TECHNICAL SPECIFICATIONS

October 19, 2015

SECANT CAISSON WALL TECHNICAL SPECIFICATIONS

Nanaimo Colliery Dam Auxiliary Spillway, Nanaimo, BC

Submitted to:
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Distribution:

2 Copies – City of Nanaimo

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1.0 SCOPE OF WORK

1.1 General

1) These Specifications provide the technical performance criteria required for the installation of the "Colliery Dam Auxiliary Spillway Secant Pile Cut-Off Wall". Contractual and other requirements for the secant pile wall construction Work are provided in other documents.

2) The secant pile wall will act as both a temporary retaining wall (during construction) and as a permanent (long term) cut-off wall for seepage control.

3) The Contractor is responsible for the site preparation and construction of the secant pile wall by installing cast-in-situ reinforced piles or caissons to form a secant wall suitably founded into competent till, in accordance with these Specifications and referenced Drawings, or with modifications as directed by the Engineer onsite.

4) It is understood that Golder Associates Ltd. will provide full-time inspection and monitoring during installation of the secant pile wall. However, the Contractor is solely responsible for the site layout, preparation and installation of the secant pile wall in conformance with the technical performance criteria of these Specifications and other contract requirements, including but not limited to provision of accurate "as built" plans, records and Quality Control/Assurance testing.

5) The Contractor must carry out installation of the secant pile wall without causing damage or unacceptable movements to the nearby existing spillway. The Contractor shall be responsible for monitoring and controlling ground vibrations, vertical and horizontal ground movements and groundwater levels associated with the Work.

6) The Contractor shall inspect and review all available Drawings and conduct such site examinations as required to be fully aware of all existing structures (spillway) and other features, including but not limited to retained tree cover, within the immediate vicinity of the project site.

1.2 Definitions

1) **Owner**: The Owner is referred to herein as the **City of Nanaimo (CoN)**

2) **Contractor**: The Contractor is referred to herein as **Copcan Civil Ltd. a Division of Gregson Holdings (Copcan)**, who is responsible for the site preparation and construction of the secant pile wall to meet the performance requirements set out in these Specifications.

3) **Engineer**: **Golder Associates Ltd. (Golder)** is providing geotechnical design and construction services to The City of Nanaimo for the project. **Herold Engineering Ltd. (Herold)** is providing structural design and construction services to The City of Nanaimo for the project.

4) **Piles or Caissons**: The secant piles or caissons are 900 mm diameter cast-in-situ reinforced concrete piles constructed in in situ within the overburden, and typically constructed using a large drill rig with a cutting head attached to the Kelly bar and temporary steel tubular casings.

5) **Primary Piles or Caissons**: The primary caissons are cast-in-situ concrete piles constructed with Steel "I" or "H" section reinforcements and are embedded into till.

6) **Secondary Piles or Caissons**: The secondary caissons are cast-in-situ unreinforced concrete piles and are embedded into till.

7) **Till-like soils:** Very dense, till-like soils generally comprising grey silt, fine to coarse grained sand, and fine to coarse grained gravel, of varying percentages. Fissured silty clay and laminations of fine silty sand were encountered within the unit, though not observed in the upper 3 to 4 m.

8) **Secant Pile or Caisson Wall**: A row of overlapping primary (reinforced) and secondary (unreinforced) cast-in-situ concrete piles forming a continuous retaining and seepage cut-off structure. The centreline to centreline horizontal spacing between primary and secondary caissons is typically 750 mm and the spacing between consecutive primary caissons (or secondary caissons) is 1.5 m.

9) **Overlap**: The overlap required between adjacent primary and secondary piles or caissons. A minimum overlap of 150 mm is required on both sides of the caissons (with the exception of end caissons) or as indicated in the Drawings.

10) **Upstream**: The area to the North and West of the secant pile cut-off wall, towards the reservoir.

11) **Downstream**: The area to the South and East of the secant pile cut-off wall, towards Harewood Creek.

12) **Temporary Working Platform**: The working platform is the graded (approximately level) temporary surface of stable soils from which the drill rigs, excavators and other equipment for caisson installation operate. Refer to the Drawings for Temporary Working Platform excavation requirements. The excavation requirements are described in a separate specification.

1.3 Description of Work

1) The construction of the secant pile wall shall include all items (including but not limited to suitable materials, supplies, equipment and personnel) necessary to construct the following:

   a) Alternating reinforced and non-reinforced secant caissons to form a continuous retaining wall and seepage cut-off along the alignment of the proposed Auxiliary Spillway Secant Pile Wall;

2) The Contractor shall:

   a) Set out the secant wall in accordance with the coordinates and elevations as indicated in the Drawings or provided by the Engineer.

   b) Carry out installation of the secant caissons as illustrated in the Drawings or as directed onsite by the Engineer to meet the performance requirements as defined in these Specifications.

   c) Carry out sampling and strength testing of concrete cylinders for Quality Control and Quality Assurance verification.

1.4 Site Conditions and Available Data

1) The subsurface conditions of the general site are presented in the Golder report titled “Auxiliary Spillway – Preliminary Design Report, Colliery Dams, Nanaimo, BC”, dated September 4, 2015”.

1.5 Review of Information by the Contractor

1) The Engineer does not warrant the correctness or completeness of the information presented in the geotechnical report(s), and of any interpretation, deduction, or conclusion regarding the subsurface conditions which may be indicated or implied by the Drawings, Specifications and the geotechnical report(s). The final pile installation depth shall depend on ground conditions encountered and will be directed by the Engineer.

2) The information provided in the geotechnical reports was obtained for the secant pile wall design purposes only and shall not be considered as indicative or in sufficient detail to establish the construction methods and procedures, which may be required for the Work indicated in the Drawings and Specifications. The subsurface information provided in the geotechnical report(s) is intended solely to provide general representation of the materials which may be encountered.

3) The Contractor shall review all information pertinent to the work, visit the site and carry out all necessary examinations or investigations and shall make independent interpretations of all available information regarding the requirements, limitations, and constraints of the Work and conditions under which the Work will be performed. The Contractor shall promptly notify the Engineer of any ambiguity, inconsistency, or error in the Construction Documents that may be discovered.

2.0 DRAWINGS LIST

1) The Drawings, together with these Specifications, define the works to be carried out for construction of the secant pile wall. The Contractor shall refer to the latest relevant drawings.

3.0 PERFORMANCE REQUIREMENTS

3.1 Secant Pile Wall

1) The secant pile wall shall be constructed to the coordinates and elevations as indicated in the Drawings, unless otherwise directed by the Engineer. The secant pile wall shall consist of essentially vertical cast-in situ caissons constructed with the following minimum dimensions:

   a) Diameter of 0.9 m;

   b) Length, including embedment into the till, as indicated in the Drawings, or as directed by the Engineer;

   c) Length of steel reinforcement in primary caissons, as indicated in the Drawings;

   d) Minimum overlap of 150 mm between adjacent caissons; and

   e) The caissons shall extend through the existing native overburden from the generally level working pad prepared prior to start of caisson installation at 72.1 m elevation, or as otherwise directed or approved by the Engineer. Subsurface conditions typically consist of sands and gravels, underlain by clayey silt to silty clay with varying amounts of sand, followed by sands and gravels, overlying “till-like” soil into which the caissons shall be suitably embedded, as indicated in the Drawings. Cobbles and boulders should be expected to be encountered. The indicator for confirming penetration into “till-like” soils will be an increase in torque and pressure anticipated in the very dense material and recovery of fresh till-like soil from the base of the caisson excavation. The groundwater level is expected to vary

between elevation 71.0m and 71.6m, and soils below the groundwater level are saturated and subject to variable seepage discharge and sloughing when excavated.

The depth of a caisson is defined as the measurement from the top of the caisson cut-off elevation, as indicated in the Drawings as 72.1 m, to the final depth of the caisson (*i.e.*, depth to the bottom of the tip of the steel reinforcement for primary caissons and depth to the bottom of cleaned, open caisson excavation for secondary caissons), as recorded on the as-built piling records. The centre of the caissons is defined as the reference point for measuring depth of penetration and embedment.

2) The following tolerances shall apply to secant caisson wall construction:

   a) Position at existing ground surface: +/- 50 mm of design location;

   b) Verticality: 1.0% of vertical or 100(V):1(H);

   c) Minimum top of caisson and top of steel reinforcement: +50 mm / -25 mm of design cut-off level as indicated in the Drawings;

   d) Position at design cut-off elevation of steel reinforcement: +/- 25 mm of design location;

   e) Minimum overlap between adjacent caissons shall extend the full depth of the caisson below existing ground surface; and

   f) Minimum concrete cover of 75 mm or greater is required for all steel reinforcement.

3) The completed secant pile wall shall consist of overlapping cast-in-situ, alternating steel reinforced primary concrete caissons and unreinforced secondary concrete caissons.

7) The minimum concrete strength requirements of the concrete caissons are specified on Herold Engineering Ltd.'s Drawing S101. The design life of the secant caisson wall is 50 to 100 years as a permanent cut-off for seepage control.

8) The maximum total lateral deflection of the secant pile wall during temporary construction conditions considering loss of soil support downslope of the proposed retaining wall shall not exceed 50 mm.

9) Construction of cast-in-situ reinforced or unreinforced concrete caissons may include or require temporary installation of a steel casing to provide support and stability during construction of the caissons through the overburden and till-like soils. All necessary templates and supporting framework shall be provided by the Contractor, including intermediate supports that may be required to prevent buckling or damage.

10) A tremie typically installed to within 2 m from the bottom of the dry caisson excavation shall be used to place the concrete for the caissons following inspection and confirmation that all loosened or disturbed materials and water have been removed and that the embedment requirements in the till-like soil have been achieved, or as approved by the Engineer. If groundwater seepage into the caisson excavation cannot be controlled, concrete shall be placed underwater by tremie methods. A sealed tremie seated on the bottom of the caisson excavation shall be used to place concrete. The tremie, with the exception of the initial fill in the bottom 2 m, shall at all times remain a minimum of 2 m below top of concrete.

11) The Contractor shall penetrate through or suitably remove all obstructions that can be reasonably anticipated in work of this nature at the site. The Contractor shall take anticipated conditions into consideration in determining the appropriate method of construction, including provisions for suitable equipment to construct caissons through soils containing cobbles and boulders.

12) On completion of the construction of the caissons, the area downstream of the temporary retaining cut-off wall shall be excavated. The excavation requirements are described in a separate specification.

13) On completion of the construction of the auxiliary spillway, a portion of the caissons, including the steel reinforcement, shall be removed prior to or as part of excavation of the "soil plug" and development of the forebay. Removal of a portion of the concrete and steel caissons across the north (upstream) perimeter of the labyrinth forms part of the Contractor's responsibilities for the overall construction of the auxiliary spillway, and are described in a separate document or specification.

4.0 MATERIALS SUPPLY

4.1 General

Unless otherwise specified, all materials shall be new and of best quality. Where applicable, work and materials shall conform to the latest edition of the Canadian Standards Association.

1) **Steel Reinforcement**: The Contractor shall supply the steel reinforcement as specified in the Drawings. Manufacturer's identification marks shall be readily identifiable on the site and shall match the reference numbers on the mill certificates provided. The "I" or "H" sections shall be supplied in lengths sufficient to achieve the minimum depths as one continuous length. Splicing of the steel reinforcement sections for the caissons is not permitted without the prior approval of the Engineer and submission of weld inspection and Non Destructive Testing (NDT) details to confirm a full strength weld.

2) **Concrete Mix**: refer to Herold Engineering Ltd.'s drawing S202.

3) **Additives**: additives including retarders may be added to the cement mix to enhance the workability of the concrete mixture, subject to the final caisson strengths meeting the performance requirements as defined in these Specifications and Drawings.

4) **Water**: The water used for construction shall be clean and free from injurious amounts of oil, alkali, organic matter or other deleterious material.

5) **Materials submittals**: The Contractor shall provide materials submittals including results of all Quality Control tests carried out on representative concrete samples and material certificates from suppliers of steel sections and reinforcements, as well as suppliers of cement and additives (if any considered).

4.2 Concrete

4.2.1 References

1) ASTM C260-10a - Air Entraining Admixtures for Concrete.

2) ASTM C494/C494M-13 - Chemical Admixtures for Concrete.

3) ASTM C1017/C 1017M-13 - Chemical Admixtures for Use in Producing Flowing Concrete.

4) CAN/CSA A3000-13 - Cementitious Materials Compendium.

5) CSA A23.1/A23.2-09 - Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

6) CSA A283-06 - Qualification Code for Concrete Testing Laboratories.

7) CSA S269.3-M92 (R2013) – Concrete Formwork.

8) ACI 207 - Mass Concrete and Thermally Controlled Concrete.

9) ACI 304 - Measuring, Mixing, Transporting, and Placing Concrete.

10) ACI 305 – Hot Weather Concreting.

11) ACI 306 – Cold Weather Concreting.

12) ACI 308 - Curing Concrete.

The more stringent requirements of the referenced standards shall govern.

4.2.2 Submittals

1) Concrete Mix Designs

   The Contractor shall be responsible for the concrete mix design and shall submit in writing all details of the concreting operations to the Engineer at least one (1) week before commencement of the construction work. The submission shall include but is not limited to details of construction sequencing, methods for preparation for concreting and methods for concreting to meet the performance requirements outlined in these Technical Specifications and Drawings. The submission shall also include of the mix proportions for each specified concrete strength, including supporting data, to demonstrate that the proposed mix designs and materials will achieve the required strength (shown on Herold Engineering Ltd.'s drawing S202), durability, and performance requirements.

2) Mill Certificates and Test Reports

   a) At least 1 week prior to commencing work provide manufacturer's test data and certification by a qualified independent inspection and testing laboratory that the following materials meet the requirements of this section.

      i) Cement

      ii) Supplementary Cementitious Materials

      iii) Admixtures

      iv) Aggregates

      v) Water

      vi) Curing products

3) Submit historical concrete test reports of proposed mix designs for review by the Engineer.

4) Submit proposed procedures for handling, placement and curing for the initial mix design, and whenever there are changes to the mix design, materials, procedures or site conditions, as determined by the Engineer.

5) Submit proposed construction joint details.

4.2.3 Concrete Materials

1) All materials shall be from the same sources throughout the work.

2) Cement : Type GU per CSA-A3000.

3) Aggregates: Use normal weight coarse and fine aggregates per CSA A23.1. Aggregates shall be assessed for Alkali-Aggregate Reactivity per CSA A23.2-27A. AAR mitigation procedures shall be qualified per CSA A23.2-28A prior to use of alkali-reactive aggregates.

4) Supplementary Cementitious Materials: per CSA-A3000.

5) Air Entraining Admixture per ASTM C260.

6) Chemical Admixtures per ASTM C494 - Non-chlorides.

7) Water: Mixing water shall be clean, potable and free from deleterious material per CSA-A23.1.

4.2.4 Concrete Mixes

1) Concrete mix designs shall properly address the anticipated transit time of the concrete, site conditions, weather conditions, concreting materials, construction methodology, and other parameters as required, for successful performance of the work. The concrete criteria are shown on Herold Engineering Ltd.'s Drawing S101.

5.0 EQUIPMENT

1) **Caisson Installation Equipment**: Caisson installation equipment shall be capable of installing the secant caissons including embedment into very dense till-like soils, to the requirements indicated in these Specifications and Drawings.

2) **Steel Casings for Caisson Installation**: The temporary steel pipe casings shall be supplied to provide temporary support and stability of the caisson excavation during construction of the caissons through the overburden and till-like soils. All necessary templates and supporting framework including intermediate supports that may be required to prevent buckling or damage shall be provided.

3) **Tremie**: A sectional tremie with sufficient length is required to extend to within 2 m from the bottom of caisson excavations to place and cast the concrete in dry caissons following inspection of the bottom of the caisson and confirmation that all loosened or disturbed materials and water have been removed and the embedment requirements in soil and bedrock (where applicable) have been achieved. If groundwater seepage into the caisson excavation cannot be controlled, concrete shall be placed underwater by tremie methods. A sealed tremie seated on the bottom of the caisson excavation shall be used to place concrete underwater. The tremie, with the exception of the initial fill in the bottom 2 m, shall at all times remain a minimum of 2 m below top of concrete.

6.0 PROCESS CONTROL

The Contractor shall submit all details of the proposed construction methods for review and acceptance by the Engineer at least one (1) week before commencement of this work or any fabrications required for this work.

6.1 Caisson Construction

1) The temporary steel casing shall be seated into the till like soils to form caissons with embedment lengths of 6.0 m, as indicated in the Drawings or as otherwise directed by the Engineer. All necessary templates and supporting framework shall be provided, including intermediate supports to prevent buckling or other damages.

2) The Contractor shall demonstrate that the steel casing is properly and fully seated and sealed in the till-like soil by demonstrating that the casing can be fully cleaned to its base, by air lift or other approved methods, so that the water issuing from the caisson on pumping is clean and free from silt and other materials. No additional payment shall be made for this demonstration.

3) Materials excavated as part of the secant pile wall construction shall be stockpiled and/or removed from the site.

4) The Contractor shall break-up, remove, core or drill through all obstructions reasonably expected to be encountered, including boulders, to meet the performance requirements indicated in these Specification and Drawings. The method used to drill into the till-like soils shall not result in over-drilling/over-excavation around or below the caisson embedment zone. No additional payment will be made for over-excavation of the embedment zone or for excess steel casings, concrete or reinforcing steel needed as a result of over-excavation.

5) The Contractor shall ensure that the bottom of the caisson is clear of loose material or mud, clean and free of water before inspection.

6) Following completion of temporary steel casing installation, drilling to final depth and cleaning of the base of the caisson, the Contractor shall provide access for the Engineer or a representative of the Engineer to sample the soil that is obtained directly from the drilling equipment (i.e. not from a stockpile) as well as monitoring the vertical alignment of the secant pile.

7) Concrete placement shall start within 3 hours of inspection. Where concreting is not carried out on the same day as the drilling, the Contractor shall examine and conduct additional cleaning or drainage of the caisson and re-inspection shall be carried out by the Engineer or a representative of the Engineer prior to concreting.

8) Concrete shall be deposited into the dry caisson by pumping or by tremie pipe. The end of the pumping hose or tremie pipe shall always be held sufficiently below the level of the concrete in the caisson so that fresh concrete enters the mass of previously placed concrete from within. The concrete shall be placed in a continuous operation in a dry caisson. If groundwater seepage into the caisson excavation cannot be controlled, concrete shall be placed underwater by tremie methods. A sealed tremie seated on the bottom of the caisson excavation shall be used to place concrete underwater. The tremie, with the exception of the initial fill in the bottom 2 m, shall at all times remain a minimum of 2 m below top of concrete.

9) No construction of adjacent caissons (primary or secondary) shall commence until 24 hours after the concreting operation has been completed for the previously installed caisson.

6.2 Concrete Installation

6.2.1 Preparation

1) Surfaces against which concrete are to be placed must be free from standing water, mud and debris. Surfaces shall be clean and free from oil, foreign matter, and loose or unsound material.

6.2.2 Forming

1) Verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed prior to concrete placement.

6.2.3 Placement

1) Place concrete in accordance with CSA A23.1 and ACI 304.

2) Notify the Engineer a minimum of 24 hours prior to commencement of concrete placement.

3) Ensure reinforcement, inserts, embedded parts, formed joints etc. are not disturbed during concrete placement.

4) Concrete shall be conveyed from mixer to the location of final placement by methods that will prevent separation or loss of materials.

5) Cold joints are not permitted.

6) Construction joints and locations shall be approved by the Engineer.

7) Tremie concrete placement is required for all placements below water level or exceeding 2 m below ground surface.

8) Implement Thermal Control Plan approved by the Engineer for mass concrete placements.

6.2.4 Hot Weather Concreting

1) When hot weather conditions exist (as defined by CSA A23.1), place concrete in compliance with CSA A23.1 and ACI 305.

6.2.5 Cold Weather Concreting

1) When cold weather conditions exist (as defined by CSA A23.1), place concrete in compliance with CSA A23.1 and ACI 306.

6.2.6 Finish

1) Finish concrete in accordance with CSA A23.1 and as indicated on the drawings.

6.2.7 Tolerances

1) Minimum concrete cover of 75 mm for all steel reinforcement.

6.2.8 Curing and Protection

1) Provide curing and protection per CSA A23.1 and ACI 308.

6.2.9 Clean-up and Disposal

1) All construction wastes such as spilled, unsuitable or waste concrete, cement slurry, wastewater, construction debris, etc., shall be properly collected and stored on site and/or properly disposed off-site by the Contractor in accordance with requirements of the authorities having jurisdiction.

7.0 QUALITY CONTROL AND QUALITY ASSURANCE

7.1 Sampling & Testing

1) The Contractor shall carry out sampling and testing of representative concrete cylinder samples in accordance with the requirements outlined in the Drawings and in Table 2, as follows:

Table 1: Concrete Cylinder Sampling and Testing Requirements

Sample Type	Sampling Frequency	Sampling Depths	Testing Requirements
Concrete Cylinders	At least 2 sets of tests per caisson and from at least 5% of all installed caissons	At least 2 depths (1 set of tests per sampling depth) per caisson	■ Testing to be carried out in accordance with CSA Part A23.2-9C ■ At least 1 test at 7 days or longer per sampling depth; and ■ At least 2 tests at 28 days or longer per sampling depth.

2) Contractor shall outsource at least 5% of concrete testing to a certified independent laboratory.

7.2 Concrete

1) The Contractor is responsible for quality control and for ensuring that all aspects of the work comply with the product manufacturer's requirements and this specification.

2) Concrete testing shall be conducted by laboratory and technicians certified to CSA A283.

3) Minimum one concrete field test shall be conducted every pile, and a minimum of one test daily for each type of concrete mix placed. The field tests shall include slump, air content and temperature.

4) Cast one set of three cylinders per field test and cure in accordance with applicable standards and requirements of these Specifications. Test a minimum of one cylinder at 7 days and two cylinders at 28 days (unless approved by Engineer) for compressive strengths. Cast additional cylinders for testing, as required.

5) Contractor shall provide adequate facilities for storage and proper curing of concrete cylinders onsite for the first 24 hours or for additional time as may be required, before transporting the cylinders to the testing lab.

6) All quality control test data obtained by the Contractor shall be submitted to the Engineer for review.

7) Concrete defects and deficiencies shall be reported to the Engineer prior to corrective actions by the Contractor. Remedial measures for deficiencies shall be submitted to the Engineer for review and approval prior to their implementation.

8) The Contractor shall repair and make good all disturbances or damages to the satisfaction of the Engineer caused by sampling or other testing done by either the Contractor's quality control or Engineer's quality assurance activities

9) The Engineer may, in its option, carry out any inspections, tests or other activities necessary to verify that the Work is performed in accordance with these Technical Specifications.

7.3 Reporting

1) The Contractor shall provide the following documentation to confirm that the performance requirements outlined in Section 3 of these Specifications have been achieved:

   a) Material submittals in accordance with Section 4 of these Specifications;

   b) As-built caisson records summarizing the following information:

      i) Project reference, location, date and time of installation including rig and operator data;

      ii) Caisson reference, size, type and length of temporary casing used (including stick-up above existing ground surface);

      iii) Position of the caisson and steel reinforcement (Easting and Northing); deviation from vertical on and perpendicular to secant wall alignment;

      iv) Existing ground surface, top of caisson and top of steel reinforcement elevations;

      v) Diameter and length of caisson including embedment into the till-like soil;

      vi) Indicative subsurface conditions including confirmation of top of till-like soils;

      vii) Size and length of steel reinforcement installed in caisson (where applicable);

      viii) Any observations including inconsistent or variable conditions encountered throughout construction process;

      ix) Concrete mix (and design strength), field test results (slump tests) and note of whether samples were taken for QA/QC verification; and

      x) Volume of concrete consumed.

   c) Concrete strength test data in accordance with Section 7 of these Specifications; and

   d) As-built drawing confirming location, geometry and depth of caissons.

8.0 INVESTIGATION/REMEDIATION OF NON-COMPLIANT CAISSONS

1) The Engineer or representative of the Engineer may reject any caissons that are out of alignment or out of position or otherwise fail to meet the specified performance requirements.

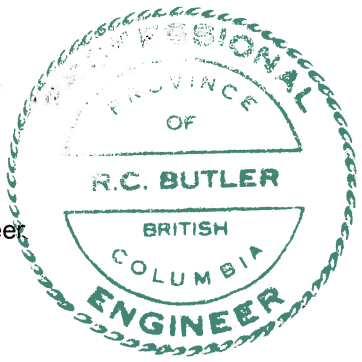
2) The Contractor shall replace rejected caisson(s) with new caisson(s) as directed by the Engineer at no additional cost to the Owner. Rejected caissons shall be cut off as directed by Engineer.

3) All supplemental caisson installations that may be required are subject to the same performance requirements as outlined in Section 3 of these Specifications and Drawings.

9.0 CLOSURE

We trust that the information contained in these technical Specifications is sufficient for your immediate requirements. Should you have any queries or require further clarification, please do not hesitate to contact the undersigned.

GOLDER ASSOCIATES LTD.



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At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

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