DEPARTMENT OF TRANSPORTATION, INFRASTRUCTURE & ENERGY
Province of Prince Edward Island
Revision 0

TENDER FORM AND AGREEMENT

THIS AGREEMENT made by and between ....., herein called the Contractor, the Party of the First Part and The Government of Prince Edward Island as represented by the Minister of Transportation, Infrastructure & Energy, the Party of the Second Part.

WITNESS, AS FOLLOWS:

1. Definitions

The definition of terms used in this Tender Form and Agreement shall conform in all respects to the definition of terms contained in the document entitled "General Provisions and Contract Specifications for Highway Construction," published by the Department of Transportation and Infrastructure Renewal of the Province of Prince Edward Island as amended on the date of closing of Tenders pursuant to this Agreement.

2. General Covenant

The Contractor hereby covenants and agrees with the Minister as herein provided in connection with the following work, namely:

CLYDE RIVER - BRIDGE CROSSING - TCH Extension Project **DISTRICT 17**

The scope of this work includes, but is not necessarily limited to the following: the supply of all labour, equipment, and materials necessary to completely fabricate, erect and complete a new bridge structure. The work on this project shall consist of excavation; slope protection; environmental controls; steel piles; cofferdam; concrete formwork and accessories; cast-in-place concrete; structural steel girders; GFRP reinforced concrete; rip rap; and all other ancillaries required to completely install the structure to the satisfaction of the Owner.

PUBLIC BIDS SHOULD BE RETURNED TO THE DEPARTMENT NO LATER THAN
2:00 PM, Thursday, February 22nd, 2018
11 Kent Street, 3rd floor Jones Building, Charlottetown, PEI

3. No Implied Contract

It is hereby understood and agreed between the parties hereto that no implied contract of any kind whatsoever, by, or on behalf, of the Minister shall arise or be implied from anything contained in this Contract, or from any position or situation of the parties at any time, and that this Contract made by the Minister is, and shall be, the only Contract upon which any rights against the Minister are to be founded.

4. How Party of the First Part is Read

Whenever this Contract is entered into by more than one party or parties of the first part, the word "Contractor" shall be read "Contractors," and pronouns in the contract referring to the Contractors shall be read as plural and whenever a corporation is the Party of the First Part, the said pronouns shall be read accordingly.

5. Consideration of Clauses as Covenants

Wherever it is stipulated that anything shall be done or performed by either of the Parties hereto, it shall have the same effect and be constructed as if such Party had entered into a covenant with the other Party to do or perform the same, and as if such covenant had been expressly made on the part of the Contractor, not only on the Contractor's own behalf, but also on the behalf of the Contractor's legal representative, successors or assigns; and as if any such covenant on the part of the Minister has been made on behalf of the Minister, and the Minister's successors in office.

6. Contractors Submission Respecting the Agreement

The Contractor shall, as part of the Contractor's submission respecting this Contract, complete the attached Schedule B, Identification of Principles; Schedule C, Schedule of Tendered Unit Prices; Schedule D, Schedule of Equipment to be used on the work; and Schedule E, Schedule of Sub-Contractors.

The Contract including all appended schedules shall be completed in complete conformity with the instructions to bidders contained in the document entitled "General Provisions and Contract Specification for Highway Construction".

In presenting the Contractor’s submission for consideration by the Minister, the Contractor understands that until, and unless, the Contract is endorsed by the Minister, no Contract between the parties shall exist and the Minister shall not be bound to endorse any Contract.

7. Performance by Contractor

The Contractor, at the Contractor's own expense, shall, except as herein otherwise specifically provided, furnish and provide all and every kind of labour and superintendence, services, tools, implements, machinery, plant materials, articles and whatsoever is necessary for the due execution of the work. The Contractor shall fully construct and erect the work in the most thorough, professional and substantial manner, in every respect to the satisfaction and approval of the Engineer. The Contractor shall complete the work within the time specified herein and deliver it to the Minister in the manner and upon the terms and conditions of the Contract.

8. Bid and Performance Security

The Contractor hereby and herewith deposits with and delivers to the Minister, as security of the due fulfilment of the Contract, one of the following, which shall remain in effect for a minimum of 30 days after tender closing:

a) a Certified Cheque in the amount stipulated in Schedule A - Schedule of Special Provisions.

OR

b) a Bank Draft in the amount stipulated in Schedule A - Schedule of Special Provisions.

OR

c) a Bid Format irrevocable standby Letter of Credit on a Government approved form in the amount stipulated in Schedule A - Schedule of Special Provisions.

OR

d) a Bid Bond in the amount stipulated in Schedule A - Schedule of Special Provisions. The Bond shall be from a surety company authorized to carry on business in Canada guaranteeing to supply a Performance Bond equal to 50% of the contract value, excluding HST, and a Labour and Material Bond equal to 25% of the contract value, excluding HST.

Performance Security must be filed with the Department before work on the project commences. This security shall be held and retained by the Minister for the due and faithful performance, observance and fulfilment by the Contractor of all the covenants, provisos, agreements, conditions and reservations in this Contract contained on the part of the Contractors to be observed, performed and complied with shall be in the form of:

a) a Certified Cheque in the amount of ten percent (10%) of the Contract value, excluding HST, which shall be retained until the warranty period (one (1) year after substantial completion) has elapsed.

OR

b) a Bank Draft in the amount of ten percent (10%) of the Contract value, excluding HST, which shall be retained until the warranty period (one (1) year after substantial completion) has elapsed.

OR

c) a Performance Format irrevocable standby Letter of Credit on a Government approved form in the amount of ten percent (10%) of the Contract value, excluding HST, which shall be retained until the warranty period (one (1) year after substantial completion) has elapsed.

OR

d) a Performance Bond equal to 50% of the contract value, excluding HST, and a Labour and Materials Bond equal to 25% of the contract value, excluding HST, both of which shall be retained until the warranty period (one (1) year after substantial completion) has elapsed.

All performance security which has an expiry date which precedes the end of warranty date must be renewed prior to the time that the security would expire. The bidder will forfeit security to the Minister if the bidder fails to enter into or carry out the Contract when called upon to do so.

It is understood and agreed that the Contractor assumes risk and must bear any loss in respect to the performance security as aforesaid, occasioned by the failure or insolvency of the banks on which any cheque was drawn or in which any deposit was made in connection with the security aforesaid.

If at any time hereafter the said Contractor should make default under the said Contract, or if the Minister acting under the powers reserved in the said Contract shall determine that the said works, or any portion thereof remaining to be done, should be taken out of the hands of the Contractor and be completed in any manner or way whatsoever than by the Contractor, or if the Contractor refuses or neglects to pay for work done or materials supplied by any person in connection with the said work, the Minister may, in either case dispose of said security for the carrying out of the construction and completion of the work of the Contract or for paying any salaries or wages for work done, or any accounts for materials supplied for the said works that may be left unpaid by the said Contractor.

In the event of any breach, default or non-performance being made or suffered by the Contractor in or in respect of any of the terms and conditions, covenants, provisions, agreements, or restrictions herein contained, which on the part of the said Contractor should be observed, performed or complied with, the said security so delivered to or deposited with the Minister or by the Minister received in respect thereof, shall by the contractor, be forfeited absolutely to the Minister.

Upon the due and faithful performance, observance and fulfilment by the Contractor of all the terms, provisions, covenants, agreements, conditions, reservations, hereinbefore contained, on the part of the Contractor to be observed, performed and complied with, the Minister shall surrender the performance security.

9. Minister Covenants to Pay

In consideration of the faithful performance by the Contractor of all and singular covenants, agreements and provisions of the Contract, the Minister hereby covenants and agrees with the Contractor that, on the full completion by the Contractor of all the work as specified in the Contract, within the time specified and limited for the final completion thereof, and to the entire satisfaction of the Engineer to be evidenced by the certificate of the Engineer in writing, the said Minister will well and truly pay, or cause to be paid, to the said Contractor the amount of the Contract price, representing the actual quantities in the several items in the Schedule of Prices, identified as Schedule C to this Contract, at the unit prices or lump sum prices quoted by the Contractor. This amount paid to the Contractor as above, shall include all and every kind of work, labour, superintendence, services, tools, implements, machinery, plant materials, articles and things whatsoever necessary for the full execution and completion of the work to the entire satisfaction of the Engineer.

10. Final Payment

It is hereby agreed by the parties hereto that the payment of the final amount due under the Contract, and the adjustment and payment of any bills that may be rendered for work done, in accordance with any alteration in or addition to the same, shall release the Minister from any and all claims or liability

on account of work performed under the said Contract or any alteration in or addition to the same.

11. No Waiver

It is hereby agreed that no condoning, excusing, or overlooking by the Minister, or any person acting on the Minister's behalf on previous occasions of breaches or defaults similar to that for which any action is taken or power is exercised, or forfeiture is claimed or enforced against the Contractor, shall be taken as a waiver of any provisions of the Contract, or as defeating, affecting or prejudicing in any way the right of the Minister under the Contract.

12. Components of the Contract

Any and all plans or drawings prepared by the Department, the document titled “General Provisions and Contract Specifications for Highway Construction”, the advertisement, the Tender Form and Agreement together with Schedule A, Schedule of Special Provisions; Schedule B, Identification of Principals; Schedule C, Schedule of Tendered Unit Prices; Schedule D, Schedule of Equipment; and Schedule E, Schedule of Sub-Contractors, as well as any addenda which may be issued by the Department pursuant to this Contract shall hereby be a part of this Contract as fully and to the same effect as if the same had been set forth at length in the body of the Contract.

13. Completion of Work

The Contractor agrees to complete the work on or before 24 August, 2019.

14. FOIPP Clause

1. By submitting your bid, you agree to disclosure of the information supplied, subject to the provisions of the Freedom of Information and Protection of Privacy Act (FOIPP).

2. Anything submitted in your bid that you consider to be "confidential information" because of its proprietary nature should be marked as "confidential" and will be subject to appropriate consideration under the Freedom of Information and Protection of Privacy Act.

3. During the delivery and installation of goods and/or services, you may have access to confidential or personal information. Should this occur, you must ensure that such information is not released to any third party or unauthorized individual.

4. Any information provided on this contract may be subject to release under the Freedom of Information and Protection of Privacy Act. You will be consulted prior to the release of any information.

IN WITNESS WHEREOF the parties hereto have hereby caused these presents to be signed and sealed on the dates stated.

SIGNED, SEALED AND DELIVERED
by the Contractor on the day
of , 2018

.....
CONTRACTOR

In the presence of:

.....

SIGNED, SEALED AND DELIVERED
by the Minister on the day
of , 2018.

.....
MINISTER

In the presence of:

.....

SCHEDULE 'A'
SCHEDULE OF SPECIAL PROVISIONS
Revision 0, Jan 30, 2018

CLYDE RIVER BRIDGE CROSSING

1. SECTION 102.10 - COMPETENCY OF BIDDER

Bidders must be capable of performing the various items of work bid upon. Bidders shall, upon the request of the Department, provide a statement covering experience on similar work and a statement of their financial resources.

2. ALTERNATE BIDS

The Department will not be entertaining alternate bids on this project.

3. VALUE ENGINEERING (VE)

The Department of Transportation, Infrastructure & Energy (TIE) will entertain proposals brought forth by any bidder for Value Engineering (VE). The Department will review all proposals for technical merit and proposed cost savings. The Department will then advise whether or not the VE Proposal is feasible. The Department's decision shall be considered final.

Proposal(s) from any bidder shall be submitted with their tender submission, bound and clearly separated from the primary tender submission, complete with a cover letter (signed and dated) summarizing the overall concept of the proposal. The cover letter shall also clearly state the amount of cost savings indicated both in written and digit format.

Proposal(s) from any bidder shall contain a detailed breakdown of all related work activities complete with associated costs (credits and debits), with the net cost savings clearly indicated.

All submitted proposals shall be reviewed by TIE as part of TIE's evaluation in to order to determine the successful Contractor.

Any proposals deemed acceptable to TIE will be eligible for cost savings sharing of 50% for the Department and 50% for the Contractor. There will be no compensation for those proposals which are deemed unacceptable.

Note the 50/50 cost savings sharing shall ***not*** be applied to any credits to the Contract nor unused quantities. The cost savings sharing shall ***ONLY*** be applied to VE Proposals brought forth by the Contractor and agreed to with the Department.

All costs related to updating TIE and/or Consultant drawings as a result of an accepted proposal shall be covered by the Contractor, independent from the 50/50 cost split items.

4. SITE VISIT

The Department of Transportation, Infrastructure & Energy (TIE) recommends that bidders visit the site during the tender period to become familiar with and take into account the existing bridge system and all relevant surrounding site conditions. The successful Contractor to have included in tender price all costs associated with performing all aspects of the work which are affected by existing conditions

or related existing conditions which arise as a result of performing any aspect of the work. The Contractor shall investigate the possible presence of underground utilities/services which maybe encountered while performing the work, and take into account all associated precautions and/or altered work methods. No additional compensation will be provided for any work items affected by existing site conditions.

Bidders are responsible for their own safety during the site visit, and are not to negatively affect the safety of the travelling public.

5. SUBMISSIONS

Prior to submission to TIE, the Contractor shall be responsible to review the content of all documents for completeness, correctness, and meeting criteria of the Contract. The Contractor shall also be responsible to coordinate submission's timing such that TIE and/or its Consultant have a reasonable and sufficient amount of time to review submission and return comments so that such comments can be incorporated into the related work without negatively affecting project schedule. Incomplete submissions that do not meet project requirements and/or which may negatively affect the Contractor's construction schedule shall be the responsibility of the Contractor.

All submissions shall be submitted via digital media as much as practically possible, unless otherwise noted and/or agreed to by TIE. Digital submissions shall be Portable Document Format (PDF), with multi-page and drawing file documents created as a file booklet as opposed to individual files, unless booklet byte size is too large for email transmission.

Note that should the Contractor decide to use any part of TIE's drawing(s) to facilitate the preparation of a submission, the Contractor shall first remove from the drawing(s) all references connected to TIE (provincial logo, title block text, engineer's seal, etc).

6. SECTION 102.13 - SCHEDULING OF THE WORK

The number of working days stipulated for this Contract is two hundred and fifty (250) working days. No claims for delays caused by whatever external agencies or factors shall be allowed. The Contractor shall work Saturdays (if he deems necessary to meet deadline) and/or maximize the hours per day on site.

The project must be completed no later than August 24, 2019

All bidders shall supply a Preliminary Construction Schedule with his Tender Documents for review by TIE. Note that TIE's evaluation of submitted bids shall include reviewing the Preliminary Schedule including but not limited to the benefit(s) of earlier completion, bridge/roadway open to traffic (entire width), and overall project completion date. Note that the tender deadline dates indicated for any Phase(s), bridge/roadway open to traffic (entire width), and/or overall project completion are the latest acceptable dates, with earlier dates acceptable.

Prior to Contract award, the selected Bidder shall submit a detailed Final Construction Schedule to TIE for review. The Final Construction Schedule shall identify all primary work activities (eg excavation, demolition, pile driving, concrete foundations, rock placement, steel box girder supply and installation, deck, barriers, earthwork backfill, collision blocks, approach slabs, waterproofing, removal of

temporary works, etc). The Final Schedule shall indicate applicable time lines and milestones for all work activities and Phases.

Throughout the project the Contractor shall notify TIE of any situations that may negatively affect the project's Final Construction Schedule.

The Contractor shall, upon TIE request at any time throughout the project, update and submit to TIE an updated Construction Schedule as TIE deems required to reflect any circumstances that may cause the need for an updated Schedule.

It is the expectation that the Earthworks General Contractor will conduct all necessary works in order to allow the bridge contractor access to this site. The general sequencing of the works is as follows:

- Construct access roads and earthen working platforms for centre pier (Earthworks contractor)
- Excavate for pier base construction (Earthworks contractor)
- Drive piles and construct cast-in-place concrete pier base (Bridge contractor)
- Construct pier shaft and hammerhead pier cap (Bridge contractor)
- re-align river bed (Earthworks contractor)
- Construct approach roads on the east end of the bridge (Earthworks contractor)
- Drive piles for east abutment and construct concrete abutment pile cap (Bridge contractor)
- Construct western approach roads to bridge structure (Earthworks contractor)
- Drive piles for west abutment and construct concrete abutment pile cap (Bridge contractor)
- Backfill abutments with Class 'A' material (Bridge contractor)
- Complete construction of bridge superstructure (Bridge contractor)
- Complete select borrow and granular base on the approaches (Earthworks contractor)
- Waterproof the bridge deck and place asphalt wearing surface (Earthworks contractor)

The above sequencing is not intended to be a succession of events as there are some items which could be worked on concurrently. The Bridge and Earthwork contractors are free to revise or modify the sequencing as they see fit in order to best achieve the desired results and to meet the budget and schedule.

Bidders are advised that the financial scheduling shall be $4.0 Million in Fiscal Year 2018/19. The remainder shall be processed during Fiscal Year 2019/20; which begins on April 1, 2019. It is anticipated that the site will be inactive during the winter months of 2018/2019.

7. SECTION 103.03 - EXTRA WORK

The Cost of any extra work shall not include the costs of service vehicles or the wages of the supervisory personnel except under special circumstances authorized by the Engineer.

Extra work shall be defined as work activity, or service, on its own or part of a larger component of work to be performed, which is not already included as a cost item in the project's Schedule C.

Note that a TIE bridge construction representative (project manager, engineer) shall compare the as-tendered scope of work versus the concerned scope of work to determine whether the concerned work is indeed extra work.

Any extra work which is to be conducted under a Time and Materials System shall be agreed to by both parties daily, and shall be complimented with the appropriate supplemental information, including, but not limited to:

a) Labour: Submit (for each worker) name, date(s), description of work performed, time of day work performed, manhours, and associated rates;
b) Material: Submit identification, quantity, backup invoices, and associated costs for each;
c) Service or rentals: Submit supporting documentation verifying costs for each item;
d) Equipment: Submit identification, date(s), description of work performed, time of day work performed, quantity of hours, as well as the equipment's year, make, and model. Equipment charges shall be paid based on the Province of PEI Machinery Rental Rates.

Failure to provide the above information, or any other documentation requested by the Engineer to assist verification of actual cost incurred, shall be cause for rejection of the Claim. All claims shall be submitted within thirty (30) days of the extra work being complete, or within the associated progress claim period. Failure to provide the requested documentation in a timely manner may result in a delay of payment for the extra claim, with no incremental extra compensation entertained.

Note that a TIE bridge construction representative (data collector, project manager, engineer) must be notified prior to the Contractor performing any activities He deems to be extra work. A bridge representative also must be notified of any non-activity items the Contractors deems extra (eg lost time and delays, meals, accommodations, services, etc) prior to these costs being incurred by the Contractor. Failure to notify may result in non-consideration of payment.

Note that TIE reserves the right to consider a lump sum cost proposal (complete with a detailed breakdown of costs as per the Time and Materials breakdown above) from the Contractor. This consideration not does eliminate TIE's option to pay for extra work via Time and Materials.

Note that TIE also reserves the right to award any extra work to a third party other than the Contractor.

NOTE: The work is being conducted within the limits of the TCH Extension Project, from the North River Roundabout to Clyde River. The earthworks are being constructed under separate contract with TIE. The successful Bridge Contractor shall liaise with the earthworks General Contractor and coordinate and schedule his works accordingly and as required. No compensation shall be entertained for any scheduling issues that may arise due to lack of correspondence between this bridge contractor and the earthworks contractor.

8. SECTION 103.04 - FINAL CLEANUP

Site cleanup to existing road, structure, and surrounding area within the contract limits will be considered incidental to the performance of the work and shall be part of this Contract's scope of work. Refer to section 103.04 for more information.

9. SECTION 104.08 - CONTRACTOR'S RESPONSIBILITY

The Contractor shall identify and place a competent and reliable representative with authority to act for the Contractor in charge of the work. The representative shall be responsible for all aspects of the work, including, but not limited to the Contractor's own forces, any and all sub-contractors, suppliers,

etc., reviewing, verifying and approving any claims for additional work submitted by sub-contractors, and organizing each day's work plan in light of completing the work within the allotted time frame. No compensation shall be given for any extra work. See Clause 103.03 above.

10. SECTION 104.10 - DAMAGE BY VEHICLES OR OTHER EQUIPMENT

Any damage to any structure elements, or adjacent property, during any activity due to vehicles, heavy equipment, or any other equipment controlled by the Contractor shall be repaired or replaced as determined by the Department and at the Contractor's expense. Do not park heavy equipment on roadway. Refer to section 104.10 for more information.

Reinstatement of existing asphalt, shoulders, ditches, adjacent property, or any other existing feature which is outside the project limits, yet which is damaged by the Contractor, shall be at the Contractor's expense with no additional cost to the Contract. Determination and extent of damage shall be at the discretion of TIE. Reinstatement shall be reasonably to that condition prior to project start.

11. SECTION 104.17 - ENVIRONMENTAL PROTECTION

Dispose of demolished materials at an approved disposal site in accordance with applicable Provincial Environmental Guidelines.

The Contractor shall be responsible to apply, obtain, and pay for all environmental permits such as but not limited to waste disposal, creosote disposal, pit material, etc. The Contractor shall provide copies of applicable permits to TIE upon request.

Any related permits applied for in advance by TIE on behalf of the successful Contractor are made solely in the interest of the project schedule. Any permits issued to TIE shall automatically become the entire responsibility of the Contractor with respect to performing all work activities in compliance with the concerned permits.

The Contractor shall be responsible to apply for, pay for, and submit a copy to TIE of both a Hazardous Waste Permit and a Pit Permit.

The Contractor shall develop and submit to TIE (for TIE's review and comment prior to the project's startup meeting with the Contractor) Environmental Control Drawing(s) indicating the type and extent of each environmental control. This drawing shall be developed based on the Contractor's proposed work methods and procedures, coincident with the work activities within the time frame of the project.

All environmental controls shall be in place prior to and during related project activities. Refer to specific bid items for related description and measurement of payment for some environmental controls. Controls without a bid item (such as but not limited to Emergency Response Kit) shall be considered incidental to the project with no additional compensation provided.

The type, location, and extent of all environmental controls shall be coordinated with TIE.

The Contractor shall be responsible to monitor (on a daily basis, including non-work days such as weekends or Holidays) all environmental controls. All environmental controls shall be maintained and/or replaced by the Contractor (at no additional cost to TIE) throughout the entire duration of the

project such that controls are effectively performing their function.

The Contractor shall provide all labour, materials, and equipment required for the installation, secure attachment, handling, and disposal of a collection system for all timber material waste generated as a result of drilling, cutting, and installing hardware, etc into any timber members. No timber material waste shall be permitted to enter the watercourse (neither directly nor indirectly). This item also includes the loading, transport from site, and disposal off site of all collected waste. This item shall have no cost line item and shall be considered incidental to the project.

No additional compensation will be provided for this item.

12. SECTION 106 - PROSECUTION AND PROGRESS, OCCUPATIONAL HEALTH AND SAFETY (OH&S) ACT AND REGULATIONS

No additional compensation shall be provided for this item. All work shall be performed in accordance with the PEI Occupational Health and Safety (OH&S) Act and Regulations.

The Contractor shall submit to TIE a copy of all OH&S reports (independent of report content) related to this construction site. The Contractor shall also submit to TIE written documentation of corrective/remedial measures taken to address any issued identified as requiring such in an OH&S report.

The Contractor shall submit to TIE a copy of a clearance letter issued to the Contractor by the PEI Workers Compensation Board indicating that the Contractor is in good standing. The Contractor shall submit to TIE additional copies verifying renewal of good standing status throughout the duration of the project.

The Contractor shall fully complete and submit to TIE (prior to mobilizing on site) the attached Hazard Assessment Form and the attached Pre-Construction Contractor Site Safety Check List. Alternatively, the Contractor may elect to use his/her own forms provided they meet or exceed (at TIE's discretion) those provided.

The Contractor is responsible to ensure that the work is performed in a safe manner and that all personal protective equipment, equipment, etc., are in good working order and safe working condition. The Contractor is also responsible to ensure that his labourers, traffic control personnel, and skilled trades people have been adequately trained in their respective roles and duties, as well as their rights and responsibilities under the PEI Occupational Health and Safety Act and Regulations.

The Contractor shall submit to TIE (prior to mobilizing on site) a written and signed document stating:
a) all equipment to be used for this project has been and will be safety maintained and is safe for use;
b) all workers have and will be safety trained to perform work activities for this project; and
c) all personal protective equipment used for this project meets latest CSA Standards.
This document shall be applicable for all equipment and workers whether under the direct operation/direction of the Contractor or a Subcontractor. The Contractor shall also submit to TIE Safety Inspection Certificates of any cranes or motorized vehicles to be used on site or in TIE's storage yard.

The Contractor is responsible to ensure that all equipment can safely enter, manoeuver within, and

exit the site. The Contractor shall take measures to ensure trucks can safely enter, manoeuver within, queue, load, off-load, and exit the site. This includes measures to provide adequate and safe turning areas as required. The Contractor shall be required to arrange and pay for any off-site areas required to facilitate truck/equipment utilization.

The Contractor shall submit to TIE upon request any documentation (example: tool box meeting minutes, incident reports, accident reports, training certificates, etc) related to safety for this project.

Delivery of earth material shall be by tandem truck only. Delivery via trailers shall not be permitted, except for rip rap material. Any other circumstances must be approved by the Department.

In accordance with Chapter 0-1, Part 2, of the Occupational Health and Safety Regulations, the Contractor shall provide portable toilet during construction.

13. SECTION 907 - VEHICLE CONFIGURATIONS AND RESTRICTIONS

There is no existing traffic to contend with. The contractor shall, at ALL times, liaise and coordinate his work with the work of the roadway General Contractor. See Clause 7 above.

14. BID ITEM # 20306 - EXCAVATION: EARTH SURPLUS/SUITABLE

The unit price bid for this item shall include the transportation of the surplus material to a separate site designated by the Contractor to be later used as common borrow material for the roadbed construction for this project's site. The unit rate bid for this item shall include the excavation, loading, transportation, stockpiling, any environmental controls required, reloading, transportation, placement, and compaction of the material. Contractor to determine in conjunction with TIE representative the extent of excavation so to place any equipment and/or manouevre trucks or equipment within the site. The Contractor is responsible for providing a separate site to temporarily store the material and ensure that it is secured for use by the Department. No additional compensation shall be entertained for any part thereof required to conduct the work as intended.

For the purpose of determining the volume of material excavated, The Contractor shall be responsible to perform a site survey of the excavated area and submit to the Department a digital file (either autocad or microstation file type) indicating sketches of applicable cross sections used to determine the volume of material. The sketches shall also indicate the associated volume of material in units of cubic metres. The survey results are to be referenced to the TIE's site survey benchmark. Otherwise, the quantity of excavated material shall be based on eight (8) cubic metres per tandem truck load and fourteen (14) cubic metres per trailer load.

The Contractor shall take due care during all ground disturbing activities on the site relative to possibly unearthing items of cultural significance. If any such items are unearthed all ground disturbing activities shall halt until applicable authorities are notified and proper care and attention has been undertaken.

CLYDE RIVER BRIDGE CROSSING

15. BID ITEM # 20307 - EXCAVATION: EARTH WASTE

The unit rate bid for this item shall include the excavation, loading, transportation, any environmental controls required, and disposal of waste material off site. Contractor to determine in conjunction with TIE representative the extent of excavation so to place any equipment and/or manouevre trucks or equipment within the site. No additional compensation shall be entertained for any part thereof required to conduct the work as intended.

Note that this item also includes the removal of the temporary abutment's backfill and associated approach roads down to the permanent side embankment underside of new topsoil.

For the purpose of determining the volume of material excavated, The Contractor shall be responsible to perform a site survey of the excavated area and submit to the Department a digital file (either autocad or microstation file type) indicating sketches of applicable cross sections used to determine the volume of material. The sketches shall also indicate the associated volume of material in units of cubic metres. The survey results are to be referenced to the TIE's site survey benchmark. Otherwise, the quantity of excavated material shall be based on eight (8) cubic metres per tandem truck load and fourteen (14) cubic metres per trailer load.

The Contractor shall take due care during all ground disturbing activities on the site relative to possibly unearthing items of cultural significance. If any such items are unearthed all ground disturbing activities shall halt until applicable authorities are notified and proper care and attention has been undertaken.

16. SECTION 20709 - CLASS D GRAVEL

This item includes the supply, placement, and compaction of Class 'D' granular backfill within the foundation areas as deemed required by TIE. Contractor shall determine and verify quantity of material required prior to ordering and site delivery.

17. BID ITEM # 20728 - BACKFILL ABUTMENTS

The unit bid price for this item shall include the supply and placement of Class 'A' granular backfill against the structure's abutments and corresponding wing walls. The granular backfill shall be compacted at 300mm lifts and shall encompass the space envelope as indicated on the drawings. Tampers or double drum rollers shall be the method of compaction within 900mm of the abutment wall. Contractor shall determine and verify quantity of material required prior to ordering and site delivery. There will be no additional compensation entertained for meeting the required 95% proctor density on the Class A backfill. Refer to attached Schedule 'F' and drawings for further details.

18. SECTION 21301 - RANDOM RIP-RAP R5

The unit bid price for this item shall include the supply and placement of random R5 rip rap as indicated on the drawings. The Contractor shall co-ordinate delivery of material on site such that it is dumped off a truck only once on site prior to its final placement. Contractor shall determine and verify quantity of material required prior to ordering and site delivery.

CLYDE RIVER BRIDGE CROSSING

19. SECTION 21309 - RANDOM RIP-RAP R250

The unit bid price for this item shall include the supply and placement of random R250 rip rap as indicated on the drawings. The Contractor shall co-ordinate delivery of material on site such that it is dumped off a truck only once on site prior to its final placement. Contractor shall determine and verify quantity of material required prior to ordering and site delivery.

Note that the TIE specification for the percent finer by mass for the 570mm size shall read 0%, not 40-55%.

20. SECTION 21801 - FILTER FABRIC

The unit bid price for this item shall include the supply and placement of filter fabric as indicated on the drawings or as required for other purposes such as but not limited to environmental controls. Filter fabric shall be type N3 at all locations.

21. SECTION 110112 - CAST-IN-PLACE CONCRETE

The unit bid price for the above listed item shall be full compensation for the mix design for each mix and certification for each mix, delivery, supply, placement, curing, formwork, form liner, false work, accessories, all inserts as shown on the drawings, and all incidentals necessary to complete all concrete and grout work as indicated on the drawings. Refer to attached Schedule 'F' and drawings for further details. No additional compensation shall be provided. The design parameters shall include LASF and a Corrosion Inhibitor. NOTE: ALL CONCRETE SHALL BE DESIGNED AS HIGH PERFORMANCE CONCRETE AND THE DESIGNER SHALL INCLUDE SPECIFIC RECOMMENDED CURING METHODS FOR EACH MIX AND/OR MIX APPLICATION WITH HIS PROPOSED MIX DESIGN.

The mix proportions for concrete and grout (indicating mix contents and associated proportions) shall be submitted to TIE for general review. The mix design and certification shall bear a P Eng stamp signed and dated by a professional engineer registered with Engineers PEI. Certification shall state that the mix design will meet or exceed project requirements.

Grout shall have a 28 day design compressive strength minimum 35 MPa.

Note that the Contractor shall determine and verify the quantity of concrete and grout required prior to ordering and site delivery.

This requirement shall also be for the following bid items:

1. Approach Slab Concrete (BID ITEM # 110117)

    1. Shall include the approach slabs at both ends of the bridge, including any and all

inserts, as shown on the drawings. Curing shall be seven (7) day continuous wet cure.

2. Concrete Footings, Walls, Abutments and Piers (BID ITEM # 130822)

    1. Shall include abutment and pier caps, footings, walls, breastwalls/backwalls, wingwalls, wingwall haunches, curtain walls, bearing plinths, bearing seats, pier shafts, hammer-head pier cap and all other inserts as shown on the drawings. Curing shall be three (3) day continuous wet cure. Finish for the piers shall smooth steel form finish.

3. Bridge Deck, Curbs, and Parapet (BID ITEM # 130861)

    1. Shall include the concrete deck, collision blocks, and traffic barriers. Curing shall be fog misting immediately after placement and seven (7) day continuous wet cure. ANY PLASTIC OR DRYING SHRINKAGE CRACKS GREATER THAN 0.4 mm SHALL BE REPAIRED WITH AN APPROVED EPOXY INJECTION MATERIAL AT NO ADDITIONAL COST TO THE CONTRACT. This item includes the supply and installation of bond breaker and gap form for the barrier control joints. A307 rods shall be paid for under Item 130864, Miscellaneous Metals.

Forming and caulking of control joints shall be considered incidental to the work. The use of Duraforms or equivalent product shall not be used on any portion of the work.

This item shall also include all costs associated with the supply, installation, fitting, and removal of form liner material on the entire surface area of both vertical faces (including all recessed and sloped surfaces) of the all collision blocks and traffic barriers.

Any defects such as but not limited to honeycombing, disintegration, spalling, cracking, stratification, segregation, cold joints, etc shall be repaired by the Contractor prior to acceptance by TIE. Determination of defect and extent shall be soley by TIE. The repair method for each type of defect shall be developed by the Contractor and submitted to TIE for review prior to commencing repairs. Repair methods shall address surface preparation / material removals, repair materials, method of placement, and curing measures. All costs associated with defect repair shall be at no additional charge to the Contract.

This item shall also include all costs associated with excavating, constructing, supplying, and installing environmental controls complete with their continued maintenance, clean out and disposal of waste material, decommissioning, removal of environmental controls, filling in, levelling out, and full reinstatement of washout pits to be used for cleaning the concrete trucks' chutes. The Contractor shall account for the quantity of pits required based on the location of concrete truck delivery relative to the site. The location of pit(s) shall be co-ordinated with a TIE representative. The Contractor shall arrange, obtain permission, and pay for any pits which may have to be located on adjacent privately owned land. No additional compensation shall be provided for any additional work and/or equipment related to washout pits.

This item shall also include all costs associated with the supply of all labour, materials, and equipment required to fill tie holes, grind smooth exposed top and leading edge of collision blocks, curbs, and the removal of any cement paste from the base of exposed vertical surfaces (ie curb, barrier, collision

blocks, etc).

Note that any lubrication material used to prime the concrete pump line shall be not be permitted to be placed within nor left as part of the permanent structure. This item shall include all costs associated with the removal from within the concrete pour space all concrete pump line lubrication material. All lubrication material shall be disposed of in coordination with TIE's Environment Management Section (EMS).

This item shall also include all costs associated with the development and submission to TIE deck formwork drawings indicating items such as but not limited to member sizes and spacings, material grades, type of hardware, and hardware location relative to the protective cover zone.

This item shall also include all costs (including all environmental controls) associated with dewatering any areas of the site in order to perform any construction activity and/or if any area becomes contaminated with earth silt during any phase of the project. Cast-in-place footings are to be poured/placed in the dry. The location of dewater outfalls shall be co-ordinated with the Department. The Contractor shall arrange, obtain permission, and pay for any outfalls which may have to be located on adjacent privately owned land. No additional compensation shall be provided for any additional work and/or equipment related to dewatering.

This item shall also include all costs associated with the development and submission by the Contractor to TIE a Dewatering Plan indicating items such as but not limited to the location of outfalls and any associated environmental controls. The Dewatering Plan shall be submitted at least two (2) weeks prior to commencing any activity which will require dewatering.

The unit price for these items shall also be full compensation for the provision of all labour, materials, energy source, and equipment required to supply heat to maintain enclosed air temperatures within criteria as indicated in CAN/CSA A23.1 latest edition. This applies to pre-pour, pour, and curing time periods.

22. SECTION 130000 - CONCRETE REINFORCEMENT: GFRP

1. Conc. Reinforcement: 10 mm Dia. (#3) GFRP (BID ITEM # 130929)

    1. The unit price bid price for the above listed item shall be full compensation for each ***metre*** of 10 mm diameter ***straight glass-fibre reinforced polymer (GFRP)*** concrete reinforcement required. Shop drawings shall be provided at no extra cost to the contract. Refer to attached Schedule 'F' and drawings.

2. Conc. Reinforcement: 13 mm Dia. (#4) GFRP (BID ITEM # 130913)

    1. The unit price bid price for the above listed item shall be full compensation for each ***metre*** of 13 mm diameter ***straight glass-fibre reinforced polymer (GFRP)*** concrete reinforcement required. Shop drawings shall be provided at no extra cost to the contract. Refer to attached Schedule 'F' and drawings.

3. Conc. Reinforcement: 16 mm Dia. (#5) GFRP (BID ITEM # 130914)

    1. The unit price bid price for the above listed item shall be full compensation for each

metre of 16 mm diameter ***straight glass-fibre reinforced polymer (GFRP)*** concrete reinforcement required. Shop drawings shall be provided at no extra cost to the contract. Refer to attached Schedule 'F' and drawings.

4. Conc. Reinforcement: 19 mm Dia. (#6) GFRP (BID ITEM # 130915)

    1. The unit price bid price for the above listed item shall be full compensation for each ***metre*** of 19 mm diameter ***straight glass-fibre reinforced polymer (GFRP)*** concrete reinforcement required. Shop drawings shall be provided at no extra cost to the contract. Refer to attached Schedule 'F' and drawings.

5. Conc. Reinforcement: 22 mm Dia. (#7) GFRP (BID ITEM # 130927)

    1. The unit price bid price for the above listed item shall be full compensation for each ***metre*** of 22 mm diameter ***straight glass-fibre reinforced polymer (GFRP)*** concrete reinforcement required. Shop drawings shall be provided at no extra cost to the contract. Refer to attached Schedule 'F' and drawings.

6. Conc. Reinforcement: 25 mm Dia. (#8) GFRP (BID ITEM # 130916)

    1. The unit price bid price for the above listed item shall be full compensation for each ***metre*** of 25 mm diameter ***straight glass-fibre reinforced polymer (GFRP)*** concrete reinforcement required. Shop drawings shall be provided at no extra cost to the contract. Refer to attached Schedule 'F' and drawings.

7. Conc. Reinforcement: 32 mm Dia. (#9) GFRP (BID ITEM # 130930)

    1. The unit price bid price for the above listed item shall be full compensation for each ***metre*** of 32 mm diameter ***straight glass-fibre reinforced polymer (GFRP)*** concrete reinforcement required. Shop drawings shall be provided at no extra cost to the contract. Refer to attached Schedule 'F' and drawings.

8. 16 mm Dia. GFRP Bent (BID ITEM # 130922)

    1. The unit price bid price for the above listed item shall be full compensation for each ***metre*** of 25 mm diameter ***bent glass-fibre reinforced polymer (GFRP)*** concrete reinforcement required. Shop drawings shall be provided at no extra cost to the contract. Refer to attached Schedule 'F' and drawings.

9. 19 mm Dia. GFRP Bent (BID ITEM # 130923)

    1. The unit price bid price for the above listed item shall be full compensation for each ***metre*** of 19 mm diameter ***bent glass-fibre reinforced polymer (GFRP)*** concrete reinforcement required. Shop drawings shall be provided at no extra cost to the contract. Refer to attached Schedule 'F' and drawings.

10. 22 mm Dia. GFRP Bent (BID ITEM # 130928)

    1. The unit price bid price for the above listed item shall be full compensation for each

metre of 22 mm diameter ***bent glass-fibre reinforced polymer (GFRP)*** concrete reinforcement required. Shop drawings shall be provided at no extra cost to the contract. Refer to attached Schedule 'F' and drawings.

11. 25 mm Dia. GFRP Bent (BID ITEM # 130924)

    1. The unit price bid price for the above listed item shall be full compensation for each ***metre*** of 25 mm diameter ***bent glass-fibre reinforced polymer (GFRP)*** concrete reinforcement required. Shop drawings shall be provided at no extra cost to the contract. Refer to attached Schedule 'F' and drawings.

12. Conc. Reinforcement: 16 mm Dia. (#5) GFRP HEADED (BID ITEM # 130931)

    1. The unit price bid price for the above listed item shall be full compensation for each ***metre*** of 16 mm diameter ***straight glass-fibre reinforced polymer (GFRP) headed*** concrete reinforcement required. Shop drawings shall be provided at no extra cost to the contract. Refer to attached Schedule 'F' and drawings.

13. Conc. Reinforcement: 19 mm Dia. (#6) GFRP HEADED (BID ITEM # 130932)

    1. The unit price bid price for the above listed item shall be full compensation for each ***metre*** of 19 mm diameter ***straight glass-fibre reinforced polymer (GFRP) headed*** concrete reinforcement required. Shop drawings shall be provided at no extra cost to the contract. Refer to attached Schedule 'F' and drawings.

Either five (5) sets of GFRP placement drawings, or digital GFRP placement drawings, indicating material grade, piece marks and associated bar size and spacing, lap locations and associated lengths, etc shall be submitted to TIE by the Contractor at no extra cost to the Contract. Also include directly on the placement drawing (not on a separate document) a detailed bar list indicating a piece mark for all bar types (including straight bars), quantity of bars for each mark, bend type, bend dimensions, total length for each mark, and grand total length for each bar diameter size. Contractor responsible to review content of placement drawings for correctness prior to submitting to TIE. Refer to attached Schedule 'F' and drawings.

The unit price for this item shall also include all costs associated with the on-site storage of material supported/elevated off the ground such that it does not get contaminated with soil, mud, earthen debris, etc, as well as to maintain the material's shop fabricated shape. GFRP material shall also be stored covered and protected from sunlight.

23. BID ITEM # 130023 - MUD SLAB

The unit price bid for the above listed item shall be full compensation for the supply and placement of concrete mud slabs that the Contractor may deem required for construction. The concrete shall have a 28 day compressive strength of 20 MPa with 4 to 6% air entrainment. Note that the Contractor shall determine and verify quantity of concrete required prior to ordering and site delivery.

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24. BID ITEM # 130826 - EXPANSION JOINTS

The per metre bid price for the above listed item shall be full compensation for each metre of expansion joint (steel angles with anchors) supplied and installed. Submit to TIE for review, either five (5) sets, or one digital copy, of shop drawings at no extra cost to the Contract. This shall also include the supply and installation of all materials required for the compression seal type joint including lubricant adhesive. For the purpose of cost the length of expansion joint shall be along the deck from inside to inside of curb. Refer to Schedule 'F' and drawings.

The unit price for this item shall also include all costs associated with the on-site storage of material supported/elevated off the ground such that it does not get contaminated with soil, mud, earthen debris, etc, as well as to maintain the material's shop fabricated shape.

25. BID ITEM # 130827 - BEARING PADS

The per unit bid price for the above listed item shall be full compensation for each bearing pad supplied and installed. Bearing pad units shall be as indicated on project drawings or in project specification. This item shall include the supply and installation of all bearing anchor bolts and associated washers, nuts, masonry plates, bearing assemblies, side angles, and neoprene gaskets. Submit to TIE for review, either five (5) sets, or one digital copy, of shop drawings at no extra cost to the Contract. All bearing pad shop drawings shall bear a P Eng stamp signed and dated by a professional engineer registered with Engineers PEI. Refer to Schedule 'F' and the drawings for further details.

The unit price for this item shall also include all costs associated with the on-site storage of material supported/elevated off the ground such that it does not get contaminated with soil, mud, earthen debris, etc.

26. BID ITEM # 130828 - DECK DRAINS

The unit bid price for the above listed item shall be full compensation for each deck drain supplied, fabricated, hot dipped galvanized, and installed. The Contractor shall submit to TIE for review prior to fabrication, either five (5) sets of shop drawings, or digital shop drawings, (indicating member sizes, member grade, and bolt and weld details) at no additional cost to the Contract.

The unit price for this item shall also include all costs associated with the on-site storage of material supported/elevated off the ground such that it does not get contaminated with soil, mud, earthen debris, etc.

27. BID ITEM # 130864 - MISCELLANEOUS METALS

The unit bid price for the above listed item shall be full compensation for each kg of miscellaneous metals (barrier expansion joint covers, barrier dowels) fabricated, hot-dipped galvanized, supplied and installed . The Contractor shall submit to TIE for review prior to fabrication, either five (5) sets of shop drawings, or digital shop drawings, (indicating member sizes, member grade, and bolt and weld details) at no additional cost to the Contract.

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The unit price for this item shall also include all costs associated with the on-site storage of material supported/elevated off the ground such that it does not get contaminated with soil, mud, earthen debris, etc.

28. BID ITEM # 130876 - GENERAL MOBILIZATION AND DEMOBILIZATION

The lump sum bid price for the above listed item shall be full compensation for the mobilization and demobilization of all equipment, material, and labour to and from the site, including land negotiations for storage areas as well as any negotiations with utilities. This item also includes the provision of parking areas for equipment and vehicle parking including any land negotiations for such. This item also includes the supply, placement, and removal from site any earth materials and associated environmental controls required as part of mobilization and demobilization. No additional compensation shall be provided.

This item shall also include allowance for permitting boat traffic to travel through the existing waterway below the concerned construction site. The Contractor shall not impede the flow of boat traffic at any time during this Contract.

Contractor shall provide a site trailer to be shared by the Contractor and Engineer. Trailer shall be equipped with electricity, lights, phone, fax, table, chairs, one (1) screened window and one (1) man door. It is the Contractor's responsibility to find a location near the structure to place the trailer. This item shall be included in the lump sum price bid for this item. The Contractor shall provide heat in the trailer at no additional cost to the Contract.

29. BID ITEM # 130994 - DECK MEMBRANE DRAINS

The unit bid price for the above listed item shall be full compensation for each deck membrane drain supplied, fabricated, hot dipped galvanized, and installed. The Contractor shall submit to TIE for review prior to fabrication, either five (5) sets of shop drawings, or digital shop drawings, (indicating member sizes, member grade, and bolt and weld details) at no additional cost to the Contract.

The unit price for this item shall also include all costs associated with the on-site storage of material supported/elevated off the ground such that it does not get contaminated with soil, mud, earthen debris, etc.

30. BID ITEM # 135101 - PROJECT LAYOUT

The lump sum bid price for the above listed item shall be full compensation for all surveying and layout of the project site, including excavation cross section survey and volume calculation, elevations, surcharge layout, footing layout, abutment and pile layout, pile cutoff elevations, girder layout, bearing and plinth elevations, haunch heights, screed elevations, toe of slope layout, temporary approach road layout, edge of pavement layout, curb and gutter layout, catchbasin and storm pipe layout, dimensions, and all other measurements and layouts required to complete the work.

The Department will provide layout information upon request of the project layout team. Any discrepancies or irregularities shall be promptly pointed out to the Engineer for resolution prior to proceeding with the work. Copies of all digital files required for on site quantity calculations shall be

provided to TIE for verification. The provision of Project Record Drawings shall be considered incidental to this item.

Contractor shall submit to TIE, at no additional cost to the Contract, a digital set of as-built drawings indicating plan locations (Northing and Easting Coordinates using the same grid system as used to locate the bridge piles), horizontal distances, and elevations (relative to project benchmarks) of primary points such as but not limited to: abutment corners, bearing seats, wingwall corners, collision blocks, approach slabs, and top of asphalt wearing surface (left side, right side, and centerline) at each abutment and at overall midspan. Also include in submission as-built top cover elevations as well as invert elevations of all storm lines and new catchbasins. The file format shall be AutoCAD Civil 3D, R 2013.

31. BID ITEM # 135220 - STEEL PIPE PILES: SUPPLY

The per metre bid price for the above listed item shall be full compensation for each metre of permanent steel pipe pile delivered to the site for intended use in the structure's foundation and shall include the supply, fabrication, installation of pile shoes on each pile's tip prior to driving; and the fabrication, supply, and installation of a pile cap plate assembly after final cut-off. Submit, either five (5) sets of shop drawings, or digital shop drawings (indicating member sizes, member grade, welded connections) to TIE for review at no additional cost to the Contract. Refer to attached Schedule 'F' and drawings.

Welding of top cap plates and tip shoes to be performed by company and welders certified with the Canadian Welding Bureau, CAN/CSA W47.1, Division 2. All welding to be performed per CAN/CSA W59 latest edition.

The unit price for this item shall also include all costs associated with the on-site storage of material supported/elevated such that it maintains its original non-deformed shape, as well as stored safely so it will remain in stored position.

The Contractor shall determine pile supply lengths for each abutment location based on the design drawing elevations and pile related details, elevation of bedrock, pile embedment into bedrock, and pile cutoff length at the top of pile.

The Contractor shall submit to TIE digital copies of mill certificates indicating heat numbers and corresponding chemical composition (components and amounts) for all pipe pile steel used for this project.

32. BID ITEM # 135221 - STEEL PIPE PILES: DRIVE

The per metre bid price for the above listed item shall be full compensation for each metre of permanent steel pipe pile driven. The price shall include the provision of all labour, materials, and equipment to drive piles, including driving templates, hammers, leads, etc. Hammers supplied shall be of sufficient size and mass to produce the energy as specified. Contractor to co-ordinate and retain a qualified testing company to perform pile driving analysis at no extra cost to the contract and shall include a minimum of three (3) test piles. Submit to TIE copy of Pile Driving Analysis Report. Refer to attached Schedule 'F' and drawings. If a hammer supplied by the Contractor is insufficient to

provide the energy required, then the Contractor shall supply a larger hammer at no extra cost to the Contract. Refer to Schedule 'F' and the drawings for further details.

Contractor shall submit to TIE for general review within reasonable time prior to pile driving the Contractor's proposed hammer energy information such as but not limited to hammer type, hammer weight or mass, and drop height.

This item also includes the preparation and submission to TIE a copy of the pile driving records complete with a plan view indicating pile piece marks corresponding with the driving records. This to be performed by the Contractor at no additional cost to the Contract.

This item also includes the handling and disposal off site of all pile cutoffs less than 3.0 metres in length, as well as the loading, transport to TIE's Charlottetown Bridge Yard, and unloading of all pile cutoffs greater than 3.0 metres in length.

This item does not include payment for hardship due to obstructions encountered during driving. Contractor to notify TIE immediately upon discovery of any obstructions. Obstructions encountered shall be removed from site sufficient to permit pile driving.

33. BID ITEM # 136122 - SILANE SEALER

The unit bid price for the above listed item shall be full compensation for the provision of all labour, materials, and equipment required for the supply and application of sealant to the entire surface area of: inside vertical face and across top horizontal surface of curbs, and the inside vertical faces (including all sloped and recessed areas) and across top horizontal surface of all collision blocks. 'Hydrozo 100' is an acceptable product or approved equal. Submit data sheet on proposed sealant to TIE for review prior to ordering sealant. Refer to manufacturer's instructions for application rates and method of application.

34. BID ITEM # 136270 - STEEL COFFERDAM (PROVISIONAL)

The lump sum price bid for the above listed item shall be full compensation for the design, supply, installation and de-commissioning of the steel sheet pile (SSP) wall cofferdam for the centre pier base. This shall include the provision of shop drawings, sealed and signed by a Professional Engineer, registered with Engineers P.E.I.; the supply and installation of SSP wall, including all connections, corner sections, wales, braces, temporary piles, and all other materials, labour and equipment required to complete the cofferdam. The SSP shall remain as stay-in-place formwork for the pier base footing and shall be cut off at the top of the footing after the pier shaft and hammer head pier cap are complete. Refer to Schedule 'F' and the drawings for further details. **This item is provisional and may not be required. The department reserves the right to remove this from the works at any time. No compensation for loss of profitt associated with this item shall be entertained.**

35. BID ITEM # 138116 - STEEL SUPERSTRUCTURE: FAB & ERECT

The lump sum price for the above listed item shall be full compensation for the fabrication, shop fabrication and related erection and dismantling, shop -coating, transport and delivery to the job site,

off-loading, any temporary site storage and related handling, and the supply and erection of the steel superstructure for the new structure. This item shall include fabrication of trapezoidal steel box girders, stiffeners, gusset plates, sole plates, diaphragms, braces, bolted connections, nelson studs, the supply and installation (tightening) of all bolts and nuts, openings, and all other incidentals required for the complete fabrication and erection of the superstructure to the satisfaction of the Engineer. Refer to Schedule 'F' and the drawings for further details.

The Contractor shall at no extra cost to the Contract submit to TIE for general review, either five (5) sets of, or digital copies of, structural steel shop drawings indicating material grades, protective coating type including extent and thickness, plan view layout complete with dimensions, cross section views as required, member sizes, piece marks, member lengths, shop fabrication and connection details (plate sizes, hole diameters & locations, weld types, size & length, bolt quantities & diameters, etc), splice locations, etc.. Submission shall account for TIE review prior to starting fabrication. Each shop drawing shall bear a P Eng stamp signed and dated by a professional engineer registered with Engineers PEI. Contractor responsible to review content of shop drawings for correctness prior to submitting to TIE. Refer to attached Schedule 'F' and drawings. Refer also to Annex A10.1 of the Canadian Highway Bridge Design Code (CHBDC) regarding fabrication and erection details.

Flange and web shop welded splices shall not be coincident (ie not at same location relative to span).

Field bolt splices are acceptable provided:

a) splice locations(s) are outside the middle third of the span. Two (2) splices maximum over span.
b) connection design and associated costs by fabricator (or retained Engineer).
c) connection detail to be indicated on submitted shop drawings.

Fabrication of structural steel members to be performed by company and welders certified with the Canadian Welding Bureau, CAN/CSA W47.1, Division 1, latest edition. All welding to be performed per CAN/CSA W59 latest edition. Bidders shall submit copies of certification to the department for their files. Companies shall also be certified bridge fabricators as defined by the Canadian Institute of Steel Construction (CISC).

The Contractor shall submit to TIE digital copies of mill certificates indicating heat numbers and corresponding chemical composition (components and amounts) for all superstructure steel used for this project.

Welding General: Refer to project specification.

Welding Inspection: Refer to project specification.

The lump sum price shall include shop-coating the entire exterior faces of the girders prior to transport. This shall include any touch-ups required after erection and deck construction. Refer to Schedule 'F and the project specifications for more details.

The lump sum price for this item shall also include all costs associated with the transport of the steel structure to the site including but not limited to coordination, related highway or bridge permits, escorts, road closures, traffic control personnel and related roadway signage, etc.

The lump sum price for this item shall also include all costs associated with performing an elevation survey along the top of the top flange of all of the as-installed girders at spaces indicated in the

drawings (to coincide with the stations indicating screed elevations on the design drawings) along the girder length. The Contractor shall then determine the haunch height at these stations based on the elevation survey, deck thickness, and screed elevations. The Contractor shall submit to TIE at no additional cost the elevation survey results and the calculated haunch heights.

The Contractor is responsible to ensure enough available space on site shall be provided for beam installation procedures. Any temporary piers, layout areas, crane pads, fill, etc. shall be included in this item, as well as any land negotiations, permits, engineering (such as but not limited to the design of any crane temporary suspended support systems, geotechnical engineering advice regarding ability of existing soil to safely support loads imposed by crane pads, fill, crane outrigger loads, etc.) required for the proper installation of the girders.

If any falsework is required, then the Contractor shall submit to TIE, either five (5) sets of, or digital copies of, design drawings which bear a P Eng stamp signed and dated by a professional engineer registered with Engineers PEI. No additional compensation will be provided for the Contractor's failure to include these provisions. Crane location and outrigger loads adjacent to new abutment and wingwalls must be approved by the Engineer prior to beam installation.

The lump sum price for this item shall also include all costs associated with the on-site storage of girders supported/elevated such that they maintain their original fabricated shape, as well as stored safely.

The Contractor shall at no extra cost to the Contract submit to TIE for general review, either five (5) sets of, or digital copies of, Lift Plan drawings indicating proposed method of beam installation including the sequence, plan view layout of crane locations and associated lifting capacities, weights and lifting points of members, size of any spreader beams, size of cables and/or straps complete with respective angle, capacity of shackles, outrigger locations, size and height of any timber blocking below outriggers, outrigger loads, outrigger bearing pressures, etc.. Submission shall account for TIE review prior to starting beam installation. Each Lift Plan drawing shall bear a P Eng stamp signed and dated by a professional engineer registered with Engineers PEI. Contractor responsible to review content of Lift Plan drawings for correctness prior to submitting to TIE.

The lump sum price for this item shall also be full compensation for the provision of all labour, materials, and equipment required to supply and install stainless steel bird protection spikes continuous across the entire width and entire length on the top surface of all exposed diaphragm bottom. Spikes to be 20 gauge as manufactured by 'Bird Control Products' located in Erie PA, or equal approved by TIE.

36. MEETINGS

The Contractor shall make himself available for meetings with local utilities, local authorities, and TIE representatives for an initial start-up meeting prior to construction to discuss temporary utility locations, traffic management plans, and any other pertinent issues related to the project. This shall be considered incidental to the project. No additional costs shall be entertained for this item.

The Contractor shall also make available his lead construction manager and site superintendent for periodic site meetings to be held throughout the construction time frame. Note that the purpose of the meetings is to discuss relevant issues with TIE, DFO, etc, and not for the Contractor to discuss internal issues nor issues with his sub-contractors, suppliers, etc.. Frequency of meetings will be maximum weekly during initial project stages, and biweekly throughout the remainder of project. This

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shall be considered incidental to the project. No additional costs shall be entertained for this item.

37. SECURITY

Security shall be considered incidental to the work and shall not be measured or paid for.

SCHEDULE B

IDENTIFICATION OF PRINCIPALS

Name of Contractor:

Mailing Address:

Principal's Name:

Title:

Mailing Address:

If Contractor is a corporation, indicate in which province of Canada is the corporation registered:

Department of Transportation Infrastucture & Energy
Province of Prince Edward Island

Schedule C
schedule of item for tender

Item Description and Price			Estimated Quantity	Contractor Total Price
EXCAV:EARTH SURPLUS/SUITABLE				
Section: 203 Item: 20306				
		PER M3		
	$	PER M3	500.00 $	
	100			
EXCAVATION: EARTH WASTE				
Section: 203 Item: 20307				
		PER M3		
	$	PER M3	100.00 $	
	100			
CLASS D GRAVEL				
Section: 207 Item: 20709				
		PER Tonnes		
	$	PER Tonnes	150.00 $	
	100			
BACKFILL ABUTMENTS				
Section: 207 Item: 20728				
		PER Tonnes		
	$	PER Tonnes	1,500.00 $	
	100			
RANDOM RIP-RAP: R5				
Section: 213 Item: 21301				
		PER Tonnes		
	$	PER Tonnes	2,610.00 $	
	100			
RANDOM RIP-RAP: R250				
Section: 213 Item: 21309				
		PER Tonnes		
	$	PER Tonnes	2,230.00 $	
	100			

Total Carried Forward $ _____
From Previous Page

Total Carried Forward $ _____

Department of Transportation Infrastucture & Energy
Province of Prince Edward Island

Schedule C
schedule of item for tender

Item Description and Price			Estimated Quantity	Contractor Total Price
FILTER FABRIC				
Section: 218	Item: 21801			
		PER Square Metr		
	$	PER M2	2,500.00 $	
	100			
CATCH BASIN: 1050MM PCP				
Section: 302	Item: 30202			
		PER unit		
	$	PER unit	3.00 $	
	100			
APPROACH SLAB CONCRETE				
Section: 1101	Item: 110117			
		PER M3		
	$	PER M3	65.00 $	
	100			
MUD SLAB				
Section: 1300	Item: 130023			
		PER M3		
	$	PER M3	270.00 $	
	100			
CONCRETE ABUTMENTS & PIER				
Section: 1308	Item: 130822			
		PER M3		
	$	PER M3	800.00 $	
	100			
EXPANSION JOINTS				
Section: 1308	Item: 130826			
		PER Metres		
	$	PER M	27.00 $	
	100			

Total Carried Forward $ _____
From Previous Page

Total Carried Forward $ _____

Department of Transportation Infrastucture & Energy
Province of Prince Edward Island

Schedule C
schedule of item for tender

Item Description and Price			Estimated Quantity	Contractor Total Price
BEARING PADS				
Section: 1308 Item: 130827				
		PER unit		
	$	PER unit	6.00 $	
	100			
DECK DRAINS				
Section: 1308 Item: 130828				
		PER unit		
	$	PER unit	4.00 $	
	100			
BRIDGE DECK, CURBS & PAREPET				
Section: 1308 Item: 130861				
		PER M3		
	$	PER M3	615.00 $	
	100			
MISCELLANEOUS METALS				
Section: 1308 Item: 130864				
		PER Kg		
	$	PER Kg	3,080.00 $	
	100			
GENERAL MOBILIZATION\DEMOBILIZATION				
Section: 1308 Item: 130876				
		PER L.S.		
	$	PER L.S.	1.00 $	
	100			
CONC. REINFORCEMENT:13mm DIA. GFRP				
Section: Item: 130913				
		PER Metres		
	$	PER M	1,450.00 $	
	100			

Total Carried Forward $ _____
From Previous Page

Total Carried Forward $ _____

Department of Transportation Infrastucture & Energy
Province of Prince Edward Island

Schedule C
schedule of item for tender

Item Description and Price			Estimated Quantity	Contractor Total Price
CONC. REINFORCEMENT:16mm DIA. GFRP				
Section: Item: 130914				
		PER Metres		
	$	PER M	20,330.00 $	
	100			
CONC. REINFORCEMENT:19mm DIA. GFRP				
Section: Item: 130915				
		PER Metres		
	$	PER M	14,680.00 $	
	100			
CONC. REINFORCEMENT:25mm DIA. GFRP				
Section: Item: 130916				
		PER Metres		
	$	PER M	5,900.00 $	
	100			
16mm DIA GFRP BENT				
Section: 1300 Item: 130922				
		PER Metres		
	$	PER M	2,680.00 $	
	100			
19mm DIA GFRP BENT				
Section: 1300 Item: 130923				
		PER Metres		
	$	PER M	1,920.00 $	
	100			
25mm DIA GFRP BENT				
Section: 1300 Item: 130924				
		PER Metres		
	$	PER M	4,670.00 $	
	100			

Total Carried Forward $ _____
From Previous Page

Total Carried Forward $ _____

Department of Transportation Infrastucture & Energy
Province of Prince Edward Island

Schedule C
schedule of item for tender

Item Description and Price			Estimated Quantity	Contractor Total Price
CONC. REINFORCEMENT:22mm DIA. GFRP				
Section: 1300 Item: 130927				
		PER Metres		
	$	PER M	1,450.00 $	
	100			
22mm DIA GFRP BENT				
Section: 1300 Item: 130928				
		PER Metres		
	$	PER M	4,290.00 $	
	100			
CONC. REINFORCEMENT:10mm DIA.(#3) GFR				
Section: 1300 Item: 130929				
		PER Metres		
	$	PER M	190.00 $	
	100			
CONC. REINFORCEMENT:32mm DIA.(#9) GFR				
Section: 1300 Item: 130930				
		PER Metres		
	$	PER M	8,060.00 $	
	100			
CONC. REINFORCEMENT:16mm DIA. GFRP (H				
Section: 1300 Item: 130931				
		PER Metres		
	$	PER M	920.00 $	
	100			
CONC. REINFORCEMENT:19mm DIA. GFRP (H				
Section: 1300 Item: 130932				
		PER Metres		
	$	PER M	11,020.00 $	
	100			

Total Carried Forward $ _____
From Previous Page
Total Carried Forward $ _____

Department of Transportation Infrastucture & Energy
Province of Prince Edward Island

Schedule C
schedule of item for tender

Item Description and Price			Estimated Quantity	Contractor Total Price
DECK MEMBRANE DRAINS				
Section: 1300 Item: 130994				
		PER unit		
	$	PER unit	7.00 $	
	100			
PROJECT LAYOUT				
Section: 1351 Item: 135101				
		PER L.S.		
	$	PER L.S.	1.00 $	
	100			
PIPE PILES: SUPPLY				
Section: 1352 Item: 135220				
		PER Metres		
	$	PER M	760.00 $	
	100			
PIPE PILES: DRIVE				
Section: 1352 Item: 135221				
		PER Metres		
	$	PER M	660.00 $	
	100			
SILANE SEALER				
Section: 1361 Item: 136122				
		PER Square Metr		
	$	PER M2	1,220.00 $	
	100			
STEEL COFFERDAM				
Section: 1362 Item: 136270				
		PER L.S.		
	$	PER L.S.	1.00 $	
	100			

Total Carried Forward $ _____
From Previous Page

Total Carried Forward $ _____

Department of Transportation Infrastucture & Energy
Province of Prince Edward Island

Schedule C
schedule of item for tender

Item Description and Price			Estimated Quantity	Contractor Total Price
STEEL SUPERSTRUCT: FAB & ERECT				
Section: 1381 Item: 138116				
		PER L.S.		
	$	PER L.S.	1.00 $	
	100			

Total Carried Forward From Previous Page $ _____

Total Carried Forward $ _____

HST $ _____

Grand Total $ _____

SCHEDULE D

SCHEDULE OF EQUIPMENT TO BE USED ON THE WORK

SCHEDULE E

SCHEDULE OF SUB-CONTRACTORS

SCHEDULE F

APPENDED ITEMS

ADDENDUMS

Hazard Assessment Form

Pre-Construction Contractor Safety Checklist Form

Joose Environmental Geotechnical Investigation Report, 12 September 2016

Joose Environmental Supplemental Geotechnical Investigation Report, 28 September, 2017

CBCL Supplementary Specifications

CBCL Design Drawings Nos S00 to S33 inclusive

TRANSPORTATION, INFRASTRUCTURE & ENERGY HAZARD ASSESSMENT FORM

This Hazard Assessment is to be completed by the Project Manager or Designate. All Employees, Subcontractors, and Visitors *Shall* be advised of all hazards noted and shall also be advised of any hazards that develop during the project.

Job Location: _____ **Job Contractor:** _____

Project Manager: _____ **Job Foreman:** _____

Administration Checklist	**Circle**	**Correction Date if "NO"**	**Generic Hazard Identification**	**Circle**	**Correction Date if "NO"**
OH&S Act on Site:	Y N		Hydro/Phone Lines:	Y N N/A	
Construction & Safety Regs on Site	Y N		Underground Cables/Pipe:	Y N N/A	
Other Application Job Regs on Site	Y N		**Overhead Hazards:**	**Y N N/A**	
Employees Trained as Per Regs:	Y N		**Water Hazards:**	**Y N N/A**	
Employees Orientation Completed:	Y N		**Applicable Signage in Place:**	**Y N N/A**	

Identified Hazard	**Priority**	**Required Action**	**Completed By**	**Date & Initial**

Priority System: ***A*** **- Correct Immediately** ***B*** **- Correct within 24 hours** ***C*** **- Correct within 3 days**

Other Hazards/ Considerations:

Comments:

Inspected By:(Print) _____ Signature: _____ Date: _____

CONTRACTOR SAFETY CHECKLIST

Use this text as a guideline for completing the attached checklist. This checklist is a general, *pre-construction* review of the contractor safety program, as well as an information session to identify what the P.E.I. Department of Transportation, Infrastructure and Energy (TIE) requires of our contractors. Where the item requires a submission, ensure that it is received. If the item does not apply, enter N/A for not applicable.

The following information will assist you in establishing what will be reviewed in each section.

1. ***Safety Policy:*** Each employer is required by law to have a safety policy and program. TIE will ask for and may require a copy of that policy and program.

2. ***Safety Representative:*** Each contractor is required to advise TIE who their safety representative is. That representative has duties as described in the Occupational Health and Safety Act.

3. ***Emergency Procedure:*** Each contractor must have a site specific layout and emergency plan complete with emergency phone numbers.

4. ***Employee Orientation:*** Each and every person working for a contractor, including sub-contractors, will be given an orientation to familiarize them with the site safety program. Unless otherwise specified, each sub-contractor is responsible for the orientation of their workers.

5. ***Safe Work Plan:*** Most contractors are involved in tasks that subject workers to hazards. In order to ensure that these workers are secured from hazard, the contractor will supply TIE with a written safe work plan which affords protection against the hazards. This plan must be signed by a company representative and communicated to the workers involved in the task.

6. ***Personal Protective Equipment Review:*** Advise that all workers require CSA Class "B" hard-hat, CSA Grade 1 ,"Green patch" , (eight inch) footwear, and eye, ear, and respiratory protection as required (boots and hat at all times).

7. ***Fall Protection:*** Fall restraint or fall arrest protection required where a fall of more than 2.4 meters is possible. **NO EXCEPTIONS.**

8. ***Housekeeping:*** Advise of daily, or as needed, clean-up requirements.

9. ***Tool Box Talks:*** Each contractor is required to conduct weekly safety meetings with their forces and advise TIE they have been done.

10. ***Material Handling/Storage:*** Advise contractor about storage areas and handling of material so as not to endanger their worker or another worker. Stacked material to be banded, chained, blocked, or otherwise secured.

11. ***Landing Platforms:*** Advise contractor about movement of material on or off platforms. All material to be secured. Platform gates or chains to be kept closed at all times workers are on platform. If not possible, worker to be tied off with fall restraint system independent of platform.

12. ***WHMIS Training:*** Receive verification that all contractor workers are trained and that the contractor submits the MSDS for chemicals on site.

13. ***GFCI:*** Advise contractor that all tools are required to have ground fault circuit interrupters (where electricity is supplied by contractor).

14. ***Accident Investigations:*** Any injury to any of their workers must be investigated and reported to TIE.

15. ***Verbal, Written, Gone:*** Explain Safety Tolerance Program.

16. ***Joint/Worker Safety Committee:*** Sites of over 20 workers must establish a safety committee; over 50, an additional worker committee. Workers required to attend committee meetings will do so and not be prevented by employers.

17. ***Fire Protection:*** All trades involved in performing hot work of any kind are required to provide fire protection at the work location.

18. ***Guardrails:*** Advise contractors that where temporary removal of guardrails is necessary, the area around them must be cordoned off with a barrier. Guardrails must be replaced as soon as possible.

19. ***First Aider:*** Each contractor is required to have a first aid kit and trained first aider. Employer must name their first aider.

20. ***Visitors:*** Advise contractor that any visitors to site must be suitably protected from hazard. They must wear hard hat, safety vest, and proper safety footwear while on site.

21. ***Task Lighting:*** Review responsibilities of task specific lighting (who provides it).

22. ***Swamper/Riggers Competency:*** Where cranes are used, the contractor must use a swamper/rigger. They shall provide TIE with a written statement identifying, by name(s), their rigger and that the named person is a competent worker as described in the construction regulations.

23. ***Scaffolds:*** Review scaffold building requirement:
    - ☞ Use all braces required by design.
    - ☞ Access ladder for platform over 1.5 meters.
    - ☞ Full width platform if height over ten feet. (PEI Regulations require double planks)
    - ☞ Full guardrails and toeboards.
    - ☞ Tied in three times base dimension or use of outriggers.
    - ☞ Engineered over 50 feet in height (standard frame type).

24. ***Elevating Work Platforms:***
    - ☞All boom and scissors lifts required to be CSA approved and have approval on machine.
    - ☞ Operators manual required on machine at all times.
    - ☞ Maintenance record on machine at all times.
    - ☞ Operator must receive training in operation of equipment.
    - ☞ Fall protection must be used at all times on a boom lift.
    - ☞ Fall protection required to be used on scissors lift when unit is being moved.

25. ***Protruding Rebar:*** Installer's of reinforcing steel must protect the protruding hazard or make arrangements to have it protected. Removal of protective coverings for task purposes only is allowed, however, protective covering must be replaced as soon as possible.

26. ***WCB Clearance Certificates:*** Advise contractor that TIE will not release any funds for payment until Workers Compensation Board Clearance Certificate has been received by TIE.

PRE-CONSTRUCTION CONTRACTOR SAFETY CHECKLIST

PROJECT: _____ DATE: _____ CONTRACTOR: _____
WORK BEING PERFORMED: _____

Print Name _____
Project Manager/Inspector

(Sign) _____

Print Name _____
Contractor Representative

(Sign) _____

✓ Means Yes ☒ Means No N/A Not Applicable

1. Safety Policy Submitted	☐	13. GFCI Requirements	☐
2. Safety Representative	☐	14. Accident/Incident Investigations Notification	☐
3. Emergency Procedure Review	☐	15. Verbal, Written, Gone	☐
4. Employee Orientation	☐	16. Joint/Worker Safety Committee	☐
5. Written Safe Work Plan Submitted	☐	17. Fire Protection	☐
6. Personal Protective Equipment Review • Hard Hats & Footwear • Safety Glasses • Hearing • Dust & Fumes	☐	18. Guardrails 19. First Aider on Staff - Name Supplied 20. Visitors & Safety Equip.	☐ ☐ ☐
7. Fall Protection	☐	21. Task Lighting	☐
8. Housekeeping	☐	22. Swampers/Riggers Competency (in writing)	☐
9. Tool Box Safety Talks (Weekly)	☐	23. Scaffolds	☐
10. Material Handling/Storage	☐	24. Elevating Work Platforms	☐
11. Landing Platforms	☐	25. Protruding Rebar Protection	☐
12. WHMIS Training Verification - MSDS Received	☐	26. WCB Clearance Certificate	☐

GEOTECHNICAL INVESTIGATION
PROPOSED CLYDE RIVER BRIDGE
CLYDE RIVER, QUEENS COUNTY, PE

JOOSE ENVIRONMENTAL PROJECT NO. JE0197

Joose Environmental Consulting Inc.
P.O. Box 19
North Wiltshire PE C0A 1Y0

September 12, 2016

Joose Environmental Project No. JE0197

Mr. Darrell Evans, P. Eng., Manager Design and Bridge Maintenance
Capital Projects Division
PEI Transportation, Infrastructure and Energy
PO Box 2000
Charlottetown, PEI
C1A 7N8

Dear Mr. Evans:

Reference: Geotechnical Investigation - Proposed Clyde River Bridge
Clyde River, Queens County, Prince Edward Island

This report presents the results of the geotechnical investigation carried out for the above-noted project, in accordance with your request. The purpose of the investigation was to establish the subsurface conditions in the vicinity of the proposed structure and, based on the conditions encountered, to provide geotechnical engineering recommendations pertaining to foundation design and construction.

PROCEDURE

The field work for the present investigation was carried out on August 30, 2016, and consisted of drilling two (2) boreholes at the site with a track-mounted CME 55 auger drill rig. The boreholes were advanced to an average depth of 10.7 m below existing grade at the locations shown on the appended Drawing No. 1.

Samples of the overburden soils encountered were taken at regular intervals by means of a conventional split spoon sampler during the performance of Standard Penetration Tests. Bedrock was proven at both borehole locations by rotary core drilling in NQ-size (45 mm core diameter).

All soil samples recovered were placed in moisture-proof containers and were delivered, with the rock core, to our office for classification and testing. All soil and rock core samples remaining after testing will be stored for a period of 60 days from the date of issue of this report after which they will be discarded unless directions to the contrary are received.

Detailed logs of the strata encountered at the site and of the sampling/testing carried out are shown on the appended Borehole Records.

The borehole locations were initially selected in the field by our personnel in conjunction with a PEI Transportation, Infrastructure and Energy (PEITIE) representative. The borehole locations, and ground surface elevations, were subsequently surveyed by PEITIE personnel relative to Geodetic Datum.

SUBSURFACE CONDITIONS

The subsurface conditions encountered at the boreholes are shown in detail on the appended Borehole Records, are summarized on Table 1 (also appended) and are described below.

Fill Materials

A layer of reddish brown fill materials was found to extend from ground surface to a depth of 1.7 m at BH-01. The fill generally consists of a gravelly silty sand with traces of wood. Similar fill materials were observed immediately west of BH-01 (i.e., along opposite shoreline). The fill encountered appears to represent the remnants of a previous dam embankment that extended across the river. No fill materials were encountered at BH-02 which was located on the mudflat.

Standard Penetration Test N-values within the fill were found to range from 3 to 8 indicating a very loose to loose relative density.

A grain size test (curve appended) performed on a split spoon sample of the fill shows it to contain 30 percent gravel, 37 percent sand and 33 percent fines (i.e., silt and clay sizes). The test sample was found to have a moisture content of 13 percent.

Marine Deposit

Marine deposited soils were encountered below the fill at BH-01 and at the surface of BH-02.

At BH-01, the marine soil consists of a 2.0 m thick layer of fine grained grey sand with some silt, trace to some organics, and frequent wood. At BH-02, a layer of reddish brown silt and sand with trace to some organics was found to extend from the ground surface to a depth of 1.5 m. The reddish brown silt and sand is underlain by a grey sand layer, 2.0 m in thickness, and similar in composition to the grey sand encountered at BH-01, without the wood.

N-values obtained within the grey sand generally range from 1 to 2 indicating a very loose relative density. The higher N-values obtained within the grey sand at BH-01 may be attributed to the presence of wood within this layer and are not deemed to be representative of the actual relative density.

N-values of 1 were obtained within the reddish brown silt and sand at BH-02 indicating a very loose relative density.

Grain size tests (curves appended) performed on split spoon samples of the grey sand recovered from BH-02 show it to contain an average of 2 percent gravel, 78 percent sand and 20 percent fines. The natural moisture content of selected samples of the grey sand was found to range from 56 to 67 percent with an average of 62 percent, indicating a compressible soil.

Glacial Till

A reddish brown glacial till stratum, ranging in thickness from 2.6 (BH-01) to 3.0 (BH-02), was encountered directly below the marine soils at the boreholes. The till was found to consist predominantly of a gravelly silty sand.

N-values obtained within the till range from 8 to 20, with an average of 13, indicating an overall compact relative density.

A grain size test (curve appended) performed on a split spoon sample of the till shows it to contain 30 percent gravel, 53 percent sand and 17 percent fines. The natural moisture content of selected till samples was found to range from 17 to 18 percent.

Bedrock

Sedimentary bedrock was encountered directly below the till stratum at both borehole locations, at an average depth of 6.4 m below ground surface. The elevation of the bedrock surface was found to range from el. -4.64 at BH-01 to el. -5.82 m at BH-02.

The rock core recovered consisted predominantly of very weak to weak, medium grained, reddish brown sandstone interbedded with stiff to hard reddish brown mudstone. The bedrock is horizontally bedded with extremely close (<20 mm) to close (60 to 200 mm) joints which typically occur along the bedding planes. An average RQD (Rock Quality Designation) value of 6 indicates very poor quality, very severely fractured bedrock.

Groundwater

It may be assumed that the groundwater table at the site is directly influenced by the water level and tidal variations within the Clyde River. An Ordinary High Water Mark (OHWM) of el. 0.65 m is understood for the subject site and is shown on the Borehole Records.

DISCUSSION AND RECOMMENDATIONS

It is understood that the proposed structure will likely either consist of a prefabricated arch or a clear span bridge.

The subsurface conditions encountered near the proposed structure alignment (i.e., at BH-02) may generally be summarized as 3.5 m of very loose marine silt/sand that directly overlies a compact glacial till stratum and sandstone bedrock, at a depth of 6.6 m. The river is tidally influenced with an OHWM located near the ground surface level of the mudflats.

Both spread footing and pile-supported foundations could be considered for use at the site based on the conditions encountered as discussed in the following sections.

Spread Footing Foundations

Spread footing foundations could be considered for use at the site provided that issues associated with excavation below the groundwater table and through the very loose mudflat soils can be addressed.

It is recommended that the groundwater table be temporarily lowered to facilitate excavation to the till surface. Control of groundwater inflow may require a temporary river diversion and will likely require pumping from a sump(s) located below the required depth of excavation.

Although lowering of the groundwater table prior to footing excavation should improve the stability of the excavation side slopes, flatter cut inclinations than the typical 1 horizontal to 1 vertical may still be necessary to achieve stable conditions. If it is preferable to limit the horizontal extent of the excavation, consideration could be given to some means of temporary shoring such as sheet piling. A large modified trench box could also be considered to assist with the safe placement of foundations and to limit the size of the excavation footprint. Precast footings placed on a granular base may also be beneficial to permit timely backfilling and to limit the time that the excavation must remain open.

Any soft or disturbed soils should be removed from the bearing surface prior to footing placement. If softening persists, consideration could be given to over-excavating the bearing surface (e.g., by 300 mm) to allow the placement of clean granular layer such as concrete stone or Class D gravel. The granular layer would help stabilize the bearing surface and should assist in groundwater control.

Spread footings placed on undisturbed till, or a granular layer placed over the till, may be designed using an allowable bearing pressure of 150 kPa. Associated total and differential settlements should be less than 25 mm and 15 mm, respectively.

All footings which will be subjected to freezing conditions should have a soil cover of at least 1.5 m (or equivalent insulation) for frost protection.

It may be prudent, at some point during the project design stage, to undertake a trial excavation onsite with a large backhoe or excavator to assess side slope stability and groundwater inflow. It may be possible to develop an excavation methodology that would limit the excavation footprint while still ensuring safe conditions for workers.

Steel H-Piles

It is expected that steel would be driven to/into the underlying sandstone/mudstone bedrock to develop the required capacity. Steel piles should be driven using a hammer with a rated energy of at least 350 J/cm^2 of net steel cross sectional area. Previous experience has shown that an actual delivered energy in the order of 200 J/cm^2 is required to attain the allowable contact stress given below. Refusal may be taken as 10 blows for the last 25 mm of pile penetration.

Actual penetration depths of steel piles into the sandstone/mudstone bedrock will depend on the driving energy delivered and the bedrock condition/strength at the pile locations. Previous experience has shown that penetration depths can vary significantly from site to site or within the same site, depending on the rock quality and strength, and can range from less than 1 m to 2 m or more.

The vertical capacity of steel piles driven to refusal, as defined above, may be determined using an allowable contact stress of 50 MPa for steel H and open end pipe piles (based on net steel area). An allowable bearing pressure of 7 MPa may be used for the design of closed end pipe piles (based on gross end area).

Re-tapping of some piles (e.g., 25 percent) within a 48-hour period is recommended to assess relaxation effects, and the requirement to re-tap additional piles.

The settlement of piles installed as outlined above and proportioned for the expected loads would be negligible. For the analysis of lateral resistance, an effective pile width of two times the pile diameter may be used.

Approach Embankments

It is understood that construction of the approach embankments will require raising present grades by up to 12 m and, depending on the type of structure selected, fill placement over the mudflat area may be required. Placement of fill directly over the very loose mudflat soils would not be ideal from a geotechnical standpoint.

Such fill placement could result in wide spread lateral displacement of the very loose soils resulting in significant "mudwaves". If, however, the fill is placed in such a manner to limit lateral displacement, our preliminary calculations indicate that up to 1 m of settlement could occur as the result of the compression of 3.5 m of mudflat soils under the weight of 12 m of new fill. Although a significant portion of this primary settlement would be expected to occur during fill placement, additional longer term secondary settlement could continue for several years. Furthermore, settlement of the embankment would be expected to vary depending on the height of new fill and the depth of the underlying mudflat soils at any given location.

In addition to settlement, other geotechnical concerns associated with leaving some or all of the mudflat soils in place below the new fill would include potential embankment slope stability issues and subjecting the new structure/associated foundations to potential high lateral loads and downdrag loads.

In view of the above, removal of the mudflat soils in their entirety from below the embankment footprint would be recommended. We would be pleased to provide further geotechnical input on this aspect of the project if requested.

CLOSING COMMENTS

A subsurface investigation is a limited sampling of a site. In the event that any conditions are encountered that differ from those encountered at the test locations, we request that we be notified immediately to permit a reassessment of our design assumptions.

We trust this report contains all of the information required at this time, and we are available at your convenience should you have any questions. We would be pleased to provide further geotechnical input for this project on an as required, as requested basis.

Sincerely,

JOOSE ENVIRONMENTAL CONSULTING INC.

George Zafiris

George W. Zafiris, P. Eng.
Geotechnical Engineer
georgez@bellaliant.net

GWZ/gz

APPENDIX

Table 1 - Borehole Summary - Proposed Clyde River Bridge

	Borehole Number	
	BH-01	BH-02
Ground Surface el., m	1.61	0.73
Fill Thickness, m	1.68	0.00
Marine Soil Thickness, m	1.98	3.50
Depth to Till, m	3.66	3.50
Till Surface el., m	-2.05	-2.77
Till Thickness, m	2.59	3.05
Depth to Bedrock, m	6.25	6.55
Bedrock Surface el., m	-4.64	-5.82
Depth of Borehole, m	10.67	10.82

NOTES:

- the boreholes were drilled at the site on August 30, 2016 using a track-mounted CME 55 auger drill rig
- ground surface elevations were provided by PEITIE and are referenced to Geodetic Datum
- bedrock was proven at both boreholes by rotary core drilling in NQ-size

JOOSE ENVIRONMENTAL

The following information is intended to assist in the interpretation of terms and symbols used on the borehole logs, test pit logs and reports.

Soils Description

Terminology describing common soil genesis:

Topsoil	-	mixture of soil and humus capable of supporting vegetative growth
Peat	-	mixture of visible and invisible fragments of decayed organic matter
Till	-	unstratified glacial deposit which may range from clay to boulders
Fill	-	material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	-	having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure
Varved	-	composed of regular alternating layers of silt and clay
Stratified	-	composed of alternating successions of different soil types, e.g. silt and sand
Layer	-	> 75 mm in thickness
Seam	-	2 mm to 75 mm in thickness
Parting	-	< 2 mm in thickness

Terminology describing soil types:

The classification of soil types are made on the basis of grain size and plasticity in accordance with the Modified Unified Soil Classification System (MUSCS) and in accordance with the Canadian Foundation Engineering Manual Fourth Edition (Canadian Geotechnical Society, 2006). The classification excludes particles larger than 75 mm (3 inches). The MUSCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter and construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

Consistency of Cohesive Soils: May be estimated using simple field tests, or described in terms of a strength scale. In the field, the undrained shear strength (s_u) can be assessed using a simple field tool appropriate for cohesive soils, in conjunction with the relevant calibration. Refer to AS 1726-1993, Table A4.

Consistency - Essentially Cohesive Soils					
Term	**Field Guide**	**Symbol**	**SPT "N" Value**	**Undrained Shear Strength su (kPa)**	**Unconfined Compressive Strength qu (kPa)**
Very soft	Oozes between fingers when	VS	0-2	<12	<25
Soft	Easily moulded with fingers.	S	2-4	12-25	25-50
Firm	Can be moulded by strong pressure of fingers.	F	4-8	25-50	50-100
Stiff	Not possible to mould with fingers.	St	8-15	50-100	100-200
Very stiff		VSt	15-30	100-200	200-400
Hard	Can be indented with difficulty by thumb nail.	H	>30	>200	>400

Note: SPT - N to q_u correlation from Terzaghi and Peck, 1967. (General guide only).

Soil Particle Sizes	
Term	**Size Range**
BOULDERS	>200 mm
COBBLES	63-200 mm
Coarse GRAVEL	20-63 mm
Medium GRAVEL	6-20 mm
Fine GRAVEL	2.36-6 mm
Coarse SAND	0.6-2.36 mm
Medium SAND	0.2-0.6 mm
Fine SAND	0.075-0.2 mm
SILT	0.002-0.075 mm
CLAY	<0.002 mm

Consistency of Non-Cohesive Soils: Is described in terms of the density index, as defined in AS 1289.0-2000. This can be assessed using a field tool appropriate for non-cohesive soils, in conjunction with the relevant calibration. Refer to AS 1726-1993, Table A5; BS5930-1999, p117.

Consistency - Essentially Non-Cohesive Soils				
Term	**Symbol**	**SPT N Value**	**Field Guide**	**Density Index (%)**
Very loose	VL	0-4	Foot imprints readily	0-15
Loose	L	4-10	Shovels Easily	15-35
Medium dense	MD	10-30	Shovelling difficult	35-65
Dense	D	30-50	Pick required	65-85
Very dense	VD	>50	Picking difficult	85-100

Standard Penetration Test (SPT): Refer to. AS 1289.6.3.1-2004. Example report formats for SPT results are shown below:

Test Report	Penetration Resistance (N)	Explanation / Comment
4, 7, 11	N=18	Full penetration; N is reported on engineering borehole log
18, 27, 32	N=59	Full penetration; N is reported on engineering borehole log
4, 18, 30/15 mm	N is not reported	30 blows causes less than 100 mm penetration (3rd interval) - test discontinued
30/80 mm	N is not reported	30 blows causes less than 100 mm penetration (1st interval) - test discontinued
rw	N<1	Rod weight only causes full penetration
hw	N<1	Hammer and rod weight only causes full penetration
hb	N is not reported	Hammer bouncing for 5 consecutive blows with no measurable penetration - test discontinued

Rock Description

Except where specified below, terminology for describing rock is as defined by the International Society for Rock Mechanics (ISRM) 2007 publication "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006"

Terminology Describing Rock Quality:

RQD	Rock Mass Quality
0 - 25	*Very Poor Quality*
25 - 50	*Poor Quality*
50 - 75	*Fair Quality*
75 - 90	*Good Quality*
90 - 100	*Excellent Quality*

Alternate (Colloquial) Rock Mass Quality	
Very Severely Fractured	*Crushed*
Severely Fractured	*Shattered or Very Blocky*
Fractured	*Blocky*
Moderately Jointed	*Sound*
Intact	*Very Sound*

RQD (Rock Quality Designation) denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 inches) long are summed up and divided by the total length of the core run. RQD is determined in accordance with ASTM D6032.

SCR (Solid Core Recovery) denotes the percentage of solid core (cylindrical) retrieved forma borehole of any orientation. All pieces of the solid (cylindrical) core are summed and divided by the total length of the core run (It excludes all portions of core pieces that are not fully cylindrical as well as crushed or rubble zones).

Fracture Index (FI) is defined as the number of naturally occurring fractures within a given length of core. The Fracture Index is reported as a simple count of the natural occurring fractures.

Refer to AS 1726-1993 (Appendix A3.3) for the description and classification of rock material composition, including:

(a) Rock type (Table A6, (a) and (b))
(b) Grain size
(c) Texture and fabric
(d) Colour (describe as per soil).

The condition of a rock material refers to its weathering characteristics, strength characteristics and rock mass properties. Refer to AS 1726-1993 (Appendix A3 Tables A8, A9 and A10).

Weathering Condition (Degree of Weathering):

The degree of weathering is a continuum from fresh rock to soil. Boundaries between weathering grades may be abrupt or gradational.

Rock Material Weathering		
Weathering Grade	**Symbol**	**Definitio**
Residual Soil	RS	Soil-like material developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the material has not been significantly transported.
Extremely Weathered Rock	XW	Rock is weathered to such an extent that it has 'soil' properties, i.e. it either disintegrates or can be remoulded in water, but substance fabric and rock structure still recognizable.
Highly Weathered Rock	HW	Strong discolouration is evident throughout the rock mass, often with significant change in the constituent minerals. The intact rock strength is generally much weaker than that of the fresh rock.
Moderately Weathered Rock	MW	Modest discolouration is evident throughout the rock fabric, often with some change in the constituent minerals. The intact rock strength is usually noticeably weaker than that of the fresh rock.
Slightly Weathered	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh Rock	FR	Rock shows no sign of decomposition or staining.

Notes:

1. Minor variations within broader weathering grade zones will be noted on the engineering borehole logs.
2. Extremely weathered rock is described in terms of soil engineering properties.
3. Weathering may be pervasive throughout the rock mass, or may penetrate inwards from discontinuities to some extent.
4. The 'Distinctly Weathered (DW)' class as defined in AS 1726-1993 is divided to incorporate HW and MW in the above table. The symbol DW should not be used.

Strength Condition (Intact Rock Strength):

Terminology Describing Rock Strength

Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	< 1
Very Weak	R1	1 - 5
Weak	R2	5 - 25
Medium Strong	R3	25 - 50
Strong Very	R4	50 - 100
Strong Extremely	R5	100 - 250
Strong	R6	> 250

Discontinuity Spacing: On the geotechnical borehole log, a graphical representation of defect spacing vs depth is shown. This representation takes into account all the natural rock defects occurring within a given depth interval, excluding breaks induced by the drilling / handling of core. Refer to AS 1726-1993, BS5930-1999.

Defect Spacing			Bedding Thickness (Sedimentary Rock Stratification)	
Spacing/Width (mm)	**Descriptor**	**Symbol**	**Descriptor**	**Spacing /Width (mm)**
			Thinly Laminated	<6
<20	Extremely Close	EC	Thickly Laminated	6 - 20
20 - 60	Very Close	VC	Very Thinly Bedded	20 - 60
60 - 200	Close	C	Thinly Bedded	60 -200
200 - 600	Medium	M	Medium Bedded	200 - 600
600 - 2000	Wide	W	Thickly Bedded	600 - 2000
2000 - 6000	Very Wide	VW	Very Thickly Bedded	>2000
>6000	Extremely Wide	EW		

Defect Spacing in 3D	
Term	**Description**
Blocky	Equidimensional
Tabular	Thickness much less than length or width
Columnar	Height much greater than cross section

Direct Persistence (areal extent)
Trace length of defect given in metres

The list on the following table provides an explanation of terms and symbols used on the geotechnical borehole, test pit and penetrometer logs.

Test Results					Test Symbols	
PI	Plasticity Index	c'	Effective Cohesion		DCP	Dynamic Cone Penetrometer
LL	Liquid Limit	c_u	Undrained Cohesion		SPT	Standard Penetration Test
LI	Liquidity Index	c'_R	Residual Cohesion		CPTu	Cone Penetrometer (Piezocone) Test
DD	Dry Density	φ'	Effective Angle of Internal Friction		PANDA	Variable Energy DCP
WD	Wet Density	φ_u	Undrained Angle of Internal Friction		PP	Pocket Penetrometer Test
LS	Linear Shrinkage	φ'_R	Residual Angle of Internal Friction		U50	Undisturbed Sample 50 mm (nominal diameter)
MC	Moisture Content	c_v	Coefficient of Consolidation		U100	Undisturbed Sample 100mm (nominal diameter)
OC	Organic Content	m_v	Coefficient of Volume Compressibility		UCS	Uniaxial Compressive Strength
WPI	Weighted Plasticity Index	$c_{\alpha\varepsilon}$	Coefficient of Secondary Compression		Pm	Pressuremeter

Test Results					Test Symbols	
WLS	Weighted Linear Shrinkage	e	Voids Ratio		FSV	Field Shear Vane
DoS	Degree of Saturation	φ'_{cv}	Constant Volume Friction Angle		DST	Direct Shear Test
APD	Apparent Particle Density	q_t / q_c	Piezocone Tip Resistance (corrected / uncorrected)		PR	Penetration Rate
s_u	Undrained Shear Strength	q_d	PANDA Cone Resistance		A	Point Load Test (axial)
q_u	Unconfined Compressive Strength	$I_{s(50)}$	Point Load Strength Index		D	Point Load Test (diametral)
R	Total Core Recovery	*RQD*	Rock Quality Designation		L	Point Load Test (irregular lump)

Sample Type

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameters tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ,NQ, BQ, etc	Rock core samples obtained with the use of standard size diamond coring bits.

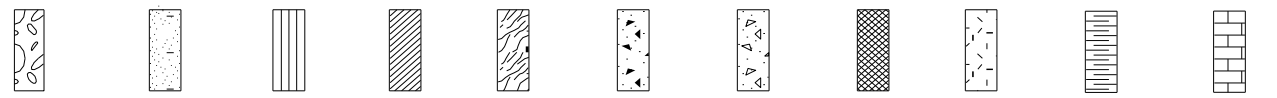
Water Level Measurement

Measurement in standpipe, piezometer, or well

Inferred

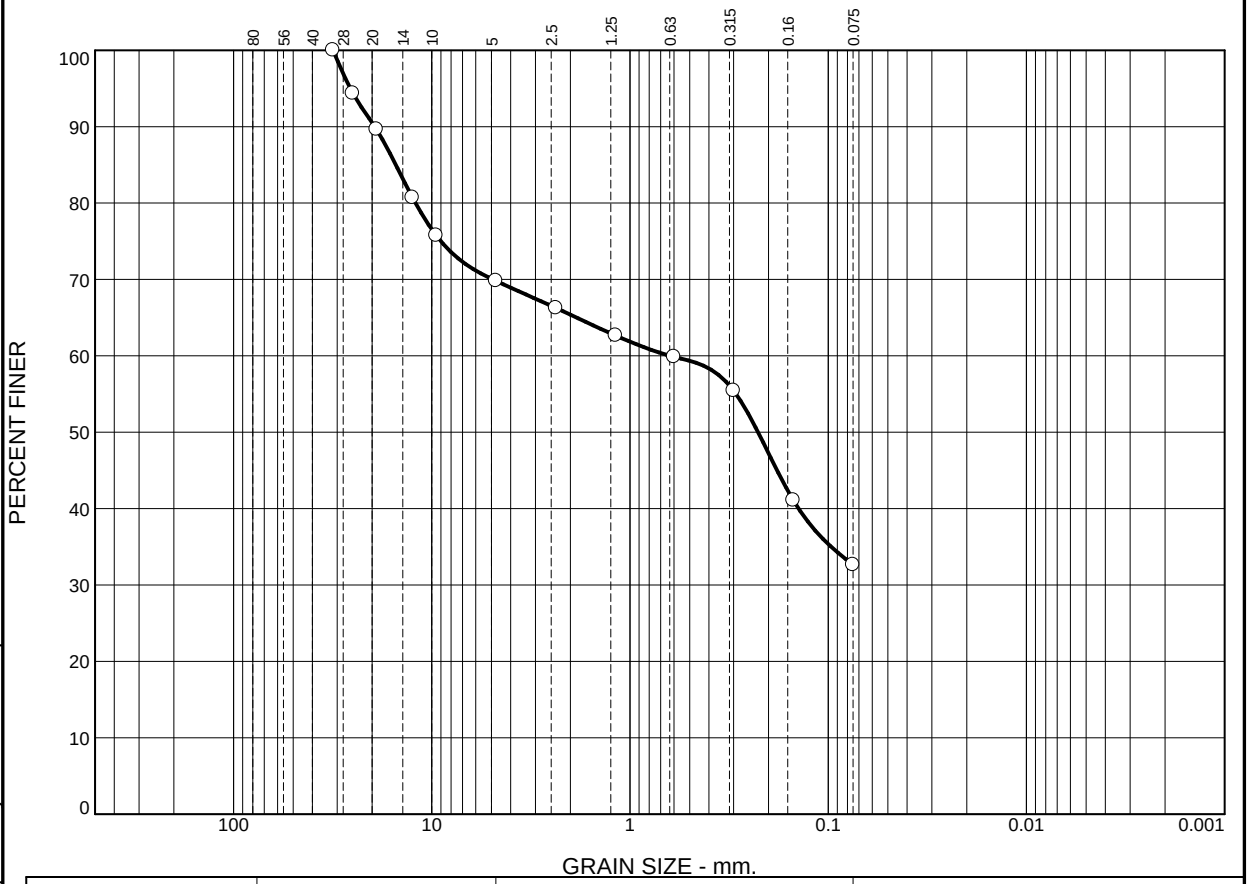
Strata Plot

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders Cobbles Gravel | Sand | Silt | Clay | Organics | Asphalt | Concrete | Fill | Igneous Bedrock | Meta-morphic Bedrock | Sedi-mentary Bedrock

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	10.3	19.9	4.4	6.7	26.1	32.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			15.1879	0.6276	0.2259					

Material Description	USCS	AASHTO
○ Fill, Aug 31,2016		

Project No. 16-12093 **Client:** Joose Environmental

Project: QC Soils Analysis, Clyde River Bridge

○ **Location:** BH#1- SS#2 **Depth:** 2'-4' **Sample Number:** 1

FUNDY Engineering

Remarks:

○Moisture Content of Sample was 12.6%

Figure

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicative of apparently identical samples.

Tested By: T.Pineau **Checked By:** D.Taweel

Particle Size Distribution Report

	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○			9.5	2.4	4.8	45.8	17.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○				0.3393	0.2520	0.1664				

Material Description	USCS	AASHTO
○ Till, August 31, 2016		

Project No. 16-12093 **Client:** Joose Environmental

Project: QC Soils Analysis Clyde River Bridge

○ **Location:** BH1-SS#8 **Depth:** 15'-17' **Sample Number:** 2

Remarks:

○Moisture Content of sample was 18.1%

FUNDY Engineering

Figure

Tested By: T.Pineau **Checked By:** D.Taweel

Particle Size Distribution Report

	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	1.8	3.7	19.4	54.2	20.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.6588	0.2796	0.2234	0.1310				

Material Description	USCS	AASHTO
○ Silt and Sand, August 31, 2016		

Project No. 16-12093 **Client:** Joose Environmental

Project: QC Soils Analysis Clyde River Bridge

○ **Location:** BH#2-SS#3 **Depth:** 5'-7' **Sample Number:** 3

Remarks:

○Moisture content of sample was 55.9%

FUNDY Engineering

Figure

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicative of apparently identical samples.

Tested By: T.Pineau **Checked By:** D.Taweel

Particle Size Distribution Report

	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	1.6	6.8	12.3	60.0	19.3	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			1.0430	0.2318	0.1937	0.1249				

Material Description	USCS	AASHTO
○ Silt, August 21, 2016		

Project No. 16-12093 **Client:** Joose Environmental

Project: QC Soils Analysis Clyde River Bridge

○ **Location:** BH2-SS#4 **Depth:** 8'-10'6" **Sample Number:** 4

Remarks:

○Moisture Content of sample was 61.7%

FUNDY Engineering

Figure

Tested By: T.Pineau **Checked By:** D.Taweel

BOREHOLE RECORD

BOREHOLE No. BH-01
(NORTH SIDE)

CLIENT PEITIE
LOCATION Proposed Clyde River Bridge, Clyde River, PEI
PROJECT No. JE0197
DRILLING Co. Logan Geotech Inc.
JE TECHNICIAN George Zafiris
CASING SIZE N
DATES: BORING August 30, 2016
WATER LEVEL Tidal; OHWM shown
DATUM Geodetic

DEPTH (Ft.)	DEPTH (m)	Ground Surface ELEVATION (m)	LITHOLOGIC DESCRIPTION	STRATA	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD%	OTHER TESTS	S.V.C.(ppm)
		1.61	GRADE								
0	0		Loose to very loose reddish brown gravelly silty sand; trace wood: FILL, rootmat/topsoil at surface		▼	SS	1	300	8		
	1					SS	2	400	7	S	
5		−0.07				SS	3	600	3		
	2		Very loose grey sand, some silt, trace to some organics: MARINE DEPOSIT; wood encountered from 1.8 to 3.0m			SS	4	100	10		
10	3					SS	5	150	12		
		−2.05				SS	6	250	2		
	4		Compact reddish brown gravelly silty sand: TILL			SS	7	350	15		
15											
	5					SS	8	350	15	S	
20	6	−4.64				SS	9	325	14		
	7		Very weak to weak, medium grained, reddish brown sandstone, interbedded with stiff to hard reddish brown mudstone: BEDROCK			NQ	10	45%	ROD 11		
25	8					NQ	11	75%	ROD 0		
30	9										
	10		Very weak to weak, medium grained, reddish brown sandstone, occasional weakly cemented seams: BEDROCK			NQ	12	83%	ROD 19		
35		−9.06									
	11		End of Borehole								
40	12										
	13										
45											

Undrained Shear Strength − kPa
20 40 60 80
Water Constant & Atterberg Limits W_P W W_L
Dynamic Penetration Test, blows/0.3m ★
Standard Penetration Test, blows/0.3m ●
10 20 30 40 50 60 70 80 90

WC=13%
WC=67%
WC=18%

Note:
S Sieve Analysis

BOREHOLE RECORD

BOREHOLE No. BH-02
(SOUTH SIDE)

CLIENT PEITIE
LOCATION Proposed Clyde River Bridge, Clyde River, PEI
PROJECT No. JE0197
DRILLING Co. Logan Geotech Inc.
JE TECHNICIAN George Zafiris
CASING SIZE N
DATES: BORING August 30, 2016
WATER LEVEL Tidal; OHWM shown
DATUM Geodetic

DEPTH (Ft.)	DEPTH (m)	Ground Surface ELEVATION (m)	LITHOLOGIC DESCRIPTION	STRATA	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD%	OTHER TESTS	S.V.C.(ppm)
0	0	0.73	GRADE								
			Very loose reddish brown silt, and sand, trace to some organics: MARINE DEPOSIT			SS	1	100	1		
	1					SS	2	300	1		
5		-0.79									
	2		Very loose grey sand, some silt, trace to some organics: MARINE DEPOSIT			SS	3	350	1	S	
10	3					SS	4	300	1	S	
		-2.77				SS	5	450	20		
	4		Compact to loose reddish brown gravelly silty sand: TILL			SS	6	300	8		
15	5										
						SS	7	300	8		
20	6	-5.82									
	7		Very weak to weak, medium grained, reddish brown sandstone; occasional stiff to hard reddish brown mudstone seams: BEDROCK			SS	8	67%	ROD 0		
25	8					SS	9	60%	ROD 7		
30	9										
	10					NQ	10	80%	ROD 0		
35		-10.09									
	11		End of Borehole								
40	12										
	13										
45											

Undrained Shear Strength – kPa
20 40 60 80
Water Constant & Atterberg Limits W_P W W_L
Dynamic Penetration Test, blows/0.3m ★
Standard Penetration Test, blows/0.3m ●
10 20 30 40 50 60 70 80 90

WC=56%
WC=62%
WC=17%

Note:
S Sieve Analysis

JOOSE ENVIRONMENTAL

BOREHOLE LOCATION PLAN

GEOTECHNICAL INVESTIGATION - PROPOSED CLYDE RIVER BRIDGE

CLYDE RIVER,QUEENS COUNTY, PEI

CLIENT: PEITIE

SCALE:		JOB NO.:	DWG NO.:
1 : 5000		JE0197	1
DATE	**DWN BY:**	**APPD BY:**	
2016/09/12	MLJ	GWZ	

SUPPLEMENTAL GEOTECHNICAL INVESTIGATION
PROPOSED CLYDE RIVER BRIDGE
CLYDE RIVER, QUEENS COUNTY, PE

JOOSE ENVIRONMENTAL PROJECT NO. JE0252

Joose Environmental Consulting Inc.
P.O. Box 19
North Wiltshire PE C0A 1Y0

September 28, 2017

Joose Environmental Project No. JE0252

Mr. Darrell Evans, P. Eng., Manager Design and Bridge Maintenance
Capital Projects Division
PEI Transportation, Infrastructure and Energy
PO Box 2000
Charlottetown, PEI
C1A 7N8

Dear Mr. Evans:

Reference: Supplemental Geotechnical Investigation - Proposed Clyde River Bridge
Clyde River, Queens County, Prince Edward Island

This report presents the results of the supplemental geotechnical investigation carried out for the above-noted project, in accordance with your request. The purpose of the present investigation was to further establish the subsurface conditions in the vicinity of the proposed structure and, based on the conditions encountered, to provide geotechnical engineering recommendations pertaining to foundation design and construction.

Pertinent subsurface information obtained during our initial geotechnical investigation (Report No. JE0197, issued September 12, 2016) has been incorporated into this report. For ease of reference, the previous report is included, in its entirety, in the Appendix.

PROCEDURE

The field work for the present investigation was carried out on September 19, 2017, and consisted of drilling two (2) additional boreholes at the site with a track-mounted CME 55 auger drill rig. For the purposes of this report the boreholes have been designated as follows:

- BH-05 - present borehole located east of river on Dixon Property;
- BH-06 - present borehole located west of river on MacQuarrie Property;
- BH-14 - previous borehole located west of river on MacQuarrie Property (previously labeled as BH-02).

BH-13, previously labeled as BH-01, is not located near the revised bridge alignment and is consequently not utilized in this report.

The present boreholes were advanced to depths ranging from 8.8 to 13.9 m below existing grade at the locations shown on the appended Drawing No. 1.

Samples of the overburden soils encountered were taken at regular intervals by means of a conventional split spoon sampler during the performance of Standard Penetration Tests. Bedrock was proven at both borehole locations by rotary core drilling in NQ-size (45 mm core diameter).

All soil samples recovered were placed in moisture-proof containers and were delivered, with the rock core, to our office for classification and testing. All soil and rock core samples remaining after testing will be stored for a period of three months from the date of issue of this report after which they will be discarded unless directions to the contrary are received.

Detailed logs of the strata encountered at the site and of the sampling/testing carried out are shown on the appended Borehole Records.

The locations and ground surface elevations of the boreholes were established in the field by a PEI Transportation, Infrastructure and Energy (PEITIE) representative. Following are the coordinates and ground surface elevations (Geodetic Datum) provided by PEITIE for the present boreholes:

Borehole No.	Northing, m	Easting, m	Ground Surface Elevation, m
BH-05	687 288.193	380 833.840	6.66
BH-06	687 211.125	380 715.970	9.71

SUBSURFACE CONDITIONS

The subsurface conditions encountered at the present boreholes are shown in detail on the appended Borehole Records, are summarized on Table 1 (also appended) and are described below. The subsurface conditions encountered at the present boreholes and at previous BH 14 (BH-02) are also depicted on the Stratigraphic Section included on Drawing No. 1 (appended).

Rootmat/Topsoil

A layer of rootmat and brown sandy topsoil, 450 mm in thickness, was encountered at the surface of BH-05. A Standard Penetration Test N-value of 7 obtained within the rootmat/topsoil indicates a loose relative density.

Fill Materials

A layer of reddish brown fill materials was found to extend from ground surface to a depth of 2.3 m at BH-06. The fill generally consists of a gravelly silty sand with occasional sandstone cobbles/boulders and traces of roots.

N-values within the fill were found to range from 3 to 54 indicating a highly variable, very loose to dense, relative density.

Grain size tests (curves appended) performed on split spoon samples of the fill show it to contain an average of 34 percent gravel, 44 percent sand and 22 percent fines (i.e., silt and clay sizes). The test samples were found to have a moisture content of 9 to 11 percent.

Glacial Till

The principal overburden soil encountered at the site was found to consist of a reddish brown glacial till. The till is generally comprised of a clayey silt and sand, some gravel, with occasional layers of coarser-grained gravelly silty sand. The till was also found to contain occasional, to some, sandstone cobbles. The depth to the till surface was found to range from 0.5 m at BH-05 to 2.3 m at BH-06. The till surface elevation was found to range from el. 6.21 m at BH-05 to el. 7.42 m at BH-06.

N-values obtained within the till range from 12 to in excess of 50, with an overall average of 24 (excluding the >50 values) indicating an overall compact relative density. The >50 N-values may be attributed to the presence of sandstone cobbles within the till, and/or the proximity to the bedrock surface.

Grain size tests (curves appended) performed on samples of the finer-grained clayey silt and sand till show it to contain an average of 18 percent gravel, 34 percent sand and 48 percent fines. A grain size test (curve appended) performed on a sample of the coarser-grained gravelly silty sand till shows it to contain 34 percent gravel, 38 percent sand and 28 percent fines. The natural moisture content of selected till samples was found to range from 15 to 16 percent.

Bedrock

Sedimentary bedrock was encountered directly below the till stratum at both borehole locations, at an average depth of 6.8 m below ground surface. The elevation of the bedrock surface was found to range from el. 4.27 at BH-06 to el. -1.57 m at BH-05.

The rock core recovered consisted predominantly of very weak to weak, medium-grained, reddish brown sandstone that is occasionally interbedded with fine-grained sandstone and/or stiff to hard reddish brown mudstone. The bedrock is horizontally bedded with extremely close (<20 mm) to moderately close (200 to

600 mm) joints which typically occur along the bedding planes. An average RQD (Rock Quality Designation) value of 36 indicates poor quality, severely fractured bedrock.

Groundwater

The groundwater table was encountered at a depth of 5.8 m (el. 0.86 m) during the drilling of BH-05. It may be assumed that the groundwater table at the site is located above, but near, the water level within the Clyde River. An Ordinary High Water Mark (OHWM) of el. 0.65 m is understood for the subject site.

Fluctuations of the groundwater table can also occur as a result of seasonal changes and/or significant precipitation events.

DISCUSSION AND RECOMMENDATIONS

It is understood that the proposed structure will likely consist of a four-span bridge.

Based on the subsurface conditions encountered, spread footing foundations, pile-supported foundations, or some combination thereof, could be considered for use at the abutment and pier locations. Since similar subsurface conditions were encountered during the present investigation as compared to those encountered during the initial investigation, the recommendations pertaining to the design of spread footing and pile-supported foundations provided in our initial report are still applicable (refer to previous in the Appendix). Some additional comments and recommendations pertaining to spread footing foundations are provided below.

Spread Footing Foundations

As recommended previously, spread footings placed on undisturbed till, or on a granular layer placed over the till, may be designed using an allowable bearing pressure of 150 kPa. Associated total and differential settlements would be less than 25 mm and 15 mm, respectively. In the event that higher capacities are required, consideration could be given to founding directly on the bedrock surface, depending on the depth of excavation required. The depth of excavation below the groundwater table may also be a limiting factor.

At BH-06, located near the proposed west abutment, sandstone bedrock was encountered at a depth of 5.4 m below ground surface. At BH-05, located near the proposed east abutment, sandstone bedrock was encountered at a depth of 8.2 m below ground surface, and approximately 2.4 m below the groundwater table.

Although the sandstone bedrock surface should not be susceptible to water disturbance, the temporary lowering of the groundwater table may be required at some locations to facilitate excavation to the bedrock surface and concrete/footing placement.

Spread footing foundations placed directly on the sandstone bedrock surface, or on a granular levelling course placed directly over the bedrock surface, may be designed for an allowable bearing pressure of up to 400 kPa. Associated total and differential settlements would be less than 25 mm and 15 mm, respectively.

The granularly levelling course, if required, could consist of a well-compacted 150 to 300 mm layer of clean crushed stone such as concrete stone or Class D gravel. The granular layer would also assist in groundwater control where necessary.

We would be pleased to provide further geotechnical design input for this project on an as-required, as-requested basis.

CLOSING COMMENTS

A subsurface investigation is a limited sampling of a site. In the event that any conditions are encountered that differ from those encountered at the test locations, we request that we be notified immediately to permit a reassessment of our design assumptions.

We trust this report contains all of the information required at this time, and we are available at your convenience should you have any questions. We would be pleased to provide further geotechnical input for this project on an as required, as requested basis.

Sincerely,

JOOSE ENVIRONMENTAL CONSULTING INC.

George Zafiris

George Zafiris

George W. Zafiris, P. Eng.
Geotechnical Engineer
georgez@jooseenv.com

GWZ/gz

APPENDIX

Table 1 - Borehole Summary - Proposed Clyde River Bridge

	Borehole Number		
	West Side		East Side
	BH-06	BH-14 (BH-02)	BH-05
Ground Surface el., m	9.71	0.73	6.66
Rootmat/Topsoil Thickness, m	0.00	0.00	0.45
Fill Thickness, m	2.29	0.00	0.00
Marine Deposit Thickness, m	0.00	3.50	0.00
Depth to Till, m	2.29	3.50	0.45
Till Surface el., m	7.42	-2.77	6.21
Till Thickness, m	3.15	3.05	7.78
Depth to Bedrock, m	5.44	6.55	8.23
Bedrock Surface el., m	4.27	-5.82	-1.57
Depth of Borehole, m	8.84	10.82	13.87

NOTES:

- BH-05 and BH-06 were drilled at the site on September 19, 2017 using a track-mounted CME 55 auger drill rig
- BH-14 (BH-02) was drilled at the site on August 30, 2016 using a track-mounted CME 55 auger drill rig
- ground surface elevations were provided by PEITIE and are referenced to Geodetic Datum
- bedrock was proven at each borehole by rotary core drilling in NQ-size

The following information is intended to assist in the interpretation of terms and symbols used on the borehole logs, test pit logs and reports.

Soils Description

Terminology describing common soil genesis:

Topsoil	-	mixture of soil and humus capable of supporting vegetative growth
Peat	-	mixture of visible and invisible fragments of decayed organic matter
Till	-	unstratified glacial deposit which may range from clay to boulders
Fill	-	material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	-	having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure
Varved	-	composed of regular alternating layers of silt and clay
Stratified	-	composed of alternating successions of different soil types, e.g. silt and sand
Layer	-	> 75 mm in thickness
Seam	-	2 mm to 75 mm in thickness
Parting	-	< 2 mm in thickness

Terminology describing soil types:

The classification of soil types are made on the basis of grain size and plasticity in accordance with the Modified Unified Soil Classification System (MUSCS) and in accordance with the Canadian Foundation Engineering Manual Fourth Edition (Canadian Geotechnical Society, 2006). The classification excludes particles larger than 75 mm (3 inches). The MUSCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter and construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

Consistency of Cohesive Soils: May be estimated using simple field tests, or described in terms of a strength scale. In the field, the undrained shear strength (s_u) can be assessed using a simple field tool appropriate for cohesive soils, in conjunction with the relevant calibration. Refer to AS 1726-1993, Table A4.

Consistency - Essentially Cohesive Soils					
Term	**Field Guide**	**Symbol**	**SPT "N" Value**	**Undrained Shear Strength su (kPa)**	**Unconfined Compressive Strength qu (kPa)**
Very soft	Oozes between fingers when	VS	0-2	<12	<25
Soft	Easily moulded with fingers.	S	2-4	12-25	25-50
Firm	Can be moulded by strong pressure of fingers.	F	4-8	25-50	50-100
Stiff	Not possible to mould with fingers.	St	8-15	50-100	100-200
Very stiff		VSt	15-30	100-200	200-400
Hard	Can be indented with difficulty by thumb nail.	H	>30	>200	>400

Note: SPT - N to q_u correlation from Terzaghi and Peck, 1967. (General guide only).

Soil Particle Sizes	
Term	**Size Range**
BOULDERS	>200 mm
COBBLES	63-200 mm
Coarse GRAVEL	20-63 mm
Medium GRAVEL	6-20 mm
Fine GRAVEL	2.36-6 mm
Coarse SAND	0.6-2.36 mm
Medium SAND	0.2-0.6 mm
Fine SAND	0.075-0.2 mm
SILT	0.002-0.075 mm
CLAY	<0.002 mm

Consistency of Non-Cohesive Soils: Is described in terms of the density index, as defined in AS 1289.0-2000. This can be assessed using a field tool appropriate for non-cohesive soils, in conjunction with the relevant calibration. Refer to AS 1726-1993, Table A5; BS5930-1999, p117.

Consistency - Essentially Non-Cohesive Soils				
Term	**Symbol**	**SPT N Value**	**Field Guide**	**Density Index (%)**
Very loose	VL	0-4	Foot imprints readily	0-15
Loose	L	4-10	Shovels Easily	15-35
Medium dense	MD	10-30	Shovelling difficult	35-65
Dense	D	30-50	Pick required	65-85
Very dense	VD	>50	Picking difficult	85-100

Standard Penetration Test (SPT): Refer to. AS 1289.6.3.1-2004. Example report formats for SPT results are shown below:

Test Report	Penetration Resistance (N)	Explanation / Comment
4, 7, 11	N=18	Full penetration; N is reported on engineering borehole log
18, 27, 32	N=59	Full penetration; N is reported on engineering borehole log
4, 18, 30/15 mm	N is not reported	30 blows causes less than 100 mm penetration (3rd interval) - test discontinued
30/80 mm	N is not reported	30 blows causes less than 100 mm penetration (1st interval) - test discontinued
rw	N<1	Rod weight only causes full penetration
hw	N<1	Hammer and rod weight only causes full penetration
hb	N is not reported	Hammer bouncing for 5 consecutive blows with no measurable penetration - test discontinued

Rock Description

Except where specified below, terminology for describing rock is as defined by the International Society for Rock Mechanics (ISRM) 2007 publication "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006"

Terminology Describing Rock Quality:

RQD	Rock Mass Quality
0 - 25	*Very Poor Quality*
25 - 50	*Poor Quality*
50 - 75	*Fair Quality*
75 - 90	*Good Quality*
90 - 100	*Excellent Quality*

Alternate (Colloquial) Rock Mass Quality	
Very Severely Fractured	*Crushed*
Severely Fractured	*Shattered or Very Blocky*
Fractured	*Blocky*
Moderately Jointed	*Sound*
Intact	*Very Sound*

RQD (Rock Quality Designation) denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 inches) long are summed up and divided by the total length of the core run. RQD is determined in accordance with ASTM D6032.

SCR (Solid Core Recovery) denotes the percentage of solid core (cylindrical) retrieved forma borehole of any orientation. All pieces of the solid (cylindrical) core are summed and divided by the total length of the core run (It excludes all portions of core pieces that are not fully cylindrical as well as crushed or rubble zones).

Fracture Index (FI) is defined as the number of naturally occurring fractures within a given length of core. The Fracture Index is reported as a simple count of the natural occurring fractures.

Refer to AS 1726-1993 (Appendix A3.3) for the description and classification of rock material composition, including:

(a) Rock type (Table A6, (a) and (b))
(b) Grain size
(c) Texture and fabric
(d) Colour (describe as per soil).

The condition of a rock material refers to its weathering characteristics, strength characteristics and rock mass properties. Refer to AS 1726-1993 (Appendix A3 Tables A8, A9 and A10).

Weathering Condition (Degree of Weathering):

The degree of weathering is a continuum from fresh rock to soil. Boundaries between weathering grades may be abrupt or gradational.

Rock Material Weathering		
Weathering Grade	**Symbol**	**Definitio**
Residual Soil	RS	Soil-like material developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the material has not been significantly transported.
Extremely Weathered Rock	XW	Rock is weathered to such an extent that it has 'soil' properties, i.e. it either disintegrates or can be remoulded in water, but substance fabric and rock structure still recognizable.
Highly Weathered Rock	HW	Strong discolouration is evident throughout the rock mass, often with significant change in the constituent minerals. The intact rock strength is generally much weaker than that of the fresh rock.
Moderately Weathered Rock	MW	Modest discolouration is evident throughout the rock fabric, often with some change in the constituent minerals. The intact rock strength is usually noticeably weaker than that of the fresh rock.
Slightly Weathered	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh Rock	FR	Rock shows no sign of decomposition or staining.

Notes:

1. Minor variations within broader weathering grade zones will be noted on the engineering borehole logs.
2. Extremely weathered rock is described in terms of soil engineering properties.
3. Weathering may be pervasive throughout the rock mass, or may penetrate inwards from discontinuities to some extent.
4. The 'Distinctly Weathered (DW)' class as defined in AS 1726-1993 is divided to incorporate HW and MW in the above table. The symbol DW should not be used.

Strength Condition (Intact Rock Strength):

Terminology Describing Rock Strength

Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	< 1
Very Weak	R1	1 - 5
Weak	R2	5 - 25
Medium Strong	R3	25 - 50
Strong Very	R4	50 - 100
Strong Extremely	R5	100 - 250
Strong	R6	> 250

Discontinuity Spacing: On the geotechnical borehole log, a graphical representation of defect spacing vs depth is shown. This representation takes into account all the natural rock defects occurring within a given depth interval, excluding breaks induced by the drilling / handling of core. Refer to AS 1726-1993, BS5930-1999.

Defect Spacing			Bedding Thickness (Sedimentary Rock Stratification)	
Spacing/Width (mm)	**Descriptor**	**Symbol**	**Descriptor**	**Spacing /Width (mm)**
			Thinly Laminated	<6
<20	Extremely Close	EC	Thickly Laminated	6 - 20
20 - 60	Very Close	VC	Very Thinly Bedded	20 - 60
60 - 200	Close	C	Thinly Bedded	60 -200
200 - 600	Medium	M	Medium Bedded	200 - 600
600 - 2000	Wide	W	Thickly Bedded	600 - 2000
2000 - 6000	Very Wide	VW	Very Thickly Bedded	>2000
>6000	Extremely Wide	EW		

Defect Spacing in 3D	
Term	**Description**
Blocky	Equidimensional
Tabular	Thickness much less than length or width
Columnar	Height much greater than cross section

Direct Persistence (areal extent)
Trace length of defect given in metres

The list on the following table provides an explanation of terms and symbols used on the geotechnical borehole, test pit and penetrometer logs.

Test Results					Test Symbols	
PI	Plasticity Index	c'	Effective Cohesion		DCP	Dynamic Cone Penetrometer
LL	Liquid Limit	c_u	Undrained Cohesion		SPT	Standard Penetration Test
LI	Liquidity Index	c'_R	Residual Cohesion		CPTu	Cone Penetrometer (Piezocone) Test
DD	Dry Density	φ'	Effective Angle of Internal Friction		PANDA	Variable Energy DCP
WD	Wet Density	φ_u	Undrained Angle of Internal Friction		PP	Pocket Penetrometer Test
LS	Linear Shrinkage	φ'_R	Residual Angle of Internal Friction		U50	Undisturbed Sample 50 mm (nominal diameter)
MC	Moisture Content	c_v	Coefficient of Consolidation		U100	Undisturbed Sample 100mm (nominal diameter)
OC	Organic Content	m_v	Coefficient of Volume Compressibility		UCS	Uniaxial Compressive Strength
WPI	Weighted Plasticity Index	$c_{\alpha\varepsilon}$	Coefficient of Secondary Compression		Pm	Pressuremeter

Test Results					Test Symbols	
WLS	Weighted Linear Shrinkage	e	Voids Ratio		FSV	Field Shear Vane
DoS	Degree of Saturation	φ'_{cv}	Constant Volume Friction Angle		DST	Direct Shear Test
APD	Apparent Particle Density	q_t / q_c	Piezocone Tip Resistance (corrected / uncorrected)		PR	Penetration Rate
s_u	Undrained Shear Strength	q_d	PANDA Cone Resistance		A	Point Load Test (axial)
q_u	Unconfined Compressive Strength	$I_{s(50)}$	Point Load Strength Index		D	Point Load Test (diametral)
R	Total Core Recovery	*RQD*	Rock Quality Designation		L	Point Load Test (irregular lump)

Sample Type

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameters tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ,NQ, BQ, etc	Rock core samples obtained with the use of standard size diamond coring bits.

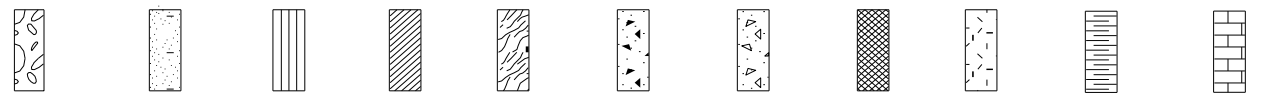
Water Level Measurement

Measurement in standpipe, piezometer, or well

Inferred

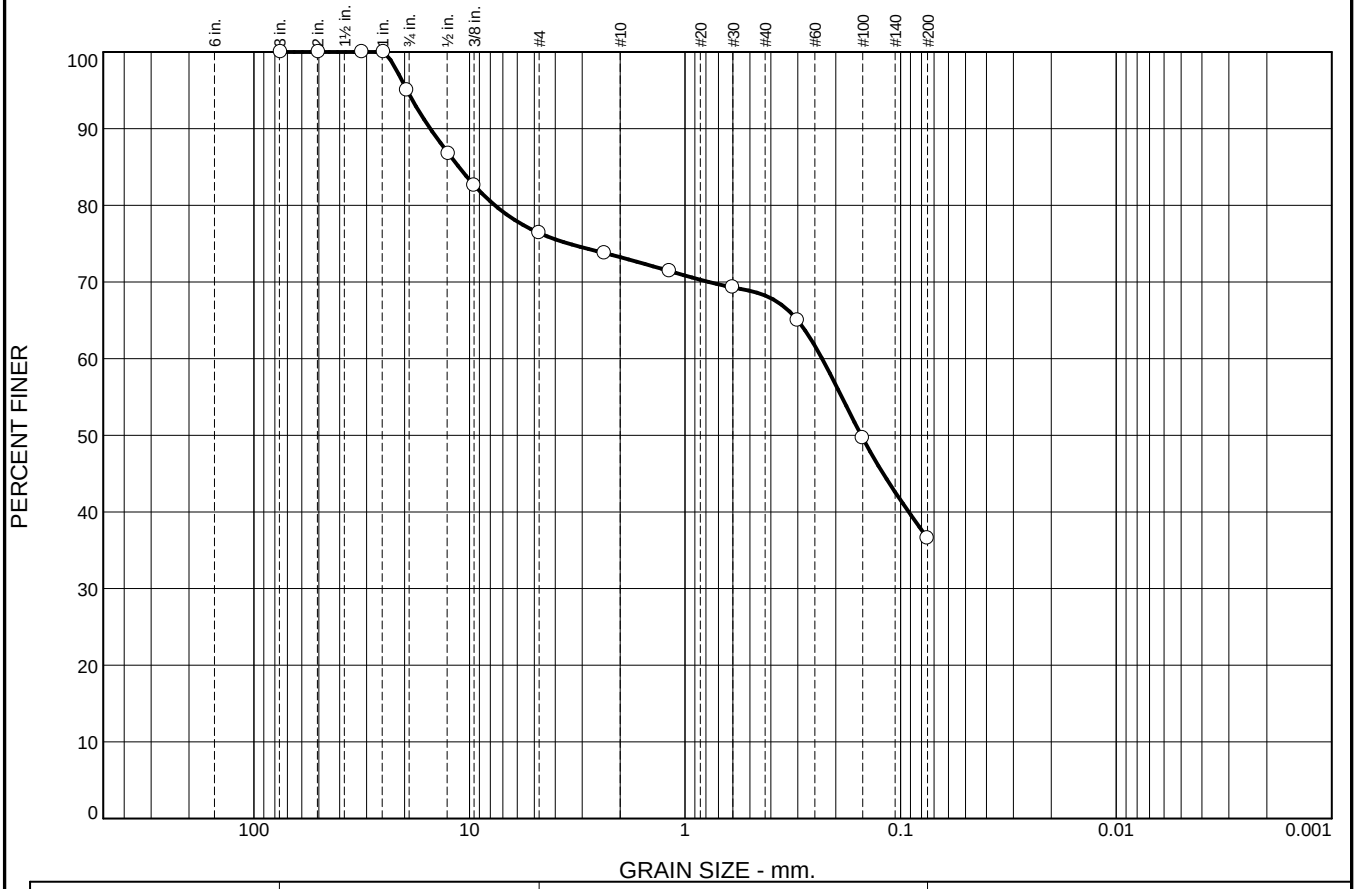
Strata Plot

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders Cobbles Gravel | Sand | Silt | Clay | Organics | Asphalt | Concrete | Fill | Igneous Bedrock | Meta-morphic Bedrock | Sedi-mentary Bedrock

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	5.5	18.1	3.2	5.0	31.6	36.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			11.1953	0.2314	0.1524					

Material Description	USCS	AASHTO
○ Insitu, Sept 20, 2017		

Project No. 17-12682 **Client:** Joose Environmental

Project: QC- Soils Analysis Clyde River Bridge

○ **Location:** BH-5-SS2 **Depth:** 2'-4' **Sample Number:** 1

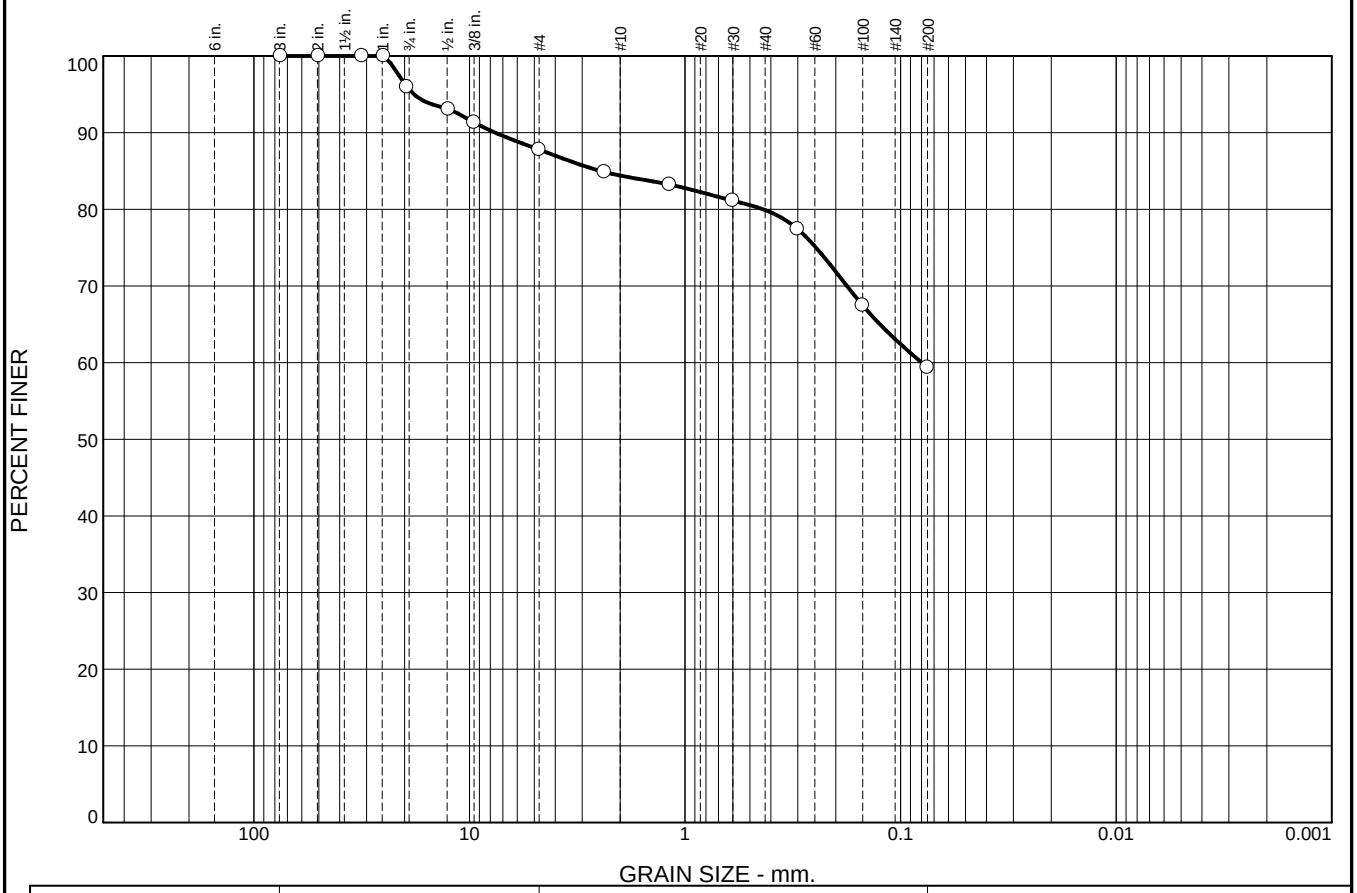
Remarks:

FUNDY Engineering

Figure

Tested By: R. Wakelin **Checked By:** D.Taweel

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	4.4	7.8	3.4	4.5	20.5	59.4	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			2.4634	0.0798						

Material Description	USCS	AASHTO
○ Insitu Sept 20, 2017		

Project No. 17-12682 **Client:** Joose Environmental

Project: QC Soils Analysis Clyde River Bridge

○ **Location:** BH-5-SS-5 **Depth:** 8'1/2"-10'1/2' **Sample Number:** 2

FUNDY Engineering

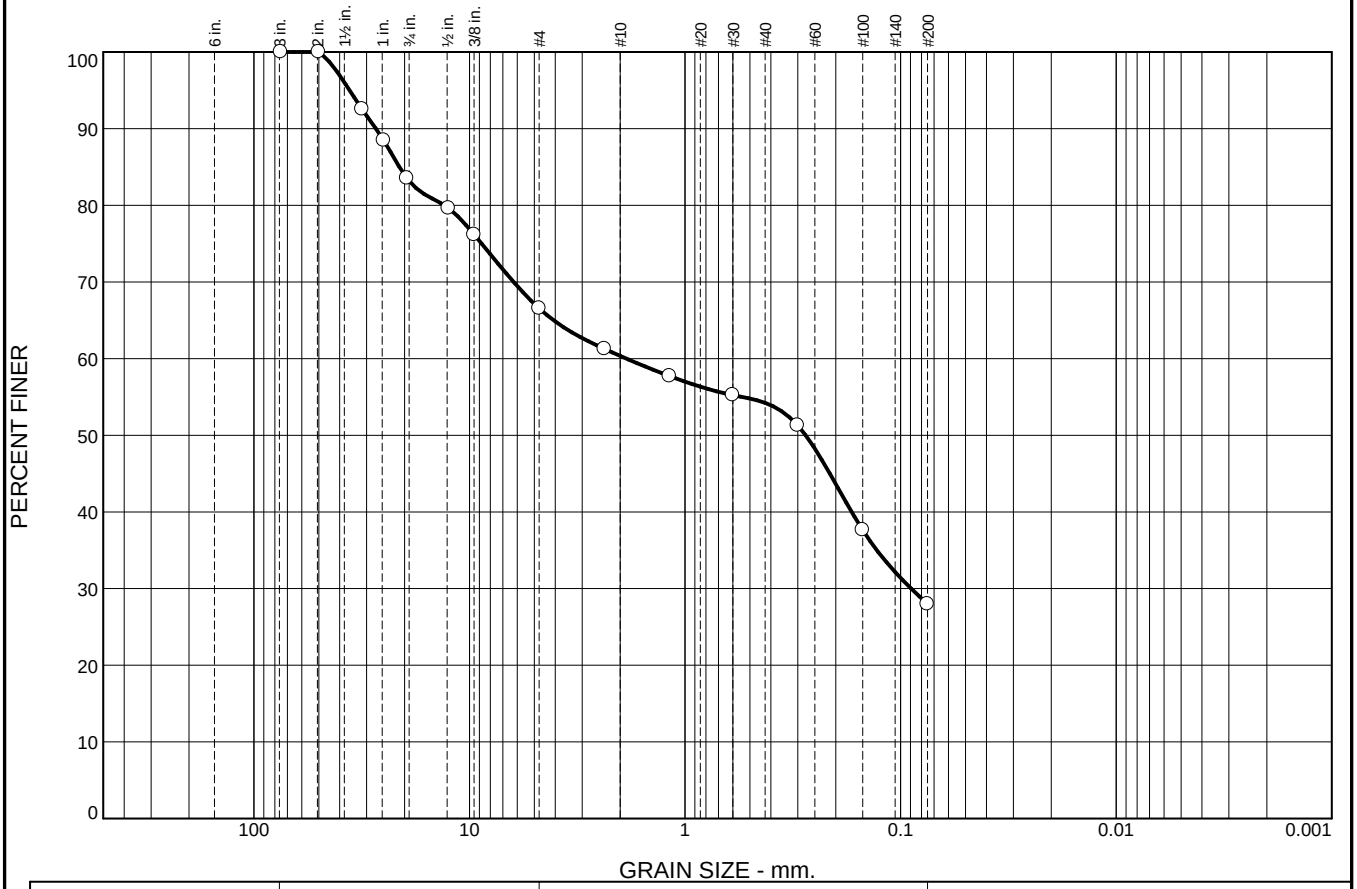
Remarks:

○Moisture content on sample is 16.4%

Figure

Tested By: R. Wakelin **Checked By:** D. Taweel

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	16.8	16.7	6.1	6.2	26.2	28.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			21.1472	1.8723	0.2758	0.0893				

Material Description	USCS	AASHTO
○ Insitu Sept 20, 2017		

Project No. 17-12682 **Client:** Joose Environmental

Project: QC- Soils Analysis Clyde River Bridge

○ **Location:** BH-5 SS-11 **Depth:** 21'-23' **Sample Number:** 3

Remarks:

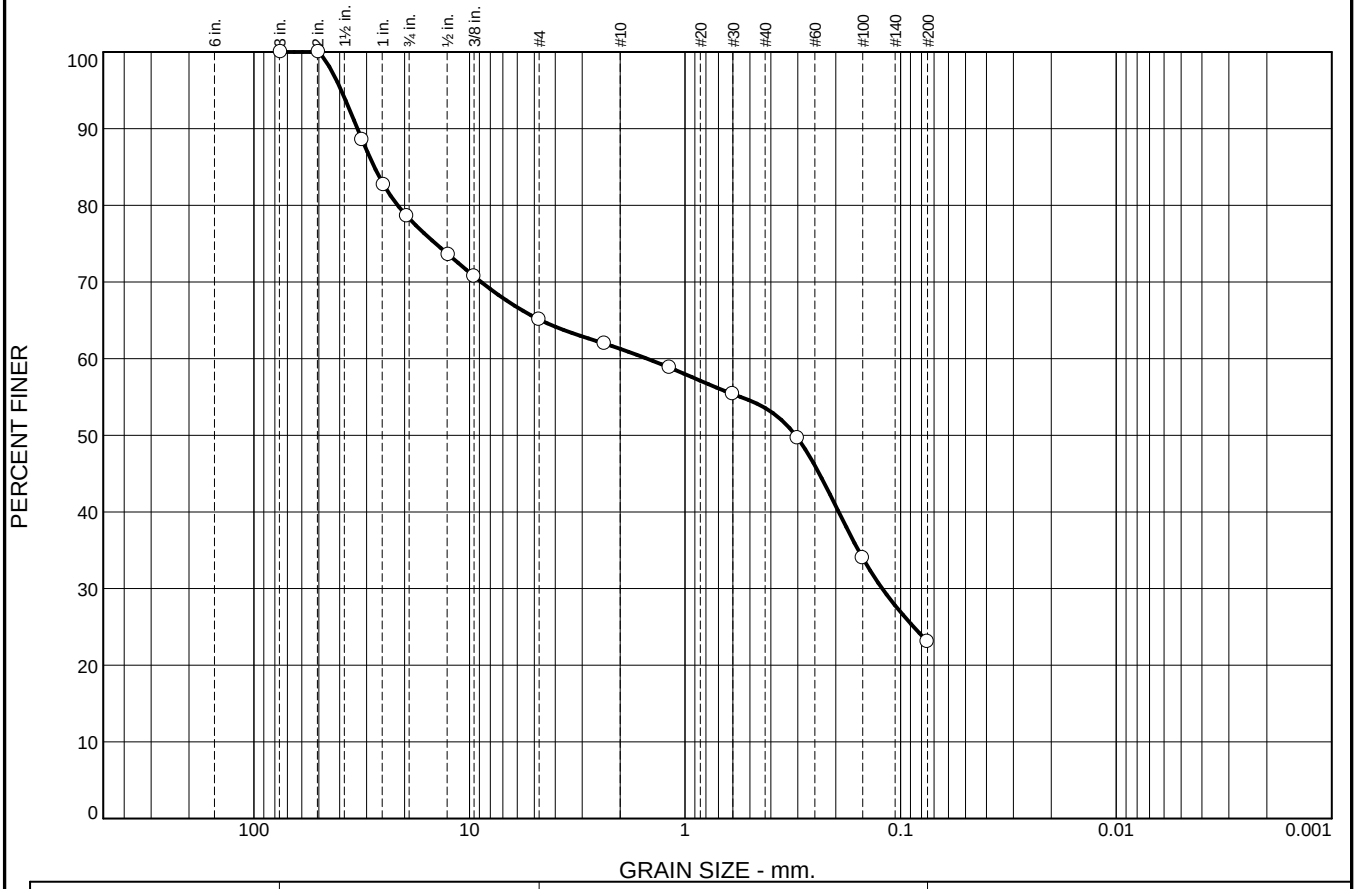
○Moisture content of sample is 14.6%

FUNDY Engineering

Figure

Tested By: R. Wakelin **Checked By:** D. Taweel

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	21.7	13.2	3.8	7.7	30.5	23.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			27.6398	1.5038	0.3069	0.1217				

Material Description	USCS	AASHTO
○ Insitu, Sept 20, 2017		

Project No. 17-12682 **Client:** Joose Environmental

Project: QC- Soils Analysis Clyde River Bridge

○ **Location:** BH-6-SS-2 **Depth:** 2'-4' **Sample Number:** 4

Remarks:

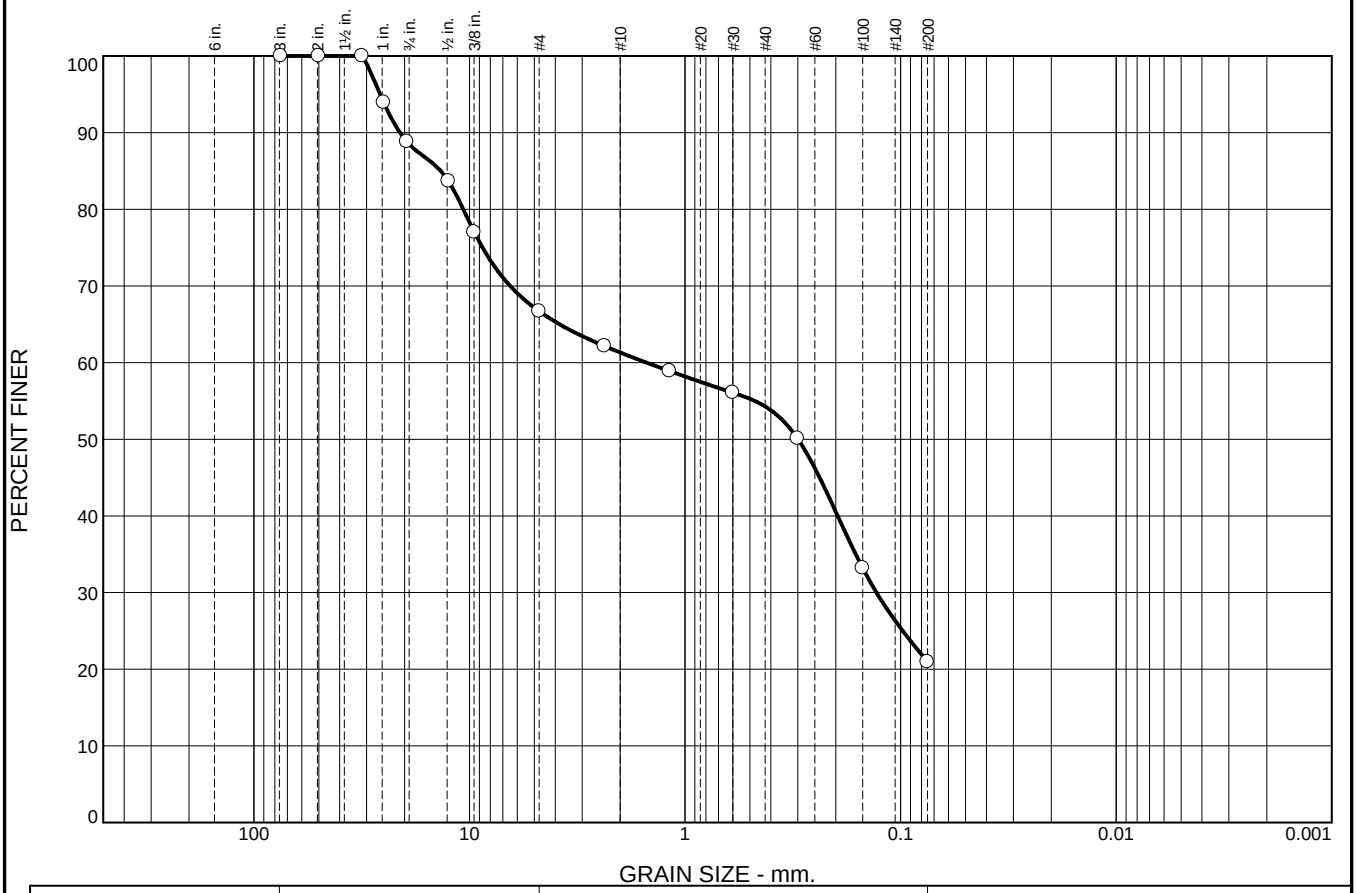
○Mositure content on sample is 8.6%

FUNDY Engineering

Figure

Tested By: R. Wakelin **Checked By:** D. Taweel

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	11.5	21.8	5.4	7.0	33.3	21.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			13.5774	1.5099	0.2986	0.1294				

Material Description	USCS	AASHTO
○ Insitu Sept 20, 2017		

Project No. 17-12682 **Client:** Joose Environmental

Project: QC- Soils Analysis Clyde River Bridge

○ **Location:** BH-6 SS-3 **Depth:** 4'-6' **Sample Number:** 5

Remarks:

○Moisture content on sample is 11.2%

FUNDY Engineering

Figure

Tested By: R. Wakelin **Checked By:** D. Taweel

BOREHOLE No. BH-05

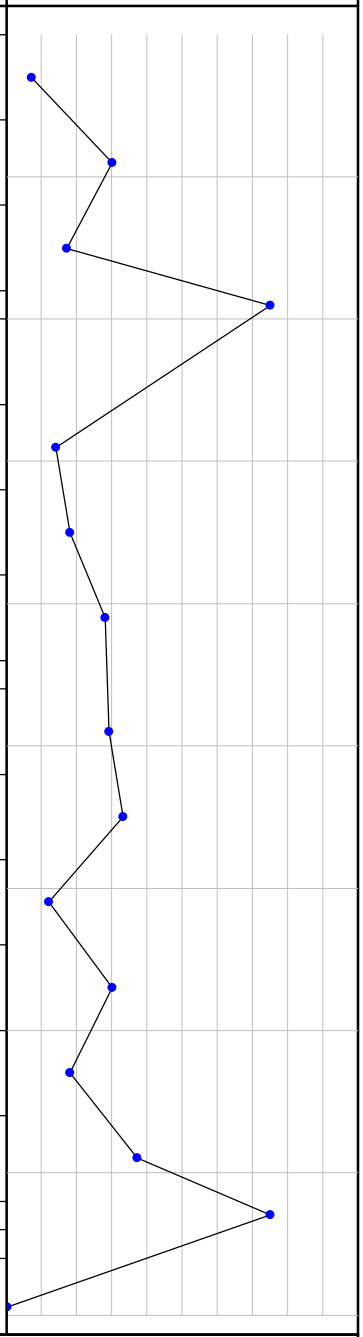
Date Drilled: 19 Sept 2017
Water Level: 5.8 m
Contractor/Equipment: Logan/CME 55 Auger

Location: Dixon Property
Elevation: 6.66
Datum: Geodetic

Project No. JE0252
Project: Clyde River Bridge
Client: PIETIE

Depth (ft / m)	Elevation, m	SOIL DESCRIPTION	Strata Plot	Water Level	Sample Type	Sample Number	Recovery, mm	SPT N-Value	RQD	Moisture Content, %	Other Tests
0 / 0	6.66	Ground Surface									
	0.00	Rootmat/Topsoil			SS	1	400	7			
1	6.21										
	0.45				SS	2	600	30		16	Sieve
3 / 1					SS	3	450	17			
6 / 2					SS	4	50	75			
					SS	5	600	14		16	Sieve
10 / 3					SS	6	450	18			
12		Compact reddish brown clayey silt and sand, some gravel, with occasional layers of gravelly silty sand: **Till**; occasional sandstone cobbles			SS	7	600	28		16	
13 / 4											
16 / 5					SS	8	600	29			
17					SS	9	600	33		16	
18											
19 / 6					SS	10	400	12			
20											
21					SS	11	450	30		15	Sieve
22											
23 / 7					SS	12	400	18			
24											
25					SS	13	450	37			
26 / 8											
	-1.57				SS	14	50	75			
27	8.23										
28											
29 / 9					NQ	15	18%		0		

SPT N-Value: 10 20 30 40 50 60 70 80 90



Joose Environmental

BOREHOLE No. BH-05

Date Drilled: 19 Sept 2017
Water Level: 5.8 m
Contractor/Equipment: Logan/CME 55 Auger

Location: Dixon Property
Elevation: 6.66
Datum: Geodetic

Project No. JE0252
Project: Clyde River Bridge
Client: PIETIE

Depth	Elevation, m	SOIL DESCRIPTION	Strata Plot	Water Level	Sample Type	Sample Number	Recovery, mm	SPT N-Value	RQD	Moisture Content, %	Other Tests	SPT N-Value (10 20 30 40 50 60 70 80 90)
10		Very weak to weak, medium grained, reddish brown sandstone, occasional fine grained sandstone layer and stiff to hard mudstone partings/seams: **Bedrock**; extremely close to moderately close joint spacing			NQ	16	63%		22			
11					NQ	17	92%		57			
12												
13					NQ	18	92%		42			
	-7.21											
14	13.87	End of Borehole										
15												
16												
17												

Joose Environmental

BOREHOLE No. BH-06

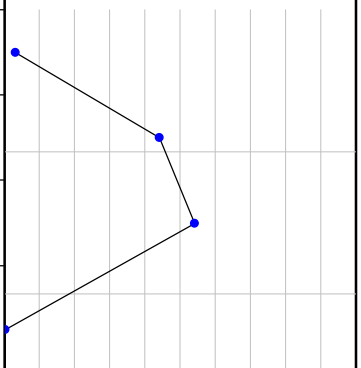
Date Drilled: 19 Sept 2017
Water Level: Within Bedrock
Contractor/Equipment: Logan/CME 55 Auger

Location: MacQuarrie Property
Elevation: 9.71
Datum: Geodetic

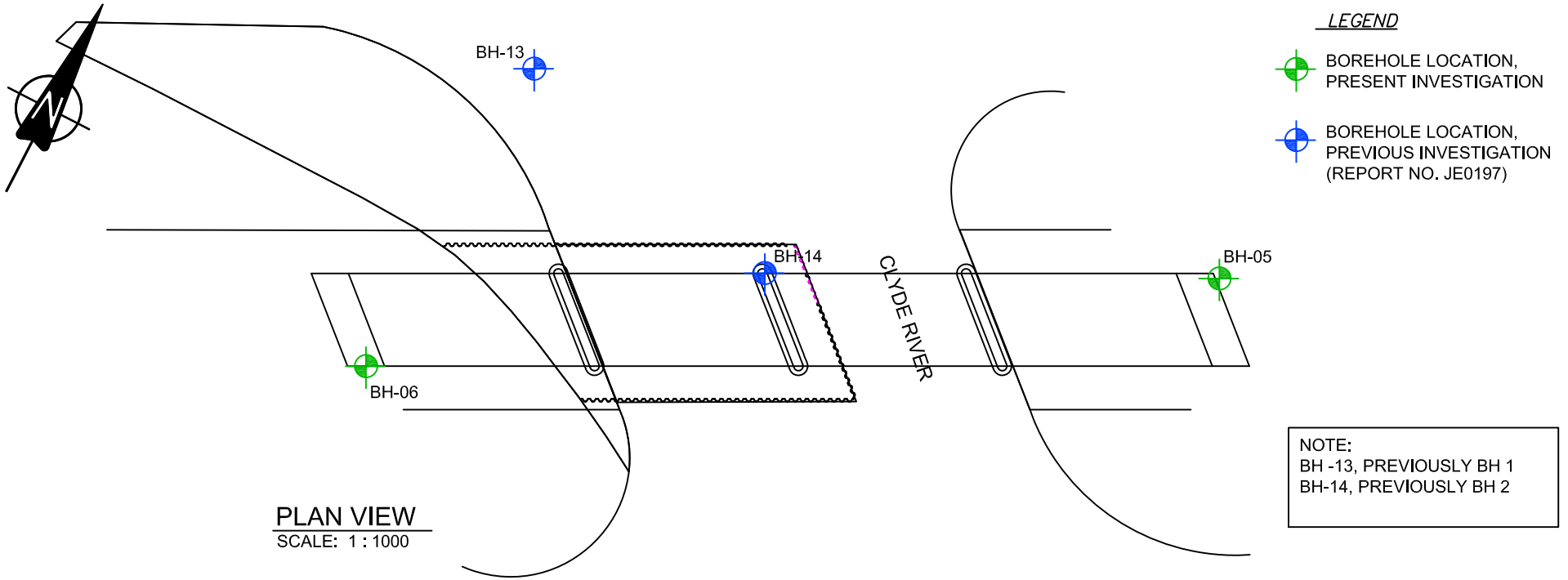
Project No. JE0252
Project: Clyde River Bridge
Client: PIETIE

Depth (ft / m)	Elevation, m	SOIL DESCRIPTION	Strata Plot	Water Level	Sample Type	Sample Number	Recovery, mm	SPT N-Value	RQD	Moisture Content, %	Other Tests
0 / 0	9.71	Ground Surface									
	0.00	Compact to very dense reddish brown gravelly silty sand, occasional sandstone cobbles/boulders, trace roots: **Fill**; upper 300 mm very loose rootmat/topsoil			SS	1	450	3			
3 / 1					SS	2	450	44		9	Sieve
5					SS	3	450	54		11	Sieve
7 / 2	7.42				AS	4	-	-			
	2.29	Compact reddish brown clayey silt and sand, some gravel and sandstone cobbles: **Till**			NQ	5	500		-		
10 / 3											
13 / 4											
16 / 5					NQ	6	550		-		
	4.27										
	5.44	Very weak to weak, medium grained, reddish brown sandstone interbedded with very stiff to hard mudstone: **Bedrock**; extremely close to moderately close joint spacing			NQ	7	100%		43		
23 / 7											
	2.40										
	7.31	Very weak to weak, medium grained, reddish brown sandstone: **Bedrock**; extremely close to moderately close joint spacing			NQ	8	100%		52		
26 / 8											
29	0.87										
9	8.84	End of Borehole									

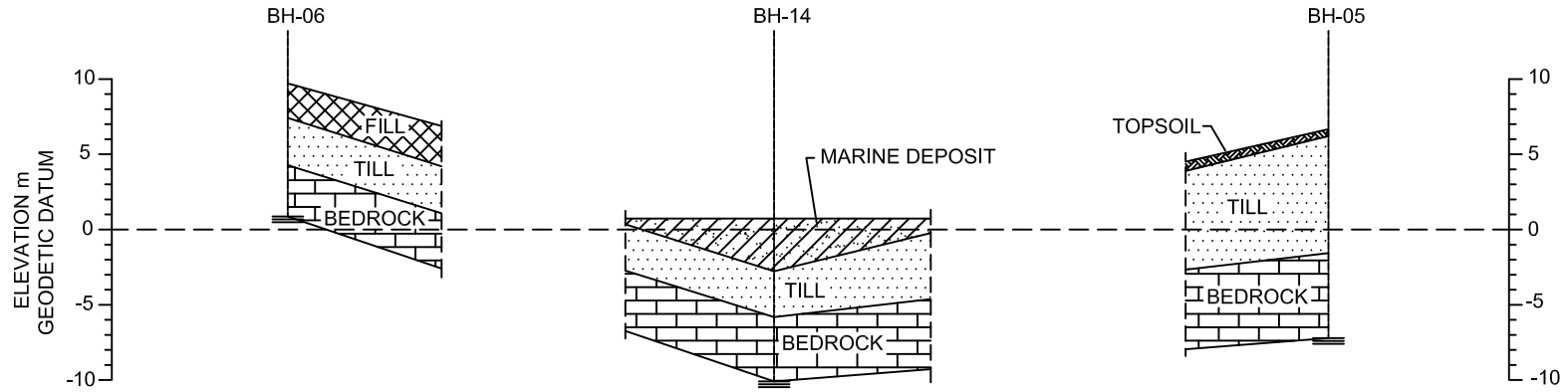
SPT N-Value
10 20 30 40 50 60 70 80 90



Joose Environmental



PLAN VIEW
SCALE: 1 : 1000



STRATIGRAPHIC SECTION
SCALE: 1 : 1000 (HORIZONTAL)
1 : 500 (VERTICAL)

JOOSE ENVIRONMENTAL

BOREHOLE LOCATION PLAN

SUPPLEMENTAL GEOTECHNICAL INVESTIGATION - CLYDE RIVER BRIDGE

CLYDE RIVER, QUEENS COUNTY, PEI

CLIENT:	PEITIE

SCALE:	JOB NO.:	DWG NO.:
1 : 1000	JE0252	1

DATE	DWN BY:	APPD BY:
2017/09/28	MLJ	GWZ

GEOTECHNICAL INVESTIGATION
PROPOSED CLYDE RIVER BRIDGE
CLYDE RIVER, QUEENS COUNTY, PE

JOOSE ENVIRONMENTAL PROJECT NO. JE0197

Joose Environmental Consulting Inc.
P.O. Box 19
North Wiltshire PE C0A 1Y0

September 12, 2016

Joose Environmental Project No. JE0197

Mr. Darrell Evans, P. Eng., Manager Design and Bridge Maintenance
Capital Projects Division
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Charlottetown, PEI
C1A 7N8

Dear Mr. Evans:

Reference: Geotechnical Investigation - Proposed Clyde River Bridge
Clyde River, Queens County, Prince Edward Island

This report presents the results of the geotechnical investigation carried out for the above-noted project, in accordance with your request. The purpose of the investigation was to establish the subsurface conditions in the vicinity of the proposed structure and, based on the conditions encountered, to provide geotechnical engineering recommendations pertaining to foundation design and construction.

PROCEDURE

The field work for the present investigation was carried out on August 30, 2016, and consisted of drilling two (2) boreholes at the site with a track-mounted CME 55 auger drill rig. The boreholes were advanced to an average depth of 10.7 m below existing grade at the locations shown on the appended Drawing No. 1.

Samples of the overburden soils encountered were taken at regular intervals by means of a conventional split spoon sampler during the performance of Standard Penetration Tests. Bedrock was proven at both borehole locations by rotary core drilling in NQ-size (45 mm core diameter).

All soil samples recovered were placed in moisture-proof containers and were delivered, with the rock core, to our office for classification and testing. All soil and rock core samples remaining after testing will be stored for a period of 60 days from the date of issue of this report after which they will be discarded unless directions to the contrary are received.

Detailed logs of the strata encountered at the site and of the sampling/testing carried out are shown on the appended Borehole Records.

The borehole locations were initially selected in the field by our personnel in conjunction with a PEI Transportation, Infrastructure and Energy (PEITIE) representative. The borehole locations, and ground surface elevations, were subsequently surveyed by PEITIE personnel relative to Geodetic Datum.

SUBSURFACE CONDITIONS

The subsurface conditions encountered at the boreholes are shown in detail on the appended Borehole Records, are summarized on Table 1 (also appended) and are described below.

Fill Materials

A layer of reddish brown fill materials was found to extend from ground surface to a depth of 1.7 m at BH-01. The fill generally consists of a gravelly silty sand with traces of wood. Similar fill materials were observed immediately west of BH-01 (i.e., along opposite shoreline). The fill encountered appears to represent the remnants of a previous dam embankment that extended across the river. No fill materials were encountered at BH-02 which was located on the mudflat.

Standard Penetration Test N-values within the fill were found to range from 3 to 8 indicating a very loose to loose relative density.

A grain size test (curve appended) performed on a split spoon sample of the fill shows it to contain 30 percent gravel, 37 percent sand and 33 percent fines (i.e., silt and clay sizes). The test sample was found to have a moisture content of 13 percent.

Marine Deposit

Marine deposited soils were encountered below the fill at BH-01 and at the surface of BH-02.

At BH-01, the marine soil consists of a 2.0 m thick layer of fine grained grey sand with some silt, trace to some organics, and frequent wood. At BH-02, a layer of reddish brown silt and sand with trace to some organics was found to extend from the ground surface to a depth of 1.5 m. The reddish brown silt and sand is underlain by a grey sand layer, 2.0 m in thickness, and similar in composition to the grey sand encountered at BH-01, without the wood.

N-values obtained within the grey sand generally range from 1 to 2 indicating a very loose relative density. The higher N-values obtained within the grey sand at BH-01 may be attributed to the presence of wood within this layer and are not deemed to be representative of the actual relative density.

N-values of 1 were obtained within the reddish brown silt and sand at BH-02 indicating a very loose relative density.

Grain size tests (curves appended) performed on split spoon samples of the grey sand recovered from BH-02 show it to contain an average of 2 percent gravel, 78 percent sand and 20 percent fines. The natural moisture content of selected samples of the grey sand was found to range from 56 to 67 percent with an average of 62 percent, indicating a compressible soil.

Glacial Till

A reddish brown glacial till stratum, ranging in thickness from 2.6 (BH-01) to 3.0 (BH-02), was encountered directly below the marine soils at the boreholes. The till was found to consist predominantly of a gravelly silty sand.

N-values obtained within the till range from 8 to 20, with an average of 13, indicating an overall compact relative density.

A grain size test (curve appended) performed on a split spoon sample of the till shows it to contain 30 percent gravel, 53 percent sand and 17 percent fines. The natural moisture content of selected till samples was found to range from 17 to 18 percent.

Bedrock

Sedimentary bedrock was encountered directly below the till stratum at both borehole locations, at an average depth of 6.4 m below ground surface. The elevation of the bedrock surface was found to range from el. -4.64 at BH-01 to el. -5.82 m at BH-02.

The rock core recovered consisted predominantly of very weak to weak, medium grained, reddish brown sandstone interbedded with stiff to hard reddish brown mudstone. The bedrock is horizontally bedded with extremely close (<20 mm) to close (60 to 200 mm) joints which typically occur along the bedding planes. An average RQD (Rock Quality Designation) value of 6 indicates very poor quality, very severely fractured bedrock.

Groundwater

It may be assumed that the groundwater table at the site is directly influenced by the water level and tidal variations within the Clyde River. An Ordinary High Water Mark (OHWM) of el. 0.65 m is understood for the subject site and is shown on the Borehole Records.

DISCUSSION AND RECOMMENDATIONS

It is understood that the proposed structure will likely either consist of a prefabricated arch or a clear span bridge.

The subsurface conditions encountered near the proposed structure alignment (i.e., at BH-02) may generally be summarized as 3.5 m of very loose marine silt/sand that directly overlies a compact glacial till stratum and sandstone bedrock, at a depth of 6.6 m. The river is tidally influenced with an OHWM located near the ground surface level of the mudflats.

Both spread footing and pile-supported foundations could be considered for use at the site based on the conditions encountered as discussed in the following sections.

Spread Footing Foundations

Spread footing foundations could be considered for use at the site provided that issues associated with excavation below the groundwater table and through the very loose mudflat soils can be addressed.

It is recommended that the groundwater table be temporarily lowered to facilitate excavation to the till surface. Control of groundwater inflow may require a temporary river diversion and will likely require pumping from a sump(s) located below the required depth of excavation.

Although lowering of the groundwater table prior to footing excavation should improve the stability of the excavation side slopes, flatter cut inclinations than the typical 1 horizontal to 1 vertical may still be necessary to achieve stable conditions. If it is preferable to limit the horizontal extent of the excavation, consideration could be given to some means of temporary shoring such as sheet piling. A large modified trench box could also be considered to assist with the safe placement of foundations and to limit the size of the excavation footprint. Precast footings placed on a granular base may also be beneficial to permit timely backfilling and to limit the time that the excavation must remain open.

Any soft or disturbed soils should be removed from the bearing surface prior to footing placement. If softening persists, consideration could be given to over-excavating the bearing surface (e.g., by 300 mm) to allow the placement of clean granular layer such as concrete stone or Class D gravel. The granular layer would help stabilize the bearing surface and should assist in groundwater control.

Spread footings placed on undisturbed till, or a granular layer placed over the till, may be designed using an allowable bearing pressure of 150 kPa. Associated total and differential settlements should be less than 25 mm and 15 mm, respectively.

All footings which will be subjected to freezing conditions should have a soil cover of at least 1.5 m (or equivalent insulation) for frost protection.

It may be prudent, at some point during the project design stage, to undertake a trial excavation onsite with a large backhoe or excavator to assess side slope stability and groundwater inflow. It may be possible to develop an excavation methodology that would limit the excavation footprint while still ensuring safe conditions for workers.

Steel H-Piles

It is expected that steel would be driven to/into the underlying sandstone/mudstone bedrock to develop the required capacity. Steel piles should be driven using a hammer with a rated energy of at least 350 J/cm^2 of net steel cross sectional area. Previous experience has shown that an actual delivered energy in the order of 200 J/cm^2 is required to attain the allowable contact stress given below. Refusal may be taken as 10 blows for the last 25 mm of pile penetration.

Actual penetration depths of steel piles into the sandstone/mudstone bedrock will depend on the driving energy delivered and the bedrock condition/strength at the pile locations. Previous experience has shown that penetration depths can vary significantly from site to site or within the same site, depending on the rock quality and strength, and can range from less than 1 m to 2 m or more.

The vertical capacity of steel piles driven to refusal, as defined above, may be determined using an allowable contact stress of 50 MPa for steel H and open end pipe piles (based on net steel area). An allowable bearing pressure of 7 MPa may be used for the design of closed end pipe piles (based on gross end area).

Re-tapping of some piles (e.g., 25 percent) within a 48-hour period is recommended to assess relaxation effects, and the requirement to re-tap additional piles.

The settlement of piles installed as outlined above and proportioned for the expected loads would be negligible. For the analysis of lateral resistance, an effective pile width of two times the pile diameter may be used.

Approach Embankments

It is understood that construction of the approach embankments will require raising present grades by up to 12 m and, depending on the type of structure selected, fill placement over the mudflat area may be required. Placement of fill directly over the very loose mudflat soils would not be ideal from a geotechnical standpoint.

Such fill placement could result in wide spread lateral displacement of the very loose soils resulting in significant "mudwaves". If, however, the fill is placed in such a manner to limit lateral displacement, our preliminary calculations indicate that up to 1 m of settlement could occur as the result of the compression of 3.5 m of mudflat soils under the weight of 12 m of new fill. Although a significant portion of this primary settlement would be expected to occur during fill placement, additional longer term secondary settlement could continue for several years. Furthermore, settlement of the embankment would be expected to vary depending on the height of new fill and the depth of the underlying mudflat soils at any given location.

In addition to settlement, other geotechnical concerns associated with leaving some or all of the mudflat soils in place below the new fill would include potential embankment slope stability issues and subjecting the new structure/associated foundations to potential high lateral loads and downdrag loads.

In view of the above, removal of the mudflat soils in their entirety from below the embankment footprint would be recommended. We would be pleased to provide further geotechnical input on this aspect of the project if requested.

CLOSING COMMENTS

A subsurface investigation is a limited sampling of a site. In the event that any conditions are encountered that differ from those encountered at the test locations, we request that we be notified immediately to permit a reassessment of our design assumptions.

We trust this report contains all of the information required at this time, and we are available at your convenience should you have any questions. We would be pleased to provide further geotechnical input for this project on an as required, as requested basis.

Sincerely,

JOOSE ENVIRONMENTAL CONSULTING INC.

George Zafiris

George W. Zafiris, P. Eng.
Geotechnical Engineer
georgez@bellaliant.net

GWZ/gz

APPENDIX

Table 1 - Borehole Summary - Proposed Clyde River Bridge

	Borehole Number	
	BH-01	BH-02
Ground Surface el., m	1.61	0.73
Fill Thickness, m	1.68	0.00
Marine Soil Thickness, m	1.98	3.50
Depth to Till, m	3.66	3.50
Till Surface el., m	-2.05	-2.77
Till Thickness, m	2.59	3.05
Depth to Bedrock, m	6.25	6.55
Bedrock Surface el., m	-4.64	-5.82
Depth of Borehole, m	10.67	10.82

NOTES:

- the boreholes were drilled at the site on August 30, 2016 using a track-mounted CME 55 auger drill rig
- ground surface elevations were provided by PEITIE and are referenced to Geodetic Datum
- bedrock was proven at both boreholes by rotary core drilling in NQ-size

JOOSE ENVIRONMENTAL

The following information is intended to assist in the interpretation of terms and symbols used on the borehole logs, test pit logs and reports.

Soils Description

Terminology describing common soil genesis:

Topsoil	-	mixture of soil and humus capable of supporting vegetative growth
Peat	-	mixture of visible and invisible fragments of decayed organic matter
Till	-	unstratified glacial deposit which may range from clay to boulders
Fill	-	material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	-	having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure
Varved	-	composed of regular alternating layers of silt and clay
Stratified	-	composed of alternating successions of different soil types, e.g. silt and sand
Layer	-	> 75 mm in thickness
Seam	-	2 mm to 75 mm in thickness
Parting	-	< 2 mm in thickness

Terminology describing soil types:

The classification of soil types are made on the basis of grain size and plasticity in accordance with the Modified Unified Soil Classification System (MUSCS) and in accordance with the Canadian Foundation Engineering Manual Fourth Edition (Canadian Geotechnical Society, 2006). The classification excludes particles larger than 75 mm (3 inches). The MUSCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter and construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

Consistency of Cohesive Soils: May be estimated using simple field tests, or described in terms of a strength scale. In the field, the undrained shear strength (s_u) can be assessed using a simple field tool appropriate for cohesive soils, in conjunction with the relevant calibration. Refer to AS 1726-1993, Table A4.

Consistency - Essentially Cohesive Soils					
Term	**Field Guide**	**Symbol**	**SPT "N" Value**	**Undrained Shear Strength su (kPa)**	**Unconfined Compressive Strength qu (kPa)**
Very soft	Oozes between fingers when	VS	0-2	<12	<25
Soft	Easily moulded with fingers.	S	2-4	12-25	25-50
Firm	Can be moulded by strong pressure of fingers.	F	4-8	25-50	50-100
Stiff	Not possible to mould with fingers.	St	8-15	50-100	100-200
Very stiff		VSt	15-30	100-200	200-400
Hard	Can be indented with difficulty by thumb nail.	H	>30	>200	>400

Note: SPT - N to q_u correlation from Terzaghi and Peck, 1967. (General guide only).

Soil Particle Sizes	
Term	**Size Range**
BOULDERS	>200 mm
COBBLES	63-200 mm
Coarse GRAVEL	20-63 mm
Medium GRAVEL	6-20 mm
Fine GRAVEL	2.36-6 mm
Coarse SAND	0.6-2.36 mm
Medium SAND	0.2-0.6 mm
Fine SAND	0.075-0.2 mm
SILT	0.002-0.075 mm
CLAY	<0.002 mm

Consistency of Non-Cohesive Soils: Is described in terms of the density index, as defined in AS 1289.0-2000. This can be assessed using a field tool appropriate for non-cohesive soils, in conjunction with the relevant calibration. Refer to AS 1726-1993, Table A5; BS5930-1999, p117.

Consistency - Essentially Non-Cohesive Soils				
Term	**Symbol**	**SPT N Value**	**Field Guide**	**Density Index (%)**
Very loose	VL	0-4	Foot imprints readily	0-15
Loose	L	4-10	Shovels Easily	15-35
Medium dense	MD	10-30	Shovelling difficult	35-65
Dense	D	30-50	Pick required	65-85
Very dense	VD	>50	Picking difficult	85-100

Standard Penetration Test (SPT): Refer to. AS 1289.6.3.1-2004. Example report formats for SPT results are shown below:

Test Report	Penetration Resistance (N)	Explanation / Comment
4, 7, 11	N=18	Full penetration; N is reported on engineering borehole log
18, 27, 32	N=59	Full penetration; N is reported on engineering borehole log
4, 18, 30/15 mm	N is not reported	30 blows causes less than 100 mm penetration (3rd interval) - test discontinued
30/80 mm	N is not reported	30 blows causes less than 100 mm penetration (1st interval) - test discontinued
rw	N<1	Rod weight only causes full penetration
hw	N<1	Hammer and rod weight only causes full penetration
hb	N is not reported	Hammer bouncing for 5 consecutive blows with no measurable penetration - test discontinued

Rock Description

Except where specified below, terminology for describing rock is as defined by the International Society for Rock Mechanics (ISRM) 2007 publication "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006"

Terminology Describing Rock Quality:

RQD	Rock Mass Quality
0 - 25	*Very Poor Quality*
25 - 50	*Poor Quality*
50 - 75	*Fair Quality*
75 - 90	*Good Quality*
90 - 100	*Excellent Quality*

Alternate (Colloquial) Rock Mass Quality	
Very Severely Fractured	*Crushed*
Severely Fractured	*Shattered or Very Blocky*
Fractured	*Blocky*
Moderately Jointed	*Sound*
Intact	*Very Sound*

RQD (Rock Quality Designation) denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 inches) long are summed up and divided by the total length of the core run. RQD is determined in accordance with ASTM D6032.

SCR (Solid Core Recovery) denotes the percentage of solid core (cylindrical) retrieved forma borehole of any orientation. All pieces of the solid (cylindrical) core are summed and divided by the total length of the core run (It excludes all portions of core pieces that are not fully cylindrical as well as crushed or rubble zones).

Fracture Index (FI) is defined as the number of naturally occurring fractures within a given length of core. The Fracture Index is reported as a simple count of the natural occurring fractures.

Refer to AS 1726-1993 (Appendix A3.3) for the description and classification of rock material composition, including:

(a) Rock type (Table A6, (a) and (b))
(b) Grain size
(c) Texture and fabric
(d) Colour (describe as per soil).

The condition of a rock material refers to its weathering characteristics, strength characteristics and rock mass properties. Refer to AS 1726-1993 (Appendix A3 Tables A8, A9 and A10).

Weathering Condition (Degree of Weathering):

The degree of weathering is a continuum from fresh rock to soil. Boundaries between weathering grades may be abrupt or gradational.

Rock Material Weathering		
Weathering Grade	**Symbol**	**Definitio**
Residual Soil	RS	Soil-like material developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the material has not been significantly transported.
Extremely Weathered Rock	XW	Rock is weathered to such an extent that it has 'soil' properties, i.e. it either disintegrates or can be remoulded in water, but substance fabric and rock structure still recognizable.
Highly Weathered Rock	HW	Strong discolouration is evident throughout the rock mass, often with significant change in the constituent minerals. The intact rock strength is generally much weaker than that of the fresh rock.
Moderately Weathered Rock	MW	Modest discolouration is evident throughout the rock fabric, often with some change in the constituent minerals. The intact rock strength is usually noticeably weaker than that of the fresh rock.
Slightly Weathered	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh Rock	FR	Rock shows no sign of decomposition or staining.

Notes:

1. Minor variations within broader weathering grade zones will be noted on the engineering borehole logs.
2. Extremely weathered rock is described in terms of soil engineering properties.
3. Weathering may be pervasive throughout the rock mass, or may penetrate inwards from discontinuities to some extent.
4. The 'Distinctly Weathered (DW)' class as defined in AS 1726-1993 is divided to incorporate HW and MW in the above table. The symbol DW should not be used.

Strength Condition (Intact Rock Strength):

Terminology Describing Rock Strength

Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	< 1
Very Weak	R1	1 - 5
Weak	R2	5 - 25
Medium Strong	R3	25 - 50
Strong Very	R4	50 - 100
Strong Extremely	R5	100 - 250
Strong	R6	> 250

Discontinuity Spacing: On the geotechnical borehole log, a graphical representation of defect spacing vs depth is shown. This representation takes into account all the natural rock defects occurring within a given depth interval, excluding breaks induced by the drilling / handling of core. Refer to AS 1726-1993, BS5930-1999.

Defect Spacing			Bedding Thickness (Sedimentary Rock Stratification)	
Spacing/Width (mm)	**Descriptor**	**Symbol**	**Descriptor**	**Spacing /Width (mm)**
			Thinly Laminated	<6
<20	Extremely Close	EC	Thickly Laminated	6 - 20
20 - 60	Very Close	VC	Very Thinly Bedded	20 - 60
60 - 200	Close	C	Thinly Bedded	60 -200
200 - 600	Medium	M	Medium Bedded	200 - 600
600 - 2000	Wide	W	Thickly Bedded	600 - 2000
2000 - 6000	Very Wide	VW	Very Thickly Bedded	>2000
>6000	Extremely Wide	EW		

Defect Spacing in 3D	
Term	**Description**
Blocky	Equidimensional
Tabular	Thickness much less than length or width
Columnar	Height much greater than cross section

Direct Persistence (areal extent)
Trace length of defect given in metres

The list on the following table provides an explanation of terms and symbols used on the geotechnical borehole, test pit and penetrometer logs.

Test Results					Test Symbols	
PI	Plasticity Index	c'	Effective Cohesion		DCP	Dynamic Cone Penetrometer
LL	Liquid Limit	c_u	Undrained Cohesion		SPT	Standard Penetration Test
LI	Liquidity Index	c'_R	Residual Cohesion		CPTu	Cone Penetrometer (Piezocone) Test
DD	Dry Density	φ'	Effective Angle of Internal Friction		PANDA	Variable Energy DCP
WD	Wet Density	φ_u	Undrained Angle of Internal Friction		PP	Pocket Penetrometer Test
LS	Linear Shrinkage	φ'_R	Residual Angle of Internal Friction		U50	Undisturbed Sample 50 mm (nominal diameter)
MC	Moisture Content	c_v	Coefficient of Consolidation		U100	Undisturbed Sample 100mm (nominal diameter)
OC	Organic Content	m_v	Coefficient of Volume Compressibility		UCS	Uniaxial Compressive Strength
WPI	Weighted Plasticity Index	$c_{\alpha\varepsilon}$	Coefficient of Secondary Compression		Pm	Pressuremeter

Test Results					Test Symbols	
WLS	Weighted Linear Shrinkage	e	Voids Ratio		FSV	Field Shear Vane
DoS	Degree of Saturation	φ'_{cv}	Constant Volume Friction Angle		DST	Direct Shear Test
APD	Apparent Particle Density	q_t / q_c	Piezocone Tip Resistance (corrected / uncorrected)		PR	Penetration Rate
s_u	Undrained Shear Strength	q_d	PANDA Cone Resistance		A	Point Load Test (axial)
q_u	Unconfined Compressive Strength	$I_{s(50)}$	Point Load Strength Index		D	Point Load Test (diametral)
R	Total Core Recovery	*RQD*	Rock Quality Designation		L	Point Load Test (irregular lump)

Sample Type

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameters tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ,NQ, BQ, etc	Rock core samples obtained with the use of standard size diamond coring bits.

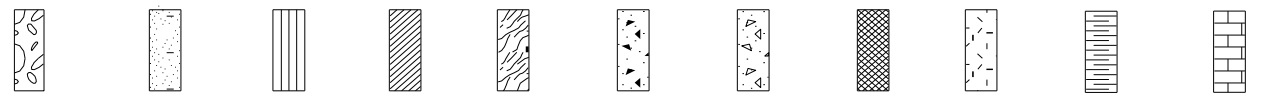
Water Level Measurement

Measurement in standpipe, piezometer, or well

Inferred

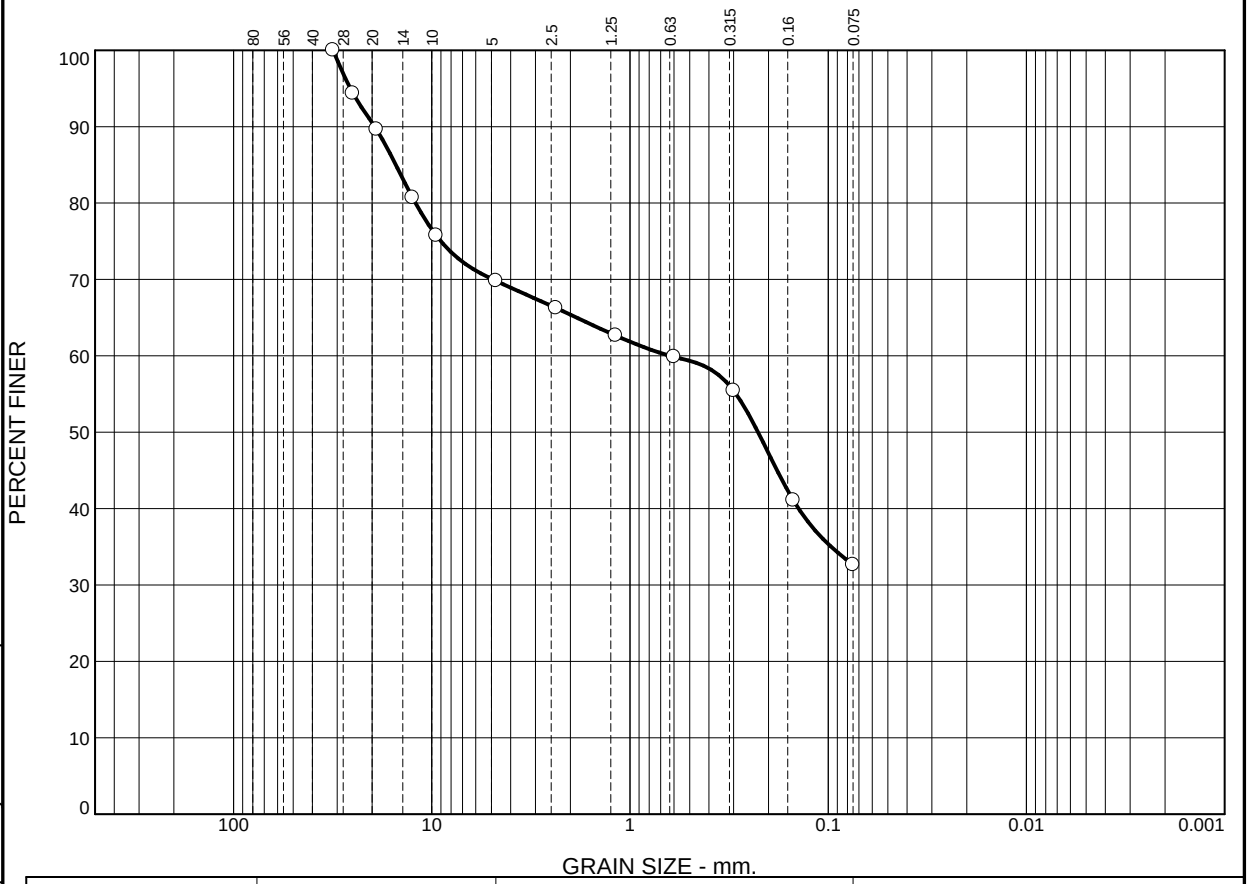
Strata Plot

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders Cobbles Gravel | Sand | Silt | Clay | Organics | Asphalt | Concrete | Fill | Igneous Bedrock | Meta-morphic Bedrock | Sedi-mentary Bedrock

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	10.3	19.9	4.4	6.7	26.1	32.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			15.1879	0.6276	0.2259					

Material Description	USCS	AASHTO
○ Fill, Aug 31,2016		

Project No. 16-12093 **Client:** Joose Environmental

Project: QC Soils Analysis, Clyde River Bridge

○ **Location:** BH#1- SS#2 **Depth:** 2'-4' **Sample Number:** 1

FUNDY Engineering

Remarks:

○Moisture Content of Sample was 12.6%

Figure

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicative of apparently identical samples.

Tested By: T.Pineau **Checked By:** D.Taweel

Particle Size Distribution Report

	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○			9.5	2.4	4.8	45.8	17.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○				0.3393	0.2520	0.1664				

Material Description	USCS	AASHTO
○ Till, August 31, 2016		

Project No. 16-12093 **Client:** Joose Environmental

Project: QC Soils Analysis Clyde River Bridge

○ **Location:** BH1-SS#8 **Depth:** 15'-17' **Sample Number:** 2

Remarks:

○Moisture Content of sample was 18.1%

FUNDY Engineering

Figure

Tested By: T.Pineau **Checked By:** D.Taweel

Particle Size Distribution Report

	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	1.8	3.7	19.4	54.2	20.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.6588	0.2796	0.2234	0.1310				

Material Description	USCS	AASHTO
○ Silt and Sand, August 31, 2016		

Project No. 16-12093 **Client:** Joose Environmental

Project: QC Soils Analysis Clyde River Bridge

○ **Location:** BH#2-SS#3 **Depth:** 5'-7' **Sample Number:** 3

Remarks:

○Moisture content of sample was 55.9%

FUNDY Engineering

Figure

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicative of apparently identical samples.

Tested By: T.Pineau **Checked By:** D.Taweel

Particle Size Distribution Report

	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	1.6	6.8	12.3	60.0	19.3	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			1.0430	0.2318	0.1937	0.1249				

Material Description	USCS	AASHTO
○ Silt, August 21, 2016		

Project No. 16-12093 **Client:** Joose Environmental

Project: QC Soils Analysis Clyde River Bridge

○ **Location:** BH2-SS#4 **Depth:** 8'-10'6" **Sample Number:** 4

Remarks:

○Moisture Content of sample was 61.7%

FUNDY Engineering

Figure

Tested By: T.Pineau **Checked By:** D.Taweel

BOREHOLE RECORD

BOREHOLE No. BH-01
(NORTH SIDE)

CLIENT PEITIE
LOCATION Proposed Clyde River Bridge, Clyde River, PEI
PROJECT No. JE0197
DRILLING Co. Logan Geotech Inc.
JE TECHNICIAN George Zafiris
CASING SIZE N
DATES: BORING August 30, 2016
WATER LEVEL Tidal; OHWM shown
DATUM Geodetic

DEPTH (Ft.)	DEPTH (m)	Ground Surface ELEVATION (m)	LITHOLOGIC DESCRIPTION	STRATA	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD%	OTHER TESTS	S.V.C.(ppm)
		1.61	GRADE								
0	0		Loose to very loose reddish brown gravelly silty sand; trace wood: FILL, rootmat/topsoil at surface		▼	SS	1	300	8		
	1					SS	2	400	7	S	
5		−0.07				SS	3	600	3		
	2		Very loose grey sand, some silt, trace to some organics: MARINE DEPOSIT; wood encountered from 1.8 to 3.0m			SS	4	100	10		
10	3					SS	5	150	12		
		−2.05				SS	6	250	2		
	4		Compact reddish brown gravelly silty sand: TILL			SS	7	350	15		
15											
	5					SS	8	350	15	S	
20	6	−4.64				SS	9	325	14		
	7		Very weak to weak, medium grained, reddish brown sandstone, interbedded with stiff to hard reddish brown mudstone: BEDROCK			NQ	10	45%	ROD 11		
25	8					NQ	11	75%	ROD 0		
30	9										
	10		Very weak to weak, medium grained, reddish brown sandstone, occasional weakly cemented seams: BEDROCK			NQ	12	83%	ROD 19		
35		−9.06									
	11		End of Borehole								
40	12										
	13										
45											

Undrained Shear Strength − kPa
20 40 60 80
Water Constant & Atterberg Limits W_P W W_L
Dynamic Penetration Test, blows/0.3m ★
Standard Penetration Test, blows/0.3m ●
10 20 30 40 50 60 70 80 90

WC=13%
WC=67%
WC=18%

Note:
S Sieve Analysis

BOREHOLE RECORD

BOREHOLE No. BH-02
(SOUTH SIDE)

CLIENT PEITIE
LOCATION Proposed Clyde River Bridge, Clyde River, PEI
PROJECT No. JE0197
DRILLING Co. Logan Geotech Inc.
JE TECHNICIAN George Zafiris
CASING SIZE N
DATES: BORING August 30, 2016
WATER LEVEL Tidal; OHWM shown
DATUM Geodetic

DEPTH (Ft.)	DEPTH (m)	Ground Surface ELEVATION (m)	LITHOLOGIC DESCRIPTION	STRATA	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD%	OTHER TESTS	S.V.C.(ppm)
0	0	0.73	GRADE								
			Very loose reddish brown silt, and sand, trace to some organics: MARINE DEPOSIT			SS	1	100	1		
	1					SS	2	300	1		
5		-0.79									
	2		Very loose grey sand, some silt, trace to some organics: MARINE DEPOSIT			SS	3	350	1	S	
10	3					SS	4	300	1	S	
		-2.77				SS	5	450	20		
	4		Compact to loose reddish brown gravelly silty sand: TILL			SS	6	300	8		
15	5										
						SS	7	300	8		
20	6	-5.82									
	7		Very weak to weak, medium grained, reddish brown sandstone; occasional stiff to hard reddish brown mudstone seams: BEDROCK			SS	8	67%	ROD 0		
25	8					SS	9	60%	ROD 7		
30	9										
	10					NQ	10	80%	ROD 0		
35		-10.09									
	11		End of Borehole								
40	12										
	13										
45											

Undrained Shear Strength – kPa
20 40 60 80
Water Constant & Atterberg Limits W_P W W_L
Dynamic Penetration Test, blows/0.3m ★
Standard Penetration Test, blows/0.3m ●
10 20 30 40 50 60 70 80 90

WC=56%
WC=62%
WC=17%

Note:
S Sieve Analysis

JOOSE ENVIRONMENTAL

BOREHOLE LOCATION PLAN

GEOTECHNICAL INVESTIGATION - PROPOSED CLYDE RIVER BRIDGE

CLYDE RIVER,QUEENS COUNTY, PEI

CLIENT: PEITIE

SCALE:		JOB NO.:	DWG NO.:
1 : 5000		JE0197	1
DATE	**DWN BY:**	**APPD BY:**	
2016/09/12	MLJ	GWZ	

DIVISION 03 – CONCRETE		Pages
03 10 00	Concrete Forming and Accessories	5
03 20 00	Concrete Reinforcement	5
03 30 00	Cast-in-Place Concrete	18
DIVISION 05 – METALS		
05 12 33	Structural Steel for Bridges	9
05 50 00	Metal Fabrications	5
DIVISION 07 – THERMAL AND MOISTURE PROTECTION		
07 19 10	Concrete Sealer and Coating	2
07 92 00	Concrete Joint Sealant	4
07 95 10	Expansion Joint System	4
07 95 63	Bearing Assemblies	6
DIVISION 09 – FINISHES		
09 97 13	Steel Coating	12
DIVISION 31 – EARTHWORK		
31 09 16	Pile Driving Templates	4
31 09 17	Pile Tests	2
31 61 13	Pile Foundations, General Requirements	8
31 62 16	Steel Pipe Piles	5

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 03 20 00 - Concrete Reinforcing

.2 Section 03 30 00 - Cast-in-Place Concrete

.3 Section 03 30 51 - Concrete for Precast Bridge Decks

.4 Section 07 92 00 - Joint Sealing

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)
.1 CSA-A23.1-04/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
.2 CSA-O86-14, Engineering Design in Wood.
.3 CSA O121-17, Douglas Fir Plywood.
.4 CSA O151-17, Canadian Softwood Plywood.
.5 CSA O153-13(R2017), Poplar Plywood.
.6 CAN/CSA-O325.0-92(R2003), Construction Sheathing.
.7 CSA O437 Series-93(R2011), Standards for OSB and Waferboard.
.8 CSA S269.1-16, Falsework for Construction Purposes.
.9 CAN/CSA-S269.3-M92(R2013), Concrete Formwork, National Standard of Canada

1.3 SUBMITTALS

.1 Provide submittals in accordance with the PEITIE Department of Transportation, Infrastructure and Energy’s General Provisions and Contract Specifications for Highway Construction.

.2 Submit shop drawings for formwork and falsework.
.1 Submit drawings and calculations stamped and signed by professional engineer registered or licensed in Province of Prince Edward Island, Canada.

.3 Indicate method and schedule of construction, shoring, stripping and re-shoring procedures, materials, arrangement of joints, special architectural exposed finishes, ties, liners, and locations of temporary embedded parts. Comply with CAN/CSA-S269.3 for formwork

drawings.

.4 Indicate formwork design data: permissible rate of concrete placement, and temperature of concrete, in forms.

.5 Indicate sequence of erection and removal of formwork/falsework as directed by the Engineer.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Store and manage hazardous materials in accordance with jurisdictional requirements.

.2 Waste Management and Disposal:
.1 Separate waste materials for reuse and recycling in accordance with the PEITIE Department of Transportation, Infrastructure and Energy’s General Provisions and Contract Specifications for Highway Construction..

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Formwork materials:
.1 For concrete without special architectural features, use wood and wood product formwork materials to CAN/CSA-O86.
.2 For concrete with special architectural features such as the end crash block pedestals and exposed sides of bridge deck and curbs, use formwork materials to CSA-A23.1/A23.2.
.3 Rigid insulation board between approach slab and wingwalls.
.4 Formwork to be constructed from lumber devoid of warped defects in order to achieve a face alignment free of distortion. This applies to all panel forms including prefabricated boards, plywood and steel panels.
.5 All formwork used for the construction of the barriers must be new.

.2 Form ties:
.1 For concrete not designated 'Architectural', use removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes larger than 25 mm diameter in concrete surface.

.3 Form liner:
.1 Plywood: to be determined by the Engineer based on the condition of the forms.
.2 Textaforme: to be used on barriers and collision blocks, both sides.

.4 Form release agent: chemically active release agents containing compounds that react with free lime present in concrete to provide water insoluble soaps, preventing concrete from sticking to forms. Form release agents must be compatible with waterproofing systems where applicable.

.5 Falsework materials: to CSA-S269.1.

.6 Sealant: to Section 07 92 00.

PART 3 - EXECUTION

3.1 FABRICATION AND ERECTION

.1 Verify lines, levels and centres before proceeding with formwork/falsework and ensure dimensions agree with drawings.

.2 Obtain the Engineer’s approval for use of earth forms framing openings not indicated on drawings.

.3 Hand trim sides and bottoms and remove loose earth from earth forms before placing concrete.

.4 Fabricate and erect falsework in accordance with CSA S269.1.

.5 Refer to structural drawings and Item 2.1.2 for concrete members requiring architectural exposed finishes.

.6 Do not place shores and mud sills on frozen ground.

.7 Provide site drainage to prevent washout of soil supporting mud sills and shores.

.8 Fabricate and erect formwork in accordance with CAN/CSA-S269.3 to produce finished concrete conforming to shape, dimensions,

locations and levels indicated within tolerances required by CSA-A23.1/A23.2.

.9 Align form joints and make watertight.
.1 Keep form joints to minimum.

.10 Use 25 mm chamfer strips on external corners and/or 25 mm fillets at interior corners, joints, unless specified otherwise. All strips to be continuous.

.11 Place all vertical v-grooves in barrier perpendicular to the deck and all horizontal v-grooves in barrier parallel to the top of the deck.

.12 Space barrier joints as shown on the drawings.

.13 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.

.14 Construct forms for architectural concrete as indicated.
.1 Joint pattern not necessarily based on using standard size panels or maximum permissible spacing of ties.

.15 Build in anchors, sleeves, and other inserts required to accommodate Work specified in other sections.
.1 Confirm anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including painting.

.16 Line forms for following surfaces as determined by the Engineer:
.1 Outer face of outside vertical edge of bridge deck and curbs.
.2 Exposed faces of abutments and wingwalls: do not stagger joints of form lining material and align joints to obtain uniform pattern.
.3 Secure lining taut to formwork to prevent folds.
.4 Pull down lining over edges of formwork panels.
.5 Confirm lining is new and not reused material.
.6 Confirm lining is dry and free of oil when concrete is poured.
.7 Application of form release agents on formwork surface is prohibited where drainage

lining is used.

.8 If concrete surfaces require cleaning after form removal, use only pressurized water stream so as not to alter concrete's smooth finish.

.9 Cost of textile lining is included in price of concrete for corresponding portion of Work.

.17 Clean formwork in accordance with CSA-A23.1/A23.2, before placing concrete.

3.2 REMOVAL AND RESHORING

.1 Leave formwork in place for following minimum periods of time after placing concrete.

.1 Two (2) days for walls.

.2 Four (4) days for beam soffits, slabs, decks and other structural members, or two (2) days when replaced immediately with adequate shoring to standard specified for falsework.

.3 Two (2) days for footings and abutments.

.2 Remove formwork when concrete has reached 50% of its design strength or minimum period noted above, whichever comes later, and replace immediately with adequate reshoring. No vehicle loading or backfilling of abutments shall take place until concrete reaches design strength.

.3 Re-use formwork and falsework subject to requirements of CSA-A23.1/A23.2.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED WORK

.1 Cast-in-place concrete: Section 03 30 00

.2 Concrete forms and accessories: Section 03 10 00

1.2 REFERENCES

.1 CAN/CSA-A23.1-14, Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete.

.2 CAN/CSA-S6-14, Canadian Highway Bridge Design Code.

.3 CSA A23.3-14, Design of Concrete Structures.

.4 ACI 440.1R-15, Guide for the Design and Construction of Concrete Reinforced with FRP Bars.

.5 CSA S806-12(R2017), Design and Construction of Building Structures with Fibre-Reinforced Polymers.

.6 CSA S807-10(R2015), Specification for Fibre-Reinforced Polymers.

.7 ASTM A1064/A1064M-17, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

1.3 SOURCE QUALITY CONTROL

.1 Submit a Quality Control Report for all the materials delivered to site prior to placement of the GFRP reinforcement. The report is to include production information, including:
.1 Supplier.
.2 Lot number of GFRP bars.
.3 Batch number of resin
.4 The start and end date of production for each production lot of material.
.5 The total linear meters produced in each lot for straight bars or the total number of bars in each lot for bent bars and anchor headed bars.

.2 Upon request, provide Engineer with testing reports documenting the following:

.1 Number of samples tested in each lot.
.2 Mean, standard deviation, and minimum values for the following properties: tensile strength, tensile elongation, transverse shear strength, and bend strength.
.3 Supply test reports at no additional cost to the Contract.

1.4 SHOP DRAWINGS

.1 Submit shop drawings in accordance with PEITIE General Provisions and Contract Specifications for Highway Construction. Shop drawings are to be stamped and signed by professional engineer registered in the Province of Prince Edward Island.

.2 Indicate bar size, location, bend dimensions and bend fabrication process for all GFRP bars.

.3 Include bar schedule containing quantity, bar size, length and bending dimensions.

.4 Indicate minimum guaranteed ultimate tensile strength and nominal modulus of elasticity for all bar sizes and types on the shop drawings.

.5 Detail lap lengths and bar development lengths to CSA S6 and ACI 440.1.

1.5 SUBSTITUTES

.1 Substitute different size bars only if permitted in writing by the Engineer. Do not substitute steel reinforcing for GFRP reinforcing or vice-versa.

1.6 HANDLING

.1 Deliver, store and handle reinforcing in accordance with manufacturer's recommendation.

.2 Do not store GFRP bars on ground. Store GFRP bars under covers to avoid direct sunlight and chemical substances.

.3 Lift, transport and store GFRP bars using multiple support points to prevent damage from sagging.

.4 Perform lifting of GFRP bar bundles with nylon slings or padded wire rope slings.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Cold-drawn annealed steel wire ties: to ASTM A1064/A1064M. Coated ties, stainless steel ties, or nylon ties for GFRP reinforcement.

.2 Chairs, bolsters, bar supports, spacers: to CSA-A23.1.

.3 Mechanical splices: subject to approval of Engineer, other than shown on the drawings.

.4 Straight glass fibre reinforced polymer bars with a guaranteed tensile strength equal and a nominal modulus of elasticity equal to the following:

Size	Guaranteed Tensile Strength (MPa)	Nominal Modulus of Elasticity (GPa)
13M	1100	60
15M	1100	60
20M	1100	60
25M	1000	60
32M	900	60

.5 Bent/shaped glass fibre reinforced polymer bars with a guaranteed tensile strength equal to 450 MPa and a nominal modulus of elasticity equal to 50 GPa.

.6 Headed glass fibre reinforced polymer bars with a pull out strength of:
.1 15M – 148kN.
.2 20M – 182kN.

.7 All GFRP bars must be supplied by the same manufacturer.

2.2 FABRICATION

.1 Obtain the Engineer's approval for locations of reinforcement splices other than those shown on placing drawings.

.2 Stamp GFRP bars with bar identification indicating bar size, fibre type, grade, modulus of elasticity, batch number, bend fabrication method, and manufacturer’s name and symbol.

.3 GFRP bars to have a sand coating or deformations for bond to the concrete.

PART 3 - EXECUTION

3.1 FIELD BENDING

.1 Examine formwork to confirm it has been completed and adequately braced in place before starting reinforcement placing.

.2 Field bending of GFRP bars is not permitted.

.3 Replace GFRP which develop cracks or splits.

.4 If required, field cut straight GFRP bars with high speed grinding cutter or saw with approval of the Engineer. Do not shear bars. Bent bars are not to be cut.

3.2 PLACING REINFORCEMENT

.1 Place reinforcing as indicated on the drawings and in accordance with CSA A23.1, CSA S6 and as follows.

.1 Clean all reinforcing of millscale, oil grease, or other deleterious material before and after erection.

.2 Secure reinforcing rigidly in position with coated tie wire, stainless steel wire, nylon ties or use approved clips at intersections supported on reinforcing chairs. Additional support chairs are required for GFRP reinforcement. Co-ordinate with GFRP supplier.

.3 Bar chairs for supporting GFRP bars to be plastic.

.4 Take care to position the bars so they do not alter during concreting and maintain the correct cover at all times.

.5 Bars are to be tied at least at every third intersection.

.6 The maximum untied length of any bar is to be 900 mm.

.7 Bar support chairs is not to exceed 900 mm average spacing in each direction.

.8 GFRP bars within formwork is to be adequately secured to prevent movement during the concrete placement. The bars are to be supported or tied to resist settlement, floating upwards, or movement in any direction during the concrete placement.

.2 Prior to placing concrete, obtain the Engineer's approval of reinforcing material and placement.

.3 Maintain cover to reinforcement during concrete pour.

3.3 QUALITY CONTROL

.1 All GFRP materials to meet the mechanical, physical and durability properties specified in this Special Provision and reference standards.

.2 Manufacturer’s quality control tests to follow parameters set forth in CSA S806 and CSA S807.

.3 If any sample within a lot does not meet the specified properties, the lot will be rejected and a new lot will be provided at no additional cost to the Contract.

3.4 QUALITY ASSURANCE

.1 The Engineer reserves the right to select up to five (5) random samples for quality assurance testing from each lot of GFRP. Complete tests according to CSA S806 and CSA S807. Have testing completed at an independent laboratory at the cost of the Owner. Results will be provided to the Contractor when they are available. If any sample within a lot does not meet the specified properties, the lot will be rejected and a new lot will be provided at no additional cost to the Contract.

.2 GFRP that does not meet the specified finishing, surface conditions, or dimensional tolerances will be rejected.

.3 Replace all rejected GFRP lots or bars at no additional cost to the Contract.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 03 10 00 - Concrete Forming and Accessories

.2 Section 03 20 00 - Concrete Reinforcing

1.2 REFERENCES

.1 ANSI/ACI 117-10(R2015), Specifications for Tolerances for Concrete Construction and Materials and Commentary.

.2 American Society for Testing and Materials International (ASTM)

.1 ASTM C260-10(R2015), Standard Specification for Air-Entraining Admixtures for Concrete.

.2 ASTM C309-11, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

.3 ASTM C330-17A, Standard Specification for Lightweight Aggregates for Structural Concrete.

.4 ASTM C494/C 494M-17A, Standard Specification for Chemical Admixtures for Concrete.

.5 ASTM C1017/C 1017M-13E1, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.

.6 ASTM C1064-17, Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.

.7 ASTM D412-16, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.

.8 ASTM D624-00(R2012), Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer.

.9 ASTM D1751-04(R2013), Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).

.10 ASTM D1752-04a(R2013), Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.

.11 ASTM D5249-10(R2016), Standard Specification for Backer Material for Use with Cold and Hot Applied Sealants in Portland

Cement Concrete and Asphalt Joints.

.3 Canadian General Standards Board (CGSB)
.1 CAN/CGSB-37.2-M88, Emulsified Asphalt, Mineral Colloid-Type, Unfilled, for Dampproofing and Waterproofing and for Roof Coatings.
.2 CAN/CGSB-51.34-M86(R1988), Vapour Barrier, Polyethylene Sheet for Use in Building Construction.

.4 Canadian Standards Association (CSA International)
.1 CSA A3000-13, Cementitious Materials Compendium.
.2 CSA-A23.1/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
.3 CSA A283-06(R2016), Qualification Code for Concrete Testing Laboratories.
.4 CSA S269.3-16, Concrete Formwork.

1.3 ACRONYMS AND TYPES

.1 Cement: hydraulic cement or blended hydraulic cement (XXb - where b denotes blended).
.1 Type GU or GUb - General use cement.
.2 Type MS or MSb - Moderate sulphate-resistant cement.
.3 Type MH or MHb - Moderate heat of hydration cement.
.4 Type HE or Heb - High early-strength cement.
.5 Type LH or LHb - Low heat of hydration cement.
.6 Type HS or HSb - High sulphate-resistant cement.

.2 Fly ash:
.1 Type F - with CaO content less than 8%.
.2 Type CI - with CaO content ranging from 8 to 20%.
.3 Type CH - with CaO greater than 20%.

.3 GGBFS - Ground, granulated blast-furnace slag.

1.4 DESIGN REQUIREMENTS

.1 Alternative 1 - Performance: in accordance with CSA-A23.1/A23.2, and as described in MIXES of PART 2 - PRODUCTS.

1.5 SUBMITTALS

.1 Provide submittals in accordance with the PEITIE Department of Transportation, Infrastructure and Energy's General Provisions and Contract Specifications for Highway Construction.

.2 Submit testing results and reports for review by the Engineer and do not proceed without written approval when deviations from mix design or parameters are found.

.3 Concrete pours: submit accurate records of poured concrete items indicating date and location of pour, quality, air temperature and test samples taken as described in PART 3 - FIELD QUALITY CONTROL.

.4 Concrete hauling time: submit for review by the Engineer deviations exceeding maximum allowable time of 120 for concrete to be delivered to site of Work and discharged after batching.

.5 Conduct aggregate tests by a testing laboratory, approved by the Engineer, under the direction of a professional engineer licensed to practice in Prince Edward Island.

1.6 QUALITY ASSURANCE

.1 Quality Assurance: in accordance with PEITIE Department of Transportation, Infrastructure and Energy's General Provisions and Contract Specifications for Highway Construction.

.2 Site Meetings: one (1) week prior to beginning concrete works.
.1 Ensure key personnel such as site supervisor, the Engineer, specialty contractor - finishing, forming, concrete producer, testing laboratories attend.
.2 Verify project requirements.

.3 Submit to the Engineer, a minimum four (4) weeks prior to starting concrete work, valid and recognized certificate from the Atlantic Concrete Association certifying that the plant delivering concrete meets conformance for concrete production facilities.
.1 When plant does not hold valid certification, provide test data and certification by qualified independent

inspection and testing laboratory that materials used in concrete mixture will meet specified requirements.

.4 A minimum four (4) weeks prior to starting concrete work, submit proposed quality control procedures for review by the Engineer on following items:
.1 Falsework erection.
.2 Hot weather concrete.
.3 Cold weather concrete.
.4 Curing.
.5 Finishes.
.6 Formwork removal.
.7 Joints.

.5 Quality Control Plan: submit written report, as described in PART 3 - VERIFICATION, to Departmental Representative verifying compliance that concrete in place meets performance requirements of concrete as established in PART 2 - PRODUCTS.

.6 Health and Safety Requirements: do construction occupational health and safety in accordance with PEITIE Department of Transportation, Infrastructure and Energy's General Provisions and Contract Specifications for Highway Construction and the Prince Edward Island Occupational Health and Safety Act.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Concrete hauling time: maximum allowable time for concrete to be delivered to site of Work and discharged not to exceed 120 minutes after batching.
.1 Modifications to maximum time limit must be agreed to the Engineer and concrete producer as described in CSA A23.1/A23.2.
.2 Submit deviations for review by the Engineer.

.2 Concrete delivery: ensure continuous concrete delivery from plant meets CSA A23.1/A23.2.

.3 Waste Management and Disposal:
.1 Separate waste materials for reuse and recycling in accordance with the PEITIE Department of Transportation, Infrastructure and Energy's General Provisions and Contract Specifications for Highway Construction.

.2 Divert unused concrete materials from landfill to local facility approved by the Engineer.
.3 Provide an appropriate area on the job site where concrete trucks can be safely washed.
.4 Divert unused admixtures and additive materials (pigments, fibres) from landfill to official hazardous material collections site as approved by the Engineer.
.5 Unused admixtures and additive materials must not be disposed of into sewer systems, into lakes, streams, onto ground or in other location where it will pose health or environmental hazard.
.6 Prevent admixtures and additive materials from entering drinking water supplies or streams. Using appropriate safety precautions, collect liquid or solidify liquid with inert, noncombustible material and remove for disposal. Dispose of waste in accordance with applicable jurisdictional regulations.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Portland Cement: to CAN/CSA A3000.

.2 Supplementary cementing materials: to CAN/CSA-A3000. Limit fly ash to 20% and silica fume to 10% proportion of the mix.

.3 Water: to CSA-A23.1 and to be free from injurious amounts of oil, acid, alkali soluble chloride, organic matter, sedimentation and other deleterious substances.

.4 Aggregates: to CAN/CSA-A23.1/A23.2. The maximum Petrographic Number of course aggregate must not exceed 140. The maximum absorption of course aggregate must not exceed 2%.

.5 Shrinkage compensating grout: premixed compound consisting of non-metallic aggregate, Portland cement, water reducing and plasticizing agents to CSA-A23.1/A23.2.
.1 Compressive strength: 50 MPa at 28 days.
.2 Consistency:
.1 Fluid: to ASTM C827. Time of efflux

through flow cone (ASTM C939), under 30 seconds.
.2 Flowable: to ASTM C827. Flow tables, 5 drops in 35 (ASTM C109, applicable portion) as to 145%.
.3 Plastic: to ASTM C827. Flaw table, 5 drops in 35 (ASTM C109, applicable portions) 100 to 125%.

.6 Curing compound: to ASTM C309, Type 2.

.7 Dampproofing:
.1 Emulsified asphalt, mineral colloid type: to CAN/CGSB-37.2.

.8 Polyethylene film under approved slabs: two (2) sheets each 6 mils thick, to CAN/CGSB-51.34.

.9 Bonding agent under bearing plinths: modified latex bonding agent.

2.2 MIXES

.1 Alternative 1 - Performance Method for specifying concrete: to meet Departmental Representative performance criteria in accordance with CAN/CSA-A23.1/A23.2.
.1 Confirm the concrete supplier meets performance criteria as established below and provide verification of compliance as described in PART 3 - VERIFICATION.
.2 Proportion normal density concrete in accordance with CAN/CSA-A23.1, Alternative 1 to give the properties for concrete in bridge decks, curb, barrier, abutments, pier wingwalls, and approach slabs. Concrete to be proportioned using Portland cement, Type SF silica fume, fine and coarse aggregates, air entraining, water reducing, and/or set regarding admixtures. Concrete mixtures shall be designed to meet the following:
.1 Minimum compressive strength at 28 days: 45 MPa.
.2 Class of exposure: C1.
.3 Chemical admixtures: type as approved and in accordance with ASTM C494.
.4 Normal size of aggregate: 20mm.
.5 Maximum water to cement ratio: 0.35 (0.4).
.6 Minimum cementitious content: 420

kg/m³.
.7 Air content: 6.5 ± 1.5%.
.8 Maximum slope before superplasticization: 60mm.
.9 Slump after superplasticization: 180 ± 30mm.
.10 Maximum spacing factor of hardened concrete not to exceed 300mm.
.11 Average spacing factor of hardened concrete not to exceed 250 mm.
.12 Rapid concrete permeability @ 28 days: <1000 coulombs.
.13 Maximum concrete temperature (from delivery equipment):
.1 Thickness >2 metres: 18°C.
.2 Thickness <2 metres: 25°C.
.14 Maximum concrete temperature (in situ): 70°C.
.15 Maximum temperature gradient: 20°C/metre.
.16 Use superplasticizer in all concrete.

PART 3 - EXECUTION

3.1 PREPARATION

.1 Obtain the Engineer's approval before placing concrete.
.1 Provide 24 hours' notice prior to placing of concrete.

.2 Place concrete reinforcing in accordance with Section 03 20 00.

.3 During concreting operations:
.1 Development of cold joints not allowed.
.2 Carry out concrete delivery and handling facilitates placing with minimum of re-handling, and without damage to existing structure or Work.

.4 Pumping of concrete is permitted only after review of equipment and mix by the Engineer.

.5 Do not disturb reinforcement and inserts during concrete placement.

.6 Prior to placing of concrete obtain the Engineer's approval of proposed method for protection of concrete during placing and curing.

.7 Protect previous Work from staining.

.8 Clean and remove stains prior to application for concrete finishes.

.9 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.

.10 Remove all debris including sawdust, chips and any other deleterious materials from the interior of the forms.

.11 Do not place load upon new concrete until authorized by the Engineer.

3.2 CONSTRUCTION

.1 Do cast-in-place concrete work in accordance with CSA-A23.1/A23.2.

.2 Sleeves and inserts:

.1 Do not permit penetrations, sleeves, ducts, pipes or other openings to pass through structural members, except where indicated or approved by the Engineer.

.2 Where approved by the Engineer, set sleeves, ties, and other inserts and openings as indicated or specified elsewhere.

.3 Sleeves and openings greater than 100 x 100 mm not indicated, must be reviewed by the Engineer.

.4 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain approval of modifications from the Engineer before placing of concrete.

.5 Check locations and sizes of sleeves and openings shown on drawings.

.6 Set special inserts for strength testing as indicated and as required by non-destructive method of testing concrete.

.3 Anchor bolts:

.1 Set anchor bolts to templates under supervision of appropriate trade prior to placing concrete.

.2 With approval of the Engineer, grout anchor bolts in preformed holes as indicated on the drawings.

.3 Protect anchor bolt holes from water accumulations, snow and ice build-ups.
.4 Set bolts and fill holes with shrinkage compensating grout.
.5 Locate anchor bolts used in connection with expansion shoes, rollers and rockers with due regard to ambient temperature at time of erection.

.4 Drainage holes and weep holes:
.1 Form weep holes and drainage holes in accordance with Section 03 10 00.
.2 Install weep hole tubes and drains as indicated.

.5 Placing of concrete:
.1 Concrete Abutments, Pier, Deck, Approach Slats, Barrier, and Haunches:
.1 Construct all concrete items in accordance with this specification and with the drawings.
.2 Barrier control joints to be formed, and spaced as detailed in the drawings.
.3 Alternate concrete barrier panels to be initially poured with remaining barrier panels being cast following curing of the first pour. A clear bond breaker is to be applied to surface of barrier joints as indicated in the drawings prior to the remaining barrier panels being cast.
.2 Consolidation:
.1 All methods of consolidation will be subject to the approval of the Engineer.
.2 Consolidate concrete thoroughly and uniformly by means of hand tamping, vibrators or finishing machines to obtain a dense, homogeneous structure, free from cold joints, voids and honeycomb.
.3 Employ a sufficient number of vibrators to adequately handle the anticipated rate of placement. Size and frequency of vibrators to be as specified in CSA A23.1. Make a stand-by vibrator available on the site at all times.
.4 Use internal vibrators wherever practicable. External type vibrators may be used where surfaces cannot be properly consolidated with the internal type

alone.

.5 Make insertion of internal vibrators systematically at intervals such that the zones of influence of the vibrator overlap.

.6 Take extreme care to ensure that the internal type vibrators do not displace the reinforcing steel or the forms. Vibrators shall have rubber or non-metallic vibrating heads if epoxy coated reinforcing steel is used.

.3 Curing concrete:

.1 Protect concrete from freezing, premature drying, high temperature and moisture loss for a period of time necessary to develop the desired properties of the concrete.

.2 Apply curing to concrete as soon as possible without damaging or marring the surface.

.3 Curing time to be as indicated in CSA A23.1 or this specification. Achieve curing by one or more of the following:

.1 Burlap: Carefully lay two (2) layers of pre-soaked burlap on the surface as soon as the concrete has set sufficiently to support the mass of the burlap without marking the surface. Overlap strips 150 mm, secured to the surface and keep wet throughout the curing period.

.2 Moisture Vapour Barrier: provide an effective vapour barrier and prevent any flow of air between it and the concrete surface. Where polyethylene sheet is used, use white opaque pigmented with a minimum thickness of 100 µm. Secure the vapour barrier to the surface and overlap 150 mm.

.3 Do not use white Pigment Liquid Membrane: curing compounds on a surface where a bond is required for additional concrete. A curing compound may be approved by the Engineer under certain circumstances where the application of moisture is impracticable and where such compounds will not jeopardize the appearance of the concrete. Apply curing compounds at

the Manufacturer's recommended application rate. Curing compounds are not permitted on construction joints, surfaces requiring weatherproofing sealants or deck sections.

.4 Water: Cure PCC bridge decks with water unless otherwise directed by the Engineer. Keep concrete exposed surfaces continuously moist for a minimum of seven (7) consecutive days after placing. The water for curing must be clean and free from any material which could cause staining or discoloration of the concrete. Protect freshly placed and consolidated concrete from the elements.

.4 Hot Weather Concreting: When the air temperature is at or above 27°C, or is likely to rise above 27°C within 24 hours, take special measures, as detailed in CSA A23.1 to protect the concrete from the effects of hot and/or drying weather conditions. The temperature of the formwork, reinforcing steel or the material on which the concrete is to be placed, shall not exceed 27°C. Concrete temperatures must not exceed those specified in CSA A23.1, Table 16.

.5 Cold Weather Concreting:

.1 When the mean air temperature is at or below 5°C or when the temperature is likely to fall below 5°C within 24 hours, place, cure and protect concrete in accordance with CSA A23.1 and this specification.

.2 Do not place concrete on or against any surface which is at a temperature less than 5°C. Remove snow and ice before concrete is deposited on any surface.

.3 Do not use calcium chloride or other de-icing chemicals as a deicing agent in the forms.

.4 If heating of the mix water and/or aggregates is used, alter the charging cycle to prevent flash setting of the concrete.

.5 Do not heat aggregates and water above 80°C. Batch water and/or aggregates heated to a temperature in excess of 40°C, in the mixer first to reduce the temperature of the combination below 40°C, prior to the addition of the cementing materials.

.6 Exclude all frozen lumps of aggregate from the mix.

.6 Protection Classes:

.1 Protection and curing depends upon the outside temperature, the wind velocity, and the size of the concrete section.

.2 Under normal circumstances the following methods of protection may be required to maintain the protection necessary for the conditions described.

.3 Heating of the mixing water and/or aggregates are required for all classes of protection.

.4 When the outside temperature during placing or during the protection period may fall below 5°C, provide adequate covering of all surfaces with tarpaulins or polyethylene sheets.

.5 When the outside temperature during placing or during the protection period may fall below 0°C, cover all surfaces with an approved insulating material, over which tarpaulins or polyethylene sheets are placed.

.6 When the outside temperature during placing or during the protection period may fall below -5°C, provide a complete housing of the concrete, together with supplementary heat. Supply heat uniformly around the concrete.

.7 For mass concrete, defined as minimum section dimension in excess of 2 m, the temperature gradient must not exceed 20°C/m from the interior of the element to the exterior face.

.8 In thin sections, less than 2 m, the temperature differential

from the interior to the exterior must not exceed 20°C.

.9 Steam or hot air blowers may be used, but provide a means of maintaining relative humidity of not less than 95%.

.10 When dry heat is used, hot air will not be permitted to flow directly onto the concrete surface. Vent exhaust fumes.

.11 Continue the protection and curing to maintain the temperature of the concrete at not less than 10°C for five (5) days after placing. Keep the concrete above 0°C for a total period of fourteen days.

.12 At the end of the curing and protection period withdraw protection and heating in such a manner as not to induce thermal shock stresses in the concrete.

.13 Gradually reduce the temperature of the concrete to avoid cracking due to sudden temperature changes near the end of the curing period. Do not completely remove the protection until the concrete has cooled to the temperature differential stated in Table 18 of CSA A23.1.

.6 Finishing of Concrete:

.1 Basic Treatment

.1 Upon removal of the forms, patch all cavities, honeycomb, and other deficiencies with a sand cement mortar of the same composition as that used in the concrete.

.2 Mortar to be composed of cement, fine aggregate and water, proportioned and mixed as specified.

.3 When the proportioning of cement and fine aggregate is not specified, mortar to consist of one (1) part by volume of cement and two (2) parts of fine aggregate.

.4 The quantity of water used in mixing the mortar must be sufficient to make it capable of being freely spread with the trowel.

.5 Mix mortar in quantities which can

be utilized within 60 minutes.

.6 Do not re-temper mortar or re-mixed with water after initial set.

.7 Remove or cut back all bolts, ties, nails, or other metal not specifically required for construction purposes, to a depth of 25 mm from the surface of the concrete unless otherwise directed by the Engineer.

.8 Keep the cavity saturated for 60 minutes prior to the application of a latex bonding agent or neat cement paste.

.9 Press or pack the mortar into the depressions so it completely fills the cavity and then finished to match the adjacent surface.

.10 Chip or rub off fins, unsightly ridges, or other imperfections flush with the surface.

.11 Apply mortar patches in excess of 25 mm in layers not exceeding 25 mm with a 30 minute interval between the placing of layers.

.12 Surface of the patch to be textured equivalent to the adjacent concrete.

.13 Do not repair honeycomb areas or cavities over 25 mm in diameter until inspected by the Engineer.

.14 Where honeycombing has occurred in non-structural elements, remove the affected area and fill with mortar as previously described.

.15 Where honeycombing has occurred in structural elements, carry out the corrective method of treatment out as directed by the Engineer.

.16 Cure all concrete and mortar and protect in accordance with CSA A23.1

.2 Smooth Form Finish:

.1 A Smooth Form Finish to be a uniform, high quality concrete which has been homogeneously placed and thoroughly compacted.

.2 A Smooth Form Finish must be uniform in colour, pattern and texture. All exposed bridge components and barriers to have a Smooth Form Finish.

.3 If the concrete, after form stripping and the basic treatment, does not exhibit such finish, perform any or all of the following operations, in order

to obtain a Smooth Form Finish:

.1 Cut out all corrodible metal within 25 mm of the surface and repair the cavities as indicated in basic treatment.

.2 Remove fins and other projections to leave a smooth, plane surface.

.3 Remove stains, rust marks or other blemishes which detract from the specified uniformity of appearance.

.3 Open Surfaces:

.1 The finished surface of concrete placed for such items as bridge decks, approach slabs, sidewalks and curbs must conform to the lines, grades and elevations shown on the contract drawings.

.2 Lay out sidewalk surfaces in blocks by use of a jointing tool, saw cutting or as indicated on the plans. Form concrete edges and expansion joints in the concrete at the designated locations.

.3 Round off joints using a 6 mm radius edging tool.

.4 Strike off sidewalk surfaces with a strike board and float.

.5 The finished surface must not vary more than 3 mm under a 3 m straight edge and to be lightly broomed transversely to produce a textured, non-slip surface.

.7 Dampproof membrane:

.1 All dampproofing material must conform to CAN/CGSB-37.2-M and apply in accordance with GCSB-37.3.

.8 Concrete sealer and coatings:

.1 Apply concrete sealers/coatings as described in Section 07 92 00.

.9 Placing and Finishing Concrete Bridge Deck:

.1 Finished surface of the deck concrete to conform to grades and elevations shown on the Contract Drawings. Prior to placing deck concrete, submit detailed information on the method and equipment proposed for handling, placing and finishing of the concrete to the Engineer. Also demonstrate to the satisfaction of the Engineer that all necessary adjustments

have been made to provide the required camber, crown, slab thickness and concrete cover over reinforcement, prior to placement. Pay particular care to the transitioning super elevation on the bridge deck.

.2 Immediately prior to placement of deck concrete, clean formwork and thoroughly moisten. Also moisten the reinforcing steel with water at the request of the Engineer. Place deck concrete continuously until completion of the section. The placing sequence for continuous structures must conform to the Contract Drawings.

.3 Finish the deck using a mechanical screed machine.

.4 The finishing machine must be self-propelled and travel on rails. Fit with a rotating cylinder screed, an adjustable powered screw auger and a vibrator mounted in front of the screed. It must be capable of forward and reverse movement under positive control. There must be provision for raising all screeds to clear the screeded surface without adjusting the legs. Provide complete with a locking device at each leg to prevent vertical adjustment. The finishing machine must be capable of obtaining an acceptable surface texture without excessive additional hand finishing. It must also have a hinge located along the centerline of the bridge to achieve the transitioning super elevation.

.5 Provide a work bridge riding on the screed rails behind the finishing machine with a working platform not higher than 0.4m above the finished surface to facilitate hand finishing work, concrete inspection, and placing of curing materials. On placements longer than 40m or wider than 10m, provide a second work bridge. When two (2) work bridges are required, the trailing work bridge will ride on the screed rails and be used for the purpose of placing the curing materials and must have sufficient clearance to allow for the proper placing of the curing materials. Screed rail chairs must be adjustable in height and made of metal.

.6 Finish deck surface to be tight, smooth, free from ridges, depressions, undulations or blemishes. Surface to receive a texture finish as indicated in this specification. Deck surface to be such that when tested with a 3m

long straight edge placed in any direction, there will not be a gap greater than 8mm between the bottom of the straight edge and the surface of the concrete.

.7 Areas which do not meet the required surface profile will be clearly marked and removed at no additional expense to the Contract. As directed by the Engineer:

.1 Grind down any areas higher than 3mm but less than 10mm.

.2 Remove and replace deviations exceeding 10mm. The quality of the repair must be equal to or greater than the adjacent concrete in the undisturbed slab.

.8 If concrete placement in the bridge deck is carried out with pumps or cranes, have available on site, at all times during placement, a minimum of two (2) pumps or cranes or combination thereof. Concrete placement in bridge decks will not be permitted between December 1st and March 31st unless otherwise advised by the Engineer.

.9 Take appropriate measures required to minimize defects in the concrete. These measures include but are not limited to: installation of wind breaks, installation of shelters, covering and protection from premature drying, timing of placements, additional workforce, and/or equipment. Upon completion of the Work, the Engineer will conduct a survey to determine the extent, if any, of defects present in the structure. The method of repair for defects identified, requiring remedial action, shall be dependent upon the location and extent of the defect. Defects identified may result in repair, or rejection and replacement.

.10 Concrete to be textured by means of a burlap drag, broom or approved alternative. Confirm the finish on the deck surface is compatible with the waterproofing membrane chosen.

.11 Do not apply water or cement to the concrete surface for finishing purposes.

.12 Water cure the deck concrete as described herein. During freezing temperatures, terminate water curing 12 hours to the end of the protection period.

3.3 SURFACE TOLERANCE

.1 Concrete tolerance in accordance with CSA-A23.1/A23.2.

3.4 FIELD QUALITY CONTROL

.1 Site tests: conduct following test in accordance with PEITIE Department of Transportation, Infrastructure and Energy's General Provisions and Contract Specifications for Highway Construction. At a minimum, conduct the following tests:
.1 Concrete pours.
.2 Slump tests.
.3 Air tests.

.2 Inspection and testing of concrete and concrete materials will be carried out by testing laboratory designated by the Engineer in accordance with CSA-A23.1/A23.2.
.1 Confirm testing laboratory is certified in accordance with CSA A283.

.3 Distribute test results to all parties.

.4 The Engineer may take additional test cylinders as required. Cure cylinders on job site under same conditions as concrete which they represent.

.5 Non-Destructive Methods for Testing Concrete: in accordance with CSA-A23.1/A23.2.

.6 Inspection or testing by the Engineer will not relieve Contractor of their contractual responsibility.

3.5 VERIFICATION

.1 Quality Control Plan: ensure concrete supplier meets performance criteria of concrete as established in PART 2 - Products, and provide verification of compliance as described in PART 1 - QUALITY ASSURANCE herein.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 05 50 00 - Metal Fabrications

.2 Section 07 95 63 - Bearing Assemblies

.3 Section 09 97 13 - Steel Coating

1.2 REFERENCES

.1 American Association for State Highway and Transportation Officials (AASHTO)
.1 AASHTO LRFD Bridge Design Specifications, 2017, 8th Edition.

.2 American Society for Testing and Materials International, (ASTM)
.1 ASTM F3125/F3125M-15a, Specification for High-Strength Structural Steel Bolts Steel and Alloy Steel, Heat Treated, 120 ksi to 150 ksi Min. Tensile Strength.
.2 ASTM A307-14e1, Standard Specification for Carbon Steel Bolts, Studs and Threaded Rod, 60 ksi Tensile Strength.
.3 ASTM A123/A123-17, Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.

.3 Canadian Standards Association (CSA International)
.1 CSA-S6-14, Canadian Highway Bridge Design Code.
.2 CSA G40.20/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
.3 CAN/CSA S16-14, Limit States Design of Steel Structures.
.4 CSA S269.1-16, Falsework for Construction Purposes.
.5 CSA W47.1-09(R2014), Certification of Companies for Fusion Welding of Steel.
.6 CSA W48-14, Filler Metals and Allied Materials for Metal Arc Welding.
.7 CSA W59-13, Welded Steel Construction, (Metal Arc Welding) (Metric version).

1.3 SHOP DRAWINGS

.1 Submit shop drawings in accordance with the PEITIE Department of Transportation, Infrastructure and Energy’s General Provisions and Contract Specifications for Highway

Construction.

.2 Each drawing submitted to bear signature and stamp of qualified professional engineer registered or licensed in Province of Prince Edward Island, Canada.

.3 Indicate shop and erection details including shop splices, cuts, copes, connections, holes, bearing plates, threaded fasteners, and welds. Indicate welds by CSA W59 welding symbols. Indicate all bird spike locations and extents and provide specifications for spikes, as well as mechanical connection to attach bird spikes to girder assemblies.

.4 Proposed welding procedures to be stamped and approved by Canadian Welding Bureau.

.5 Submit description of methods, temporary bracing and strengthening, sequence of erection and type of equipment proposed for use in erecting structural steel.

.6 Falsework drawings submitted to bear signature and stamp of qualified professional engineer registered or licensed in Province of Prince Edward Island, Canada.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store and handle to prevent damage.

.2 Provide protective blocking for lifting, transportation and storing.
.1 Exercise care during fabrication, transportation and erection so as not to damage girders, bearing, etc.
.2 Do not notch edges of members.
.3 Do not cause excessive stresses.

.3 Mark mass on members weighing more than 3 tonnes.

.4 Allow for no portion of steel comes into contact with ground.

.5 Provide the Engineer with delivery schedules minimum seven (7) days prior to shipping.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with PEITIE Department of Transportation, Infrastructure and Energy's General Provisions and Contract Specifications for Highway Construction.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Structural steel, excluding rolled angle, HSS members and sole plates: to CSA G40.20/G40.21, grade and types 350WT Category 2 with the exception of girder and diaphragm steel which is to be type AT.

.2 All rolled angle shapes, sole plates: to CSA G40.21M Grade 350W.

.3 All HSS members to CSA G40.20 Class C (cold-formed, non-stress-relieved).

.3 High strength Type 1 bolts, nuts and washers: to ASTM F3125/F3125M.

.4 Anchor bolts, washers and nuts: to ASTM A307, or better, galvanized.

.5 Bearings: to Section 07 95 63.

.6 Welding electrodes: to CSA W48 series. Filler metal shall be in accordance with Table 5-1 of Filler Requirements for Exposed Bare Applications of CSA-G40.21M, 350A, 350AT, 400AT and ASTM A242 and SEE Steels of the CSA W59 Specification.

.7 Stud shear connectors: to CSA W59, Clause 5.5.6 and Appendix H.

.8 Hot dip galvanizing: to ASTM A123, minimum zinc coating of 763 g/m^2.

.9 Deposited weld metals in full penetration welds are required to have a minimum Charpy Impact Energy of 27 joules at -30°C in accordance with Appendix A of CSA S6. Provide certification at no additional cost.

.10 Fabrication must not commence prior to the review of shop drawings by the Engineer. Any fabrication done without the reviewed shop

drawings may be rejected. Do all steel fabrication in accordance with CSA W59 and in accordance with the reviewed shop drawings.

.11 Workmanship and finish to be of the best modern general practice in the bridge fabrication and construction industry. Conduct stressing, flame cutting and planning carefully and accurately. Pay particular attention to the neatness and uniformity of finish of all parts of the work exposed to view.

.12 Transport structural steel components in such a manner so as to avoid development of fatigue cracks and deformation. When the components are stored on the job site, place on timbers so that they do not make contact with the ground and are supported to avoid fatigue cracking, deformation or over-stressing. Store in a location where they will not be subjected to damage or surface contamination.

.13 Steel coating: see Section 09 97 13.

.14 Bird spikes: 600mm long stainless steel bird spikes fastened to girder assemblies by mechanical means at locations and extents indicated on Contract Drawings.

2.2 SOURCE QUALITY CONTROL

.1 Provide the Engineer prior to fabrication, with two (2) copies of steel producer certificates, in accordance with CSA G40.20/G40.21.

.2 Have welding performed by companies certified by the Canadian Welding Bureau (CWB) in accordance with the requirements of CSA W47.1, Division 1.

.3 Have fabrication performed by a CISC Quality Certified Fabricator for steel bridges. Provide a copy of the certificate upon request by the Engineer.

.4 The acceptance criteria for all welding inspections will be based on CSA W59, Section 12, Dynamic Steel Structures.
.1 Visually inspect all welds. All full penetration welds, except those specified in

webs, must be 100% inspected by Radiographic or Ultrasonic methods. When welds are tested by the Ultrasonic method, perform spot Radiography on 10% of those welds tested.

.2 Inspect full penetration welds in webs by Radiographic or Ultrasonic methods for at least 25% of the weld length. Perform the inspection nearest the tension flange. If defects are identified, conduct additional inspections to determine the extent of these defects. Consider the bottom 1900mm of web the web tension zone for all sections of girders.

.3 Web-to-flange fillet welds will be subject to magnetic particle inspection in accordance with the following:

.1 Submerged arc welds: 25 percent of length.

.2 Semi-automatic welds: 50 percent of length.

.3 Manual welds: 100 percent of length.

.4 Fillet welds for attaching gusset plates, diaphragms and stiffeners must have 25 percent of the total weld length tested by magnetic particle inspection.

.5 Test all gusset plates and stiffeners for attaching diaphragms and/or bracing for 100 percent of the weld length, for the bottom 1900mm of web and the bottom tension flange.

.5 Provide the Engineer with two (2) copies of certified test reports for Charpy V-notch tests.

.6 Provide suitable facilities and cooperate with inspection organization and the Engineer in carrying out inspection and tests required.

PART 3 - EXECUTION

3.1 ERECTION

.1 Clean steel surfaces to the Engineer’s approval when staining or defacing occurs.

.2 Verify location of substructure units, elevations of bearing seats and location of anchor bolts before erection of structural steel; report discrepancies to the Engineer.

.3 Do not disturb river banks or embankments

without prior written permission of the Engineer.

.4 Before erection of structural steel, verify location of substructure units, elevation of bearing seats and location of anchor bolts. Immediately report any discrepancies to the Engineer.

.5 Restrict drifting during assembly to minimum required to bring parts into position without enlarging or distorting holes, and without distorting, kinking or sharply bending metal of any unit.
.1 Enlarge holes if necessary by reaming only after written approval is obtained from the Engineer.
.2 Reamed holes not to exceed size of bolt used by more than 2 mm.

.6 Fabricate and install bearings as indicated. Do not fasten and grout bearings and anchor bolts into final position on beam seats until girders in place and bearings are properly aligned beneath centerline of bearing points on girders.

.7 Place anchor bolts to elevations and locations indicated.
.1 Protect holes against entry of water and foreign material.
.2 Provide heating and protection as directed by the Engineer and completely fill space around anchor bolts with grout.

.8 Have the fabricator erect the whole of the fabricated structural steel work supplied under the Contract. Supply all materials, tools, equipment, plant and labour necessary for the erection of the steel work. Have the fabricator erect the structural steel in accordance with the requirements of the AASHTO specification and CSA-S6 specifications.

3.2 INSTALLATION

.1 Do falsework in accordance with CSA S269.1, except where specified otherwise.

.2 Do fabrication and erection of structural steel in accordance with CAN/CSA-S6, Design of Highway Bridges and AASHTO Standard

Specifications for Highway Bridges.

.3 Do welding in accordance with CSA W59, except where specified otherwise.
.1 For CSA G40.20/G40.21, grade 350WT steel, deposited weld metal to have Charpy V-Notch value not lower than that of steel.
.2 Do welding in shop unless otherwise permitted by the Engineer.
.3 Weld only at locations indicated.

.4 High strength bolting: in accordance with CAN/CSA-S6 and CAN/CSA S16. Use 'turn-of-nut' tightening method to bring bolts to the slip critical condition.

.5 Finish: members true to line, free from twists, bends, open joints, sharp corners and sharp edges.

.6 Allowable tolerance for bolt holes:
.1 Matching holes for bolts to line up so that dowel 2 mm less in diameter than hole passes freely through assembled members at right angles to such members.
.2 Finish holes not more than 2 mm in diameter larger than diameter of bolt unless otherwise specified by the Engineer. Holes shall be drilled (not punched) at all field splice and end diaphragm connection locations.
.3 Centre-to-centre distance between any two (2) holes of group to vary by not more than 1 mm from dimensioned distance between such holes.
.4 Centre-to-centre distance between any two groups of holes to vary not more than following:

Centre-to-Centre distance in metres	Tolerance in plus or minus mm
less than 10	1
10 to 20	2
20 to 30	3

.5 Correct mis-punched or mis-drilled members only as directed by the Engineer.

.7 Span length tolerances:
.1 Girders and beams: plus or minus 6 mm
.2 Centre-to-centre of bearing stiffeners and bearing plates: plus or minus 3 mm.

.8 Girder support requirements:
.1 Support top and bottom flanges of ends of girders and intermediate bearing locations of continuous girders parallel to each other at girder webs.
.2 Install flat and smooth except as otherwise indicated.
.3 Install bearing stiffeners after girder support requirements have been met.
.4 Do not machine or grind flanges of girders to correct irregularities unless permitted by the Engineer.

.9 Shop splices:
.1 Use complete joint penetration groove welds finished flush.
.2 Details of butt joints to CSA W59.
.3 Use only as approved by the Engineer.

.10 Camber:
.1 Camber tolerances for plate girders to be in accordance with CSA S6.
.2 Record measurements of camber of each girder, at points indicated.
.3 Fabricate field splices to conform to required camber.
.4 Submit diagram to the Engineer showing camber for each girder fabricated.
.5 Advise the Engineer immediately when camber of fabricated girder is not within specified tolerances.
.6 Submit proposal for corrective measures.
.7 Do not undertake remedial measures until proposal has been approved by the Engineer.
.8 Verify stud length requirements based on as-built girder cambers.

.11 Shop erection:
.1 Support each girder on its bearing points and measure and record deflection at same points indicated for measurement of camber.
.2 Measure deflections in plane of girder web.
.3 Submit diagram to the Engineer showing deflection measurements for each girder before delivery.
.4 Shop erection is not required for single span girders with no field splices.

.12 Field splices: as indicated on drawings.

Additional splices to approval of the Engineer.

.13 Mark members in accordance with CSA G40.20/G40.21.
.1 Do not use die stamping.
.2 Place marking at locations not visible from exterior after erection when steel is to be left in unpainted condition.

.14 Match marking: shop mark bearing assemblies and splices.

.15 Protect exposed concrete surfaces of substructures from staining due to weathering of unpainted steel as follows:
.1 Protect top surfaces of concrete with waterproof cover and drain away from vertical faces.
.2 Use galvanized anchors for anchorage to concrete.
.3 Submit details of installation and methods of support to the Engineer for review prior to commencing protection work.

.16 Detail bolts and install with threads excluded from shear planes.

.17 Stainless steel bird spikes shall be fastened to girder assemblies with chemical adhesive to manufacturer's standards and recommendations.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 03 30 00 - Cast-in-Place Concrete

.2 Section 05 12 33 - Structural Steel for Bridges

.3 Section 07 95 63 - Bearing Assemblies

.4 Section 09 97 13 - Steel Coating

1.2 REFERENCES

.1 American Society for Testing and Materials International, (ASTM)
.1 ASTM A53/A 53M-12, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Steamless.
.2 ASTM A269-15a, Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
.3 ASTM A307-14, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
.4 ASTM F3125/F3125M-15a, Standard Specification for High Strength Structural Steel Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi to 150 ksi Min. Tensile Strength.
.5 ASTM A123/A123M-17, Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.

.2 Canadian General Standards Board (CGSB)
.1 CAN/CGSB-1.40-97, Anti-corrosive Structural Steel Alkyd Primer.
.2 CAN/CGSB-1.181-92, Ready-Mixed, Organic Zinc-Rich Coating.

.3 Canadian Standards Association (CSA International)
.1 CAN/CSA-G40.20/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel.
.2 CAN/CSA-S16-14, Limit States Design of Steel Structures.
.3 CSA W47.1-09(R2014), Certification of Companies for Fusion Welding of Steel.
.4 CSA W48-14, Filler Metals and Allied Materials for Metal Arc Welding (Developed in co-operation with the Canadian Welding

Bureau).
.5 CSA W59-13, Welded Steel Construction (Metal Arc Welding) (Imperial Version).

.4 The Environmental Choice Program
.1 CCD-047a-98, Paints, Surface Coatings.
.2 CCD-048-98, Surface Coatings - Recycled Water-borne.

1.3 SUBMITTALS

.1 Product Data:
.1 Submit manufacturer's printed product literature, specifications and data sheet in accordance with the PEITIE Department of Transportation, Infrastructure and Energy's General Provisions and Contract Specifications for Highway Construction.
.2 Submit two copies of WHMIS MSDS - Material Safety Data Sheets in accordance with PEITIE Department of Transportation, Infrastructure and Energy's General Provisions and Contract Specifications for Highway Construction. Indicate VOC's:
.1 For finishes, coatings, primers and paints.

.2 Shop Drawings
.1 Submit shop drawings in accordance with the PEITIE Department of Transportation, Infrastructure and Energy's General Provisions and Contract Specifications for Highway Construction.
.2 Indicate materials, core thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.

1.4 QUALITY ASSURANCE

.1 Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.

.2 Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

.3 Have welding performed by companies certified by the Canadian Welding Bureau (CWB) in accordance with the requirements of CSA W47.1, Division 1.

.4 Have fabrication performed by a CISC Quality Certified Fabricator for steel bridges. Provide a copy of the certificate upon request by the Engineer.

.5 Pre-installation Meetings: Conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, Shipping, Handling and Unloading:
.1 Deliver, store, handle and protect materials from damage.

1.6 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with the PEITIE Department of Transportation, Infrastructure and Energy's General Provisions and Contract Specifications for Highway Construction.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Steel sections and plates: to CAN/CSA-G40.20/G40.21, Grade 350W.

.2 Welding materials: to CSA W59.

.3 Welding electrodes: to CSA W48 Series.

.4 Bolts and anchor bolts: to ASTM F3125/F3125M.

.5 Grout: non-shrink, non-metallic, flowable, 15 MPa at 24 hours.

2.2 FABRICATION

.1 Fabricate work square, true, straight and accurate to required size, with joints closely fitted and properly secured.

.2 Where possible, fit and shop assemble work, ready for erection.

.3 Ensure exposed welds are continuous for length of each joint. File or grind exposed welds smooth and flush.

2.3 FINISHES

.1 Galvanizing: hot dipped galvanizing with zinc coating 720 g/m² to ASTM A123/A123M.

.2 Shop coat primer: to CAN/CGSB-1.40.

2.4 SHOP PAINTING

.1 Apply one (1) shop coat of primer to metal items, with exception of galvanized or concrete encased items.

.2 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.

.3 Clean surfaces to be field welded; do not paint.

PART 3 - EXECUTION

3.1 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 the Engineer such as dowels, anchor clips, bar anchors, shear studs, expansion bolts and shields, and toggles.

.4 Exposed fastening devices to match finish and be compatible with material through which they pass.

.5 Provide components for building by other sections in accordance with shop drawings and schedule.

.6 Make field connections with bolts to CAN/CSA S16.1, or weld.

.7 Hand items over for casting into concrete to appropriate trades together with setting

templates.

.8 Touch-up field welds, bolts and burnt or scratched surfaces after completion of erection with primer.

.9 Touch-up galvanized surfaces with zinc rich primer where burned by field welding or damaged.

3.2 CLEANING

.1 Perform cleaning after installation to remove construction and accumulated environmental dirt.

.2 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED WORK

.1 Section 03 30 00 - Cast-in-Place Concrete

.2 Section 03 30 51 - Precast Concrete for Bridge Deck

1.2 REFERENCES

.1 NCHRP 244, Condition Evaluation of Concrete Bridges Relative to Reinforcement Corrosion, Volume 5: Methods of Evaluating the Effectiveness of Penetrating Sealers.

1.3 WASTE MANAGEMENT

.1 Separate waste materials for disposal in accordance with PEITIE Department of Transportation, Infrastructure and Energy's General Provisions and Contract Specifications for Highway Construction.

.2 Remove from site and dispose of packaging materials at appropriate recycling facility.

.3 Do not dispose of unused sealer material into any waterway, on to the ground or in other locations where it will pose health or environmental hazard.

.4 Divert unused sealer material from landfill to official hazardous material collections site approved by the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Clear penetrating silane sealer to be a clear water repellant silane sealer which prevents water and chloride intrusion into the concrete and conforms to the following requirements:
.1 Penetration into concrete: 3 - 6mm.
.2 Surface appearance: no visual change after application.
.3 Water vapour transmission: 100% transmitted (NCHRP 244).
.4 Chloride apsorption reduction: 80% improvement over control.
.5 Water adsorption: 90% improvement over control (NCHRP 244).

PART 3 - EXECUTION

3.1 APPLICATION

.1 Apply clear penetrating sealant to top surface of concrete bridge deck.

.1 Do not apply if surface ambient temperature is 4°C or below or when humidity is over 90%.

.2 Apply to manufacturer's recommendations.

.2 Bridge:

.1 Apply concrete coating to tops and sides of traffic barriers and crash blocks, outside edges of the bridge deck for the full length of the bridge; underside of the bridge deck from the exterior girder lines to the outside edges of the bridge only (each side of deck, full length of the bridge); and exposed surfaces of wingwalls, abutments and piers, projecting down 600mm (min) below finished grades. Apply the coating along the exterior edge of the deck and curbs, with the coating terminated at the top edge of the 25 x 25 chamfer at the top of the curbs, leaving the top surface and inside edge of both the narrow and wide curbs uncoated.

.2 Do not apply if rain is imminent.

.3 Surface ambient temperature must not be less than 7°C or above 32°C during 24 hours after the application.

.4 Fresh concrete must be cured for ten days prior to application.

.5 Install to manufacturer's recommendations.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 03 30 00 - Cast-in-Place Concrete

1.2 REFERENCES

.1 ASTM C719-14, Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle).

.2 ASTM C793-05(R2017), Standard Test Method for Effects of Laboratory Accelerated Weathering on Elastomeric Joint Sealants.

.3 ASTM D1475-13, Standard Test Method For Density of Liquid Coatings, Inks, and Related Products.

.4 ASTM D7116-16, Standard Specification for Joint Sealants, Hot Applied, Jet Fuel Resistant Types, for Portland Cement Concrete Pavements.

.5 Down Corporate Test Method 0098.

.6 Dow Corporate Test Method 0208.

.7 MIL-2-8802, Sealing Compound.

1.3 SUBMITTALS

.1 Submit product data in accordance with PEITIE Department of Transportation, Infrastructure and Energy’s General Provisions and Contract Specifications for Highway Construction.

.2 Submit samples in accordance with PEITIE Department of Transportation, Infrastructure and Energy’s General Provisions and Contract Specifications for Highway Construction.

.3 Submit manufacturer's instructions in accordance with PEITIE Department of Transportation, Infrastructure and Energy’s General Provisions and Contract Specifications for Highway Construction.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, handle, store and protect materials to prevent damage to packaging.

.2 Deliver and store materials in original wrappings and containers with manufacturer's seals and labels, intact. Protect from freezing, moisture, water and contact with ground or floor.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for disposal in accordance with PEITIE Department of Transportation, Infrastructure and Energy's General Provisions and Contract Specifications for Highway Construction.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Unused sealant material must not be disposed of into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.

.4 Divert unused joint sealing material from landfill to official hazardous material collections site approved by Departmental Representative.

.5 Empty plastic joint sealer containers are not recyclable. Do not dispose of empty containers with plastic materials destined for recycling.

.6 Fold up metal banding, flatten, and place in designated area for recycling.

1.6 PROJECT CONDITIONS

.1 Environmental Limitations: conform to manufacturer's written instructions.

.2 Substrate Conditions:
.1 Do not proceed with installation of materials until contaminants capable of interfering with adhesion are removed from substrates.

1.7 ENVIRONMENTAL REQUIREMENTS

.1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials; and regarding labelling and provision of Material Safety Data Sheets (MSDS) acceptable to Labour

Canada.

.2 Conform to manufacturer's recommended temperatures, relative humidity, and substrate moisture content for application and curing of sealants including special conditions governing use.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Two component, 100% silicone rubber sealant designed to seal joints and accommodate typical thermal movements to the following requirements:

Test Method	Test	Value
As Supplied		
MIL-2-8802	Extrusion Rate, g/min	200-550
ASTM D1475	Specific Gravity	1.25-1.35
As Installed -	at 25°C (77°F) and 50 percent RH	
CTM² 0093	Skin-Over Time, minutes, maximum	20
CTM 0208	Non-Volatile Content, percent minimum	93
ASTM D3585	Joint Elongation, percent minimum	600
ASTM D3583	Joint Modulus at 100 percent, psi (kPa)	3-12 (21-83)
	Joint Cure Rate, percent of total cure, hours	
	50 percent	4-6
	75 percent	24
	100 percent	48-160
Performance		
ASTM C719	Movement, 10 cycles at +100/-50 percent, joints 1-3" (25.4-76.2mm) wide	Pass
ASTM D793	Accelerated Weathering at 5,000 hours	No cracks, blisters or bond loss

PART 3 - EXECUTION

3.1 JOINT SEALANT APPLICATION

.1 Apply sealant to the following:
- .1 Between deck slab thickening and abutment.
- .2 Between approach slab bridge deck.
- .3 Between approach slab and wingwalls.
- .4 Between bridge deck curb and curb on approach slab.

.2 Clean bonding joint surfaces of harmful matter substances including dust, rust, oil grease, and other matter which may impair Work.

.3 Make joint surfaces are dry and frost free.

.4 Prepare surfaces in accordance with manufacturer's directions.

.5 Apply sealant to manufacturer's instructions.

.6 Curing: to manufacturer's recommendations.

.7 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.

3.2 WARRANTY

.1 Products applied under this Section shall include a three-year performance warranty beyond the manufacturer's normal one-year warranty.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 03 30 00 - Cast-in-Place Concrete

1.2 REFERENCES

.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
.1 Material Safety Data Sheets (MSDS).

.2 Transport Canada (TC)
.1 Transportation of Dangerous Goods Act, 1992 (TDGA).

1.3 SUBMITTALS

.1 Submit product data and samples in accordance with PEITIE Department of Transportation, Infrastructure and Energy’s General Provisions and Contract Specifications for Highway Construction.

.2 Submit manufacturer's instructions in accordance with the PEITIE Department of Transportation, Infrastructure and Energy’s General Provisions and Contract Specifications for Highway Construction.
.1 Instructions to include installation instructions for each product used.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, handle, store and protect materials to prevent damage to packaging.

.2 Deliver and store materials in original wrappings and containers with manufacturer's seals and labels, intact. Protect from freezing, moisture, water and contact with ground or floor.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for disposal in accordance with PEITIE Department of Transportation, Infrastructure and Energy’s General Provisions and Contract Specifications for Highway Construction.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Unused sealant material must not be disposed

of into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.

.4 Divert unused joint sealing material from landfill to official hazardous material collections site approved by the Engineer.

.5 Empty plastic joint sealer containers are not recyclable. Do not dispose of empty containers with plastic materials destined for recycling.

.6 Fold up metal banding, flatten, and place in designated area for recycling.

1.6 PROJECT CONDITIONS

.1 Environmental Limitations: conform to manufacturer's written instructions.

.2 Substrate Conditions:
.1 Do not proceed with installation of materials until contaminants capable of interfering with adhesion are removed from substrates.

1.7 ENVIRONMENTAL REQUIREMENTS

.1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials; and regarding labelling and provision of Material Safety Data Sheets (MSDS) acceptable to Labour Canada.

.2 Conform to manufacturer's recommended temperatures, relative humidity, and substrate moisture content for application and curing of sealants including special conditions governing use.

1.8 WARRANTY

.1 Products applied under this Section to include a three-year performance warranty beyond the manufacturer's normal one-year warranty.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Total movement required: 42mm.

.2 Joint to be a preformed compression seal that meets the following properties:

PROPERTIES	TEST METHODS	REQUIREMENT
Tensile Strength, min	ASTM D412	13.8 MPa
Elongation at Break, min	ASTM D412	250%
Hardness, Shore A	ASTM D2240	55 ± 5
Oven Aging, 70 hrs at 100°C	ASTM D573	
Tensile Strength, loss, max		20%
Elongation, loss, max		20%
Hardness, Shore A		0 to 10
Oil Swell, 70 hrs at 100°C	ASTMD471	
Weight change, max		45%
Ozone Resistance, 70 hrs at 40°C	ASTM D1149	No cracks
Temperature recovery	ASTM D3542	
72 hrs at -10°C, 50%, Deflection, min		88%
22 hrs at -29°C, 50%, Deflection, min		83%
70 hrs at 100°C, 50%, Deflection, min		85%

.3 Adhesive: to manufacturer’s recommendations and meeting ASTM D4070.

PART 3 - EXECUTION

3.1 PROTECTION

.1 Protect installed Work of other trades from staining or contamination.

3.2 JOINT SEALANT APPLICATION

.1 Clean bonding joint surfaces of harmful matter substances including dust, rust, oil grease, and other matter which may impair Work.

.2 Make joint surfaces are dry and frost free.

.3 Prepare surfaces in accordance with manufacturer's directions.

.4 Apply adhesive to manufacturer's instructions.

.5 Install compression seal in one continuous length. Splices are not allowed.

.6 Curing: to manufacturer's recommendations.

.7 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

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 03 30 00 - Cast-in-Place Concrete

.2 Section 05 12 33 - Structural Steel for Bridges

1.2 REFERENCES

.1 ASTM A167-99(2009), Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

.2 ASTM A240/A240M-17, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

.3 ASTM B36/B36M-13, Standard Specification for Brass Plate, Sheet, Strip, And Rolled Bar.

.4 ASTM B121/B121M-16, Standard Specification for Leaded Brass Plate, Sheet, Strip, and Rolled Bar.

.5 ASTM D4894-15, Standard Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials.

.6 ASTM D4895-16, Standard Specification for Polytetrafluoroethylene (PTFE) Resin Produced From Dispersion.

.7 CAN/CSA-S6-14, Canadian Highway Bridge Design Code.

.8 CAN/CSA G40.21M-13, General requirements for rolled or welded structural quality steel/ Structural quality steel

.9 CSA G189-1966(R2003), Sprayed Metal Coatings for Atmospheric Corrosion Protection.

.10 CSA W59-13, Welded Steel Construction (Metal Arc Welding).

1.3 SUBMITTALS

.1 Submit in writing, a minimum of thirty (30) days in advance of installation, the name of the manufacturer supplying the bearings, including manufacturer's part number and the

physical dimensions of bearings.

.2 Submit shop drawings in accordance with the PEITIE Department of Transportation, Infrastructure and Energy's General Provisions and Contract Specifications for Highway Construction and including as a minimum the following:
.1 Total bearing dimensions.
.2 Part numbers for bearings.
.3 Maximum load capacity.
.4 Load capacity at serviceability limit states
.5 Rotational capacity of each bearing under maximum and minimum load.
.6 Compression stiffness.
.7 Maximum movement capacity.
.8 Installation details.
.9 Material properties of the bearing components and test procedures employed to determine the properties.
.10 All welds and necessary connections of bearing components.

.3 Submit in advance of installation the manufacturer's certification that materials supplied meet the specified requirements of these specifications.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 All materials must conform to the requirements of CAN/CSA-S6.

.2 Bearings to be of an approved type sufficient to provide as a minimum, the loading and movement capacities indicated in the Contract Documents.

.3 Steel: in accordance with CAN/CSA G40.21M, Grade 350W.

.4 Stainless steel is type 304 as per ASTM A240 and A167, bright annealed Grade 4 or mirror finished Grade 8.

.5 Teflon (polytetra fluoroethylene, PTFE) 100% virgin, 15% glass filled reinforced or 25% carbon fiber filled reinforced in accordance

with ASTM D4894 or D4895.

.6 Sealing rings to be made from brass that complies to ASTM B36/B36M half hard (for rings of rectangular cross sections) and ASTM B121, Composite 2 for rings of circular cross sections.

.7 Bearing pressure, compressive deflections, rotation and shear deformations must conform to the limits as specified in CAN/CSA-S6.

2.2 FABRICATIONS

.1 Dimensions of the bearings to be as indicated on the Drawings. Have bearing sizes confirmed by the Supplier so they conform to the requirements of CAN/CSA-S6; design highway live load to be CL625. Bearing details and dimensions are based on assumed dimensions. If dimensions of actual bearing assembly is different than those shown on the design drawings, upon approval by the Engineer make adjustments as required to maintain finished road elevations and proper clearance for the bearing assemblies.

.2 Bearings are to be fabricated to be replaceable.

.3 All exposed steel surfaces of bearing assemblies must be hot dip galvanized in accordance with ASTM A123 with minimum zinc coating of 720 g/m² or metallized in accordance with CSA G189.

.4 Mark each bearing with the date of manufacture and an individual alphanumeric identification.

.5 The pot must be deep enough for the seal and piston rim to remain in full contact with the vertical face of the pot wall.

.6 Provision for rotation about any horizontal axis to be by deformation of the elastomer. Limit the rotation of the elastomer about a horizontal axis so that the vertical strain induced at the perimeter of the elastomer at SLS does not exceed 15% of the elastomer thickness. Load a pot bearing with at least 25% of the SLS load capacity in order to provide satisfactory rotational operation.

.7 The induced eccentricity, e, as a result of shifting of the axial load from the centre of the bearing under the maximum rotation at SLS must not exceed 4% of the diameter of the elastomer.

.8 The average pressure on the elastomer at SLS must not exceed 40 MPa. Treat surfaces of the elastomer with a lubricant that is not detrimental to the elastomer.

.9 Sealing rings:

.1 General: use a seal between the pot and the piston. At SLS, the seal must be designed to prevent escape of elastomer under compressive load and simultaneously applied cyclic rotations. At ULS, it must also be sufficient to prevent escape of elastomer under the compressive load and simultaneously applied static rotation. These requirements will be deemed satisfied if the sealing rings meet the requirements below:

.1 Rings with rectangular cross-section:

.1 When the cross section of the rings is rectangular, use three rings. Each ring must be circular in plan and cut at one point around its circumference. Faces of the cut to be bevelled at 45° to the vertical. Orient the rings so that the three cuts are equally spaced around the circumference of the pot.

.2 The width of each ring must be equal to or greater than the larger of 0.02 internal diameter of the pot and 6mm, but not exceed 20mm. The depth of each ring must be equal to or greater than the larger of 0.2 times the width and 1mm.

.2 Rings with circular cross-section:

.1 When the cross section of the rings is circular, use one circular closed ring with an outside diameter equal to the internal diameter of the pot. It must have a cross-sectional diameter equal to or greater than the larger of 0.0175 the internal diameter of the

pot and 4mm.

.10 Pot:

.1 Pot to consist of a wall and a base. Design all of the components of the pot to act structurally as a single unit.

.2 The thickness of the base must be equal to or greater than the larger of 0.06 the internal diameter of the pot and 20mm when bearing directly on concrete or grout, and equal to or greater than the larger of 0.04 the internal diameter of the pot and 15mm when bearing directly on steel girders or load distribution plates.

.3 At ULS, the pot wall must be thick enough to resist all induced forces. In lieu of rigorous analysis, this requirement may be satisfied for unguided sliding pot bearings by using a wall thickness specified in CAN/CSA-S6.

.11 Piston:

.1 Piston to have the same plan shape as the inside of the pot. Piston to be thick enough to resist the loads imposed on it, but not less than 0.06 the internal diameter of the pot.

.2 The perimeter of the piston must have a rim through which horizontal loads can be transmitted. Diameter of the piston rim to be smaller than the internal diameter of the pot by 0.5 to 1.25mm. Set the piston perimeter above the rim back or taper to prevent binding. The height of the piston rim must be large enough to transmit the horizontal forces between the pot and the piston as specified in CAN/CSA-S6.

2.3 TOLERANCES

.1 Bearing tolerances must be as indicated in the following table:

Bearing Tolerances

Bearing Thickness	</-40mm	-0mm to +3mm
Bearing Thickness	>40mm	-0mm to +6mm
Bearing plan dimension		-0mm to +6mm

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install bearings accurately with respect to the location and elevation, on level and smooth bearing surfaces where indicated on the Drawings.

.2 Adjust bearing plinth elevations when bearing thickness varies from the reference bearing thickness shown on the Drawings.

.3 Tolerance for top of bearing elevations shall be as indicated in the table below:

Tolerance for Top of Bearing Elevations

Structure Type	Top of Bearing Elevation
Concrete Structures	+2.5mm
Steel Structures	+3.0mm
Box Girders	+2.0mm
Deviation from Level	±0.1°

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 05 12 33 - Structural Steel for Bridges

.2 Section 05 50 00 - Metal Fabrications

1.2 REFERENCES

.1 ASTM D269-97(R2015), Test Method for Insoluble Matter in Rosin and Rosin Derivatives.

.2 ASTM D4541-17, Test Method for Pull- Off Strength of Coatings Using Portable Adhesion-Testers.

.3 ASTM F3125/F3125M-15a, Standard Specification for High Strength Structural Steel Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi to 150 ksi Min. Tensile Strength.

.4 ASTM F2660-13, Standard Test Method for Qualifying Coatings for Use on A490 Structural Bolts Relative to Environmental Hydrogen Embrittlement.

.5 CGSB-GP-12C, Standard paint Colours, Parts 1 to 3.

.6 CGSB 1-GP-171M, Coating, Inorganic Zinc.

.7 CGSB 1-GP-180Ma, Coating, Polyurethane, Two Package, General Purpose.

.8 CGSB 164-GP-IMP, Leachate Extraction Procedure.

.9 CSA-S269.2-16, Access Scaffolding for Construction Purposes.

.10 SSPC, (Steel Structure Painting Council), Steel Structures Painting Manuals - Volumes 1 and 2, "Good Painting Practice" and "Systems and Specifications".

.11 SSPC-Guide 6, Guide for Containing Debris Generated During Paint Removal Operations, 2015.

.12 SSPC-Guide 7, Guide for the Disposal of Lead-Contaminated Surface Preparation Debris, 2015.

.13 SSPC Guide 10-2006, Joint Surface Preparation Standard: Near-White Metal Blast Cleaning.

.14 SSPC Paint 20-2004, Zinc-Rich Coating.

1.3 SUBMITTALS

.1 Submit three (3) copies of the following in accordance with the PEITIE Department of Transportation, Infrastructure and Energy's General Provisions and Contract Specifications for Highway Construction prior to the start of coating operations.
.1 Abrasive to be utilized along with manufacturer's specifications.
.2 Coating(s) to be utilized along with manufacturer's specifications.
.3 Material Safety Data Sheets for all products. MSDS must remain at the place of work at all times.

1.4 QUALITY CONTROL

.1 All material and equipment furnished and work done, will be subject to inspection by the Engineer. An appointed inspector must be permitted on the paint shop floor at any point during operations. Such inspection does not relieve any of the responsibility for furnishing the qualified labour, equipment, staging, etc., necessary to meet the requirements of this specification, or the safe accessibility to the work for the purposes of inspection.

.2 Keep accurate records containing details such as weather, temperatures, dew points and times for the various coating applications and shall make these records available to the Engineer upon request.

.3 Give at least 48 hours notice prior to work commencing. Coordinate activities with the Engineer to confirm all aspects of the work are inspected. Repair defective work not conforming to this specification at no additional cost to the Contract.

.4 Methods of inspection and inspection procedures to be as directed by the Engineer, who shall govern both methods and standards. All findings will be recorded and will become

part of the Project's Quality Assurance Records.

.5 Perform coating inspection in accordance with the procedures outlined in SSPC Manual, Volume 1, Chapter 5, "Inspection".

.6 Make profile measurements on a random basis by use of replica tape and spring micrometer or by micrometer depth gauge.

.7 Perform dry film coating thickness readings in accordance with SSPC-PA 2, "Measurement of Dry Paint Thickness with Magnetic Cages".

.8 When necessary, test the ambient and surface temperature and humidity by thermometer, surface thermometer and psychrometer with recognized psychometric tables.

.9 Destructive testing may be required where inadequate adhesion of the coating(s) is suspected. Do adhesion testing in accordance with ASTM D4541. Minimum adhesion of the coating under evaluation to be 1.7 MPa (250 psi). Repair coatings damaged as the result of destructive testing at no extra cost to the Contract. Have repair procedures and materials approved by the Engineer prior to application.

1.5 DELIVERY OF PRODUCT

.1 Supply coating materials in new condition. Package the two component coatings separately.

.2 Package coating components in proportions that are consistent with the manufacturer's normal method of packaging.

.3 Each container must bear a label which clearly shows the manufacturer's name or brand of coating, the lot number and date of manufacture.

PART 2 - PRODUCTS

2.1 COATING SYSTEMS

.1 Coatings applied to structural steel to consist of:
.1 Inorganic zinc primer plus high build modified aluminum epoxy mastic mid-coat plus

high build aliphatic polyurethane top coat in a selected colour.

.2 Application of coating systems: apply the inorganic zinc primer to the prepared metal surface by airless spray equipment or as recommended by the manufacturer. For new construction apply the inorganic zinc at the shop as well as the intermediate and top coats in the shop.

.3 Acceptable products: confirm the latest formulation of the proposed coating products to be utilized in the work satisfy the requirements of this specification. The primer and top coats must be compatible with each other and must be manufactured by the same company. All coating work and systems for the purpose of this specification will be considered a fully cured system prior to being accepted by the Engineer. No accelerators for the purpose of force curing the coating system will be accepted without prior written approval.

2.2 ETHYL SILICATE/ POTASSIUM ZINC-RICH PRIMER

.1 Inorganic zinc primer to be a two-component self-curing type which, when mixed and applied in accordance with the manufacturer's instructions, cures without the use of a separate curing solution, and has the properties described herein. The inorganic zinc primer must meet or exceed the requirements of Steel Structures Painting Council SSPC Paint 20 zinc rich primers (Type 1, inorganic).

.2 Pigment: zinc portion of the pigment to be a finely divided zinc powder containing, by weight, a minimum of 94% metallic zinc. All other fillers contained in the pigment must be inert substances with an average particle size of 6 microns.

.3 Vehicle: vehicle components to consist primarily of a partially hydrolyzed ethyl and or potassium silicate, in an appropriate hydrocarbon solvent. Storage life of the vehicle to be nine (9) months minimum at 25°C.

.4 Mixed coating: total zinc portion to be at

least 84% by dry weight of the total solids of the dried coating. Coating to tolerate up to 1% water contamination by weight without gelation, within five (5) minutes. The usable pot life of the mixed coating must be not less than four (4) hours at 25C. There must be no hard settling which cannot be easily re-dispersed during this period.

.5 Colour: inorganic zinc coating to be formulated so as to produce a distinct contrast in colour with the blast cleaned metal surfaces.

.6 Primer coating to be certified as a Class B coating for slip coefficient and creep resistance as per Appendix A of ASTM F3125 or ASTM F2660. Coat faying surfaces with the Class B primer coating as outlined in ASTM F3125/3125M or ASTM F2660.

2.3 HIGH BUILD MODIFIED ALUMINUM EPOXY MASTIC

.1 Coating to be a self-priming, two- component, high build, aluminum filled epoxy mastic. The coating must be compatible with inorganic zinc primers, catalyzed epoxies, catalyzed phenols or other coatings as recommended by the coating manufacturer. The coating must also be compatible for use over most generic types of coatings which are tightly adhering and properly prepared.

.2 Solids by volume of the coating, when mixed, to be 90.2% when tested in accordance with ASTM D269, total pigment by weight.

.3 Pigment: primary pigment to be aluminum and must represent a minimum of 17% of the total pigment by weight.

.4 Mixed coating: mixed coating must be capable of being top coated with most generic types of coatings after curing a minimum of 24 hours at 24°C. Final cure is attained after five (5) days minimum at 24°C. The pot life of the mixed coating must be a minimum of 4 hours when the material and ambient temperature are 24°C and the material has been thinned according to manufacturer's recommendations. The coating must be capable of being applied when the material is at a temperature as low

as 10°C.

2.4 HIGH BUILD ALIPHATIC POLY-URETHANE FINISH COAT

.1 High build aliphatic polyurethane finish coat to be a two component, high solids, high build, spray applied coating with a satin or semi-gloss finish that is highly resistant to weather, abrasion, corrosive fumes, splash and spillage of acids, alkalines, solvents, salts and water. It must provide adequate hiding when applied in a single coat directly over aluminum mastic and provide long term colour and gloss retention. The coating shall be compatible with inorganic zinc primers, catalyzed epoxies, catalyzed phenols or other overcoats, as recommended by the coating manufacturer. The coating must also be compatible to be applied over most generic types of coatings which are tightly adhering and properly prepared.

.2 Mixed coating: two components of the system to have a shelf life of 12 months minimum. The pot life for the mixed material will be four hours at 24°C.

.3 Finish coat colour to be light grey. Provide colour chip to the Engineer prior to executing work.

.4 Apply the finish coat on girders in the shop. All touch-ups carried out in the field are to be colour matched to the satisfaction of the Engineer. If the touch-up colour match cannot be achieved, re-apply the entire finish coat in the field at no additional expense to the Contract.

.5 Complete all field coating activities within an appropriate containment system to prevent materials from falling or spilling into the waterways or land area surrounding the structure.

2.5 BLAST MEDIA

.1 Abrasive blast media to be clean and sharp silica sand, washed industrial sand, steel grit, or a slag material of suitable size, weight and angular shape to produce the degree of cleaning specified and anchor pattern/ profile required. The blast media must contain

no more than 1% by weight of water soluble solids. There must be less than 10 ppm oil in the abrasive and no trace of salts or toxic material. When cleaning by air blasting with sand abrasives, provide adequate separators and traps to remove detrimental amounts of water and oil from the compressed air before it reaches the nozzle.

.2 Dispose materials unsuitable for use in the work off-site in an approved manner at no additional cost to the Contract. Re-claimed abrasive material will not be acceptable with the exception of steel grit.

PART 3 - EXECUTION

3.1 GENERAL

.1 Shop coat all steel girders.

.2 Paint shops or fabrication shops where painting is performed must be well lit, free of dust and maintained at the correct temperature and relative humidity for the coating being applied.

.3 Coating systems to be as detailed in these specification. The manufacturer's data sheets are part of this specification. Should there be any conflict between these two specifications, the decision of the Engineer will prevail.

.4 All surfaces to be coated must be free from contamination prior to any application. Do not carry out any coating work when the surface is less than 3°C above the dew point, nor when it is likely that there will be a change in the conditions within four (4) hours of application that would be detrimental to the coating system. Apply coatings uniformly and without sags, foreign material, dust, contamination, cracks or other blemishes. Surface to be coated must be free of weld splatter, welding flux and cutting slag. Lightly grind all sharp corners and edges to a 1.0mm chamfer to break the sharp edge and make all holes free of burrs and cutting chips. Clean oil and grease with solvent to meet the requirements of SSPC SP-1 prior to blasting

cleaning in preparation for coating. Remove defects and repair to the satisfaction of the Engineer.

.5 Arrange for shop visits from the coating manufacturer's technical representative a minimum of one (1) visit per month while the job is in progress. For projects scheduled for completion in less than one month, have the manufacturer's representative arrange to visit the site at least once. After each visit, have the manufacturer's representative provide a written report to the Engineer within five (5) working days.

.6 All coating work and systems for the purpose of this specification will be considered a fully cured system prior to being accepted by the Engineer. No accelerators for the purpose of force during the coating system will be accepted without prior written approval. Do not apply coating when the building openings create wind gusts in excess of 15 km per hour unless it can be demonstrated to the Engineer that adequate precautions have been made available which are acceptable to the Engineer. The decision of the Engineer will be final.

3.2 SURFACE PREPARATION

.1 Equipment: abrasive blast cleaning equipment to be of a quality and size sufficient to perform the work within the time available in the contract. Abrasives used in the Work must be free of chlorides and other contaminants which could affect the coating being applied and must produce the anchor pattern required by the coating system. Blast equipment must have adequate in line "driers" to ensure moisture is completely removed during blasting operations. Ground spray and blasting equipment to avoid build-up of static electricity. Remove detrimental amounts of water and oil from any compressed air supply suited for blast cleaning by means of appropriate functional traps, separators and heaters before the airstream reaches the nozzles.

.2 Blast clean all surfaces to meet the requirements of SSPC SP10 which is a surface

free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products and other foreign matter. The surface roughness of the cleaned surface must be from 5 to 15µm. Do not apply paint until the Engineer has inspected and accepted the cleaned surface. Surfaces which have been painted without the acceptance of the cleaning by the Engineer must have the paint removed by blast cleaning and must be accepted by the Engineer before it can be re-painted.

.3 Steel surface profile requirements to be a minimum 20% of the total film thickness specified, or as recommended by the coating manufacturer to achieve good coating adhesion and coverage.

.4 Do not paint the tops of girder top flanges.

.5 Only shop prime the interior of girders, splice plates and within 200mm of edges of field splice plates on girders. Mid and top coats to exterior splice locations to be field applied.

3.3 REPAIR OF DEFECTS

.1 Before application of any further coat of material, repair all damage and/or contamination to previous coats to the approval of the Engineer. In the case of repair, the procedures must be in an acceptable manner as approved by the Engineer. In the case of removal, replace the work by work and materials which conform to the specification. This clause will have full effect regardless of the fact that the defective work may not have been previously identified by the Engineer.

3.5 ENVIRONMENTAL AND SAFETY CONTROLS

.1 Protect and preserve the environment during the progress of the Work in conformance with the Guidelines for the "Application and Removal of Structural Steel Protective Coatings".

.2 Provide protective enclosures and filters to contain dust or water in an effective manner and to minimize impacts from dust, water and coating particles entering the environment

when washing or removing coating.

.3 Do not dispose of waste materials (i.e., used coatings, solvents and refuse) in the aquatic environment, elsewhere on the highway or adjacent the right-of-way. Such material must be disposed of according with applicable legislation.

.4 Do all methods and materials for constructing the protective enclosure in accordance with regulatory agency requirements having jurisdiction.

3.6 PLATFORMS AND ENCLOSURES

.1 Where environmental protection is required, i.e., to protect the work piece or work place from the environment, or the environment from the work being performed. This includes, but not be limited to: tents, heating or ventilating, negative air pressure, dust collectors, enclosures, etc. Provide these at no additional cost to the Contract. For field operations, install a full (total) enclosure surrounding all washing, coating and surface preparation activities. Refer to SSPC Guide 6.

.2 The plans and drawing for the enclosure, submit scaffolds and platforms for review as detailed herein. Do not begin construction until all these documents have been reviewed. Drawings to include but not be limited to the following detailed information:
.1 Method and schedule of construction.
.2 Actual loads to be imposed on the existing structure.
.3 Details of proposed attachments to the existing structure.
.4 Size and shape of all platform components.
.5 Scaffold erection and dismantling diagrams.
.6 Material specifications and sources.
.7 Arrangement of access platforms, ladders and guardrail.

.3 Use access scaffolding and supporting platforms designed in accordance with the provisions of CSA-S269.2, the National Building Code of Canada and all relevant codes and standards referenced therein.

.4 At the conclusion of sandblasting and coating operations, dismantle the protective enclosure and remove from the site.

3.7 COATINGS APPLICATION

.1 Apply coatings in accordance with the manufacturer's written instructions.

.2 Shop apply coatings unless erection method increases the probability of coating damage (i.e. – launching).

.3 Field apply the final coatings at splice locations.

.4 Apply coatings as per the specified minimum and maximum film thicknesses. The nominal rate of application for the coating systems to have a minimum/maximum DFT of 250 - 400 m. Apply the inorganic zinc at 25-75 m, apply the aluminum epoxy mastic at 25-150 m DFT and the aliphatic polyurethane at 25-100 m DFT.

.5 Take all measurements concerning DFT by calibrating the Dry Film Gauge to read zero at the "top of the blasted profile". Measuring methods and equipment must conform to SSPC-PA2.

.6 For coating system, stripe coat all edges, corners, crevices, rivets, bolts, welds and sharp edges with the aluminum polyamide epoxy mastic prior to the steel receiving the final coat in accordance with the coating manufacturer's recommendations. Do striping with brushes, daubers, or mitts and extend a minimum of 2.5cm from the edge being coated. Provide brushes and daubers and use to work coatings into cracks, crevices and locations which cannot be adequately coated by spray application.

3.8 EXTENDED WARRANTY

.1 Provide a warranty for the coating system that expressly states the work will be free of defects in materials and workmanship for a period of 60 months from the date the work is accepted by the Engineer.

.2 During the warranty period, the Engineer will

inspect the coating system, and will advise the Contractor and Manufacturer, in writing, of any repairs that are required. Intermediate inspections may be made and warranty repairs claimed and repaired by the Contractor and Manufacturer each year of 60 months warranty period.

.3 Failure of the protective coating system may include but not be limited to:

.1 Any de-bonding or failure of adhesion of the coating either to the structural steel or other coatings.

.2 The appearance of any rust stains on the coated structure due to loss of coating or leaking from joints between structural members (staining from leaking expansion joints or from structural components not coated under the contract will be exempt from the provision of the warranty).

.3 Failure of the coating to resist chipping and abrasion from normal site conditions.

.4 Any loss of normal gloss or rapid colour change.

.4 Complete warranty repair within 45 days of notification, or if this would place repair in unsuitable weather conditions, by June 15 of the following year.

.5 Repairs under warranty must include all costs to supply material, labour and equipment necessary to restore the coating system to acceptable condition. Payment for warranty repairs will not be made separately, but will be included in the unit bid price for steel fabrication and steel erection.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 31 61 13 - Pile Foundations - General Requirements

.2 Section 31 62 16 - Steel Pipe Piles

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM)
- .1 ASTM A252-10, Standard Specification for Welded and Seamless Steel Pipe Piles.
- .2 ASTM A307-14E1, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile.
- .3 ASTM F3125/F3125M-15a, Standard Specification for High Strength Structural Steel Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi to 150 ksi Min. Tensile Strength.

.2 Canadian Standards Association (CSA International)
- .1 CAN/CSA-G40.20/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels.
- .2 CAN/CSA-S16-14, Design of Steel Structures.
- .3 CSA W47.1-09(R2014), Certification of Companies for Fusion Welding of Steel Structures.
- .4 CSA W48-14, Filler Metals and Allied Materials for Metal Arc Welding.
- .5 CSA W59-13, Welded Steel Construction (Metal Arc Welding) (metric version).

.3 Canadian General Standards Board (CGSB)
- .1 CAN/CGSB-1.171-98, Inorganic Zinc Coating.
- .2 CAN/CGSB-1.184-98, Coal Tar-Epoxy Coating.

.4 The Master Painters Institute (MPI)/Architectural Painting Specification Manual, (ASM-[February 2004]).
- .1 MPI #19, Inorganic Zinc Rich Primer.

.5 The Society for Protective Coatings (SSPC)
- .1 SSPC-SP 5/NACE No.1-2006, White Metal Blast Cleaning Joint Surface Preparation

Standard.

1.3 SYSTEM DESCRIPTION

.1 The design of pile templates and centralizers are the responsibility of the Contractor. Designs must be stamped by an Engineer licensed to practice in the Province of Prince Edward Island.

.2 Design Requirements: design templates to safely withstand following loads:
.1 Gravity loads to which template are subjected.
.2 Maximum lateral thrust of applied at top chord of batter pile guides.
.3 Lateral loads to firmly hold pile in position when driving.

1.4 SUBMITTALS

.1 Provide submittals in accordance with the PEITIE Department of Transportation, Infrastructure and Energy’s General Provisions and Contract Specifications for Highway Construction.

.2 Product Data: submit manufacturer's printed product literature, specifications and datasheet.
.1 Include product characteristics, performance criteria, and limitations.

.3 Submit shop drawings and indicate following items:
.1 Material.
.2 Anchorage, field control and alignment methods.
.3 Design parameters.
.4 Tolerance for driving pile.
.5 Removable members.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for disposal in accordance with the PEITIE Department of Transportation, Infrastructure and Energy’s General Provisions and Contract Specifications for Highway Construction.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Steel sections and plates: to CAN/CSA-G40.20/G40.21, Type 300W.

.2 Pile sleeves: to CAN/CSA-G40.20/G40.21.
.1 Fabricate vertical pile sleeves in two half-sleeves if approved by the Engineer.

.3 Welding materials: to CSA W48 and CSA W59.

.4 Bolts, nuts and washers: to ASTM F3125M.

2.2 FABRICATION

.1 Fabricate structural steel for templates: to CAN/CSA-S16.

.2 Welding: to CSA W59.

.3 Use welding companies qualified under CSA W47.1.

PART 3 - EXECUTION

3.1 PREPARATION

.1 Lining:
.1 Line inside surfaces of sleeves and pile guides with timber strips 25 mm thick or nylon roping 25 mm thick to provide protection to pile coating during driving operation.
.1 Show full details of linings and attachment on shop drawings.

.2 Painting:
.1 Prepare vertical sleeves of templates and other steel used for connection to piling for painting by blast cleaning to SSPC-SP 5/NACE No.1 and apply one coat of inorganic zinc and two coats of coal tar epoxy.

.3 Repairs:
.1 Repair damaged coatings with compatible material to approval of the Engineer.

3.2 POSITIONING

.1 Position and hold template in location to receive piles.
.1 Confirm pile positions are within tolerances specified.

.2 Before driving batter piles set templates to within 10 mm of elevations as shown on the drawings.

.3 Secure templates to vertical piles in accordance with shop drawings before batter piles are placed.

3.3 PLACING BATTER PILES

.1 Remove members in templates as necessary to place batter piles.

.1 Replace members prior to placing other batter piles or driving of batter piles.

.2 Indicate members to be removed for this operation on shop drawings.

.3 Mark them "Removable".

3.4 REMOVAL OF TEMPLATES

.1 Avoid damage to piling when removing templates.

.2 When instructed by the Engineer, remove templates from Project site.

3.5 CLEANING

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

3.6 PROTECTION

.1 Protect templates from damage.

.2 Repair damage to templates, formwork or concrete arising from operations as reviewed by the Engineer at no extra cost to the Contract.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 31 09 16 - Pile Driving Templates

.2 Section 31 61 13 - Pile Foundations - General Requirements

.3 Section 31 62 16 - Steel Pipe Piles

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM)
.1 ASTM D1143-07(R2013), Standard Test Method for Piles Under Static Axial Compressive Load.
.2 ASTM D4945-12, Standard Test Method for High-Strain Dynamic Testing of Piles.

.2 AASHTO T298-15, Standard Method of Test for High-Strain Dynamic Testing of Piles

1.3 SUBMITTALS

.1 Provide submittals in accordance with the PEITIE Department of Transportation, Infrastructure and Energy's General Provisions and Contract Specifications for Highway Construction.

.2 Quality assurance submittals:
.1 Test reports: submit three (3) copies of dynamic test reports for piles from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

3.1 GENERAL

.1 Notify the Engineer of pile driving operations at least seven (7) days in advance of work.

.2 If a pile is suspect of meeting refusal on a boulder and within the native soils, conduct Pile Driving Analyser (PDA) testing to confirm capacity.

.3 Supply and erect equipment and temporary structures necessary for making tests.

.4 The Engineer will to select piles for testing during performance of Work.

.5 Perform test in presence of the Engineer.

.6 Provide shelter, enclosures and lighting for observation, testing and recording of data.

.7 If PDA testing indicates that the design capacity is not obtained, remove the obstruction by drilling through pile, followed by drilling the pile to refusal in bedrock.

.8 Perform PDA tests on at least one (1) vertical and one (1) battered 508 dia. x 12.7 pipe pile in each abutment to ensure pile capacities noted on the Drawings are met.

.9 Perform PDA testing on at least one (1) vertical and one (1) battered pile on each side of the pier pile cap for a total of four (4) piles.

3.2 TESTING

.1 Do PDA testing in accordance with AASHTO T298.

3.3 TEST EVALUATION

.1 Have a qualified geotechnical engineer interpret results for predicting pile performance and capacity.

.2 Carry out additional load tests as directed by the Engineer if pile fails to sustain test load.

.3 Test validity will be determined by the Engineer.

3.4 CLEANING

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

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 31 09 16 - Pile Driving Templates

.2 Section 31 09 17 - Pile Tests

.3 Section 31 62 16 - Steel Pipe Piles

1.2 REFERENCES

.1 Joose Environmental Clyde River Geotechnical Report, Project JE0197 Issued on September 12, 2016 and supplemented on September 28, 2017, Project JE0252.

1.3 SUBMITTALS

.1 Provide submittals in accordance with the PEITIE Department of Transportation, Infrastructure and Energy’s General Provisions and Contract Specifications for Highway Construction.

.2 Sub-surface investigation report: when site conditions differ from those indicated, submit written notification to the Engineer and await further instructions.

.3 Submit schedule of planned sequence of driving to the Engineer for review, as specified.

.4 Spliced piles: when authorized, submit design details of splice complete with signature and stamp of qualified professional engineer registered or licensed in Province of Prince Edward Island, Canada. Design all splices of piles and construct as full-strength splices.

.5 Equipment:
.1 Submit prior to pile installation for review by the Engineer, list and details of equipment for use in installation of piles.
.2 Impact hammers: submit manufacturer's written data as specified.
.3 Non-impact methods; submit characteristics to evaluate performance.

.6 Submit driveability analysis as specified, to the Engineer for approval of hammers.

.7 Quality assurance submittals:
.1 Test reports: submit three (3) copies of

certified test reports for piles from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

.2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's instructions.

.2 Protect piles from damage due to excessive bending stresses, impact, abrasion or other causes during delivery, storage and handling.

.3 Replace damaged piles as directed by the Engineer.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for disposal in accordance with the PEITIE Department of Transportation, Infrastructure and Energy’s General Provisions and Contract Specifications for Highway Construction.

1.6 EXISTING CONDITIONS

.1 Sub-surface investigation report is available upon request.

.2 Notify the Engineer in writing if subsurface conditions at site differ from those indicated and await further instructions from the Engineer.

1.7 SCHEDULING

.1 Provide schedule of planned sequence of driving to the Engineer’s for review, not less than two weeks prior to commencement of pile driving. Undertake pile driving operations at time indicated on the Project Schedule.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Material requirements for piles are specified in Section 31 62 16.

.2 Supply or fabricate full length piles as indicated and provide equipment to handle full length piles without cutting and splicing.

.3 Splice piles only with written approval of the Engineer.

.1 When permitted, provide details for the Engineer review.

.2 Design details of splice to bear dated signature stamp of professional engineer registered or licensed in Province of Prince Edward Island, Canada.

2.2 EQUIPMENT

.1 Impact hammers: provide manufacturer's name, type, rated energy per blow at normal working rate, mass of striking parts of hammer, mass of driving cap and type and elastic properties of hammer and pile cushions.

.2 Non-impact methods of installation such as augering, jacking, vibratory hammers or other means are not acceptable unless approved by the Engineer. If approved, provide full details of characteristics necessary to evaluate performance.

.3 Hammer:

.1 Select hammers on basis of driveability analysis using wave equation theory, performed to show that piles can be driven to levels indicated.

.2 Driveability analysis to include, but not be limited to the following: hammer, cushion, and cap block details; static soil parameters; quake and damping factors, total soil resistance, blow count, pile stresses and energy throughput at representative penetrations.

.3 When required criteria cannot be achieved with the proposed hammer, use larger hammer and take other measures as required.

.4 Information on hammer requirements provided in Joose Environmental Clyde River Geotechnical Report, Project JE0197 Issued on September 12, 2016 and supplemented on September 28, 2017, Project JE0252.

PART 3 - EXECUTION

3.1 PREPARATION

.1 Protection:
.1 Protect adjacent structures, services and work of other sections from hazards due to pile driving operations.
.2 Arrange sequencing of pile driving operations and methods to avoid damages to adjacent existing structures.
.3 When damages occur, remedy damaged items to restore to original or better condition at own expense.

.2 Confirm ground conditions at pile locations are adequate to support pile driving operation and load testing operation.
.1 Make provision for access and support of piling equipment during performance of Work.

.3 Drive piles only when excavation has been completed.

.4 Pre-boring of holes may be acceptable to facilitate pile alignment control.

3.2 INSTALLATION

.1 Leads: construct pile driver leads to provide free movement of hammer.
.1 Hold leads in position at top and bottom, with guys, stiff braces, or other means reviewed by the Engineer, to ensure support to pile while being driven.
.2 Inclined leads to be used for battered piles.
.3 Length: provide sufficient length of leads to ensure that use of follower is unnecessary.
.4 Swing leads:
.1 Not permitted.

.2 Followers:
.1 Provide followers of such size, shape, length and mass to permit driving pile in desired location to required depth and resistance.
.2 Provide followers with socket or hood carefully fitted to top of pile to minimize loss of energy and prevent damage to pile.
.3 Drive applicable load test piles using similar follower.

.3 Ultimate design load capacity of pile is 1482kN in compression.

.4 Installation of each pile will be subject to review by the Engineer.
.1 The Engineer will be sole judge of acceptability of each pile with respect to final driving resistance, depth of penetration or other criteria used to determine load capacity.
.2 The Engineer to review final driving of all piles prior to removal of pile driving rig from site.

.5 Use open end drive shoes to protect all piles during driving.

.6 Drive each pile to refusal as per recommendation given in Joose Environmental Clyde River Geotechnical Report, Project JE0197 Issued on September 12, 2016 and supplemented on September 28, 2017, Project JE0252.
.1 If tip elevation various from the theoretical tip elevation, confirm refusal using PDA testing as directed by the Engineer.

.7 Drive each pile to practical refusal in bedrock.
.1 Do not overdrive to cause damage to piles in bedrock.
.2 The Engineer will determine refusal criteria for piles driven to rock based on type of pile and driving equipment.

.8 Drive each pile to pile tip elevation as indicated.

3.3 APPLICATION / DRIVING

.1 Use driving caps and cushions to protect piles.
.1 Reinforce pile heads as required by the Engineer.
.2 Piles with damaged heads as determined by the Engineer will be rejected.

.2 Hold piles securely and accurately in position while driving. The use of a driving template should be considered.

.3 Deliver hammer blows along axis of pile.

.4 Allow for no contact between pile and structure takes place when driving batter piles adjacent to existing structures.

.5 Do not drive batter piles until all vertical piles have been fully driven.

.6 Restrike already driven piles lifted during driving of adjacent piles to confirm set.

.7 Remove loose and displaced material from around piles after completion of driving, and leave clean, solid surfaces to receive foundation concrete.

.8 Use of water jet:
.1 If permitted, provide details for the Engineer review.
.2 Restriction: when conditions are unacceptable, as determined by the Engineer, stop using water jet.

.9 Cut off piles neatly and squarely at elevations as indicated to tolerance of plus or minus 5 mm.
.1 Provide sufficient length above cut-off elevation so that part damaged during driving is cut off.
.2 Do not cut tendons or other reinforcement, which will be used to tie pile caps to pile.

.10 Remove cut-off lengths from site on completion of work.

3.4 OBSTRUCTIONS

.1 Where obstruction is encountered that causes sudden unexpected change in penetration resistance or deviation from specified tolerances, notify the Engineer.

.2 The presence of cobbles in approach fills and adjacent existing abutment footings may require that obstructions be removed by drilling during pile driving operations. Drive all piles to refusal in bedrock.

3.5 FIELD QUALITY CONTROL

.1 Pile Driving Analyzer:
.1 Use Pile Driving Analyzer and Wave Equation Analysis to determine and confirm driving criteria.
.1 The Engineer will select piles.
.2 Work to be performed by geotechnical engineer registered or licensed to practice in the Province of Prince Edward Island, Canada.

.2 Prepare piles to be instrumented by drilling and tapping holes for installation of strain transducers and accelerometers, as directed by the Engineer.

.3 Provide assistance, as required, in instrumentation process during initial set-up and during test.

.4 Make allowance for probable interruption in driving for:
.1 Changing/modifying hammer, cap, cushions, or other equipment;
.2 Replacing/adjusting of transducers and accelerometers;
.3 Assessing of monitored results.

.5 Replace/adjust hammer and modify cap, cushions, and other equipment, as directed by the Engineer.

.6 Confirm the final set has been achieved, when instructed by re-striking instrumented piles as directed.

.7 Measurement:
.1 Maintain accurate records of driving for each pile, including:
.1 Type and make of hammer, stroke or related energy.
.2 Other driving equipment including water jet, driving cap, cushion.
.3 Pile size and length, location of pile in pile group, location or designation of pile group.
.4 Sequence of driving piles in group.
.5 Number of blows per metre for entire length of pile and number of blows per 25 mm for last 300 mm.
.6 Final tip and cut-off elevations.
.7 Other pertinent information such as

interruption of continuous driving, pile damage.

.8 Record elevation taken on adjacent piles before and after driving of each pile.

.2 All measurements, observations and calculations associated with pile driving analyzer and wave equation analysis.

.3 Provide the Engineer with and electronic copy of records.

3.6 CLEANING

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

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 31 09 16 - Pile Driving Templates

.2 Section 31 09 17 - Pile Tests

.3 Section 31 61 13 - Pile Foundations, General Requirements

1.2 REFERENCES

.1 American Petroleum Institute (API)
.1 API SPEC 5L-15, Specification for Line Pipe, Includes Errata 1, 43rd Edition.

.2 American Society for Testing and Materials International (ASTM)
.1 ASTM A106/A 106M-15, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
.2 ASTM A252-10, Standard Specification for Welded and Seamless Steel Pipe Piles.

.3 Canadian General Standards Board (CGSB)
.1 CAN/CGSB-1.171-98, Inorganic Zinc Coating.
.2 CAN/CGSB-1.184-98, Coal Tar-Epoxy Coating.

.4 Canadian Standards Association (CSA International)
.1 CSA-G40.20/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
.2 CSA W47.1-09(R2014), Certification of Companies for Fusion Welding of Steel Structures.
.3 CSA W48-14, Filler Metals and Allied Materials for Metal Arc Welding.
.4 CSA W59-13, Welded Steel Construction (Metal Arc Welding) (metric version).
.5 CSA W186-M1990(R2016), Welding of Reinforcing Bars in Reinforced Concrete Construction.
.6 CSA-Z245.1-14, Steel Pipe.

.5 Joose Environmental Clyde River Geotechnical Report, Project JE0197 Issued on September 12, 2016 and supplemented on September 28, 2017, Project JE0252.

1.3 SUBMITTALS

.1 Provide submittals in accordance with the PEITIE Department of Transportation, Infrastructure and Energy's General Provisions and Contract Specifications for Highway Construction.

.2 Product data: submit manufacturer's printed product literature, specifications and datasheet.

.3 Submit shop drawings and indicate: pile shoes, splice detail, pile cap, tip reinforcement.
.1 Each drawing stamped and signed by professional engineer registered or licensed in Province of Prince Edward Island, Canada.

.4 Quality Assurance: test reports:
.1 Prior to fabrication, and, if requested, provide the Engineer with two (2) copies of steel producer's certificates in accordance with ASTM A252 and API SPEC 5L.
.2 One Charpy V-notch test required per heat and results reported to the Engineer by manufacturer.
.3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Submit details of pile stock material to be used, as described in PART 3 - FABRICATION, for review by the Engineer.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store and handle to prevent damage to products.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.3 Deliver new, undamaged materials to site, accompanied by certified test reports, with manufacturer's logo and mill identification mark provided on pipe piling.

.4 Storage and Protection:
.1 Store and handle pipe piling in accordance with manufacturer's written instructions to prevent permanent deflection, distortion or damage to interlocks.

.2 Support pipe piling on level blocks or racks spaced not more than 3m apart and not more than 0.60m from ends.
.3 Store pipe piling to facilitate required inspection activities and prevent damage to coatings and corrosion prior to installation.

.5 Waste Management and Disposal:
.1 Separate waste materials for disposal in accordance with the PEITIE Department of Transportation, Infrastructure and Energy's General Provisions and Contract Specifications for Highway Construction.
.2 Divert unused metal materials from landfill to metal recycling facility as approved by the Engineer.
.3 Divert unused concrete materials from landfill to local facility as approved by the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Steel pipe: seamless, welded, straight longitudinal seam or spiral butt, of sizes and wall thicknesses indicated, plain, bevelled, flame, machine cut ends to CSA-C40.2M, Grade 350W.

.2 Pipe material to have following minimum properties:
.1 Yield strength: 350MPa.
.2 Tensile strength: 410 MPa.
.3 Weldable steel: to ASTM A106 carbon equivalent less than 0.55%.

.3 Pipe chemical composition: to ASTM A252.

.4 Pile tip reinforcement: to CSA-G40.20/G40.21, Grade 350W.

.5 Open-ended pile driving shoes: to CSA-G40.20/G40.21, Grade 300W.

.6 Splices: to CSA-G40.20/G40.21, Grade 350W.

.7 Pile caps: to CSA G40.20/40.21, Grade 350W.

.8 Welding electrodes: to CSA W48 series.

PART 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 datasheets.

3.2 FABRICATION

.1 Fabricate full length piles to eliminate splicing during installation wherever possible.

.2 Full length piles may be fabricated from piling material by splicing lengths together.
.1 Use complete joint penetration groove welds.

.3 Submit details of planned use of pile material stock to the Engineer for approval prior to start of fabrication. Re-use cut-off lengths as directed by the Engineer.

.4 Allowable tolerance on axial alignment to be 0.25% as measured by 3 m straight edge.

.5 Allowable deviation from straight line over total length of fabricated pile to be 30mm.

.6 Install pile tip reinforcement, splices and driving shoes as indicated.

.7 Repair defective welds as directed by the Engineer.
.1 Repairs: to CSA W59.
.2 Unauthorized weld repairs may be rejected.

.8 Repair damaged exterior protective coating of piles.

3.3 INSTALLATION

.1 Install piling in accordance with Section 31 61 13.

.2 If approved by the Engineer, splice piles in place during installation by welding. To prevent distortion, tack opposite points first and then weld opposite sections for pipe walls thinner than 10 mm weld against a backup ring.

Hold members in alignment during splicing operation. Make splice by complete joint penetration groove welds as indicated on shop drawings.

.3 Perform internal visual inspection of steel pipe, joints and base prior to placing of concrete. Keep the inside of pipe free from foreign matter.

.4 Assemble and install reinforcement cages as indicated.

.5 Install driving shoes during shop fabrication.

3.4 WELDING

.1 Weld to CSA W59.

.2 Welding certification of companies: to CSA W47.1, Division 2.

.3 Welding certification of companies welding steel reinforcing bars placed in reinforced concrete: in accordance with CSA W186.

END OF SECTION