temperature/volume adjustment controls.

.3 Operation of all equipment and systems, under each mode of operation, including:

.1 HVAC control features.

.2 Exhaust air systems.

.3 Supply / Exhaust fans.

.4 Unit heaters.

.5 Fans.

.2 At the completion of Phase 3, the Contractor shall submit the following to the Consultant:
COMMISSIONING

.1 A letter certifying that all work specified under this Contract is complete, clean and operational in accordance with the Specification and Drawings.

.2 A copy of Phase 2 Verification Certificates provided by the specialist trades for submission to the Consultant.

.3 Record Drawings as specified.

.4 A letter from the testing and balancing agency certifying that all necessary data for inclusion in operating and maintenance manuals has been received.

.5 A statement confirming completion of EMCS acceptance test, Section 15900

.3 Upon receipt of all documents and a satisfactory outcome of the verification procedure, the Consultant will provide a Certificate of Verification for Phase 3.

.4 Substantial Performance may, thereupon, be declared.

Phase 4 - Demonstration and Acceptance shall not commence until the commissioning process Phase 3 has been successfully completed - verification certificate issued and Substantial Performance declared. The demonstration process is a statement of satisfaction from the Consultant and Owner upon completion. Total Performance will not be accomplished without this achievement.

3. EXECUTION

The following systems are to be commissioned:

3.1 Plumbing

.1 Domestic hot and cold water systems - system pressure tests, flush and clean lines, system pressures at fixtures, water delivery at each fixture; identification of piping systems.

.2 Storm drainage - system pressure tests, pipe identification.

.3 Sanitary drainage - system pressure tests, pipe identification.

.4 Fixtures - cleaning, test hot and cold water and drain, installation.

3.2 Fire Extinguishers

.1 Confirm fire extinguisher location and charge. Verify that all tags are filled out and signed.

3.3 HVAC Systems

.1 Duct System - pressure tests, insulation, identification, air balance identification.

.2 Supply / Exhaust Fans - installation, rotation, motor current draw, accessories dampers, etc., air balance, identification.

.3 Control Valves - installation, controls, capacity modulation.
3.4 General

.1 Contractor shall arrange for presentation and demonstration of mechanical equipment and systems by appropriate specialists and shall ensure that required Manufacturer's Representatives are in attendance.

3.5 Demonstrations

.1 Provide one (1) working day for demonstration of equipment to the Owner.

.2 Demonstrate specific starting and general maintenance requirements for each major piece of equipment. Ensure all labelling and identification is completed.

.3 Demonstrate the following systems, in the form of instruction seminars and Contractor-guided tour of the facility.

- .1 Air Systems;
- .2 Fire Protection Systems;
- .3 Plumbing Systems;
- .4 Control Systems;

.4 Demonstrate the following pieces of equipment:

- .1 Unit heaters;
- .2 Fans;
- .3 Fire Extinguishers;

.5 Prepare a schedule identifying the proposed sequence of demonstration. Sequence of demonstration shall correspond to full system starting. Submit for review by Engineer one (1) month prior to demonstration.

.6 Answer all questions raised by Owner at demonstrations; if unable to satisfactorily answer questions immediately, provide written response within three (3) days.
.7 Provide a professionally produced DVD of all instructions and demonstrations. Engage the services of a professional video production company to provide two (2) copies of the edited DVD(s).

END OF SECTION
1. **GENERAL**

1.1 **Scope**

.1 Balance, adjust, and test air systems and equipment and submit reports in identical units to those shown on Contract Documents.

.2 Contractor shall prepare the facility for balancing.

1.2 **Quality Assurance**

.1 Work specified in this Section shall be performed by an Independent Agency specializing in this type of work, and paid by the Contractor.

.2 Balancing of both air systems and sound level readings shall be performed by the same agency.

.3 Balancing procedures shall be in accordance with the latest, current requirements NEBB, SMACNA and ASHRAE Standards.

1.3 **Site Visits**

.1 Minimum of three (3) site visits shall be made during construction to correspond with the general monthly site meetings held by the Contractor. After each site visit, a written report shall be submitted to the Contractor and Consultant. Site visits shall commence after the start of air distribution work and be spread over the construction period to the start of the balancing work.

.2 A review of the installation shall be made at the specified site visit and any additional dampers or valves required for proper balance shall be reviewed with the Consultant and the Contractors.

.3 Allow two (2) visits to site to adjust systems for seasonal changes and to check and reset fans and outlets during warranty. Coordinate the time of visit with the Owner. Submit reports to Consultant.

.4 Begin balancing after balancing preparation and after systems have been completed and are in full working order. Place systems and equipment into full operation and continue operation during each working day of balancing.

1.4 **Balancing Agenda**

.1 General: Submit balancing agenda to the Consultant and Commissioning Contractor for review at least sixty (60) days prior to the start of balancing work. Start balancing work after agenda has been approved. Include in the agenda the following:

.1 Schedule: Overall schedule outlining the balancing of each specific system. Include in the schedule any requirements for Owner shutdowns, Contractor or Consultant participation that may be required.

.2 Descriptive Data: General description of each system including associated equipment and different operation cycles, listing of flow and terminal measurements to be performed and selection points for proposed sound measurements.
.3 Procedure Data: Procedures for converting test measurements to establish compliance with requirements, specify type of instrument to be used, method of instrument application (by sketch) and correction factors.

.4 Sample Forms: Form showing application of procedures to typical systems.

1.5 Balance Report

.1 Submit two (2) copies of balancing reports to Consultant prior to final acceptance of project.

.2 Provide four (4) copies of final reports to Contractor for inserting in Owner's Operating and Maintenance Manuals as described in Section 15015 - Documentation.

.3 Include types, serial number and dates of calibration of all instruments in the reports.

1.6 System Data

.1 The following information shall be provided:

.1 Duct Air Quantities: All mains supplying more than 10% of Volume, outside air.

- Duct sizes;
- Number of pressure readings;
- Sum of velocity measurements;
- Average velocity;
- Duct recorded air flow rate;
- Duct design air flow rate.

.2 Air Inlet and Outlets

- Outlet identification location and designation;
- Manufacturers catalogue identification and type;
- Application factors;
- Design and recorded velocities;
- Design and recorded air flow rates;
- Deflector vane or diffuser cone settings.

.3 Heating Equipment (Unit Heaters, etc.)

- Design Data:
  - Heat transfer rate;
  - Pressure drop.

- Installation Data:
  - Manufacturer, model, type;
  - Capacity;
  - Pressure drops;
  - Flow rates.

- Recorded Data:
  - Element type and identification (location and designation);
BALANCING

Pressure drop;
Flow rate;
Pressure relief valve setting.

.4 Sound Level Data

Diagram or description of relationship of sound source and measuring instrument;
"A" scale time weighted average reading;
Reading at each octave band frequency.

2. PRODUCTS

2.1 Instruments

.1 Provide calibration histories for each instrument. Recalibration or use of other instruments may be requested when accuracy of readings is questionable.

3. EXECUTION

3.1 General Procedure

.1 Permanently mark, by stick-on labels, settings on valves, splitters, dampers, and other adjustment devices.

.2 Subsequent to correctional work, take measurements to verify balance has not been disrupted or that any such disruption has been rectified.

.3 Balancing shall be performed to the following accuracies:

.1 Air terminal outlets ±10%

.2 Air central equipment ±5%

3.2 Air System Procedure

.1 Perform balancing, adjusting and testing with building doors and windows in their normal operation position.

.2 The following procedure shall be adopted for central systems:

.1 Ensure dampers or volume control devices are in fully open position.

.2 Balance central apparatus to ±10% air flow.

.3 Balance branches, mains to ±10% air flow.

.4 Recheck central apparatus.

.5 Balance all terminal air outlets to ±10%.

.6 Rebalance central apparatus to ±5%. 
.7 Recheck all air outlets.

.8 Perform acoustical measurements.

.9 Perform building pressurization tests and measurements at minimum and maximum outdoor air damper positions of the main air unit(s).

When balancing air outlets:

.1 Rough balance furthest outlets and then balance sequentially back to source.

.2 Fine balance furthest outlet back to source.

.4 Take static pressure readings and air supply temperature readings at ten (10) points on each air system.

.5 Make air quantity measurements in ducts by "Pitot Tube" traverse of entire cross sectional area. If readings are inconsistent across duct, relocate to two duct *diameters *widths and re-do traverse.

.6 Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control only by duct internal devices such as dampers and splitters.

.7 Vary total system air quantities by adjustment of fan speeds. Vary branch air quantities by damper regulation.

.8 Where modulating dampers are provided, take measurements and balance at extreme conditions.

.9 Complete balancing to achieve positive building pressure unless otherwise instructed. A positive pressure relative to outside of 10 Pa minimum and 20 Pa maximum shall be achieved, measured with negligible outside wind velocity.

3.3 Balancing Report

.1 Submit draft copies of reports prior to final acceptance of project.

.2 Include types, serial number and dates of calibration of instruments.

.3 Record test data on a sepia made from the latest available revised set of Mechanical Drawings and submit four (4) copies upon completion of the balancing contract for inclusion in equipment and maintenance manuals.

.4 Install at each piece of mechanical equipment a "Data Register" showing significant operating temperatures, pressures, amperes, voltage, brake horsepower. "Data Register" to be enclosed in a plastic holder securely attached to the equipment or to a wall in the adjacent area.

.5 Submit with report, fan curves with operating conditions plotted. Submit grille and diffuser shop drawings and diffusion factors.
.6 Report shall be indexed as follows:

- Air
- Summary
- Procedure
- Instrumentation
- Drawings
- Equipment Summary
- Fan Sheets
- Fan Curves
- Fan Profile Data
- Static Data
- Air Monitoring Station Data
- Traverse Data and Schedule
- Terminal Unit Summary
- Outlet Data Summary and Schematics (per system)
- Building Pressurization Data Diagnostic
- Instrumentation
- Drawings

### 3.4 Bring the work to an operating state and ready for balancing, including:

.1 Clean equipment and ductwork.

.2 Install air terminal devices.

.3 Replace filters with specified filters prior to balancing.

.4 Verify lubrication of equipment.

.5 Install permanent instrumentation.

.6 Complete the "start-up" of equipment.

.7 Check rotation and alignment of rotating equipment and tension of belted drives.

.8 Verify ratings of overload heaters in motor starters.

.9 Set control points of automatic apparatus, check-out sequence of operation.

.10 Make available control diagrams and sequence of operation.

.11 Clean work, remove temporary tags, stickers, and coverings.

.12 Make available one (1) copy of Maintenance Manuals especially for use in balancing.

.13 Provide Balancing Agency a complete set of Mechanical Drawings and Specifications.
3.5 **Co-operate with the Balancing Agency as follows:**

.1 Make corrections as required by Balancing Agency.

.2 Allow Balancing Agency free access to site during construction phase. Inform Balancing Agency of any major changes made to systems during construction and provide a complete set of Record Drawings for their use.

.3 Operate automatic control system and verify set points during balancing.

3.6 **Balancing Valves and Dampers**

.1 Provide and install balancing valves, dampers, and other materials requested by the Balancing Agency and/or necessary to properly adjust or correct the systems to design flows, without additional cost to Owner.

3.7 **Pulleys and Sheaves**

.1 Provide and install pulleys and sheaves for rotating equipment, as required to properly balance the systems to design flows, without additional cost to Owner.

**END OF SECTION**
TESTING

1. GENERAL

1.1 Scope

.1 Test low velocity ducts.

.2 Performance testing of equipment.

.3 Manufacturer's start-up of equipment.

1.2 Quality Assurance

.1 Test equipment and material where required by specification or authority having jurisdiction to demonstrate its proper and safe operation.

.2 Test procedures in accordance with the National Fire Code of Canada 2010 and current applicable portions of ASME, ASHRAE, and other recognized test codes as far as field conditions permit.

.3 Perform tests on-site to the satisfaction of the Consultant.

.4 Piping, fittings or equipment shall not be concealed or covered until inspected and approved by the Consultant. Provide ample written notice (two working days) to the Consultant before tests.

.5 Coordinate with Consultant at start of project, those tests that will require witnessing by the Consultant, and provide notice to the Consultant at least five (5) working days prior to the commencement of testing.

.6 Use factory trained representatives and submit Manufacturer's check sheets for starting the following specialty equipment.

.1 Fans

.2 Unit Heaters

.3 Control components

.4 Chemical cleaning and treatment

.7 Prior to starting, testing, balancing, adjusting and cleaning processes, verify with Consultant any tests required to be witnessed. Provide sufficient notice to Consultant prior to commencement of procedures.

.8 Consultant shall be allowed to witness any testing, adjusting, starting, balancing and cleaning procedures.

.9 Assume all costs associated with starting and testing, including the supply of testing or cleaning medium.
Prior to starting equipment or systems, secure and review Manufacturer's installation, operation and starting instructions. Read in conjunction with procedures defined herein.

Use Manufacturer's or Supplier's starting personnel where required to ensure integrity of Manufacturer's warranty.

Compare installations to published Manufacturer's data and record discrepancies. Items proving detrimental to equipment performance shall be corrected prior to equipment starting.

Some processes involved in starting procedures defined in this Section may be duplications of authorities' verification. To facilitate expedient completion of project, arrange for authorities to assist or witness these procedures.

All starting, testing procedures shall be in accordance with applicable portions of the current referenced version of the National Building Code of Canada 2010, the National Fire Code of Canada 2010, the standards from ASME, ASHRAE, AABC, CSA, NFPA, SMACNA, and ASTM.

Personnel involved in starting, testing, balancing and adjusting procedures shall be experienced in the design and operation of mechanical equipment and systems being checked and shall be able to interpret results of the reading and tests.

Assume all liabilities associated with starting, testing and balancing procedures.

### 1.3 Submittals

Obtain certificates of approval, acceptance, and comply with current rules and regulations from authorities having jurisdiction and include in Operating and Maintenance Manuals.

Perform tests as specified and upon completion of mechanical installation. Provide certification of tests with detailed data as required. Itemise each test as to time performed and personnel responsible. Include in Operating and Maintenance Manuals.

### 1.4 Liability

Take charge of plant during tests, assume responsibility for damages in event of injury to personnel, building or equipment and bear costs for liability, repairs, and restoration in this connection.

### 2. PRODUCTS

Not Applicable.

### 3. EXECUTION

### 3.1 Pressure Tests

Provide equipment, materials and labour for tests and pay expenses. Use test instruments from approved laboratory or manufacturer and furnish certificate showing degree of accuracy. Install permanent gauges and thermometers used for tests just prior to tests to avoid possible changes in calibration.
.2 Carry out tests for eight-hour period and maintain pressure with no appreciable pressure drop. Where leakage occurs, repair and re-test and pay necessary costs for re-witnessing.

.3 Drainage Systems: Test by filling with water to produce water pressure to 30 kPa minimum and 62 kPa maximum.

.4 Water Piping: Test to 1-1/2 times maximum working pressure or 1033 kPa, whichever is greater, water pressure measured at system low point.

.5 Natural Gas: Test as required by current edition of CAN/CGA 149.1, and authority having jurisdiction.

.6 Ducts: Test ducts as per current edition of SMACNA Manual.

.7 Check systems during application of test pressure including visual check for leakage of water test medium, soap bubble test for air.

.8 During heating and cooling piping system tests, check linear expansion at elbows, U bends, expansion joints and offsets for proper clearance.

.9 When using water as test medium for system not using water, evacuate and dehydrate the piping and certify the lines are dry. Use agency specializing in this type of work.

.10 Should tests indicate defective work or variance with specified requirements, make changes immediately to correct the defects. Correct leaks by re-making joints in screwed fittings, cutting out and re-welding welded joints, re-making joints in copper lines. Do not caulk.

3.2 General

.1 Conduct performance tests to demonstrate equipment and systems meet specified requirements after mechanical installations are completed and pressure tested. Conduct tests as soon as conditions permit. Make changes, repairs, and adjustments required prior to operating tests.

.2 Where required by the Authority having jurisdiction, gas fired appliances rated in excess of 117 kW shall be subjected to an operational test established by the Authority and shall pass this test before being approved for operation.

.3 Meet with Division 16 manufacturers, suppliers, and other specialists as required to ensure all phases of work are properly coordinated prior to the commencement of each particular testing procedure. Establish all necessary manpower requirements.

.4 Operate and test motors and speed switches for correct wiring and sequences and direction of rotation. Check and record overload heaters in motor starters.

.5 Confirm voltages and operating amperages at full load.
.6 Failure to follow instruction pertaining to correct starting procedures may result in re-evaluation of equipment by an Independent Testing Agency selected by Owner at Contractor's expense. Should results reveal equipment has not been properly started, equipment may be rejected, removed from Site, and replaced. Replacement equipment shall also be subject to full starting procedures, using same procedures specified on the originally installed equipment.

3.3 Procedures

.1 Procedures shall be identified in the following five (5) distinct phases:

.1 Pre-Starting: Visual inspection.

.2 Starting: Actual starting procedure.

.3 Post-Starting: Operational testing adjusting or balancing, and equipment run-in phase.

.4 Pre-Interim Acceptance of the Work: Final cleaning, re-testing, balancing and adjusting, and necessary maintenance.

.5 Post-Interim Acceptance of the Work: Repeat tests and fine-tuning resulting from corrective action of deficiency clean-up.

.2 Check specified and shop drawing data against installed data.

.3 Check the installation is as defined by contract documents and as per Manufacturer's recommendations including Manufacturer's installation check sheets.

END OF SECTION
SEISMIC CONTROL

1. GENERAL

1.1 Scope

.1 Complete set of approved shop drawings of mechanical equipment, piping, and ductwork equipment that is to be seismically restrained.

.2 Include, as a minimum, basic equipment layout, length and width, installed operating weights of equipment to be isolated and distribution of weight at isolation points.

.3 Signed and sealed by a licensed Professional Engineer licensed registered in the Province of British Columbia.

.4 Calculations (including combining shear and tensile loads) to support seismic restraint designs shall be signed and sealed by a qualified registered Professional Engineer.

.5 Include, as a minimum, a tabulation of design data for each snubber, including specific anchorage details.

.6 Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

.7 Product Data:

a. Manufacturer’s product data including details of materials, construction, dimensions of individual components, installation details, and finishes.

b. Schedule of seismic control component type with location and static and dynamic load on each.

c. Interlocking Snubbers: Include load deflection curves up to 1/2-inch (12 mm) deflection in x, y, and z planes.

1.2 Qualifications

.1 Seismic restraints shall be same manufacturer. Select and certify using published or factory certified data.

.2 Seismic restraint manufacturer shall be a member of the Vibration Isolation and Seismic Control Manufacturer’s Association (VISCMA).

.3 Seismic Control:

Designer Qualifications:

d. Professional Engineer registered in the Province of British Columbia.

e. Minimum of 5 years’ work experience certifying seismic snubber and anchorage details.
f. Components shall bear anchorage pre-approval "R" number, from OSHPD or other agency acceptable to AHJ (Authority Having Jurisdiction), showing maximum seismic restraint ratings.

.4 Manufacturer’s Seismic Certification: Certification that specified equipment will withstand earthquake forces. Include the following:

a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.

b. Dimensioned Outline Drawing of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

c. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

1.3 Design Requirements

1. Design equipment, anchorage and support systems for vertical and lateral loading in accordance with OBC.

2. Provide seismic control as required to maintain integrity of mechanical piping, ductwork, and equipment installed in this project, so they will “withstand” earthquake forces.

3. Design shall comply with requirements of this Specification, applicable codes, and requirements of Section 22 00 10.

4. Design, size and install for equipment throughout facility, whether shown or not.

5. Designed by a licensed Professional Engineer in the Province of Ontario.


2. PRODUCTS

2.1 Seismic Restraints

.1 Resilient Isolation Washers and Bushings: One-piece, moulded neoprene, having a durometer 50, plus or minus 5, with a flat washer face.

.2 Seismic Snubbers: Factory fabricated using welded structural steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

.3 Restraining Cables: Galvanized steel aircraft cables with end connections made of steel assemblies that swivel to final installation angle and utilize two clamping bolts for cable engagement.

.4 Anchor Bolts:
1. Seismic-rated, drill-in, and stud-wedge or female-wedge type.

2. Select anchor bolts with strength required for anchor and as tested according to ASTM E488

.5 Manufacturers:

1. Mason Industries, Inc.


4. Or approved equivalent.

2.2 Spring Hangers

.1 Hangers capable of a 10° misalignment shall be provided unless otherwise specified.

3. EXECUTION

3.1 Examination:

.1 Examine areas and equipment to receive seismic control devices for compliance with requirements, installation tolerances, and other conditions affecting performance.

.2 Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

.3 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Installation:

.1 Install products in accordance with manufacturers’ written instructions.

.2 Notify local representative of seismic restraint materials manufacturer prior to installing seismic restraint devices.

.3 Representative of seismic restraint materials manufacturer shall provide a written report of compliance with installed equipment.

.4 No rigid connections between equipment and building structure shall be made which degrades seismic restraint system herein specified.

.5 Electrical conduit to restrained equipment shall be looped to allow free motion of equipment without damage to electrical wiring.

.6 Install seismic snubbers on isolated equipment.
.7 Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

.8 Install restraining cables at each trapeze and individual pipe hanger. At trapeze anchor locations, shackle piping to trapeze. Install cables so they do not bend across sharp edges of adjacent equipment or building structure.

.9 Install steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe hangers.

.10 At trapeze anchor locations, shackle piping and equipment to trapeze.

.11 Install resilient bolt isolation washers on equipment anchor bolts.

.12 Upon completion of seismic restraint material installation and before startup of restrained equipment, all debris shall be cleaned from beneath all protected equipment, leaving equipment free to contact snubbers.

3.3 Field Quality Control:

1. Testing: Conduct the following field quality-control testing:

   .1 Isolator seismic-restraint clearance.

   .2 Snubber minimum clearances

2. Seismic Control Component Inspection:

   .1 Conduct periodic inspections of material installation with assistance of manufacturer’s representative. Report in writing deviations from good installation practice.

   .2 Upon completion of seismic restraint device installation inspect completed system with assistance of manufacturer’s representative. Report in writing installation errors, improperly selected snubber devices, or other fault in the system that could affect performance of the system.

3.4 Adjusting

   .1 Adjust snubbers according to manufacturer’s written recommendations and additional corrections as required by the manufacturers’ representative site visit per Article 3.03.B.

   .2 Adjust seismic restraints to permit free movement of equipment within normal mode of operation.

   .3 Torque anchor bolts according to equipment manufacture’s written recommendations to resist earthquake forces.

END OF SECTION
1. **GENERAL**

1.1 **Scope**

.1 Supply all labour, materials and equipment required and necessary to isolate and restrain the equipment as indicated on the Drawings and specified herein and guarantee the function of the materials and equipment supplied.

.2 Install 300 mm long flex connection on all duct work connected to isolated equipment.

1.2 **Qualifications**

.1 All vibration isolators and bases shall be supplied by an acceptable supplier with the exception of isolators which are factory installed and are standard equipment with the machinery.

.2 Provide shop and placement drawings for all vibration isolation elements for review, before materials are ordered. The drawings shall bear the stamp and signature of the responsible Supplier's Technical Representative.

.3 The work shall be carried out in accordance with the Specification and, where applicable, in accordance with the Manufacturer's instructions and only by workmen experienced in this type of work.

2. **PRODUCTS**

2.1 **Isolators**

.1 Spring isolators located out of doors or in humid areas shall have Rustoleum painted housing and neoprene coated springs, unless otherwise indicated on Drawings.

2.2 **Open Spring Isolators**

.1 Springs shall be "ISO-Stiff" having equal stiffness in the horizontal and vertical planes with a working deflection between 0.3 and 0.6 of solid deflection.

.2 Spring mounts shall be complete with levelling devices, minimum 6 mm thick neoprene sound pads and zinc chromate plated hardware.

.3 Sound pads shall be sized for a minimum deflection of 1.2 mm and shall meet the requirements for neoprene isolators.

2.3 **Closed Spring Isolators**

.1 Compression springs shall be used both for hangers and floor mount isolators.

.2 Springs shall be stable under operating conditions.

.3 Housings shall incorporate a minimum 6 mm thick sound pad sized for a minimum static deflection of 1.2 mm meeting the requirements for neoprene isolators.
.4 Floor mount units shall incorporate neoprene side stabilisers with a minimum 6 mm clearance.

2.4 Neoprene Isolators

.1 All neoprene isolators shall be tested to latest ASTM specifications.

.2 Where a ribbed pad is used, the height of the ribs shall not exceed 0.7 times the width of the rib. A steel layer shall be used to distribute the load in a multi-layered unit.

.3 Neoprene pads or elements shall be selected at the Manufacturer's optimum recommended loading and shall not be loaded beyond the limit specified in the neoprene Manufacturer's literature.

2.5 Inertia Bases

.1 Concrete inertia bases shall be a minimum of 1.5 times the weight of the isolation equipment and shall be constructed using a channel iron perimeter and adequate reinforcing. The concrete shall be rated at 20 MPa. Design shall be by the isolation suppliers.

.2 Concrete inertia bases shall meet the requirements of the isolation Supplier's Shop Drawings.

.3 Structural steel bases shall be sufficiently rigid to prevent misalignment or undue stress on the machine, and to transmit design loads to the isolators.

2.6 Spring Hangers

.1 Hangers capable of a 10° misalignment shall be provided unless otherwise specified.

3. EXECUTION

3.1 Application

.1 Provide vibration isolator for mechanical motor driven equipment throughout, unless specifically noted otherwise.

.2 Set steel bases for 25 mm clearance between housekeeping pad and base. Set concrete inertia bases for 50 mm clearance. Adjust equipment level.

.3 Deflections 12 mm and over shall use steel spring isolators.

.4 Deflections 5 mm and under shall use neoprene isolators.

.5 Horizontal limit springs shall be provided on fans in excess of 1.5 kPa static pressure except vertical discharge fans and on hanger supported, horizontally mounted axial fans where thrust due to static pressure exceeds 300 N.

.6 All equipment mounted on vibration isolators shall have a minimum clearance of 50 mm to other structures, piping equipment, etc. All isolators shall be adjusted to make equipment level.
.7 Prior to making piping connections to equipment with operating weights substantially different from installed weights, the equipment shall be blocked up with temporary shims to the final heights. When full load is applied, the isolators shall be adjusted to take up the load just enough to allow shim removal.

.8 Adjustable, horizontal stabilizers on close spring isolators shall be adjusted so that the side stabilizers are clear under normal operating conditions.

.9 All piping connections to isolated equipment shall be supported resiliently for the following distances or to the nearest flexible pipe connector.

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Distance, m</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 - 40 mm</td>
<td>3.0</td>
</tr>
<tr>
<td>50 - 65 mm</td>
<td>4.5</td>
</tr>
<tr>
<td>75 - 100 mm</td>
<td>7.0</td>
</tr>
<tr>
<td>125 - 200 mm</td>
<td>9.0</td>
</tr>
<tr>
<td>225 - 275 mm</td>
<td>13.5</td>
</tr>
<tr>
<td>300 - 350 mm</td>
<td>15.0</td>
</tr>
</tbody>
</table>

The three closest hangers to the vibration source shall be selected for the lesser of a 25 mm static deflection or the static deflection of the isolated equipment. The remaining isolators shall be selected for the lesser of the 25 mm static deflection or 1/2 the static deflection of the isolated equipment.

.10 Spring hangers shall be installed without binding.

.11 Adjust isolators as required and ensure springs are not compressed.

.12 Provide neoprene side snubbers or retaining springs where side torque or thrust is developed.

.13 Where movement limiting restraints are provided, they shall be set in a position with minimum 6 mm air gap. Restraints, isolator equipment and attachment points shall be designed to withstand the impact of the isolated equipment subjected to an acceleration not exceeding 3 g without permanent distortion or damage.

.14 Wiring connections to isolated equipment shall be flexible.

3.2 Performance

.1 Install isolators of type and deflection according to the following table, whichever provides the greater deflection.
VIBRATION ISOLATION

The required static deflection of isolators for equipment exceeding 0.35 kW (1/2 hp) is indicated below. Spring isolators shall be "open spring". Closed spring isolators shall only be used where specified.

<table>
<thead>
<tr>
<th>Machine Speed, r/min</th>
<th>Basement</th>
<th>Upper Floor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 400</td>
<td>Special*</td>
<td>Special*</td>
</tr>
<tr>
<td>400 - 600</td>
<td>25 mm</td>
<td>50 mm</td>
</tr>
<tr>
<td>600 - 800</td>
<td>12 mm</td>
<td>25 mm</td>
</tr>
<tr>
<td>800 - 1100</td>
<td>5 mm</td>
<td>12 mm</td>
</tr>
<tr>
<td>1100 - 1500</td>
<td>3 mm</td>
<td>4 mm</td>
</tr>
</tbody>
</table>

* "Special" indicates as directed by the acoustical consultant.

END OF SECTION
SUPPORTS, ANCHORS AND SEALS

1. GENERAL

1.1 Scope

.1 Pipe hangers and supports.

.2 Duct hangers and supports.

.3 Sleeves

.4 Pipe anchors.

1.2 Reference Standards

.1 Pipe supports shall meet the requirements of current edition of ANSI B31.1, Power piping.

.2 Duct hangers shall follow the recommendations of the current edition of the SMACNA Duct Manuals.

1.3 General Requirements

.1 Provide hangers and supports to secure equipment in place, prevent vibration, maintain grade; provide for expansion and contraction and to accommodate insulation; provide insulation protection saddles.

.2 Install supports of strength and rigidity to suit loading without unduly stressing building. Locate adjacent to equipment to prevent undue stresses in piping and equipment.

.3 Select hangers and supports for the service and in accordance with the Manufacturer's recommended maximum loading. Hangers shall have a 5.0 safety factor.

.4 Fasten hangers and supports to building steel or inserts in concrete construction.

.5 Provide and set sleeves required for equipment, including openings required for placing equipment. Provide sleeves for all pipe and duct penetrations through walls, ceilings, floors and footings.

.6 Dielectrically isolate dissimilar metals.

.7 Obtain approval from the Consultant prior to drilling for inserts and supports for piping systems.

.8 Obtain approval from the Consultant prior to using percussion type fastenings.

.9 Use of piping or equipment for hanger supports is not permitted.

.10 Use of perforated band iron, wire or chain as hangers is not permitted.

.11 Do not weld piping, ductwork or equipment supports to building metal decking or building structural steel supports unless prior written approval has been obtained from the Consultant.
.12 Where deemed necessary by the Consultant, the Contractor shall, at his own cost, employ a Structural Consultant to design equipment supports and/or pipe anchors.

2. PRODUCTS

2.1 Inserts

.1 Inserts shall be malleable iron case or galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.

.2 Size inserts to suit threaded hanger rods.

2.2 Pipe Hangers and Supports

.1 Hangers, Pipe sizes 15 mm to 40 mm: adjustable wrought steel ring.

.2 Hangers, Pipe sizes 50 mm to 100 mm and Cold Pipe Sizes 150 mm and over: adjustable wrought steel clevis.

.3 Multiple or Trapeze Hangers: steel channels with welded spacers and hanger rods, cast iron roll and stand for hot pipe sizes 150 mm and over.

.4 Wall Support, Pipe Sizes to 50 mm: cast iron hook.

.5 Wall Support, Pipe Sizes 65 mm and over: welded steel bracket and adjustable wrought steel clevis.

.6 Vertical Support: steel riser clamp.

.7 Floor Support, Pipe Sizes to 100 mm and all cold pipe sizes: steel heavy duty u-bolt, c/w locknuts, steel floor plate and structural steel support.

.8 Install hangers so they cannot become disengaged by movements of supported pipe.

2.3 Hanger Rods

.1 Provide steel hanger rods, threaded both ends, threaded one end, or continuous threaded.

2.4 Duct Hangers and Supports

.1 Conform to current edition of SMACNA handbooks.

2.5 Flashing

.1 Steel Flashing: 0.55 mm galvanized steel.

.2 Lead Flashing: 25 kg/m² sheet lead for waterproofing, 5 kg/m² sheet lead for soundproofing.

.3 Safes: 25 kg/m² sheet lead or 0.5 mm neoprene.

.4 Caps: Steel, 0.7 mm thickness minimum, 1.6 mm thickness at fire resistance structures.
2.6 **Sleeves**

.1 Pipes through Floors: Form with 1.2 mm galvanized steel.

.2 Pipes through Beams, Walls, Fire Proofing, Footings, and Potentially Wet Floor: Form with steel pipe or 1.2 mm thickness galvanized steel.

.3 Ducts: Form sleeves with galvanized steel.

.4 Size large enough to allow for expansion with continuous insulation.

2.7 **Pipe Seals**

.1 Provide “Link-seal” pipe sealing system where passing through room foundation walls.

2.8 **Finishes on Hanger Rods, Hangers and Supports**

.1 All steel hanger rods, hangers and supports shall be galvanized or factory primed with alkyd red oxide primer to CAN/CGSB-1.40.

3. **EXECUTION**

3.1 **Inserts**

.1 Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

.2 Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying piping over 100 mm or ducts over 1500 mm wide.

.3 Where concrete slabs form finished ceiling, finish inserts flush with slab surface.

.4 Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab.

3.2 **Pipe Hangers and Supports**

.1 Support horizontal steel and copper piping as follows:

<table>
<thead>
<tr>
<th>Nominal Pipe Size</th>
<th>Distance Between Supports</th>
<th>Hanger Rod Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Steel</td>
<td>Copper</td>
</tr>
<tr>
<td>15 mm</td>
<td>1.8 m</td>
<td>1.5 m</td>
</tr>
<tr>
<td>20 mm to 40 mm</td>
<td>2.1 m</td>
<td>1.8 m</td>
</tr>
<tr>
<td>50 mm &amp; 65 mm</td>
<td>3.0 m</td>
<td>2.4 m</td>
</tr>
<tr>
<td>80 mm &amp; 100 mm</td>
<td>3.6 m</td>
<td>3.0 m</td>
</tr>
<tr>
<td>150 mm to 300 mm</td>
<td>4.2 m</td>
<td>4.0 m</td>
</tr>
</tbody>
</table>
SUPPORTS, ANCHORS AND SEALS

<table>
<thead>
<tr>
<th>Nominal Pipe Size</th>
<th>Distance Between Supports</th>
<th>Hanger Rod Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>350 mm to 450 mm</td>
<td>6.0 m</td>
<td>25 mm</td>
</tr>
</tbody>
</table>

.2 Install hangers to provide minimum 12 mm clear space between finished covering and adjacent work.

.3 Place a hanger within 300 mm of each horizontal elbow.

.4 Use hangers which are vertically adjustable 40 mm minimum after piping is erected.

.5 Support horizontal soil pipe near each hub with 1500 mm maximum spacing between hangers.

.6 Support vertical piping at every other floor. Support vertical soil pipe at each floor at hub.

.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.8 Where practical, support riser piping independently of connected horizontal piping.

.9 Use oversized hangers to accommodate pipe insulation thickness. For pipes up to 50 mm, use high density rigid pipe insulation at hanger location, with an insulation protection shield. For pipes 65 mm and over, use insulation protection saddle.

.10 Trim all drops to have maximum three (3) threads exposed.

3.3 Low Velocity Duct Hangers and Supports

.1 Hanger Minimum Sizes:

.1 Up to 750 mm wide: 25 mm x 1.6 mm at 3000 mm spacing.

.2 790 to 1200 mm wide: 40 mm x 1.6 mm at 3000 mm spacing.

.3 Over 1200 mm wide: 40 mm x 1.6mm at 2400 mm spacing.

.2 Horizontal Duct on Wall Supports Minimum Sizes:

.1 Up to 450 mm wide: 40 mm x 1.6 mm or 25 x 25 x 3 mm at 2400 mm spacing.

.2 475 mm to 1000 mm wide: 40 mm x 40 mm x 3 mm at 1200 mm spacing.

.3 Vertical Duct on Wall Supports Minimum Sizes at 3600 mm spacing:

.1 Up to 600 mm wide: 40 mm x 1.6 mm.

.2 625 mm to 900 mm wide: 25 mm x 25 mm x 3 mm.

.3 925 mm to 1200 mm wide: 30 mm x 30 mm x 3 mm.
3.4 Medium and High Velocity Duct Hangers and Supports

.1 Hanger Minimum Sizes:
   .1 Up to 900 mm wide: 2 at 25 mm x 1.6 mm at 3000 m spacing.
   .2 925 mm to 1500 mm wide: 2 at 25 mm x 1.6 mm at 2400 m spacing and 50 mm x 50 mm x 6 mm trapeze.
   .3 1525 mm to 3000 mm wide: 2 at 38 mm x 2.6 mm at 2400 mm spacing and 50 mm x 50 mm x 7 mm trapeze.
   .4 3025 to 6600 mm wide: 3 at 12 mm diameter at 1200 mm spacing and 65 mm x 65 mm x 5 mm trapeze.

.2 Round Duct Hangers Minimum Sizes at 3000 mm spacings:
   .1 Up to 450 mm diameter: 25 mm x 1.6 mm.
   .2 475 mm to 900 mm diameter: 25 mm x 2.6 mm.
   .3 925 mm to 1250 mm diameter: 40 mm x 2.6 mm.
   .4 1275 mm to 2100 mm diameter: 2 at 40 mm x 2.6 mm from girth reinforcing angle.

.3 Vertical Duct Floor Supports Minimum Sizes:
   .1 Up to 1200 mm wide: 40 mm x 40 mm x 3 mm.
   .2 Over 1200 mm wide: 50 mm x 50 mm x 3 mm.
   .3 Rivet to duct and tie angles together with rod, angles or band iron.
   .4 Angle reinforcing may be used for support omitting trapeze.

3.5 Equipment Bases and Supports

.1 Provide for floor-mounted equipment, reinforced concrete housekeeping bases poured directly on structural floor slab 100 mm thick minimum, extended 100 mm minimum beyond machinery bedplates. Provide templates, anchor bolts and accessories required for mounting and anchoring equipment.
.2 Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

.3 Rigidly anchor ducts and pipes immediately after vibration connections to equipment.

3.6 Flashing

.1 Flash and counterflash where mechanical equipment passes through weather or waterproofed walls, floors, and roofs.

.2 Flash vent and soil pipes projecting 75 mm minimum above roof membrane with lead worked 25 mm minimum into hub, 200 mm minimum clear on sides with minimum 600 mm x 600 mm sheet size. For pipes through outside walls turn flange back into wall and caulk. For R.C.A.B.C. certified/insured projects, use aluminum flashing, installed as per R.C.A.B.C. specifications.

.3 Flash floor drains over finished areas with lead 250 mm clear on sides with minimum 900 mm x 900 mm sheet size. Fasten flashing to drain clamp device.

.4 Provide curbs for mechanical roof installations minimum 200 mm high. Flash and counterflash with steel; solder and make waterproof.

.5 Provide lead flashing around ducts and pipes passing from electrical, process, pump room, installed according to Manufacturer’s data for sound control.

3.7 Sleeves

.1 Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeve.

.2 Extend sleeves through potentially wet floors 25 mm above finished floor level. Caulk sleeves full depth and provide floor plate.

.3 Piping and duct work passing through floor, ceiling or wall, close off space between duct and sleeve and non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.

.4 Piping passing through floor, roof or wall, close off space between pipe and sleeve with synthetic rubber compound mechanical type seals.

.5 Sleeves provided through walls or floors where liquids could potentially pass from one side to the other, provide sleeves with a 25 mm “flange” welded to the external face of the sleeve at the mid point of the thickness of the structure to provide a water stop.

.6 Install chrome-plated escutcheons where piping passes through finished surfaces.

END OF SECTION
PIPE AND PIPE FITTINGS

1. GENERAL

1.1 Quality Assurance

.1 Welding materials, fabrication standards and labour qualifications must conform to ANSI/ASME B31.1, ANSI B16.25, ASME Section IX, and the Provincial Board of Labour Regulations latest current editions.

.2 Use welders fully qualified and licensed by Provincial Authorities.


.5 Domestic Water, Drainage and Vent Piping: current Provincial and Municipal Codes.

.6 Refrigerant Piping: CSA B52, Mechanical Refrigeration Code.

.7 All below grade steel piping shall be yellow jacketed with taped and sealed joints.

.8 Non-specified pipe joining and pipe fitting methods such as T-drill and press fit are not permitted in any piping system covered under Division 15.

2. PRODUCTS

2.1 Pipe

<table>
<thead>
<tr>
<th>Service</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>.1 Sanitary drainage, and vent, inside</td>
<td>DWV copper, ASTM B306</td>
</tr>
<tr>
<td>building, above ground</td>
<td>Cast iron, CSA B70</td>
</tr>
<tr>
<td></td>
<td>PVC-DWV, CAN/CSA B182.1</td>
</tr>
<tr>
<td></td>
<td>Laboratory Sink Waste: Pegas PVDF</td>
</tr>
<tr>
<td></td>
<td>Superblue Polypropylene meeting</td>
</tr>
<tr>
<td></td>
<td>ULC/ORD-C996.1</td>
</tr>
<tr>
<td>.2 Sanitary drainage, and vent, inside</td>
<td>Cast iron, CSA B70</td>
</tr>
<tr>
<td>building, below ground</td>
<td>PVC-DWV, CAN/CSA B182.1</td>
</tr>
<tr>
<td>.3 Sanitary drainage and vent, outside</td>
<td>Cast iron, CSA B70</td>
</tr>
<tr>
<td>building</td>
<td>PVC, SDR-35 for sizes to 300 mm, ASTM-D3034,</td>
</tr>
<tr>
<td></td>
<td>complete with tracer wire.</td>
</tr>
<tr>
<td>.4 Storm drainage, inside building, above</td>
<td>Cast iron, CSA B70</td>
</tr>
<tr>
<td>ground</td>
<td>PVC-DWV, CAN/CSA B182.1</td>
</tr>
</tbody>
</table>
### PIPE AND PIPE FITTINGS

<table>
<thead>
<tr>
<th>Service</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>.5 Domestic water, above ground (inside building)</td>
<td>Type L hard copper for cold water and Type K hard copper for hot water and recirc. water for sizes up to 100 mm, ASTM B88M</td>
</tr>
<tr>
<td></td>
<td>Ductile Iron centrifugally cast for cold water main sizes 100 mm and larger, ANSI/AWWA C151/A21.51. No steel piping allowed for domestic hot water.</td>
</tr>
<tr>
<td>.6 Domestic Water (buried inside building)</td>
<td>Type K soft copper, ASTM B88M</td>
</tr>
<tr>
<td>.7 Domestic water service (below ground)</td>
<td>Type K soft copper, ASTM B88M, PVC, Class 150, conforming to CSA B137.3 and AWWA C900, complete with tracer wire</td>
</tr>
<tr>
<td>.8 Hot water and glycol heating to 120°C</td>
<td>Steel, Sch.40, ASTM A53, Grade B heating to 120°C</td>
</tr>
<tr>
<td>.9 Natural gas, propane Grade B</td>
<td>Steel, Sch.40, ASTM A53</td>
</tr>
<tr>
<td>.10 Equipment drains and overflows</td>
<td>Sch.40, galvanized steel, ASTM A120</td>
</tr>
<tr>
<td></td>
<td>Type L hard copper ASTM B88M</td>
</tr>
<tr>
<td>.11 Refrigerant</td>
<td>ACR copper, ASTM B280</td>
</tr>
<tr>
<td>.12 Oil (above ground)</td>
<td>Steel, Sch.40, ASTM A120</td>
</tr>
<tr>
<td>.13 Diesel Fuel (Underground)</td>
<td>OPW Inc PISCES CPN series double-wall primary pipe inside crush-resistant AXP series double-wall access pipe.</td>
</tr>
<tr>
<td>.14 Diesel engine exhaust, Grade B</td>
<td>Steel, Sch.40, ASTM A53, UL Listed Insulated Position Pressure Piping System</td>
</tr>
</tbody>
</table>

#### 2.2 Fittings and Joints

<table>
<thead>
<tr>
<th>Service</th>
<th>Material</th>
<th>Joint</th>
</tr>
</thead>
<tbody>
<tr>
<td>.1 Sanitary drainage and vent inside building, above ground</td>
<td>Cast iron</td>
<td>Gasket clamp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wrought or Cast copper</td>
</tr>
<tr>
<td>Service</td>
<td>Material</td>
<td>Joint</td>
</tr>
<tr>
<td>---------</td>
<td>----------</td>
<td>-------</td>
</tr>
<tr>
<td>.2 Sanitary drainage and vent, inside building, below ground</td>
<td>Cast iron (hubless fitting)</td>
<td>Gasket &amp; clamp</td>
</tr>
<tr>
<td></td>
<td>PVC-DWV</td>
<td>Solvent weld</td>
</tr>
<tr>
<td>.3 Sanitary drainage and vent, outside building</td>
<td>Cast iron</td>
<td>Hub &amp; spigot</td>
</tr>
<tr>
<td></td>
<td>PVC</td>
<td>Solvent weld</td>
</tr>
<tr>
<td>.4 Storm drainage, inside building, below ground</td>
<td>Cast iron</td>
<td>Gasket &amp; clamp</td>
</tr>
<tr>
<td></td>
<td>PVC-DWV</td>
<td>Solvent weld</td>
</tr>
<tr>
<td>.5 Domestic water, above ground</td>
<td>Wrought copper, bronze</td>
<td>Lead free solder, brazed for pipes over 50 mm</td>
</tr>
<tr>
<td></td>
<td>Cast bronze</td>
<td>Screwed</td>
</tr>
<tr>
<td></td>
<td>Ductile Iron pipe</td>
<td>Grooved mechanical</td>
</tr>
<tr>
<td>.6 Domestic water, buried</td>
<td>PVC</td>
<td>Hub &amp; spigot, with O-ring</td>
</tr>
<tr>
<td></td>
<td>Copper pipe</td>
<td>No joints permitted underground</td>
</tr>
<tr>
<td>.7 Hot water and glycol heating 120ºC</td>
<td>Banded malleable iron, 1033 kPa, up to 50 mm</td>
<td>Screwed</td>
</tr>
<tr>
<td></td>
<td>Steel, same schedule as pipe, for sizes 50 mm and larger</td>
<td>Welded</td>
</tr>
<tr>
<td></td>
<td>Wrought copper</td>
<td>95-5 solder, brazed bronze, for pipes over 50 mm</td>
</tr>
<tr>
<td></td>
<td>Cast brass</td>
<td>Screwed</td>
</tr>
<tr>
<td></td>
<td>Cast bronze</td>
<td>Flare tube</td>
</tr>
<tr>
<td>.8 Natural gas, propane</td>
<td>Banded malleable iron, 1033 kPa (150 psi), for</td>
<td>Screwed</td>
</tr>
</tbody>
</table>
### PIPE AND PIPE FITTINGS

<table>
<thead>
<tr>
<th>Service</th>
<th>Material</th>
<th>Joint</th>
</tr>
</thead>
<tbody>
<tr>
<td>sizes 40 mm and under</td>
<td>Steel, same schedule as pipe, for sizes 50 mm and larger: and for high pressure (over 860 kPa) - all sizes; and for piping installed outdoors - all sizes</td>
<td>Welded</td>
</tr>
<tr>
<td>.9 Equipment drains and overflows</td>
<td>Galvanized banded malleable iron</td>
<td>Screwed</td>
</tr>
<tr>
<td>.10 Refrigerant</td>
<td>Wrought copper, bronze</td>
<td>Screwed</td>
</tr>
<tr>
<td>.11 Oil (above ground)</td>
<td>Cast brass</td>
<td>Screwed</td>
</tr>
<tr>
<td>.12 Diesel Fuel (Underground)</td>
<td>NO BURIED JOINTS ALLOWED</td>
<td></td>
</tr>
<tr>
<td>.13 Diesel engine exhaust</td>
<td>Steel, same schedule as pipe, all sizes</td>
<td>Welded</td>
</tr>
<tr>
<td>.14 Use factory fabricated butt welded fittings for welded steel pipes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.15 Use long radius elbows for steel and cast iron water piping, including grooved mechanical fittings.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 2.3 Unions, Flanges and Couplings

.1 Size 50 mm and under: 1033 kPa malleable iron, bronze to iron ground joint unions for threaded ferrous piping, air tested for gas service, all bronze for copper piping.

.2 Sizes 65 mm and over: 1033 kPa forged steel welding neck flanges for ferrous piping, 1033 kPa bronze slip-on flanges for copper piping. Gaskets shall be 1.5 mm thick performed synthetic rubber bonded asbestos. Gaskets for gas service shall be synthetic rubber.

.3 Flange bolting: For systems up to 120°, use carbon steel stud bolts, semi-flushed and heavy hex nuts, ASTM A307-GrB. For systems up to 215°C, use alloy steel bolts ASTM A193-GrB7, and semi-finished heavy hex nuts ASTM A194-Gr2H.

.4 Where permitted by the Consultant, use grooved mechanical couplings to engage and lock grooved or shouldered pipe ends and to allow for some angular deflection, contraction and expansion. Couplings consist of malleable iron housing-clamps, C-shaped composition...
sealing gasket EPDM Grade E and steel bolts. Use galvanized couplings for galvanized pipe. Victaulic brand or Grinnel Gruv-Lok only.

3. EXECUTION

3.1 Preparation

.1 Ream pipes and tubes. Clean off scale and dirt, inside and outside, before assembly. Remove welding slag or other foreign material from piping.

.2 Protect all steel pipes when stored on site from external conditions and ensure protective coating remains intact. If in the opinion of the Consultant, deterioration of the protective coating has instigated corrosion, all rust must be removed down to bare metal and prime coated with red oxide paint.

3.2 Connection

.1 Screw joint steel piping up to and including 40 mm. Weld piping 65 mm and larger, including branch connections. Screw or weld 50 mm piping for liquid systems, weld 50 mm piping for air and gas systems.

.2 Socket weld diesel fuel piping including branch connections. Weld piping for natural gas systems.

.3 Make screwed joints with full cut standard taper pipe threads with approved non-toxic joint compound applied to male threads only.

.4 Make joints for plain end pipe with gasket and clamp type mechanical fastener.

.5 Clamp cast iron water pipe at fittings with 20 mm rods and properly anchor and support.

.6 Use grooved mechanical couplings and mechanical fasteners, only where permitted by the Consultant.

.7 Use galvanized couplings with galvanized pipe.

.8 Make connections to equipment, specialty components, and branch mains with unions or flanges.

.9 Provide dielectric type connections wherever joining dissimilar metals in open systems. Brass adapters and valves are acceptable.

.10 Use insulating plastic spacers for copper pipe installation in metal studs.

3.3 Route and Grades

.1 Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping wherever practical at common elevations. Install concealed pipes close to the building structure to keep furring to a minimum.

.2 Slope water piping 0.2% and provide hose bibb drains at low points.
.3 Equip low points with 20 mm drain valves and hose nipples.

.4 Provide air collection chambers with manual air vent at all high points of system. Collection chambers to be 25 mm dia. or line size whichever is greater and 150 mm high minimum. Square tees may only be used to assist with complete venting and draining.

.5 Make reductions in water and steam pipes with eccentric reducing fittings installed to provide drainage and venting. Top flat for water, bottom flat for steam.

.6 Grade horizontal drainage and vent piping 2% minimum, unless noted otherwise.

.7 Pipe the discharge from all relief valves, safety valves, vents, drains, equipment blowdowns, water columns and overflows to the nearest building drain. Pipe to glycol recovery tanks for a glycol based system.

3.4 Installation

.1 Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected.

.2 Provide clearance for proper installation of insulation and for access to valves, air vents, drains and unions.

.3 Install piping material specified as inside the building to 2400 mm outside of building.

.4 Yellow jacket buried steel lines, joints and fittings, prime coat and paint lines exposed to outdoors.

3.5 Underground Fuel Piping

.1 Install all underground fuel piping in complete accordance with manufacturer’s printed instructions.

3.6 PVDF Acid Waste Pipe

.1 Pegas FRPP and PVDF pipe and fittings shall be joined using the Pegas mechanical joint coupling. Mechanical joint fittings shall be Schedule 40 and meet or exceed ASTM-F1412.

.2 At fire separations, provide intumescent fire stop assembly in accordance with CAN4-5115-M or ULC-5115-95 including a 50 pa pressure difference.

.3 When transitioning to PVDF from FRPP at a fire separation, penetrate the separation with FRPP and locate the Pegas coupling as close as possible to the fire stop system. The sleeve of the Pegas coupling at the FRPP/PVDF joint shall be of PVDF. Do not fire stop at a joint or over a coupling.

3.7 Welded Pipe Branch Connections

.1 Make branch connections according to the following schedule.

Legend:
**PIPE AND PIPE FITTINGS**

- **T**: Forges tee or reducing tee
- **S**: Socolet
- **W**: Weldolet

<table>
<thead>
<tr>
<th>PIPE SIZE (mm)</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>65</th>
<th>75</th>
<th>100</th>
<th>150</th>
<th>200</th>
<th>250</th>
<th>300</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T</td>
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<td>HEADER</td>
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</tr>
<tr>
<td>PIPE SIZE</td>
<td>S</td>
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<td>W</td>
<td>W</td>
<td>W</td>
<td>W</td>
<td>W</td>
</tr>
</tbody>
</table>

**END OF SECTION**
1. **GENERAL**

1.1 **Scope**

.1 Piping insulation.

.2 Adhesives, tie wires, tapes.

.3 Recovering.

1.2 **Quality Assurance**

.1 Insulation shall be installed by skilled workmen regularly engaged in this type of work.

.2 Materials shall meet or exceed fire and smoke hazard ratings as stated in this Section and defined in applicable building codes.

1.3 **Submittals**

.1 Submit Shop Drawings which indicate complete material data, "K" value temperature rating, density, finish, recovery jacket of materials proposed for this project and indicate thickness of material for individual services.

1.4 **Job Conditions**

.1 Deliver material to job site in original non-broken factory packaging, labelled with Manufacturer's density and thickness.

.2 Perform work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

2. **PRODUCTS**

2.1 **General**

.1 Insulation Materials, Recovery Jackets, Vapour Barrier Facings, Tapes and Adhesives: Composite fire and smoke hazard ratings shall not exceed 25 for flame spread and 50 for smoke developed.

.2 All insulation materials shall meet current Building Code Standards, and packages or containers of such materials shall be appropriately labelled.

.3 Insulate fittings and valve bodies with preformed removable insulated fittings.

2.2 **Materials**

.1 Cold Piping: Formed fine fibrous glass or formed mineral fibre pipe insulation, with factory applied vapour barrier jacket, factory moulded to conform with piping, "K" value at 24°C maximum 0.035 W/m°C. Service temperature -14°C to 100°C.
PIPING INSULATION

.2 Refrigerant Piping: Formed plastic of closed cell structure or closed cell elastomer, "K" value maximum 0.04 W/m°C at 24°C. Insulation shall have a maximum water vapour transmission rating of 0.1 perms.

.3 Recovery Jackets:
   .1 ULC labelled thermo-canvas flamespread less than 25 smoke developed less than 50.
   .2 0.4 mm embossed aluminum sheet for piping.

3. EXECUTION

3.1 Preparation
   .1 Do not install covering before piping and equipment has been tested and approved.
   .2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

3.2 Installation
   .1 Ensure insulation is continuous through inside walls. Pack around pipes with fire proof self-supporting insulation material, properly sealed.
   .2 Insulate complete system including fittings, valves, unions, flanges, strainers. Do not insulate flexible connections and expansion joints. Terminate insulation neatly with plastic material travelled on a bevel.
   .3 Finish insulation neatly on hangers, supports and other protrusions.
   .4 Locate insulation or cover seams in least visible locations. Locate seams on piping in ceiling spaces on the underside of the pipe.
   .5 Provide recovering jackets on exposed insulation throughout. Make smooth uneven insulated surfaces before recovering.
   .6 Cover insulation exposed to outdoors with aluminum jacket secured with aluminum bands on 200 mm centres or screws on 150 mm centres. Lap joints 75 mm minimum and seal with compatible waterproof lap cement.
   .7 Cold Piping: seal lap joints with 100% coverage of vapour barrier adhesive. Seal butt joints with 50 mm wide strips of vapour barrier sealed with vapour barrier adhesive. For fittings and valves, apply hydraulic insulating cement; or apply factory fabricated insulation half shells, seal all laps and joints.
   .8 Refrigerant Piping: cover fittings and valves with equivalent thickness of pipe insulation material. Apply with edges tightly butted. Seal joints with sealer.
   .9 Use high density inserts and carry insulation through hangers and pipe supports.
### Piping Insulation

#### 3.3 Insulation Installation Thickness Schedule

<table>
<thead>
<tr>
<th>Piping or Equipment</th>
<th>Pipe Sizes, mm</th>
<th>Insulation Thickness (fibreglas), mm</th>
<th>Insulation Thickness (closed cell phenolic), mm</th>
<th>Recovery Jacket</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Refrigerant Piping</td>
<td>All sizes</td>
<td>(Closed Cell) 25</td>
<td>-</td>
<td>Aluminum</td>
</tr>
<tr>
<td>2. Condensate Drains from Indoor Air Conditioning Units</td>
<td>All sizes</td>
<td>12</td>
<td>15</td>
<td>Aluminum</td>
</tr>
</tbody>
</table>

**Note:** Pipe insulation for piping installed in 38 mm x 92 mm wall cavity can be reduced 15 mm, for pipe sizes 40 mm to 65 mm. Install insulation to thickness specified piping outside the wall cavity.

**END OF SECTION**
1. GENERAL

1.1 Scope

.1 Clean-outs
.2 Floor drains
.3 Air chambers or water hammer arresters
.4 Backflow preventers
.5 Vacuum breakers
.6 Pressure reducing valves

1.2 General Requirements

.1 Provide materials, equipment and labour to install plumbing as required by Provincial and Local Codes and as specified herein.

.2 Provide water and drainage connections to equipment furnished in other Sections of this Specification and as supplied by the Owner.

.3 Provide an approved water meter and bypass installation conforming to Local Codes and Standards.

.4 Provide and include charges for connections to Municipal and Utility Company Service.

1.3 Submittals

.1 Submit Shop Drawings for review by the Consultant, in accordance with the General Conditions. Provide Shop Drawings for the following items:

.1 Clean-outs

.2 Floor Drains

.3 Water hammer arresters

.4 Backflow Preventers

.5 Vacuum Breakers

2. PRODUCTS

2.1 Clean-Outs and Clean-Out Access Covers

.1 Provide caulked or threaded type extended to finished floor or wall surface. Ensure ample clearance at clean-out for rodding of drainage system.
2.2 Floor Drains

.1 All duco coated, 220 mm dia. cast iron body, reversible flashing clamp with seepage openings, 102 mm outlet, round strainer, polished bronze, and sediment bucket. Standard of acceptance: Jay R. Smith #2005Y-A-PB-B

.2 Floor drains shall have polished bronze reinforced tractor strainer.

2.3 Water Hammer Arresters

.1 Fit water supply to each fixture or group of fixtures with an air chamber. Provide air chambers same size as supply line or 20 mm minimum, and minimum 450 mm long.

.2 Install stainless steel bellows type water hammer arresters on water lines connected to solenoid valves, flush valves, and to fixture or group of fixtures complete with accessible isolation valve.

2.4 Backflow Preventer Assemblies

.1 Provide backflow preventer assembly complete with shut-off valves before and after check valves and test cocks. Assembly shall meet current AWWA requirements and CSA B64 standards.

.2 Provide complete reduced pressure principle type assembly, consisting of pressure differential relief valve, located between two (2) positive seating replaceable check valves with stainless steel or bronze seats Watts Series 909. Provide strainer between gate valve and first check valve on units 50 mm and smaller.

.3 Provide complete double check valve type assembly consisting of two (2) positive sealing replaceable check valves with stainless steel or bronze seats. Provide check valve on units 50 mm and smaller. Watts Series 719

.4 Provide complete atmospheric vent backflow preventer assembly, consisting of two (2) positive sealing replaceable check valves with bronze seats, integral stainer and threaded vent connection. Watts Series 9D

2.5 Vacuum Breaker Assemblies

.1 Provide pressure type vacuum breaker assembly complete with shut-off valves before and after check valves and test cocks. Assembly shall consist of one (1) positive sealing check valve and one (1) atmospheric vent disk with stainless steel or bronze seats complete with shut-off valves before and after check valves and test cocks. Assembly shall meet ANSI / ASSE standard 1020 requirements and CSA B64 standards. Watts Series 800 M4QT
.2 Provide atmospheric type vacuum breaker assembly complete with shut-off valve before assembly. Assembly shall consist of one (1) free floating poppet to seal the atmospheric vent under flow conditions. Watts No. 288A. For bottom inlet and outlet, Watts Series 288A.

.3 Provide hose connection type vacuum breaker assembly, consisting of a check valve disc assembly to be vandal proof and drainable, Watts Series 8A. For freezing conditions, Watts Series NF8.

2.6 Pressure Reducing Valves

.1 25 mm and smaller: Bronze body, SS integral strainer, renewable SS seat, high temperature rated diaphragm suitable for hot or cold water. Rated at maximum inlet pressure of 2100 kPa, maximum reduced pressure 175 kPa, maximum temperature 90°C.

.2 30 mm and larger: Pilot operated, cast iron body, modified globe design, threaded ends to 50 mm, flanged ends 65 mm and larger. Maximum inlet pressure 2100 kPa. Maximum temperature 90°C. Bronze trim. Pilot control system: bronze with SS trim, hydraulically operated, diaphragm actuated.

.3 Size to suit flow capacities and service.

.4 Provide with gate valve and union on inlet and outlet, globe valve bypass, pressure gauge on inlet and outlet and pressure relief valve on reduced pressure side.

3. EXECUTION

3.1 Installation

.1 Bury outside water and drainage pipe minimum 2400 mm, unless noted otherwise.

.2 Lubricate clean-out plugs with mixture of graphite and linseed oil. Prior to building turnover remove clean-out plugs, re-lubricate and reinstall using only enough force to ensure permanent leakproof joint.

.3 Install backflow prevention devices on plumbing lines, to code requirements, where contamination of domestic water may occur. Generally necessary on hose bibbs and flush valves.

.4 Where floor drains are located over occupied areas, provide waterproof installation.

.5 Drainage lines shall grade 2% unless otherwise indicated on Drawings.

.6 Install pressure reducing valves to limit maximum static pressure at plumbing fixtures to 550 kPa.

.7 Locate plumbing vents minimum 5 m from air intakes.

END OF SECTION
FIRE EXTINGUISHERS

1. GENERAL

1.1 Scope

.1 Fire extinguishers.

.2 Fire extinguisher cabinets and mounting hardware.

1.2 General Requirements

.1 Provide portable hand extinguishers where indicated on Drawings and specified herein.

1.3 Quality Assurance

.1 Fire protection equipment and installation shall be approved by local Fire Commissioner.

.2 Equipment and installation shall meet the requirements of NFPA 10 Portable Fire Extinguishers.

1.4 Submittals

.1 Submit Shop Drawings for review. Submit with Shop Drawings Material Safety Data Sheets (MSDS) for each chemical used in the Fire Extinguishers.

2. PRODUCTS

2.1 Portable Hand Fire Extinguishers

.1 Multi-Purpose Dry Chemical (Type 1): Pressurized with hose and shut-off nozzle or integral shut-off nozzle and mounting brackets 4.5 kg capacity rating 4A:60BC; 9.0 kg capacity rating 10A:80BC.

3. EXECUTION

3.1 Installation

.1 Fire extinguishers shall be installed so that the top of fire extinguisher is 900 mm AFFL.

END OF SECTION
TERMINAL HEAT TRANSFER UNITS

1. GENERAL

1.1 Scope

.1 Electric unit heaters
.2 Electric Baseboard Heater
.3 Related accessories and specialties
.4 Coordinate all electrical requirements with including confirmation of voltage requirements for all equipment.

1.2 Related Work Specified in Other Sections

.1 Section 15010 - General Mechanical Provisions.

1.3 Quality

.1 Units shall be rated in accordance with Canadian Standards Association (CSA), ANSI Z 83.8 and CSA 2.6 for commercial / industrial installation.
.2 Unit shall bear CSA label.
.3 Motors: refer to Section 15010.
.4 Terminal heat transfer units shall be product of manufacturer regularly engaged in production of such units who issues complete catalogue data on such products.

1.4 Warranty

.1 The unit heater shall have a warranty of 12 (twelve) months from the date of installation.

1.5 Submittals

.1 Shop Drawings: Submit Shop Drawings for all products specified in this Section.
.2 Include certified power and control wiring schematics with each Shop Drawing.
.3 Start-up and Commissioning Data: Submit start-up and commissioning data in accordance with requirements of Section 15020.

2. PRODUCTS

2.1 General

.1 Factory apply baked primer coat on metal surfaces of enclosure or cabinet of all unit heaters unless otherwise stated.

2.2 Electric Unit Heaters

.1 Casing: 1.2 mm steel with threaded connections for hanger rods, with electrostatically applied powder coat prime finish.
TERMINAL HEAT TRANSFER UNITS

.2 Element: Durable stainless steel heating elements. Elements shall be arranged concentrically.

.3 Fan: Direct drive propeller type with aluminium blade, statically and dynamically balanced. Motor mounted in cold compartment. Fan delay for residual heat purge.

.4 Air Outlet: Adjustable louvered diffuser, factory mounted.

.5 Controls: Line voltage thermostat.

.6 Standard of acceptance: Reznor EGHB

2.3 Electric Baseboard Heater

.1 20-22 gauge steel body with steel tubular heating element with aluminium fin. Panels shall have mounting holes for ease of installation. Factory baked enamel finish, colour white.

.2 Provide plugs and manual radiator air-vent for unused connections.

.3 Standard of acceptance: Reznor EBHB

3. EXECUTION

3.1 General Installation Requirements

.1 The installation should follow in accordance with CSA B149

.2 Provide each unit at high points with easily accessible manual air vent. If not easily accessible, extend vent to exterior surface of cabinet for each servicing.

.3 Pipe and wire per Manufacturer’s instructions and all applicable codes.

.4 Coordinate all required control wiring and power wiring required for a complete installation.

.5 Manufacturer’s technical/service representative shall provide commissioning of the system.

.6 Install all equipment in complete accordance with Manufacturer’s printed instruction.

END OF SECTION
UNITARY AIR CONDITIONING EQUIPMENT

1. GENERAL

1.1 Scope

.1 Provide one complete split type direct expansion (DX) air conditioning systems including indoor unit, outdoor unit, refrigerant piping, insulation and controls in Glenmore Pump Station electrical room.

.2 Provide one complete outdoor package air conditioning systems that includes compressor, condenser, evaporator, refrigerant circuits, insulation and controls in Eldorado Pump Station electrical room.

.3 Coordinate all electrical requirements including confirmation of voltage requirements for all equipment.

1.2 Related Work Specified in Other Sections

.1 Section 15010 - General Mechanical Provisions.

.2 Section 15200 - Piping Insulation.

1.3 Quality

.1 Units shall be rated in accordance with Air Conditioning, Heating and Refrigeration Institute (AHRI) Standard 210 and bear AHRI certification label.

.2 Unit shall bear CSA label.

1.4 Warranty

.1 The compressor shall have a warranty of seven (7) years from the date of installation.

1.5 Submittals

.1 Shop Drawings: Submit Shop Drawings for all products specified in this Section.

.2 Include certified power and control wiring schematics with each Shop Drawing.

.3 Test Data: Submit pipe leakage and flow test sheets, and other test data as per requirements of Section 15030.

.4 Start-up and Commissioning Data: Submit start-up and commissioning data in accordance with requirements of Section 15020.

2. PRODUCTS

2.1 General

2.2 Glenmore Pump Station's electrical room is serviced by an air cooled condenser split system as per the equipment schedule and drawings. The system shall consist of indoor ceiling mounted
UNITARY AIR CONDITIONING EQUIPMENT

evaporator unit, refrigerant pipework, a remote air cooled condensing unit and a wall mounting electronic zone controller.

2.3 Equipment

.1 Outdoor unit shall be supported under culvert roof.

.2 Indoor Unit:

.1 Heavy gauge steel construction with integral inlet and discharge grille, with automatic oscillating vanes

.2 Cabinet with 25 mm neoprene coated insulation.

.3 3-Speed fan. Forward curved centrifugal fans constructed of galvanized steel. Fan noise levels not to exceed 45 db(A) @ 1 m when operating at high speed.

.4 A built-in condensate pan and drain.

.5 Condensate discharge to nearest convenient drain.

.6 A factory pressure tested evaporator coil with copper tubes and aluminum fins.

.3 Outdoor Unit (Condensing Unit):

.1 Remote unit of vertical draw - vertical or horizontal discharge design using R410A refrigerant.

.2 A minimum 0.6 mm thick zinc coated alloy steel casing with an electrostatically applied enamel finish coat, removable top and front panels, and grille type guards for the condenser coil and condenser fan.

.3 A load matching variable speed inverter controlled compressor.

.4 Compressors shall be fully hermetic scroll type, complete with crankcase heaters, motor protection and an internal pressure relief valve.

.5 A condensing coil with copper tubing and aluminum fins.

.6 Control shall include compressor condenser fan motor contactors, control circuit transformer, ambient compressor lock-out, fuse, manual reset, high-low pressure controls, over current protection.

.7 Capability to operate with up to 50 m of refrigerant line

.8 Capability to operate at -18°C without no degradation of system performance

.4 Controls – The system will be provided complete with a microprocessor based control system. The system shall be complete with:

.1 An indoor, wall mounted controller that will:
UNITARY AIR CONDITIONING EQUIPMENT

.1 Provide space temperature and setpoint
.2 Scheduling
.3 Have a large LCD display
.4 Manual override for, on/off, fan speed, vane position and air sweep louvers
.5 Provide access to diagnostics and condenser status
.6 Temperature set point adjustment, remote monitoring and fault indication

2.4 Outdoor Package Cooling Unit

.1 Eldorado Pump house electrical room is serviced by package air conditioning unit as per the equipment schedule and drawings. The system shall consist of evaporator, compressor, condenser, refrigerant circuit, and a wall mounting electronic zone controller.

.2 The unit shall be weatherproof and equipped for outdoor installation, for the prevention of rain and snow into the unit.

.3 The package unit shall be ELT approved and operate down to -20 degree C as standard.

2.4.1 Quality

.1 It is the intent of this Specification that the Manufacturer provides package cooling unit designed and manufactured specifically to the requirements of this project. Overall dimensions and configuration are to be as shown on the plans and as described in the specifications. Take responsibility for the engineering and operational integrity of the unit.

.2 Provide unit produced by a recognized Manufacturer who maintains a local service agency and parts stock.

.3 Air flow rate, external static pressure, filter face velocity, air side pressure drop shall be the same or better than specified for alternate selections.

.4 Fans shall be AMCA certified.

.5 Provide all motors with thermal overload protection, disconnect switch. All motors shall be TEFC, high efficiency type.

.6 Start-up of unit shall be executed by Manufacturer's personnel. A complete Manufacturer's check list of field start-up tests must be submitted with operations and maintenance instructions and shall be signed by start-up technician and mechanical trade, field supervisor as certified satisfactory for operation.

.7 Pre-wired package air conditioning unit shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the
UNITARY AIR CONDITIONING EQUIPMENT

Canadian Electrical Code. Unit shall be tested to CSA Standard C746-98 and must bear an EEV (energy efficiency verification) label provided by CSA.

2.4.2 Submittals

.1 Submit Shop Drawing which shall include the following minimum information. Shop Drawings submitted without this information shall be automatically rejected.

.1 Construction details: Submit unit construction drawings for the following components:

.1 Side panels, including connection details.
.2 Top panel, including connection details.
.3 Floor, including connection details.
.4 Doors, hinges, latch.
.5 Fan, motor and drive, mounting and isolation.
.6 Cooling section.
.7 Pipe and conduit penetration through casing or floor.
.8 Drain pan.

.2 Materials of Construction: Indicate material and gauge of all construction components.

.3 Fan Performance Data: Submit fan performance curves as well as performance tables.

.4 Cooling Section: Submit a drawing showing refrigerant evaporator coil, circuiting arrangement, connection sizes, and materials of construction.

.5 Air Filters: Media, efficiency rating, velocity, pressure drop charts and capacities. Indicate mounting method and arrangement.

.6 Vibration isolator Shop Drawings.

.7 Table indicating pressure drops through all components of the unit.

.8 Detailed composite wiring diagrams showing factory installed wiring, including wiring of the control components.

.9 Sound Levels: Submit sound power levels generated by the unit at the inlet and outlet of the unit and outside the fan section. List for individual octave bands in dB referenced to A rating.

2.5 Components

.1 Package cooling unit shall consist of, but not be limited to, some or all of the following components:
UNITARY AIR CONDITIONING EQUIPMENT

.1 Cabinet
   .1 Minimum 1.3 mm galvanized steel. Exterior finish coat shall be an electrostatically applied enamel, to all exposed surfaces.
   .2 Insulate evaporator compartment with 12 mm thick, 2 lb density, neoprene faced, fibreglass insulation.
   .3 Internal structure parts including base are hot dipped galvanized steel.

.2 Evaporator Blower
   .1 Evaporator fan to be direct drive centrifugal type with double width double inlet.
   .2 Motor, fan bearings and drive assembly shall be located inside the fan plenum.

.3 Coils
   .1 A condensing coil and an evaporator coil with copper tubing and aluminum fins.
   .2 A coated, galvanized, steel condensate drain pan is included.
   .2 Solenoid valves, an externally equalized expansion valve and a high pressure switch.
   .3 The refrigerant circuit includes a liquid line filter drier and a high pressure switch. Unit supplied with R-407 C refrigerant.

.4 Filters
   .1 Filter shall be 2” pleated disposable filter with non-woven cotton fabric media with a metal support grid and heavy duty cardboard enclosing frame. Filters shall be minimum Merv 7.
   .4 Slide removal filters shall slide into a formed metal track, sealing against metal spacers at each end of the track.
   .5 Limit filter velocity based on face area to less than 2.5 m/s.
   .6 The filter shall be Class II listed by UL.
   .7 Provide one Dwyer 2000 magnehelic filter gauge for each bank of filters, complete with static pressure tips and aluminum tubing. Flush mount gauge on the exterior of the unit.

.5 Compressor
   .1 Scroll compressors shall also incorporate a suction gas cooled motor, integral centrifugal oil pump, vibration isolating mountings and internal overloads.
   .2 Controls for hermetic compressor units shall include compressor and condenser fan motor contactors, supply fan contactors and overload protection, control circuit transformer, cooling relays, ambient compressor lockout, automatic reset low pressure controls, and manual reset high pressure controls on compressors over 6 tons. Head
UNITARY AIR CONDITIONING EQUIPMENT

pressure actuated fan cycling control shall be provided on all multiple condenser fan units.

Compressors shall be located on the right side of the unit in a service enclosure complete with hinged access doors c/w leverlok handles for ease of service. Enclosure shall include 2” (50mm) 24 kg/m³, insulation.

G Controller

.1 The controller shall include an adjustable low limit set point for freeze protection to cease equipment operation in the event of low discharge temperature. If the discharge air temperature falls below the adjusted set point, the blowers will shut down.

.2 The cooling function shall be modulating discharge air complete with sensor.

.4 The electronic temperature control system shall provide up to 3 stages of mechanical cooling control to maintain room temperature. The minimum run and off time for the compressors shall be variable based on load requirements.

.5 The controller shall have indication and troubleshooting LED lights, multi-meter set point and sensor temperature test points, and a common alarm contact in the event of equipment failure.

.6 Provide a system of motor control, including all necessary terminal blocks, motor contactors, motor overload protection, grounding lugs, control transformers, auxiliary contactors and terminals for the connection of external control devices or relays.

.7 Install and wire non-fused disconnect switch in CEMA/NEMA 3 weatherproof configuration.

.8 Automatic controls shall be housed in a control panel mounted in air conditioning unit, which will meet that standard of the specific installation.

.9 Provide remote mounted control panel for the purpose of switching and visual indication of operations. Each panel to include the following items:

___ Engraved lamicoid faceplate
___ System ON-OFF switch
___ System ON light
___ Cooling ON light
___ Clogged pre-filter light with unit mounted filter air pressure switch

2.6 Electrical Requirements

.1 Outdoor unit:

.1 Refer to HVAC layout drawing
UNITARY AIR CONDITIONING EQUIPMENT

.2 Indoor unit:
   .1 Refer to HVAC layout drawing

3. EXECUTION

3.1 General Installation Requirements

   .1 All refrigeration piping must be separately insulated.

   .2 Route all refrigeration piping to comply with the equipment manufacturer’s maximum length guidelines.

   .3 Pipe and wire per Manufacturer’s instructions and all applicable codes.

   .4 All condensate discharges are to be piped to the nearest suitable drain.

   .5 Coordinate all required control wiring and power wiring required for a complete installation.

   .6 Manufacturer’s technical/service representative shall provide commissioning of the system.

END OF SECTION
1. **GENERAL**

1.1 **Scope**

.1 Direct drive centrifugal inline fan- Ceiling Exhaust

.2 Direct drive centrifugal inline fan- Sidewall Exhaust

.3 Fan accessories

1.2 **Quality Assurance**

.1 Conform to AMCA Bulletins regarding construction and testing. Fans shall bear AMCA certified rating seal.

.2 Fans shall bear CSA label.

.3 Motors: refer to Section 15010.

1.3 **Submittals**

.1 Submit with Shop Drawings acoustical data and fan curves showing fan performance with fan and system operating point plotted on curves, including equipment weights and centre of gravity diagrams for suspended fans.

1.4 **Job Conditions**

.1 Do not operate fans for any purpose, temporary or permanent until ductwork is clean, filters are in place, bearings are lubricated and fan has been run under close supervision of unit manufacturer.

1.5 **Alternates**

.1 Equivalent fan selections shall not increase motor kilowatts, increase rpm, increase noise level, increase tip speed by more than 10%, or increase inlet air velocity by more than 20%, from that of the specified fan.

2. **PRODUCTS**

2.1 **General**

.1 Statically and dynamically balance fan so no objectionable vibration or noise is transmitted to occupied areas of the building.

.2 Provide balanced variable sheaves for motors 11 kW and under and fixed sheave for 15 kW and over.

.3 Fans are to be capable of accommodating static pressure variations of ±10% with no objectionable operating characteristics.
.4 External static pressure means external to the fan cabinet and all accessories such as backdraft dampers, mixing boxes, filters and coils, etc. These accessories if supplied as part of the unit are considered as internal losses for fan.

2.2 Direct Drive Centrifugal Inline Fan- Ceiling Exhaust

.1 The fan housing is constructed of heavy gauge galvanized steel and shall include inlet guard.

.2 Constructed of aluminum, non-overloading, backward inclined centrifugal wheel

.3 Statically and dynamically balanced in accordance to AMCA Standard 204-05

.4 Motor enclosures shall be totally enclosed fan cooled

.5 Motor is to be DC electronic commutation type.

.6 Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.

.7 Housing and bearing supports should prevent vibration and rigidly support the shaft and bearing assembly.

.9 Motorized damper for minimal resistance of flow

.10 Standard of acceptance: Greenheck SQ series.

2.3 Direct Drive Centrifugal Inline Fan- Sidewall Exhaust

.1 The fan housing is constructed of heavy gauge galvanized steel and shall include square duct mounting collars.

.2 Constructed of aluminum, non-overloading, backward inclined centrifugal wheel

.3 Statically and dynamically balanced in accordance to AMCA Standard 204-05

.4 Motor enclosures shall be totally enclosed fan cooled

.6 Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.

.7 Speed control feature.

.8 Housing and bearing supports should prevent vibration and rigidly support the shaft and bearing assembly.

.9 Motorized damper for minimal resistance of flow.

.10 Standard of acceptance: Loren Cook SQN-B.
3. EXECUTION

3.1 Installation

.1 Where inlet or outlet is exposed, provide safety screen.

.2 Install fan in accordance with manufacturer’s instructions.

3.2 Performance

.1 Refer to HVAC layout drawing

END OF SECTION
1. **GENERAL**

1.1 **Scope**

.1 Louvers

.2 Dampers

1.2 **Quality Assurance**

.1 Air flow tests and sound level measurement shall be made in accordance with applicable ADC equipment test codes, ASHRAE Standards and AMCA Standards.

.2 Unit rating shall be approved by ADC and AMCA.

.3 Manufacturer shall certify catalogued performance and ensure correct application of air outlet types.

.4 Outside louvres shall bear AMCA seal for free area and water penetration.

1.3 **Project Conditions**

.1 Review requirements of outlets as to size, finish and type of mounting prior to submitting Shop Drawings and schedules of outlets.

.2 Positions indicated are approximate only. Check locations of outlets and make necessary adjustments in position to conform with Architectural features, symmetry and lighting arrangement.

1.4 **Submittals**

.1 Submit Shop Drawings with complete catalogue information, materials of construction, dimensions and accessories for all air outlets, louvres and components in this Specification Section, and as scheduled.

.2 Submit colour selection charts of finishes for approval prior to fabrication.

2. **PRODUCTS**

2.1 **General**

.1 Base air outlet application on space noise level of NC 30 maximum.

.2 Provide supply outlets with sponge rubber seal around the edge.

2.2 **Louvres**

.1 Type A (L-1)

.1 Louvers shall be constructed entirely of extruded aluminum, alloy 6063-T5. Blades and frames shall be minimum 2.06 mm wall thickness. Louver assemblies shall be
AIR OUTLETS

152.4 mm deep with 35-degree stationary drainable blades. Louver performance shall be based on tests and procedures in accordance with AMCA publication 511 and comply with the requirements of the AMCA Certified Rating Program. Louvers shall be designed to withstand a 100 mph wind equivalent wind load. Each louver shall be fitted with 12.7 mm mesh x 1.60 mm diameter aluminum bird screen. Bird screen shall be expanded aluminum construction and suitable for interior mounting. Louvers shall be supplied with a standard mill finish. Louvers shall receive a Class 1 (colour) anodize finish complying with AAMA 611-98. Finish is applied to chemically etched and pretreated aluminum to a minimum thickness of 0.7 - 1.0 mil. Confirm colour prior to ordering. Standard of acceptance: EH Price DE635, size as indicated on the drawings.

.2 Acoustic louvers shall be constructed of aluminum blades, perforated aluminum liner. Media shall be shot-free inorganic glass fiber with long, resilient fibers, bonded with thermosetting resin. Glass fiber shall be packed with a minimum 10% compression to eliminate voids and setting. Combustion ratings shall be equal to or less than the combustion ratings noted below when tested in accordance with ASTM E84, UL 723 and NFPA255; Flame spread Classification <25; Smoke Development Rating< 50.

Transmission loss performance in accordance with ASTM E90 and Air performance and water penetration ratings shall be certified by AMCA 500. Standard of acceptance: EH Price QA645, size as indicated on the drawings.

2.3 Motorized Damper

.1 Type B (MD)

As specified in the drawings

3. EXECUTION

3.1 Priming

.1 Paint ductwork visible behind air outlets matte black.

3.2 Sizing

.1 Size air outlets as indicated on HVAC layout drawing

END OF SECTION
1. **GENERAL**

1.1 **Scope**

.1 Complete and fully operational system of automatic controls, including Control devices, components, wiring and all materials and labour.

.2 Submissions of technical system data.

.3 Demonstration of proposed installed controls system to the Owner.

1.2 **Work by Other Trades**

.1 **Division 16** shall provide 600V power for Controls Panels, SCU’s and Central Computer Equipment.

.2 **Division 15** shall install thermal wells, control valves and devices on piping, furnished by the HVAC controls contractor.

.3 All control dampers are supplied by HVAC controls contractor.

1.3 **Abbreviations**

.1 SCU Standalone Control Unit

1.4 **Quality Assurance**

.1 Install all components in accordance with the latest regulations of the Canadian Electrical Code, applicable Municipal and Provincial Codes and Regulations, and latest CSA Electrical Bulletins.

.2 The equipment manufacturer shall have trained service representatives resident in the Province where project is located.

.3 The following components shall be stocked locally:

   .1 Replacement SCU and internal components

   .2 Replacement Sensors and Actuators

1.5 **Submittals**

.1 Submit Shop Drawings in accordance with Section 15010.

.2 Provide Shop Drawings including complete operating data, system drawings, wiring diagrams and written detailed operational description of sequences and engineering data on each control system component. Include sizing and arrangements as requested.

.3 Submit approved Shop Drawings for inclusion in operating and maintenance manuals.
1.6 Owner Orientation

.1 Contractor to provide three (3) weeks written notice to the Consultant and Building Owner prior to commencing formal training sessions.

.2 Formal training sessions shall commence only after "As-built" Drawings have been completed, reviewed and approved by the Consultant and shall be in addition to Section 15010 requirements.

.3 Provide for operator training according to the following schedule.

.1 A seminar/workshop covering all aspects of system use as follows:

.1 Operation of hardware components

.2 System software configuration

.3 User/system interaction

.4 Calibration of sensors and system

.5 Trouble shooting of system and components

.6 Preventative maintenance

.2 Coordinate above seminars/workshops to occur during peak cooling and heating season as well as during one shoulder season.

1.7 Warranty

.1 The warranty provisions shall commence for one year from the date of final acceptance and shall include at no cost all material and labour required to correct control system equipment failures that occur during the one year period.

.2 The Contractor shall supply and install at no cost all system software and hardware updates and upgrades occurring prior to the expiration of the warranty period.

1.8 System Activation

.1 Submit control calibration check sheet prior to system acceptance. Check sheets to include unit identification, controller/transmitter tag numbers, device controlled, controller PID settings, interlock devices and wire tag numbers.

.2 Set damper linkages, static pressure/volume controls as required by the Balancing Trade.

.3 Adjust and calibrate all room thermostats thirty (30) days prior to system acceptance.
1.9 Acceptance Testing

.1 A final operational acceptance test of seven (7) consecutive days shall be conducted on the complete and total installed and operational control system to demonstrate that it is functioning properly in accordance with the Specifications.

.2 The correct operation of all monitored and controlled points shall be demonstrated as well as the operation and capabilities of all sequences, reports, specialized control programs and algorithms, diagnostics and all other software.

.3 In the event of the failure of function, during the test, of any of the hardware components or software application or routines, the test will recommence and run until seven (7) failure-free test days have occurred.

.4 After successful completion of the acceptance test, the Consultant will issue written acceptance of the control system.

.5 Prior to acceptance of the work, submit hard copy and electronic copy on CD of final data base listings.

1.10 Costs

.1 All costs incurred in testing the controls system, including Owner and Consultant demonstration cost shall be included for under this Contract. No additional charges will be entertained by the Owner.

1.11 Delivery and Storage

.1 Products shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants, within the storage condition limits published by the equipment manufacturer. Dampers shall be stored so that seal integrity, blade alignment and frame alignment are maintained.

1.12 Operation Manual

.1 A control system operation manual shall include the control system sequence of operation, and procedures for the system start-up, operation and shut-down. The operation manual shall include as-built control system detail drawings. The operation manual shall include the as-built configuration checksheets, the procedures for changing control system setpoints, and the procedures for placing system controllers in the manual control mode.

.1 The procedures for changing control system setpoints shall describe the step-by-step procedures required to change the process variable setpoints, the alarm setpoints, the bias settings, and setpoint reset schedules.

.2 The procedures for placing system controllers in the manual control mode shall describe step-by-step procedures required to obtain manual control of each controlled device and to manually adjust their positions.
2. PRODUCTS

2.1 Approved Contractors and/or Suppliers

.1 Refer to Section 15010.

2.2 General Equipment Requirements

.1 Units of the same type of equipment shall be products of a single manufacturer. Each major component of equipment shall have the manufacturer's name and address, and the model and serial number in a conspicuous place. Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in a satisfactory commercial or industrial use for two (2) years prior to use on this project. The two (2) years' use shall include applications of equipment and materials under similar circumstances and of similar size. The two (2) years' experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a two (2) year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6,000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization. Items of the same type and purpose shall be identical, including equipment, assemblies, parts and components. Automatic temperature controls shall be direct digital controls that will provide the required sequence of operation.

.2 Electrical and Electronic Devices

.1 Electrical, electronic, and electro pneumatic devices shall have a NEMA ICS 1 enclosure in accordance with NEMA 250.

.3 Standard Signals

.1 Except for air distribution terminal unit control equipment, the output of all analog transmitters and the analog input and output of all controllers shall be 4 to 20 mAdc signals. The signal shall originate from current-sourcing devices.

.4 Ambient Temperature Limits

.1 Devices installed outdoors shall operate within limit ratings of -40 to 66°C. Instrumentation and control elements shall be rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location.

2.3 Control Panels

.1 Mount control panels on vibration free wall or free standing angle iron supports. Provide engraved plastic nameplates for instruments and controls inside cabinet and on cabinet face.

.2 Provide pans and rails for mounting terminal blocks, relays, wiring and other necessary devices.
.3 Provide an individual switch for disconnection and a fuse for isolation of all panel mounted instruments requiring a 120 VAC supply.

.4 Make all wiring connections in the shop from the equipment mounted on the panel to numbered terminal blocks conveniently located in the panel, including the power supply for all instruments.

.5 Identify all wiring by means of stamped markings on heat shrinkable tubing. Install all wiring neatly and laced or bunched into cable form using plastic wire clips, where practical, contained in plastic wiring channels with covers. Maximum twenty-five (25) conductors to each wire bundle.

2.4 Wire

.1 Standards for wiring and standards of installation for wiring shall be as Division 16.

.2 Control wiring for digital functions shall be 18 AWG minimum with 300 V insulation.

.3 Control wiring for analog functions shall be 18 AWG minimum with 300 V insulation, twisted and shielded, 2 or 3 wire to match analog function hardware.

.4 Sensor wiring shall be 18 AWG minimum twisted and shielded, 2 or 3 wire to match analog function hardware or 16 AWG as required by code.

.5 Transformer current wiring shall be 16 AWG minimum.

2.5 Power-Line Surge Protection

.1 Equipment connected to ac circuits shall be protected from power-line surges. Equipment protection shall meet the requirements of IEEE C62.41. Fuses shall not be used for surge protection.

2.6 Surge Protection for Transmitter and Control Wiring

.1 Control-panel equipment shall be protected against surges induced on control and transmitter wiring installed outside. The equipment protection shall be tested in the normal mode and in the common mode, using the following two waveforms:

.1 A 10-microsecond by 1,000-microsecond waveform with a peak voltage of 1,500 V and a peak current of 60 amperes

.2 An eight microsecond by 20-microsecond waveform with a peak voltage of 1,000 V and a peak current of 500 amperes

2.7 Conduits and Cables

.1 All wiring shall be in conduit or trays. Conform to Division 16 requirements for conduit and tray specifications.

.2 Seal conduit where such conduit leaves heated areas and enters unheated area.
HVAC CONTROLS GENERAL PROVISIONS

.3 Run low level signal lines in separate conduit from high level signal and power transmission lines.

.4 Identify each cable and wire at every termination point.

.5 Where applicable, mount field interface equipment (i.e. relays, transducers, etc.) in local device cabinets adjacent to field interface panels.

.6 Colour code all conductors and conduits by permanently applied colour bands on maximum 10 m intervals. Colour code shall follow base building schedule.

2.8 Related Accessories

.1 Provide and install all necessary transformers, transducers, interposing relays, interface devices, contractors, starters and EP's to perform control functions required.

.2 It is the responsibility of the Contractor to identify, at the time of tender submission, all additional items not specified that are required to meet the operational intent specified.

.3 Items required but not identified at the time of tender acceptance shall be the Contractor's responsibility.

2.9 Electronic Room Temperature Sensor

.1 The sensor may be either RTD or thermistor type providing the following minimum performance requirements are met:

.1 Accuracy: ±0.5°C

.2 Operating Range: 2°C to 46°C

.3 Setpoint Adjustment Range: 2°C to 30°C

.4 Setpoint Modes: Heating, Cooling, Night Setback

.5 Calibration Adjustments: None required

.2 Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points in the system.

2.10 Differential Pressure Sensors

.1 The sensor shall be of the diaphragm type with 4-20ma DC output

.1 Accuracy ±0.5% or better

.2 Operating Range 0 to 500 Pa
HVAC CONTROLS GENERAL PROVISIONS

2.11 Dampers

.1 Extruded aluminum (6063T5) damper frame shall not be less than 2.03 mm in thickness. Damper frame to be 100 mm deep and shall be insulated with polystyrofoam on four sides. Entire frame shall be thermally broken by means of polyurethane resin pockets, complete with thermal cuts. Blades to be extruded aluminum (6063T5) profiles, internally insulated with expanded polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29 and a temperature index of 55. Blade and frame seals shall be of extruded silicone and be secured in an integral slot within the aluminum extrusions. Bearings are to be composed of a Celcon inner bearing fixed to 11 mm aluminum hexagon blade pin, rotating within a polycarbonate outer bearing inserted in the frame, resulting in no metal-to-metal or metal-to-plastic contact. Linkage hardware shall be installed in the frame side and constructed of aluminum and corrosion-resistant, zinc-plated steel, complete with cup-point trunnion screws for a slip-proof grip. Dampers are to be designed for operation in temperatures ranging between -40°C and 85°C. Dampers shall be available with either opposed blade action or parallel blade action.

.2 Each end switch shall be a hermetically sealed switch with a trip lever and over-travel mechanism. The switch enclosure shall permit setting the position of the trip lever that actuates the switch. The trip lever shall be aligned with the damper blade.

.3 Damper leakage shall be certified under the AMCA certified rating program and shall carry AMCA seal:

.1 Low Leakage: 8.6 L/s/m² at 250 Pa pressure difference for a 1220 mm x 1220 mm damper.

.2 Standard of Acceptance: refer to Section 15010.

2.12 Damper Operators

.1 Electronic Non-Modulating Damper Operators

.1 Spring return, 24 VAC operating voltage, on-off operation, 70 seconds maximum running time for 90° opening and 30 seconds maximum closing time.

.2 Provide sufficient damper motors to achieve unrestricted movement, with a minimum of one (1) damper operator per damper section.

.2 Electronic Modulating Damper Operators

.1 Spring return, 24 VAC operating voltage, 0-10 VDC input signal, 0-10 VDC position output signal, 70 seconds maximum running time for 90° opening and 30 seconds maximum closing time.

.2 Provide sufficient damper motors to achieve unrestricted movement, with a minimum of one (1) damper operator per damper section.
3. EXECUTION

3.1 Installation

.1 Verify location of thermostats and other exposed control sensors with drawings before installation. Locate thermostats 1500 mm above floor.

.2 Install all safety limits at the operator’s level.

END OF SECTION
CONTROL SEQUENCES

1. GENERAL

.1 The control sequences contain a general description of the intent of the operation of the systems to be controlled. The Contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.

.2 All set points and times of operation given in the control sequences are indicative. Final set points shall be dictated by site conditions.

.3 The relationships between the points, systems and building are described in the control sequences.

.4 Supply and install all control, wiring, and ancillaries required to provide the functionality described within this Section.

.5 Provide all materials and labour to complete and make all systems operational to the requirements listed in codes, regulations, industry standards and local by-laws.

.6 All materials to be new and fully warranted for one (1) year unless stated otherwise.

.7 Perform all work in co-ordination with all other trades and contractors on the owners property.

.8 Use skilled and licensed labourers and journeyman to perform all work.

2. PRODUCTS

.1 Not Applicable

3. EXECUTION

.1 Provide data base for all hardware points listed for system operation to meet Specification operating sequences.

4. DESIGN CONDITIONS:

.1 Kelowna, British Columbia

<table>
<thead>
<tr>
<th></th>
<th>Winter (99.6%)</th>
<th>-18 °C (-0.94 °F)</th>
<th>Dry Bulb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outdoor ambient</td>
<td>Summer (0.4%)</td>
<td>32.7 °C (90.86 °F)</td>
<td>Dry Bulb</td>
</tr>
</tbody>
</table>

.2 Indoor Design Conditions

- Heating: 10°C (50°F)
- Cooling: Electrical Room: 25°C (77°F)
  - Pump Room: Free Cooling to maintain 35°C (95°F)

.3 Ventilation based on NBCC 2010 and ASHRAE 62.1-2010
5. CONTROL SEQUENCES

5.1 General

.1 Free cooling shall be provided in the Pump room using louver and exhaust fans.

.2 Mechanical cooling shall be provided in the Electrical Room using air conditioner.

.3 All controls are local and without a building automation system.

.4 Programmable thermostats and controllers are required to achieve the sequences of operations.

5.2 PUMP ROOM

1. Room thermostat monitors the ambient space temperature.
   1.1 Initial setting is 10°C for heating and 25°C for cooling.

2. Exhaust fan, unit heaters are OFF.

3. Temperature decreases to 1.5°C below heating set point
   3.1 Unit heaters signalled on.

4. Temperature increases to 1.5°C above heating set point
   4.1 Unit heaters signalled off.

5. Temperature increases to 1.5°C above cooling set point
   5.1 L-1 opens and Exhaust fan starts.

5.3 ELECTRICAL ROOM

1. Room thermostat monitors the ambient space temperature.
   1.1 Initial setting is 10°C for heating and 25°C for cooling.

2. Unit heater is OFF.

3. Temperature decreases to 1.5°C below heating set point
   3.1 Unit heater signalled on.

4. Temperature increases to 1.5°C above heating set point
   4.1 Unit heater signalled off.

5. Temperature increases to 1.5°C above cooling set point
   5.1 AC is ON.

END OF SECTION
1. GENERAL

1.1 General

.1 The work to be performed under this Contract shall include the labour, equipment, and materials required to complete the electrical installation for all works related to the McKinley Reservoir UV equipment upgrade in Kelowna, British Columbia, as specified in the Contract Documents.

.2 The contractor shall take full responsibility for and shall coordinate the work of Division 16 and Division 17 to guarantee a complete and finished installation of the electrical and instrumentation & control systems. The Division 16 drawings and specifications are to be read together with drawings and specifications of all other Divisions and specifically Divisions 11, 15 and 17. Additional information necessary to complete the work is included in other sections of the drawings and specifications.

.3 This section covers items related to Division 16 and supplements the requirements for other Divisions.

.4 All tables shown on the Division 16 drawings and specifications are for information purposes only and may show partial lists of equipment and materials. A complete takeoff for all drawings and specifications shall be done by the Contractor in order to determine accurate quantities of equipment and materials.

.5 Definitions:

   .1 SUPPLY – Shall mean that so noted equipment is to be purchased, assembled and shipped undamaged to the site. Where an item is supplied by the owner, by others, or by another division, the work of mounting, connecting and commissioning the item shall be included in the contract unless specifically otherwise noted.

   .2 PROVIDE – Shall be mean that the so noted equipment is to be supplied, installed, connected, adjusted, calibrated, tuned, cleaned, commissioned and placed into full service. The contractor shall provide all required work and materials and to terminate all required conductors and wires.

   .3 INSTALL – Shall be mean to put the specified item into full operation, securely fastened and connected to the system. The contractor shall provide all work and material which is necessary to securely fasten and give a presentable finished appearance including all necessary connections and conductors. Such noted equipment must be fully calibrated and tested.

   .4 APPROVED – Shall mean that the so noted equipment is to be officially accepted by the Engineer prior ordering, fabrication and installation.
.5 **COORDINATE** – Shall mean to make all arrangements directly with agencies, individuals and other trades, confirm schedules, be in attendance at the time work is carried out, take full responsibility for having the work carried out correct and in timely manner to meet the construction schedule.

.6 **FIELD WIRING** – Shall mean all labour and material necessary to connect all devices and equipment regardless of voltage and current other than digital and analog PLC inputs and outputs, and 24V power supply wiring for all instruments and local control panels and shall also include all interconnecting cables between portions of the system.

.7 **POWER WIRING** – Shall mean all labour and material necessary to connect all devices and equipment regardless of voltage and current other than 24V to provide power supply to equipment and local control panels and shall also include all interconnecting cables between portions of the system.

.8 **OWNER** shall mean the City of Kelowna or its appointed representative.

.9 **ENGINEER** shall mean AECOM or its appointed representative.

1.2 Codes and Standards

.1 Comply with all rules of the Canadian Electrical Code, CSA Standard C22.1 and the applicable building codes. Do Underground Systems in accordance with CAN/CSA-C22.3 No. 7 except where specified otherwise.

.2 The design of electrical and instrumentation systems shall conform to the latest edition, including all supplements and addenda of the following codes and standards:

- **ANSI** American National Standards Institute
- **ASTM** American Society for Testing Materials
- **ABC** Alberta Building Code
- **CEC** Canadian Electrical Code
- **CSA** Canadian Standards Association
- **EEMAC** Electrical and Electronic Manufacturers of Canada
- **ESA** Electrical Safety Act of British Columbia
- **FM** Factory Mutual Engineering Corp
- **IEEE** Institute of Electrical and Electronics Engineers
- **IEC** International Electrotechnical Commission
- **IES** Illuminating Engineering Society
- **IPCEA** Insulating Power Cable Engineers Association
- **ISA** International Society of Automation
- **NBC** National Building Code of Canada
- **NEMA** National Electrical Manufacturers Association
- **NETA** Maintenance Testing Specifications
- **NFPA** National Fire Protection Association
GENERAL ELECTRICAL PROVISIONS

SAMA  Scientific Apparatus Makers Association
ULC   Underwriters Laboratories of Canada

.3 Quality of work specified and/or shown on the drawings shall not be reduced by the foregoing requirements.

.4 Give all required notices, submit drawings, obtain all permits, licenses and certificates and pay all fees required for this work.

.5 Furnish a Certificate of Final Inspection and approvals from inspection authority to the Engineer.

1.2 Work Included

.1 Work included is described in 16015

1.3 Related Work

.1 General Requirements: Division 01
.2 Site Work: Division 02
.3 Concrete: Division 03
.4 Equipment: Division 11
.5 Mechanical: Division 15
.6 Instrumentation and Controls: Division 17

1.4 Requirements of Work

.1 The Contractor shall be ultimately responsible and shall provide for the supply, installation, certification, adjustment, tuning and start-up and commissioning of a complete, coordinated system that shall reliably perform the intended functions.

.2 Supply, install, commission, and provide warranty for a complete and fully documented electrical system as specified herein. The electrical and control system may contain packaged equipment, component subsystems and appurtenances specified in this and other sections (Divisions 11, 15 and Division 17) of the specifications.

.3 The Work includes all equipment, hardware, software, labour and services necessary to provide fully functional, coordinated electrical system for the entire facility (new and existing systems modifications). Supply all items and accessories specified by the Contract Drawings or the specification in the quality and quantity
required. Perform all operations as designated by the specification according to the methods prescribed, complete with all necessary labour and incidentals.

.4 Where packaged, stand-alone control systems are supplied under other Divisions of this Contract, co-ordinate and ensure Submittal Drawings, Motor Control Schematics, and Control Wiring Drawings are provided in accordance with the requirements of this section and in accordance with the contract drawings.

.5 Where modifications are made to packaged systems, stand-alone control systems, or other contractor equipment supplied under other Divisions of this Contract, and the modifications are due to vendor or Contractor changes to the systems in question, the systems may be considered acceptable provided:

.1 The proposed system and/or its modifications satisfy the intent of the specifications, and

.2 The changes or modifications combined for all aspects of work by all trades do not result in a cost addition to the Contract.

.3 Approved by the Engineer

.6 Where packaged, stand-alone equipment with control systems are pre-purchased by owner or supplied by under other Divisions of this Contract, provide all necessary labour, material and cabling to install and connect the equipment and provide power supply including where required stand-alone 24VDC power supply. Ensure the correct functionality of any equipment supplied under other Divisions.

.7 The contract drawings for Division 16, detail the wiring requirements, cables, terminations, contained within packaged systems supplied under other Divisions of this Contract or pre-purchased. These drawings have been produced to accurately show the intent for the packaged system. If the packaged system provided differs from that shown on the drawings, or if modified terminations, cabling or interfaces are required to properly integrate the actual equipment to the process, electrical distribution, the Contractor is to provide cables, wiring, and terminations to satisfy the general intent as per the drawings, at no additional cost to the Contract.

.8 Documentation referred to includes as a minimum:

.1 Equipment descriptive data.

.2 Equipment installation, service manuals, operation and maintenance manuals, and recommended spare parts lists.

.3 Schematics and interconnecting wiring diagrams.
GENERAL ELECTRICAL PROVISIONS

.4 The recording of conductor identification, field terminals, changes, etc., on all electrical schematic drawings provided as part of this specification or by others as it relates to the equipment with this scope of supply.

.5 Instrumentation and control panel shop drawings, face layouts, schematics and point-to-point wiring diagrams.

.9 Codes, Rules, Permits, and Fees

.1 Comply with all laws, ordinances, rules, regulations, codes, standards and orders of all authorities having jurisdiction relating to this work.

.2 Comply with CSA Standards, Canadian Electrical Code, Canadian Underwriters' Laboratories and the applicable building codes.

.10 Compliance

.1 Failure to comply with the drawings and specifications shall be cause for rejection of the work and the contractor shall be required to make all required changes to comply with the drawings and specifications at no additional cost to the Owner or their agents and representatives.

.2 Where a conflict exists between any applicable code, regulation, directives, standard or manufacturers recommended practice for any item and what is shown on drawings or specified, seek clarification from the Engineer prior to submitting tender or allow for the most expensive alternative.

.11 Alternative Equipment

.1 The contractor is required to base the bid on the specified equipment. The price increase or decrease for the alternative equipment shall be shown separately. The engineer shall review alternative equipment after tender submissions and shall have a sole judgment of the acceptability of alternatives.

.12 Standards of Workmanship

.1 Execute all work in a manner that will result in the completed installation presenting an acceptable appearance, to a level of quality defined in the general conditions of this specification.

.2 Employ a competent supervisor and all necessary licensed tradesmen to complete the work in the required time.

.3 Arrange and install products to fit properly into designated building spaces.

.4 Ensure products are installed in accordance with the recommendations and ratings of the product manufacturers.
GENERAL ELECTRICAL PROVISIONS

.5 The Engineer reserves the right to require the dismissal from the site of workers deemed incompetent.

.6 In case of dispute, decisions as to the acceptability of the quality of work rest solely with the Engineer, whose decision is final.

.13 Contract Drawings and Specifications

.1 Refer to Division 1.

.2 Supply all items and accessories specified in the quality and quantity required. Perform all operations as designated by the specification according to the methods prescribed, complete with all necessary labour and incidentals.

.3 Provide all minor items and work that are reasonably necessary to complete the work.

.4 If discrepancies or omissions in the specifications are found, or if intent or meaning is not clear, consult the Engineer for clarification before submitting tender. If the clarification has not been requested, the contractor shall allow for the more expensive alternative.

.14 Errors and Omissions

.1 In the event of errors or discrepancies between the drawings and/or specifications, the contractor shall obtain a ruling before tenders are submitted.

.2 If a ruling has not been requested the contractor shall allow in the tendered price for more expensive alternative.

.15 Coordination with Other Divisions

.1 The General Contractor shall be responsible for coordinating all trades, such as instrumentation and controls, process mechanical, HVAC for the equipment which is installed under this Contract.

.2 The responsibility to determine which Division provides various products and work rests with the General Contractor. Additional compensation will not be considered because of differences in interpretation of specifications.

.3 Treat any item or subject omitted from this Division’s specifications, but which is mentioned or reasonably specified in other Divisions’ specifications or drawings and pertains to the instrumentation and control system, as being integral to the overall system. Provide such specified items or subjects.
.4 Lay out the Work and equipment with due regard to architectural, structural and mechanical features. Architectural and structural drawings take precedence over electrical drawings regarding locations of walls, doors and equipment.

.5 Examine and study the architectural, structural and mechanical drawings for items affecting the installation of the work under this specification and locate wireways, instruments, controlled equipment and control panels accordingly and in such way that required clearances can be maintained, and to avoid conflict with other installations.

.6 Do not cut structural members without prior written approval of the Structural Engineer.

.7 Examine previously constructed work and notify the Engineer of any conditions which prejudice the proper completion of this Work.

.8 The Contractor shall thoroughly check drawings and specifications of all other trades for conflict and coordination with the control and instrumentation trade. If any conflict is found, obtain a ruling from the Engineer before proceeding.

.16 Environmental Requirements

.1 Unless otherwise noted, all equipment wiring methods in the process area shall meet CSA (NEMA) 4X rating.

.2 Unless otherwise indicated, in control rooms or electrical rooms CSA (NEMA) 1A rating is acceptable.

1.5 Drawings and Specifications

.1 The General Conditions, Supplementary Conditions and Division 01 are a part of this specification and shall apply to this Division.

.2 The intent of the drawings and specifications is to include all labour, products and services necessary for complete work, tested and ready for operation.

.3 Symbols used to represent various electrical devices often occupy more space on the drawing than the actual device does when installed. In such instances, do not scale locations of devices from electrical symbols. Install these devices with primary regard for usage of wall space, convenience of operation and grouping of devices.

.4 These specifications and the drawings and specifications of all other divisions shall be considered as an integral part of the accompanying drawings. Any item or subject omitted from either the specifications or the drawings but which is mentioned or reasonably specified in and by the others, shall be considered as properly and sufficiently specified and shall be provided.
GENERAL ELECTRICAL PROVISIONS

.5 Provide all minor items and work not shown or specified but which are reasonably necessary to complete the Work.

.6 If discrepancies or omissions in the drawings or specifications are found, or if the intent or meaning is not clear, advise the Engineer for clarification before submitting tender.

.7 Responsibility to determine which Division provides various products and work rests with the Contractor. Additional compensation will not be considered because of differences in interpretation of specifications.

1.6 Quality Assurances

.1 Codes, Rules, Permits & Fees

.1 Comply with all laws, ordinances, rules, regulations, codes and orders of all authorities having jurisdiction relating to this work.

.2 Comply with all rules of the Canadian Electrical Code, CSA Standard C22.1 and the applicable building codes. Quality of work specified and/or shown on the drawings shall not be reduced by the foregoing requirements.

.3 Immediately after award of contract and prior to installation, verify location, arrangement and point of attachment for service and service entrance equipment with supply authority and inspection departments. Failure to do so will render this Division responsible for any corrections necessary without additional compensation.

.4 Give all required notices, submit drawings, obtain all permits, licenses and certificates and pay all fees required for this work.

.5 Furnish a Certificate of Final Inspection and approvals from inspection authority to the Engineer.

.2 Standard of Workmanship:

.1 Execute all work in a competent manner and to present an acceptable appearance when completed.

.2 Employ a competent supervisor and a sufficient number of licensed tradesmen to complete the Work in the required time.

.3 Arrange and install products to fit properly into designated building spaces.

.4 Unless otherwise specified or shown, install products in accordance with recommendations and ratings of manufacturers.
1.7 Submittals

.1 Within 20 days of award of Contract, the Contractor shall submit a completed equipment procurement schedule which lists the manufacturer and model of equipment, indicating the projected ordering, shop drawing submittal date and delivery dates of all products to meet the required construction schedule.

.2 Prior to delivery of any products to job site and sufficiently in advance of requirements to allow ample time for checking, submit shop drawings for review as specified in Division 01. Submit shop drawings for all equipment as required in each section of this specification.

.3 Prior to submitting the shop drawings to the Engineer, the Contractor shall review the shop drawings to determine that the equipment complies with the requirements of the specifications and drawings.

.4 The term “shop drawing” means drawings, diagrams, illustrations, schedules, performance characteristics, brochures and other data which are to be provided by the Contractor to illustrate details of a portion of the Work.

Indicate materials, methods of construction and attachment of support wiring, diagrams, connections, recommended installation details, explanatory notes and other information necessary for completion of Work. Where equipment is connected to other equipment, indicate that such items have been coordinated, regardless of the section under which the adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.

Adjustments made on shop drawings by the Engineer are not intended to change the contract price. If adjustments affect the value of the work state such in writing to the Engineer prior to proceeding with the Work.

.5 Manufacture of products shall conform to revised shop drawings.

.6 Keep one complete set of shop drawings at job site during construction.

.7 Shop drawings showing details of seismic restraint of electrical equipment and associated installations shall include the approximate weight of the item to be restrained. The shop drawings shall be sealed by a Professional Engineer registered in the Province of B.C. The Professional Engineer shall be responsible for reviewing the method of seismic restraint and attachment to the structure with the Engineer prior to installation. The Contractor shall submit seismic restraint calculations upon request for review by the Engineer.

.8 Shop drawings shall include but not be limited to:

.1 MCC (Engineered shop drawings) and Starters and VFD’s
GENERAL ELECTRICAL PROVISIONS

.2 Lose 600 or 120/208VAC motor starters.
.3 Lighting Control Panels
.4 Cable Trays
.5 Cables
.6 Panelboards and Circuit Breakers
.7 Lighting Fixtures
.8 Remote Operator Stations (Engineered shop drawings)
.9 Emergency Lights and Exit Signs
.10 Power Metering
.11 Forced Fan Wall Heaters and Baseboard Heaters
.12 Manual motor starters and Motor Disconnect Switches
.13 Transformers
.14 Relays
.15 Security panel and components; door switches, access control.

1.8 Record Drawings

.1 The Contractor shall keep one complete set of white prints at the site office, including all addenda, change orders, site instructions, clarifications and revisions for the purpose of record drawings. As the work on site proceeds, the Contractor shall clearly record in Red Pencil all as-built conditions which deviate from the original contract documents. Record drawings to include circuiting of all devices, conduit and feeder runs (complete with conductor size and number) and locations of all electrical equipment.

.2 Contractor to forward letter of certification and as-built CAD drawings to the Engineer for final review. As-Built drawings to be submitted in the form of one set of CAD files.

1.9 Operation and Maintenance Manuals

.1 Within 30 days prior to substantial performance, the Contractor shall submit a draft copy of the proposed contents of each maintenance manual to the Engineer for review. Once the draft copy is approved, the Contractor will supply 4 copies in suitably labeled, hard back, D-Ring type commercial binders, each complete with an
index and tabbed title sheets for each section. Final copies of manuals to be received by Engineer not less than 7 days prior to substantial performance.

.2 All maintenance manual data shall be printed on 8 ½ in x 11 in heavy bond, indexed, tabbed, punched and bound in the binders. Each manual shall have a title sheet which is labeled “Operation & Maintenance Manual”, and lists the Project name, Contractor’s & Engineer’s names, date submitted, and a Table of Contents for each volume. If a manual exceeds 75 mm in thickness, provide additional manuals as required.

.3 Each section of the manual shall contain the following information:

.1 Systems Descriptions. A brief synopsis of each system typed and inserted at the beginning of each section. Include sketches and diagrams where appropriate.

.2 Descriptive and technical data.

.3 Maintenance and operating instructions for all electrical equipment and controls. (These operating instructions need not be manufacturer's data but may be typewritten instructions in simple language to guide the Owner in the proper operation and maintenance of his installation.)

.4 A copy of all wiring diagrams complete with wire coding.

.5 List of spare parts of all electrical equipment complete with names and addresses of sales, service representatives and suppliers.

.6 Copy of test data

.7 A motor list showing each motor number, name, horsepower, full load amperes, overload settings, nameplate, current rating, heater size and type, and current being drawn, on the form specified in Section 16980.

.8 Include type and accuracy of instruments used to obtain test data.

.9 Copy of final inspection certificate.

.10 Copy of the purchase order, showing equipment make and model numbers issued to the manufacturer complete with all addenda. All cost details may be hidden.

.11 Copy of all warranty certificates.

.12 Set of final reviewed Shop Drawings.

.13 Names, addresses, phone numbers and facsimile numbers of Contractor, Engineer, sub-contractors and suppliers used on the Work together with a specification reference of the portion of the Work they undertook.
1.10 Product Handling

.1 Use all means necessary to protect the products of this Division before, during and after installation and to protect products and installed work of all other trades.

.2 Immediately make good any damage by repair or replacement at no additional cost to the Owner and to the approval of the Engineer.

.3 Remove advertising labels from all electrical equipment. Do not remove identification of certification labels.

.4 Remove dirt, rubbish, grease, etc. resulting from this work from all surfaces, including the inside of all cabinets, equipment enclosures, panelboard tubs, etc.

1.11 Alternate and Separate Prices

.1 In accordance with the Instructions to Bidders, state on the Tender Form in the space provided, the amount to be added or deleted from the base bid tender amount for the use and installation of equipment as an alternate to those specified.

1.12 Guarantee

.1 Replace or repair at no cost to the Owner any defective material or workmanship during the Warranty Period except where, in the opinion of the Engineer, such defects are due to the misuse or neglect by the Owner.

.2 This general guarantee shall not act as a waiver of any specified or special equipment guarantees which cover a greater length of time.

1.13 Progress Claims

.1 Within thirty (30) days after award of contract, a breakdown of material and equipment items including labour and expense components shall be compiled in the Engineer’s format. Subsequent requests for payment shall be documented accordingly.

2. PRODUCTS

2.1 Selected Products and Equivalents

.1 Products and materials provided shall be new and free from all defects. Defective products or materials will be rejected, regardless of previous inspections. The Contractor shall be responsible to remove and replace defective products at their expense, and shall be responsible for any resulting delays and associated expenses which result from defective products being rejected. Related materials shall be of the same manufacturer throughout the project.
.2 Products and materials referred to in the specifications by trade names, manufacturer's name and catalogue reference are those which shall be used as the basis for the Tender.

.3 The design has been based on the use of the specified product.

2.2 Alternative Products

.1 All product substitutions must be approved by the Engineer. Failure to obtain approval from the Engineer will result in the alternative product being rejected, in which case the Contractor shall provide an approved product at no additional cost to the Owner.

.2 The Contractor shall assume full responsibility for ensuring that when providing alternative products or materials, all space, weight, connections, power and wiring requirements etc. are considered. Any costs incurred for additional components, changes to services, structural or space requirements, layouts and plans, etc. that may be necessary will be borne by the Contractor.

.3 Suppliers to submit all requests for alternative product approval to the Engineer. Submissions must be received by the Engineer not less than seven (7) working days prior to the close of tenders. Submissions received after the “Cut-Off” date will not be reviewed.

All submissions which are approved by the Engineer shall be identified as “Approved Alternatives” in an Addendum. Alternative products not listed in the Addendum will be rejected.

.4 Approval of an alternate is not intended to change the original specifications unless specifically stated in the addenda. The submitter is responsible for all costs incurred by other trades as well as his own, to install the product/system in accordance with the contract documents.

.5 All submissions to be provided with technical data and whatever pertinent information that may be required by the Engineer to evaluate equivalency to the specified product. The responsibility to provide sufficient technical data with respect to submissions will remain solely with those making the submission.

.6 The Engineer will review the shop drawings for the equipment which deviates from the original specification only after the contractor provides written explanation that each substitution complies with at least one of the following criteria:

.1 The specified equipment is no longer available.

.2 The proposed alternative equipment has advanced technical characteristics than the specified equipment and it will be provided without contract price increase.
.3 The proposed alternative equipment has same technical characteristics as the specified equipment but brings significant cost savings to the Owner.

.4 The proposed alternative equipment carries significant construction cost savings for the Owner

2.3 Quality of Products

.1 All products provided shall be CSA Approved, Canadian Underwriters' Laboratory approved where applicable, and new, unless otherwise specified.

.2 If products specified are not CSA approved, obtain special approval from the local regulatory authority. Pay all applicable charges levied and make all modifications required for approval.

.3 Products provided, if not specified, shall be new, of a quality best suited to the purpose required and their use subject to approval by the Engineer.

2.4 Uniformity of Manufacture

.1 Unless otherwise specifically called for in the Specifications, uniformity of manufacture shall be maintained for similar products throughout the work.

2.5 Product Finishes

.1 Finish all cabinets, panelboards, switchboards, equipment cabinets, cable trays, etc. in ANSI 61 grey enamel unless otherwise specified.

.2 Apply primer on all items which are to be finished on the job.

.3 Touch up all damaged painted finishes with matching lacquer, or, if required by the Engineer, completely repaint damaged surface.

2.6 Use of Products during Construction

.1 Any equipment used for temporary or construction purposes shall be approved by the Engineer and in accordance with the General Conditions, "Use of Premises." Clean and restore to "as new" condition all equipment prior to the time of substantial completion.

.2 The warranty period shall not begin until the date of substantial performance of the work.
3. **EXECUTION**

3.1 **Site Examination**

.1 Examine the site of work and become familiar with all features and characteristics affecting this Work before submitting tender.

.2 No additional compensation will be given for extra work due to existing conditions which such examination should have disclosed.

.3 Report to the Engineer any unsatisfactory conditions which may adversely affect the proper completion of this work.

3.2 **Coordination with Other Divisions**

.1 Examine the drawings and specifications of all divisions and become fully familiar with their work. Before commencing work, obtain a ruling from the Engineer if any conflict exists, otherwise no additional compensation will be made for any necessary adjustments.

.2 Lay out the work and equipment with due regard to architectural, structural and mechanical features. Architectural and structural drawings take precedence over electrical drawings regarding locations of walls, doors and equipment.

.3 Do not cut structural members without approval of the Engineer.

.4 Coordinate with all Divisions installing equipment and services, and ensure that there are no conflicts.

.5 Install anchors, bolts, pipe sleeves, hanger inserts, etc. in ample time to prevent delays.

.6 Examine previously constructed work and notify the Engineer of any conditions which prejudice the proper completion of this work. Commencement of this work without such notification shall constitute acceptance of other work.

3.3 **Location of Outlets and Luminaires**

.1 Electrical drawings are, unless otherwise indicated, drawn to scale and approximate distances and dimensions may be obtained by scaling. Figured dimensions shall govern over scaled dimensions. Where exact dimensions and details are required, refer to Architectural and Structural drawings.

.2 Outlet and equipment locations shown on the drawings are approximate. Locations may be revised up to 3 meters to suit construction and equipment arrangements without additional cost to the Owner, provided that the Contractor is notified prior to the installation of the outlets, or equipment.
GENERAL ELECTRICAL PROVISIONS

.3 Maintain luminaire locations wherever possible. Notify the Engineer of conflicts with other services.

.4 Unless otherwise specified or shown, install products in accordance with recommendations and ratings of manufacturers.

3.4 Separation of Services

.1 Maintain separation between electrical wiring system and building piping, ductwork, etc. so that wiring system is isolated (except at approved connections to such systems) to prevent galvanic corrosion.

.2 In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is not permitted.

.3 Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings may be used for the support of wiring only when approval is obtained from the Engineer and the ceiling installer, and approved clips or hangers are used.

3.5 Equipment Identification

.1 3 mm thick plastic lamicoid name plates, white face, black core, mechanically attached with self tapping screws, 6 - 8 mm high lettering, to be attached to the front face of the following equipment:

- MCC (Designation, voltage)
- Starters, contactors, Disconnects (Designation, voltage, load controlled)
- Panelboard (Designation, voltage, Bus Capacity)
- Terminal cabinets and pull boxes (system, voltage)
- Transformers (designation, capacity, primary and secondary voltage)
- Control panels (Designation, supply voltage, source panel)

Nameplates:

<table>
<thead>
<tr>
<th>NAMEPLATE SIZES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size 1 x 50 mm</td>
</tr>
<tr>
<td>Size 2 x 70 mm</td>
</tr>
<tr>
<td>Size 3 x 70 mm</td>
</tr>
<tr>
<td>Size 4 x 90 mm</td>
</tr>
<tr>
<td>Size 5 x 90 mm</td>
</tr>
</tbody>
</table>

.1 Wording on nameplates to be approved by the Engineer prior to manufacture.

.2 Allow for average of twenty-five (25) letters per nameplate.
.2 Color code exposed conduits (including conduits above T-bar ceilings), junction and pull boxes, and metallic sheathed cables with paint or plastic tape (25 mm wide band) at 15 metre intervals.

Color coding to be as follows:

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>MAJOR BAND</th>
<th>MAJOR BAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Voltage 1</td>
<td>Yellow</td>
<td>Purple</td>
</tr>
<tr>
<td>347/600 V Normal</td>
<td>Dk. Blue</td>
<td></td>
</tr>
<tr>
<td>120/208 V Normal</td>
<td>Lt. Blue</td>
<td></td>
</tr>
<tr>
<td>120/240 V Emerg.</td>
<td>Lt. Blue</td>
<td>Black</td>
</tr>
<tr>
<td>UPS System</td>
<td>Lt. Blue</td>
<td>White</td>
</tr>
<tr>
<td>Fire Alarm System</td>
<td>Red</td>
<td></td>
</tr>
<tr>
<td>Telephone</td>
<td>Lt. Green</td>
<td></td>
</tr>
<tr>
<td>Computer &amp; Networks</td>
<td>Black</td>
<td>Yellow</td>
</tr>
</tbody>
</table>

.3 Provide neatly typed circuit directories in panelboards to indicate the area or equipment controlled by each branch circuit.

.4 All conductors shall be identifiable by coloured insulation and permanent markers at every terminal and accessible points throughout its entire run.

Conductors:
- Equipment Grounding – Green
- Neutral Conductor – White

<table>
<thead>
<tr>
<th>347/600 Volt System</th>
<th>120/208 Volt System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase A – Red</td>
<td>Phase A – Red</td>
</tr>
<tr>
<td>Phase B – Black</td>
<td>Phase B – Black</td>
</tr>
<tr>
<td>Phase C – Blue</td>
<td>Phase C – Blue</td>
</tr>
</tbody>
</table>

.5 Install yellow plastic warning tape, 300 mm below grade, above all underground ducts.

.6 Provide permanent, corrosion resistant warning markers, suitable to the local inspection authority, imbedded in the surface of concrete slabs which are directly above high voltage cables and duct banks.

3.6 **Wiring to Equipment Supplied by Others**

.1 Equipment supplied by the Owner or under other Divisions will be moved to the installation site by others. However, the electrical connection to the equipment shall be done by this Division.
GENERAL ELECTRICAL PROVISIONS

3.7 Testing
   .1 Refer to Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment and Systems.

3.8 Single Line Diagram
   .1 Provide and mount a framed as-built single line diagram to be located adjacent to the main electrical equipment. Use a clear plexiglass cover. The diagram shall be 914 mm x 600 mm minimum, with all lettering Leroyed.

3.9 Instructions to Owner's Personnel
   .1 Refer to Section 16990 - Electrical Equipment and Systems Demonstration and Instruction.

3.10 Access Panels
   .1 Where electrical equipment, junction boxes, remote ballasts or the like are concealed, access panels shall be supplied. Panels shall be of adequate size for servicing of the electrical work and complete with necessary frames and hinged doors held closed with captive fasteners. Coordinate type and size of panels with the Engineer.

3.11 Mounting Heights
   .1 Unless a conflict exists, use the following as mounting heights from finished floors to centre of device.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receptacles in Process Rooms</td>
<td>1000 mm</td>
</tr>
<tr>
<td>Receptacles and Telephone Outlets</td>
<td>300 mm</td>
</tr>
<tr>
<td>Light Switches</td>
<td>1400 mm</td>
</tr>
<tr>
<td>Fire Alarm Manual Stations</td>
<td>1400 mm</td>
</tr>
<tr>
<td>Fire Alarm Bells</td>
<td>2100 mm</td>
</tr>
<tr>
<td>Thermostats</td>
<td>1400 mm</td>
</tr>
<tr>
<td>Wall-mounted speakers</td>
<td>2100 mm</td>
</tr>
<tr>
<td>Panelboards, starters, and disconnects</td>
<td>2000 mm</td>
</tr>
<tr>
<td>(to top of cover)</td>
<td></td>
</tr>
<tr>
<td>End of Line Resistors</td>
<td>1800 mm</td>
</tr>
<tr>
<td>Outlets above Counters</td>
<td>175 mm</td>
</tr>
</tbody>
</table>

3.12 Sealing of Wall and Floor Openings
   .1 All conduit and cable entries through outside walls of buildings, through partition walls separating electrical rooms from other areas, through fire separations, and
through floors above grade shall be sealed to prevent passage of moisture, dust, gasses, flame, or to maintain pressurization. Gases

.2 Openings shall be sealed when all wiring entries shown on the drawings have been completed.

.3 Sealing material shall be fire resistant and shall not contain any compounds which will chemically affect the wiring jacket or insulating material. Cable penetrations through fire separations to be sealed.

3.13 Housekeeping Pads

.1 All floor mounted electrical equipment installed by this Division shall be mounted on concrete housekeeping pads which, unless otherwise noted, shall be the responsibility of the Contractor.

.2 The Contractor shall determine the extent of the housekeeping pads required and supply all information and details as to size and locations to the Engineer within thirty days after the award of the Contract.

3.14 Sleeves

.1 Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.

.2 For wall, partitions and ceilings the ends shall be flush with the finish on both sides but for floors they shall extend 4 in above finished floor level.

.3 The space between the sleeve and the conduit shall be filled with Dow Corning silicone RTV foam for fire stop and caulked around the top and bottom with approved permanently resilient, non-flammable and weatherproof silicone base compound and ensure that the seal is compatible with the floor and ceiling finishes.

.4 Locate and position sleeves exactly prior to construction of walls, floors.

.5 Failure to comply with the above requirements shall be remedied at this Division's expense.

3.15 Temporary Lighting and Power

.1 Provide grounded extension cords and temporary lights required for electrical work.

.2 Coordinate with General Contractor for obtaining temporary power service.

.3 If Owner’s operations will be affected by any power outage required for this work, give adequate notice to the Owner and do not interrupt power until approval has been obtained. Coordinate any service interruption with Owner and do not
compromise daily operations. Maximum power outage permitted will not exceed 6 hours.

.4 Give adequate notice to Contractor of any power outage required for this work. Schedule outages to provide least interference with other work.

3.16 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 and motor control centres, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

3.17 Seismic Restraint

.1 Refer to Section 16195 – Seismic Restraints for specific requirements related to the seismic restraint of all major items of electrical equipment, including those items supported from suspended ceiling systems.

END OF SECTION
SCOPEx  OF  WORK

1. GENERAL

.1 The Electrical work to be done under this contract includes, but is not limited to, the supply of all materials, labour, equipment and permits necessary for the complete, fully functional and coordinated electrical system. The work shall include but not be limited to supply, assembly, shop testing, installation, site testing and commissioning of all power and controls systems.

.2 This specification section does not show all required electrical work. The required electrical work is shown on the all contract drawings and specifications, as specified herein. A guarantee of all workmanship and materials for a period specified herein is also required.

.3 Site Location

   .1 Eldorado Reservoir, Beaver Lake Rd, Lake Country, British Columbia.

   .2 Glenmore Booster Station, 9265 Seaton Rd, Lake Country, British Columbia.

.4 Site Condition

   .1 Power supply on site is available at 25kV/3Ph/4W, 600/347VAC/3Ph, 4W, 60HZ, and 120/208VAC/60Hz.

2. QUALITY OF PRODUCTS

.1 Provide new materials, equipment and articles incorporated in the Work, 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 Defective materials, equipment and articles whenever found may be rejected regardless of previous inspection. Inspection by the Engineer or his Representative does not relieve the Contractor of his responsibility but is merely a precaution against oversight or error. Remove and replace defective materials at own expense and be responsible for all delays and expenses caused by rejection.

.3 Unless otherwise indicated in the specifications, maintain uniformity of manufacturer for any particular or like item throughout the building.

.4 Permanent labels, trademarks and nameplates on materials, equipment and articles are not acceptable in prominent locations except where required for operating instructions and when located in mechanical or electrical rooms.

.5 Immediately upon signing the Contract, review Product requirements and anticipate foreseeable delivery delays in any items. If delays in deliveries of materials,
SCOPE OF WORK

equipment or articles are foreseeable, propose substitutions or other remedial action in ample time to prevent delay in performance of the Work.

.6 To receive approval, proposed substitutes must equal or exceed the quality, finish and performance of those specified and/or shown, and must not exceed the space requirements allotted on the drawings.

.7 All provided equipment and materials must be CSA approved.

3. RELATED WORK

.1 The Administrative Sections under Division 0 (Bidding and Contract Requirements) and 1 (General Requirements) shall be considered to be part of these Specifications.

.2 Related work shall include but not limited to:

   .1 Instrumentation and Controls work - specified in the Division 17, shall be considered to be a part of these Specifications for proper coordination between the Control system and the Electrical portions of the Work. The Electrical system work shall be supplied under the General Work Contract. The Division 17 Contractor shall be under the Division 16 responsibility for purpose of contract coordination.

   .2 Integration of the HVAC system specified under Division 15 into the new electrical system shall be considered to be a part of these Specifications and shall be coordinated with the General Contractor.

   .3 The access security system provision will be coordinated by the Contractor, so the District standard system (Chubb/Edwards) is installed and commissioned by this contract at both sites. Contractor will coordinate the work with local Chubb-Edwards (contact Jane Taiji - Commercial Account Manager at tel: 1.250.860.1026 X 2803 or mobile: 250-863-8925).

   .4 Various process equipment will be supplied under separate divisions. The process equipment shall be incorporated by the Contractor into the overall electrical system at the both the Eldorado Reservoir Site and Glenmore Booster Station. The various process equipments will be installed on site by others, and tied into the electrical system by this contract.

4. GENERAL REQUIREMENTS

.1 All inspection and other permits, licenses required by various Inspection Agencies and local regulations related to Electrical Trade.

.2 Special testing or inspection, additional to the above as specified.
SCOPE OF WORK

.3 Utility connections.

.4 Scaffolding.

.5 Shop Drawings.

.6 Project Record Documents (As-Built Drawings) where specified.

.7 General Clean-up.

.8 Operating and Maintenance Data, where specified.

5. SCOPE OF ELECTRICAL WORK

.1 Power distribution system components, as defined on the Contract Drawings.

.2 Main power supply source on both sites is an integrated 600V/3φ/60Hz Motor Control Centre based on EATON Freedom MCC2100. The MCC will contain breakers, supply VFD's and integrated with PLC & SCADA controls. The Owner approved integrator and equipment supplier for this project is Interior Instrument Tech Services Ltd. in Kelowna. (1115 St. Paul St., Kelowna, BC, V1Y 2C6. Contact Ken Hansen at 250.717.8814).

.3 Conductors, including all types of wires, conductors, cables, which form an integral part of the electrical power system.

.4 Cables systems which are intended to enclose or support all forms of electrical conductors used for any purpose covered by this scope. This includes cable trays, raceways and all forms of rigid, flexible, metallic and non-metallic conduit, and including conduit for communication systems or others, which may be installed at a later date, or buried conduit for wiring work by others, only when such buried conduit is indicated in the Contract Documents.

.5 Control panels associated with any electrical equipment covered under this section of Work.

.6 Circuit breakers of all types, and for all applications associated with electrical equipment which receives its power supply from the main, or emergency (including battery) system.

.7 Duct systems, including underground, riser, etc. which are intended to contain cables, buses or any device associated with or connected to the power system.

.8 Emergency power and lighting systems.

.9 Grounding systems, as required by the Electrical Code, or as otherwise specified in the bid documents.
SCOPE OF WORK

.10 Lighting all forms of electric lighting devices, both individual and packaged types, including complete modular and integrated ceiling together with all associated troffers, deflectors, diffusers, ballasts, lens, tubes and mounting devices, and which are used for all purposes, such as floodlighting exterior parking areas, landscaping lighting, display lighting, operating room lighting, etc.

.11 Motor starters of all types and for all types of applications, including combination starters, unless part of Mechanical Equipment.

.12 Transformers of various types, dry, and for all applications, except control transformers supplied with Mechanical Equipment included in Division 15.

.13 Alarm, annunciation and signaling systems, heat or smoke detection. Complete, including detection, control, indicating and annunciating devices.

6. WORK INCLUDED (GLENMORE BOOSTER STATION)

.1 The work included is the provision and commissioning of a complete and fully functional electrical system for the new Glenmore Booster Station. The work shall include any equipment, material and labour not specifically noted or detailed in the Specifications and Drawings but which is evidently required to furnish a complete system. The work shall include but not be limited to:

.1 Provide all necessary power arrangements to allow construction before 600VAC service and MCC can be energized. Provide transformers, cables, panels, receptacles, lighting and all required tools for temporary power for construction trailers and construction site.

.2 The Owner will arrange with BC Hydro provision of a new 600VAC service to the site. BC Hydro will provide a medium voltage underground cable and a new pad mount transformer. In coordination with BC Hydro civil design, the Contractor shall provide underground ducts from the new BC Hydro provided transformer to the electrical room. Before the transformer is installed and MCC energized, the contractor shall arrange with BC Hydro for temporary power arrangements and or provide a generator c/w fuel at his own cost.

.3 Provide all grounding, including but not limited to MCCs and MCC entrance grounding, bonding of all equipment and bonding to all metal piping system. Complete grounding/bonding system in accordance with Canadian Electrical Code requirements and as detailed in contract drawings.

.4 Provide Motor Control Centre MCC as indicated on drawings and specifications and all feeders and control wiring to the connected motors and other loads as indicated on drawings. Refer to P&ID, single line diagrams and motor schematic drawings for additional information.
.5 Program and setup all Power Monitors and smart overloads in MCC to provide a fully functional, reliable and operational electrical and control system. The Contractor is responsible to setup, test, and commission all communication equipment and parameters for all Modbus TCP devices in the MCC. The Contractor will also be responsible for the set up, testing and commissioning of any Smart Overloads, VFD's, Power Monitor, installed in the MCC. The Contractor shall allow for services of a qualified equipment representative to carry out setup and testing of such devices. The equipment representative shall provide a written report to the Engineer with “as-left” settings for all smart relays and protective devices, including but not limited the list of all VFD set-up parameters.

.6 Setup, test and commission all Circuit Breakers.

.7 Provide all motor disconnected switches c/w all required mounting hardware as indicated on the drawings.

.8 Provide door contact switches and conduit to smoke detectors to a security panel. Refer to Instrument Specification Sheets for more information.

.9 Provide all lighting. Provide luminaries, switches, lighting control and power outlets c/w all required wiring.

.10 Provide exit signs and emergency lighting.

.11 Provide all required underground electrical ducts, conduits and cable trays.

.12 Provide all transformers and circuit breaker panels as indicated on the drawings and specifications.

.13 Provide all cabling, wireways, underground ducts, cable trays and material for power supply and field wiring of ALL equipment, including instrumentation and Local Control Panels, other than 24 VDC instrument power supply. Refer to P&ID and controls drawings for more information. Unless otherwise noted provide 120VAC power supply from the closest non-essential circuit breaker panel for all electrical equipment show on the P&ID drawings as electrical power supplied (ES). Use minimum 2C#12 Teck90 cable. Refer to Division 17 drawings for more information.

.14 Provide general power, transformers, panel boards, receptacles, raceways, wall boxes, pull boxes, wall plates, etc. as specified and detailed.

.15 Provide antenna post, antenna post precast base, ground conductor. Coordinate with div. 17 for final antenna post height.

.16 Provide as-built drawings and Operation and Maintenance Manuals (OEM).

.17 Provide seismic restraints for all electrical equipment and installations.
**SCOPE OF WORK**

.18 Provide baseboard heaters c/w the associated thermostats as depicted in the Division 15 drawings and specifications.

.19 Provide combined Fire Alarm and Security system as indicated on the drawings. All wiring for this system shall be installed in dedicated conduits.

.20 Provide power supply, conduits, control wiring and motor starters and protection for all HVAC equipment to include but not be limited to electric unit heater(s), electric baseboard heaters, as indicated on the Division 15 drawings and specifications. Refer to HVAC drawings for additional information.

.21 Field commissioning, adjustments and certified manufacturers acceptance report.

.22 Submission of shop drawings.

.23 Allow in the tender price a journeyman electrician to work on site for an additional three days as directed by the Engineer to make any changes and adjustments.

.24 Unless specifically otherwise notes all conduits shall be surface mounted.

7. **WORK INCLUDED (ELDORADO RESERVOIR LOW LIFT STATION)**

.1 The work included is the provision and commissioning of a complete and fully functional electrical system for the new Eldorado Reservoir Low Lift Station. The work shall include any equipment, material and labour not specifically noted or detailed in the Specifications and Drawings but which is evidently required to furnish a complete system. The work shall include but not be limited to:

.1 Provide all necessary power arrangements to allow construction before 600VAC service and MCC can be energized. Provide transformers, cables, panels, receptacles, lighting and all required tools for temporary power for construction trailers and construction site.

.2 Provision of a new 600VAC service to the site. Provide a new pole complete for primary dip to underground duct, that includes as per drawings, expulsion type fuses, GOB load breaker and MOV line surge suppressors.

.3 Provide dead end front, pad mount transformer 25kV/600V with precast base. Provide medium voltage underground cable from private pole to new pad mount transformer, complete with HV terminations suitable for pole and transformer bushing connection. Provide low voltage cables from transformer secondary to MCC in electrical room.
SCOPE OF WORK

.4 Before the transformer is installed and MCC energized, the contractor shall arrange for temporary power supply to site and or provide a generator c/w fuel at his own cost.

.5 Provide underground duct bank between the new low lift station and the existing flowmeter & chlorination injection vault. Provide underground duct bank, and associated electrical pull boxes between the low lift station and existing chemical building.

.6 Provide all grounding, including but not limited to MCCs and MCC entrance grounding, bonding of all equipment and bonding to all metal piping system. Complete grounding/bonding system in accordance with Canadian Electrical Code requirements and as detailed in contract drawings.

.7 Provide Motor Control Centre MCC as indicated on drawings and specifications and all feeders and control wiring to the connected motors and other loads as indicated on drawings. Refer to P&ID, single line diagrams and motor schematic drawings for additional information.

.8 Program and setup all Power Monitors and smart overloads in MCC to provide a fully functional, reliable and operational electrical and control system. The Contractor is responsible to setup, test, and commission all communication equipment and parameters for all Modbus TCP devices in the MCC. The Contractor will also be responsible for the set up, testing and commissioning of any Smart Overloads, VFD’s, Power Monitor, installed in the MCC. The Contractor shall allow for services of a qualified equipment representative to carry out setup and testing of such devices. The equipment representative shall provide a written report to the Engineer with “as-left” settings for all smart relays and protective devices, including but not limited the list of all VFD set-up parameters.

.9 Setup, test and commission all Circuit Breakers.

.10 Provide all motor disconnected switches c/w all required mounting hardware as indicated on the drawings.

.11 Provide door contact switches and conduit to smoke detectors to a security panel. Refer to Instrument Specification Sheets for more information.

.12 Provide all lighting. Provide luminaries, switches, lighting control and power outlets c/w all required wiring.

.13 Provide exit signs and emergency lighting.

.14 Provide all required underground electrical ducts, conduits and cable trays.

.15 Provide all transformers and circuit breaker panels as indicated on the drawings and specifications.
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SCOPE OF WORK

.16 Provide all cabling, wireways, underground ducts, cable trays and material for power supply and field wiring of ALL equipment, including instrumentation and Local Control Panels, other than 24 VDC instrument power supply. Refer to P&ID and controls drawings for more information. Unless otherwise noted provide 120VAC power supply from the closest non-essential circuit breaker panel for all electrical equipment show on the P&ID drawings as electrical power supplied (ES). Use minimum 2C#12 Teck90 cable. Refer to Division 17 drawings for more information.

.17 Provide general power, transformers, panel boards, receptacles, raceways, wall boxes, pull boxes, wall plates, etc. as specified and detailed.

.18 Provide as-built drawings and Operation and Maintenance Manuals (OEM).

.19 Provide seismic restraints for all electrical equipment and installations.

.20 Provide baseboard heaters c/w the associated thermostats as depicted in the Division 15 drawings and specifications.

.21 Provide combined Fire Alarm and Security system as indicated on the drawings. All wiring for this system shall be installed in dedicated conduits.

.22 Provide power supply, conduits, control wiring and motor starters and protection for all HVAC equipment to include but not be limited to electric unit heater(s), electric baseboard heaters, as indicated on the Division 15 drawings and specifications. Refer to HVAC drawings for additional information.

.23 Field commissioning, adjustments and certified manufacturers acceptance report.

.24 Submission of shop drawings.

.25 Allow in the tender price a journeyman electrician to work on site for an additional three days as directed by the Engineer to make any changes and adjustments.

.26 Unless specifically otherwise notes all conduits shall be surface mounted.

8. WORK INCLUDED (ELDORADO TREATED WATER RESERVOIR)

.1 The work included is the provision and commissioning of a complete and fully functional electrical system for the new Eldorado Treated Water Reservoir. The work shall include any equipment, material and labour not specifically noted or detailed in the Specifications and Drawings but which is evidently required to furnish a complete system. The work shall include but not be limited to:
SCOPE OF WORK

.1 Provide all necessary power arrangements to allow construction before 120/208VAC service can be energized. Provide transformers, cables, panels, receptacles, lighting and all required tools for temporary power for construction trailers and construction site.

.2 In the Eldorado reservoir existing chemical building electrical room, modify existing Square D MCC No. 22886917-001 to accommodate new feeder breaker for the TW reservoir. Provide underground ducts for feeder and control cables from existing mcc and control panel to the TW reservoir. Provide feeder cable, multi-conductor control cables, and analog cable to the TW reservoir from the chemical building electrical room via underground ducts.

.3 Provide all grounding, including but not limited to transformer TX-C and MCC entrance grounding, bonding of all equipment and bonding to all metal piping system. Complete grounding/bonding system in accordance with Canadian Electrical Code requirements and as detailed in contract drawings.

.4 Provide all motor disconnected switches c/w all required mounting hardware as indicated on the drawings.

.5 Provide door contact switches and conduit to smoke detectors to a security panel. Refer to Instrument Specification Sheets for more information.

.6 Provide all lighting. Provide luminaries, switches, lighting control and power outlets c/w all required wiring.

.7 Provide exit signs and emergency lighting.

.8 Provide all required underground electrical ducts, conduits and cable trays.

.9 Provide all transformers and circuit breaker panels as indicated on the drawings and specifications.

.10 Provide all cabling, wireways, underground ducts, cable trays and material for power supply and field wiring of ALL equipment, including instrumentation and Local Control Panels, other than 24 VDC instrument power supply. Refer to P&ID and controls drawings for more information. Unless otherwise noted provide 120VAC power supply from the closest non-essential circuit breaker panel for all electrical equipment show on the P&ID drawings as electrical power supplied (ES). Use minimum 2C#12 Teck90 cable. Refer to Division 17 drawings for more information.

.11 Provide general power, transformers, panel boards, receptacles, raceways, wall boxes, pull boxes, wall plates, etc. as specified and detailed.

.12 Provide as-built drawings and Operation and Maintenance Manuals (OEM).

.13 Provide seismic restraints for all electrical equipment and installations.
SCAPE OF WORK

.14 Provide baseboard heaters c/w the associated thermostats as depicted in the Division 15 drawings and specifications.

.15 Provide power supply, conduits, control wiring to electric unit heaters.

.16 Field commissioning, adjustments and certified manufacturers acceptance report.

.17 Submission of shop drawings.

.18 Allow in the tender price a journeyman electrician to work on site for an additional three days as directed by the Engineer to make any changes and adjustments.

.19 Unless specifically otherwise notes all conduits shall be surface mounted.

9. OTHER WORK

.1 Refer to Divisions 11, 15, 17 and coordinate Other Work as required to complete scope of electrical work.

.2 Special testing or inspection not specified.

.3 Instrumentation and Control wiring and 24 VDC power supply wiring.

.4 Communication wiring.

.5 Remote Operator Stations for solenoid valves.

.6 Control wiring associated with equipment (not necessarily mechanical equipment) not included in the Electrical Specifications, (buried conduit, wireways and cable trays for such wiring shall be included).

.7 All excavation, backfill and removal of surplus material to Electrical Service Trenching (Division 02).

.8 Concrete protective encasement around duct, conduit systems and concrete light standard bases and pull pits (Division 03).

.9 Cast iron covers to pull pits.

.10 Perforations through roofing materials for electrical servicing or attachments.

.11 Painting (on site), except touch-up of electrical equipment (Division 9).

.12 Ducted fans and heaters (Division 15).
SCOPE OF WORK

10. UNITS OF MEASUREMENT

.1 The Contract Documents have been prepared using the modified International System (SI) units of metric measurement. Whenever appropriate, available metric products shall be used unless otherwise specified herein.

.2 Only metres (m) and millimetres (mm) are used. Generally, metres are used for measurements of 10 metres or more, and millimetres for measurements below 10 m.

.3 All measurements on drawings are in millimetres unless otherwise indicated.

11. CONVERSIONS

.1 The following three conversion methods were used in product and location dimensions:

.1 Hard Conversion: Industry available products which are manufactured in metric measurements.

.2 Soft Conversion: Products which are still manufactured in Imperial units and are converted in specifications using arithmetic conversion factors.

.3 Rationalized Conversion: Dimensions which are soft converted and rounded off for ease of measurements.

.2 In cases where measurements may be open for interpretation, dual dimensions have been incorporated until hard conversions can be used exclusively.

12. DEFINITIONS

.1 All terminologies, abbreviations and acronyms used in this document are as listed in the various Standards, Codes, Rules and Bulletins used herein.

13. REFERENCE

.1 Imperative tense has been used throughout this Document for work intended for the successful Contractor. There shall be no work exclusions unless they have been clearly identified as such herein.

.2 Any reference to “Engineer”, “Consultant” or "Design Authority" shall mean representative of AECOM.

END OF SECTION
1. GENERAL

1.1 Scope

.1 References to completion of the Work in other sections require that full functional testing and operational demonstration be performed for each and every system included in the Work of Division 16. Testing and start-up for each system by Division 16 to include the following activities:

.1 Pre start-up visual inspections and testing.
.2 Start-up for energization and full functional demonstration.
.3 Post start-up tests and operational checks.
.4 All corrective and follow-up actions and any retesting as necessary.

.2 Prior to the final demonstration and instructional seminars required, test and check all portions of the electrical system for satisfactory operation. All tests to be done in the presence of the Engineer and/or the Engineer’s representative, suitably logged, tabulated, signed and incorporated in project documentation.

.3 Testing and verification to include, but not be limited to the following:

<table>
<thead>
<tr>
<th>Test</th>
<th>Performance by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal visual and mechanical inspections</td>
<td>electrical trade and low tension systems installers</td>
</tr>
<tr>
<td>Megger tests</td>
<td>electrical trade</td>
</tr>
<tr>
<td>Load balance tests</td>
<td>electrical trade</td>
</tr>
<tr>
<td>Motor current recordings</td>
<td>electrical trade with Division 11/15</td>
</tr>
<tr>
<td>Distribution voltage checks</td>
<td>electrical trade</td>
</tr>
<tr>
<td>Power factor readings</td>
<td>electrical trade</td>
</tr>
<tr>
<td>Witness testing</td>
<td>one consultant's representative, one electrical trade representative and one owner’s representative</td>
</tr>
<tr>
<td>Grounding</td>
<td>electrical trade</td>
</tr>
<tr>
<td>Low tension systems</td>
<td>low tension systems installation and electrical trade representative</td>
</tr>
</tbody>
</table>

.4 Pre start-up checks and function tests for major electrical distribution equipment to be provided by authorized manufacturer's service representative. Division 16 to include all costs for involvement of manufacturer's representatives for this work.
.5 Provide records of all production tests required by EEMAC or CSA for all power
distribution equipment to the Engineer prior to field testing with applicable copies of
factory tests issued to the independent testing firm for comparative results.

.6 Any manufacturer, supplier or contractor who objects to test procedures, methods
and test voltage levels specified herein to confirm objections in writing at least 10
working days prior to tender closing stating all reasons for such objections. Failing
to do this constitutes acceptance of all test procedures stated herein and ensures
that warranties are not voided by such tests and procedures.

1.2 Pre-functional Checkout

.1 Conduct functional testing in accordance with the requirements of Section 01650.
Prior to functional testing, adjust and make operational all protective devices. Prior
to energization of equipment, perform a functional checkout of the control circuit
consisting of energizing each control circuit and operating each control, alarm or
malfunction device and each interlock in turn to verify that the specified action
occurs. Submit a description of the proposed functional test procedures prior to the
performance of functional checkout.

.2 Verify that motors are connected to rotate in the correct direction. Verification may
be accomplished by momentarily energizing the motor, provided the Contractor
confirms that neither the motor nor the driven equipment will be damaged by
reverse operation.

1.3 Check-Out Tags

.1 Upon receipt of equipment attach a "Check-Out Tag" to each piece of equipment
which has an equipment number assigned.

.2 On completion of each phase of the installation, enter the appropriate information on
the tag. Include test results or make cross-reference to appropriate test form in the
'Remark' section.

.3 Tag: size 90 mm x 215 mm, yellow coloured tag stock with metal reinforced eye.

1.4 Load Balance

.1 Measure phase current to panelboards and motor control centre with normal loads
operating at time of acceptance. If load unbalance exceeds 15 percent, 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 percent of
rated voltage of equipment.

.3 Submit, at completion of work, a report listing phase and neutral currents on
panelboards, switchboards, transformers and motor control centres, operating under
normal load. State hour and date on which each load was measured, and voltage at time of test.

1.5 Minimum Test Requirements

.1 The tests stipulated in this section are minimum requirements.

.2 Conduct additional tests recommended by equipment manufacturers or as deemed necessary by the Engineer as construction progresses.

1.6 Insulation Resistance Measurements

.1 General

.1 Prior to energizing the equipment, conduct insulation resistance measurements on conductors and energized parts of electrical equipment. Minimum acceptable values of insulation resistance shall be in accordance with the applicable ICEA, EEMAC or ANSI standards for the equipment or material being tested, unless otherwise specified. Record the ambient temperature at which insulation resistance is measured on the test form.

.2 Record insulation resistance measurements on the appropriate forms. Insulation with resistance of less than 10 megohms is not acceptable.

.2 Test Instruments

.1 Unless otherwise specified, use the following insulation resistance testers (Megger):

.1 500 V instrument for circuits, feeders and equipment up to 350 V.

.2 1000 V instrument for 350-600 V circuits, feeders and equipment.

.3 Conductor and Cable Tests

.1 Measure the phase-to-ground insulation resistance for all circuits 120 volts and above except lighting circuits. Measurements may be made with motors and other equipment connected. Disconnect solid state equipment unless the equipment is normally tested by the manufacturer at voltages in excess of 1000 volts DC.

.2 Check phase rotation and identify each phase conductor of each feeder.

.3 Check each feeder for continuity, short circuits and grounds.

.4 After installing cable but before splicing and terminating, perform insulation resistance test on each phase conductor.
.5 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.

.6 Replace entire length of cable if cable fails to meet any of test criteria.

1.7 Circuit Breakers (All Voltages)

.1 Visually inspect all connections and assemblies and check all manual operations and physical interlocks on circuit breakers as specified.

.2 Check correct position indication.

1.8 Motor Control Centre and Circuits

.1 Conduct tests and record information.

.2 Verify continuity of wiring.

.3 Verify correctness of operation by operation of all controls, interlocks and automatic devices.

.4 In the cases of motor starters, make these tests with starter racked out and with control fuse removed, using a temporary "foreign" control supply.

.5 With the incoming feeder cable disconnected, with all feeder switches and motor starters racked in, with all feeder switches and motor starter contactors open and with ground detector and voltmeter fuses removed, Megger between phases and each phase to ground. Megger readings shall be 10 megohms or higher.

.6 With the load end of each cable connected to the load (motor etc.) and with the contactor or switch open, Megger the outgoing feeder cables and motor windings to ground by connecting the Megger to the load side terminals of the starter or switch. Test only one phase on motor starters, and all three phases on fused switch feeder units. Megger readings shall be 5 megohms or higher.

.7 Verify phase rotation.

.8 Visually inspect fuses and verify overload settings with motor nameplate data. Verify MCP settings.

1.9 AC Motors

.1 Conduct tests and record information.

.2 Check for proper lubrication.

.3 Check for direction of rotation, verify correct rotation.

.4 Check for vibration and excessive noise.
TESTING

.5 Measure the insulation resistance of all motors before they are connected. Motors 50 hp and larger shall have their insulation resistance measured at the time of delivery as well as when they are connected. Insulation resistance values less than 10 megohms are not acceptable.

.6 With the incoming feeder cable disconnected, with all feeder switches and motor starters racked in, or connected, with all feeder switches and motor starter contactors open and with ground detector and voltmeter fuses removed, Megger between phases and each phase to ground. Megger readings shall be 10 megohms or higher.

.7 With the load end of each cable connected to the motor and with the contactor or switch open, Megger the outgoing feeder cables and motor windings to ground by connecting the Megger to the load side terminals. Test/record one phase on motor starters, all three phases on fused switch feeder units. Megger readings shall be 5 megohms or higher.

1.10 Calibration and Verification

.1 Description

.1 Calibrate and verify the following equipment supplied under this Contract:

.1 600 V MCC
.2 Transformers
.3 Panelboards and Breakers
.4 UPS Equipment
.5 Electrical Metering Equipment

.2 Conduct the calibration and verification in the field after installation and connection of equipment, but prior to energization.

.3 Calibration and Verification

.1 Ensure that all equipment is installed, connected and cleaned inside and out.
.2 Ensure that the specified tests have been carried out.
.3 The electrical rooms are clean and are adequately illuminated and heated.
.4 Provide 120V power for test purposes.
.5 Provide qualified personnel to assist in the calibration and verification.
.6 Provide all other facilities, equipment and personnel as reasonably required to assist in the calibration and verification.

.7 Ensure all bus and cable connections are tightened to manufacturer's specifications.

.8 Clean all relays with dry, dust-free compressed air.

1.11 Test Forms

.1 The forms listed below and included in this section are referenced from other sections of the specifications.

<table>
<thead>
<tr>
<th>Form No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>16030-A</td>
<td>Wire and Cable Resistance Test Data Form</td>
</tr>
<tr>
<td>16030-B</td>
<td>Insulation Resistance Test Report</td>
</tr>
<tr>
<td>16030-C</td>
<td>Installed Motor Test Form</td>
</tr>
<tr>
<td>16030-D</td>
<td>Dry Transformer Test Data Form</td>
</tr>
<tr>
<td>16030E</td>
<td>Motor Control Center Test Form</td>
</tr>
<tr>
<td>16030V</td>
<td>Installed Motor Starter Test Form</td>
</tr>
<tr>
<td>16030Z</td>
<td>Installed VFD Test Form</td>
</tr>
</tbody>
</table>
# Testing

**16030-A. Wire and Cable Resistance Test Data Form**

<table>
<thead>
<tr>
<th>Location of Test</th>
<th>Insulation Resistance (megohms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
</tr>
</tbody>
</table>

CERTIFIED ___________________________  Date ________________
Contractor's Representative

WITNESSED ___________________________  Date ________________
Owner's Representative
## 16030-B. CABLE INSULATION RESISTANCE TEST REPORT

<table>
<thead>
<tr>
<th>CLIENT:</th>
<th>REF. NO.:</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCATION:</td>
<td>DATE:</td>
</tr>
<tr>
<td>APPROX. TEST TEMP.:</td>
<td>TEST VOLTAGE:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CABLE IDENTIFICATION:</th>
<th>PHASE TO GROUND</th>
<th>PHASE TO PHASE</th>
<th>REMARKS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
<td>AB</td>
</tr>
</tbody>
</table>

### NOTES:
1. All readings in megohms unless otherwise noted.
16030-C. INSTALLED MOTOR TEST FORM:

Motor Equipment Number ________________________ Date of test ________________

Equipment Driven ________________________________

MCC Location ____________________________ Ambient temp _______ °C

Resistance:

Insulation resistance phase-to-ground megohms:

   Phase A ______ , Phase B ______ , Phase C ________

Current at Full Load:

   Phase _____ Current, _______ Amp
   Phase _____ Current, _______ Amp
   Phase _____ Current, _______ Amp

Thermal Overload Device: Manufacturer/catalog #_____________ Ampere ______

Circuit breaker (MCP) setting: ________________

Motor Nameplate Markings:

   Mfr __________ Type _______ Frame ___________ hp ________
   Volts _______ Phase _______ RPM _______ **Service factor ________
   Amps _______ Freq _______ Hz Ambient temp rating ___________________ °C
   Time rating ______________________ **Design letter ________________
      (EEMAC MG1-10.35) (EEMAC MG-1.16)
   kVA Code letter _________________ Insulation class ______________

**Required for 3-phase squirrel cage induction motors only.

CERTIFIED ________________________________ Date ________________
   Contractor’s Representative

WITNESSED ________________________________ Date ________________
   Owner’s Representative
TESTING

16030-D. DRY TRANSFORMER TEST DATA FORM:

Equipment No. ___________________________  Temperature ________________

Location ________________________________

Winding: Primary __________________________ Secondary __________________________

A. INSULATION-RESISTANCE TEST:

The test shall be made with a megohmmeter at the test voltage for a period of 1 minute.

<table>
<thead>
<tr>
<th>Voltage rating</th>
<th>Test voltage</th>
<th>Phase</th>
<th>Test results (megohms)</th>
<th>Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-600</td>
<td>1000</td>
<td>A-GRD</td>
<td></td>
<td>A-B</td>
</tr>
<tr>
<td>601-5000</td>
<td>2500</td>
<td>B-GRD</td>
<td></td>
<td>B-C</td>
</tr>
<tr>
<td>5000+</td>
<td>5000</td>
<td>C-GRD</td>
<td></td>
<td>C-A</td>
</tr>
</tbody>
</table>

Resistance readings less than the manufacturer’s recommended value or less than 10 megohms shall be brought to the attention of the Construction Manager.

B. DIELECTRIC-ABSORPTION TEST:

The test shall be made with a megohmmeter at the test voltage for a period of 10 minutes.

1. TEST RESULTS:

   (Megohms)

<table>
<thead>
<tr>
<th>Phase</th>
<th>Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-GRD</td>
<td>A-B</td>
</tr>
<tr>
<td>B-GRD</td>
<td>B-C</td>
</tr>
<tr>
<td>C-GRD</td>
<td>C-A</td>
</tr>
</tbody>
</table>

2. POLARIZATION INDEX:

\[
\frac{10 \text{ minute reading}}{1 \text{ minute reading}} = \text{polarization index}
\]

   (from paragraph "A" above)

<table>
<thead>
<tr>
<th>Phase</th>
<th>Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-GRD</td>
<td>A-B</td>
</tr>
<tr>
<td>B-GRD</td>
<td>B-C</td>
</tr>
<tr>
<td>C-GRD</td>
<td>C-A</td>
</tr>
</tbody>
</table>

Polarization index values less than 2 shall be brought to the attention of the Construction Manager.

CERTIFIED ___________________________  Date __________________________

Contractor’s Representative

WITNESSED ___________________________  Date __________________________

Owner’s Representative
## 16030-V. INSTALLED MOTOR STARTER TEST DATA FORM

### PROJECT: JOB NO.  PAGE 1 OF 1

### LOCATION: ENGINEER: DATE:

### EQUIPMENT NUMBER (TAG.) PANEL MFG. SERIAL No.

<table>
<thead>
<tr>
<th>VOLTAGE</th>
<th>CONTROL VOLTAGE: 120V</th>
<th>RATING:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Inspect for damage and missing parts (At panel site reception)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Inspect for loose nuts and bolts, look for loose parts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Inspect for dirt and foreign material</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Inspect insulators and quality of insulated parts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Inspect and set relays</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Inspect wiring and look for loose wiring connections</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Check ground connections</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Check terminals for shorts, open circuits using Ohmmeter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Check interconnection with exterior devices – using Ohmmeter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Check fuses sizes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Test Insulation Resistance; Megohms @ ___________ Volts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Check Mechanical &amp; Electrical operation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### POWER RELAY / CONTACTORS OPERATION CHECKED:

### MANUAL / AUTOMATED PANEL FUNCTION CHECKED:

### INTERFACE WITH OTHER SYSTEM / CONTROL DEVICES CHECK:

### TEST VOLTAGE 3Ø (1Ø):

- A
- B
- C

### TEST FEEDER CURRENT 3Ø (1Ø):

- A
- B
- C

### COMMENTS:

____________________________________________________________________________________

____________________________________________________________________________________

CERTIFIED Contractor's Representative

Date

WITNESSED Owner's Representative

Date
TESTING

16030-E. MOTOR CONTROL CENTER TEST FORM:

Equipment No. ________________  Ambient room temperature ________________
Location ____________________________________________

A. MECHANICAL CHECK:

All bolted connections either bus to bus or cable to bus shall be torqued to the manufacturer's recommendations. Confirm the MCC is secured against seismic forces in compliance with the Alberta Building Code and Section 16195.

B. ELECTRICAL TESTS:

1. Measure insulation resistance of each bus section phase to phase and phase to ground for 1 minute using a megohmmeter at 1000 volts.

   Test results (megohms)
   Phase     Phase
   A-GRD _____  A-B _____
   B-GRD _____  B-C _____
   C-GRD _____  C-A _____

2. Set the circuit breaker in the starter unit to comply with the requirements of driven equipment in compliance with the CEC.

3. Motor overload heater elements shall be sized and installed based on the actual nameplate full load amperes of the motor connected to the starter.

CERTIFIED ___________________________  Date ________________
Contractor's Representative

WITNESSED ___________________________  Date ________________
Owner's Representative
### 16030-Z. INSTALLED VFD TEST DATA FORM

<table>
<thead>
<tr>
<th>VFD Equipment No.</th>
<th>Date of Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driven Motor Equipment No.</td>
<td></td>
</tr>
<tr>
<td>Driven Load Characteristic:</td>
<td>Constant Torque</td>
</tr>
</tbody>
</table>

#### Set-points:
- **Minimum Frequency**: _____ Hz
- **Maximum Frequency**: _____ Hz
- **Acceleration Time**: _____ Sec
- **Deceleration Time**: _____ Sec

<table>
<thead>
<tr>
<th>Speed Range</th>
<th>Manual RPM</th>
<th>Remote RPM</th>
</tr>
</thead>
</table>

| VFD Current at Full Load: | PH.A _____ Amp, PH.B _____ Amp, PH.C _____ Amp. |
| Motor Current: | PH.A _____ Amp, PH.B _____ Amp, PH.C _____ Amp. |

#### Motor Nameplate Data:
- **Mfr:** ____________ **Mfr Type:** ____________ **Frame:** ________ **HP:** _____
- **Volts:** ________ **Phase:** ________ **RPM:** ________ **Service Factor:** ____________
- **Amps:** ________ **Freq:** ________ **HZ:** ________ **Ambient Temp. Rating:** ____________ °C
- **Time Rating:** ____________ **Design Letter:** ____________
- **kVA Code Letter:** ____________ **Insulation Class:** ____________

---

**CERTIFIED** ____________________________ **Date** ____________________________

Contractor’s Representative

**WITNESSED** ____________________________ **Date** ____________________________

Owner's Representative

**END OF SECTION**
1. GENERAL

1.1 Related Work

.1 Refer to Division 1 for General Requirements related to the Contract Documents.

.2 Refer to Division 11 (Process Mechanical), Division 15 (Mechanical), and Division 17 (Instrumentation) for mechanical and instrumentation work related to the electrical installation.

1.2 Description of Work

.1 The Contractor shall furnish and install as shown or specified herein the following basic materials and shall complete the Work in compliance with the following methods. The section shall include but not be limited to:

.1 Concrete Platforms, Foundations and Pits
.2 Electrical Equipment Mounting and Provisions
.3 Raceways
.4 Outlet Boxes, Pull Boxes and Junction Boxes
.5 Conduit Seals
.6 Wire and Cable
.7 Receptacles
.8 Line Voltage Switches
.9 General Installation and Location of Outlets and Equipment
.10 Special Requirements and Connections to Special Equipment
.11 Equipment Identification
.12 Equipment Cleanup
.13 Cutting and Patching
.14 Excavating, Trenching and Backfilling
.15 Remodeling
.16 Painting and Finishing
BASIC MATERIALS AND METHODS

1.3 Quality Assurance

.1 All materials and equipment shall be new and of best quality, of the type best suited for the purpose intended, and be made by nationally recognized and substantially established manufacturers.

.2 Where such listing is available, all electrical materials used in the Work shall be listed by the Canadian Standards Association, and shall bear the “CSA” label.

1.4 Codes and Standards

.1 Do complete installation in accordance with CSA C22.1 (latest revision) 2009, BC Building Code.

.2 Do underground systems in accordance with CSA C22.3 No.7-M86 except where specified otherwise.

.3 In general all Work shall be executed in accordance with the current codes, standards, statutes or recommendations of the following technical societies, trade organizations, and governing agencies, and shall be subject to the inspection of those departments having jurisdiction:

.1 Canadian Electrical Code (CEC) Latest Edition
.2 BC Building Code and WCB
.3 Institute of Electrical & Electronics Engineers (IEEE)
.4 National Fire Protection Association (NFPA)
.5 National Electrical Manufacturers Association (NEMA)
.6 International Organization for Standardization (ISO)
.7 International Electro technical Commission (IEC)
.8 Canadian Standards Association. (CSA)
.9 Insulated Cable Engineers Association (ICEA)
.10 Illuminating Engineering Society of North America (IES)

.4 Where work required by the drawings and specifications is above the standards required by these organizations or agencies, it shall be done as shown or specified.

.5 All fees, permits, licenses, etc., necessary in order to complete the Work of this section shall be obtained and paid by the Contractor.
BASIC MATERIALS AND METHODS

1.5 Quality Assurance

.1 All materials and equipment shall be new and of best quality, of the type best suited for the purpose intended, and be made by nationally recognized and substantially established manufacturers. The type and weight of material used for each purpose shall be as herein specified, and all material shall conform with the requirements of the latest standard specifications of the "ASTM" for that particular material.

.2 All electrical materials used in the Work shall be listed by the Canadian Standards Association, and shall bear a "CSA" label.

1.6 Shop Drawings

.1 Provide Shop Drawings as specified in Section 16010 – Electrical General Requirements.

1.7 Coordination of Work

.1 Cooperate and coordinate with other trades on the project.

.2 Make suitable arrangements with other trades to make provision for the electrical work and be responsible for the assurance that such provisions are satisfactory for the electrical work.

.3 Check drawings and specifications of other trades for conflict and coordination with the electrical trade. If any conflicts are found, obtain a ruling from the Engineer before proceeding.

2. PRODUCTS

2.1 Concrete Platforms, Foundations and Pits

.1 Unless otherwise specified or indicated, all floor mounted equipment (such as switchboards, motor control center, transformers, etc.) shall be anchored to two 100 mm by 50 mm minimum channel iron sills, by tack welding or bolting. Sills shall be furnished by the Contractor to suit the equipment and shall be installed so that equipment is 100 mm above floor.

.2 Where a membrane waterproofed floor or pressure slab is under the equipment, there shall be provided a 100 mm high concrete platform poured separately on top of finished floor slab. This platform shall not extend more than 50 mm in all directions beyond the maximum dimensions of the equipment. The 100 mm channel sills specified above shall be furnished and installed in this platform.

.3 In addition to the above, the Contractor shall provide all foundations and pits required for installation of the Work specified herein.
.4 The above specified concrete work shall be constructed of dense concrete composed of 1 part Portland cement, 2 parts clean, sharp sand, and 4 parts crushed stone or gravel. All exposed surfaces shall be finished with 1:2 mix cement mortar troweled smooth with beveled edges. All necessary anchor bolts, washers, templates, etc., shall be furnished complete and bolts shall be built into foundations with proper size sleeves.

2.2 Electrical Equipment Mounting and Provisions

.1 Wherever electrical switch gear, troughs, panel boards, etc., are indicated mounted on wall surfaces, the Contractor shall first install a 19 mm (¾ in) Type BD plywood panel of sufficient size for mounting all equipment. Plywood panels shall be cleanly cut, without burrs or splinters, square, and painted two coats of gray fire retardant preservative on both sides.

.2 Plywood shall be anchored to walls by means of toggle or expansion anchors. Equipment shall be attached to plywood by means of wood screws.

.3 Wherever indicated by the drawings or by other sections of this specification, furnish and install wiring troughs to facilitate connections to electrical equipment. Troughs shall be constructed of code gauge metal, prime coated inside and out and with a gray enamel finish coat. Covers shall be screw attachment type. Troughs shall be installed wherever two or more safety switches or motor starters occur at one location, fed from a common set of conductors, to allow tap connections to be made outside of the switch or starter cover.

2.3 Raceways

.1 Galvanized Rigid Conduit (GRC): shall not be used in wet process areas.

.2 Intermediate Metal Conduit (IMC): IMC (galvanized steel) shall not be used.

.3 Electrical metallic tubing (EMT): EMT shall not be used in process areas.

.4 Aluminum conduit; In general, heavy wall aluminum alloy conduit shall be used throughout except as specified hereinafter. Heavy wall conduit aluminum alloy with smooth interior and carefully reamed ends and shall bear the CSA label. Elbows and couplings shall contain the same alloying chemistry as the conduit. Heavy wall, aluminum conduit shall be used in all runs where required for mechanical protection. Heavy wall conduit only shall be used in hazardous areas and in poured concrete above ground. See "Special Requirements" for installation of conduit buried in earth. All aluminum couplings and fittings shall be of the threaded type.

.5 Rigid non-metallic conduit shall be made of virgin polyvinyl chloride resin, extruded, Schedule 40 RPVC conduit, light grey in color, supplied in 3 m lengths each with a coupling. It shall be CSA listed and bear the label for use above ground, underground direct burial and concrete encased. It shall be cut square with all rough edges removed from ends to protect the wires from abrasion. All connections shall be made by solvent welding. All fittings shall be installed in accordance with
the manufacturer’s recommended procedures. Expansion joints shall be provided wherever conduit crosses building expansion joints or where a wide temperature differential exists.

.6 Flexible metal conduit shall be used for connections to motors, fixed appliances and recessed luminaires where required. Maximum lengths of flexible conduit used to install motors, appliances or transformers shall be 750 mm. Metal conduits shall be jumpered by use of grounding bushing with pressure type wire terminal. A green grounding conductor shall be installed in all flexible metal conduit over two (2) meters in length; or 300 mm diameter or larger; conductor size shall be as indicated or as required by the Canadian Electrical Code.

.7 All empty conduits shall include a polypropylene fish cord between pull boxes.

.8 Conduits shall be fastened using two hole steel straps for conduits larger than 53 mm. Beam clamps shall be used to secure conduits to exposed steel work.

2.4 Boxes and Fittings

.1 Process area outlet boxes shall be aluminum standard electrical type with knockout openings as required and shall be manufactured by Appleton, Crouse-Hinds or equal and approved.

.2 Size boxes in accordance with CSA C22.1.

.3 102 mm square or larger outlet boxes as required for special devices. Gang boxes where wiring devices are grouped.

.4 Outlet boxes shall be at least 37 mm (1½ in) deep, 100 mm (4 in) square or octagonal stamped steel type with 100 mm (4 in) square device covers of size to accommodate devices noted. Outlet boxes in masonry walls may be special masonry type. Outlet boxes on exposed conduit runs in unfinished areas and equipment rooms shall be 100 mm (4 in) square or multi-gang boxes with matching covers. Outlet boxes on exposed conduit runs in finished areas or where indicated shall be cast FS type with covers as specified elsewhere. Outlet boxes for receptacle devices shall be provided with grounding lead lug or screw.

.5 Exterior outlet boxes noted as WP (weatherproof) shall be a flush FS type box with at least 4 machine screw connections for a gasketed device and cover.

.6 Pull boxes and junction boxes are generally not indicated on drawings except for special requirements. The Contractor shall install pull boxes or junction boxes as required to facilitate wire pulling. Pull boxes and junction boxes shall be galvanized code gauge steel with removable or hinged covers and shall be sized as required. Pull boxes and junction boxes shall be installed in accessible locations and shall not be installed in finished spaces without approval of the Engineer.

.7 Cast FS or FD feraloy boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle.
.8 Provide insulation barriers in gang type switch boxes containing more than one switch when connected to different voltage.

.9 Explosion-proof outlets shall be as specified elsewhere.

.10 On all conduit systems the connector fitting shall be of the insulated throat type. Where rigid conduit is connected to a threadless box, double locknut method shall be used.

.11 All metal conduit fittings shall be of steel and for aluminum conduits shall be alum, as manufactured by The Thomas and Betts Co., Steel City Company, RACO, or equal. Malleable iron fittings shall not be used on any conduits.

.12 If RAB box used minimum of four cover screws are required.

2.5 Wiring Devices

.1 The catalogue numbers shown below are for the particular manufacturer’s series and all necessary suffixes shall be added for the requirements as stated. All devices shall be specification grade minimum and wherever possible shall be of the same manufacture.

.2 Devices to be brown with stainless steel coverplates in all but mechanical areas unless noted otherwise. Use galvanized steel coverplates in mechanical areas and for surface mounted devices.

2.6 Switches

.1 120-277 V, 20 A, single and double pole, three and four-way: As Hubbell No. 1221, 1222, 1223 and 1224.

.2 For wet locations use the following switches: 20 A, 120 V single pole ivory, side wired press-switch, as Hubbell #1281.

.3 Manually - operated general purpose AC switches shall have the following features:

   .1 Terminal holes approved by AWG #10 wire.
   .2 Silver alloy contacts.
   .3 Urea or melamine molding for parts subject to carbon tracking.
   .4 Suitable for back and/or side wiring.

2.7 Receptacles

.1 Duplex 15 A, 120 V, 3 wire, ivory, U-ground, as Hubbell No. 5252, with the following features:
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.1 White urea molded housing.
.2 Suitable for #10 AWG for back and side wiring.
.3 Eight back wired entrances, four side wiring screws.
.4 Break-off links for use as split receptacles.
.5 Triple wipe contacts and riveted grounding contacts.

.2 Duplex 15 A, 120 V, 3 wire, ivory, U-ground ground fault receptacle, as Hubbell No. GF-5261.
.3 Single 15 A, 120 V, 3 wire housekeeping receptacle with stainless steel plate engraved with Housekeeping, as Hubbell No. 5262.

2.8 Coverplates

.1 Use stainless steel 1 mm thick coverplates on all wiring devices mounted in flush-mounted outlet boxes unless otherwise specified.
.2 Weatherproof double lift spring - loaded cast aluminum coverplates, complete with gaskets for single receptacles or switches.
.3 Weatherproof spring - loaded cast aluminum coverplates complete with gaskets for single receptacles or switches.
.4 Use gasketted DS cast covers on FS and FD type boxes.

2.9 Wiring and Box connectors

.1 To CSA C22.2 No. 65 Wire Connectors.
.2 EEMAC 1Y-2, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

2.10 Connectors

.1 Pressure type wire connectors: with current carrying parts same material as conductors sized to fit the conductors as required.
.2 Fixture type splicing connectors: with current carrying parts same material as conductors sized to fit the conductors 10 AWG or less.
.3 Bushing stud connectors: to EEMAC 1Y-2 to consist of:
   .1 Connector body and stud clamp for stranded copper conductors.
   .2 Clamp for copper conductors.
2.11 Wire Connectors

.1 Use 3M “Scotchlock”, self-insulated connectors for hand twist wire joints for lighting, small power, and control wiring up to #12AWG wire size.

.2 Use T & B non-insulated ring type compression lugs for terminating #10 AWG and smaller motor connections. Tape with rubber and scotchtape. Lugs to accept ten - 32 x 3/8 in machine bolts.

.3 Terminate conductors #8 AWG and larger with Thomas & Betts Colour-Keyed compression connectors Series 54000, or on lugs provided with equipment.

.4 Thomas & Betts “KOPR-SHIELD” compound Series CP8 on all terminations for compression connectors.

2.12 Wire and Cable – 1000 Volt Rated

.1 All wire and cable for feeder and branch of circuits shall conform to the requirements of the current edition of the CEC and shall meet all relevant Specifications. Conductors shall be 1000 volt rated for all motor feeders operated from VFDs or power feeders to equipment that includes VFDs., or 600 V rated, coated soft-drawn copper or annealed copper, and unless otherwise noted on the plans and in these specifications, shall have type THWN or THHN insulation. Wire and cable shall not be older than 12 months.

.2 Wire and cable shall comply with the latest editions of ICEA standard WC5 (5-61-402) for thermoplastic insulated wire.

.3 Conductor sizes shall be standard American Wire Gauge (AWG) sizes and shall be as noted on the drawings. All conductors No. 12 and smaller shall be solid; No. 10 and larger, stranded. Minimum size shall be No. 12, unless otherwise noted. Wire size on 120 volt, 20 ampere branch circuit runs over 25 metres shall be increased to No. 10 (minimum) to limit excessive voltage drop. All 3 phases, 4 wire (20 ampere) branch circuit home runs for ballasted lighting shall be minimum No. 10 wire. Wire size requirements larger than No. 12 shall be as noted on the Drawings or as required for the load listed.

.4 All wire and cable shall be delivered to the job in standard coils and reels with approved tag noting length, wire size, insulation type, and manufacturer’s name;
and shall be suitably protected from weather and damage during storage and handling.

.5 Branch circuit lighting, receptacle and power wire shall be type RW90 XLPE copper wire. Wire for special systems shall be as specified for the system. Recessed fixture leads and continuous row LED fixture wiring shall be type RW90 XLPE. All wire in process rooms, fan rooms and other areas with high ambient temperature conditions shall be type RW90 XLPE.

.6 Splices shall be made with solderless - tapeless, mechanical wire connectors with spring action to maintain constant pressure on the conductors. Connectors shall be U.L. listed and equal to 3M Scotchblok Brand, Type Y, R, G, and B, or Ideal Model 45I, 452, 455, and 453.

.7 Splices and taps in wireways shall be made using 3M Scotchblok Brand #562 and 567 self-stripping tap connectors for copper conductor size No. 12 and No. 10. For conductors size No. 8 and larger, use approved gutter taps similar to OZ/Gedney type PMX combination parallel gutter taps and covers.

.8 Where taping of conductors is required, use minimum of two layers wrapped half-lapped. Tape shall be U.L. listed 3M Scotch Branch 33+, or equal. Splices in areas of high ambient temperatures (boiler control panels, electric heating element controls and junction boxes, etc.) shall be made with crimp type, zinc plated steel, connectors with wrap-cap insulators equal to Ideal crimp connector.

.9 Branch circuit wire and cable shall be factory color-coded by integral pigmentation, and feeder cables shall be color-coded at all terminations with plastic colored tape, with a separate color for each phase and neutral conductor. The color code indicated in the accompanying chart shall be used consistently throughout the electrical installation.

<table>
<thead>
<tr>
<th>CONDUCTOR</th>
<th>SYSTEM VOLTAGE</th>
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<tbody>
<tr>
<td></td>
<td>208/120 V</td>
</tr>
<tr>
<td></td>
<td>600/347 V</td>
</tr>
<tr>
<td>PHASE A</td>
<td>RED</td>
</tr>
<tr>
<td>PHASE B</td>
<td>BLACK</td>
</tr>
<tr>
<td>PHASE C</td>
<td>BLUE</td>
</tr>
<tr>
<td>NEUTRAL</td>
<td>WHITE</td>
</tr>
<tr>
<td>EQUIP. GND.</td>
<td>GREEN</td>
</tr>
</tbody>
</table>

2.13 Building Wires

.1 Conductors: stranded for 12 AWG and larger.

.2 Minimum conductor size 12 AWG.

.3 Copper conductors: size as indicated, with 1000 VAC insulation of chemically cross-linked thermosetting polyethylene material rated RW90.
2.14 Teck Power and Control Cables

.1 To CSA C22.2 No. 131 – Teck Cable.

.2 Minimum conductor size is #12 AWG for power cables and #14 AWG for control cables Conductors:
   .1 Grounding conductor: copper.
   .2 Circuit conductors: size as indicated.

.3 Insulation:
   .1 Type: Chemically cross-linked thermosetting polyethylene. RW90: 1000 VAC for power, 600 VAC for control wiring.
   .2 Direct buried Teck cable shall be Teck RWU90.

.4 Inner jacket:
   .1 Polyvinyl chloride.

.5 Armour:
   .1 Interlocking aluminum.

.6 Overall covering:
   .1 Polyvinyl chloride, FT4 rating – UV protected

2.15 Variable Speed Drive Cable

.1 For VFD drive applications, provide variable speed drive rated cables between the VFD drive and motor.

.2 Cable shall comply to:
   .1 CSA C22.2 No. 123 – Metal sheath cables

.3 Variable Speed Drive Cables shall include:
   .1 Triple grounded, increased dielectric type Teck cable suitable to reduce the high-frequency noise emissions of the drive and reduce the bearing current effects.
   .2 Contain a geometric arrangement of the conductors to ensure identical coupling capacitance is obtained.
.3 Provide type W connectors for dry or wet locations. Refer to Teck Cable connectors for additional requirements.

.4 Acceptable Products

.1 Nexans DriveRx 1kV rated cable or equivalent

.4 All control wires terminated in the PLC cabinets shall be stranded.

.5 Connectors:

.1 Watertight approved for TECK cable, equal to Thomas & Betts Star-Teck ST series aluminum fittings in all areas.

2.16 Aluminum Conductors

.1 Aluminum wire shall not be used.

2.17 Fastening and Supports

.1 All fastening and supports to meet requirements of Section 16191

.2 Secure equipment to poured concrete with expandable inserts.

.3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.

.4 Fasten exposed conduit or cables to building construction or support system using straps.

.1 One-hole malleable iron straps to secure surface conduits and cables 50 mm and smaller.

.2 Two hole steel straps for conduits and cables larger than 50 mm.

.3 Beam clamps to secure conduit to exposed steel work.

.5 Provide metal brackets, frame hangers, clamps, and related types of support structures where indicated or as required to support conduit and cable runs.

.6 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.7 Do not use wire lashing or perforated strap to support or secure raceways or cables.

.8 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Engineer.

.9 Install fastenings and supports as required for each type of equipment, cable and conduit, and in accordance with manufacturer’s installation recommendations.
3. EXECUTION

3.1 General Installation

.1 Conduits shall be sized as noted or as required by CEC for number and size of conductors installed except that 19 mm shall be minimum size for all conduit runs. Maximum size shall be as allowed by the CEC and within the limits of commonly manufactured sizes.

.2 All conduit joints shall be cut square, threaded, reamed smooth and drawn up tight. Bends or offsets shall be made with standard conduit ells or field bends made with an approved bender or hickey.

.3 All metal conduit and metal raceways except as noted below and unless the building construction forms an approved means of support, shall be securely positioned by stainless steel or aluminum straps, clamps and hangers with suitable fastenings. Concealed conduits shall be run in a direct line with long sweep bends and offsets. Exposed conduits shall be run parallel to and at right angles to building lines and neatly grouped and supported with approved conduit hangers or channel supports. Wooden plugs shall not be used.

.4 All conduit, fittings and boxes shall be concealed where building construction will permit except drops from ceilings, risers from floor to island motors or appliances in equipment areas.

.5 All conduits 25 mm diameter and larger shall be provided with expansion fittings where the conduits cross building joints. Conduit with continuous horizontal runs over 30 m, without a minimum of two 90° bends, shall be provided with expansion fittings. Expansion fittings in poured concrete shall be OZ/Gedney Type "AX" with Type "BJ" bonding jumper. For Electrical Metallic Conduit (EMT) use Type "TX" expansion fittings.

.6 Conduits shall be continuous from outlet to outlet, from outlets to cabinets, pull or junction boxes and shall be secured to all boxes with locknuts and bushings in such manner that each system shall be electrically continuous throughout. Conduit ends shall be capped to prevent entrance of foreign materials during construction. Conduit size changes shall occur only at outlet or pull boxes.

.7 Rigid non-metallic conduit shall be used only where noted on the drawings. Even where use is indicated, rigid non-metallic conduit shall not be used above grade or where exposed, even partially. No non-metallic elbows shall be used anywhere. All elbows shall be galvanized rigid steel, with a minimum radius of 12 times the conduit diameter.

.8 The Contractor shall provide and install all conduits and wiring for power, controls, and communications, noted on drawings for Division 11. Coordinate with Division 11 for devices to be connected by conduits, and the number and size of control conduits to be installed by Division 16.
.9 The Contractor shall provide and install all conduits for power, controls, and communications, plus wiring for any 120 volt power supply requirements noted on drawings for Division 11. Control and signal conductors shall be provided and installed by Division 11. Coordinate with Division 11 for devices to be connected by conduits, and the number and size of control conduits to be installed by Division 16.

.10 This Contractor shall provide and install all conduits and wiring for power, controls, and communications, noted on drawings for Division 15. Coordinate with Division 15 for devices to be connected by conduits, and the number and size of control conduits to be installed by Division 16.

.11 All cables, wires and conduits to enter into bottom of equipment which is installed in potential washdown process areas.

.12 All junction boxes and pull boxes shall have rubber gasket and minimum four machine screws for cover.

3.2 Location of Outlets and Equipment

.1 Outlets shall be installed at the heights and approximate designated positions as shown on drawings or indicated in specifications, unless otherwise directed. Outlets in similar rooms shall be installed in the same relative location in each room. Outlets shall not be installed back-to-back but shall be offset approximately 150 mm (6 in), or 600 mm (24 in) in fire-rated walls.

.2 Outlets shall be located to clear piping, ductwork and other obstructions. Switch outlets shall be on latch side of door except where type of construction dictates otherwise. Outlets in masonry or tile shall be located as far as practical adjacent to horizontal and vertical mortar joints to minimize cutting.

.3 All outlet boxes installed in plaster, plasterboard, acoustic tile, or paneled surfaces shall be provided with plaster rings except 100 mm (4 in) octagonal ceiling boxes. Outlet boxes installed in masonry, tile or concrete surfaces, shall be provided with square corner type extension rings where special masonry boxes are not used. All outlet boxes shall be protected from entrance of foreign materials during the construction period.

.4 All outlet boxes shall be concealed except where shown or noted otherwise. Outlet boxes, plaster rings or extension rings shall be installed flush with the finished surface. Openings for boxes in masonry, tile, plasterboard, paneling, or similar surfaces shall be cut in by trades installing the surface material and shall be exact box size. The Contractor shall verify type and depth of finished surface so that outlet will be flush.

.5 Verify locations and dimensions of electrical equipment, particularly in the case of door swings, heights of cabinets and counters, shelves and location of equipment installed by Owner or other trades.
.6 Mounting heights indicated on drawings shall be to centerline of outlet unless indicated otherwise. Heights may be adjusted to align with mortar joints as specified above, however, all similar outlets in a given area shall be adjusted to the same height unless specifically noted at the outlet.

.7 Duplex receptacle outlets indicated to be installed above counters shall be mounted in horizontal plane not less than 75 mm (3 in) higher than the top of the counter backsplash or at heights indicated.

.8 All similar equipment shall be installed at the same heights throughout the building, such as panelboards, motor starters, etc.

3.3 Special Requirements

.1 All metallic conduit buried in earth exterior shall be specially protected against corrosion and deterioration by one of the following methods:

.1 Field coat entire conduit and fittings with asphalt paint equal to Bitumastic #50.

.2 Use 40 mil PVC coated conduit, equal to Perma-Cote Standard by Perma-Cote Industries.

.2 All couplings shall be painted after assembly. All nicks in plastic coated conduit shall be painted with plastic material as recommended by manufacturer. Where bitumastic paint is applied, the paint must be thoroughly dry prior to backfilling.

.3 Exterior conduit shall be installed a minimum of 600 mm (24 in) below grade. Where multiple conduit runs are indicated, they shall be installed in the same trench. Backfilling shall be as specified elsewhere. Provide drain tees in each conduit and pitch conduit to drain tee. Provide gravel drain pocket below drain tee. On long runs drain tees shall be installed a maximum of 30 m (100 ft) apart.

.4 Conduits in poured concrete shall not be larger than 1/3 of the thickness of the slab and shall be located entirely within the middle 1/3 of the concrete member.

.5 Where conduits pass through roof, care should be taken to provide proper flashing and seal against moisture leakage.

.6 Conduit shall not be installed outside of building walls or exterior court areas except where specifically noted.

.7 All conduit systems must be installed complete before conductors are pulled in. Wire shall not be drawn into conduit until after the conduit system is complete and has been thoroughly swabbed out. Wire shall not be drawn into conduit in such a manner as to injure the insulation.
3.4 Connections to Special Equipment

.1 Special equipment is hereby defined as all equipment that is not specified under this section but requires connections by the Contractor, as indicated on the drawings. Such equipment includes blowers, pumps, and 120 volt power supply to instrumentation and control equipment. Connections shall be performed by the Contractor. This contractor shall verify the locations of such connections by securing from the equipment suppliers or Division 11, 17 or 15 contractors, templates, detail drawings and roughing-in measurements.

.2 Unless otherwise specified, the Contractor is responsible for furnishing such equipment is also responsible for setting the equipment in place.

.3 All equipment included in this division of the specifications requiring connections shall be provided with proper openings, tappings, flanges, etc., ready for final connection.

.4 The Contractor shall provide and install conduit plus cables for all low-voltage wiring required by Division 11 for process mechanical and conduit plus cables for all low-voltage wiring required by Division 15 for mechanical. Coordinate with Divisions 11, 15 and 17 for conduit sizes, cable requirements locations, and routings.

3.5 Equipment Identification

.1 All electrical equipment furnished by the Contractor shall be provided with identification indicating its use or function. Equipment to be identified shall include, but not be limited to switchboards, panelboards, distribution panels, automatic transfer switches, special system control panels, motors, and motor starters, push-button stations, pilot light, special lighting or control switches, emergency receptacles, special receptacles, communication system pull boxes and junction boxes, and empty conduits provided for future use. Normal use lighting switches, receptacles and conduit will not require identification unless specifically noted otherwise.

.2 Identification labels shall be white laminated plastic plates with black engraved letters. Letters shall be minimum of 6 mm (1/4 in) high and centered on the plates. Attach plates with self tapping screws or pop rivets. They shall be glued as well. Flush panelboards occurring in corridors shall have identification plate on interior, attached with adhesive. Labels for the emergency distribution equipment shall be red laminated plastic plates with white letters.

.3 For communication systems pull or junction boxes and blank outlet boxes, plastic laminated engraved, adhesive backed labels, black color, shall be used for identification (attach to inside of coverplate in finished areas).

.4 Distribution sections, motor control center, etc., shall have individually identified breakers or switches with identification directly adjacent to the device and not in a typed directory.
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.5 Panelboards shall be provided with a neatly typed directory with plastic protector of circuits describing loads and areas served. Room names or Owner’s room numbers shall be used; do not use plan room numbers. Spare positions shall be left blank on directory.

.6 Hand lettering of identification will not be acceptable. Temporary labels used during construction shall be completely removed and surface repainted if required.

.7 Devices using standard wall plates and requiring identification shall be provided with engraved plates. Plates shall be machine engraved and the letters filled in with white enamel, with minimum 6 mm (1/4 in) high letters.

.8 Identify electrical equipment with name plates and labels as indicated in Section 16010, following the requirements;
   .1 Wording on nameplates to be approved by Engineer prior to manufacture.
   .2 Allow for average of twenty-five letters per nameplate.
   .3 Identification to be English.
   .4 Disconnects and contactors: indicate equipment being controlled and voltage.
   .5 Terminal cabinets and pull boxes: indicate system and voltage.
   .6 Local Control Panel: indicate equipment being controlled and voltage.
   .7 Transformers: indicate capacity, primary and secondary voltages.

3.6 Wiring Termination

.1 All wires are to be terminated on approved lugs or terminal blocks suitable for copper conductors.

3.7 Equipment Cleanup

.1 Special care must be taken for protection of panels, switches, starters, etc. All must be kept completely protected from weather elements, painting, etc., until the building is substantially completed. Damage from rust, paint, scratches, etc., shall be corrected as directed by the Engineer.

.2 Clean all switchgear, motor controls, etc., and take special care to remove dirt, mortar, wire scraps, etc., from junction boxes and switchgear interiors.

.3 Clean light fixtures and lamps thoroughly, just prior to final inspection. Fixture globes, enclosures, shielding, etc., shall be cleaned by an approved method.
.4 Accessible elements of disconnecting and protective devices of equipment, coils of dry type transformers and the like shall be cleaned with compressed air (less than 15 psi) and the enclosures vacuum cleaned prior to being energized.

.5 Protection of electrical equipment during painting of the building shall be the responsibility of the Contractor. This shall not relieve the Contractor of the responsibility for checking to assure that adequate protection is being provided.

### 3.8 Cutting and Patching

.1 In existing construction this contractor shall perform all cutting required and all necessary patching after completion to restore the surface to its original condition, unless otherwise indicated.

.2 In new construction the Contractor will be required under the Contract Documents to leave all chases and openings in walls, floors, ceilings, partitions, etc., where shown on the drawings or otherwise necessary to receive electrical work, but the Contractor shall furnish full information as to locations, dimensions, etc., of such chases and openings, including provision and proper setting of sleeves and other equipment in such time as to cause no delay to the Work.

.3 Should any cutting of walls, floors, ceilings, partitions, etc., be required for proper installation of the Work or apparatus of the Contractor, or be made necessary on account of the Contractor’s failure to give proper information at the time required, such cutting shall be done at the Contractor’s own expense, restoring the Work to its original condition.

.4 All cutting and patching done by this contractor shall be subject to the direction and approval of the Engineer. This contractor shall not endanger the stability of the structure by cutting, digging, or otherwise, and shall not be at any time cut or alter work of any other contractor without Engineer's consent.

### 3.9 Excavating, Trenching and Backfilling

.1 The Contractor shall perform all excavation to the depths indicated on the drawings or specified. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from trench or other excavations to prevent slides or cave-ins. All excavated materials not required or usable for backfilling shall be removed from the site. Necessary grading shall be done to prevent surface water from flowing into trenches or other excavations and onto adjacent property. Furnish all pumping required to keep excavated space clear of water during construction. The Engineer will inspect excavation and approve soil conditions and direct procedure if unsatisfactory conditions are discovered. Provide sheeting and shoring as may be necessary for the protection of the Work and the safety of personnel and to conform with WorkSafe BC regulations. Protect bottom of excavation from frost and do not place structures or pipe on frozen ground.

.2 Prior to opening an excavation, effort shall be made to determine whether underground installations such as sewer, telephone, water, fuel, electric lines, etc.
will be encountered, and if so, where such underground installations are located. When the excavation approaches the estimated location of such an installation, the exact location shall be determined and when it is uncovered, proper supports shall be provided for the existing installation. Utility companies shall be contacted and advised of proposed work prior to the start of actual excavation.

.3 Backfill excavations below finished grades with similar materials to that removed in excavation, free from rubbish and other unsuitable material. Backfilling shall be done to finished grades indicated on the Drawings. If no finished grading is to be done in excavated areas, the Contractor shall backfill to existing grades and restore the surface to its original condition. All backfill shall be compacted in 150 mm (6 in) lifts to 95% maximum density.

.4 The Contractor shall be responsible for protecting trenches and providing adequate crossovers where pedestrian and vehicular traffic occurs. Guard rails, flags, lamps, etc., shall be used for such protection.

.5 This Contractor shall be responsible for the replacement of existing street pavement, curbs, sidewalks, etc., removed or damaged in the course of the work unless such pavement, curbs and sidewalks are to be reconstructed under the Contract Documents. The Contractor shall make necessary arrangements to perform such repairs and shall pay all costs in connection therewith and include it in his Tender.

3.10 Remodeling Work

.1 Contractor shall visit existing buildings before submitting bid and become familiar with existing conditions.

.2 In general, wiring in existing buildings shall remain as is except as noted on drawings or specified elsewhere.

.3 When existing walls, ceilings, floors, electrical panels, light fixtures, switches, or other outlets are removed, the Contractor shall extend existing circuiting, if required; install junction boxes in walls, ceilings or floors, if required, to continue circuiting; remove all unused wire; remove all unused conduit where accessible; and install new plates with blank gangs as required on existing outlet boxes.

.4 Added loads to existing circuiting shall be balanced between phases. On existing panelboard where circuitry is changed, the Contractor shall furnish a revised, typed panel directory.

.5 Where new conduit is surface mounted in existing finished areas, the Contractor shall be responsible for painting the new conduit and boxes to match the existing surface finish.

.6 Existing equipment removed and not reused shall become the Contractor's property and be removed from the site, unless otherwise specified or shown.
BASIC MATERIALS AND METHODS

.7 The Contractor shall coordinate all removal work to maintain services to all equipment and areas until such time as these items are removed or demolished.

.8 The Contractor shall work closely with the Owner to coordinate removal or relocation of all telephone conduit and outlets. Provide Owner minimum of 48 hours notice of any demolition affecting telephone services or equipment.

.9 The facility must remain in operation during construction. Contractor shall provide any temporary connections necessary to maintain services to the existing service. Provide advance notice of minimum 72 hours to the Owner of any temporary service outages. Advance notice shall be in writing with copies to the Engineer. Provide temporary generator power when outages are anticipated to exceed 1 hour in duration.

.10 In general, the Contractor shall assume that all work which involves a service outage shall be performed on an overtime basis. Work shall continue until service is restored.

3.11 Check Lists

.1 The following check lists are provided as a guide only. All work shall be strictly to specifications and the latest Canadian Electrical Code.

.1 Raceways, Cables and Conductors

.1 Conduits are free of kinks.

.2 The conduits are new (salvaged raceways permitted only with special permission).

.3 Approved raceways are used for the application and environment in which they are placed.

.4 Conduits do not have more than the equivalent of three 90° bends.

.5 Conduits are properly and adequately supported.

.6 Conduits are installed neatly, attractively and grouped wherever and whenever possible.

.7 Conduits that are supported on hanger racks must have the spacing of the support based on the size of the smallest raceway in the group.

.8 Conduits are mechanically free of undue stress and strain.

.9 Insulating bushings are installed on all raceways that contain conductors #8 AWG or larger.

.10 Radii of conduit bends to conform to code standards.
BASIC MATERIALS AND METHODS

.11 Conduits are sloped to prevent accumulation of moisture in electrical distribution equipment or in boxes.

.12 Conduits terminate with approved connectors or couplings.

.13 Unused conduits or empty conduits are properly capped to prevent debris, dirt, etc. from entering.

.14 Rigid metal conduit is properly reamed and threaded.

.15 Rigid metal conduit has two locknuts and a bushing wherever it terminates.

.16 EMT may not be in contact with the earth.

.17 EMT may not be mounted in wet locations (e.g. EMT may not be installed on the surface of a roof).

.18 Expansion fittings or similar methods are used whenever the expansion and contraction of the conduit is a factor.

.19 Field bends on PVC are free of deformations, kinks and thermal scarring.

.20 Pull strings and or pull boxes are present for conduit lengths in excess of 30 m.

.21 Conduit fill meets code standard.

.22 Conduits penetrating a firewall, outside wall or routed through a hazardous location are properly sealed.

.23 Conduits requiring bonding conductors must have the bonding conductor routed inside of the raceway.

.24 Conduits must never contain spliced conductors.

.25 Mechanical protection is required for conduits that are subject to injury (e.g. Conduit riser on a power pole located in a lane or driveway).

.26 Pulling compound has been removed and cleaned from the exterior of the conduit.

.27 Conduits that emerge from concrete structures that are subject to frost heaval must be sleeved to prevent the conduit from being strained.

.28 Condulets such as LB, LL, LR, T, C do not contain spliced conductors (special permission may be granted).

.29 Condulets are accessible for maintenance purposes.
.30 Seal tight flexible conduit is kept as short as necessary to provide a flexible connection.

.31 10 mm flexible conduit is kept to 750 mm or less in length.

.32 Only plenum rated (FT4) cables are to be placed in plenum spaces.

.33 Termination bushing or sleeve is present for AC90 cables (BX).

.34 Cables are properly and adequately supported.

.35 Conductors are color coded.

.36 Conductors and cables are clearly and legibly identified as required by the specifications.

.37 Vertically oriented cables are properly supported with no undue strain being experienced by the connector.

.38 Cables and conductors are installed only when ambient temperatures are acceptable for the conductor's insulation rating.

.39 Cables and conductors are terminated with approved connectors.

.40 Distribution cables and conductors are within the maximum allowable 3% voltage drop.

.41 Cables and conductors routed through areas with an ambient temperature above 30 °C are de-rated.

.42 Cables and conductors contained within a raceway with more than three current carrying conductors are de-rated.

.43 Insulation rating of conductors is correct for the application (e.g. RW90 required for conductors connecting luminaires).

.44 Single conductor armoured cables with significant sheath currents must be de-rated or isolated from ground.

.45 Paralleled conductors must be same size, type, length, insulation and terminated in an identical manner.

.46 Paralleled conductors are placed in approved configurations.

.47 Cables placed in cable trays are properly spaced or the cables are de-rated.

.48 Cable tray loading capacity is within acceptable limits.
.49 Cables in cable trays passing through a firewall are fire stopped with an approved sealing agent.

.50 Cable trays are clearly identified with tags.

.51 A bonding conductor accompanies metallic cable trays.

.52 Bus-ways are located in a dry and non-corrosive environment.

.2 Boxes, Cabinets and Wireways

.1 Splitter boxes are mounted to allow the hinged door to fall open (hinges are located along the lower edge).

.2 Covers for splitter boxes and wire-ways are secured without any strain being imposed on the cover from conductors contained within.

.3 Enclosures are rated for the environment in which they are placed.

.4 Boxes are sufficiently large to accommodate all the conductors they contain and for all the devices that may either be mounted on them or within them.

.5 Junction boxes, termination boxes, cabinets and wire racks are tagged, labeled and or color coded.

.6 Junction boxes, termination boxes, cabinets and wire racks are adequately supported.

.7 Junction boxes, termination boxes, cabinets and wire racks are free of damage, scratches and dents.

.8 A minimum of 225 mm of conductor length is present at each outlet box.

.9 Cover plates are on the boxes and are adequately secured (all screws or bolts are on).

.10 Unused openings in boxes, cabinets and fittings are closed.

.11 Conductors of different power systems contained within the same enclosure are suitably barriered.

.12 Pull boxes or junction boxes are large enough to accommodate the required bending radius of the conductors.

.13 Junction boxes, termination boxes, cabinets and wire racks are fully accessible.
.14 Junction boxes, termination boxes, cabinets and wire racks are color coded where required.

.3 Receptacles and Switches

.1 Overcurrent protection of receptacles to be no larger than the current rating of the receptacle.

.2 Mounting height of receptacle conforms to specifications and drawings.

.3 Receptacle ‘grade ‘matches the requirements of the specifications.

.4 Receptacles are bonded and the receptacle-bonding pin has been correctly selected.

.5 Receptacles are free of cracks, marks, paint and damage.

.6 Receptacles are mounted in locations where mechanical damage to the receptacle will not occur.

.7 Cover plates approved for the location of the receptacle and for the mounting type (e.g. do not place flush type cover plate on a surface mounted enclosure) are secured to the receptacle.

.8 Receptacles are firmly secured to their enclosures.

.9 Receptacles are mounted flush to their enclosures.

.10 Locking type of receptacles are used in areas subject to a more severe duty.

.11 Split duplex receptacles have the ungrounded conductor link removed.

.12 Ground fault type receptacles are tested.

.13 Split duplex receptacles are protected by two pole breakers.

.14 Color coding of receptacles conforms to specifications.

.15 Conductors are properly secured to receptacle terminals.

.16 Voltage rating of the switch matches or exceeds the supply voltage.

.17 Switches are adequately secured to their enclosures.

.18 Switches appear flush with their enclosures or with the finished surface.

.19 Cover plate for the switch approved for the application.
.20 Terminations and connections are secure and conform to standard wiring practices.

.21 Switches are rated for the type of load that they control or provide disconnection for (e.g. motor load must have switch rated in horsepower).

.22 LED on low voltage switches are operational.

.23 Switches are free of cracks, marks, paint or other defects.

.24 Switches are color coded as per the specification.

.25 Switches are mounted at suitable heights and in locations approved by code and as per the drawings and specifications.

.26 Switches are operational and controlling the load as prescribed in the specifications and drawings.

.27 Rating of dimmer switch is within the limits of the load being controlled.

END OF SECTION
1. GENERAL

1.1 Related Work

.1 Excavating, Trenching and Backfilling: Division 2

.2 Concrete Form-Work: Division 3

.3 Concrete Reinforcement: Division 3

.4 Cast-In-Place Concrete: Division 3

1.2 Shop Drawings

.1 Submit shop drawings for precast manholes in accordance with Section 16010.

2. PRODUCTS

2.1 PVC Ducts

.1 PVC ducts, type DB2, encased in reinforced red concrete.

2.2 PVC Duct Fittings

.1 Rigid PVC solvent welded type couplings, bell end fittings, plugs, caps, adaptors as required to make complete installation.

.2 Expansion joints to manufacturer’s recommendation for long runs, or PVC ducts leaving/entering buildings.

.3 Rigid PVC 5° angle couplings.

2.3 Pre-Cast Concrete Manholes

.1 Precast concrete manholes and auxiliary sections fabricated in steel forms.

.2 Aggregates: to CAN3-A23.1.

.3 Cement: to CAN3-A5, Type 30.

.4 Steel welded wire fabric mesh reinforcing: to CSA G30.3. Openings and critical areas trimmed with steel reinforcing bars: to CSA G30.12.

.5 Pulling inserts and bolts for racks integrally cast in concrete: to ANSI/ACI-347-78.

.6 Neoprene gasket seals between manhole sections: to ASTM D1056-85.
.7 Standard of Acceptance: Con-Force vault 8-0004.

2.4 Drainage

.1 Floor drain fittings in each manhole consisting of floor drain, back water valve, trap and pipe connection to dry sump.

2.5 Manhole Necks

.1 Concrete manhole neck to bring cover flush with finished grade in paved areas and 40 mm above grade in unpaved areas.

.2 Build up neck with concrete brick and mortar to achieve above if necessary.

2.6 Manhole Frames and Covers

.1 Bolted on covers to prevent unauthorized entry.

2.7 Grounding

.1 Ground rods: 3 m x 19 mm copper clad complete with 2/0 AWG conductor for metal structure and cable rack grounding.

2.8 Cable Racks

.1 Hot dipped galvanized cable racks and supports.

.2 12 x 100 mm preset inserts for rack mounting.

2.9 Cable Pulling Equipment

.1 Pulling iron 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 Markers

.1 Concrete type cable markers: 100 x 600 x 100 mm, with words; "cable", "joint" or "conduit" impressed in top surface, with arrows to indicate change in direction of duct runs.

3. EXECUTION

3.1 Installation General

.1 Install underground duct banks and manholes including formwork.
CONCRETE ENCASED DUCT BANKS AND MANHOLES

.2 Build duct bank and manholes on undisturbed soil or on well compacted granular fill not less that 150 mm thick, compacted to ninety-five (95%) percent or maximum proctor dry density.

.3 Open trench completely between manholes 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 if unstable soil conditions are found. Confirm this requirement with Structural Engineer prior to constructing "mud slab".

.5 Install ducts at elevations and with slope as indicated and minimum slope of one (1) to four hundred (400) towards a manhole.

.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 at not less than 75 mm horizontally and vertically. Stagger joints in adjacent layers at least 150 mm and make joints watertight. Encase duct bank with 75 mm thick concrete cover. Use galvanized steel conduit for sections extending above finished grade level or as specified on drawings.

.8 Make transpositions, offsets and changes in direction using 5º bend sections. Do not exceed a total of 20º with duct offset.

.9 Use bell ends at duct terminations in manholes 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 fifty (50%) percent of its specified strength before backfilling.

.14 Use anchors, ties and trench jacks as required to secure ducts and prevent 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 steel or 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 In each duct install 6 mm nylon pull rope continuous throughout each duct run with 3 m spare rope at each end.

### 3.2 Manholes

1. Install precast manholes.

2. Provide 115 mm deep window to facilitate cable bends in wall at each duct connection. Terminate ducts in bell-end fitting flush with window face. Provide four 10 m steel dowels at each duct run connection to anchor duct run. On runs of sixteen (16) ducts and over, support concrete duct encasement on a 700 mm wide by 75 mm thick concrete pier poured against the manhole wall between slab and bottom of duct run, provide dowels for anchoring.

3. Alternately connect large duct runs by leaving a square opening in wall, later pouring duct run and wall opening in one pour, and install 10 m x 3 m reinforcing rods in duct run at manhole connection.

4. Install manhole frames and covers for each manhole. Set frames in concrete grout onto the manhole neck.

5. Drain floor towards sump with one (1) to forty-eight (48) slope minimum and install drainage fittings as indicated.

6. Install cable racks, anchor bolts and pulling irons as indicated.

7. Grout frames of manholes. Cement grout to consist of two parts sand and one part cement and sufficient water to form a plastic slurry.


9. Spray paint an "X" on ceiling of manhole above floor drain or sump pit.

### 3.3 Markers

1. Mark location of duct runs under hard surfaced areas not terminating in manhole 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.

3.4 Inspections

.1 Advise Engineer so that they may inspect ducts prior to placing and be present during placement of concrete and clean-out.

END OF SECTION
1. **GENERAL**

1.1 **Work Included**

.1 Provide a complete system of conduit and fittings for installation of wiring as shown on the drawings.

.2 Coordinate the location of the conduits and fittings so as not to interfere with existing other services.

1.2 **Related Work in Other Sections**

.1 Instrumentation Cables: Section 17123

.2 Wire and Box Connectors – 0-1000 V: Section 16151

.3 Fastenings and Supports: Section 16191

2. **PRODUCTS**

2.1 **Rigid Steel Conduit**

.1 Galvanized rigid conduit shall not be used, with exception of extension of PVC to ensure mechanical protection in non-process area.

.2 Fittings: cast metal "Condulet" as manufactured by Crouse-Hinds Canada Ltd. including gasketted covers in damp locations.

.3 Expansion joints: cast metal Crouse-Hinds type XJ or approved alternate.

2.2 **EMT Conduit**

.1 Not to be used in this project for process application.

.2 The Engineer has to approve the installation of EMT.

2.3 **Rigid PVC Conduit**


.2 Fittings: threaded male or female solvent weld connectors and solvent weld couplings, as supplied by conduit manufacturer.

.3 Solvent: as recommended by conduit manufacturer.
CONDUITS, CONDUIT FASTENINGS & CONDUIT FITTINGS

2.4 Flexible Conduit

.1 Connectors: slip-proof, insulated throat or non-metallic bushings, steel, Thomas & Betts Ltd. "Tite-Bite", Series 300.

2.5 Rigid PVC Duct

.1 Duct: Rigid non-metallic conduit of unplasticized polyvinyl chloride Type DB-2, conforming to CSA Standard manufactured by Canron Plastics Ltd.

.2 Accessories: Bell ends, couplings, adapters, bends and other fittings of same material as duct. Use solvent recommended by manufacturer. Horizontal, vertical and foundation spacers as manufactured by Pilgrim Products Ltd.

2.6 Liquid-Tight Flexible Conduit

.1 Conduit: flexible metal conduit with liquid-tight PVC jacket. Industrial Wire & Cable "Liquiseal".

.2 Connectors: captive sealing jacket and ground cone insulated throat, steel (Thomas & Betts Ltd. "Super-Tight", Series 6000).

2.7 Zinc Fittings

.1 Shall not be used.

3. EXECUTION

3.1 Installation

.1 Install conduits to conserve headroom in exposed locations and cause interference in spaces through which they pass.

.2 Replace conduit if kinked or flattened more than 1/10th of its original diameter.

.3 Mechanically bend steel conduit over 19 mm diameter.

.4 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

.5 Install fish cord in empty conduits.

.6 Where conduits become blocked, remove and replace blocked section.

.7 Do not use liquids to clean out conduits.

.8 Dry conduits out before installing wire.
3.2 Surface Conduits

.1 Run parallel or perpendicular to building lines.

.2 Run conduits in flanged portion of structural steel.

.3 Group conduits wherever possible on surface channels.

.4 Do not pass conduits through structural members except as indicated.

.5 Do not locate conduits less than 75 mm parallel to hot water lines with minimum of 25 mm at crossovers.

3.3 Wiring Method

.1 In building: concealed above ceiling and in walls in finished areas, on surface or in slab in open plant area and mechanical room, unless otherwise specified.

.2 In-slab: As detailed in this Section.

.3 In process rooms: surface mounted rigid aluminum conduit.

.4 In wet well: surface mounted PVC conduit.

3.4 Rigid Steel Conduit

.1 Use for all security system requirements.

.2 Use for all communications cable requirements, where approved by Engineer.

3.5 EMT Conduit

.1 It may not be used in damp locations, corrosive atmosphere, underground, outdoors, nor in areas exposed to mechanical damage.

.2 Do not use E.M.T. conduit in process areas.

3.6 Rigid PVC Conduit

.1 Use as raceways for following applications

- In poured concrete floors and walls and on underground runs exterior to the buildings unless otherwise noted.
- Wiring installed in areas subject to intermittent or continuous moisture but not surface mounted.
- Rigid PVC conduit shall not be surface mounted in all process areas.
.2 Use strictly in accordance with the Canadian Electrical Code. Do not use in return air plenums and for exit and fire escape lights.

.3 Provide insulated ground wire in all rigid PVC conduits in accordance with the Canadian Electrical Code.

.4 Where rigid PVC conduit is set in poured concrete, solvent joints must be completed and allowed to set as per manufacturer's instructions.

3.7 Flexible Conduit

.1 Use metal liquid tight flexible conduit as raceways for following applications:
   - Connections to fractional h.p. motors in dry locations.
   - Flexible connections to luminaires.

.2 Provide a separate insulated ground wire in all flexible conduits.

3.8 Rigid PVC Duct

.1 Provide a separate green insulated copper ground wire in all ducts sized as required by the Code.

.2 Arrange ducts in a horizontal layer separated by plastic spacers to provide spacing between duct centres, as shown on the drawings.

.3 Support duct bank on plastic spacers 35 mm between ducts. Foundation spacers to maintain at least 76 mm clearance between ducts and exterior coverage.

.4 Make joints with tapered couplings to provide a secure watertight connection. Stagger all joints to provide 200 mm vertical and horizontal clearance between adjacent couplings. Where needed, use factory bends to provide bends of radius required.

.5 When all ducts are installed, brace whole assembly at each spacer group to prevent duct floating when concrete is placed.

.6 Terminate ducts with standard bell ends where ducts enter cable pits, junction boxes and building interiors.

.7 Cap ends of unused ducts with plug ends of same material as ducts.

.8 Seal all joints in ducts with solvent cement.
3.9 Liquid-Tight Flexible Conduit

.1 Use as raceways for following applications:

- At all motors, pipe mounted control devices, and other devices subject to movement or water.

.2 At all motors provide a short length before connecting to the motor terminal box. Minimum length shall be 450 mm plus 4 times the conduit diameter.

.3 Provide a separate ground wire within flexible conduit, bonded to motor frames and system ground.

3.10 Workmanship

.1 Install all conduit and wiring exposed, unless otherwise shown on the drawings (underground ducts). Do not recess conduit in columns, except as noted, without permission.

.2 Where conduit is run exposed, run parallel to building lines. Where conduits are grouped (two or more), space evenly, make bends concentric and mount on Unistrut racks.

.3 Lay out conduit to avoid interference with other work. Maintain a minimum clearance of 150 mm from steam or hot water piping, vents, etc.

.4 Slabs on grade: Install rigid PVC conduit in the gravel base below concrete slabs. Provide mechanical protection around stub-ups through slab and extend 150 mm beyond concrete. When rigid aluminum conduit is installed in contact with earth it shall be protected by Polykin #940 tape. Extend taping 300 mm above finished grade.

.5 Metal conduit installations in concrete pours: Tie down conduit to prevent shifting. All joints are to be made up tight to ensure ground continuity. To prevent concrete entry, seal rigid fittings with tape, pack outlet boxes and cap conduit terminations both in boxes and stub-ups. Apply Polykin #940 tape to the conduit 152 mm both sides of the point of leaving slab.

.6 Do not place conduit in concrete slabs in which slab thickness is less than four times conduit diameter. Place conduits larger than this size under floor. Conduits to have minimum 25 mm concrete cover.

.7 Organize conduit in slabs to minimize crossovers. Obtain approval and minimum concrete cover required from structural engineer prior to installing conduits in slabs.

.8 At all recessed panels cap 2 - 25 mm and 4 - 19 mm empty conduits from panel into ceiling above and below for future use.
CONDUITS, CONDUIT FASTENINGS & CONDUIT FITTINGS

.9 Provide Brady underground warning tapes 300 mm below grade above all underground conduits. Tape shall be yellow warning tape, 150 mm wide.

.10 Where conduits or ducts enter or exit concrete structures below grade provide 16 mm x 1500 mm steel reinforcing dowels to prevent shearing. Extend dowel 1000 mm beyond concrete and band conduit to dowel. The first 3 meter length of conduit extending from the structure to be Polykin wrapped rigid steel.

.11 Where conduit is installed in floor slabs to run up at equipment or motors, carefully check all conduit locations. Verify conduit locations for mechanical equipment from shop drawings or detail drawings. Brace all stub-ups. Stub-ups shall be rigid steel.

.12 Where aluminum conduit is required to be bent, do not heat, and do not bend conduit in such a way as to reduce pipe cross section area at any point. Radii of bends shall be as per Canadian Electrical Code.

.13 For all runs of conduits, do not include more than equivalent of 4 - quarter bends. Provide conduit fittings, pullboxes and junction boxes where necessary. Pulling elbows shall not be used except by special permission.

.14 Where possible, install conduits so that they are not trapped, cap turned up conduits to prevent the entrance of dirt of moisture during construction. Swab out conduit and thoroughly clean internally before wires and cables are pulled.

.15 Take extreme care in reaming ends of all conduit to ensure a smooth interior finish that will not damage the insulation of the wires.

.16 Use insulated non-metallic bushings on all conduit terminations.

.17 Ensure electrical continuity in all conduit systems.

.18 All conduit shown exposed in finished areas is to be free of unnecessary labels and trade marks.

.19 Install a 90 lb test line in all conduits left empty by this contractor including those which others will pull cables, wires, etc.

.20 Conduits and ducts crossing building expansion joints shall have conduit expansion fittings to suit the type of conduit used, and shall be Crouse-Hinds, Sceptre, or approved fitting.

.21 Seal conduits with duct seal where conduits are run between heated and unheated areas. Where conduits, cables, or cable trays pierce fire separations, seal openings with Dow Corning 3-6548 sealant or approved equal.

.22 Where conduits pass through walls, they shall be grouped and installed through openings. After all conduits shown on the drawings are installed, wall openings
shall be closed with material compatible with the wall construction. Review size and quantity of conduit sleeves with the Consultant.

.23 Where drawings show conduit designations, these conduits shall be identified at each point of termination with Thomas & Betts "Ty-Rap" No. TY532M labels.

.24 Where conduit finish is damaged, repair or replace.

.25 Use "Condulet" fittings for power and telephone type conduit terminations in lieu of boxes where support is not provided.

.26 All branch circuit wiring, home-runs, communication and data to be minimum 20 mm diameter unless otherwise stated.

.27 Provide necessary flashing and pitch pockets, making watertight joints where conduits pass through roof or watertight membranes.

.28 Where panelboard branch circuit conduits are amalgamated, size shall not exceed 25 mm diameter.

.29 Cables of different voltage classes shall generally run in separate conduits unless approved by the Engineer.

END OF SECTION
1. GENERAL

1.1 Scope of Work

.1 Provide cable tray as shown on the drawings.

.2 Coordinate the location of the support channels so as not to interfere with existing other services. Support channels to be preset in concrete structure were feasible.

1.2 Related Work in Other Sections

.1 Instrumentation Cables: Section 17124

.2 Wire and Cable – 0-1000 V: Section 16050

.3 Fastenings and Supports: Section 16191

2. PRODUCTS

2.1 Cable Trays

.1 Cable trays and fittings: to EEMAC F5-1.

.2 Ladder type, Class D1 to CSA C22.2 No.126. Cable trays to meet the requirements of CAN/CSA-C22.2 No.126-M91 Cable Tray Systems, and EEMAC F5-1 (1976) Cable Tray and Accessories.

.3 Cable trays to be rigid aluminum ladder type class D1 with 300 mm rung spacing, for power cables, as manufactured by SuperiorTray Systems Inc., Electrovert, Cooper, Pilgrim, Code Electric or Engineer approved equal.

.4 Instrument cable trays shall be aluminum vent-rib type.

.5 Provide rod hanger clamps, cadmium plated rod hangers, wall mounted support brackets, and all the necessary accessories for complete installation.

.6 Provide all elbows, tees, crosses, turn downs, covers, enclosures, conduit clamps, etc. for complete continuous installation. Field fabricate only those fittings not available from tray manufacturer. Minimum radius 600 mm.

.7 Instrumentation type cable tray 150 mm required for individual cable drops for power and instrumentation is not typically shown on contract drawings for clarity, however contractor shall provide such tray were two or more cables are located together.

.8 Aluminium cable tray do not need to be painted.
2.2 Accessories

.1 Environmental water tight outdoor seal.

.2 Fire stop system minimum 2 hour rating.

.3 Cable termination kits.

.4 UDP Aluminum to Steel isolators.

2.3 Design Rating

.1 System to be designed to match customer supplied data.

.2 Standard system is rated for 40°C ambient with 50°C heat rise based on free air rating.

.3 Data system is rated for 40°C ambient with 35°C heat rise base on free air rating.

3. EXECUTION

3.1 Installation

.1 Suspend cable trays at 3000 mm centres on rod hangers and hanger clamps or channels. Fasten hangers to channels securely mounted to the structure.

.2 Install trays and raceways above the lighting fixtures and below duct work and piping. Coordinate this work with the other trades to ensure adequate horizontal and vertical clearances.

.3 Remove sharp burrs or projections to prevent damage to cables or injury to personnel.

.4 Fire stop all penetrations through walls or floors

.5 Provide minimum vertical clearance above the trays and raceways of 450 mm for power and 300 mm for instrumentation cables. This clearance can be reduced at duct crossovers but shall not be less than 150 mm.

.6 Provide minimum 600 mm horizontal clearance on one side of cable tray throughout.

.7 All trays are shown diagrammatically on the drawings. The exact location is to be determined in the field. Tray runs shall be installed to prevent interferences with process or service piping and ducting, lighting fixtures and to maintain clearance for tray access. The exact location of tray supports and runs shall be coordinated with the work of other trades.
.8 Tray routes and tray supports shall not be installed until the location of same has been reviewed by the Engineer.

.9 Tray systems shall be installed in such a manner as to conserve head-room and minimize the use of free space through which they pass. Maintain a minimum 2250 mm clear head-room wherever possible.

.10 Trays shall be run parallel to building lines unless otherwise shown on the drawings. Where two or more trays run the same route, they shall be parallel and offsets and bends shall be uniform.

.11 Where tray is mounted on unistrut type shelf brackets and anywhere the support member is below 2100 mm AFF in a walking area, the ends of support shall be cut flush with tray. The end of unistruts, etc. shall be permanently capped (plastic caps). Sharp corners and edges of tray shall be suitably protected to prevent personal hazard.

.12 Beam clamps shall be used to fasten support systems to structural steel. Welding, drilling and cutting of structural steel shall not be performed without approval by the Engineer.

.13 Where hanger rods are used, the rods shall be cadmium plated steel and shall not be smaller than 12 mm in diameter.

.14 A bare stranded #2/0 copper ground conductor shall extend the length of each power tray route and shall solidly connect sections of tray runs to the ground bus of the electrical room. Ground conductor on tray shall be grounded to tray every 15 metres with approved grounding clamps. Provide a minimum #2 AWG copper wire as above in the instrumentation trays, or where instrumentation tray runs parallel to power tray, bond instrumentation tray to power tray ground every 15 metres.

.15 Cables of different voltage classes shall generally run in separate trays. Where a common tray is shown on drawings, the cables for different voltage classes shall be separated from each other by metal barriers (barrier strips) as manufactured by the tray manufacturer.

.16 All trays shall be checked for surface smoothness prior to installation and all burrs, ridges, etc. on tray surfaces facing cables shall be removed.

.17 Cable trays shall be sized as indicated on drawings. If any discrepancies are found or changes in tray size are required, advise the Engineer before installing the tray.

.18 Provide tray covers to 450 mm above floor slab where tray penetrates vertically through the floor.

END OF SECTION
1. GENERAL

1.1 Work Included

.1 Provide a complete system of wiring, making all connections necessary for the installation shown on drawings.

1.2 References, Codes and Standards

.1 CSA C22.2 No. 0.3, Test Methods for Electrical Wires and Cables.

.2 Install and rate power cables in accordance with the Canadian Electrical Code requirements or in accordance with ICEA requirements where permissible.

1.3 Product Data

.1 Submit product data in accordance with Section 16010 - Electrical General Requirements.

2. PRODUCTS

2.1 Building Wires

.1 Conductors: stranded for 10AWG and larger. Minimum size: 12AWG.

.2 Copper conductors: size as indicated, with 1000 V insulation of chemically cross-linked thermosetting polyethylene (XLPE) material rated RW90.

.3 Copper conductors: size as indicated, with thermoplastic insulation type TWU rated at 600 V.

2.2 Teck Cable

.1 Comply to:

.1 CSA C22.2 No. 131 – Teck Cable.

.2 Minimum conductor size is #12 AWG for power cables and #14 AWG for control cables.

.3 Conductors:

.1 All conductors shall be copper.

.2 Circuit conductors: size as indicated.
.4 Insulation:

.1 Type: Chemically cross-linked thermosetting polyethylene (XLPE): 1000 VAC for power, 600 VAC for control wiring.

.5 Jackets: Shall be sun resistant.

.6 Armour: Interlocking aluminum.

.7 Temperature Rating: 90°C to -40°C.

.8 “HL” and “FT4” rated per CSA.

.9 Low Acid Gas and Lead Free.

.10 Fastenings:

.1 One hole steelstraps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.

.2 Channel type supports for two or more cables at 1000 mm centers.

.3 Six mm diameter threaded rods to support suspended channels.

.11 Connectors:

.12 Watertight and explosion-proof approved for TECK cable.

2.3 Variable Speed Drive Cable

.1 For VFD drive applications, provide variable speed drive rated cables between the VFD drive and motor.

.2 Cable shall comply to:

.1 CSA C22.2 No. 123 – Metal sheath cables

.3 Variable Speed Drive Cables shall include:

.1 Triple grounded, increased dielectric type Teck cable suitable to reduce the high-frequency noise emissions of the drive and reduce the bearing current effects.

.2 Contain a geometric arrangement of the conductors to ensure identical coupling capacitance is obtained.

.3 Provide type W connectors for dry or wet locations. Refer to Teck Cable connectors for additional requirements.
.4 Acceptable Products

.1 Nexans DriveRx 1kV rated cable or equivalent

.4 Connectors:

.1 Watertight and explosion-proof approved for TECK cable.

2.4 Teck Cable Connectors

.1 Comply to:

.1 CSA C22.2 No. 18.3 – Conduit, tubing, and cable fittings

.2 Size connectors to suit cable diameters and in accordance with the recommendations of the cable manufacturer.

.3 Connectors are to be malleable iron, liquid and dust tight, with aluminum ground ring, with multi-fingered flange, gland bushing, Thomas & Betts "Sabre Tooth" Series 10464 or Crouse Hinds TMC.

.4 In hazardous locations use Thomas & Betts type c/w sealing compound.

.5 Connectors:

.1 Connects to be watertight approved for the use of TECK cables (dry-type not acceptable) equal to Thomas & Betts Star-Teck aluminum fittings in non-classified areas and Thomas & Betts Star-Teck explosion proof for classified environments.

.2 Material compatible with the connecting body such as junction, outlet or splice boxes to which the connection is made. Grounding ring or “fingers” and neoprene bushing is required.

.6 Approved Products:

.1 Hazardous and Corrosive locations

.1 Thomas & Betts STAR TECK XP all with heat-shrink sleeve applied.

.2 Corrosive locations

.1 Thomas & Betts STAR TECK, all with PVC coating.

.3 All other areas

.1 Thomas & Betts STAR TECK
2.5 Control Cables

.1 Type LVT: 2 soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of thermoplastic jacket and armour of closely wound aluminum wire.

.2 Low energy 300 V control cable: stranded annealed copper conductors sized as indicated, with PVC insulation type TWH with shielding of tape coated with diamagnetic material braid over each pair and overall covering of interlocked armour of aluminum strip.

.3 600 V type: stranded annealed copper conductors, sizes as indicated with PVC insulation type R90, cross-linked polyethylene type with shielding of metalized tapes over each pair of conductors and overall covering of thermoplastic jacket with sheath of aluminum interlocked armour.

3. EXECUTION

3.1 General

.1 Minimum conductor size #12 AWG except for luminaire drops which can be #14 AWG if fed from 15 A circuits. Do not use XLPE and TWH.

3.2 Installation of Building Wires

.1 Install wiring as follows:

.1 In conduit systems in accordance with Section 16110.

.2 In trenches in accordance with Section 16105.

.3 In wireways and auxiliary gutters in accordance with Section 16115.

3.3 Installation of Teck Cable 0 - 1000 V

.1 Comply with Canadian Electric Code, CAN/CSA C22.1 – 02.

.2 Install cables in cable troughs or trays as indicated on drawings. Space so that no de-rating factor is applied or de-rate cable ampacity as required.

.3 Where cables pass through poured concrete or masonry wall, install sleeves for the cables.

.4 In-line splices are not permitted.
.5 Provide mechanical protection for cables where cables rise through a floor using sleeves or slots. Provide channels, angle sills or rigid conduit sleeves which protrude at least 150 mm above the finished floor.

.6 Where cables are grouped and not run in tray, support on channels. Run cables parallel to the lines of the building. Bends are to be concentric. Channel spacing not to exceed 1500 mm.

.7 Fasteners for single cables larger than 51 mm, two hole strap type. For single cables less than 51 mm, one hole malleable iron type. Group cables whenever possible. Use non-ferrous fasteners in wet locations. Use aluminum "P" clamps when fastening to support channel.

.8 All power cables shall be clamped to vertical or inclined trays with clamps as manufactured by the tray manufacturer. All power and control cables shall be secured to horizontal trays with adequately sized tie wraps.

.9 Cinch anchors shall be used to fasten the strut brackets to walls. Concrete beams shall not be drilled without prior authorization by the Engineer. Care shall be taken in drilling concrete blocks or masonry work to ensure the surface will not be cracked.

.10 Powder actuated fastening tools shall not be used without written approval from the Engineer.

.11 Unistrut channels complete with beam clamps and floor anchor plates shall be provided. Unistrut sections for this purpose shall be sized as required.

.12 Teck connectors shall be installed in accordance with the recommendation of the cable manufacturer.

.13 All cable entries to motors, field devices, instruments, control stations and panels in process areas shall be from the side or bottom.

### 3.4 Installation of Armoured Cables

.1 Group cables wherever possible.

.2 Install cable in trenches in accordance with Section 16105.

.3 Terminate cables in accordance with Section 16153 - Connectors and Terminations.

.4 Terminate armour with approved connectors.

.5 For ACWU cable, use non-magnetic connectors, ground armour and ground conductor at supply and only use non-metallic cable entrance plates. Support runs on steel or aluminum channels with spacers and clamps. Space cables to provide free air ampacity ratings unless otherwise shown.
3.5 Surface Installation for Teck Cables

.1 Install individual runs of teck cable or multiple runs, where specified or as specified herein.

.2 Fasten unistrut to the ceiling or wall as required.

.3 Secure cables to unistrut with cable clamps.

.4 Provide corrosion resistant clamps, hot dip galvanized, stainless steel or PVC coated.

.5 Install unistrut supports with a maximum spacing of one (1) metre.

.6 One (1) or two (2) surface mounted cables may be strapped using one (1) hole straps and stand-off spacers. Fastening, strapping and support materials shall be compatible with the area conditions.

.7 Three (3) or more cables shall be installed in 100 mm or larger cable tray.

3.6 Workmanship

.1 Before pulling wire, ensure conduit is dry and clean. If moisture is present, thoroughly dry out conduits; vacuum if necessary. To facilitate pulling, recognized specially manufactured wire pulling lubricants may be used. Do not use grease. Employ suitable techniques to prevent damage to wire when ambient temperature is below the minimum permitted for each insulation type. Do not pull wires into incomplete conduit runs.

.2 Installation to be free of opens and grounds. Before energization, measure insulation resistance as per Section 16030 and comply with the Canadian Electrical Code. Submit data sheet with values measured.

.3 Do not install any conductor smaller than #12 AWG, except where specifically indicated otherwise, i.e. for fire alarm system station circuits, P.A. wiring, etc.

.4 Provide sizes of conductors as shown on drawings. Voltage drop from lighting panels to farthest outlet must not exceed 2% at full load in any case. Advise Engineer if problem is foreseen.

.5 Exercise care in stripping insulation from wire. Do not nick conductors.

3.7 Cable Identification

.1 All Teck90 cables shall be identified with Thomas & Betts "Ty-Rap" No. TY532M or equal at each termination. The labels shall be securely attached to the cables.
District of Lake Country  
Eldorado Treated Water Reservoir &  
Glenmore Booster Station  
60488627

WIRES AND CABLES UP TO 1000V

.2 Conductor and cable designations shall correspond to those shown on the drawings or as agreed upon with the Consultant.

.3 Where Teck90 cables exit from cable trays, the cables shall be identified as described for terminations.

.4 Each phase conductor cable of power feeders shall be color coded at all terminations and taps to identify phasing. Color coding shall be provided by the attachment of color phase tape as indicated in Section 16010 – Electrical General Requirements.

.5 For control wiring, identify each conductor with the wire numbers shown on the drawings or agreed upon with the Consultant using a printed heat shrink wire marker as Brady Perma Sleeve or Raychem TMS.

3.8 Wiring Identification, Coding and Balancing

.1 For branch circuit wiring, follow identification system shown on the drawings and as specified in Section 16010 - Electrical General Requirements.

.2 Connect single phase equipment to minimize imbalance on feeders. Adjust branch circuiting shown as required for optimum balancing. Record all changes on "record" drawings.

.3 Colour code all feeders at all terminations, at all points where taps are made, and at all panelboards, switchboards, motor control centres, etc. Use two wraps of 3M #471 plastic film tape 48 mm wide.

.4 Conductors sized No. 10 and smaller are required to be factory coloured, not taped on site.

.5 For direct current wiring use red for positive and black for negative.

3.9 Testing

.1 Provide testing as per section 16030.

.2 All power and control wiring shall be tested for insulation resistance value with a 1000 volt megger. Resistance values shall be as recommended by the cable manufacturer.

.3 All wire test results shall be properly tabulated, signed, dated, and submitted to the Engineer.

END OF SECTION
1. GENERAL

1.1 Description

.1 Supply and install a complete grounding system. Securely and adequately ground all components of the electrical system in accordance with the Canadian Electrical Code CSA C22.1, as amended for use in the Province of British Columbia.

.2 The system to consist of cables, ground rods, supports, and all necessary materials and inter-connections to provide a complete system. Measured resistance to ground of the network shall not exceed 5 ohms.

.3 All ground conductors shall be run in conduit.

1.2 Reference Standards

.1 This section conforms to the following reference standards:

   .1 Canadian Electrical Code as adopted by the Province of BC (CEC).
   .2 CSA C22.2 No. 41-2013, Grounding and Bonding Equipment
   .2 IEEE 80 – AC Grounding Systems

2. PRODUCTS

.1 Rod electrodes copper clad steel, 3/4" (19 mm) dia. by 3m long. Ground electrode inspection boxes for non-traffic areas, Slacan cat. #22109 or equal or for traffic areas, A.E. Concrete cat. #3-RT or equal.

.2 Conductors: Bare, stranded, soft annealed copper wire, size No. 4/0 AWG for ground grid, electrode interconnections, metal structures, transformers, and ground connections.

.3 Conductors: PVC insulated coloured green, CSA FT4 rated for indoors, CSA FT1 rated for outdoors, stranded soft annealed copper wire, size No. 2/0 AWG or larger as required by CEC, for grounding cable sheaths, raceways, pipe work, building structures, process equipment, pump bases, stairs and guard-rails.

.4 Conductors: No. 4/0 extra flexible (425 strands) copper conductor for underground work, tie to ufer ground, substation grid and connections to transformers, MCC, connection of fence gates and building structures and tie to main ground bus.

.5 Bolted removable test links to permit isolation from electrodes and grounding bus.

.6 Accessories: Non-corroding, necessary for complete grounding system, type, size material as indicated, including:
GROUNDING

.1 Grounding and bonding bushings.

.2 Protective type clamps.

.3 Mechanical type conductor connectors.

.4 Compression type conductor connectors.

.5 Bonding jumpers, straps.

.7 Wire connectors and terminations comply with Section 16122.

.8 Wall mounted main ground bus bars on insulated stand-offs for grounding lighting and control distribution transformers, miscellaneous and future electrical equipment in Electrical Room.

.9 Wall mounted telecommunications main ground bus bars on insulated stand-offs for grounding telephone board, communications equipment cabinets and racks, PLC main control panels.

.10 Cable to pipe connectors to be made with Burndy GAR connectors.

.11 In the main electrical room and all sub electrical rooms, provide a copper ground bar complete with lugs suitable to terminate all equipment ground cables.

3. EXECUTION

3.1 Grounding - General

.1 All frames and metallic enclosures of all electrical equipment and electrically operated equipment shall be grounded through the conduit system or via a ground wire.

.2 All transformers, switchgear, motor control centres, panelboards and splitters fed from the main distribution centre shall be grounded by grounding conductors sized in accordance with the Canadian Electrical Code. The ground wire shall be terminated at each end with an appropriate grounding lug which shall be connected to the equipment ground bus. Ground wire to be green TWH.

.3 All sub panels such as lighting panels, local distribution panels, etc., shall be grounded with a green ground wire run back to the panel from which it is fed. The ground conductor shall be sized according to the Canadian Electrical Code.

.4 All main motor control centres, switchgear, and all panels requiring equipment grounds shall contain a ground bus of adequate size, and tapped for lugs for the ground wire required.
Grounding

.5 Connect using #4/0 bare copper conductors from the main power distribution MCC and control cabinet ground bus to the main ground bus and ground ring. Test the system for ground resistance and install additional ground rods as necessary to meet a minimum requirements of 5 ohms.

.6 All bolted connections must be accessible.

.7 All motors shall be grounded by means of an adequately sized green ground wire contained within the feeder cable.

.8 Include a separate green ground wire in all power conduits including branch circuit wiring sized to Table 16, Canadian Electrical Code.

.9 Expansion joints and telescoping sections of raceways shall be bonded using jumper cables as per Canadian Electrical Code.

.10 Use Burndy compression connectors or approved equal for all grounding splices and terminations unless otherwise shown on the Drawings. For bolted ground connections use Burndy Engineering Company's "Durium" or approved equal hardware.

.11 Connect all transformer neutrals to the main building ground wire, using compression terminations.

.12 Install rigid conduit sleeves where ground wires pass through concrete slabs.

.13 Conduit installed buried in earth or installed in or under grade floor slabs shall have separate ground wire installed, whether the conduits are metal or not.

.14 Ground all utility services to the electrical system ground.

.15 Selected ground rods shall be accessible with ground wells as shown on Drawings.

.16 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.

.17 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.

.18 Install a separate ground conductor to all outdoor lighting standards.

.19 Connect building structural steel and metal siding to ground by tie to steel structure, connect every second column, as per provided detail to ground loop.

.20 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.
.21 All sub panels such as lighting panels, local distribution panels, etc., shall be grounded with a green ground wire run back to the panel from which it is fed. The ground conductor shall be sized according to the Canadian Electrical Code.

3.2 Equipment Grounding

.1 Install grounding connections to typical equipment included in, but not necessarily limited to the following list: service equipment, transformers, switchgear, duct systems, frames of motors, process equipment frames, main process pipes, starters, control panels, building steel work, generators, distribution panels, outdoor lighting posts.

3.3 Grounding Bus

.1 Install copper grounding bus mounted on insulated supports on wall of the main electrical room and all sub electrical rooms.

.2 Ground items of electrical equipment in electrical room to ground bus with individual bare stranded copper connections as shown on drawings.

3.4 Electrodes

.1 Install rod electrodes and make grounding connections.

.2 Bond separate, multiple electrodes together.

.3 Use size 4/0 AWG copper conductors for connections to electrodes.

.4 Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails. Ground as indicated.

.5 Provide an ufer ground as indicated on drawings, install in one side of the building foundation, at maximum 150mm above the lowest surface in contact with soil.

3.5 Power and Instrumentation Cable Tray

.1 Where cable tray is installed, provide a ground conductor along the entire length of cable tray. The size of the ground conductor shall be minimum #2/0. Bond ground conductor to each section of tray and at the intervals not exceeding 15 m. Home run ground conductor back to main building ground bus

3.6 Communication Systems

.1 Install grounding connections for telephone, fire alarm, intercommunication systems as follows:

.1 Telephones: make telephone grounding system in accordance with telephone company's requirements.
GROUNDING

.2 Fire alarm, intercommunication systems as indicated on drawings.

3.7 Field Quality Control

.1 Perform tests in accordance with Section 16980 – Testing, Adjusting and Balancing of Electrical Equipment and Systems.

.2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Engineer and local authority having jurisdiction over installation.

.3 Perform ground resistance tests using fall of potential method to determine performance of ground installation. Provide results to the engineer prior to system energisation.

.4 Perform tests before energizing electrical system.

.5 Disconnect ground fault indicator during tests.

END OF SECTION
FASTENINGS AND SUPPORTS

1. GENERAL

1.1 Work Included

.1 Supply and install all hangers, supports and inserts for the installation shown on the drawings and specified herein, as necessary to fasten electrical equipment securely to the building structure.

1.2 Related Work

.1 Cable Tray: Section 16115
.2 Conduits, Conduit Fastenings and Conduit Fittings: Section 16110
.3 Seismic Restraints: Section 16195

2. PRODUCT

2.1 Framing and Support System

.1 Materials:

.1 Intermediate duty supporting structures shall employ P1000 Unistrut or equal together with the manufactures connecting components and fasteners for a complete system.

.2 Heavy duty supporting structures to be fabricated and welded from steel structural members and prime painted before installation.

.2 Finishes:

.1 Outdoors, wet locations: Hot dipped galvanized.

.2 Indoors, dry locations: Galvanized when available, prime painted if not available.

.3 Nuts, bolts, machine screws: Cadmium plated.

.3 Unistrut:

.1 Section P1000 or as required for load and span, with mounting screws, or approved. P1000 or equal is a minimum standard for supporting conduits 50 mm and larger.

2.2 Concrete and Masonry Anchors

.1 Materials: Hardened steel inserts, zinc plated for corrosion resistance. All anchor bolts must be galvanized.
FASTENINGS AND SUPPORTS

.2 Components: non-drilling anchors for use in predrilled holes, sized to safely support the applied load with a minimum safety factor of four.

.3 Manufacturer: Hilti (Canada) Limited or approved equal.

2.3 Non-Metallic Anchors

.1 Material: Plastic anchors for sheet metal screws.

2.4 Conduit Supports

.1 General: Malleable iron one-hole conduit straps where exposed to weather. Stamped galvanized steel two-hole straps indoors.

.2 Structural Steel: Crouse-Hinds “Wedgetite” supports or equivalent manufactured by Appleton.

.3 Masonry, concrete, stone, etc.: Anchors.

.4 Title: Toggle bolts.

.5 Metal studs, ceiling hangers, etc.: “Caddy-Clips” or approved equivalent.

.6 Unistrut: Unistrut conduit clamps.

2.5 Cable Supports and Clamps

.1 General: As per conduit supports, except that for single conductor cables, suitable non-ferrous, or approved stainless steel or aluminum clamps shall be used.

3. EXECUTION

3.1 General

.1 Do not cut or drill beams, joists or structural steel unless written permission of the Consultants is obtained.

.2 Distance between conduit or cable supports not to exceed code requirements.

.3 Supports to be suitable for the real loads imposed by equipment.

.4 Supports to be securely fastened, free from vibration and excessive deflection or rotation. Maximum deflections are 4 mm over a 1 meter span and 8 mm over a 2 meter span.

.5 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer’s installation recommendations.

.6 Provide conduit rack with 25% spare capacity for multiple runs.
FASTENINGS AND SUPPORTS

.7 Provide channel support with fittings for vertical runs of conduit and cables.

3.2 Installation

.1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors.

.2 Secure equipment to poured concrete with expandable inserts.

.3 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

.4 Fasten exposed conduit or cables to building construction or support system using straps.
   \.1 One-hole malleable iron or steel straps to secure surface conduits and cables 50 mm and smaller.
   \.2 Two-hole steel straps for conduits and cables larger than 50 mm.
   \.3 Beam clamps to secure conduit to exposed steel work.

.5 Suspended support systems.
   \.1 Support individual cable or conduit runs with 6 mm diameter threaded rods and spring clips.
   \.2 Support 2 or more cables or conduits on channels supported by 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.

.6 Shot driven pins may only be used with written approval of the structural engineer.

.7 Use round or pan head screws for fastening straps, boxes, etc.

.8 Do not support heavy loads from the bottom chord of open web steel joists.

.9 For surface mounting of two or more conduits use channels at 1.5 m oc spacing.

.10 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.11 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.12 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of the Engineer.

END OF SECTION
1. **GENERAL**

1.1 **Related Work**

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 **Regulatory Requirements**

.1 Restraints shall meet the requirements of the British Columbia Building Code (BCBC) 2012.

.2 All installations to meet requirements of the Zone 1 based on the latest revision of the BC Building Code.

1.3 **Seismic Restraint Design and Inspection**

.1 Arrange and pay for the services of a B.C. registered professional structural engineer. This structural engineer, herein referred to as the seismic engineer shall provide all required engineering services related to seismic restraints of installed electrical equipment.

.2 The seismic engineer shall provide assistance to the contractor as necessary during the course of equipment installation.

.3 The seismic engineer shall inspect the completed seismic installation and shall submit a letter to the consultant stating that the complete seismic installation is installed in accordance with his drawings and recommendations and it complies with the regulatory requirements.

1.4 **Submittals**

.1 Submit shop drawings of all restraining devices, including details of attachment to the structure, either tested in an independent testing laboratory or approved by a B.C. registered professional engineer.

.2 Proposed inserts or connections to structure to follow directions of Engineer.

1.5 **Scope of Work**

.1 Provide restraint of electrical equipment, including floor mounted distribution and control panels and switchboards, transformers, generator set, luminaires, etc., which is part of the building electrical service systems to prevent injury or hazard to persons and equipment and to retain equipment in its normal position in the event of an earthquake.
SEISMIC RESTRAINTS

.2 Provide all seismic restraint related hardware, including bolts and anchors, from point of attachment to equipment through to and including attachment to structure.

.3 It is the entire responsibility of equipment manufacturers to design their equipment so that the strength and anchorage of internal components of the equipment exceeds the force level used to restrain and anchor the unit itself to the supporting structure.

2. PRODUCTS

2.1 General

.1 Provide anchor bolts, straps and other mounting materials as specified by the seismic engineer.

3. EXECUTION

.1 Carry out all seismic restraint works on electrical equipment as per the recommendation of the seismic engineer and in accordance with the B.C. Building Code.

.2 Coordinate the work with other trades as required.

END OF SECTION
1. GENERAL

1.1 Description

.1 Contractor to furnish all labour, materials, equipment, and services necessary for the supply, delivery and testing of three-phase, liquid-immersed transformer, designed to step down distribution voltage as required. All equipment specified in this section to be furnished through a single transformer manufacturer who will be responsible for the design, manufacture, factory testing, and delivery to site.

.2 The step-down transformer will be filled with oil-insulated type transformer fluid, and will include de-energize tap changer (DETC).

.3 The step-down transformer will be suitable for outdoor operation, for installation on a concrete pad in an open space with possible public access site.

.4 Electrical power feed, conduit, wires, instrumentation, control system, and other components not provided by the Manufacturer, but required for a complete installation, shall be supplied by the Contractor. The equipment to be provided by the Contractor shall consist of:

.1 T-A: Outdoor oil filled transformer, 3-phase, 500 kVA, 24.940/14.4kV grounded wye, 600 V/347 V un-grounded wye KNAN / 65°C.

1.2 Related Work

.1 Section 16010: Electrical General Requirements

.2 Section 16030: Electrical Testing

.3 Section 16160: Grounding

.4 Section 16195: Seismic Restraint and Anchoring

1.3 Reference Standards

.1 This section conforms to the following reference standards:

.1 CAN/CSA-C2.1-06 (R2017) - Single-Phase and Three-Phase Liquid-Filled Distribution Transformers

.2 CAN/CSA-227.4-06 (R2017) Three-Phase, Pad-Mounted Distribution Transformers with Separable Insulated High-Voltage Connectors.

.3 CSA C50 Insulating Oil for Transformers and Switches.

.5 IEEE Standard C57.12.00 2010, General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers.


.7 IEEE Standard C57.12.26: Standard for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors (34 500 Grd Y/19 920 V and Below; 2500 kVA and Smaller).

.8 IEEE Standard C57.12.28: Pad-Mounted Equipment Enclosure Integrity

.9 CAN/CSA-C88-M90 - Electrical Power Systems and Equipment

.10 EEMAC 6L1 Standard Accessories for Power Transformers.

.11 EEMAC GL1-3 Bushings

.12 CSA C802.1 Maximum Losses for Power Transformers.

1.4 Shop Drawings and Product Data

.1 Submit Shop Drawings and product data to requirements of Section 16010.

.2 Shop drawings will include as a minimum the following:

   .1 Dimensioned positions of mounting devices.
   .2 Dimensioned positions of terminations.
   .3 Identified internal and external component layout on assembly drawing, with parts list.
   .4 Overall dimensions, weights and liquid capacities.
   .5 Complete electrical nameplate.
   .6 Identified internal and external component layout on assembly drawing.
   .7 Schematics and wiring diagrams.
   .8 Life cycle cost information on high efficiency transformers.

.3 Provide operation and maintenance data for liquid cooled transformers and accessories for incorporation into the O&M documentation.
1.5 Shipment, Protection and Storage

.1 All shipping and handling requirements will comply with provisions of in this Specification.

.2 Transformers will be transported using air-cushioned suspension trailers or vehicles.

.3 All shipping and handling requirements to comply with provisions of this section and Section 01650.

.4 Handle pad-mounted transformers components in accordance with manufacturer's instructions. Use factory installed lifting provisions.

2. PRODUCTS

2.1 Transformer Characteristics

.1 General: Liquid-filled, pad-mounted transformer, complying with IEEE C57.12.26 and , with primary load break disconnect switches, tap changer, submerged fuse tank, secondary terminals in separate compartments, and accessories in a weather-resistant, tamper-proof enclosure. Isolate and interlock high- and low-voltage compartments. Doors shall be provided with padlockable three-point latch and penta-head bolt.

.2 Transformers shall comply with the .

.3 Enclosure: Enclosure base shall have a 4 mil (0.1 mm) thick tar-mastic undercoat.

.4 Transformer: Unit shall be dead front, 3-phase, two winding, 60 Hertz, 65 degrees C rise above a 40 degrees C ambient. Self-cooled kVA ratings shall be as noted in the drawings and data sheet. High voltage shall be 24,950V wye with two 2-1/2 percent taps above and below normal. BIL shall be 125 kV. Low voltage shall be as indicated in the drawings. Insulating liquid shall be Envirotemp (FR3) seed oil-based dielectric coolant non-fire propagating having a fire point not less than 300 degrees C when tested in accordance with ASTM D117, R-Temp, or equal. Insulating liquid shall contain less than 1-ppm PCB chemicals.

.5 Percent Impedance Voltage: Provide the following impedances subject to a +/- 7.5 percent impedance variation:
.6 Primary Compartment: Provide the following equipment as a minimum:

.1 Dead-front construction.

.2 Radial construction.

.3 Three dead-front elbow-type MOV 15-kV lightning type arresters.

.4 Load-break elbow switch.

.5 Draw-out dry well mounted current-limiting fuses.

.6 Medium-voltage bushing inserts and bushings for separable elbow connectors conforming to IEEE 386 and rated for 27 kV, 125 kV BIL, 200 amperes continuous, 10,000-ampere rms symmetrical for a time duration of 0.17 second. Provide a parking stand for each elbow connector. Equip connector with steel-reinforced hook-stick eye, grounding eye, test point, and arc-quenching material.

.7 External tap changing handle operable only when the transformer is de-energized.

.7 Low-Voltage Compartment: Provide the following equipment as a minimum:

.1 Secondary low-voltage bushings with spade terminals designed for copper conductors.

.2 Liquid level gauge, dial type.

.3 Thermometer, dial type.

.4 Oil filling connection.

.5 Drainage and oil sample valves.

.6 Neutral ground strap, removable.
.7 Corrosion-resistant nameplate and connection diagram in conformance with IEEE C57.12.26 except that the number of gallons (litres) of coolant shall be shown.

.8 Transformer case grounding pad.

.9 Non-PCB and CSA/ULc label.

2.2 Transformer Mounting

.1 Transformer suitable for mounting on pre-cast or poured-in-place concrete slab.

2.3 Winding Material

.1 Both high and low voltage windings to be made of copper.

2.4 Hazardous Materials and Compounds

.1 Polychlorinated biphenyls (PCBs) cannot be used in any equipment.

.2 Certified tests for PCB content to be performed on all insulating liquids used in the equipment and the results to be issued prior to shipment to permit transportation of the equipment and copies of the reports to be included in the shipping documents and quality control program reports.

2.5 Core Grounding

.1 The transformer core to be insulated from the tank and grounded at one easily accessible location (either through the hand hole or manhole).

2.6 Tank Construction

.1 The transformer to be of the sealed tank type and to be filled with unused Envirotex (FR3) oil, non-toxic, based dielectric transformer fluid.

.2 Base to be suitable for jacking, skidding or rolling in any direction.

.3 Provided with pressure relief device.

.4 Top plate to be gasketed and bolted in place to allow for core removal and inspection.

2.7 Seismic Protection

.1 Transformer to be designed and installed to withstand seismic forces in accordance with the Building Code of British Columbia for Zone 1.

.2 Provide information on seismic restraint requirements.
.3 Contractor will provide details on seismic anchoring requirements.

2.8 Voltage Taps

.1 Four - 2.5% taps, 2 - FCAN, 2 - FCBN. Centre tap designed for 25 kV (24,940V) voltage systems.

2.9 Rating Plates

.1 Rating plates stainless steel, affixed in an easily readable position and include the following information:
  .1 Voltage rating at no load.
  .2 Percent impedance voltage on centre and extreme taps as obtained during factory test.
  .3 Polarity, winding connection and IEC phase displacement symbols or vector diagram.
  .4 Permissible residual evacuation pressure in kPa.
  .5 Rating of the transformer.

2.10 Off-Circuit Taps (De-energized tap changer - DETC).

.1 Four (4) 2.5% full capacity taps, two (2) above rated voltage and two (2) below rated voltage, to be provided in the high voltage winding for transformers. The tap position switch to be externally operated, with provision for padlocking, and is to include a nameplate specifying that the transformer must be de-energized before operating the switch.

2.11 Wiring and Terminal Blocks

.1 All control wiring to be stranded copper and without splices. All wires to be identified at both ends with plastic tube type wire markers machine printed. Wire identification to agree with that on the schematic and wiring diagrams contained in the shop drawings. All terminal blocks to be identified and marked with the wire numbers.

.2 All external wiring from temperature gauges, gas relays, and other devices to the control cabinet to be enclosed in rigid aluminum or, when appropriate, flexible liquid seal type conduit with aluminum or stainless steel connectors, locknuts and strapping.

2.12 Neutral Termination

.1 For all transformers, the neutral point of the low voltage winding to be brought out through a bushing into the LV termination enclosure of the transformer.
The neutral connection and bushing to have minimum current rating of at least that of the self-cooled (KNAN) transformer rating.

2.13 Finishes

.1 Clean all parts of scale, rust and excess weld.

.2 Inside of the tank shot blasted and treated to prevent chemical action with transformer oil.

.3 When free from oil and moisture, paint the exterior of the tank and accessories in accordance with Section 16010.

.4 Painting

.1 Provide with a factory-applied, corrosion-resistant finish which shall withstand 3,000 hours of exposure to the salt spray test specified in ASTM B117 without loss of paint or release of adhesion of paint primer coat to the metal surface in excess of 1/16 inch from the scribed test mark. Finish color shall be ANSI Z55.1 No. 61 light gray.

.2 All paint will not contain lead.

2.14 Transformer Pads:

.1 Provide precast concrete transformer pads sized per transformer manufacturer requirements. Provide reinforcement for parkway (nontraffic) loading.

2.15 Factory Test:

.1 Perform the following factory tests:

.1 Routine factory tests, IEEE C57.12.00 Section 8.1 and .

.2 ANSI full wave impulse test, observed by oscilloscope.

.3 ANSI reduced full wave, chopped wave impulse test with oscillograph record.

.4 Complete ANSI temperature tests.

.5 Dissolved gas in fluid analysis test after Performance Guarantee Test

.6 Insulation tests on auxiliary devices and wiring

.7 Power factor test

.8 Core insulation tests - one test to be done just prior to shipping for comparison with on-site receiving test

.9 Sound level test or type test data
PAD MOUNT LIQUID FILLED TRANSFORMER

.10 Control circuit functional test

.11 Fluid composition tests - water content, acidity, celluloid and PCB content after Performance Guarantee Tests

2.16 Acceptable Manufacturers

.1 Partner Technologies Inc. (PTI Transformers)

.2 Carte International

.3 Copper Power Systems - EATON

.4 ABB

2.17 Spare parts

.1 Provide maintenance materials and spare parts in accordance with Section 16010.

3. EXECUTION

3.1 Pre-installation

.1 Contractor will ensure manufacturer recommended factory tests are provided for equipment.

.2 Contractor will provide completed test sheets for Acceptance.

3.2 Installation

.1 Contractor will install transformers only after other work in area is completed and in accordance with manufacturer’s instructions.

.2 Contractor will ensure concrete pad fully cured for 28 days before installation of transformers.

.3 Use spreader bars on slings when lifting transformers into place.

.4 Set and secure transformer in place rigid, plumb, square. Bolt size to be minimum 20 mm diameter. Installation will conform with seismic requirements of British Columbia Building Code for Zone 1 installations.

.5 Contractor will ensure internal connections are mechanically tight.

.6 Contractor will ensure all connections are made.
PAD MOUNT LIQUID FILLED TRANSFORMER

.7 Connect transformer ground terminals to system ground. Pad-mounted transformer shall have all noncurrent-carrying metal parts connected to a solid earth ground electrode as per contract drawings.

.8 Set taps to produce rated secondary voltage at no-load.

.9 Wire one set contacts on liquid temperature measuring device, liquid level gauge, gas detector relay, winding temperature detector relay, to sound alarm when unsafe conditions reached, wire second set contacts to trip transformer circuit interrupter.

3.3 Field Testing and Inspection

.1 Contractor will conduct tests in accordance with manufacturer's recommendations and with Section 16020.

.2 After the installation has been completed, conduct an operating test demonstrating that all equipment devices operate in accordance with the requirements of the drawings and specifications.

.3 Operating Test: Energize the transformer and adjust the output voltage to the specified value. Further readjust tap settings, if necessary, after the facility being served is in normal operation.

3.4 Manufacturer services

.1 Provide a factory-trained manufacturer's representative to assist, supervise, and inspect Contractor's Equipment Checkout.

END OF SECTION
**EQUIPMENT DATA SHEET**

**DISTRICT OF LAKE COUNTRY**

**ELDORADO TREATED WATER RESERVOIR AND GLENMORE BOOSTER STATION**

**ELDORADO RESERVOIR PUMP STATION**

**NEW SUBSTATION - PADMOUNT TRANSFORMER**

**EQUIPMENT**

**MAIN SUPPLY TRANSFORMER**

**Tag Number**

**REF. NO.**

**SEC. 16340**

**Client Project No:**

T.B.D

**Project Title:**

ELDORADO RESERVOIR LOW LIFT PUMP STATION

**Project No.:**

60488627

**Data Sheet No.:**

XFMR-01 (CAN)

**MANUFACTURER**

**MODEL**

**SERIAL NO.**

**REQUIRED NO.**

**SITE CONDITIONS**

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**LOCATION**

- INDOOR
- OUTDOOR
- TROPICAL
- DUST
- CORROSIVE GASES
- OTHER

**LOW CONCENTRATION DUST**

**TRANSFORMER DESIGN**

**DISTRIBUTION TRANSFORMER**

- CSA C2

**RATING**

(3 PHASE, 60 HZ)

- 25kV / 600V / 500 kVA

**IMPEEDANCE**

- STD
- TYP. > 4%

**PAD MOUNTED TRANSFORMER**

- CSA C277.2
- CSA C277.4 (Dead Front)

**POWER TRANSFORMER**

- CSA CAN3 C88

**WINDING CONNECTION**

- WYE / WYE
- Yyn1

- OTHER

**PRIMARY**

- 24,950 V
- Std BIL
- 125kV (peak)

**SECONDARY**

- 600 V
- Std BIL
- 30kV

**SYSTEM CONNECTIONS & FEATURES**

**PRIMARY**

- TOP MOUNTED BUSHINGS

- SIDE MOUNTED BUSHINGS

- EXPOSED BUSHINGS

- ENCLOSED BUSHINGS (terminal box)

- NEUTRAL GROUNDING
  - SOLID
  - RESISTANCE

**SECONDARY**

- TERMINAL BOX / THROAT
  - TOP ENTRY
  - BOTTOM ENTRY
  - BUS DUCT ENTRY (CABLE BUS)
  - SPACE FOR STRESS CONES

**CABLES**

- TYPE HV HLPE
- SIZE #1
- NO./PH 1

- TYPE TECK
- SIZE 350MCM
- NO./PH 2

**ACCESSORIES**

- CT'S:
  - TYPE
  - RATIO 55
  - ACCURACY

- LIGHTNING ARRESTER
  - 27kV MCOV PARKING STAND TYPE

- TERMINAL CONNECTORS
  - NEMA

**OPTIONAL ACCESSORIES**

- TEMPERATURE ALARM CONTACTS (49)
- LIQUID LEVEL ALARM CONTACTS (71)
- HIGH PRESSURE SWITCH (63)
- SUDDEN PRESSURE RELAY
- PROVISION FOR COOLING
- OTHER (LIST)

**MISCELLANEOUS**

**PAINT**

- STD GREEN
- VENDOR GREY
- AS SPECIFIED (xxxxxxx)

**WEIGHTS**

- CORE & COILS
- TANK & FITTINGS
- COOLING LIQUID
- VOLUME
- MAKE / TYPE
- TOTAL INSTALLED WT.

**TRANSFORMER LOSSES @ RATED VOLTAGE**

- NO LOAD
- FULL LOAD

**EFFICIENCY @**

- 50% FULL LOAD
- 75% FULL LOAD
- 100% FULL LOAD
- 125% FULL LOAD

- EFFICIENCY COST FACTOR $ / kw

**NOTES**

- Temp. Rise 65Deg.C
- HV TAPS: 4@ 2.5% -2 FCAN, +2RCBN
- Primary fusing C/W Bay-O-Net current limiting fuse
- Suitable to handle harmonic load (K rated)

**REMARKS**

- APPROVED VENDORS: COOPER (EATON), PTI (PARTNER TECHNOLOGIES INC.), CARTE INTERNATIONAL, ABB.

**VENDOR TO COMPLETE DATA SHEET**
1. **GENERAL**

1.1 **Description**

.1 Provide CSA approved panelboards for 120/280 VAC and 120/240VAC branch circuit distribution as indicated schedules and shown on the drawings, complete with all items listed.

1.2 **Shop Drawings**

.1 Submit Shop Drawings in accordance with Section 16010 – Electrical General Requirements.

2. **PRODUCTS**

2.1 **Panelboards**

.1 Tub: CSA code gauge galvanized steel, reversible top and bottom, finish painted ANSI 61 grey enamel or as specified in Section 16010 - Electrical General Requirements.

.2 Mains: Copper, ampere ratings as shown, solderless lug connectors sized for cables in panels without breakers, bolt-on connectors for all main breakers and branch circuit breakers.

.3 Neutral Bars: Copper with the same ampere ratings as mains, solderless lugs for connections. Neutral Bars are required for all panelboards.

.4 Front shields to cover breaker assembly and neutral bars, leaving wiring gutters accessible when fronts removed.

.5 Front Covers, Doors: CSA code gauge galvanized steel, with doors, concealed hinges, combination locks and latches, interior plastic covered circuit directory cardholders, concealed mounting screws, finish painted, same size as tubs where surface mounted, overlapping trim with wall gaskets where flush mounted.

.6 Locks, Keys: All locks keyed alike.

.7 Branch Circuit Breakers: Thermal magnetic with "ON", "OFF" and "TRIPPED" positions, single, two pole or three pole as shown; ampere ratings as shown; bolt-on line connections, solderless lug load connections; common trip for two and three pole; rated 120 VAC and 208 VAC 10,000 A symmetrical short circuit interrupting capacity in 120/208 volt panelboards.

.8 Spaces: Stamp out spaces, install removable fillers where breaker spaces are shown.
.9 Ground Fault Circuit Interrupters: Breakers having both 5 mA ground fault sensitivity and over current protection, of the amperage rating indicated, shall be installed in the panelboards where required. Wire each ground fault breaker with a separate neutral conductor wired through the interrupter to the ground bus.

.10 Provide a panelboard integrated direct bus connected Surge Protection (TVSS) unit for all 120/208V and 120/240V panels. Rate Surge Protective device as 125kA suitable for a three phase, grounded system or single phase panel, depending on application.

.11 Provide surface mounted panelboards.

.12 Manufacturer and model: Eaton, Schneider or Engineer approved equal.

2.2 Branch Circuit Breakers

.1 Branch circuit breakers shall have bolt-on type bus connectors.

.2 Circuit breakers shall have an overcenter toggle mechanism that will provide quickmake, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- and three-pole circuit breakers shall have common tripping of all poles.

.3 There shall be two forms of visible trip indication. The circuit breaker handle shall reside in a tripped position between ON and OFF.

.4 Panels shall be provided with no less than 15% spare breakers installed based on capacity of panel. Spare breakers shall be 15 A, single-pole. For example, a 42 circuit panel shall be provided with no less than 6 spare breakers installed. If 15% of panel capacity requires more space than the panel has available after loads have been circuited, fill any remaining circuit space with spare breakers.

.5 Size, number of poles and voltage rating as indicated on drawings.

3. EXECUTION

3.1 Mounting

.1 Provide supports independent of conduits. Match trim and door heights on adjacent panelboards.

3.2 Wiring

.1 For panelboards install branch circuit wiring in neat bundles at sides of wiring gutters, with wires to branch breakers horizontal.
.2 Connections to transformers shall be in flexible conduit and shall enter the enclosure below the coils.

3.3 Identification

.1 Provide lamacoid plate securely and permanently attached to the exterior of each panelboard door showing panelboard designation, voltage and source of feed.

.2 For all ground fault breakers, provide a sign indicating that circuits are so protected and that equipment should be tested regularly.

3.4 Branch Circuit Directory

.1 Provide typed directory identifying all branch circuits. Directory to indicate device and location.

3.5 Locking Straps

.1 Locking Straps: To permit automatic tripping of breakers but prevent manual switching, for exit lights, receptacles feeding emergency battery packs, fire alarm panels and where designated.

END OF SECTION
1. GENERAL

1.1 Description

.1 Provide heavy duty type disconnect switches for 347/600 volt and 120/208 volt distribution as indicated on the drawings, as manufactured by Eaton Electric (Cutler-Hammer), Schneider Electric - Square D, Siemens or Engineer approved equal suitable for industrial applications.

2. PRODUCTS

2.1 Disconnect Switches

.1 Ratings: 600 volts for 347/600 volt distribution, 240 volts for 120/208 volt distribution. Unless otherwise shown, 3 pole for 3 phase, 3 wire distribution, 3 pole and solid neutral for 3 phase 4 wire distribution. Ampere ratings as shown on the drawings or to suit load requirements. For motors, use disconnect switches with hp ratings at least equal to motor hp.

.2 Enclosures: CSA code gauge galvanized steel, hinged doors, external operating handles. Disconnect switches in dry locations inside shall be EEMAC-12 and EEMAC-4/4X in process areas. Provide ON-OFF switch position indication on switch enclosure cover.

.3 Finish: One primer coat and one finish coat on all metal surfaces, colours as per Section 16010 - Electrical General Requirements.

.4 Switch mechanisms: Quick make and quick break action with self wiping contacts, solderless pressure lug connectors. For switches 100 amperes and over, provide non-tracking arc shrouds. All switch poles to operate together from a common operating bar. Provide for padlocking disconnect switches in "Off" position. Doors to be interlocked and complete with defeat mechanism, to prevent opening when handle in ON position.

.5 Neutral Bars: Where distribution system has grounded neutral conductor, provide neutral bar where required with ampere rating equal to switch rating, in enclosure. Provide ground bar for terminating ground conductors.

.6 Fuse Holders: Provide fuse holders (relocatable and suitable without adapters) on load side of switches, ampere rating equal to switch ratings, suitable for fuses specified.


2.2 Fuses

.1 If specified, all fuses to be 100,000 ampere (minimum) interrupting capacity of the current limited type. In addition, fuses feeding motors to be of the time delay type. Provide one full set of spare fuses, three for each different ampere rating used, stored in suitable enclosure.

3. EXECUTION

3.1 Disconnect Switches

.1 Mounting: Install within site and as close as possible to the associated motor. Provide supports independent of conduits. Wall mount where possible, otherwise provide Unistrut frame support. Where switches are grouped mount in uniform arrangement.

.2 Wiring: Connect line and load cable to all switches.

.3 Fuse Rating: Install so that rating is visible.

.4 Identification: Provide lamacoid plate in accordance with Section 16010 - Electrical General Requirements, on each switch showing voltage, source of supply and load being fed, for example:

AHU-1
600 Volts, Ø 3
Fed from MCC-400

END OF SECTION
1. GENERAL

.1 Provide energy efficient dry type K rated transformers 600 volts primary to 120/208 volts or 120/240 volts.

.2 The transformers shall be designed to treat all 3rd, 5th, 7th and 9th harmonics produced.

.3 3rd harmonics and other zero sequence currents shall be treated in the secondary windings through flux cancellation and not coupled into the primary windings. Trapping these currents in the primary delta winding as in a delta-wye transformer configuration is not acceptable.

.4 Product Data - Three Phase, Four Wire Secondary

.1 Submit product data in accordance with Section 16010 – Electrical General Requirements.

.5 Transformers to conform to Energy Star, C802, TP1 standards, and are to be approved to CSA Code Part 2, Standard C22.2, No. 47 and CSA C9.

2. PRODUCTS

2.1 Transformers

.1 General: Dry type, air cooled, self ventilated. Enclosures to be NEMA 12 type, code gauge steel, complete with ventilating openings, access panels, mounting brackets, and solderless primary and secondary cable connectors. Enclosures to have zinc chromate prime coat and enamel finish coat per Section 16010. Transformers to be three phase as noted on the drawings.

.2 Dry type transformers shall be minimum K13 rated, phase shifting manufactured by Delta, Schneider, Eaton, Power Quality International, or approved equivalent.

.3 Design

.1 Type: ANN

.2 3 phase, kVA sizes as indicated on drawings, 600 V input, 120/208 V output, 60 Hz.

.3 1 phase, kVA sizes as indicated on drawings, 600 V input 120/240 V output, 60 hz.

.4 All winding conductors to be copper.
.5 The secondary winding shall be interconnected to obtain an angular displacement with respect to the primary winding. Displacement as noted on drawings.

.6 Voltage primary taps: two point five (2.5%) percent Full capacity above and below normal

.7 Insulation: 220 °C.

.8 Basic Impulse Level (BIL): 10 kV B.I.L.

.9 Average Sound Level: To meet the local municipal & building codes and meet at minimum the following criteria:

- 45 dB max. up to 45 kVA
- 50 dB max. up to 150 kVA
- 55 dB max. up to 300 kVA
- 60 dB max. above 500 kVA

.10 Impedance: 2.5 – 3.8% max. up to 75 kVA
- 3.0 – 4.8% max. 112½ kVA or larger

.11 Enclosure: NEMA 12, removable metal front panel

.12 Mounting: Up to 45 kVA suitable for wall or floor mounting and above 45 kVA suitable for floor mounting unless otherwise shown

.13 Finish: In accordance with Section 16010 – Electrical General Requirements.

.14 Three Phase Windings: Arrange with three primary windings connected in delta and three secondary windings connected in wye.

.15 Max. Winding Temperature: 80 °C rise with temperature continuous full load

.16 Efficiency: greater than ninety-eight (98%) percent per Energy Star energy savings program requirements

2.2 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 – Electrical General Requirements.

3. EXECUTION

3.1 Installation

.1 Mount dry type transformers up to 45 kVA as indicated.
.2 Mount dry type transformers above 45 kVA on floor.

.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 Mount transformers as indicated on drawings and connect primary, secondary, neutral and ground conductors. Provide brackets and bolts for wall mounted transformers. Ensure all transformers have good ventilation.

.9 Do not use permanent distribution system dry type transformers for temporary power distribution without permission for the Engineer.

.10 Mount transformers to reduce direct and transmitted noise. Mount core and coils of transformers on vibration and sound absorbing pads.

.11 Record secondary voltage when transformers are carrying approximately seventy-five (75%) percent of full load. Adjust tap connections to give a continuous secondary voltage of 120 volts phase to neutral. Set tap connections for above 120 volts rather than below.

.12 Connections to transformers shall be in flexible conduit and shall enter the enclosure below the coils.

.13 Before energization, keep transformers or storage room enclosures above 10 °C ambient.

END OF SECTION
MOULDED CASE CIRCUIT BREAKERS

1. GENERAL

1.1 Product Data

.1 Submit product data in accordance with Section 16010 - Electrical General Requirements.

.2 Include time-current characteristic curves for breakers with interrupting capacity of
30,000 A symmetrical (rms) and over at system voltage.

2. PRODUCTS

2.1 Breakers General

.1 Bolt-On Moulded Case Circuit Breaker: Quick-make, quick-break type, for manual
and automatic operation with temperature compensation for 40 °C ambient.

.2 Plug-In Moulded Case Circuit Breakers: Quick-make, quick-break type, for manual
and automatic operation with temperature compensation for 40 °C ambient, for suite
load centres for residential projects.

.3 Common-Trip Breakers: With single handle for multi-pole applications.

.4 Magnetic instantaneous trip elements in circuit breakers to operate only when value
of current reaches setting. Trip settings on breakers with adjustable trips to range
from 3-8 times current rating.

.5 Circuit breakers with interchangeable trips as indicated.

2.2 Thermal Magnetic Breakers

.1 Moulded case circuit breaker to operate automatically by means of thermal and
magnetic tripping devices to provide inverse time current tripping and instantaneous
tripping for short circuit protection.

2.3 Solid State Trip Breakers

.1 Moulded case circuit breaker to operate by means of a solid-state trip unit with
associated current monitors and self-powered shunt trip to provide inverse time
current trip under overload condition, and long time, short time, and instantaneous
tripping for phase and ground fault short circuit protection.

2.4 Optional Features

.1 Include where indicated on drawings:

.1 Shunt trip
MOULDED CASE CIRCUIT BREAKERS

.2 Auxiliary switch
.3 Motor-operated mechanism
.4 Under-voltage release
.5 On-off locking device
.6 Handle mechanism
.7 Keyed interlocks
.8 Non-auto
.9 Solid state trip units.

2.5 Enclosure for Individually Mounted Breakers

.1 Enclosure shall be CSA code gauge galvanized steel, hinged door, front mounted external operating handle, lockable in “off” position, EEMAC-12 unless shown otherwise. Use EEMAC-4 enclosure for wet environment or as shown “WP” on drawings. Increase enclosure size above standard for large cables.

.2 Where distribution system has grounded neutral conductor, provide neutral bar, with ampere rating equal to breaker/switch rating in enclosure.

3. EXECUTION

3.1 Installation

.1 Install circuit breakers as indicated.

.2 Identification: Provide lamicoid plate on each breaker showing voltage, source of supply and load being fed - 120/208 V, 3 phase, 4 W fed from LDP No.1 to Splitter Trough No. 1.
1. GENERAL

1.1 Related Work

1. General Electrical Requirements: Section 16010

2. Section 16020 – Spares

3. Seismic Restraints: Section 16195

4. Section 16510 - Battery Operated Emergency and Exit Luminaires

1.2 Documents

1. This section of the specifications forms part of the Contract Document and are to be read, interpreted, and coordinated with all other parts.

1.3 Work Includes

1. This section includes for the supply and installation of luminaires complete with lamps, ballasts, supports, and accessories, and for the supply of plaster frames, trim rings, and back boxes for plaster or drywall ceilings or concrete. The luminaire schedule as shown on electrical drawings.

1.4 General Requirements

1. All lighting fixtures will be purchased by the Contractor unless noted otherwise. Include in the tender price administration of all shop drawings, purchase of all lamps, receiving fixtures on site, uncrating of all the lighting fixtures and clean up.

2. Install lighting as shown on Architectural and Electrical Drawings and as indicated in Contract Documents.

3. Provide and install all materials, components, and services necessary for a complete power wiring distribution system for lighting.

4. Prepare all forms to show compliance with applicable energy use regulations.

5. Any “Alternative” equipment or item of work in lieu of the specified equipment or item of work shall be subject to review and approval by the Consultant at least ten (10) working days prior to the tender closing. Failure to submit within that deadline constitutes a guarantee that the specified products will be supplied. The Lighting Designer will invoice the party submitting an “Alternate”, at Senior Designer hourly rates, to review any product not listed in the specifications.

6. Submittal of a bid for this project shall include a written acknowledgement of these terms from the Contractor. With any “alternate” product, submit a breakdown cost showing the net difference to be deducted or added to the tender price, if accepted.
LIGHTING EQUIPMENT

 Include for and assume responsibility for any additional installation cost by all disciplines affected by the substitution and cost of additional review time expended by other trades and disciplines, resulting from the substitution.

.7 Submit with tender bid for this project total “lot cost of lighting fixtures and complete bill of material.

.8 Substitution for the specified lighting products is not acceptable and will not be considered. Failure to include one of these specified products as part of the Base Bid may, at the discretion of the Owner, invalidate the entire lighting product bid and exclude the Contractor from further consideration.

.9 Within ten (10) working days of contract award, the successful Contractor shall submit a complete list of lighting products he intends on furnishing with manufacturer and catalogue designations, along with currently quoted lead times for delivery of same. Should the Contractor anticipate that the delivery schedule of any specified product may adversely impact the construction schedule, he shall bring it to the attention of the Owner at this time.

1.5 Section Includes

.1 Interior and exterior light fixtures, fixture finishes, and accessories

.2 Lamp holders

1.6 Related Sections

.1 General Electrical Requirements: Section 16010

.2 Conduits, Conduit Fastenings, and Conduit Fittings: Section 16110

.3 Wires and Cables: Section 16122

.4 Outlet Boxes, Conduit Boxes, and Fittings: Section 16050

.5 Fastenings and Supports: Section 16191

.6 Seismic Restraints: Section 16195

.7 Grounding: Section 16160

1.7 References


.2 Underwriters’ Laboratories Canada (ULC).

.3 Illuminating Engineering Society of North America (IES).

.4 Canadian Standards Association (CSA).
.5 ANSI C82.4, Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps.

.6 CGSB 31-GP-103Ma, Heavy Phosphate Conversion Coatings for Iron and Steel (for Corrosion Resistance).

.7 CGSB 31-GP-105Ma, Zinc Phosphate Conversion Coatings for Paint Base.

.8 CGSB 31-GP-106M, Coating, Conversion, Iron Phosphate for Paint Base.

.9 Installation of lighting equipment to conform to the current edition of the Canadian Electrical Code as amended and supplemented by Provincial, Municipal, or other regulatory agencies having jurisdiction.

.10 Luminaires to conform to CSA C22.2 No. 9, ballasts to CSA C22.2 No. 74, ANSI C82.1 and lamps.

.11 Wherever acrylic lens material is specified, it shall mean the use of 100% virgin acrylic materials. Reference to polystyrene or plastic lens materials shall mean only light stable types guaranteed not to yellow for a five year period. Lenses shall be a minimum nominal thickness of 3 mm (0.125 in).

1.8 Submittals, Shop Drawings, and Product Data

.1 Submittals

.1 Submit shop drawings, samples, and product data in accordance with Section 16010 – General.

.2 Provide the required number of submittals promptly and deliver through appropriate channels, leaving sufficient time for adequate review and possible resubmittals without jeopardizing Project Schedule.

.3 Contractor is responsible for all verification and actual field dimensions, quantities, coordination, and compliance with Contract Documents.

.4 Submit ballast shop drawings with each applicable fixture shop drawing. If required by the Consultant, submit certified heat run test data for each type of ballast mounting.

.2 Contractor shall provide fully dimensioned shop drawings for all fixture types and all custom mounding hardware.

.1 No release of orders for lighting equipment shall be made until review of submittals is complete.
.2 Submit shop drawings for all products as follows:

.1 Provide complete, fully dimensioned detail drawings including all major components and details of fabrication.

.2 Provide requisite schematics and plans indicating assembly and installation of components.

.3 Provide inventory of all equipment to be supplied including types, quantities, and reference to applicable drawings and schematics.

.3 Submit a list of fixture types and quantities and catalogue cuts for all product data. Such data shall show both technical and pictorial detail, marked specifically to show the optional or alternate components required, the exact catalogue number, and type designation corresponding to the type indicated in the Fixture Schedule. Include this data also with Maintenance Manual and the Consultant’s review stamp.

.4 For lighting fixtures used for general illumination:

.1 Candlepower distribution curve and table. Data in table shall have vertical angles no greater than 10° increments (5°, 15°, 25°, etc.). All asymmetric distributions shall have quadrants represented in 22.5° increments (parallel, 22.5°, 45°, … normal), or sufficient increments to fully describe asymmetric light distribution.

.2 Coefficient of Utilization (CU) tables.

.3 Visual Comfort Probability (VCP) table (fluorescent fixtures only) for 100 foot candle room with reflectance of 80% ceiling, 50% wall, and 20% floor with task height of 2.5 ft.

.4 Zonal lumens stated numerically in 10° increments (5°, 15°, etc.), or smaller increments for narrow beam fixtures.

.1 For all other fixtures, provide candlepower distribution curve and table with minimum 10° increments (5°, 15°, etc.) or small ° increments for narrower distribution fixtures.

.2 Submittals shall include complete driver information on all LED fixtures.

.3 Submittals shall indicate designation, manufacturer’s name, beam spread and Centre Beam Candle Power (for the reflector lamps only), rated life, mean and initial lumen output, and colour temperature base.
1.9 Source Quality Control

.1 The Contractor/Manufacturer must own and operate his own shop for fabrication of architectural light fixtures and be regularly engaged in the fabrication and installation of such equipment. Fabrication and installation of such equipment shall comprise no less than 90% of the Contractor/Manufacturer's business.

.2 The Manufacturer must have been engaged in the fabrication of the above equipment for at least the past 5 years.

.3 The light fixture schedules are pre-approved and are the standard of acceptance to be met through quality, performance, and architectural design.

1.10 Installation, Operation, and Maintenance Data

.1 Submit under provisions of Section 01735 – Operation and Maintenance Data.

1.11 Delivery and Storage

.1 Equipment shall be individually wrapped, sealed, and substantially crated for shipment. All handling and shipping shall be performed in accordance with Manufacturer’s recommendations. Store products in unopened cartons in a protected location.

1.12 Warranty

.1 Provide Contract warranties as well as factory warranties. All equipment and labour in this Contract shall be free from defects in products or workmanship during Warranty Period unless otherwise noted or approved by the Owner.

.2 Solid state electronic drivers shall have a warranty period of 5 years.

.3 LED fixtures and electronic drivers shall be supplied warranted as a system, with driver for the period of 60 months from the date of acceptance of the work; fixture for a period of minimum 24 months. Include labour for replacing fixtures in the warranty.

.1 Note: LED and driver system warranty shall be available from fixture manufacturer and shall be registered to the project. This contractor is responsible for all administration in requesting the warranty and providing it to the Owner.

2. PRODUCTS

2.1 General

.1 Provide all products with CSA labels or appropriate approvals for all mounting conditions.
LIGHTING EQUIPMENT

.2 Provide lighting fixtures new and complete with mounting accessories, junction boxes, trims, and lamps.

.3 All products of the same specified type are to be of the same manufacturer.

.4 Fixture type catalogue number does not necessarily denote required mounting equipment or accessories. Provide all appropriate mounting accessories for all mounting conditions.

.5 All fixtures shall have the appropriate frame that is compatible with the ceiling type into which they are installed. Verify all ceiling types at the shop drawing review.

.6 Provide appropriate accessories for proper mounting of all fixtures. For fixtures suspended from ceiling, provide pendants or aircraft cables complete with accessories to complete the installation as indicated on the drawings.

.7 Recessed luminaires shall be of the pre-wired type with the junction box and, where applicable, the ballast forming an integral part of the assembly with satisfactory access.

.8 Provide only luminaires, which are structurally well designed and constructed, and which use new materials of the highest commercial grade available. Unless specifically noted otherwise, luminaires to be of the quality stated in the manufacturers’ catalogues and data sheets. Luminaires shall be designed for adequate dissipation of ballast and lamp heat, and for seismic conditions as specified in Section 16010 – Electrical General Requirements.

.9 Luminaire bodies for high corrosive areas to be non-metallic or epoxy-coated.

.10 Hinges, latches, and other exposed hardware to be non-metallic, or 316 stainless steel for corrosion-resistant luminaires. Use 316 stainless steel chains for suspension of corrosion-resistant luminaires.

.11 Where light fixture or light fixture suspension apparatus penetrates metal pan or sheet metal ceiling or canopies, an approved copy of the shop drawings of those fixtures shall be provided to the ceiling manufacturer. Apertures in the ceiling or openings for suspension cables shall be pre-cut by the ceiling manufacturer to suit light fixtures. Instruct the manufacturer accordingly.

.12 If the words “or equivalent” or “or approved equal” are not indicated after light fixture manufacturer catalogue number in the Fixture Schedule, then no other manufacturer will be acceptable for that particular type.

2.2 Fixture Construction

.1 General

.1 All fixtures shall be free of inappropriate light leaks.
LIGHTING EQUIPMENT

.2 Fixtures in non-accessible ceilings and in the columns shall be accessible junction boxes, ballasts, and transformers through fixture apertures.

.3 No metal clips, screws, angles, etc. shall be visible when the fixture is viewed from below.

.4 All mounting frames installed in damp locations or in plaster ceiling shall be galvanized.

.5 Extruded fixture housings shall have a minimum thickness of 2.3 mm (3/32 in) and be smooth and free of tooling lines. Die cast end plates and joiner sections shall have a minimum thickness of 2 mm (3/32 in) thickness and concealed fasteners.

.6 Die casts shall be smooth, free of pits, grooves, and imperfections.

.7 Spinning shall be smooth and clean with finished edges, and free of spinning lines.

.8 Sheet metal fixture housings shall be of welded construction with seams filled and ground smooth. Any exceptions shall be noted under individual fixture types.

.9 All adjustable fixtures shall have locking rotation and tilt devices.

.10 Pendant-mounted fixtures shall have stems with ball swivels or be cable-mounted to allow 45 degrees swing in any direction from vertical.

.11 Ball swivels and cable end hardware shall be concealed with sleeve.

.2 Fixture utilizing both 120 V services and 347 V services or utilizing more than one 120 V service or more than one 347 V service shall have wiring sections and separate wiring connections and labelling as necessary to satisfy all Code and local inspection requirements.

.3 Reflector Cones

.1 Provide 45 degrees lamp image cut-off when viewed from below unless indicated otherwise.

.2 Reflector cones shall have a minimum thickness of 0.8 mm (0.03125 in) and be manufactured of uniform gauge Alcoa 3002 alloy, free of spin marks, or other manufacturing defects. The use of plastic for cones or trim rings is not acceptable.

.3 Reflector finish shall be semi-specular by means of an Alzak process. Reflector inner surface shall be free of water spotting and shall maintain a reflectivity ratio of no less than 80% on clear specular finish unless otherwise noted.
.4 Cone flange shall be formed as an integral part of the cone and shall have an identical appearance as the inner cone unless otherwise indicated. Flange overlap shall have a perpendicular orientation to the cone and shall have adequate width to cover the ceiling opening with no visible light leaks.

.5 Fixtures with Alzak reflector cones shall all be furnished by the same manufacturer, unless otherwise indicated. All reflector cones shall have iridescent suppressant finish for fluorescent and HID fixtures unless otherwise specified.

2.3 Drivers

.1 LED Drivers

.1 Use drivers that are capable of operating number of LEDs indicated on Fixture Schedule at full light output. Secure driver by screws; slip-in is not be acceptable. For all drivers within a single fixture, provide by one manufacturer.

.2 Use divers complying with all applicable energy codes.

.3 Driver operating voltage shall be 120-277 V, unless noted otherwise. All LED drivers, shall meet the following criteria:

   .1 Use drivers certified by cUL.
   .2 Voltage rating to be the same as the circuit that supplies the lighting fixture, which uses the driver
   .3 Minimum driver efficiency of 85 percent.
   .4 Power factor: minimum 95 percent.
   .5 Match driver output current to the number of LEDs supplied in the fixture.
   .6 The fundamental driver frequency is 60 Hz.

2.4 LED Fixtures

.1 Manufacture fixture housings from minimum #22 gauge CR steel for indoor fixtures and aluminum for damp/wet location and outdoor fixtures.

.2 Do not use fixture housing with pressure fit construction or utilizing rivets, when applicable, incorporate lenses in hinged frame utilizing hidden release mechanism of a heavy duty standard (i.e., visible frame releases will not be accepted). Securely retain lenses in the frame assembly utilizing the equivalent of stainless steel piping clips.

.3 Outdoor fixtures shall have weather tight LED driver compartment and high performance aluminum heat sinks.
.4 All painting to be done after cutting.

2.5 Fixture Finishes

.1 Baked Enamel Finish:

.1 Conditioning of metal before painting:

.1 For corrosion-resistance conversion coating to CGSB 31-GP-103Ma.

.2 For paint base, conversion coating to CGSB 31-GP-105Ma, CGSB 31-GP-106M.

.2 Finish metal surfaces of luminaire housing and reflectors with high gloss polyester powercoat or alzak aluminum to give smooth, uniform appearance, free from pinholes or defects.

.3 Finish reflector and other inside surfaces as follows:

.1 White minimum reflection factor 85 percent.

.2 Colour fastness: yellowness factor not above 0.02 and after 250 h exposure in Atlas fade-ometer not to exceed 0.05.

.3 Film thickness not less than 0.03 mm average and in no areas less than 0.025 mm.

.4 Gloss not less than 80 units as measured with Gardner 60° gloss meter.

.5 Flexibility: withstand bending over 12 mm mandrel without showing signs of cracking or flaking under 10 times magnification.

.6 Adhesion: 24 mm square lattice made of 3 mm squares cut through film to metal with sharp razor blade. Adhesive cellulose tape applied over lattice and pulled. Adhesion satisfactory if no coating removed.

.2 Finish painted fixtures with synthetic enamel, with acrylic, alkyd, epoxy, polyester or polyurethane base applied after the fixture is completely constructed. Use light stabilized, baked on at minimum 180°C, and catalytically or photochemically polymerized after application.

.3 Clean and treat all metal parts with phosphate or chromate bonding process after fabrication for maximum paint adhesion.

.4 For all polished decorative metals (brass, chrome, etc.), use a clear protective finish, baked-on lacquer or air-cured urethane.

.5 All custom colour finishes are to be approved by Engineer.
.6 For all fixtures, lenses, diffusers, and fittings ensure a flame spread rating is less than 250. Shop drawings are required.

2.6 Lighting Fixture Schedule

.1 Catalogue numbers in the Lighting Fixture Schedule are shown to indicate approved manufacturer and fixture quality requirements. The numbers may or may not include variations or special light fixture features as specified in the associated fixtures. Include all features as specified in the Schedule.

2.7 Wire Guards

.1 Provide wire guards to all fixtures that are mounted so that any part of the fixture is less than 2400 mm (8'-0") above adjacent floor, unless noted otherwise in the Fixture Schedule.

.2 For all fixtures in service rooms, provide wire guards.

2.8 Lighting Control

.1 Provide indoor outdoor lighting control panels in accordance with the contract drawings.

.2 Provide lighting contactor panels, motion (occupancy) sensors, daylight (photosensors) sensors, electronic timers and or dimming control wall switches in accordance with the drawings and the lighting schedules.

.3 Photosensors and/or occupancy sensors and electronic timers shall be provided with manual overrides in some areas so that the end users can easily switch the spaces they are occupying manually.

.4 Occupancy sensors shall be either passive infrared or ultrasonic technology. Dual-technology (passive infrared and ultrasonic) occupancy sensors shall be used where required in administration area (washrooms, storage rooms, mechanical rooms, access hallways and in control rooms)

3. EXECUTION

3.1 Verification of Conditions

.1 Confirm all ceiling depths against the final architectural ceiling plans and sections to ensure that recessed fixtures can be installed in all ceiling conditions and advise the Engineer immediately of any discrepancies prior to ordering of the fixtures or proceeding with the work. Prior to order of modified fixtures for non-standard ceiling depths, confirm with the Engineer.
3.2 Installation – General

.1 Lighting fixtures shall be installed as indicated on architectural reflected ceiling plans, Electrical Drawings, and per approved shop drawings.

.2 Lighting fixtures are indicated in the Lighting Fixture Schedule by means of type letters that correspond to similar letters on the plans.

.3 Lighting fixtures shall be installed in accordance with fixture manufacture’s written instructions, applicable requirements of CED, applicable authorities, and with recognized industry practices.

.4 Verify locations and spacing of lighting fixtures with reflected ceiling plans and notify Consultant of any variance or conflict between the plans and field conditions. Do not proceed until conflict has been resolved.

.5 Work shall be coordinated with other trades. Lighting fixture locations shall have priority over locations of ducts, diffusers, sprinklers, smoke detectors, and other non-structural obstructions.

.6 All fixtures shall be supported directly from the building structural members or from bridging attached to the structural members by rod hangers and inserts. Provide all necessary hardware and blocking to ensure that fixtures hang true.

.7 Lighting fixtures shall be adequately supported and braced to satisfy seismic codes. Refer to Section 16195 – Seismic Restraints.

.8 Install recessed luminaires to permit removal from below, unless noted otherwise, to gain access to outlet or pre-wired luminaires box. Make final connection from boxes to luminaires with flexible conduit. AC-90 (with No. 14 AWG conductors) may be used, but shall be independently supported (e.g. not from connectors), and have anti-shorts installed. With either type of connection method, the length of the flexible connection shall not exceed 2 metres.

.9 For recessed luminaires, in particular for pot-lights and strip luminaires, support luminaires independent of suspended ceiling system to comply with seismic requirements.

.10 Fixtures installed in suspended T-bar ceiling shall be equipped with T-bar clips. Clips shall be securely fastened to suspended T-bar ceiling system framing members. The light fixture shall be centered in the ceiling grid opening. Provide a minimum of two clips, on each on diagonal opposite corners, and provide more clips if required by local authority having jurisdiction. Clips shall be reusable and not closed down with rivets.

.11 Provide every light outlet in the building with a lighting fixture as instructed, complete with lamps and other accessories necessary for its proper installation and operation. If a fixture type is not designed for any particular outlet, obtain the necessary details.
from the Consultant prior to submission of tender. Alternatively, supply a suitable fixture for the outlet involved as directed by the Consultants.

.12 Effectively ground all light fixtures. Fixtures with their sockets so far apart as to give less than perfect contact at the lamps, or with poor grounds, will be rejected and shall be replaced by the Contractor without charge.

.13 Install lighting fixtures true to the surface in or to which they are mounted, and except where otherwise indicated on the Drawings, align correctly with building or room walls as the case directs. Mount wall fixtures at elevations specified or as shown on Architectural or Electrical Drawings. Where no elevation is shown, confirm mounting height with the Consultant prior to rough-in.

.14 Where lighting fixtures are stern hung from “ball and socket” swivels at the ceiling, use stranded wire, #16AWG (19 x 29) minimum size, from outlet box to the fixture.

.15 Where lighting fixtures are chain-suspended, use solid conductor in armoured cable or flexible conduit and secure to the chain with white or clear nylon cable ties, as specified elsewhere.

.16 Provide lamicoid plate (white letters on blue background) with inscription “U.P.S.” as fastened to T-bar or fixture frame for all lighting fixtures connected to the UPS system.

.17 All fixtures shall be installed with the bottom of the fixture housing aligned with the finished ceiling line unless otherwise noted in the manufacturer’s installation instructions.

.18 Ceiling insulation shall be a minimum of 75 mm (3 in) away from fixture.

.19 Provide wiring channel for mounting of LED linear fixtures and wiring in between fixtures, suspended below mechanical piping, ductwork, etc., as directed on 15 mm (0.6 in) rigid conduit or 10 mm (0.4 in) galvanized rod hangers, on 2440 mm (8 ft) centres.

.20 Nominal size of channels 70 x 70, 10 mm (0.4 in) steel minimum, baked white enamel finish, complete with channel connectors, and closure pieces, coverpieces, mounting hickey, fixture connectors, etc., with jointer pieces 300 mm (12 in) in length minimum to form a rigid assembly.

### 3.3 Workmanship

.1 Provide suitable extension couplings for wall-mounted luminaires.

.2 Hand and mount luminaires to prevent distorting frame, housing, sides, or lens frame and permit correct alignment of several luminaires in a row.

.3 Support luminaires as indicated on the Drawings, level and plumb, and turn with structure and other equipment in horizontal or vertical position as intended. Install
wall or side bracket mounted luminaire housing rigidly, and adjust to neat flush fit with mounting surface.

.4 Where luminaires are required to be supported from the building structure, use a minimum of two 6.35 mm rods per luminaire.

.5 Apply a protective coat of bituminous paint to surfaces of recessed luminaires, which are in contact with concrete.

3.4 Installation of Recessed Fixtures

.1 Holes shall be cut to exact fixture size so that no gaps will be present when trims or cones are installed.

.2 Round holes in acoustical tile ceilings shall be cut using adjustable diameter cutter on slow speed drill press.

.3 Holes in metal pan and/or sheet metal ceiling and/or ceiling canopy shall be pre-cut by ceiling manufacturer based on approved shop drawings of the light fixtures located in these areas. Electrical contractor shall be responsible for coordination between Division 16 and metal ceiling manufacturer(s) of light fixtures installation in areas with metal ceilings.

.4 Installation of trims shall be tight with no gaps or light leaks. Reflector cones, baffles, aperture plates, and decorative elements shall be installed after completion of plastering. Ceiling tile work painting, and general clean up in areas. Caulking or sealing fixture trim cones to ceiling to eliminate light leaks or gaps shall not be acceptable.

.5 Where fixtures are recessed into non-accessible ceiling and the fixture specified are not pre-wired, wire to an outlet box adjacent to each fixture and visible only when the fixture is removed, connect to the fixture with suitable high-temperature wire in at least 1200 mm (48 in) of flexible conduit. Install fixtures so that they may be readily removed to gain access to these outlet boxes.

.6 Provide site-fabricated insulation shields over all recessed lighting fixtures without insulation rated housing installed in ceilings above areas where thermal insulation is to be installed. Shields shall be constructed of a size and material acceptable to the Electrical Inspector.

3.5 Field Quality Control

.1 Operate each fixture after installation and connection. Each fixture shall be inspected for proper connection and operation.

.2 Perform testing of operation of temporary or emergency power systems.

.3 Verify that all lenses, louvres, baffles, fixture trim cones, diffusers, and other parts are thoroughly cleaned in a manner recommended by the manufacturer.
LIGHTING EQUIPMENT

.4 Replace all lamps used during construction with new lamps prior to final acceptance of the Project.

3.6 Luminaire Wiring

.1 Connect recessed luminaires to outlet boxes with maximum 10 mm (0.4 in) flexible conduit and 90 °C wire.

3.7 Branch Circuit Wiring

.1 Where the Drawings do not show conduit routing or conduit sizes and wire counts, supply and install a complete system of conduit and wire for the lighting system. Make all connections and install all conductors for the switching and branch circuiting indicated and required. Run conduit parallel to major building lines.

.2 Conductors shall be #12R90 XLPE minimum.

.3 Provide a neutral for each circuit (phase conductor).

.4 Conduits shall be sized in accordance with code requirements for wire count installed. In no case shall conduit less than 19 mm be used for home runs. Base conduit fill on maximum of six phase conductors per conduit, resulting in a derating of 70% as per Canadian Electrical Code.

.5 Provide equipment grounding connections for lighting luminaires as required. Tighten connections to comply with tightening torques specified in UL Standard 486A to ensure permanent and effective grounds.

3.8 Control and Circuiting

.1 In general, all fixtures circuits are controlled by local switching.

.2 Where no switching is shown, lighting shall be motion sensor switched.

.3 Where circuiting is not specifically shown, provide sufficient 15A-1P breakers and wiring to limit loading to 1200 watts per circuit to code whichever is the most restrictive.

3.9 Fixtures in Service Rooms

.1 Before mounting any fixture in mechanical, electrical, or other service rooms, obtain written approval of layout to be used. Layout must suit equipment limitations in the room.

3.10 Adjustments

.1 Coordinate with Section 01770 - Close-out Procedures.
LIGHTING EQUIPMENT

.2 All adjustable fixtures shall be aimed as instructed by the Engineer. Personal, lifts, and ladders shall be provided as required. Contractor shall advise Engineer two weeks in advance of scheduled aiming.

.3 Adjust exit sign directional arrows, if required.

3.11 Cleaning

.1 Coordinate with Section 01770 - Close-out Procedures.

.2 Remove all plastic bags form parabolic fixtures after construction is finished and prior to final acceptance.

.3 All necessary equipment, materials, wiring, and fixtures shall be removed from those areas affected by the construction. Materials that are not part of the lighting or electrical distribution system shall be removed from the Site.

.4 All lighting fixtures shall be cleaned in a manner approved by the manufacturer and shall be free of dirt and debris upon completion of installation.

3.12 Demonstration

.1 Coordinate with Section 01770 - Close-out Procedures.

.2 Building personnel shall be trained to operate lighting control system. Building personnel shall be advised on relamping procedures and be given a list of lamps required for the fixtures on the Project.

3.13 Protection

.1 Lighting fixtures, once installed, shall be protected from damage during the remainder of the construction period.

END OF SECTION
BATTERY OPERATED EMERGENCY AND EXIT LUMINAIRES

1. GENERAL

1.1 Related Work

.1 Section 16195 - Seismic Restraints
.2 Section 16505 – Lighting Equipment

1.2 Regulatory Requirements

.1 All units to comply with CSA Performance Standard C22.2 No.141, and recognized by Section 46 of the Canadian Electrical code, Part I, latest edition.

2. PRODUCTS

2.1 Exit Signs Luminaires

.1 Provide exit sign units. Each unit to be complete with the following:

.1 Cast aluminium housing that is impact and scratch-resistant in all areas.
.2 Replaceable chevron directional indicator faceplate.
.3 Each letter to be 150 mm high cut-outs with green LED’S.
.4 LED’S to be rated for 25 years life.
.5 Input voltage to be 120 V.
.6 Faceplate and housing to have no visible unused knockouts.
.7 Automatic recharge after discharge.
.8 Test Switch and LED to provide visual and manual means of monitoring the system operations.
.9 Complete with nickel cadmium batteries.

.2 Exit sign luminaires to be installed as follows:

C1 ceiling mounted, single face.
C1A ceiling mounted, single face, arrows as indicated.
C2A ceiling mounted, double face, arrows as indicated.
E2A end wall mounted, double face, directional arrows as indicated.
W back wall mounted.
WA back wall mounted, arrows as indicated.
2.2 Emergency Luminaires

.1 Provide emergency lighting units for automatic operation on power failure. Each unit to be complete with the following:

.1 Sealed pure lead battery.

.2 Fully automatic charger.

.3 Automatic changeover relay.

.4 Miniature LED lamp.

3. EXECUTION

3.1 Installation

.1 Power to exit sign luminaires and emergency lighting luminaires in each building to be provided from a separate 15 A breaker in the buildings panelboard.

.1 Provide 15 A, 120-volt normal power circuit and single receptacle for emergency lighting luminaries.

.2 All exit sign luminaries wiring to be installed in separate conduits and all conductors to be No. 12 gauge minimum with RW90 X-link insulation.

.3 Provide mounting brackets and locate as shown on drawings.

END OF SECTION
1. GENERAL

1.1 Work Included

.1 Provide a complete system of wiring, making all connections necessary for the installation shown on drawings.

1.2 Special Codes

.1 Install and rate power cables in accordance with the Canadian Electrical Code requirements or in accordance with IPCEA requirements where permissible.

2. PRODUCTS

2.1 Fan-Forced Heaters

.1 Provide unit heaters as shown on Mechanical Drawings.

.2 Unit heaters c/w associated thermostats shall be installed to meet the CEC area classifications.

.3 Mechanical assembly to be self contained, factory assembled unit, complete with heating element, reflector, housing, mounting brackets and controls.

.4 Provide all required wiring.

.5 Provide the associated thermostats as indicated on drawings.

<table>
<thead>
<tr>
<th>Tag</th>
<th>Location</th>
<th>Manufacturer and Model</th>
<th>Power, Voltage</th>
<th>Notes</th>
<th>Area Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>EUH-112</td>
<td>Glenmore Booster Station</td>
<td>Chromalox</td>
<td>5kW, 600VAC, 3Ph</td>
<td>Provide ceiling mount bracket &amp; Thermostat</td>
</tr>
<tr>
<td>2.</td>
<td>EUH-113</td>
<td>Glenmore Booster Station</td>
<td>Chromalox</td>
<td>5kW, 600VAC, 3Ph</td>
<td>Provide ceiling mount bracket &amp; Thermostat</td>
</tr>
<tr>
<td>3.</td>
<td>EUH-212</td>
<td>Eldorado Pump. Station</td>
<td>Chromalox</td>
<td>5kW, 600VAC, 3Ph</td>
<td>Provide wall mount Thermostat</td>
</tr>
<tr>
<td>4.</td>
<td>EUH-213</td>
<td>Eldorado Pump. Station</td>
<td>Chromalox</td>
<td>5kW, 600VAC, 3Ph</td>
<td>Provide wall mount Thermostat</td>
</tr>
</tbody>
</table>

2.2 Electric Baseboard Heaters

.1 Provide electric baseboard heaters as shown in Division 15.
ELECTRIC UNIT HEATERS

.2 Mechanical assembly to be self contained, factory assembled unit, complete with heating element, reflector, housing, disconnect switch, mounting brackets and thermostat.

.3 Provide all required wiring.

.4 Provide the associated thermostats as indicated on drawings.

<table>
<thead>
<tr>
<th>Tag</th>
<th>Location</th>
<th>Manufact. and Model</th>
<th>Power, Voltage</th>
<th>Notes</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>EBH- 1 / Glenmore Booster Station El. Rm.</td>
<td>Chromalox or approved Equal</td>
<td>0.75 kW, 120VA, 1Ph</td>
<td>Provide wall mount Thermostat</td>
<td>Unclassified</td>
</tr>
<tr>
<td>2.</td>
<td>EBH- 2 / Eldorado Pump Station El. Rm.</td>
<td>Chromalox or approved Equal</td>
<td>1kW, 120VA, 1Ph</td>
<td>Provide wall mount Thermostat</td>
<td>Unclassified</td>
</tr>
</tbody>
</table>

3. EXECUTION

3.1 Installation

.1 Install as shown on drawings and specifications.

.2 Provide all required mounting hardware.

.3 Power supply as shown on the drawings.

END OF SECTION
1. **GENERAL**

.1 The contractor shall supply, install, and make operational all Full Voltage Magnetic Starters (FVR) as shown on the Electrical Drawings, Single line diagrams and Motor Control Schedules.

.2 Nominal system power is 600 volts, 60 Hz alternating current. Control circuitry shall be in accordance with the schematic drawings.

1.2 **Related Work**

.1 General Requirements: Section 16010

.2 Connections to Mechanical Equipment: Section 16850

.3 Motor Control Centres: Section 16820

.4 Single Line Electrical Drawings

1.3 **Starter Requirements**

.1 In general, there are categories of starting equipment for three phase motors:

.1 Integral Mounted Starters: Some items of mechanical equipment such as HVAC equipment, have the starter mounted as part of the equipment. For this equipment, supply disconnects and wire to the terminals of the equipment.

.2 Separately Mounted Starters: For motors without integral mounted starters, supply separately mounted starters as indicated on the Drawings and wire the equipment.

.3 Starters in Motor Control Centre: For motors fed from motor control centre, wire from the equipment to the motor control center section/starter. See section 16820.

.2 Provide manual starters for all single phase motors unless otherwise indicated on the motor schedule.

.3 Provide interlocking between starters where required.

.4 All starter accessories such as pilot lights, Local-Off-Remote, Start-Stop, etc. whether integrally or remote mounted shall be heavy duty oil tight, unless otherwise specified.
1.4 Shop Drawings and Product Data

.1 Submit shop drawings in accordance with Section 16010 - Electrical General Requirements. Indicate:

  .1 Mounting method and dimensions
  .2 Starter size and type
  .3 Layout of identified internal and front panel components
  .4 Enclosure types
  .5 Wiring diagram for each type of starter, interconnection diagrams.

    .1 PLC to Starter commands: start/stop, remote fault reset, frequency reference for VFDs.

    .2 Starter to PLC status: starter fault, starter running, starter ready, Local-Off-Remote switch in Remote position, motor current, fault code and motor frequency for the VFDs.

2. PRODUCT

2.1 Full Voltage Magnetic Starters

.1 Provide NEMA Specifications Contactors.

.2 Magnetic of size, type rating and enclosure type as indicated with components as follows:

  .1 Contactor solenoid operated, rapid action type.

  .2 Electronic motor overload protective device (smart overload) in each phase, manually reset from outside enclosure with built-in Modbus TCP communication port. Provide a reset push-button for smart overload reset/test without opening the enclosure door.

  .3 Each smart overload shall be supplied with an Operator Panel c/w door adapter. Operator panels shall be door mounted. The Operator Panels shall have digital display and program push buttons.

  .4 Provide smart overload programming and diagnostic software c/w all required programming cables and adapters.

  .5 All power and control wiring to be terminated on terminals in cubical.
.6 All wiring and schematic diagram inside starter enclosure in visible location.

.7 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.

.8 For all motors 22.4 kW and above, the starters shall contain RTD / thermistor control relay and accessories.

.9 Each motor starter installed in a MCC shall be supplied with a smart overload device with a built in Modbus TCP communication port. The smart overload devices shall be Schneider TeSys T or Eaton Motor Insight

.3 Ethernet Communications

.1 Each smart overload shall have an integrated Ethernet (Modbus TCP) connection. Gateways or Ethernet I/O modules are not allowed.

.2 The following smart overload variables must be available through Modbus TCP:

.1 Motor Current
.2 Motor Run
.3 Local-Off-Remote switch in Remote position
.4 Fault
.5 Fault Code
.6 Elapsed Run Time
.7 Motor Start/Stop Command
.8 Fault – Remote Reset Command

.3 The mode of operation is as follows:

.1 In Local Mode – the associated motor shall run
.2 In Off Mode – The motor shall be prevented from running
.3 In Remote Mode – The motor start/stop commands shall be through Modbus TCP

.4 Approved Manufacturers

.1 EATON (Cutler-Hammer) or Engineer approved equal.
3. EXECUTION

3.1 Installation

.1 Install Full Voltage Starters in a Motor Control Centre as specified in Section 16820 of the specifications. Where noted starter equipment may be wall-mounted on 25 mm plywood backboard or in custom manufactured control panels.

.2 Ensure correct fuses and overload device elements are installed.

.3 Lamacoid nameplates for all door mounted control devices. A nameplate schedule shall be supplied at the time drawings are reviewed for approval.

.4 The fully qualified manufacture’s representative must be present at the site during the drives setup, test and commissioning.

3.2 Tests

.1 Perform tests in accordance with Section 16030 of the specifications and manufacturer’s instructions.

.2 All connections, tests, settings and adjustments are to be completed and the certificate of manufacturers verification is to be received prior to energizing of the VFD. The manufacturers representative shall be present when the VFD is first energized.

.3 Provide test reports proving absence of any harmful harmonics, transients or other anomalies and provide the Engineer with written certification that the drive has been properly installed, wired and adjusted. Where dangerous or questionable electrical anomalies exists, provide at no additional cost such remedies as are required to eliminate any possibility of damage to the VFD, motors, or any equipment in the station and to limit harmonics to within allowable limits.

.4 Operate switches, contactors, soft starters and VFDs to verify correct functionality prior to connecting to equipment motor load.

.5 Perform starting and stopping sequences of starter equipment and relays.

.6 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

3.3 Drawings

.1 The Contractor shall supply the following information for the Contract Administrator's review and acceptance before manufacture and/or shipment:

.1 Equipment specifications.
MOTOR STARTERS TO 600 V

.2 Schematic drawings.
.3 Wiring diagrams.
.4 General arrangement and dimensional drawings.
.5 General arrangement of pushbuttons, selector switches, potentiometers and instrumentation.

.2 Control details shall be developed between the VFD supplier and MCC supplier before manufacture.

3.4 Warranty

.1 The vendor supplying the variable frequency drive equipment shall provide the owner with a warranty with each respective item of equipment supplied. This warranty shall include conformance to this specification with regards to THD, RFI and EMI emissions.

3.5 Operation and Maintenance Manuals

.1 Provide operation and maintenance data for all starter equipment and incorporate it into the manual in accordance with Section 01735 – Operation and Maintenance Data.
.2 Detailed instructions to permit effective operation, maintenance and repair.
.3 Technical data:
.1 Schematic diagram of components, controls and relays.
.2 Illustrated parts lists with parts catalogue numbers.
.3 Certified copy of factory test results.

END OF SECTION
1. GENERAL

1.1 Description

.1 The contractor shall supply, install, and make operational all Variable Frequency Drives (VFD) as shown on the Electrical Drawings, Single line diagrams, Wiring Schematics and as specified herein.

.2 Variable Frequency Drives shall be capable of continuous, high efficiency operation of squirrel cage, induction type motors that drive variable torque type loads, or constant torque type loads where applicable.

.3 Drives shall be able to operate motors to the minimum speed compatible with the pumping requirements.

.4 VFD's must meet IEEE 519-1992 with respect to generated harmonics and THD and conform to the Supply Utility’s Power Quality Requirements. The point of common connection shall be the existing utility transformer secondary connection point (main protective breaker 600V).

.5 Refer to specifications Section 16820 for Variable Frequency Drives installation in Motor Control Centres.

1.2 Related Work

.1 Section 16010: Electrical General Requirements

.2 Section 16030: Electrical Testing

.3 Section 16820: Motor Control Centre

.4 Section 16850: Connections to Mechanical Equipment

1.3 Codes and Standards

.1 All equipment shall be designed, manufactured and tested in accordance with the applicable current CSA, EEMAC, ANSI, IEEE and NEMA standards and, in particular, the following:


.2 CAN/CSA-C22.2 Industrial Control Equipment No. 14-M91.


.4 Equipment shall have CSA approval by a recognized certification agency.

.5 Equipment shall comply with the standard of the local electrical authority.
.6 Equipment shall be designed and manufactured in compliance with ISO-9001 quality standards.

.7 CSA Standard C22.1 Canadian Electrical Code as adopted by the Province of BC.


.9 IEC 61800-2 and -3 EN 50082-1 and -2 EMC immunity requirements.

1.4 VFD Selection Criteria

.1 All items listed in this Section shall be capable of satisfactory operation indoors, installed integral to a motor control centre, and shall be suitable for connection to, and operation on, the following plant electrical system:

.1 Low Voltage System Characteristics:

<table>
<thead>
<tr>
<th>Nominal system voltage, V</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase</td>
<td>3</td>
</tr>
<tr>
<td>Frequency, Hz</td>
<td>60</td>
</tr>
<tr>
<td>Available Fault Current</td>
<td>35,000A rms symmetrical</td>
</tr>
<tr>
<td>System Neutral</td>
<td>Solid grounded</td>
</tr>
</tbody>
</table>

.2 Fault Availability: The variable frequency drive (VFD) assemblies shall be designed for an available fault level of 35 kA RMS symmetrical (minimum) at the incoming terminals.

.3 Ambient temperature (Basis for Design): 40°C maximum

1.5 Shop Drawings and Product Data

.1 Submit shop drawings in accordance with Section 16010 - Electrical General Requirements. Indicate and Section 01330:

.1 Dimensioned outline drawing showing overall length, height and depth.

.2 Dimensioned cable entry and exit locations.

.3 Schematic and wiring diagrams.

.4 Dimensioned layout of internal and front mounted components.

.5 Configuration of identified compartments.

.6 Power and Control connection diagrams, including all communications features.

.7 Product performance sheets.
.8 Provide a complete harmonic analysis of the electrical system, detailing the expected performance of the harmonic mitigation system to be supplied (refer to Harmonic Mitigation specifications in Item 2.7, below).

.2 Provide operation and maintenance data for variable frequency drive controllers, including the following:

.1 All approved shop drawing information listed above.

.2 Troubleshooting flowcharts for all device faults.

.3 An instruction manual for programming and hardware provided with the equipment at time of shipment.

.3 Provide the Owner with VFD communication software and cable required to connect a laptop to the VFD for troubleshooting and data gathering.

2. PRODUCTS

2.1 VFD Starters

.1 VFDs are to be supplied as part of an integral, factory-assembled motor control center package.

.2 VFD cabinets shall have door-mounted HMI interface and controls interface.

.3 VFD disconnecting means (circuit breaker) shall be provided at the VFD cabinet section.

.4 To ensure a properly coordinated system, all drives and ancillary components shall be the product of one manufacturer, and shall be provided by the authorized local representative who has both sales and technical service for sole-source responsibility.

.5 Use standard designs and factory pre-assembled VFD sections, fully tested prior to delivery to site. No field modified systems will be allowed.

.6 The Contractor shall be responsible for coordinating the requirements of the drive, harmonic mitigation strategy and motor characteristics with the motor control center, process equipment, and drive suppliers. The coordination shall include, but is not limited to, the following:

.1 A guarantee that the drive meets the load demands and acceleration requirements of the driven equipment throughout the speed range when the input voltage varies over a range of ±10%;

.2 Ensuring complete compatibility of the drive’s current limit (thermal overload) protection with the motor thermal withstand capability; and,
.3 Ensuring adequate drive and harmonic mitigation sizing to meet the motor requirements and power system requirements as specified.

.7 Drives shall be suitably rated for the full load amps of the specific motor served, operating at specified service factor at installed altitude and expected high ambient temperature. Drive and motor horsepower, where shown on drawings or specified elsewhere, shall be for information only and not as direction to the Contractor for equipment sizing. Actual sizing shall be coordinated and verified with the equipment and motor suppliers; where a larger drive is required as a consequence of this coordination, the larger unit shall be supplied and any associated costs shall be included in the bid price.

.8 The providing contractor shall be responsible for coordinating the harmonic mitigation strategy with the drive and MCC supplier to ensure full compatibility.

.9 A load side line filter shall be provided where indicated on the drawing / data sheet; if no indication is made, provide where required to protect motor winding from over-voltage due to long motor leads, or as per manufacturer recommendations.

.10 Controlled acceleration and deceleration times, separately adjustable, shall be provided. The supplier shall provide adjustable damping for the response to speed change.

.11 Separately adjustable minimum and maximum frequency limits shall be provided.

.12 The drive shall be capable of regulating the frequency to a ±1% of the set point over the full input voltage and ambient temperature operating range.

.13 The product data shall indicate the efficiency, power factor, kW output, heat rejection and harmonic distortion of the drive at 25%, 50%, 75% and 100% operating points.

.14 Audible noise levels produced by the drive shall be not greater than 80 dBA sound pressure when measured at one meter, at any point throughout the operating range of the drive.


.16 The listing of specific manufacturers does not imply acceptance of their products which do not meet the specified ratings, features and functions. Manufacturers listed are not relieved from meeting these specifications in their entirety. Acceptable Manufacturers for Variable Frequency Drives as supplied by the following acceptable manufacturers:

.1 EATON (Cutler-Hammer), SVX900X (CPX series) or DG1 (PowerXL Series)

.2 Engineer approve alternate
.17 Environmental Conditions: The VFD shall be suitable for use in normal indoor non-hazardous industrial environments subject to the following conditions:

.1 Ambient temperature range of 0 to 40°C.

.2 Humidity range from 5 to 95%, non-condensing.

.3 Altitude range up to 1,000 metres without derating the VFD's output power capability.

.4 To ensure adequate heat dissipation the VFD unit shall include fan assisted cooling, with automatic thermostat control, such that it would not degrade the enclosure rating. The function of the fan thermostat shall be to maintain temperature within the drive and also extend life of the fan due to prolong idle time of the pumps.

.5 Drives will be installed in motor control centre.

.18 Drive Construction:

.1 Design the VFD cabinets to provide for ease of maintenance.

.2 The VFD shall consist of the following major components:

.1 3-pole circuit breaker.

.2 Input rectifier section to supply fixed DC bus voltage.

.3 Smoothing reactor for the DC bus.

.4 DC bus capacitors.

.5 The VFD shall employ PWM (pulse width modulated) inverter system utilizing Insulated Gate Bipolar Transistors (IGBT) power switching devices and shall include DC link filters.

.6 Suitable dv/dt filters (RLC output filter network) to control output voltage spikes and to control rise times of the output pulses, to permit use of long motor leads and control cables.

.7 Built-in ground fault protection.

.8 Microprocessor to control PWM pulse generation, preferably a separate microprocessor specifically dedicated to PWM pulse generation.

.9 Provide harmonic mitigation, as specified herein, to limit total harmonic distortion (voltage and current) to levels specified.

.10 The VFD shall have a nominal current rating at least 10% in excess of the motor nameplate full load amp rating. Overload service factors of 150% for one minute must be provided to ensure adequate safety margins.

.3 For each VFD, include as standard, a door mounted operator interface module with backlit LCD display to configure VFD parameters, and display operation and fault code diagnostic information. Module is to be mounted on the VFD cabinet door.
.4 Separate the VFD power terminal blocks physically from control signal terminal blocks.

.5 The VFD shall be modularly constructed. Provide printed circuit boards with plug-in connections and easily removable from the drive. Provide power components readily accessible with "fast-on" or screw terminal connections for easy removal. The control printed circuit board shall be interchangeable with all comparable HP ranges of VFD's from the same manufacturer.

.6 Provide a complete inventory (as specified) of spare cooling fans, and fuses, for each VFD supplied.

2.2 Motor Operations

.1 Unless otherwise noted elsewhere, inverter-rated AC induction motors shall be used to operate loads over a 35 to 110% speed range reaching rated nameplate horsepower (hp) at 60 Hz.

.2 Motor operation may be continuous or intermittent with frequent starting and stopping.

2.3 Input Power

.1 Unless otherwise specified, the VFD shall accept nominal 600 VAC ±10% 3Ø, 60 Hz, power supply, with line frequency variation of up to +/-5 Hz.

.2 VFDs shall have nominal voltage rating of 690 V AC; if this rating is not available, confirm acceptability of product with Engineer minimum of ten (10) days prior to bid close.

.3 The VFD shall withstand switching surge of three (3) times the normal peak line to ground voltage at ½ cycle or less duration, without damage.

.4 The VFD shall tolerate power line interruptions of 50% voltage sag for up to 0.5 seconds without shutting down on a fault, providing an extended power loss ride-through. If the drive trips on undervoltage, the drive shall activate the Automatic Restart/Reset for undervoltage trips and utilizing the flying start function to allow the drive to restart immediately when the power returns, if in "Auto" and the control calls for the drive to run. The VFD shall match the motor rotating speed and take control.

.5 The VFD shall present a displacement power factor of 0.95 lagging or better to the AC line at any speed or load.

.6 Efficiency of VFD shall be not less than 96% at 60 hertz output when driving the specified maximum load. Determine the efficiency by measuring true RMS power into the drive and measuring motor output on a dynamometer.

.7 The variable frequency control to operate satisfactorily when connected to a bus supplying other solid state power conversion equipment which may be causing up to
10 percent total harmonic voltage distortion and commutation notches up to 36,500 Volt microseconds, or when other VFD are operated from the same bus.

.8 The VFD shall not require an input isolation transformer.

.9 The VFD shall not be sensitive to supplied power that has one phase grounded (Delta) or referenced to earth ground (Wye).

.10 The VFD shall not be sensitive to incoming phase sequence.

.11 The VFD shall include transient voltage suppression to allow reliable operation encountered in an industrial power distribution system.

### 2.4 Output Power

.1 The VFD shall produce a three-phase output for the motor load.

.2 The VFD output power stage shall convert the rectified DC into 3Ø AC power utilizing voltage source type digitally generated sine weighted pulse width modulation (PWM) switching signals.

.3 Unless otherwise specified, the standard VFD output frequency shall be adjustable from 10 to 66 Hz.

.4 Unless otherwise specified, the VFD output voltage shall be adjustable from 0 to 600 V AC, reaching 600 V AC at 60 Hz.

.5 Unless otherwise specified, the VFD shall produce a reduced volts-per-hertz (V/Hz) ratio in the below 60 Hz range.

.6 Unless otherwise specified, the VFD shall supply a constant 600 V AC output when operating above 60 Hz.

.7 The volts-per-hertz output of the VFD shall not be affected, or require readjustment when other drive adjustments (such as maximum speed) are changed.

.8 Provide selectable constant V/Hz ratio or configurable V/Hz ratio. The VFD shall have selectable pre-programmed V/Hz ratios and the capability of programming a custom V/Hz pattern. Specific V/Hz patterns shall be available for both constant torque and variable torque applications and shall be programmable.

.9 When subject to the range of ambient conditions stated herein, the VFD shall be capable of maintaining 100% of rated output current continuously.

.10 When subject to the range of ambient conditions stated herein, the VFD shall be capable of delivering 150% of rated output current for up to one minute.

.11 The VFD output waveform shall be the PWM type waveform producing smooth torque at low frequencies and low harmonics.
.12 The VFD shall have a programmable PWM carrier frequency. Minimum PWM frequency range of 2 - 15 kHz.

.13 The VFD shall be capable of operating output open circuited with no fault or damage for start-up and testing purposes.

.14 Manufacturer shall indicate, at time of tender, the anticipated levels of audible and electrical noise, harmonics and heat generated. These levels shall meet the specification and be warranted and supported by actual test data. Failure to provide this information shall be grounds to reject the proposed drive.

2.5 Protection Systems

.1 The drive shall be capable of withstanding up to 35 kA symmetric short circuit current.

.2 The drive shall be equipped with a minimum of 15 msec. power loss ride-through capability.

.3 The loss of AC input power longer than 15 msec shall cause the drive to shutdown in an orderly fashion, without causing pulsations in the drive or motor system.

.4 The drive shall have the capability of being restarted with a Auto signal from the SCADA control system.

.5 The drive shall not be affected by radio frequencies emitted by portable radio transmitters.

.6 The drive shall protect itself against the following as a minimum:

.1 Under/over voltage.
.2 Incoming power system phase loss
.3 Overcurrent.
.4 Over temperature.
.5 Output short circuit
.6 Output ground fault.
.7 Output power phase loss and current imbalance
.8 DC Bus overvoltage
.9 Inverter Over-temperature
.10 Stall.

.7 Provide minimum two programmable form C contacts (with interposing relays) for alarming of any above items to SCADA for Auto alarm “VFD FAULT”.

.8 Loss of input power or faults (when cleared) shall be "self reset", i.e. after the loss of AC supply power, there shall be an orderly shutdown of the system. After restoration of power, the drive shall self reset and start automatically if in "AUTO" and the control calls for the drive to run.
VARIABLE FREQUENCY DRIVES

.9 VFD output faults and short circuit faults shall be manual reset at unit HMI.

.10 Provide optional motor thermistor relay temperature protection when specified on data sheets.

2.6 Control Features

.1 Provide complete integrated control and metering as follows;

.1 Door mounted Hand-off-Auto selector switch.
.2 Door mounted non-resettable elapse time hour meter.
.3 Adjustable linear acceleration and deceleration from 1.0 to 20 seconds.
.4 Adjustable maximum drive output voltage.
.5 Adjustable maximum voltage/hertz.
.6 Adjustable IR compensation.
.7 Adjustable slip compensation.
.8 Adjustable current limit from 10 to 150%.
.9 Adjustable minimum speed, 0 to 50%.
.10 Adjustable maximum speed, 50 to 110%.
.11 Input terminals for Auto interlocks. Allow for two interlocks.
.12 Sufficient I/O for all discrete and analog signals as indicated on contract drawings and wiring schematics.
.13 Minimum of three (3) discrete relay outputs.

.2 The VFD shall have communications capability to interface with facility’s control system (PLC) via MCC’s network (Ethernet TCP/IP).

.3 Surge Suppression

.1 Provide isolation and voltage surge suppression for contacts used for external monitoring to limit inductive switching surges to less than 200 V peak. Provide DC coils with free-wheeling diodes to limit inductive surges to 28 V peak.

.4 Human-Machine Interface (HMI) on VFD Front Door

.1 Provide a digital local operator interface on the drive door complete with the following features as a minimum:
.1 Speed raise/lower pushbuttons with digital frequency display for local speed adjustment.

.2 START / STOP pushbutton.

.3 FAULT RESET pushbutton.

.4 VFD RUN indicator.

.5 VFD FAULT indicator.

.6 Parameter selection and programming capability

.2 VFD’s shall be provided with the ability to run “Hand” from two separate locations: from a field-mounted control station (Place ‘A’), from local control station mounted on MCC/VFD door (Place ‘B’), and Autoly via the facility SCADA control system (Auto). Refer to contract drawings for additional details.

.3 The VFD shall shut down in a controlled fashion when operator station is disconnected or Hand-off-Auto switch is in “Off” position.

.5 Speed Control

.1 Speed control mode selection as follows:

   .1 Hand: Speed set point from drive HMI keypad setting.

   .2 Auto: Speed set point from SCADA system via network (Ethernet TCP/IP) or the 4-20mA Analog Interface.

.6 Control Functionality

.1 Field selector switch set to “Auto” and drive panel selector switch to "Auto" enables the motor to be started, stopped and speed controlled by the SCADA. By default, this control will be via Ethernet.

.2 Field selector switch set to “Hand” enables motor to be started, stopped and speed controlled from the field operator station.

.3 Field selector switch set to “Auto” and Drive panel selector switch to "Hand" enables the motor to be started, stopped and speed controlled from the VFD HMI.

.4 Either control location set to “Off” will stop the motor.

.5 The Contractor’s control system integrator (See Section 16820, item 2.11) will program the SCADA to control and monitor the VFD’s in accordance with the control philosophy included.
2.7 Filters and Harmonic Mitigation

.1 The VFD manufacturer shall provide integrated harmonic mitigation, dv/dt filter, RFI filters and TIF filters, plus all accessories required to meet performance criteria as defined herein.

.2 Drives shall be supplied with an acceptable means to limit harmonics, interference and noise as noted in these Specifications.

.3 Harmonic Distortion may be limited by means of passive filtering, line reactors, DC chokes, low-harmonic drives (18 pulse), or a tested combination thereof. Any harmonic reduction strategy used must be supplied by a single supplier; combination of several different supplier solutions is not permitted.

.4 Performance Criteria - Harmonic Distortion:

.1 Harmonic loading will not exceed a motor service factor of 1.0.

.2 The point-of-common coupling (PCC) for this project is defined as the output terminals of the main incoming breaker (600V) of the facility (main breaker).

.3 Maximum total voltage demand distortion (TDDv) with all duty equipment in simultaneous operation shall be less than 5%. This reading will be verified during commissioning at the MCC customer (info) meter.

.4 Maximum harmonic current distortion of waveform (% of fundamental) at the PCC shall be as per IEEE 519-1992, Table 10.3; IEEE-519 definition of PCC is superseded by this specification. The ratio of $I_{sc}/I_{L}$ (ratio of short circuit current available to maximum fundamental load current) for this project is expected to be ~10. Notwithstanding IEEE 519 requirements, on this project, for this ratio, the current distortion limits are as follows:

.5 Where is the harmonic multiple of the 60 Hz base frequency

<table>
<thead>
<tr>
<th>h</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>h &lt; 11</td>
<td>4.0%</td>
</tr>
<tr>
<td>11 &lt; h &lt; 17</td>
<td>2.0%</td>
</tr>
<tr>
<td>17 &lt; h &lt; 23</td>
<td>1.5%</td>
</tr>
<tr>
<td>23 &lt; h &lt; 35</td>
<td>0.6%</td>
</tr>
<tr>
<td>35 &lt; h</td>
<td>0.3%</td>
</tr>
</tbody>
</table>

.6 Total current harmonic demand distortion (TDDi) shall be less than 6% when measured at the PCC (as defined previously).

.7 Provide components, as required, to de-tune the system to eliminate destructive overcurrents and overvoltages, and to prevent attraction of harmonics from other sources.
.8 Compliance shall be verified with on-site field measurements of both the voltage and current harmonic distortion at the SG-9010A / SG-9010B customer info meter, by comparison with and without the VFDs operating.

.9 The limits above shall be met under worst-case operating conditions as follows:

.1 All pumping system running

.2 All air handling supply/exhaust fans running

.3 Approximately 10 kW of miscellaneous load, including lighting, HVAC and other running concurrently.

.10 Harmonic mitigation methods shall be provided accordingly, such that the maximum harmonic distortion does not exceed the above limits, at the PCC, under worst-case conditions.

.11 The harmonic mitigation methods used shall not cause any interference with the facility’s control system, nor cause a leading power factor due to capacitive components under any load scenario (including no load).

.12 The Contractor shall provide, as part of the tender bid, a technical description of the proposed harmonic mitigation strategy. This description shall include details of what is being supplied to meet the requirements of this specification. This mitigation strategy will be evaluated by the Engineer.

.13 At the time of shop drawing review, the Contractor shall provide a full harmonic analysis of the complete electrical system, from the secondary of the utility transformer to the loads, detailing the expected performance of the harmonic mitigation strategy proposed by the equipment supplier. The analysis shall include TDD (voltage) at the PCC, and TDD (current) at the PCC. It shall provide detailed harmonic levels to the 50th order. This analysis will be reviewed by the Engineer to ensure the solution provided will meet the harmonic requirements of this specification prior to final approval of the equipment. If the analysis determines that these specifications will not be adequately met by means of the proposed solution, the Contractor shall provide additional or alternate means to meet the requirements at no additional cost.

.5 Performance Criteria - RFI and TIF

.1 Acceptable level of telephone interference factor TIF shall be with I*T less than 1500 balanced, and less than 100 residual, at the PCC.

.2 RFI shall be removed from conductive paths with filters on inputs and outputs of the system. Enclosure shall be shielded.

.3 RFI filtering shall limit radio frequency interference to meet FCC Class A radiation limits. This standard allows a maximum field strength at 30 metres of:
.1 30-80 MHz, 300 mV/m

.2 88-216 MHz, 50 mV/m

.3 216-1000 MHz, 70 mV/m

.6 Passive Harmonic Filters (Harmonic Trap)

.1 Where passive harmonic filtering is used, the following requirements apply, in addition to those listed previously.

.2 The harmonic mitigation equipment and all of its components shall be manufactured and tested in accordance with the latest applicable standards of UL, CSA and NEMA.

.3 Demonstration of compatibility between the harmonic mitigation equipment and the VFD must be available upon request.

.4 Harmonic mitigation equipment shall be warranted to be free of defects in materials and workmanship for a period of 12 months from the date of start-up or 24 months from the date of installation.

.5 Factory Performance Testing: Manufacturer must be capable of factory testing for harmonic mitigating performance and energy efficiency under actual variable frequency drive loads. A detailed description of the program and a sample test report must be provided at time of tender.

.6 Subject to compliance with all of the contract documents and specifications, the acceptable filter manufacturers are MIRUS International Inc., MTE Matrix Harmonic Filter or approved equivalent.

.7 The harmonic mitigation equipment must never introduce a capacitive reactive power (KVAR), which is greater than 20% of its kVA rating.

.8 The harmonic mitigation equipment must not introduce a leading power factor when the facility is operating on emergency standby power.

.9 The harmonic mitigation equipment shall be provided with a means to automatically disengage capacitive components. The capacitive components are to be automatically brought online only as the load increases, and only when running at sufficient load to ensure that the capacitive components will not contribute to a leading power factor. This system must not create a situation where “chatter” will occur at a given operating point (capacitor is switched on-and-off as the load is varied around a specific speed setpoint).

.10 The harmonic mitigation equipment shall not resonate with system impedances or attract harmonic currents from other harmonic sources.
.11 The full load efficiency of the harmonic mitigation equipment / VFD combination shall be greater than 96%. The harmonic mitigation equipment itself shall have efficiency no less than 98%.

.12 All inductor and wiring shall be copper.

.13 Insulation class: 220°C system. Temperature rise: 130°C

.14 Anti-vibration pads shall be used between the reactor or transformer core and the enclosure.

.15 Harmonic filter shall be included in the VFD cabinet, as a part of the MCC assembly.

.16 Submit for approval before shipment certified production test results with serial numbers for harmonic mitigation performance and energy efficiency under actual variable frequency drive loading.

.7 Active Harmonic Filters (AHF)

.1 Where active harmonic filtering is used, the following requirements apply, in addition to those listed previously:

.1 AHF shall be designed to operate from an input voltage of 575 volts AC to 600 volts AC, plus 10% minus 25%.

.2 AHF shall be designed to operate with a voltage frequency of 47 hertz to 63 hertz.

.3 AHF heat losses shall not exceed more than 3.5 percent of the unit kVAR rating

.4 AHF amperage output shall be 50-100 amperes (sized by MCC vendor).

.5 AHF shall include, but shall not be limited to, a door interlocked fused disconnect rated at 100,000 AIC (ampere interruption capacity) at rated voltage of the MCC.

.6 AHF shall monitor the load current utilizing two CT’s mounted on the AC incoming phases of the MCC.

.7 AHF shall analyze the content of the load current for harmonics from the 2nd to the 50th harmonic and shall determine the reactive current content representing displacement power factor.

- AHF shall inject cancellation for every harmonic order from 2nd to 50th order.
- Non-linear loads (VFD’s) shall have input line reactors included that are rated 3 percent or higher impedance (inductance).
.8 AHF shall provide field selection as a harmonic filter or for reactive current correction or both. Dual operation is required for this Project.

.9 AHF shall provide for load balancing of AC lines current for harmonic and reactive currents regardless of actual load distribution per phase.

.10 AHF shall have up to 10 minutes of logic ride-through in the event of power loss.

.11 AHF shall be designed with a current limiting function to protect the IGBT's.
   - When the current limit level is attained, a message shall be displayed indicating the output capacity is at maximum capacity and the at-maximum capacity relay shall be activated.
   - Operation shall continue indefinitely at this level without trip or degradation of AHF.

.12 AHF shall have automatic restart capability upon power loss return and fault resets.
   - Fault trip limit shall occur after five restarts within a 5 minute period.
   - Automatic restart shall occur for the following faults and may include other faults:
     (a) AC line overvoltage.
     (b) AC line under-voltage.
     (c) AC line power loss.
     (d) AC line phase imbalance, over-temperature, under-temperature, and DC bus overvoltage.

.13 Upon occurrence of the fault trip limit, AHF shall stop output current production and lock out restart until the fault is manually cleared.

.14 AHF shall incorporate an over-temperature output roll back that shall reduce the total output current to reduce power component heating in order to maintain maximum current correction within the electrical system.

.15 AHF shall be compatible with SPD, EMC filters, SCR snubber coils, and switched mode power supplies (SMPS) included by vendor in the MCC line.

.16 AHF shall have a door-mounted human machine interface (HMI) with touch screen control rated NEMA 12 (IP65).

.17 AHF & HMI shall provide external communications via a RJ45 connector with Modbus TCP/IP, and provide remote run/stop and display of operating parameters, set-up parameters and diagnostic functions.
VARIABLE FREQUENCY DRIVES

3. EXECUTION

3.1 Installation

.1 Install Variable Frequency Drives in a Motor Control Centre as specified in Section 16820 of the specifications.

.2 Ensure correct fuses and overload device elements are installed.

.3 Lamicoid nameplates for all door mounted control devices. A nameplate schedule shall be supplied at the time drawings are reviewed for approval.

.4 The fully qualified manufacturer’s representative must be present at the site during the drives setup, test and commissioning.

3.2 Tests

.1 Perform tests in accordance with Section 16010 of the specifications and manufacturer’s instructions.

.2 All connections, tests, settings and adjustments are to be completed and the certificate of manufacturer’s verification is to be received prior to energizing of the VFD. The manufacturer’s representative shall be present when the VFD is first energized.

.3 Provide test reports proving absence of any harmful harmonics, transients or other anomalies and provide the Engineer with written certification that the drive has been properly installed, wired and adjusted. Where dangerous or questionable electrical anomalies exists, provide at no additional cost such remedies as are required to eliminate any possibility of damage to the VFD, motors, or any equipment in the station and to limit harmonics to within allowable limits.

.4 Operate switches, contactors, soft starters and VFDs to verify correct functionality prior to connecting to equipment motor load.

.5 It is the intent of this specification to provide a VFD and harmonic mitigation installation that does not adversely affect any other electrical system in the facility.

.6 The Contractor will use services of a qualified agency to conduct a harmonic analysis upon completion of fine tuning and commissioning phase of the installation. The harmonic analysis shall be scheduled for a period of high flow to allow as much load as possible to be running. Contractor shall perform a Fourier transform (FFT) analysis spectrum for each waveform covering the fundamental to the 50th harmonic. Should the waveform analysis indicate that either the input or output voltage and current levels of the VFD(s) exceed NEMA Standards for electric motors and IEEE 519, and the requirements of this specification, then the Contractor shall provide, all the necessary equipment to correct the harmonic distortion to the levels specified without additional cost to the Owner.
.7 Provide certified copies of all production test results required by CSA and NEMA.

.8 The Owner representative reserves the right to witness the factory tests. Notify the Engineer twenty (20) working days in advance that the assembly is ready for testing.

3.3 Shipping

.1 VFDs shall be shipped to site integral with the MCC packages.

.2 Shipping: Include the cost of loading, transportation and off-loading.

3.4 Installation

.1 Check factory-made connections for mechanical security and electrical continuity.

.2 Make field power and control connections as indicated.

.3 Ensure correct overload protection relays are installed.

3.5 Spare Parts and Maintenance Materials

.1 Provide spare parts and maintenance materials based on manufacturer's recommendations.

.2 As a minimum, the spare parts shall include the following:

   .1 Power fuses: one set of 3 for each size used.

   .2 Control fuses: 10 of each size used.

   .3 Indicating lights: 4 lamps of each type used.

   .4 Control transformer: 1 of each size used.

   .5 Other field-replaceable items: 2 sets component parts.

   .6 VFD cooling fans: 2 of size used.

   .7 Any other additional components, which the VFD vendor recommends to be kept as spares for emergency repairs.

3.6 Warranty

.1 The vendor supplying the variable frequency drive equipment shall provide the owner with a warranty with each respective item of equipment supplied. This warranty shall include conformance to this specification with regards to THD, RFI and EMI emissions.
3.7 Operation and Maintenance Manuals

.1 Provide operation and maintenance data for all starter equipment and incorporate it into the manual in accordance with Section 01735 – Operation and Maintenance Data.

.2 Detailed instructions to permit effective operation, maintenance and repair.

.3 All VFD parameter settings shall be included in the O&M manuals.

.4 Technical data:
   .1 Schematic diagram of components, controls and relays.
   .2 Illustrated parts lists with parts catalogue numbers.
   .3 Certified copy of factory test results.

END OF SECTION
## Pump Variable Frequency Drive

### Device Specification

#### General Information
- **Altitude (m):** 1100 <500 m
- **Min/Max Ambient Temperature (°C):** 5 / 40
- **Relative Humidity (%):** 90 (non-condensing)
- **Corrosive Gas or Atmosphere:** N/A
- **VFD assembly:** Part of MCC structure
- **EEMAC / NEMA type:** 1A (gasket)

#### Input Power
- **Allowable THDI @ PCC:** 8%
- **Allowable THDv @ PCC:** 5%
- **Frequency (Hz):** 60
- **Phase:** 3
- **Short Circuit (kA SYM):** 35
- **Source Transformer:** 500kVA (TBC with BCHPA)
- **System Neutral:** Grounded
- **Voltage (V):** 600

#### Motor Data
- **Current (A):** 208 FLA (est.)
- **Distance from VFD:** Varies (min 6m).
- **Frame:** T.B.D.
- **Insulation Class:** H
- **Phase:** 3
- **Power (kW/HP):** 200 HP / 149.2kW
- **Protection:** Field interlocks - thermal (thermistor)
- **Supplied By:** Equipment Vendor (Motor)
- **Torque Design:** Coordinate with Pump Vendor
- **Type:** Inverter Duty AC Motor
- **Voltage (V):** 575

#### Load Data
- **Load type:** Centrifugal Pump
- **Controlled Acceleration:** 0-20 sec. Max
- **Controlled Deceleration:** 0-20 sec. Max
- **Load Characteristics:** Variable Torque
- **Load Duty:** TBD
- **Speed Range Min / Max rpm.:** By pump equipment vendor

#### External Control
- **Analog Signal:** Yes (1AI/1AO)
- **Communications Interface:** Ethernet (Modbus TCP/IP)
- **Digital Outputs:** Yes (2)
- **Discrete Inputs (VDC):** Yes (6)
- **Hand/Off/Auto Switch:** Yes
- **Reversing:** N/A

#### Local Control
- **Hand/Off/Remote Switch:** Field Only
- **HMI Screen Local:** Yes

#### Drive Filters
- **dV/dt Output Filter:** Yes
- **Harmonic Filters:** Yes (See Section 16815)

#### Options / Protection
- **Electronic Stall Protection:** Yes
- **I(2)t Protection:** Yes
- **Max. Frequency:** Yes
- **Over-speed:** Yes
- **Power Outage Ride Through:** 8 cycles
- **Restart after Power Failure:** Automatic
- **Restart after Trip:** Manual / Automatic - PLC

#### Reference Info
- **Wiring Diagram:** Drawing E-103
- **Telephone Interf. limits:** By vendor – see 16815
- **Shop Inspections:** Required
- **MFG STD tests:** Required

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**Notes:**

Vendor will complete or update data based on supplied equipment.

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**Revision:** 0  **Date:** 03 / 2017  **Description:** Issued for Tender  **By:** KB  **Approved:** LCS

* Also applies to VFD-110;
### PUMP VARIABLE FREQUENCY DRIVE

#### DEVICE SPECIFICATION

<table>
<thead>
<tr>
<th>GENERAL INFORMATION</th>
<th>STARTER DATA</th>
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<td>Relative Humidity (%)</td>
<td>90 (non-condensing)</td>
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<tr>
<td>Corrosive Gas or Atmosphere</td>
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<tr>
<td>VFD assembly</td>
<td>Part of MCC structure</td>
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<td>EEMAC / NEMA type</td>
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<td>Allowable THDI @ PCC</td>
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<td>Frame</td>
<td>T.B.D.</td>
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<td>Insulation Class</td>
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<td>Phase</td>
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<td>Torque Design</td>
<td>Coordinate with Pump Vendor</td>
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<td>Type</td>
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<td>Voltage (V)</td>
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<th>LOAD DATA</th>
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<tr>
<td>Controlled Acceleration</td>
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<td>Controlled Deceleration</td>
<td>0-20 sec. Max</td>
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<tr>
<td>Load duty</td>
<td>TBD</td>
</tr>
<tr>
<td>Speed Range Min / Max rpm.</td>
<td>By pump equipment vendor</td>
</tr>
</tbody>
</table>

### REFERENCES

- Control Acceleration: 0-20 sec. Max
- Load Characteristics: Variable Torque
- Load Duty: TBD
- Speed Range Min / Max rpm: By pump equipment vendor

### Notes:

- Vendor will complete or update data based on supplied equipment.

### Revision

- 0 Date: 03 / 2017 Description: Issued for Tender
- Issued for Tender: By: KB By: - Approved: LCS

* Also applies to VFD-110;
1. GENERAL

1.1 Description

.1 Provide all motor control centres (MCC) as detailed in this specification and as shown on the contract drawings E202 and E302.

.2 Ensure proper coordination of motors type overloads with equipment supplier. Motors to be 575V AC, 3Ø, 3 Wire, fed from a 600 VAC, 3Ø, 3 Wire power supply.

.3 Motor Control Center(s) (MCC) shall consist of structure(s), bus power distribution system and various motor control and distribution units. MCC (s) shall be built, designed and tested to the latest applicable standards of NEMA Publication ICS 2-322, UL 845 and the CEC.

.4 MCC(s) equipment shall;

   .1 be CSA certified.

   .2 Comply with the requirements of the local Authority Having Jurisdiction.

   .3 Be designed and manufactured in compliance with ISO 9001 quality standards.

   .4 Meet IEC 61800-2 and -3, EN 50082-1 and -2 EMC immunity requirements

1.2 Related Work

   .1 Section 16010: Electrical General Requirements

   .2 Section 16030: Electrical Testing

   .3 Section 16810: Motor Starters - 0-600 Volts

   .4 Section 16815: Variable Frequency Drives

   .5 Section 16430: Panelboards

   .6 Section 16461: Dry Type Transformers

1.3 Reference Standards

   .1 This section conforms to the following reference standards:


       .2 ANSI/IEEE C62.41, Recommended Practice for Surge Voltages in Low Voltage AC Power Circuits.


.5 ANSI C84.1 - Voltage Ratings for Electric Power Systems and Equipment.

.6 CAN/CSA-C22.2 No. 14 - Industrial Control Equipment.

.7 CSA Standard C22.1 Canadian Electrical Code as adopted by the Province of BC (CEC).

.8 CAN/CSA C22.2 No. 5-13, Molded Case Circuit Breakers

.9 CAN3-C17, Alternating - Current Electricity Metering.

.10 CAN3-C13, Instrument Transformers.

.11 IEEE 519: Guide for Harmonic content and Control.

.12 NEMA Publication ICS 2-322.

.13 UL 845 – Motor Control Centers.

.14 UL 1283 Standard for Electromagnetic Interference Filters.

.15 UL 1449 Standard for Surge Protective Devices.

1.4 Shop Drawings

.1 Submittals in accordance with Sections 01330 – Submittals and Section 16010 – General Electrical Requirements. Obtain wiring diagrams and information from other trades on control systems. Co-ordinate and incorporate information on motor starter and control shop drawings. Provide shop drawings for all components of the motor control center including the Control Cabinet back plate, if included in MCC lineup.

.2 Indicate on shop drawings:

.1 Overall width, height and depth of the MCCs

.2 Dimensioned layout of internal and front mounted components

.3 Floor anchoring method and dimensioned foundation template.

.4 Dimensioned cable entry and exit locations.

.5 Dimensioned front view elevation.
.6 Dimensioned layout of internal and front mounted components.

.7 Configuration of identified compartments.

.8 Schematic and unit wiring diagrams depicting remote devices and wiring.

.9 Single Line diagrams.

.10 Starter, component and nameplate schedules.

.11 Starters / VFD’s elementary individual diagrams.

.12 Ethernet Network Diagram

.3 Prepare shop drawings and wiring diagrams for motor starters and control supervision of suitably qualified staff.

.4 Consult with the Engineer during preparation of shop drawings as required to ensure correct interpretation.

1.5 Submittals for Close Out

.1 Include for submission of the following information for record purposes in accordance with Section 16010 – Electrical General Requirements and Section 01735 – Operations and maintenance data:

.1 Final as-built drawings and information,

.2 Unit wiring diagram for each individual starter, VFD, and feeder breaker compartment or bucket, updated to reflect “as-built” conditions based on Installation Contractor mark-ups. “Typical” wiring diagrams of any type are not acceptable,

.3 Troubleshooting flowcharts for all VFD device faults,

.4 Certified production test reports,

.5 Certification of proper installation and setup,

.6 Certified Production Test reports (FAT),

.7 List of recommended spares,

.8 Recommended maintenance requirements, and

.9 Warranty information.
2. PRODUCTS

2.1 Motor Control Centre

.1 It is the contractor's must responsibility to ensure that the layout and dimensions of the MCCs are coordinated with the space available for installation and with all other related equipment. The MCC arrangements shown on the drawings are schematic only and the contractor is to submit the proposed final arrangements for review and approval by the engineer.

.2 The motor overloads in the MCC shall match to the manufacturer's recommendations and the full load nameplate current for the used motors.

.3 Set the circuit breakers in accordance with the CEC and manufacturer's recommendations.

.4 Independent vertical sections fabricated from rolled flat steel sheets, bolted together to form rigid, completely enclosed assembly.

.5 Finish ASA61 Grey

.6 Enclosure: NEMA 1A (gasketed) unless otherwise specified.

.7 Each vertical section divided into compartment units, as indicated.

.8 Horizontal wireways, equipped with cable supports, across top and bottom, extending full with of motor control center, isolated from busbars by steel barriers.

.9 Vertical wireways for load, communication and control conductors extending full height of vertical sections, and equipped with cable tie supports.

.10 Installation and wiring to units accessible with doors open and units in place.

.11 Provision for outgoing cables to exit via top or bottom.

.12 Removable lifting means.

.13 Main horizontal and branch vertical, three phase high conductivity tin plated copper busbars in separate compartment, insulated, self-cooled, extending entire width and height of motor control centre, supported on insulators and rated for 600VAC.

.14 Branch vertical busbars for distribution of power to units in vertical sections.

.15 No other cables, wires, equipment in main and branch busbar compartments.

.16 Buswork bracing: 42 kA RMS symmetrical short-circuit current.

.17 Bus supports of glass filled polyester.
.18 Power and control terminals.

.19 Wiring and schematic diagram inside each starter and compartment enclosure.

.20 Identify each wire and terminal for external connections, within starter with permanent number marking identical to the associated diagram.

.21 Motor circuit interrupter and circuit breakers with operating lever on outside of enclosure with provision for:

.1 Lockable in “Off” position with up to three padlocks

.2 Lockable in “On” position

.3 Provision for preventing switching to “On” position while the enclosure door is open.

.22 Copper ground bus extending full width of all cubicals and located at the bottom of the MCC.

.23 Lugs at each end of ground bus for size #3/0 AWG Copper grounding cable.

.24 The contractor shall ensure proper coordination of motor overloads with equipment supplier. Unless otherwise indicated, all motors shall be 600 V AC, 3-phase, 4 wire.

.25 The contractor to provide equipment identification as per Section 16010.

2.2 Molded Case Circuit Breakers

.1 Molded case circuit breaker: quick-make, quick break type, for manual operating with temperature compensation for 40 °C ambient.

.2 Common-trip: with single handle for multi-pole applications.

.3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range 6-15 times current rating.

.4 Each breaker shall have “Engaged” and “Disengaged” positions and it shall be possible to close the breaker compartment door in any of these positions. The breaker shall be equipped with a mechanical breaker position indicator located such that the circuit breaker position is visible with the front door open.

.5 All circuit breaker indications and operations for each breaker shall be without opening enclosure door.

.6 Provision for padlocking in the “Off” position.

.7 Circuit breakers shall be as indicated on drawings.
.8 Set each circuit breaker in accordance with C.E.C. and the manufacturer's recommendations.

2.3 Starter Requirements

.1 See attached drawings for MCC's structure and starter requirements. Comply with the requirements of Specification Section 16810 for individual starter requirements.

.2 Various HP FVNR NEMA size starters accommodating, magnetic contactor, solid state smart overload, shunt trip circuit breaker/disconnect and control devices, as indicated.

.3 Units EEMAC size 5 and smaller, circuit breaker units 225 A and smaller, plug-in type with self-disconnect. Guide rail supports for units to ensure that stabs make positive contact with vertical bus. Provision for units to be installed or removed, off load, while buses energized.

.4 Front mounting in section sized for the application. Circuit breaker, contactor, overload and through bus to be sized as indicated on drawings and specified herein.

.5 Class II, Type B, Fieldbus (Ethernet) wiring.

.6 Status must be accessible via the network bus: Ethernet (Modbus TCP/IP).

.7 Manufactured integral to MCC or for side by side MCC configuration and provision for bus disconnection for shipping and future changeout requirements. Outgoing cables shall exit either via bottom or top.

.8 Vertical wireways for load and control conductors extending full height of vertical sections, and equipped with cable tie supports

.9 Unit mounting:

.1 Engaged position - unit stabbed into vertical bus.

.2 Withdrawn position - unit isolated from vertical bus but supported by structure. Terminal block accessible for electrical testing of starter.

.3 Provision for positive latching in either engaged or withdrawn position and padlocking in withdrawn position.

.4 Stab-on connectors free floating tin plated clips, self-aligning, backed up with steel springs.

.10 External operating handle of circuit switch interlocked with door to prevent door opening with switch in "on" position. Provision for one and four padlocks to lock operating handle in "off" position and lock door closed.

.11 Hinge unit doors on same side.
.12 Overload relays manually reset from front with door closed.

.13 Pushbuttons, selection switches and indicating lights mounted at the front door of the associated MCC section unless otherwise indicated.

.14 Unless otherwise indicated, when installed with associated Remote Operator Station, each motor starter MCC section shall have:

.1 Each motor Hand-Off-Auto or On/Off switches.
.2 Run (Green) and Fault (Red) indication lights
.3 Overload Reset push button
.4 External Fault Reset push button.

.15 Devices and components by one manufacturer (See 2.11) to facilitate maintenance.

.16 Pull-apart terminal blocks for power and control to allow removal of FVNR starter units without removal of field wiring.

.17 Also allow for a manufacturer’s representative site visit to setup all smart overloads and VFD parameters The representative shall be knowledgeable in Ethernet configuration.

2.4 Overload Relays

.1 Solid State smart overload devices to support device level buses (Ethernet TCP/IP), as specified in Section 16810 – Motor Starters.

.2 Built-in communications shall allow immediate access to status information, motor performance data, and diagnostics, as well as performing motor control supervision functions. Diagnostic information should include: device, trip, warning status, time to trip/time to reset (thermal overload) and history of past trips.

.3 The device must be resettable everywhere – manual, remote, by the device level bus and automatic. Smart Motor Overload protective device must support and be able to provide diagnostics for the following types of starter circuits:

.1 Direct (non-reversing) starter.
.2 Reversing starter.

.4 The device must support four inputs and two outputs, minimum. Device must support run time checks that can be set for the starting or stopping of motors. All controls and diagnostics to be accessible via the device level bus.

.5 Control and Signaling. If the automatic level switches to manual operation, or if local control is activated by means of a local manual/automatic key switch, the bus
control commands must be ignored and the feeder can now be exclusively controlled via the operating module or using the local control station.

.6 The smart motor protection device must also have the capability to operate and function with the device level bus disconnected, on reconnection the device must become live on the network with all information available to the DCS, and this must be done without interruption to the process.

.7 The smart device to continuously inform the SCADA about the current operating state:

.1 Actual phase current in %
.2 ON/OFF
.3 Warning
.4 Fault

.8 Settable current Limits: to be supported, these current limits are to inform the supervision system about critical states in the system. For example, a current which is below the lower current limit setting could mean a dry pump situation. The overloading of a pump, for example, can be quickly detected by the display of ‘upper current limit exceeded.’

.9 The device is to be self-monitoring and if there is a fault, the device must switch to the safe state (OFF, or maintain operating state - monostable or bistable behavior).

.10 The device must have the capability to be checked during running – without switching off of the motor. The device must support graphical software for setup and further diagnostics, this to be included with the device, vendor to provide details on licensing and amount of copies to be permitted, all costs to be included.

.11 Mount in cubicle section and wire as per drawings.

2.5 Variable Frequency Drives (VFDs)

.1 Variable Frequency Drives shall be mounted in MCCs sections accommodating lockable circuit breaker/disconnect, variable frequency drive, line filter, “one-time” SCR drive input fuses, motor protecting output filter and keypad type operator interface. VFDs shall support and include the module for connection via the network bus (Ethernet TCP/IP).

.2 The drive supplier shall also provide load side filter/reactors as necessary to eliminate peak voltage spikes in excess of 1000 V and provide a voltage rise time limit of 2ms. The combined inductance, capacitance and resistance of the output filter shall be specifically designed to reduce voltage waveform dV/dT and minimize parasitic resonance interaction between inductive and capacitive elements of the motor leads.
.3 Manufactured integral to MCC or for integration into MCC with configuration and provision for bus disconnection for shipping and future changeout requirements. Outgoing cables shall exit either via bottom or top.

.4 Motor circuit interrupter, motor protection type circuit breaker with operating lever on outside of enclosure and provision for:

.1 Locking in “OFF” position with up to 3 padlocks.

.2 Locking in “ON” position.

.3 Provision for preventing switching to “ON” position while enclosure door open.

.4 Through bus, circuit breaker, control contactor and terminals for panel mount harmonic filters shall be provided where indicated.

.5 Through bus, circuit breaker, control contactor, autotransformer and 18 pulse rectifier shall be provided where indicated.

.6 Control transformer complete with primary and secondary fusing of sufficient VA to handle associated controls, fans, etc.

.7 Identify each wire and terminal for external connections, with permanent number marking identical to diagram. Wiring and schematic diagram inside enclosure.

.8 Provision for remote electrical reset from SCADA PLC shall also be provided.

.9 “Variable Torque Control” AC Drives suitable for 690 V AC, 3Ø, specified HP continuous duty centrifugal pumps, fans, etc. Drive efficiency shall be 97% or better at full speed and full load. Fundamental power factor shall be 0.98 at all speeds and loads.

.10 “Constant Torque Control” AC Drives suitable for 690 V AC, 3Ø, specified HP continuous duty conveyors. Drive efficiency shall be 97% or better at full speed and full load. Fundamental power factor shall be 0.98 at all speeds and loads.

.11 Switching frequency will automatically adjust to optimize performance and audible noise.

.12 Drive capable of starting into a rotating motor with no delay.

.13 Drive capable of operating on a voltage range of 525 to 690 VAC.

.5 Warranty:

.1 Warranty shall be 12 months from date of certified start-up, not to exceed 30 months from date of shipment. The warranty shall include all parts, labor, travel time, and expenses.
.6 Certification:

.1 A qualified manufacturer’s representative shall attend the commissioning of the VFD and provide the Engineer with written certification that the drive has been properly installed and adjusted.

.2 After receipt of the manufactures representative written certification the warranty period shall commence.

.3 Cost of commissioning and certification to be included with the drive supply.

.7 Device level bus module setup and testing to be included with the drive must be compatible with the master control station (SCADA).

.8 Reference Sections:

.1 Refer to Section 16815 (Variable Frequency Drives) for detailed information.

2.6 Control Transformers

.1 VA range: as required by load

.2 Class B insulation

.3 Primary voltage: 600 V AC

.4 Secondary voltage: 120 V AC

.5 Primary: Dual fuses

.6 Secondary: hot fused (miniature breaker), neutral grounded

.7 All welded construction

.8 Install in each starter section in the MCCs

2.7 Transient Voltage Surge Suppression

.1 The specified system shall be designed, manufactured, tested and installed in compliance with CSA, NFPA (20, 70 75 and 80) and Underwriters Laboratories (UL 1449, UL 1283).

.2 600V, 3 phase, 60 Hz, 3 wire plus ground.

.3 The TVSS maximum continuous operating voltage shall be greater than 115% of the nominal system operating voltage to ensure the ability of the system to withstand temporary RMS overvoltage (swell) conditions.
.4 All protection modes (including Neutral to Ground) of the TVSS shall be internally fused at the component level with fuses \( I^2T \) capability to allow the suppressors maximum rated transient current to pass through the suppressor without fuse operation.

.5 In addition to LED status indicators, the unit shall be equipped with an alarm relay with one set of Normally Open and Normally Closed (Form C) dry contacts rated for 120 VAC, 1 Amp (minimum). The contacts will change state and indicate a failure of the unit, a phase loss condition, undervoltage or a full power loss condition.

.6 Model: Eaton Clipper Power System or Engineer approved equal.

2.8 Relays

.1 All relays installed in the MCCs shall be 4PDT with 120VAC rated contacts.

2.9 Power Monitors

.1 Digital Display (Two lines) c/w programming keypad mounted on the associated MCC door.

.2 Ethernet (Modbus TCP/IP) RJ45 Communication Port

.3 Measurement of: Current, Voltage, Power Factor, Frequency, Active and Reactive Power, Cumulative kWh. All these registers must be accessible through the Ethernet or DeviceNet communications port.

.4 Provide all necessary mounting hardware including but not limited to terminal blocks, shorting block, current transformers, fuses and

.5 Power Supply: 120 VAC

.6 Acceptable Products:

.1 Schneider PM5360 series or approved equal.

2.10 Panelboards and Transformers

.1 For panelboards 120/280 VAC and 120/240VAC branch circuit distribution as indicated on schedules and are embedded in the MCC structure, see provisions of section 16430.

.2 For dry transformers 600V/120/208V suppling branch circuit distribution that are embedded in the MCC structure, see provisions of section 16461.

2.11 MCC Acceptable Manufactures

.1 EATON – Freedom MCC2100.
.2 The Owner’s system integrator and Division 17 Contractor for this project is Interior Instrument Tech Services Ltd. in Kelowna. (1115 St. Paul St., Kelowna, BC, V1Y 2C6. Contact Ken Hansen at 250.717.8814.). MCC will be integrated for controls, VFD system and local control cabinet, in one structure.

3. EXECUTION

3.1 Installation

.1 Check factory-made connections for mechanical security and electrical continuity. All bus connections to be torqued to manufacturer’s recommended standards after the control centre is in place.

.2 Make field power and control connections as indicated on the drawings.

.3 Provide 100 mm high concrete platform for each MCC. Locate new MCC sections. Motor Control Center to be anchored to floor housekeeping pad which have been leveled and grouted into place.

.4 Measure all terminals and buses for grounds. Instruments or control devices sensitive to megger voltage to be isolated from the circuit.

.5 Clean interior of motor control centre and vacuum if necessary prior to energizing.

.6 Settings of overload trip and MCP trip to be confirmed by the Contractor based on actual motor nameplate data. Assume starter and associated motor at same ambient of 20°C. It shall be the electrical contractor responsibility to see that all motors have the proper electronic/thermal overload protection in each phase conductor with settings/heater selected after the respective motor is on the job site.

.7 Allow a minimum of two days on-site for a fully qualified MCC manufacturer’s representative to setup all devices in the MCCs. The representative must be knowledgeable in the DeviceNet communication and parameters setup.

3.2 Motor Starters and Devices

.1 Equip the MCCs with the combination starters as specified in Section 16810 - Motor Starters to 600 V, and as shown on the drawings and listed in the attached diagrams.

.2 All starters in MCCs, including VFD’s shall be pre-wired in Ethernet network.

.3 All power monitors in MCCs shall be pre-wired in Ethernet network.

.4 Motor starters in MCCs shall be wired with the associated Remote Operator Stations to complete fully functional assemblies.
3.3 Ethernet Requirements

.1 For Process Equipment and HVAC fan control use the following:

.1 The MCC(s) shall incorporate proven open communications using the Ethernet TCP/IP protocol as administered by ODVA for Ethernet protocol and published in IEE 802.3 and the TCP/IP protocol suite.

.2 All VFDs, smart overloads as integrated into a FVNR starter and other motor control equipment as required for a particular MCC shall communicate to the local control section system using native Ethernet (Modbus TCP/IP). No other protocol or communication method is permitted.

.3 The entire MCC will have a local Ethernet switch section, complete with local power supply located in the dedicated control section of the MCC line.

3.4 Starter Verification

.1 Field check motor starters supplied prior to commissioning equipment. As a minimum, verify the following:

.1 Check of control circuits.

.2 Verify that overload relay installed is correctly sized for motor used.

.3 Record overload relay size and motor nameplate amperage.

.4 Visual inspection of fuses and contactors.

.5 Ensure all connections are tight.

.2 Measure and record motor amps, under load conditions and compare with full load amps and motor service factor. Report any excessive readings and unbalance. Measure voltage as close to motor terminals as possible while motor is running.

.3 Set all motor circuit protectors to the minimum level that will consistently allow the motor to start under normal starting conditions.

3.5 Testing

.1 To ensure smooth startup and system reliability, the supplied MCC must be shop tested prior to arrival at the job site.

.2 The equipment, software and network system must be qualified and tested to assure reliability and to confirm that all parts operate independently and as an integrated system.

.3 MCC Tests documented as required in section 16010 and 16015.
To this end the following tests programs are required:

1. Qualification Test Program (Qualification of specific MCC elements)

2. UL/CSA test programs must be conducted for the connectors, trunk and drop cable assemblies, and the cable installation as a total system. The following network properties shall be met:
   1. Impedance 120 Ω ±10% (at 500kHz).
   2. Transmission rate tested at 12 Mbit/sec to 500kbit/sec (minimum).
   3. Capacitance between conductors 12 pF/ft at 500 kHz (maximum).
   4. HD4 CRC check (maximum number listed).
   5. Attenuation 0.29 db/2000 ft at 12 Mbit/sec  0.50 db at 500 kHz (maximum).
   6. UL/CSA test programs must be conducted for the network power supply.
   7. Software qualification testing to include code functionality, program logic and error conditions. Software functions shall be demonstrated to the Engineer during FAT.

3. Reliability Test Program to include the following:
   1. Electromagnetic- compatibility (electrical noise) series of tests.
   2. Electrostatic discharge immunity test.
   3. Chattering contactor test.
   4. Surge immunity tests.
   5. High current noise effect (jogging starter) test.
   6. RFI – immunity test.
   7. Load testing – all devices (VFD’s, O/L relays etc.) fully loaded and subjected to their respective temperature rise tests.
   8. Power supplies tested for regulation under load, ability to withstand a short circuit and reverse output capacity.

4. Functional Test Program to include the following:
   1. Network cable and connectors integrity tests.
.2 Network verification tests – For each device, a node address and data rate is set and verified.

.3 A command to verify operation to be transmitted to each device output to energize and de-energize its respective contactor or activate the VFD.

.4 Each drive is connected to a motor, and the control, acceleration and stability of the drive verified.

.5 Documentation verification – Ensure that proper paper and electronic publications, wiring diagrams and structure data sheets are provided.

.5 Once on site the manufacturer’s representative shall attend the commissioning of the MCC and all smart devices and provide the Engineer with written certification that the completed assembly has been properly installed, configured and setup. Certification will include:

.1 Verification & Documentation of Node Number, Equipment Label, Part Number, and copy of downloaded file.

.2 Verification of Network communication status.

.3 Check back circuit conformation testing.

.4 H.O.A. & E-Stop Test and network fault test (Unit will drop out in network is lost & will operate “manually” via H.O.A.).

.6 All forms requested by Section 16030.

END OF SECTION
## Site Conditions

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## Bus Rating

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## MCC Data

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## Motor Starters

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<td>HOA Switches</td>
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<td>Indication Lights</td>
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<td>Smart Type</td>
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<td>Communication protocol</td>
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## Test Results

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## Feeder Data

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## Metering

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## Shipping Sections

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<td>Weight</td>
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## Notes

Vendor will complete or update data based on supplied equipment.
### SITE CONDITIONS
- Altitude (m): 650 m
- Location: ELDORADO LOW LIFT STATION EL. RM.
- Max Ambient Temperature (°C): 40
- Min Ambient Temperature (°C): 5
- Relative Humidity (%): 90 (non-condensing)
- Corrosive Gas or Atmosphere: N/A

### BUS RATING
- Main Horizontal Bus Rating (A): 600
- Vertical Bus Rating (A): 300
- Ground Bus: 300A, copper
- Neutral Bus: N/A
- Main Horizontal Bus Bracing (kA sym): 42
- Main Horizontal Bus Material: Copper
- Main Horizontal Bus Plating: Tin
- Insulated: Yes
- Copper: N/A

### ENCLOSURE DATA
- Enclosure Rating: NEMA 1A
- Frequency (Hz): 60
- Installation: Front Access only
- Vertical Bus Material: Copper
- Vertical Bus Plating: Tin

### MOTOR STARTERS
- Combination type: Yes
- HOA Switches: No
- Indication Lights: No
- Auxiliary Contacts (Total Qty.): 4 (2NO/2NC)
- Smart Type: Yes
- Communication protocol: Ethernet (Modbus TCP/IP)

### FEEDER DATA
- Specification Section: 16810 / VFD's
- Entry: Top/Bottom
- Feeder Size: 2 x 3C 250 MCM
- METERING
  - Specification Section: 16820
  - Type: Digital
  - Communication capability: Ethernet (Modbus TCP/IP)

### METERING
- Specification Section: 16820
- Type: Digital
- Communication capability: Ethernet (Modbus TCP/IP)

### TESTING
- Functional Tests: Witnessed
- Megger: Non-Witnessed

### DIMENSION DATA
- Maximum Dimensions: As per layout (E-302)
- Length: TBD
- Depth: 508 mm
- Height: 2388 mm
- Weight: TBD
- Shipping Sections: 2 (<2500 mm)

### Notes:
Vendor will complete or update data based on supplied equipment.

### Manufacturer:
EATON

### Model:
Freedom MCC 2100

### Approved Alternate(s):
Schneider / Allen-Bradley

### Revision
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1. GENERAL

1.1 Work Included

.1 Control equipment such as (a) pushbutton stations, indicating lights, control and relay panels, are provided under this specification to form complete control system in conjunction with (b) such items as motor control centre, starters, and (c) items provided under Division 15 for example, pressure flow, float, solenoid valves, panels, pneumatic electric switches, transducers, duct and space thermostats [except heating systems]. Some or all of preceding items are interconnected under Part 3 of this specification. Specify control components and assemblies, relative work and interface between Divisions 15, 17 and 16. Ensure work required to be performed is indicated on layout drawings, diagrams and motor starter and control list.

1.2 Shop Drawings

.1 Submit shop drawings in accordance with Section 16010 - Electrical General Requirements.

.2 Include schematic, wiring, interconnection diagrams.

2. PRODUCTS

2.1 AC Control Relays

.1 Convertible contact type: contacts field convertible from NO to NC, electrically held. Coil rating: 120 V. Contact rating: 600 V, 20 A.

.2 Universal pole type: electrically held with 4 poles, convertible from NO to NC by changing wiring connections. Coil rating: 120 V. Contact rating: 600 V, 20 A.

.3 Fixed contact type: general purpose with 3 poles. Coil rating 120V, 50 VA. Contact rating: 600 V, 20 A.

2.2 Relay Accessories

.1 Standard contact cartridges: normally-open - convertible to normally-closed in field.

2.3 Oil-tight Limit Switches

.1 Snap action type: roller lever, top push actuator, CSA type 1 enclosure. Contact rating EEMAC b600.

.2 Surface Plug-in mounted.
2.4 Sealed Contact Oil-tight Limit Switches

.1 Lever type switches: roller operated, single pole, double throw. Contact rating: EEMAC B-600.

.2 Push type switches: actuated by plunger located on tip of operating head, spring return single pole, double throw. Contact rating: EEMAC B-600.

.3 Wobble stick cat whisker type switches: actuated by rod extending from tip of operating head. Moving rod in any direction operates contacts. Single pole, double throw. Contact rating: EEMAC B-600.

.4 Lever operated: time delay switch: adjustable time delay from 1/2 s to 15 s plus 25%. Contact rating: EEMAC B-600.

.5 Plug-in construction switches: CSA Type [4], [two] [four] circuit, lever type, contact rating: EEMAC B-600.

2.5 Solid State Timing Relays

.1 Construction: ac operated electronic timing relay with solid-state timing circuit to operate output contact. Timing circuit and output contact completely encapsulated to protect against vibration, humidity and atmospheric contaminants.

.2 Operation: on-delay or off-delay.

.3 Potentiometer: self contained external to provide time interval adjustment.

.4 Supply voltage: 120 VAC, 60 Hz.

.5 Temperature range: minus 20 °C to 60 °C.

.6 Output contact rating: maximum voltage 300 VAC or DC. Current: EEMAC B300.

.7 Timing ranges: minimum 1.0 s, maximum 60 s.

2.6 Instantaneous Trip Current Relays

.1 Enclosure: CSA Type 1

.2 Contacts: NO, NC automatic reset with adjustable tripping point.

.3 Control: 3 wire, with provision for shorting contacts during accelerating period of motor.
CONTROL DEVICES

2.7 Operator Control Stations

.1 Enclosure: CSA Type 4, surface mounting.

2.8 Pushbuttons

.1 Heavy duty. Operator flush type as indicated. Black with 1-NO and 1-NC contacts rated at 10 A, AC, labels as indicated. Stop pushbuttons coloured red, labeled “Emergency Stop”.

2.9 Selector Switches

.1 Maintained position labelled as indicated heavy duty operators standard, contact arrangement as indicated, rated 300 V, 5 A, AC.

2.10 Indicating Lights

.1 Heavy duty Oil-tight, full voltage, LED cluster type, push-to-test, lens colour: as indicated, supply voltage: 120 V, lamp voltage: 120 V, labels as indicated.

2.11 Control and Relay Panels

.1 CSA Type 1 sheet steel enclosure with hinged padlockable access door, accommodating relays timers, labels, as indicated, factory installed and wired to identified terminals.

.2 EEMAC 4 rated for all panels installed in process areas.

2.12 Control Circuit Transformers

.1 Single phase, dry type.

.2 Primary: 600 V, 60 Hz AC.

.3 Secondary: 120 VAC.

.4 Rating: 150 VA.

.5 Secondary fuse: 5 A.

.6 Close voltage regulations as required by magnet coils and solenoid valves.

2.13 Remote Operator Station

.1 Wall or pedestal mounted.
CONTROL DEVICES

.2 EEMAC 4 Enclosure, for corrosive environment EEMAC 4X.

.3 Enclosures to have sufficient depth to accommodate to contact blocks in tandem (total of four blocks).

.4 Enclosures to be sized by the contractor to accommodate all required switches and indication lights as shown on the drawings.

.5 All switches, push-buttons, and indication lights shall be identified with lamacoid plates as shown on the drawings.

3. EXECUTION

3.1 Installation

.1 Install pushbutton stations, control and relay panels, field control devices and interconnect as indicated on drawings.

3.2 Field Quality Control

.1 Perform tests in accordance with Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment and Systems.

.2 Depending upon magnitude and complexity, divide control system into convenient sections, energize one section at a time and check out operation of section.

.3 Upon completion of sectional test, undertake group testing.

.4 Check out complete system for operational sequencing.

.5 Submit to Consultant one copy of test results.

END OF SECTION


1. **GENERAL**

1.1 **Related Work**

.1 Mechanical: Division 11 and 15

.2 Motor Starters up to 600 V: Section 16810

1.2 **Requirements**

.1 Provide a complete system of wiring to motors and controls as specified herein and as shown on the drawings.

.2 Unless specifically noted otherwise, wire and leave in operation all electrically operated equipment supplied under all contracts related to this project. Examine the drawings and shop drawings of all Divisions for the extent of electrically operated equipment supplied under other contracts.

.3 All control wiring diagrams shown on the drawings illustrate typical control circuits applicable to the equipment. Control circuits may vary with different manufacturers of equipment. Verify all control circuits with the suppliers of the equipment and make any corrections that may be required without any additional cost.

.4 Unless specifically noted otherwise, provide all pushbuttons, relays, starters, etc. necessary for the operation of equipment. Check all starters, relay coils and thermal elements to ensure that they provide the necessary protection for motors.

.5 Do not operate motors and controls until approval is obtained from the trade providing equipment.

.6 Examine drawings and shop drawings of other Divisions to obtain exact location of motors and equipment shown on drawings. Where necessary, obtain conduit locations from other trades' drawings and shop drawings.

.7 Assist in placing in operation all mechanical equipment having electrical connections.

.8 Provide three phase starters with fused 120 volt control transformers and overload relays.

.9 Provide all power wiring for all motors and control wiring as indicated on the drawings.

.10 In general, wiring for freezestats, firestats, E.P. switches, P.E. switches, dampers, temperature controllers, flow switches, solenoid valves, etc., for heating ventilating and air conditioning equipment will be under a separate contract. Provide terminations in starters and MCCs for control wiring so that starter control circuits...
CONNECTIONS TO MECHANICAL EQUIPMENT

may be extended. Where 120 volt power is required for mechanical equipment, i.e. roll type filters, refrigerated aftercoolers, control cabinets, etc. wiring to the equipment terminals is the work of this Division.

.11 Refer to Motor Control Equipment Schedule.

2. PRODUCTS

2.1 3 Phase Motor Disconnect Switches

.1 Industrial Type "A", having quick make, cover interlocks and padlocking switch in the closed or open position. Use EEMAC 4 enclosures outdoors, and EEMAC 1 indoors switches to be H.P. rated, Westinghouse heavy duty type.

2.2 120 Volt, 1 Phase Disconnect Switches

.1 Manual starter without overload relay.

2.3 208 Volt, 1 Phase Motor Disconnect Switches

.1 Manual starter without overload relay.

3. EXECUTION

3.1 Installation

.1 Provide disconnect switches adjacent to all motors.

.2 Provide all wiring between all force flow and unit heaters and their thermostats. Install wiring between all flow switches and valve monitors and the fire alarm panel.

.3 Do control wiring as indicated on the drawings and the motor control schedules.

END OF SECTION
1. GENERAL

1.1 Related Work

.1 Electrical equipment testing: section 16030

.2 Testing, Adjusting and Balancing of Electrical Equipment and Systems: Section 16980

.3 Electrical Equipment and Systems Demonstration and Instruction: Section 16990

.4 Instrumentation and Control General Requirements: Section 17010

1.2 Coordination

.1 Coordinates starting of electrical equipment and systems with testing, adjusting and balancing, and demonstration and instruction of:

.1 Electrical equipment and systems specified in Division 16

.2 Mechanical equipment and systems specified in Division 11 and 15

.3 Instrumentation equipment and systems specified in Division 17

.4 Other equipment and systems specified in other Divisions.

.2 Where any equipment or system requires testing, adjusting or balancing prior to starting, ensure that such work has been completed prior to starting of electrical equipment and systems.

2. PRODUCTS

Not applicable

3. EXECUTION

3.1 Energizing Main Electrical System

.1 Prior to energizing main electrical system:

.1 Verify supply authority voltage and phase rotation.

.2 Close and open all devices to ensure proper mechanical operation.
3.2 Starting Motors

.1 Prior to starting motors:

.1 Verify phase rotation at motor control centres.

.2 Confirm motor nameplate data with motor starter solid state overloads.

3.3 Energizing Equipment

.1 Prior to energizing equipment provided under other Sections and equipment provided by the Owner.

.2 Confirm equipment nameplate data with characteristics of power supply.

3.4 Testing of Instrumentation Loops

.1 After all devices within a loop have been connected the loop shall be checked for correct functioning and interaction with other loops.

.2 All test results shall be properly recorded on loop certification sheets.

.3 Operation of final control elements such as solenoid valves, actuators, etc. shall first be checked by manual control.

.4 Test functionality of instrument or field device by energization.

3.5 Instrumentation Testing - General

.1 Prior to commissioning and start-up activities, a series of operational tests will be performed by the Contractor, with the Engineer in attendance, including, but not be limited to:

.1 Verification of correct transmission of signals to the receiving device.

.2 On completion of installation, check all controlling inputs and controlled outputs for individual correctness prior to activation of any line equipment.

.3 Subsequently, perform all equipment function operation and interlock checks prior to activation of any line equipment (dry run check).

.4 Finally, place all equipment on line and energize for an actual controlled operation cycle.

.5 Complete any corrective action necessary that has been identified as part of the checkout procedure, on an ongoing basis.
STARTING OF ELECTRICAL EQUIPMENT & SYSTEMS

.2 For those parts of the system that are software programmable, perform software commissioning and start-up. Determine the sequence in which the software commissioning and start-up shall occur and coordinate the performance of software commissioning and start-up with the Engineer.

.3 During software commissioning and start-up, perform the manual or automatic activation of field devices. Confirm the integrity and functional operation associated with the wiring and equipment which is required to operate with the software systems provided.

.4 For software commissioning and start-up, include, but do not limit to:
   .1 Process control strategy verification
   .2 Operator interface device verification down to final control drives
   .3 Alarm annunciation system verification
   .4 Systems power fail/restart testing to verify proper operation
   .5 Verification of all trip, alarm, and display functions

.5 Conduct final verification of commissioning of all systems through actual operation of the various parts of the process as determined by the District and the Contract Administrator.

.6 Control System commissioning will be considered complete when, in the opinion of the Engineer, the control system hardware or designated portion has properly operated for seven (7) continuous days, 24 hours per day without interruption. This 7-day period is in addition to any test periods or operational demonstrations specified elsewhere. The objective will have been achieved once it has been demonstrated that all systems are operating and have complied with the specified performance requirements herein.

END OF SECTION
1. GENERAL

1.1 Intent

.1 Except where otherwise specified, arrange and pay for testing, adjusting, balancing and related requirements specified herein.

.2 If test results do not conform to applicable requirements, repair, replace, adjust or balance equipment and systems. Repeat testing as necessary until acceptable results are achieved.

.3 Provide all labour, materials, instruments and equipment necessary to perform the tests specified.

.4 All tests shall be witnessed by persons designated by the Owner, who shall also sign the test documentation.

.5 Submit procedures proposed in writing for approval two (2) weeks prior to test.

1.2 Related Work

.1 Electrical General Requirements: Section 16010

.2 Starting of Electrical Systems and Equipment: Section 16970

.3 Instrumentation and Controls Sections: 17800 and 17810

1.3 Manufacturer's Production Test Records

.1 If requested, submit copies of production test records for production tests required by EEMAC and CSA standards for manufactured electrical equipment.

1.4 Site Testing Reports

.1 Log and tabulate test results on appropriate test report forms.

.2 Submit forms to the Engineer for approval prior to use.

.3 Submit completed test report forms as specified, immediately after tests are performed.
1.5 Reference Documents

.1 Perform tests in accordance with:
  .1 The Contract Documents
  .2 Requirements of authorities having jurisdiction
  .3 Manufacturer's published instructions
  .4 Applicable CSA, IEEE, IPCEA, EEMAC and ASTM standards

.2 If requirements of any of the foregoing conflict, notify the Engineer before proceeding with test and obtain clarification.

1.6 Manufacturer's Site Services

.1 Arrange and pay for the site services of approximately qualified manufacturer's representatives where site testing, adjusting, or balancing of electrical equipment or systems' performed by Manufacturer's representatives is:
  .1 Specified, or
  .2 Otherwise required to ensure that electrical equipment and systems are operational in full compliance with the Contract Documents

1.7 Sequencing and Scheduling

.1 Except where otherwise specified, perform all testing, adjusting, balancing and related requirements specified herein prior to Interim Acceptance of the Work.

.2 Perform voltage testing and adjusting after user occupancy or utilization of facility.

2. PRODUCTS

2.1 Test Equipment

.1 Provide all equipment and tools necessary to perform testing, adjusting and balancing specified herein and as otherwise required.
3. **EXECUTION**

3.1 **Testing of Wiring and Wiring Devices**

.1 All power and control wiring shall be tested for insulation resistance value with a 1000 volt megger. Resistance values shall be as recommended by cable manufacturer. Test results shall be properly tabulated, signed, dated and submitted with maintenance manuals.

.2 Test service grounding conductors for ground resistance.

.3 Test all wiring devices for correct operation.

.4 Test all receptacles for proper polarity and circuitry.

3.2 **Ground Resistance Testing**

.1 Measure ground resistance to earth using fall of potential method to verify compliance with CSA C22.2 No. 0.4 and Specifications requirements.

3.3 **Load Balance Testing**

.1 Perform load tests when as many loads as possible, prior to Interim Acceptance of the Work, are operable.

.2 Turn on all possible loads.

.3 Test load balance on all feeders at distribution centres, motor control centre and panelboards.

.4 If load balance exceeds 15%, reconnect circuits to balance loads.

3.4 **Voltage Testing and Adjusting**

.1 Test voltage at all panelboards.

.2 Test voltage at motor control centre.

.3 Adjust transformer tap settings to compensate for under-voltage or over-voltage conditions, if directed to do so by the Engineer.

3.5 **Instrument Testing**

.1 Prior to the completion of the Work, perform comprehensive testing of the installation. Include the following activities:

.1 Pressure testing of all piping systems
.2 Wire insulation tests

.3 Wire continuity tests including associated terminations

.4 Grounding system continuity and isolation tests

.5 Any other testing necessary to verify the operation of equipment and installation work

.2 Where appropriate, provide the services of a manufacturer’s representative for equipment to assist with any of the equipment tests to be performed. Any components, incorrect wiring, or systems found to be defective or deficient during the tests shall be repaired or replaced.

.3 Coordinate test schedules with the Engineer.

.4 The participation in testing activities and use of the equipment during testing periods by the Owner shall be allowed provided it does not adversely affect specified testing requirements.

.5 Prior to the commencement of any testing, the Contractor shall ensure that all spare parts, expendables, and test equipment pertinent to the system being tested are on site. Test equipment shall include all necessary multi-meters, process instrument calibrators for 4-20 mA, 24 VDC devices and signal generators or simulators. Test equipment shall be provided by the Contractor and shall remain the property of the Contractor at the end of all testing.

3.6 Instrument Calibration

.1 In situ, calibrate and adjust all instrumentation to verify correct operation, range adjustment, compensation, scaling, etc. Provide instrument calibration services for all individual components such as signal transmitters, analyzers, transducers, power supplies, and like equipment where appropriate.

.2 Provide certified calibration reports for each instrument. In the reports, include, but do not limit to, such information as:

.1 Device tag number

.2 Equipment description

.3 Service application

.4 Process variable measurement range

.5 Description of calibration equipment used
.6 “As left” calibration data

.7 Date, name, and signature of technician

.3 Include calibration reports in the operating and maintenance manuals described in Section 16010.

3.7 Instrumentation Installation Verification

.1 When the system installation has been completed (or part thereof), perform detailed verification checks for all systems supplied and installed as part of the Work. In the checks and reviews, include the following:

.1 Certify that the equipment has been installed as per the Contract drawings and recommended installation procedures, reporting any discrepancies to the Engineer.

.2 Certify that the equipment power and grounding requirements have been satisfied, reporting any discrepancies to the Engineer. For the grounding system, include an itemized check of each instrument circuit to verify the correct isolation of all shields and instrument grounds.

.3 Certify that all terminations to the equipment are properly installed. Report any discrepancies to the Engineer.

.4 Certify that all wiring continuity (whether new or existing) has been verified.

.5 Certify that the installation (or part thereof as completed) is ready for commissioning and start-up.

.2 Undertake any corrective action found to be necessary during the course of the verification checkout and review.

.3 Report any discoveries of defects or deficiencies in writing to the Engineer for any equipment supplied by the Owner.

.4 Allow for the participation of the Owner in the verification checks. Such participation shall not relieve the Contractor of any of the obligations.

Prepare the various reports and certificates described herein. Forward three (3) copies of each report or certificate to the Engineer. Clearly identify any discrepancies which require action on the part of the Engineer.

END OF SECTION
1. GENERAL

1.1 Intent

.1 Provide demonstration and instruction sessions to familiarize Owner's operation and maintenance personnel with electrical systems and their operation and maintenance.

.2 Submit system sign off sheets for each system listed prior to substantial completion.

.3 Complete a motor survey sheet for each motor and submit prior to substantial completion. Include a control wiring diagram for each motor neatly drawn in ladder form. Indicate all terminal and wire numbers. Identify all associated control components. Provide typed copies of these lists and diagrams in the operating/maintenance manuals. Include motor overload selection charts for each type and application of overload relay.

.4 All sign off and survey sheets shall be typewritten.

1.2 Manufacturer's Site Services

.1 Arrange and pay for appropriately qualified manufacturers representatives to provide or assist in providing electrical equipment and system demonstration and instruction as specified herein.

1.3 Contractor/Owner Coordination

.1 Owner will chair demonstration and instruction sessions.

.2 Establish agendas for demonstration and instruction sessions in conjunction with Owner. Coordinate scheduling of sessions with Owner.

2. EXECUTION

2.1 Systems Demonstration

.1 Demonstrate operation of following systems:

.1 600 Volt Electrical Distribution System
.2 208/120 Volt System
.3 Process Mechanical Equipment Connections and Controls
.4 Instrumentation equipment
.5 PLC cabinets and SCADA control
**MOTOR SURVEY SHEET**

**Motor Name & Number**

**Manufacturer**

- **H.P.** ________________ Max. Ambient ________________ °C
- **R.P.M.** ________________ Service Factor ________________
- **Volts** ________________ / ________________ / ________________ Insulation Class ________________
- **AMPS** ________________ / ________________ / ________________ EEMAC Design ________________
- **PHASE** ________________ Time Rating ________________
- **Frame** ________________ Type ________________
- **Serial #**
- **Model #**
- **Starter** ________________ Type ________________

**OPERATING CONDITIONS**

- **Full Load Operating Amps** ________________ A ________________ B ________________ C ________________
- **Full Load Operating Voltage** ________________ A-B ________________ B-C ________________ C-A ________________
- **Overload Relay Installed** ________________ Adjustable Setting ________________ %
- **M.C.P. AMPS** ________________ Adjustable Setting ________________
- **Acceleration Time (If over 5 seconds)** ________________
- **Reduced Voltage Starter Tap Setting** ________________
- **Reduced Voltage Starter Transition Time Setting** ________________

**Special Controls and Remarks (Thermistor and Relay Type, Capacitors and where connected, etc.)**

- ________________
SYSTEM COMPLETION AND COMMISSIONING

SYSTEM: 

The above system is installed as per the drawings and specifications, is complete and has been commissioned.

Electrical Contractor

Signed by: _______________________________ Dated: _______________________________

General Contractor

Signed by: _______________________________ Dated: _______________________________

Deficiencies Attached

ZD? @DY

This system has been reviewed by:

The Consultant

Signed by: _______________________________ Dated: _______________________________

The Owner's personnel have been instructed in the operation and maintenance of the above system:

The Owner

Signed by: _______________________________ Dated: _______________________________

The above does not constitute a waiver of any of the requirements of the Contract Documents.

ELECTRICAL CONTRACTOR

______________________________

GENERAL CONTRACTOR

______________________________

Address:

______________________________

______________________________

______________________________

Phone:

______________________________

END OF SECTION
1. GENERAL

1.1 General

.1 This section covers items related to Division 17 and supplements and requirements of other Divisions.

.2 The contractor shall take full responsibility for and shall coordinate the work of Division 16 and Division 17 to guarantee a complete and finished installation of the electrical and instrumentation & control systems. The Division 17 drawings and specifications are to be read together with drawings and specifications of all other Division and specifically Division 16. Additional information necessary to complete the work is included in other sections of the drawings and specifications.

.3 All tables shown of the Division 17 drawings and specifications are for information purposes only and may show partial lists of equipment and materials. A complete takeoff for all drawings and specifications shall be done by the Contractor in order to determine accurate quantities of equipment and materials.

.4 Definitions

.1 Interpret specialized terms not explicitly defined herein in accordance with ISA S51.1, NEMA ICS 1, ANSI/IEEE Std 100, and The Communications Standard Dictionary, by Martin H. Weik.

.2 SCADA – Supervisory Control and Data Acquisition System. A SCADA system includes controllers, networks, computers (SCADA computers), computer software user interface (SCADA software), communication equipment and communication protocols. A SCADA system monitors the entire plant control system in real time.

.3 PCS – Plant Control System. Same as SCADA.

.4 PLC - Programmable Logic Controller: The digital system that performs digital and analog control in a stand-alone or shared control system.

.5 HMI - Human-Machine Interface: an industrial computer panel or operator interface terminal, usually installed outside of a control room, which allows viewing of the various process area real-time graphics, viewing alarms, changing of process parameters and modes and other operator control actions. The functionality of HMI is independent of the SCADA computers (servers/clients).

.6 SUPPLY – Shall mean that so noted equipment is to be purchased, assembled and shipped undamaged to the site. Where an item is supplied by the owner, by others, or by another division, the work of mounting connecting and...
commissioning the item shall be included in the contract unless specifically otherwise noted.

.7 PROVIDE – Shall mean that the so noted equipment is to be supplied, installed, connected, adjusted, calibrated, tuned, cleaned, commissioned and placed into full service.

.8 INSTALL – Shall mean to put the specified item into full operation, securely fastened and connected to the system. The contractor shall provide all work and material which is necessary to securely fasten and give a presentable finished appearance including all necessary connections and conductors. Such noted equipment must be fully calibrated and tested.

.9 APPROVED – Shall mean that the so noted equipment is to be officially accepted by the Engineer prior ordering, fabrication and installation.

.10 COORDINATE – Shall mean to make all arrangements directly with agencies, individuals and other trades, confirm schedules, be in attendance at the time work is carried out, take full responsibility for having the work carried out correct and in timely manner to meet the construction schedule.

.11 FIELD WIRING – Shall mean all labour and material necessary to connect all instrumentation and control devices and equipment, both discrete and analog, regardless of voltage and current, and all power supply wiring other than 120 VAC power supply wiring and shall also include all interconnecting cables between portions of the system.

.12 COMMUNICATION WIRING – shall mean all work and material required for connection of control data communications including but not limited to Ethernet DH485, Modbus Plus and Fieldbus communications.

.13 OWNER shall mean the District of Lake Country or its appointed representative.

.14 ENGINEER shall mean AECOM or its appointed representative.

1.2 Requirements of Work

.1 The Contractor shall be ultimately responsible and shall provide for the supply, installation, certification, adjustment, tuning and start-up and commissioning of a complete, coordinated system that shall reliably perform the intended functions.

.2 Supply, install, commission, and provide warranty for a complete and fully documented instrumentation and control system as specified herein. The instrumentation and control system may contain packaged equipment, component subsystems and appurtenances specified in this and other sections (Divisions 11, 15 and Division16) of the specifications.
.3 The Work includes all hardware, software, labour and services necessary to provide fully functional, coordinated control system for the entire plant addition (new and existing systems modifications). Supply all items and accessories specified by the Contract Drawings or the specification in the quality and quantity required. Perform all operations as designated by the specification according to the methods prescribed, complete with all necessary labour and incidental.

.4 Component subsystems of the instrumentation and control system will include, but are not limited to the following:

.1 Primary elements and transmitters

.2 Control valves

.3 Final control elements

.4 Instrumentation and control field devices

.5 Instrumentation and control junction boxes and control panels

.6 Instrumentation wiring and cabling

.7 Instrumentation power supplies

.8 Operator interface computers and associated software

.9 Communications and Data Networks

.5 Where packaged, stand-alone control systems are supplied under other Divisions of this Contract, co-ordinate and ensure Submittal Drawings, Motor Control Schematics, Instrument Specification Sheets (ISS), and Control Wiring Drawings are provided in accordance with the requirements of this section and in accordance with the Division 17 Drawings.

.6 Where modifications are made to packaged systems, stand-alone control systems, or other contractor equipment supplied under other Divisions of this Contract, and the modifications are due to vendor or Contractor changes to the systems in question, the systems may be considered acceptable provided:

.1 The proposed system and/or its modifications satisfy the intent of the specifications, and

.2 The changes or modifications combined for all aspects of work by all trades do not result in a cost addition to the Contract

.3 Approved by the Engineer.
.7 Where packaged, stand-alone equipment with control systems are pre-purchased by owner or supplied by under other Divisions of this Contract, provide all necessary labour, material and cabling to install and connect the equipment to the required remote monitoring and/or control functions. Coordinate and provide all supplies to complete end-to-end commissioning of all required remote monitoring and/or control functions. Ensure the correct functionality of any equipment supplied under other Divisions.

.8 The contract drawings for Division 17, detail the wiring requirements, cables, terminations, and SCADA interface requirements for equipment and control systems contained within packaged systems supplied under other Divisions of this Contract or pre-purchased. These drawings have been produced to accurately show the control intent for the packaged system. If the packaged system provided differs from that shown on the drawings, or if modified terminations, cabling or interfaces are required to properly integrate the actual equipment to the process, electrical distribution, or SCADA, the Contractor is to provide cables, wiring, and terminations to satisfy the general intent as per the drawings, at no additional cost to the Contract.

.9 Documentation referred to includes as a minimum:

.1 Equipment descriptive data
.2 Equipment installation, service manuals, operation and maintenance manuals, and recommended spare parts lists
.3 Schematics and interconnecting wiring diagrams
.4 The recording of conductor identification, field terminals, changes, etc., on the Instrument Loop Diagrams (ILDs) provided as part of this specification or by others as it relates to the equipment with this scope of supply.
.5 Instrumentation and control panel shop drawings, face layouts, schematics and point-to-point wiring diagrams.

.10 References

.1 This specification contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>API RP550</td>
<td>Manual on Installation of Refinery Instruments and Control Systems,</td>
</tr>
<tr>
<td></td>
<td>Part I - Process Instrumentation and Control Sections 1 Through 13</td>
</tr>
<tr>
<td>ASME Section VII</td>
<td>Rules for Construction of Pressure Vessels</td>
</tr>
<tr>
<td>ASTM B68</td>
<td>Seamless Copper Tube</td>
</tr>
</tbody>
</table>
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ASTM D883 Terms Relating to Plastics
CEC C22.1 Canadian Electrical Code – Part 1 Latest Edition
IEEE 100 Dictionary of Electrical and Electronic Terms
ISA RP7.1 Pneumatic Control Circuit Pressure Test
ISA RP12.6 Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations
ISA S5.1 Symbols, graphic
ISA S5.4 Instrumentation & Instrument Loop Diagrams
ISA S18.1 Annunciator Sequences and Specifications
ISA S51.1 Process Instrumentation Terminology
NEMA 250 Enclosures for Industrial Controls and System
NEMA ICS 1 General Standards for Industrial Control and System
NEMA ICS 2 Industrial Control Devices, Controllers, and Assemblies
SAMA PMC 17-10 Bushings and Wells for Temperature Sensing Elements
UBC Uniform Building Code
UL 1012 Power Supplies
UL 94 Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

.11 Codes, Rules, Permits, and Fees

.1 Comply with all laws, ordinances, rules, regulations, codes, standards and orders of all authorities having jurisdiction relating to this work.

.2 Comply with CSA Standards, Canadian Underwriters’ Laboratories and the applicable building codes.

.12 Compliance

.1 Failure to comply with the Drawings and Specifications shall be cause for rejection of the work and the contractor shall be required to make all required changes to comply with the drawings and specifications at no additional cost to the Owner or their agents and representatives.

.2 Where a conflict exists between any applicable code, regulation, directives, standard or manufacturers recommended practice for any item and what is shown on drawings or specified, seek clarification from the Engineer prior to submitting Tender or allow for the most expensive alternative.

.13 Alternative Equipment

.1 The contractor is required to base the bid on the specified equipment. The price increase or decrease for the alternative equipment shall be shown separately.
The Engineer shall review alternative equipment after Tender submissions and shall have a sole judgment of the acceptability of alternatives.

.14 Errors and Omissions

.1 In the event of errors or discrepancies between the Drawings and/or Specifications, the contractor shall obtain a ruling before Tender is submitted.

.2 If a ruling has not been requested the contractor shall allow in the tendered price for more expensive alternative.

.15 Standards of Workmanship

.1 Execute all work in a manner that will result in the completed installation presenting an acceptable appearance, to a level of quality defined in the general conditions of this Specification.

.2 Employ a competent supervisor and all necessary licensed tradesmen to complete the work in the required time.

.3 Arrange and install products to fit properly into designated building spaces.

.4 Ensure products are installed in accordance with the recommendations and ratings of the product manufacturers.

.5 The Engineer reserves the right to require the dismissal from the site of workers deemed incompetent.

.6 In case of dispute, decisions as to the acceptability of the quality of work rest solely with the Engineer, whose decision is final.

.16 Contract Drawings and Specifications

.1 Refer to Division 1.

.2 Supply all items and accessories specified in the quality and quantity required. Perform all operations as designated by the specification according to the methods prescribed, complete with all necessary labour and incidentals.

.3 Provide all minor items and work that are reasonably necessary to complete the work.

.4 If discrepancies or omissions in the specifications are found, or if intent or meaning is not clear, consult the Engineer for clarification before submitting tender. If the clarification has not been requested, the contractor shall allow for the more expensive alternative.
.17 Coordination with Other Divisions

.1 The General Contractor shall be responsible for coordinate all trades, such as electrical, process mechanical, HVAC for the equipment which is installed under this contract.

.2 The responsibility to determine which Division provides various products and work rests with the General Contractor. Additional compensation will not be considered because of differences in interpretation of specifications.

.3 Treat any item or subject omitted from this Division’s specifications, but which is mentioned or reasonably specified in other Divisions’ specifications or drawings and pertains to the instrumentation and control system, as being integral to the overall system. Provide such specified items or subjects.

.4 Lay out the Work and equipment with due regard to architectural, structural and mechanical features. Architectural and structural drawings take precedence over electrical drawings regarding locations of walls, doors and equipment.

.5 Examine and study the architectural, structural and mechanical drawings for items affecting the installation of the work under this specification and locate wireways, instruments, controlled equipment and control panels accordingly and in such way that required clearances can be maintained, and to avoid conflict with other installations.

.6 Do not cut structural members without prior written approval of the Structural Engineer.

.7 Examine previously constructed work and notify the Engineer of any conditions which prejudice the proper completion of this Work.

.8 The contractor shall thoroughly check drawings and specifications of all other trades for conflict and coordination with the control and instrumentation trade. If any conflict is found, obtain a ruling from the Engineer before proceeding.

.18 Environmental Requirements

.1 Unless otherwise noted, all equipment wiring methods in the plant process area shall meet or exceed EEMAC 4 rating.

.2 Unless otherwise indicated, in control rooms or electrical rooms EEMAC 12 rating is acceptable.
1.3 Equipment

.1 Receiving, Storing, and Protection of Components during Construction

.1 Examine each component upon delivery to site. Report all damage noted to the Engineer prior to accepting or rejecting delivery.

.2 Make provision for off-loading for all equipment deliveries. Off-loading should only be performed by trained and qualified personnel.

.3 Perform a preliminary examination upon delivery to ensure that:

   .1 All instrumentation and control components supplied for this project under this section of the specifications comply with the requirements stated in these specifications.

   .2 All instrumentation and control components that have been supplied under other sections of this specification, or that have been pre-purchased under previous contracts and are to be connected to instrumentation and control components supplied under this section of the specifications, comply with the requirements stated in the instrument specification sheets and as defined by the specifications.

.2 Itemize all non-conformities noted above and forward them to the Engineer. Any delays in construction resulting from the delivery to site of non-conforming instrumentation and control components supplied under this contract are to be borne by the Contractor.

.3 Do not allow installation of primary elements or other sensitive equipment until construction is sufficiently completed to provide an “operating condition” environment. Notify the Engineer prior to installing any equipment of this type.

.4 Ensure that covers, where required, are properly installed on all equipment. Provide all covers, padding, guards, etc., as required to guard any equipment against damage to finish, proper operation, or life expectancy.

.5 Return all damaged equipment to the factory for total corrective repairs. If deemed necessary by the Engineer, the damaged equipment shall be replaced with new product. The Contractor shall bear any costs due to construction delays resulting from the delay in delivery of acceptable equipment supplied under this contract.

.6 All labour and material required for installation of the Instrumentation and Control equipment as specified, shown on the drawings and as indicated in the associated user manuals must be provided. All required mounting hardware required to mount the equipment shall be provided by the contractor.

.7 The instrumentation and control equipment provided under this contract or supplied by others and installed by the contractor shall be installed in such way to fully
comply with the manufacturer’s instructions, all applicable installation standards and these specifications and drawings. The equipment must be installed in such way so that it can be easily read and serviced. Unless otherwise indicated in these specification and drawings, all instruments which have local indicator displays and all HMI panels shall be mounted in such way that the center point of the HMI is 1500 mm above the floor and must be oriented in such way that it is easy to view them.

.8 All instruments and control panel installed together shall be aligned horizontally and vertically in such way to present a neat and orderly appearance. They shall also be aligned and symmetrical with other equipment and architectural elements.

1.4 Documentation

.1 Submittals

.1 Submit a schedule within 10 days of award of the Contract to the Engineer showing projected ordering and delivery dates of all products to meet the required construction schedule. Provide all necessary information regarding ordering and delivery dates for electrical and control products as required for scheduling.

.2 Provide catalog cuts of all equipment, devices and materials where requested by the individual specification sub-sections. Catalog information includes technical specifications and application information, including ratings, range, weight, accuracy, adjustability, etc. Edit the catalog cuts to show only the information which applies to the proposed product for this project.

.3 Assemble the catalog cuts in a folder or binder. Each folder or binder shall contain a cover sheet that is indexed by item and cross-referenced to the appropriate specification sub-section.

.4 After receiving approval of the list of products and equipment from the Engineer, but prior to delivery of any products or equipment to job site and sufficiently in advance to allow ample time for checking, submit shop drawings for review. The list of equipment for which shop drawings are to be provided includes, but is not limited to:

.1 Control Panels

.2 Instrumentation equipment (include instrument specification sheet for each device as per Section 17701)

.3 All specially fabricated materials and equipment

.4 Terminals

.5 Relays
.6 Instrument Mounting Stands

.7 Terminal and Wire Marking System

.8 All Ethernet Network Equipment

.9 All signal cables

.10 UPS

.5 Review, modify, and approve the shop drawings prior to submitting shop drawings to the Engineer for review. Contractor approval of a drawing indicates the following:

.1 The drawing has been checked by the person making the approval.

.2 The equipment or material complies in all respects with the requirements of the specifications and drawings.

.3 The quantities, if indicated on the drawing, are correct.

.4 The physical dimensions of the components are such that they can be installed without interference with the building structure or other equipment, and that after installation, there are sufficient clearances on all sides for maintenance, servicing, and operation of the equipment.

.5 The points of attachment are clearly indicated, i.e., TOP, BOTTOM, SIDE, etc.

.6 The arrangement and location are properly oriented.

.7 The product is suitable for its intended use.

.6 Stamp and sign the shop drawing to show approval, indicating the above has been complied with. If Contractor revisions are too extensive, return the submission to the supplier for revision, then repeat the shop drawing approval process before submitting them to the Engineer.

.7 Manufacture of products shall conform to shop drawings marked as reviewed by the Engineer and returned to the Contractor.

.8 Keep one complete, maintained set of shop drawings at the job site during the construction period.

.9 Refer to Section 01330 for further information on shop drawing submittals.

.10 Shop drawings must be clear and legible. Fax copies are not acceptable.
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.11 The Engineer’s review includes a general overview of shop drawings for conformity to project requirements and intentions in accordance with the construction agreement and does not relieve the contractor of responsibility to correct any errors, omissions and discrepancies.

.2 Operations and Maintenance Manuals

.1 Refer to Division 1 and Division 16 for general O&M manual submittal information.

.2 In addition to the requirements specified in Section 01735, provide the following information:

.1 Table of Contents - Arrange contents sequentially by systems under section numbers. Label tabs of dividers between each to match section numbers in the Table of Contents.

.2 Systems Descriptions - A brief synopsis of each system typed and inserted at the beginning of each section. Include sketches and diagrams where appropriate.

.3 Maintenance and operating instructions for all electrical equipment and controls - These operating instructions need not be manufacturer’s data, but may be typewritten instructions in simple language to guide the Owner in the proper operation and maintenance of his installation.

.4 A copy of all wiring diagrams complete with wire coding.

.5 Include type and accuracy of instruments used.

.6 Set of final reviewed shop drawings.

.7 Provide a tabulated list of all consumables utilized (fuses, lamps, etc.) indicating where used, type, rating, and reorder details.

.8 Provide a tabulated list of all components supplied (hardware and software) for the installation, complete with make, model, manufacturer, part order number, and source of supply.

2. PRODUCTS

2.1 General

.1 Refer to the requirements of Division 1.

.2 Selected Products
.1 Provide products and materials that are new and free from all defects. Refer to Clause 1.2.2 for further details.

.2 Products and materials called for on the drawings or in the specifications by trade names, manufacturer’s name, and catalogue reference are those which are to be used as the basis for the Tender.

.3 The design has been based on the use of the first named product, where acceptable products are listed in the specification.

.3 Review of Products

.1 Immediately after notification of award of the Contract, review with the Engineer the list of products proposed, including any alternatives submitted with tender.

.2 After agreement on product list has been reached, no subsequent changes will be permitted except as specified hereafter.

.4 Substitution of Products after Contract Award

.1 All product substitutions must be approved by the Engineer. Failure to obtain approval from the Engineer will result in the alternative product being rejected, in which case the Contractor shall provide an approved product at no additional cost to the Owner.

.2 After acceptance of the list of products, no substitution of any item will be permitted unless the approved item cannot be delivered in time to comply with the work schedule.

.3 To receive acceptance, proposed alternates are to equal or exceed the quality, finish and performance of those specified and/or shown, and not to exceed the physical space allotted. The Contractor shall assume full responsibility for ensuring that when providing alternative products or materials, all space, weight, connections, power and wiring requirements etc. are considered. Any costs incurred for additional components, changes to services, structural or space requirements, layouts and plans, etc. that may be necessary will be borne by the Contractor.

.4 Provide to the Engineer documentary proof of equality, difference in price (if any), and delivery dates, in the form of certified quotations from suppliers of both specified items and proposed substitutions.

.5 Include costs for any required revisions to other structures and products to accommodate such substitutions. All extra costs are, unless negotiated otherwise, the responsibility of the Contractor.

.6 Refer to Division 0 for additional information on substitutions.
.7 The engineer will review the shop drawings for the equipment which deviates form the original specification only after the contractor provides written explanation that each substation comply with at least one of the following criteria:

.1 The specified equipment is no longer available.

.2 The proposed alternative equipment has advanced technical characteristics than the specified equipment and it will be provided without contract price increase.

.3 The proposed alternative equipment has same technical characteristics as the specified equipment but brings significant cost savings to the Owner.

.4 The proposed alternative equipment carries significant construction cost savings for the Owner.

.5 Quality of Products

.1 All products provided to be CSA Approved, and Canadian Underwriters' Laboratory approved where applicable.

.2 If products specified are not CSA or cUL approved, obtain approval of the relevant provincial regulatory authority. Pay all applicable charges levied and make all modifications required for approval.

.3 Products provided, if not specified, to be of a quality best suited to the purpose required and their use is subject to approval by the Engineer.

.6 Uniformity of Manufacture

.1 Unless otherwise specifically called for in the specification, uniformity of manufacture is to be maintained for similar products throughout the work.

.7 Product Finishes

.1 The Contractor is to specify proposed finishes to be used for Engineer’s review.

.8 Use of Products during Construction

.1 Any equipment used for temporary or construction purposes are to be approved by the Contract Administrator and in accordance with Division 1 of this specification. Clean and restore to “as new” condition all equipment prior to the time of substantial completion. All computers supplied for the Work shall be new and unused.
2.2 Instrumentation

.1 General

.1 Instruments to be suitable for the environmental conditions in which they are to be installed.

.2 Determine where injurious conditions may be expected to occur and make proper provision to protect the instruments to ensure their proper and reliable operation.

.3 Provide power surge protectors, heating cables, and devices to protect instruments, equipment, and lines from being functionally impaired or damaged by power surges or environmental conditions. Each panel assembly shall include transient voltage surge suppression equipment at all power entry points.

2.3 Identification

.1 Refer to Division 16 for general identification requirements. Provide lamacoid nameplates as per the requirements of Division 16. Identify the loop tag number (where applicable) and the device name and function on the nameplate.

.2 Where it is not possible to attach a lamacoid nameplate to a field instrument component, provide the component with a stainless steel metal tag firmly wired to the device and identified with the loop tag number.

.3 Identify all wires where they terminate at the marshalling panels, junction boxes, and field devices with the cable tag plus suffix. Make and attach the identification as per the requirements of Division 16.

.4 Clearly mark all panels, main feeders, pull boxes, junction boxes, etc., to indicate the nature of service.

.5 Identify all control wires with coloured insulation and permanent wire markers at every terminal and at accessible points throughout their entire run. Refer to requirements of Division 16.

.6 Identify all exposed feeder conduits for all systems and all control conduits at all pull box locations, where the conduits enter or leave a room, and 13 meters on centre throughout the room. This shall apply to conduits above removable ceilings. Use Thomas & Betts TY-RAP 5532-M labels conduit identification.

.1 For direct current wiring use black for negative and white for positive.

.2 For thermistor wiring to motors, use red and blue coloured, insulated wire.

.7 Identify all individual instruments.
3. EXECUTION

3.1 Site Examination

.1 Refer to the requirements of Division 1.

.2 No additional compensation will be given for extra work due to existing conditions which such examination should have disclosed.

3.2 Coordination with Other Divisions

.1 Examine the specifications of all divisions and become fully familiar the work. Before commencing work, obtain a ruling from the Engineer on any conflicting issues between divisions. No compensation will be made for any costs arising from conflict not identified before work has commenced.

.2 Coordinate the work to be performed under this section of the specification with all divisions installing equipment to ensure that there are no conflicts. The Division 17 Drawings and Specifications are to be read together with drawings and specifications of all other Divisions and specifically Division 16. Additional information required for complete work is contained in other sections of the Drawings and Specifications and equipment user and installation manuals.

.3 Lay out the work and equipment with due regard to architectural, structural, and mechanical features. Architectural and structural drawings take precedence over electrical drawings regarding locations of walls, doors, and equipment.

.4 Examine previously constructed work and notify the Engineer of any conditions which prejudice the proper completion of this work.

3.3 Product Handling

.1 Use all means necessary to protect the products included in this division before, during, and after installation, and to protect products and installed work of all other trades.

.2 Any damage to the products and/or installed work shall be repaired or replaced by the Contractor at no additional cost to the Owner, and to the approval of the Engineer.

.3 Remove advertising labels from all products installed that have such labels attached. Identification or CSA labels are not to be removed.

.4 Remove dirt, rubbish, grease, etc., resulting from work performed under this section of the contract from all external and internal surfaces of all electrical equipment including all enclosures.
3.4 Separation of Services

.1 Maintain separation between the electrical wiring system, building piping, ductwork, and the instrumentation cables so that each system is isolated (except at approved connections to such systems) to prevent galvanic corrosion. In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is unacceptable.

.2 Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings may be used for the support of wiring only when approval is obtained from the Engineer and the ceiling installer, and only if approved clips or hangers are used.

3.5 Equipment Identification

.1 3 mm thick plastic laminoid name plates, white face, black core, mechanically attached with self tapping screws, 4 - 12 mm high lettering, to be attached to the front face of the following equipment:

.1 Local Control Panels

.2 Instruments

.3 Analog Junction Boxes

.4 Control Junction Boxes

3.6 Nameplates

<table>
<thead>
<tr>
<th>NAMEPLATE SIZES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size 1</td>
</tr>
<tr>
<td>Size 2</td>
</tr>
<tr>
<td>Size 3</td>
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<tr>
<td>Size 4</td>
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<tr>
<td>Size 5</td>
</tr>
<tr>
<td>Size 6</td>
</tr>
<tr>
<td>Size 7</td>
</tr>
</tbody>
</table>

.1 Wording on nameplates to be approved by Engineer prior to manufacture.

.2 Allow for average of twenty-five (25) letters per nameplate.

3.7 Equipment Connections

.1 Prior to the connection of signal wiring to process control and instrumentation devices, check the device voltage rating and polarity for compatibility with the corresponding loop and/or schematic diagram. Where device and circuit
characteristics are found to be incompatible, the connections are not to be made. Report the condition immediately to the Engineer.

2 All control wiring diagrams illustrate typical control circuits applicable to the type of equipment specified. Control circuits may vary with different manufacturers of equipment. Verify all control circuits with the suppliers of the equipment and make any corrections to the control wiring diagrams that may be required.

3 Provide power disconnect switches for all 24 VDC and 120 VAC powered instruments.

3.8 Access Panels

1 Provide access panels where instrumentation and control system junction boxes are concealed. Panels to be of adequate size for servicing of the concealed junction box and complete with necessary frames and hinged doors held closed with captive fasteners. The type and size of panels are to be coordinated with the Engineer.

3.9 Instrument Mounting Stands

1 Supply and install instrumentation mounting stands as required. Stands are to be either floor or wall mounted. The mounting stands are to be fabricated from aluminum and supplied painted.

2 Supply and install protective drip shield for any exterior stand-mounted instrumentation equipment. The drip shield is to extend 50 mm at the top and sides from the front face of the equipment. The drip shield is to be fabricated from aluminum and supplied painted.

3.10 Sealing of Wall and Floor Openings

1 Seal all conduit and cable entries passing through outside walls of buildings, through partition walls separating electrical rooms from other areas, through fire separations, and through floors above grade. Follow recommendations of Section 16010.

2 Seal openings after all wiring entries have been completed.

3.11 Sleeves

1 Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.

2 For walls, partitions and ceilings, the ends shall be flush with the finish on both sides. For floors, the ends shall extend 100 mm above finished floor level.

3 Fill the space between the sleeve and the conduit with fire stop material and caulk around the top and bottom with approved permanently resilient, non-flammable and
weatherproof silicone base compound. Ensure that the seal is compatible with the floor and ceiling finishes.

3.12 Testing of Instrumentation Loops

.1 After all devices within a loop have been connected, check the loop for correct functioning and interaction with other loops, where applicable. Provide written notice to the Engineer when the loops are going to be tested so that the tests may be witnessed at the Engineer’s discretion. Coordinate testing with work of other contractors that interface to the Work specified herein, and in particular, with all pre-purchased equipment suppliers.

.2 Check the operation of final control elements such as solenoid valves, actuators, etc., by manual control before checking with automatic control.

.3 Test all tubing for leaks in compliance with ISA RP7.1. Isolate all instruments when tubing is being tested to protect against over pressure.

.4 Perform tests and record results on the test data forms that are included in this section for every loop included in the Work. Develop additional and/or more detailed test forms as necessary to suit more complex instrumentation.

.5 Sign and date all test reports. Submit the test reports to the Engineer within 5 working days of testing.

3.13 Calibration

.1 Instruments are to be factory pre-calibrated. Provide a printed record of the factory calibration parameters for all devices including “smart” devices.

.2 Prior to calibration completely program all “smart” transmitters including entries of the appropriate range and tag number. Provide a printed record of smart device serial numbers against their assigned tag number.

.3 All instruments are to be field set up and calibrated by an accredited instrument technician working under the approval of the instrument manufacturer.

.4 Calibrate all instruments to an accuracy of 1/2 of one percent of full range, or to the manufacturer’s stated accuracy of the instrument whenever an accuracy of 1/2 of one percent is not achievable.

.5 Prior to instrument installation, perform the following applicable calibration for each instrument and its associated signal conditioning equipment:

   .1 Calibrate all inline flowmeters by a draw-down test

   .2 Calibrate all vacuum and pressure instruments by manometer or accurate test instrument and hand test pump
.3 Calibrate gas detectors using standard gas sample

.4 Calibrate temperature instruments against a standard lab thermometer.

### 3.14 Commissioning

.1 Refer to the requirements of Division 1 for additional commissioning requirements.

.2 Inspections

.1 Provide two (2) weeks written notice to the Engineer prior to energizing any system to allow for inspection by the Engineer of the following:

.1 Proper mounting

.2 Proper connections

.2 During commissioning demonstrate to the Engineer proper calibration and correct operation of all instruments and gauges.

.3 Commissioning of the instrumentation and control system is to include, but not be limited to the following:

.1 Supervise installation of components, wiring connections and piping connections.

.2 Supervise wiring continuity and pipe leak tests.

.3 Verify instrument calibration and provide written report.

.4 Function check and adjust under operational conditions the instruments and control equipment. This shall include all software control logic and HMI software.

.5 Coordinate instruments and control equipment supplier’s service personnel as required for complete system testing.

.6 Instruct plant personnel in correct method of operation of instruments and control equipment.

.7 Direct plant personnel at hand-over as to final adjustment of the system for correct operation of plant.

.8 Ensure that the instrumentation and control equipment suppliers cooperate to complete the work of this section.

.9 Verify signal levels and wiring connections to all instrumentation and control equipment.
.10 The Contractor shall be responsible for the supply of all consumables such as fuses, lamps, bulbs, etc., that are applicable to all systems except the owner supplied equipment or systems during start-up and commissioning. At completion of commissioning, provide 10% spare inventory of each type of consumable. In addition, provide a tabulated list of all consumables utilized indicating where used, type, rating, and re-order details. Include with the operation and maintenance manual information.

3.15 Training

.1 Provide training, described in detail in Divisions 1 and 11, as required by plant personnel to become fully competent in the proper operation and maintenance of all control devices, control valves, PLCs, control computers, and ancillary instrumentation described under this section of the specification. Pay particular attention to complicated electronic devices such as magnetic flowmeters, “smart” transmitters, microwave level transmitters, ultrasonic level transmitters.

3.16 Work on Existing Equipment

.1 It is the contractor’s responsibility to obtain and use the owner’s Operation and Maintenance Manuals related to the existing equipment and to accurately take-off existing wiring schematics in order to do all necessary rewiring on the existing equipment as indicated in these specifications and drawings.

.2 Coordinate with the owner before de-energizing or changing the setup of any piece of existing equipment.

3.17 Cleaning

.1 Before acceptance all instrumentation and control equipment exterior and surfaces and control panels and junction interiors and general work areas must be clean. All damaged paint surfaces must be restored to factory-quality finish.

3.18 Wiring to Equipment Supplied by Others

.1 Equipment supplied by the Owner or under other Division will be moved to the installation site by other. However, all instrumentation & control, field and communication wiring and connections shall be done by this division.

3.19 Permits, Costs and Inspection

.1 The contractor is to obtain all necessary and required permits and pay all associated costs at his own expense.
.2 The contractor shall provide Certificates of Acceptance from the local Electrical Inspection Authority after the work is completed.

.3 If any changes are required by the Electrical Inspection Authority, notify the Engineer prior making those changes.

3.20 Warranty

.1 The contractor shall guarantee/warranty all equipment and labour which he provided for the project and replace at his own expense any part which may fail within a period of two years after final acceptance.

3.21 Test Forms

<table>
<thead>
<tr>
<th>Form No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITR</td>
<td>Instrument Test Report</td>
</tr>
<tr>
<td>LPCHK</td>
<td>Instrument Loop Check Sheet</td>
</tr>
</tbody>
</table>

END OF SECTION
## INSTRUMENT LOOP CHECK

### INSTRUMENT TAG NO.

<table>
<thead>
<tr>
<th>LOOP NO.</th>
<th>SHEET NO.</th>
<th>P &amp; I DWG. NO.</th>
</tr>
</thead>
<tbody>
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</table>

### INSTALLATION COMPLETE

- Primary Element
- Impulse Lines
- Block and Drain Valves
- Air Supply/Filter/Reg.
- Wiring
- Tracing/Insulation/Housing
- Mounting and Location
- CDACS I/O & Status

### CALIBRATED

- Impulse Lines Press. Tested

### LOOP CHECKED

- Element To Receiver
- X Mtr. to Receiver
- X Mtr./Trans. to Receiver
- X Mtr./Trans. to Switches
- Switches to Annunciator
- Interlocking Circuit
- Controller to Valve
- Controller Action D or R

### REMARKS:

- READY FOR START-UP
- DATE: __________________________
- INSTALLER: _______________________
- CLIENT: ________________________
INSTRUMENT TEST REPORT

SYSTEM: ____________________________

SERVICE: ____________________________

LOCATION: ____________________________

MAKE: _______________________________________

SERIAL NO.: ____________________________

ELEMENT: ____________________________

DESIGN SETTING/RANGE: ____________________________

CONTACT TO: ____________________________ ON: ____________________________

ASSOCIATED INSTRUMENT: ____________________________

INSTRUMENT CONDITION: ____________________________

PROJECT NO.: ____________________________

TAG NO.: ____________________________

MODEL: _______________________________________

CSA: _______________________________________

RANGE: _______________________________________

CONTACT TO: ____________________________ ON: ____________________________

ASSOCIATED INSTRUMENT: ____________________________

CONFORM TO SPEC: ____________________________

DATA SHEET: ____________________________

<table>
<thead>
<tr>
<th>TEST METHOD</th>
<th>TEST 1</th>
<th>TEST 2</th>
</tr>
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<tr>
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<td>INPUT</td>
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<td>INC.</td>
<td>DEC.</td>
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<td>TEST POINT 2</td>
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<td>TEST POINT 4</td>
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<tr>
<td>TEST POINT 5</td>
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| COMMENTS | |
|----------|-
| 75%      | |
| 50%      | |
| 25%      | |
| 25%      | 50%  | 75%  | 25%  | 50%  | 75%  |

TESTED BY: ____________________________ ACCEPTED BY: ____________________________

DATE: ____________________________ DATE: ____________________________

END OF SECTION
SCOPE OF WORK

1. GENERAL

1.1 Project Description

1.1.1 Control System Description

1. Control System/Instrumentation work to be done under this Contract includes, but is not limited to, the supply of materials, labour, equipment, and permits necessary for the complete control system manufacturing, assembly, shop testing, installation, site testing and commissioning for both new Glenmore Booster Station & Eldorado reservoir Treated water reservoir and Low Lift Pump Station.

2. This specification section does not show all required I&C work. The required I&C work is shown on the Contract Drawings, Specifications, and as specified herein. A guarantee of all workmanship and materials for a period specified herein is also required.

3. Related Work shall include but not be limited to:
1. Electrical work - specified in the Electrical Sections under Division 16, shall be considered to be a part of these Specifications for proper coordination between the Control system and the Electrical portions of the Work.

2. System Integration of the new HVAC system specified under Division 15 into the new control system shall be considered to be a part of these Specifications and shall be coordinated by the Contractor.

1.2 Work Included

.1 The Work included is the provision and commissioning of a complete and fully functional plant control system. The work shall include any equipment, material and labour not specifically noted or detailed in the specifications and drawings but which is evidently required to furnish a complete system. The work shall include but not be limited to:

.1 **Glenmore Booster Station**

.1 Provide all instruments shown in the specifications and drawings, unless specifically noted as supplied by others, complete with required their installation & mounting supports and hardware. The instruments shall include but not be limited to:

.1 TIT-100A - Pump room Temp. Transmitter
.2 TIT-100A - Electrical room Temp. Transmitter
.3 PIT-101A – Pumps Suction Pressure Indicating Transmitter
.4 PIT-102A – Pumps Discharge Pressure Indicating Transmitter
.5 PIT-106A – Pressure Zone PZ 495 Pressure Indicating Transmitter
.6 PIT-108A – Pressure Zone PZ 560 Pressure Indicating Transmitter
.7 FIT-102B – Pump Discharge Flow Indicating Transmitter
.8 XV-103A – Valve Position Indication
.9 AIT-111A – Beaver Lake Trunk water analyzer (Rez. Cl. / pH / Temp.)
.10 AIT-112A – Glenmore Suction Main water analyzer (Rez. Cl. / pH / Temp.)
.11 AIT-113A – Glenmore Suction Main Turbidity Indicating Transmitter Analyzer.
SCOPE OF WORK

.2 Provide control panel, to include but not be limited to:
   .1 Schneider ScadaPack 357 c/w optional analog outputs.
   .2 Schneider ScadaPack I/O expansion module 5607 c/w optional analog outputs (qty 1)
   .3 Xetwave Single 900MHz Ethernet/Serial Radio Modem.
   .4 Schneider Magelis HMI 12” Colour, TFT, LCD
   .5 8 Port, 10/100/1000MB Industrial Ethernet Switch
   .6 Power On & General Alarm LED Pilot Light, general reset push button.
   .7 Panel block terminals, Wireway, DIN Rail, Relays and Panel wiring.
   .8 Termination of the CAT5E cables.
   .9 Termination of all signal wires.
   .10 Provision of 24VDC power supply.
   .11 Provision of 120VAC power.
   .12 Provision of 1500VA, 120Vac UPS System.
   .13 Panel CSA Testing and Certification, FAT and field SAT.
   .14 Panel approval shop drawings, As-built drawings and O&M Manuals.

.2 Eldorado Low Lift Booster Station

.1 Provide all instruments shown in the specifications and drawings, unless specifically noted as supplied by others, complete with required their installation & mounting supports and hardware. The instruments shall include but not be limited to:
   .1 TIT-210A1 - Electrical room Temp. Indication Transmitter
   .2 TIT-211A1 - Pump room Temp. Indication Transmitter
   .3 PIT-201B1 – PUMP 1 - Discharge Pressure Indicating Transmitter
   .4 PIT-202B1 – PUMP 2 - Discharge Pressure Indicating Transmitter
   .5 PIT-203B1 – PUMP 3 - Discharge Pressure Indicating Transmitter
SCOPE OF WORK

.2 Provide control panel, to include but not be limited to:

.1 Schneider ScadaPack 334 c/w optional analog outputs.

.2 Schneider ScadaPack I/O expansion module 5607 c/w optional analog outputs (qty 1)

.3 Schneider Magelis HMI 12" Colour, TFT, LCD

.4 8 Port, 10/100/1000MB Industrial Ethernet Switch, Fiber/Copper, Fiber to terminate with SC connectors.

.5 Power On & General Alarm LED Pilot Light, general reset push button.

.6 Panel block terminals, Wireway, DIN Rail, Relays and Panel wiring.

.7 Termination of the CAT5E cables.

.8 Termination of all signal wires.

.9 Provision of 24VDC power supply.

.10 Provision of 120VAC power.

.11 Installation of 6 Port Fiber Optic Termination Enclosure and termination of Fiber Optic Cables termination cassette(s) c/w SC connectors.

.12 Provision of 1500VA, 120Vac UPS System.

.13 Panel CSA Testing and Certification, FAT and field SAT.

.14 Panel approval shop drawings, As-built drawings and O&M Manuals

.3 Eldorado Water Reservoir

.1 Provide all instruments shown in the specifications and drawings, unless specifically noted as supplied by others, complete with required their installation & mounting supports and hardware. The instruments shall include but not be limited to:

.1 TIT-212A1 – Valves Rm.Temp. Indication Transmitter

.2 LIT-210A – Level in Tanks Indicating Transmitter C/W two U/S probes

.3 FIT-208A – Reservoir Discharge Flow Indicating Transmitter

.4 LSL-210C1/LSH-210B – TW Reservoir Cell 1 Level Switch Low / High
SCOPE OF WORK

1. Provide modifications to existing control panel, to include but not be limited to the following:
   1. Installation and Wiring of 8 Point Analog Input Module, Schneider 5501 Module (x2)
   2. Installation and Wiring of 4 Point Analog Output Module, Schneider 5502 Module.
   3. Installation and Wiring of Schneider 5404-120, 16 point, 120V Discrete Input Module
   4. Installation and Wiring of 10 Port Industrial Ethernet Switch c/w 2FO Ports.
   5. Installation of 8 Port Fiber Optic Termination Enclosure and termination of Fiber Optic Cables termination cassette(s) c/w SC connectors.
   6. Fiber/Copper Ethernet switch. Fiber to terminate with SC connectors.

2. Provide all instruments shown in the specifications and drawings, unless specifically noted as supplied by others, complete with required their installation & mounting supports and hardware. The instruments shall include but not be limited to:
   1. AIT-207A – Treated water reservoir residual chlorine analyzer (Cl. / pH / Temp.)
   2. FC-006A - 50PPD Ejector
   4. FCV-006A - 50PPD Chloromatic Control Valve
   5. FCV-006B - Chlorine Gas Vacuum 120Vac Shutoff Valve

5. The I/O are as listed in 17600.
.6 Provide control and power supply wiring between instruments and local control panels (as indicated in Instrument Index, the I/O list, P&ID drawings, local control panels layout drawings, Instrument Index and all other drawings and specifications).

.7 Provide as-built drawings and wiring diagrams for control panel.

.8 The Contractor shall setup, test, and commission all communication equipment and parameters. The Contractor shall allow for services of a qualified equipment representative to carry out setup and testing.

.9 Allow time in the tender price to work for one two additional days / site as directed by the Engineer to make any changes and adjustments.

.10 Allow in the tendered price sufficient time to test, adjust, demonstrate and troubleshoot the complete control system including all devices and wiring. The Contractor shall have a fully qualified and available Control technician(s) to work totally independent or with the installed equipment representative until a complete control system is commissioned and works reliably and trouble free. The technician must be available and dedicated to the commissioning during all the time of the commissioning.

.11 The Contractor shall be fully qualified and equipped to carry out the testing of all control and instrumentation equipment and systems or as an alternative, shall provide the services of a qualified manufacturer representative to carry out testing.

.12 The Contractor shall make provision for training applicable to the HMI application, software and system components.

.13 The Contractor shall assume full responsibility for protection and safekeeping of all equipment supplied.

.14 Preparation for Division 17 shop drawings to be submitted to the Engineer for review and approval.

.15 Allow in the tendered price for adequate time for on-site commissioning time for the programmers to complete the work. During that time, the programmers shall make changes to the application as directed by the Engineer provided this does not preclude the programmers from completing the original scope of work within the time allotted. The instrumentation and control technicians must be available at the site at the same time.

.16 Following completion of the plant operations testing, the General Contractor to rectify any outstanding deficiencies.
.17 The Contractor will also be required to provide Warranty Services Support during the maintenance period for the equipment applicable under its scope of responsibilities.

2. PRODUCTS

.1 Refer to all other Drawings and Specifications.

3. EXECUTION

.1 Refer to all other Drawings and Specifications.

END OF SECTION
1. GENERAL

1.1 Product Data

.1 Submit product data in accordance with Division 1 and Division 16.

1.2 Related Work

.1 Refer to Division 16.

1.3 Inspection

.1 Provide adequate notice to the Engineer so that all cable installations can be inspected prior to connecting equipment.

1.4 Standards

.1 All wire and cable shall be CSA approved.

2. PRODUCTS

2.1 Twisted Pair Shielded Cables (TPSH)

.1 TPSH shall be constructed as follows:

.1 2 copper conductors, stranded, minimum #18 AWG, PVC insulated, twisted in nominal intervals of 50 mm. Conductor identification to be by black and white coloured insulation.

.2 ACIC armored cables insulated for 600V, -40 °C to 105 °C (Dry) (75 °C Wet).

.3 100% coverage aluminum foil or tape shield.

.4 Separate bare stranded copper drain wire, minimum #18 AWG.

.5 Overall flame retardant PVC jacket to CSA-C22.2.

.6 Where multiconductor TPSH cables are called for, each pair shall be individually shielded, continuous number coded, and the cable assembly shall have an overall shield and overall flame retardant PVC jacket

.7 Metal armor is not required if cable installed in a dedicated conduit.

2.2 RTD and Multi Conductor Shielded Cable

.1 RTD cables shall be CSA approved and shall be constructed as follows:
1. 3 or more copper conductors, stranded, minimum #18 AWG.
2. PVC insulated for 600 V.
3. 100% coverage aluminum foil or tape shield.
4. Separate bare stranded copper drain wire.
5. Overall flame retardant PVC jacket to CSA-C22.2.

2.3 Teck Cables
.1 As per Section 16122.

2.4 Control Cables
.1 As per Section 16122.

2.5 Ethernet Network Cable
.1 CAT 6 Cable shall be CSA approved and shall be constructed as follows
   .1 Complies with TIA/EIA-568-B2 Cat 5E standards.
   .2 Twenty-four (24) gauge solid copper conductors
   .3 Minimum four (4) twisted pairs
   .4 Bandwidth 600 MHz
   .5 Type – Plenum Rated Cable.

2.6 Fiber Optic Riser Distribution Cable
.1 Provide fiber optic cables. Route cables using cable trays and underground conduits and ducts as indicated on the drawings.
.2 Indoor/outdoor rated, riser cable c(UL) CMR FT4
.3 Rated for minimum 1 Gbps
.4 Fiber Cables shall be Aluminum Interlocked armored.
.5 Compliance with the following standards IEC 60793, ISO/IEC 11801 and EIA/TIA 492 specifications.
.6 Fiber optic cable to be 12 strand, 50/125 µm, tight fiber, OFCR and FT4 rating that meet ANSI/EIA/TIA 568B.3 standards.
INSTRUMENTATION CABLE

.7 Colour-coded PVC buffers, black colour jacket.

.8 Fiber optic cabling to be marked with manufacturer’s name, sequential length, cable type and rating, strand count and cUL/CSA listing.

.9 Optimized for operation in the 850/1300 nm wavelength.

.10 Max Attenuation (dB/km): 3.5/1.0

.11 Multimode (OM3)

.12 Maximum backbone nominal cable length: 300 m @ 1Gps

.13 Physical Characteristics:

.1 Crush Resistance (EIA-455-41): 2000 N/cm

.2 Impact Resistance (EIA-455-25): 2000 Impacts @ 1.6 N-m

.3 Operating Temperature: -40 to +70 °C

.4 Minimum Bend Radius Installation: 20 X OD

.5 Minimum Bend Radius Long Term: 10 x OD

.14 Manufacturer and model: General Cable BE0121ANR-ILRA or Engineer approved equal

2.7 Wall Mounted Fiber Optic Patch Panels

.1 Fiber Patch Panels

.1 Locate in LCPs or as shown on the drawings

.2 The fiber patch panels shall be supplied with breakout kits, 1 meter pigtails and heat shrink fusion splices

.3 Each patch panel shall house minimum of two 6 SC duplex multimode adapter plates (OM3 50/125um), Leviton 5F100-2QC or Engineer approved equal.

.4 Dimensions shall be WxHxD= 410x311x90 mm

.5 Each fiber patch panel multimode adapter shall be labeled with the associated fiber cable tag number.

.6 Manufacturer and Model: Leviton 5W110-00N or engineer approved equal.

.2 Mini Fiber Patch Panels – installed when specifically noted on the drawings
.1 Locate in LCPs as shown on the drawings

.2 The fiber patch panels shall be supplied with breakout kits, 1 meter pigtails and heat shrink fusion splices

.3 Each patch panel shall house minimum of 6 SC duplex multimode adapters, Panduit CMSTIW

.4 Dimensions shall be WxHxD= 120x170x46 mm

.5 Manufacturer and Model: Panduit CBXF12IW-AY

3. EXECUTION

3.1 Analog Signals

.1 Use TPSH cable for all low level analog signals such as 4-20 mA, 1-5 VDC, 0-10 VDC, pulse type circuits 24 VDC and under, and other signals of a similar nature.

.2 Use RTD cable for connections between RTDs and transmitters.

3.2 Digital Signals

.1 Use TPSH cable for all low level input (24 V and below) and output signals to the plant control system.

.2 For discrete and device wiring use #14 THWN wires. Color code shall be:

   .1 White   120 VAC neutral
   .2 Black   120 VAC hot
   .3 Red     24 VDC positive
   .4 Blue    24 VDC negative
   .5 Orange  Discrete Inputs
   .6 Yellow  Discrete Outputs
   .7 Brown   All other wires
   .8 Green   Ground

.3 Use Teck cable or wire and conduit or barrier cable tray for power to instruments, for 120 V signals other than those mentioned above and as otherwise indicated on the drawings. Use stranded wire and cable to supply power to instruments.
3.3 Installation

1. Install all instrumentation cables in conduit systems or in cable trays. Use a minimum of 300 mm length of liquid tight flexible conduit to connect the field sensors to the conduit. Refer to Division 16 conduit or cable tray requirements.

2. All non-armoured instrumentation cables shall be installed in dedicated conduits, dedicated cable trays or when installed in non-dedicated cable trays, provide barriers in the tray to separate instrumentation cables from power cables.

3. At each end of the run leave sufficient cable length for termination.

4. Do not make splices in any of the instrumentation cable runs. Where splices are required, obtain approval from the Engineer prior to installing the cable. Do not splice cables to gas detection heads.

5. Where splices are necessary in instrumentation cables other than coaxial cables, perform such splices on terminal blocks in terminal boxes. Keep splices in instrumentation cable to a minimum and separated physically from power circuits. Cable shields shall be terminated on insulated terminals and carried through to the extent of the cable.

6. Ground cable shields at one end only. Unless otherwise specified, ground the shields at the marshalling panel.

7. Protect all conductors against moisture during and after installation.

8. Ground cable shields at one end only, unless otherwise specified by the equipment supplier.

9. Protect all conductors against moisture during and after installation.

10. Terminate armour with approved connector.

3.4 Conductor Terminations

1. All equipment supplied shall be equipped with terminal blocks to accept conductor connections.

2. Instrumentation conductors, where terminated at equipment terminals other than clamping type terminal blocks, shall be equipped with Burndy-YAE-2 or STA-KON, self-insulated, locking type terminators, sized as required to fit conductors and screw terminals.
3.5 Testing

.1 Test all conductors for opens, shorts, or grounds. Resistance values shall not be less than those recommended by the cable manufacturer.

3.6 Identification

.1 Identify all instrumentation cables and wires.

.2 Identify each conductor with wire numbers using a machine printed heat shrink wire marker, similar to Raychem TMS or equivalent.

END OF SECTION
1. **GENERAL**

1.1 **Description**

.1 The Work includes the provision of miscellaneous instrumentation.

.2 Refer to Section 17010 and 16010 for general electrical, instrumentation and control requirements.

1.2 **General**

.1 Use normally open contacts for alarm actuation which close to initiate the alarm.

.2 Use normally open contact outputs to control equipment. The contacts close to start the equipment.

.3 For contacts monitored by solid state equipment, such as programmable controllers or annunciators, hermetically seal and design for switching currents from 20 to 100 mA at 24 VDC.

.4 For contacts monitored by electromagnetic devices, such as mechanical relays, rate NEMA ICS 2, designation B300.

.5 Provide double barriers between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.

.6 Use switch electrical enclosures that are rated NEMA 4X as a minimum.

.7 Make all contacts in Class 1, Division 1 and 2 areas monitored by solid-state circuits safe by suitable intrinsic safety barriers or relays.

.8 Where required, use 120 VAC switches that have a 3 A rating.

2. **PRODUCTS**

2.1 **Selector Switch**

.1 2 or 3 position maintained, unless indicated spring return, as per Drawings and Specifications

.2 Mounting hole size 30.5 mm with standard knob, front enclosure EEMAC4 with front panel mounting ring mounting method.

.3 One million mechanical cycles.

.4 Legend with legend as indicated on drawings and specifications.
MISCELLANEOUS INSTRUMENTATION

.5 Each position to have minimum two sets of N.O. contacts rated at 10 A at 120 VAC.

.6 Approvals: CSA

.7 Approved manufacturer Allen Bradley Bulletin 800T or Engineer approved equal.

2.2 Pilot Lights

.1 Cap colour as per drawings and specifications.

.2 Mounting hole size 30.5 mm with standard knob, front enclosure CEMA4 with front panel mounting ring mounting method.

.3 LED type, voltage rating as per drawings and specifications.

.4 Legend plate with legend as indicated on drawings and specifications.

.5 Push to test type.

.6 Approval: CSA

.7 Approved manufacturer Allen Bradley Bulletin 800T or Engineer approved equal.

2.3 Push Buttons

.1 Flush head unit.

.2 Mounting hole size 30.5 mm with standard knob, front enclosure CEMA4 with front panel mounting ring mounting method.

.3 250,000 mechanical cycles.

.4 Legend plate with legend as indicated on drawings and specifications.

.5 Each position to have minimum of three sets of N.O. contacts rated at 120 VAC.

.6 Approval: CSA

.7 Approved manufacturer Allen Bradley Bulletin 800T or Engineer approved equal.

2.4 Circuit Breakers in Control Panels

.1 Finger safe design.

.2 A positively trip-free mechanism (breaker cannot be defeated by holding the handle in ON position).

.3 Mounts on DIN rail.
MISCELLANEOUS INSTRUMENTATION

.4 Tripping Characteristics: Type C.
.5 Maximum voltage: 240 VAC
.6 Electromechanical life: 6000 operations (1 operation = 2 switching events ON/OFF).
.7 Interrupt Rating: 1 pole 10 kA @240 VAC
.8 Approval: CSA
.9 Approved manufacture: Omron LY4N or Omron MY4N or Engineer approved equal.

2.5 General Purpose Relays

.1 4DPDT AgCdO contacts, rated 10 A @ 120 VAC
.2 Coil Voltage as required (24 VDC, 24 VAC, 120 VAC)
.3 Plug-in Quick Connect Solder Terminals
.4 DIN Rail mounted bas with screw terminals.
.5 LED or mechanical relay status indication.
.6 Life expectancy: 250,000 cycles
.7 Approved manufacturer Allen Bradley Bulletin 1492-SPU or Engineer approved equal.

2.6 Mag Flowmeters Interposing Relays

.1 Solid State Relay
.2 Load Voltage: 120 VAC
.3 Control (Input) Voltage: 24 VDC
.4 DIN Rail mounted bas with screw terminals.
.5 LED relay status indication.
.6 Life expectancy: 200,000 energized hours.
.7 Approvals: CSA
.8 Approved manufacturer Allen Bradley Bulletin 700-SK or Engineer approved equal.
2.7  **PLC Digital Output Interposing Relays**

.1  1SPDT contact

.2  Contact Voltage: 24 VDC, 120 VAC

.3  Control (Input) Voltage: 24 VDC

.4  DIN Rail mounted.

.5  LED or mechanical relay status indication.

.6  Approvals: CSA

.7  Approved manufacturer Phoenix Contact – type ART-NR.2961105

2.8  **E-Stop Switch**

.1  Push – Pull and Twist to release.

.2  Two positions

.3  Non illuminated.

.4  Additional contacts: 3 N.O. and 3 N.C. (3 x Allen Bradley 800T-XA)

.5  Built-in contacts: 1 N.O. and 1 N.C.

.6  CSA Approved

.7  Model: Allen Bradley 800T-FXT6A1 or Engineer approved equal

2.9  **Position Switch – Door Contact**

.1  Mechanical Protection: IP67.

.2  Accessories: Lever arm or as required by the application.

.3  Built-in contacts: 1 N.O. and 1 N.C.

.4  CSA Approved

.5  Model: Siemens 3SE2, Schneider 9007C or Engineer approved equal

2.10  **Key Switch**

.1  Two position – maintained with 2 N.O. contacts.

.2  CSA Approved
2.11 Occupancy Sensor

All occupancy sensors shall be hardwired type; battery type shall not be permitted

.1 The sensor shall use passive infrared technology. The unit shall fit in/on a standard single gang switch box.

.2 Rated capacity 600 watts minimum at 120 VAC

.3 Sensitivity shall be adjustable

.4 The sensor shall have a test mode for performance testing.

.5 Test LED shall indicate motion

.6 The area of coverage shall be approximately 180 degrees by 6 m.

2.12 Photoelectric Smoke Detector

All smoke detectors shall be hardwired type;

.1 Four Wire c/w Sounder

.2 Included protection against false/nuisance alarms caused by dust, RF and ambient light.

.3 LED indication

.4 Power supply: 24VDC

.5 Alarm contact 0.5 Amp @30VDC

.6 Heat detector with fixed threshold at 57.2°C

.7 cUL rated

.8 Manufacturer and Model: GE-ESL 500N Series

3. EXECUTION

3.1 Installation

.1 Locate and wire as indicated on the drawings.

END OF SECTION
1. **GENERAL**

1.1 **Work Included**

.1 All powered actuators, electro-pneumatic positioners and/or digital valve controllers shall be supplied together with mechanical equipment (e.g. valves, gates etc.) by the mechanical equipment suppliers under Division 15.

.2 All sizing and selection of modulating and on/off actuators and control valve components shall be undertaken by the mechanical equipment supplier under Division 15.

.3 Sizing and matching of all powered actuators to controlled devices shall be undertaken by the mechanical equipment supplier(s) under Division 15 and coordinate with the work specified herein.

.4 Valve/gate supplier shall supply appropriate air sets for each pneumatic actuator.

.5 Provide control wiring for the actuators, electro-pneumatic positioners and digital valve controllers.

.6 Setup parameters & test all electrical and pneumatic powered actuators, electro-pneumatic positioners, digital valve controllers and accessories.

1.2 **Related Work**

.1 Process Piping: Division 15.

.2 Process Valves: Section 15105

.3 Detailed Valve Specification Sheets: Division 15.

.4 P&ID Drawings.

.5 Controls and Instrumentation: Sections 17010, 17123, 17701 and 17702.

1.3 **Submittals for Review**

.1 Submittals in accordance with Division 1 and Section 17010.

.2 Furnish shop drawings for complete actuator assemblies and accessories prior to delivery.

.3 Provide calculations for sizing, noise, cavitation and actuator torque calculations, etc., in addition to the requirements of other Divisions.

.4 Submit a completed ISA S20.50 Instrument Specification Sheet for each device.

1.4 **Submittals For Information Only**
.1 Submit the following in addition to the requirements of Division 1 and Section 17010:

.2 Factory calibration and testing reports. Handwritten reports not to be accepted.

.3 Operations and maintenance manuals in accordance with Division 11.

1.5 Service Conditions

.1 Provide electrical enclosures rated for the area classification. Refer to Division 16 for classification of plant areas.

.2 Refer to Section 17010 for additional details.

1.6 Shipment, Protection and Storage

.1 Ship and store equipment in accordance with Division 1 and Section 17010.

1.7 Delivery and Storage

.1 Deliver valves and actuators to site use loading methods, which do not damage casings or coatings.

.2 Clearly tag all control valves and actuators, stating size, type, coatings and mating parts.

.3 When stored on site use storage methods recommended by the manufacturer to prevent damage, undue stresses, or weatherproofing.

1.8 Process Valve and Actuator Schedules

.1 Refer to the drawings for valve and actuator identification. Power actuated devices, which require automation, as shown on the P&ID’s. Actuators and all ancillary instrumentation are as specified under Division 17. The device material specifications are found under Division 15.

.2 Actuator type abbreviations are referenced in Divisions 11 and 15.

1.9 Coordination

.1 The valve and gate suppliers are to provide verification that the control actuators are compatible with their valves and gates and are correctly sized.

.2 The valve supplier is responsible for mating the actuator to the valve. Valve manufacturer is responsible for providing all actuator mounting hardware such are flanges, mounting bolts, actuator stem & nut etc.

.3 The gate supplier is responsible for mating the actuator to the gate. Gate manufacturer is responsible for providing actuator mounting flange. Refer to Section 11202 for requirements for gates and gate actuators.
POWERED ACTUATORS

2. PRODUCTS

2.1 General

.1 Provide new material only.

.2 Division 15 supplier shall also provide all actuator mounting hardware and accessories mounted on the device prior to shipment.

.3 Unless otherwise noted all actuators, positioners and discrete valve controllers shall be of EEMAC 4X construction, suitable for use in an industrial environment.

.4 Tag the control devices, accessories and actuators to indicate operating characteristics. Tag the actuator inlet and outlet ports for electric or pneumatic services. Electric actuators must be CSA approved.

.5 Provide a remote hardwired hand switch for all On/off pneumatic valves and gates with 3 position functionality 'R/O/C' where; 'R' position (Remote Mode) allows the Plant Control System control over the valve position, 'O' position (Manual Open) drives the valve to the Open position and 'C' position (Manual Close) drives the valve to the Closed position.

.6 All actuators shall be Rotork.

2.2 Actuator Types

.1 Electro-Mechanical Actuators, General

.1 Provide electric actuators of type shown on the P&IDs.

.2 Unless noted otherwise, the actuator will fail to the last position when the control function or power fails.

.3 Unless otherwise specified, electric actuators to be 208VAC 3 ph/60 Hz for service. Provide each actuator with a high torque, reversible motor which is capable of continuous duty over the full operating range.

.2 Electric Quarter Turn Actuators, Open/Close Type (EMQO) and Modulating Type (EMQM)

.1 Provide electric operators suitable for mounting on quarter turn valves or dampers intended for on/off and modulating service.

.2 Provide each actuator with built-in motor overload protection.

.3 Fit each actuator with a hand wheel, which will enable manual override control of the valve.
POWERED ACTUATORS

.4 Each actuator to be capable of operating in any horizontal or vertical orientation.

.5 Provide external mechanical indication of valve position. Provide an external visual position indicator for each positioner.

.6 House internal components in an EEMAC 4 enclosure, moisture-resistant and corrosion-resistant. Internal components to be permanently lubricated.

.7 Motors will be rated at twenty (20%) percent intermittent duty cycle.

.8 Provide adjustable mechanical limit stops to ensure over-turning of the valve does not occur.

.9 Protect exterior mounted actuators against low temperature and condensation.

.10 The actuator speed will be field adjustable.

.11 Provide a terminal board for field wiring. Include contacts to indicate the open/closed status of the valve.

.12 The actuator shall have the following I/O signals:

.1 Position control: 4-20mA

.2 Position indication: 4-20mA

.3 OCR switch in Remote position: 120VAC rated dry contact

.4 Valve Opened: 120VAC rated dry contact

.5 Valve Closed: 120VAC rated dry contact

.6 Valve Failed: 120VAC rated dry contact

.13 Actuator shall be Rotork IQ or EIM TEC2000 series suitable for 60 starts per hour.

3. EXECUTION

3.1 Preparation

.1 Prior to installation of the valve and/or gate actuators, field measure and check all equipment locations, pipe alignments, and structural installations. Ensure that sufficient space and accessibility is available for pneumatic and electric actuators.

.2 Where conflicts are identified, inform the Engineer and initiate the necessary modifications at no cost to the Owner.
3.2 **Installation**

.1 Install actuators, related panels, and the interconnecting air tubing and wiring as shown in the drawings, and as recommended by the manufacturer.

.2 Install control valves as described in Division 15.

3.3 **Field Testing and Commissioning**

.1 Factory test each actuator assembly prior to shipment.

.2 The manufacturer's representative will be required to commission the powered actuators to verify the installation, setup all parameters and make final travel limits and torque adjustments.

3.4 **Training**

.1 Provide training in accordance with Division 1.

**END OF SECTION**
1. GENERAL

1.1 Standards of Conformance


.2 ISA Standard -S20: Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.

.3 Underwriter Laboratories, UL508, Standards for Industrial Control Equipment.

.4 National Electrical Manufacturers Association (NEMA), Pub. No. ICS-6, enclosures for industrial controls and systems.

.5 Canadian Standards Association (CSA).

.6 Approvals

.1 Factory Mutual (FM) approval for explosion proof and intrinsic safety I5.

.2 Canadian Standards Association (CSA) approval for explosion proof and intrinsic safety C6.

1.2 General Instrumentation Requirements

.1 Provide instruments with conformably coated printed circuit boards if available from the listed manufacturers in order to prevent damage by dust, moisture, fungus and airborne contaminants.

.2 Provide instruments complete with mounting hardware, floor stands, wall brackets or instrument racks as required by the manufacturer.

.3 Provide instrument enclosures NEMA/EEMAC rated for the environment. In hazardous areas, meet the Area and zone rating as shown or specified. In areas subject to flooding, provide submergence rated enclosures. Enclosures in process areas a minimum of NEMA 4X.

1.3 Submittals

.1 Comply with the provisions and requirements of Sections 17010 and 01330.

.2 Submit the following for each model instrument provided:

.1 Manufacturer’s design and performance specification data and descriptive literature.

.2 Equipment dimensioning and installation requirements and recommendations.
.3 Required and optional accessories lists.

.4 Electrical signal and power connection diagrams.

.5 Operation and maintenance documentation for each type instrument after product approval.

.6 Calibration certifications from the manufacturer for each calibrated instrument.

.7 List of recommended spare parts and spare parts to be provided.

.8 List of optional accessories.

.3 Submit the following for each instrument provided:

.1 Tag number and description.

.2 Complete model number.

.3 Instrument Data Sheets (ISA Standard -S20) with all fields completed.

.4 Catalog literature edited to indicate specific items provided.

.5 Mounting details for all typical installation requirements and special details for non-typical applications.

.6 Methods and materials required for installation. Include power and signal connection details.

.7 Other specific submittal information as specified in the particular instrument specification.

1.4 Quality Assurance

.1 Provide instrumentation of rugged construction designed for the site conditions. Provide only new, standard, first-grade materials throughout, conforming to standards established by Underwriter’s Laboratories (UL), Inc., CSA approved and so marked or labeled, together with manufacturer’s brand or trademark.

.2 Provide material and equipment in accordance with applicable codes and standards, except as modified by the specifications.

.3 Use single source manufacturer for each instrument type. Use the same manufacturer for different instrument types whenever possible.

.4 Coordinate instrumentation to assure proper interface and system integration. Provide signal processing equipment, to include, but not be limited to, process sensing and measurement, transducers, signal converters, conditioners, transmitters, receivers and power supplies.
1.5 Delivery, Storage, and Handling

.1 Provide and securely attach the tag number and instructions for proper field handling and installation to each instrument prior to packaging.

.2 Package instrumentation to provide protection against shipping damage, dust, moisture and atmospheric contaminants.

.3 Include a shipping label which contains the following information:

.1 Tag number and description.

.2 Instructions for unloading, transporting, storing and handling at the site.

2. PRODUCTS

2.1 Instruments

.1 Provide instrumentation as required and specified in Instrument Specification Sheets (ISSs) in Section 17701 to provide fully functioning Instrumentation and Control system.

.2 In general, alarm contacts close to alarm. Normally closed contacts that open on detection of the alarm condition or loss of power are only required for high priority critical or safety shutdown alarms.

.3 All Profibus instruments shall be supplied with the latest version of GSD and DTM files.

.4 Provide all additional data communication hardware and software required to configure, test and commission all Ethernet (Modbus TCP) devices.

2.2 Instrument Manufacturers

.1 Provide instruments from the manufacturers listed in Instrument Specification Sheets (ISSs) in Section 17701.

2.3 Setup, Startup and Commissioning

.1 Setup, test, startup and commission all instruments.

.2 The contractor shall allow for services of a qualified equipment representative to carry out setup and testing of all instruments.
3. EXECUTION

3.1 Installation

.1 Install instruments as indicated on the drawings & specifications and instrument installation & user manuals.

.2 Install, setup, calibrate and commission all instruments.

.3 All instruments supplied shall be setup, calibrated and tested by a qualified equipment representative.

END OF SECTION
1. GENERAL

1.1 References - General

1. Refer To Section 17010.

1.2 PLC/Input Output (IO) Index

1 The following is the PLC/Input Output itemized lists included as part of this Work.

2 The I/O lists below may not show all required inputs and outputs. The contractor shall verify the exact number of I/O points from all drawings and specifications.

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### P&ID Designation: Analogue Output

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(I/O expansion for Treated Water Reservoir)

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2. PRODUCTS

.1 Provide RTU components as indicated above.

3. EXECUTION

.1 Provide all cables & wires and associated cable ducts, wire-ways, cable trays and conduits to connect field instruments, motor starters equipment and other devices to the associated I/Os in the tables above.

.2 All Inputs and Outputs may not be shown at the tables above. The contractor shall do a complete take-off from all drawings and specifications for the accurate I/O list.

END OF SECTION
# Instrument Index

**Eldorado Treated Water Reservoir & Glenmore Booster Station**

**Lake Country, British Columbia**

## INSTRUMENT INDEX

**District of Lake Country**

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**SUPPLY CODES:**
- C - Contractor
- O - Owner, P-Part of Package

**SUPPLY FROM:**
- JE-1106
- JE-1106A
- JE-1106B

**Dwg**
- P-200
- P-300
- P-201

**Sheet**
- F-1

**Remarks**
- E-202
- E-303

**Power Supply From**
- CP-1
- CP-120

**Date:** 27/03/2017
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Instrument Index
SUPPLY CODES: C-Contractor, O - Owner, P-Part of Package
27/03/2017
1. GENERAL

1.1 Description

.1 The Work includes the provision of all instrument specification sheets.

.2 Refer to Section 17010 for general instrumentation and control requirements related to instrument specification sheets.

1.2 Instrument Specification Sheets

.1 Provide data sheets to itemize detailed information regarding the specification of instruments included as part of this work.

.2 Use forms in accordance with ISA Standard S20 as a template for the preparation of the specification sheets.

.3 Instrumentation Specification Sheets are enclosed after this page.

2. PRODUCTS

.1 Not Applicable.

3. EXECUTION

.1 Not Applicable.

END OF SECTION
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### District of Lake Country

#### Eldorado Treated Water Reservoir & Glenmore Booster Station

**Lake Country, British Columbia**

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1. **MANUFACTURER**: E + H
2. **MODEL NO.**: MEMNOSENS pH & Temp Sensor
3. **TYPE**: Orbisint CPS11D
4. **SERVICE**: WATER
5. **TAG No.'S.**: As per Instrument Index
6. **SENSOR**: Glass Electrode
7. **RANGE**: 1 to 14
8. **PROCESS DATA**: Drinking water
9. **CONNECTION**: 1/4" FNPT
10. **MATERIAL**: Vender Wetted
11. **MOUNTING**: Wall
12. **FLOWRATE**: 0 or 100 mL/min
13. **MAX PRESSURE**: 827 kPa (120 psi)
14. **TEMPERATURE**: 0 to 50 °C
15. **AREA CLASSIFICATION**: General Purpose
16. **SIGNAL CABLE LENGTH**: n/a
17. **APPROVALS REQUIRED**: CSA, ANSI 61
18. **CABLE LENGTH**: 5 m
19. **TAG No.**: AIT-133A
20. **MODEL No.:** LIQUILINE CM444
21. **TYPE**: Wall / Braket
22. **OUTPUT / COMM BUS**: multichannel 4-20mA
23. **RELAY CONTACTS**: SPDT
24. **INPUT METHOD**: Facia Mounted Keypad
25. **INDICATOR**: Multi line LED Display
26. **ENG UNITS**: 0-14 pH / 0-50 °C TEMP.
27. **HOUSING**: metal/plastic/polycarbonate housing
28. **ACCUACY**: +/- 2% of reading or 0.5 pH whichever is greater
29. **POWER SUPPLY**: 110VAC @ 60 Hz
30. **ENCLOSURE**: NEMA 4X
31. **MOUNTING**: Wall
32. **AREA CLASSIFICATION**: General purpose
33. **APPROVALS REQUIRED**: CSA, EPA 180.1
34. **TAGGING**: Each sensor to be c/w a SS tag number
35. **ALTERNATES**: HACH, ABB
36. **PROCUREMENT**: FLOWFIT Flowcell Assembly
37. **Sample Flow Rotameter**
38. **ACCESSORIES**: Installation, Operation and Maintenance Manual
### Eldorado Treated Water Reservoir & Glenmore Booster Station

#### Lake Country, British Columbia

**TRANSMITTER**

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**NOTES**

- Each sensor to be c/w a SS tag number
- HACH, ABB
- Flowcell CCA250
- Sample Flow Rotameter

**ACCESSORIES**

- Installation, Operation and Maintenance Manual
### District of Lake Country

**Eldorado Treated Water Reservoir & Glenmore Booster Station**  
Lake Country, British Columbia

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<th>TAG No.</th>
<th>COMMUNICATION</th>
<th>POSITION LIMIT SIGNALS</th>
<th>FAIL ACTION</th>
<th>MANUAL CONTROL</th>
<th>INDICATOR</th>
<th>REMOTE INTERFACE MODULE REQ'D</th>
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<th>RANGE</th>
<th>ACTUATOR FITTING TYPE</th>
<th>POWER SUPPLY</th>
<th>ENCLOSURE</th>
<th>TEMPERATURE RATING</th>
<th>AREA CLASSIFICATION</th>
<th>APPROVALS REQUIRED</th>
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<th>VALVE TYPE</th>
<th>VALVE SERVICE</th>
<th>VALVE SIZE</th>
<th>REQ'D TORQUE</th>
<th>PROCUREMENT</th>
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<td>1</td>
<td>Rotork</td>
<td>IQ</td>
<td>Modulating Part turn 90° electrical actuator</td>
<td>FX-#### (REFER TO P&amp;ID DRAWINGS)</td>
<td>n/a</td>
<td>Adjustable through 100% of range, N/C, open at limit</td>
<td>As indicated on P&amp;IDs, or last position if not indicated</td>
<td>Facia Mounted Controls, Clutch, Handwheel</td>
<td>LCD display, (position, control &amp; fault status)</td>
<td>Yes</td>
<td>N/A</td>
<td>N/A</td>
<td>Direct Mount</td>
<td>208VAC, 1ph, 60Hz</td>
<td>EEMAC 4X</td>
<td>-40 to +40 deg C</td>
<td>NON-CLASSIFIED</td>
<td>CSA</td>
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<td>Bracket and Drive Nut</td>
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<td>POSITION SWITCHES</td>
<td>2 X NO &amp; NC contacts rated 2A, 250 Vac</td>
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<td>NEMA 4/4X</td>
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### District of Lake Country
Eldorado Treated Water Reservoir & Glenmore Booster Station
Lake Country, British Columbia

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#### 1. MANUFACTURER
Endress+Hauser

#### 2. MODEL No.
Promag 50W

#### 3. TYPE
Magnetic Flowmeter

#### 6. TAG No.
See Instrument Index

#### 7. SERVICE
See Instrument Index

#### 8. LINE SIZE
See Instrument Index

#### 9. METER SIZE
As per Index

#### 10. CONNECTION TYPE RATING
Flanged 150 lb. / IP68

#### 12. LINING MATERIAL
Suitable for Drinking Water (AWWA Class D)

#### 13. ELECTRODE DESIGN
Bullet Nosed

#### 14. ELECTRODE MATERIAL
316 SS

#### 15. AREA CLASSIFICATION
General Classification

#### 16. FINISH
Standard Enamel

#### 17. GROUNDING RINGS
316 SS

#### 18. ULTRASONIC CLEANER
No

#### 19. POWER SUPPLY
120 VAC / 60 Hz

#### 20. SIGNAL CABLE LENGTH (METERS)
As required (min 20M)

#### 21. APPROVALS REQUIRED
CSA

#### 22. TAG No.
See Instrument Index

#### 23. MOUNTING
Remote - Wall (surface mount)

#### 24. COMMUNICATION
Standard 4-20mA Hart

#### 25. INDICATOR TYPE RANGE
LCD Engineering Units

#### 26. ENGINEERING UNITS RANGE
See Instrument Index See Instrument Index

#### 27. MAX VELOCITY
10 m/s

#### 28. TOTALIZER PULSE OUTPUT
Through standard 4-20mA Hart

#### 29. AREA CLASSIFICATION
General Classification

#### 30. FAST-CONNECT
M12 x 1 Fast Connect - Male Receptacle

#### 31. POWER SUPPLY
120VAC / 60 Hz

#### 32. APPROVALS REQUIRED
CSA

#### 33. INPUT / OUTPUT SIGNALS

#### 34. ENCLOSURE
EEMAC 4

#### 37. PROCUREMENT
Transmitter, Flow element, signal cable

#### 38. NOTES ALTERNATES
fast connecte receptacle Krohne, ABB, Siemens

#### 41. TAGGING
Each Flowmeter transmitter and flow element c/w a SS tag number
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**E 1. MANUFACTURER**
Endress+Hauser

**E 2. MODEL No.**
Prosonic 91W

**E 3. TYPE**
Clamp-on Ultrasonic Flowmeter

**E 6. TAG No.**
FE-208A

**E 7. SERVICE**
Treated Water

**E 8. LINE SIZE**
750mm

**E 9. METER SIZE**
Vendor to Advise

**E 10. CONNECTION TYPE**
straps

**E 11. TEST KITS AND FILTERS**

**E 12. MEASUREMENT RANGE**
0 - 10 m/sec.

**E 13. FLOWRATE**
tbd

**E 14. MAX PRESSURE**

**E 15. TEMPERATURE**
−20 to +80 °C

**E 16. AREA CLASSIFICATION**
General Classification

**E 17. ENCLOSURE / PROTECTION**
NEMA 6P / IP68 for strap-on probes

**E 19. POWER SUPPLY**
120 VAC / 60 Hz

**E 20. SIGNAL CABLE LENGTH (METERS)**
As required (min 25M)

**E 21. APPROVALS REQUIRED**
CSA

**E 22. TAG No.**
See Instrument Index

**E 23. MOUNTING**
Remote - Wall Mount

**E 24. COMMUNICATION**
Standard 4-20mA Hart

**E 25. INDICATOR TYPE RANGE**
LCD Engineering Units

**E 26. ENGINEERING UNITS RANGE**
See Instrument Index See Instrument Index

**E 27. MAX VELOCITY**
10 m/s

**E 28. TOTALIZER PULSE OUTPUT**
Through standard 4-20mA Hart

**E 29. AREA CLASSIFICATION**
See Instrument Index

**E 30. FAST-CONNECT**
M12 x 1 Fast Connect - Male Receptacle

**E 31. POWER SUPPLY**
120VAC / 60 Hz

**E 32. APPROVALS REQUIRED**
CSA

**E 33. INPUT / OUTPUT SIGNALS**

**E 34. ENCLOSURE**
EEMAC 4 or Explosion Proof

**N 37. PROCUREMENT**
Transmitter, U/s Probes, signal cable

**N 38. ALTERNATES**
siemens, GE

**N 41. TAGGING**
Each Flowmeter transmitter and flow element c/w a
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**Manufacturer:** Siemens - Milltronics

**Model:** Multiranger 200 HMI

**Vessel Type:** Tank

**Vessel Material:** Concrete

**AGITATION (Y or N):** See P&IDs

**Cable Type Length:** 2 Wire TPSPH 100 feet

**Sensor Tag No.:** See Instrument Index

**Model No.:** XPS-15

**Connection Type Rating:** See Instrument Index

**Material Sensor Coating:** See Instrument Index

**Area Classification:** See Instrument Index

**Transmitter Tag No.:** See Instrument Index

**Output Signal:** 4 to 20 mA DC (750 OHM Max.)

**Required Supply Voltage:** 120VAC

**Enclosure Rating Material:** NEMA 4X, Manufacturer's Std

**Local Display:** Multiple Lines

**Area Classification:** See Instrument Index

**Accuracy:** 0.01

**Ambient Temp Rating (Deg. F):** 0 to +80

**Number of Measuring Points:** One, unless otherwise specifically noted

**Adj. Span (cm):** Six 120VAC Relays, 4 control and 2 alarm

**Press (kPa):** Atmospheric

**Temp (Deg. F):** 0 - 75

**Specific Gravity:** 1 kg/l

**Viscosity (cp):** 0 - 50 Deg.C

**Approvals Required:** CSA or cUL

**Procurement:** Sensors (X2), Transmitter, programming unit, signal cable, sensor mounting bracket

**Alternates:** E + H Prosonic

**Tagging:** Each transmitter to be c/w a SS tag number
## Float Level Switch

### District of Lake Country
**Eldorado Treated Water Reservoir & Glenmore Booster Station**

**Lake Country, British Columbia**

### Design by: KSB
### Drawn by: KSB
### Project No.: 60488627
### Date: March 2017

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### Manufacturer
- **Xylem**

### Model Number
- **ENM10**

### TAG No.
- **LSH-050**

### Actuation
- Normally Closed on normal Level

### Switch Mounting

### Switch Operating Temperature

### Test Kits and Filters

### Output

### Enclosure Material
- Polycarbonate

### Enclosure Rating

### Electrical Connections

### Cable Length

### Service

### Area Classification
- NON-CLASSIFIED, SUITABLE FOR DRINKING WATER

### Approvals Required
- CSA or cUL

### Notes
- **Procurement**: Float level switch, junction box, mounting bracket or fixture,
- **Alternates**: Magnelrol, Dwyer
- **Tagging**: Provide SS Tag for each instrument

---

### Special Notes
- **Notes**: Provide SS Tag for each instrument
**District of Lake Country**

**Eldorado Treated Water Reservoir & Glenmore Booster Station**

Lake Country, British Columbia

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<td>Gauge plus valve and diaphragm as required</td>
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Date: 3/27/2017

File: 17701-ISS_IFC.xls
## District of Lake Country

**Eldorado Treated Water Reservoir & Glenmore Booster Station**

Lake Country, British Columbia

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1. GENERAL

1.1 Description

.1 The Work includes the provision of all necessary testing, instrument calibration, and installation verification, for each system and piece of equipment complete with written reports prior to system completion. After system completion (or part thereof), the Contractor shall commence commissioning and start-up activities as specified in Section 17810.

.2 Conform to the general requirements of Section 01650 regarding testing of the instrumentation and control equipment and coordinate instrumentation and control work to facilitate testing of other equipment.

.3 Refer to Section 17010 for general instrumentation and control requirements related to testing, calibration, and installation verification.

.4 Refer to Sections 16970 and 16980 for additional information and requirements.

2. PRODUCTS

Not applicable.

3. EXECUTION

3.1 Testing

.1 Prior to the completion of the Work, perform comprehensive testing of the installation. Include the following activities:

.1 Pressure testing of all pneumatic piping systems

.2 Wire insulation tests

.3 Wire continuity tests including associated terminations

.4 Grounding system continuity and isolation tests

.5 Any other testing necessary to verify the operation of equipment and installation work

.2 Provide the services of a manufacturer’s representative for equipment to assist with any of the equipment tests to be performed. Any components, incorrect wiring, or
systems found to be defective or deficient during the tests shall be repaired or replaced.

.3 Coordinate test schedules with the Engineer.

.4 The participation in testing activities and use of the equipment during testing periods by the Owner is allowed provided it does not adversely affect specified testing requirements. Such participation shall not relieve the Contractor of any of the obligations stipulated herein.

.5 Prior to the commencement of any testing, the Contractor shall ensure that all spare parts, expendables, and test equipment pertinent to the system being tested are on site. Test equipment shall include all necessary multi-meters, process instrument calibrators for 4-20 mA, 24 VDC devices and signal generators or simulators. Test equipment shall be provided by the Contractor and shall remain the property of the Contractor at the end of all testing.

3.2 Calibration

.1 In situ, calibrate and adjust all instrumentation to verify correct operation, range adjustment, compensation, scaling, etc. Provide instrument calibration services for all individual components such as signal transmitters, analyzers, transducers, power supplies, and like equipment where appropriate.

.2 Provide certified calibration reports for each instrument. In the reports, include, but do not limit to, such information as:

.1 Device tag number

.2 Equipment description

.3 Service application

.4 Process variable measurement range

.5 Description of calibration equipment used

.6 “As found” calibration data

.7 “As left” calibration data

.8 Date, name, and signature of technician

.3 Include calibration reports in the operating and maintenance manuals described in Section 01735.
3.3 Installation Verification

.1 When the system installation has been completed (or part thereof), perform detailed verification checks for all systems supplied and installed as part of the Work. In the checks and reviews, include the following:

.1 Certify that the equipment has been installed as per the Contract drawings and recommended installation procedures, reporting any discrepancies to the Engineer.

.2 Certify that the equipment power and grounding requirements have been satisfied, reporting any discrepancies to the Engineer. For the grounding system, include an itemized check of each instrument circuit to verify the correct isolation of all shields and instrument grounds.

.3 Certify that all terminations to the equipment are properly installed. Report any discrepancies to the Engineer.

.4 Certify that all wiring continuity (whether new or existing) has been verified.

.5 Certify that all pneumatic signal tubing and components have been leak tested and are leak free.

.6 Certify that all process taps and instrument connections have been performed according to the requirements detailed herein and shown on the drawings.

.7 Certify that the installation (or part thereof as completed) is ready for commissioning and start-up.

.8 Witnessed Functional Acceptance Test shall be done on the complete control system. During this test, the contractor has to execute component by component and loop by loop tests. The correct results have to be verified in the field, on the associated PLCs, HMI and SCADA applications. The test shall be performed using approved procedures and shall be signed off upon satisfactory completion.

.2 Undertake any corrective action found to be necessary during the course of the verification checkout and review.

.3 Report any discoveries of defects or deficiencies in writing to the Engineer for any equipment supplied by the Owner.

.4 Allow for the participation of the Owner’s personnel in the verification checks. Such participation shall not relieve the Contractor of any of the obligations.
.5 Prepare the various reports and certificates described herein. Forward three (3) copies of each report or certificate to the Engineer. Clearly identify any discrepancies which require action on the part of the Engineer.

END OF SECTION
1. GENERAL

1.1 Description

.1 In cooperation with the Engineer the Contractor shall perform extensive commissioning and start-up functions to verify the operation of all of the systems described herein as the installation in completed. Cooperation will be required to facilitate the timely performance of these activities. The Contractor, under the direction of the Engineer, will coordinate and schedule all activities associated with commissioning and start-up, and the Contractor shall cooperate and arrange its schedule of the Work to facilitate the timely performance and completion of this work.

.2 Commissioning and handover of the facilities will comply with the requirements of Section 01670.

.3 Refer to Section 17010 for general instrumentation and control requirements related to commissioning and start-up.

.4 It is the responsibility of the Contractor to provide a coordinated commissioning and start-up plan. The overall plan will be presented to the Owner and Engineer for approval.

2. PRODUCTS

Not applicable

3. EXECUTION

3.1 General

.1 Prior to commissioning and start-up activities, a series of operational tests will be performed by the Contractor, including, but not be limited to:

.1 Verification of correct transmission of signals from field instrument to the receiving device (RTU).

.2 On completion of installation, check all controlling inputs and controlled outputs for individual correctness prior to activation of any line equipment.

.3 Subsequently, perform all equipment function operation and interlock checks prior to activation of any line equipment (dry run check).

.4 Finally, place all equipment on line and energize for an actual controlled operation cycle.
.5 Complete any corrective action necessary that has been identified as part of the checkout procedure, on an ongoing basis.

.2 For those parts of the system that are software programmable, perform software commissioning and start-up. Determine the sequence in which the software commissioning and start-up shall occur and coordinate the performance of software commissioning and start-up with the Engineer.

.3 During software commissioning and start-up, perform the manual or automatic activation of field devices. Confirm the integrity and functional operation associated with the wiring and equipment which is required to operate with the software systems provided.

.4 For software commissioning and start-up, include, but do not limit to:

.1 Process control strategy verification

.2 Operator interface device verification down to final control device

.3 SCADA and HMI Operator Interface Panel verification, including but not limited to: mimics, alarms, tag scaling, trends and reports.

.4 System operation in manual, auto and fail mode

.5 Systems power fail/restart testing to verify proper operation

.6 Verification of all trip, alarm, and display functions

.5 Conduct final verification of commissioning of all systems through actual operation of the various parts of the process as determined by the Owner and the Engineer.

.6 Coordinate work with the centrifuge supplier representative.

.7 Control System commissioning will be considered complete when, in the opinion of the Engineer, the control system hardware or designated portion has properly operated for seven (7) continuous days, 24 hours per day without interruption. This 7 day period is in addition to any test periods or operational demonstrations specified elsewhere. The objective will have been achieved once it has been demonstrated that all systems are operating and have complied with the specified performance requirements herein.

END OF SECTION
1. GENERAL

1.1 Description

.1 Provide maintenance and operator training for the complete control system.

.2 Refer to the requirements of Section 01664 for general requirements related to personnel training.

.3 Refer to Section 17010 for general instrumentation and control requirements related to personnel training.

2. PRODUCTS

Not applicable.

3. EXECUTION

3.1 General

.1 Prepare a training plan for each category listing formal courses, including course descriptions and the duration of each course. Training shall be held at both Glenmore Booster Station and at Eldorado site reservoir facility. The training plans shall also include descriptions of informal training and a duration estimate for each session, and shall be submitted 45 days prior to performance of the training.

.2 Training aids which will be utilized by any supplier/presenter, such as PP presentation, overhead displays, wall charts, etc., will be provided to the Engineer for further use/reference.

.3 All instructions and instructional materials, including trainees’ workbooks, instructor’s guides, training aids, equipment, and system manuals shall be provided. Only proven accepted modern teaching techniques shall be used. Each course instructor shall be assigned full-time status and shall not perform other duties which will interrupt the instruction during the training session.

3.2 Maintenance Training

.1 Provide detailed maintenance training, including software use and configuration, for the maintenance staff as to the detailed and routine maintenance of the equipment as well as troubleshooting procedures. For this training, include any audio-visual training aids as well as all pertinent literature provided in a bound format of each person, as well as “hands on” training for familiarization with the equipment. The training shall include but not be limited to: explanation of the format and use of the
PERSONNEL TRAINING

OEM (Operation and Maintenance Manual), detailed description of regular maintenance procedures, troubleshooting procedures and safety in maintenance procedures.

.2 The maintenance training shall be based on five (5) trainees in two four (4) hour sessions.

.3 The training course shall cover all installed instruments.

.4 The training course shall cover but not be limited to:

   .1 Explanation of the use and format of the instrumentation and control operating and maintenance manuals.

   .2 Demonstrate how to conduct daily, weekly, monthly and yearly maintenance procedures using the Operation and Maintenance Manual (OEM). Indicate what sort of conditions should be expected and where each maintenance task is recorded on the manufacturer's scheduled maintenance log sheets.

   .3 Operation, calibration, testing and care and handling for each supplied instrument. The contractor shall also:

       .1 Demonstrate common problems and simple troubleshooting techniques which do not require the manufacturer's technical representative’s expertise in making repairs.

       .2 That components of the system should be visually inspected and what should be noted for maintenance record purposes.

       .3 Basic troubleshooting procedures for all instruments.

   .4 Safety and maintenance procedures. A safety manual shall be provided by the contractor and handed to the Owner.

3.3 Operator Training

   .1 For the detailed operator training, include, but do not necessarily restrict to representatives from the equipment suppliers who shall provide on-site training for the operation as to the function and operation of the equipment.

   .2 The operator training shall be based on five (5) – six (6) trainees attending in two separate sessions for four (4) hours per session.

END OF SECTION
Exhibit A –
Geotechnical Report
File 6263R

April 19, 2016

AECOM,
3275 Lakeshore Road,
Suite 201,
Kelowna, BC.
V1W 3S9

Attention: Stephen Horsman, P.Eng., P.E.
Project Engineer

Dear Mr. Horsman,

Preliminary Geotechnical Investigation and Report For
Proposed Eldorado Treated Water Reservoir
District of Lake Country, BC

1.0 INTRODUCTION

1.1 Authorization

The work reported upon in this document was authorized by yourself on behalf of AECOM on March 4, 2016.

1.2 Qualifications

Use of this report is subject to the Statement of Qualifications and General Conditions, which is attached. The reader's attention is specifically drawn to these conditions as it is considered essential that they be followed for the proper use and interpretation of this report.

1.3 Terms of Engagement

The terms under which our services are provided are attached.

1.4 Authorized Use of Report

This report has been prepared exclusively for the client listed above, for the use of others on their design team and for relevant approving authorities.
2.0 SCOPE OF THE REPORT

This report is intended to address geotechnical engineering considerations related to the construction of a proposed Eldorado Treated Water Reservoir with ancillary works (nearby known as the proposed reservoir) in Lake Country, BC. An overview site plan is available on the attached Site Location Plan, in Figure 6263R-1. The proposed reservoir with ancillary works will be located at 5000 Beaver Lake Road, as shown on the attached Eldorado Treated Water Reservoir Borehole Location Plan, in Figure 6263R-2. The final designs for the proposed structures were not complete at the time of the field investigation for this report.

It is understood that the proposed reservoir will be an enclosed, partially buried cast-in-place concrete structure. The proposed reservoir site will also require a low lift pump station, which is understood to be a slab-on-grade structure. Figure 6263R-2 shows the proposed locations of both these structures.

This report is intended to address the following specific items:

a) Site description and surficial geology
b) The geotechnical field and laboratory investigations carried out for the project
c) The engineering properties and characteristics of the subsoils at the site
d) The suitability of in situ soils for proposed constructions
e) Groundwater and temporary excavation considerations
f) Preliminary recommendations for foundations and ground preparation for foundations
g) Frost protection for foundations
h) Site, roof, and perimeter foundation drainage
i) Preliminary service trench excavation and backfill recommendations
j) Pavement structure design recommendations
k) Site grading cut and fill slopes

3.0 SITE DESCRIPTION AND SURFICIAL GEOLOGY

3.1 Site Description

The proposed reservoir site is located at 5000 Beaver Lake Road in Lake Country, BC, adjacent to the existing Eldorado Balancing Reservoir and ancillary buildings, which are shown on the attached Figure 6263R-2. The site and surrounding area are located in a
relatively unpopulated west-facing mountain side, with estimated slope gradients in the vicinity ranging between 3H:1V and 10H:1V sloping down towards the east. The site slopes downward towards the south with slope gradients estimated to average about 2.5H:1V.

The site is situated no less than 50 m behind the crest of a knoll above Vernon Creek and Clark Creek. At the time of the investigation, the proposed construction sites were covered in short vegetation with some construction debris and stockpiled soils encountered near the proposed reservoir location.

3.2 **Surficial Geology**

Available surficial geology mapping indicates that the surficial soils at the proposed reservoir site are ice contact sediments consisting of sand and gravel, boulders and some diamicton layers.

The materials encountered during the field investigation were consistent with the above descriptions with the sand and gravel material being the predominant soil type encountered at the site.

4.0 **INVESTIGATIONS**

4.1 **Field Investigation**

The field investigation was carried out on March 31, 2016 utilizing a B61 truck mounted drill rig owned and operated by Mud Bay Drilling Ltd. The geotechnical investigation consisted of making two boreholes at the locations shown on the attached Figure 6263R-2. The purposes of the investigation were to identify the stratigraphy of the subsoils at the borehole (BH) locations and to recover disturbed samples of the soils for further classification and testing in the laboratory. SDS cone penetration field tests were also carried out on the undisturbed soils to estimate the relative densities of the subsoils encountered. Standpipe piezometers were installed at a select borehole location to monitor static groundwater levels at the site, if any.

A layer of organic material and topsoil, ranging between 0.3 m and 0.6 m in thickness, was encountered at the ground surface at both borehole locations.

The undisturbed in situ soils encountered beneath the topsoils at the borehole locations generally consisted of gravelly sands, ranging between 3.7 m and 4.3 m below the existing ground surface. The gravelly sands were generally dry, and compact to dense in terms of relative density. The gravelly sands were underlain by silty sands at both borehole locations, to the terminus of the boreholes at 4.6 m below the ground surface. The silty sands were damp and very dense in terms of relative density. The boreholes were terminated due to drill rig refusal at both borehole locations.

A standpipe piezometer was installed at the location of BH 3 to a depth of 2.7 m below the existing ground surface. The standpipe depth was limited due to sloughing borehole side
walls. When checked on April 7, 2016, seven days after the field investigation, the standpipe was measured to be dry.

Detailed logs of the test pits are provided on the attached Records of Exploration.

4.2 Laboratory Investigation

The laboratory investigation consisted of natural moisture content determinations on all of the recovered samples, and two grain-size analyses on select samples. The results of the laboratory testing are shown on the attached Records of Exploration and on the attached sieve analysis test reports.

5.0 ENGINEERING PROPERTIES AND CHARACTERISTICS OF THE SUBSOILS

5.1 Organic, Topsoil and Uncontrolled Fill Materials

The organic and topsoil materials encountered at the borehole locations are not suitable for any engineering application at the site as no engineering properties can be reasonably assigned to them.

5.2 In Situ Granular Soils

5.2.1 Settlement

The undisturbed in situ gravelly sands and silty sands were compact to very dense in terms of relative density. These undisturbed materials will experience negligible settlement under expected loads.

5.2.2 Frost Susceptibility

On the basis of the attached grain-size analyses, the tested in situ gravelly sands have between 4 and 19 percent passing the 0.075 mm diameter sieve and should be considered to be moderately frost susceptible for design. The silty sands are also moderately frost susceptible.

5.2.3 Lateral Earth Pressure Coefficients and Unit Weights

The gravelly sands can be provided an angle of internal friction ranging between 32 and 34 degrees for use in design. The following parameters are estimated for the in situ gravelly sands:

1)  Earth Pressure Coefficients:
    a)  At Rest ( K₀ ) = 0.47
    b)  Active ( Kₐ ) = 0.31

2)  A dry unit weight of 20.4 kN/m³
5.2.4 Allowable Bearing Capacity

A safe allowable bearing capacity of 100 kPa and a factored ultimate bearing resistance of 150 kPa may be used for foundation design above the undisturbed, compact to dense gravelly sands encountered at the site provided that all foundation soils preparation and other recommendations made in this report are adhered to.

5.2.5 Modulus of Subgrade Reaction

A safe average modulus of subgrade reaction ($k_{avg}$) value equal to 15 MPa/m can be used for engineered reinforced concrete slab design above the undisturbed compact to dense gravelly sands encountered at site provided that all foundation soils preparation and other recommendations made in this report are adhered to.

5.2.6 Seismic Considerations

The undisturbed natural soils at this site can be classified as British Columbia Building Code Site Class ‘C’ for seismic design considerations.

5.2.7 California Bearing Ratio

A California Bearing Ratio value of 18 may be used for pavement design purposes above the undisturbed in situ gravelly sands encountered at this site.

5.2.8 Corrosivity and Sulfate Attack Considerations

The Golder Associates Ltd. (GAL) authored *Report On Geotechnical Investigation Proposed Eldorado Water Storage Reservoir And Facilities Beaver Lake Road District Of Lake Country, Lake Country, BC*, dated June 3, 2005, noted that the materials encountered at the proposed reservoir site are not considered to be corrosive to ductile iron based on the AWWA Standard C-105 10 point system.

The above GAL report indicated that Levelton Consultants Ltd. completed sulfate testing on the site soils and determined that there was negligible risk of sulfate attack to concrete constructions at the site.

6.0 SUITABILITY OF IN SITU SOILS FOR PROPOSED CONSTRUCTIONS

6.1 Organic and Topsoil Materials

The organic and topsoil materials can be salvaged as a non-structural finished surface for the site.

6.2 Sand Materials

The silty sands and gravelly sands can be reused at the site as trench backfill above pipe zones for on site utilities, subgrade and embankment fill below subgrade levels for roadways
and/or general site grading fill, provided the work is done in accordance with this report and local bylaws.

7.0 GROUNDWATER CONSIDERATIONS

Groundwater seepage was not noted at the time of investigation and static groundwater levels were below the base of the standpipe piezometers installed for the purposes of this report. The GAL authored Report On Geotechnical Investigation Proposed Eldorado Water Storage Reservoir And Facilities Beaver Lake Road District Of Lake Country, Lake Country, BC, dated June 3, 2005, identified groundwater in a borehole in the immediate vicinity of the proposed reservoir construction at an elevations to be more than 3.4 m below the ground surface. The GAL test pits surrounding the borehole location did not identify groundwater at that depth such that it is suspected that the noted groundwater may have infiltrated from the surface and perched on the very dense tillish materials. The removal of this water, if encountered, would be quick and easy with a sump and pump.

Provided that the base of excavation is above groundwater levels as expected, the work can proceed in accordance with recommendations provided in this report. However, if final design elevations require excavation of more than 300 mm below the perched groundwater table, the geotechnical engineer should be consulted for site specific recommendations related to the placement and compaction of engineered fill.

8.0 PRELIMINARY TEMPORARY EXCAVATION RECOMMENDATIONS

8.1 General

Temporary excavated slopes can be made as steep as they can be safely maintained by the contractor provided they are in compliance with the current WorkSafe BC regulations and the project requirements. If unsure of the stability of the excavation side slopes, the contractor should engage the services of a geotechnical engineer to assure compliance with the WorkSafe BC guidelines. The recommendations made in this report are guidelines and are not intended to provide assurances of excavation safety during construction.

8.2 Temporary Cut Slopes

As a general guideline, a temporary side slope excavation ranging of 1.0H:1V can be used for the excavations in the undisturbed gravelly sands above groundwater levels encountered at the proposed reservoir site. These recommended slope gradients should be confirmed by the geotechnical engineer at the onset of side-slope construction.
9.0 PRELIMINARY RECOMMENDATIONS FOR FOUNDATIONS, AND GROUND PREPARATION FOR FOUNDATIONS

9.1 Foundations

In discussion with yourself, it was understood that the proposed Eldorado Treated Water Reservoir structure will be founded on a monolithic concrete slab, and the proposed Eldorado low lift pump station structure will be founded on strip and pad foundations.

The safe load bearing parameters provided in the above Section 5.0 can be used structural design provided that all recommendations made in this report are adhered to. Irrespective of the maximum safe allowable soil bearing capacity, no strip foundation should be less than 450 mm in width, no pad foundation should have a horizontal dimension of less than 750 mm and the underside of all foundation elements, interior and exterior, should not be less than 1.0 m below adjacent finished grades.

The final civil, structural, and any other relevant design drawings should be provided to the geotechnical engineer prior to construction to ensure the recommendations provided in this report are still appropriate.

9.2 Construction above/behind Slope Faces

All foundations located above natural slopes at this site must be located at least 3 m behind an imaginary line that is drawn upward from the toe of the natural slope at a gradients of 2H:1V.

Engineered fill slopes are those permanent constructed slopes that are required for supporting foundation elements.

In the event that engineered fill slopes are required for the proposed structures, the slopes should be constructed such that structural foundations are located behind an imaginary line that is extended upward and behind the toe of a 2.0H:1V slope gradient, where the slope toe intersects with competent in situ ground surfaces. Furthermore, structural foundations should be located a horizontal distance of at least 2.0 m behind the face of any finished permanent fill slope.

Engineered slopes should be constructed in accordance with recommendations provided in Sections 9.3 c) and 14.0 of this report.

In the event that engineered slopes are to be constructed at gradients that are steeper than 2.0H:1V, earth retention structures may be required to provide the necessary support.

9.3 Ground Preparation for Foundation Soils

The following ground preparation methods and procedures should be adhered to for the proposed foundation soils related to the proposed reservoir and low lift pump station structures in/on the undisturbed in situ soils at the site.
a) Excavations for foundation soil preparation must conform to WorkSafe BC regulations and guidelines, this report, and project requirements.

b) All existing topsoil, uncontrolled fill, soft and/or loose and/or frozen materials should be removed to a depth that meets the following criteria:

   i) to expose the natural and undisturbed in situ sands,

   ii) to an elevation that is at least 300 mm below the base of the proposed underside of foundations

   iii) to an elevation at least 1.0 m below the base of the proposed undersides of slab-on-grades for unheated buildings and at least 300 mm below the base of proposed undersides of slab-on-grades for heated buildings,

   iv) to an elevation at least 1.0 m below adjacent finished outside grades.

The outside edge at the base of excavation elevation should be located outside the perimeter of the proposed structure by a horizontal distance that is at least equal to the vertical difference between the base of excavation and underside of the proposed structure, or at least 900 mm, whichever is greater.

The geotechnical engineer should be provided an opportunity to observe the base of excavation prior to proceeding with the backfill stage. In the event that the excavated base has a slope gradient that exceeds 5H:1V, benched excavations may be required as instructed by the geotechnical engineer.

c) The above prepared surfaces should be covered with at least 300 mm of clean (less than 7 percent passing the 0.075 mm sieve), well-graded crushed 75 mm (-) sands and gravels placed in thin lifts and compacted to 100 percent of standard proctor maximum dry density (SPD) in accordance with ASTM D-698. For workability purposes below the proposed reservoir monolithic concrete foundation, it may be preferred to use well-graded, crushed 25 mm(-) sands and gravels.

Any utility services that will exist below the undersides of the foundations should be installed during the above backfilling stage, as discussed on Section 12.0 of this document.

d) The proposed structure foundations can be placed directly on the above prepared surface.

e) For the proposed low-lift pump station, following the removal of the concrete foundation structure form-work, 25 mm (-) imported sands and gravels or 25 mm fractured drain rock can be placed and compacted to 100 percent of SPD to raise the grades to the underside of interior slab elevations.

Any utility services requiring installation below the undersides of the floor slabs should be installed during the above backfilling stage.
f) To help promote good curing of the concrete slab, a polyethylene moisture barrier should be placed on the compacted surface prior to placing concrete for floor slabs. Concrete for floor slabs can be poured directly on the above prepared surface.

9.4 Proposed Reservoir Backfill

Backfill placed outside and within 300 mm of the proposed reservoir should consist of well-graded and clean 75 mm (-) imported sands and gravels placed in lifts not exceeding 300 mm and compacted to 95 percent of maximum Standard Proctor dry Density (SPD) in accordance with ASTM D-698. The uppermost 0.3 m can consist of those materials required for landscaping.

Unless otherwise specified for overlying structures designed by others, backfill requirements outside the above noted zone can consist of clean 150 mm (-) pitrun sands and gravels, or salvaged materials approved by the geotechnical engineer, that are moisture conditioned, placed in 300 mm lifts and compacted to 95 percent of maximum SPD to a level that is approximately 0.3 m below the finished surface grades. The uppermost 0.3 m can consist of those materials required for landscaping.

10.0 FROST PROTECTION

Adequate frost protection for structural foundations can be provided by at least 900 mm of ground cover above foundation base levels or the equivalent in Styrofoam insulation (R10 or better).

11.0 DRAINAGE

11.1 General Site Drainage

Finished outside ground surfaces should be graded such that surface water is directed away from and not toward the structures.

11.2 Roof Drainage

Roof drainage should be done in accordance with the current edition of the British Columbia Building Code.

The roof drainage should not connect to the perimeter foundation drainage in any circumstances.

11.3 Perimeter Foundation Drainage

In the event that the proposed reservoir structure is buried on all sides by at least 1.0 m and the burial elevation difference is no greater than 3.0 m on opposite sides of the structure, no perimeter foundation drainage will be required. If the above conditions are not the case, this structure will require perimeter foundation drainage to reduce hydrostatic pressure build-up,
should water eventuate into the structure backfill. The following procedures should be adhered to:

i) The perimeter drains should be 100 mm diameter rigid perforated PVC pipe.

ii) The pipe should be set with perforations facing downwards on a geotextile filter (Nilex 4535 or an approved equivalent), approximately 200 mm outside of foundation edges and at or below foundation base levels, or at least 1.0 m below finished grades, whichever is deeper.

iii) The top and sides of the pipe should be covered with approximately 150 mm of washed and clean 25 mm drain rock. The pipe/drain rock combination should be completely enclosed within the geotextile filter. Where it closes, the geotextile filter should overlap by at least 150 mm.

iv) Where it leaves the foundation perimeter, the pipe should be connected to a 100 mm diameter rigid non-perforated PVC pipe and directed with positive downward drainage away from the structure to an approved frost-free outlet.

v) In no circumstances should the perimeter drain system be connected to the roof drain system.

The proposed Eldorado Low Level Pump Station will not require perimeter foundation drainage provided all interior floor slab surfaces are at least 200 mm above adjacent finished outside grades. In the event that this is not the case, perimeter drainage should be installed for these structures using the above recommendations.

12.0 TRENCH EXCAVATIONS AND BACKFILL RECOMMENDATIONS

12.1 Trench Excavation Side Slope Stability

Trench constructions must conform to WorkSafe BC regulations and guidelines, this report, and project requirements.

12.2 General Trench Excavation and Backfill Recommendations

Where utility installations will be located below base of interior and/or exterior foundation elevations they should be backfilled in accordance with Section 9.0 of this report prior to final ground preparation for foundations. Alternatively, conduit can be installed prior to foundation constructions for later utility installs. Any utility installation should be done such no excavation will be required after foundation construction within a horizontal distance of the foundations that is equal to twice the vertical distance between the base of foundation and the utility line and/or conduit.
12.3 Trench Foundation Soils Preparation

All existing uncontrolled fill, soft and/or loose and/or frozen materials should be removed to expose the natural and undisturbed in situ sands. If unexpected geotechnical conditions arise for trench constructions, the geotechnical engineer should observe the base of trench excavation prior to proceeding beyond this point.

Specifications related to trench foundation soil materials, construction methods and procedures, and quality assurance and control should conform with related local by-law specifications and this report.

12.4 Pipe Zone and Trench Backfill

Specifications related to pipe zone and trench backfill materials, construction methods and procedures, and quality assurance and control should conform with local by-law requirements.

13.0 PAVEMENT STRUCTURE DESIGN

13.1 General Pavement Structure Discussion And Design Qualifications

In discussion with yourself, the roadway and parking lot for the proposed reservoir site may be finished with a gravel or asphalt surface. It is also understood that the pavement structure design for this site should adhere to DoLK specifications and guidelines.

The road structure designs provided below will satisfy the strength requirements for the specified traffic loads, but will not address frost susceptibility in its entirety. Full frost protection should be provided at this site and the method of providing this will depend on finished site grades. Generally, full frost protection would require a road structure consisting of at least 900 mm of non-frost susceptible granular soils, or its equivalent in insulating value.

The pavement structure design life assumes that a road maintenance program exists such that cracks are filled before the underlying road structure is damaged due to the introduction of moisture.

13.2 On Site Pavement and Parking Area Structure Requirements

It is understood that the proposed on site roadways and parking areas will subjected to approximately 1-2 light vehicles per day, and a monthly chemical truck delivery.

The following pavement structure design for an asphalted roadway is based on the DoLK Subdivision And Development Servicing Bylaw No. 97-139, which defines a road structure design life expectancy as 15 years.
For design purposes, a value equal to $5.6 \times 10^5$ Equivalent Single Axle Loads (ESAL) has been used for this road structure design as the minimum required by the DoLK for an Industrial Road Classification (1 ESAL = 8165 kg).

On the basis of gathered information, the design qualifications provided above and the subgrade preparation recommendations provided below, the following minimum on site roadway and parking area road structure is recommended at the subject site.

<table>
<thead>
<tr>
<th>THICKNESS (mm)</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 OR 150</td>
<td>DoLK Hot Mix Asphalt (two lifts) OR MoTI 25mm(-) High Fines Surfacing Aggregate</td>
</tr>
<tr>
<td>100</td>
<td>DoLK 25 mm(-) Crushed Granular Base Course</td>
</tr>
<tr>
<td>300</td>
<td>DoLK 75 mm(-) Granular Sub-base Course</td>
</tr>
<tr>
<td></td>
<td>For Prepared Subgrade (See 13.3 Below)</td>
</tr>
</tbody>
</table>

13.3 Subgrade Preparation

a) Subgrade preparation should include the removal of all soft, loose, frozen, organic, non-engineered fill soils, snow, and any other deleterious materials below travelled areas to expose the undisturbed in situ sands, or to design top of subgrade elevations, whichever is deeper.

The horizontal extent of the subgrade surface should be extended at least 1.0 m from the outside edges of the proposed travelled areas, curb and gutter, or sidewalk, or as wide as possible due to nearby constraints. At locations where a road embankment must be constructed, the base of the excavation should be further extended for a horizontal distance defined by an imaginary line extending outside the asphalted roadway, curb and gutter, or sidewalk at a 2H:1V slope gradient, until it intersects the competent undisturbed in-situ soils. The excavation should be done such that equipment does not travel on excavated subgrade surfaces.

The exposed excavation surface should be observed by the geotechnical engineer to confirm that all obvious deleterious materials have been removed to expose a competent subgrade surface before proceeding with the next stage of construction.

b) Where excavation to levels that exceed the thickness requirements given in the above noted road structures are needed, backfill materials used to elevate the subgrade to the design elevation should consist of clean, well-graded 150 mm (minus) sands and gravels, or approved salvaged materials, that are moisture conditioned and compacted in 300 mm loose lifts to at least 95 percent of SPD. The upper 300 mm of the subgrade materials should be compacted to at least 100 percent of SPD.
c) The finished subgrade surface should be provided with a crown or cross fall gradient of at least two percent to allow efficient drainage toward the outer edges of the traveled surface areas of any moisture that may accumulate within the finished road structure.

d) It is recommended that the finished subgrade surface be inspected by the geotechnical engineer and possibly proof rolled in order to identify any soft or weak areas before placing subbase materials. Soft or weak areas should be excavated and replaced with clean, well-graded 150 mm (minus) sands and gravels compacted to at least 100 percent of SPD.

13.4 Subbase, Base and Asphalt Constructions

Specifications related to the pavement structure materials, construction methods and procedures, and quality assurance and control should conform with DoLK specifications and this report. If used, the High Fines Surfacing Aggregate materials should conform with Ministry of Transportation and Infrastructure (MoTI) specifications and this report.

13.5 Concrete Sidewalks, Curbs, and Gutters

Specifications related to concrete sidewalk, curb, and gutter materials, construction methods and procedures, and quality assurance and control should conform with DoLK specifications and this report.

13.6 Drainage

Good drainage should be provided for this site by grading and/or piping. Specifications and methods related to drainage materials, construction methods and procedures, and quality assurance and control testing should conform with DoLK specifications and this report.

The site should be maintained in a well-drained condition throughout the construction phase in order to reduce the potential for damaging the damp subgrade soils by construction traffic due to pumping actions in the subsoils and to prevent excessive erosion of the unfinished construction during storm events.

14.0 SITE GRADING CUT AND FILL SLOPES

Finished permanent cut and fill slopes should be constructed such that side slope gradients are 2.0H:1V or flatter, where feasible; otherwise retaining structures and/or soil reinforcement methods using geogrid and/or geotextiles may be required.

All fill materials placed against existing slopes with slope gradients steeper than 5H:1V should be done in accordance with MoTI construction specifications; specifically; Section 201.37, which states that the construction ". . .shall be terraced in a continuous series of steps a minimum of 1.5 m wide as the embankment rises".

Finished slopes should be provided with erosion protection. Compaction requirements of earthen fill slopes will vary depending on application and location, and can be discussed with the geotechnical engineer during the design phase.
15.0 CONCLUSIONS AND RECOMMENDATIONS

It is concluded that, from a geotechnical point of view, the proposed constructions can safely proceed provided the recommendations made in this report are followed.

It is recommended that:

a) The items contained in Sections 5.0 to 14.0, inclusive, of this report are followed.

b) The geotechnical engineer inspect all soils and soils related construction on the project to assure that:

   i) all soils conditions are as good or better than those inferred in this report, and that

   ii) all soils and soils related construction conforms to this report, designs provided, and appropriate specifications for the work.

c) Any design(s) or other work for soils or for soils related structures connected with this project and prepared by others be submitted to the geotechnical engineer for review regarding conformity to the project requirements and intent of this report.

We trust that the contents of this report are appropriate for your immediate needs. If you should have any questions please call our office at your convenience.

Yours truly,
Fletcher Paine Associates Ltd.

Robert M. Scherz, P.Eng.
Geotechnical Engineer

Terry L. Eddy, P.Eng.
Review Engineer
STATEMENT OF QUALIFICATIONS AND GENERAL CONDITIONS

1. Standard of Care

This report has been prepared in accordance with generally accepted geotechnical engineering practices in this area. No other warranty, expressed or implied, is made.

2. Basis of the Report

This report has been prepared for the specific site, design objective, development and purpose that was described to Fletcher Paine Associates Ltd. (FPA) by the client and summarized in this letter. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the report are only valid to the extent that there has been no material alteration to or variation from any of the said descriptions provided to FPA, unless FPA was specifically requested by the Client to review and revise the report in light of such alteration or variation.

3. Uses of the Report

The information and opinions expressed in this report are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THIS REPORT OR ANY PORTION THEREOF WITHOUT FPA’s EXPRESS WRITTEN CONSENT. FPA WILL CONSENT TO ANY REASONABLE REQUEST BY THE CLIENT TO APPROVE THE USE OF THIS REPORT BY OTHER PARTIES AS APPROVED USERS. The ownership and copyright of this report remain the property of FPA, who authorizes only the Client and Approved Users to make copies of the report and only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell or otherwise make available the report or any portion thereof, or any copy of the report or portion thereof, to any other party without the express written permission of FPA.

4. Complete Report

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to FPA by the Client, communications between FPA and the Client, and to any other reports prepared by FPA for the Client relative to the specific site described in the report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS, AND OPINIONS EXPRESSED IN THE REPORT, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. FPA CANNOT BE RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

5. Interpretation of the Report

a) Nature and Exactness of Soil Description: Classification and identification of soils, rocks, and geologic units have been based upon commonly accepted methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from these systems have been used they are specifically mentioned. Classification and identification of the type and condition of soils, rocks and geologic units are judgmental in nature. Accordingly, FPA cannot warrant or guarantee the exactness of the descriptions of in situ ground conditions set forth in the Report.

b) Logs of Test Holes, Pits, Trenches, etc.: The test hole logs are a record of information obtained from field observations and laboratory testing of selected samples as well as an interpretation of the likely subsurface stratigraphy at the test holes sites. In some instances normal sampling procedures do not recover a complete or any sample. Soil, rock or geologic zones have been interpreted from the available data. The change from one zone to another, indicated on the logs as a distinct line, may be transitional. The same limitations apply to test pit and other logs.
c)  Stratigraphic and Geologic Sections: The stratigraphic and geologic sections indicated on drawings contained in this report are interpreted from logs of test holes, test pits or other available information. Stratigraphy is inferred only at the locations of the test holes or pits to the extent indicated by items 5. a) and b) above. The actual geology and stratigraphy, particularly between these locations, may vary considerably from that shown on the drawings. Since natural variations in geologic conditions are inherent and a function of the historic site environment, FPA does not represent or warrant that the conditions illustrated are exact and the user of the report should recognize that variations may exist.

d)  Groundwater Conditions:  Groundwater conditions shown on logs of test holes and test pits, and/or given within the text of this report, record the observed conditions at the time of their measurement. Groundwater conditions may vary between test hole and test pit locations and can be affected by annual, seasonal, and special meteorological conditions, or by tidal conditions for sites near the seas. Groundwater conditions can also be altered by construction activity. These types of variation need to be considered in design and construction.

e)  Changes of Exposed Ground:  Many geologic materials deteriorate rapidly upon exposure to climatic elements. Deterioration may be caused by precipitation, sunshine and/or the action of frost. Therefore, site conditions may vary considerably from the time of the making of the tests performed for preparation of the report and the time of actual construction.

f)  Influence of Construction Activity:  Construction activities can alter and damage the in situ ground conditions. The influence of all anticipated construction activities on the geologic environment should be considered in formulating and implementing the final design and construction techniques.

Wherever changes in the site occur after the preparation of the report or conditions are observed which indicate results clearly incompatible with the test results on which the report is based, the client and any other users of this report should notify FPA as soon as possible so that FPA will be able to provide necessary revisions to its report prior to any commencement of or alteration in design and construction.

6. Observations during Construction

Observations of geologic conditions should be carried out during the site preparation, excavation and construction to verify the conditions predicted by the report. Such observations should be communicated to FPA to allow for confirmation and/or alteration of the geotechnical recommendations or design guidelines presented in the report.

Whenever changes in the site occur after the preparation of the report or conditions are observed which indicate results clearly incompatible with the test results on which the report is based, then the client should notify FPA as soon as possible so that FPA will be able to provide necessary revisions to its report prior to any commencement of or alteration in design and construction.

7. Samples

FPA normally disposes of all unused soil and rock samples after 90 days of completing the testing program for which the samples were obtained. Further storage or transfer of samples can be made at the owner’s expense upon written request.
# Record of Exploration - Borehole No. 2

**Project No:** 6263R  
**Project:** Eldorado Treated Water Reservoir  
**Client:** AECOM  
**Project Location:** Eldorado Reservoir, Lake Country, BC  

**Borehole Location:** See Figure 6263R-2  
**Drilling Contractor:** Mud Bay Drilling Ltd.  
**Drilling Date:** March 31, 2016  
**Auger Size:** 150 mm solid stem

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
<th>Sample</th>
<th>SDS Cone Penetration Test (blows/0.3m)</th>
<th>Moisture Content (%)</th>
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<tr>
<td>1</td>
<td>TOPSOIL</td>
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</tr>
<tr>
<td>2</td>
<td>SAND</td>
<td>2</td>
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</tr>
<tr>
<td>3</td>
<td>SAND</td>
<td>3</td>
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</tr>
<tr>
<td>4</td>
<td>silty, some gravel, very dense, brown, damp</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 5        | End of borehole at 4.6 m due to drill rig refusal  
  No groundwater seepage encountered  
  Borehole sides sloughed at 0.9 m and deeper |        |                                        |                      |

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fletcherpaine@shawlink.ca

This Record of Exploration forms a part of the report referenced by the above Fletcher Paine Associates Ltd. project number. It should not be read or interpreted on a stand-alone basis and dissemination of the information is limited as outlined in the referenced report.
# Record of Exploration - Borehole No. 3

**Project No:** 6263R  
**Project:** Eldorado Treated Water Reservoir  
**Client:** AECOM  
**Project Location:** Eldorado Reservoir, Lake Country, BC

**Borehole Location:** See Figure 6263R-2  
**Drilling Contractor:** Mud Bay Drilling Ltd.  
**Drilling Date:** March 31, 2016  
**Auger Size:** 150 mm solid stem

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<th>Subsurface Profile</th>
<th>Description</th>
<th>Sample</th>
<th>SDS Cone Penetration Test (blows/0.3m)</th>
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<td>gravelly, trace to some silt, compact to dense, brown, dry</td>
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<td>silty, some gravel, very dense, brown, damp</td>
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| End of borehole at 4.6 m due to drill rig refusal  
No groundwater seepage encountered  
Borehole sides sloughed at 2.7 m and deeper |

**Standpipe Data**  
Stand April 7, 2016  
dry to 2.7 m below ground

---

Fletcher Paine Associates Ltd.  
2250 - 11th Avenue  
Vernon, B.C.  
V1T 7X8  
Ph. (250) 542-0377  
Fax. (250) 542-1220  
fletcherpaine@shawlink.ca

This Record of Exploration forms a part of the report referenced by the above Fletcher Paine Associates Ltd. project number. It should not be read or interpreted on a stand-alone basis and dissemination of the information is limited as outlined in the referenced report.
Sieve Analysis
ASTM C136 & C117

PROJECT: Proposed Eldorado Treated Water Reservoir
CLIENT: AECOM
SOURCE: Borehole 2
DATE: 31-Mar-16
LOCATION: Lake Country, BC
MATERIAL: Sand and Gravel, trace silt
Sampled By: RMS
Project No: 6263R

Gradation Specifications: No Specification

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Remarks:
- Sampled from Borehole 2, Sample 1, Depth 0.9 m

Reporting of this test result constitutes testing services only. Engineering interpretation or evaluation of the test result is provided only upon written request.
Data presented in this report is for the exclusive use of the Client listed above. F.P.A. will not take any responsibility for any unauthorized use.
**Fletcher Paine Associates Ltd.**  
*Consulting Geotechnical and Materials Engineers*

**SIEVE ANALYSIS**  
ASTM C136 & C117

**PROJECT:** Proposed Eldorado Treated Water Reservoir  
**CLIENT:** AECOM  
**SOURCE:** Borehole 2  
**DATE:** 31-Mar-16

**LOCATION:** Lake Country, BC  
**MATERIAL:** Sand, gravely, some silt  
**Sampled By:** RMS  
**Project No:** 6263R

**GRADATION SPECIFICATIONS:** No Specification

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**REMARKS:**  
- Sampled from Borehole 2, Sample 3, Depth 3.4 m

---

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TERMS OF ENGAGEMENT

1. General

Fletcher Paine Associates Ltd. (FPA) shall render its services to the Client for this project with that degree of care, skill and diligence normally provided in the performance of services for projects of a similar nature to that contemplated.

In rendering services to the Client, FPA may, at its discretion and at any stage, engage subconsultants to FPA to carry out its duties and responsibilities as set forth.

2. Compensation

Charges for the services rendered will be made in accordance with our Schedule of Fees in effect at the time the work is performed. All charges will be made in, and will be payable in, Canadian Dollars. Invoices will be due and payable on receipt without holdback. A monthly service charge will be applicable to invoices remaining unpaid after 30 days.

3. Notices

FPA will designate a project manager who shall be responsible for the project. The Client shall designate an authorized representative to act with respect to the project.

4. Termination

Either party may terminate this engagement with cause upon seven (7) days notice in writing. The Client shall forthwith pay for all services performed, including all expenses and other charges payable that are associated with obligations incurred by FPA for this project.

5. Environment and Pollution

The FPA field investigation, laboratory testing and engineering recommendations are not intended to address or evaluate pollution of soil or pollution of groundwater. When practical, FPA will cooperate with the Client's environmental consultant during the field work phase of the investigation.

6. Professional Responsibility

FPA will provide the standards of care, skill and diligence normally provided by a Professional Engineer in the performance of engineering services as contemplated for this project.

7. Limitations of Liability

FPA shall not be responsible for:

a) The failure of a Contractor to perform work in accordance with the relevant contract documents for the Project;

b) The design of, or defects in, equipment provided by or on behalf of the Client by others, for incorporation into the Project;

c) Any damage to subsurface structures or utilities; resulting from subsurface investigations for the Project;

d) Any cross-contamination of ground or groundwater resulting from subsurface investigations for the Project;

e) Any costs incurred for stopping the flow of artesian water from test holes in the event that such conditions are encountered during any field investigation for the Project;

f) Any decisions made by the Client in relation to the Project that are inconsistent with, or contrary to, the advice provided by FPA;

g) Any consequential loss, injury, or damages suffered by the Client, including but not limited to loss of use, loss of earnings, or business interruption;

h) The distribution of any document or report prepared for the Client by or on behalf of FPA for the Project without express authorization by FPA.
Notwithstanding anything to the contrary, the aggregate liability of FPA, including liability for professional negligence and fundamental breach of contract, shall be limited to the amount of Professional Liability insurance carried by FPA.

The Client’s failure to accept the professional recommendations and advice of FPA with respect to the geotechnical conditions at the Project shall relieve FPA of and from any and all legal liability, whether in contract or in tort, to the Client for all manner of loss and damage accruing to the Client, including consequential loss and damage, which may arise out of the FPA services.

8. Personal Liability

The Client agrees that FPA’s principals and employees have no personal liability to the Client in respect of a claim whether in contract, tort, and/or any other cause of action in law, and expressly agrees that it will bring no proceedings and take no action in any court of law against any of FPA’s principals or employees in their personal capacities.

9. Third Party Liability

This report was prepared by FPA for the Client and the material presented in it reflects the opinions and judgements of FPA as based upon the information available at the time of its preparation. Any use(s) made of this report by a third party is/are the sole responsibility of such third parties. FPA will not accept any responsibility for damages suffered by any third party as a result of decisions made or actions taken that are ostensibly based upon this report. Any use or reliance upon this report by a third party must be authorized in writing by FPA.

10. Documents

All of the Documents prepared by FPA in connection with the Project are instruments of service for the execution of the Work. FPA retains the property and copyright in those Documents, whether the Project is executed or not. These Documents may not be used on any other project without prior written agreement and remuneration.

11. Field Services

Where applicable, the field services recommended are the minimum necessary to ascertain that the Contractor’s work is being carried out in general conformity with the intent of our recommendations. Any reduction from the level of services recommended will result in FPA providing qualified opinions regarding the adequacy of the work.

12. Confirmation of Professional Liability Insurance

As required by the Association of Professional Engineers and Geoscientists of British Columbia, it is required that our firm advise whether or not Professional Liability Insurance is held. It is also required that a space for you to acknowledge this information is provided. Accordingly, this notice serves to advise you that FPA carries professional liability insurance. If you wish to acknowledge receipt of this information please sign and return a copy of this form.
File 6263B

April 19, 2016

AECOM,
3275 Lakeshore Road,
Suite 201,
Kelowna, BC.
V1W 3S9

Attention: Stephen Horsman, P.Eng., P.E.
Project Engineer

Dear Mr. Horsman,

Preliminary Geotechnical Investigation and Report For
Proposed Glenmore Booster Station Structure
District of Lake Country, BC

1.0 INTRODUCTION

1.1 Authorization

The work reported upon in this document was authorized by yourself on behalf of AECOM on March 4, 2016.

1.2 Qualifications

Use of this report is subject to the Statement of Qualifications and General Conditions, which is attached. The reader's attention is specifically drawn to these conditions as it is considered essential that they be followed for the proper use and interpretation of this report.

1.3 Terms of Engagement

The terms under which our services are provided are attached.

1.4 Authorized Use of Report

This report has been prepared exclusively for the client listed above, for the use of others on their design team and for relevant approving authorities.
2.0 **SCOPE OF THE REPORT**

This report is intended to address geotechnical engineering considerations related to the construction of a proposed booster station in Lake Country, BC. An overview site plan is available on the attached Site Location Plan, in Figure 6263B-1. The proposed booster station will be located near the intersection of Seaton Road and Glenmore Road, as shown on the attached Glenmore Booster Station Borehole Location Plan, in Figure 6263B-2. The final design for the proposed structure was not complete at the time of the field investigation for this report.

It is understood that the proposed booster station will be a slab-on-grade one-storey structure. Figure 6263B-2 shows the proposed location for the booster station structure.

This report is intended to address the following specific items:

a) Site description and surficial geology

b) The geotechnical field and laboratory investigations carried out for the project

c) The engineering properties and characteristics of the subsoils at the site

d) The suitability of in situ soils for proposed constructions

e) Groundwater and temporary excavation considerations

f) Preliminary recommendations for foundations and ground preparation for foundations

g) Frost protection for foundations

h) Site, roof, and perimeter foundation drainage

i) Preliminary service trench excavation and backfill recommendations

j) Pavement structure design recommendations

k) Site grading cut and fill slopes

3.0 **SITE DESCRIPTION AND SURFICIAL GEOLOGY**

3.1 **Site Description**

The proposed Glenmore booster station site is located on the south side of Seaton Road in Lake Country BC, east of its intersection with Glenmore Road and adjacent to an existing pressure regulating station, as shown on the attached Figure 6263B-2. The site and surrounding area are located within a rural area of Lake Country, generally surrounded by...
single family residential homes. The site and general area slope down towards the east at approximate 10H:1V slope gradients.

3.2 Surficial Geology

Available surficial geology mapping indicates that the surficial soils at the site are glacial outwash sediments consisting of sand, sandy gravel and boulders.

The materials encountered during the field investigation were consistent with the above descriptions, with the sand material being the predominant soil type encountered at the site.

4.0 INVESTIGATIONS

4.1 Field Investigation

The field investigation was carried out on March 31, 2016 utilizing B61 truck mounted drill rig owned and operated by Mud Bay Drilling Ltd. The geotechnical investigation consisted of making one borehole at the proposed Glenmore Booster Station site, located as shown on the attached Figure 6263B-2. The purposes of the investigation were to identify the stratigraphy of the subsoils at the borehole (BH) location and to recover disturbed samples of the soils for further classification and testing in the laboratory. A SDS cone penetration field test was also carried out on the undisturbed soils to estimate the relative densities of the subsoils encountered. A standpipe piezometer was installed at the borehole location to monitor static groundwater levels at the site, if any.

The borehole was made through a 25 mm thick asphalt surface, which was underlain by fill consisting of a mixture of damp compact sands and gravels to a depth of 0.6 m below the ground surface.

The undisturbed in situ soils encountered beneath the asphalt and fill at the borehole location consisted of sands to the terminus of the borehole, at a depth of 6.1 m below the existing ground surface. The sands were generally dry to damp, and compact to dense in terms of relative density.

A standpipe piezometer was installed to a depth of 3.0 m below the existing ground surface. The standpipe depth was limited due to sloughing borehole side walls. When checked on April 7, 2016, seven days after the field investigation, the standpipe was measured to be dry.

Detailed logs of the test pits are provided on the attached Records of Exploration.

4.2 Laboratory Investigation

The laboratory investigation consisted of natural moisture content determinations on all of the recovered samples, and one grain-size analysis on a select sample. The results of the laboratory testing are shown on the attached Records of Exploration and on the attached sieve analysis test reports.
5.0 ENGINEERING PROPERTIES AND CHARACTERISTICS OF THE SUBSOILS

5.1 Uncontrolled Fill Materials

The uncontrolled fill materials encountered at the borehole location are not suitable for any engineering application at the site as no engineering properties can be reasonably assigned to them.

5.2 In Situ Sands

5.2.1 Settlement

The undisturbed sands are considered to be compact to dense in terms of relative density. These materials should be expected to experience negligible settlement, when applied with typical loads for the proposed structure.

5.2.2 Frost Susceptibility

On the basis of the attached grain-size analyses, the tested in situ sands had 8 percent passing the 0.075 mm diameter sieve. This material can be considered to be frost susceptible in some degree.

5.2.3 Allowable Bearing Capacity

A safe allowable bearing capacity of up to 100 kPa may be used for conventional strip and pad foundation design above the undisturbed, compact to dense sands encountered at the site provided that all foundation soils preparation and other recommendations made in this report are adhered to.

5.2.4 California Bearing Ratio

A California Bearing Ratio value of 15 may be used for pavement design purposes above the undisturbed in situ sands encountered at this site.

6.0 SUITABILITY OF IN SITU SOILS FOR PROPOSED CONSTRUCTIONS

6.1 Uncontrolled Fill Materials

The uncontrolled fill materials can be salvaged as a non-structural finished surface for the sites.

6.2 Sand Materials

The sands can be reused at the site as trench backfill above pipe zones for on site utilities, subgrade and embankment fill below subgrade levels for roadways and/or general site grading fill, provided the work is done in accordance with this report and the relevant local by-laws.
7.0 GROUNDWATER CONSIDERATIONS

Groundwater seepage was not noted at the time of investigation and on the basis of natural moisture contents of the in situ soils, static groundwater levels are at least 6.0 m below the existing ground surface at the site. A standpipe peizometer installed to a 3 m depth was dry when checked at a later date.

8.0 PRELIMINARY TEMPORARY EXCAVATION RECOMMENDATIONS

8.1 General

Temporary excavated slopes can be made as steep as they can be safely maintained by the contractor provided they are in compliance with the current WorkSafe BC regulations and the project requirements. If unsure of the stability of the excavation side slopes, the contractor should engage the services of a geotechnical engineer to assure compliance with the WorkSafe BC guidelines. The recommendations made in this report are guidelines and are not intended to provide assurances of excavation safety during construction.

8.2 Temporary Cut Slopes

As a general guideline, a temporary side slope excavation with a 1.0H:1V gradient can be used for the excavations in the undisturbed sands above static groundwater levels encountered at the site. These recommended slope gradients should be confirmed as safe by the geotechnical engineer during construction.

9.0 PRELIMINARY RECOMMENDATIONS FOR FOUNDATIONS AND GROUND PREPARATION FOR FOUNDATIONS

9.1 Foundations

In discussion with yourself, it was understood that the Glenmore Booster Station structure will be founded on strip and pad foundations.

A safe allowable bearing capacity of 100 kPa can be given for the above noted structure provided that all recommendations made in this report are adhered to. Irrespective of the maximum safe allowable soil bearing capacity, no strip foundation should be less than 450 mm in width, no pad foundation should have a horizontal dimension of less than 750 mm and the underside of all foundation elements, interior and exterior, should not be less than 1.0 m below adjacent finished grades.

The final civil, structural, and any other relevant design drawings should be provided to the geotechnical engineer prior to construction to ensure the recommendations provided in this report are still appropriate.
9.2 Fill Slopes

Engineered fill slopes are those permanent constructed slopes that are required for supporting foundation elements.

In the event that engineered fill slopes are required for the proposed structure, the slopes should be constructed such that structural foundations are located behind an imaginary line that is extended upward and behind the toe of a 2.0H:1V slope gradient, where the slope toe intersects with competent in situ ground surfaces. Furthermore, structural foundations should be located a horizontal distance of at least 2.0 m behind the crest of any finished permanent fill slope.

Constructed engineered slopes should generally be constructed using the same recommended materials and construction methods as those provided in Sections 9.3 c) and 14.0 of this report.

In the event that engineered slopes are to be constructed at gradients that are steeper than 2.0H:1V, earth retention structures may be required to provide the necessary support.

9.3 Ground Preparation for Foundation Soils

The following ground preparation methods and procedures should be adhered to for the proposed foundation soils related to the booster station structure in/on the undisturbed in situ soils at the site.

a) Excavations for foundation soil preparation must conform to WorkSafe BC regulations and guidelines, this report, and project requirements.

b) All existing topsoil, uncontrolled fill, soft and/or loose and/or frozen materials should be removed to a depth that meets the following criteria:

i) to expose the natural and undisturbed in situ sands,

ii) to an elevation that is at least 300 mm below the base of the proposed underside of foundations

iii) to an elevation at least 1.0 m below the base of the proposed undersides of slab-on-grades for unheated buildings and at least 300 mm below the base of proposed undersides of slab-on-grades for heated buildings,

iv) to an elevation at least 1.0 m below adjacent finished outside grades.

The outside edge at the base of excavation elevation should be located outside the perimeter of the proposed structure by a horizontal distance that is at least equal to the vertical difference between the base of excavation and underside of the proposed footings, or at least 900 mm, whichever is greater.
The geotechnical engineer should be provided an opportunity to observe the base of excavation prior to proceeding with the backfill stage. In the event that the excavated base has a slope gradient that exceeds 5H:1V, benched excavations may be required as instructed by the geotechnical engineer.

c) The above prepared surfaces should be covered with at least 300 mm of clean (less than 7 percent passing the 0.075 mm sieve), well-graded crushed 75 mm (-) sands and gravels placed in thin lifts and compacted to 100 percent of standard proctor maximum dry density (SPD) in accordance with ASTM D-698.

Any utility services that will exist below the undersides of the foundations should be installed during the above backfilling stage, as discussed on Section 12.0 of this document.

d) The proposed structure foundations can be placed directly on the above prepared surface.

e) Following the removal of the concrete foundation structure form-work, 75 mm (-) imported sands and gravels can be placed and compacted to 100 percent of SPD to an elevation at least 150 mm below the undersides of interior slabs. 25 mm (-) imported sands and gravels or 25 mm fractured drain rock can placed on the above prepared surface and compacted to 100 percent of SPD to raise the grades to the underside of interior slab elevations.

Any utility services requiring installation below the undersides of the floor slabs should be installed during the above backfilling stage.

f) To help promote good curing of the concrete slab, a polyethylene moisture barrier should be placed on the compacted surface prior to placing concrete for floor slabs. Concrete for floor slabs can be poured directly on the above prepared surface.

10.0 FROST PROTECTION

Adequate frost protection for structural foundations can be provided by at least 900 mm of ground cover above foundation base levels or the equivalent in Styrofoam insulation (R10 or better).

11.0 DRAINAGE

11.1 General Site Drainage

Finished outside ground surfaces should be graded such that surface water is directed away from and not toward the structures.
11.2 Roof Drainage

Roof drainage should be done in accordance with the current edition of the British Columbia Building Code.

The roof drainage should not connect to the perimeter foundation drainage in any circumstances.

11.3 Perimeter Foundation Drainage

The Glenmore Booster Station will not require perimeter foundation drainage provided all interior floor slab surfaces are at least 200 mm above adjacent finished outside grades. In the event that this is not the case, perimeter drainage should be installed for this structure. The following procedures should be adhered to for perimeter drainage construction:

i) The perimeter drains should be 100 mm diameter rigid perforated PVC pipe.

ii) The pipe should be set with perforations facing downwards on a geotextile filter (Nilex 4535 or an approved equivalent), approximately 200 mm outside of foundation edges and at or below foundation base levels, or at least 1.0 m below finished grades, whichever is deeper.

iii) The top and sides of the pipe should be covered with approximately 150 mm of washed and clean 25 mm drain rock. The pipe/drain rock combination should be completely enclosed within the geotextile filter. Where it closes, the geotextile filter should overlap by at least 150 mm.

iv) Where it leaves the foundation perimeter, the pipe should be connected to a 100 mm diameter rigid non-perforated PVC pipe and directed with positive downward drainage away from the structure to an approved frost-free outlet.

v) In no circumstances should the perimeter drain system be connected to the roof drain system.

12.0 TRENCH EXCAVATIONS AND BACKFILL RECOMMENDATIONS

12.1 Trench Excavation Side Slope Stability

Trench constructions must conform to WorkSafe BC regulations and guidelines, this report, and project requirements.

12.2 General Trench Excavation and Backfill Recommendations

Where utility installations will be located below base of interior and/or exterior foundation elevations they should be backfilled in accordance with Section 9.0 of this report prior to final ground preparation for foundations. Alternatively, conduits can be installed prior to foundation constructions for later utility installs. Any utility installation should be done such
no excavation will be required after foundation construction within a horizontal distance of the foundations that is equal to twice the vertical distance between the base of foundation and the utility line and/or conduit.

12.3 Trench Foundation Soils Preparation Below Structures

All existing uncontrolled fill, soft and/or loose and/or frozen materials should be removed to expose the natural and undisturbed in situ sands. In the event that unexpected geotechnical conditions arise, the geotechnical engineer should observe the base of trench excavation prior to proceeding beyond this point.

Specifications related to trench foundation soil materials, construction methods and procedures, and quality assurance and control should conform with related local by-law specifications and this report.

12.4 Pipe Zone and Trench Backfill

Specifications related to pipe zone and trench backfill materials, construction methods and procedures, and quality assurance and control should conform with related local by-law specifications.

13.0 PAVEMENT STRUCTURE DESIGN

13.1 General Pavement Structure Discussion And Design Qualifications

In discussion with yourself, the roadway and parking lot for the proposed Glenmore Booster Station site may be finished with a gravel or asphalt surface. It is also understood that the pavement structure design for this site should adhere to DoLk specifications and guidelines.

The road structure designs provided below will satisfy the strength requirements for the specified traffic loads, but will not address frost susceptibility in its entirety. Full frost protection should be provided at this site and the method of providing this will depend on finished site grades. Generally, full frost protection would require a road structure consisting of at least 900 mm of non-frost susceptible granular soils, or its equivalent in insulating value.

The pavement structure design life assumes that a road maintenance program exists such that cracks are filled before the underlying road structure is damaged due to the introduction of moisture.

13.2 On Site Pavement and Parking Area Structure Requirements

It is understood that the proposed on site roadways and parking areas will subjected to approximately 1-2 light vehicles per day.
The following pavement structure design for an asphalted roadway is based on the DoLK Subdivision And Development Servicing Bylaw No. 97-139, which defines a road structure design life expectancy as 15 years.

For design purposes, a value equal to $5.6 \times 10^2$ Equivalent Single Axle Loads (ESAL) has been used for this road structure design as the minimum required by the DoLK for an Industrial Road Classification (1 ESAL = 8165 kg).

On the basis of gathered information, the design qualifications provided above and the subgrade preparation recommendations provided below, the following minimum on site roadway and parking area road structure is recommended at the subject site:

<table>
<thead>
<tr>
<th>THICKNESS (mm)</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 OR 150</td>
<td>DoLK Hot Mix Asphalt (two lifts) OR MoTI 25mm(-) High Fines Surfacing Aggregate</td>
</tr>
<tr>
<td>100</td>
<td>DoLK 25 mm(-) Crushed Granular Base Course</td>
</tr>
<tr>
<td>300</td>
<td>DoLK 75 mm(-) Granular Sub-base Course</td>
</tr>
<tr>
<td></td>
<td>For Prepared Subgrade (See 13.3 Below)</td>
</tr>
</tbody>
</table>

13.3 Subgrade Preparation

a) Subgrade preparation should include the removal of all soft, loose, frozen, organic, non-engineered fill soils, snow, and any other deleterious materials below travelled areas to expose the undisturbed in situ sands, or to design top of subgrade elevations, whichever is deeper.

The horizontal extent of the subgrade surface should be extended at least 1.0 m from the outside edges of the proposed travelled areas, curb and gutter, or sidewalk, or as wide as possible due to nearby constraints. At locations where a road embankment must be constructed, the base of the excavation should be further extended for a horizontal distance defined by an imaginary line extending outside the asphalted roadway, curb and gutter, or sidewalk at a 2H:1V slope gradient, until it intersects the competent undisturbed in-situ soils. The excavation should be done such that equipment does not travel on excavated subgrade surfaces.

The exposed excavation surface should be observed by the geotechnical engineer to confirm that all obvious deleterious materials have been removed to expose a competent subgrade surface before proceeding with the next stage of construction.

b) Where excavation to levels that exceed the thickness requirements given in the above noted road structures are needed, backfill materials used to elevate the subgrade to the design elevation should consist of clean, well-graded 150 mm (minus) sands and gravels, or approved salvaged materials, that are moisture conditioned and compacted in 300 mm loose
lifts to at least 95 percent of SPD. The upper 300 mm of the subgrade materials should be compacted to at least 100 percent of SPD.

c) The finished subgrade surface should be provided with a crown or cross fall gradient of at least two percent to allow efficient drainage toward the outer edges of the traveled surface areas of any moisture that may accumulate within the finished road structure.

d) It is recommended that the finished subgrade surface be inspected by the geotechnical engineer and possibly proof rolled in order to identify any soft or weak areas before placing subbase materials. Soft or weak areas should be excavated and replaced with clean, well-graded 150 mm (minus) sands and gravels compacted to at least 100 percent of SPD.

13.4 Subbase, Base and Asphalt Constructions

Specifications related to the pavement structure materials, construction methods and procedures, and quality assurance and control should conform with DoLk specifications and this report. If used, the High Fines Surfacing Aggregate materials should conform with Ministry of Transportation and Infrastructure (MoTI) specifications and this report.

13.5 Concrete Sidewalks, Curbs, and Gutters

Specifications related to concrete sidewalk, curb, and gutter materials, construction methods and procedures, and quality assurance and control should conform with DoLk specifications and this report.

13.6 Drainage

Good drainage should be provided for this site by grading and/or piping. Specifications and methods related to drainage materials, construction methods and procedures, and quality assurance and control testing should conform with DoLk specifications and this report.

The site should be maintained in a well-drained condition throughout the construction phase in order to reduce the potential for damaging the damp subgrade soils by construction traffic due to pumping actions in the subsoils and to prevent excessive erosion of the unfinished construction during storm events.

14.0 SITE GRADING CUT AND FILL SLOPES

Finished permanent cut and fill slopes should be constructed such that side slope gradients are 2.0H:1V or flatter, where feasible; otherwise retaining structures and/or soil reinforcement methods using geogrid and/or geotextiles may be required.

All fill materials placed against existing slopes with slope gradients steeper than 5H:1V should be done in accordance with MoTI construction specifications; specifically; Section 201.37, which states that the construction "shall be terraced in a continuous series of steps a minimum of 1.5 m wide as the embankment rises".
Finished slopes should be provided with erosion protection. Compaction requirements of earthen fill slopes will vary depending on application and location, and can be discussed with the geotechnical engineer during the design phase.

15.0 CONCLUSIONS AND RECOMMENDATIONS

It is concluded that, from a geotechnical point of view, the proposed constructions can safely proceed provided the recommendations made in this report are followed.

It is recommended that:

a) The items contained in Sections 5.0 to 14.0, inclusive, of this report are followed.

b) The geotechnical engineer inspect all soils and soils related construction on the project to assure that:

i) all soils conditions are as good or better than those inferred in this report, and that

ii) all soils and soils related construction conforms to this report, designs provided, and appropriate specifications for the work.

c) Any design(s) or other work for soils or for soils related structures connected with this project and prepared by others be submitted to the geotechnical engineer for review regarding conformity to the project requirements and intent of this report.

We trust that the contents of this report are appropriate for your immediate needs. If you should have any questions please call our office at your convenience.

Yours truly,
Fletcher Paine Associates Ltd.

Robert M. Scherz, P.Eng.
Geotechnical Engineer

Terry L. Eddy, P.Eng.
Review Engineer
STATEMENT OF QUALIFICATIONS AND GENERAL CONDITIONS

1. Standard of Care

This report has been prepared in accordance with generally accepted geotechnical engineering practices in this area. No other warranty, expressed or implied, is made.

2. Basis of the Report

This report has been prepared for the specific site, design objective, development and purpose that was described to Fletcher Paine Associates Ltd. (FPA) by the client and summarized in this letter. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the report are only valid to the extent that there has been no material alteration to or variation from any of the said descriptions provided to FPA, unless FPA was specifically requested by the Client to review and revise the report in light of such alteration or variation.

3. Uses of the Report

The information and opinions expressed in this report are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THIS REPORT OR ANY PORTION THEREOF WITHOUT FPA’s EXPRESS WRITTEN CONSENT. FPA WILL CONSENT TO ANY REASONABLE REQUEST BY THE CLIENT TO APPROVE THE USE OF THIS REPORT BY OTHER PARTIES AS APPROVED USERS. The ownership and copyright of this report remain the property of FPA, who authorizes only the Client and Approved Users to make copies of the report and only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell or otherwise make available the report or any portion thereof, or any copy of the report or portion thereof, to any other party without the express written permission of FPA.

4. Complete Report

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to FPA by the Client, communications between FPA and the Client, and to any other reports prepared by FPA for the Client relative to the specific site described in the report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS, AND OPINIONS EXPRESSED IN THE REPORT, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. FPA CANNOT BE RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

5. Interpretation of the Report

a) Nature and Exactness of Soil Description: Classification and identification of soils, rocks, and geologic units have been based upon commonly accepted methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from these systems have been used they are specifically mentioned. Classification and identification of the type and condition of soils, rocks and geologic units are judgmental in nature. Accordingly, FPA cannot warrant or guarantee the exactness of the descriptions of in situ ground conditions set forth in the Report.

b) Logs of Test Holes, Pits, Trenches, etc.: The test hole logs are a record of information obtained from field observations and laboratory testing of selected samples as well as an interpretation of the likely subsurface stratigraphy at the test holes sites. In some instances normal sampling procedures do not recover a complete or any sample. Soil, rock or geologic zones have been interpreted from the available data. The change from one zone to another, indicated on the logs as a distinct line, may be transitional. The same limitations apply to test pit and other logs.
c) Stratigraphic and Geologic Sections: The stratigraphic and geologic sections indicated on drawings contained in this report are interpreted from logs of test holes, test pits or other available information. Stratigraphy is inferred only at the locations of the test holes or pits to the extent indicated by items 5. a) and b) above. The actual geology and stratigraphy, particularly between these locations, may vary considerably from that shown on the drawings. Since natural variations in geologic conditions are inherent and a function of the historic site environment, FPA does not represent or warrant that the conditions illustrated are exact and the user of the report should recognize that variations may exist.

d) Groundwater Conditions: Groundwater conditions shown on logs of test holes and test pits, and/or given within the text of this report, record the observed conditions at the time of their measurement. Groundwater conditions may vary between test hole and test pit locations and can be affected by annual, seasonal, and special meteorological conditions, or by tidal conditions for sites near the seas. Groundwater conditions can also be altered by construction activity. These types of variation need to be considered in design and construction.

e) Changes of Exposed Ground: Many geologic materials deteriorate rapidly upon exposure to climatic elements. Deterioration may be caused by precipitation, sunshine and/or the action of frost. Therefore, site conditions may vary considerably from the time of the making of the tests performed for preparation of the report and the time of actual construction.

f) Influence of Construction Activity: Construction activities can alter and damage the in situ ground conditions. The influence of all anticipated construction activities on the geologic environment should be considered in formulating and implementing the final design and construction techniques.

Wherever changes in the site occur after the preparation of the report or conditions are observed which indicate results clearly incompatible with the test results on which the report is based, the client and any other users of this report should notify FPA as soon as possible so that FPA will be able to provide necessary revisions to its report prior to any commencement of or alteration in design and construction.

6. Observations during Construction

Observations of geologic conditions should be carried out during the site preparation, excavation and construction to verify the conditions predicted by the report. Such observations should be communicated to FPA to allow for confirmation and/or alteration of the geotechnical recommendations or design guidelines presented in the report.

Whenever changes in the site occur after the preparation of the report or conditions are observed which indicate results clearly incompatible with the test results on which the report is based, then the client should notify FPA as soon as possible so that FPA will be able to provide necessary revisions to its report prior to any commencement of or alteration in design and construction.

7. Samples

FPA normally disposes of all unused soil and rock samples after 90 days of completing the testing program for which the samples were obtained. Further storage or transfer of samples can be made at the owner’s expense upon written request.
# Record of Exploration - Borehole No. 1

**Project No:** 6263B  
**Project:** Glenmore Booster Station  
**Client:** AECOM  
**Project Location:** Seaton Road, Lake Country, BC  
**Borehole Location:** See Figure 6263B-2  
**Drilling Contractor:** Mud Bay Drilling Ltd.  
**Drilling Date:** March 31, 2016  
**Auger Size:** 150 mm solid stem

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
<th>Sample</th>
<th>Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Ground Surface</td>
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</tr>
<tr>
<td>1</td>
<td>ASPHALT - 25 mm</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>FILL, mixture of sand and gravel, compact, brown, damp</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>SAND, trace silt, trace gravel, compact to dense, brown, dry to damp</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

- SDS Cone Penetration Test (blows/0.3m)
- Moisture Content (%)
- Standpipe Data: April 7, 2016 dry to 3.0 m below ground

End of borehole at 6.1 m  
No groundwater seepage encountered  
Borehole sides sloughed at 3.1 m and deeper

---

**Fletcher Paine Associates Ltd.**  
2250 - 11th Avenue  
Vernon, B.C. V1T 7X8  
Ph. (250) 542-0377 Fax. (250) 542-1220  
fletcherpaine@shawlink.ca

This Record of Exploration forms a part of the report referenced by the above Fletcher Paine Associates Ltd. project number. It should not be read or interpreted on a stand-alone basis and dissemination of the information is limited as outlined in the referenced report.
**PROJECT:** Proposed Glenmore Booster Station

**LOCATION:** Lake Country, BC

**MATERIAL:** Sand, trace silt, trace gravel

**Sampled By:** RMS

**SOURCE:** Borehole 1

**DATE:** 31-Mar-16

<table>
<thead>
<tr>
<th>SIEVE (mm)</th>
<th>% Passing</th>
<th>MIN. %</th>
<th>MAX. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
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<td>50</td>
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<td>25.0</td>
<td>100</td>
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</tr>
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<td>19.0</td>
<td>96.7</td>
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</tr>
<tr>
<td>12.5</td>
<td>96.6</td>
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</table>

**GRADATION SPECIFICATIONS:** No Specification

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<tr>
<th>WASH ANALYSIS</th>
<th>LIMITS</th>
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</thead>
<tbody>
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<td>SIEVE (mm)</td>
<td>% Passing</td>
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<tr>
<td>9.50</td>
<td>96.5</td>
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<tr>
<td>4.75</td>
<td>95.7</td>
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<tr>
<td>2.36</td>
<td>93.0</td>
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<tr>
<td>1.18</td>
<td>85.5</td>
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<tr>
<td>0.600</td>
<td>62.4</td>
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<tr>
<td>0.300</td>
<td>23.2</td>
</tr>
<tr>
<td>0.150</td>
<td>11.5</td>
</tr>
<tr>
<td>0.075</td>
<td>8.1</td>
</tr>
</tbody>
</table>

**REMARKS:**
- Sampled from Borehole 1, Sample 1, Depth 1.2 m

---

Reporting of this test result constitutes testing services only. Engineering interpretation or evaluation of the test result is provided only upon written request.

Data presented in this report is for the exclusive use of the Client listed above. F.P.A. will not take any responsibility for any unauthorized use.
TERMS OF ENGAGEMENT

1. General

Fletcher Paine Associates Ltd. (FPA) shall render its services to the Client for this project with that degree of care, skill and diligence normally provided in the performance of services for projects of a similar nature to that contemplated.

In rendering services to the Client, FPA may, at its discretion and at any stage, engage subconsultants to FPA to carry out its duties and responsibilities as set forth.

2. Compensation

Charges for the services rendered will be made in accordance with our Schedule of Fees in effect at the time the work is performed. All charges will be made in, and will be payable in, Canadian Dollars. Invoices will be due and payable on receipt without holdback. A monthly service charge will be applicable to invoices remaining unpaid after 30 days.

3. Notices

FPA will designate a project manager who shall be responsible for the project. The Client shall designate an authorized representative to act with respect to the project.

4. Termination

Either party may terminate this engagement with cause upon seven (7) days notice in writing. The Client shall forthwith pay for all services performed, including all expenses and other charges payable that are associated with obligations incurred by FPA for this project.

5. Environment and Pollution

The FPA field investigation, laboratory testing and engineering recommendations are not intended to address or evaluate pollution of soil or pollution of groundwater. When practical, FPA will cooperate with the Client's environmental consultant during the field work phase of the investigation.

6. Professional Responsibility

FPA will provide the standards of care, skill and diligence normally provided by a Professional Engineer in the performance of engineering services as contemplated for this project.

7. Limitations of Liability

FPA shall not be responsible for:

a) The failure of a Contractor to perform work in accordance with the relevant contract documents for the Project;

b) The design of, or defects in, equipment provided by or on behalf of the Client by others, for incorporation into the Project;

c) Any damage to subsurface structures or utilities; resulting from subsurface investigations for the Project;

d) Any cross-contamination of ground or groundwater resulting from subsurface investigations for the Project;

e) Any costs incurred for stopping the flow of artesian water from test holes in the event that such conditions are encountered during any field investigation for the Project;

f) Any decisions made by the Client in relation to the Project that are inconsistent with, or contrary to, the advice provided by FPA;

g) Any consequential loss, injury, or damages suffered by the Client, including but not limited to loss of use, loss of earnings, or business interruption;

h) The distribution of any document or report prepared for the Client by or on behalf of FPA for the Project without express authorization by FPA.
Notwithstanding anything to the contrary, the aggregate liability of FPA, including liability for professional negligence and fundamental breach of contract, shall be limited to the amount of Professional Liability insurance carried by FPA.

The Client's failure to accept the professional recommendations and advice of FPA with respect to the geotechnical conditions at the Project shall relieve FPA of and from any and all legal liability, whether in contract or in tort, to the Client for all manner of loss and damage accruing to the Client, including consequential loss and damage, which may arise out of the FPA services.

8. Personal Liability

The Client agrees that FPA's principals and employees have no personal liability to the Client in respect of a claim whether in contract, tort, and/or any other cause of action in law, and expressly agrees that it will bring no proceedings and take no action in any court of law against any of FPA's principals or employees in their personal capacities.

9. Third Party Liability

This report was prepared by FPA for the Client and the material presented in it reflects the opinions and judgements of FPA as based upon the information available at the time of its preparation. Any use(s) made of this report by a third party is/are the sole responsibility of such third parties. FPA will not accept any responsibility for damages suffered by any third party as a result of decisions made or actions taken that are ostensibly based upon this report. Any use or reliance upon this report by a third party must be authorized in writing by FPA.

10. Documents

All of the Documents prepared by FPA in connection with the Project are instruments of service for the execution of the Work. FPA retains the property and copyright in those Documents, whether the Project is executed or not. These Documents may not be used on any other project without prior written agreement and remuneration.

11. Field Services

Where applicable, the field services recommended are the minimum necessary to ascertain that the Contractor's work is being carried out in general conformity with the intent of our recommendations. Any reduction from the level of services recommended will result in FPA providing qualified opinions regarding the adequacy of the work.

12. Confirmation of Professional Liability Insurance

As required by the Association of Professional Engineers and Geoscientists of British Columbia, it is required that our firm advise whether or not Professional Liability Insurance is held. It is also required that a space for you to acknowledge this information is provided. Accordingly, this notice serves to advise you that FPA carries professional liability insurance. If you wish to acknowledge receipt of this information please sign and return a copy of this form.
Exhibit B – IITS Electrical, Instrumentation and Integration Scope of Supply Documents
We are pleased to quote the following:

<table>
<thead>
<tr>
<th>Item</th>
<th>Qty</th>
<th>Description</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Eldorado Low Lift Pump Station MCC consisting of:</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- Cutler Hammer MCC 2100 Series.</td>
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<td></td>
<td></td>
<td>- Section 1 - 814mm 400A, 600V, 3P, 4W Main Service Section c/w Metering Cubical.</td>
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<td></td>
<td></td>
<td>- Section 2 - 508mm 160KA Surge Protector, Power Metering, Size1 FVNR Starter, 4 x 50A Feeder Breakers Section.</td>
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<tr>
<td></td>
<td></td>
<td>- Section 3 - 610mm 30KVA Transformer &amp; Panelboard Section.</td>
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<td></td>
<td></td>
<td>- Section 4 - 814mm Pump 1 100Hp VFD c/w Mirus Harmonic Filter and 3% Load Reactor Section.</td>
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<td></td>
<td></td>
<td>- Section 5 - 814mm Pump 2 100Hp VFD c/w Mirus Harmonic Filter and 3% Load Reactor Section.</td>
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<td></td>
<td></td>
<td>- Section 6 - 814mm Pump 3 100Hp VFD c/w Mirus Harmonic Filter and 3% Load Reactor Section.</td>
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<td></td>
<td></td>
<td>- Section 7 - 712mm PLC Control Section.</td>
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<td></td>
<td></td>
<td>- MCC CSA Certification and Testing.</td>
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<td></td>
<td></td>
<td>- MCC Approval, As-built Drawings and O&amp;M Manuals.</td>
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<td></td>
<td></td>
<td>- MCC Shipping to site included. Offloading &amp; installation by others.</td>
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<tr>
<td>2</td>
<td>1</td>
<td>Eldorado Low Lift Pump Station PLC Control Panel consisting of:</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- SCADAPack 357 PLC System.</td>
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<td></td>
<td></td>
<td>- 8” C-More TFT Operator Interface.</td>
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<td></td>
<td></td>
<td>- 5 Port, 10/100/1000MB Industrial Ethernet Switch c/w 1 FO Port.</td>
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<tr>
<td></td>
<td></td>
<td>- 70W, 24Vdc Power Supply.</td>
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<td></td>
<td></td>
<td>- 1000VA, 120Vac UPS System.</td>
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<td></td>
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<td>- 8 Port FO Termination Enclosure c/w FO Cable Ends &amp; Patch Cable.</td>
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<td></td>
<td></td>
<td>- Power On &amp; General Alarm LED Pilot Light.</td>
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<td></td>
<td></td>
<td>- Alarm Reset Push Button.</td>
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<td></td>
<td></td>
<td>- Panel Terminals, Wireway, DIN Rail, Relays and Wiring Material.</td>
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<tr>
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<td>- Panel CSA Testing and Certification.</td>
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<td></td>
<td></td>
<td>- Panel Approval, As-built Drawings and O&amp;M Manuals.</td>
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<tr>
<td></td>
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<td>- Installed in Section 7 of MCC with all VFD interconnecting wiring.</td>
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<tr>
<td>3</td>
<td>1</td>
<td>Eldorado Low Lift Pump Station Instrumentation consisting of:</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- 4 only Pressure Transmitters.</td>
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<td></td>
<td>- 2 only Room Temperature Transmitters.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- 1 only Station Discharge Strap-on Ultrasonic Flowmeter.</td>
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<tr>
<td></td>
<td></td>
<td>- 1 only Building Security System c/w Door Enter Limit Switches.</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- Instrumentation Equipment Installation &amp; Calibration, wiring by others.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>- AECOM 101, 102, 103 Forms.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- Instrumentation Equipment Approval Drawings and O&amp;M Manuals.</td>
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<tr>
<td>Item</td>
<td>Qty</td>
<td>Description</td>
<td>Unit Cost</td>
<td>Total Cost</td>
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<tr>
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<td>------------</td>
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<tr>
<td>4</td>
<td>1</td>
<td>Eldorado New Reservoir PLC Control Panel consisting of:</td>
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<tr>
<td></td>
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<td>- 42&quot;H x 30&quot;W x 12&quot;D Nema 4 Enclosure c/w Backplate &amp; Footkit</td>
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<td>- SCADAPack 334 PLC System.</td>
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<td>- 8&quot; C-More TFT Operator Interface.</td>
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<td>- 2 only Siemens Multiranger 100 Ultrasonic Level Transmitters.</td>
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<td>- 5 Port, 10/100/1000MB Industrial Ethernet Switch c/w 1 FO Port.</td>
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<td>- 70W, 24Vdc Power Supply.</td>
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<td>- 1000VA, 120Vac UPS System.</td>
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<td>- 8 Port FO Termination Enclosure c/w FO Cable Ends &amp; Patch Cable.</td>
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<td>- Power On &amp; General Alarm LED Pilot Light.</td>
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<td>- Alarm Reset Push Button.</td>
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<td>- Panel Terminals, Wireway, DIN Rail, Relays and Wiring Material.</td>
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<td>- Panel CSA Testing and Certification.</td>
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<td>- Panel Approval, As-built Drawings and O&amp;M Manuals.</td>
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<td>- Panel Shipping to site included. Offloading &amp; installation by others.</td>
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<td>5</td>
<td>1</td>
<td>Eldorado New Reservoir Ethernet Radio System consisting of:</td>
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<td>- Xetwave Single 900MHz Ethernet/Serial Radio Modem.</td>
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<td>- Polyhaser Coax Cable Surge Arrestor.</td>
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<td>- Comprod 10db, 7 Element 900MHz Yagi Antenna.</td>
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<td>- Valid Manufacturing 4.25M Tall Antenna Pole.</td>
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<td>- Coax Cable &amp; Connectors.</td>
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<td>- Radio System and Antenna Pole Installation.</td>
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<td>6</td>
<td>1</td>
<td>Eldorado New Reservoir Instrumentation consisting of:</td>
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<td>- 2 only Siemens XPS15 Transducer c/w 10 Meters of Cable.</td>
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<td>- 4 only Xylem ENM10 Float Switches c/w 13 Meters of Cable.</td>
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<td>- 4 only Hatch Intrusion Limit Switches.</td>
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<td>- 2 only Hatch Instruments Junction Boxes c/w Wiring Terminals.</td>
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<td>- 1 only Valve Chamber Room Temperature Transmitters.</td>
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<td>- 1 only Valve Chamber Security System c/w Door Enter Limit Switch.</td>
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<td>- Instrumentation Equipment Installation &amp; Calibration, wiring by others.</td>
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<td>- AECOM 101, 102, 103 Forms.</td>
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<td>- Instrumentation Equipment Approval Drawings and O&amp;M Manuals.</td>
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<td>7</td>
<td>1</td>
<td>Eldorado Existing Reservoir PLC Control Panel Modifications consisting of:</td>
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<td>- Installation and Wiring of 8 Point Analog Input Module.</td>
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<td>- Installation and Wiring of 4 Point Analog Output Module.</td>
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<td>- Installation and Wiring of 10 Port Industrial Ethernet Switch c/w 2 FO Ports.</td>
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<td>- Installation of 8 Port Fiber Optic Termination Enclosure and termination of Fiber Optic Cables.</td>
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<td>- Control Panel Additions Approval and As-built Drawings.</td>
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</tbody>
</table>
## QUOTATION

**TO:** AECOM

**ATTENTION:** Brett deWynter, P.Eng.

**REFERENCE:** Eldorado Pump Stn & Reservoir - Motor Control Center, Instrumentation and Control Panel.

### QUOTATION TERMS:
- Firm 30 Days, Corix Standard Commercial Terms & Conditions Apply.
- **PAYMENT TERMS:** 90% Net 30 Days, 10% Holdback.
- **FUNDS:** Canadian Dollars
- **TAXES:** 7% PST is included where applicable. 5% GST is extra on all items.
- **DELIVERY:** Approval Drawings: 3-4 Weeks After Receipt of Purchase Order. Equipment: 10-12 Weeks After Return of Approved Drawings.
- **FOB:** Jobsite
- **WARRANTY:** 1-Year after date of shipment. For **WARRANTY REPAIRS**, freight to and from our Kelowna facility is not included.

### Item Description

<table>
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<tr>
<th>Item</th>
<th>Qty</th>
<th>Description</th>
<th>Unit Cost</th>
<th>Total Cost</th>
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</table>
| 8    | 1   | Eldorado Existing Reservoir Instrumentation consisting of:  
- 1 only Endress+Hauser 8 Channel Multifunction Transmitter.  
- 1 only Endress+Hauser Chloromax Chlorine Probe.  
- 1 only Endress+Hauser Orbisint Memosens pH & Temp Sensor.  
- 1 only Endress+Hauser FLOWFIT-W Flowcell Assembly.  
- 1 only Esko ELF Sample Flow Rotameter.  
- Instrumentation Equipment Installation & Calibration, wiring by others.  
- AECOM 101, 102, 103 Forms.  
- Instrumentation Equipment Approval Drawings and O&M Manuals. | | |
| 9    | 1   | Eldorado Existing Chlorine System Modifications consisting of:  
- 1 only Denora MA3002 50PPD Gas Flow Rotameter.  
- 1 only Denora 70CV/2000 50PPD Chloromatic Valve.  
- 1 only Denora EJ17C1XX 50PPD Ejector.  
- 1 only Denora BM-2827-5 Chlorine Gas Vacuum 120Vac Shutoff Valve.  
- 1 only Asco 1" Brass Body, 120Vac Soleoid Valve c/w Manual Bypass.  
- Gas Chlorine Equipment Installation & Calibration, wiring by others.  
- Gas Chlorine Equipment Approval Drawings and O&M Manuals. | | |
| 10   | 1   | Eldorado New & Existing Sites PLC, HMI & SCADA Programming consisting of:  
- Upgrade of the Existing iFix 300 Tag SCADA Software to Unlimited Tag System.  
- Low Lift Pump Stn, New and Existing Reservoir PLC System Programming.  
- Low Lift Pump Stn, New Reservoir Local HMI Programming.  
- Eldorado iFix SCADA Programming Additions.  
- System Start-up and Commissioning.  
- Camp Road iFix SCADA Programming Additions. | | |

**PER:** Ken Hansen, A.Sc.T.

**ATTENTION:** Brett deWynter, P.Eng.

**REFERENCE:** Eldorado Pump Stn & Reservoir - Motor Control Center, Instrumentation and Control Panel.

**TO:** AECOM

**ATTENTION:** Brett deWynter, P.Eng.

**REFERENCE:** Eldorado Pump Stn & Reservoir - Motor Control Center, Instrumentation and Control Panel.
TO: AECOM  
ATTENTION: Brett deWynter, P.Eng.  
REFERENCE: Eldorado Pump Stn & Reservoir - Motor Control Center, Instrumentation and Control Panel.

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<th>Total Cost</th>
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QUOTATION EXCLUSIONS:
1) Any Civil or Mechanical works such as ditching, trenching, bedding sand or inline Flowmeter Installation.
2) Any concrete cutting or coring work. Wall or floor penetration may be required for installation of some of the equipment.
3) Any supply and installation of piping systems.
4) Cost for any permits other than an electrical permit for our portion of the project work.
5) Any electrical wiring other than the existing reservoir PLC control panel modification wiring as listed above and the installation of the radio antenna coax cable.
6) Any site facilities, a first aid attendant or confine space entry assessments.
# QUOTATION

**TO:** AECOM  
Suite 201, 3275 Lakeshore Road  
Kelowna, BC V1W 3S9  
**DATE:** March 26, 2017

**ATTENTION:** Brett deWynter, P.Eng.  
**PHONE NO:** 250.980.7104  
**FAX NO:** 250.762.7789

**REFERENCE:** Glenmore Road Booster Pump Station - Motor Control Center, Instrumentation & Control Panel.  
**EMAIL:** brett.deWynter@aecom.com  
**CELL NO:** 250.869.7126

---

**QUOTATION**

**TO:** AECOM  
**QUOTE NO:** 032617KH-002

**DATE:** March 26, 2017  
**PHONE NO:** 250.980.7104

**ATTENTION:** Brett deWynter, P.Eng.  
**FAX NO:** 250.762.7789

**REFERENCE:** Glenmore Road Booster Pump Station - Motor Control Center, Instrumentation & Control Panel.  
**EMAIL:** brett.deWynter@aecom.com  
**CELL NO:** 250.869.7126

We are pleased to quote the following:

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<th>Total Cost</th>
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</table>
| 1    | 1   | Glenmore Road Booster Pump Station MCC consisting of:  
- Cutler Hammer MCC 2100 Series.  
- Section 1 - 508mm Utility Service Pull Section.  
- Section 2 - 814mm 400A, 600V, 3P, 4W Main Service Section c/w Metering Cubical.  
- Section 3 - 610mm x 610mm Corner Section.  
- Section 4 - 508mm 160KVA Surge Protector, Power Metering, Size1 FVNR Starter, 4 x 50A Feeder Breakers Section.  
- Section 5 - 610mm 30KVA Transformer & Panelboard Section.  
- Section 6 - 1016mm Pump 1 200Hp VFD c/w 3% DC Chock Inlet Filter and 3% Load Reactor Section.  
- Section 7 - 1016mm Pump 2 200Hp VFD c/w 3% DC Chock Inlet Filter and 3% Load Reactor Section.  
- Section 8 - 712mm PLC Control Section.  
- MCC CSA Certification and Testing.  
- MCC Approval, As-built Drawings and O&M Manuals.  
- MCC Shipping to site included. Offloading & installation by others. | | |
| 2    | 1   | Glenmore Road Booster Pump Stn PLC Control Panel consisting of:  
- SCADAPack 357 PLC System.  
- 8" C-More TFT Operator Interface.  
- 5 Port, 10/100/1000MB Industrial Ethernet Switch.  
- 70W, 24Vdc Power Supply.  
- 1000VA, 120Vac UPS System.  
- Power On & General Alarm LED Pilot Light.  
- Alarm Reset Push Button.  
- Panel Terminals, Wireway, DIN Rail, Relays and Wiring Material.  
- Panel CSA Testing and Certification.  
- Panel Approval, As-built Drawings and O&M Manuals.  
- Installed in Section 8 of MCC with all VFD interconnecting wiring. | | |
| 3    | 1   | Glenmore Road Booster Pump Station Ethernet Radio System consisting of:  
- Xetwave Single 900MHz Ethernet/Serial Radio Modem.  
- Polyhaser Coax Cable Surge Arrestor.  
- Comprod 10db, 7 Element 900MHz Yagi Antenna.  
- Valid Manufacturing 4.25M Tall Antenna Pole.  
- Coax Cable & Connectors.  
- Radio System and Antenna Pole Installation. | | |

---

**SUITE 201, 3275 LAKESHORE ROAD**  
**KELOWNA, BC V1W 3S9**  
**PHONE NO:** 250.717.8813  
**FAX NO:** 250.717.8814
### QUOTATION

**TO:** AECOM  
**ATTENTION:** Brett deWynter, P.Eng.  
**REFERENCE:** Glenmore Road Booster Pump Station - Motor  
Control Center, Instrumentation & Control Panel.

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<th>Description</th>
<th>Unit Cost</th>
<th>Total Cost</th>
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</table>
| 4    | 1   | Glenmore Road Booster Pump Station Instrumentation consisting of:  
- 4 only Pressure Transmitters.  
- 3 only Room Temperature Transmitters.  
- 1 only Station Discharge Strap-on Ultrasonic Flowmeter.  
- 1 only Building Security System c/w Door Enter Limit Switches.  
- 2 only Xylem ENM10 Float Switches c/w 13 Meters of Cable.  
- 1 only Endress+Hauser 8 Channel Multifunction Transmitter.  
- 2 only Endress+Hauser Chloromax Chlorine Probe.  
- 2 only Endress+Hauser Orbisint Memosens pH & Temp Sensor.  
- 1 only Endress+Hauser Turbimax Turbidity Sensor.  
- 3 only Endress+Hauser FLOWFIT-W Flowcell Assembly.  
- 3 only Esko ELF Sample Flow Rotameter.  
- Instrumentation Equipment Installation & Calibration, wiring by others.  
- AECOM 101, 102, 103 Forms.  
- Instrumentation Equipment Approval Drawings and O&M Manuals. |  |  |
| 5    | 1   | Glenmore Road Booster Station PLC, HMI & SCADA Programming consisting of:  
- Glenmore Road Booster Pump Station PLC System Programming.  
- Glenmore Road Booster Pump Station Local HMI Programming.  
- Eldorado iFix SCADA Programming Additions.  
- System Start-up and Commissioning.  
- Camp Road iFix SCADA Programming Additions.  |  |  |

**PER:** Ken Hansen, A.Sc.T.

**QUOTATION TERMS:** Firm 30 Days, Corix Standard Commercial Terms & Conditions Apply.  
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**WARRANTY:** 1-Year after date of shipment. For WARRANTY REPAIRS, freight to and from our Kelowna facility is not included.

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2) Any concrete cutting or coring work. Wall or floor penetration may be required for installation of some of the equipment.
3) Any supply and installation of piping systems.
4) Cost for any permits other than an electrical permit for the radio antenna coax cable installation.
5) Any electrical wiring other than the installation of the radio antenna coax cable.
6) Any site facilities, a first aid attendant or confine space entry assessments.