THE CITY OF WINNIPEG

BID OPPORTUNITY

BID OPPORTUNITY NO. 772-2017

FERMOR AVENUE BRIDGE OVER SEINE RIVER – BRIDGE REHABILITATION, PEDESTRIAN-CYCLIST UNDERPASS STRUCTURE AND ROADWORKS FROM ST. ANNE'S ROAD TO ARCHIBALD STREET

TABLE OF CONTENTS

UNDERGROUND WORKS

PART B - BIDDING PROCEDURES

B1. CONTRACT TITLE

B1.1 **FERMOR AVENUE BRIDGE OVER SEINE RIVER – BRIDGE REHABILITATION, PEDESTRIAN-CYCLIST UNDERPASS STRUCTURE AND ROADWORKS FROM ST. ANNE'S ROAD TO ARCHIBALD STREET**

B2. SUBMISSION DEADLINE

B2.1 The Submission Deadline is 12:00 noon Winnipeg time, March 13, 2018.

B2.2 Bids determined by the Manager of Materials to have been received later than the Submission Deadline will not be accepted and will be returned upon request.

B2.3 The Contract Administrator or the Manager of Materials may extend the Submission Deadline by issuing an addendum at any time prior to the time and date specified in B2.1.

B3. SITE INVESTIGATION

B3.1 Further to C3.1, the Bidder may view the Site without making an appointment.

B3.2 The Bidder is advised that at no time can the Bidder access any other private owned property unless authorized by the City and approved by the Contractor Administrator.

B4. ENQUIRIES

B4.1 All enquiries shall be directed to the Contract Administrator identified in D4.1.

B4.2 If the Bidder finds errors, discrepancies or omissions in the Bid Opportunity, or is unsure of the meaning or intent of any provision therein, the Bidder shall notify the Contract Administrator of the error, discrepancy or omission, or request a clarification as to the meaning or intent of the provision at least five (5) Business Days prior to the Submission Deadline.

B4.3 Responses to enquiries which, in the sole judgment of the Contract Administrator, require a correction to or a clarification of the Bid Opportunity will be provided by the Contract Administrator to all Bidders by issuing an addendum.

B4.4 Responses to enquiries which, in the sole judgment of the Contract Administrator, do not require a correction to or a clarification of the Bid Opportunity will be provided by the Contract Administrator only to the Bidder who made the enquiry.

B4.5 The Bidder shall not be entitled to rely on any response or interpretation received pursuant to B4 unless that response or interpretation is provided by the Contract Administrator in writing.

B5. CONFIDENTIALITY

B5.1 Information provided to a Bidder by the City or acquired by a Bidder by way of further enquiries or through investigation is confidential. Such information shall not be used or disclosed in any way without the prior written authorization of the Contract Administrator. The use and disclosure of the confidential information shall not apply to information which:

(a) was known to the Bidder before receipt hereof; or

(b) becomes publicly known other than through the Bidder; or

(c) is disclosed pursuant to the requirements of a governmental authority or judicial order.

B5.2 The Bidder shall not make any statement of fact or opinion regarding any aspect of the Bid Opportunity to the media or any member of the public without the prior written authorization of the Contract Administrator.

B6. ADDENDA

B6.1 The Contract Administrator may, at any time prior to the Submission deadline, issue addenda correcting errors, discrepancies or omissions in the Bid Opportunity, or clarifying the meaning or intent of any provision therein.

B6.2 The Contract Administrator will issue each addendum at least two (2) Business Days prior to the Submission Deadline, or provide at least two (2) Business Days by extending the Submission Deadline.

B6.2.1 Addenda will be available on the Bid Opportunities page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt/bidopp.asp

B6.2.2 The Bidder is responsible for ensuring that he/she has received all addenda and is advised to check the Materials Management Division website for addenda regularly and shortly before the Submission Deadline, as may be amended by addendum.

B6.3 The Bidder shall acknowledge receipt of each addendum in Paragraph 10 of Form A: Bid. Failure to acknowledge receipt of an addendum may render a Bid non-responsive.

B7. SUBSTITUTES

B7.1 The Work is based on the Plant, Materials and methods specified in the Bid Opportunity.

B7.2 Substitutions shall not be allowed unless application has been made to and prior approval has been granted by the Contract Administrator in writing.

B7.3 Requests for approval of a substitute will not be considered unless received in writing by the Contract Administrator at least five (5) Business Days prior to the Submission Deadline.

B7.4 The Bidder shall ensure that any and all requests for approval of a substitute:

(a) provide sufficient information and details to enable the Contract Administrator to determine the acceptability of the Plant, Material or method as either an approved equal or alternative;

(b) identify any and all changes required in the applicable Work, and all changes to any other Work, which would become necessary to accommodate the substitute;

(c) identify any anticipated cost or time savings that may be associated with the substitute;

(d) certify that, in the case of a request for approval as an approved equal, the substitute will fully perform the functions called for by the general design, be of equal or superior substance to that specified, is suited to the same use and capable of performing the same function as that specified and can be incorporated into the Work, strictly in accordance with the proposed work schedule and the dates specified in the Supplemental Conditions for Substantial Performance and Total Performance;

(e) certify that, in the case of a request for approval as an approved alternative, the substitute will adequately perform the functions called for by the general design, be similar in substance to that specified, is suited to the same use and capable of performing the same function as that specified and can be incorporated into the Work, strictly in accordance with the proposed work schedule and the dates specified in the Supplemental Conditions for Substantial Performance and Total Performance.

B7.5 The Contract Administrator, after assessing the request for approval of a substitute, may in his/her sole discretion grant approval for the use of a substitute as an “approved equal” or as an “approved alternative”, or may refuse to grant approval of the substitute.

B7.6 The Contract Administrator will provide a response in writing, at least two (2) Business Days prior to the Submission Deadline, to the Bidder who requested approval of the substitute.

B7.6.1 The Contract Administrator will issue an Addendum, disclosing the approved materials, equipment, methods and products to all potential Bidders. The Bidder requesting and obtaining the approval of a substitute shall be responsible for disseminating information regarding the approval to any person or persons he/she wishes to inform.

B7.7 If the Contract Administrator approves a substitute as an “approved equal”, any Bidder may use the approved equal in place of the specified item.

B7.8 If the Contract Administrator approves a substitute as an “approved alternative”, any Bidder bidding that approved alternative may base his/her Total Bid Price upon the specified item but may also indicate an alternative price based upon the approved alternative. Such alternatives will be evaluated in accordance with B17.

B7.9 No later claim by the Contractor for an addition to the Total Bid Price because of any other changes in the Work necessitated by the use of an approved equal or an approved alternative will be considered.

B8. BID COMPONENTS

B8.1 The Bid shall consist of the following components:

(a) Form A: Bid;

(b) Form B: Prices, hard copy;

(c) Bid Security;

a) Form G1: Bid Bond and Agreement to Bond, or
Form G2: Irrevocable Standby Letter of Credit and Undertaking, or
a certified cheque or draft.

B8.2 Further to B8.1, the Bidder should include the written correspondence from the Contract Administrator approving a substitute in accordance with B7.

B8.3 All components of the Bid shall be fully completed or provided, and submitted by the Bidder no later than the Submission Deadline, with all required entries made clearly and completely.

B8.4 The Bid shall be submitted enclosed and sealed in an envelope clearly marked with the Bid Opportunity number and the Bidder's name and address.

B8.4.1 Samples or other components of the Bid which cannot reasonably be enclosed in the envelope may be packaged separately, but shall be clearly marked with the Bid Opportunity number, the Bidder's name and address, and an indication that the contents are part of the Bidder’s Bid.

B8.4.2 A hard copy of Form B: Prices must be submitted with the Bid. If there is any discrepancy between the Adobe PDF version of Form B: Prices and the Microsoft Excel version of Form B: Prices, the PDF version shall take precedence.

B8.5 Bidders are advised not to include any information/literature except as requested in accordance with B8.1.

B8.6 Bidders are advised that inclusion of terms and conditions inconsistent with the Bid Opportunity document, including the General Conditions, will be evaluated in accordance with B17.1(a).

B8.7 Bids submitted by facsimile transmission (fax) or internet electronic mail (e-mail) will not be accepted.

B8.8 Bids shall be submitted to:

The City of Winnipeg
Corporate Finance Department
Materials Management Division
185 King Street, Main Floor

Winnipeg MB R3B 1J1

B9. BID

B9.1 The Bidder shall complete Form A: Bid, making all required entries.

B9.2 Paragraph 2 of Form A: Bid shall be completed in accordance with the following requirements:

(a) if the Bidder is a sole proprietor carrying on business in his/her own name, his/her name shall be inserted;

(b) if the Bidder is a partnership, the full name of the partnership shall be inserted;

(c) if the Bidder is a corporation, the full name of the corporation shall be inserted;

(d) if the Bidder is carrying on business under a name other than his/her own, the business name and the name of every partner or corporation who is the owner of such business name shall be inserted.

B9.2.1 If a Bid is submitted jointly by two (2) or more persons, each and all such persons shall identify themselves in accordance with B9.2.

B9.3 In Paragraph 3 of Form A: Bid, the Bidder shall identify a contact person who is authorized to represent the Bidder for purposes of the Bid.

B9.4 Paragraph 13 of Form A: Bid shall be signed in accordance with the following requirements:

(a) if the Bidder is a sole proprietor carrying on business in his/her own name, it shall be signed by the Bidder;

(b) if the Bidder is a partnership, it shall be signed by the partner or partners who have authority to sign for the partnership;

(c) if the Bidder is a corporation, it shall be signed by its duly authorized officer or officers and the corporate seal, if the corporation has one, shall be affixed;

(d) if the Bidder is carrying on business under a name other than his/her own, it shall be signed by the registered owner of the business name, or by the registered owner's authorized officials if the owner is a partnership or a corporation.

B9.4.1 The name and official capacity of all individuals signing Form A: Bid should be printed below such signatures.

B9.5 If a Bid is submitted jointly by two (2) or more persons, the word "Bidder" shall mean each and all such persons, and the undertakings, covenants and obligations of such joint Bidders in the Bid and the Contract, when awarded, shall be both joint and several.

B10. PRICES

B10.1 The Bidder shall state a price in Canadian funds for each item of the Work identified on Form B: Prices.

B10.1.1 For the convenience of Bidders, and pursuant to B8.4.2 and B17.4.2, an electronic spreadsheet Form B: Prices in Microsoft Excel (.xls) format is available along with the Adobe PDF documents for this Bid Opportunity on the Bid Opportunities page at the Materials Management Division website at http://www.winnipeg.ca/matmgt/.

B10.2 The quantities listed on Form B: Prices are to be considered approximate only. The City will use said quantities for the purpose of comparing Bids.

B10.3 The quantities for which payment will be made to the Contractor are to be determined by the Work actually performed and completed by the Contractor, to be measured as specified in the applicable Specifications.

B10.4 Payments to Non-Resident Contractors are subject to Non-Resident Withholding Tax pursuant to the Income Tax Act (Canada).

B10.5 Form :B Prices is Organized into Parts. Bidders shall provide a total price for each Part and, on the summary sheet, a Total Bid Price consisting of the sum of prices for Part A to Part F.

B11. DISCLOSURE

B11.1 Various Persons provided information or services with respect to this Work. In the City's opinion, this relationship or association does not create a conflict of interest because of this full disclosure. Where applicable, additional material available as a result of contact with these Persons is listed below.

B11.2 The Persons are:

(a) BellMTS – Information exchanged regarding the existing twelve (12) conduit concrete encased ductbank along westbound Fermor Avenue in order to facilitate the duct bank relocation;

(b) Aquajet Canada Inc. – Hydro-vac expedition for the twelve (12) conduit concrete encased ductbank and 200 mm High Pressure transverse to Fermor Avenue, west of Archibald Street was carried out by AquaJet Canada Inc on August 2017 to determine depth.

B12. QUALIFICATION

B12.1 The Bidder shall:

(a) undertake to be in good standing under The Corporations Act (Manitoba), or properly registered under The Business Names Registration Act (Manitoba), or otherwise properly registered, licensed or permitted by law to carry on business in Manitoba; and

(b) be financially capable of carrying out the terms of the Contract; and

(c) have all the necessary experience, capital, organization, and equipment to perform the Work in strict accordance with the terms and provisions of the Contract.

B12.2 The Bidder and any proposed Subcontractor (for the portion of the Work proposed to be subcontracted to them) shall:

(a) be responsible and not be suspended, debarred or in default of any obligations to the City. A list of suspended or debarred individuals and companies is available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt/debar.stm

B12.3 The Bidder and/or any proposed Subcontractor (for the portion of the Work proposed to be subcontracted to them) shall:

(a) have successfully carried out Work similar in nature, scope and value to the Work;

(b) be fully capable of performing the Work required to be in strict accordance with the terms and provisions of the Contract;

(c) have a written workplace safety and health program if required pursuant to The Workplace Safety and Health Act (Manitoba);

(d) have successfully carried out at least three (3) deep excavations to the level that groundwater pressures have to be mitigated with construction means, methods, techniques, and equipment that are consistent with the proposed method of excavation, shoring, and dewatering detailed in the Specifications;

(e) employ key staff who have successfully carried out at least three (3) deep excavations to the level that groundwater pressures have to be mitigated with construction means, methods, techniques, and equipment that are consistent with the proposed method of excavation, shoring, and dewatering detailed in the Specifications.

B12.4 Further to B12.3(c), the Bidder shall, within five (5) Business Days of a request by the Contract Administrator, provide proof satisfactory to the Contract Administrator that the Bidder/Subcontractor has a workplace safety and health program meeting the requirements of The Workplace Safety and Health Act (Manitoba), by providing:

(a) Written confirmation of a safety and health certification meeting SAFE Work Manitoba's SAFE Work Certified Standard (e.g., COR™ and SECOR™) or

(i) a copy of their valid Manitoba COR certificate and Letter of Good Standing (or Manitoba equivalency) as issued under the Certificate of Recognition (COR) Program administered by the Construction Safety Association of Manitoba or by the Manitoba Heavy Construction Association's WORKSAFELY™ COR™ Program; or

(ii) a copy of their valid Manitoba SECOR™ certificate and Letter of Good Standing (or Manitoba equivalency) as issued under the Small Employer Certificate of Recognition Program (SECOR™) administered by the Construction Safety Association of Manitoba or by the Manitoba Heavy Construction Association's WORKSAFELY™ COR™ Program or

(b) a report or letter to that effect from an independent reviewer acceptable to the City. (A list of acceptable reviewers and the review template are available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt/.

B12.5 The Bidder shall submit, within three (3) Business Days of a request by the Contract Administrator, proof satisfactory to the Contract Administrator of the qualifications of the Bidder and of any proposed Subcontractor.

B12.6 The Bidder shall provide, on the request of the Contract Administrator, full access to any of the Bidder's equipment and facilities to confirm, to the Contract Administrator's satisfaction, that the Bidder's equipment and facilities are adequate to perform the Work.

B13. BID SECURITY

B13.1 The Bidder shall provide bid security in the form of:

(a) a bid bond, in the amount of at least ten percent (10%) of the Total Bid Price, and agreement to bond of a company registered to conduct the business of a surety in Manitoba, in the form included in the Bid Submission (Form G1: Bid Bond and Agreement to Bond); or

(b) an irrevocable standby letter of credit, in the amount of at least ten percent (10%) of the Total Bid Price, and undertaking issued by a bank or other financial institution registered to conduct business in Manitoba and drawn on a branch located in Winnipeg, in the form included in the Bid Submission (Form G2: Irrevocable Standby Letter of Credit and Undertaking); or

(c) a certified cheque or draft payable to "The City of Winnipeg", in the amount of at least fifty percent (50%) of the Total Bid Price, drawn on a bank or other financial institution registered to conduct business in Manitoba.

B13.1.1 If the Bidder submits alternative bids, the bid security shall be in the amount of the specified percentage of the highest Total Bid Price submitted.

B13.1.2 All signatures on bid securities shall be original.

B13.1.3 The Bidder shall sign the Bid Bond.

B13.1.4 The Surety shall sign and affix its corporate seal on the Bid Bond and the Agreement to Bond.

B13.2 The bid security of the successful Bidder and the next two (2) lowest evaluated responsive and responsible Bidders will be released by the City when a Contract for the Work has been duly

executed by the successful Bidder and the performance security furnished as provided herein. The bid securities of all other Bidders will be released when a Contract is awarded.

B13.2.1 Where the bid security provided by the successful Bidder is in the form of a certified cheque or draft pursuant to B13.1(c), it will be deposited and retained by the City as the performance security and no further submission is required.

B13.2.2 The City will not pay any interest on certified cheques or drafts furnished as bid security or subsequently retained as performance security.

B13.3 The bid securities of all Bidders will be released by the City as soon as practicable following notification by the Contract Administrator to the Bidders that no award of Contract will be made pursuant to the Bid Opportunity.

B14. OPENING OF BIDS AND RELEASE OF INFORMATION

B14.1 Bids will be opened publicly, after the Submission Deadline has elapsed, in the office of the Corporate Finance Department, Materials Management Division, or in such other office as may be designated by the Manager of Materials.

B14.1.1 Bidders or their representatives may attend.

B14.1.2 Bids determined by the Manager of Materials, or his/her designate, to not include the bid security specified in B13 will not be read out.

B14.2 Following the submission deadline, the names of the Bidders and their Total Bid Prices (unevaluated, and pending review and verification of conformance with requirements) will be available on the Closed Bid Opportunities (or Public/Posted Opening & Award Results) page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt/

B14.3 After award of Contract, the name(s) of the successful Bidder(s), their address(es) and the Contract amount(s) will be available on the Closed Bid Opportunities (or Public/Posted Opening & Award Results) page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt/

B14.4 The Bidder is advised that any information contained in any Bid may be released if required by The Freedom of Information and Protection of Privacy Act (Manitoba), by other authorities having jurisdiction, or by law or by City policy or procedures (which may include access by members of City Council).

B14.4.1 To the extent permitted, the City shall treat as confidential information, those aspects of a Bid Submission identified by the Bidder as such in accordance with and by reference to Part 2, Section 17 or Section 18 or Section 26 of The Freedom of Information and Protection of Privacy Act (Manitoba), as amended.

B15. IRREVOCABLE BID

B15.1 The Bid(s) submitted by the Bidder shall be irrevocable for the time period specified in Paragraph 11 of Form A: Bid.

B15.2 The acceptance by the City of any Bid shall not release the Bids of the next two (2) lowest evaluated responsive Bidders and these Bidders shall be bound by their Bids on such Work until a Contract for the Work has been duly executed and the performance security furnished as herein provided, but any Bid shall be deemed to have lapsed unless accepted within the time period specified in Paragraph 11 of Form A: Bid.

B16. WITHDRAWAL OF BIDS

B16.1 A Bidder may withdraw his/her Bid without penalty by giving written notice to the Manager of Materials at any time prior to the Submission Deadline.

B16.1.1 Notwithstanding C23.3, the time and date of receipt of any notice withdrawing a Bid shall be the time and date of receipt as determined by the Manager of Materials.

B16.1.2 The City will assume that any one of the contact persons named in Paragraph 3 of Form A: Bid or the Bidder's authorized representatives named in Paragraph 13 of Form A: Bid, and only such person, has authority to give notice of withdrawal.

B16.1.3 If a Bidder gives notice of withdrawal prior to the Submission Deadline, the Manager of Materials will:

(a) retain the Bid until after the Submission Deadline has elapsed;

(b) open the Bid to identify the contact person named in Paragraph 3 of Form A: Bid and the Bidder's authorized representatives named in Paragraph 13 of Form A: Bid; and

(c) if the notice has been given by any one of the persons specified in B16.1.3(b), declare the Bid withdrawn.

B16.2 A Bidder who withdraws his/her Bid after the Submission Deadline but before his/her Bid has been released or has lapsed as provided for in B15.2 shall be liable for such damages as are imposed upon the Bidder by law and subject to such sanctions as the Chief Administrative Officer considers appropriate in the circumstances. The City, in such event, shall be entitled to all rights and remedies available to it at law, including the right to retain the Bidder's bid security.

B17. EVALUATION OF BIDS

B17.1 Award of the Contract shall be based on the following bid evaluation criteria:

(a) compliance by the Bidder with the requirements of the Bid Opportunity, or acceptable deviation therefrom (pass/fail);

(b) qualifications of the Bidder and the Subcontractors, if any, pursuant to B12 (pass/fail);

(c) Total Bid Price;

(d) economic analysis of any approved alternative pursuant to B7.

B17.2 Further to B17.1(a), the Award Authority may reject a Bid as being non-responsive if the Bid is incomplete, obscure or conditional, or contains additions, deletions, alterations or other irregularities. The Award Authority may reject all or any part of any Bid, or waive technical requirements or minor informalities or irregularities, if the interests of the City so require.

B17.3 Further to B17.1(b), the Award Authority shall reject any Bid submitted by a Bidder who does not demonstrate, in his/her Bid or in other information required to be submitted, that he/she is responsible and qualified.

B17.4 Further to B17.1(c), the Total Bid Price shall be the sum of the quantities multiplied by the unit prices for each item shown on Form B: Prices.

B17.4.1 Further to B17.1(a), in the event that a unit price is not provided on Form B: Prices, the City will determine the unit price by dividing the Amount (extended price) by the approximate quantity, for the purposes of evaluation and payment.

B17.4.2 The electronic Form B: Prices and the formulas imbedded in that spreadsheet are only provided for the convenience of Bidders. The City makes no representations or warranties as to the correctness of the imbedded formulas. It is the Bidder's responsibility to ensure the extensions of the unit prices and the sum of Total Bid Price performed as a function of the formulas within the electronic Form B: Prices are correct.

B18. AWARD OF CONTRACT

B18.1 The City will give notice of the award of the Contract or will give notice that no award will be made.

B18.2 The City will have no obligation to award a Contract to a Bidder, even though one or all of the Bidders are determined to be responsible and qualified, and the Bids are determined to be responsive.

B18.2.1 Without limiting the generality of B18.2, the City will have no obligation to award a Contract where:

(a) the prices exceed the available City funds for the Work;

(b) the prices are materially in excess of the prices received for similar work in the past;

(c) the prices are materially in excess of the City's cost to perform the Work, or a significant portion thereof, with its own forces;

(d) only one (1) Bid is received; or

(e) in the judgment of the Award Authority, the interests of the City would best be served by not awarding a Contract.

B18.3 Where an award of Contract is made by the City, the award shall be made to the responsible and qualified Bidder submitting the lowest evaluated responsive Bid, in accordance with B17.

B18.3.1 Following the award of contract, a Bidder will be provided with information related to the evaluation of his/her Bid upon written request to the Contract Administrator.

PART C - GENERAL CONDITIONS

C0. GENERAL CONDITIONS

C0.1 The *General Conditions for Construction* (Revision 2006 12 15) are applicable to the Work of the Contract.

C0.1.1 The *General Conditions for Construction* are available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt/gen_cond.stm

C0.2 A reference in the Bid Opportunity to a section, clause or subclause with the prefix "**C**" designates a section, clause or subclause in the *General Conditions for Construction*.

PART D - SUPPLEMENTAL CONDITIONS

GENERAL

D1. GENERAL CONDITIONS

D1.1 In addition to the General Conditions for Construction, these Supplemental Conditions are applicable to the Work of the Contract.

D2. SCOPE OF WORK

D2.1 The Work to be done under the Contract shall consist of the Rehabilitation of Fermor Avenue Bridge over Seine River, construction of Pedestrian-Cyclist Underpass Structure and Roadworks from St. Anne's Road to Archibald Street.

D2.2 The major components of the Work are as follows:

D2.2.1 **Part A – Fermor Avenue Bridge Rehabilitation**

(a) Construction of temporary shoring and installation of temporary traffic barriers;

(b) Removal of existing approach slabs;

(c) Excavate behind abutment for abutment reconstruction;

(d) Temporarily support and protect existing BellMTS duct bank lines;

(e) Demolish and remove existing deck overhang and isolate Stage 1 and Stage 2;

(f) Jack-up and temporarily support superstructure at west and east abutments;

(g) Complete abutment repairs, including concrete removals, installation of cathodic protection, concrete repairs, and installation of new bearings;

(h) Lower superstructure onto newly repaired abutments;

(i) Remove existing high-density overlay;

(j) Remove by hydro-demolition existing concrete bridge deck including existing top mat of reinforcing steel;

(k) Remove by hydro-demolition existing concrete bridge deck (full depth) over piers, bottom mat of reinforcing steel. Remove existing pier and abutment diaphragms;

(l) Remove existing steel girder splice plates. Install new splice plates and cast new pier and abutment diaphragms;

(m) Fabrication and installation of deck overhang;

(n) Supply and installation of top mat stainless steel reinforcement and cast new concrete overlay and overhang;

(o) Construction of traffic barrier and installation of aluminum handrail;

(p) Sandbast existing steel girders and apply new protection system;

(q) Miscellaneous repair to intermediate diaphragms;

(r) Miscellaneous repairs to concrete piers;

(s) Construction of approach slabs;

(t) Construction of median barrier;

(u) Place deck waterproofing and protection system;

(v) Construction of asphalt overlay.

D2.2.2 **Part B – Pedestrian- Cyclist Underpass under Fermor Avenue (Station 0+148 to 0+188)**

(a) Construction and installation of temporary traffic barrier and temporary shoring;

(b) Structural excavation ;

(c) Sub-grade compaction;

(d) Placement of underpass sub-base, base course material and board insulation;

(e) Construction of underpass structure and underpass approach slab;

(f) Place waterproofing and installation of underpass lighting.

D2.2.3 **Part C – Construction of Retaining Walls**

(a) Installation of temporary traffic barrier;

(b) Construction of sheet pile driving, concrete cladding, copping, handrail, etc;

(c) Construction of traffic barrier footing and traffic barrier;

(d) Construction of granular rib construction, rip-rap and erosion control blanket.

D2.2.4 **Part D – Construction of Overhead Sign Structures (OHSS)**

(a) Construction of OHSS foundations;

(b) Fabrication and installation of OHSS's;

(c) Salvage and re-installation of St. Vital Biz Pole;

(d) Installation of roadside barriers and end treatments for overhead sign structures and other appurtenances.

D2.2.5 **Part E – Fermor Avenue Reconstruction, Rehabilitation and Related Works – Surface Works**

(a) Construction of temporary median crossovers;

(b) Construction of temporary asphalt lanes;

(c) Planing of existing mainline asphalt to various depth (average planning thickness 50 mm);

(d) Perform clearing and grubbing;

(e) Removal of boulevard trees;

(f) Preparation of existing ground surface;

(g) Removal of existing pavement, curb, sidewalk, medians;

(h) Renewal of existing concrete slabs;

(i) Earthwork excavation and fill;

(j) Sub-grade compaction;

(k) Placement of separation geotextile fabric;

(l) Placement of sub-base and base course material;

(m) Construction of concrete curbs, bullnose and sidewalks;

(n) Construction of asphalt and concrete pavement;

(o) Construction of asphaltic shoulders;

(p) Construction of active transportation pathways;

(q) Construction roadway median barriers;

(r) Supply and install guardrail systems and et-end treatments;

(s) Placement of mainline asphalt;

(t) Construction of various stone rip-rap and french drains;

(u) Removals, salvage and installation of fencing;

(v) Landscaping works;

(w) Perform reflective crack maintenance.

D2.2.6 **Part F – Fermor Avenue Reconstruction – Underground Works**

(a) Removal of existing catchbasins, catch-pits, CSP culverts;

(b) Installation and adjustment of drainage inlets and manholes;

(c) Installation of CSP culverts;

(d) Installation of new outfalls;

(e) New trenchless LDS, manholes, catchbasins and catch pits;

(f) Install sub-drains;

(g) Relocate existing hydrants;

(h) Install French drains.

D3. DEFINITIONS

D3.1 When used in this Bid Opportunity:

(a) "**ASTM** " means American Society for Testing and Materials ;

(b) "**CSA** " means Canadian Standard Association ;

(c) "**Others** " means any person, firm, corporation, utility or other entity employed by or having a contract directly or indirectly with the City other than through the Contractor ;

(d) "**RFI** " means Request for Information and means written documentation sent by the Contractor to the Contract Administrator requesting written clarification (s) and / or interpretation(s) of the Drawings, Specifications and / or Contract requirements and / or other pertinent information required to complete the work.

(e) "**Site** " means In addition to the definition of Site in GC C1.1 bb), "Site" shall also refer to lands or areas delineated in the Drawings as being furnished by the City upon which the Work is to be performed, including rights-of-way and easements for access thereto, and such other lands furnished by the City which are designated for the use of the Contractor for the performance of the Work;

(f) "**Submittal** " shall be a term synonymous with the term "Shop Drawings";

D3.2 Within the text of the Specifications, reference may be made to the following acronyms in relation to codes, standards and organizations:

AABC	Associated Air Balance Council
AASHTO	American Association of State Highway and Transportation Officials
ABMA	American Bearing Manufacturers Association
ACI	American Concrete Institute
ADC	Air Diffusion Council
AGMA	American Gear Manufacturers Association
AHRI	Air-Conditioning, Heating and Refrigeration Institute
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMCA	Air Movement and Control Association International, Inc.
ANSI	American National Standards Institute
APHA	American Public Health Association
API	American Petroleum Institute

AREMA	American Railway Engineering and Maintenance-of-Way Association
ASA	Acoustical Society of America
ASCE	American Society of Civil Engineers
ASCII	American Standard Code for Information Interchange
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASTM	ASTM International (formerly American Society for Testing and Materials)
ATP	Active Transportation Pathway
AWMAC	Architectural Woodwork Manufacturers Association of Canada
AWPA	American Wood Protection Association
AWS	American Welding Society
AWWA	American Water Works Association
CAN	National Standard of Canada
CBAC	Clay Brick Association of Canada
CBM	Certified Ballast Manufacturers
CCA	Canadian Construction Association
CCMC	Canadian Construction Materials Centre
CEA	Canadian Electricity Association
CEC	Canadian Electrical Code
CEMA	Canadian Electrical Manufacturers Association
CGA	Canadian Gas Association
CGSB	Canadian General Standards Board
CISC	Canadian Institute of Steel Construction
CISPI	Cast Iron Soil Pipe Institute
CITC	Canadian Institute of Timber Construction
CIU	Canadian Institute of Underwriters
CLA	Canadian Lumberman's Association
CLSAB	Canadian Lumber Standards Accreditation Board
CMAA	Crane Manufacturers Association of America
CMHC	Canada Mortgage and Housing Corporation
CPCA	Canadian Paint and Coatings Association
CPCI	Canadian Precast/Prestressed Concrete Institute
CRCA	Canadian Roofing Contractors' Association
CRSI	Concrete Reinforcing Steel Institute
CSA	Canadian Standards Association
CSDMA	Canadian Steel Door Manufacturers Association
CSPI	Corrugated Steel Pipe Institute

CSSBI	Canadian Sheet Steel Building Institute
CTI	Cooling Technology Institute
CWB	Canadian Welding Bureau
CWC	Canadian Wood Council
CWDMA	Canadian Window & Door Manufacturers Association
DIN	Deutsche Industries Norm
EEI	Edison Electric Institute
EEMAC	Electrical Equipment Manufacturers Association of Canada
EFC	Electro-Federation Canada
EIA	Electronic Industries Alliance
EJMA	Expansion Joint Manufacturers Association
ETL	Intertek Testing Services (formerly ETL Testing Laboratories)
FCC	Federal Communications Commission (USA)
FM	Factory Mutual Engineering Corporation
FSA	Fluid Sealing Association
GANA	Glass Association of North America
IAO	Insurers' Advisory Organization
IAPMO	International Association of Plumbing and Mechanical Officials
IBC	International Building Code (published by ICC)
IBRM	Institute of Boiler and Radiator Manufacturers
ICC	International Code Council
ICEA	Insulated Cable Engineers Association
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IGMAC	Insulating Glass Manufacturers Association of Canada
ISA	International Society of Automation
ISO	International Organization for Standardization
LDS	Land Drainage System
LTIC	Laminated Timber Institute of Canada
MCAC	Mechanical Contractors Association of Canada
MFMA	Metal Framing Manufacturers Association
MPTA	Mechanical Power Transmission Association
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
NAAMM	National Association of Architectural Metal Manufacturers (USA)
NABA	National Air Barrier Association
NACE	NACE International (formerly National Association of Corrosion Engineers)
NAIMA	North American Insulation Manufacturers Association

NBC	National Building Code of Canada
NEBB	National Environmental Balancing Bureau (USA)
NEC	National Electrical Code (USA)
NECA	National Energy Conservation Association
NEMA	National Electrical Manufacturers Association (USA)
NESC	National Electric Safety Code (published by IEEE)
NFPA	National Fire Protection Association (USA)
NLGA	National Lumber Grades Authority
NRC	National Research Council Canada
NSF	National Sanitation Foundation
OECI	Overhead Electrical Crane Institute
OSHA	Occupational Safety & Health Administration (USA)
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PDI	Plumbing and Drainage Institute
RMA	Rubber Manufacturers Association
RSIC	Reinforcing Steel Institute of Canada
SAE	Society of Automotive Engineers
SI	International System of Units
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association (USA)
SSPC	The Society for Protective Coatings
TAC	Transportation Association of Canada
TIAC	Thermal Insulation Association of Canada
UL	Underwriters Laboratories Inc.
ULC	Underwriters Laboratories of Canada
WCB	Workers Compensation Board (Manitoba)

D3.3 Where the edition, version or revision date of a referenced regulation, code or standard is not identified, conform to the latest edition or revision of the referenced regulation, code or standard, including amendments and revisions.

D3.3.1 Where a regulation, code or standard stipulates the edition, version or revision date of a subordinate regulation, code or standard, conform to the stipulated edition, version or revision of the subordinate regulation, code or standard to the extent of the primary regulation, code or standard.

D4. CONTRACT ADMINISTRATOR

D4.1 The Contract Administrator is Dillon Consulting Limited, represented by:

Jeff Crang, P. Eng., PTOE
Project Manager

Telephone No. 204 453-2301 Email Address jcrang@dillon.ca

D4.2 At the pre-construction meeting, Jeff Crang, P. Eng., PTOE will identify additional personnel representing the Contract Administrator and their respective roles and responsibilities for the Work.

D4.3 Bids Submissions must be submitted to the address in B8.

D5. CONTRACTOR'S SUPERVISOR

D5.1 At the pre-construction meeting, the Contractor shall identify his/her designated supervisor and any additional personnel representing the Contractor and their respective roles and responsibilities for the Work.

D5.2 At least two (2) business days prior to the commencement of any Work on the site, the Contractor shall provide the Contract Administrator with a phone number where the supervisor identified in D5.1 or an alternate can be contacted twenty-four (24) hours a day to respond to an emergency.

D6. OWNERSHIP OF INFORMATION, CONFIDENTIALITY AND NON DISCLOSURE

D6.1 The Contract, all deliverables produced or developed, and information provided to or acquired by the Contractor are the property of the City and shall not be appropriated for the Contractors own use, or for the use of any third party.

D6.2 The Contractor shall not make any public announcements or press releases regarding the Contract, without the prior written authorization of the Contract Administrator.

D6.3 The following shall be confidential and shall not be disclosed by the Contractor to the media or any member of the public without the prior written authorization of the Contract Administrator;

(a) information provided to the Contractor by the City or acquired by the Contractor during the course of the Work;

(b) the Contract, all deliverables produced or developed;

(c) any statement of fact or opinion regarding any aspect of the Contract.

D6.4 A Contractor who violates any provision of D6 may be determined to be in breach of Contract.

D7. NOTICES

D7.1 Except as provided for in C23.2.2, all notices, requests, nominations, proposals, consents, approvals, statements, authorizations, documents or other communications to the Contractor shall be sent to the address or facsimile number identified by the Contractor in Paragraph 2 of Form A: Bid.

D7.2 All notices, requests, nominations, proposals, consents, approvals, statements, authorizations, documents or other communications to the City, except as expressly otherwise required in D7.3 D7.4 or elsewhere in the Contract, shall be sent to the attention of the Contract Administrator identified in D4.1.

D7.3 Notwithstanding C21, all notices of appeal to the Chief Administrative Officer shall be sent to the attention of the Chief Financial Officer at the following:

The City of Winnipeg

Attn: Chief Financial Officer
Office of the Chief Administrative Officer
Susan A. Thompson Building
2nd Floor, 510 Main Street
Winnipeg MB R3B 1B9

D7.4 All notices, requests, nominations, proposals, consents, approvals, statements, authorizations, documents or other communications required to be submitted or returned to the City Solicitor shall be sent to the following facsimile number:

The City of Winnipeg
Legal Services Department
Attn: Director of Legal Services

Facsimile No.: 204-947-9155

D7.5 **Bids Submissions must not be submitted to this facsimile number. Bids must be submitted in accordance with B8.**

D8. FURNISHING OF DOCUMENTS

D8.1 Upon award of the Contract, the Contractor will be provided with five (5) complete sets of the Bid Opportunity. If the Contractor requires additional sets of the Bid Opportunity, they will be supplied to him/her at cost.

D9. NO LOBBYING

D9.1 Bidders are prohibited from engaging in any form of political or other lobbying, of any kind whatsoever in relation to this Bid Opportunity, or to influence the outcome of the procurement process.

D9.2 Without limiting the generality of D9.1, Bidders shall not contact or attempt to contact anyone other than the Contract Administrator, either directly or indirectly, at any time during the procurement process on matters related to the procurement process, the Bid Opportunity documents, or the Bids.

SUBMISSIONS

D10. AUTHORITY TO CARRY ON BUSINESS

D10.1 The Contractor shall be in good standing under The Corporations Act (Manitoba), or properly registered under The Business Names Registration Act (Manitoba), or otherwise properly registered, licensed or permitted by law to carry on business in Manitoba, or if the Contractor does not carry on business in Manitoba, in the jurisdiction where the Contractor does carry on business, throughout the term of the Contract, and shall provide the Contract Administrator with evidence thereof upon request.

D11. SAFE WORK PLAN

D11.1 The Contractor shall provide the Contract Administrator with a Safe Work Plan at least five (5) Business Days prior to the commencement of any Work on the Site but in no event later than the date specified in C4.1 for the return of the executed Contract.

D11.2 The Safe Work Plan shall be prepared and submitted in the format shown in the City's template which is available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt/safety/default.stm

D12. INSURANCE

D12.1 The City shall provide and maintain the following owner controlled project insurance coverage to remain in place :

(a) All risks course of construction insurance for the value of the bridge rehabilitation and pedestrian underpass. Such policy will be written in the joint names of the City, Contractor and Subcontractors including testing and commissioning and shall remain in place until Substantial Performance. The Contractor shall be responsible for deductibles up to $50,000 except for flood and water damage losses subject to $100,000 deductible.

(b) All risk property insurance for full replacement cost of the existing structure while performing the Work. The Contactor shall be responsible for deductibles up to $250,000 per occurrence for losses during the

(c) Wrap-up liability insurance in an amount of no less than ten million dollars ($10,000,000) inclusive per occurrence and ten millions dollars ($10,000,000) general aggregate, covering bodily injury, personal injury, damage to the existing structure, hook liability property damage and products and completed operations consistent with industry standard insurance policy wordings. Wrap up liability insurance to also include evidence of contractual liability and cross liability clauses.

(i) The Contractor shall be responsible for deductibles up to $50,000 maximum of any one loss.

(ii) The City will carry such insurance to cover the City, Contractors, and Subcontractors as insured's. Provision of this insurance by the City is not intended in any way to relieve the Contractor from his obligations under the terms of the Contract. Specifically, losses relating to deductibles for insurance, as well as losses in excess of limits of coverage and any risk of loss that is not covered under the terms of the insurance provided by the City remains with the Contractor.

(iii) BellMTS, Manitoba Hydro, Shaw and Telus shall be shown as additional insured, as required by contract.

(iv) Wrap-up liability insurance shall be maintained from the date of the commencement of the Work until the date of Total Performance of the work and shall include an additional twenty-four (24) months completed operations coverage which will take affect after Total Performance.

D12.2 The Contractor shall provide and maintain the following insurance coverage at all times during the performance of the Work and throughout the warranty period:

(a) commercial general liability insurance, in the amount of at least five million dollars ($5,000,000.00) inclusive, with the City added as an additional insured, with a cross-liability clause, such liability policy to also contain contractual liability, unlicensed motor vehicle liability, non-owned automobile liability, broad form property damage cover and products and completed operations;

(b) Automobile Liability Insurance covering all motor vehicles, owned and operated and used or to be used by the Contractor directly or indirectly in the performance of the Work. The Limit of Liability shall not be less than $2,000,000 inclusive for loss or damage including personal injuries and death resulting from any one accident or occurrence;

(c) Contractor's pollution liability (CPL) in the amount of at least one million dollars ($1,000,000) per occurrence and two million dollars ($2,000,000) annual aggregate insuring against claims covering third-party injury and property damage claims and including clean-up costs and transported cargo as a result of pollution conditions arising suddenly or gradually from the Contractor operations and completed operations. Such policy to name the City as an additional insured and remain in place throughout the warranty period;

(d) Property insurance for equipment, tools, field office and portable toilets used by the Contractor directly or indirectly in the performance of the Work on the project that may be owned, rented, leased or borrowed.

D12.3 Deductibles shall be borne by the Contractor.

D12.4 All policies shall be taken out with insurers duly licensed to carry on business in the Province of Manitoba.

D12.5 The Contractor shall provide the City Solicitor with a certificate(s) of insurance, in a form satisfactory to the City Solicitor, at least two (2) Business Days prior to the commencement of any Work but in no event later than the date specified in the C4.1 for the return of the executed Contract.

D12.6 The Contractor shall not cancel, materially alter, or cause each policy to lapse without providing at least thirty (30) Calendar Days prior written notice to the Contract Administrator.

D13. PERFORMANCE SECURITY

D13.1 The Contractor shall provide and maintain performance security until the expiration of the warranty period in the form of:

(a) a performance bond of a company registered to conduct the business of a surety in Manitoba, in the form attached to these Supplemental Conditions (Form H1: Performance Bond), in the amount of fifty percent (50%) of the Contract Price; or

(b) an irrevocable standby letter of credit issued by a bank or other financial institution registered to conduct business in Manitoba and drawn on a branch located in Winnipeg, in the form attached to these Supplemental Conditions (Form H2: Irrevocable Standby Letter of Credit), in the amount of fifty percent (50%) of the Contract Price; or

(c) a certified cheque or draft payable to "The City of Winnipeg", drawn on a bank or other financial institution registered to conduct business in Manitoba, in the amount of fifty percent (50%) of the Contract Price.

D13.1.1 Where the performance security is in the form of a certified cheque or draft, it will be deposited by the City. The City will not pay any interest on certified cheques or drafts furnished as performance security.

D13.2 If the bid security provided in his/her Bid was not a certified cheque or draft pursuant to B13.1(c), the Contractor shall provide the City Solicitor with the required performance security within seven (7) Calendar Days of notification of the award of the Contract by way of letter of intent and prior to the commencement of any Work on the Site and in no event later than the date specified in the C4.1 for the return of the executed Contract.

D14. SUBCONTRACTOR LIST

D14.1 The Contractor shall provide the Contract Administrator with a complete list of the Subcontractors whom the Contractor proposes to engage (Form J: Subcontractor List) at or prior to a pre-construction meeting, or at least two (2) Business Days prior to the commencement of any Work on the Site but in no event later than the date specified in the C4.1 for the return of the executed Contract.

D15. EQUIPMENT LIST

D15.1 The Contractor shall provide the Contract Administrator with a complete list of the equipment which the Contractor proposes to utilize (Form K: Equipment List) at or prior to a pre-construction meeting, or at least two (2) Business Days prior to the commencement of any Work on the Site but in no event later than the date specified in the C4.1 for the return of the executed Contract.

D16. DETAILED WORK SCHEDULE

D16.1 The Contractor shall provide the Contract Administrator with a detailed work schedule at least two (2) Business Days prior to the commencement of any Work on the Site but in no event later than the date specified in the General Conditions for the return of the executed Contract.

D16.2 The detailed work schedule shall consist of a "baseline schedule" component showing the planned start and completion dates for all activities/tasks. In addition, the detailed work schedule shall consist of an "update schedule" component showing the Contractor's updated planned or actual start, progress and completion dates for each activity/task as construction proceeds in order to compare Contractor's planned baseline schedule versus actual execution of the Work.

D16.3 The Contractor's planned baseline detailed work schedule will be reviewed by Contract Administrator as a Submittal for conformance to the Project intent and general conformance to the requirements of the Contract.

D16.4 Contractor shall not change the baseline portion of the detailed work schedule, once it has been reviewed without issue by Contract Administrator, without prior consent or until requested by the Contract Administrator.

D16.5 The detailed work schedule shall consist of the following:

(a) a critical path method (C.P.M.) schedule for the Work;

(b) a Gantt chart for the Work based on the C.P.M. schedule;

(c) capacity to show simultaneously the planned baseline schedule as well as the update schedule for each activity/task ;

all acceptable to the Contract Administrator.

D16.6 Further to D16.5(a), the C.P.M. schedule shall clearly identify the start and completion dates of all of the following activities/tasks making up the Work as well as showing those activities/tasks on the critical path:

(a) Date of Commencement of the Work;

(b) Mobilization to Site;

(c) Critical Stages as listed in D30;

(d) Substantial Performance;

(e) Total Performance;

(f) Demobilization from Site.

D16.7 Landscaping Maintenance and other Maintenance

D16.8 Further to D16.5(b), the Gantt chart shall show the time on a weekly basis, required to carry out the Work of each trade, or specification division. The time shall be on the horizontal axis, and the type of trade shall be on the vertical axis.

D16.9 Without changing the baseline portion of the detailed work schedule, at least once per month or within two (2) Working Days upon request from the Contract Administrator, Contractor shall accurately update the "update schedule".

D16.10 Should Contractor's operations fall behind the accepted detailed work schedule, Contractor shall, at no change in Contract Price, take corrective action to get back on schedule.

D16.11 Contractor shall provide sub-schedules to define critical portions of the Work upon reasonable request from the Contract Administrator.

D17. ENVIRONMENTAL PROTECTION PLAN

D17.1 Prior to commencing construction activities or delivery of materials to Site, submit an Environmental Protection Plan for review and approval by Contract Administrator. The Environmental Protection Plan shall present a comprehensive plan to address all of the Contractor's chosen means and methods towards performing the Work that may impact the environment. The submission of the Environmental Protection Plan to the Contract Administrator shall in no way relieve the Contractor of full responsibility for the success or failure of all environmental management practices and procedures.

D17.2 The Contractor is advised that at least the following Acts, Regulations, and By-laws apply to the Work:

(a) Federal

(i) Canadian Environmental Assessment Act, 2012 (CEAA, 2012)

(ii) Canadian Environmental Protection Act (CEPA) C.33;

(iii) Fisheries Act C.F-14;

(iv) Hazardous Products Act C.H.-3;

(v) Transportation of Dangerous Goods Act and Regulations C.34;

(vi) Migratory Birds Convention Act and Regulations, c. 22;

(vii) Species at Risk Act, c. 29;

(viii) And any other applicable Acts, Regulations and By-laws;

(ix) Applicable Fisheries and Oceans Canada (DFO) Operational Statements for Manitoba for stream crossings and bridge works;

(x) The DFO Freshwater Intake End-of-Pipe Fish Screen Guidelines, DFO 1995;

(xi) DFO Policy for the Management of Fish Habitat 1986;

(xii) Federal Policy on Wetland Conservation 1991;

(xiii) Transportation Association of Canada's National Guide to Erosion and Sediment Control on Roadway Projects, 2005.

(b) Provincial

(i) The Dangerous Goods Handling and Transportation Act D12;

(ii) The Endangered Species and Ecosystems Act E111;

(iii) The Environment Act C.E125;

(iv) The Fire Prevention Act F80;

(v) The Manitoba Heritage Resources Act H39-1;

(vi) The Manitoba Noxious Weeds Act N110;

(vii) The Manitoba Nuisance Act N120;

(viii) Pesticides and Fertilizers Control Act P40;

(ix) The Water Protection Act, c. W65;

(x) The Public Health Act C.P210; and

(xi) The Workplace Safety and Health Act W210;

(xii) The Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat, Manitoba Natural Resources and DFO, 1996;

(xiii) And current applicable associated regulations;

(xiv) And any other applicable Acts, Regulations, and By-laws.

(c) Municipal

(i) The City of Winnipeg By-law Neighbourhood Liveability No. 1/2008 and all amendments;

(ii) The City of Winnipeg Traffic By-law No. 1573/77 and all amendments;

(iii) City of Winnipeg Best Management Practices Handbook for Activities In and Around the City's Waterways and Watercourses, City of Winnipeg, 2005;

(iv) City of Winnipeg Motor Vehicle Noise Policies and Guidelines;

(v) The City of Winnipeg Sewer By-law No. 92/2010 and all amendments;

(vi) Any other applicable Acts, Regulations, and By-laws and associated updates and amendments.

D17.3 The Contractor is advised that the following environmental protection measures apply to the Work.

D17.3.1 Materials Handling and Storage

(a) Storage of construction materials and equipment will be confined within a fenced area or at a location approved by the Contract Administrator with environmental protection (e.g. silt fence) as appropriate.

(b) Construction materials will not be deposited or stored on or near watercourses unless written acceptance from the Contract Administrator is received in advance.

(c) Construction materials and debris will be tied down or secured if severe weather and high wind velocities are forecasted. Work shall be suspended during extreme high wind conditions.

(d) Construction materials and debris will be prevented from entering watercourses. In the event that materials and/or debris inadvertently enter the land drainage system, the Contractor will be required to remove the material to an appropriate landfill or storage facility and restore the watercourse to its original condition.

D17.3.2 Fuel Handling and Storage

(a) The Contractor will obtain all necessary permits from Manitoba Sustainable Development (MSD) for the handling and storage of fuel products and shall provide copies to the Contract Administrator.

(b) All fuel handling and storage facilities will comply with The Dangerous Goods and Transportation Act Storage and Handling of Petroleum Products Regulation and any local land use permits.

(c) Fuels, lubricants and other potentially hazardous materials as defined in The Dangerous Goods and Transportation Act will be stored and handled within approved storage areas.

(d) The Contractor will ensure that any temporary fuel storage areas established for construction of the project are contained by an impermeable dike and are located a minimum distance of 100 m away from Seine River and any other watercourse. Dikes will be designed, constructed, and maintained to retain not less than one hundred percent (100%) of the capacity of the total number of containers or one hundred and ten percent (110%) of the largest container, whichever is greatest. The dikes will be constructed of clay or similar impervious material. If this type of material is not available, the dike will be constructed of locally available material and lined with high-density polyethylene (HDPE). Furthermore, the fuel storage area(s) will be secured by a barrier such as a high fence and gate to prevent vandalism.

(e) The Contractor will ensure that all fuel storage containers are inspected daily for leaks and spillage.

(f) Products transferred from the fuel storage area(s) to specific Work sites will not exceed the daily usage requirement.

(g) When servicing requires the drainage or pumping of fuels, lubricating oils or other fluids from equipment, a groundsheet of suitable material (such as HDPE) and size will be spread on the ground to catch the fluid in the event of a leak or spill.

(h) Wash, refuel and service machinery and store fuel and other materials for the machinery a minimum of 100 m away from watercourses to prevent deleterious substances from entering the water.

(i) The area around storage sites and fuel lines will be distinctly marked and kept clear of snow and debris to allow for routine inspection and leak detection.

(j) The deposit of deleterious substances into water frequented by fish is prohibited under the Fisheries Act, 1985. The Contractor will take appropriate precautions to ensure that potentially deleterious substances (such as fuel, hydraulic fluids, oil, sediment, etc.) do not enter any water body.

(k) Machinery is to arrive on Site in a clean condition and is to be maintained free of fluid leaks.

(l) A sufficient supply of materials, such as absorbent material and plastic oil booms, to clean up minor spills will be stored nearby on Site. The Contractor will ensure that additional material can be made available on short notice. Additionally, appropriate staff on Site will be trained in proper handling of deleterious liquids (i.e. fueling) and trained on how to prevent and clean-up minor spills.

D17.3.3 Waste Handling and Disposal

(a) The construction area will be kept clean and orderly at all times and at the completion of construction.

(b) At no time during construction will personnel or construction waste be permitted to accumulate for more than one (1) day at any location on the construction Site, other than at a dedicated storage area as may be approved by the Contract Administrator.

(c) The Contractor will, during and at the completion of construction, clean up the construction area and all resulting debris shall be deposited at a Waste Disposal Ground operating under the authority of Waste Disposal Grounds Regulation, Manitoba Regulation 150/91. Exceptions are liquid industrial and hazardous wastes which require special disposal methods.

(d) On Site volumes of sewage and/or septage will be removed on a weekly basis.

(e) The Contractor will ensure sewage, septage and other liquid wastes generated on Site are handled and disposed of by a certified disposal contractor.

(f) Indiscriminate dumping, littering, or abandonment will not take place.

(g) No burning of waste or other materials is permitted.

(h) Clearing debris will be disposed of by chipping and/or mulching with the material being used by the City of Winnipeg for future uses.

(i) The Contractor will use structurally suitable Site excavation material as fill within the project. Should excavated material exceed fill needs, the remainder would be stockpiled for use on other local projects.

(j) Structurally unsuitable site excavation material will be removed by the Contractor.

(k) Waste storage areas will not be located so as to block natural drainage.

(l) Runoff from a waste storage area will not be allowed to cause siltation of a watercourse.

(m) Waste storage areas will be left in a neat and finished appearance and/or restored to their original condition to the satisfaction of the Contract Administrator.

(n) Equipment will not be cleaned near (within 100 m) watercourses; contaminated water from onshore cleaning operations will not be permitted to enter watercourses.

(o) The Contractor will notify and receive written approval from the Contract Administrator prior to discharge from any dewatered areas. The discharge will be released into a

well-vegetated area, filter bag, settling basin, or storm sewer system to remove suspended material and other deleterious substances from the discharge before it finds its way into any watercourse. Discharge from dewatering areas may require approved disposal via the sanitary sewer system or disposal truck in accordance with Construction Specifications, at the request of the Contract Administrator.

(p) Flows will be dissipated so that dewatering discharges minimize erosion at the discharge point.

D17.3.4 Dangerous Goods/Hazardous Waste Handling and Disposal

(a) Dangerous goods/hazardous waste are identified by, and will be handled according to, The Dangerous Goods Handling and Transportation Act and Regulations.

(b) The Contractor will be familiar with The Dangerous Goods Handling and Transportation Act and Regulations.

(c) The Contractor will have on Site staff that are trained and certified in the handling of the dangerous/hazardous goods, when said dangerous/hazardous goods are being utilized on Site for the performance of the Work.

(d) Different waste streams will not be mixed.

(e) Disposal of dangerous goods/hazardous wastes will be at approved hazardous waste facilities.

(f) Liquid hydrocarbons will not be stored or disposed of in earthen pits on Site.

(g) Used oils will be stored in appropriate drums, or tankage until shipment to waste oil recycling centres, incinerators, or secure disposal facilities approved for such wastes.

(h) Used oil filters will be drained, placed in suitable storage containers, and buried or incinerated at approved hazardous waste treatment and disposal facilities.

(i) Dangerous goods/hazardous waste storage areas will be located at least 100 m away from the ordinary high water line of any watercourse or wetland areas and be diked.

(j) Dangerous goods/hazardous waste storage areas will not be located so as to block natural drainage.

(k) Runoff from a dangerous goods/hazardous waste storage area will not be allowed to cause siltation of a watercourse.

(l) Dangerous goods/hazardous waste storage areas will be left in a neat and finished appearance and/or restored to their original condition to the satisfaction of the Contract Administrator.

D17.3.5 Emergency Response

(a) The Contractor will ensure that due care and caution is taken to prevent spills.

(b) The Contractor will report all major spills of petroleum products or other hazardous substances with significant impact on the environment and threat to human health and safety (as defined in Table 1 below) to Manitoba Sustainable Development, immediately after occurrence of the environmental accident, by calling the 24 hour emergency phone number (204) 945-4888.

(c) The Contractor will designate a qualified supervisor as the on Site emergency response coordinator for the project. The emergency response coordinator will have the authority to redirect manpower in order to respond in the event of a spill.

(d) The following actions will be taken by the person in charge of the spilled material or the first person(s) arriving at the scene of a hazardous material accident or the on Site emergency response coordinator.

(i) Notify emergency-response coordinator of the accident:

- Identify exact location and time of the accident.
- Indicate injuries, if any.

- Request assistance as required by magnitude of accident [Manitoba Sustainable Development 24 hour Spill Response Line (204) 945-4888, Police, Fire Department, Ambulance, company backup].

(ii) Attend to public safety:

- Stop traffic, roadblock/cordon off the immediate danger area.
- Eliminate ignition sources.
- Initiate evacuation procedures if necessary.

(iii) Assess situation and gather information on the status of the situation, noting:

- Personnel on Site.
- Cause and effect of spill.
- Estimated extent of damage.
- Amount and type of material involved.
- Proximity to waterways, sewers and manholes.

(iv) If safe to do so, try to stop the dispersion or flow of spill material:

- Approach from upwind.
- Stop or reduce leak if safe to do so.
- Dike spill material with dry, inert absorbent material or dry clay soil or sand.
- Prevent spill material from entering waterways and utilities by dyking.
- Prevent spill material from entering manholes and other openings by covering with rubber spill mats or dyking.

(v) Resume any effective action to contain, clean up, or stop the flow of the spilled product.

(vi) The emergency response coordinator will ensure that all environmental accidents involving contaminants shall be documented and reported to Manitoba Sustainable Development according to The Dangerous Goods Handling and Transportation Act Environmental Accident Reports Regulation 439/87.

(vii) When dangerous goods are used on Site, materials for containment and cleanup of spill material (e.g., absorbent materials, plastic oil booms, and oversized recovery drums) shall be available on Site.

(viii) Minor spills of such substances that may be contained on land with no significant impact on the environment may be responded to with in-house resources without formal notification to Manitoba Sustainable Development.

(ix) City emergency response, 9-1-1, shall be used if other means are not available.

Table D17-1: Environmental Accident Reporting

Reportable Quantities of Spills that must be Reported to Manitoba Sustainable Development [(204) 944-4888]		
Classification	**Hazard**	**Reportable Quantity or Level**
1	Explosives	All
2.1	Compressed Gas (Flammable)	100 L*
2.2	Compressed Gas	100 L*
2.3	Compressed Gas (Toxic)	All
2.4	Compressed Gas (Corrosive)	All
3	Flammable Liquids	100 L

4	Flammable Solids	1 Kg
5.1 Packing Groups I and II	Oxidizer	1 Kg or 50 L
Packing Group III	Oxidizer	5 Kg or 50 L
5.2	Organic Peroxide	1 Kg or 1 L
6.1 Packing Group I	Acute Toxic	1 Kg or 1 L
Packing Groups II and III	Acute Toxic	5 Kg or 5 L
6.2	Infectious	All
7	Radioactive	Any discharge or level exceeding 10 m Sv/h at the package surface and 200 uSv/h at 1 m from the package surface
8	Corrosive	5 Kg or 5 L
9.1	Miscellaneous (except PCB Mixtures)	50 Kg
9.1	PCB Mixtures	500 grams
9.2	Aquatic Toxic	1 Kg or 1 L
9.3	Wastes (Chronic Toxic)	5 Kg or 5 L

** Container Capacity (refers to container water capacity)*
Source: Environmental Accident Reporting Regulation M.R. 439/87

D17.3.6 Noise and Vibration

(a) Noise generating activities will be limited to the hours indicated in the City of Winnipeg Neighbourhood Liveability By-law No. 1/2008. The activities will generally be restricted to 7:00 AM to 7:00 PM. weekdays with written permission of the Contract Administrator and the City of Winnipeg for any after-hours or weekend work required for special cases. No extended or alternative working hours/dates will be permitted for pile driving activities.

(b) The Contractor will be responsible for scheduling Work to avoid potential noise problems and/or employ noise reduction measures to reduce noise to acceptable limits. The Contractor will also demonstrate to the Contract Administrator that Works to be performed during the night-time period, on Sundays, and Holidays will not exceed the approved limit.

(c) The Contractor will locate stationary noise generating equipment (e.g., generators) away from sensitive receptors and wildlife areas.

(d) Construction vehicles and equipment will adhere to posted speed limits.

D17.3.7 Dust and Emissions

(a) Construction vehicles and machinery will be kept in good working order by the Contractor through the use of inspection and maintenance.

(b) The Contractor will minimize construction equipment idling times and turn off machinery, when feasible.

(c) Dust control practices implemented by the Contractor during construction will include regular street cleaning and dampening of construction access roads and Works areas with water or approved chemicals at an adequate frequency to prevent the creation of dust.

(d) Only water or chemicals approved by the Contract Administrator will be used for dust control. The use of waste petroleum or petroleum by-products is not permitted.

(e) The Contractor will ensure that trucks which are used to haul excavated material and backfill material to and from the Work site utilize tarpaulin covers during transport to prevent material from falling onto the street and creating dust.

(f) Stockpiled soils will be wetted down or covered with tarpaulin covers to prevent the creation of dust, when appropriate.

D17.3.8 Erosion Control

(a) The Contractor will develop a sediment control plan prior to beginning construction in adherence with the Transportation Association of Canada National Guide to Erosion and Sediment Control on Roadway Projects, 2005 and to the satisfaction of the Contract Administrator.

(b) Sediment control will be applied to all in-water works to prevent the release or re-suspension of sediments to the watercourse. A turbidity curtain will be used to contain sediments from coffer dam construction/removal and riprap placement, if warranted. This turbidity curtain should isolate as small an area as possible to complete the works, and should be completely removed once turbidity within the isolated area has returned to background levels.

(c) The Contractor will inspect all sediment control structures daily during heavy construction activity in the areas of the structures and after a heavy rainfall to ensure their continued integrity.

(d) Exposure of soils along drain slopes will be kept to the minimum practical amount, acceptable to the Contract Administrator.

(e) Effective sediment and erosion control measures (e.g., straw mulch, erosion control blankets, interceptor ditches) will be used both during construction and until vegetation is re-established to prevent sediment-laden runoff from entering wetlands and other watercourses.

(f) All areas disturbed during construction will be landscaped and revegetated with native lant species in order to restore and enhance the Site and protect against soil erosion unless otherwise indicated.

(g) The disturbed surface will be revegetated as soon as possible and done so as to create a dense root system in order to defend against soil erosion within the Work area and any other disturbed areas susceptible to erosion.

(h) The loss of topsoil and the creation of excessive dust by wind during construction will be prevented by the addition of temporary cover crop, water or tackifier, if conditions so warrant.

(i) The Contractor will routinely inspect all erosion and sediment control structures and immediately carry out any necessary maintenance. Several inspections will be performed during rainy days.

(j) Construction activities will be avoided during periods of high winds to prevent erosion and the creation of dust.

D17.3.9 Runoff Control

(a) Measures will be undertaken to ensure that runoff containing suspended soil particles is minimized from entering the land drainage system to the extent possible to the satisfaction of the Contract Administrator.

(b) Areas that are heavily disturbed and vulnerable to erosion or gullying will be diked to redirect surface runoff around the area prior to spring runoff.

(c) Construction activities on erodible slopes will be avoided during spring runoff and heavy rain falls.

(d) Soil and fill will not be stockpiled on immediate watercourse bank areas.

D17.3.10 Fish

(a) The Contractor will adhere to all of the protection measures below, in keeping with the provisions of the Fisheries Act and DFO's mandate for the prevention of serious harm to fish.. The contractor will also adhere to the conditions provided in the DFO authorization for the Works, as described in Section D18 below.

(b) Due to the presence of spawning fish species no in-stream works will occur between April 1 and June 15 of any given year.

(c) If possible, bridge works will be constructed during periods of no flow or very low flow. Flowing water should be diverted around the construction area using a dam and bypass pump or temporary flume (culvert). Water will be diverted in a manner that avoids sediment generation to downstream areas and does not alter the volume of flow in the watercourse. Use coffer dams made of non-earthen material such as aquadams, sand bags, sheet pile or clean granular material wrapped in poly-plastic or other suitable isolation materials. Ensure any pump inlets are appropriately screened following the DFO Freshwater Intake End-of-Pipe Fish Screen Guidelines. Ensure all isolation materials are completely removed from the watercourse once construction is complete.

(d) Any fish trapped within the isolated area will be captured and returned to the watercourse unharmed. Fish includes fin fish, crayfish and mussels (clams).

(e) All bridge works will be limited to within road's right-of-way.

(f) A buffer of vegetation will be maintained when working along waterways, where possible.

(g) Culvert stormwater outfalls will be installed according to the Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat (Manitoba Natural Resources and DFO, 1996) and will include an erosion and sediment control plan and mitigation to prevent the release or transport of deleterious substances to the river.

(h) The duration of Work and amount of disturbance to the bed and banks of the water body will be minimized.

(i) Use only clean rock for armouring the channel areas, and haul it in from an appropriate land-based source. Avoid using poor quality limestone that breaks down quickly when exposed to the elements or acid generating rocks typical from metal mines. All rock will be clean and free of fine materials and of appropriate size to resist displacement during high flow events.

(j) The rock is placed such that it does not constrict the channel or change the hydraulics in a way that might damage the bed and/or banks of the watercourse or interfere with fish passage.

(k) Where grading of stream banks is required they are sloped by pulling material back from the water's edge. Stabilize any waste materials removed from the Work site, above the ordinary high water mark, to prevent them from entering any water body. Spoil piles could be contained with silt fence, flattened, covered with biodegradable mats or tarps, and/or planted with preferably native grass or shrubs.

(l) Shoreline vegetation will be retained to the greatest extent possible to maximize the stability of the banks.

(m) Machinery will be operated from outside of the water and in a manner that minimizes disturbance to the banks of the water body.

(n) The intake of any pumps used in surface waters will be screened to meet the DFOs Freshwater Intake End-of-Pipe Fish Screening Guidelines (1995).

D17.3.11 Wildlife

(a) The Contractor will adhere to all of the protection measures below, as well as the protection and mitigation measures for barn swallows, a Migratory bird species also protected under the federal Species At Risk Act (SARA), as described in Section D17.

(b) The clearing of trees, shrubs or vegetation should be avoided between May 15 and September 30 of any year to protect nesting and breeding season for migratory birds

and other wildlife, unless otherwise identified by a Project Biologist. Any trees or shrubs to be removed should be checked for active nests before removal.

(c) No one will disturb, move or destroy migratory birds' nests; see Section D17 for more information on required mitigation for existing birds' nests in the Work area.

(d) If a nest is encountered, Work will cease in the immediate area and the Contract Administrator will be contacted for further direction.

(e) In the event that Species At Risk are encountered during the project construction, all Work will cease in the immediate area, the Site will be made safe and the Contract Administrator will be contacted.

D17.3.12 Wetlands

(a) The Contractor will implement the following environmental protection measures to prevent the new loss of wetland functions, in accordance with the Federal Policy on Wetland Conservation:

(b) The Contractor will clearly mark wetland limits near the construction footprint prior to commencement of the Work and will remain marked throughout the construction period.

(c) Wetlands will not be disturbed without written permission from the Contract Administrator.

(d) Should additional wetlands be encountered during construction, construction in that area will halt until the area is properly marked.

(e) Construction equipment will avoid the marked wetland areas as much as possible, where feasible.

(f) The Contractor will not discharge water into adjacent wetlands without written permission from the Contract Administrator, having confirmed the quality of the water to be discharged and the capacity of the receiving wetland.

(g) Any fish located within the wetlands to be disturbed by the project will be captured and returned to a nearby watercourse unharmed.

D17.3.13 Vegetation

(a) The Contractor will clearly mark the disturbance limit prior to commencement of the Work and will remain marked throughout the construction period.

(b) Vegetation will not be disturbed without written permission from the Contract Administrator.

(c) The Contractor will limit the removal of trees and snags (standing dead trees), surface disturbance and vegetation clearing.

(d) Herbicides and pesticides will not be used adjacent to any surface watercourse.

(e) Trees or shrubs will not be felled into watercourses.

(f) Areas where vegetation is removed during clearing and construction activities will be stabilised and revegetated as soon as possible in accordance with the landscaping plans forming part of the Contract, or as directed by the Contract Administrator.

(g) Trees damaged during construction activities will be examined by bonded tree care professionals. Viable trees damaged during construction activities will be pruned according to good practices by bonded tree care professionals.

D17.3.14 Landscaping

(a) Construction waste (excluding common construction gravel, sand, etc.) will be removed to a minimum depth of 600mm below final grade in all areas that are to be backfilled with suitable material and revegetated in accordance with the City of Winnipeg Standard Construction Specifications.

(b) Topsoil will be stripped prior to construction and salvaged for use during landscaping. Surplus topsoil will be properly stockpiled for use in other projects.

(c) The Contractor will adhere to the landscaping plan for the maintenance of initial stages and development stages of the plant community.

D17.3.15 Heritage Resources

(a) If heritage material is located during the construction and soil removal process, all Work will cease and the Contractor will immediately contact the Contract Administrator. The Historic Resource Branch, Manitoba Culture, Heritage, Tourism and Sport or the Project Archaeologist, will be contacted by the Contract Administrator to determine the nature and extent of the archaeological material and to arrange for its recovery. The archaeological remains will be recovered by salvage excavation upon authorization by the Contract Administrator, having consulted with the Historic Resources Branch, Manitoba Culture, Heritage, Tourism and Sport.

(b) The Contractor will be prepared to continue his Work elsewhere on the project while the Archaeologist investigates the find and determines its heritage value.

(c) The Contractor is advised that he may be denied access to such areas of the project until such time as a thorough archaeological investigation is conducted or the find is deemed to have no heritage value.

(d) Construction and excavation Work will not resume until the Contract Administrator, having consulted with the Historic Resources Branch, Manitoba Culture, Heritage, Tourism and Sport, or the Project Archaeologist, authorizes a resumption of Work.

(e) If human remains are uncovered during the construction and soil removal process, all Work will cease and the Heritage Resources Branch, Manitoba Culture, Heritage, Tourism and Sport will be contacted by the Contract Administrator. The Historic Resources Branch will contact the City of Winnipeg Police.

(f) If the human remains are not considered forensic, (i.e., no foul play suspected), they will be removed by the Historic Resources Branch, Manitoba, Culture, Heritage, Tourism and Sport or the Project Archaeologist and turned over to the Province.

(g) If the human remains are considered forensic, the City of Winnipeg Police will be responsible for their removal.

(h) Additional information may be obtained by contacting: Archaeological Assessment Services, Historic Resources Branch.

D17.3.16 Construction Traffic

(a) Workforce parking will be limited to the areas designated for such as detailed in the Contract Documents, or as otherwise may be directed by the Contract Administrator.

(b) Large equipment will be equipped with flashing beacons and/or an audible “back up” warning device that is audible when the transmission is in reverse.

(c) The Contractor will adhere to the Standard Provisions of the Standard Construction Specifications, and of the Manual of Temporary Traffic Control in Work Areas on City Streets of the City of Winnipeg Public Works Department.

(d) The Contractor’s laydown area, construction Site and access road will be fenced and gated to secure the Site and materials and to discourage pedestrian entrance to construction areas and to control any potential hazard to the public, particularly children.

(e) For circumstances where the Contract Administrator has accepted Site access of special equipment or material, the Contractor will provide adequate flagmen for traffic control in the vicinity of any public buildings.

D17.3.17 Access

(a) The Contractor will maintain access to affected residential properties.

(b) The Contractor will provide or maintain general and off-street access to any affected business during construction.

D18. ENVIRONMENTAL PROTECTION PLAN – MIGRATORY BIRDS

D18.1 In addition to the provisions outlined in Section D17, prior to commencing construction activities or delivery of materials to Site, the Contractor shall provide mitigation measures at the Fermor Bridge site to protect barn swallows under the federal *Migratory Birds Convention Act,* a bird species that is currently listed as a 'threatened' species on Schedule 1 of the federal Species At Risk Act (SARA). These Acts provide legal protection to barn swallows, and contravention of these Acts can result in legal actions and monetary fines.

D18.2 The Contractor shall provide appropriate mitigation measures as outlined in Appendix 'D'

D18.3 Notwithstanding the measurement and payment terms of Environmental Protection Plan – Migratory Birds during construction, including monitoring shall be considered incidental to the work.

D19. ENVIRONMENTAL PROTECTION PLAN – FISH AND FISH HABITAT

D19.1 In addition to the provisions outlined in Section D17, the DFO Authorization for the Works will be issued once authorized by DFO and will state the terms and conditions that the Contractor shall abide by to prevent serious harm to fish.

D19.2 Notwithstanding the measurement and payment terms of Environmental Protection Plan – Fish and Fish Habitat during construction, including monitoring shall be considered incidental to the work.

D20. ENVIRONMENTAL PROTECTION PLAN – WATERWAYS PERMIT

D20.1 In addition to D17, the Waterways Permit will be issued once authorized by the City of Winnipeg, Planning, Property and Development Department, Waterways Section and will state condition that the Contractor shall abide by.

D20.2 The Contractor shall provide appropriate mitigation and protection measures as required in and around the regulated area in a manner that protects and sustains the environment.

D20.3 Notwithstanding the measurement and payment terms of Environmental Protection Plan – Waterways Permit during construction, including monitoring will be considered incidental to the all work.

D21. WATER MANAGEMENT PLAN

D21.1 Provide the Contract Administrator with a water management plan at least five (5) Business Days prior to commencement of any Work on the Site but in no event later than the date specified in the General Conditions for the return of the executed Contract.

D21.2 The Water Management Plan shall be prepared and submitted in a format that clearly identifies how the Contractor will undertake dewatering activities at the Site during construction.

D21.3 The Water Management Plan shall include provisions for drawing down the water table sufficiently to dewater the excavation to maintain dry conditions for construction. This will require the use of wells. The Water Management Plan shall be further updated or altered as dictated by Site conditions. The Water Management Plan shall remain in effect until all construction and backfill activities are completed.

(a) Subject to the approval of the Contract Administrator, water with negligible suspended solids may be pumped into the LDS sewer.

(b) For water containing suspended solids, provide alternative means to remove the water from the Site.

(c) Formal approval for pumping water into the LDS sewer system must be obtained from the Contract Administrator in writing seven (7) days prior to commencement of pumping.

D22. DEWATERING AND DRAINAGE DURING CONSTRUCTION

D22.1 In addition to C6, in coordination to D21 the Contractor is solely responsible for planning, implementing, maintaining and monitoring an effective dewatering and drainage system for the Site during performance of the Work.

D22.2 The Contractor is responsible for the control, diversion, storage and pumping of all water including without limitation rain, snow melt, groundwater, leaking infrastructure and water in pipes throughout all stages of the Work.

D22.3 Be aware, a portion of the Work involves excavation for the Primary Dike and it is anticipated that the excavation will penetrate a silt layer that may result in higher than average groundwater flows.

D22.4 Contractor shall only discharge to the land drainage system meeting in accordance with the requirements specified. The combined sewer system is ineligible to use for discharge.

D22.5 Do not pump or drain any water containing excessive suspended materials or harmful substances into waterways, sewers or other drainage systems. Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with governing authority's limitations and requirements.

D22.6 The Contractor shall be responsible for all damages within or outside the Site directly resultant from Contractor's actions, omissions or neglect which may be caused by or which may result from water backing up, flowing through, overflowing or excessive surcharge of drainage systems.

D22.7 The Contractor shall organize and bear all costs related to the effective dewatering of excavations and all other pumping and drainage necessary for the proper execution of the Work, including keeping the pipes, structures, shafts, excavations and trenches free of undesirable accumulations of groundwater, seepage, surface water, melt water or rainwater.

D22.8 Dispose of all water drained or pumped as above by discharging it to drainage ditches or natural water course as reviewed by the Contract Administrator, and in compliance with all local, Municipal, Provincial and Federal environmental regulations, ordinances, bylaws, etc., and provide documentation indicating that authority has been granted to discharge effluent water into any drainage ditch, brook, creek or river. Contractor shall develop and implement at their own cost any filtration, settlement or other acceptable treatment methods required prior to disposal.

D22.9 Keep all drainage channels, gutters, swales, ditches, sewers, culverts and disposal areas free of silt, sand, debris and gravel and remove such deposits as required.

D22.10 Accept responsibility for any actionable damage, inconvenience or interference caused by the dewatering and drainage operations to the surrounding properties, yards, businesses, fields, houses, other buildings, roads, streets, approaches, driveways, utilities, services or other improvements which may be affected by a lowering or raising of the water table and bear all costs of repair, replacement, reinstatement or alteration of same.

D22.11 Dewatering and drainage during construction, including groundwater, will be considered incidental to the Contract and there will be no measurement and payment item for this portion of the Work

D23. SITE PLAN

D23.1 The Contractor shall provide the Contract Administrator with a Site Plan at least five (5) Business Days prior to the commencement of any Work on the Site but in no event later than the date specified in C4.1 for the return of the executed Contract.

D23.2 The Contractor shall submit a Site Plan for Stage 0 of the Work to the Contract Administrator with:

(a) access points from public roads to laydown areas;

(b) construction access crossings of the rail lines (if any);

(c) fenced laydown area locations including gates;

(d) staging areas for various types of work (Undergrounds, Pedestrian-Cyclist Underpass, Bridge, Roadworks etc.);

(e) office facility locations with power supply, for both the Contractor and Contract Administrator.

D23.3 Site Plans after Stage 0 to be submitted after Stage 0 works are underway.

SCHEDULE OF WORK

D24. COMMENCEMENT

D24.1 The Contractor shall not commence any Work until he/she is in receipt of a letter of intent from the Award Authority authorizing the commencement of the Work.

D24.2 The Contractor shall not commence any Work on the Site until:

(a) the Contract Administrator has confirmed receipt and approval of:

(i) evidence of authority to carry on business specified in D10;

(ii) evidence of the workers compensation coverage specified in C6.15;

(iii) the twenty-four (24) hour emergency response phone number specified in D5.2;

(iv) the Safe Work Plan specified in D11;

(v) evidence of the insurance specified in D12;

(vi) the performance security specified in D13;

(vii) the subcontractor list specified in D14;

(viii) the equipment list specified in D15;

(ix) the detailed work schedule specified in D16;

(x) the Environmental Protection Plan specified in D17, D18, D19, D20;

(xi) the Water Management Plan specified in D21;

(xii) the Site Plan specified in D23.

(b) the Contractor has attended a pre-construction meeting with the Contract Administrator, or the Contract Administrator has waived the requirement for a pre-construction meeting.

D24.3 The Contractor shall not commence the Work on the Site before April 17, 2018, and shall commence the Work on Site no later than April 24, 2018, as directed by the Contract Administrator and weather permitting.

D24.4 The Contractor shall not commence work on the proposed work at 2 Alpine Avenue (southeast corner Fermor Avenue / St. Anne's intersection sidewalk) and 133/135 Niakwa Road (pathway between Alpine Avenue and Niakwa Road) prior to receipt of confirmation from the City of Winnipeg and the Contract Administrator regarding successful acquisition of the property in question.

D24.5 The City intends to award this Contract by April 10, 2018.

D24.5.1 If the actual date of award is later than the intended date, the dates specified for Critical Stages, Substantial Performance, and Total Performance will be adjusted by the difference between the aforementioned intended and actual dates.

D25. DAMAGE TO EXISTING STRUCTURES AND PROPERTY

D25.1 Further to Section 3.13 of CW 1130 of the General Requirements, special care shall be taken to avoid damage to existing adjacent structures and properties during the course of the Work.

D25.2 Any damage cause by the Contractor or their Subcontractors to the adjacent structures or properties shall be promptly repaired by the Contractor at their own expense to the satisfaction of the Contract Administrator.

D26. ENCROACHMENT ON PRIVATE PROPERTY

D26.1 Further to Section 3.11 of CW 1130 of the General Requirements, the Contractor shall confine their work to the Site at all times, except if he has received written permission from the property owner to use lands outside of Site. The Contractor shall provide the Contract Administrator with a copy of any written permission he has received to enter onto private property, if requested by the Contract Administrator, and the Contractor is solely responsible for all costs associated with such arrangements.

(a) Private property for which the City has obtained temporary construction easements or permanent easements is excluded from the requirements of D26.1.

D26.2 The Contractor's construction activities shall be confined to the minimum area necessary for undertaking the work and they shall be responsible for all damage to private property resulting from their work. Particular care shall be taken to assure no damage is done to building, fencing, trees and plants, and provision shall be made to maintain full drainage for private properties during construction.

D27. RESTRICTED WORK HOURS

D27.1 Further to clause 3.10 of CW 1130, the Contractor shall require written permission forty-eight (48) hours in advance from the Contract Administrator for any work to be performed between 2000 hours and 0700 hours, or on Saturdays, Sundays, Statutory Holidays and or Civic Holidays.

(a) It is anticipated that some stages of the Work will require work to be performed during these times.

D28. WORK BY OTHERS

D28.1 Contractor shall coordinate the Work of this Contract with the work of Others and City forces so as to not hinder, delay or interfere with the Others and/or City forces in the performance of their work. Contractor shall connect their Work with the work of Others as shown in the Contract.

D28.2 Contractor shall report to the Contract Administrator any apparent deficiencies in other's and/or City's work which would affect the Work of this Contract immediately as they come to Contractor's attention and Contractor shall confirm such report in writing within ten (10) Calendar Days of becoming aware of the deficiency. Failure by Contractor to so report shall invalidate any claims against the City by reason of the deficiencies of other's and/or City forces work except as to those of which Contractor was not reasonably aware.

D28.3 Work by others on or near the Site will include but not necessarily be limited to:

(a) BellMTS and Shaw – BellMTS installation of twelve (12) conduits concrete encased ductbank by trench method to abandon the existing ductbank along the North embankment of Fermor Avenue between approximate sta. 6+220 to 6+790 (WB Control line). Work is anticipated to be completed in the north embankment between February – March 2018 excluding a 20 m section through the existing dike that is anticipated to be completed in June 2018 and complete Works between November – March of 2019. BellMTS to adjust and recast existing BellMTS vaults along the north shoulder to proposed grade during summer construction. The Contractor is expected to cooperate with the BellMTS to facilitate construction;

(b) Manitoba Hydro Street Lighting – Removal of poles, permanent/temporary street lighting and active pathway lighting installation will be taking place throughout Contract;

(c) Manitoba Hydro Electrical – Miscellaneous Hydro works will be taking place through the project such as relocating anchor wire (s), pedestals, and hydro distribution pole;

(d) Manitoba Hydro Gas – Protection of existing lines;

(e) Winnipeg Transit – removal and reinstallation of bus stop no. 50539 shelter from concrete base, southbound St. Anne's Road at Fermor Avenue approximately Sta. 0+260 (reinstall Sta. 0+265)(Southbound St. Anne's Road Control Line). Removal of bus stop No. 50852, westbound Alpine Avenue and relocation of bus stop no. 50581 along Alpine Avenue westbound lane near the junction of Seagrim Avenue. Various removal/reinstallation of bus stop signage;

(f) City of Winnipeg Traffic Services – Replacement of signs, painting of permanent/temporary traffic lines, pavement markings and maintenance of traffic signage and lane delineators during winter 2018/2019. The Contractor is expected to cooperate with the City of Winnipeg Traffic Services to facilitate construction. Installation required throughout various Phases/Stages of the Work;

(g) City of Winnipeg Traffic Signals – Removal and modification of existing traffic signals plant and installation of new Traffic Signals plant. Temporary removal of Traffic signal pits during traffic staging. Modifications/installations required throughout various Phases/Stages of the Work at the intersection of Fermor Avenue and St. Anne's Road and the North leg of Archibald Street at Fermor Avenue;

(h) City of Winnipeg – Geomatics Branch – Miscellaneous works on survey monuments;

(i) Benchmark Advertisement – Removal and relocation of ads for the concrete benches and garbage containers at the intersection of Fermor Avenue and St. Anne's Road, and Fermor Avenue and Archibald Street prior to construction and post construction.

D29. SEQUENCE OF WORK

D29.1 Further to C6.1, the sequence of work shall be as follows:

(a) The staging as described and illustrated on drawings GE-008 to GE-021 is to be followed in the sequence as presented. The Contractor may propose alternate staging; however final approval will be by the Contract Administrator. Construction activity is to be limited to one (1) lane of the roadway at a time for all works except mainline asphalt paving. No construction shall commence on the subsequent lanes under construction to the satisfaction of the Contract Administrator.

(b) Initial planing operations are to be limited to one (1) lane of the roadway at a time. Planing of the adjacent lane of the roadway is not to commence until the Contract Administrator has approved the opening of the previously completed and asphalt overlaid lane to traffic.

(c) Not all sub-sub stages are illustrated for lane at a time construction areas.

(d) List of major activities in each stage are not necessarily the suggested order of completion.

(e) Alternations to the staging shown herein to be presented and approved in writing by the Contract Administrator at least two (2) days prior to implementing change. (Two (2) weeks prior for full closure).

D29.1.2 The Sequence of Work on St. Anne's Road shall be as follows:

(a) On St. Anne's Road, construction activity is to be limited to one (1) lane of roadway at a time. No construction shall commence on the subsequence lanes until the concrete Works is completed on the lane under construction to the satisfaction of the Contract Administrator.

(b) The general sequence of Work in each lane as follows:

(i) Pavement removal and excavation;

(ii) Subgrade compaction;

(iii) Placement of separation geotextile fabric;
(iv) Placement of sub-base and base course materials;
(v) Construction of plain dowelled concrete;
(vi) Construction of curb;
(vii) Construction of concrete sidewalk renewal;
(viii) Boulevard restoration;
(ix) Landscaping.

D29.1.3 Stepcut and seal concrete joints in exposed concrete pavement prior to opening areas to general traffic.

D29.1.4 The Sequence of Work on Fermor Avenue for Final Asphalt Overlay in 2019

(a) Adjustment of manholes and catch basins to final grade;

(b) Further to CW 3410, Clause 9.2, the Contractor shall correct unacceptable surface irregularities as deemed by the Contract Administrator, and shall be incidental to the Work and approved prior to placing final asphalt lift;

(c) Placement of mainline asphalt overlay utilizing automatic grade control;

(d) Longitudinal and transverse cold joint preparation in accordance with CW 3410, Clause 9.5.2 (b).

D29.1.5 Placing the topsoil and finished grading of all boulevard and median areas shall be completed prior to commencing construction of the asphaltic concrete overlay.

D29.1.6 Landscaping is to occur throughout project as areas will be to final graded.

D29.1.7 At the end of a day of asphalt placement, there shall be no drop off accessible to traffic along any longitudinal joint, expecting the longitudinal joint between the gutter and approaches and any median openings available to traffic.

D29.1.8 Immediately following the completion of the asphaltic concrete work for Stage 1, the Contractor shall clean up the site and remove all plant, surplus material, waste and debris other than that left by the City or other Contractors.

D30. CRITICAL STAGES

D30.1 The Contractor shall achieve critical stages of the Work in accordance with the following requirements:

(a) **Stage 0 – 2018**

(i) Concrete median crossovers shall be completed and open to one (1) lane traffic each direction from west of the underpass to east of the bridge within ten (10) consecutive Calendar Days.

(ii) Mitigation measures to be conducted at the Fermor Avenue Bridge to protect barn swallows and prevent returning barn swallows from nesting shall be completed by May 1, 2018.

(b) **Stage 1 – 2018**

(i) Eastbound half of Pedestrian – Cyclist Underpass and westbound half of Bridge Structure works including moment slabs, concrete barriers from Sta. 4+745 to 4+840, North Retaining wall and active transportation pathways north of the bridge including approach roadworks as outlined in Stage 1B shall be completed by October 31, 2018;

(ii) Concrete pavement reconstruction at Fermor Avenue/ St. Anne's Intersection as outlined in Stage 1A and 1B shall be completed by October 31, 2018;

(iii) Realignment of the Primary Dike on the north side of Fermor Avenue embankment west of the Seine River shall be completed by June 1, 2018.

(c) **Stage 2 – 2019**

(i) Pedestrian – Cyclist Underpass, Bridge Structure works including but not limited to moment slabs, concrete median barriers, south retaining wall as outlined in Stage 2A and 2B shall be completed by August 31, 2019;

(ii) Concrete median barriers on the bridge structure shall be completed and westbound and eastbound Fermor Avenue curb lanes on the bridge structure and approaches shall be open to traffic by October 2, 2019.

D30.2 When the Contractor considers the Work associated with each critical stage to be completed, the Contractor shall arrange, attend and assist in the inspection of the Work with the Contract Administrator for purposes of verifying Completion. Any defects or deficiencies in the Work noted during that inspection shall be remedied by the Contractor at the earliest possible instance and the Contract Administrator notified so that the Work can be re-inspected.

D30.3 The date on which each critical stage Work has been accepted by the Contract Administrator as being completed to the requirements of the Contract is the date on which completion of that critical stage has been achieved.

D31. TRANSIT SHELTER RELOCATIONS

D31.1 Through the coordination of the Contract Administrator, the removal and installation of these transit shelter structures shall be done by Winnipeg Transit. The locations of these shelters are as follows:

(a) Bus stop location #50539 is located at the northwest corner of Fermor Avenue/ St. Anne's Intersection.

D32. SUBSTANTIAL PERFORMANCE

D32.1 The Contractor shall achieve Substantial Performance by October 31, 2019.

D32.2 When the Contractor considers the Work to be substantially performed, the Contractor shall arrange, attend and assist in the inspection of the Work with the Contract Administrator for purposes of verifying Substantial Performance. Any defects or deficiencies in the Work noted during that inspection shall be remedied by the Contractor at the earliest possible instance and the Contract Administrator notified so that the Work can be re-inspected.

D32.3 The date on which the Work has been certified by the Contract Administrator as being substantially performed to the requirements of the Contract through the issue of a certificate of Substantial Performance is the date on which Substantial Performance has been achieved.

D33. TOTAL PERFORMANCE

D33.1 The Contractor shall achieve Total Performance by July 20, 2020.

D33.2 When the Contractor or the Contract Administrator considers the Work to be totally performed, the Contractor shall arrange, attend and assist in the inspection of the Work with the Contract Administrator for purposes of verifying Total Performance. Any defects or deficiencies in the Work noted during that inspection shall be remedied by the Contractor at the earliest possible instance and the Contract Administrator notified so that the Work can be re-inspected.

D33.3 The date on which the Work has been certified by the Contract Administrator as being totally performed to the requirements of the Contract through the issue of a certificate of Total Performance is the date on which Total Performance has been achieved.

D34. LIQUIDATED DAMAGES

D34.1 If the Contractor fails to achieve Critical Stages, Substantial Performance or Total Performance in accordance with the Contract by the days fixed herein for same, the Contractor shall pay the City the following amounts per Calendar Day for each and every Calendar Day following the days fixed herein for same during which such failure continues:

(a) **Stage 0 – 2018**

(i) D30.1(a)(i) – Four Thousand dollars ($4000.00);

(ii) D30.1(a)(ii)– Seventeen Hundred and Fifty dollars ($1750.00);

(b) **Stage 1 - 2018**

(i) D30.1(b)(i) – Seventy-Five Hundred dollars ($7500.00);

(ii) D30.1(b)(ii) – Eight Thousand dollars ($8000.00);

(iii) D30.1(b)(iii) – Six Thousand dollars ($6000.00).

(c) **Stage 2 – 2019**

(i) D30.1(c)(i) – Seventy-Five Hundred dollars ($7500.00);

(ii) D30.1(c)(ii) – Seventy-Five Hundred dollars ($7500.00);

(d) Substantial Performance – Seventy – Five Hundred dollars ($7500.00);

(e) Total Performance – Two thousand dollars ($2000.00).

D34.2 The amounts specified for liquidated damages in D34.1 are based on a genuine pre-estimate of the City's losses in the event that the Contractor does not achieve critical stages, Substantial Performance or Total Performance by the days fixed herein for same.

D34.3 The City may reduce any payment to the Contractor by the amount of any liquidated damages assessed.

D35. SCHEDULED MAINTENANCE

D35.1 The Contractor shall perform the following scheduled maintenance in the manner and within the time periods required by the Specifications:

(a) Maintenance of Sod Areas as specified in in CW 3510;

(b) Maintenance of Embankment Seeding Areas as specified in CW 3520 and D39;

(c) Maintenance of Naturalized Area Seeding as specified in CW 3520 and E45;

(d) Maintenance of Trees, Shrubs and Groundcover Plantings as specified in E37;

(e) Landscaping Maintenance Year 1 as specified in E38;

(f) Reflective Crack Maintenance during two (2) year warranty period as specified in CW 3250;

(g) Crack Sealing the interface between all Curb and Gutter and Asphalt Pavements shall be completed as specified in E22.

D35.2 Determination of Substantial Performance and Total Performance shall be exclusive of scheduled maintenance identified herein. All scheduled maintenance shall be completed prior to the expiration of the warranty period. Where the scheduled maintenance cannot be completed during the warranty period, the warranty period shall be extended for such period of time as it takes the Contractor to complete the scheduled maintenance.

CONTROL OF WORK

D36. JOB MEETINGS

D36.1 Regular weekly job meetings will be held at Site. These meetings shall be attended by a minimum of one (1) representative of the Contract Administrator, one (1) representative of the

City and one (1) representative of the Contractor. Each representative shall be a responsible person capable of expressing the position of the Contract Administrator, the City and the Contractor respectively on any matter discussed at the meeting including the Work schedule and the need to make any revisions to the Work schedule. The progress of the Work will be reviewed at each of these meetings.

D36.2 The Contract Administrator reserves the right to cancel any job meeting or call additional job meetings whenever he/she deems it necessary.

D37. LAYOUT OF THE WORKS

D37.1 Further to C6 and CW 1130 Clause 3.15, the Contract Administrator will provide the following:

(a) basic centrelines and an elevation of the proposed works for:
   a) Part A – Bridge Rehabilitation;
   b) Part B- Pedestrian – Cyclist Underpass;
   c) Part C – Retaining Walls;
   d) Part D – Overhead Sign Structure;
   e) Part F – Underground Works;

(b) reference lines and final design elevations of the proposed works at intervals and offsets deemed necessary by the Contract Administrator for:
   a) Part E - Surface Works (including Landscaping Works).

D37.2 The Contractor shall be responsible for the following related to D37.1(a):

(a) the true and proper layout of the Work and for the correctness of the location, levels, dimensions, and alignment of all aspects of the Work. The Contractor shall provide all required instruments and competent personnel for performing all layouts;

(b) should any error appear or arise in location, levels, dimensions, and/or alignments during the course of the Work, the Contractor shall promptly rectify such errors to the satisfaction of the Contract Administrator, at their own expense;

(c) the Contract Administrator shall be notified at least one (1) Working Day prior to any Work being commenced in order to have the option to check and review all elevations and layouts at their discretion;

(d) carefully protect and preserve all benchmarks, stakes, and other items used in giving the basic data supplied by the Contract Administrator. Any such benchmarks or stakes removed or destroyed by the Contractor, without the consent of the Contract Administrator, shall be replaced by the Contract Administrator at the expense of the Contractor;

(e) the Contractor shall arrange and carry on their Work so as not to conflict with the collection of any data in anyway by the Contract Administrator. The Contractor shall adjust Work and/or remove any interference as directed by the Contract Administrator at the expense of the Contractor.

D37.3 The Contractor shall be responsible for the following related to D37.1(b):

(a) the layout of any additional grades required as deemed necessary by the Contractor. Grades that the Contractor is responsible for includes but is not limited to sub-grade, sub-base, and base course elevations;

(b) the Contractor shall provide all required instruments and competent personnel for performing all layouts. Any Work found to be defective due to errors in layout by the Contractor shall be corrected at the expense of the Contractor;

(c) the Contract Administrator shall be notified at least one (1) Working Day prior to any Work being commenced in order to have the option to check and review all elevations and layouts at their discretion;

(d) carefully protect and preserve all benchmarks, stakes, and other items used in giving the basic data supplied by the Contract Administrator. Any such benchmarks or stakes removed or destroyed by the Contractor, without the consent of the Contract Administrator, shall be replaced by the Contract Administrator at the expense of the Contractor. The Contract Administrator shall be notified at least two (2) Working Days prior to expecting replacement of any benchmarks, stakes, and other items used to coney the basic data to the Contractor;

(e) the Contractor shall arrange and carry on their Work so as not to conflict with the collection of any data and layout of reference lines and design elevations in anyway by the Contract Administrator. The Contractor shall adjust Work and/or remove any interference as directed by the Contract Administrator at the expense of the Contractor.

D38. PRIME CONTRACTOR – THE WORKPLACE SAFETY AND HEALTH ACT (MANITOBA)

D38.1 Further to C6.24, the Contractor shall be the Prime Contractor and shall serve as, and have the duties of the Prime Contractor in accordance with The Workplace Safety and Health Act (Manitoba).

D39. THE WORKPLACE SAFETY AND HEALTH ACT (MANITOBA) – QUALIFICATIONS

D39.1 Further to B12.4, the Contractor/Subcontractor must, throughout the term of the Contract, have a Workplace Safety and Health Program meeting the requirements of The Workplace Safety and Health Act (Manitoba). At any time during the term of the Contract, the City may, at its sole discretion and acting reasonably, require updated proof of compliance, as set out in B12.4.

MEASUREMENT AND PAYMENT

D40. PAYMENT

D40.1 Further to C12, the City may at its option pay the Contractor by direct deposit to the Contractor's banking institution.

D41. PAYMENT SCHEDULE

D41.1 Further to C12, payment shall be in accordance with the following payment schedule:

(a) Portions of Work designated for Lump Sum payment will be paid for on a monthly pro-rated basis as determined by the Contract Administrator in consultation with the Contractor provided the portion of the Work to be paid for has been permanently incorporated into the Works.

WARRANTY

D42. WARRANTY

D42.1 Notwithstanding C13.2, the warranty period shall begin on the date of Substantial Performance and shall expire one (1) years thereafter for regional street asphalt rehabilitation (mill & fill) , and two (2) years thereafter for pavement reconstruction works, unless extended pursuant to C13.2.1 or C13.2.2, in which case it shall expire when provided for thereunder.

D42.1.1 For the purpose of Performance Security, the warranty period shall be two (2) year.

D42.2 Notwithstanding C13.2, the Contract Administrator may permit the warranty period for a portion or portions of the Work to begin prior to the date of Substantial Performance if a portion of the Work cannot be completed because of unseasonable weather or other conditions reasonably beyond the control of the Contractor but that portion does not prevent the balance of the Work from being put to its intended use.

D42.2.1 In such case, the date specified by the Contract Administrator for the warranty period to begin shall be substituted for the date specified in C13.2 for the warranty period to begin.

FORM H1: PERFORMANCE BOND
(See D13)

KNOW ALL MEN BY THESE PRESENTS THAT

_____
(hereinafter called the "Principal"), and

_____ ,
(hereinafter called the "Surety"), are held and firmly bound unto **THE CITY OF WINNIPEG** (hereinafter called the "Obligee"), in the sum of

_____

_____ dollars ($_____.____)

of lawful money of Canada to be paid to the Obligee, or its successors or assigns, for the payment of which sum the Principal and the Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS the Principal has entered into a written contract with the Obligee for

BID OPPORTUNITY NO. 772-2017

FERMOR AVENUE BRIDGE OVER SEINE RIVER – BRIDGE REHABILITATION, PEDESTRIAN-CYCLIST UNDERPASS STRUCTURE AND ROADWORKS FROM ST. ANNE'S ROAD TO ARCHIBALD STREET

which is by reference made part hereof and is hereinafter referred to as the "Contract".

NOW THEREFORE the condition of the above obligation is such that if the Principal shall:

(a) carry out and perform the Contract and every part thereof in the manner and within the times set forth in the Contract and in accordance with the terms and conditions specified in the Contract;
(b) perform the Work in a good, proper, workmanlike manner;
(c) make all the payments whether to the Obligee or to others as therein provided;
(d) in every other respect comply with the conditions and perform the covenants contained in the Contract; and
(e) indemnify and save harmless the Obligee against and from all loss, costs, damages, claims, and demands of every description as set forth in the Contract, and from all penalties, assessments, claims, actions for loss, damages or compensation whether arising under "The Workers Compensation Act", or any other Act or otherwise arising out of or in any way connected with the performance or non-performance of the Contract or any part thereof during the term of the Contract and the warranty period provided for therein;

THEN THIS OBLIGATION SHALL BE VOID, but otherwise shall remain in full force and effect. The Surety shall not, however, be liable for a greater sum than the sum specified above.

AND IT IS HEREBY DECLARED AND AGREED that the Surety shall be liable as Principal, and that nothing of any kind or matter whatsoever that will not discharge the Principal shall operate as a discharge or release of liability of the Surety, any law or usage relating to the liability of Sureties to the contrary notwithstanding.

IN WITNESS WHEREOF the Principal and Surety have signed and sealed this bond the

_____ day of _____ , 20____ .

SIGNED AND SEALED
in the presence of:

_____
(Witness as to Principal if no seal)

_____
(Name of Principal)

Per: _____ (Seal)

Per: _____

_____
(Name of Surety)

By: _____ (Seal)
(Attorney-in-Fact)

FORM H2: IRREVOCABLE STANDBY LETTER OF CREDIT
(PERFORMANCE SECURITY)
(See D13)

_____
(Date)

The City of Winnipeg
Legal Services Department
185 King Street, 3rd Floor
Winnipeg MB R3B 1J1

RE: PERFORMANCE SECURITY – BID OPPORTUNITY NO. 772-2017

FERMOR AVENUE BRIDGE OVER SEINE RIVER – BRIDGE REHABILITATION, PEDESTRIAN-CYCLIST UNDERPASS STRUCTURE AND ROADWORKS FROM ST. ANNE'S ROAD TO ARCHIBALD STREET

Pursuant to the request of and for the account of our customer,

_____ ,
(Name of Contractor)

_____
(Address of Contractor)

WE HEREBY ESTABLISH in your favour our irrevocable Standby Letter of Credit for a sum not exceeding in the aggregate

_____

_____ Canadian dollars.

This Standby Letter of Credit may be drawn on by you at any time and from time to time upon written demand for payment made upon us by you. It is understood that we are obligated under this Standby Letter of Credit for the payment of monies only and we hereby agree that we shall honour your demand for payment without inquiring whether you have a right as between yourself and our customer to make such demand and without recognizing any claim of our customer or objection by the customer to payment by us.

The amount of this Standby Letter of Credit may be reduced from time to time only by amounts drawn upon it by you or by formal notice in writing given to us by you if you desire such reduction or are willing that it be made.

Partial drawings are permitted.

We engage with you that all demands for payment made within the terms and currency of this Standby Letter of Credit will be duly honoured if presented to us at:

_____
(Address)

and we confirm and hereby undertake to ensure that all demands for payment will be duly honoured by us.

All demands for payment shall specifically state that they are drawn under this Standby Letter of Credit.

Subject to the condition hereinafter set forth, this Standby Letter of Credit will expire on

_____ .
(Date)

It is a condition of this Standby Letter of Credit that it shall be deemed to be automatically extended from year to year without amendment from the present or any future expiry date, unless at least 30 days prior to the present or any future expiry date, we notify you in writing that we elect not to consider this Standby Letter of Credit to be renewable for any additional period.

This Standby Letter of Credit may not be revoked or amended without your prior written approval.

This credit is subject to the Uniform Customs and Practice for Documentary Credit (2007 Revision), International Chamber of Commerce Publication Number 600.

_____
(Name of bank or financial institution)

Per: _____
(Authorized Signing Officer)

Per: _____
(Authorized Signing Officer)

FORM J: SUBCONTRACTOR LIST

(See D14)

FERMOR AVENUE BRIDGE OVER SEINE RIVER – BRIDGE REHABILITATION, PEDESTRIAN-CYCLIST UNDERPASS STRUCTURE AND ROADWORKS FROM ST. ANNE'S ROAD TO ARCHIBALD STREET

Portion of the Work	Name	Address
PARTS A – D - STRUCTURAL WORKS		
Supply of Materials:		
Precast Portable Concrete Barrier (PPCB)		
Structural Concrete		
Sheet Piling		
Stainless Steel Reinforcing		
ChromX Reinforcing		
Steel Reinforced Elastomeric Expansion Bearings		
Steel Girder Splice Plates		
Aluminum Pedestrian Handrail		
Miscellaneous Metal		
FRP Girder Strengthening		
Installation/Placement		
Structural Removals		
Temporary Bridge Jacking		
Structural Concrete		
Reinforcing		
Steel Reinforced Elastomeric Expansion Bearings		
Steel Girder Splice Plates		
Aluminum Pedestrian Handrail		
Cast-in-place Concrete piles		
Steel Overhead Sign Support Structures		
Underpass Lighting		
Miscellaneous Metal		

FORM J: SUBCONTRACTOR LIST

(See D14)

FERMOR AVENUE BRIDGE OVER SEINE RIVER – BRIDGE REHABILITATION, PEDESTRIAN-CYCLIST UNDERPASS STRUCTURE AND ROADWORKS FROM ST. ANNE'S ROAD TO ARCHIBALD STREET

Portion of the Work	Name	Address
PART E – SURFACE WORKS		
Supply of Materials:		
Concrete		
Asphalt		
Base Course & Sub-base Course		
Geotextile Materials		
Paving Stones		
Sub-drain Pipe		
ET – 31 End Treatment		
Steel Beam Guardrail		
Crash Attenuation Barriers		
Crash Attenuation Barrels		
Installation/Placement		
Asphalt Planing		
Concrete		
Asphalt		
Base Course & Sub-base Course		
Paving Stones		
ET-31 End Treatment		
Steel Beam Guardrail		
Crash Attenuation Barriers		
Crash Attenuation Barrels		
LANDSCAPING:		
Supply of Materials		
Planting Medium		
Plant Material – Trees, Shrubs and Vines		

FORM J: SUBCONTRACTOR LIST

(See D14)

FERMOR AVENUE BRIDGE OVER SEINE RIVER – BRIDGE REHABILITATION, PEDESTRIAN-CYCLIST UNDERPASS STRUCTURE AND ROADWORKS FROM ST. ANNE'S ROAD TO ARCHIBALD STREET

Portion of the Work	Name	Address
Site Furnishings		
Ornamental Barrier Fence		
Sodding		
Seed Mixes		
Naturalized Area Seed Mix		
Wet Blend Seed Mix		
Interlocking Paving Stones		
Installation/Placement		
Planting Medium		
Plant Material – Trees, Shrubs, and Vines		
Site Furnishing		
Ornamental Barrier Fence		
Sodding		
Naturalized Area Seeding Mix		
Wet Blend Seeding Mix		
Clay Brick Paving		
Tree Removal		
PART F - UNDERGROUND WORKS:		
Supply of Materials		
Trenchless Pipe Installations		
Culverts		
Catch Pits/Ring Sections/Ditch Inlet Grates		
Other (Describe)		
Installation/Placement		

FORM J: SUBCONTRACTOR LIST

(See D14)

FERMOR AVENUE BRIDGE OVER SEINE RIVER – BRIDGE REHABILITATION, PEDESTRIAN-CYCLIST UNDERPASS STRUCTURE AND ROADWORKS FROM ST. ANNE'S ROAD TO ARCHIBALD STREET

Portion of the Work	Name	Address
Trenchless Pipe Installation		
Culverts		
Catch Pits/Ring Sections/Ditch Inlet Grates		
Others (Describe)		

FORM K: EQUIPMENT
(See D15)

FERMOR AVENUE BRIDGE OVER SEINE RIVER – BRIDGE REHABILITATION, PEDESTRIAN-CYCLIST UNDERPASS STRUCTURE AND ROADWORKS FROM ST. ANNE'S ROAD TO ARCHIBALD STREET

1. Category/type: Rotomill

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

2. Category/type: Hydro-demolition Unit

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

3. Category/type: Earth Moving / Excavation

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

FORM K: EQUIPMENT
(See D15)

FERMOR AVENUE BRIDGE OVER SEINE RIVER – BRIDGE REHABILITATION, PEDESTRIAN-CYCLIST UNDERPASS STRUCTURE AND ROADWORKS FROM ST. ANNE'S ROAD TO ARCHIBALD STREET

4. Category/type: Base Placement / Compaction / Grading

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

5. Category/type: Concrete Slip Forming Paving

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

6. Category/type: Asphalt Paving

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

FORM K: EQUIPMENT

(See D15)

FERMOR AVENUE BRIDGE OVER SEINE RIVER – BRIDGE REHABILITATION, PEDESTRIAN-CYCLIST UNDERPASS STRUCTURE AND ROADWORKS FROM ST. ANNE'S ROAD TO ARCHIBALD STREET

7. Category/type: Asphalt Milling

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

8. Category/type: Miscellaneous

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

9. Category/type: Others

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

Make/Model/Year: _____ Serial No.: _____

Registered owner: _____

PART E - SPECIFICATIONS

GENERAL

E1. APPLICABLE SPECIFICATIONS AND DRAWINGS

E1.1 These Specifications shall apply to the Work.

E1.2 *The City of Winnipeg Standard Construction Specifications* in its entirety, whether or not specifically listed on Form B: Prices, shall apply to the Work.

E1.2.1 *The City of Winnipeg Standard Construction Specifications* is available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt/Spec/Default.stm

E1.2.2 The version in effect three (3) Business Days before the Submission Deadline shall apply.

E1.2.3 Further to C2.4(d), Specifications included in the Bid Opportunity shall govern over *The City of Winnipeg Standard Construction Specifications*.

E1.3 The following are applicable to the Work:

Specification No.	Specification Title
	Table of Contents
26 05 01	Common Work Results – Electrical
26 05 20	Wire and Box Connectors 0-1000 V
26 05 21	Wires and Cables
26 05 28	Grounding Secondary
26 05 31	Splitters, Junction, Pull Boxes and Cabinets
26 05 32	Outlet Boxes , Conduit Boxes and Fittings
26 05 34	Conduits, Conduit Fastenings and Conduit Fittings
26 05 44	Installation of Cables in Trenches and in Ducts
26 09 24	Lighting Control Devices – Low Voltage
26 21 17	Panelboards Breaker Type
26 27 16	Electrical Cabinets and Enclosures
26 27 26	Wiring Devices
26 28 21	Moulded Case Circuit Breakers

City of Winnipeg Drawing No.	Consultant Drawing No.	Drawing Name/Title
GENERAL		
P-3489-2017-GE-001	GE-001	COVER SHEET
P-3489-2017-GE-002	GE-002	DRAWING LIST
P-3489-2017-GE-003	GE-003	GENERAL LAYOUT AND MAJOR ITEMS OF WORK
P-3489-2017-GE-004	GE-004	REMOVALS (1 OF 4)
P-3489-2017-GE-005	GE-005	REMOVALS (2 OF 4)
P-3489-2017-GE-006	GE-006	REMOVALS (3 OF 4)
P-3489-2017-GE-007	GE-007	REMOVALS (4 OF 4)
P-3489-2017-GE-008	GE-008	CONSTRUCTION STAGING – STAGE 0 (1 OF 2)
P-3489-2017-GE-009	GE-009	CONSTRUCTION STAGING – STAGE 0 (2 OF 2)
P-3489-2017-GE-010	GE-010	CONSTRUCTION STAGING – STAGE 1A (1 OF 2)
P-3489-2017-GE-011	GE-011	CONSTRUCTION STAGING – STAGE 1A (2 OF 2)
P-3489-2017-GE-012	GE-012	CONSTRUCTION STAGING – STAGE 1B (1 OF 2)
P-3489-2017-GE-013	GE-013	CONSTRUCTION STAGING – STAGE 1B (2 OF 2)
P-3489-2017-GE-014	GE-014	CONSTRUCTION STAGING – STAGE 1C (1 OF 2)
P-3489-2017-GE-015	GE-015	CONSTRUCTION STAGING – STAGE 1C (2 OF 2)

P-3489-2017-GE-016	GE-016	CONSTRUCTION STAGING – STAGE 2A (1 OF 2)
P-3489-2017-GE-017	GE-017	CONSTRUCTION STAGING – STAGE 2A (2 OF 2)
P-3489-2017-GE-018	GE-018	CONSTRUCTION STAGING – STAGE 2B (1 OF 2)
P-3489-2017-GE-019	GE-019	CONSTRUCTION STAGING – STAGE 2B (2 OF 2)
P-3489-2017-GE-020	GE-020	CONSTRUCTION STAGING – STAGE 2C (1 OF 2)
P-3489-2017-GE-021	GE-021	CONSTRUCTION STAGING – STAGE 2C (2 OF 2)
CIVIL – STRUCTURAL BRIDGE		
B-118-2017-CS-001	CS-001	GENERAL NOTES
B-118-2017-CS-002	CS-002	GENERAL ARRAGEMENTS OF REHABILITATED BRIDGE
B-118-2017-CS-003	CS-003	OVERALL PLAN OF BRIDGE REHABILITATION WORKS
B-118-2017-CS-004	CS-004	BORE HOLE 1 OF 6
B-118-2017-CS-005	CS-005	BORE HOLE 2 OF 6
B-118-2017-CS-006	CS-006	BORE HOLE 3 OF 6
B-118-2017-CS-007	CS-007	BORE HOLE 4 OF 6
B-118-2017-CS-008	CS-008	BORE HOLE 5 OF 6
B-118-2017-CS-009	CS-009	BORE HOLE 6 OF 6
B-118-2017-CS-010	CS-010	BRIDGE CONSTRUCTION STAGING 1 OF 4
B-118-2017-CS-011	CS-011	BRIDGE CONSTRUCTION STAGING 2 OF 4
B-118-2017-CS-012	CS-012	BRIDGE CONSTRUCTION STAGING 3 OF 4
B-118-2017-CS-013	CS-013	BRIDGE CONSTRUCTION STAGING 4 OF 4
B-118-2017-CS-014	CS-014	SUPERSTRUCTURE JACKING SUPPORT FOR ABUTMENT WORKS
B-118-2017-CS-015	CS-015	EXISTING ABUTMENT AND APPROACH SLAB REMOVALS 1 OF 2
B-118-2017-CS-016	CS-016	EXISTING ABUTMENT AND APPROACH SLAB REMOVALS 2 OF 2
B-118-2017-CS-017	CS-017	ABUTMENT MODIFICATIONS 1 OF 5
B-118-2017-CS-018	CS-018	ABUTMENT MODIFICATIONS 2 OF 5 NEW BEARING SEAT ELEVATIONS
B-118-2017-CS-019	CS-019	ABUTMENT MODIFICATIONS 3 OF 5 CATHODIC PROTECTION DETAILS
B-118-2017-CS-020	CS-020	ABUTMENT MODIFICATIONS 4 OF 5 NEW WINGWALL DETAILS
B-118-2017-CS-021	CS-021	ABUTMENT MODIFICATIONS 5 OF 5 NEW WINGWALL DETAILS
B-118-2017-CS-022	CS-022	ABUTMENT BEARING REPLACEMENT DETAILS 1 OF 2
B-118-2017-CS-023	CS-023	ABUTMENT BEARING REPLACEMENT DETAILS 2 OF 2
B-118-2017-CS-024	CS-024	EXISTING BRIDGE DECK
B-118-2017-CS-025	CS-025	REHABILITATED BRIDGE DECK
B-118-2017-CS-026	CS-026	TEMPORARY FRAMING SUPPORT FOR EXISTING GIRDERS
B-118-2017-CS-027	CS-027	REMOVAL AND PLACING SEQUENACE OF CONCRETE BRIDGE DECK 1 OF 2
B-118-2017-CS-028	CS-028	REMOVAL AND PLACING SEQUENACE OF CONCRETE BRIDGE DECK 2 OF 2
B-118-2017-CS-029	CS-029	EXISTING BRIDGE DECK UNDERSIDE REPAIRS
B-118-2017-CS-030	CS-030	EXISTING STEEL GIRDER STRENGTHENING DETAILS
B-118-2017-CS-031	CS-031	EXISTING CONRETE GIRDER STRENGTHENING DETAILS
B-118-2017-CS-032	CS-032	EXISTING PIER DIAPHRAGM REPLACEMENT DETAILS
B-118-2017-CS-033	CS-033	EXISTING AND REHABILITAIED BRIDGE DECK DETAILS 1 OF 3
B-118-2017-CS-034	CS-034	EXISTING AND REHABILITATED BRIDGE DECK DETAILS 2 OF 3
B-118-2017-CS-035	CS-035	EXISTING AND REHABILITATED BRIDGE DECK DETAILS 3 OF 3
B-118-2017-CS-036	CS-036	REHABILITATED BRIDGE DECK REINFORCING DETAILS 1 OF 2
B-118-2017-CS-037	CS-037	REHABILITAIED BRIDGE DECK REINFORCING DETAILS 2 OF 2
B-118-2017-CS-038	CS-038	APPROACH SLAB DETAILS 1 OF 2
B-118-2017-CS-039	CS-039	APPROACH SLAB DETAILS 2 OF 2

B-118-2017-CS-040	CS-040	SHOULDER BARRIER DETAILS 1 OF 2
B-118-2017-CS-041	CS-041	SHOULDER BARRIER DETAILS 2 OF 2
B-118-2017-CS-042	CS-042	MEDIAN BARRIER DETAILS
B-118-2017-CS-043	CS-043	ALUMINUM PEDESTRIAN HANDRAIL LAYOUT
B-118-2017-CS-044	CS-044	ALUMINUM PEDESTRIAN HANDRAIL DETAILS 1 OF 3
B-118-2017-CS-045	CS-045	ALUMINUM PEDESTRIAN HANDRAIL DETAILS 2 OF 3
B-118-2017-CS-046	CS-046	ALUMINUM PEDESTRIAN HANDRAIL DETAILS 3 OF 3
B-118-2017-CS-047	CS-047	SLOPE PROTECTION WORKS 1 OF 2
B-118-2017-CS-048	CS-048	SLOPE PROTECTION WORKS 2 OF 2
B-118-2017-CS-049	CS-049	BRIDGE STRUCTURE REINFORCING STEEL SCHEDULE 1 OF 2
B-118-2017-CS-050	CS-050	BRIDGE STRUCTURE REINFORCING STEEL SCHEDULE 2 OF 2
RETAINING WALLS		
B-118-2017-CS-051	CS-051	RETAINING WALL LAYOUT WESTBOUND
B-118-2017-CS-052	CS-052	RETAINING WALL LAYOUT EASTBOUND 1 OF 2
B-118-2017-CS-053	CS-053	RETAINING WALL LAYOUT EASTBOUNO 2 OF 2
B-118-2017-CS-054	CS-054	RETAINING WALL DETAILS 1 OF 3
B-118-2017-CS-055	CS-055	RETAINING WALL DETAILS 2 OF 3
B-118-2017-CS-056	CS-056	RETAINING WALL DETAILS 3 OF 3
B-118-2017-CS-057	CS-057	ROADWAY SHOULDER BARRIER DETAILS 1 OF 2
B-118-2017-CS-058	CS-058	ROADWAY SHOULDER BARRIER DETAILS 2 OF 2
B-118-2017-CS-059	CS-059	ROADWAY NORTH SHOULDER BARRIER DETAILS 1 OF 2
B-118-2017-CS-060	CS-060	ROADWAY NORTH SHOULDER BARRIER DETAILS 2 OF 2
B-118-2017-CS-061	CS-061	ROADWAY MEDIAN BARRIER DETAILS 1 OF 2
B-118-2017-CS-062	CS-062	ROADWAY MEDIAN BARRIER DETAILS 2 OF 2
B-118-2017-CS-063	CS-063	RETAINING WALL AND ROADWAY BARRIER JOINT DETAILS
B-118-2017-CS-064	CS-064	CATCHBASIN ROOF SLAB AND MISCELLANEOUS METALS
UNDERPASS		
U-243-2017-CS-065	CS-065	PEDESTRIAN CYCLIST UNDERPASS GENERAL ARRANGEMENT
U-243-2017-CS-066	CS-066	PEDESTRIAN CYCLIST UNDERPASS STAGES 1A, 1B & 1C
U-243-2017-CS-067	CS-067	PEDESTRIAN CYCLIST UNDERPASS STAGES 2A, 2B & 2C
U-243-2017-CS-068	CS-068	PEDESTRIAN CYCLIST UNDERPASS ELEVATIONS
U-243-2017-CS-069	CS-069	PEDESTRIAN CYCLIST UNDERPASS CONCRETE DETAILS 1 OF 3
U-243-2017-CS-070	CS-070	PEDESTRIAN CYCLIST UNDERPASS CONCRETE DETAILS 2 OF 3
U-243-2017-CS-071	CS-071	PEDESTRIAN CYCLIST UNDERPASS CONCRETE DETAILS 3 OF 3
U-243-2017-CS-072	CS-072	PEDESTRIAN CYCLIST UNDERPASS REINFORCING DETAILS 1 OF 5
U-243-2017-CS-073	CS-073	PEDESTRIAN CYCLIST UNDERPASS REINFORCING DETAILS 2 OF 5
U-243-2017-CS-074	CS-074	PEDESTRIAN CYCLIST UNDERPASS REINFORCING DETAILS 3 OF 5
U-243-2017-CS-075	CS-075	PEDESTRIAN CYCLIST UNDERPASS REINFORCING DETAILS 4 OF 5
U-243-2017-CS-076	CS-076	PEDESTRIAN CYCLIST UNDERPASS REINFORCING DETAILS 5 OF 5
U-243-2017-CS-077	CS-077	PEDESTRIAN CYCLIST UNDERPASS APPROACH SLAB DETAILS
U-243-2017-CS-078	CS-078	PEDESTRIAN CYCLIST UNDERPASS WINGWALL DETAILS 1 OF 3
U-243-2017-CS-079	CS-079	PEDESTRIAN CYCLIST UNDERPASS WINGWALL DETAILS 2 OF 3
U-243-2017-CS-080	CS-080	PEDESTRIAN CYCLIST UNDERPASS WINGWALL DETAILS 3 OF 3
U-243-2017-CS-081	CS-081	PEDESTRIAN CYCLIST UNDERPASS LIGHTING PLAN
U-243-2017-CS-082	CS-082	PEDESTRIAN CYCLIST UNDERPASS LIGHTING DETAILS
U-243-2017-CS-083	CS-083	PEDESTRIAN CYCLIST UNDERPASS REINFORCING STEEL SCHEDULE 1 OF 6

U-243-2017-CS-084	CS-084	PEDESTRIAN CYCLIST UNDERPASS REINFORCING STEEL SCHEDULE 2 OF 6
U-243-2017-CS-085	CS-085	PEDESTRIAN CYCLIST UNDERPASS REINFORCING STEEL SCHEDULE 3 OF 6
U-243-2017-CS-086	CS-086	PEDESTRIAN CYCLIST UNDERPASS REINFORCING STEEL SCHEDULE 4 OF 6
U-243-2017-CS-087	CS-087	PEDESTRIAN CYCLIST UNDERPASS REINFORCING STEEL SCHEDULE 5 OF 6
U-243-2017-CS-088	CS-088	PEDESTRIAN CYCLIST UNDERPASS REINFORCING STEEL SCHEDULE 6 OF 6
OHSS		
U-243-2017-CS-089	CS-089	S787 - NB ST ANNE'S ROAD AT FERMOR AVENUE
U-243-2017-CS-090	CS-090	S757 - FABRICATION DETAILS 1
U-243-2017-CS-091	CS-091	S787 - FABRICATION DETAILS 2
U-243-2017-CS-092	CS-092	S788 - SB ST ANNE'S ROAD AT FERMOR AVENUE
U-243-2017-CS-093	CS-093	S788 - FABRICATION DETAILS
U-243-2017-CS-094	CS-094	S789 - WB FERMOR AVENUE AT ST ANNE'S ROAD
U-243-2017-CS-095	CS-095	S789 - FABRICATION DETAILS 1
U-243-2017-CS-096	CS-096	S789 - FABRICATION DETAILS 2
U-243-2017-CS-097	CS-097	S789 - CRASH CUSHION WITH TENSION STRUT BACKUP
U-243-2017-CS-098	CS-098	S790 - EB FERMOR AVENUE AT ALPINE AVENUE
U-243-2017-CS-099	CS-099	S790 - FABRICATION DETAILS
U-243-2017-CS-100	CS-100	OLD ST VITAL BIZ POLE RELOCATION
CIVIL - TRANSPORATION		
P-3489-2017-CT-001	CT-001	CONTROL LINE GEOMETRY - FERMOR AVENUE (1 OF 2)
P-3489-2017-CT-002	CT-002	CONTROL LINE GEOMETRY - FERMOR AVENUE (2 OF 2)
P-3489-2017-CT-003	CT-003	CONTROL LINE GEOMETRY - ST ANNE’S ROAD
P-3489-2017-CT-004	CT-004	CONTROL LINE GEOMETRY - FERMOR-ST ANNE'S INTERSECTION
P-3489-2017-CT-005	CT-005	CONTROL LINE GEOMETRY - ALPINE AVENUE & ARCHIBALD NW ATP
P-3489-2017-CT-006	CT-006	CONTROL LINE GEOMETRY - PATHWAYS (1 OF 2)
P-3489-2017-CT-007	CT-007	CONTROL LINE GEOMETRY - PATHWAYS (2 OF 2)
P-3489-2017-CT-008	CT-008	GENERAL ARRANGEMENT
P-3489-2017-CT-009	CT-009	FERMOR AVENUE - START TO STA. 4+085 (PLAN PROFILE)
P-3489-2017-CT-010	CT-010	FERMOR AVENUE - STA. 4+085 TO 4+215 (PLAN PROFILE)
P-3489-2017-CT-011	CT-011	FERMOR AVENUE - STA. 4+215 TO 4+355 (PLAN)
P-3489-2017-CT-012	CT-012	FERMOR AVENUE - STA. 4+215 TO 4+355 (PROFILE)
P-3489-2017-CT-013	CT-013	FERMOR AVENUE - STA. 4+355 TO 4+51 5 (PLAN)
P-3489-2017-CT-014	CT-014	FERMOR AVENUE - STA. 4+355 TO 4+515 (WB PROFILE)
P-3489-2017-CT-015	CT-015	FERMOR AVENUE - STA. 4+355 TO 4+515 (EB PROFILE)
P-3489-2017-CT-016	CT-016	FERMOR AVENUE - STA. 4+515 TO 4+665 (PLAN)
P-3489-2017-CT-017	CT-017	FERMOR AVENUE – STA. 4+5l5 TO 4+665 (WB PROFILE)
P-3489-2017-CT-018	CT-018	FERMOR AVENUE - STA. 4+515 TO 4+665 (EB PROFILE)
P-3489-2017-CT-019	CT-019	FERMOR AVENUE - STA. 4+665 TO 4+825 (PLAN)
P-3489-2017-CT-020	CT-020	FERMOR AVENUE - STA. 4+665 TO 4+825 (WB PROFILE)
P-3489-2017-CT-021	CT-021	FERMOR AVENUE - STA. 4+665 TO 4+825 (EB PROFILE)
P-3489-2017-CT-022	CT-022	FERMOR AVENUE - STA. 4+825 TO 4+475 (PLAN)
P-3489-2017-CT-023	CT-023	FERMOR AVENUE - STA. 4+825 TO 4+975 (PROFILE)
P-3489-2017-CT-024	CT-024	FERMOR AVENUE - STA. 4+975 TO 5+135 (PLAN)
P-3489-2017-CT-025	CT-025	FERMOR AVENUE - STA. 4+975 TO 5+135{PROFILE)
P-3489-2017-CT-026	CT-026	FERMOR ÀVENUE - STA. 5+135 TO 5+290 (PLAN)

P-3489-2017-CT-027	CT-027	FERMOR AVENUE - STA. 5+135 TO 5+290 (WB PROFILE)
P-3489-2017-CT-028	CT-028	FERMOR AVENUE - STA. 5+135 TO 5+290 (EB PROFILE)
P-3489-2017-CT-029	CT-029	FERMOR AVENUE - STA. 5+290 TO 5+545 (PLAN)
P-3489-2017-CT-030	CT-030	FERMOR AVENUE - STA. 5+290 TO 5+545 (WB PROFILE)
P-3489-2017-CT-031	CT-031	FERMOR AVENUE - STA. 5+290 TO 5+545 (EB PROFILE)
P-3489-2017-CT-032	CT-032	FERMOR AVENUE - STA. 5+545 TO END (PLAN)
P-3489-2017-CT-033	CT-033	FERMOR AVENUE - STA. 5+545 TO END (WB PROFILE)
P-3489-2017-CT-034	CT-034	FERMOR AVENUE - STA. 5+545 TO END (EB PROFILE)
P-3489-2017-CT-035	CT-035	ST. ANNE'S ROAD - START TO STA. 0+160 (PLAN PROFILE)
P-3489-2017-CT-036	CT-036	FERMOR & ST, ANNES TURN LANES
P-3489-2017-CT-037	CT-037	ARCHIBALD TURN LANES
P-3489-2017-CT-038	CT-038	ARCHIBALD STREET (PLAN-PROFILE)
P-3489-2017-CT-039	CT-039	ALPINE AVENUE ACCESS & SEAGRIM ROAD PLAN
P-3489-2017-CT-040	CT-040	ALPINE AVENUE ACCESS. PROFILES (1 OF 2)
P-3489-2017-CT-041	CT-041	ALPINE AVENUE ACCESS, PROFILES (2 OF 2)
P-3489-2017-CT-042	CT-042	ALPINE AVENUE CUL DE SAC (PLAN PROFILE)
P-3489-2017-CT-043	CT-043	FERMOR & ARCHIBALD ATP AND SDIEWALK
P-3489-2017-CT-044	CT-044	FERMOR PATHWAY - START TO STA. 0+195 (PLAN PROFILE)
P-3489-2017-CT-045	CT-045	FERMOR PATHWAY - STA. 0+195 TO END (PLAN PROFILE)
P-3489-2017-CT-046	CT-046	PEDESTRIAN OVERPASS - START TO STA. 6+915 (PLAN PROFILE)
P-3489-2017-CT-047	CT-047	PEDESTRIAN OVERPASS - STA. 6+915 TO 7+055 (PLAN PROFILE)
P-3489-2017-CT-048	CT-048	PEDESTRIAN OVERPASS - STA. 7+055 TO END (PLAN PROFILE)
P-3489-2017-CT-049	CT-049	PEDESTRIAN UNDERPASS - START TO STA. 0+115 (PLAN PROFILE)
P-3489-2017-CT-050	CT-050	PEDESTRIAN UNDERPASS - STA 0+115 TO STA 0+240(PLAN PROFILE)
P-3489-2017-CT-051	CT-051	PEDESTRIAN UNDERPASS - STA TO+240 TO END (PLAN PROFILE)
P-3489-2017-CT-052	CD-052	CROSS SECTIONS (1 OF 6)
P-3489-2017-CT-053	CT-053	CROSS SECTIONS (2 OF 6)
P-3489-2017-CT-054	CT-054	CROSS SECTIONS (3 OF 6)
P-3489-2017-CT-055	CT-055	CROSS SECTIONS (4 OF 6)
P-3489-2017-CT-056	CT-056	CROSS SECTIONS (5 OF 6)
P-3489-2017-CT-057	CT-057	CROSS SECTIONS (6 OF 6)
P-3489-2017-CT-058	CT-058	DETAILS 1 OF 2
P-3489-2017-CT-059	CT-059	DETAILS 2 OF 2
P-3489-2017-CT-060	CT-060	CONCRETE JOINT LAYOUT (1 OF 2)
P-3489-2017-CT-061	CT-061	CONCRETE JOINT LAYOUT (2 OF 2)
P-3489-2017-CT-062	CT-062	CRASH CUSHION LAYOUT AND DETAILS
P-3489-2017-CT-063	CT-063	GUARDRAIL LAYOUT EB FERMOR PEDESTRIAN UNDERPASS
P-3489-2017-CT-064	CT-064	GUARDRAIL LAYOUT WB FERMOR PEDESTRIAN UNDERPASS
P-3489-2017-CT-065	CT-065	GUARDRAIL LAYOUT WB FERMOR BRIDGE
P-3489-2017-CT-066	CT-066	GUARDRAIL DETAILS
P-3489-2017-CT-067	CT-067	ET-31 GUARDRAIL DETAILS
CIVIL – UTILITIES		
P-3489-2017-CU-001	CU-001	FERMOR AVENUE - START TO STA. 4+200 (PLAN PROFILE)
P-3489-2017-CU-002	CU-002	FERMOR AVENUE - STA. 4+200 TO STA 4+450 (PLAN PROFILE)
P-3489-2017-CU-003	CU-003	FERMOR AVENUE – STA. 4+700 TO STA 5+000 (PLAN PROFILE)
P-3489-2017-CU-004	CU-004	FERMOR AVENUE – STA. 5+000 TO STA 5+250 (PLAN PROFILE)
P-3489-2017-CU-005	CU-005	FERMOR AVENUE – STA. 5+250 TO STA 5+615.5 (PLAN PROFILE)

P-3489-2017-CU-006	CU-006	ST. ANNE'S- STA 0+950 TO STA. 1+200 (PROFILE)
P-3489-2017-CT-007	CU-007	PEDESTRIAN UNDERPASS - STA. 0+050 TO STA 0+250 (PLAN PROFILE)
P-3489-2017-CT-008	CU-008	LDS STANDARD DETAILS 1
P-3489-2017-CT-009	CU-009	LDS STANDARD DETAILS 2
P-3489-2017-CT-010	CU-010	LDS STANDARD DETAILS 3
P-3489-2017-CT-011	CU-011	LDS STRUCTURE LOCATION TABLES
LANDSCAPING		
P-772-2017-LS-1	LS-01	LANDSCAPE KEY PLAN
P-772-2017-LS-2	LS-02	LANDSCAPE PLAN ST ANNE S ROAD AT FERMOR AVENUE
P-772-2017-LS-3	LS-03	LANDSCAPE PLAN - FERMOR AVENUE UNDERPASS
P-772-2017-LS-4	LS-04	LANDSCAPE PLAN - FERMOR AVENUE BRIDGE
P-772-2017-LS-5	LS-05	LANDSCAPE PLAN - FERMOR AVE. AT ARCHIBALD ST.
P-772-2017-LS-6	LS-06	DETAILED PLAN - ST. ANNE'S RD. AT FERMOR AVE. (NORTH)
P-772-2017-LS-7	LS-07	DETAILED PLAN - ST. ANNE'S ROAD AT FERMOR AVE. (SOUTH)
P-772-2017-LS-8	LS-08	DETAILED PLAN - MULTI-USE PATHWAYS NORTH OF FERMOR UNDERPASS
P-772-2017-LS-9	LS-09	DETAILED PLAN - ALPINE AVE. TO NIAKWA RD. AT SEINE RIVER
P-3489-2017-LS-10	LS-10	DETAILED PLAN - ARCHIBALD ST. AT FERMOR AVE.(NORTH)
P-3489-2017-LS-11	LS-11	LANDSCAPE DETAILS

E2. GEOTECHNICAL REPORT

E2.1 Further to C3.1, the geotechnical report is provided to aid the Contractor's evaluation of the pavement structure and/or existing soil conditions. The Geotechnical Report is contained in Appendix 'A'.

E2.2 Test hole logs from September 2017 Trek Geotechnical report – Rev 1 and from the supplemental investigation of September 2016 are provided in the drawings to aid the Contractor's evaluation of the existing soil conditions.

E3. PAVEMENT CORE REPORT

E3.1 Further to C3.1, the pavement core report is provided to aid the Contractor's evaluation of the existing pavement structures. The Pavement Core report is contained in Appendix 'C'.

E4. SHOP DRAWINGS

E4.1 Description

E4.1.1 This Specification shall revise, amend, and supplement the requirements of CW 1110.

E4.1.2 The Contractor shall provide all Submittals and Shop Drawings required in the Contract as well as any additional Submittals reasonably requested by the Contract Administrator, at the Contractor's expense.

E4.1.3 The term "Shop Drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures, and other data, which are to be provided by the Contractor to illustrate details of a portion of the Work.

E4.1.4 Original drawings are to be prepared by the Contractor, subcontractor, supplier, distributor, or manufacturer, which illustrate the appropriate portion of Work; showing fabrication, layout, setting, or erection details as specified in appropriate sections.

E4.2 Contractor's Responsibilities

E4.2.1 Review Shop Drawings, product data, and samples prior to submission and stamp and sign drawings indicating conformance to the Contract requirements.

E4.2.2 The Contractor shall provide all Submittals and Shop Drawings required in the Contract as well as any additional Submittals reasonably requested by the Contract Administrator, at the Contractor's expense.

E4.2.3 Verify:

(a) field measurements;

(b) field construction criteria;

(c) catalogue numbers and similar data.

E4.2.4 Coordinate each shop drawing submission with the requirements of the Work and Contract Documents. Shop Drawings of separate components of a larger system will not be reviewed until all related drawings are available.

E4.2.5 Notify Contract Administrator, in writing at time of shop drawing submission, of deviations from requirements of Contract Documents.

E4.2.6 Responsibility for deviations in Shop Drawing submission from requirements of Contract Documents is not relieved by the Contract Administrator's review of submission, unless the Contract Administrator gives written acceptance of specified deviations.

E4.2.7 Responsibility for errors and omissions in the shop drawing submission is not relieved by the Contract Administrator's review of the submittals.

E4.2.8 The Contractor shall make any corrections required by the Contract Administrator and shall resubmit the required number of corrected copies of Shop Drawings. The Contractor shall direct specific attention in writing or on resubmitted Shop Drawings to revisions other than the corrections requested by the Contract Administrator on the previous submission.

E4.2.9 After the Contract Administrator has reviewed and returned the copies, distribute the copies to sub-trades as appropriate.

E4.2.10 Maintain one (1) complete set of reviewed Shop Drawings, filed by Specification section number, at the Site for use and reference by the Contract Administrator and Subcontractors.

E4.3 Submission Requirements

E4.3.1 Schedule submittals at least fourteen (14) Calendar Days before dates reviewed submittals will be needed, and allow for a fourteen (14) Calendar Days period for review by the Contract Administrator of each individual submission and re-submission, unless noted otherwise in the Contract.

E4.3.2 Submit five (5) paper prints or one (1) electronic PDF of Shop Drawings. The Contractor is advised that for paper copies, the Contract Administrator will retain three (3) copies of all submittals and return two (2) copies to the Contractor.

E4.3.3 Further to CW 1110, all submissions must be in metric units. Where data is in imperial units, the correct metric values shall also be shown on the submissions for Contract Administrator review.

E4.3.4 Accompany shop drawing submissions with a transmittal letter containing:

(a) Date;

(b) project title and bid opportunity number;

(c) Contractor's name and address;

(d) number of each Shop Drawing, product data, and sample submitted;

(e) specification section, title, number, and clause;

(f) drawing number and detail/section number;

(g) other pertinent data.

E4.3.5 Shop drawing submissions shall include:

(a) date and revision dates;

(b) project title and bid opportunity number;

(c) name of:

(i) Contractor;

(ii) Subcontractor;

(iii) supplier;

(iv) manufacturer;

(v) separate detailer when pertinent.

(d) identification of product or material;

(e) relation to adjacent structure or materials;

(f) field dimensions, clearly identified as such;

(g) specification section name, number and clause number or drawing number and detail/section number;

(h) applicable standards, such as CSA or CGSB numbers;

(i) Contractor’s stamp, initialled or signed, certifying review of submission, verification of field measurements, and compliance with Contract Documents.

E4.3.6 Shop Drawings for the following components shall bear the seal of a Professional Engineer registered in the province of Manitoba:

(a) Pile Dynamic Analyser (PDA) Testing;

(b) Temporary Shoring;

(c) All Form Details, as requested by the Contract Administrator;

(d) Form Details for Deck Pours;

(e) Bearing Layout and Details;

(f) Metal Fabrications, Layout, and Erection Details for steel beam spans;

(g) Metal Fabrication, Layout and Erection Details for Expansion Joints;

(h) Reinforcing Steel Layout and Details;

(i) Handrails and Miscellaneous Metals.

E4.4 Other Considerations

E4.4.1 Fabrication, erection, installation, or commissioning may require modifications to equipment or systems to conform to the design intent. Revise pertinent Shop Drawings and resubmit.

E4.4.2 Material and equipment delivered to the Site will not be paid for until pertinent Shop Drawings have been submitted and reviewed.

E4.4.3 Incomplete shop drawing information will be considered as stipulated deductions for the purposes of progress payment certificates.

E4.4.4 No delay or cost claims will be allowed that arise because of delays in submissions, re-submissions, and review of Shop Drawings;

E4.4.5 Only two (2) reviews of Shop Drawings will be made by the Contract Administrator at no cost. Each additional review will be charged to the Contractor at the Contract Administrator's scheduled rates and at the discretion of the Contract Administrator. The Contract Administrator’s charges for the additional Work will be deducted from the Contractor’s Progress Certificates.

E5. VERIFICATION OF WEIGHTS

E5.1 All material which is paid for on a weight basis shall be weighed on a scale certified by Consumer & Corporate Affairs, Canada.

E5.1.1 All weight tickets shall have the gross weight and the time and date of weighing printed by an approved electro/mechanical printer coupled to the scale.

E5.1.2 The tare weight and net weight may either be hand written or machine printed. All weights, scales and procedures shall be subject to inspection and verification by the Contract Administrator. Such inspection and verification may include, but shall not be limited to:

(a) checking Contractor's scales for Consumer & Corporate Affairs certification seals;

(b) observing weighing procedures;

(c) random checking of either gross or tare weights by having such trucks or truck/trailer(s) combinations as the Contract Administrator shall select weighed at the nearest available certified scale;

(d) checking tare weights shown on delivery tickets against a current tare.

E5.1.3 No charge shall be made to the City for any delays or loss of production caused by such inspection and verification.

E5.2 The Contractor shall ensure that each truck or truck/trailer(s) combination delivering material which is paid for on a weight basis carries a tare not more than one (1) month old.

E5.2.1 The tare shall be obtained by weighing the truck or truck/trailer(s) combination on a certified scale and shall show:

(a) upon which scale the truck or truck/trailer(s) combination was weighed;

(b) the mechanically printed tare weight;

(c) the license number(s) of the truck and trailer(s);

(d) the time and date of weighing.

E5.3 Further to clause 3.16.3 of CW 1130 no charge shall be made to the City for any delays or loss of production caused by inspection and verification.

GENERAL REQUIREMENTS

E6. MOBILIZATION AND DEMOBILIZATION

E6.1 Description

E6.1.1 General

(a) This Specification covers all operations relating to the mobilization and demobilization of the Contractor to the Site, as specified herein.

(b) The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Works as hereinafter specified.

E6.1.2 Scope of Work

(a) The Work under this Specification shall include but not be limited to:

(i) mobilizing and demobilizing on-site Work facilities;

(ii) supplying, setting up, laying out, and removing site office facilities as detailed in E7 supplying and installing secure fencing/gates for portions of the laydown areas the Contractor wishes to secure;

(iii) maintaining and removing any access roadways as needed into the laydown areas;

(iv) Traffic Control (E9),and Traffic Management (E10).

E6.2 Materials

E6.2.1 All materials supplied under this Specification shall be of a type approved by the Contract Administrator, and shall be subject to inspection and testing by the Contract Administrator.

E6.2.2 The Contractor shall be responsible for the supply, safe storage and handling of all materials as set forth in this Specification. All materials shall be handled in a careful and workmanlike manner, to the satisfaction of the Contract Administrator.

E6.3 Equipment

E6.3.1 All equipment shall be of a type acceptable to the Contract Administrator and shall be kept in good working order.

E6.4 Construction Methods

E6.4.1 Layout of On-Site Work Facilities

(a) The Contractor shall mobilize all on-site Work and other temporary facilities.

(b) Upon completion of construction activities, the Contractor shall remove all on-site Work and other temporary facilities.

E6.4.2 Site Security

(a) The Contractor has discretion on what areas of the site they wish to secure. This may include the Contractor's lay down area, material storage areas, and/or access roads. These areas may be fenced and gated for security and to discourage pedestrian entrance to construction areas and to control any potential hazard to the public, particularly children. The Contractor shall not fence off areas where public traffic or pedestrians need to travel, such as open roadway lanes or sidewalks/bike paths.

E6.4.3 Access Roadway

(a) The Contractor shall note the laydown areas available within each Phase/Stage of the work on the Staging Drawings referenced in E10. The drawings indicate where accesses can and cannot be constructed from other public right of way.

(b) When the Contractor wishes to install an access along a laydown border marked "Contractor Laydown Area – Access", they shall make a written request to the Contract Administrator before commencing construction. The Contract Administrator shall have two (2) Business Days to review and respond to the request.

(c) The Contractor shall maintain any access roadway they install.

(d) Upon completion of the Work, the area shall be restored to its original condition.

E6.4.4 Restoration of Existing Facilities

(a) Upon completion of the Work and demobilization, the Contractor shall restore existing facilities to their original condition, to the approval of the Contract Administrator.

E6.5 Measurement and Payment

E6.5.1 Mobilization and Demobilization

(a) "Mobilization and Demobilization" will not be measured. This Item of Work will be paid for at a percentage of the Contract Lump Sum Price, which price shall be payment in full for supplying all materials and for completing all operations herein described and all other items incidental to the work included in this Specification, accepted and measured by the Contract Administrator. These percentages shall be as follows:

(i) when Contract Administrator is satisfied that construction has commenced thirty percent (30%);

(ii) during construction, percentage distributed equally on a monthly basis at the discretion of the Contract Administrator sixty percent (60%);

(iii) upon Total Performance ten percent (10%).

(b) Note that "Mobilization and Demobilization" applies to work in all Parts of the project, but is listed for measurement and payment only under Part A.

E7. OFFICE FACILITIES

E7.1 The Contractor shall supply office facilities meeting the following requirements:

(a) The field office shall be for the exclusive use of the Contract Administrator.

(b) The building shall be conveniently located near the site of the Work.

(c) The building shall have a minimum floor area of 80 square metres, a height of 2.4 meters. Each building shall have two (2) windows for cross ventilation and a door entrance with a suitable lock.

(d) The building shall be suitable for all weather use. It shall be equipped with an electric heater and air conditioner so that the room temperature can be maintained between either sixteen to eighteen degrees Celsius (16-18^{o}C) or twenty-four to twenty-five degrees Celsius (24-25^{o}C).

(e) The building shall be adequately lighted with fluorescent fixtures and have a minimum of three (3) wall outlets.

(f) The building shall be furnished with two (2) desks with chairs, one (1) drafting table with a stool, a table with chairs suitable to seat at least fifteen (15) people at a time for meetings, one (1) four (4) drawer, lockable legal size filing cabinet, and a minimum of fifteen (15) chairs;

(g) The field office (s) combined shall be equipped with a water cooler and be supplied so as never to run out of water. They shall be equipped with one (1) fridge, one (1) microwave, and one (1) coffee maker;

(h) A portable toilet shall be located near the field office building. The toilet shall have a locking door and be for the exclusive use of the Contract Administrator and other personnel from the City.

(i) The field office building and the portable toilet shall be cleaned on a weekly basis immediately prior to each site meeting. The Contract Administrator may request additional cleaning when he/she deems it necessary.

E7.2 The Contractor shall be responsible for all installation and removal costs, all operating costs, and the general maintenance of the office facilities.

E7.3 The office facilities will be provided from the date of the commencement of the Work to the date of Substantial Performance is completed.

E8. PROTECTION OF TREES

E8.1 The Contractor will field-verify the presumed limits of work indicated on the Drawings, and flag all trees that require pruning or removal to facilitate the work, subject to the Contract Administrator's approval. Above ground clearance for overhanging branches in the work zone must be anticipated. No trees may be removed or pruned without written approval from the Contract Administrator. Forestry Branch will conduct an appraisal of affected trees concurrently with the Contract Administrator's review.

E8.1.1 Trees within or adjacent to a construction area that are not approved for removal by the Contract Administrator must be protected during construction by means of a barrier surrounding the TPZ as outlined in E8.6. Activities that are likely to injure or destroy the tree are not permitted within the TPZ.

E8.1.2 Activities which are likely to injure or destroy the tree are not permitted within the TPZ.

E8.1.3 Tree pruning or root pruning of City of Winnipeg owned trees may only be done by a Contractor approved by the project's Qualified Tree Consultant (refer to E8.1.5) or Urban Forestry Branch.

E8.1.4 No objects may be attached to trees protected by City of Winnipeg by-laws without written authorization by the City of Winnipeg.

E8.1.5 No City of Winnipeg tree or tree protected by a City of Winnipeg by-law may be removed without the written permission of the City of Winnipeg.

E8.2 Take precautions to ensure tree limbs overhanging the Site are not damaged by construction equipment. Contact the Forestry Branch for consultation on pruning of overhanging or damaged limbs and branches and other unanticipated problems with trees during construction of the Works.

E8.3 American elm trees are not to be pruned between April 1 and August 1 and Siberian elm trees between April 1 and July 1 of any year under provisions of The Dutch Elm Disease Act.

E8.4 All damage to existing trees caused by the Contractor's activities shall be repaired to the requirements and satisfaction of the Contract Administrator and the Forestry Branch. Damages must be repaired by an individual with a Manitoba Arborist licence or by the Forestry Branch.

The Contractor will remove and replace any trees deemed to have died or that are dying due to damage from carelessness during construction. Removal and replacement costs will be determined by size, market price of the largest transplantable tree of same or different species and may include appraised value of existing tree as determined by current International Society of Arboriculture evaluation procedure presently used by Forestry Branch in conjunction with City Claims Branch. For reference, the estimated replacement cost of a 600 mm diameter American elm on a boulevard based on this appraisal system is approximately $27,000.00.

E8.5 Tree Protection Zone

E8.5.1 The following is a chart showing optimal distances for determining a tree protection zone (the roots of a tree can extend from the trunk to approximately two (2) to three (3) times the distance of the drip line). Some site conditions may dictate the need for a smaller TPZ. The City of Winnipeg Urban Forestry Branch must be notified in these instances. Forestry will determine if the smaller TPZ is acceptable in the specific circumstance and advise of any additional tree protection or removal requirements.

Table E8-2: Tree Protection Zones

Trunk Diameter (DBH)	Minimum Protection Distances Required
<10 cm	2.0 m
11-40 cm	2.4 m
41-50 cm	3.0 m
51-60 cm	3.6 m
61-70 cm	4.2 m
71-80 cm	4.8 m
81-90 cm	5.4 m
91-100 cm+	6.0 m

E8.5.2 Diameter at breast height (DBH) measurement of tree trunk is taken at 1.4 m above ground.

E8.5.3 Tree Protection Zone distances are to be measured from the outside edge of the tree base towards the drip line and may be limited by an existing paved surface, provided the existing paved surface remains intact throughout the construction work.

E8.6 Tree Protection Barriers

E8.6.1 Trees within tree protection zones shall be protected by means of a “tree protection barrier” meeting the following Specifications:

(a) the required barrier is a 1.2 m high orange plastic web snow fencing on 50 mm x 100 mm frame or as directed by the City of Winnipeg Urban Forestry Branch in accordance with the City of Winnipeg Protection of Existing Tree Specifications. The barrier can be lowered around branches lower than 1.2 m. The barrier location can be adjusted to align with curbs and edges at clear path of travel zones;

(b) trees identified to be at risk by the Contract Administrator are to be strapped with 25 mm x 100 mm x 2400 mm wood planks, or suitably protected as approved by the Contract Administrator;

(c) tree protection barriers are to be erected prior to the commencement of any construction or grading activities on the site and are to remain in place throughout the entire duration of the project. The applicant shall notify the City of Winnipeg prior to commencing any construction activities to confirm that the tree protection barriers are in place;

(d) all supports and bracing used to safely secure the barrier should be located outside the TPZ. All supports and bracing should minimize damage to roots. No grade change, storage of materials or equipment is permitted within this area. The tree protection barrier must not be removed without the written authorization of the City of Winnipeg;

(e) excavation shall be performed in a manner that minimizes damage to the existing root systems. Where possible, excavation shall be carried out such that the edge of the excavation shall be a minimum of 1.5 times the diameter (measured in inches), with the outcome read in feet, from the closest edge of the trunk. Where roots must be cut to facilitate excavation, they shall be pruned neatly at the face of excavation; and

(f) operation of equipment within the drip line of the trees shall be kept to a minimum required to perform the work required. Equipment shall not be parked, repaired, refuelled; construction materials shall not be stored, and earth materials shall not be stockpiled within the driplines of trees. The drip line of a tree shall be considered to be the ground surface directly beneath the tips of its outmost branches. The Contractor shall ensure that the operations do not cause flooding or sediment deposition on areas where trees are located.

E8.7 Utility Construction, Engineering and Capital Construction Projects

E8.7.1 It is recognized that there are cases where trees are growing overtop existing utilities or beside capital infrastructure. While the guidelines in this section still apply, in these cases some modification to Table 9 - 1 in addition to root pruning may be permitted provided non-open trench methods of construction are employed (as defined in CW 2110 and CW 2130).

E8.7.2 Root Pruning will be required to be done under the direction of, and along with, written sign-off by the Project’s Qualified Tree Consultant (Refer to E8.8). The objective is to avoid severance of anchor roots, which provide upright support for trees and minimize damage to the tree.

E8.7.3 Above ground clearance for overhanging branches in the work zone must be anticipated. The utility or its consultant is required to have a Forestry approved tree service raise the crown of all branches to provide adequate clearance for construction equipment.

E8.8 Qualified Tree Consultants

E8.8.1 An arborist certified by the International Society of Arboriculture (ISA) who has a diploma (minimum) in arboriculture or urban forestry.

E8.8.2 A landscape architect who is a member in good standing of the Manitoba Association of Landscape Architects.

E8.9 Measurement and Payment

E8.9.1 No separate measurement or payment will be made for the protection of trees.

E9. TRAFFIC CONTROL

E9.1 Further to clauses 3.6, 3.7 and 3.8 of CW 1130:

(a) Where directed by the Contract Administrator, the Contractor shall construct and maintain temporary asphalt ramps to alleviate vertical pavement obstructions such as manholes and planing drop-offs to the satisfaction of the Contract Administrator. Payment shall be in accordance with CW 3410.

(b) In accordance with the Manual of Temporary Traffic Control on City Streets (MTTC), the Contractor ("Construction Agency" in the manual) shall be responsible for placing, maintaining and removing the appropriate temporary traffic control devices as specified by the MTTC or by the Traffic Management Branch of the City of Winnipeg Public Works Department. The Contractor shall bear all costs associated with the placement of temporary traffic control devices by their own forces or subcontractor.

E9.2 Notwithstanding E9.1, in accordance with the MTTC, the Contract Administrator shall make arrangements with the **Traffic Services Branch of the City of Winnipeg** to place, maintain, and remove all **regulatory signs** and traffic control devices authorized and/or required by the Traffic Management Branch in the following situations:

(a) Parking restrictions;

(b) Stopping restrictions;

(c) Turn restrictions;

(d) Diamond lane removal;

(e) Full or directional closures on a Regional Street;

(f) Traffic routed across a median;

(g) Full or directional closure of a non-regional street where there is a requirement for regulatory signs (turn restrictions, bus stop relocations, etc.) to implement the closure.

(h) Approved Designated Construction Zones with a temporary posted speed limit reduction. Traffic Services will be responsible for placing all of the advance signs and 'Construction Ends' (TC-4) signs. The Contractor is still responsible for all other temporary traffic control including but not limited to barricades, barrels and tall cones.

E9.2.1 An exception to E9.2 is the 'KEEP RIGHT/KEEP LEFT' sign (RB-25 / RB-25L) which shall be supplied, installed, and maintained by the Contractor at their own expense.

E9.2.2 Further to E9.2, where the Contract Administrator has determined that the services of the Traffic Services Branch are required, the City shall bear the costs associated with the placement of temporary traffic control devices by the Traffic Services Branch of the City of Winnipeg in connection with the works undertaken by the Contractor.

E10. TRAFFIC MANAGEMENT

E10.1 Further to clause 3.7 of CW 1130, refer to Construction Staging Drawings for the traffic management details of each Stage.

E10.2 The Contractor may not close lanes or sidewalks unless work will commence within twenty-four (24) hours. Work must then proceed in the area continuously unless paused due to work by others.

E10.3 The Contractor shall provide a designated Traffic Coordinator for the duration of the Work. The Traffic Coordinator shall:

(a) be the sole contact for the Contract Administrator for all traffic control and traffic management planning. The Traffic Coordinator will also be the contact for the City of

Winnipeg Traffic Management, Traffic Services, and Traffic Signals in relation to all traffic control for the Work, and third parties such as those listed under D28;

(b) at each site meeting, provide the Contract Administrator with a minimum two (2) week outlook on planned routine traffic control operations. The information shall be supplemented as necessary with supporting schematic drawings indicating the location and type of traffic control to be implemented;

(c) at each site meeting, work with the Contract Administrator, City of Winnipeg staff, and third parties listed in D28 to refine agreed upon traffic control measures for the minimum two (2) week outlook;

(d) communicate agreed upon traffic control measures to the Contractor's forces. This includes co-ordinating all flagging operations and barricades/signage supply and setup;

(e) on a daily basis at a minimum, install, move, check, and maintain Contractor signs and barricades as required to ensure they are in the proper location;

(f) ensure compliance of the Contractor's forces with the agreed upon traffic control measures.

E10.4 Single lane closures in the northbound and southbound lanes at the Fermor Avenue and St. Anne's Road Intersection shall only be permitted when required for construction activities when approved by the Traffic Management Branch. Storage/parking of materials, construction equipment or vehicles is on Regional Streets shall be permitted upon approval by the Contract Administrator, in consultation with the Traffic Management Branch.

E10.5 Further to clause 3.7 of CW 1130, for Alpine Avenue Works:

E10.5.1 East/West traffic at Alpine Avenue must be maintained during construction to allow for one (1) lane of traffic in each direction to go straight through. When no work is being performed and providing it is safe for vehicles, east and west lane closures in the intersection will not be permitted.

E10.6 Further to clause 3.7 of CW 1130, for Archibald Street and Royal Salinger Road Works:

E10.6.1 North/South traffic at the intersection must be maintained during construction to allow for one (1) lane of traffic in each direction to go straight through and another lane in each direction to turn. When no work is being performed in the intersection and providing it is safe for vehicles, east and west closures in the intersection will not be permitted.

E10.6.2 Depending on what tasks are bring performed, the Contractor shall not manage traffic around their crews with a moving or growing protection Work Zone. In other words, the Contractor will be permitted to close an entire gutter lane within the project limits if there is only minor Work taking place at one end of the project. This shall be done for items such as milling, concrete repairs, and asphalting.

E10.6.3 Pedestrian and cyclist access must be maintained at all times.

E10.7 Where left turn exists, an additional lane to accommodate the left turn storage shall be maintained, unless otherwise approved by the Contract Administrator.

E10.8 Intersecting local streets, median opening and private approach access shall be maintained at all times unless joint/slab repairs or planing/paving operations require temporary closure. Temporary closures are to be staggered such that consecutive approaches are not closed at the same time and shall be completed during off peak hours. Flagpersons may be necessary to maintain the flow of traffic during certain Work operations.

E10.9 Should the Contractor be unable to maintain pedestrian or vehicular access to a residence or business, he/she shall review the planned disruption with the business or residence and the Contract Administrator, and take reasonable measures to minimize the impact. The Contractor shall provide a minimum of (24) hours notification to the affected residence or business and the Contract Administrator, prior to disruption of access.

E10.10 Winnipeg Transit access to be maintained, including bus stops. Should the Contractor be unable to maintain bus stops or side street bus routes, it shall be reviewed with the Contract Administrator at least forty-eight (48) hours to see if modifications can be made.

E11. REFUSE AND RECYCLING COLLECTION

E11.1 While access to refuse and/or recycling collection vehicles is restricted, on collection day(s) the Contractor shall move all of the affected property owners refuse and/or recycling materials to a nearby common area, prior to an established time, in accordance with E11.2 to permit the normal collection vehicles to collect the materials. Immediately following recycling collection the Contractor shall return recycling receptacles to the addresses marked on the receptacles.

E11.2 Collection Schedule:

50 Alpine Avenue

Collection Day(s):	**Tuesday and Friday**
Collection Time:	**7:00 AM to 6:00 PM**
Common Collection Area:	City of Winnipeg collection vehicles will access the three (3) multifamily units from Seagrim Road to Alpine Avenue. The Contractor is to ensure access out from Alpine Avenue to Seagrim Road is accessible at all times during the collection days.

113 &135 Niakwa Road

Collection Day(s):	**Tuesday and Friday**
Collection Time:	**7:00 AM to 6:00 PM**
Common Collection Area:	City of Winnipeg collection vehicles will access Appleton Estates units from Niakwa Road and exit on St. Anne's Road. Contractor is to ensure that access to these service locations be accessible at all times during the collection days

E11.3 No measurement or payment will be made for the work associated with this specification.

E12. PEDESTRIAN SAFETY

E12.1 During the project, a temporary snow fence shall be installed at locations, as deemed by the Contract Administrator . The Contractor shall be responsible for maintaining the snow fence in a proper working condition. No measurement for payment shall be made for this work.

E13. WATER OBTAINED FROM THE CITY

E13.1 Further to clause 3.7 of CW 1120, the Contractor shall pay for all costs, including sewer charges, associated with obtaining water from the City in accordance with the Waterworks and Sewer By-laws.

E14. SURFACE RESTORATIONS

E14.1 Further to clause 3.3 of CW 1130, when Total Performance is not achieved in the year the Contract is commenced, the Contractor shall temporarily repair any Work commenced and not completed to the satisfaction of the Contract Administrator. The Contractor shall maintain the temporary repairs in a safe condition as determined by the Contract Administrator until permanent repairs are completed. The Contractor shall bear all costs associated with temporary repairs and their maintenance.

E14.2 Where the Contractor chooses to perform any part of the Work that impacts the existing surface conditions for pedestrian, bicycle and vehicle passage, without promptly completing the final surface works required in Contract, the Contractor shall construct temporary surface

restorations meeting the requirements of 3.3 of CW 1130 and to the satisfaction of the Contract Administrator. The Contractor shall maintain the temporary surface restorations in a safe condition until the final surface works are completed by the Contractor according to Contract. The Contractor shall bear all costs associated with temporary surface restorations and their maintenance.

ROADWORKS

E15. CLEARING AND GRUBBING

E15.1 Description

E15.1.1 General

(a) This specification covers clearing and grubbing and removal of individual trees.

(b) Referenced Standard Construction Specifications.

(i) CW 3010 – Clearing and Grubbing.

E15.1.2 Definitions

(a) Clearing consists of cutting off standing trees, brush and scrub at or close to existing grade and disposing of felled trees, previously uprooted trees and stumps, and surface debris.

(b) Grubbing consists of excavation and disposal of stumps and roots, boulders and rock fragments of specified size to not less than specified depth below existing ground surface.

(c) Clearing and Grubbing Areas consist of clumps of standing trees, brush, scrub, and surface debris.

(d) Individual trees consist of trees larger than 200 mm (caliper) in open grassed areas with no brush or scrub surrounding them.

E15.1.3 Protection

(a) Prevent damage to fencing, trees, natural features, bench marks, existing buildings existing pavement, utility lines, Site appurtenances, water courses, root systems of trees which are to remain.

(b) Repair damaged items to approval of Contract Administrator. Replace trees designated to remain, if damaged, as directed by Contract Administrator.

(c) The Contractor shall not remove any trees or perform any clearing and grubbing that has not been clearly marked by the Contract Administrator. If the Contractor removes any tree, regardless of size or species, that was not approved by the Contract Administrator, the Contractor shall supply and install five (5) trees of a species and calliper equal to or greater than that which was removed. The replaced trees shall be installed at a location determined by the Contract Administrator, which may be in or near the Site.

(d) Protect existing trees and vegetation to remain as per E8.6.1(b) Protection of Trees.

(e) Limit Site disturbance including earthwork and clearing of vegetation to:

(i) 12 m beyond the building perimeter;

(ii) 1.5 m beyond road way, walkways, ditches and main utility trenches; and

(iii) 5 m beyond sports fields and parking.

(f) Maintain access roads to prevent accumulation of construction related debris on roads.

E15.1.4 Wood Waste Management and Disposal

(a) Consider felled timber from which saw logs, pulpwood, posts, poles, ties, or fuel wood can be produced as saleable timber:

(i) trim limbs and tops, and saw into saleable lengths for pulpwood, for poles, for ties, and for fuel wood;

(ii) stockpile adjacent to Site; and

(iii) City to have first right of refusal for saleable timber.

E15.2 Materials

E15.2.1 Soil material for fill:

(a) soil material: free of debris, roots, wood, scrap material, vegetable matter, refuse, soft unsound particles, deleterious, or objectionable materials.

E15.2.2 Temporary Erosion and Sedimentation Control

(a) Provide temporary erosion and sedimentation control as per D17.

E15.2.3 Preparation

(a) Inspect Site and verify with Contract Administrator items designated to remain.

(b) Locate and protect utility lines: preserve in operating condition active utilities traversing Site.

(c) Notify Contract Administrator immediately of damage to or when unknown existing utility lines are encountered.

E15.3 Construction Methods

E15.3.1 Clearing

(a) Clearing includes cutting of trees into sections and satisfactory disposal of trees and other vegetation designated for removal, including felled trees, shrubs, scrub and rubbish occurring within cleared areas.

(b) Clear as directed by Contract Administrator, by cutting at or close to existing grade. In areas to be subsequently grubbed, height of stumps left from clearing operations to be not more than 1000 mm above ground surface.

(c) Cut off unsound branches on trees designated to remain as directed by Contract Administrator.

E15.3.2 Grubbing

(a) Grub out all stumps and roots from clearing and grubbing areas.

(b) Grub out visible rock fragments and boulders, greater than 300 mm in greatest dimension, but less than 0.25 m^3.

(c) Fill depressions made by grubbing with suitable fill material and to make new surface conform to existing adjacent ground surface.

E15.3.3 Individual Tree Removal

(a) Remove trees, including roots, as noted on construction drawings and as approved by the Contract Administrator.

(b) Fill depressions made by root removal with suitable fill material and to make new surface conform to existing adjacent ground surface.

E15.3.4 Removal and Disposal

(a) Remove cleared and grubbed materials off site.

E15.3.5 Finished Surface

(a) Leave ground surface in condition suitable for immediate grading operations to approval of Contract Administrator.

E15.3.6 Cleaning

(a) On completion and verification of performance of work, remove surplus materials, excess materials, rubbish, tools and equipment.

E15.4 Measurement and Payment

E15.4.1 Clearing and Grubbing will be measured on an area basis and paid for at the Contract Unit Price per hectare as "Clearing and Grubbing". The area to be paid for will be the total hectares of Clearing and Grubbing performed in accordance with this specification and accepted by the Contract Administrator.

E15.4.2 Removal of individual trees smaller than 20 cm in caliper size shall be considered incidental to the Item of Work: "Clearing and Grubbing".

E15.4.3 Removal of individual trees larger than 20 cm diameter at breast height (dbh) shall be measured on a per unit basis and paid for at the Contract Unit Price for the following Items of Work. The quantity to be paid for shall be the total number of individual trees removed in accordance with this Specification, accepted and measured by the Contract Administrator.

(a) Items of Work:

(i) Tree Removal 20 cm dbh to 59 cm dbh

(ii) Tree Removal 60 cm dbh to 100 cm dbh

E16. HYDRO EXCAVATION AND TEMPORARY PROTECTION OF BELLMTS DUCTS

E16.1 Description

E16.1.1 This specification shall cover the removal of earthen material immediately adjacent to underground utilities infrastructure by means of high pressure water spray, and the recovery of excavated material by vacuum type means or equivalent method as approved by Contract Administrator.

E16.1.2 In addition, this specification covers the soft excavation to expose any underground utilities to determine the depth of the underground utility and whether it would interfere with the installation of the proposed Works on site.

E16.1.3 These underground utilities include, **but not limited to,** Manitoba Hydro cables, Manitoba Hydro gas, BellMTS cables, BellMTS duct bank, existing sewers, and existing watermain.

E16.2 Materials

E16.2.1 Backfill Material

(a) Backfill material for backfill of shafts after hydro-excavation has been completed shall consist of sand as per City of Winnipeg Standard Construction Specification CW 2030.

E16.3 Construction Methods

E16.3.1 Prior to commencement of any construction works adjacent to underground utilities, the Contractor shall use soft digging or hand excavation to expose the underground utilities.

E16.3.2 Once the elevation of the top of the pipe or duct has been determine the resulting excavation shall be backfilled with bedding sand to the elevation of the existing ground.

E16.4 Measurement and Payment

E16.4.1 Soft excavation to expose underground utilities will be considered incidental to the Work. No measurement and payment will be made within this section.

E17. CONSTRUCTION OF TINTED CONCRETE BIKE PATH

E17.1 Description

E17.1.1 General

(a) This specification covers the construction of "Cloud Gray" tinted concrete sidewalk, intended to delineate the bike paths on the right turn channelization islands at Fermor

Avenue / St. Anne's Road and Fermor Avenue / Archibald Street intersections. The tinted concrete is finished at grade as identified on the drawings. Care must be taken with consistency in water/cement ratio and finishing as the color can be affected load to load.

(b) Referenced Standard Construction Specifications

(i) CW 3310 – Portland Cement Concrete Pavement Works;

(ii) CW 3325 – Portland Cement Concrete Sidewalks.

E17.2 Materials and Equipment

E17.2.1 Materials

(b) Concrete mix design shall comply with CW 3310, Clause 6.2 b).

(c) All other materials as per CW 3310, Clause 5.

(a) The base mix design shall conform to Section 6 of CW 3310 with the following alterations:

(i) Type 1 mix as per Section 6.2 of CW 3310.

(b) Slump for hand placement shall be 80 mm +/- 20 mm prior to adding superplasticizers (if needed) to facilitate finishing without adding water to the surface Alterations to the base mix design will be considered by the Contract Administrator if necessary to account for the concrete tint material and finishing operations.

E17.2.2 Equipment

E17.2.3 Equipment as per CW 3310 Clause 8.

E17.2.4 Concrete Tint

(a) "Cloud Gray" coloured metal oxide pigment used to permanently color ready-mix concrete. Approved Product List:

(i) Lafarge Cloud Gray - NR-5010R (2 bags) supplied through Interstar Materials.

(b) Contractor to cast one (1) sample of each coloured concrete sample minimum 200 mm by 200 mm in area using base concrete mix for approval by Contract Administrator.

(c) Tinted concrete shall not be placed until sample color has been accepted by the Contract Administrator. The Contractor shall demonstrate that the sample will achieve the approximate color advertised by the pigment supplier using local concrete mix materials.

E17.2.5 Liquid Membrane-Forming Curing Compound

(a) Curing Compound shall be clear (no pigment), and water based conforming to the requirements of ASTM C309.

E17.2.6 Other Materials

(a) All other materials as per CW 3310

E17.2.7 Floating and Finishing Equipment

(a) Use only wood or magnesium floats. Bull floats used for initial finishing shall be constructed of wood only.

E17.2.8 Other Equipment

(a) All other equipment as per CW 3310.

E17.3 Construction Methods

E17.3.1 100 mm Cloud Gray Tinted Concrete Bike Path

(a) Construction as per Contract Drawings and as per CW 3310 and CW 3325

(b) Clean finishing tools and equipment and let dry prior to finishing. Wet tools will fade the colouring. Wetting of tools during finishing operation is not permitted.

(c) Place concrete at a consistent slump. No water shall be added on Site. Superplasticizer may be added at a rate suggested by the concrete supplier if additional workability is needed.

(d) No localized water spray or fogging is permitted to assist in finishing as this will locally fade the colour.

(e) Clear curing compound only shall be used. The use of water curing or plastic film is not allowed. Plastic film for insulation in cold weather must be approved by the Contract Administrator.

E17.4 Measurement and Payment

E17.4.1 Construction of Tinted Concrete

E17.4.2 Construction of Cloud Gray Tinted Concrete Bike Path will be measured on an area basis and paid for at the Contract Unit Price per square metre for "100 mm Tinted Concrete Bike Path". The area to be paid for will be the total number of square meters of tinted concrete supplied and placed at grade, in accordance with this specification and as measured and accepted by the Contract Administrator.

E18. TRANSIT SHELTER FOUNDATION

E18.1 Description

E18.1.1 This Specification shall cover the installation of concrete bus shelter pad foundations as identified on the Drawings.

E18.1.2 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Work as hereinafter specified.

E18.2 References

E18.2.1 Referenced Specifications and Drawings

(a) The latest version of the City of Winnipeg Standard Construction Specifications:

(i) CW 3310 – Portland Cement Concrete Pavement Works;

(ii) CW 3325 – Portland Cement Concrete Sidewalk.

E18.3 Materials and Equipment

E18.3.1 General

(a) All materials supplied under this Specification shall be of a type approved by the Contract Administrator, and shall be subject to inspection and testing by the Contract Administrator.

(b) The Contractor shall be responsible for the supply, safe storage and handling of all materials as set forth in this Specification. All materials shall be handled in a careful and workmanlike manner, to the satisfaction of the Contract Administrator.

E18.3.2 Concrete and Reinforcing Steel

(a) Concrete mix design shall comply with Clause 6.2a) of the latest version of the CW 3310.

(b) All other materials as per Clause 5 of the latest version of the CW 3310.

E18.3.3 Electrical

(a) Provide and install new buried electrical service to the proposed bus shelters. Coordinate the 120/240 volt underground service point with Manitoba Hydro.

E18.4 Construction Methods

E18.4.1 Construction shall take place in accordance with the Drawings and CW 3310 and CW 3325.

E18.4.2 All forming is incidental to the unit price Bid for the specification.

E18.4.3 Verify dimensions of bus shelter pads prior to construction.

E18.4.4 Meet existing grades and slopes unless otherwise indicated on the Drawings. Notify the Contract Administrator where this requirement will not result in positive drainage.

E18.4.5 Removal of any existing concrete bus shelter pad shall be incidental to the Work.

E18.5 Measurement and Payment

E18.5.1 Transit Shelter Foundations

E18.5.2 Constructing the Transit Shelter Foundations shall be paid for at the Contract Unit rice per square metre for “Transit Shelter Foundations”, measured as specified herein, performed in accordance with this specification and accepted by the Contract Administrator, which price shall be paid in full for supplying all materials and for performing all operations herein describe and all other items incidental to the work. The area to be paid for shall be the total number of square metres of Transit Shelter Foundations constructed in accordance with this specification and as measured and accepted by the Contract Administrator.

E19. PARTIAL DEPTH PATCHING OF EXISTING JOINTS

E19.1 Description

E19.1.1 General

(a) This specification covers the Partial Depth Patching of existing concrete pavement joints.

E19.1.2 Referenced Standard Construction Specifications

(a) CW 3230 – Full-Depth Patching of Existing Slabs and Joints;

(b) CW 3410 – Asphalt Concrete Pavement Works.

E19.2 Materials

E19.2.1 Asphalt Materials

(a) Asphalt material will be Type 1A supplied in accordance with Sections 5 and 6 of CW 3410.

E19.2.2 Tack Coat

(a) Tack Coat will be undiluted SS-1 emulsified asphalt.

E19.3 Construction Methods

E19.3.1 Planing of Joints

(a) Plane existing joints designated by the Contract Administrator to a minimum depth of 50 mm and a maximum of depth 90 mm to remove ravelled or deteriorated concrete. Width of joint to be planed will vary with depth.

(b) Should the depth of joint deterioration exceed the maximum indicated, as determined by the Contract Administrator, the entire joint shall be renewed and paid for in accordance with CW 3230 as a full depth joint repair. Planing completed shall be paid for in accordance with Section 14.7 of this specification

(c) Dispose of material in accordance with Section 3.4 of CW 1130.

E19.3.2 Placement of Asphalt Material

(a) Prior to placement of asphalt material, the planed joint shall be swept or blow clean of any loose material.

(b) Apply Tack Coat uniformly on the entire surface of the planed joint. The application rate shall not exceed 0.23 litres per square metre. The planed joint shall be dry prior to applying the tack coat.

(c) Place and compact asphalt material in accordance with Section 9.3 of CW 3410 to the satisfaction of the Contract Administrator. The finished elevation of the patch shall be flush with surrounding pavement surface.

(d) Compact the asphalt material to an average ninety-five percent (95%) of the 75 blow Marshall Density of the paving mixture with no individual test being less than ninety percent (90 %).

(e) Ensure that no traffic is allowed to travel over the patched area until the asphalt has cooled to atmospheric temperature.

E19.4 Measurement and Payment

E19.4.1 Partial Depth Planing of Existing Joints

(a) Partial Depth Planing of Existing Joints will be measured on an area basis and paid for at the Contract Unit Price per square metre for “Partial Depth Planing of Existing Joints”. The area to be paid for will be the total number of square metres of joints planed in accordance with this specification, accepted and measured by the Contract Administrator.

E19.4.2 Asphalt Patching of Partial Depth Joints

(a) Asphalt Patching of Partial Depth Joints will be measured on an area basis and paid for at the Contract Unit Price per square metre for “Asphalt Patching of Partial Depth Joints”. The area to be paid for will be the total number of square metres of joints patched in accordance with this specification, accepted, and measured by the Contract Administrator.

E20. ASPHALT PATCHING OF MISCELLANEOUS CONCRETE

E20.1 Description

E20.1.1 General

(a) This specification covers the placement of asphalt patches in various situations to prepare a concrete pavement for subsequent placement of mainline asphalt pavement overlay. This includes patching full depth concrete repairs, cracks and joints, and vertical faults.

E20.2 References

E20.2.1 Referenced Standard Construction Specifications

(a) CW 1130-R2 – Site Requirements;

(b) CW 3250-R7 – Joint and Crack Maintenance;

(c) CW 3410-R10 – Asphaltic Concrete Pavement Works.

E20.3 Material and Equipment

E20.3.1 Asphalt Materials

(a) Asphalt material supplied shall be as per CW 3250 (Type 1 Asphalt Material).

E20.3.2 Equipment

(a) Equipment as per CW 3410-R10 Clause 8.

E20.4 Construction Methods

E20.4.1 Full Depth Concrete Repairs

(a) Place asphaltic concrete over the newly constructed joint repair where there is a minimum of 20 mm elevation difference between repair surface and adjacent pavement surface. Remove any loose or debonded asphalt at the joint perimeter and place new asphaltic concrete in these areas as well.

(b) Dispose of all material in accordance with Section 3.4 of CW 1130-R2.

(c) Prior to placement of asphaltic concrete patching material, ensure surface is clean and dry.

(d) Prepare the joint surface with a uniform application of Tack Coat applied in small quantities sufficient to wet the concrete surface.

(e) Place and compact asphaltic concrete over the joint repair in accordance with CW 3410-R8 Clause 9.3 and to the satisfaction of the Contract Administrator so that the finished elevation of the patch is flush with surrounding asphalt surface.

(f) Compact the asphalt material to an average ninety-five percent (95%) of the 75 blow Marshall Density of the paving mixture with no individual test being less than ninety percent (90%).

(g) Ensure that no traffic is allowed to cross the patched area until the asphalt has cooled to atmospheric temperature.

E20.4.2 Crack/Joint Patching

(a) Construction Methods as per CW 3250-R7 Clause 3.4.

E20.5 Measurement and Payment

E20.5.1 Asphalt Patching of Miscellaneous Concrete will be measured on an area basis and paid for at the Contract Unit Price per square metre for “Asphalt Patching of Miscellaneous Concrete”. The area to be paid for will be the total number of square metres of full depth joints, cracks and joints, and vertical faults patched in accordance with this specification, accepted, and measured by the Contract Administrator.

E21. INTERLOCKING PAVING STONES

E21.1 Description

E21.1.1 Further to the latest version of the City of Winnipeg Standard Construction Specification CW 3335, this Specification shall cover the:

(a) Supply and installing of interlocking paving stones (unit pavers) used in Transit Stop paving band square;

(b) Supplying and installing clay brick (unit pavers) in formed blockouts used in paving pattern/fields as indictor strips;

(c) Supply and installing of sand setting bed.

E21.1.2 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies and all other things necessary or and incidental to the satisfactory performance and completion of all Work as hereinafter specified.

E21.2 References Specifications and “Drawings”

(a) The latest version of the City of Winnipeg Standard Construction Specifications

(i) CW 3330 – Installation of Interlocking Paving Stones;

(ii) CW 3335 – Installation of Interlocking Paving Stones on a Lean Concrete Base;

(iii) ASTM C902 - Standard Specification for Pedestrian and Light Traffic Paving Brick.

E21.3 Materials

E21.3.1 General

(a) All materials supplied under this Specification shall be of a type approved by the Contract Administrator, and shall be subject to inspection and testing by the Contract Administrator.

(b) The Contractor shall be responsible for the supply, safe storage and handling of all materials as set forth in this Specification. All materials shall be handled in a careful and workmanlike manner, to the satisfaction of the Contract Administrator.

E21.3.2 Interlocking Paving Stones:

(a) Concrete interlocking paving stones (unit pavers) for bus stop indicator paver squares, supplied by:

Barkman Concrete
Phone: (204) 667-3310
www.barkmanconcrete.com

(b) As shown on the Drawings and as follows:

(i) Blue Holland Pavers 200 x 200 x 60 mm.

(c) Concrete interlocking paving stones (unit pavers) for indicator strips shall be precast concrete pavers conforming to CAN3-A231.2, Further to CAN3-A231.2.6.1.1, where concrete pavers are shipped for installation before the pavers are 28 days old, the average compressive strength of these pavers at the time of delivery to the work site shall be not less than 40 MPA.

(d) Clay Brick pavers (unit pavers) for indictor strips and paving areas/fields shall conform to ASTM C902. Type 1, dimensional tolerance: 1/8", wire cut face, solid (not cored), as manufactured by Endicott Clay Products Company and supplied by:

Alsip's Industrial Products Ltd.
Winnipeg, MB
Phone: (204) 667-3330

(e) Or equal as accepted by the Contract Administrator in accordance with B7. Colour are as shown on the Drawings and as follows:

(i) Endicott Clay Brick Paver 194 x 92 x 57 mm (Manganese Ironspot);

(ii) Endicott Clay Brick Paver 194 x 92 x 57 mm (Medium Ironspot).

E21.3.3 Bedding Sand

(a) Bedding sand shall be fine aggregate as specified in Specification CW 3330.

E21.3.4 Joint Sand

(a) Joint sand as specified in Specification CW 3330.

E21.3.5 Other Materials

(a) All other materials, including aggregates for the lean concrete mix, the lean concrete mix, bedding sand and filler sand shall be in accordance with CW 3335-R1.

E21.4 Equipment

(a) All equipment shall be of a type acceptable to the Contract Administrator and shall be kept in good working order.

E21.5 Construction Method

E21.5.1 Install concrete sidewalk with blockouts as specified on Drawings.

E21.5.2 Preparation of Sand Base

(a) Remove all accumulated debris from blockouts;

(b) Install bedding sand to the depths indicated on the Drawings and to CW 3330;

(c) Do not compact sand base prior to installing pavers.

E21.5.3 Installation of Indicator Strip Paving Stones in Blockouts and in paving band square.

(a) Paving stone type and color as shown on Drawings. Utilize blue pavers for bus stop(s) as indicated the Drawings.

(b) Utilize Manganese Ironspot for sidewalk Indictor strips and Medium Ironspot for interlocking paving stone (unit pavers) for concrete blockouts, as indicated on Drawings.

(c) Interlocking paving stones shall be installed in formed concrete blockouts in accordance with CW 3335, set in locations and patterns as shown on the Drawings. Spaces between joints shall be 3 mm maximum and shall be uniform and consistent while maintaining true patterns as indicated on the Drawings.

(d) Contractor to verify the laid dimensions of unit pavers prior to the construction of blockouts in concrete sidewalk. Use specified pavers to test formwork layout for blockouts.

(e) Install concrete sidewalk complete with blockouts for paving stones as specified on the Drawings.

(f) Spread only sufficient area which can be covered with pavers same day.

(g) Contractor to verify the exact dimension of pavers prior to construction of blockouts in concrete sidewalk.

(h) Where paving pattern is interrupted by vertical structural elements, pavers must be saw cut and fit true and hand tight.

(i) Commence installation of pavers against edge to obtain straightest possible course for installation.

(j) Pavers shall be cut with saw only to obtain true even undamaged edges. Chipped pavers are unacceptable.

(k) Crews shall work on installed pavers, not on sand layer.

(l) Spread and fine grade joint sand over paving surface and sweep into joints.

(m) Compact pavers with vibratory plate compactor having mass of at least 113 kg. Compaction is incidental to the price for supply and installation of paving stone.

(n) Sweep remaining sand over all paving areas and remove from site.

(o) Replace at no extra cost all whole or cut stones marked as unacceptable.

(p) Remove cracked, chipped, broken or otherwise damaged paving materials from Site immediately.

(q) Upon completion, clean in accordance with manufacturers recommendations.

E21.6 Quality Assurance

E21.6.1 All workmanship and all materials furnished and supplied under this Specification are subject to close and systematic inspection and testing by the Contract Administrator including all operations, from the selection and production of materials, through to final acceptance of the Work. The Contractor shall be wholly responsible for the control of all operations incidental thereto notwithstanding any inspection of approval that may have been previously given. The Contract Administrator reserves the right to reject any materials or works that are not in accordance with the requirements of this specification.

E21.7 Measurement and Payment

E21.7.1 Interlocking Paving Stones

(a) Interlocking Paving Stones will be measured on an area basis and will be paid for at the Contract Unit Price per square metre for, “Items of Work” listed below and measured as specified herein, which price shall be payment in full for performing all operations herein described and all other items incidental to the Work included in this

Specification. The area to be paid for shall be the total installed area of each type of unit paving, accepted and measured by the Contract Administrator.

(b) Items of Work:

(i) Clay Brick Paving – Manganese Ironspot 194 x 92 x 57 mm;

(ii) Clay Brick Paving – Medium Ironspot 194 x 92 x 57 mm;

(iii) Transit Blue Holland Paver 200 x 200 x 60 mm.

E21.7.2 Lean Concrete Base

(a) Lean concrete base shall be measured and paid for in accordance with CW 3335-R1.

E22. SEALING INTERFACE BETWEEN CONCRETE AND ASPHALT SURFACES

E22.1 Description

E22.1.1 Further to D35.1(g) the Contractor shall seal the interface of the asphalt roadways to concrete curb and gutters one (1) year after substantial completion.

E22.2 Materials

E22.2.1 Joint sealant shall be supplied as per CW 3250.

E22.3 Construction Methods

E22.3.1 Sealing of the interface shall be completed using joint sealant in accordance with Clause 3.2 and 3.3 of CW 3250.

E22.4 Measurement and Payment

E22.4.1 Sealing the interface of the concrete and asphalt surfaces will be measured on a length basis and paid for at the Contract Unit Price for “Crack Sealing” regardless of the width of the crack. The length to be paid for will be the total number of metres of cracks routed and/or cleaned and sealed in accordance with this specification, accepted and measured by the Contract Administrator.

E23. CURB AND GUTTER – VARIOUS FORMATS

E23.1 Description

E23.1.1 General

(a) This specification covers the Work related to the installation of Mountable Barrier curb and gutter, as specified on the Contract Drawings.

E23.2 References

E23.2.1 Referenced Standard Construction Specifications

(a) CW 3310 – Portland Cement Concrete Pavement Works.

E23.2.2 Referenced Standard Details and Drawings

(a) Mountable Curb– SD-201;

(b) Modified Curb – SD-203B.

E23.3 Materials and Equipment

E23.3.1 Materials

(a) Materials supplied shall be as per CW 3310 Clause 5.

E23.3.2 Equipment

(a) Equipment as per CW 3310 Clause 8.

E23.4 Construction Methods

E23.4.1 Mountable Barrier Curb and Gutter

E23.4.2 Mountable Barrier Curb and Gutter shall be constructed where specified using the SD-201 shape for the curb, and the Contract Drawings for the gutter width and height. Unless directed by the Contract Administrator, the curb and gutter shall be slip formed.

E23.4.3 Integral Modified Barrier Curb and Gutter

E23.4.4 Modified Barrier Curb and Gutter shall be constructed where specified using the SD-203B shape for the curb, and the Contract Drawings for the gutter width and height. Unless directed by the Contract Administrator, the curb and gutter shall be slip formed.

E23.4.5 Where directed by the Contract Administrator to be hand formed, the Contractor shall use wood forms and templates to ensure the curb is shaped properly. Wood forms and templates shall be constructed to allow for the placement of curb and gutter in unison to ensure adhesion of the integral curb.

E23.4.6 Sawcut all curb and gutter types transversely every 3 m.

E23.4.7 Transitions between curb and gutter types as per Contract Drawings.

E23.5 Measurement and Payment

E23.5.1 Curb and Gutter - Various Formats

(a) Construction of various formats of mountable barrier curb and gutter will be measured on a length basis and will be paid for at the Contract Unit Price per metre for the "Concrete Curbs, Curb and Gutter, and Splash Strips" items below, measured as specified herein, which price shall be payment in full for performing all operations herein described and all other items incidental to the Work included in the specification.

(b) Transitions between curb and gutter types will be paid for at the more costly Contract Unit Price of the two (2) curb and gutter types.

(i) Concrete Curbs, Curb and Gutter, and Splash Strips;

(ii) Construction of Mountable Barrier Curb and Gutter (120 mm ht);

(iii) Construction of Integral Modified Barrier Curb and Gutter (180 mm ht).

E24. REMOVAL AND DISPOSAL OF MISCELLANOUS CONCRETE UNIT PAVERS

E24.1 Description

E24.1.1 General

(a) This Specification covers the Work related to the removal and disposal of existing concrete unit paver medians as specified herein and as shown on the Drawings. This Specification shall cover unit paver removal Works, including all necessary staging, demolition, removal, disposal, transporting, unloading, stockpiling, and disposal of applicable materials.

(b) The work done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Works as hereinafter specified.

E24.2 References

E24.2.1 Referenced Standard Construction Specifications

(a) CW 1130 – Site Requirements;

(b) CW 3235 – Renewal of existing miscellaneous concrete slabs.

E24.3 Construction Methods

E24.3.1 Removal and Disposal of Existing Concrete Unit Paver Medians

(a) Removal and disposal of existing concrete unit paver medians shall be as per CW 3235, Clause 3.1 to the limits as shown on the Drawings or as otherwise directed by the Contract Administrator.

E24.4 Measurement and Payment

E24.4.1 Removal and Disposal of Existing Concrete Unit Paver Medians will be measured on an area basis and paid for at the Contract Unit Price per square metre as "Removal and Disposal of Concrete Unit Pavers". The area to be paid for will be the total square metres of Removal and Disposal of Miscellaneous Concrete Unit Pavers performed in accordance with this specification and accepted by the Contract Administrator.

E25. BIKE LANE SURFACE PAINTING

E25.1 The work of this section comprises the furnishing of all labour, equipment and materials required to complete the surface painting as shown on the drawings and as hereinafter specified. Painting is limited to delineate designated cyclist crossing at the right turn channelization at the Fermor Avenue / St. Anne's Road and Fermor Avenue / Archibald Street intersections, as specified on the drawings.

E25.2 Materials

E25.2.1 Paint colour, "Green" shall conform to City of Winnipeg specification for reflectorized traffic paint or suitable equivalent for application to asphalt / concrete surface.

(a) HITEX International Group –PumaTrack mmA Cold Applied Surface Treatment;

(b) Or approved equal.

E25.3 Construction Methods

E25.3.1 The Bike Lane Surfacing Painting shall be installed in accordance with the manufacturer's installation manual.

E25.3.2 Refer to:

(a) HITEX CM Primer and PumaTrack Rollable Road Surface System – Appendix 'J'.

E25.4 Measurement and Payment

E25.4.1 Surface Painting will be measured and paid for by a square metre basis paid for the Contract Unit Price per square meter for "Bike Lane Surface Paint (Green)". The area to be paid will be the total square are of Surface Paint supplied and placed in accordance with this specification and accepted by the Contract Administrator.

E26. PAINTED PAVEMENT MARKINGS

E26.1 Description

E26.1.1 The work of this section comprises the furnishing of all labour, equipment and materials required to complete the line painting as shown on the drawings and as hereinafter specified. Painting is limited to parking stalls on private property where work has occurred to remove and install median islands on private property, as specified on the drawings.

E26.1.2 Painting of all public roadways for permanent and temporary roadworks is not included and will be completed by the City of Winnipeg Traffic Services Branch.

E26.2 Materials

E26.2.1 Paint shall conform to City of Winnipeg specification for reflectorized traffic paint or suitable equivalent for application to asphalt / concrete surface.

(a) CGSB 1-GP-74M + Amdt-May-81, alkyd traffic paint;

(b) High Gloss Traffic Paint (IBIS Products Limited).

E26.2.2 Paint colours shall be:

E26.2.3 Yellow: all centre lines and parking stall lines. White: stop bars.

(a) CGSB 1-GP-12C + Amdt-Dec-84, yellow 505-308, white 513-301 (MTO Spec. 1710);(White 40-2478, Yellow 40-3057-IBIS Products Limited);

(b) Federal Traffic Paint, Yellow 40-3597 Qual No 80087, White 40-3596 Qual No 80086 (IBIS Products Limited);

(c) High Gloss Traffic Paint, Yellow 40-1821 (IBIS Products Limited).

E26.2.4 Thinner to CGSB 1-GP-5M.

E26.2.5 Glass Beads: Overlay Type: To CGSB 1-GP-744Amdt-May-81.

E26.3 Construction Methods

E26.3.1 Line painting to be done upon completion of asphalt paving work and curing time. All lines are to be to as per the drawings or as required by TAC standards.

E26.3.2 No markings shall be performed when the temperature is below 10^0 Celsius nor during rainfall or fog, or until the surface is perfectly dry. No markings shall be done if, in the opinion of the Contract Administrator, the conditions are not conducive to provide a top quality result.

E26.3.3 Immediately before application of the paint, the existing surface shall be dry and entirely free from dirt, grease, oil acids, laitance, or other foreign matter which would reduce the bond between the coat of paint and the asphalt/concrete. The surface shall be thoroughly cleaned by sweeping and blowing as required to remove all dirt, laitance and loose materials.

E26.3.4 Suitable chalkline layouts of proposed lines and arcs shall be spotted in advance of the paint application. Control points shall be spaced at such intervals as will ensure accurate location of all markings.

E26.3.5 When discrepancies between the drawings and the field layout occur, these discrepancies are to be reported to the Contract Administrator for further action before proceeding with the application of paint.

E26.3.6 The Contractor shall provide an experienced technician to supervise the location, alignment, layout, dimension, and application of the paint.

E26.3.7 Paint shall be applied at a rate of 200 lineal feet per gallon (60 m per 4.5 L) and maintain a uniform lines unless otherwise indicated on specifications drawings.

E26.3.8 The paint shall be mixed in accordance with the manufacturer’s instructions before application. The paint shall be thoroughly mixed and applied to the surface of the concrete with the marking machine. The surface shall receive two (2) coats; the first coat shall be thoroughly dry before the second coat is applied.

E26.3.9 Glass beads are to be added to paint as per manufacturer's specifications.

E26.3.10 The paint applicator to be an approved pressure type mobile distributor capable of applying paint in single or double and dashed lines, and that will ensure uniform application and having a positive shut-off.

E26.3.11 In the application of straight strips, any deviation in the edges exceeding 1/2 inch in 50 feet shall be obliterated and the marking corrected. The width of the markings shall be as designated within a tolerance of five percent (5%). All paintings shall be performed to the satisfaction of the Contract Administrator by competent and experienced equipment operators, labourers, and artisans in a neat and workmanlike manner.

E26.3.12 Thoroughly clean distribution tank before refilling with paint of different colour.

E26.3.13 After application of the paint, all markings shall be protected while the paint is drying. The fresh paint shall be protected from injury or damage of any kind. The Contractor shall be directly responsible and shall erect or place suitable warning signs, flags, or barricades, protective screens, or coverings as required. All surfaces shall be protected from disfiguration by spatter, splashes, spillage drippings, of paint or other materials.

E26.3.14 Parking stall lines will be painted as per drawing and/or as directed by the Contract Administrator. Each stall line will be 75 mm wide and 6.0 m long.

E26.4 Measurement and Payment

E26.4.1 Line painting will be measured and paid for on a length basis paid for at the Contract Unit Price per linear metre for "Painted Pavement Markings". The length to be paid for will be the total length of Line Paint supplied and placed in accordance with this specification and accepted by the Contract Administrator.

E27. SIGN SUPPORT CLAMPS

E27.1 Description

E27.1.1 General

(a) This Specification covers all operations relating to the installation of new sign support clamps.

(b) The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Works as hereinafter specified.

E27.1.2 The Contractor shall install all new sign support clamps at the locations as directed by the Contract Administrator. The City shall supply all sign support clamps.

E27.1.3 All costs in connection with the installation of sign support clamps are incidental to the Contract.

E28. CRASH ATTENUATION BARRIERS

E28.1 Description

E28.1.1 The Work covered under this item shall include all operations related to the supply, fabrication, delivery and installation of the Crash Attenuation Barriers and associated materials in accordance with NCHRP Report 350 Test Level 3.

E28.1.2 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of the Work as hereinafter specified. All materials supplied under this Specification shall be subject to inspection and acceptance by the Contract Administrator.

E28.1.3 Site specific requirements for installation of Crash Attenuation Barriers will be in accordance with drawings CS – 085 and CT-62. General supply, loading, hauling, unloading, storing and installing is as per Manufacturer's recommended procedures.

E28.1.4 The Contractor shall provide manufacturers product data sheet and Shop Drawings prior to supply and installation. The Shop Drawings will be subject to acceptance by the Contract Administrator.

E28.2 Materials

E28.2.1 Materials shall be supplied in accordance with the manufacturer's product manual and in accordance with NCHRP Report 350.

E28.2.2 The Contractor shall be responsible for the supply, safe storage and handling of all materials set forth in this specification.

E28.2.3 Approved products are:

(a) Quadguard II and associated hardware by Trinity Highway Products;

(b) Tau-II by Barrier Systems;

(c) Or approved equal.

E28.2.4 Appurtenances including but not limited to posts, neoprence spacer blocks, Quadbeam panels, and associated hardware shall be in accordance with NCHRP Report 350

E28.3 Construction Methods

E28.3.1 The Crash Attenuation Barriers shall be installed in accordance with the manufacturer's installation manual.

E28.3.2 Refer to:

(a) Quadguard Installation Manual, see Appendix 'F';

(b) Tau II Assembly Manual, see Appendix 'F'.

E28.3.3 Related items, including concrete foundations, reinforcing steel, Quadbeam panels, posts, neoprene spacer blocks,connection hardware, excavation, granular levelling materials and compaction is as per the Contract Drawings.

E28.4 Measurement and Payment

E28.4.1 Supply and Installation of each Crash Attenuation Barrier, including all product materials, concrete foundations, reinforcing steel, Quadbeam panels, posts, neoprene spacer blocks, connection hardware, excavation, granular levelling materials and compaction will be measured for payment on a unit basis and paid for at the Contract Unit Price for, "Items of Work" listed here below.

E28.4.2 The unit price for items of work listed below will be payment in full for the supply, delivery and installation associated with the roadway and all related operations as herein described and all other items incidental to the work included, accepted and measured by the Contract Administrator.

E28.4.3 Items of Work:

(a) Supply and Installation of Crash Attenuation Barrier

(i) Quadguard II System with Concrete Backup – QG210024;

(ii) Quadguard II System with Tension Strut Backup – QG210036.

E29. CRASH ATTENUATION BARRELS

E29.1 Description

E29.1.1 The Work covered under this item shall include all operations related to the supply, fabrication, delivery and installation of the new Crash Attenuation Barrels and associated materials in accordance with NCHRP Report 350.

E29.1.2 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of the Work as hereinafter specified. All materials supplied under this Specification shall be subject to inspection and acceptance by the Contract Administrator.

E29.1.3 Site specific requirements for installation of Crash Attenuation Barrels will be in accordance with drawing GE-011. General supply, loading, hauling, unloading, storing and installing is as per Manufacturer's recommended procedures.

E29.1.4 The Crash Attenuation Barrel manufacturer product data sheet shall be submitted to the Contract Administrator for approval prior to supply and installation.

E29.2 Materials

E29.2.1 Materials shall be supplied in accordance with the manufacturer's product manual and in accordance with NCHRP Report 350.

E29.2.2 The Contractor shall be responsible for the supply, safe storage and handling of all materials set forth in this specification.

E29.2.3 Approved products are:

(a) Big Sandy Impact Attenuator Sand Barrels by TrafFix Devices Inc.;

(b) Fitch Sand Barrel System by Quixote Transportation Saftey Inc;

(c) Or approved equal.

E29.2.4 Sand required for the barrels shall contain a minimum of five percent (5%) rock salt (NaCL), by weight.

E29.3 Construction Methods

E29.3.1 The Crash Attenuation Barriers shall be installed in accordance with the manufacturer's installation manual.

E29.3.2 Refer to:

(a) Traffix Big Sandy Installation Manual, see Appendix 'G';

(b) Energite FITCH Assembly Manual, see Appendix 'G'.

E29.3.3 The Contractor shall be responsible for loading, and unloading as well as storing of the crash attenuation barrels. The Contractor shall supply all necessary equipment for loading, hauling, unloading, and storing of the components.

E29.3.4 Prior to commencing installation of the protection at a location, the Contractor shall verify that it can be installed in strict accordance with the Drawings. Should there be a conflict between a proposed location and any facility the Contract Administrator shall be notified immediately.

E29.3.5 Barrels associated with the roadway detour shall be relocated by the Contractor between Stage 1 and Stage 2. Relocation shall include all necessary equipment, materials, labour, safe storage and related operations required to relocate the barrels to the satisfaction of the Contract Administrator.

E29.3.6 Crash Attenuation Barrels associated with the roadways detour are to be salvaged and delivered to city yards as directed by the Contract Administrator after the detour is removed.

E29.4 Measurement and Payment

E29.4.1 Supply and installation of Crash Attenuation Barrels, and all related appurtenances will be measured on a unit basis and paid for per barrel at the Contract Unit Price in accordance with this Specification, accepted and measured by the Contract Administrator.

E29.4.2 The unit price for "Supply and Place Crash Attenuation Barrels" will be payment in full for the supply and delivery of the barrels to site, placement and filling of barrels, relocation of barrels associated with the roadway detour and all related operations as herein described and all other items incidental to the work included, accepted and measured by the Contract Administrator.

E29.4.3 Relocation of barrels associated with the roadway detour shall be considered incidental to the Work.

E30. W-BEAM GUARDRAIL SYSTEM

E30.1 Description

E30.1.1 The Work shall consists of:

(a) supply and installation of roadside hazard protection meeting the AASHTO Manual for Assessing Safety Hardware (MASH) Test Level 3 or *NCHRP Report 350: Recommended Procedures for the Safety Performance Evaluation of Highway Features*, including:

(i) W-Beam guardrail (Midwest Guardrail System) with steel posts and neoprene spacer blocks;

(ii) end treatments.

(b) supply, loading, hauling, unloading, storing and installing of roadside hazard protection guardrail, guardrail end treatment, posts, and all related appurtenances in accordance with the Drawings and Manufacturer's recommended installation procedures;

(c) field drilling, threading and cutting bolts, as required;

(d) supply, placing and compacting backfill material.

E30.2 Materials

E30.2.1 The Contractor shall be responsible for the supply, safe storage and handling of all materials set forth in this specification.

E30.2.2 Guardrails and posts shall be stored in neat regular piles, on blocks or built up platforms, in order to avoid damage or contamination, and for ease of checking, handling, and inspection.

E30.2.3 Testing, Inspection and Approval

(a) All materials supplied under this specification shall be subject to inspection and testing by the Contract Administrator or by the Testing Laboratory designated by the Contract Administrator. There shall be no charge for any materials taken by the Contract Administrator for testing purposes.

(b) Materials which fail to meet these specifications will be rejected, and shall be replaced or repaired at no additional cost.

E30.2.4 Guardrails and Terminal Elements

(a) All guardrail sections and other components shall match the design profiles and dimensions of the AASHTO/ARTBA hardware requirements.

(b) The guardrails and terminal elements shall be manufactured from open hearth, electric furnace or basic oxygen semi-spring steel sheet, all in general accordance with the AASHTO Standard Designation M180 and shall conform to the Drawings provided in the contract and in the AASHTO-AGC-ARTBA publication "A Guide to Standardized Highway Barrier Hardware".

(c) Guardrails shall be punched for splice and post bolts in conformity with AASHTO Standard to the designated number of and centre to centre spacing of posts. If holes are punched after galvanizing, the galvanizing around the hole shall be repaired in accordance with the latest edition of CSA Standard G164-M92 (R2003) or ASTM A780/A780M-09.

(d) Guardrails shall have minimum yield strength of 345 MPa, minimum tensile strength of 483 MPa, and minimum elongation of twelve percent (12%) in 50 mm length.

(e) The thickness of guardrails and terminal elements shall be manufactured according to Table 2 (Class A Type II) of AASHTO Standard M180 with nominal base metal thickness of 2.67 mm, galvanized finished thickness of 2.82 mm, with a tolerance of 0.23 mm.

(f) Sheet width for the W-beam guardrail shall be 483 mm with a permissible tolerance of minus 3 mm.

(g) All guardrails and terminal elements shall be hot dip galvanized according to CAN/CSA A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

(h) All welding for the fabrication of terminal elements shall conform to the requirements of CSA W59M. All welders, welding operators and tackers shall be approved by the Canadian Welding Bureau in their particular category.

(i) A copy of the producer's certificate, conforming to Section 16 of CSA G40.20M, for each of the mechanical and chemical tests, including impact tests, shall be provided to the Contract Administrator upon request.

(j) Terminal ends to be ET-31 by Trinity Highway Products, LLC as indicated on Drawings or approved equal in accordance with B7.

E30.2.5 Steel Posts

(a) Steel posts shall be W150 x 14;

(b) Steel for posts and hardware shall conform to CAN/CSA Standard G40.21 Grade 350W or ASTM Standard A36 and shall be hot dip galvanized after fabrication conforming to ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

E30.2.6 Neoprene Spacer

(a) Spacers shall be King Blocks by Trinity Highway Products, LLC or approved equal in accordance with B7.

(b) Bolts, nuts, washers and other appurtenances.

(c) All bolts, nuts and washers shall be according to ASTM A307 and shall be hot dip galvanized conforming to the current edition of ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

E30.2.7 Markings

(a) Each guardrails shall be marked with the following information:

(i) Name, trademark, or brand of the manufacturer.

(ii) Identification symbols or code for heat.

(iii) Week number and year of production.

(b) Markings shall be clearly and permanently stamped in the valley of the centre corrugation, placed at the location clear of the splice overlap, and shall not be obscured after installation. The height of the letters and numerals shall be within the range of 19 to 32 mm.

E30.3 Construction Methods

E30.3.1 Handling and Storage of Materials

(a) All materials shall be handled in a careful and workmanlike manner and the sections and ends shall be stored on blocks or built-up platforms.

(b) Bolts and malleable washers shall be stored separately in suitable bins for inspection, checking and handling.

E30.3.2 Site Inspection

(a) Prior to commencing installation of the protection at a location, the Contractor shall verify that it can be installed in strict accordance with the Drawings. This shall include contacting all utilities and other owners of underground facilities in order to ensure that the proposed location of the posts is not in conflict with existing or proposed utilities and installations.

(b) Should there be a conflict between a proposed location and any facility the Contract Administrator shall be notified immediately.

E30.3.3 Assembly and Installation

(a) All materials and parts shall be assembled and installed in accordance with the manufacturers' requirements and recommended procedures, refer to Appendix 'H'

E30.3.4 Post Installation

(a) Holes for the posts shall be 300 mm in diameter and be excavated by auger.

(b) Excavated material which is unsuitable for use as backfill shall be replaced with granular material meeting the requirements of Section 2.2 of Specification CW 3110 for base course material.

(c) Crushed limestone base course is not allowed for use.

(d) The posts shall rest directly and solidly on the bottom of the hole.

(e) After the post is installed, it shall be backfilled. Backfill shall be thoroughly compacted, using pneumatic tampers, in layers not exceeding 150 mm. Unsuitable material at the bottom of the holes excavated shall be replaced with granular material at the Contractor's expense, as directed by the Contract Administrator.

(f) The Contractor shall thoroughly compact the bottom of the holes.

(g) Surplus excavated material and debris shall be removed from the Site.

E30.3.5 Guardrail Installation

(a) Guardrail shall be accurately set to the required depth and alignment, in a manner resulting in a smooth continuous installation, as shown on the Drawings or as directed by the Contract Administrator. Permissible tolerance for plumb and grade of posts shall be 6 mm.

(b) Any guardrail material requiring field modification to fit shall be reported to the Contract Administrator for its acceptance of the modification prior to the Work being carried out.

(c) Modification by flame cutting method is prohibited.

(d) Modification by cold cutting method with a suitable drill press is allowed.

(e) Field guardrail modification is considered incidental to the Work. Adequate edge distances of guardrail material shall be maintained during the modification process. All exposed steel areas shall be patched with two (2) coats of zinc-rich paint.

(f) Guardrail laps shall be in the direction of traffic flow.

(g) Bolts shall be tightened to a torque of 100 Nm.

(h) The Contractor shall take all necessary precautions to eliminate damage to galvanizing. Minor abrasions shall be repaired by re-galvanizing. The method to be used for repair of any damage shall be accepted by the Contract Administrator before such Work is commenced. The Contractor shall repair or replace components to the satisfaction of the Contract Administrator.

E30.3.6 ET-31 End Treatment

(a) The ET-31 end treatment, or approved equal in accordance with Appendix 'G' and meeting MASH Test Level 3, shall be installed as indicated on the Drawings. Installation of the ET-31 end treatment shall be completed in accordance with the Specifications and the manufacturer's recommendations.

E30.3.7 Cleaning

(a) After installation of the rail system has been completed, the entire rail system shall be thoroughly cleaned to the satisfaction of the Contract Administrator.

E30.4 Measurement and Payment

E30.4.1 Supply and installation of roadside hazard protection guardrail, posts, and all related appurtenances will be measured on a length basis and paid for at the Contract Unit Price for the "Steel Beam Guardrail". The length to be paid for will be the total number of metres of Steel Beam Guardrail in accordance with this Specification, accepted and measured by the Contract Administrator.

E30.4.2 Supply and installation of ET-31 end treatments, associated posts and appurtenances will be measured on a unit basis and paid for at the Contract Unit Price for the "ET-31 End Treatment". The amount to be paid for will be the total number of units installed in accordance with this Specification, accepted and measured by the Contract Administrator.

E31. REMOVAL AND SALVAGE EXISTING ALUMINUM BALANCED GUARDRAIL SYSTEM AND POSTS

E31.1 Description

E31.1.1 General

(a) Further to CW 3650, this Specification shall cover the removal and salvage of existing aluminum balance barrier rails and posts as specified on the contract drawings or as directed by the Contract Administrator. The Work to be done under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all other things necessary for and incidental to the satisfactory performance and completion of all Work specified

E31.1.2 The Contractor shall return aluminum balance guardrail system and posts to City Bridge Yard:

(b) Contact for City personnel to arrange suitable time and date of delivery:

a) Michael Terleski, C.E.T

Work: (204) 983-5004 or Mobile: (204) 794-8510
Bridge Operations Technologist
City of Winnipeg
Public Works Department
Email: Mterleski@winnipeg.ca

E31.2 Referenced Standard Construction Specifications

(a) CW 3650 – Installation of Aluminum Balanced Barrier.

E31.3 Materials

(a) The existing aluminum balanced guardrail and posts shall be safely removed and returned to the City of Winnipeg Yard as requested by the Contract Administrator.

(b) The Contractor shall be responsible for the safe storage and handling of all materials set forth in this Specification.

(c) All damage or missing materials or components resulting from handling and storage operations shall be replaced by the Contractor's expense, to the satisfaction of the Contract Administrator.

E31.4 Construction Methods

E31.4.1 General

(a) Existing aluminum balanced guardrail shall be carefully removed from the existing barrier posts by either hand or mechanical method, taking care not to damage the aluminum balanced guardrail. The aluminum balanced guardrail is to be stock piled on-site and delivered back to the City of Winnipeg Yard at 960 Thomas Avenue.

(b) Each existing aluminum balanced guardrail post is to be safely lifted vertically by means of mechanical method ensuring that no structural damage has occurred. The posts are to be stock piled on-site and delivered back to the City of Winnipeg Yard at 960 Thomas Avenue.

E31.5 Measurement and Payment

E31.5.1 General

E31.5.2 Removal, stockpiling and delivery of aluminum balanced guardrail and posts will be measured on a length basis and paid for at the Contract Unit Price per unit for "Removal and Salvage of Existing Aluminum Balance Guardrail System and Posts". The unit to be paid for will be the total meters of barrier rail and posts removed in accordance with this specification and accepted by the Contract Administrator.

E32. PRIMARY DIKE RECONSTRUCTION AND BELLMTS DUCT BACKFILL

E32.1 Description

E32.1.1 General

(a) This Specification covers all operations, phases of removal and/or placement of all materials necessary for excavation, reconstruction, backfilling of highly plastic clay for the Primary Dike, Berm and all Works pertaining to backfilled material for the construction of the BellMTS duct bank structure, as specified on Drawings CT-050 and CT-056.

E32.1.2 This Specification shall amend and supplement Specification No. CW 3170.

E32.1.3 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies and all things necessary for and incidental to the satisfactory performance and completion of all Work as hereinafter specified.

E32.2 Scope of Work

E32.2.1 The Work under this Specification shall include:

E32.2.2 Realignment of existing City of Winnipeg Primary Line of Defense (PLD or Primary Dike);

E32.2.3 Existing Dike Excavation;

E32.2.4 BellMTS utility duct excavation beneath the Primary Dike and backfill materials for the realigned BellMTS utility duct structure ;

E32.2.5 Supply, loading, hauling, placing compacted highly plastic clay fill material for the construction of the Primary Dike and Berm.

E32.3 Reference

E32.3.1 Referenced Standard Construction Specifications:

(a) CW 1130 – Site Requirement;

(b) CW 3170 – Earthwork and Grading.

E32.4 Submittals

(a) Prior to commencement of the Work, the Contractor shall submit an Earthwork and Grading work plan detailing the proposed construction sequence, methodology, and schedule of all Earthworks and Grading Works specified herein and in accordance with the construction methods below.

(b) The submitted work plan shall include but not necessarily limited to:

(i) Designated excavation and disposal areas for each month of the scheduled work including Primary Dike reconstruction and Berm East and West of the Pedestrian- Cyclist Underpass.

(ii) Procedures to minimize the disturbance to vegetation during excavation and material placement.

(iii) Proposed location of site work roads between excavation and disposal areas.

E32.5 Materials and Equipment

E32.5.1 General

(a) The Contractor shall be responsible for the supply, safe storage and handling of all materials set forth in this Specification.

E32.5.2 Testing and Approval

E32.5.3 All materials supplied under this Specification shall be subject to inspection and testing by the Contract Administrator or by the Testing Laboratory designated by the Contract Administrator. There shall be no charge to the City for any materials taken by the Contract Administrator for testing purposes.

E32.5.4 The Contract Administrator shall approve all materials at least seven (7) days before any construction is undertaken. If, in the opinion of the Contract Administrator, such materials, in whole or in part, do not conform to the Specification detailed herein or are found to be defective in manufacture or have become damaged in transit, storage or handling operations, then such material shall be rejected by the Contract Administrator and replaced by the Contractor at his own expense.

E32.5.5 Bedding and Backfill Material

(a) Backfill material for backfill of BellMTS utility duct structure shall consist of highly plastic clay fill material.

E32.5.6 Clay Fill

(a) Further to Specification CW 3170, Clause 5.4, backfill material for the Primary Dike and Berm shall consist of high plasticity clay soil, with a liquid limit in excess of fifty percent (50%). The clay shall be unfrozen and free of deleterious materials such as roots, organics, silt, sand, gravel, ice, snow or any other undesirable materials that would detract from the properties of low permeability clay soil.

E32.5.7 Equipment

E32.5.8 Contractor to select compaction equipment to prevent damage to BellMTS duct structure.

E32.5.9 Provide all equipment to properly execute Work. Maintain such equipment in a workable, safe condition while in use during this project.

E32.5.10 Contract Administrator shall review equipment to be used to execute Work prior to execution.

E32.6 Construction Methods

E32.6.1 General Staging and Construction Requirements

(a) During excavation the removal of the existing vegetation cover shall be minimized to the greatest extent possible.

(b) Within the limits of the work, any fallen timber, logs, and other surface litter and/or debris shall be removed by the Contractor and disposed of off-site. This is considered incidental to the work, and no separate payment will be made.

(c) The excavation shall proceed in a manner such that the open and active excavation area is minimized at all times, the existing vegetation is maintained as much as possible.

E32.6.2 Inspection of Excavation

E32.6.3 Backfill material shall not be placed in an excavation until the excavation has been inspected and approved by a Geotechnical Engineer.

E32.6.4 The Contractor shall have available suitable light for the inspection of each excavation through its entire length.

E32.6.5 Any improperly prepared excavation shall be corrected to the satisfaction of the Contract Administrator.

E32.6.6 Realignment of Primary Dike and Berm Fill

(a) Further to CW 3170, Clause 9.6 , dike backfill shall be placed to obtain the required lines, grades, and cross-sections shown on the Drawings.

(b) Materials shall be deposited and spread in uniform homogenous layers in maximum 150 mm thick lifts (uncompacted thickness), for the full width of the dike.

(c) Each lift shall be thoroughly compacted to a minimum of ninety five percent (95%) Standard Proctor maximum dry density ASTM D698 within two percent (2%) of the optimum moisture content.

(d) Where the moisture content of the clay is too high, the material shall be thoroughly worked until the specified moisture content can be achieved.

(e) The clay subgrade of each lift shall be scarified a minimum depth of 50 mm prior to placement of the succeeding lift, to ensure a uniform homogenous fill zone.

(f) Grade tolerance for Primary Dike and Berm fill is ± 50 mm from the lines and grades shown on the Drawings, provided positive drainage is achieved.

(g) Placement of clay fill in a frozen state shall not be permitted.

(h) A compacted clay blanket shall be placed on the upstream (wet) side of the Primary Dike, as well as a clay cut-off trench beneath the centreline of Primary Dike tying into high ground to the north and the roadway embankment to the south.

(i) The clay blanket shall be placed and compacted minimum 500 mm below final grade or underside of Pedestrian-Cyclist underpass subgrade.

(j) The clay cut-off trench should extend minimum 300 mm below the permeable silt layer and into native high plastic clay. The base of cut-off trench should be minimum 1.2 m wide.

(k) When any portion of the dike has, in the opinion of the Contract Administrator, been sufficiently completed that trimming is feasible, the Contractor shall commence trimming operations. Before final acceptance of the Work the embankment shall, if required by the Contract Administrator, be retrimmed.

E32.6.7 Excavation of Existing Primary Dike

(a) All materials shall be excavated to the required lines and grades shown on the Drawings.

(b) All excavated material shall be uniformly and continuously deposited in successive layers within the designated disposal embankment areas to the required lines and grades, as accepted or approved by the Contractor Administrator. Placement of excavated material in a frozen state shall not be permitted.

(c) No temporary stockpiling of excavated material shall be permitted.

E32.7 Quality Control

E32.7.1 All workmanship and all materials furnished and supplied under this Specification are subject to close and systematic inspection and testing by the Contract Administrator, including all operations from the selection and production of materials, through to final acceptance of the Work. The Contractor shall be wholly responsible for the control of all operations incidental there to notwithstanding any inspection or approval that may have been previous given. The Contract Administrator reserves the right to reject any materials or Works that are not in accordance with the requirements of this Specification.

E32.7.2 The Contractor

E32.8 Measurement and Payment

E32.8.1 Measurement and payment for highly plastic clay include clay blanket and clay trench cut-off and all related works will be considered incidental in this specification. No separate measurement will be paid for these components.

E32.8.2 Highly Plastic Clay Fill

E32.8.3 Highly Plastic Clay Fill will be measured on a volume basis and paid at the Contract Unit Price per cubic metre for, "Highly Plastic Clay Fill". The volume to be paid for will be the total number of cubic metre compacted in place in accordance with Specification CW 3170 and accepted by the Contract Administrator, as determined by the method of Average End Areas. No separate payment will be made for material hauled from a suitable Site material stockpile rather than directly from excavation.

E32.8.4 Dike Excavation

E32.8.5 Excavation of the Existing Dike and related Works will be measured on a volume basis and paid for at the Contract Unit price per cubic metre for "Dike Excavation". The volumes to be paid for will be the total number of cubic meters of surplus suitable and/or unsuitable Site material excavation in its original position and determined by the method of Average End Areas.

E33. MANITOBA HYDRO NATURAL GAS MAINS, GAS SERVICES AND HYDRO POLES

E33.1 Description

E33.1.1 General

(a) The Contractor shall follow all requirements listed in Appendix 'I' and Appendix "K" when working around natural gas mains, gas services and Hydro distribution poles.

(b) A 219.1 mm steel distribution pressure gas main runs along northbound St. Anne's Road at Fermor Avenue including a 60.3 mm gas service(s) in the vicinity of Fermor Avenue / St. Anne's Road intersection. A Manitoba Hydro High Pressure Safety Watch may be required where excavations are within 1.0 m of the 219.1 mm gas main.

(c) Prior to excavation, the Contractor shall expose the gas main by hydro-excavation every 25 m and at catchbasin locations in order to confirm the elevation of the pipe.

E33.2 Contractors carrying out repair work or working in proximity to the 219.1 mm steel distribution pressure gas main shall meet the following conditions and technical requirements.

E33.2.1 General Execution

a) A minimum of 900 mm cover shall be maintained in all areas where equipment will be crossing, traveling or compacting over the 219.1 mm gas main. Vibratory compaction cannot be used over or within 1.0 m of main.

b) If equipment must cross, travel, or compact over the gas main with less than the minimum depth cover, earth bridging or steel plates shall be placed over the main and extend a minimum 1.0 m on either side at each crossing location.

E33.2.2 Roadway Excavation, Subbase and base course Construction

a) When working with less than minimum cover, a minimum 300 mm of granular material shall be bladed into place with track equipment offset from the pipeline. Then static compaction equipment would be allowed and built up in layers until minimum cover is achieved.

b) A smooth edge bucket shall be used for any excavations within 1.0 m of a large diameter distribution pressure main.

c) Subbase material shall be bladed into place as opposed to being end dumped over the 219.1 mm gas main in areas with less than minimum cover.

d) Caution must be used to ensure the integrity of the pipeline coating. Any damages to the coating must be reported to and repaired at no cost by Manitoba Hydro prior to backfilling by the Contractor.

E33.3 Tree Installation

E33.3.1 Should any trees be considered, a minimum 1.9 m of separation shall be maintained in all areas between center line of new trees and the 219.1 mm and 60.3 mm gas mains. Under no circumstances are trees approved to be planted closer.

E33.4 Catch basin, Manholes, and LDS Removal and Installation

E33.4.1 Proposed excavation for the removal and installation of catch basins within 1.0 m of gas main, in which case will require exposure are to be completed by hand or Hydro-excavation.

E33.4.2 A minimum separation of 300 mm shall be maintained between any Manitoba Hydro facility and new underground structures.

E33.5 Sidewalk Renewals

E33.5.1 Excavations shall be limited to removal of the existing concrete sidewalk. All further excavation within 1.0 m of any natural gas main or service must be completed by hand or soft dig methods.

E33.5.2 All cost associated with the work in proximity to the natural gas mains, gas services and hydro poles shall be incidental to the applicable type of pavement construction and no additional payment shall be made.

E34. HYDRO EXCAVATION

E34.1 Description

E34.1.1 General

(a) This Specification covers all operations relating to the removal of earthen material immediately adjacent to underground utilities infrastructure by means of high pressure water spray, and the recovery of evacuated material by vacuum type means or equivalent method as approved by the Contract Administrator in accordance with E47.3.1(e).

(b) The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Works as hereinafter specified.

E34.2 Equipment

E34.2.1 Hydro excavation unit shall be capable of maintaining a minimum working pressure of 10,000 psi, at a rate of flow of 10 to 12 gallons per minute. The unit should be adjustable, so as to provide adequate pressure to remove earthen material.

E34.2.2 Spray head shall be equipped with a rotating type nozzle, in order to provide a wider path of cut.

E34.3 Construction Methods

E34.3.1 Hydro-Removal of Earthen Material

(a) Earthen material adjacent to utility entity shall be sprayed with high pressure water so as to remove all such material.

E34.3.2 Recovery of Excavated Material

(a) The recovery of excavated material shall be done using vacuum type method, or other type method as approved by the Contract Administrator.

(b) The recovery of material shall follow immediately behind the excavation, to avoid excavated areas from filling with excavated material.

(c) The use of mechanical sweepers will not be allowed.

(d) Dispose of material in accordance with Section 3.4 of CW 1130.

E34.3.3 Backfill of Hydro Excavated Hole

(a) The Contractor shall be responsible for the backfill of the hydro excavated hole with flowable cement-stabilized fill or sand backfill upon completion of the work described herein, to the approval of the Contract Administrator.

E34.4 Measurement and Payment

E34.4.1 Hydro Excavation

(a) There will be no measurement and payment for Hydro Excavation as it will be considered incidental to the Contract.

E34.4.2 Backfill

(a) Cement-Stabilized fill or sand backfill is considered incidental to Hydro Excavation and no separate measurement or payment will be made.

LANDSCAPING

E35. PRUNING OF EXISTING TREES

E35.1 Description

E35.1.1 Provide all labour, materials, methods, equipment and accessories for pruning of existing trees within the limit of Work.

E35.2 Quality Assurance

E35.2.1 Pruning shall be provided by a person with a Manitoba Arborists Certificate with demonstrable experience sourcing and Work.

E35.2.2 Contact the City of Winnipeg Forestry Branch at (204) 986-2004 to arrange an on-site meeting to review trees to be pruned. Meeting to include the Contract Administrator.

E35.3 Pruning Methodology

E35.3.1 Prune as required to remove dead, broken or damaged limbs.

E35.3.2 Prune back to healthy growth while maintaining balanced crown shape.

E35.3.3 Employ clean sharp tools.

E35.3.4 Make cuts smooth and flush with outer edge of branch collar near the main stem or branch.

E35.3.5 Cuts must be smooth and sloping to prevent accumulation of water on cut.

E35.3.6 Do not leave small stumps (“horns”) on trunks or main branches.

E35.3.7 Prune according to accepted horticultural practices as outline in “The Pruning Manual”, Publication No. 1505-1977 by Agriculture Canada.

E35.3.8 American Elm Trees are not to be pruned between April 1 and August 1, and Siberian Elm Trees between April 1 and July 1 of any year under provisions of The Dutch Elm Disease Act.

E35.4 Measurement and Payment

E35.4.1 Pruning of Existing Trees shall be measured for on a unit basis and will be paid for at the Contract Unit Price per tree for “Pruning of Existing Trees”. Price shall be payment in full for supplying materials and for performing the Work specified herein.

E36. PLANTING MEDIUM & FINISHED GRADING

E36.1 Description

E36.1.1 Provide all labour, materials, methods, equipment and accessories for the supply and installation of planting medium for planting beds, tree pits, turf areas and riverbank restoration work.

E36.2 References

E36.2.1 Agriculture and Agri-Food Canada

a) The Canadian System of Soil Classification, Third Edition, 1998.

E36.2.2 Canadian Council of Ministers of the Environment (CCME) Guidelines.

E36.2.3 The City of Winnipeg Standard Construction Specifications

a) CW 1130 – Site Requirements;

b) CW 3540 – Topsoil and Finish Grading for Establishment of Turf Areas.

E36.3 Submittals

E36.3.1 Submit 0.5 kg sample of planting medium to National Testing Laboratory, or approved alternate, and indicate present use and intended use. Prepare and ship sample in accordance with Provincial regulations and testing laboratory requirements.

E36.3.2 Submit two (2) copies of soil analysis and recommendations for corrections to Contract Administrator.

E36.4 Quality Assurance

E36.4.1 Inform Contract Administrator of proposed source of materials to be supplied and provide a sample for review by Contract Administrator prior to installation.

E36.4.2 Testing of planting medium to be carried out and paid for by Contractor. Prepare and ship planting medium samples to approved laboratory in accordance with Provincial regulations and laboratory requirements, indicating intended use on each sample.

E36.4.3 Test planting medium for nutrients N, P, K, micronutrients, soluble salt content, pH value and OM (organic matter).

E36.4.4 Acceptance of planting medium is subject to an inspection of material and confirmation of test results. Do not commence soft landscaping work until Contract Administrator has accepted planting medium.

E36.5 Delivery, Storage and Handling

E36.5.1 Store materials in a dry area, protected from freezing, sedimentation and contamination.

E36.5.2 Deliver and store fertilizer in waterproof bags labeled with weight, analysis and name of manufacturer.

E36.6 Materials

E36.6.1 Planting Medium: In accordance with CW 3540.

E36.7 Construction Method

E36.7.1 Subsoil Preparation

(a) Prepare subsoil in accordance with Specification CW 3540.

(b) Prior to placing topsoil on embankments, scarify subsoil across the slope to a depth of 75 mm.

E36.7.2 Planting Medium Placement

(a) Obtain approval of tree pit excavation, subsoil scarification and rough grading of areas to receive planting medium prior to placement.

(b) Place planting medium in accordance with Specification CW 3540 in uniform layers over unfrozen sub-grade, to a compacted depths set out in CW 3540.

(c) Eliminate rough spots and low areas, Prepare a loose, friable bed, boot firm and uniform.

E36.7.3 Soil Amendments

(a) Apply lime, sulphur, or other soil amendment at a rate determined and recommended from planting medium sample test.

(b) Mix soil amendment well into full depth topsoil prior to application of fertilizer.

E36.7.4 Finished Grading and Rolling

(a) Per CW 3540.

(b) Fine grade entire soil area to elevations as indicated on the drawings. Eliminate rough spots and low areas Leave surfaces smooth, uniform and firm against foot printing with a fine loose texture.

E36.7.5 Surplus Material

(a) Dispose of unused planting medium off Site in accordance with CW 1130.

E36.7.6 Cleaning

(a) Perform cleaning to remove accumulated environmental dirt from all paved surfaces of building faces. Remove surplus materials, rubbish, tools and equipment barriers.

E36.8 Measurement and Payment

E36.8.1 Supply and placement of planting medium in tree wells will not be measured. This item of Work shall be considered incidental to the cost of "Supply and Installation of Trees" performed in accordance with relevant Specification Sections and accepted by the Contract Administrator.

E36.8.2 Supply and placement of planting medium for naturalized seeding areas will not be measured. This item of Work shall be considered incidental to the cost of "Naturalized Area Seeding". No separate measurement or payment will be made.

E36.8.3 Supply and placement of planting medium for wet blend seeding areas will not be measured. This item of Work shall be considered incidental to the cost of "Wet Blend Seeding". No separate measurement or payment will be made.

E36.8.4 Supply and placement of planting medium for sod areas will not be measured. This item of Work shall be considered incidental to the cost of "Sodding". No separate measurement or payment will be made.

E36.8.5 Supply and placement of planting medium for shrub beds be paid for on an installed volume basis, as measured in the field by the Contract Administrator, for "Supply and Place Planting Medium for Shrub Beds". Price shall be payment in full for supplying materials and for performing the Work.

E37. TREES, SHRUBS AND GROUNDCOVER PLANTINGS

E37.1 Description

E37.1.1 Provide all labour, materials, methods, equipment and accessories for the supply and installation of trees.

E37.2 References

E37.2.1 Agriculture and and Agri-Food Canada (AAFC)

(a) Plant Hardiness Zones in Canada-2000.

E37.2.2 Canadian Nursery Landscape Association (CNLA)

(a) Plant Canadian Standards for Nursery Stock-2001.

E37.2.3 Department of Justice Canada (JUS)

(a) Plant Canadian Environmental Protection Act (CEPA), 1999, c. 33;

(b) Transport of Dangerous Goods Act (TDGA), 1992, c.34.

E37.2.4 Health Canada / Workplace Hazardous Materials Information System (WHMIS)

(a) Materials Safety Data Sheets (MSDS).

E37.3 Submittals

E37.3.1 Submit product data for:

(a) Fertilizer.

E37.4 Source Quality Control

E37.4.1 Obtain approval from Contract Administrator of plant material at source.

E37.4.2 Notify Contract Administrator of source of material at least seven (7) days in advance of shipment. No work under this Section is to proceed without approval.

E37.4.3 Acceptance of plant material at source does not prevent rejection on Site prior to or after planting operations.

E37.4.4 Plant material imported from other nations will not be accepted.

E37.4.5 Bare root plant material will not be accepted.

E37.5 Storage and Protection

E37.5.1 Coordinate the shipping of plants and excavation of holes to ensure minimum time laps between digging and planting.

E37.5.2 Protect plant material from frost, excessive heat, wind and sun during delivery.

E37.5.3 Protect plant material from damage during transportation:

(a) When delivery distance is less than 30 km and vehicle travels at speeds under 80 km/h, tie tarpaulins around plants or over vehicle box.

(b) When delivery distance exceeds 30 km or vehicle travels at speeds over 80 km/h, use enclosed vehicle where practical.

(c) Protect foliage and rootballs using anti-desiccants and tarpaulins, where use of enclosed vehicle is impractical due to size and weight of plant material.

E37.5.4 Protect stored plant material from frost, wind and sun as follows:

(a) For bare root plant material, preserve moisture around roots by heeling-in or burying roots in topsoil and watering to full depth of root zone.

(b) For pots and containers, maintain moisture level in containers.

(c) For balled and burlapped and wire basket rootballs, place to protect branches from damage. Maintain moisture level in root zones.

E37.5.5 Remove broken and damaged roots with sharp pruning shears. Make clean cut and cover cuts over 20 mm diameter with wound dressing.

E37.5.6 Keep roots moist and protect from sun and wind. Heel-in trees that cannot be planted immediately in shaded areas and water well.

E37.6 Scheduling

E37.6.1 Order plant material as soon as possible after award of contract to ensure plant availability. Request substitutes as required.

E37.6.2 Provide Contract Administrator a written schedule fourteen (14) days in advance of shipment of plant material. Schedule to include: quantity and type of plant material, shipping dates, arrival dates on Site, and planting dates.

E37.7 Warranty of Nursery Stock

E37.7.1 For all plant material a one (1) year warranty period is required.

E37.7.2 During the warranty period, upon written notification from the Contract Administrator, the Contractor warrants to replace and replant any nursery stock found dead and/or in poor condition as soon as possible thereafter, without cost to The City. "Poor Condition" shall be interpreted as meaning nursery stock on which branches are dead or dying, or have not shown satisfactory growth in leaves. Exempted is nursery stock damaged by accidental causes or vandalism, which stock shall be replaced at the cost of The City.

E37.7.3 End-of-Warranty inspection will be conducted by Contract Administrator.

E37.7.4 Contact Administrator reserves the right to extend Contractor's warranty responsibilities for an additional one (1) year if, at end of initial warranty period, leaf development and growth is not sufficient to ensure future survival.

E37.8 Replacements

E37.8.1 During warranty period, remove from Site any plant material that has died or failed to grow satisfactorily as determined by the Contract Administrator.

E37.8.2 Extend warranty on replacement plant material for a period equal to the original warranty period.

E37.8.3 All required replacements shall be by plants of at least the same size and species as specified, and shall be supplied and planted in accordance with the original Drawings and Specifications.

E37.8.4 Should the replaced plant material not survive, the Contractor will be responsible to replace it a third time and guarantee it for a period equal to the original warranty period unless it is determined that unique Site conditions or inadequate maintenance causes the death of plants.

E37.9 Plant Material

E37.9.1 Type of root preparation, sizing, grading and quality: comply to Canadian Standards for Nursery Stock.

E37.9.2 Source of plant material: grown in Zone 3 only in accordance with Plant Hardiness Zones in Canada.

E37.9.3 Plant material must be planted in zone indicated as appropriate for its species.

E37.9.4 Plant material free of disease, insects, defects or injuries and structurally sound with strong fibrous root system.

E37.9.5 Substitutions to plant material as indicated on planting plan are not permitted unless written approval has been obtained as to type, variety and size. Plant substitutions must be of similar species and of equal size as those originally specified.

E37.9.6 Refer to Plant Specification List on the Drawings and the Drawings for species, quantities, size and quality of plant materials.

E37.10 Water

E37.10.1 Water free of impurities that would hinder plant growth. The Contractor shall provide water, so that all costs to provide water for the watering operation and all associated costs shall be borne by the Contractor. These costs may include hydrant permit and meter rental fees.

E37.10.2 Further to clause 3.7 of CW 1120, the Contractor shall pay for all costs associated with obtaining water in accordance with the Waterworks By-law. Sewer charges will not be assessed for water obtained from a hydrant.

E37.11 Planting Medium: backfill with planting medium per the Planting Medium Specification.

E37.12 Stakes: 76 mm dia. x 244 mm ht. wooden stakes.

E37.13 Tree Tie: biodegradable or polyethylene fabric strapping, minimum 30 mm wide.

E37.14 Mulch: Clean wood chip mulch free of leaves, branches and other extraneous matter, consisting of chips not less than 15 mm nor larger than 75 mm in size and not more than 20 mm thick.

E37.15 Fertilizer: synthetic start-up slow release fertilizer with an N-P-K analysis of 12-36-15 ratio at a rate of 4 kg per 100 m^2.

E37.16 Pre-Planting Preparation

E37.16.1 Obtain approval from Contract Administrator of finish grading, and planting medium installation prior to commencing Work in this section.

E37.16.2 Ensure plant material is acceptable to the Contract Administrator.

E37.16.3 Remove damaged roots and branches from plant material with sharp clean equipment treating wounds as necessary to maintain plant health.

E37.16.4 Apply anti-desiccant to deciduous trees in leaf in accordance with manufacturer's instructions.

E37.17 Plant Material Layout

E37.17.1 For individual trees:

(a) Stake out locations of all trees and obtain approval from Contract Administrator prior to excavating tree pits.

(b) Excavate tree pits to depths and widths indicated on the Drawings.

(c) Remove rocks, roots, debris and toxic material from the tree pit.

(d) Scarify sides of planting hole.

(e) Protect excavations from freezing. Remove any water prior to planting.

(f) If the planting location contains a stump with a diameter less than 15 cm it shall be removed.

(g) Tree pits shall be excavated to a width and length to provide minimum 15 cu.m of a combination of planting median and suitable insitu soil (amended as required based on insitu soil test results).

E37.17.2 For shrubs, groundcovers, vines, perennials:

(a) Prepare planting beds. Refer to Planting Medium Specification.

(b) Lay out plants per drawings carefully ensuring spacing specified on the Drawings.

(c) Obtain Contract Administrator approval of plant layouts and make any necessary adjustments on Site.

E37.17.3 Remove water which enters excavations or planting beds prior to planting. Notify Contract Administrator if water source is groundwater.

E37.18 Planting

E37.18.1 For jute burlap rootballs, cut away top one third (1/3) of wrapping and wire basket without damaging rootball. Do not pull burlap or rope from under rootball.

E37.18.2 For container stock or rootballs in non-degradable wrapping, remove entire container or wrapping without damaging rootball. Loosen rootball to encourage bonding with planting medium and subgrade.

E37.18.3 Plant vertically in locations as indicated. Orient plant material to give best appearance in relation to structure, roads and walks.

E37.18.4 For trees and shrubs:

(a) Backfill planting medium in 150 mm lifts. Tamp each lift to eliminate air pockets. When two thirds (2/3) of depth of planting pit has been backfilled, fill remaining space with water. After water has penetrated into soil, backfill to finish grade.

(b) Form watering saucer as indicated on the Drawings.

E37.18.5 For groundcovers, vines and perennials: backfill soil evenly to finish grade and tamp to eliminate air pockets.

E37.18.6 Water plant material thoroughly.

E37.18.7 After soil settlement has occurred, fill with soil to finish grade.

E37.18.8 Dispose of burlap, wire and container material off Site.

E37.19 Tree Supports

E37.19.1 Install tree supports as indicated on the Drawings taking care not to damage or puncture underground utilities.

E37.19.2 Use double stake tree support for deciduous trees:

(a) Place first stake on prevailing wind side of tree trunk.

(b) Drive stakes minimum 150 mm into undisturbed soil beneath bottom of roots. Ensure stakes are secure, vertical and unsplit.

(c) Install tree tie 1500 mm above grade.

E37.20 Pruning

E37.20.1 Undertake corrective pruning after planting to eliminate torn and broken branches. Do not damage lead branches or remove smaller twigs along main branches. Do not prune to compensate for root loss.

E37.20.2 Pruning shall be performed by a certified arborist or tree professional.

E37.21 Maintenance

E37.21.1 Maintain plant material from date of planting to the end of the warranty period. Refer to Landscape Maintenance Specification.

E37.22 Measurement and Payment

E37.22.1 Supply and installation of trees will be measured on a unit basis, and will be paid for at the Contract Unit Price per unit for installed plants, as verified in the field by the Contract Administrator, for the following Items of Work, which price shall be payment in full for performing all operations herein described and all other items incidental to the Work included in this Specification.

E37.22.2 Items of Work:

(a) Trees

(i) Manitoba Maple;

(ii) Amur Maple;

(iii) American Elm;

(iv) Basswood;

(v) Cottonwood (male);

(vi) Peachleaf Willow;
(vii) Burr Oak;
(viii) Hackberry.

(b) Shrubs
(i) Pygmy Caragana;
(ii) Meyer Lilac;
(iii) Snowberry;
(iv) Pavement Rose.

(c) Vines
(i) Englemann's Ivy.

E38. LANDSCAPE MAINTENANCE

E38.1 Description

E38.1.1 Provide all labour, materials, methods, equipment and accessories for the maintenance of trees following acceptance of the plant material to start warranty.

E38.1.2 In general, the Work shall include:

(a) Fertilizing;
(b) Watering;
(c) Weed Control;
(d) Pest and Disease Control;
(e) Winter Preparation.

E38.1.3 Maintenance shall be performed on an as required basis.

E38.1.4 Mowing will be performed by City staff, following acceptance as outlined in City of Winnipeg Standard Specification CW 3510.

E38.2 Maintenance and Warranty Period

E38.2.1 Maintenance shall occur between the date of installation and up to a period of one (1) year from date landscaped areas are accepted to start warranty. The warranty period for plant materials will be coincidental to the maintenance period.

E38.2.2 Thirty (30) days after the planting installation has been completed, the Contract Administrator shall perform an inspection of the plant material to determine if the plant material is acceptable to start warranty.

E38.3 Materials and Equipment

E38.3.1 Materials shall conform to the requirements of related Specification sections.

E38.3.2 Provide all equipment to properly execute Work. Maintain such equipment in a workable, safe condition while in use during this project.

E38.3.3 Contract Administrator shall review equipment to be used to execute Work prior to execution.

E38.4 Method

E38.4.1 General

(a) Provide watering service within twenty-four (24) hours, weeding services within forty-eight (48) hours of the request by the Contract Administrator. Monitor the Site and advise the Contract Administrator of conditions that might void the Contractor's warranty responsibilities.

(b) The Contractor shall maintain a log noting times, dates, equipment used, and quantity of materials used and areas treated for each maintenance application. Forms shall be provided by Contract Administrator. Submit log to Contract Administrator upon request. Contractor shall notify Contract Administrator of the exact time Contractor proposes to commence each application.

(c) Schedule operations in accordance with growth, health, weather conditions, and use of Site.

(d) Perform each operation continuously and completely within a reasonable time period.

(e) Store equipment and materials off Site.

(f) Collect and dispose of debris or excess material on the day the maintenance is undertaken.

E38.4.2 Maintenance of Trees:

(a) Fertilizing: Apply fertilizer only at frequency, ratio and rates as recommended by manufacturer. Water immediately after fertilizing. Apply fertilizer no later than May 30 of each maintenance year.

(b) Watering: Apply water as required to supplement rainfall and to maintain optimum growing conditions. In general, water once a week to achieve rates as indicated. Allow soil to adequately dry between watering to prevent over saturation without creating water stress. Subject to the above-noted requirements, the Contractor must water at least once a week between May 1 and October 15 inclusive. A complete record is to be kept of each series of waterings for all planted trees noting location and date of watering. This record is to be given to the Contract Administrator when requested. Apply 40 litres of water per 25 mm calliper per application using a deep root feeder or low pressure open flow nozzle and hose. The water stream must not gouge the soil and mulch.

(c) Weed Control: Inspect and undertake weed control weekly during the first year of maintenance and monthly during the second year. By hand, remove all weeds with their roots from tree pits and tree beds and dispose of off Site. When weeding operation is complete, replace and rake displaced mulch to its original condition.

(d) Pests and Diseases: Obtain written approval of Contract Administrator prior to using any pesticide. Control pests and disease through pruning or application of pesticides. Use species specific pesticides where possible. Use only pesticides of low mammalian toxicity. Strictly follow manufacturer's written instructions.

(e) Pruning: The Contractor shall provide a person with a Manitoba Arborist's Certificate for each work crew or Work Site. Prune as required to remove dead, broken or damaged limbs. Prune back to healthy growth while maintaining balanced crown shape. Employ clean sharp tools. Make cuts smooth and flush with outer edge of branch collar near the main stem or branch. Cuts must be smooth and sloping to prevent accumulation of water on cut. Do not leave little stumps ("horns") on trunks or main branches. Prune according to accepted horticultural practices as outline in "The Pruning Manual", Publication No. 1505-1977 by Agriculture Canada.

(f) Winter Preparation: Ensure adequate moisture in tree root zones prior to freeze-up.

E38.5 Measurement and Payment

E38.5.1 Landscape maintenance shall be paid for on a lump sum basis for the items of work listed below. Price shall be payment in full for supplying all material and performing all operations herein described and all other items incidental to the Work included in this Specification.

E38.5.2 Items of Work:

a) Landscape Maintenance Year 1.

E39. SITE FURNISHINGS

E39.1 Description

E39.1.1 Provide all labour, materials, methods, equipment and accessories for the supply and install of benches, waste receptacles, and bike racks.

E39.2 Submittals

E39.2.1 Submit product data and shop drawings for benches, waste receptacles and bike racks, indicating sizes, assembly, method of anchorage, finish and installation details.

E39.3 Materials

E39.3.1 Bench

(a) ‘‘Tache’ Bench, City of Winnipeg product no. 52501089 per SCD-120Acomplete with arms or approved alternate; Frame finish: black powdercoat. Supplier contact: Aaron Lennon, 204-986-5505; alennon@winnipeg.ca.

E39.3.2 Waste Receptacle

(a) Waste Receptacle: City of Winnipeg product no. 52501063BLK per SCD-119, Metal Slat Type, black powdercoat finish. Complet with Wire Basket, City of Winnipeg product no. 52501058GLV , or approved alternate. Supplier contact: Aaron Lennon, 204-986-5505; alennon@winnipeg.ca.

E39.3.3 Concrete for Bases

(a) Unreinforced concrete to CW 2160, Mix Design Type B.

E39.4 Construction Methods

E39.4.1 All work is to be located and installed in accordance with the Drawings and manufacturer’s written instructions.

E39.4.2 All furnishings to be installed plumb and true to correct elevations and location, as directed by the Contract Administrator. The Contractor shall confirm proposed locations of all site furnishings with Contract Administrator prior to installation.

E39.4.3 All furnishings to be carefully handled so that no parts will be bent, broken, or otherwise damaged. Contractor is responsible for replacing any damaged furnishings, prior to installation, at no cost to the City.

E39.4.4 Concrete bases will be constructed in accordance with CW 2160.

E39.5 Measurement and Payment

E39.5.1 The supply and installation of Site Furnishings will be paid for on a unit basis each for the Items of Work listed below. Price shall be payment in full for supplying materials and for performing the Work in accordance with this Specification and accepted by the Contract Administrator. Prices include all mounting hardware.

E39.5.2 Items of Work:

(a) Supply and Install Benches;

(b) Supply and Install Waste Receptacles.

E39.5.3 The supply and installation of concrete bases at site furnishing locations shall be considered incidental to the Works of this Specification. No measurement and payment will be made for this Work.

E40. ORNAMENTAL BARRIER FENCE

E40.1 Description

E40.1.1 General

(a) The work covered under this item shall include all operations related to supply and installation of new ornamental barrier fencing.

(b) The work done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Works as hereinafter specified.

E40.2 Submittals

E40.2.1 Shop Drawings

(a) The Contractor shall submit to the Contract Administrator for review and approval, at least Ten (10) Business Days prior to the scheduled commencement of any fabrication, the proposed Shop Drawings showing fabrication details of ornamental barrier fencing.

E40.3 Materials

E40.3.1 General

(a) The Contractor shall be responsible for the supply, safe storage and handling of all materials set forth in this Specification. All materials supplied under this Specification shall be subject to inspection and acceptance by the Contract Administrator.

E40.3.2 Fencing

(a) Ornamental Barrier Fencing

(i) Omega Eco Panel Fencing system, 1245 mm height, colour: black; supplied by OMEGA II Fence Systems, 1735 St-Elzear Blvd. West, Laval (Quebec) Canada H7L 3N6; phone 1 (800) 836-6342.

E40.4 Construction Methods

E40.4.1 Ornamental Barrier Fence

(a) Install ornamental barrier fencing per manufacturer's specifications.

E40.5 Measurement and Payment

E40.5.1 Ornamental Barrier Fencing will be measured for payment on a linear basis and paid for at the Contract Unit Price per metre for "Ornamental Barrier Fencing" which price shall be payment in full for supplying all materials and for completing all operations herein described and all other items incidental to the Work included in this Specification, accepted and measured by the Contract Administrator.

E41. REMOVAL, INSTALLATION, SALVAGE AND RECONSTRUCTION OF FENCING

E41.1 Description

E41.1.1 General

(a) The work covered under this item shall include all operations related to the removals, termination, supply and installation of fencing as shown on the Contract Drawings:

(b) The work done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Works as hereinafter specified.

E41.2 Reference Materials

(a) Standard Construction Specifications CW 3550 – Chain Link Fencing.

E41.3 Materials

E41.3.1 General

(a) The Contractor shall be responsible for the supply, safe storage and handling of all materials set forth in this Specification. All materials supplied under this Specification shall be subject to inspection and acceptance by the Contract Administrator.

E41.3.2 Miscellaneous Metal

(a) Hardware to be hot dip galvanized.

E41.3.3 Wood

(a) Wood posts, rails and pickets to be pressured treated wood to match existing wood fence in appearance and material.

E41.3.4 Backfill Material

(a) To CW 2030, Type 2.

E41.4 Construction Method

E41.4.1 Sequencing

(a) The chain link fencing designated to be removed at the new St. Andrews approach to eastbound Fermor Avenue shall not be removed until the new chain link fencing for the existing St. Elmo's approach has been constructed, installed and approved by the Contract Administrator.

E41.4.2 Protection

(a) Prevent movement, settlement or damage of adjacent lands. Make good damage caused by demolition.

E41.4.3 St. Elmo's Road – Chain Link Fence Installation

(a) Install new chain link fencing to the limits shown in the Drawing in accordance with CW 3550.

E41.4.4 St. Andrew's Road – Chain Link Fence Removal and Termination

(a) Remove existing terminal post and chain link fence to the limits shown on the contract drawings and as identified by the Contract Administrator.

(b) Install new terminal post and attach wire mesh fabric to new terminal post in accordance with CW 3550 and at the location identified by the Contract Administrator.

(c) The post holes remaining following the removal of fencing shall be backfilled and compacted to the satisfaction of the Contract Administrator. All concrete rubble shall be removed and disposed of by the Contractor.

(d) In the event of damage to any materials by the Contractor, the Contractor shall immediately notify the Contract Administrator and make all repairs or replacements necessary, at their own expense, to the satisfaction of the Contract Administrator.

E41.4.5 Removal, Salvage and Reconstruction of Wood Fence

(a) Partial sections at the Safeway parking lot wood fence designated for removal shall be carefully removed and salvaged.

(b) Posts to be removed and disposed of by the Contractor.

(c) The sections to be removed and salvaged will be identified and approved by the Contract Administrator prior to removal.

(d) The post holes remaining following the removal of the fencing shall be backfilled and compacted to the satisfaction of the Contract Administrator. All concrete rubble shall be removed and disposed of by the Contractor.

(e) In the event of damage to any materials by the Contractor, the Contractor shall immediately notify the Contract Administrator and make all repairs or replacements necessary, at their own expense, to the satisfaction of the Contract Administrator.

(f) Install wood fence at new location as directed by the Contract Administrator.

(g) New fence posts shall be supplied and installed to match the removed posts.

(h) The Contractor has the option of replacing the wood fence with all new material. If the Contractor chooses to replace wood fence with all new material, the Contractor is to dispose of removed fence off site.

E41.5 Quality Control

E41.5.1 Inspection

(a) All workmanship and materials furnished and supplied under this Specification are subject to the close and systematic inspection by the Contract Administrator including all operations from the selection and production of materials through to final acceptance of the specified Work.

(b) The Contractor shall be wholly responsible for the control of all operations incidental thereto notwithstanding any inspection or approval that may have been previously given. The Contract Administrator reserves the right to reject any materials or works which are not in accordance with the requirements of this Specification.

E41.5.2 Access

(a) The Contractor shall have limited access to both properties. The Contractor is to notify the Contract Administrator a minimum of forty-eight (48) hours in advance prior to Work.

E41.6 Measurement and Payment

E41.6.1 Installation of Chain Link Fencing

(a) Chain Link Fencing will be measured for payment on a linear basis and paid for a the Contract Unit Price per metre for “Installation of Chain Link Fencing 1.22 m, height– St. Elmo’s Road” which prices shall be payment in full for supply all materials and for completing all operations herein described and all other items incidental to the Work included in this Specification, accepted and measured by the Contract Administrator.

E41.6.2 Removal and Disposal of Chain Link Fence

(a) The removal and disposal of existing chain link fencing will be measured on a per linear basis and paid for at the Contract Unit Price per metre for “Chain Link Fence Removal – St. Andrews Road”. The length to be paid for will be the total number of metres of chain link fence removed and disposed in accordance with this specification, accepted and measured by the Contract Administrator.

E41.6.3 Backfilling post holes, removing and disposing of fence posts, concrete post foundations and concrete rubble shall be considered incidental to “Chain Link Fence Removal” and no separate measurement or payment will be made.

E41.6.4 Reconstruction of Wood Fence

(a) The reconstruction of wood fencing will be measured on a per linear basis and paid for at the Contract Unit Price per metre for “Reconstruction of Wood Fence”. The length to be paid for will be the total number of metres of wood fence removed and reconstructed in accordance with this Specification, accepted and measured by the Contract Administrator.

E41.6.5 Removing and disposing of fence materials, backfilling post holes, concrete post foundations and concrete rubble shall be considered incidental to “Reconstruction of Wood Fence” and no separate measurement or payment will be made.

E42. NIAKWA TRAIL ROUTE IDENTIFIER BOLLARD RELOCATION

E42.1 Description

E42.1.1 General

(a) This specification shall cover the removal, and storage and re-installation of existing wood route identifier bollards.

E42.2 Materials

E42.2.1 Granular backfill

(a) To CW 2030, Type 2.

E42.3 Construction Methods

E42.3.1 Removal

(a) Remove existing route identifier bollard and sign by prying or jacking it out of the granular foundation in a manner that does not damage to post or the sign.

E42.3.2 Storage

(a) Wrap post and sign in protective plastic or paper and store safely off site until the site is ready for reinstallation in its new location.

E42.3.3 Reinstallation

(a) Confirm location prior to excavating. Post to be oriented with sign facing oncoming pedestrian and cycle traffic, perpendicular to the multiuse path, and min. 500 mm from the edge of the path.

(b) Excavate to depth to ensure exposed height of post matches previous installation. Allow for min. 100 mm depth compacted granular in the bottom of the excavation.

(c) Insert post and brace plumb and square to the path edge. Backfill with granular and tamp firmly in 150 mm lifts around the post.

(d) Final lift of granular backfill to be 25 mm above finished grade and crowned to drain away from the post.

E42.3.4 Clean Up

E42.3.5 Remove all excavated materials and excess granular from the site. Restore any damage to surrounding turf or structures to pre-construction condition.

E42.4 Measurement and Payment

(a) Relocation of existing route identifier bollards will be paid for at the Contract Unit Price for “Relocation of Route Identifier Bollards”, measured on a unit basis. The unit price will include all operations herein described and all other items incidental to the work included in this specification.

E43. PEBBLE FINISH PLANTERS

E43.1 Description

E43.1.1 General

(a) This specification covers the removal, salvage and storage of twenty-one (21) raised concrete planters for the following locations:

(i) Six (6) planters on the centre median, west of St. Anne’s Road on Fermor Avenue;

(ii) Three (3) planters North boulevard on Fermor Avenue, West of St. Anne’s Road;

(iii) Three (3) planters on the centre median, north leg of Fermor Avenue/St. Anne’s Road intersection;

(iv) Six (6) planters on boulevard, northeast corner of Fermor Avenue/St. Anne’s Road Intersection;

(v) Three (3) planters on the centre median, south leg of Fermor Avenue/St. Anne’s Road Intersection;

(vi) Six (6) Planters at the Southwest corner of Fermor Avenue / St. Anne's Road Intersection.

E43.2 The Contractor shall return pebble finish planters to the Old St. Vital BIZ executive director Maurice Allard, phone (204) 504-9535; info@oldstvitalbiz.com

E43.3 Measurement and Payment

E43.3.1 Removal and delivery of pebble finish planters to the Old. St. Vital BIZ will be paid for at the Contract Unit Price for "Salvaging Pebble Finish Planters", measured on a unit basis. The unit price will include all operations herein described and all other items incidental to the work included in this specification.

E44. SODDING

E44.1 Description

E44.1.1 General

(a) This specification shall amend and supplement City of Winnipeg Standard Construction Specification CW 3510 "Sodding", and covers all operations relating sod supply and installation, including preparation of finish grade, watering and rolling, and thirty (30) day maintenance.

(b) The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Works as hereinafter specified.

E44.2 References

E44.2.1 Referenced Standard Construction Specifications

(a) CW 3510 Sodding;

(b) CW 3540 Topsoil and Finish Grading.

E44.2.2 Referenced Standard Details

(a) SD-243- Sodding Details.

E44.3 Materials

E44.3.1 General

(a) The Contractor shall be responsible for the supply, safe storage and handling of all materials set forth in this Specification. All materials supplied under this Specification shall be subject to inspection and acceptance by the Contract Administrator.

E44.3.2 Turf Grass Sod

(a) Turf grass sod shall conform to CW 3510.

(b) Sod shall be a mixture of ninety-five percent (95%) Kentucky bluegrass, using equal proportions of any three (3) Class 2 cultivars, and five percent (5%) Creeping Red fescue.

(c) Soil and fine grading shall conform to CW 3540 and Section E38 Planting Medium & Finish Grading.

E44.4 Construction Methods

E44.4.1 Installation of Topsoil and Finish Grading, Preparation of Finish Grade, Placement of Sod, Watering and Rolling and 30 Day Maintenance

(a) Install 75 mm topsoil in accordance with CW 3540

(b) Sod placement, watering and rolling and thirty (30) day maintenance shall conform to CW 3510-R9 and SD-243.

(c) Install one (1) width of sod, 600 mm, along all sidewalks, roadways and active transportation pavements in naturalized areas.

E44.5 Measurement and Payment

E44.5.1 Turf Grass Sod

(a) Turf Grass Sod will be measured on an area basis and paid for at the Contract Unit Price per square metre for "Items of Work", which price shall be payment in full for supplying all materials and for completing all operations herein described and all other items incidental to the work included in this Specification, accepted and measured by the Contract Administrator.

(i) Items of Work:

¨ Sodding width greater than or equal to 600 mm.

E44.5.2 Payment for each item of work for supply and installation of sod shall include thirty (30) day maintenance before acceptance in accordance with CW 3510.

E44.5.3 Payment shall be in accordance with the following:

(a) seventy-five percent (75%) of quantity following supply and placement of sod including topsoil depth as specified in Form B.

(b) twenty-five percent (25%) of quantity following termination of the thirty (30) day maintenance period before acceptance.

E44.6 Measurement and Payment

E44.6.1 Turf Grass Sod

(a) Turf Grass Sod will be measured on an area basis and paid for at the Contract Unit Price per square metre for "Items of Work", which price shall be payment in full for supplying all materials and for completing all operations herein described and all other items incidental to the work included in this Specification, accepted and measured by the Contract Administrator.

(i) Items of Work:

¨ Sodding width greater than 600 mm (complete with 75 mm imported topsoil).

E44.6.2 Payment for each item of work for supply and installation of sod shall include thirty (30) day maintenance before acceptance in accordance with CW 3510.

E44.6.3 Payment shall be in accordance with the following:

(a) Seventy-five percent (75%) of quantity following supply and placement of sod including topsoil depth as specified in Form B.

(b) Twenty-five percent (25%) of quantity following termination of the thirty (30) day maintenance period before acceptance.

E45. NATURALIZED AREA SEEDING

E45.1 Description

E45.1.1 Further to CW 3520 and CW 3540, this specification shall cover sub-grade preparation and the supply and placement of seed in areas designated to be naturalized.

E45.2 Materials

E45.2.1 Naturalized Area Seed Mix

Common name	**Latin name**	**% by weight**
Northern Wheatgrass	*Agropyron dasystachyum*	8%

Big Bluestem	*Agropyron gerardii*	20%
Western Wheatgrass	*Agropyron smithii*	10%
Slender / Awned Wheat Grass	*Agropyron trachycaulum*	5%
Canada Wildrye	*Elymus canadensis*	15%
Switchgrass	*Panicum virgatum*	8%
Fowl Blue Grass	*Poa palustris*	4%
Green Needle Grass	*Stipa viridula*	30%

E45.2.2 Wet Blend Seed Mix

Common name	**Latin name**	**% by weight**
Fowl blue grass	*Poa palustris*	25%
Ticklegrass	*Agrostis scabra*	20%
Big bluestem	*Agropyron gerardii*	15%
Canada wild rye	*Elymus canadensis*	10%
Tufted hairgrass	*Deschampsia cespitosa*	30%

E45.3 Equipment

E45.3.1 Scarification equipment shall be suitable for the area being scarified, shall be capable of scarifying the sub-grade to the specified depth and shall be accepted by the Contract Administrator. For confined areas a toothed bucket may be acceptable. For larger areas tilling equipment may be required.

E45.4 Construction Methods

E45.4.1 Preparation of Existing Grade

(a) Prior to placing topsoil, in areas to be seeded greater in width than 600 mm, prepare the existing sub-grade by scarifying to a minimum depth of 75 mm and to a maximum depth of 100 mm to the satisfaction of the Contract Administrator.

(b) Scarification shall consist of breaking up and loosening the sub-grade. No scarification shall occur within the edge of a tree canopy (or drip line).

E45.4.2 Placement of Planting Medium

(a) Depth and placement of planting medium to be in accordance with Specification Section E39.

E45.4.3 Rates

(a) Naturalized Area Seed Mix shall be sown at a rate of 1.0 kilograms per 100 square meters.

E45.5 Measurement and Payment

E45.5.1 Seeding

(a) Supply, placement and maintenance of Naturalized Seed Mixes will be paid for at the Contract Unit Price per square metre for the Items of Work listed below, measured as specified herein, which price shall be payment in full for supplying all materials and for completing all operations herein described and all other items incidental to the work included in this Specification.

(b) Items of Work:

(i) Naturalized Area Seeding Mix;

(ii) Wet Blend Seeding Mix.

E45.5.2 Payment for Naturalized Area Seeding shall be in accordance with the following:

(a) Sixty five (65%) percent of quantity following supply and placement.

(b) Remaining thirty five (35%) percent of quantity following termination of the Maintenance Period

STRUCTURAL WORKS

E46. STRUCTURAL EXCAVATION

E46.1 Description

E46.1.1 This Specification covers all operations relating to the following:

(a) Excavation required to construct the Underpass, Retaining walls, and Bridge Rehabilitation Works.

E46.1.2 The Works also include the following items, which are incidental to the Work.

(a) Preparation of the base of excavations.

(b) The design, fabrication, erection, and removal of all temporary shoring, and such temporary protective measures as may be required to construct the Works.

(c) The off-site disposal of surplus and unsuitable material.

(d) Dewatering and or precipitation removal of the excavations as may be required for construction of the structures in the dry.

E46.1.3 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Work as hereinafter specified.

E46.2 Submittals

E46.2.1 The Contractor shall submit to the Contract Administrator for review and approval, at least ten (10) Business Days prior to the commencement of any excavations on the Site the following:

(a) Detailed design calculations and Shop Drawings for all shoring that is signed, sealed, and dated by a Professional Engineer experienced in shoring design and licensed to practice in the Province of Manitoba in accordance with E4 Shop Drawings.

E46.3 Materials and Equipment

E46.3.1 General

(a) Protection

(i) The Contractor shall provide protection to ensure no damage to existing facilities and equipment, including Bell MTS ducts.

(b) Excavation

(i) The Contractor shall be responsible for the supply, safe storage, and handling of all materials as set forth in this Specification. All materials shall be handled in a careful and workmanship-like manner, to the satisfaction of the Contract Administrator.

(ii) All excavated materials shall be subject to inspection and testing by the Contract Administrator or by the Testing Laboratory designated by the Contract Administrator. There shall be no charge to the City for any materials taken by the Contract Administrator for testing purposes.

(iii) Excavated material shall be unclassified excavation and shall include the excavation and satisfactory disposal of all cleared and grubbed materials, earth, gravel, sandstone, loose detached rock, shale, rubbish, cemented gravel

or hard pan, disintegrated stone, rock in ledge or mass formation wet or dry, trees, shrubs, augured material for the vertical drains, abandoned utilities, existing timber or other culverts and structures, or all other material of whatever character which may be encountered.

E46.3.2 Equipment

(a) All equipment shall be of a type acceptable to the Contract Administrator and shall be kept in good working order.

E46.4 Construction Methods

E46.4.1 Excavation

(a) Excavations shall be completed to the elevations required to construct the Works or to such other elevations as may be directed by the Contract Administrator in the field. Excavation sequence shall be done in a “top down” direction, in order to maintain stability. The dimensions of the excavation shall be such as to give sufficient clearances for the construction of forms and their subsequent removal.

(b) All material shall be brought to the surface by approved method, suitable fill material placed on site where required as approved by the Contract Administrator or disposed of away from the site.

(c) After each excavation is completed, the Contractor shall notify the Contract Administrator.

(d) The Contractor shall excavate only material that is necessary for the expeditious construction of the structure or as set out by the Contract Administrator in the field. If the Contract Administrator permits the excavation of existing stock piles, or trenches within the right-of-way, the Contractor shall, on completion of the Work, backfill the trenches to the elevation of the original ground existing at the time of excavation and compact the backfill material, all at their own expense and as directed by the Contract Administrator.

(e) All excess excavated material shall become the property of the Contractor and shall be removed from the site.

(f) During construction the Contractor may be required to dewater excavations. Dewatering of excavations shall be completed in accordance with D21 Water Management Plan.

(g) No measurement and payment of dewatering of excavation will be made and shall be considered incidental to the Work.

E46.5 Measurement and Payment

E46.5.1 Structural Excavation

(a) The excavation required for the construction of Underpass, Retaining Walls, and Bridge Rehabilitation Works will not be measured. They will be paid for at the Contract Lump Sum Price for the “Structural Excavation”, which price will be payment in full for supplying all materials/equipment and performing all operation herein described and all other items incidental to the Work included in this Specification and accepted by the Contract Administrator.

E47. STRUCTURAL BACKFILL

E47.1 Description

E47.1.1 This Specification covers all operations relating to the following:

(a) Backfilling required to construct the Underpass, Retaining Walls, and for Bridge Rehabilitation.

E47.1.2 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all

things necessary for and incidental to the satisfactory performance and completion of all Work as hereinafter specified.

E47.2 Materials

E47.2.1 General

(a) Protection

(i) The Contractor shall provide protection to ensure no damage to existing facilities and equipment, and utilities.

(b) Backfilling

(i) All materials supplied under this Specification shall be subject to inspection and testing by the Contract Administrator or by the Testing Laboratory designated by the Contract Administrator. There shall be no charge to the City for any materials taken by the Contract Administrator for testing purposes.

(ii) All materials shall be accepted by the Contract Administrator at least seven (7) days before any construction is undertaken. If, in the opinion of the Contract Administrator, such materials in whole or in part, do not conform to the Specification detailed herein, or are found to be defective in manufacture, or have become damaged in transit, storage, or handling operations, then such material shall be rejected by the Contract Administrator and replaced by the Contractor at their own expense.

(iii) Backfill materials shall be free of frozen lumps and shall be placed and compacted in an unfrozen state. Backfill shall not be placed on frozen subsoil.

(iv) All granular backfill for the Bridge, Retaining Walls, Underpass including levelling base fill shall be clean and free from organic material and in accordance with CW 2030-R7.

(v) All granular backfill for the Bridge Retaining Walls, Underpass shall be Type 1 Material in accordance with the following gradation requirements:

CANADIAN METRIC SIEVE SIZE	PERCENT PASSING BY WEIGHT
50 000	100
20 000	75 – 100
5 000	45 – 85
2 500	35 – 55
315	15 – 35
160	5 – 20
80	0 – 7

(vi) Non-granular cohesive material shall be highly plastic clay (exhibiting putty-like properties with considerable strength when dry) and non-organic. Material with very high swelling potential such as bentonite clay will not be permitted. When proposed material characteristics are in question, the Contract Administrator may require the Contractor to classify the material using Test Method ASTM D2487 – Classification of Soils for Engineering Purposes. Non-granular cohesive material shall have a minimum Plasticity Index of 40. The non-granular cohesive material shall be free or rocks and stones.

(vii) Excavated material may be used for backfilling provided it meets the above requirements. Excavated granular material intended to be used for backfilling must not be contaminated by top soil or organic materials.

E47.2.2 Equipment

(a) All equipment shall be of a type acceptable to the Contract Administrator and shall be kept in good working order.

E47.3 Construction Methods

E47.3.1 Backfilling

(a) The Contract Administrator shall be notified at least one (1) working day in advance of any backfilling operations. No backfill shall be placed against any concrete until accepted by the Contract Administrator.

(b) All backfill material shall be supplied, placed, and compacted in lifts of 150 mm (maximum) to a minimum of ninety-five percent (95%) of Standard Proctor Dry Density. Lifts shall be brought up on all sides at the same time.

(c) The Contractor shall be required to provide necessary water or equipment during compaction of backfill material to achieve the required densities.

(d) The Standard Proctor Density for granular and clay backfill material shall be determined at the optimum moisture content in accordance with standard laboratory Proctor Compaction Test Procedure.

(e) The field density of the compacted layers shall be verified by Field Density Tests in accordance with ASTM Standard, Test for Density of Soil in Place by the Sand-Cone Method, or equivalent as accepted by the Contract Administrator in accordance with B7 Substitutes.

(f) The frequency and number of tests to be made shall be as determined by the Contract Administrator.

(g) All workmanship and materials furnished and supplied under this Specification are subject to close and systematic inspection and testing by the Contract Administrator including all operations from the selection and production of materials through to final acceptance of the specified Work. The Contractor shall be wholly responsible for the control of all operations incidental thereto notwithstanding any inspection or acceptance that may have previously been given. The Contract Administrator reserves the right to reject any materials or Works which are not in accordance with the requirements of this Specification.

(h) The Contract Administrator shall be allowed free access for the inspection and control testing of constituent materials both at the site of the Work and at any plant used for production of the materials to determine whether the material is being supplied and placed in accordance with this Specification.

(i) Any backfill material that does not meet the gradation and/or compaction requirements of this Specification shall be removed and replaced by the Contractor at their own expense, to the satisfaction of the Contract Administrator.

E47.4 Measurement and Payment

E47.4.1 The backfilling required for the construction of Underpass, Retaining Walls, and Bridge Rehabilitation will not be measured. They will be paid for at the Contract Lump Sum Price for “Structural Backfill”, which price will be payment in full for supplying all materials/equipment and performing all operation herein described and all other items incidental to the Work included in this Specification and accepted by the Contract Administrator.

E48. TEMPORARY SHORING

E48.1 Description

E48.1.1 This Specification shall cover all operations related to the design, supply and installation of a temporary shoring for separating the grades between the different phases of project.

E48.1.2 The work to be done by the Contractor under this Specification shall include the furnishings of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Work as hereinafter specified.

E48.2 Scope of Work

E48.2.1 The design, fabrication, erection, and removal of all temporary shoring, and such temporary protective measures as may be required to construct the Works.

E48.2.2 The Work covered under this item shall include all operations relating to structural excavation, installation, and removal of shoring systems required to construct the Underpass Structure, Bridge Rehabilitation Works and other work as indicated on the Drawings including dewatering procedures for the duration of the construction period as specified herein.

E48.2.3 Completion of the Temporary Shoring will be in accordance with the Construction Phasing Drawings.

E48.2.4 Limits of Work as indicated on the Construction Drawings.

E48.3 General

E48.3.1 The Contractor shall be responsible for design, construction and removal where required of the temporary shoring and is subject to the approval of the Contract Administrator.

E48.4 Submittals

E48.4.1 The Contractor shall prepare the design and drawings, Sealed by a Professional Engineer Registered in the Province of Manitoba for the temporary shoring as shown on the Drawings.

E48.4.2 The design and drawings for the temporary shoring are to be submitted to the Contract Administrator for review a minimum of fourteen (14) days prior the installation of the temporary shoring.

E48.4.3 The Professional Engineer who designed the temporary shoring system shall inspect the temporary shoring system during construction, and certify, in writing to the Contract Administrator, that construction is in conformance with the approved design.

E48.5 Materials

E48.5.1 All materials supplied under this Specification shall be of a type approved by the Contract Administrator, and shall be subject to inspection and testing by the Contract Administrator.

E48.5.2 The Contractor shall be responsible for the supply, safe storage and handling of all materials as set forth in this Specification. All materials shall be handled in a careful and workmanlike manner, to the satisfaction of the Contract Administrator.

E48.6 Measurement and Payment

E48.6.1 Temporary Shoring will not be measured and will be paid for at the Contract Lump Sum Price for “Temporary Shoring,” which price shall be payment in full for performing all operations herein described and all other items incidental to the Work included in this Specification and accepted by the Contract Administrator.

E49. SHEET PILE RETAINING WALL

E49.1 Description

E49.1.1 This Specification covers all operations related to the construction of steel sheet pile retaining walls.

E49.1.2 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Works as hereinafter specified.

E49.2 Submittals

E49.2.1 Certificates

(a) At least two (2) weeks prior to start of pile driving, submit to the Contract Administrator, two (2) copies of steel producer mill test data and certification that steel piling, delivered to job site, meets requirements of this Section and is in accordance with CAN/CSA-G40.20-13.

E49.3 Materials

E49.3.1 The Contractor shall be responsible for the supply, safe storage and handling of all materials set forth in this Specification. All materials supplied under this Specification shall be subject to inspection and acceptance by the Contract Administrator.

E49.3.2 Steel Sheet Piles: To CAN/CSA-G40.21-13 (including chemical and mechanical requirements), Grade 350W, and following:

(a) Continuous interlocking, flat web with minimum web thickness 13.3 mm and minimum mass of 155.4 kg/m^2.

(b) Continuous interlocking (Z) section:

(i) Minimum effective section modulus of 2600 cm^3 per metre of wall.

(ii) Minimum flange thickness of 15.2 mm.

(iii) Minimum web thickness of 13.3 mm.

(c) Sheet Piling: As manufactured by Gerdau, section designation PZC26 or in accordance with B8 by Contract Administrator.

(d) Special Corners: Shop fabricate by welding or provide standard fabricated special corner connectors for type of steel piling supplied.

(e) Interlocks: Section of interlock bar of 1 m minimum length which will pass along full length of pile without binding.

(f) Mark each piece of sheet piling legibly by stencilling or die-and-stamping with the following information:

(i) Heat Number;

(ii) Manufacturer's Name;

(iii) Length and Section Number.

(g) Do not precut lifting or slinging holes in sheet piles.

E49.4 Construction Methods

E49.4.1 Delivery, Handling and Storage

(a) Use slings for lifting piling so that mass is evenly distributed and piling is not subjected to excessive bending stresses.

(b) Store sheet piling on level ground or provide supports so that sheet piling is level when stored. Provide blocking at spacing not exceeding 5 m so that there is no excessive sagging in piling. Overhang at ends not to exceed 0.5 m. Block between lifts directly above blocking in lower lift.

(c) If material is stockpiled on structure, ensure that the structure is not overloaded.

E49.4.2 Installation

(a) Welding to be in accordance with CSA W59-03 except where specified otherwise.

(b) Pile installation is not to commence until all required quality control tests have been completed and test results approved by the Contract Administrator.

(c) For installation of sheet piles, provide installation equipment capable of installing sheet pile to elevations indicated.

(d) Submit full details of method and sequence of installation of piling to Contract Administrator for approval prior to start of pile installation work. Details must include

guide frames and bracing if required, setting and driving sequence and number of piles in panels for driving.

(e) Do not drive sheet piles within a radius of 8 metres of concrete which has been in place for a time shorter than three (3) days unless authorized by the Contract Administrator.

(f) Remove loose and displaced material from around sheet piles after completion of driving, and leave clean, solid surfaces to receive backfill.

(g) Provide sufficient length above cut-off elevation so that part damaged during driving is cut off. Cut off sheet piles neatly and squarely at elevations indicated.

(h) When installation is complete, face of wall at top of sheet piles to be within 25 mm of location as indicated and deviation from batter not to exceed 1 in 100.

(i) If, in the opinion of the Contract Administrator, piles are placed beyond tolerances specified, the Contractor may be required to remove such piles and install new piles to the specified tolerances at his own expense.

(j) Cut weep holes as indicated. Provide filter material in area of weep holes as indicated.

(k) Remove cut-off lengths from site on completion of work.

(l) Drill 50 mm dia. hole through sheet pile to match locations for installation of steel reinforcing bars.

E49.4.3 Obstructions

(a) If an obstruction is encountered during driving, leave obstructed pile and proceed to drive remaining piles. Return and attempt to complete driving of obstructed pile later.

(b) Advise the Contract Administrator immediately if impossible to drive pile to full penetration, and obtain direction from Contract Administrator on further steps required to complete work.

E49.4.4 Cutting

(a) When flame cutting tops of piles and flame cutting weep holes in piles, adopt the following procedure:

(b) When air temperature is above $0^{o}C$, no pre-heat is necessary.

(c) When air temperature is below $0^{o}C$, pre-heat until steel 25 mm on each side of line of cut has reached a temperature very warm to hand (approximately $35^{o}C$). Tempil stocks or temperature indicating crayon marks may be used to measure temperature.

(d) Use torch guiding device to ensure smooth round holes or straight edges.

(e) Make cut smooth and free from notches throughout thickness. If grinding is employed to remove notch or crack, finished radius to be minimum 5 mm.

E49.4.5 Splicing

(a) Use full length piles unless splicing is indicated or unless approved by Contract Administrator.

E49.5 Quality Control

E49.5.1 Source Quality Control: Hot Rolled Steel Sheet Piling

(a) Provide results of tests of sheet piling material to be used on project as follows:

(i) One (1) tension test (and one (1) bend test) from each heat for quantities of finished material less than 50 tonnes.

(ii) Two (2) tension tests (and two (2) bend tests) from each heat for quantities of finished material exceeding 50 tonnes.

(b) Tension tests in accordance with CAN/CSA-G40.20-13; (bend tests in accordance with ASTM-A6/A6M-13).

E49.5.2 Quality Assurance

(a) Inspection and testing of steel sheet piling material to be carried out by testing laboratory designated by the Contract Administrator at any time during the course of the Work.

(b) Materials inspected or tested by the Contract Administrator which fail to meet Contract requirements will be rejected at any time in course of work.

(c) Where tests or inspections by designated testing laboratory reveal work not in accordance with Contract requirements, Contractor to pay costs for additional tests or inspections as Contract Administrator may require to verify acceptability of corrected work.

E49.6 Measurement and Payment

E49.6.1 Supplying and Driving Steel Sheet Piles

(a) Supply and driving of steel sheet piles will not be measured. This Item of Work will be paid for at the Contract Lump Sum Price for "Supply and Drive Steel Sheet Piles," which price shall be payment in full for supplying all materials and for completing all operations herein described and all other items incidental to the Work included in this Specification, accepted and measured by the Contract Administrator.

(b) Splicing of piles shall be incidental to the Works.

E50. SUPPLYING AND PLACING SUBSURFACE DRAINAGE

E50.1 Description

E50.1.1 General

(a) This Specification covers all operations relating to the supply and installation of the subdrain pipe and drain systems located, at each abutment, both sides of underpass and in front of and behind retaining walls (horizontal and vertical), including leads and connections to catch basins.

(b) The Work to be done by the Contractor under this Specification shall include the furnishing of the superintendence, overhead, labour materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Work as hereinafter specified.

E50.2 Material and Equipment

E50.2.1 General

(a) The Contractor shall be responsible for the supply, safe storage and handling of all materials set forth in the Specification. All materials supplied under this Specification shall be subject to inspection and acceptance by the Contract Administrator.

E50.2.2 Drain Pipes, Fittings, and Accessories

(a) Perforated and non-perforated drain pipes, fittings, and other accessories and appurtenances for the superstructure deck and abutment substructure drain pipe system, shall conform to the requirements of the City of Winnipeg Standard Construction Specification CW 3610-R5 and requirements CSA G401-14, for Corrugated Steel Pipe (CSP). Corrugated steel drain pipe shall be perforated and non-perforated, aluminized Type 2, 1.6 mm gauge, complete with filter sock and with the diameter as shown on the Contract Drawings.

(b) All other drain pipes, fittings, and other accessories and appurtenances shall conform to the requirement of Standard Construction Specification CW 2130-R12 and CW3120-R4.

E50.2.3 Drainage Fabric

(a) Drainage fabric shall be in accordance with CW3120-R4 or as accepted by the Contract Administrator in accordance with B7 Substitutes.

E50.2.4 Drainage Material

(a) Drainage material shall be in accordance with Specification CW 3120-R4.

E50.2.5 Equipment

(a) All equipment shall be of a type acceptable to the Contract Administrator and shall be kept in good working order.

E50.3 Construction Methods

E50.3.1 Subdrain Systems

(a) Install a perforated drain pipe system as shown on the Drawings. The supply and installation of this drain pipe system shall include the drain pipe, all required fittings, drain pipe drainage materials, and the filter fabric.

(b) The drain pipe shall be laid to the line and grade shown on the Contract Drawings or as directed by the Contract Administrator with the separate sections securely jointed together by means of tightly drawn coupling bands.

(c) Subdrain Systems in front of the retaining walls must be completely installed and backfilled within two (2) weeks of the initial excavation for the subdrain systems.

(d) Following installation of the vertical drains behind the sheetpile retaining wall and installation of the drain holes in the steel sheetpiles, any existing native material between the drain hole and the vertical drains shall be replaced with Type 1 granular backfill.

(e) The vertical drains behind the retaining walls, drain holes, subdrains in front of the retaining walls, and granular backfill for roadway shoulder construction shall be installed in the same construction season as, and immediately following, the excavation in front of the sheetpile retaining walls.

E50.4 Measurement and Payment

E50.4.1 Subdrain Systems

(a) The supply and installation of the subsurface drainage system will not be measured. This Item of Work will be paid for at the Contract Lump Sum Price for the “Supplying and Placing Subsurface Drainage”, which price shall be payment in full for supplying all materials and for completing all operations herein described and all other items incidental to the work included in this Specification, and accepted by the Contract Administrator.

E51. EROSION CONTROL BLANKET (ECB)

E51.1 Description

E51.1.1 This Specification shall cover the supply, installation, and maintenance of Erosion Control Blanket (ECB), as herein specified.

E51.1.2 The Contractor shall coordinate silt fencing activities with the referenced specifications noted in E1.

E51.1.3 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Works as hereinafter specified.

E51.2 Referenced Specifications and Drawings

(a) The latest edition and subsequent revisions of the following:

(i) ASTM D1117 – Standard Guide for Evaluating Nonwoven Fabrics;

(ii) ASTM D1388 – Standard Test Method for Stiffness of Fabrics;

(iii) ASTM D6525 – Standard Test Method for Measuring Nominal Thickness of Rolled Erosion Control Products;

(iv) ASTM 6818 – Standard Test Method for Ultimate Tensile Properties of Rolled Erosion Control Products;

(v) Erosion Control Technology Council (ECTC) Guidelines.

(b) The following specifications

(i) D17 – Environmental Protection Plan;

(ii) E52– Silt Fence Barrier;

(iii) E63 – Structural Removals.

E51.3 Scope of Work

E51.3.1 The Work under this Specification shall include the following items, to the limits as shown on the Drawings or as otherwise directed by the Contract Administrator:

(a) Supplying and installing erosion control blanket on disturbed slopes and channel banks above riprap limits.

(b) Supplying and temporarily installing erosion control blanket to protect disturbed slopes where sodding and permanent vegetation/restoration is eventually to take place.

(c) Complying with all requirements outlined in D17, “Environmental Protection Plan”.

E51.4 Submittals

E51.4.1 The Contractor shall submit to the Contract Administrator for review and approval, at least ten (10) Business Days prior to the commencement of any scheduled Work on the Site, a proposed schedule, including methods and sequence of operations.

E51.4.2 The Contractor shall submit to the Contract Administrator for review and approval, at least ten (10) Business Days prior to the commencement of any scheduled Work on the Site, the proposed material(s) to undertake the Work. Data submitted shall summarize the physical, mechanical, and chemical characteristics of the material.

E51.5 Materials

E51.5.1 General

(a) All materials supplied under this Specification shall be of a type approved by the Contract Administrator, and shall be subject to inspection and testing by the Contract Administrator.

(b) The Contractor shall be responsible for the supply, safe storage and handling of all materials as set forth in this Specification. All materials shall be handled in a careful and workmanlike manner, to the satisfaction of the Contract Administrator.

E51.5.2 Handling and Storage of Materials

(a) All materials shall be handled and stored in a careful and workmanlike manner, to the satisfaction of the Contract Administrator.

E51.5.3 Erosion Control Blanket

(a) Erosion Control Blanket shall be a machine-produced mat of seventy percent (70%) agricultural straw and thirty percent (30%) coconut blanket with a functional longevity of up to twenty-four (24) months. Suitable products include SC 150 Extended Term manufactured by North American Green, or approved equivalent in accordance with B7“Substitutes”.

(b) The blanket shall be of consistent thickness with the straw and coconut evenly distributed over the entire area of the mat.

(c) The blanket shall be covered on the topside with heavyweight photodegradable polypropylene netting having ultraviolet additives to delay breakdown and a maximum 159 mm x 159 mm mesh and on the bottom side with a lightweight photodegradable

polypropylene netting with a maximum 127 mm x 127 mm mesh. The blanket shall be sewn together on 381 mm centres (maximum) with degradable thread.

(d) Erosion Control Blanket shall have the following properties:

(i) Matrix seventy percent (70%) Straw Fibre (0.19kg/m^2) and thirty percent (30%) Coconut Fibre (0.08kg/ m^2);

(ii) Netting top side heavyweight photodegradable with UV additives (1.47 kg/100 m^2);

(iii) Bottom side lightweight photodegradable minimum netting weight (0.73 kg/100m^2); and

(iv) Degradable thread.

(e) Staples used to secure Erosion Control Blanket shall be as recommended by the Manufacturer.

E51.6 Equipment

E51.6.1 General

(a) All equipment shall be of a type acceptable to the Contract Administrator and shall be kept in good working order.

E51.7 Construction Methods

E51.7.1 General

(a) Erosion Control Blanket shall be placed on all disturbed and exposed slopes for which revegetation is required.

(b) Locations of Erosion Control Blanket will be confirmed on site with the Contract Administrator.

E51.7.2 Erosion Control Blanket Installation

(a) The Erosion Control Blanket shall be rolled out in the direction of the water flow.

(b) The upper edges of the blanket on the side slopes and the edges at the terminal ends of the installation shall be placed in a 150 mm x 150 mm trench.

(c) The upper edges shall be stapled at 1000 mm intervals and the terminal edges shall be stapled at 300 mm intervals within the trench. The trench shall be then be backfilled and compacted. The side and end seams shall be overlapped edge over edge (shingle style) with an overlap of 150 mm. The side seams shall be stapled at 1000 mm intervals and the end seams shall be stapled at 300 mm intervals.

(d) At 10 m intervals, the Contractor shall place a double row of staggered staples to secure the blankets. The staples shall be spaced 100 mm apart. The remainder of the blanket shall be stapled at a rate of four (4) staples per m^2. The blanket may have to be trimmed to size to conform to the area to be covered.

(e) Transverse joints and end seams in the Erosion Control Blanket shall have a minimum overlap of 150 mm and secured with 200 mm staples a maximum of 300 mm apart.

(f) Should the Contract Administrator determine that the Contractor has not installed the Erosion Control Blanket properly or has damaged the blankets from construction activities resulting in sediment releases beyond the Work area; the Contractor shall retrieve all sediment that has left the construction area, to the fullest extent possible, at his own cost. As a minimum, the Contractor shall remove all deltas and sediment deposited in drainage ways and re-grade the areas where sediment removal results in exposed soil. The removal and restoration shall take place within five (5) working days of discovery unless precluded by legal, regulatory, or physical access restraints. If precluded, removal and restoration must take place within five (5) working days of obtaining access. The Contractor is responsible for contacting all local, regional, provincial, and federal authorities before working in surface waters and for obtaining

applicable permits. The Contractor's restoration Work to restore property outside of the designated Work area shall be at his own cost.

E51.7.3 Complying with Environmental Protection Requirements

(a) The Contractor shall be responsible for maintaining sediment control measures at the site to prevent sediment releases into Seine River from areas disturbed as a result of his work during and following construction. Sediment and erosion control measures shall comply with the requirements of D17, “Environmental Protection Plan”.

(b) The Contractor shall monitor his work and implement appropriate sediment control measures as site conditions warrant. Such measures may include installation of silt fences, straw bales, or other measures as required in the event that there is runoff from the site.

(c) The Contractor shall monitor, maintain, repair all sediment control measures until vegetation has re-established in restored areas and there no longer is a potential for sediment releases due to construction.

(d) Disturbed areas shall be restored. Erosion control blankets, as approved by the Contract Administrator, shall be used to control potential erosion of areas where vegetation has been damaged, up until permanent vegetation has been re-established.

E51.8 Quality Control

E51.8.1 Inspection

(a) All workmanship and all materials furnished and supplied under this Specification are subject to close and systematic inspection and testing by the Contract Administrator including all operations from the selection and production of materials through to final acceptance of the specified Work.

(b) The Contractor shall be wholly responsible for the control of all operations incidental thereto, notwithstanding any inspection or acceptance that may have been previously given. The Contract Administrator reserves the right to reject any materials or Works, which are not in accordance with the requirements of this Specification.

E51.9 Measurement and Payment

E51.9.1 Erosion Control Blanket

(a) Supplying and installing erosion control blanket will not be measured shall be paid for at the Contract Lump Sum Price for “Supply and Install Erosion Control Blanket”, performed in accordance with this Specification and accepted by the Contract Administrator, which price shall be paid in full for supplying all materials and for performing all operations herein described and all other items incidental to the Work.

E52. SILT FENCE BARRIER

E52.1 Description

E52.1.1 This Specification shall cover all operations relating to the work necessary for the supply, installation, and maintenance of silt fence barrier, as herein specified.

E52.1.2 The Contractor shall coordinate silt fencing activities with the referenced specifications noted in D17 Environmental Protection Plan.

E52.1.3 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Works as hereinafter specified.

E52.2 Referenced Specifications and Drawings

E52.2.1 The latest edition and subsequent revisions of the following:

(a) ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3);

(b) ASTM D3786 – Standard Test Method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method;

(c) ASTM D4355 – Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus;

(d) ASTM D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity;

(e) ASTM D4533 – Standard Test Method for Trapezoid Tearing Strength of Geotextiles;

(f) ASTM D4632 – Grab Breaking Load and Elongation of Geotextiles;

(g) ASTM D4751 – Standard Test Method for Determining Apparent Opening Size of a Geotextile;

(h) ASTM D4833 – Standard Test Method for Determining Apparent Opening Size of a Geotextile;

(i) CW 3550 – Chain Link and Drift Control Fence.

E52.2.2 The latest version of the City of Winnipeg Standard Construction Specifications

(a) CW 3550 – Chain Link and Drift Control Fence.

E52.3 Scope of Work

E52.3.1 The Work under this Specification shall include the following items, to the limits as shown on the Drawings or as otherwise directed by the Contract Administrator:

(a) Supplying and installing temporary silt fence barrier;

(b) Maintaining silt fence barrier until final site restoration;

(c) Removing silt fence barrier;

(d) Complying with all requirements outlined in D16, “Environmental Protection Plan”.

E52.4 Submittals

E52.4.1 The Contractor shall submit to the Contract Administrator for review and approval, at least ten (10) Business Days prior to the commencement of any scheduled Work on the Site, a proposed schedule, including methods and sequence of operations.

E52.4.2 The Contractor shall submit to the Contract Administrator for review and approval, at least ten (10) Business Days prior to the commencement of any scheduled Work on the Site, the proposed material(s) to undertake the Work. Data submitted shall summarize the physical, mechanical, and chemical characteristics of the material.

E52.5 Materials

E52.5.1 General

(a) All materials supplied under this Specification shall be of a type approved by the Contract Administrator, and shall be subject to inspection and testing by the Contract Administrator.

(b) The Contractor shall be responsible for the supply, safe storage and handling of all materials as set forth in this Specification. All materials shall be handled in a careful and workmanlike manner, to the satisfaction of the Contract Administrator.

E52.5.2 Handling and Storage of Materials

(a) All materials shall be handled and stored in a careful and workmanlike manner, to the satisfaction of the Contract Administrator.

E52.5.3 Fence Posts

(a) Fence posts shall be 38 mm x 38 mm untreated wood posts, 41 mm steel tee posts, or punched steel U posts, minimum length of 1.2 m.

E52.5.4 Filter Fabric

(a) Filter fabric shall be a woven geotextile material specifically designed for a silt fence applications, meeting the following minimum requirements:

Table E52-3: Filter Fabric Requirements

Property	Test Method	Value
Grab Tensile Strength	ASTM D4632	0.55 kN
Grab Tensile Elongation	ASTM D4632	15%
Mullen Burst	ASTM D3786	2060 kPa
Puncture	ASTM D4833	0.285 kN
Trapezoid Tear	ASTM D4533	0.285 kN
UV Resistance	ASTM D4355	80% @ 500 hrs
Apparent Opening Size (AOS)	ASTM D4751	0.60 mm
Flow Rate	ASTM D4491	405 l/min/m^2

b) The fabric shall be inert to commonly encountered soil chemicals, hydrocarbons, mildew and bacteria.

E52.5.5 Wire Mesh

a) Wire mesh shall be galvanized or plain metal with 3.0 mm wire gauge and wire spacing at 150 mm o/c.

E52.5.6 Fencing Material Fasteners

a) Staples or wire ties of sufficient strength and spacing to withstand a 530 N (120 lbf) pull test at any point on the wire mesh.

E52.6 Equipment

E52.6.1 General

a) All equipment shall be of a type acceptable to the Contract Administrator and shall be kept in good working order.

E52.7 Construction Methods

E52.7.1 General

a) Silt fencing which should be installed at the start of the work, shall be installed along areas where there is stripped or exposed soil where run-off would enter the Seine River. Final locations of the silt fence barrier will be dependent upon site conditions and the Contractor's activities and methods, and may require adjustment.

b) Locations of silt fence barrier will be confirmed on site with the Contract Administrator.

c) Work shall be undertaken in accordance with D17, "Environmental Protection Plan" to prevent deleterious substances from entering into Seine River during construction.

E52.7.2 Silt Fence Barrier Installation

a) Excavate a 150 mm x 150 mm anchor trench along alignment of silt fence barrier.

b) Install fence posts in accordance with Manufacturer's recommended installation methods. Fence posts shall be firmly driven into undisturbed soil, or are completely and firmly backfilled if installed via auger methods.

c) Attach wire mesh as support backing for silt fence barrier filter fabric with specified fasteners. Attach silt fence barrier filter fabric on top of wire mesh in similar fashion. Overlap any fence seams (wire mesh or filter fabric) by 450 mm minimum. Ensure that wire mesh and filter fabric are installed on the upslope side of the post and are fully laid within the anchor trench.

d) Install and compact impermeable excavated materials into anchor trench and slope as required. Compact to ninety-five percent (95%) of maximum dry density in accordance with ASTM D-698.

E52.7.3 Silt Fence Barrier Maintenance

a) Silt fence barrier shall be inspected daily and prior to commencing other construction activities.

b) All silt fences shall be inspected immediately after runoff event and at least daily during prolonged rainfall or runoff. Any required repairs shall be made immediately. The silt fence barriers shall be maintained in place, without gaps, and without undermining, so as to prevent sediment passage through and under the barrier. Silt fence barriers shall be maintained vertical without tears and without sagging. Fence posts shall remain upright and shall not be loosely placed into the ground.

c) Accumulated sediment that is 300 mm or greater in depth shall be carefully removed and disposed of offsite without disturbing the silt fence barrier. Accumulated sediment shall also be removed as necessary to perform maintenance repairs. Accumulated sediment shall be removed immediately prior to removal of the silt fence barrier.

E52.7.4 Silt Fence Barrier Removal

a) Remove silt fences following completion of all site construction activities (including final restoration and cleanup) and after installation of all permanent erosion control measures and satisfactory establishment of permanent vegetation.

b) Restore areas disturbed, without releasing any deleterious substances to the adjacent watercourse.

E52.7.5 Complying with Environmental Protection Requirements

a) The Contractor shall be responsible for maintaining sediment control measures at the site to prevent sediment releases into Seine River from areas disturbed as a result of his work during and following construction. Sediment and erosion control measures shall comply with the requirements of D17, “Environmental Protection Plan”.

E52.8 Quality Control

E52.8.1 Inspection

a) All workmanship and all materials furnished and supplied under this Specification are subject to close and systematic inspection and testing by the Contract Administrator including all operations from the selection and production of materials through to final acceptance of the specified Work.

b) The Contractor shall be wholly responsible for the control of all operations incidental thereto, notwithstanding any inspection or acceptance that may have been previously given. The Contract Administrator reserves the right to reject any materials or Works, which are not in accordance with the requirements of this Specification.

E52.9 Measurement and Payment

E52.9.1 Silt Fence Barrier

(a) Supplying, installing, maintaining, and removing silt fence barrier shall not be measured and shall be paid for at the Contract Lump Sum Price for “Supply and Install Silt Fence Barrier”, performed in accordance with this Specification and accepted by the Contract Administrator, which price shall be paid in full for supplying

all materials and for performing all operations herein described and all other items incidental to the Work.

(b) Payment for silt fence barrier shall be based on the following breakdown:

(i) Following supply and installation: Sixty percent (60%)

(ii) Following final removal: Forty percent (40%)

(c) Removal of accumulated sediment from the silt fence shall be considered incidental to the Work and no separate measurement or payment shall be made.

(d) Temporary removal and reinstallation of the silt fence to facilitate other project activities shall be considered incidental to the Work and no separate measurement or payment shall be made.

E53. STRAW WATTLES

E53.1 Description

E53.1.1 This Specification shall cover the supply and installation of straw wattles required as erosion control measures to mitigate any deleterious materials from entering the existing Land Drainage System and river, as herein specified.

E53.2 Materials

E53.2.1 The 300 mm diameter straw roll shall consist of straw or wood fibre that has been compressed and placed onto a biodegradable poly or plastic netting. Stenlog is an approved product. Submit proposed straw wattle data sheet for review and acceptance at least five (5) Working Days prior to installation.

E53.3 Construction Methods

E53.3.1 Install 300 mm Stenlog or other straw wattle sediment control material in accordance with the manufacturer's specifications around all riprap areas related to drainage inlets and outlets, and catch basins within seeded areas.

E53.3.2 Install 300 mm Stenlog or other straw wattle sediment control material in accordance with the manufacturer's specifications wherever the Contract Administrator directs to prevent sediment from entering the river.

E53.3.3 Install straw wattles so that no gaps exist between the soil and the bottom of the wattle, and the ends of adjacent wattles are overlapped 150 mm minimum to prevent water and sediment passing. Achieve a tight seal between the wattle segments.

E53.3.4 Dogleg terminal ends of straw wattle up the slope to prevent channelling of sedimentation.

E53.3.5 Use 300 mm wooden stakes to fasten straw wattle to the soil. Place stakes on each side of the straw wattle, lying across the natural fibre twine, spaced 1200 mm on centre. Leave 30 to 50 mm of wood stake exposed above the wattle.

E53.3.6 Avoid damage to wattles. Damaged areas of wattles should be cut and tied off, then treated as terminal ends.

E53.3.7 At the direction of the Contract Administrator, the straw wattles shall be removed after seeding has established and before the end of the warranty period.

E53.4 Measurement and Payment

E53.4.1 Installation of straw wattles will be considered incidental to the Contract and no separate measurement for payment will be made.

E54. TEMPORARY PRECAST CONCRETE BARRIER

E54.1 Description

(a) This Specification covers the transportation, placement and assembly of precast concrete barriers to the limit shown on the Construction Staging Drawings.

(b) The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Works as hereinafter specified.

E54.2 Scope of Work

(a) The Work under this Specification shall involve:

(i) Transporting (including loading) temporary precast concrete traffic barriers as mentioned in E54.5.1(c) to project site and installation on site;

(ii) Relocating temporary precast concrete barriers on Site between construction phasing as shown on the Drawings;

(iii) Removing from site and transporting (including unloading) temporary precast concrete traffic barriers E54.5.1(c);

(iv) Maintaining the precast concrete traffic barriers in position on site throughout the project as part of his/her overall work and traffic management plans (no additional payment for maintenance).

E54.3 Materials

E54.3.1 General

(a) All materials supplied under this Specification shall be of a type approved by the Contract Administrator, and shall be subject to inspection and testing by the Contract Administrator.

(b) The Contractor shall be responsible for the supply, safe storage and handling of all materials as set forth in this Specification. All materials shall be handled in a careful and workmanlike manner, to the satisfaction of the Contract Administrator.

E54.3.2 Precast Concrete Barriers

(a) The precast concrete barriers will be supplied by the City of Winnipeg Public Works Department And consist of two (2) types of barrier as follows:

(i) Type 1 – Standard Barrier;

(ii) Type 2 – Anchored Barrier.

E54.4 Equipment

E54.4.1 General

(a) All equipment shall be of a type acceptable to the Contract Administrator and shall be kept in good working order.

E54.5 Construction Methods

E54.5.1 Transporting Precast Concrete Barriers

(a) The Contractor shall be responsible for the pickup and delivery of the pre-cast concrete barriers and all applicable components to the site. The Contractor shall supply equipment capable of lifting and loading the barriers at the City yard and safely transporting to, and unloading the barriers at the site. Any damage occurring to the barriers during loading, transporting and unloading shall be repaired at the Contractor's expense.

(b) Prior to leaving the yard the Contractor's personnel shall inspect the barriers in conjunction with City personnel and note any obvious damage. The Contractor shall provide the Contract Administrator with a written description of any damage noted prior to transportation of the barriers.

(c) The City will supply the contractor with all precast concrete barriers required for the project. These barriers will be available to the contractor as specified in bid

opportunity 1104-2017. The Contractor should review this Bid Opportunity and familiarize himself with the pickup and barrier availability requirements.

(d) A minimum of twenty-four (24) hours' notice is required prior to pick up of the barriers. Once the barriers have reached the Site they shall be carefully unloaded, placed and assembled at the locations shown on the Drawings.

E54.5.2 Installation of Precast Concrete Barriers

(a) Precast concrete barriers shall be installed in proper vertical and horizontal alignment and properly connected to the satisfaction of the Contract Administration.

(b) Schedules for installing or removing the precast concrete barriers shall be approved by the Contract Administrator prior to any Work beginning on those items.

(c) Once the concrete section of each barrier has been placed, the Contractor shall anchor the barrier in a manner approved by Contract Administrator. Should there be any missing nuts bolts or washers, the Contractor shall supply new galvanized nuts, bolts and/or washers.

E54.5.3 Maintain and adjust temporary concrete barriers as required through the duration of the Project, the maintenance and adjustment to temporary precast concrete barriers shall be deemed incidental to the Work.

E54.5.4 Relocation of Precast Concrete Barriers

(a) The Contractor shall relocate precast concrete barriers between construction phasing as shown on the Drawings.

E54.5.5 Removal and Transportation of Precast Concrete Barriers

(a) The Contractor shall be responsible for the removal and delivery of the precast concrete barriers and all applicable components from Site. The Contractor shall return all barriers to the City Bridge Yard, as identified in E54.5.1(c). The Contractor shall supply all necessary equipment to unload and return the barriers to their designated locations within the City Bridge Yard. Any damage occurring to the barriers during loading, transporting, and unloading shall be repaired at the Contractor's expense. Any missing items or components originally supplied by the City shall be replaced at the Contractor's expense. Upon return of the barriers, the Contractor's personnel and City's personnel shall inspect and inventory the barriers and all applicable components.

E54.6 Quality Control

E54.6.1 Inspection

(a) All workmanship and materials furnished and supplied under this Specification are subject to the close and systematic inspection by the Contract Administrator including all operations from the selection and production of materials through to final acceptance of the specified Work.

(b) The Contractor shall be wholly responsible for the control of all operations incidental thereto notwithstanding any inspection or approval that may have been previously given. The Contract Administrator reserves the right to reject any materials or works which are not in accordance with the requirements of this Specification.

E54.6.2 Access

(a) The Contractor shall allow the Contract Administrator free access to all parts of the Work at all times. The Contractor shall supply samples to the Contract Administrator or his inspector for testing purposes as required. There will be no charge to the City for samples taken.

E54.7 Measurement and Payment

E54.7.1 Type 1 - Standard Barrier

(a) Transporting, installing, relocating and removal of precast concrete barriers shall be paid for at the Contract Unit Price per unit for "Type 1 - Standard Barrier", measured as specified herein, performed in accordance with this Specification and accepted by the Contract Administrator, which price shall be paid in full for supplying all materials and for performing all operations herein described and all other items incidental to the Work.

E54.7.2 Type 2 - Anchorable Barrier

(a) Transporting, installing, relocating and removal of precast concrete barriers shall be paid for at the Contract Unit Price per unit for "Type 2 - Anchorable Barrier", measured as specified herein, performed in accordance with this Specification and accepted by the Contract Administrator, which price shall be paid in full for supplying all materials and for performing all operations herein described and all other items incidental to the Work.

E55. STRUCTURAL CONCRETE

E55.1 Description

E55.1.1 This Specification shall cover all operations relating to the preparation of Portland Cement structural concrete for, and all concreting operations related to, the construction of structural concrete works as specified herein and as shown on the Drawings.

E55.1.2 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Work as hereinafter specified.

E55.2 Scope of Work

E55.2.1 The Work under this Specification shall include:

(a) Supplying and placing structural concrete for underpass;

(b) Supplying and placing structural concrete for retaining wall;

(c) Supplying and placing structural concrete for abutment wingwalls and maskwalls;

(d) Supplying and placing structural concrete for diaphragms;

(e) Supplying and placing structural concrete for New Deck, this includes delaminated deck soffit zones, full depth over pier diaphragms, full depth at superstructure isolation zone, full depth overhang, full depth sidewalk and partial depth over remaining deck;

(f) Supplying and placing structural concrete for bridge traffic barriers;

(g) Supplying and placing structural concrete for repairs for full depth deck removals (Hydro-demolition Blow-through repairs);

(h) Supplying and placing structural concrete for approach slabs;

(i) Supplying and placing structural concrete for the roadway traffic barriers and footings;

(j) Quality control tests of all concrete supplied.

E55.3 Submittals

E55.3.1 General

(a) The Contractor shall submit to the Contract Administrator for review and approval, at least fourteen (14) Days prior to the commencement of any scheduled Work on the Site, a proposed schedule, including methods and sequence of operations.

(b) The Contractor shall submit to the Contract Administrator for review and approval, at least fourteen (14) Days prior to the commencement of any Work on Site, the proposed materials to be used.

E55.3.2 Concrete Mix Design Requirements

(a) The Contractor shall submit a concrete mix design statement to the Contract Administrator for each of the concrete types specified herein that reflects the specified performance properties of the concrete. The mix design statement shall contain all the information as outlines on the concrete mix design statement as shown on the Manitoba Ready Mix Concrete Association website (www.mrmca.com). In addition, the mix design statement must indicate the expected method of placement (buggies, chute, or pump) methods are to be used, the method of placement must include a clear description of the pumping methods (line, vertical drop, length of hose, etc.).

(b) The Supplier shall submit directly, in confidence, to the City of Winnipeg, the concrete mix designs for each of the concrete types specified herein. The purpose of this confidential submission will be for record keeping purposes and may be used as information related to supplementary testing and investigation of suspected defective concrete. The City of Winnipeg will advise the Supplier if the in information needs to be released to third parties. The concrete mix design shall contain a description of the constituents and proportions, and at the minimum the following:

(i) Cementitious content in kilograms per cubic metre or equivalent units, and type of cementitious materials;

(ii) Designated size, or sizes, of aggregates, and the gradation;

(iii) Aggregate source location(s);

(iv) Weights of aggregates in kilograms per cubic metre or equivalent units. Mass of aggregates is saturated surface dry basis;

(v) Maximum allowable water content in kilograms per cubic metre or equivalent units and the water/cementitious ratio;

(vi) The limits for slump;

(vii) The limits for air content;

(viii) Quantity of other admixtures;

(ix) Certification that all concrete constituents are compatible;

(x) Certification that the concrete mix(es) will meet the specified concrete performance criteria requirements.

(c) The concrete mix design statements must be received by the Contract Administrator a minimum of fourteen (14) days prior to the scheduled commencement of concrete placement for each of the concrete types. The concrete mix designs must be received by the City of Winnipeg a minimum of five (5) Business Days prior to the scheduled commencement of concrete placement for each the concrete types.

(i) The mix design statement shall also include the expected slump measurement for each concrete type. The tolerances for acceptance of slump measurements in the field, by the Contract Administrator, shall be in accordance to CSA A23.1-04 Clause 4.3.2.3.2.

(ii) Any change in the constituent materials of any approved mix design shall require submission of a new concrete mix design statement, mix design, and mix design test data. If, during the progress of the Work, the concrete supplied is found to be unsatisfactory for any reason, including poor workability, the Contract Administrator may require the Contractor to make any necessary adjustments and associated resubmissions.

E55.3.3 Concrete Mix Design Test Data

(a) Concrete

(i) The Contractor shall submit to the Contract Administrator for review and approval, at least twenty (20) Business Days prior to the scheduled commencement of concrete placement, test data showing that the concrete to be supplied will meet the performance criteria stated in this Specification for each concrete type.

(ii) The Contractor shall submit at a minimum, the test data to prove that the minimum compressive strength, flexural strength for Fibre Reinforced Concrete (FRC) only, air content, and slump of the concrete to be supplied meets or

exceeds the performance criteria. In addition, test data shall be submitted to support requirements for post-cracking residual strength index (Ri) and fibre dispersion in accordance with the Canadian Highway Bridge Design Code (CHBDC) CAN/CSA-S6-14, Section 16, Fibre Reinforced Structures, Clause 16.6. Notwithstanding CHBDC Section 16, Clause 16.6, testing for Ri of concrete shall be completed in accordance with E55.7.5(e).

(iii) Testing for air void system shall be completed in accordance with E56.14(c).

(iv) Testing for rapid chloride permeability shall be completed in accordance with E56.14(d).

(v) Testing for flexural strength of concrete reinforced with fibres shall be completed in accordance with ASTM C1609.

(vi) All tests shall be based on the concrete samples taken from the point of discharge into the formwork. For example, at the concrete chute from the delivery truck if being placed by buggies, or at the end of the pump line should the Contractor choose to pump the concrete into place.

E55.3.4 Aggregates

(a) The Contractor shall furnish, in writing to the Contract Administrator for review and approval, at least twenty (20) Business Days prior to the scheduled commencement of concrete placement, the location of the sources where aggregate will be obtained in order that some may be inspected and tentatively accepted by the Contract Administrator. Changes in the source of aggregate supply during the course of the Contract shall not be permitted without notification in writing to and the expressed approval of the Contract Administrator.

(b) The Contractor shall submit to the Contract Administrator for review and approval recent test information on sieve analysis of fine and coarse aggregates in accordance with CSA Standard Test Method A23.2-2A.

(c) The Contractor shall submit to the Contract Administrator for review and approval recent test information on tests for organic impurities in fine aggregates for concrete, in accordance with CSA Standard Test Method A23.2-7A.

(d) The Contractor shall submit to the Contract Administrator for review and approval recent test information on relative density and absorption of coarse aggregate, in accordance with CSA Standard Test Methods A23.2-12A.

(e) The Contractor shall submit to the Contract Administrator for review and approval recent test information on petrographic examination of aggregates for concrete, in accordance with CSA Standard Test Methods A23.2-15A. The purpose of the petrographic analysis is to ensure the aggregates provided are of the highest quality for use in the production of concrete and will produce a durable overlay. An acceptable aggregate will have an excellent rating as judged by an experienced petrographer, with a (weighted) petrographic number typically in the range of 100 to 120.

(f) The Contractor shall submit to the Contract Administrator for review and approval recent test information on resistance to degradation of large-size coarse aggregate by abrasion and impact in the Los Angeles Machine, in accordance with CSA Standard Test Method A23.2-16A.

(g) The Contractor shall submit to the Contract Administrator for review and approval recent test information on potential alkali reactivity of cement aggregate combinations (mortar bar method), in accordance with CSA Standard Test Method A23.2-27A.

E55.3.5 The Contractor shall submit to the Contract Administrator copies of all material quality control test results.

E55.3.6 Notification of Ready Mix Supplier

(a) The Contractor shall submit to the Contract Administrator the name and qualifications of the Ready Mix Concrete Supplier that he is proposing to use, at least twenty (20) Business Days prior to the scheduled commencement of concrete placement. The

Contract Administrator will verify the acceptability of the Supplier and the concrete mix design requirements. Acceptance of the Supplier and the concrete mix design(s) by the Contract Administrator does not relieve or reduce the responsibility of the Contractor or Supplier from the requirements of this Specification.

E55.3.7 Temporary False Work, Formwork and Shoring Works

(a) The Contractor shall submit to the Contract Administrator for review and approval, at least twenty (20) Business Days prior to the scheduled commencement of concrete placement, detailed design calculations and shop drawings for any temporary Works, including falsework, formwork, and shoring, that are sealed, signed and dated by a Professional Engineer licensed to practice in the Province of Manitoba.

(b) Design Requirements

(i) All forms shall be of wood, metal or other materials as approved by the Contract Administrator.

(ii) The falsework, formwork, and shoring for these Works shall be designed by a Professional Engineer registered in the Province of Manitoba. Falsework shall be designed according to the requirements of CSA S269.1, “False Work for Construction Purposes.” The shop drawings shall bear the Professional Engineer's seal. Shop drawings submitted without the seal of a Professional Engineer will be rejected. The submission of such shop drawings to the Contract Administrator shall in no way relieve the Contractor of full responsibility for the safety and structural integrity of the formwork and shoring.

(iii) The falsework, formwork, and shoring for these Works shall be designed to safely support all vertical and lateral loads until such loads can be supported by the concrete all in accordance with CSA Standard CAN/CSA S269.3-M92. All proposed fastening methods to the existing deck superstructure must be submitted to the Contract Administrator for review and approval.

(iv) The loads and lateral pressures outlined in Part 3, Section 102 of "Recommended Practice for Concrete Formwork", (ACI 347) and wind loads as specified by the National Building Code shall be used for design. Additional design considerations concerning factors of safety for formwork elements and allowable settlements outlined in Section 103 of the above reference shall apply.

(v) As a minimum, the following spacing’s shall apply for studding and walers:

- 20 mm plywood: studding 400 mm centre to centre (max);
- walers 760 mm centre to centre (max).

(vi) Forms shall be designed and constructed so that the completed Work will be within minus 3 mm or plus 6 mm of the dimensions shown on the Drawings.

(vii) Formwork shall be designed to provide chamber, where applicable, to maintain the specified tolerance to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete, due to construction loads.

(viii) Slots, recesses, chases, sleeves, inserts, bolts, hangers, and other items shall be accommodated in the design, in coordination and cooperation with the trade concerned. No openings in structural members are to be shown on the shop drawings without the prior written approval of the Contract Administrator.

(ix) Shores shall be designed with positive means of adjustment (jacks or wedges). All settlement shall be taken up before or during concreting as required.

(x) Mud sills of suitable size shall be designed beneath shores, to be bedded in sand or stone, where they would otherwise bear on soil. The soil below shores must be adequately prepared to avoid settlement during or after concreting. Shores must not be placed on frozen ground.

(xi) Shores shall be braced horizontally in two (2) directions and diagonally in the same two (2) vertical planes so that they can safely withstand all dead and moving loads to which they will be subjected.

(xii) All exposed edges shall be chamfered 20 mm unless otherwise noted on the Drawings.

(xiii) Formwork shall be designed to have sufficient strength and rigidity so that the resultant finished concrete conforms to the shapes, lines, and dimensions of the members shown on the Drawings.

(xiv) Forms shall be designed to be sufficiently tight to prevent leakage of grout or cement paste.

(c) Shop drawings shall show design loads, type, and number of equipment to be used for placing the concrete, method of construction, method of removal, type and grade of materials, and any further information that may be required by the Contract Administrator. The Contractor shall not proceed with any Work on site until the shop drawings have been reviewed and approved in writing by the Contract Administrator. Falsework must be designed to carry all loads associated with construction of overhangs including deflection due to dead loads, placement of concrete, hoarding, construction live loads, and any other loads that may occur.

(d) For timber formwork and falsework, the shop drawings shall specify the type and grade of lumber and show the size and spacing of all members. The shop drawings shall also show the type, size and spacing of all ties or other hardware, and the type, size and spacing of all bracing.

E55.3.8 Screed for Deck Slab Concrete

(a) Plans for anchoring support rails shall be submitted to the Contract Administrator for review and acceptance at least fourteen (14) Days prior to the scheduled commencement of concrete placement. The Contract Administrator's written acceptance must be received by the Contractor prior to the installation of any anchorage devices.

E55.3.9 Concrete Deck Slab Pour Sequence and Schedule

(a) The Contractor shall pour the deck slab concrete in accordance with the pour sequence as outlined in the Drawings. Should the Contractor opt to submit an alternate construction pour sequence for the deck slab concrete, the Contractor shall submit the proposed alternate construction pour sequence to the Construction Administrator for review, at least twenty (20) Business Days prior to the scheduled commencement of concrete placement.

(b) The Contractor shall submit to the Contract Administrator for review, at least fourteen (14) Days prior to the placement of concrete, details of the construction joints.

(c) The Contractor shall submit to the Contract Administrator for review and approval, at least fourteen (14) Days prior to scheduled commencement of concrete placement, the proposed concrete placement schedule for all other structural concrete placements of this Specification.

E55.4 Materials

E55.4.1 General

(a) All materials supplied under this Specification shall be of a type approved by the Contract Administrator, and shall be subject to inspection and testing by the Contract Administrator.

(b) The Contractor shall be responsible for the supply, safe storage and handling of all materials as set forth in this Specification. All materials shall be handled in a careful and workmanlike manner, to the satisfaction of the Contract Administrator.

E55.4.2 Handling and Storage of Materials

(a) All materials shall be handled and stored in a careful and workmanship like manner, to the satisfaction of the Contract Administrator. Storage of materials shall be in accordance with CSA Standard CAN/CSA-A23.1-04.

E55.4.3 Concrete

(a) Concrete materials susceptible to frost damage shall be protected from freezing.

(b) Concrete shall have nominal compressive strengths (f'c) and meet the requirements for hardened concrete as specified in the following Table E55-4.

Table E55-4: Requirements for Hardened Concrete

Type of Concrete	Location	Nominal Compressive Strength [MPa]	Class of Exposure	Air Content Category	Max Aggregate Size	Special Requirements	Post Residual Cracking Index
Type 3	Abutment Wingwalls and Maskwall, Underpass Structure, Diaphragms, Deck Slab, Sidewalk Slab, Approach Slabs, Bridge Traffic Barriers, Retaining Wall Coping, Curbs and Roadway Traffic Barriers	35 @ 28 Days	C-1	1	20 mm	Synthetic Fibres	0.15

(c) Design Requirements

(i) The Contractor shall design falsework, formwork and shoring for the new Bridge deck slab overhangs to be released prior to the placement of the deck concrete. The formwork shall not extend beneath the underside of the existing deck.

E55.4.4 Aggregates

(a) General

(i) All aggregates shall be handled to prevent segregation and inclusion of any foreign substances, and to obtain uniformity of materials. The two (2) sizes of coarse and fine aggregates, and aggregates secured from different sources, shall be piled in separate stockpiles. The site of the stockpiles shall be cleaned of all foreign materials and shall be reasonably level and firm or on a built up platform. If the aggregates are placed directly on the ground, material shall not be removed from the stockpile within 150 mm of the ground level. This material shall remain undisturbed to avoid contaminating the aggregate being used with the ground material.

(ii) The potential for deleterious alkali-aggregate reactivity shall be assessed in accordance with CSA A23.2-27A-04. Current (less than eighteen (18) months old) test data evaluating the potential alkali-silica reactivity of aggregates tested in accordance with CSA A23.2-14A-04 or CSA A23.2-25A-04 is required.

(iii) Petrographic analysis when performed shall be in accordance with MTO (Ministry of Transportation Ontario) Lab Test Method LS 609. The (weighted) petrographic number shall not exceed 130.

E55.4.5 Fine Aggregate

(a) Fine aggregate shall meet the grading requirements of CSA A23.1-04, Table 10, FA1, be graded uniformly and not more than three percent (3%) shall pass a 75 um sieve. Fine aggregate shall consist of sand, stone, screenings, other inert materials with similar characteristics or a combination thereof, having clean, hard, strong, durable, uncoated grains free from injurious amounts of dust, lumps, shale, alkali, organic matter, loam or other deleterious substances.

(b) Tests of the fine aggregate shall not exceed the limits for standard requirements prescribed in CSA A23.1-04, Table 12.

E55.4.6 Coarse Aggregate - Standard

(b) The maximum nominal size of coarse aggregate shall be 20 mm and meet the grading requirements of CSA A23.1-04, Table 11, Group I. Coarse aggregate shall be uniformly graded and not more than two percent (2%) shall pass a 75 um sieve.

Coarse aggregate shall consist of crushed stone or gravel or a combination thereof, having hard, strong, durable particles free from elongation, dust, shale, earth, vegetable matter or other injurious substances. Coarse aggregate shall be clean and free from alkali, organic or other deleterious matter; shall have a minimum of two (2) fractured faces; and shall have an absorption not exceeding three percent (3%).

(c) The aggregate retained on the 5 mm sieve shall consist of clean, hard, tough, durable, angular particles with a rough surface texture, and shall be free from organic material, adherent coatings of clay, clay balls, an excess of thin particles or any other extraneous material.

(d) Course aggregate when tested for abrasion in accordance with ASTM C131 shall not have a loss greater than thirty percent (30%).

(e) Tests of the coarse aggregate shall not exceed the limits for standard requirements prescribed in CSA A23.1-04, Table 12, for concrete exposed to freezing and thawing.

E55.4.7 Admixtures

(a) Air-entraining admixtures shall conform to the requirements of ASTM C260.

(b) Chemical admixtures shall conform to the requirements of ASTM C494 or C1017 for flowing concrete.

(c) All admixtures shall be compatible with all other constituents. The addition of calcium chloride, accelerators and air-reducing agents, will not be permitted, unless otherwise approved by the Contract Administrator.

E55.4.8 Cementitious Materials

(a) Cementitious materials shall conform to the requirements of CSA-A3001 and shall be free from lumps.

(b) Should the Contractor choose to include a silica fume admixture in the concrete mix design, the substitution of silica fume shall not exceed eight percent (8%) by mass of cement.

(c) Should the Contractor choose to include fly ash in the concrete mix design, the fly ash shall be Class CI or F and the substitution shall not exceed thirty percent (30%) by mass of cement.

(d) Cementitious materials shall be stored in a suitable weather-tight building that shall protect these materials from dampness and other destructive agents. Cementitious materials that have been stored for a length of time resulting in the hardening, or the formation of lumps, shall not be used in the Work.

E55.4.9 Water

(a) Water to be used for all operations in the Specification, including mixing and curing of concrete or grout, surface texturing operations, and saturating the substrate shall conform to the requirements of CSA A23.1-04 and shall be free of oil, alkali, acidic, organic materials or deleterious substances. The Contractor shall not use water from shallow, stagnant or marshy sources.

E55.4.10 Synthetic Fibres

(a) The synthetic fibres shall consist of one hundred percent (100%) virgin polypropylene or one hundred percent (100%) virgin polylefin as accepted by the Contract Administrator. The dosage shall be designed by the Contractor to meet the requirements for post-cracking residual strength index (Ri) and fibre dispersion in accordance to CHBDC CAN/CSA S6-14, Section 16, Fibre-Reinforced Structures, Clause 16.6. Notwithstanding CHBDC Section 16, Clause 16.6, testing for Ri of concrete shall be completed in accordance with E55.7.5(e).

E55.4.11 Formwork

(a) Formwork materials shall conform to CSA Standard A23.1, and American Concrete Publication SP4, “Formwork for Concrete.”

(b) Form sheeting plywood to be covered with form liner or to be directly in contact with soil shall be exterior Douglas Fir, concrete form grade, conforming to CSA Standard O121-08, a minimum of 20 mm thick.

(c) Where form liner is not being used, form sheeting shall be Douglas Fir, overlay form liner type conforming to CSA Standard O121-08. Approved Manufacturers are "Evans" and "C-Z."

(d) Boards used for formwork shall be fully seasoned and free from defects such as knots, warps, cracks, etc., which may mark the concrete surface.

(e) No formwork accessories will be allowed to be left in place within 50 mm of the surface following form removal.

(f) Items to be left in place, **i.e., within the structural concrete component, but not within the outer 50 mm,** must be made from a non-rusting material or galvanized steel; and they shall not stain, blemish, or spall the concrete surface for the life of the concrete.

(g) Nothwithstanding Clause E55.4.11(f), where the structural concrete component is reinforced with black steel reinforcing (refer to Table E55-4: Requirements for Hardened Concrete for permissible components), the use of black steel formwork accessories will be permitted.

(h) Forms for exposed surfaces that do not require a form liner may be either new plywood or steel as authorized by the Contract Administrator.

(i) Studding shall be spruce or pine and shall have such dimensions and spacing that they shall withstand without distortion all the forces to which the forms shall be subjected.

(j) Walers shall be spruce or pine, with minimum dimensions of 100 mm x 150 mm. Studding shall be spruce or pine, with minimum dimensions of 50 mm x 150 mm.

(k) Stay-in-place formwork or false work is not acceptable and shall not be used by the Contractor unless specifically shown on the Drawings.

E55.4.12 Form Coating

(a) Form coating shall be "Sternson C.R.A." by Sternson, "SCP Strip Ease" by Specialty Construction Products, or equal as accepted by the Contract Administrator, in accordance with B7 Substitutes.

E55.4.13 Permeable Formwork Liner

(a) Formwork liner shall be Texel Drainaform, Hydroform, or equal as accepted by the Contract Administrator, in accordance with B7 Substitutes. This formwork liner shall be used on all exposed substructure and superstructure formed surfaces, except soffit surfaces, or where a normal form finish is specified.

(b) Paper-lined forms shall be used on all soffit surfaces, such as deck slab overhangs. The Contractor shall provide conclusive evidence that the paper-lined form proposed for use will not stain or otherwise blemish the hardened concrete surface.

E55.4.14 Architectural Formwork Liner

(a) The Contractor shall supply and install the architectural concrete finish formwork liner for use at retaining wall cladding and underpass structure as shown on the drawings in accordance with the Manufacturer's recommended procedures. Approved products are Sika Greenstreak concrete form liner No. 454.

E55.4.15 Curing Compound

(a) Curing compounds shall be liquid membrane-forming and conform to the requirements of ASTM Standard C309-98a.

(b) Curing compound for approach slabs and slope paving shall be resin-based and white-pigmented.

(c) WR Meadows 1215 WHITE Pigmented Curing Compound is an approved product, or equal as accepted by the Contract Administrator, in accordance with B7 Substitutes.

E55.4.16 Curing Blankets

(a) Curing blankets for wet curing shall be 100 percent polyester, 3 mm thick, white in colour. An approved product is “Mirafi Geotextile P150”. Alternately, a 10 oz burlap, 5 mil polyethylene, curing blanket white in colour shall be used; “Curelap” manufactured by Midwest Canvas, together with a second layer of burlap, or equal as accepted by the Contract Administrator, in accordance with B7 Substitutes.

E55.4.17 Bonding Agents

(a) Latex Bonding Agent

(i) Latex bonding agent shall be Acryl-Stix, SikaCem 810, or equal as accepted by the Contract Administrator, in accordance with B7 Substitutes. Polyvinyl acetate-based latexes will not be permitted. Planicrete AC by MAPEI is approved for use as a latex bonding agent on concrete greater than twenty-eight (28) days in age.

(b) Bonding Grout

(i) The grout for bonding the new deck slab concrete to the existing concrete deck slab concrete shall be mixed in an agitating hopper slurry pump and shall consist of the following constituents, by weight:

- 1 part water;
- 1 part latex bonding agent;
- 1½ parts Type GUSF Portland cement.

(ii) The consistency of the bonding grout shall be such that it can be brushed on the existing concrete surface in a thin, even coating that will not run or puddle in low spots.

E55.4.18 Epoxy Adhesive

(a) Epoxy adhesive for bonding concrete to steel shall be one (1) of the following approved products: Sternson ST432 or ST433, Dural Duralbond, Capper Capbond E, Sikadur 32 Hi-bond, Concressive 1001 LPL, Meadows Rezi-Weld 1000, or equal as accepted by the Contract Administrator, in accordance with B7 Substitutes.

E55.4.19 Epoxy Grout

(a) Epoxy grout shall be one (1) of the following approved products: Sternson Talygrout 100, Sika Sikadur 42, CPD Epoxy Grout by Specialty Construction Products, Meadows Rezi-Weld EG-96, or equal as accepted by the Contract Administrator, in accordance with B7 Substitutes.

E55.4.20 Cementitious Grout

(a) Cementitous grout shall be nonshrink and nonmetalic. Approved products are Sternson M-bed Standard, Specialty Construction Products CPD Non-Shrink Grout, Sika 212 Non-Shrink Grout, or equal as accepted by the Contract Administrator, in accordance with B7 Substitutes. The minimum compressive strength of the grout at 28 days shall be 40 MPa.

E55.4.21 Patching Mortar

(a) Patching mortar shall be made of the same material and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than 1 part cement to 2 parts sand by damp loose volume. White Portland Cement shall be substituted for a part of the grey Portland Cement on exposed concrete in order to produce a colour matching the colour of the surrounding concrete, as determined by a trial patch. The quantity of mixing water shall be no more than necessary for handling or placing.

E55.4.22 Flexible Joint Sealant

(a) Flexible joint sealant for all horizontal, vertical, and sloping joints shall be guaranteed non-staining, grey polyurethane, accepted by the Contract Administrator and applied in strict accordance with the details shown on the Drawings and the Manufacturer's instructions including appropriate primers if recommended. Approved products are Vulkem 116 by Mameco, Sonolastic NP1 by Sonneborn, Sikaflex-1a by Sika, Bostik 915 by Bostik, or equal as accepted by the Contract Administrator, in accordance with B7 Substitutes.

E55.4.23 Fibre Joint Filler

(a) Fibre joint filler shall be rot-proof and of the preformed, nonextruding, resilient type made with a bituminous fibre such as Flexcell and shall conform to the requirements of ASTM Standard D1751-99 or equal as accepted by the Contract Administrator, in accordance with B7 Substitutes.

E55.4.24 EMSEAL Precompressed Foam Joint Filler

(a) Expansion joint seal shall be EMSEAL BEJS or equivalent as approved by the Contract Administrator to ASTM C711 and ASTM G155-00A.

(b) Sealant system shall be comprised of three (3) components:

(i) Cellular polyurethane foam impregnated with hydrophobic one hundred percent (100%) acrylic, water-based emulsion, factory coated with highway-grade, fuel resistant silicone;

(ii) Field-applied epoxy adhesive primer;

(iii) Field-injected silicone sealant bands.

(c) Impregnation agent to have proven non-migratory characteristics. Silicone coating to be highway-grade, low-modulus, fuel resistant silicone applied to the impregnated foam sealant at a width greater than maximum allowable joint extension and which when cured and compressed will form a bellows. Depth of seal as recommended by manufacturer. BEJS foam seal to be installed into manufacturer's standard field-applied epoxy adhesive. The BEJS SYSTEM is to be installed recessed from the surface such that when the field-applied injection band of silicone is installed between the substrates and the foam-and-silicone-bellows, the system will be ½" (12 mm) down from the substrate surface.

(d) Material shall be capable, as a dual seal, of movements of +50% to -50% (100% total) of nominal material size. Changes in plane and direction shall be executed using factory fabricated "Universal 90" transition assemblies. Transitions shall be warranted to be watertight at inside and outside corners through the full movement capabilities of the product.

(e) All substitute candidates to be certified in writing to be free in composition of any waxes or asphalts, wax compounds or asphalt compounds. All substitute candidates shall be certified in writing to be:

(i) Capable of withstanding sixty-five degrees Celsius (65°C) for three (3) hours while compressed down to the minimum of movement capability dimension of the basis of design product (minus fifty percent (-50%) of normal material size) without evidence of any bleeding of impregnation medium from the material;

(ii) That the same material after the heat stability test will self-expand to the maximum of movement capability dimension of the basis-of-design product (plus fifty percent (-50%) of nominal material size) within twenty-four (24) hours at room temperature twenty degrees Celsius (20°C).

E55.4.25 Low density EVA Foam

(a) Low density ethylene vinyl acetate (EVA) foam shall be supplied and installed to the thicknesses and extents shown on the Drawings. Maximum density of EVA foam shall be 30 kg/m^3. EVA foam shall be of type approved by the Contract Administrator.

(b) Alternatively, low density polyethylene foam may be substituted for EVA foam. The maximum density of polyethylene foam shall be 30 kg/m^3. Low density polyethylene

foam shall be Ethafoam™ 180 by Dow Chemical Company, or equivalent as approved by the Contract Administrator in accordance with B7 Substitutes.

E55.4.26 Extruded Polystyrene Foam

(a) Supply and install extruded polystyrene foam (also known as Styrofoam™) to the thicknesses and extents as shown on the Drawings. Extruded polystyrene foam shall be Styrofoam™ Brand Cladmate™ or equivalents as approved by the Contract Administrator in accordance with B7 Substitutes.

(b) Low density Styrofoam shall be the type accepted by the Contract Administrator, in accordance with B7 Substitutes.

(c) High density Styrofoam shall be expanded polystyrene with a minimum compressive stress of 207 kPa at ten percent (10%) deformation.

(d) Low density Styrofoam shall be the type accepted by the Contract Administrator, in accordance with B7 Substitutes.

E55.4.27 Backup Rod

(a) Backup rod shall be pre-formed compressible polyethylene, urethane, neoprene, or vinyl foam backer road, extruded into a closed cell form and oversized thirty to fifty percent (30 to 50%).

E55.4.28 Screed Bases and Chairs

(a) Screed bases shall be Hilti HAS 304 stainless steel threaded rods, or equal as accepted by the Contract Administrator, in accordance with B7Substitutes.

(b) Screed chairs shall be Mega Screed as supplied by Brock White Canada Company, or equal as accepted by the Contract Administrator, in accordance with B7 Substitutes.

E55.4.29 Stainless Steel Dowels

(a) Traffic barrier dowels shall conform to the requirements of ASTM A 955/A 955M Standard Specification for Deformed and Plain Stainless-Steel Bars for Concrete Reinforcement, as specified in E57.5.3(c).

(b) The dowels shall be fabricated to the details shown on the Drawings.

E55.4.30 Waterstop

(a) The waterstop, as indicated on the Drawings, shall be PVC waterstop conforming to CGSB 41-6P-35M polyvinyl chloride, edges wire looped for tying, or as accepted by the Contract Administrator, in accordance with B7 Substitutes.

(b) Install PVC waterstop in all joints in a continuous manner as show on the Drawings. Install waterstop continuous without displacing reinforcement. But weld splices to manufacturer's directions. Secure in place to prevent dislodgement during placing of concrete.

(c) Tie the waterstop adequately for support in accordance with manufacturer's instruction, but at spacing no greater than 300 mm to ensure proper embedment and to prevent displacement during concrete placement.

(d) No separate measurement or payment will be made for the waterstop as it is considered incidental to the Contract Lump Sum Price for "Supply and Place Structural Concrete (retaining wall cladding joints).

E55.4.31 Dampproofing

(a) Dampproofing materials shall be applied to all buried concrete surfaces in contact with the soil to within 300 mm of Finished Ground Elevation, with the exception of those surfaces cast directly against the soil or in contact with prefabricated drainage composite. Dampproofing materials shall be mineral colloid emulsified asphalt complying with Canadian General Standards Board Specification No. 37.16-M89. Acceptable product is Bakelite/Flintguard 710-11 Foundation Coating as manufactured by Bakor, Elsro Fibrated Foundation Coating, Insulmastic 7103 Fibered Waterproofing,

or equal as accepted by the Contract Administrator, in accordance with B7 Substitutes.

(b) All damaged concrete, including tie holes to be filled with non-shrink grout prior to application of dampproofing.

(c) Primer for dampproofing shall be asphalt primer, penetrating type conforming to CGSB 37-GP-9Ma. Acceptable products are Bakor Penetrating 910-01 Asphalt Primer as manufactured by Bakor Inc., Elsro Asphalt Primer No. 510, Insulmastic 7501 C/B Roof & Foundation Primer, or equal as accepted by the Contract Administrator, in accordance with B7 Substitutes.

E55.4.32 Miscellaneous Materials

(a) Miscellaneous materials shall be of the type specified on the Drawings or as accepted by the Contract Administrator, in accordance with B7 Substitutes.

E55.4.33 Benchmark Plugs

(a) Benchmark plugs shall be supplied by the City of Winnipeg. Installation by the Contractor shall be considered incidental to these Works. Installation locations shall be determined by the Contract Administrator.

E55.5 Equipment

E55.5.1 General

(a) All equipment shall be of a type acceptable to the Contract Administrator and shall be kept in good working order.

E55.5.2 Vibrators

(a) The Contractor shall have sufficient numbers of internal concrete vibrators and experienced operators on site to properly consolidate all concrete in accordance with ACI 309. The type and size of vibrators shall be appropriate for the particular application, the size of the pour, and the amount of reinforcing and shall conform to standard construction procedures.

(b) The Contractor shall have standby vibrators available at all times during the pour.

E55.5.3 Placing and Finishing Equipment for Bridge Deck Concrete, and Approach Slabs

(a) Placing Equipment

(i) Adjacent exposed reinforcing steel shall be adequately protected during concrete placement.

E55.5.4 Screed

(a) The Contractor shall use a mechanical screed to strike the surface of the superstructure deck concrete. However, Contractor may choose to use a mechanical or non-mechanical screed to strike the surface of the sidewalk slab concrete.

(b) The screed shall be constructed to span the full out-to-out width of the bridge deck for concrete placement in one (1) continuous operation.

(c) Screed rails are required and shall be sufficient in number and length to ensure that the concrete cover is maintained and the finished elevation of the deck slab concrete meets the design elevations.

(d) Screed guides shall be placed and fastened in position to ensure finishing of the concrete to the required profile. Supporting rails, upon which the finishing machine travels, shall be placed outside the area to be concreted. Provisions for anchorage of supporting rails shall provide for horizontal and vertical stability; positive anchorage may be required by the Contract Administrator. A hold-down device shot into concrete will not be permitted, unless the concrete is to be subsequently resurfaced.

(e) The mechanical screed on guides or rails shall be supported so that they are completely clear of the finished surface.

(f) Internal vibration of the concrete will be required with mechanical screeding. Care shall be taken not to overwork the concrete surface.

(g) Care shall be taken to ensure that the screed bars are seated uniformly on the screed chairs and that the ends of the screed bars do not overhang the screed chairs by more than 75 mm.

(h) Screed surface touching concrete shall not be made of aluminum (magnesium acceptable).

(i) The supply, setup, operation, and takedown of the screed for deck slab concrete shall be considered incidental to the placement of the deck slab concrete. No separate measurement or payment shall be made for this Work.

E55.5.5 Moveable Work Bridges for Deck Slab Concrete

(a) At least two (2) moveable Work Bridges will be required (one (1) for finishing operations and one (1) for curing operations), independent of the screeding and finishing machines for the deck slab concrete.

(b) These moveable Work Bridges shall travel guided on rails supported clear of the finished structural deck concrete.

(c) The Contractor shall install a sturdy walkway with safety railing on each side of the Work area for the purpose of providing access to the Work Bridge.

(d) The supply, set up, operation, and takedown of the moveable Work Bridges shall be considered incidental to the placement of the Bridge Deck concrete. No separate measurement or payment shall be made for this Work.

E55.5.6 Moveable Deck Hoarding

(a) The moveable deck hoarding shall be constructed on wheels or rollers for ready mobility. Another acceptable method is to have stationary sides, with the roof on wheels or rollers.

(b) The rail system for the movable deck hoarding can be the same rail system used for the screed and the Work Bridges, subject to the approval of the Contract Administrator.

(c) The roof of the hoarding shall be checked for damage and water tested before each concrete pour, and all repairs shall be made, as required, before concrete placing will be allowed to begin.

(d) The hoarding shall not be removed from overtop of a newly completed structural deck without first obtaining permission from the Contract Administrator.

E55.6 Construction Methods

E55.6.1 General

(a) It is intended that this Section cover all construction Work associated with Structural Concreting operations.

(b) Rate of application shall be the rate required to meet the requirements of ASTM C309-98a for the texture of concrete the curing compound is being applied to.

E55.6.2 Temporary False Work, Formwork, and Shoring

(a) Construction Requirements

(i) The Contractor shall construct falsework, formwork and shoring for the new deck slab concrete overhangs strictly in accordance with the accepted shop drawings.

(ii) All forms shall be of wood, metal or other materials as approved by the Contract Administrator.

(iii) The falsework, formwork, and shoring for these Works shall be erected, and braced, as designed, and maintained to safely support all vertical and lateral

loads until such loads can be supported by the concrete. All proposed fastening shall be as shown on the accepted shop drawings.

(iv) Forms shall be constructed and maintained so that the completed Work is within minus 3 mm or plus 6 mm of the dimensions shown on the Drawings.

(v) Formwork shall be cambered, where necessary to maintain the specified tolerance to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete, due to construction loads.

(vi) Slots, recesses, chases, sleeves, inserts, bolts, hangers, and other items shall be formed or set in coordination and cooperation with the trade concerned. No openings shall be made in structural members that are not shown on the shop drawings without the prior written approval of the Contract Administrator.

(vii) Shores shall be provided with positive means of adjustment (jacks or wedges). All settlement shall be taken up before or during concreting as required.

(viii) Mud sills of suitable size shall be provided beneath shores, bedded in sand or stone, where they would otherwise bear on soil. The soil below shores must be adequately prepared to avoid settlement during or after concreting. Shores must not be placed on frozen ground.

(ix) Shores shall be braced horizontally in two (2) directions and diagonally in the same two (2) vertical planes so that they can safely withstand all dead and moving loads to which they will be subjected.

(x) All exposed edges shall be chamfered 20 mm unless otherwise noted on the Drawings.

(xi) Formwork shall have sufficient strength and rigidity so that the resultant finished concrete conforms to the shapes, lines, and dimensions of the members shown on the Drawings.

(xii) Forms shall be constructed so as to be sufficiently tight to prevent leakage of grout or cement paste.

(b) Form panels shall be constructed so that the contact edges are kept flush and aligned.

(c) Forms for the concrete barriers shall be accordingly aligned to each other and to the geometry shown on the Drawings so as to provide a smooth, continuous barrier. Any misalignments in the barrier shall be cause for rejection and removal of same. No snap ties within the barriers shall be placed below 250 mm above the top of the upper lift elevation.

(d) Forms shall be clean before use. Plywood and other wood surfaces shall be sealed against absorption of moisture from the concrete by a field applied form coating or a factory applied liner as accepted by the Contract Administrator.

(e) Where prefabricated panels are used, care shall be taken to ensure that adjacent panels remain flush. Where metal forms are used, all bolts and rivets shall be counter sunk and well ground to provide a smooth, plane surface.

(f) Form accessories to be partially or wholly embedded in the concrete, such as ties and hangers, shall be commercially manufactured types. The portion remaining within the concrete shall leave no metal within 50 mm of the surface when the concrete is exposed to view. Spreader cones on ties shall not exceed 30 mm in diameter. All fittings for metal ties shall be of such design that, upon their removal, the cavities which are left will be of the smallest possible size. Torch cutting of steel hangers and ties will not be permitted. Formwork hangers for exterior surfaces of decks and curbs shall be an acceptable break-back type with surface cone, or removable threaded type. Cavities shall be filled with cement mortar and the surface left sound, smooth, even and **uniform in matching colour of surrounding concrete**.

(g) Formwork shall be constructed to permit easy dismantling and stripping and such that removal will not damage the concrete. Provision shall be made in the formwork for shores to remain undisturbed during stripping where required.

(h) It shall be permissible to use the forms over again where possible to a maximum of three (3) uses, provided they are thoroughly cleaned and in good condition after being

removed from the former portions of the Work. The Contract Administrator shall be the sole judge of their condition and his decision shall be final regarding the use of them again.

(i) Where required by the Contract Administrator, the Contractor shall cast test panels not using less than two (2) panels of representative samples of the forms he proposes for reuse and shall strip them after forty-eight (48) hours for the Contract Administrator to judge the type of surface produced.

(j) All form lumber, studding, ties etc., becomes the property of the Contractor when the Work is finished, and it shall be removed from the concrete and the Site by the Contractor after the concrete is set, incidental to the Work of this Specification, and the entire site shall be left in a neat and clean condition.

E55.6.3 Concrete Construction Joints

(a) Concrete construction joints shall be located only where shown on the Drawings or as otherwise directed in writing by the Contract Administrator. Concrete construction joints shall be formed at right angles to the direction of the main reinforcing steel. All reinforcing steel shall be continuous across the joints.

(b) Forms shall be re-tightened and all reinforcing steel shall be thoroughly cleaned at the joint prior to concreting.

(c) After the forms are stripped off the construction joint, the entire face of the joint, including the reinforcing steel, shall be thoroughly cleaned down to sound concrete and the surface roughened.

(d) Refer to E55.6.15, “Preparation for Concreting Against Hardened Concrete”, for the requirements to prepare the hardened concrete at a construction joint for receiving new concrete.

E55.6.4 Bridge Deck Screeds

(a) Setting Deck Screeds

(i) The Contractor shall adjust screeds to maintain uniform slab thickness. Adjust screed heights to plan elevations or to such other elevation as may be determined by the Contract Administrator in the field. Screed bases will be permitted to be drilled and grouted into existing concrete and shall be adjustable to achieve the required elevations.

(ii) The screed chairs and screed rail supports shall be spaced to prevent deflections of the screed bars or screed rails during screeding operations.

E55.6.5 Concrete Bridge Traffic Barrier Joints

(a) For the joint sealing at all locations, the contractor shall submit shop drawings and his proposed installation procedures to the Contract Administrator for approval fourteen (14) days prior to installation.

(b) The installation of the fibre joint filler and the EMSEAL joint sealing shall be undertaken as shown on the drawings.

(c) EMSEAL joint seals shall not be field spliced except when specifically permitted by the Contract Administrator in writing.

(d) Furnish fibre joint filler for each joint in a single piece for the required depth and width for each joint, unless otherwise approved by the Contract Administrator. If permitted, multiple pieces shall be fastened together for a given joint by butting ends and securing in place by stapling or other positive fastening methods.

(e) The EMSEAL joint sealing at the barrier joints shall be installed as per the Manufacturer’s recommendations.

(f) All joint sealing of Bridge traffic barriers shall take place prior to the installation of the Bituminous Paving.

(g) The supply and installation of EMSEAL joint sealing and fibre joint fillers shall be considered incidental to the Work, and no additional measurement or payment shall be made for this Work.

E55.6.6 Anchor Units for Bridge Traffic Barrier Posts and End Rail Units

(a) All anchor units shall be as specified on the Drawings.

(b) All anchor units shall be held securely in place so as not to become displaced during concrete placement operations.

E55.6.7 Permeable Formwork Liner

(a) Permeable formwork liner shall be used on all exposed surfaces, except on soffit surfaces, or surfaces where a normal an architectural form finish is specified.

(b) The permeable formwork liner shall be used for only one (1) application.

(c) The supply, setup, application, and removal of permeable formwork liner shall be considered incidental to the placement of structural concrete, and no separate measurement or payment shall be made for this Work.

E55.6.8 Architectural Formwork Liner

(a) Architectural formwork liner shall be used at locations shown on the drawings.

(b) The architectural formwork liner shall be replaced after each use unless specifically allowed to be reused by the Manufacturer, as approved by the Contract Administrator.

(c) The supply, setup, installation, and removal of architectural formwork liner shall be considered incidental to the placement of structural concrete, and no separate measurement or payment shall be made for this Work.

E55.6.9 Control Joint Seals

(a) Formed control joints sealant for all horizontal, vertical and sloping joints shall be applied in strict accordance with the details shown on the Drawings and the Manufacturer's instructions including appropriate primers if recommended.

(b) Form control joints shall be thoroughly cleaned before sealing.

E55.6.10 Benchmarks

(a) The Contractor shall install benchmark plugs supplied by the Contract Administrator at such locations on the structure as may be directed by the Contract Administrator.

E55.6.11 Structure Identification Date

(a) The Contractor shall indent into the exposed concrete a structure identification date at such location at the west end of the structure as shown on the Drawings, in accordance with the detail shown on the Drawings, or as otherwise directed by the Contract Administrator.

E55.6.12 Approach Slabs Works

(a) The Contractor shall undertake the approach slab Works, as shown on the Drawings.

E55.6.13 Supply of Structural Concrete

(a) All structural concrete shall be supplied from a plant certified by the Manitoba Ready Mix Concrete Association. The Contractor, upon request from the Contract Administrator, shall furnish proof of this certification.

(b) All mixing of concrete must meet the provisions of CSA A23.1-04, Clause 5.2, Production of Concrete.

(c) Time of Hauling

(i) The maximum time allowed for all types of concrete to be delivered to the Site of the Work, including the time required to discharge, shall not exceed one hundred and twenty (120) minutes after batching. Batching of all types of concrete is considered to occur when any of the mix ingredients are introduced

into the mixer, regardless of whether or not the mixer is revolving. For concrete that includes silica fume and fly ash, this requirement is reduced to ninety (90) minutes.

(ii) Each batch of concrete delivered to the Site shall be accompanied by a time slip issued at the batching plant, bearing the time of batching. In hot or cold weather, or under conditions contributing to quick stiffening of the concrete, a time less than one hundred and twenty (120) and/or ninety (90) minutes may be specified by the Contract Administrator. The Contractor will be informed of this requirement twenty-four (24) hours prior to the scheduled placing of concrete.

(iii) To avoid the reduction of delivery and discharge time in hot weather, the Contractor will be allowed to substitute crushed ice for a portion of the mixing water provided the specified water/cementitious ratio is maintained. All of the ice shall be melted completely before discharging any of the concrete at the delivery point.

(iv) Unless otherwise noted in Table E55-4: Requirements for Hardened Concrete, no retarders shall be used.

(v) The concrete, when discharged from truck mixers or truck agitators, shall be of the consistency and workability required for the job without the use of additional mixing water. If the slump of the concrete is less than that designated by the mix design statement, then water can be added on site provided the additional water meets the requirements of CSA A23.1-04 5.2.4.3.2. If additional water is to be added on site, it must be done under the guidance of the Suppliers' designated quality control person. The Supplier shall certify that the addition of water on site does not change the Mix Design for the concrete supplied. Any other water added to the concrete without such control will be grounds for rejection of the concrete by the Contract Administrator.

(vi) A record of the actual proportions used for each concrete placement shall be kept by the Supplier and a copy of this record shall be submitted to the City upon request.

(d) Delivery of Concrete

(i) The Contractor shall satisfy himself that the Concrete Supplier has sufficient plant capacity and satisfactory transporting equipment to ensure continuous delivery at the rate required. The rate of delivery of concrete during concreting operations shall be such that the development of cold joints will not occur. The methods of delivering and handling the concrete shall facilitate placing with a minimum of rehandling, and without damage to the structure or the concrete.

E55.6.14 Concrete Placement Schedule

(a) The Contractor shall submit to the Contract Administrator the proposed concrete placement schedule for all concrete placements for review and approval. If, in the opinion of the Contract Administrator, the volume of the placement is deemed larger than can be placed with the facilities provided, the Contractor shall either:

(i) Limit the amount to be placed at any time (using adequate construction joints);

(ii) Augment his facilities and Plant in order to complete the proposed placement;

(iii) In the case of continuous placing, provide additional crews and have adequate lighting to provide for proper placing, finishing, curing and inspecting.

(b) The Contractor shall adhere strictly to the concrete placement schedule, as approved by the Contract Administrator.

E55.6.15 Preparation for Concreting Against Hardened Concrete

(a) All hardened concrete against which new concrete is to be placed shall be prepared in the following manner:

(i) Concrete shall be removed to sound concrete or to the limits as shown on the Drawings, whichever is greater. The resulting surface shall be roughened to remove latent cement and miscellaneous debris.

(ii) All existing surfaces and exposed reinforcing steel are to be sandblasted to reveal a clean substrate and kept clean until concrete placement. Sandblasting shall be followed by a high pressure water wash to remove all residues.

(iii) Immediately prior to placing new concrete, bonding grout shall be thoroughly brushed onto the entire surface of the existing hardened concrete in a thin and even coating that will not run or puddle.

(iv) For the Bridge median slab, during concreting of the deck slab, the top surface of the concrete shall be roughened using a small rake running longitudinally between barrier dowels.

E55.6.16 Placing Structural Concrete

(a) General

(i) The Contractor shall notify the Contract Administrator at least one (1) Working Day prior to concrete placement so that an adequate inspection may be made of formwork, shoring, reinforcement, deck joints, mechanical screed setup, movable hoarding, and related Works. No concrete pour shall be scheduled without the prior written approval of the Contract Administrator.

(b) Dry Run for Deck Slab Screed Machine

(i) The Contractor shall conduct a dry run of the screed machine in the presence of the Contract Administrator to verify that the screed supporting rails are properly set to ensure compliance with the specified longitudinal and transverse deck grades. Sufficient screed supporting guide rails to provide the required coverage for the entire pour, as approved by the Contract Administrator, shall be set out and adjusted for height at least one (1) Working Day prior to the proposed pour. The Contract Administrator will verify that the screed machine and screed rails have been adjusted so that the height of the screed above the existing concrete at each point meets the requirements. To confirm the Contractor's adjustments of the machine and screed rails, the screed machine shall be "dry run", and screed clearance measurements taken at each support point by the Contractor. Resetting of the machine and/or screed rails shall be done by the Contractor as required by the Contract Administrator.

(c) Placing Structural Concrete

(i) Placement of deck concrete shall not be permitted when the surface moisture evaporation exceeds 0.75 kg/m2/h. Fog misting is mandatory regardless of drying conditions. The Contractor shall use fog misting operations as accepted by the Contract Administrator.

(ii) The nomograph, Figure D1, Appendix D of CSA Standard A23.1-04 shall be used to estimate surface moisture evaporation rates.

(iii) Equipment for mixing or conveying concrete shall be thoroughly flushed with clean water before and after each pour. Water used for this purpose shall be discharged outside the forms. All equipment and processes are subject to acceptance by the Contract Administrator.

(iv) Concrete shall be conveyed from the mixer to the place of final deposit by methods which will prevent segregation and a marked change in consistency.

(v) Runways for concrete buggies and all pumping equipment shall be supported directly by the formwork and not on reinforcement.

(vi) Before depositing any concrete, all debris shall be removed from the space to be occupied by the concrete, and any mortar splashed upon the reinforcement or forms shall be removed.

(vii) Formwork liners shall be cooled immediately prior to placing concrete by spraying with cold water.

(viii) Placing of concrete, once started, shall be continuous. No concrete shall be placed on concrete which has sufficiently hardened to cause the formation of seams or "cold joints" within the section. If placing must be interrupted,

construction joints shall be located where shown on the Drawings or as accepted by the Contract Administrator.

(ix) Concrete shall be placed as nearly as possible in its final position. Rakes or mechanical vibrators shall not be used to transport concrete.

(x) The maximum free drop of concrete into the forms shall not be greater than 1.5 m, otherwise rubber tubes or pouring ports spaced not more than 1.5 m vertically and 2.5 m horizontally shall be used. The Contractor shall obtain the Contract Administrator's acceptance, prior to pouring concrete, of all placing operations.

(xi) All concrete, during and immediately after depositing, shall be consolidated by mechanical vibrators so that the concrete is thoroughly worked around the reinforcement, around embedded items, and into the corners of forms, eliminating all air or stone pockets which may cause honeycombing, pitting, or planes of weakness. Mechanical vibrators shall have a minimum frequency of 7000 revolutions per minute immersed.

(xii) Vibrators shall be inserted systematically into the concrete at intervals such that the zones of influence of the vibrator overlap (generally 300 mm to 900 mm). Apply the vibrator at any point until the concrete is sufficiently compacted (5 to 15 seconds), but not long enough for segregation to occur. The vibrators shall be inserted vertically and withdrawn out of the concrete slowly. Spare vibrators in good working condition shall be kept on the job site during all placing operations.

(xiii) Concrete shall not be placed during rain or snow unless adequate protection is provided for formwork and concrete surfaces, to the satisfaction of the Contract Administrator.

(xiv) Before any concrete is placed for the approach slabs, or Bridge deck slab, the Contractor shall demonstrate to the satisfaction of the Contract Administrator before each pour that all necessary adjustments have been made to provide the required camber, crown, slab thickness, and concrete cover. This demonstration may be carried out by means of an attachment securely fastened to the finisher's strike-off machine and moving the machine and the strike-off across the deck over the reinforcing steel with a minimum 3 mm clearance between the steel and attachment.

E55.6.17 Finishing of Concrete Surfaces

(a) Finishing Operations for Unformed Surfaces

(i) The Contractor shall ensure that sufficient personnel are provided for the finishing of the slab surfaces. In the event that the depositing, vibrating, and screeding operations progress faster than the concrete finishing, the Contractor shall reduce the rate of concrete placement or cease the depositing of concrete until the exposed area of unfinished concrete has been satisfactorily minimized. The Contract Administrator's judgement in this matter shall be final and binding on the Contractor. All loads of concrete that exceed the one hundred and twenty (120) minute discharge time limit during the delay, while the finishing operations catch up, shall be rejected.

(b) Type 1 Finish – Exposed Formed Surfaces

(i) A permeable formwork liner finish shall be applied to all exposed formed surfaces including all exposed concrete surfaces not included in Type 2, Type 3, Type 4 finishes.

(ii) Exposed surfaces imply all surfaces exposed to view including surfaces to 300 mm below finish grade elevations.

(iii) All surfaces to receive a formwork liner finish shall be formed using an approved permeable formwork liner.

(iv) The surfaces shall be patched as specified in this Specification.

(c) Type 2 Finish – Unformed Surfaces

(i) All unformed concrete surfaces shall be finished as outlined hereinafter.

(ii) Screeding of all unformed concrete surfaces shall be performed by the sawing movement of a straightedge along wood or metal strips or form edges that have been accurately set at required elevations.

(iii) Screeding shall be done on all concrete surfaces as a first step in other finishing operations. Screeding shall be done immediately after the concrete has been vibrated.

(iv) After screeding, the concrete shall not be worked further until ready for floating. Floating shall begin when the water sheen has disappeared. Concrete surfaces after floating shall have a uniform, smooth, granular texture.

(d) Type 3 Finish - Surfaces Below Finished Grade

(i) All surfaces below 300 mm below finished grade except underside of footings shall be patched in accordance with the requirements of Sections E55.4.17, E55.4.18 and E55.6.21 of this Specification.

(ii) All surfaces below 300 mm below finish grade shall receive dampproofing in accordance with E55.4.31 of this Specification.

(e) Working Base Concrete Finish

(i) During placing, concrete working base shall be vibrated, screeded and floated.

(ii) The supply, set up, operation, and finishing of working base concrete shall be considered incidental to the works of this specification, and no separate measurement or payment shall be made for this Work.

E55.6.18 General Curing Requirements

(a) Refer to E55.6.21 for cold weather curing requirements and E55.6.22 of this Specification for hot weather curing requirements.

(b) The use of curing compound shall not be allowed on concrete areas that are to receive additional concrete, dampproofing, a waterproofing membrane, or an asphalt overlay.

(c) Freshly finished concrete shall have either a curing compound applied, or shall be moist cured by immediately applying wet curing blankets to the exposed concrete surface immediately following finishing operations and continuously wetted for at least seven (7) consecutive days thereafter. Construction joints shall be cured by means of wet curing blankets only.

(d) Curing compound shall be applied at the rate required by ASTM P198 for the accepted product. The compound must be applied uniformly and by roller. Spraying of the compound will not be permitted.

(e) Concrete shall be protected from the harmful effects of sunshine, drying winds, surface dripping, running water, vibration, and mechanical shock. No machinery shall travel in the vicinity of freshly placed concrete for a period of twenty-four (24) hours. Concrete shall be protected from freezing until at least twenty-four (24) hours after the end of the curing period.

(f) Changes in temperature of the concrete shall be uniform and gradual and shall not exceed 3ºC in one (1) hour or 20ºC in twenty-four (24) hours.

(g) Care shall be exercised to ensure that the polyester curing blanket is well drained and that it is placed as soon as the surface will support it without deformation. The Contractor shall ensure that water from the polyester curing blankets does not run into areas where concrete placement and finishing operations are underway. If this occurs, concrete placement shall stop until the problem is corrected satisfactory to the Contract Administrator.

(h) Formed surfaces shall receive, immediately after stripping and patching, the same curing as finished surfaces, with the exception of the Bridge deck overhang surfaces.

(i) For curing of barriers, formwork shall remain in place for six (6) consecutive days following concreting. The top surface of the concrete surface shall be moist cured during this timeframe.

E55.6.19 Form Removal

(a) The Contractor shall notify the Contract Administrator at least one (1) Working Day prior to form removal. The Contractor shall not commence any form removal operations without the prior written acceptance of the Contract Administrator.

(b) All forms shall remain in place and the concrete shall not be loaded for a minimum of seven (7) days after initial concrete placement, unless otherwise authorized by the Contract Administrator in writing.

(c) Notwithstanding the above, the minimum strength of in-place concrete prior to removal of vertical forms for deck extensions shall be 25 MPa, with the added provision that the member shall be of sufficient strength to safely carry its own weight, together with super-imposed construction loads. Bridge deck overhang forms shall be loosened before forms are constructed and concrete is placed for bridge traffic barriers. Stripping of these forms shall not be permitted until a concrete strength of 28 MPa has been achieved by the deck slab concrete and the concrete bridge traffic barriers.

(d) Field-cured test specimens representative of the cast-in-place concrete being stripped shall be tested as specified in this Specification to verify the concrete strength.

E55.6.20 Patching of Formed Surfaces

(a) The Contractor shall notify the Contract Administrator at least one (1) Working Day prior to removal of forms. Immediately after forms have been removed and before the Contractor commences any surface finishing or concrete patching operations, all newly exposed concrete surfaces shall be inspected by the Contract Administrator.

(b) Any repair or surface finishing started before this inspection may be rejected and required to be removed.

(c) Patching of formed surfaces shall take place within twenty-four (24) hours of formwork removal.

(d) All formed concrete surfaces shall have bolts, ties, struts, and all other timber or metal parts not specifically required for construction purposes cut back 75 mm from the surface before patching.

(e) Minor surface defects caused by honeycomb, air pockets greater than 5 mm in diameter, voids left by strutting, and tie holes shall be repaired by removing the defective concrete to sound concrete, dampening the area to be patched, then applying bonding grout followed by patching mortar. Bonding grout shall be well brushed onto the area immediately prior to patching. When the bonding grout begins to lose the water sheen, the patching mortar shall be thoroughly trowelled into the repair area to fill all voids. It shall be struck off slightly higher than the adjacent concrete surface and left for one (1) hour before final finishing to facilitate initial shrinkage of the patching mortar. It shall be touched up until it is satisfactory to the Contract Administrator. The patch shall be cured as specified in this Specification. **The final colour shall match the surrounding concrete**.

(f) Concrete shall be cast against forms which will produce plane surfaces with no bulges, indentations, or protuberances other than those shown on the Drawings. All objectionable fins, projections, offsets, streaks, or other surface imperfections on the concrete surface shall be removed by means acceptable to the Contract Administrator. Cement washes of any kind shall not be used.

(g) The arrangement of panel joints shall be kept to a minimum. Panels containing worn edges, patches, or other defects which will impair the texture of concrete surfaces shall not be used.

E55.6.21 Cold Weather Concreting

(a) The requirements of CSA Standard A23.1-04 shall be applied to all concreting operations during cold weather, i.e., if the mean daily temperature falls below five degrees Celsius (5°C) during placing or curing.

E55.6.22 Hot Weather Concreting

(a) General

(i) The requirements of this section shall be applied during hot weather, i.e., air temperatures forecast to go higher than twenty-seven degrees Celsius (27°C) during placing.

(ii) Concrete at discharge shall be at as low a temperature as possible, preferably as low as fifteen degrees Celsius (15°C), but not above 25°C. Concrete containing silica fume shall be between ten degrees Celsius (10°C) minimum and eighteen degrees Celsius (18°C) maximum at discharge. Aggregate stockpiles should be cooled by water sprays and sun shades.

(iii) The Contractor shall use cold water and/or ice in the mix to keep the temperature of the fresh concrete down, if required. Ice may be substituted for a portion of the mixing water; provided it has melted by the time mixing is completed.

(iv) Form and conveying equipment shall be kept as cool as possible before concreting by shading them from the sun, painting their surfaces white and/or the use of water sprays.

(v) Sun shades and wind breaks shall be used as required during placing and finishing.

(vi) Work shall be planned so that concrete can be placed as quickly as possible to avoid "cold joints".

(vii) The Contract Administrator's acceptance is necessary before the Contractor may use admixtures such as retardants to delay setting, or water reducing agents to maintain Workability and strength, and these must appear in the Mix Design Statement submitted to the Contract Administrator.

(viii) Hot weather curing shall follow immediately after the finishing operation.

(b) Hot-Weather Curing

(i) When the air temperature is at or above twenty-five degrees Celsius (25°C), curing shall be accomplished by fog misting and by using saturated absorptive fabric, in order to achieve cooling by evaporation. Note that fog misting is mandatory for all deck slab and median slab pours at all temperatures.

(ii) Mass concrete shall be water cured for the basic curing period when the air temperature is at or above twenty degrees Celsius (20°C), in order to minimize the temperature rise of the concrete.

(c) Job Preparation

(i) When the air temperature is forecast to rise to twenty-five degrees Celsius (25°C) or higher during the placing period, provisions shall be made by the Contractor for protection of the concrete in place from the effects of hot and/or drying weather conditions. Under severe drying conditions, the formwork, reinforcement, and concreting equipment shall be protected from the direct rays of the sun or cooled by mist fogging and evaporation, to the satisfaction of the Contract Administrator.

(d) Concrete Temperature

(i) The temperature of the concrete as placed shall be as low as practicable and in no case greater than the following temperatures, as shown in Table E55-5 “Acceptable Concrete Temperature”, for the indicated size of the concrete section.

Table E55-5: Acceptable Concrete Temperatures

Thickness of Section	Temperature degrees Celsius (°C)	
	Minimum	Maximum
Less than:		
1.0 m	10	27
1.2 m	5	25

E55.6.23 Cleanup

(a) The Contractor shall cleanup equipment and construction debris on at least a daily basis to the satisfaction of the Contract Administrator.

E55.7 Concrete Quality

E55.7.1 Inspection

(a) All workmanship and all materials furnished and supplied under this Specification are subject to close and systematic inspection and testing by the Contract Administrator including all operations from the selection and production of materials through to final acceptance of the specified Work.

(b) The Contractor shall be wholly responsible for the control of all operations incidental thereto, notwithstanding any inspection or acceptance that may have been previously given. The Contract Administrator reserves the right to reject any materials or Works, which are not in accordance with the requirements of this Specification.

(c) Quality Assurance testing shall be undertaken by the Contract Administrator. Quality Control testing shall be undertaken by the Contractor.

E55.7.2 Access

(a) The Contractor shall allow the Contract Administrator free access to all parts of the Work at all times. The Contractor shall supply samples to the Contract Administrator or his inspector for testing purposes as required. There will be no charge to the City for samples taken.

E55.7.3 Materials

(a) All materials supplied under this Specification shall be subject to inspection and testing by the Contract Administrator or by the Quality Assurance Testing Laboratory designated by the Contract Administrator. There shall be no charge to the City of Winnipeg for any materials taken by the Contract Administrator for testing purposes.

(b) All materials shall conform to CSA Standard A23.1-04.

(c) All testing of materials shall conform to CSA Standard A23.2-04.

(d) All materials shall be submitted to the Contract Administrator for acceptance at least twenty (20) Business Days prior to its scheduled incorporation into any construction. If, in the opinion of the Contract Administrator, such materials, in whole or in part, do not conform to the Specifications detailed herein or are found to be defective in manufacture or have become damaged in transit, storage, or handling operations, then such material shall be rejected by the Contract Administrator and replaced by the Contractor at his own expense.

E55.7.4 Quality Assurance and Quality Control

(a) The Contract Administrator shall be afforded full access for the inspection and control and assurance testing of concrete and constituent materials, both at the Site of Work and at any plant used for the production of concrete, to determine whether the concrete is being supplied in accordance with this Specification.

(b) The Contract Administrator reserves the right to reject concrete in the field that does not meet the Specifications.

(c) The Contractor shall provide, without charge, the samples of concrete and the constituent materials required for Quality Assurance tests and provide such assistance and use of tools and construction equipment as is required.

(d) Quality Assurance and control tests will be used to determine the acceptability of the concrete supplied by the Contractor.

(e) The Contractor will be required to undertake Quality Control tests, of all concrete supplied. All test results are to be copied to the Contract Administrator immediately after the tests have been performed.

(f) The frequency and number of concrete Quality Control tests shall be in accordance with the requirements of CSA Standard A23.1-04. An outline of the quality tests is indicated below.

(g) Contract Administrator shall undertake cove meter survey of top of bridge deck and inside face of barriers. Concrete areas with cover not within specified tolerances will be rejected.

E55.7.5 Concrete Testing

(a) Slump tests shall be made in accordance with CSA Standard Test Method A23.2-5C-04, "Slump of Concrete". If the measured slump falls outside the limits in E55.3.2 of this Specification, a second test shall be made. In the event of a second failure, the Contract Administrator reserves the right to refuse the use of the batch of concrete represented.

(b) Air content determinations shall be made in accordance with CSA Standard Test Method A23.2-4C-04, "Air Content of Plastic Concrete by the Pressure Method". If the measured air content falls outside the limits in E55.3.2 of this Specification, a second test shall be made at any time within the specified discharge time limit for the mix. In the event of a second failure, the Contract Administrator reserves the right to reject the batch of concrete represented.

(c) The air-void system shall be proven satisfactory by data from tests performed in accordance with the latest edition and all subsequent revisions of ASTM Standard Test Method C457 for all types of concrete. The spacing factor, as determined on concrete cylinders moulded in accordance with CSA Standard Test Method A23.2-3C, shall be determined prior to the start of construction on cylinders of concrete made with the same materials, mix proportions, and mixing procedures as intended for the project. If deemed necessary by the Contract Administrator to further check the air-void system during construction, testing of cylinders may be from concrete as delivered to the job Site and will be carried out by the Contract Administrator. The concrete will be considered to have a satisfactory air-void system when the average of all tests shows a spacing factor not exceeding 230 microns with no single test greater than 260 microns.

(d) Rapid chloride permeability testing shall be performed in accordance with ASTM C 1202 or CAN/CSA A23.2-23C, with testing performed at 56 days for all types of concrete.

(e) Testing for post-cracking residual strength index (Ri) of FRC shall be conducted at the Contractor’s expense as follows: one (1) set of five (5)concrete beam specimens, 100 mm by 100 mm by 350 mm long, shall be tested to failure using the same test set up in the latest ASTM C1609. The average of the peak loads is the cracking load of the concrete (Pcr), and shall be provided to the Contract Administrator. A second set of five concrete beam specimens shall be tested to failure in accordance with the latest ASTM C1399. The average of the peak loads during the reloading is the post cracking load of the concrete (Ppcr). The Ri is equal to the ratio of Ppcr over Pcr. The Contractor shall submit a summary of the results of all post-cracking residual strength index tests, including all load defection curves. Tests conducted in accordance to the latest ASTM C1399 will be considered invalid by the Contract Administrator if the initial crack in the specimen has occurred after 0.5 mm deflection. Specimens shall be sampled in accordance with E55.7.5(f).

(f) Samples of concrete for test specimens shall be taken in accordance with CSA Standard Test Method CSA-A23.2-1C-04, "Sampling Plastic Concrete".

(g) Test specimens shall be made and cured in accordance with CSA Standard Test Method A23.2-3C-04, "Making and Curing Concrete Compression and Flexure Test Specimens".

(h) Compressive strength tests at twenty-eight (28) days shall be the basis for acceptance of all concrete supplied by the Contractor. For each twenty-eight (28) day strength test, the strength of two (2) companion standard-cured test specimens shall be determined in accordance with CSA Standard Test Method A23.2-9C-04, "Compressive Strength of Cylindrical Concrete Specimens", and the test result shall be the average of the strengths of the two (2) specimens. A compressive strength test at seven (7) days shall be taken, the strength of which will be used only as a preliminary indication of the concrete strength, a strength test being the strength of a single standard cured specimen.

(i) Compressive strength tests on specimens cured under the same conditions as the concrete Works shall be made to check the strength of the in-place concrete so as to determine if the concrete has reached the minimum allowable working compressive strength as specified in Table E55-4 of this Specification and also to check the adequacy of curing and/or cold weather protection. At least two (2) field-cured test specimens shall be taken to verify strength of the in-place concrete. For each field-cured strength test, the strength of field-cured test specimens shall be determined in accordance with CSA Standard Test Method A23.2-9C-04, "Compressive Strength of Cylindrical Concrete Specimens", and the test result shall be the strength of the specimen.

E55.7.6 Corrective Action

(a) If the results of the tests indicate that the concrete is not of the specified quality, the Contract Administrator shall have the right to implement additional testing, as required, to further evaluate the concrete, at the Contractor's expense. The Contractor shall, at his own expense, correct such Work or replace such materials found to be defective under this Specification in an acceptable manner to the satisfaction of the Contract Administrator.

E55.8 Measurement and Payment

E55.8.1 Supplying and placing structural concrete will not be measured. This Work shall be paid for at the Contract Lump Sum Price for the “Items of Work” listed here below, which price shall be payment in full for supplying all materials and for performing all operations herein described and all other items incidental to the Work included in this Specification and accepted by the Contract Administrator.

E55.8.2 Items of Work:

(a) Supply and Place Structural Concrete:

(i) Bridge Rehabilitation;

- Abutment Wingwall Repairs;
- Diaphragms;
- New Deck Concrete;
- Approach Slabs;
- Traffic Barriers.

(ii) Pedestrian-Cyclist Underpass;

- Underpass Structure;
- Traffic Barrier Footing;
- Traffic Barrier.

(iii) Retaining Walls;

- Cladding;

- Coping ;
- Traffic Barrier Footing;
- Traffic Barrier.

E55.8.3 Supplying and placing structural concrete for Hydro-demolition Blow-through Repairs will be measured on square meter bases for additional bridge deck depth from bottom of the deck to the intended depth of hydrodemolition. This Work shall be paid for at the Contract Unit Price per square meter for the "Hydro-demolition Blow-through Repairs" under "Supply and Place Structural Concrete", which price shall be payment in full for supplying and installing formwork, supplying all materials and for performing all operations herein described and all other items incidental to the Work included in this Specification, accepted and measured by the Contract Administrator.

E55.8.4 Supplying and installing all the listed materials, concrete design requirements, equipment, construction methods, and quality control measures associated with this Specification and Drawings shall be considered incidental to "Supply and Place Structural Concrete", unless otherwise noted herein. No measurement or payment shall be made for this Work unless indicated otherwise.

E55.8.5 Moveable Deck and Approach Slab Hoarding

(a) Supplying, setting up, operating, and removing of the moveable deck hoarding will not be measured and will be paid for at the Contract Lump Sum Price for "Supply and Install Moveable Hoarding", which price shall be payment in full for supplying all materials and for performing all operations herein described and all other items incidental to the Work included in this Specification and accepted by the Contract Administrator.

E56. SELF COMPACTING CONCRETE

E56.1 Description

E56.1.1 This Specification shall cover all operations relating to the preparation of self-compacting concrete for, and all concreting operations related to, the construction of concrete works as specified herein and as shown on the Drawings.

E56.1.2 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all work as hereinafter specified.

E56.2 Referenced Specifications and Drawings

E56.2.1 The latest edition and subsequent revisions of the following:

a) ACI 309 – Guide for Consolidation of Concrete;
b) ACI 347 – Guide to Formwork for Concrete;
c) American Concrete Publication SP4 – Formwork for Concrete;
d) ASTM A780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings;
e) ASTM C131 – Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine;
f) ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete;
g) ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete;
h) ASTM C457 – Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete;
i) ASTM C494 – Standard Specification for Chemical Admixtures for Concrete;
j) ASTM C1017 – Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete;

k) ASTM C1202 – Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration;

l) ASTM C1399 – Standard Test Method for Obtaining Average Residual-Strength of Fibre-Reinforced Concrete;

m) ASTM C1609 – Standard Test Method for Flexural Performance of Fibre-Reinforced Concrete (Using Beam with Third Point Loading);

n) ASTM D1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types);

o) CAN/CSA A23.1/A23.2 – Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete;

p) CAN/CSA A3001 – Cementitious Materials for Use in Concrete;

q) CAN/CSA G40.21 – General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel;

r) CAN/CSA G164-M92 – Hot Dip Galvanizing of Irregularly Shaped Articles;

s) CAN/CSA O121 – Douglas Fir Plywood;

t) CAN/CSA-S6 – Canadian Highway Bridge Design Code;

u) CAN/CSA S269.1 – False Work for Construction Purposes;

v) CAN/CSA S269.3 – Concrete Formwork;

w) ICRI Guideline No. 03732 – Selecting and Specifying Concrete Surface Preparation for Coatings, Sealers, and Polymer Overlays;

x) Ministry of Transportation Ontario MTO Lab Test Method LS 609 – Petrographic Analysis of Coarse Aggregate;

y) Ontario Provincial Standard Specification OPSS 1010 – Material Specification for Aggregates – Base, Subbase, Select Subgrade, and Backfill Material;

z) SSPC-SP6/NACE No.3 Commercial Blast Cleaning.

E56.3 Scope of Work

E56.3.1 The Work under this Specification shall involve the following concrete Works:

a) Abutment pilecap refacing concrete Works as shown on the Drawings;

b) Retaining Wall cladding;

c) Quality Control and Quality Assurance testing, including retention of a third-party testing company, acceptable to the Contract Administrator, retained and paid for by the Contractor. Quality Control testing shall be undertaken by the Contractor.

E56.4 Submittals

E56.4.1 General

(a) The Contractor shall submit to the Contract Administrator for review and approval, at least ten (10) Business Days prior to the commencement of any scheduled Work on the Site, a proposed schedule, including methods, material and sequence of operations.

E56.5 Concrete Mix Design Test Data

E56.5.1 Concrete

a) The Contractor shall submit to the Contract Administrator for review and approval, at least twenty (20) Business Days prior to the scheduled commencement of concrete placement, test data showing that the concrete to be supplied will meet the performance criteria stated in this Specification for each concrete type.

b) The Contractor shall submit to the Contract Administrator copies of all material quality control test results.

E56.5.2 Notification of Ready Mix Supplier

(a) The Contractor shall submit to the Contract Administrator the name and qualifications of the Ready Mix Concrete Supplier that he is proposing to use, at least twenty (20) Business Days prior to the scheduled commencement of concrete placement. The Contract Administrator will verify the acceptability of the Supplier and the concrete mix design requirements. Acceptance of the Supplier and the concrete mix design(s) by the Contract Administrator does not relieve or reduce the responsibility of the Contractor or Supplier from the requirements of this Specification.

E56.5.3 Temporary False Work, Formwork and Shoring Works

(a) The Contractor shall submit to the Contract Administrator for review and approval, at least ten (10) Business Days prior to the scheduled erection of Temporary False Work, Formwork, and Shoring Works, Shop Drawings for any temporary Works, including false work, formwork, and shoring, that are sealed, signed and dated by a Professional Engineer licensed to practice in the Province of Manitoba.

(b) Design Requirements

(i) All forms shall be of wood, metal or other materials as approved by the Contract Administrator.

(ii) The false work, formwork, and shoring for these Works shall be designed by a Professional Engineer registered in the Province of Manitoba. False work shall be designed according to the requirements of the requirements of the CAN/CSA S269.1. The Shop Drawings shall bear the Professional Engineer's seal. Shop Drawings submitted without the seal of a Professional Engineer will be rejected. The submission of such Shop Drawings to the Contract Administrator shall in no way relieve the Contractor of full responsibility for the safety and structural integrity of the formwork and shoring.

(iii) The false work, formwork, and shoring for these Works shall be designed to safely support all vertical and lateral loads until such loads can be supported by the concrete all in accordance with the requirements of CAN/CSA S269.3. All proposed fastening methods to the existing structure must be submitted to the Contract Administrator for review and approval. Drilling into the precast concrete girders will not be accepted.

(iv) The loads and lateral pressures outlined in Part 3, Section 102 of ACI 347 and wind loads as specified by the Manitoba Building Code shall be used for design and the formwork design must be calculated to resist at least the full hydrostatic concrete pressure. Additional design considerations concerning factors of safety for formwork elements and allowable settlements outlined in Section 103 of the above reference shall apply.

(v) As a minimum, the following spacing's shall apply, for studding and waling:

- 20 mm plywood: studding 400 mm centre to centre (max);
- Walers 760 mm centre to centre (max).

(vi) Forms shall be designed and constructed so that the completed Work will be within minus 3 mm or plus 6 mm of the dimensions shown on the Drawings.

(vii) Formwork shall be designed to provide camber, where applicable, to maintain the specified tolerance to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete, due to construction loads.

(viii) Slots, recesses, chases, sleeves, inserts, bolts, hangers, and other items shall be accommodated in the design, in coordination and cooperation with the trade concerned. No openings in structural members are to be shown on the Shop Drawings without the prior written approval of the Contract Administrator.

(ix) Shores shall be designed with positive means of adjustment (jacks or wedges). All settlement shall be taken up before or during concreting as required.

(x) Mud sills of suitable size shall be designed beneath shores, to be bedded in sand or stone, where they would otherwise bear on soil. The soil below shores must be adequately prepared to avoid settlement during or after concreting. Shores must not be placed on frozen ground.

(xi) Shores shall be braced horizontally in two (2) directions and diagonally in the same two (2) vertical planes so that they can safely withstand all dead and moving loads to which they will be subjected.

(xii) All exposed edges shall be chamfered 20 mm unless otherwise noted on the Drawings.

(xiii) Formwork shall be designed to have sufficient strength and rigidity so that the resultant finished concrete conforms to the shapes, lines, and dimensions of the members shown on the Drawings.

(xiv) Forms shall be designed to be sufficiently tight to prevent leakage of grout or cement paste.

(c) Shop Drawings shall show design loads, type, and number of equipment to be used for placing the concrete, method of construction, method of removal, type and grade of materials, and any further information that may be required by the Contract Administrator. The Contractor shall not proceed with any Work on site until the Shop Drawings have been reviewed and approved in writing by the Contract Administrator. False work must be designed to carry all loads associated with construction of overhangs including deflection due to dead loads, placement of concrete, hoarding, construction live loads, and any other loads that may occur.

(d) For timber formwork and false work, the Shop Drawings shall specify the type and grade of lumber and show the size and spacing of all members. The Shop Drawings shall also show the type, size and spacing of all ties or other hardware, and the type, size and spacing of all bracing.

E56.6 Materials

E56.6.1 General

(a) All materials supplied under this Specification shall be of a type approved by the Contract Administrator, and shall be subject to inspection and testing by the Contract Administrator.

(b) The Contractor shall be responsible for the supply, safe storage and handling of all materials as set forth in this Specification. All materials shall be handled in a careful and workmanlike manner, to the satisfaction of the Contract Administrator.

E56.6.2 Handling and Storage of Materials

(a) All materials shall be handled and stored in a careful and workmanlike manner, to the satisfaction of the Contract Administrator. Storage of materials shall be in accordance with the latest edition and all subsequent revisions of CAN/CSA-A23.1.

E56.6.3 Concrete

(a) Concrete materials susceptible to frost damage shall be protected from freezing.

(b) Concrete shall be Agilia Vertical, LaFarge North America, proprietary ready-mix concrete, or accepted equal and meet the requirements for hardened concrete as specified in the following Table E56-6.

Table E56-6: Concrete Mix Design Requirements

Type of Concrete	Location	Nominal Compressive Strength MPa	Class of Exposure	Air Content Category	Max Aggregate Size	Special Requirements	Slump-Flow
Type 2	Retaining Wall Cladding, Abutment Cap Resurfacing	35 @ 28 Days	C-1	1	10 mm	Self-Compacting Concrete 28-Day Moist Cured Electrical Resistivity < 15,000 ohm-cm Low-Shrinkage Concrete according to the definition of CAN/CSA- A23.1, Clause 8.9.2	550-650 mm

E56.6.4 Formwork

(a) Formwork materials shall conform to CAN/CSA A23.1, and American Concrete Publication SP4, “Formwork for Concrete.”

(b) Form sheeting plywood to be covered with form liner or to be directly in contact with soil shall be exterior Douglas Fir, concrete form grade, conforming to CSA Standard O121-M1978, a minimum of 20 mm thick.

(c) Where form liner is not being used, form sheeting shall be Douglas Fir, overlay form liner type conforming to CAN/CSA “O121”. Approved Manufacturers are “Evans” and “C-Z.”

(d) Boards used for formwork shall be fully seasoned and free from defects such as knots, warps, cracks, etc., which may mark the concrete surface.

(e) No formwork accessories will be allowed to be left in place within 50 mm of the surface following form removal. Items to be left in place must be made from a non-rusting material or galvanized steel; and they shall not stain, blemish, or spall the concrete surface for the life of the concrete.

(f) Forms for exposed surfaces that do not require a form liner may be either new plywood or steel as authorized by the Contract Administrator.

(g) Studding shall be spruce or pine and shall have such dimensions and spacing that they shall withstand without distortion all the forces to which the forms shall be subjected.

(h) Walers shall be spruce or pine, with minimum dimensions of 100 mm x 150 mm. Studding shall be spruce or pine, with minimum dimensions of 50 mm x 150 mm.

(i) Stay-in-place formwork or false work is not acceptable and shall not be used by the Contractor unless specifically shown on the Drawings.

E56.6.5 Form Coating

(a) Form coating shall be "Sternson C.R.A." by Sternson, "SCP Strip Ease" by Specialty Construction Products, or equal as accepted by the Contract Administrator, in accordance with B7, “Substitutes”.

E56.6.6 Permeable Formwork Liner

(a) Formwork liner shall be Texel Drainaform, Hydroform, or equal as accepted by the Contract Administrator, in accordance with B7, “Substitutes”. This formwork liner shall be used on all formed surfaces.

E56.6.7 Patching Mortar

(a) Patching mortar shall be made of the same material and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than one (1) part cement to two (2) parts sand by damp loose volume. White Portland Cement shall be substituted for a part of the grey Portland Cement on exposed concrete in order to produce a colour matching the colour of the surrounding concrete, as determined by a trial patch. The quantity of mixing water shall be no more than necessary for handling or placing.

E56.6.8 Flexible Joint Sealant

(a) Flexible joint sealant for all horizontal, vertical, and sloping joints shall be guaranteed non-staining, grey polyurethane , accepted by the Contract Administrator and applied in strict accordance with the details shown on the Drawings and the Manufacturer's instructions including appropriate primers if recommended. Approved products are Vulkem 116 by Mameco, Sonolastic NP1 by Sonneborn, Sikaflex-1a by Sika, Bostik 915 by Bostik , or equal as accepted by the Contract Administrator, in accordance with B7, “Substitutes”.

E56.6.9 Fibre Joint Filler

(a) Fibre joint filler shall be rot-proof and of the preformed, nonextruding, resilient type made with a bituminous fibre such as Flexcell and shall conform to the requirements of ASTM D1751 or equal as accepted by the Contract Administrator, in accordance with B7, “Substitutes ”.

E56.6.10 Backup Rod

(a) Backup rod shall be preformed compressible polyethylene, urethane, neoprene, or vinyl foam backer road, extruded into a closed cell form and oversized thirty to fifty percent (30 to 50%).

E56.6.11 Miscellaneous Materials

(a) Miscellaneous materials shall be of the type specified on the Drawings or as accepted by the Contract Administrator, in accordance with B7, “Substitutes ”.

E56.7 Equipment

E56.7.1 General

(a) All equipment shall be of a type acceptable to the Contract Administrator and shall be kept in good working order.

E56.8 Construction Methods

E56.8.1 General

(a) It is intended that this Section cover all construction Work associated with Structural Concreting operations.

(b) Rate of application shall be the rate required to meet the requirements of ASTM C309 for the texture of concrete the curing compound is being applied to.

E56.8.2 Temporary False Work, Formwork, and Shoring

(a) Construction Requirements

(i) The Contractor shall construct false work, formwork and shoring strictly in accordance with the accepted Shop Drawings.

(ii) The false work, formwork, and shoring for these Works shall be erected, and braced, as designed, and maintained to safely support all vertical and lateral

loads until such loads can be supported by the concrete. All proposed fastening shall be as shown on the accepted Shop Drawings.

(iii) Forms shall be constructed and maintained so that the completed Work is within minus 3 mm or plus 6 mm of the dimensions shown on the Drawings.

(iv) Formwork shall be cambered, where necessary to maintain the specified tolerance to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete, due to construction loads.

(v) Slots, recesses, chases, sleeves, inserts, bolts, hangers, and other items shall be formed or set in coordination and cooperation with the trade concerned. No openings shall be made in structural members that are not shown on the Shop Drawings without the prior written approval of the Contract Administrator.

(vi) Shores shall be provided with positive means of adjustment (jacks or wedges). All settlement shall be taken up before or during concreting as required.

(vii) Mud sills of suitable size shall be provided beneath shores, bedded in sand or stone, where they would otherwise bear on soil. The soil below shores must be adequately prepared to avoid settlement during or after concreting. Shores must not be placed on frozen ground.

(viii) Shores shall be braced horizontally in two (2) directions and diagonally in the same two (2) vertical planes so that they can safely withstand all dead and moving loads to which they will be subjected.

(ix) All exposed edges shall be chamfered 20 mm unless otherwise noted on the Drawings.

(x) Formwork shall have sufficient strength and rigidity so that the resultant finished concrete conforms to the shapes, lines, and dimensions of the members shown on the Drawings.

(xi) Forms shall be constructed so as to be sufficiently tight to prevent leakage of grout or cement paste.

(b) Form panels shall be constructed so that the contact edges are kept flush and aligned.

(c) Forms for the concrete barriers shall be accordingly aligned to each other and to the geometry shown on the Drawings so as to provide a smooth, continuous barrier. Any misalignments in the barrier shall be cause for rejection and removal of same.

(d) Forms shall be clean before use. Plywood and other wood surfaces shall be sealed against absorption of moisture from the concrete by a field applied form coating or a factory applied liner as accepted by the Contract Administrator.

(e) Where prefabricated panels are used, care shall be taken to ensure that adjacent panels remain flush. Where metal forms are used, all bolts and rivets shall be counter sunk and well ground to provide a smooth, plane surface.

(f) Form accessories to be partially or wholly embedded in the concrete, such as ties and hangers, shall be commercially manufactured types. The portion remaining within the concrete shall leave no metal within 50 mm of the surface when the concrete is exposed to view. Spreader cones on ties shall not exceed 30 mm in diameter. All fittings for metal ties shall be of such design that, upon their removal, the cavities which are left will be of the smallest possible size. Torch cutting of steel hangers and ties will not be permitted. Formwork hangers for exterior surfaces of decks and curbs shall be an acceptable break-back type with surface cone, or removable threaded type. Cavities shall be filled with cement mortar and the surface left sound, smooth, even and uniform in colour.

(g) Formwork shall be constructed to permit easy dismantling and stripping and such that removal will not damage the concrete. Provision shall be made in the formwork for shores to remain undisturbed during stripping where required.

(h) It shall be permissible to use the forms over again where possible to a maximum of three uses, provided they are thoroughly cleaned and in good condition after being removed from the former portions of the Work. The Contract Administrator shall be the

sole judge of their condition and his decision shall be final regarding the use of them again.

(i) Where required by the Contract Administrator, the Contractor shall cast test panels not using less than two (2) panels of representative samples of the forms he proposes for reuse and shall strip them after forty-eight (48) hours for the Contract Administrator to judge the type of surface produced.

(j) All form lumber, studding, etc., becomes the property of the Contractor when the Work is finished, and it shall be removed from the concrete and the site by the Contractor after the concrete is set, incidental to the Work of this Specification, and the entire site shall be left in a neat and clean condition.

E56.8.3 Concrete Construction Joints

(a) Concrete construction joints shall be located only where shown on the Drawings or as otherwise directed in writing by the Contract Administrator. Concrete construction joints shall be formed at right angles to the direction of the main reinforcing steel. All reinforcing steel shall be continuous across the joints.

(b) Forms shall be re-tightened and all reinforcing steel shall be thoroughly cleaned at the joint prior to concreting.

(c) After the forms are stripped off the construction joint, the entire face of the joint, including the reinforcing steel, shall be thoroughly cleaned down to sound concrete and the surface roughened.

(d) Refer to, E56.8.6, “Preparation for Concreting Against Hardened Concrete”, for the requirements to prepare the hardened concrete at a construction joint for receiving new concrete.

E56.8.4 Permeable Formwork Liner

(a) Permeable formwork liner shall be installed according to the manufacturer’s instructions. The Contractor shall ensure the linear is free of folds, bends, or wrinkles that would create a non-uniform surface finish.

(b) The permeable formwork liner shall be used for only one (1) application.

(c) The supply, setup, application, and removal of permeable formwork liner shall be considered incidental to the placement of structural concrete, and no separate measurement or payment shall be made for this Work.

E56.8.5 Supply of Concrete

(a) All concrete shall be supplied from a plant certified by the Manitoba Ready Mix Concrete Association. The Contractor, upon request from the Contract Administrator, shall furnish proof of this certification.

(b) All mixing of concrete must meet the provisions of CAN/CSA A23.1, Clause 5.2, Production of Concrete.

(c) Time of Hauling

(i) The maximum time allowed for all types of concrete to be delivered to the Site of the Work, including the time required to discharge, shall not exceed one hundred and twenty (120) minutes after batching. Batching of all types of concrete is considered to occur when any of the mix ingredients are introduced into the mixer, regardless of whether or not the mixer is revolving. For concrete that includes silica fume and fly ash, this requirement is reduced to ninety (90) minutes.

(ii) Each batch of concrete delivered to the Site shall be accompanied by a time slip issued at the batching plant, bearing the time of batching. In hot or cold weather, or under conditions contributing to quick stiffening of the concrete, a time less than one hundred and twenty (120) and/or ninety (90) minutes may be specified by the Contract Administrator. The Contractor will be informed of this requirement twenty-four (24) hours prior to the scheduled placing of concrete.

(iii) To avoid the reduction of delivery and discharge time in hot weather, the Contractor will be allowed to substitute crushed ice for a portion of the mixing water provided the specified water/cementitious ratio is maintained. All of the ice shall be melted completely before discharging any of the concrete at the delivery point.

(iv) Unless otherwise noted in Table E56-6 “Requirements for Hardened Concrete”, no retarders shall be used.

(v) The concrete, when discharged from truck mixers or truck agitators, shall be of the consistency and workability required for the job without the use of additional mixing water. If the slump of the concrete is less than that designated by the mix design statement, then water can be added on site provided the additional water meets the requirements of CAN/CSA A23.1 5.2.4.3.2. If additional water is to be added on site, it must be done under the guidance of the Suppliers' designated quality control person. The Supplier shall certify that the addition of water on site does not change the Mix Design for the concrete supplied. Any other water added to the concrete without such control will be grounds for rejection of the concrete by the Contract Administrator.

(vi) A record of the actual proportions used for each concrete placement shall be kept by the Supplier and a copy of this record shall be submitted to the City upon request.

(d) Delivery of Concrete

(i) The Contractor shall satisfy himself that the Concrete Supplier has sufficient plant capacity and satisfactory transporting equipment to ensure continuous delivery at the rate required. The rate of delivery of concrete during concreting operations shall be such that the development of cold joints will not occur. The methods of delivering and handling the concrete shall facilitate placing with a minimum of rehandling, and without damage to the structure or the concrete.

(e) Concrete Placement Schedule

(i) The Contractor shall submit to the Contract Administrator the proposed concrete placement schedule for all concrete placements for review and approval. If, in the opinion of the Contract Administrator, the volume of the placement is deemed larger than can be placed with the facilities provided, the Contractor shall either:

- Limit the amount to be placed at any time (using adequate construction joints);
- Augment his facilities and Plant in order to complete the proposed placement;
- In the case of continuous placing, provide additional crews and have adequate lighting to provide for proper placing, finishing, curing and inspecting.

(ii) The Contractor shall adhere strictly to the concrete placement schedule, as approved by the Contract Administrator.

(iii) At least two (2) days prior to the first self-compacting concrete pour, a Pre-Pour Meeting shall be held at the work site. The purpose of the meeting will be to confirm the understanding of all parties of the schedule and procedure for the concrete pour and concurrent quality control and quality assurance testing. The meeting shall be attended by a minimum of one (1) representative of the Contract Administrator, one (1) representative of the City, the Contractor's Site Superintendent, the Contractor's Supervisor, the concrete supplier's designated quality control representative responsible for ensuring the supplied concrete meets the Contract Specifications for supply and delivery, and a representative of the third-party testing company. Each representative shall be a responsible person capable of expressing the position of the party they represent on any matter discussed at the meeting including the Work schedule and the need to make any revisions to the Work schedule.

E56.8.6 Preparation for Concreting Against Hardened Concrete

(a) All hardened concrete against which new concrete is to be placed shall be prepared in the following manner:

(i) The resulting surface shall be roughened to remove latent cement and miscellaneous debris.

(ii) Following the completion of concrete removals, all surfaces at the cold joint interface including concrete and exposed reinforcing steel are to be sandblasted to the requirements of SSPC-SP6/NACE No.3 Commercial Blast Cleaning to reveal a clean substrate and kept clean until concrete placement. Sandblasting shall be followed by a high pressure water wash to remove all residues.

E56.8.7 Placing Concrete

(a) General

(i) The Contractor shall notify the Contract Administrator at least one (1) Working day prior to concrete placement so that an adequate inspection may be made of formwork, shoring, reinforcement and related Works.

(b) Placing Concrete

(i) Equipment for mixing or conveying concrete shall be thoroughly flushed with clean water before and after each pour. Water used for this purpose shall be discharged outside the forms. All equipment and processes are subject to acceptance by the Contract Administrator.

(ii) Concrete shall be conveyed from the mixer to the place of final deposit by methods which will prevent segregation and a marked change in consistency.

(iii) Runways for concrete buggies and all pumping equipment shall be supported directly by the formwork and not on reinforcement.

(iv) Before depositing any concrete, all debris shall be removed from the space to be occupied by the concrete, and any mortar splashed upon the reinforcement or forms shall be removed.

(v) Formwork liners shall be cooled immediately prior to placing concrete by spraying with cold water.

(vi) Placing of concrete, once started, shall be continuous. No concrete shall be placed on concrete which has sufficiently hardened to cause the formation of seams or “cold joints” within the section. If placing must be interrupted, construction joints shall be located where shown on the Drawings or as accepted by the Contract Administrator.

(vii) When the Contractor chooses to pump the concrete, the operation of the pump shall produce a continuous flow of concrete without air pockets. The equipment shall be arranged such that vibration is not transmitted to freshly placed concrete that may damage the concrete. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients.

(viii) Concrete shall be placed as nearly as possible in its final position. Rakes or mechanical vibrators shall not be used to transport concrete.

(ix) The maximum free drop of concrete into the forms shall not be greater than 1.5 m, otherwise rubber tubes or pouring ports spaced not more than 1.5 m vertically and present on a minimum of two (2) opposite faces of the pier column form shall be used. The Contractor shall obtain the Contract Administrator's acceptance, prior to pouring concrete, of all placing operations.

(x) Concrete shall not be placed during rain or snow unless adequate protection is provided for formwork and concrete surfaces, to the satisfaction of the Contract Administrator.

E56.8.8 General Curing Requirements

(a) Refer to E56.8.11, “Cold Weather Concreting” for cold weather curing requirements and E56.8.12“Hot Weather Concreting” of this Specification for hot weather curing requirements.

(b) Concrete shall be protected from the harmful effects of sunshine, drying winds, surface dripping, running water, vibration, and mechanical shock. No machinery shall travel in the vicinity of freshly placed concrete for a period of twenty-four (24) hours. Concrete shall be protected from freezing until at least twenty-four (24) hours after the end of the curing period.

(c) Changes in temperature of the concrete shall be uniform and gradual and shall not exceed three degrees Celsius (3°C) in one (1) hour ortwenty degrees Celsius (20°C) in twenty-four (24) hours.

(d) The use of curing compound shall not be allowed on concrete areas that are to receive additional concrete, dampproofing, a waterproofing membrane, or an asphalt overlay.

(e) Formed surfaces shall receive, immediately after stripping and patching, the curing compound coating.

(f) For curing of formed surfaces, formwork shall remain in place for seven (7) consecutive days following concreting. The top surface of the concrete surface shall be moist cured during this timeframe.

(g) Curing compound shall be applied at the rate specified by the Manufacturer for the accepted product. The compound must be applied uniformly and by roller.

(h) Following the completion of patching operations, the surface shall be sprayed with an initial coating of curing compound, as per the Manufacturer’s recommendations. As soon as initial set has occurred, the surface shall receive a second roller-applied application of curing compound, to the satisfaction of the Contract Administrator.

E56.8.9 Form Removal

(a) The Contractor shall notify the Contract Administrator at least one (1) Working Day prior to form removal. The Contractor shall not commence any form removal operations without the prior written acceptance of the Contract Administrator.

(b) All forms shall remain in place and the concrete shall not be loaded for a minimum of seven (7) days after initial concrete placement, unless otherwise authorized by the Contract Administrator in writing.

(c) Field-cured test specimens representative of the cast-in-place concrete being stripped shall be tested as specified in this Specification to verify the concrete strength.

E56.8.10 Patching of Formed Surfaces

(a) The Contractor shall notify the Contract Administrator at least one (1) Working Day prior to removal of forms. Immediately after forms have been removed and before the Contractor commences any surface finishing or concrete patching operations, all newly exposed concrete surfaces shall be inspected by the Contract Administrator.

(b) Any repair or surface finishing started before this inspection may be rejected and required to be removed.

(c) Patching of formed surfaces shall take place within twenty-four (24) hours of formwork removal.

(d) All formed concrete surfaces shall have bolts, ties, struts, and all other timber or metal parts not specifically required for construction purposes cut back 75 mm from the surface before patching.

(e) Minor surface defects caused by honeycomb, air pockets greater than 5 mm in diameter, voids left by strutting, and tie holes shall be repaired by removing the defective concrete to sound concrete, dampening the area to be patched, then applying bonding grout followed by patching mortar. Bonding grout shall be well brushed onto the area immediately prior to patching. When the bonding grout begins

to lose the water sheen, the patching mortar shall be thoroughly trowelled into the repair area to fill all voids. It shall be struck off slightly higher than the adjacent concrete surface and left for one (1) hour before final finishing to facilitate initial shrinkage of the patching mortar. It shall be touched up until it is satisfactory to the Contract Administrator. The patch shall be cured as specified in this Specification. The final colour shall match the surrounding concrete.

(f) Concrete shall be cast against forms which will produce plane surfaces with no bulges, indentations, or protuberances other than those shown on the Drawings. All objectionable fins, projections, offsets, streaks, or other surface imperfections on the concrete surface shall be removed by means acceptable to the Contract Administrator. Cement washes of any kind shall not be used.

(g) The arrangement of panel joints shall be kept to a minimum. Panels containing worn edges, patches, or other defects which will impair the texture of concrete surfaces shall not be used.

E56.8.11 Cold Weather Concreting

(a) The requirements of CAN/CSA A23.1 shall be applied to all concreting operations during cold weather, i.e., if the mean daily temperature falls below five degrees Celsius (5°C) during placing or curing.

E56.8.12 Hot Weather Concreting

(a) General

(i) The requirements of this section shall be applied during hot weather, i.e., air temperatures forecast to go higher than twenty-seven degrees Celsius (27°C) during placing.

(ii) Concrete at discharge shall be at as low a temperature as possible, preferably as low as fifteen degrees Celsius (15°C), but not above twenty-five degrees Celsius (25°C). Concrete containing silica fume shall be between ten degrees Celsius (10°C) minimum and eighteen degrees Celsius (18°C) maximum at discharge. Aggregate stockpiles should be cooled by water sprays and sun shades.

(iii) The Contractor shall use cold water and/or ice in the mix to keep the temperature of the fresh concrete down, if required. Ice may be substituted for a portion of the mixing water; provided it has melted by the time mixing is completed.

(iv) Form and conveying equipment shall be kept as cool as possible before concreting by shading them from the sun, painting their surfaces white and/or the use of water sprays.

(v) Sun shades and wind breaks shall be used as required during placing and finishing.

(vi) Work shall be planned so that concrete can be placed as quickly as possible to avoid "cold joints".

(vii) The Contract Administrator's acceptance is necessary before the Contractor may use admixtures such as retardants to delay setting, or water reducing agents to maintain Workability and strength, and these must appear in the Mix Design Statement submitted to the Contract Administrator.

(viii) Hot weather curing shall follow immediately after the finishing operation.

(b) Hot-Weather Curing

(i) When the air temperature is at or above twenty-five degrees Celsius (25°C), curing shall be accomplished by fog misting and by using saturated absorptive fabric, in order to achieve cooling by evaporation. Note that fog misting is mandatory for all deck slab and median slab pours at all temperatures.

(ii) Mass concrete shall be water cured for the basic curing period when the air temperature is at or above twenty degrees Celsius (20°C), in order to minimize the temperature rise of the concrete.

(c) Job Preparation

(i) When the air temperature is forecast to rise to twenty-five degrees Celsius (25°C) or higher during the placing period, provisions shall be made by the Contractor for protection of the concrete in place from the effects of hot and/or drying weather conditions. Under severe drying conditions, the formwork, reinforcement, and concreting equipment shall be protected from the direct rays of the sun or cooled by mist fogging and evaporation, to the satisfaction of the Contract Administrator.

(d) Concrete Temperature

(i) The temperature of the concrete as placed shall be as low as practicable and in no case greater than the following temperatures, as shown in Table E56-7 "Acceptable Concrete Temperatures", for the indicated size of the concrete section.

Table E56-7: Acceptable Concrete Temperatures

Thickness of Section, (Meters)	Temperatures degrees Celsius (°C)	
	Minimum	Maximum
Less than: 1 1.2	 10 5	 27 25

E56.8.13 Cleanup

(a) The Contractor shall clean up equipment and construction debris on at least a daily basis to the satisfaction of the Contract Administrator.

E56.9 Concrete Quality

E56.10 Inspection

(a) All workmanship and all materials furnished and supplied under this Specification are subject to close and systematic inspection and testing by the Contract Administrator including all operations from the selection and production of materials through to final acceptance of the specified Work.

(b) The Contractor shall be wholly responsible for the control of all operations incidental thereto, notwithstanding any inspection or acceptance that may have been previously given. The Contract Administrator reserves the right to reject any materials or Works, which are not in accordance with the requirements of this Specification.

(c) Quality Assurance testing shall be undertaken by a third-party testing company, acceptable to the Contract Administrator, retained and paid for by the Contractor. Quality Control testing shall be undertaken by the Contractor.

E56.11 Access

(a) The Contractor shall allow the Contract Administrator free access to all parts of the Work at all times. The Contractor shall supply samples to the Independent Inspector for testing purposes as required. There will be no charge to the City for samples taken.

E56.12 Materials

(a) All materials supplied under this Specification shall be subject to inspection and testing by the Independent Quality Assurance Testing Laboratory approved by the Contract Administrator. There shall be no charge to the City of Winnipeg for any materials taken by the Independent Inspector for testing purposes.

(b) All materials shall conform to the latest edition and all subsequent revisions of CAN/CSA A23.1.

(c) All testing of materials shall conform to the latest edition and all subsequent revisions of CAN/CSA A23.2.

(d) All materials shall be submitted to the Contract Administrator for acceptance at least twenty (20) Business Days prior to its scheduled incorporation into any construction. If, in the opinion of the Contract Administrator, such materials, in whole or in part, do not conform to the Specifications detailed herein or are found to be defective in manufacture or have become damaged in transit, storage, or handling operations, then such material shall be rejected by the Contract Administrator and replaced by the Contractor at his own expense.

E56.13 Quality Assurance and Quality Control

(a) The Contract Administrator shall be afforded full access for the inspection and control and assurance testing of concrete and constituent materials, both at the site of Work and at any plant used for the production of concrete, to determine whether the concrete is being supplied in accordance with this Specification.

(b) The Contract Administrator reserves the right to reject concrete in the field that does not meet the Specifications.

(c) The Contractor shall provide, without charge, the samples of concrete and the constituent materials required for Quality Assurance tests and pay for such tests and assistance and use of tools and construction equipment as is required.

(d) Quality Assurance and Control tests will be used to determine the acceptability of the concrete supplied by the Contractor.

(e) The Contractor will be required to retain qualified third-party testing company to undertake Quality Assurance tests, of all concrete supplied. All test results are to be copied to the Contract Administrator immediately after the tests have been performed.

(f) The frequency and number of concrete Quality Control and Quality Assurance tests shall be in accordance with the requirements of CAN/CSA A23.1. An outline of the quality tests is indicated below.

(g) Any and all Work performed by the Contractor for which the results of Quality Assurance testing, certified by the third-party testing company and as required by this Specification, cannot be produced by the Contractor may be rejected by the Contract Administrator.

E56.14 Concrete Testing

(a) Slump tests shall be made in accordance with CSA Standard Test Method A23.2-5C, "Slump of Concrete". If the measured slump falls outside the limits in Table E56-6 Concrete Mix Design Requirements" of this Specification, a second test shall be made. In the event of a second failure, the Contract Administrator reserves the right to refuse the use of the batch of concrete represented.

(b) Air content determinations shall be made in accordance with CSA Standard Test Method A23.2-4C, "Air Content of Plastic Concrete by the Pressure Method". If the measured air content falls outside the limits in Table E56-6 “Concrete Mix Design Requirements” of this Specification, a second test shall be made at any time within the specified discharge time limit for the mix. In the event of a second failure, the Contract Administrator reserves the right to reject the batch of concrete represented.

(c) The air-void system shall be proven satisfactory by data from tests performed in accordance with the latest edition and all subsequent revisions of ASTM Standard Test Method C457. The spacing factor, as determined on concrete cylinders moulded in accordance with CSA Standard Test Method A23.2-3C, shall be determined prior to the start of construction on cylinders of concrete made with the same materials, mix proportions, and mixing procedures as intended for the project. If deemed necessary by the Contract Administrator to further check the air-void system during construction, testing of cylinders may be from concrete as delivered to the job Site and will be carried out by the Contract Administrator. The concrete will be considered to have a satisfactory air-void system when the average of all tests shows a spacing factor not exceeding 230 microns with no single test greater than 260 microns.

(d) Rapid chloride permeability testing shall be performed in accordance with ASTM C1202.

(e) The conductivity of the concrete shall be determined in accordance with ASTM C1202, and shall meet the special requirements of Table E56-6.

(f) Samples of concrete for test specimens shall be taken in accordance with CSA Standard Test Method A23.2-1C, "Sampling Plastic Concrete".

(g) Test specimens shall be made and cured in accordance with CSA Standard Test Method A23.2-3C, "Making and Curing Concrete Compression and Flexure Test Specimens".

(h) Compressive strength tests at twenty-eight (28) days shall be the basis for acceptance of all concrete supplied by the Contractor. For each twenty-eight (28) day strength test, the strength of two (2) companion standard-cured test specimens shall be determined in accordance with CSA Standard Test Method A23.2-9C, "Compressive Strength of Cylindrical Concrete Specimens", and the test result shall be the average of the strengths of the two (2) specimens. A compressive strength test at seven (7) days shall be taken, the strength of which will be used only as a preliminary indication of the concrete strength, a strength test being the strength of a single standard cured specimen.

(i) Compressive strength tests on specimens cured under the same conditions as the concrete Works shall be made to check the strength of the in-place concrete so as to determine if the concrete has reached the minimum allowable working compressive strength as specified in Table E56-6 of this Specification and also to check the adequacy of curing and/or cold weather protection. At least two (2) field-cured test specimens shall be taken to verify strength of the in-place concrete. For each field-cured strength test, the strength of field-cured test specimens shall be determined in accordance with CSA Standard Test Method A23.2-9C, "Compressive Strength of Cylindrical Concrete Specimens", and the test result shall be the strength of the specimen.

E56.15 Corrective Action

(a) If the results of the tests indicate that the concrete is not of the specified quality, the Contract Administrator shall have the right to implement additional testing, as required, to further evaluate the concrete, at the Contractor's expense. The Contractor shall, at his own expense, correct such Work or replace such materials found to be defective under this Specification in an acceptable manner to the satisfaction of the Contract Administrator.

E56.16 Measurement and Payment

E56.16.1 Supplying and placing structural concrete will not be measured. This Work shall be paid for at the Contract Lump Sum Price for the “Items of Work” listed here below, which price shall be payment in full for supplying all materials and for performing all operations herein described and all other items incidental to the Work included in this Specification and accepted by the Contract Administrator.

E56.16.2 Items of Work:

(a) Supply and Place Structural Concrete:

(i) Bridge Rehabilitation:

¨ Abutment Repairs.

(ii) Retaining Walls:

¨ Cladding.

E56.16.3 Supplying and installing all the listed materials, concrete design requirements, equipment, construction methods, and Quality Control and Quality Assurance measures associated with this Specification and Drawings shall be considered incidental to “Supply and Place Structural Concrete”, unless otherwise noted herein. No measurement or payment shall be made for this Work unless indicated otherwise.

E57. SUPPLYING AND PLACING REINFORCING STEEL

E57.3 Description

E57.3.1 This Specification shall cover all operations relating to the supply, fabrication, delivery, and placement of ChrōmX 4100 and stainless steel reinforcing, and associated bar accessories, as specified herein and as shown on the Drawings.

E57.3.2 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Work as hereinafter specified.

E57.4 Scope of Work

E57.4.1 The Work under this Specification shall involve supplying and placing all steel reinforcing, as shown on the Drawings for the following Works:

Table E57-8: Scope of Work

Item	Type of Steel Reinforcing
Underpass	ChrōmX 4100
Retaining Wall	ChrōmX 4100
Abutments	ChrōmX 4100
Deck and Sidewalk	Stainless Steel Reinforcement
Diaphragms	Stainless Steel Reinforcement
Approach Slabs	Stainless Steel Reinforcement
Bridge Traffic Barriers	Stainless Steel Reinforcement
Roadway Traffic Barrier Footing	ChrōmX 4100
Roadway Traffic Barrier	ChrōmX 4100

E57.5 References

E57.5.1 All related Specifications and reference Standards are in accordance with the most current issue or latest revision:

(a) ASTM A1035– Standard Specifications for Deformed and Plain, Low-Carbon, Chromium, Steel Bars for Concrete Reinforcement;

(b) ASTM A955M – Standard Specification for Deformed and Plain Stainless-Steel Bars for Concrete Reinforcing;

(c) ASTM A615M – Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement;

(d) CAN/CSA A23.1/A23.2 – Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete;

(e) CAN/CSA G30.18-M92 – Billet Steel Bars for Concrete Reinforcement;

(f) ACI 315R – Manual of Engineering and Placing Drawings for Reinforced Concrete Structures;

(g) Reinforcing Steel Institute of Canada (RSIC), Manual of Standard Practice.

E57.6 Submittals

E57.6.1 General

b) The Contractor shall submit to the Contract Administrator for review and approval, at least twenty-one (21) Days prior to the scheduled commencement of any fabrication, and the qualifications of the Contractor and its Operators.

c) The Contractor shall submit to the Contract Administrator for review and approval, at least fourteen (14) Days prior to commencement of any schedule Work on the Site, a proposed schedule, including methods and sequence of operations.

d) The Contractor shall submit to the Contract Administrator for review, at least fourteen (14) Days prior to the commencement of any Work on Site a Certificate of Compliance from the Manufacturer stating that the stainless steel materials supplied comply with the provisions of ASTM A955M and these Specifications, including corrosion resistance.

e) Contractor shall submit all original mill certificates to the Contract Administrator prior to placement of reinforcing on site.

f) Contractor to submit Shop Drawings (including bar lists) in accordance with section E4 and the latest edition of the Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada (RSIC).

E57.7 Materials

E57.7.1 General

(a) The Contractor shall be responsible for the supply, safe storage, and handling of all materials set forth in this Specification. All materials shall be handled in a careful and workmanlike manner, to the satisfaction of the Contract Administrator.

(b) Bundles of reinforcing steel shall be identified by tags containing bar marks.

(c) The reinforcing steel shall not be placed directly on the ground. Sufficient timber pallets or blocking shall be placed under the reinforcing steel to keep them free from dirt and mud.

E57.7.2 Handling and Storage of Stainless Steel Reinforcing

(a) Stainless steel reinforcing shall be store separately from other reinforcing steel with the bar tags maintained and clearly visible until placing operations commence. Stacks of bundles of straight bars shall have adequate blocking to prevent contact between the layers of bundles.

(b) Chains for steel bands used for shipping shall not be in direct contact with stainless steel reinforcing. Wood or approved alternate should be used to protect the bars

(c) Nylon or polypropylene slings shall be used for moving stainless steel reinforcing.

(d) Keep carbon steel tools, chains, slings, etc. off stainless steel reinforcing.

E57.7.3 Reinforcing Steel

(a) Reinforcing steel shall be deemed to include all reinforcing bars, tie-bars, mechanical connections and dowels.

(b) ChrōmX 4100, shall conform to the requirements of ASTM A 1035 CM Grade 100.

(c) Stainless steel, as shown on the Drawings, shall be a high-manganese, low-nickel, nitrogen-strengthened austenitic stainless steel. Stainless steel reinforcing shall meet or exceed the minimum requirements of ASTM A955M, 300 Series, minimum Grade 420, of the Types listed below in Table E57-9, “Type of Stainless Steel Reinforcing”. Reinforcing deformations shall conform to the requirements of ASTM A615M. All hooks and bends shall be bent using pin diameters and dimension recommended by Reinforcing Steel Institute of Canada (RSIC), Manual of Standard Practice.

(d) If, in the opinion of the Contract Administrator, any reinforcing steel provided for the concrete Works exhibit flaws in manufacture or fabrication, such material shall be immediately removed from the Site and replaced with acceptable reinforcing steel. No additional costs will be applied to this Contract for the replacement of deficient reinforcing steel.

(e) All reinforcing steel shall be straight and free from paint, oil, millscale, and injurious defects. Rust, surface seams or surface irregularities will not be cause for rejection, provided that the minimum dimensions, cross-sectional area, and tensile properties of

a hand wire-brushed specimen are not less than the requirements of CSA Standard CAN/CSA G30.18-M92 and ASTM A955M.

Table E57-9: Types of Stainless Steel Reinforcing

Common or Trade Name	AISI Type	UNS Designation
Type 316 LN	316 LN	S31653
Type 2205	Duplex 2205	S31803
Type 2304	EnduraMet 2304	S32304

E57.7.4 Bar Accessories

(a) Bar accessories shall be of types suitable for each type of reinforcing and a type acceptable to the Contract Administrator. They shall be made from a non-rusting material, and they shall not stain, blemish, or spall the concrete surface for the life of the concrete.

(b) Bar chairs, bolsters, and bar supports shall be cementitious material as acceptable to the Contract Administrator. Plastic, PVC or galvanized bar chairs may be permitted if accepted in writing by the Contract Administrator prior to installation.

(c) The use of pebbles, pieces of broken stone or brick, plastic, metal pipe, and wooden blocks, will not be permitted.

(d) Placing of bar supports shall be done to meet the required construction loads.

(e) Tie wire shall be the following:

(i) Stainless steel, fully annealed 1.6 mm diameter wire, Type 316 or 316L for stainless steel reinforcing and ChrōmX 4100.

(f) Approved products are as supplied by Con Sys Inc., Box 341, Pinawa, Manitoba, Canada R0E 1L0 (204) 753-2404, or equal as accepted by the Contract Administrator in accordance with B7. Bar accessories are not included in the Drawings and shall include bar chairs, spacers, clips, wire ties, wire (16 gauge minimum), or other similar devices and are to be acceptable to the Contract Administrator. The supplying and installation of bar accessories shall be deemed to be incidental to the supplying and placing of reinforcing steel.

E57.7.5 Mechanical Splices

(a) Mechanical splices shall meet the requirements of the reinforcing steel manufacturer. The proposed mechanical splice shall be submitted to the Contract Administrator for acceptance.

E57.7.6 Bonding Agent/Grout

(a) Epoxy resin shall be conform to the requirements of ASTM C881. Type I or Type IV, Grade 3 epoxy shall be used for bonding reinforcing steel into hardened concrete. An approved product is Hilti RE500 V3 or equal, as approved by the Contract Administrator in accordance with B7 “Substitutes”.

(b) An aggregate filler may be used in accordance with manufacturer's directions when the drilled hole is sized for the head of a stud rather than a shaft only.

E57.8 Construction Methods

E57.8.1 Fabrication of Reinforcing Steel

(a) ChrōmX 4100;

(i) All reinforcing steel shall be fabricated in accordance with the latest edition of the Reinforcement Steel Manual of Standard Practice by the RSIC, to the lengths and shapes as shown on the Drawings.

(ii) Low carbon chromium steel reinforcing shall be bent to the proper shape in a plant that has suitable devices for bending as recommended in Reinforcing Steel Institute of Canada (RSIC) Manual of Standard Practice.

(iii) Heating shall not be used as an aid in bending of low carbon chromium steel reinforcing. The equipment used in the plant shall not cause any surface contamination or damage to the surface of the bars. Bar cutting shall be done by shearing or with a water-cooled saw. Torch cutting shall not be permitted.

(b) Reinforcing Steel;

(c) Stainless Steel Reinforcing;

(i) Heating shall not be used as an aid in bending stainless steel reinforcing.

(ii) Hooks and bends should be smooth and not sharp.

(iii) Fabrication of the solid stainless steel reinforcing shall be such that the bar surfaces are not contaminated with deposits of iron and/or non-stainless steel or damage to the surface of the bars.

(iv) The stainless steel reinforcing shall be mechanically or chemically de-scaled prior to fabrication, leaving a totally passive stainless steel finish free of millscale, slag, or oxidation. Iron contamination shall be removed with picking paste or by wire brushing. Wire brush cleaning shall be done with stainless steel wire brushes only.

(v) All hand tools shall be stainless tools that have not been used on carbon steel.

E57.8.2 Placing of Reinforcing Steel

(a) Reinforcing steel shall be placed accurately in the positions shown on the Drawings and shall be retained in such positions by means of a sufficient number of bar accessories so that the bars shall not be moved out of alignment during or after the depositing of concrete. The Contract Administrator's decision in this matter shall be final.

(b) Reinforcing steel shall be free of all foreign material in order to ensure a positive bond between the concrete and steel. The Contractor shall also remove any dry concrete which has been deposited on the steel from previous pouring operations before additional concrete may be placed. Intersecting bars shall be tied positively at each intersection.

(c) Splices in reinforcing steel shall be made only where indicated on the Drawings. Prior acceptance by the Contract Administrator shall be obtained where other splices must be made. Welded splices shall not be permitted.

(d) Reinforcing steel shall be placed to provide a clear space between the reinforcing bars as shown on the Drawings to accurately place preformed holes where necessary.

(e) Reinforcing steel shall not be straightened or re-bent in a manner that shall injure the metal. Bars with bends not shown on the Drawings shall not be used.

(f) Heating of reinforcing steel shall not be permitted without prior acceptance by the Contract Administrator.

(g) Reinforcing steel shall be placed within the tolerances specified in CAN/CSA A23.1.

(h) The Contractor shall supply and place all necessary support accessories to ensure proper placement of reinforcing steel. All reinforcement shall be accurately placed in the positions shown on the Drawings, and firmly tied and chaired before placing the concrete.

(i) Distances from the forms shall be maintained by means of stays, spacers, or other approved supports. Spacers and supports for holding reinforcing steel at the required location and ensuring the specified concrete cover over the reinforcing steel shall be as specified in E57.7.4 “Bar Accessories”.

(j) Welding or tack welding is not permitted.

(k) Unless otherwise shown on the Drawings, the minimum distance between bars shall be 40 mm.

(l) Bars shall be tied at all intersections, except where spacing is less than 250 mm in each direction, when alternate intersections may be tied.

E57.8.3 Splicing

(a) Splices shall only be provided as shown on the Drawings. Splices other than as shown on the Drawings shall not be permitted without the written approval of the Contract Administrator.

(b) For lapped splices, the bars shall be placed in contact and wired together in such a manner as to maintain a clearance of not less than the required minimum clear distance to other bars, and the required minimum distance to the surface of the concrete. In general, suitable lap lengths shall be supplied as detailed on the Drawings.

E57.9 Quality Control

E57.9.1 Inspection

(a) All workmanship and all materials furnished and supplied under this Specification are subject to close and systematic inspection and testing by the Contract Administrator including all operations from the selection and production of materials through to final acceptance of the specified Work.

(b) The Contractor shall be wholly responsible for the control of all operations incidental thereto, notwithstanding any inspection or acceptance that may have been previously given. The Contract Administrator reserves the right to reject any materials or Works, which are not in accordance with the requirements of this Specification.

(c) A minimum of one (1) Business Day advance notice shall be given to the Contract Administrator prior to the placing of any concrete to allow for inspection of the reinforcing steel.

(d) After all reinforcing steel has been placed, a final inspection shall be made prior to the placement of concrete to locate any damage or deficiencies. All visible damage or any deficiencies shall be repaired to the satisfaction of the Contract Administrator before concrete is placed.

E57.9.2 Access

(a) The Contract Administrator shall be afforded full access for the inspection and control testing of reinforcing steel, both at the Site of Work and at any plant used for the fabrication of the reinforcing steel, to determine whether the reinforcing steel is being supplied in accordance with this Specification.

E57.9.3 Quality Testing

(a) Quality control testing may be used to determine the acceptability of the reinforcing steel supplied by the Contractor.

(b) The Contractor shall provide, without charge, the samples of reinforcing steel required for quality control tests and provide such assistance and use of tools and construction equipment as is required.

E57.10 Measurement and Payment

(a) Supplying and Placing Reinforcing Steel Bars shall be measured on a mass basis, as computed from the reviewed Shop Drawings.

(b) Supplying and Placing Reinforcing Steel Bars will be paid for at the Contract Unit Price per kilogram for the “Items of Work” listed here below, which price shall be payment in full for supplying all materials and for completing all operations herein described and all other items incidental to the work included in the Specification, accepted and measured by the Contract Administrator.

E57.10.1 Items of Work:

(a) Supply of Reinforcing Steel;

(i) ChrōmX 4100;

(ii) Stainless Steel Reinforcing.

(b) Placing Reinforcing Steel.

E57.10.2 The measurement excludes the mass of bar accessories, which are incidental to the Works.

E57.10.3 Supplying and Installing all listed materials, construction methods, and quality control measures associated with this Specification and Drawings shall be considered incidental to "Supply of Reinforcing Steel" and "Placing Reinforcing Steel", unless otherwise noted herein. No measurement or payment shall be made for this Work unless indicated otherwise by the Contract Administrator.

E58. MISCELLANEOUS METAL

E58.1 Description

E58.1.1 General

(a) This Specification covers all operations relating to the following:

(i) Supply, fabrication, and erection of miscellaneous metal as shown or described on the Drawings and in this Specification. Miscellaneous metal includes, but is not limited to:

- Steel Girder Splice Plates;
- Concrete Girder Flexural Strengthening Assembly;
- Bearing Plates (Stainless Steel Plate, Top Plates and Retaining Plates);
- Anchorage System at Pier Diaphragm at SU3;
- Abutment Shear Block Inserts;
- Threaded Rods and Plate in Pier Diaphragms and Piercap;
- Handrail Preset Anchor Units;
- Retaining Wall Shear Studs;
- Barrier Steel Inlet at Catchbasin and Catch Pit.

(ii) Quality control of materials and fabrication, including magnetic particle testing of welds.

(iii) Galvanizing of miscellaneous metal.

(b) The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Works as hereinafter specified.

E58.2 References

E58.2.1 References and Related Specifications:

(a) All related Specifications shall be current issued or latest revision at the first date of tender advertisement;

(b) CAN/CSA G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steel;

(c) CAN/CSA W48, Filler Metals and Allied Materials for Metal Arc Welding;

(d) CSA W59, Welded Steel Construction (Metal Arc Welding);

(e) CAN/CSA G164, Hot Dip Galvanizing of Irregularly Shaped Articles;

(f) CSA W47.1, Certification of Companies for Fusion Welding of Steel;

(g) ASTM A36, Standard Specification for Carbon Structural Steel;

(h) ASTM A53, Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless;

(i) ASTM A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished;

(j) ASTM A123, Standard Specification for Zinc (Hot Dipped Galvanized) Coatings on Iron and Steel Products;

(k) ASTM A276, Standard Specification for Standard Specification for Stainless Steel Bars and Shapes;

(l) ASTM A320, Standard Specification for Alloy Steel and Stainless Steel Bolting Materials for Low Temperature Service;

(m) ASTM F3125, High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength ;

(n) ASTM A404, Standard Specification for General Requirements for Stainless Steel Bars, Billets and Forgings;

(o) ASTM A449, Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use;

(p) ASTM A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement;

(q) ASTM A500, Standard Specification for Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes;

(r) ASTM A514, Standard Specification for High- Yield- Strength, Clenched and Tempered Alloy Steel Plate, Suitable for Welding;

(s) ASTM A516, Standard Specification for Pressure Vessel Plates, Carbon Steel, For Moderate and Low Temperature Service;

(t) ASTM A517, Standard Specification for Pressure Vessel Plates, Alloy Steel, High Strength, Quenched and Tempered;

(u) ASTM A615, Standard Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement;

(v) ASTM A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar;

(w) ASTM B22, Standard Specification for Bronze Castings for Bridges and Turntables;

(x) ASTM B29, Standard Specification for Refined Lead;

(y) ASTM B100, Standard Specification for Wrought Copper-Alloy Bearing and Expansion Plates and Sheets for Bridge and Other Structural Use;

(z) ANSI B46.1, Surface Texture (Surface Roughness, Waviness, and Lay);

(aa) AASHTO/AWS D1.5M/D1.5, Bridge Welding Code;

(bb) AWS D1.1, Structural Welding Code – Steel;

(cc) AWS D1.6, Structural Welding Code – Stainless Steel.

E58.3 Submittals

E58.3.1 The Contractor shall submit the following to the Contract Administrator:

(a) Copies of Mill Test Certificates showing chemical analysis and physical tests of all miscellaneous metal prior to commencement of fabrication. Miscellaneous metal without this certification will be rejected.

(b) Two (2) copies of Charpy V-notch certified test reports for splice plates prior to the start of fabrication.

(c) Certification of chemical analysis and physical tests for all materials;

(d) A complete set of Shop Drawings prior to commencement of fabrication. The Contractor shall indicate on the Shop Drawings all the necessary material specifications for the materials to be used and identify the components in accordance with the Drawings and Specifications. Applicable welding procedures, stamped as approved by the Canadian Welding Bureau, shall be attached to the Shop Drawings. In no case will the Contractor be relieved of responsibility for errors or omissions in the Shop Drawings.

(e) Clearly indicate shop and erection details including cuts, copes, connections, holes, bearing plates, threaded fasteners, and welds. Indicate welds by CSA / AWS welding symbols.

(f) Shop Drawings shall be drawn to the same system (Metric or Imperial) as the Contract Drawings.

(g) Manufacturer's test reports of mechanical tests on high strength bolts, if requested by the Contract Administrator.

E58.4 Materials

E58.4.1 General

(a) The Contractor shall be responsible for the supply, safe storage and handling of all materials set forth in this Specification. All materials supplied under this Specification shall be subject to inspection and acceptance by the Contract Administrator.

(b) The Contractor shall mark all materials to identify its material specification and grade. This shall be done by suitable marking or by a recognized colour coding.

(c) The types and grades of structural steel used shall be as shown on the Drawings or as specified in this Specification.

(d) Materials called for under these Specifications and on the Drawings shall, unless otherwise specified, satisfy the testing procedures and be in strict accordance with the requirements set out in the latest edition of the standards identified.

E58.4.2 General Requirements for Miscellaneous Metals

(a) Miscellaneous metals shall conform to the material grades specified on the Drawings, and meet the requirements and satisfy the testing procedures of CSA G40.21.

(b) Furnish to the Contract Administrator's Shop Inspector mill test reports, properly correlated to all steel sections to be used for steel construction under this Specification.

(c) Fabrication shall be carried out in the Fabricator's own plant, the use of subcontractors for all or portions of the fabrication will only be considered unless applied for in writing by the Fabricator and subsequently approved in writing by the Contract Administrator. The Fabricator shall be fully responsible for the quality of work and shall bear all additional costs related to work being carried out at the subcontractors plant such as additional quality inspections, shipment, etc.

(d) When mill test certificates originate from a mill outside of Canada or the United States of America, the Contractor shall have the information on the mill test certificate tested and verified by independent testing by a Canadian laboratory. This laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply with the requirements of OSO/IEC 17025 for the specific tests or types of tests required by the material standard specified on the mill test certificate. The mill test certificate shall be stamped with the name of the Canadian laboratory and appropriate wording stating that the material is in conformance with the specified requirements. The stamp shall include the appropriate material specification number, testing date and the signature of an authorized officer of the Canadian laboratory.

E58.4.3 Steel Girder Splice Plates

(a) Steel shall be in accordance with CSA G40.21-13 or ASTM A709, A588, A572 and A36;

(b) Grade and Type;

(i) CSA-G40.21-13 Grade 350WT Category 3.

(c) Before the start of fabrication, supply to the Contract Administrator the results of the low temperature Charpy impact tests made in accordance with CSA-G40.21-13. Three (3) test pieces for heat of splice plates shall be taken. The tests shall be taken at the temperature of minus thirty degrees Celsius (-30^{o} C(-22^{o} F)) and shall have the following guaranteed minimum average level of energy absorption:

(i) Category 3 material - 27 Joules (20 ft-lbs).

(d) Material for Charpy specimens shall be supplied to the Contract Administrator for inspection when requested;

(e) High Strength Bolts, Nuts and Washers;

(i) Bolts to ASTM F3125M, Grade A325, Type 1, nuts to ASTM A563-C3 Grade DH3 and washers to ASTM F436 Type 1. Galvanized bolted items may be used when approved by the Contract Administrator. Bolt tightening shall be provided by means of the turn of nut method.

(ii) Proof shall be submitted to the Contract Administrator demonstrating that the bolts, nuts and washers meet the chemical composition, mechanical properties, dimensions, workmanship and head burst as required by ASTM A325/ A325M, A563/ A563M and F436/ F436M. Verification of the acceptability of assemblage of zinc coated bolts shall be provided with the bolts, nuts and washers delivered to the job site shall also be submitted to the Contract Administrator.

(iii) For bolts supplied from a manufacturer outside of Canada or United States of America, the above information shall be independently verified by testing by a Canadian laboratory as outlined in the Clause E58.4.2(d)

E58.4.4 Concrete Girder Flexural Strengthening Assembly

(a) Concrete girder flexural strengthening assembly shall be supplied and installed by the Contractor as shown on the Drawings.

E58.4.5 Bearing Plates

(a) Steel for retaining plates and bearing top plates shall be in accordance with latest edition of CAN/CSA G40.21, Grade 300W.

(b) All retaining plates and bearing top plates shall be hot-dip galvanized in accordance with ASTM A123 and CSA G164 to a minimum net retention of 610 g/m^2.

(c) Stainless steel plates shall in accordance E58.4.16

(d) Any other item shown in the bearing units in drawings will be incidental to bearing units.

E58.4.6 Threaded Rod Pipe Assemblies

(a) Threaded rod pipe assemblies shall be supplied and installed by the Contractor as shown on the Drawings.

(b) The assemblies shall conform to ASTM A53 “Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless” for pipes and CSA-G40.21-13 Grade 300W (A572 Grade 42) for plates.

(c) Threaded rod pipe assemblies shall be hot-dip galvanized in accordance with ASTM A123/A123M – Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

E58.4.7 Threaded Rods

(a) Threaded rods shall be supplied and installed by the Contractor as shown on the Drawings.

E58.4.8 Abutment Shear Block Inserts

(a) Shall be supplied and installed by the Contractor as shown on the Drawings.

E58.4.9 Stainless Steel plates and threaded roads

(a) Shall be supplied and installed by the Contractor as shown on the Drawings.

E58.4.10 Anchor Units for Aluminum Pedestrian Handrail/Bicycle Rail

(a) Anchor units for the aluminum pedestrian handrail/bicycle rail shall be stainless steel Acrow-Richmond Type DGRS-1

E58.4.11 Railing Neprene Pads

(a) Railing neprene pads shall be supplied and installed by the Contractor as shown on the Drawings.

(b) Neprene pads shall conform to ASTM D2240 and ASTM D412, low temperature Grade 4 or 5 with a Shore A durometer hardness of 50.

E58.4.12 Welded Steel Construction

(a) Welded steel construction (Metal Arc Welding) shall conform to the requirements and satisfy the testing procedures of CSA W59, AWS D1.6 and Welded Highway & Railway Bridges - AWS D1.1 of The American Welding Society & Addendum.

E58.4.13 Shear Stud Connectors

(a) Shear stud connectors shall conform to the requirements of ASTM A108, Grades 1015, 1018 and 1020.

E58.4.14 Barrier Steel Inlet at Catchbasin and Catch Pit

(a) Shall be supplied and installed by the Contractor as shown on the Drawings.

E58.4.15 Zinc

(a) Zinc for hot dipped, galvanized coatings shall conform to the requirements of ASTM A123.

E58.4.16 Stainless Steel

(a) Stainless steel bolts, nuts, washers, inserts, etc. when shown on the Drawings shall conform to the requirements of ASTM A320, Class B8. Stainless steel double headed studs and stainless steel dowels when shown on the Drawings, shall conform to the requirements of ASTM A276, Type 304L (UNS S30403).

(b) Stainless steel plates and perforated plates as shown on the Drawings shall be Type 316 or Type 316L, UNS S31600 or UNS S31603 and conform to the requirement for ASTM A240 and ASTM A666.

E58.5 Construction Methods

E58.5.1 Fabrication

(a) General

(i) The workmanship shall meet established practice in modern shops. Special emphasis shall be placed in prevention of cracks, notch-like flaws and bruises that may lower the structure's resistance to fatigue and brittle fracture.

(ii) The punching of identification marks on members will not be allowed unless authorized in writing by the Contract Administrator.

(iii) If damage occurs to the miscellaneous metal during fabrication, the Contract Administrator shall be notified immediately to facilitate the implementation of remedial measures. Remedial repair measures are subject to the approval of the Contract Administrator.

(iv) Dimensions and fabrication that control field matching of parts shall receive careful attention in order to avoid field adjustments.

(v) Field high-tensile bolted connections shall have all holes drilled or sub-punched and reamed using steel templates. Templates shall be located with utmost care as to position and angle and firmly bolted in place.

(vi) Cutting shall be in accordance with AWS D1.1, D1.6 and CSA W59.

(b) Clean Material

(i) The material shall be clean, free from rust, mill scale, and other foreign matter before being worked in the shop. Material shall be cleaned by wheelabrating, sandblasting or other methods subject to the Contract Administrator's approval.

(c) Finish

(i) All portions of the Work shall be neatly finished. Shearing, cutting, chipping and machining shall be done neatly and accurately. Finished members shall be true to line and free from twists, bends, open joints, and sharp corners and edges.

(d) Machining

(i) General

- Machining shall be carried out as indicated on the Drawings and in these Specifications in accordance with established machine shop practice. All machined surfaces shall be free of flaws, cracks and machining ridges and shall present a polished appearance.

(ii) Facing of Bearing Surfaces

- The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall meet the ANSI surface roughness requirements as defined in ANSI B46.1, Surface Roughness, Waviness and Lay, Part I:

Steel Slabs	ANSI 2,000
Heavy plates in contact in shoes to be welded Milled ends of compression members,	ANSI 1,000
Milled or ground ends of stiffeners and fillers	ANSI 500

(iii) Care shall be taken that the completed surfaces are protected from damage from the time of machining until the installation in a structure.

(iv) Grinding

- Final grinding and machining of the surface of all tension members shall be done parallel to the tensile forces that will occur in the assembled member.

(v) Butting Joints

- Butting joints in compression members shall be faced and brought to an even bearing by milling or other methods meeting the Contract Administrator's approval.

(vi) Bored Holes

- Bored holes shall be true to specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other, unless otherwise required. The final surface shall be produced by a finished cut. Boring of holes in built-up members shall be done after assembly is complete.

(vii) Flat Machined Surfaces

- Where called for on the Drawings, flat machined surfaces shall be obtained by planing or machine grinding, or other methods meeting the Contract Administrator's approval. The direction of machining and the extent of the areas to be machined shall be as indicated on the Drawings or as directed by the Contract Administrator. Flat machined surfaces shall be straight, true and smooth.

(viii) Curved Machined Surfaces

- Curved surfaces shall be machined carefully in accordance with Drawings and Specifications in order to ensure correct fit of mating parts.

(e) Bending

(i) When bending is necessary in order to meet the requirements of the design, it shall be done with care and by methods subject to the approval of the Contract Administrator. The bend line shall be at right angles to the direction of rolling. The internal radius of bend of load carrying sections shall not be less than twice the thickness of the bend section when bent cold, and if a smaller radius of bend is essential, the material shall be bent hot and later annealed. Before

bending, the edges of the section in the region of the bend shall be smoothed and rounded to a radius of 2 mm.

(f) Stress Relieving

(i) Stress relieving of the structure or any component parts attached to the structure shall be done only if called for on the Drawings or in the Special Provisions. If stress relieving is called for, it shall conform to the requirements of AWS D1.1, D1.6 and CSA W59.

(g) Holes

(i) General

¨ Except where a specific method of holing materials is shown on the Drawings or required in the Special Provisions, all holes shall be either drilled or sub-punched and reamed with the exception of the holes and slots in the rectangular steel guardrail which may be punched. Poor matching holes will be cause for rejection.

(ii) Punched Holes and Slots

¨ For holes and slots punched full size, the diameter or size of the die shall not exceed that of the punch by more than 2 mm. All holes and slots which are punched shall have burrs and sharp edges removed. All holes shall be clean-cut without torn of ragged edges. The punching shall not distort the structural member. If required by the Contract Administrator, a sample of the punching operation shall be carried out to the satisfaction of the Contract Administrator prior to the start of fabrication.

(iii) Drilled Holes

¨ Drilling shall be done with twist drills or core drills, and all burrs and sharp edges shall be removed carefully. Care shall be taken to centre the drill accurately and to ensure that the hole is perpendicular to the member. Holes shall be clean-cut, without torn or ragged edges.

(iv) Sub-Punched and Reamed Holes

¨ All holes shall be sub-punched or sub-drilled to a diameter 5 mm smaller than the nominal hole diameter, and enlarged by reaming to the correct diameter. The diameter of the die shall not exceed the diameter of the punch by more than 2 mm. Holes shall be clean-cut without torn or ragged edges. Reamed holes shall be truly cylindrical and perpendicular to the member and all burrs shall be removed carefully. All reaming shall be done with twist reamers which shall be directed by mechanical means.

(v) Allowable Tolerance for Holes

¨ All matching holes for bolts shall register with each other so that a gauge 2 mm less in diameter than the hole shall pass freely through the assembled members in a direction at right angles to such members. Finished holes shall be not more than 2 mm in diameter larger than the diameter of the bolt passing through them unless otherwise specified by the Contract Administrator. The centre-to-centre distance between any two (2) holes of a group of holes shall not vary by more than 1 mm from the dimensioned distance between such holes. Mispunched or misdrilled members shall not be corrected by welding.

(h) Welding

(i) Specifications

¨ Welding shall conform to the requirements of the Structural Welding Code - Steel of the American Welding Society AWS D1.1 and addendum and CSA W59 Welded Steel Construction. Welding of stainless steel shall conform to the requirement of the American Welding Society AWS D1.6.

(ii) Welding Operator Qualification

- Welding operators shall be qualified in accordance with the requirements of C.W.B. at the time of fabrication for the processes that will be required as part of the Work. Qualification shall have been issued within two (2) years of commencement of fabrication.
- The reports of the results of the qualification tests shall bear the welding operator's name, the identification mark he will use and all pertinent data of the tests. Evidence that the welding operators have been executing satisfactory welding in the required processes within the six (6) month period immediately prior to commencement of fabrication shall also be provided to the Contract Administrator. The Contractor shall bear the whole cost and be fully responsible for the qualification of all welding operators.

(iii) Welding Procedures, Specifications and Qualification

- Welding procedures that conform in all respects to the approved procedures of AWS D1.1, D1.6 and CSA W59 shall be deemed as pre-qualified and are exempt from tests or qualifications.
- Welding procedures that do not conform to approved procedures in AWS D1.1, D1.6 and CSA W59 shall be qualified by tests carried out in accordance with AWS D1.1 or D1.6.
- The Contract Administrator may accept previous qualifications of the welding procedure.

(iv) Welding Materials

- All electrodes for manual shielded metal arc welding shall conform to the low-hydrogen classification requirements of the latest edition of the American Welding Society's Filler Metal Specification AWS A5.1 or AWS A5.5 and the CAN/CSA W48 Specification and be capable of producing weld metal having an impact strength of at least 27 J (Charpy V-Notch) at minus eighteen degrees Celsius (-18^{o}C).
- All bare electrodes and flux used in combination for submerged arc welding, the electrode and gas shielding used in combination for gas metal-arc welding, or the electrode and shielding medium used in combination for flux cored arc welding of steels shall conform to the requirements in the latest edition of the American Welding Society AWS A5.17, A5.18 or A5.20 and CAN/CSA W48 and be capable of producing weld metal having a minimum impact strength of 27 J (Charpy V Notch) at minus eighteen degrees Celsius (-18^{o}C), or shall be capable of producing low alloy weld metal having the mechanical properties listed in Table 4.1.1 of AWS D1.1.
- Low alloy weld properties shall be determined from a multiple pass weld made in accordance with the requirements of the latest edition of the applicable Specification (AWS A5.17, A5.18, or A5.20) or the welding procedure specification.
- Every user shall demonstrate that each combination of electrode and shielding medium will produce weld metal having the above mechanical properties until the applicable AWS Filler Metal Specification is issued. At that time, the AWS Filler Metal Specification will control. The test assembly for Grades E100XX and E110XX shall be made using CAN/CSA G40.21M 700Q or ASTM A514/A517 steel.
- The Contract Administrator may accept evidence of record of a combination that has been satisfactory tested in lieu of the test required, provided the same welding procedure is used.
- Electrodes conforming to AWS A5.1 shall be purchased & delivered in hermetically sealed containers or shall be dried for at least two (2) hours between two hundred and thirty degrees Celsius (230°C) and two hundred and sixty degrees Celsius (260°C) before they are used. Electrodes conforming to AWS A5.5 shall be purchased & delivered in hermetically sealed containers or shall be dried one (1) hour and fifteen

(15) minutes at a temperature of four hundred and twenty-five degrees Celsius (425°C) + fifteen degrees Celsius (15°C) before being used.

- All electrodes for use in welding ASTM A514/A517 and CSA 700 Q. steel having a strength lower than that of the E100XX classification shall be dried for 1 hour + 15 min. at a temperature of four hundred and twenty-five degrees Celsius (425°C)+ fifteen degrees Celsius (15°C) before being used.
- Electrodes shall be dried prior to use if the hermetically sealed container shows evidence of damage. Immediately after removal from hermetically sealed containers or from drying ovens, electrodes shall be stored in ovens held at a temperature of at least one hundred and twenty degrees Celsius (120ºC). E70XX electrodes that are not used within four (4) hours, E80XX within two (2) hours, E90XX within one (1) hour, and E100XX and E110XX within 0.5 hour after removal from hermetically sealed containers or removal from a drying or storage oven shall be re-dried before use. In humid atmospheres, these time limits will be reduced as directed by the Contract Administrator. Electrodes that have been wet shall not be used. Electrodes shall be re-dried no more than once.
- Flux used for submerged arc welding shall be non-hygroscopic, dry and free of contamination from dirt, mill-scale, or other foreign material. All flux shall be purchased in moisture-proof packages capable of being stored under normal conditions for at least six (6) months without such storage affecting its welding characteristics or weld properties.
- Flux from packages damaged in transit or handling shall be discarded or shall be dried before use at a minimum temperature of one hundred and twenty degrees Celsius (120°C) for one (1) hour. Flux shall be placed in the dispensing system immediately upon opening a package. If flux is used from an open package or an open hopper that has been inoperative for four (4) hours or more, the top 25 mm shall be discarded. Flux that has been wet shall not be used. Flux fused in welding shall not be reused.

(v) Preheat and Interpass Temperature

- The minimum preheat and interpass temperatures for welding miscellaneous metal shall conform to AWS D1.1,D1.6 and CSA W59.

(vi) Welding Processes

- Welding processes which do not conform to the provisions of AWS D1.1, D1.6 or CSA W59 shall not be used without the written approval of the Contract Administrator.

Table E59-10: Welding Process

Base Metal	Welding Process					Base Metal
	SMAW		GMAW	FCAW	SAW	
CSA	CSA	CSA	CSA	CSA	CSA	
G40.21M	W48.1	W48.3	W48.4	W48.5	W48.6	ASTM
	AWS	AWS	AWS	AWS	AWS	
	A.5.1	A5.5	A5.18,5.28	A5.20	A5.17,5.23	
230G	E60XX		E70S-X	E60T-X	F6X-XXX	A53 Gr B
260W,260T	E70XX		E70U-X	E70T-X	F7X-XXXX	A500 Gr A
						A516Gr55,60
						A36
300W	E70XX		E70S-X	E70T-X[a]	F7X-XXXX	A441>4"
300T	or	E70XX		or	or	A550GrB
	E60XX		E70U-X	F60T-X	F6X-XXXX	A501
350G[d]						A529
350W						A570Gr D,E

						A572Gr42,45
						A607Gr45
						A242[c]
						A441#4"
						A516Gr65,70
350R[b,c]			E70S-X			A570Gr50,55
350A[b,c]	E70XX	E70XX		E70T-X[a]		588[c]
			E70U-X		F7X-XXXX	A606
						A607Gr50,55
400A[b,c]						A618
						A633Gr,A,B, C,D
400G[d],400W						
400T		E80XX	GrE80S	GrE80T	GrF80	A572Gr60,65
480W		E90XX	GrE90S	Gr390T	GrF90	
480T						
480A[b,d]		E100XX	GrE100S	GrE100T	GrF100	
700Q[d]		E110XX	GrE110S	Gr3110T	GrF110	A514
						A517

Footnotes for Matching of Base Metal and Electrode Combinations
a) Exclusive of E70T-2, E70T-3, E70T0-G
b) When steels of Types R and A are used in the exposed, bare, unpainted condition, the electrodes suggested or others producing a similar alloy composition in the deposited metal should be used. For applications where the material is not boldly exposed, where a colour match is not important, for all but capping passes in multipass welds and for narrow single pass welds, the electrodes suggested for Grades 300T, 400T and 480T may be used (See CAN/CSA G40.21M).
c) See Clauses 5.2.1.4 and 5.2.1.5 and Table 5-2 of CSA W59.
d) See Mfg. Specifications.

Use of the same-type filler metal having the next higher mechanical properties as listed in the AWS or CSA Specifications is permitted:
.1 In joints involving base metals of different yield points or strength, filler metal applicable to the lower strength base metal may be used subject to the Contract Administrator's approval.
.2 When welds are to be stress relieved, the deposited weld metal shall not exceed 0.05% vanadium.
.3 See AWS D1.1 article 4.20 for Electroslag and Electrogas weld metal requirements. Appendix C Impact Requirements are mandatory.
.4 Lower strength filler metal may be used for fillet welds and partial penetration groove welds when indicated on the plans or in the special provisions.

(vii) Distortion and Shrinkage Stresses

- Distortion and shrinkage stresses shall be kept to a minimum by the use of jigs and fixtures, utilizing heat distribution and a welding sequence. Areas contiguous to welding operations shall be preheated to a maximum temperature of one hundred and twenty degrees Celsius (120°C), if necessary in the estimation of the Contract Administrator to prevent distortion or weld cracking. The provisions of AWS D1.1, D1.6 and CSA W59 shall be followed in the control of distortion and shrinkage stresses.

(viii) Tack Welding

- All tack welds shall be a minimum of 10 mm in length and made with low hydrogen electrodes and shall not be incorporated in the final structure without specific written authorization by the Contract Administrator.

(ix) Stud Shear Connectors

- The accessories, equipment and welding procedures for the installation of the shear connectors shall be in accordance with AWS D1.1 and CSA W59. Welding by hand will not be allowed.

(x) Hot-Dip Galvanizing

- Galvanizing, when called for on the Drawings, shall be done in accordance with ASTM A123 and CSA G164;

- All metal surfaces to be galvanized shall be cleaned thoroughly of rust, rust scale, mill scale, dirt, paint and other foreign material to SSPC – SP 6 (sand, grit or shop blasting or pickling) prior to galvanizing.
- Heavy deposits of oil and grease shall be removed with solvents prior to blasting or pickling to SSPC – SP 1.

E58.5.2 Handling, Delivery and Storage of Materials

(a) Precautionary measures shall be taken to avoid damage to miscellaneous metal during handling, transit, stockpiling and erecting. Pinholes, or other field connection holes shall not be used for lifting purposes. Special attention is directed to the shipping and storing of miscellaneous metal.

(b) Damaged parts shall not be installed in the structure and may be rejected at the discretion of the Contract Administrator.

(c) Materials that are not placed directly in the structure shall be stored above probable high water, on skids, platforms or in bins in a manner that will prevent distortion or the accumulation of water or dirt on the miscellaneous metal. The materials shall be kept separate and stored properly for ease of inspection, checking and handling and shall be drained and protected from corrosion.

E58.5.3 Erection

(a) Layout

(i) Before erection of miscellaneous metal, the Contractor shall satisfy himself that the installation locations are in accordance with the Drawings and Specifications. All discrepancies discovered by the Contractor shall be brought immediately to the attention of the Contract Administrator.

E58.5.4 Workmanship

(a) The parts shall be assembled as shown on the Drawings and all match marks shall be observed. The material shall be handled carefully so that no parts will be bent, broken or otherwise damaged.

(b) Hammering which will injure or distort the member is not permitted.

E58.5.5 Misfits and Field Fitting

(a) Misfits of any part or parts to be erected under this Specification may be cause for rejection. No field fitting shall be undertaken by the Contractor until the cause for misfit of parts has been determined and the Contract Administrator, so informed, has given direct approval to accept the Contractor's proposed corrective measures. The Contract Administrator's decision as to the quantity of such work to be performed at the Contactor’s expense will be final and binding.

E58.5.6 Field Welding

(a) All field welding shall be electric arc welding, and shall be carried out in accordance with the Drawings, AWS D1.1,D1.6 and CSA W59.

E58.5.7 Final Cleaning

(a) All metal surfaces shall be left free of dirt, dried concrete, debris or foreign matter to the satisfaction of the Contract Administrator.

E58.6 Quality Control

E58.6.1 The Contractor shall be responsible for making a thorough inspection of materials to be supplied under this Work. All miscellaneous metal shall be free of surface imperfections, pipes, porosity, laps, laminations and other defects.

(a) Welding

(i) All welding may be subject to inspection by Non-Destructive Testing. This inspection shall be carried out in a manner approved of the Contract Administrator.

(ii) The Contractor shall provide sufficient access and shop area to permit the performance of the tests.

(iii) The Contractor shall give the Contract Administrator not less than twenty-four (24) hours' notice of when work will be ready for testing and shall advise the Contract Administrator of the type and quantity of work that will be ready for testing.

(iv) All defects revealed shall be repaired by the Contractor at their own expense and to the approval of the Contract Administrator.

E58.7 Quality Assurance

E58.7.1 All materials will be subject to physical inspection by the Contract Administrator and will be subject to rejection during the course of the Work and for the length of time as specified in the General Conditions, if, in the opinion of the Contract Administrator, the materials involved do not meet the requirements of the Drawings and this Specification.

E58.7.2 All materials shall be subject to testing by the Contract Administrator and will be approved only if the requirements of the Drawings, standards and this Specification are met. The Contractor shall supply the specimens for testing in accordance with the requests of the Contract Administrator.

E58.7.3 The Contractor shall furnish facilities for the inspection of material and workmanship in the mill, shop and field, and the Contract Administrator shall be allowed free access to the necessary parts of the Works.

E58.8 Measurement and Payment

E58.8.1 Supply, fabrication and erection of miscellaneous metal will not be measured and will be paid for at the Contract Lump Sum Price for "Items of Work" listed here below, which price shall be payment in full for performing all operations herein described and all other items incidental to the Work included in this Specification and accepted by the Contract Administrator.

E58.8.2 Items of Work:

(a) Miscellaneous Metal

(i) Bridge Rehabilitation;

- Steel Girder Splice Plates;
- Concrete Girder Flexural Strengthening Assembly;
- Other Items - Dowels, Inserts, Threaded Rods & Bearing Plates.

(ii) Pedestrian-Cyclist Underpass;

- Miscellaneous Metal.

(iii) Retaining Walls;

- Miscellaneous Metal.

E58.8.3 Installation of Preset Anchor Units

(a) The installation of the precast anchor units for railing will not be measured. This Item of Work is considered incidental to the Contract Lump Sum Price for the "Miscellaneous Metal".

E58.8.4 Supply and Installation of Railing Neoprene Pads

(a) The supply of the railing neoprene pads will not be measured. This Item of Work is considered incidental to the Contract Lump Sum Price for the "Miscellaneous Metal".

(b) The installation of the railing neoprene pads for railing will not be measured. This Item of Work is considered incidental to the Contract Lump Sum Price for the "Miscellaneous Metal".

E59. HOT-POURED RUBBERIZED ASPHALT WATERPROOFING

E59.1 Description

(a) This Specification shall cover the supply of labour, equipment, tools, and material necessary for the application of hot poured rubberized asphalt waterproofing on the bridge deck and approach slab, as specified herein and as shown on the Drawings.

(b) The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all other things necessary for and incidental to the satisfactory completion of all Work as hereinafter specified.

E59.2 Referenced Specifications and Drawings

(a) The latest version of the City of Winnipeg Standard Construction Specifications and the latest edition and all subsequent revisions of the following standards:

(i) CAN/CGSB-27.9M – Primer, Asphalt, Unfilled for Asphalt Roofing, Dampproofing and Waterproofing;

(ii) CGSB-37-GP-50M – Hot Applied Rubberized Asphalt for Roofing and Waterproofing;

(iii) CGSB-37-GP-51M – Application of Hot Applied Rubberized Asphalt for Roofing and Waterproofing;

(iv) CGSB-37-GP-56M – Membrane, Bituminous, Prefabricated and Reinforced for Rooting.

E59.3 Scope of Work

(a) The Work under this Specification shall involve:

(i) Preparing the concrete deck and to receive the waterproofing membrane;

(ii) Applying primer to the concrete deck and approach slab surfaces;

(iii) Placing the asphalt waterproofing membrane on the concrete deck and approach slab;

(iv) Placing polyester fabric protection layers and protection board, as shown on the Drawings;

(v) Suppling and installing wick drains and associated end drainage at the interface of the bridge deck and bridge traffic.

E59.4 Submittals

(a) The Contractor shall submit to the Contract Administrator for review and approval, at least ten (10) Business Days prior to the commencement of any scheduled Work on the Site, a proposed schedule, including methods and sequence of operations.

(b) The Contractor shall submit to the Contract Administrator for review and approval, at least ten (10) Business Days prior to the commencement of any scheduled Work on the Site, the proposed material(s) to undertake the Work. Data submitted shall summarize the physical, mechanical, and chemical characteristics of the material.

E59.5 Materials

E59.5.1 General

(a) The Contractor shall be responsible for the supply, safe storage and handling of all materials as set forth in this Specification. All materials shall be handled in a careful and workmanlike manner.

(b) The Contractor shall be responsible for the supply, safe storage and handling of all materials as set forth in this Specification. All materials shall be handled in a careful and workmanlike manner, to the satisfaction of the Contract Administrator.

E59.5.2 Hot Poured Rubberized Asphalt Waterproofing

(a) The hot poured rubberized asphalt waterproofing system shall consist of the following compounds:

(i) Primer;

(ii) Hot applied rubberized asphalt waterproofing membrane;

(iii) Polyester fabric;

(iv) Protection board.

(b) The hot poured rubberized asphalt waterproofing membrane shall be a two (2) layer, fabric-reinforced system. Each layer shall be 2.0 to 3.0 mm in thickness. The intermediate fabric reinforcement shall be placed between the layers.

(c) The Contractor shall supply and install approved protection board to cover the hot poured rubberized asphalt waterproofing membrane.

E59.5.3 Primer

(a) The entire concrete surface to be waterproofed shall receive a prime coat conforming to the requirements of damproofing / waterproofing primer CGSB37-GP-9Ma, 930-18 (BAKOR) or approved equivalent in accordance with in accordance with B7, “Substitutes”, at an application rate in accordance with the Manufacturer’s recommended methods.

(b) Primer shall be stored at temperatures of 5^{o}C and above to facilitate handling. Materials shall be stored in a dry location and shall be kept in an upright position.

E59.5.4 Hot Poured Rubberized Asphalt Waterproofing Membrane (Two (2) layers)

(a) The hot poured rubberized asphalt waterproofing membrane shall be Bemalastic 1213 BDM by McAsphalt or 790-11 by BAKOR, or an approved equivalent, in accordance with B7 “Substitutes”.

(b) The waterproofing membrane shall be melted, mixed, and applied according to the Manufacturer’s recommendations.

(c) The layering operation shall be such that the waterproofing membrane is applied in two (2) 2.0 mm – 3.0 mm thick layers.

(d) Discontinuities in the waterproofing membrane shall be avoided and joints lapped a minimum of 150 mm. The waterproofing membrane shall be applied to the entire bridge deck and approach slab and shall extend up the face of the barriers to the top (proposed elevation) of the asphalt pavement.

(e) At the Contract Administrator’s discretion, samples from the kettles shall be tested by the Contractor.

E59.5.5 Polyester Fabric

(a) An intermediate reinforcing layer shall be placed between the layers of waterproofing membrane. The intermediate reinforcing layer shall be spun-bonded polyester fabric such as Reemay 2016 grade, BAKOR Polyester Fabric Reinforcing Sheet, McAsphalt Fabric Reinforcement BP-16 or approved equivalent in accordance with B7 “Substitutes”, and set into the first layer of waterproofing membrane to achieve a minimum of fifty percent (50%) bleed through. Maximum overlap or gap between sheets of 6 mm.

E59.5.6 Protection Board

(a) The protection board shall be a durable panel of 3 mm thickness specifically designed to provide a protective cushion between the hot mix asphalt pavement and the hot-applied rubberized asphalt waterproofing membrane for bridges and shall be approved by the Contract Administrator.

(b) The protection board shall be BAKOR Asphalt Protection Board, McAsphalt Protection Board BP-Asp PB, or approved equivalent in accordance with B7, “Substitutes”.

(c) The protection boards shall be placed on top of the upper layer of waterproofing and rolled by means of a linoleum or lawn type roller while the membrane is still warm to

ensure good contact with the membrane. The protection boards shall be placed with edges overlapping 25 mm both longitudinally and transversely. The protection board's edge shall be within 5 mm of all barriers. Protection boards shall be placed such that the longitudinal (direction of traffic) joints are staggered at least 150 mm. Instances where edges of the protection board curl up, the edges shall be cemented down using asphalt waterproofing. Protection boards that are warped, distorted, or damaged in any way shall be rejected.

E59.5.7 Surface Conditioner

(a) Surface conditioner shall be applied to the concrete surfaces of the bridge deck, and approach slab and shall conform to the Manufacturer's recommended methods.

E59.6 Wick Drains

(a) Wick drains shall consist of composite polypropylene with a total thickness of 3.6 mm, supplied in widths of 100 mm.

(b) The puncture strength shall be a minimum of 0.45kN, measured in accordance with the requirements of the latest edition of ASTM D4833

(c) Wick Drain shall be one (1) of the approved products: American Wick Drain and distributed by Layfield and Nilex Inc under private labels Nilex NuDdrain MD7407 and Layfield Wick Drain Type 1, or an approved equal as accepted by the Contract Administrator in accordance with B7, "Substitutes".

(d) The rubber membrane shall consist of butyl rubber with a total thickness of 1.2 mm.

(e) Rubber membrane shall be one (1) of the approved products: Elastoshet 6147, BP47 Elastomeric Reinforcement, BAKOR 990-25, or an approved equal as accepted by the Contract Administrator in accordance with B7, "Substitutes".

E59.7 Equipment

E59.7.1 General

(a) All equipment shall be of a type acceptable to the Contract Administrator and shall be kept in good working order.

E59.8 Construction Methods

E59.8.1 General

(a) No installation work shall be performed during rainy or inclement weather and on frost or wet covered surfaces.

(b) Temporary protection of the membrane shall be provided to prevent mechanical damage or damage from spillage of oil or solvents until such time as permanent protection is provided.

E59.8.2 Melting On-Site

(a) Cakes of rubberized asphalt waterproofing shall be melted in an approved double shell melter under continuous agitation until the material can be drawn free flowing and lump free from the melter.

(b) The temperature of the rubberized asphalt waterproofing shall not exceed two hundred and eighteen degrees Celsius (218°C) at any time during the entire melting procedure.

E59.8.3 Application

(a) 1.2 thick 300 mm wide Bituthene 3000 shall be placed as shown in drawings prior to placement of waterproofing membrane in accordance with the Manufacturer's requirements.

(b) The entire concrete surface area onto which the hot poured rubberized asphalt waterproofing is to be applied shall be thoroughly cleaned by means of sand blasting. The sand blasted surfaces shall be sound, free from curing compounds, laitance, and

scaling. All rough spots, ridges and edges in the concrete surface resulting from protrusions of concrete aggregate or cement paste shall be removed by light chipping or grinding to leave a smooth and level surface. Immediately prior to the application of the hot poured rubberized asphalt waterproofing, a final cleaning of the concrete surfaces shall be done using high velocity compressed air. The concrete surfaces shall be dry, clean, and free from frost, dust, dirt, and all foreign matter. The Contractor shall contain and collect all products of the sand blasting operation including dust, debris, and spent abrasive so as to ensure that all of these materials are prevented from entering into and being deposited into Sturgeon Creek. All debris and spent abrasive shall be collected and disposed of off-site by the Contractor at a proper disposal facility. The Contractor is responsible for the preparation of the concrete surfaces to ensure that the hot-poured rubberized asphalt waterproofing can be installed in accordance with the Manufacturer's requirements.

(c) The Contractor shall ensure that the concrete surfaces onto which the hot poured rubberized asphalt waterproofing is to be applied is prepared (including supply and application or waterproofing primer) to the degree that the hot poured rubberized asphalt waterproofing can be installed in accordance with the Manufacturer's requirements.

(d) After the concrete deck and approach slab have been cleaned, they shall be covered with surface conditioner. The quantity used shall be 160 mL/m2, or as recommended by the Manufacturer. The surface conditioner shall be allowed to dry before the application of the rubberized asphalt waterproofing.

(e) The primer shall be applied at a uniform rate, as recommended by the Manufacturer, avoiding over-spraying or ponding of material. The primer shall be dry before applying the rubberized asphalt waterproofing.

(f) The rubberized asphalt waterproofing shall be brought to a temperature of between 190^{o}C and 218^{o}C.

(g) The application of the rubberized asphalt waterproofing shall be carried out under the supervision of experienced personnel.

(h) Apply membrane in a smooth fashion, free from air pockets, wrinkles, or tears, and in accordance with the Manufacturer's recommended methods. Ensure full bond of membrane to substrate.

(i) Apply the first layer of hot rubberized asphalt membrane evenly to a minimum thickness of 2 mm to form a continuous monolithic coating over horizontal and vertical surfaces.

(j) Apply fabric reinforcing sheet and firmly press into first layer of hot membrane. Overlap fabric approximately 6 mm ensuring that a layer of membrane is present between overlaps. Apply a second layer of membrane over the fabric to a minimum thickness of 3 mm.

(k) The Contractor shall supply and install an elastomeric sheet membrane which is compatible with the hot-poured rubberized asphalt waterproofing material. The elastomeric sheet membrane shall be installed at the designated locations shown on the Drawings. Installation of the heavy-duty elastomeric sheet membrane shall be in accordance with the Manufacturer's recommendations.

(l) Protection course shall be rolled onto hot applied rubberized asphalt membrane surface while still warm and tacky.

(m) Lap protection course shall be 50 mm on side laps and 150 mm on end laps, staggering laps.

E59.8.4 Installation of Wick Drains

(a) Wick drains shall be installed along the full length of the bridge deck and approach slab at the interface between the slab and traffic barrier.

(b) Wick drains shall be installed when the hot poured rubberized asphalt waterproofing membrane is still hot and tacky.

(c) Special attention shall be given to waterproofing and wick drain modifications at deck drain pipe locations.

(d) Tack coat shall not be applied to wick drains.

E59.9 Quality Control

E59.9.1 Inspection

(a) All workmanship and all materials furnished and supplied under this Specification are subject to close and systematic inspection and testing by the Contract Administrator including all operations from the selection and production of materials through to final acceptance of the specified Work.

(b) The Contractor shall be wholly responsible for the control of all operations incidental thereto, notwithstanding any inspection or acceptance that may have been previously given. The Contract Administrator reserves the right to reject any materials or Works, which are not in accordance with the requirements of this Specification.

E59.9.2 Access

(a) The Contractor shall allow the Contract Administrator free access to all parts of the Work at all times. The Contractor shall supply samples to the Contract Administrator or his inspector for testing purposes as required. There will be no charge to the City for samples taken.

E59.10 Measurement and Payment

E59.10.1 Hot-Poured Rubberized Asphalt Waterproofing

(a) Hot-poured rubberized asphalt waterproofing with protection board shall be paid for at the Contract Lump Sum Price for "Hot-Poured Rubberized Asphalt Waterproofing with Protection Board", and performed in accordance with this Specification and accepted by the Contract Administrator, which price shall be paid in full for supplying all materials and for performing all operations herein described and all other items incidental to the Work.

E60. WATERPROOFING MEMBRANE WITH PROTECTION BOARD

E60.1 Description

(a) This Specification shall cover the supply of labour, equipment, tools, and material necessary for the application of waterproofing membrane on the underpass exterior surface, as specified herein and as shown on the Drawings.

(b) The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all other things necessary for and incidental to the satisfactory completion of all Work as hereinafter specified.

E60.2 Referenced Specifications

(a) The latest version of the following standards;

a) ICRI Guideline No. 03732.

E60.3 Scope of Work

(a) The Work under this Specification shall involve:

a) Preparing the underpass exterior surfaces to receive the waterproofing membrane;

b) Applying primer to the underpass exterior surfaces;

c) Placing the waterproofing membrane on the underpass exterior surfaces;

d) Placing protection board, 300 wide butyl rubber membrane and dimpled drain board as shown on the Drawings;.

E60.4 Submittals

(a) The Contractor shall submit to the Contract Administrator for review and approval, at least ten (10) Business Days prior to the commencement of any scheduled Work on the Site, a proposed schedule, including methods and sequence of operations.

(b) The Contractor shall submit to the Contract Administrator for review and approval, at least ten (10) Business Days prior to the commencement of any scheduled Work on the Site, the proposed material(s) to undertake the Work. Data submitted shall summarize the physical, mechanical, and chemical characteristics of the material.

E60.5 Materials

E60.5.1 General

(a) The Contractor shall be responsible for the supply, safe storage and handling of all materials as set forth in this Specification. All materials shall be handled in a careful and workmanlike manner.

(b) The Contractor shall be responsible for the supply, safe storage and handling of all materials as set forth in this Specification. All materials shall be handled in a careful and workmanlike manner, to the satisfaction of the Contract Administrator.

E60.5.2 Waterproofing Membrane

(a) The waterproofing membrane shall be one (1) of the following systems. Other systems may be used at the approval of the Contract Administrator:

(i) Bituthene 3000 as manufactured by Grace Construction Products;

(ii) Torchflex TP-250-FF as manufactured by IKO Industries;

(iii) Sopralene Flame 250 as manufactured by Soprema;

(iv) Bridge Deck Membrane as manufactured by Bridge Preservation;

(v) Two (2) component methyl methacrylate (MMA) resin membrane as manufactured by Stirling Lloyd.

(b) The Contractor shall supply and install approved protection board to cover the waterproofing membrane

(c) At the Contract Administrator's discretion, samples from the waterproofing membrane shall be tested by the Contractor.

E60.5.3 Primer

(a) The entire concrete surface to be waterproofed shall receive a prime coat in accordance with the Manufacturer's recommended methods.

(b) Primer shall be stored at temperatures in accordance with the Manufacturer's specifications. Materials shall be stored in a dry location and shall be kept in an upright position.

E60.5.4 300 mm Wide Rubber Membrane Strips

(a) 1.2 mm thick 300 mm wide Bituthene 3000 as manufactured by Grace Construction Products.

E60.5.5 Protection Board

(a) The protection board shall be asphaltic panels of minimum thickness 10 mm laid in two (2) layers with staggered joints.

E60.5.6 Dimpled drain board

(a) Dimpled drain board shall be Nilex ND50 and shall be applied full height as shown on the Drawings.

E60.6 Equipment

E60.6.1 General

(a) All equipment shall be of a type acceptable to the Contract Administrator and shall be kept in good working order.

E60.7 Construction Methods

E60.7.1 General

(a) No installation work shall be performed during rainy or inclement weather and on frost or wet covered surfaces.

(b) Temporary protection of the membrane shall be provided to prevent mechanical damage or damage from spillage of oil or solvents until such time as permanent protection is provided.

(c) The Contractor shall perform all the operations involved in waterproofing in sequential order, such that there are no delays between individual operations except those necessary to meet the requirements of this Specification.

(d) The Contractor shall give the Contract Administrator forty-eight (48) hours' notice prior to commencing any waterproofing operations.

E60.7.2 Application

(a) 1.2 thick 300 mm wide Bituthene 3000 shall be placed as shown in Drawings and over construction joints prior to placement of waterproofing membrane in accordance with the Manufacturer's requirements.

(b) Concrete to be waterproofed shall be completely surface dry and cured at least fourteen (14) days before application of waterproofing can commence.

(c) The entire concrete surface area onto which the waterproofing system is to be applied shall be thoroughly cleaned and prepared in accordance with the International Concrete Repair Institute (ICRI) to Concrete Surface Profile 3 (CSP-3) minimum, or to the degree stipulated by the waterproofing membrane manufacturer, whichever is stricter. Surface preparation shall be accomplished by shot blasting, sand blasting, or other approved methods and accepted by the Contract Administrator.

(d) Immediately prior to application of the waterproofing membrane, the Contractor shall air blast the concrete surface to remove all dust and any other foreign material.

(e) The waterproofing membrane shall be allowed to cure as per the manufacturer's recommendations prior to covering with two (2) layers of asphaltic protection board. The protection board shall be installed with staggered joints.

(f) Dimpled drain board shall be installed over protection board at underpass exterior walls to the limits shown on the Drawings.

E60.8 Quality Control

E60.8.1 Inspection

(a) All workmanship and all materials furnished and supplied under this Specification are subject to close and systematic inspection and testing by the Contract Administrator including all operations from the selection and production of materials through to final acceptance of the specified Work.

(b) The Contractor shall be wholly responsible for the control of all operations incidental thereto, notwithstanding any inspection or acceptance that may have been previously given. The Contract Administrator reserves the right to reject any materials or Works, which are not in accordance with the requirements of this Specification.

E60.8.2 Access

(a) The Contractor shall allow the Contract Administrator free access to all parts of the Work at all times. The Contractor shall supply samples to the Contract Administrator or his inspector for testing purposes as required. There will be no charge to the City for samples taken.

E60.9 Measurement and Payment

E60.9.1 Waterproofing Membrane with Protection Board

(a) Waterproofing membrane with protection board and dimpled drain board will not be measured and shall be paid for at the Contract Lump Sum Price for "Waterproofing Membrane with Protection Board ", and performed in accordance with this Specification and accepted by the Contract Administrator, which price shall be paid in full for supplying all materials and for performing all operations herein described and all other items incidental to the Work.

E61. RANDOM STONE RIP-RAP

E61.1 Description

E61.1.1 These Specifications govern all operations necessary for and pertaining to the supplying and placing of approved riprap as a protective covering along the side slopes of the river channel or such other places as may be indicated on the Drawings or designated by the Contract Administrator in the field.

E61.1.2 This Specification shall amend and supplement Specification No. CW 3615.

E61.2 Referenced Specifications

(a) All reference standards and related specifications shall be current issue or latest revision at the date of tender advertisement.

(b) Specifications

a) CW 3615-R4 – for Random Stone Rip-rap

b) CW 3130-R4 for “Separation Geotextile Fabric”.

E61.3 Submittals

E61.3.1 The Contractor shall submit the proposed supplier(s) and location of quarry sites at least ten (10) business days prior to the supply of riprap to the Site, to confirm that sufficient quantity of specified rock is available.

E61.3.2 The Contractor shall supply representative test results at least ten (10) business days prior to the supply of riprap to the Site, demonstrating that the material to be supplied is of adequate quality and gradation to satisfy the material specifications contained herein.

E61.4 Materials

E61.4.1 Rock

(a) Rock for riprap shall consist of hard, dense, durable rock. The rock shall be quarried rock or fieldstone, dense and durable, and resistant to the action of frost and water and suitable in all other respect for the purpose intended. Stone rip-rap shall be free of sod, roots, organic material and debris prior to placement. Individual pieces of stone shall be free of defects such as seams or cracks prior to placement. Where stipulated, rock is to be of the same type as that existing in place meeting the following properties:

(i) minimum bulk specific gravity of 2.6 (ASTM C127);

(ii) maximum Los Angeles abrasion loss of thirty –two percent (32%) (ASTM C535);

(iii) maximum Magnesium Sulphate Soundness Loss of thirteen percent (13%) (ASTM C88);

(iv) maximum absorption of two and a half percent (2.5%) (ASTM C127);

(v) gradation requirements, as follows:

¨ The riprap shall be well graded having a full range and even distribution of sizes and shall conform to the following gradation:

Table E61-11: Gradation Requirements for Rip-rap

Diameter (mm)	Percent Passing by dry Weight
350	100%
300	75%
200	25%
5	0-5%

(b) Individual particles shall be shaped such that no dimension is greater than four (4) times the smallest dimension. Flat, elongated, or platy particle shapes will not be accepted.

(c) The diameter shall be taken as the average of the shortest and longest dimension measured on an individual piece of riprap.

(d) Contractors supplying riprap shall be responsible for demonstrating that the material is of adequate quality, gradation, and volume to meet the material specifications contained herein.

(e) All materials set forth in this Specification shall be subject to inspection and testing by the Contract Administrator or by the testing laboratory designated by the Contract Administrator.

(f) The Contract Administrator will visit proposed quarry Sites for inspection of the proposed riprap material and quarry faces a minimum of fourteen (14) days prior to supply and placement of riprap.

(g) No supply and placement of riprap will be permitted prior to the Contract Administrator approving the source.

(h) The testing frequency necessary to confirm the material quality will be specified at the discretion of the Contract Administrator.

E61.4.2 Geotextile

(a) The geotextile shall be non-woven type, and supplied and placed in accordance with CW 3130-R4 for “Separation Geotextile Fabric”.

E61.5 Construction Methods

(a) The bed for riprap shall be shaped and trimmed to the lines as shown on the Drawings or as staked in the field by the Contract Administrator, prior to placing of any riprap. No riprap shall be placed until the bed has been inspected and approved by the Contract Administrator.

(b) Place a layer of geotextile fabric under the riprap. Anchor the geotextile fabric on the upstream and downstream end of the rock filled trenches as shown on the Drawings.

(c) Place the rock riprap carefully on the geotextile fabric so that it does not tear. Place the rock in such a manner that the larger stones are uniformly distributed and smaller rocks serve to fill the spaces between the larger rocks. Sufficient hand work shall be done to procure a neat and uniform surface with the thickness as shown on the Drawings.

E61.6 Measurement and Payment

E61.6.1 Random stone riprap will not be measured and paid for at the Contract Lump Sum Price for “Supply and Place Riprap” installed in accordance with this Specification and accepted by the Contract Administrator.

E61.6.2 This work shall include all necessary trimming and excavation and the removal off site, of the excess excavated material, unless otherwise specified in the Specifications for the Work.

E61.6.3 Sub-excavation and disposal of excavated soil, shaping the riprap bed, supplying, loading, hauling, placing geotextile and stone riprap shall be considered incidental to the Work.

E62. GRANULAR RIB CONSTRUCTION

E62.1 Description

E62.1.1 The Work covered under this item shall include all items relating to the construction of Granular Ribs, as shown on Drawings.

E62.1.2 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Work as hereinafter specified.

E62.2 Scope of Work

E62.2.1 The scope of this Work is not necessarily confined to the following, which is compiled as a general outline:

(a) Excavation;

(b) Supply and placement of all backfill materials;

(c) Supply and placement of 600 mm thick clay cap;

(d) Compaction of backfill materials.

E62.3 Materials

E62.3.1 General

(a) The Contractor shall be responsible for the supply, safe storage, and handling of all materials set forth in this Specification. All materials supplied under this Specification shall be subject to inspection and testing by the Contract Administrator. There shall be no charge to the City for any materials taken by the Contract Administrator for testing purposes.

(b) The Contractor shall supply all materials incidental to these Works. All materials must be on hand prior to commencement of the Work.

E62.3.2 Aggregate

(a) Rockfill for Granular Ribs

(i) Backfill for granular ribs shall consist of sound, dense, durable crushed limestone. The material shall be free from organics, roots, silt, clay, snow, ice or any other deleterious material.

(ii) Backfill for granular ribs shall consist of 100 mm down in accordance with Clause 2.1 of CW 3110 (latest edition) with the following modifications:

Parameter	**Test Method**	**Specified Limit**
Bulk Specific Gravity	ASTM C127	2.6 minimum
LA Abrasion	ASTM C131	35% maximum
Soundness	ASTM C88	13% maximum

E62.3.3 Clay cap shall be as per City specification CW 3170, clause 5.

E62.4 Construction Methods

E62.4.1 Compaction Testing Program

(a) The Contractor shall carry out a Compaction Testing Program to facilitate quality control during construction. This program shall be carried out to demonstrate that the

means, methods and techniques of compaction proposed by the Contractor are consistent with achieving the degree of compaction specified.

(b) The Contractor shall provide all necessary labour, material and equipment necessary to carry out the compaction testing program. All testing shall be carried out in the presence of the Contract Administrator. Minimum requirements for the testing program will include:

(i) The first granular rib shall be used as a test trench. Additional test trenches (if required) shall be located immediately adjacent to completed test trenches. The test trench shall be excavated to the lines and grades shown on the drawings and backfilled as noted herein.

(ii) Placement of the backfill material shall be in maximum lift thicknesses (prior to compaction) of 400 mm, if compacted using a hoe-pack. If a direct-insertion vibratory probe will be used for compaction, the trench may be backfilled in full prior to compaction. The equipment to be used shall be subject to review and acceptance by the Contractor Administrator.

(iii) Compaction of the backfill in the manner proposed for construction to achieve a maximum apparent field density. The degree of compaction will be determined by measurement of the volume of backfill material before and after compaction.

(iv) Such other testing as necessary to demonstrate that the Contractor's proposed means, method(s), techniques and equipment are consistent with achieving the specified degree of compaction during construction.

(c) The contractor shall carry out in the proximity of any Manitoba Hydro distribution poles, as Specified in "Appendix 'I' – Manitoba Hydro – Safe Excavation and Saftey Watch Guidelines" and "Appendix 'K' – Manitoba Hydro Standard Drawings : Allowable Excavation around Existing Poles CD 30-35". Any damages to the Hydro distribution poles must be reported and repaired at no cost to Manitoba Hydro or the Contract Administrator Prior to backfilling.

(d) As a result of the Compaction Testing Program, the Contractor must establish the following:

(i) the compaction equipment proposed for use;

(ii) the protocol for operations;

(iii) degree of compactive effort required.

(e) No construction of granular ribs shall commence until the Contractor has demonstrated through the Compaction Testing Program that the proposed methods of compaction will meet the specified requirement for each portion of the works. Acceptance of the Compaction Testing Program shall in no way relieve the Contractor from his contractual obligation of achieving the specified degree of compaction during construction.

E62.4.2 Granular Rib Construction

(a) The Contractor shall monitor his compaction operations during construction to ensure the compaction methods selected based on the Compaction Testing Program are consistently achieving the specified results.

(b) The Contractor shall advise the Contract Administrator of any modifications to his proposed methods that are required if the required degree of compaction is not being achieved.

E62.4.3 Excavation

(a) The excavation for each rib shall be a width of 1.2 metres and shall extend to the lines and grades shown on the drawings. The excavation for sideslopes shall be cut as near vertical as possible. Any deleterious or sloughed material at the base of the excavation or during backfilling shall be removed prior to further backfilling.

(b) The Contractor shall maintain a dry excavation and will be required to take the necessary corrective actions to prevent water from entering or accumulating in the excavation.

E62.4.4 Backfilling and Compaction

(a) Backfilling of each granular rib shall commence immediately after excavation has been completed and shall not be left open. Excavation of adjacent ribs will not be permitted until backfilling of the excavated rib is complete.

(b) Backfilling and compaction shall proceed following the protocol determined in the Compaction Testing Program.

(c) Care shall be taken to prevent contamination of the crushed limestone backfill. Should contamination of the backfill occur, the affected backfill shall be removed and disposed as directed by the Contract Administrator and will be incidental to the Works.

E62.5 Compaction Testing Program

E62.5.1 The Compaction Testing Program shall be incidental to Granular Rib construction.

E62.6 Measurement and Payment

E62.6.1 Granular Rib Construction

(a) The supplying, and placing of crushed limestone backfill for granular rib construction, and also the trial rib construction will not be measured and paid for the Contract Lump Sum Price for “Granular Rib Construction”. The crushed limestone backfill material supplied and placed in accordance with this specification, accepted and measured by the Contract Administrator.

(b) No separate measurement and payment will be made for the excavation and disposal of soil or contaminated backfill material from the rib trenches. Excavation and disposal of soil and or contaminated backfill material will be considered incidental to the contract.

(c) No separate measurement and payment will be made for the compaction of granular rib backfill. All backfill compaction will be considered incidental to the contract.

(d) No separate measurement and payment will be made for the supply and placement of 600 mm clay cap and shall be incidental to “Granular Rib Construction”.

E63. STRUCTURAL REMOVALS

E63.1 Description

E63.1.1 General

(a) This Specification shall cover all operations relating to the removal and disposal of miscellaneous existing bridge components, as specified herein and as shown on the Drawings. This Specification shall cover structural removal Works, including all necessary staging, demolition, removal, salvaging, transporting, unloading, stockpiling, dismantlement, and disposal of applicable materials.

(b) The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Works as hereinafter specified.

E63.2 References

(a) D17 Environmental Protection Plan;

(b) E9 Traffic Control;

(c) E10 Traffic Management;

(d) E12 Pedestrian Safety;

(e) City of Winnipeg By-Law No. 7070/97 Part 5, Control of Discharge to Sewers;

(f) ICRI Guideline No. 03732.

E63.3 Details of The Existing Structure

(a) The applicable details and structure dimensions of the existing structures are shown on the Drawings for information only in establishing the methods and limits of Work.

(b) The information shown has been obtained from existing Drawings, measurements, and observations at the Site. The accuracy of this information is not guaranteed and the Contractor must verify all information before commencing Work.

(c) A Bridge Condition Assessment was completed by Dillon Consulting Limited. The testing report is provided in Appendix 'H'.

E63.4 Scope of Work

E63.4.1 The Work under this Specification shall specifically include the following items to the limits as shown on the Drawings or as otherwise directed by the Contract Administrator:

(a) Removal and disposal of the existing bridge structure as follows:

(i) Full-depth superstructure isolation;

(ii) Complete removal and disposal of existing bridge overhangs including sidewalk posts and railings and concrete traffic barrier complete with aluminum balance barrier;

(iii) Complete removal and disposal of the raised concrete median;

(iv) Partial depth removal and disposal of the bridge deck;

(v) Full-depth removal and disposal of the bridge deck at the abutments diaphragms, piers, interior concrete diaphragms to be replaced, or at other locations marked for full-depth repairs on the Drawings or as identified by the Contract Administrator on Site;

(vi) Complete removal and disposal of all abutment and pier diaphragms and any interior concrete diaphragms marked for replacement;

(vii) Complete removal and disposal of the steel girder top-flange splice plates;

(viii) Complete removal and disposal of the concrete approach slabs including any bridge expansion joints;

(ix) Complete removal and disposal of the abutment backwalls, maskwalls and wingwalls;

(x) Complete removal and disposal of the existing abutment bearing assemblies;

(xi) Complete removal and disposal of any abandoned electrical and communication conduits not removed by others;

(xii) Complete removal and disposal of any other structural items identified on the Drawings but not explicitly listed in the above list.

(b) All materials not identified for salvage shall be disposed of at an approved disposal facility by the Contractor. Any disposal fees shall be considered incidental to this work;

(c) Temporarily protecting the live BellMTS ductbank currently suspended from the steel girders beneath the bridge and penetrating through the concrete backwalls continuing as a buried ductbank east and west away from the bridge;

(d) Completing all structural removals with appropriate equipment satisfactory to the Contract Administrator. Under no circumstances shall demolition products find their way into the watercourse. See D17 Environmental Protection Plan for more information;

(e) Providing saw cuts as shown on the Drawings and where otherwise necessary to limit the extent of demolition;

(f) Repairing any over demolition and damage to reinforcing steel or other structural components to the satisfaction of the Contract Administrator;

(g) Complying with any and all environmental requirements identified in the Specifications or otherwise applicable to the proposed Works.

E63.5 Submittals

E63.5.1 General

(a) The Contractor shall submit to the Contract Administrator for review and approval, at least ten (10) Business Days prior to the commencement of any removal Works on Site, a detailed removal plan and schedule clearly illustrating the method and sequence by which he proposes to perform the structural removals including a description of the measures that will be implemented to meet the applicable environmental requirements identified in "PART D - Supplemental Conditions". The removal procedure shall include Detailed Design notes and Shop Drawings that are sealed, signed, and dated by a Professional Engineer licensed to practice in the Province of Manitoba necessary for the following proposed items:

(i) Work platforms (suspended from the existing superstructure, supported from the existing ground, or otherwise);

(ii) BellMTS Ducts Protection Cover;

(iii) Type and capacity of removal equipment;

(iv) Sequence of removal operations;

(v) Design of demolition catch platforms (if different than work platforms) to contain all removal/demolition debris from entering into the watercourse below;

(vi) Description of the measures that will be implemented to meet the requirements of identified in "PART D - Supplemental Conditions".

E63.5.2 Hydro-Demolition

(a) The Contractor shall prepare and submit to the Contract Administrator for review and approval, at least ten (10) Business Days prior to the commencement of any hydro-demolition Work on Site, a hydro-demolition plan detailing the Contractor's proposed hydro-demolition runoff control and disposal methods and procedures. Wastewater from the hydro-demolition process shall meet the requirements of the City of Winnipeg By-Law No. 7070/97 Part 5, Control of Discharge to Sewers, prior to entering the City's land drainage sewer system. At no time can runoff of wastewater be permitted to enter the watercourse or the City's land drainage system unfiltered.

E63.6 Materials

E63.6.1 General

(a) All materials supplied under this Specification shall be of a type approved by the Contract Administrator and shall be subject to inspection and testing by the Contract Administrator.

(b) The Contractor shall be responsible for the supply, safe storage and handling of all materials as set forth in this Specification. All materials shall be handled in a careful and workmanlike manner, to the satisfaction of the Contract Administrator.

E63.7 Demolition Catch Platforms and Work Platforms

(a) Shall be in accordance with E66 Temporary Protection System.

E63.8 Equipment

E63.8.1 General

(a) All equipment shall be of a type acceptable to the Contract Administrator and shall be kept in good working order.

E63.8.2 Hydro-Demolition Equipment

(a) The hydro-demolition equipment shall be a self-propelled tracked machine that utilizes a high pressure water jet stream capable of removing concrete to the limits shown on the Drawings or as directed by the Contract Administrator and be capable of removing rust and concrete particles from reinforcing steel. The use of a hand-held lance shall be acceptable for horizontal and vertical surfaces. Pneumatic hammers (15 kg,

35 pound class maximum) may be used in areas that are inaccessible or inconvenient to the self-propelled machine such as, but not limited to, areas not to exceed 300 mm away from the bridge edges, subject to approval of the Contract Administrator.

(b) The above specified self-propelled tracked machine shall meet the minimum/maximum dimensions shown on the Drawings with respect to track spacing, length of machine, etc. and shall not exceed 2500 kg GVW.

(c) The use of any hydro-demolition equipment not conforming to the above requirements will not be permitted unless a formal request is provided by the Contractor for the Contract Administrator's review accompanied by a sealed, signed, and dated letter prepared by a Professional Engineer licensed to practice in the Province of Manitoba certifying that the proposed hydro-demolition equipment will not detrimentally affect the structural integrity of the structure.

E63.9 Sequence of Structural Removals

E63.9.1 Construction sequencing of all structural removals shall take place as shown on the Drawings.

E63.10 Construction Methods

E63.10.1 General

(a) The Contractor shall be fully responsible for ensuring the Public safety in all areas, and will be held responsible for any loss or damage caused due to neglect by the Contractor or his employees.

(b) The Contractor shall provide flagmen, guards, barricades, railings, and necessary warning lights, and whenever/wherever necessary, warning signs and lights at the excavations, temporary sidewalks, removals, and/or other construction, to secure the safety of workmen and the Public. The safety precautions shall comply with all Provincial Statutes applicable to the Work. The Contractor shall provide all other protective measures as may be required by any Law in force in Manitoba and the Canada Labour Code.

(c) Traffic and pedestrian control shall conform to the requirements of E9 "Traffic Control", E10 "Traffic Management" and E12 "Pedestrian Safety".

(d) Under no circumstances shall the Contractor close any portion of existing roadways or walkways to traffic without prior written approval of the Contract Administrator. If any existing roadway is to be closed to traffic in no case shall the Contractor commence any construction operations until such time that all the signs, barricades, and flashers have been erected to the satisfaction of the Contract Administrator.

(e) The Contractor shall generally prevent any unspecified and undesirable movement or settlement of the existing structure, damage to any existing structures to remain, and damage to any services, paving, trees, landscaping and adjacent grades not specified for removal/disturbance. The Contractor shall design and provide any bracing, shoring or underpinning necessary to complete the work as required and shall have any designs for this Work sealed, signed and dated by a Professional Engineer licensed to practice in the Province of Manitoba. If the safety of the structure and/or existing services appears to be endangered during structural removal operations or if the Work is detrimentally impacting the environment, the Contractor shall cease operations and notify the Contract Administrator immediately. Additionally, if the Work is proceeding in a fashion unsatisfactory to the Contract Administrator for any reason, the Contractor will be notified and shall cease operations immediately.

(f) In no case will the Contractor be permitted to use removal equipment, or other equipment or methods which may cause damage to any remaining structural components or to any new construction. In the event that any component is damaged, the Contractor shall repair such component at his own expense to the satisfaction of the Contract Administrator.

(g) Construction methods specific to the removal of each bridge component are provided in the following Clauses. Generally, the items have been listed in the order of removals however the Removal Sequence outlined in E63.9 shall govern.

E63.10.2 Full-Depth Superstructure Isolation

(a) No removal works including the full-depth superstructure isolation will be permitted to occur prior to the implementation of the necessary traffic control requirements in accordance with E9 Traffic Control including the installation of the PPCBs anchored to the live portion of the bridge deck as shown on the Drawings.

(b) Isolate the Stage 1 and Stage 2 superstructures as shown on the Drawings. Superstructure isolation may be accomplished by a full-depth saw cut along either side of the isolation however the minimum bottom rebar mat projections shall be obtained by subsequent removals with the use of hand removal, hydro-demolition, or other means acceptable to the Contract Administrator.

(c) The smooth vertical edge created by a full-depth saw cut will subsequently require further removal to achieve the minimum desired surface profile specified herein.

E63.10.3 Approach Slab Removal

(a) Remove and dispose of the existing approach slabs for each construction stage as shown on the Drawings.

E63.10.4 Bridge Deck Overhang Removal

(a) Remove and dispose of the existing north bridge deck overhang (Stage 1) and existing south deck overhang (Stage 2) including the existing concrete/steel barriers. The overhangs shall be removed prior to jacking the superstructure in accordance with E64 Temporary Jacking of Superstructure.

(b) Removal of the main overhang may be accomplished by a full-depth saw cut along the exterior of the outermost girder provided that any existing reinforcement required to be maintained is not damaged in the process. Subsequent removal around existing reinforcement specified to be maintained will be required with the use of hand removal, hydro-demolition, or other means acceptable to the Contract Administrator.

E63.10.5 Abutment Removals

(a) Remove and dispose of the existing abutment concrete for each construction Stage to the limits shown on the Drawings including the existing abutment backwalls, wingwalls, front/top/backsides of the abutment cap, and abutment bearings.

(b) Removals may be accomplished by full-depth saw cuts where possible provided any existing reinforcement required to be maintained is not damaged in the process. Subsequent removal around existing reinforcement specified to be maintained will be required with the use of hand removal, hydro-demolition, or other means acceptable to the Contract Administrator.

(c) See E46 Structural Excavation for specifications for excavating behind the abutments to expose the abutment backwall and other components for removal. Extreme caution shall be exercised during Stage 1 removals due to the presence of the BellMTS ductbank penetrating through the concrete backwall and continuing east and west away from the bridge buried below grade. The Contractor shall be responsible for protecting the BellMTS ductbank to BellMTS and the Contract Administrator's satisfaction in accordance with E66 Temporary Protection System.

(d) Upon jacking and shoring of the superstructure as per E64 Temporary Jacking of Superstructure, the Contractor shall remove and dispose of the existing abutment bearings. Any existing bearing anchors shall be removed or cut to a final depth of 75 mm inside the final concrete surface.

(e) The final surface preparation of the abutment concrete to remain (concrete substrate) shall be conducted by abrasive blasting, hydro-demolition, or other means acceptable to the Contract Administrator. The resulting surface shall achieve the required elevations while being roughened to the minimum following requirements:

(i) For horizontal surfaces, concrete shall be removed, roughened, and prepared in accordance with ICRI Guideline No. 03732, CSP6 (Medium Scarification).

(ii) For vertical surfaces, concrete shall be removed, roughened, and prepared in accordance with ICRI Guideline No. 03732, CSP4 (Light Scarification).

E63.10.6 Partial Depth Deck Removal

(a) Remove and dispose of the concrete deck slab to the depths and limits shown on the Drawings for each construction Stage. The Contractor is advised that the final extent of removal may be +/- 0-15 mm from that shown on the Drawings. The concrete deck slab may be removed by a combination of saw cutting, rotomilling and hydro-demolition, or by any other means acceptable the Contract Administrator.

(b) Removal by hydro-demolition shall be completed in accordance with this Specification.

(c) The final surface preparation of the deck concrete to remain (concrete substrate) shall be conducted by abrasive blasting, hydro-demolition, or other means acceptable to the Contract Administrator. The resulting surface shall be roughened to the minimum following requirements:

(i) For horizontal surfaces, concrete shall be removed, roughened, and prepared in accordance with ICRI Guideline No. 03732, CSP8 (Scabbled)

(ii) For vertical surfaces, concrete shall be removed, roughened, and prepared in accordance with ICRI Guideline No. 03732, CSP6 (Medium Scarification).

(d) The Contractor is advised that due to the existing condition of the deck, there exists the potential for full-depth “blow-throughs” of the deck to occur. The Contractor shall take care during the hydro-demolition process to minimize the occurrence of any blow-throughs. Any blow-throughs will need to be cast along with partial depth deck concrete as specified on the Drawings and will be measured and paid as per EXX “Structural Concrete”.

E63.10.7 Full-Depth Deck Removal

(a) Remove and dispose of the concrete deck slab full-depth for each construction Stage as specified on the Drawings.

(b) The full-depth removals shall be by hydro-demolition, hand removal, or other means acceptable to the Contract Administrator.

(c) Removal by hydro-demolition shall be completed in accordance with this Specification.

(d) Caution shall be taken to ensure that the existing bottom mat of reinforcing steel is not damaged during the full-depth removal operation. Any damage to the existing reinforcement shall be repaired at the Contractor’s expense to the satisfaction of the Contract Administrator.

(e) The existing bridge deck expansion joints and seals shall also be removed and disposed for each construction Stage. Equipment used for the removal of the expansion joint system shall be selected so that no damage is caused to the concrete deck and abutment concrete specified to remain. Any damage to the existing concrete deck and abutment concrete specified to remain shall be repaired at the Contractor’s expense to the satisfaction of the Contract Administrator.

E63.10.8 Concrete Diaphragm Removals

(a) Remove and dispose of the existing abutment and pier concrete diaphragms as well as interior concrete diaphragms identified on the Drawings for each construction Stage.

(b) Removals may be accomplished by full-depth saw cuts where possible provided any existing components required to be maintained are not damaged in the process. Subsequent removal around existing components specified to be maintained will be required with the use of hand removal, hydro-demolition, or other means acceptable to the Contract Administrator.

(c) During the removal of diaphragms, the Contractor shall make sure not to damage the existing shear studs on the steel girders, rebar inserts in the concrete girders, or other components as shown in the Drawings.

E63.10.9 Removal Methods by Hydro-Demolition

(a) Prior to the commencement of any removal operation by hydro-demolition, the hydro-demolition equipment shall be calibrated on an area of sound concrete approximately 600 mm x 1500 mm as directed by the Contract Administrator. The cost of the calibration procedure is incidental to the Work. The Contractor shall provide the Contract Administrator with the following settings:

(i) Water pressure;

(ii) Machine staging control (step);

(iii) Nozzle size;

(iv) Nozzle speed.

(b) During the calibration, any or all of the above settings may be adjusted in order to achieve removal in accordance with the requirements of the Drawings. When the designated depth of removal is attained, the settings shall be recorded and maintained throughout the removal operation unless otherwise directed by the Contract Administrator. The depth of removal shall be verified periodically and, if necessary, the equipment recalibrated to ensure the depth of removal as indicated on the Drawings is achieved.

(c) Wastewater from the hydro-demolition process shall meet the requirements of the City of Winnipeg By-Law No. 7070/97 Part 5, Control of Discharge to Sewers, prior to entering the City's land drainage sewer system. At no time can runoff of wastewater be permitted to enter the watercourse, or enter the City's land drainage system unfiltered. The Contractor shall complete daily pH tests in the presence of the Contract Administrator on wastewater runoff to ensure that all discharging of wastewater is in compliance with the City's By-laws. All test reports shall be submitted to the Contract Administrator, and must be within acceptable limits prior to any wastewater entering the City's land drainage sewer system.

(d) The Contractor shall take all necessary precautions to ensure that no sound concrete located below the required depth of removal is damaged or removed. Any damage caused to sound concrete or reinforcing steel beyond the required limit of removal or excessive removal of concrete beyond the required depth of removal by the Contractor during any demolition procedure will be repaired by the Contractor at the Contractor's own expense to the satisfaction of the Contract Administrator.

(e) Where applicable, any "shadowing" of the reinforcing steel by concrete not removed by the process of hydro-demolition shall be removed by the Contractor through other approved means.

(f) After the hydro-demolition is completed, the remaining concrete surface shall be inspected through methods of sounding by the Contract Administrator to ensure that all deteriorated concrete has been removed. Should deteriorated concrete be found, the Contractor shall remove the areas of deteriorated concrete by additional passes of the hydro-demolition equipment or other equipment approved by the Contract Administrator. Payment for removal of these areas shall be considered incidental to the Work.

(g) Upon completion of the hydro-demolition of each section of the Work, the Contractor shall remove all cuttings, slurry containing the products of hydro-demolition, and all other debris from the resulting concrete surface so as to produce a thoroughly clean surface. Cleaning of each section shall be done before debris and water are allowed to dry on the deck surface and prior to the placement of reinforcing steel.

(h) There is a possibility that during hydro-demolition, blow-throughs may occur. Since it is difficult to predict when or even if a blow-through will occur, the following contingency plan shall be undertaken by the Contractor for this eventuality:

(i) In instances where a blow-through of the deck does occur, the Contractor will be required to halt the water jet immediately and stop the flow of water and deck solids. The latter may be accomplished by immediately placing sandbags in the location of the blow-through opening. Sandbags shall be supplied on standby by the Contractor for just such an occurrence. After the blow-through opening is dammed, the hydro-demolition work may resume.

(i) All exposed reinforcing steel which is left unsupported by the hydro-demolition process shall be adequately supported and protected from all equipment. All reinforcing steel damaged or dislodged by these operations, as deemed by the Contract Administrator, shall be replaced with new reinforcing of the same size at the expense of the Contractor.

E63.11 Waste Handling and Disposal of Removed Materials

(a) Dispose of all surplus and unsuitable material off-site, in accordance with D17 Environmental Protection Plan.

(b) Wherever practical, the Contractor shall recycle disposed materials.

(c) The Contractor shall submit a list of locations of disposal/recycling for all removed materials to the Contract Administrator.

(d) The Contractor shall promptly haul all removed materials indicated for disposal, off and away from the site. No storage of any materials on-site will be allowed without written approval from the Contract Administrator. It shall be the Contractor's responsibility to find suitable disposal areas away from the site.

E63.12 Bridge Deck Survey

(a) The Contractor shall complete a survey of the existing bridge deck on a 1 m x 1 m grid prior to commencing any deck removals (with exception of the superstructure isolation and deck overhang removals). The elevations shall be submitted to the Contract Administrator for comparison with the final deck surface elevations to determine the final extent of removals.

(b) The Contractor shall complete a survey of the final bridge deck on the same 1 m x 1 m grid as used E63.12(a) after completion of all removals and final preparation of the deck surface. The elevations shall be submitted to the Contract Administrator for review and comparison with the pre-existing survey to determine the final extent of removals.

(c) The Contract Administrator shall use the results of the final survey to provide the final screed elevations for the new deck slab concrete. The final screed elevations shall be provided within five (5) Business Days from receipt of the survey elevations.

E63.13 Construction Load Limitations for Equipment

(a) Following removal of the top mat of reinforcing steel and until the completion of the deck slab and sidewalk concrete, equipment travelling across the deck shall be limited to a gross vehicle weight of 2,500 kg travelling with its wheels overtop the girder centerlines.

E63.14 Quality Control

E63.14.1 Inspection

(a) All workmanship and all materials furnished and supplied under this Specification are subject to close and systematic inspection and testing by the Contract Administrator including all operations from the selection and production of materials through to final acceptance of the specified Work.

(b) The Contractor shall be wholly responsible for the control of all operations incidental thereto, notwithstanding any inspection or acceptance that may have been previously given. The Contract Administrator reserves the right to reject any materials or Works, which are not in accordance with the requirements of this Specification.

E63.14.2 Access

(a) The Contractor shall allow the Contract Administrator free access to all parts of the Work at all times. The Contractor shall supply samples to the Contract Administrator or his inspector for testing purposes as required. There will be no charge to the City for samples taken.

E63.15 Measurement and Payment

E63.15.1 Structural Removals

(a) Structural removals shall not be measured. Structural Removals shall be paid for at the Contract Lump Sum Prices for the "Items of Work" listed here below for all Work performed in accordance with this Specification and accepted by the Contract Administrator, which price shall be payment in full for supplying all materials and for performing all operations herein described and all other items incidental to the Work included in this Specification and accepted by the Contract Administrator.

(b) Items of Work:

(i) Structural Removals;

- Full-depth Superstructure Isolation and Overhangs;
- Hydrodemolition;
- All Other Removals (Diaphragms, Abutments and Approach Slabs).

(c) Full-Depth Deck Removal (due to Blow-Throughs) will not be measured and is considered incidental to Contract Lump Sum price for "Hydrodemolition".

E64. TEMPORARY JACKING OF SUPERSTRUCTURE

E64.1 Description

(a) This Specification shall cover all operations related to bridge superstructure jacking and supporting as indicated on the Drawings.

(b) The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all other things necessary for and incidental to the satisfactory completion of all Work as hereinafter specified.

E64.2 Scope of Work

E64.2.1 The Work under this Specification shall involve:

(a) Temporary shoring and jacking shall be provided as required to undertake the abutment modifications, bearing replacement, and associated works at the abutments and in accordance with the details shown on the Drawings.

(b) Raising the slab superstructure at the abutments is intended to permit the contractor to carry out the following works:

(i) Removal of existing abutment bearings;
(ii) Installation of new abutment bearings;
(iii) Rehabilitation of the abutment;
(iv) Miscellaneous modifications to the abutments.

(c) The jacking scheme shown on the Drawings is an acceptable approach for the shoring and jacking system required to raise the superstructure at both abutments. The jacking and shoring scheme concept may be modified to suit the Contractor's design and operations.

(d) The Contractor will be responsible for the final choice and design of the shoring and jacking system that is acceptable to the Contract Administrator.

E64.3 Submittals

E64.3.1 The Contractor shall submit to the Contract Administrator, at least fourteen (14) calendar days prior to commencement of any jacking and supporting operation, detailed drawings of the Contractor's proposed jacking and supporting system, equipment and procedures. The detailed plans shall be designed by, prepared by and bear the seal of a Professional Engineer (Design Engineer), registered to practice in the Province of Manitoba. The detailed drawings shall include, but not be limited to: type, number and location of jacks and all other equipment and structures to be used for jacking; details of standby jacking, and supporting equipment (including provisions for allowing normal expansion / contraction movements of the bridge superstructure); jacking loads; superstructure support details; and procedures and sequence of work for jacking up and supporting the bridge superstructure and transferring of load onto the bearing assemblies.

E64.3.2 The submission of the detailed drawings will in no way relieve the Contractor of the full responsibility for the design and proper operation of the jacking and supporting system. The Contractor's Design Engineer shall be responsible for visiting the site as often as is necessary to inspect the jacking and supporting equipment and procedures so as to ensure that the work is carried out in accordance with the Design Engineer's sealed detailed drawings. The Contractor shall provide the Contract Administrator with a letter bearing the seal of the Design Engineer, certifying after personal inspection of the work that the jacking and supporting is being carried out in accordance with the sealed detailed drawings.

E64.4 Equipment

E64.4.1 The jacking system shall be capable of jacking the superstructure simultaneously, uniformly and equally at the abutments. The jacking system shall also be capable of releasing load, lowering the bridge superstructure and transferring load to the bearings simultaneously, uniformly and equally.

E64.4.2 The Contractor shall have adequate standby jacking and supporting equipment at the site prior to starting any jacking in order to ensure that bridge superstructure jacking and supporting is continuous, timely and achieved without interruption.

E64.5 Construction Methods

E64.5.1 Both abutments locations need not be jacked simultaneously. Jack the superstructure along a line parallel with the centerline of bearing as shown on the Drawings

E64.5.2 Jacking and temporary supporting operations shall be undertaken in such a manner to prevent distortion and provide equal lift of the superstructure. The Contractor shall jack up and lower the superstructure simultaneously, uniformly and equally. Change in soffit elevation at any point along the jacking line shall not vary by more than +/- 2 mm from the average.

E64.5.3 Monitoring jack extension alone is not sufficient for maintaining elevation control – deflection of jack supports must also be accounted for.

E64.5.4 Jacks and supporting structures shall have a minimum safe working load at least one hundred and fifty percent (150%) of the expected jacking forces.

E64.5.5 The Contractor is advised that during jacking of the abutments, force effects will be induced in the superstructure, primarily at the adjacent pier. The maximum jacking heights provided on the Plans are provided to limit the force effects in the superstructure to tolerable limits.

E64.5.6 The Contractor shall jack the bridge the minimum vertical dimension required to carry out the abutment and superstructure modifications and related works.

E64.5.7 Jacking operations shall be performed when there is no traffic on the bridge.

E64.5.8 The Contractor shall locate the jacking and supporting equipment such that it does not interfere with the required construction operations. After jacking, blocking can be erected for temporary support. Blocking shall be erected immediately adjacent to each side of each

jacking bearing plate. The total bearing area of blocking per jacking point shall be, at minimum, equal to the area of the jacking bearing plate.

E64.5.9 Prior to jacking the Contractor shall establish and have in place a method of defining and measuring the elevation of the underside of the superstructure relative to a fixed point on the substructure unit immediately below. Monitoring points shall be provided under each girder.

E64.5.10 The Contractor shall be responsible for taking these measurements in the presence of the Contract Administrator. The following measurements shall be done to monitor the rate and amount of jacking and to establish the vertical location of the bridge superstructure at completion of all works.

(a) Prior to jacking;

(b) At completion of jacking;

(c) After jack release, lowering the bridge superstructure and transferring of load onto bearing assemblies.

E64.5.11 The Contractor's temporary supports shall be designed for and must be capable of allowing the normal expansion / contraction movements of the bridge superstructure to take place while they are being used.

E64.5.12 The shoring and jacking design shall include provision of lateral restraint to the superstructure.

E64.5.13 Sequence of Work

(a) After jacking the superstructure at the abutments, perform all operations as per the Drawings.

E64.6 Measurement and Payment

(a) Jacking and supporting of the bridge superstructure shall be paid for at the Contract Lump Sum Price for "Temporary Superstructure Jacking and Support System", and will be considered full compensation for all labour, materials, tools, equipment and incidentals required to complete the work to the satisfaction Contract Administrator.

E65. SUPPLY AND INSTALLATION OF BEARINGS

E65.1 Description

E65.1.1 The Work shall consist of:

(b) Supply, fabrication, delivery and installing bearings, top plate (where applicable), stainless steel plate(where applicable), retaining plate, threaded inserts and bolts (where applicable) as shown on the Drawings and in this Specification;

(c) Cutting and removing existing anchor bolts;

(d) Quality control of materials and fabrication;

(e) Metalizing and/or galvanizing of steel components (where applicable).

E65.2 References

E65.2.1 All related Specifications and reference Standards are in accordance with the most current issue or latest revision.

E65.3 Submittals

E65.3.1 The Contractor shall submit the following to the Contract Administrator, in accordance with the Specification:

(a) Detailed Shop Drawings for the bearings that are stamped, signed and dated by a Professional Engineer registered or licensed to practice in the Province of Manitoba in accordance with E4 shop drawings.

(b) Documentation of all Quality Control testing undertaken for bearings as specified herein.

E65.4 Materials

E65.4.1 Bearings

(a) The bridge bearings shall be supplied and installed by the Contractor as shown on the Drawings.

(b) Expansion bearings shall be laminated elastomeric as shown on the Drawings.

E65.4.2 Bearing Top Plates and Retaining Plates

(a) Plates and all required fittings shall be supplied and installed by the Contractor as shown on the Drawings.

(b) Steel for plates shall be in accordance with latest edition of CAN/CSA G40.21, Grade 300W.

(c) All plates shall be hot-dip galvanized in accordance with ASTM A123 and CSA G164 to a minimum net retention of 610 g/m^2.

E65.4.3 Bearing Miscellaneous

(a) All miscellaneous plates and fittings shall be supplied and installed by the Contractor as shown on the Drawings.

E65.4.4 Threaded rods and Epoxy

(a) Threaded rods and Epoxy shall be in accordance with the Drawings and E68 Drilling and Placing Dowels.

E65.4.5 Welding Consumables

(a) The requirements of E58 Miscellaneous Metal shall apply.

E65.5 Bearing Fabrication and Supply

E65.5.1 Bearings shall be fabricated from new materials. Bearings shall be designed and fabricated in accordance with the latest editions of AASHTO LRFD Bridge Design Manual, AASHTO LRFD Bridge Construction Specifications and AASHTO M251 “Standard Specification for Plain and Laminated Elastomeric Bridge Bearings”.

E65.5.2 Internal steel reinforcing plates for laminated bearings shall be rolled mild steel with a minimum yield strength of 300 MPa. All other steel shall be in accordance with the latest edition of CAN/CSA G40.21, Grade 300W.

E65.5.3 Stainless steel plates shall conform to the latest edition of ASTM Standard A167, Type 304.

E65.5.4 PTFE surface shall be unfilled flat sheets made from pure virgin PTFE resin satisfying the requirements of the latest edition of ASTM D4894. PTFE shall be resistant to all acids, alkalis and petroleum products, stable at temperatures from negative two hundred and twenty degrees Celsius(-220°C) to two hundred and sixty degrees Celsius(+260°C), non-flammable and non-absorbing of water.

E65.5.5 Elastomer shall be neoprene or natural rubber, AASHTO low temperature Grade 4 or 5 with a Shore A Hardness of 60 and a shear modulus (G) between 0.90 and 1.38 MPa.

E65.5.6 Recess the PTFE into the steel backing plate to a depth of one half (1/) the PTFE thickness. The shoulders of the recess shall be sharp end square. Prepare the steel surface by grit blasting and bond over the entire area using an adhesive approved by the PTFE manufacturer.

E65.5.7 All exposed surfaces of the steel plates shall be zinc metalized. Surfaces to be metalized shall be blast cleaned in accordance with SSPC-SP5, “White Metal Blast Cleaning”.

E65.5.8 The overall dimensions of the bearings shall be within a tolerance of +/- 3 mm in plan and height. PTFE fabrication tolerances shall be in accordance with the latest edition of the AASHTO LRFD Bridge Construction Specifications. Other fabrication tolerances for the elastomeric pads shall be in accordance with the latest version of AASHTO M251.

E65.5.9 Bearings shall be clearly marked with their position on site and direction of installation. Markings shall be clearly visible on all bearings to prevent mix-up on site. Information marked on the bearings must correspond with the information contained on the approved Shop Drawings for the bearings. Bearings shall be supplied with suitable handling devices as required. Temporary clamping devices shall be used to maintain the correct orientation of the parts during handling, transport, storage, and installation but are not to be used for slinging or suspending bearings unless specifically designed for this purpose. Bearings shall be protected during handling, transport, storage, and installation from damage, distortion, and all deleterious material and contaminants including moisture and dust.

E65.5.10 The bearing Supplier shall verify the condition of the bearings supplied to the work site.

E65.5.11 The internal steel plates shall be sand-blasted and cleaned of all surface coating rust, mill scale before bonding, shall be free of sharp edges and burrs, and shall have a minimum edge cover of 5 mm of elastomer.

E65.5.12 Welding procedures shall be such as to minimize distortion of the bearing components and to avoid damage to finished work or bonded materials. All welding shall conform to the requirements of CSA Standard W59-03 (R208).

E65.5.13 Completed bearings shall have the supplier's name (or trademark) and a serial number indelibly marked thereon. The serial number shall be unique and such as to enable other bearings manufactured at the same time to be traced through the production control records should the need arise. Where practicable the serial number shall also be visible after installation of the bearing in the structure.

E65.6 Corrosion Protection

E65.6.1 All exposed surfaces of the steel plates shall be zinc metalized. Surfaces to be metalized shall be blast cleaned in accordance with SSPC-SP5, "White Metal Blast Cleaning".

E65.6.2 All non-sliding bearing surfaces shall be zinc metallized with a minimum coating of 0.25 mm in accordance with CSA Standard G189-1966 (R2003) "Sprayed Metallic Coatings for Atmospheric Corrosion Protection".

E65.6.3 All edges of steel (bearing plates, etc.) to be metallized shall be slightly rounded in order that metallizing will adhere.

E65.7 Construction Methods

E65.7.1 General

(a) Any structural steel components that in the opinion of the Contract Adminstrator have been damaged or otherwise rendered useless by the improper handling by the Contractor shall be replaced by the Contractor at his own expense.

(b) Bearings stored on site shall be carefully handled, stored, and protected from direct sunlight, moisture, extreme temperatures, heavy loads, and to the satisfaction of the Contract Administrator.

E65.7.2 Threaded Rod for retaining plate

(a) Shall be supplied and installed as perE68 "Drilling and Placing Dowels" as shown on the Drawings.

(b) Where applicable, the location of the threaded rod in relation to the expansion bearing assembly shall correspond with the temperature at the time of erection, as directed by the Contract Administrator.

E65.7.3 Bearings

(a) Before erection of the bearings, the Contractor shall satisfy himself that the location of substructure units and elevations of bridge seats are in accordance with the Drawings and Specifications. All discrepancies discovered by the Contractor shall be brought immediately to the attention of the Contract Administrator.

(b) The Contractor shall accurately assemble and install the bearings as specified on the Drawings and as directed by the Contract Administrator.

(c) Bearing centrelines shall be within +/-3 mm of their correct positions after installation. Threaded fixings shall be tightened uniformly to avoid overstressing any part of the bearing. Bearings and their surrounding areas shall be left clean after installation.

(d) Where applicable, the stainless steel surface of the bearings, the Teflon coated bearing pads and the machined surfaces of steel bearings that have been cast into the girders shall be protected from damage at all times. The plywood and polyethylene covers shall not be removed until immediately prior to the positioning of the bearings over the bearing seats.

(e) The bearings shall be set on the property finished bearing areas in exact position and shall have a full and even bearing on the concrete.

(f) Where the design requires that the girders bear on neoprene pads placed directly on abutment seat concrete, the Contractor shall supply and install shims cut from lead sheeting as determined by the Contract Administrator to ensure full and uniform bearing.

(g) Any bearings that in the opinion of the Contract Administrator have been damaged or otherwise rendered unusable by improper storage or handling by the Contractor shall be replaced by the Contractor at his expense.

E65.7.4 Equipment

(a) All equipment shall be of a type acceptable to the Contract Administrator and shall be kept in good working order.

E65.8 Guarantee

E65.8.1 Fabrication Guarantee

(a) Upon installation of the bearings the bearing Supplier shall inspect the bearings and certify in writing that the bearings have been properly installed. The Contractor shall provide a written guarantee that the bearings will perform satisfactorily within the design range of movement under the design loads for a period of five (5) years from the date of bearing installation. The supplier shall state that they have reviewed the installation procedures and find it in accordance with their recommendations. The supplier shall guarantee the replacement of the bearings at no cost to the City of Winnipeg in the event that the bearings do not perform satisfactorily within the design range of movement and under the design loads.

E65.8.2 Installation Guarantee

(a) The Contractor shall ensure that the bearings are installed in such a manner that will not void the fabrication guarantee.

(b) The Contractor shall guarantee in writing, the performance of the bearings for a period of five (5) years from the date of bearing installation. Provided in the guarantee for the replacement of the bearings at no cost to the City of Winnipeg in the event that the bearings do not perform satisfactorily in the range of design movement and under the design loads.

E65.9 Measurement and Payment

E65.9.1 Supply, Fabrication, Delivery and Installation of Steel Reinforced Elastomeric Bearings will be measured on a unit basis and paid for at the Contract Unit Price for “Items of Work"

listed here below, measured as specified herein, which price shall be payment in full for supplying all materials and for performing all operations herein described and all other items incidental to the Work included in this Specification and accepted by the Contract Administrator.

E65.9.2 Items of Work:

(a) Supply, Fabrication and Delivery of Steel Reinforced Elastomeric Expansion Bearings.

(i) The supply and installation of the elastomeric masonry pad, will not be measured. This Item of Work is considered incidental to the Contract Lump Sum Price for the "Supply, Fabrication and Delivery of Steel Reinforced Elastomeric Expansion Bearings".

(ii) Bearing plates (stainless steel plates, top plates and retaining plates) will not be measured and will be paid for at the Contract Lump Sum Price for "Miscellaneous Metal", which price shall be payment in full for supplying all materials and for performing all operations herein described and all other items incidental to the Work included in this Specification and accepted by the Contract Administrator.

E66. TEMPORARY PROTECTION SYSTEM

E66.1 Description

E66.1.1 This Specification shall cover all operations related to the design, supply, installation, maintenance and removal of temporary protective systems.

E66.1.2 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all other things necessary for and incidental to the satisfactory completion of all Work as hereinafter specified.

E66.2 Scope of Work

E66.2.1 The Work under this Specification shall involve:

(a) Demolition Catch Platforms and Work Platforms;

(b) BellMTS Ducts Protection Cover;

(c) Temporary protective systems shall also intended to permit the contractor to carry out the following works:

(i) Surface preparation and metalizing of bridge steel girders;

(ii) Shear strengthening of concrete girders.

E66.3 Submittals

E66.3.1 The protective systems shall be designed by, prepared by, and bear the seal and signature of a Professional Engineer (Design Engineer) registered in the Province of Manitoba. Detailed drawings, specifications and design notes for the protective systems, bearing the seal and signature of the Design Engineer shall be submitted by the Contractor to the Contract Administrator at least seven (7) calendar days prior to the start of any protection system installation. The submission of the protection system detailed drawings, specifications and design notes to the Contract Administrator shall in no way relieve the Contractor of full responsibility for the design and safe and effective functioning of the protective system.

E66.3.2 The Contractor shall provide the Contract Administrator with proof that the protective systems are installed in accordance with the detailed drawings and specifications. This proof shall be in the form of a letter bearing the seal and signature of protective systems' Design Engineer certifying that the protective system Design Engineer has carried out a personal inspection of the installation, and that the installation is in accordance with the design.

E66.4 Construction Methods

E66.4.1 The Contractor shall be responsible for constructing the temporary protective systems.

E66.4.2 The Contractor shall be fully responsible for ensuring the public safety in areas underlying and adjacent to the construction site. The Contractor will be responsible for any loss or damage caused as a result of the Contractor's actions. Any debris that enters the roadway envelope of a travelled lane shall be immediately cleaned up by the Contractor.

E66.4.3 It can be suspended from the existing superstructure, supported from the existing ground, or otherwise. Any stay-in-place anchorages that are installed shall be stainless steel, and shall be set back a minimum of 12 mm from the exposed surface, and subsequently grouted with a high quality grout. The details of any proposed anchorages or attachments to the existing structure shall be included in the submitted drawings of the temporary protective system, and subject to the approval of the Contract Administrator.

E66.5 Demolition Catch Platforms and Work Platforms

E66.5.1 The Contractor shall provide all necessary access/work platforms to facilitate structural removals and associated inspection of all Works by the Contract Administrator.

E66.5.2 The platforms shall be designed by the Contractor's Engineer to support the anticipated construction live load as well as any anticipated dead load resulting from fallen removal/demolition debris.

E66.5.3 The platforms shall be designed to be of a type that does not detrimentally affect the structural integrity of the existing bridge structure. Drilling into the girders to secure any platforms shall not be permitted.

E66.5.4 The Contractor shall construct temporary protective systems to prevent debris, tools, forms, waste products, construction materials and equipment, and any material whatsoever from falling into river or otherwise entering the adjacent travelled lanes. The Contractor shall take all necessary safety precautions to ensure that no materials leave the construction work areas and subsequently enter the roadway envelope or river during the Contractor's construction operations. The roadway envelope of any travelled lane is defined as follows. Horizontally, it is the space occupied from hypothetical lane edge to lane edge.

E66.5.5 For work above river (i.e. along the edges of the bridge structure), a catch platform system shall be provided. For work beside traffic, a protective wall system shall be provided. Together, these items shall be referred to as the temporary protective systems. The Contractor shall be responsible for the design, supply, installation, maintenance and removal of the temporary protective systems.

E66.5.6 The systems shall include but not necessarily be limited to deck edge platforms along both exterior edges of the bridge and other catch platforms beneath the bridge superstructure as required for construction purposes and to collect and contain products of demolition, hydrodemolition and all other debris, and prevent them from falling onto underlying surfaces.

E66.5.7 The protective systems shall be designed and constructed as required to catch and retain all products of demolition, including those produced by hydrodemolition. Collection and containment information and details associated with the demolition catch platform as related to control and containment of products of hydrodemolition including runoff from hydrodemolition shall form part and parcel of the hydrodemolition runoff control plan detailed in the Specification for Structural Removals.

E66.5.8 The Contractor is advised that construction work including but not limited to; dismantling, general demolition and removals, hydro demolition, reinforcing bar installation, concrete forming, concrete pouring, and related construction works will be occurring in close proximity to the travelling public and over Seine River

E66.6 BellMTS Ducts Protection Cover

E66.6.1 The protection cover shall be designed by the Contractor's Engineer to support the anticipated construction live load as well as any anticipated dead load resulting from fallen removal/demolition debris.

E66.6.2 The protection cover shall be designed to be of a type that does not detrimentally affect the structural integrity of the existing bridge structure. Drilling into the girders to secure any the protection cover shall not be permitted.

E66.7 Measurement and Payment

E66.7.1 Measurement

(a) Design, supply, installation, maintenance and removal of temporary protective systems will be paid for on a lump sum basis and no measurement will be made for this work.

E66.7.2 Payment

(a) Design, supply, installation, maintenance and removal of temporary protective systems will not be measured and paid for the Contract lump sum price for "Temporary Protective Systems/Work Platform", and will be considered full compensation for all labour, materials, tools, equipment and incidentals required to complete the work to the satisfaction Contract Administrator.

E67. DISTRIBUTED GALVANIC CORROSION CONTROL

E67.1 Description

(a) The Work under this section consists of designing, supplying, installing and energizing a zinc-based galvanic corrosion control system consisting primarily of embedded zinc anodes, including required electrical connections, materials, testing and ensuring continuity of the reinforcing steel to all elements as outlined in the construction drawings.

(b) The Works also include designing, supplying and installation of one (1) monitoring system to check the activeness of the protection system in terms of polarization potential and current density.

(c) The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies and all things necessary for and incidental to the satisfactory performance and completion of all Works as hereinafter specified.

E67.2 References

(a) ACI 222R (2001) Protection of Metals in Concrete Against Corrosion;

(b) ASTM B6 Standard Specification for Zinc;

(c) ASTM B69 (2001) Standard Specification for Rolled Zinc;

(d) ASTM B418 Standard Specification for Cast and Wrought Galvanic Zinc Anodes;

(e) SSPC-10 (1994) Near-White Blast Cleaning.

E67.3 Submittals

(a) Shop drawings showing typical galvanic corrosion control system installation details, such as distributed anode installation locations, type and location of anode standoff spacers, reinforcing connections shall be prepared by the Contractor and submitted for approval prior to any field installations. The shop drawings shall clearly illustrate the layout of the anodes as applies to the abutments on this project, in both elevation and section views.

E67.4 Materials

E67.4.1 Zinc Anode

(a) Distributed galvanic units shall be alkali-activated zinc with nominal exterior dimensions of 32 mm. The distributed anode unit shall consist of 0.89 kg of zinc per

linear meter of anode. The zinc anode shall be manufactured in compliance with ASTM B418 Type II (Z13000) and ASTM B69 Rolled Special High Grade Zinc (Z13004) using zinc in compliance with ASTM B6 Special High Grade (Z13001) with iron content less than 15 ppm. The dimensions and zinc content of the anode shall be as recommended by the Contractor's enlisted NACE specialist and as approved by the Contract Administrator.

(b) The zinc shall be alkali-activated with a pH greater than 14. The anode unit shall contain no constituents that are corrosive to reinforcing steel as per ACI 222R such as chlorides, bromides, or other halides. The anode unit shall be supplied with a minimum of two (2) lead wires of sufficient length to make connections between anodes and the reinforcing steel.

(c) The galvanic protection shall be Galvanode DAS distributed anode system supply by Vector Corrosion Technologies, or approved equal.

(d) Application for approved equals shall be requested in writing two (2) weeks before submission of project bids. Application for galvanic anode equals shall include verification of the following information:

(i) The zinc anode is alkali-activated with a pH of 14 or greater;

(ii) The anode unit does not contain any corrosive constituents detrimental to reinforcing steel, e.g. chloride, bromide, etc;

(iii) Proven track record of the anode technology showing satisfactory field performance with a minimum of three projects of similar size and application;

(iv) Independent third party evaluation of the anode technology, e.g. Hitec, Concrete Innovations Appraisal Service, BRE, etc.

E67.5 Construction Methods

E67.5.1 General

(a) The galvanic corrosion protection shall consist of the anodes as indicated on the Drawings. The anode units are connected to the reinforcing steel and encased in a concrete with a minimum of 50.8 mm of clear concrete cover over the anode units.

E67.5.2 Manufacturer Technical Assistance

(a) The Contractor shall enlist and pay for a NACE-qualified Cathodic Protection Specialist employed by the corrosion mitigation technology company to provide the design of distributed anode to be used as well as a monitoring system.

(b) The Contractor will enlist and pay for the services of a NACE-qualified corrosion technician supplied by the galvanic anode manufacturer to provide training and on-site technical assistance during the installation of the galvanic protection system. The qualified corrosion technician shall have verifiable experience in the installation and testing of embedded galvanic control systems for reinforced concrete structures.

(c) The Contractor shall coordinate its work with the designated corrosion technician to allow for site support during project start-up and initial anode installation. The technician shall provide Contractor training and support for development of application procedures, shop drawings for submittals, anode and concrete installation, reinforcing steel connection procedures, and verification of electrical continuity of embedded steel.

E67.5.3 Surface Preparation

(a) The abutments concrete removals shall be performed in accordance with the lines and grades shown on the Drawings.

(b) After the removals, any additional spalled and delaminated concrete should be removed until solid concrete is encountered.

(c) Exposed reinforcing steel and concrete should be cleaned by abrasive blasting or other means to remove all corrosion by-products and other materials that may inhibit bonding of the concrete encasement.

E67.5.4 Reinforcing Steel Connections

(a) The Contractor shall directly connect each anode unit to exposed reinforcing steel on each abutment receiving corrosion protection. Alternately, the anodes can be wired together and connected to a minimum of two (2) electrical (negative) connections per abutment. Whenever possible, electrical connections should be located where reinforcing steel is exposed. If no exposed steel exists after preparation of the abutment, a small area of concrete shall be removed to expose a tie.

(b) Electrical connections to the reinforcing steel shall be established using suitable mechanical, welded stud or brazing techniques. Proposed electrical connection details shall be approved by the anode manufacturer and shall be detailed on the shop drawing submittal.

E67.5.5 Electrical Continuity

(a) Reinforcing steel shall be tested for electrically continuity. Maximum DC resistance shall be 1 ohm or maximum DC voltage shall be 1 mV. Steel found to be discontinuous shall have continuity re-established by tying to other bars with steel tie wire or other approved means.

E67.5.6 Installation of Anodes

(a) Distributed galvanic anode units shall be installed as shown on the Drawings. The anodes shall be installed as per manufacturer's instructions.

E67.5.7 Concrete Placement

(a) Concrete shall be placed in such a manner to ensure that no segregation or air voids exist after concrete placement.

E67.6 Measurement and Payment

(a) The supply and installation of distributed galvanic protection system as shown on the Drawings will not be measured and paid for at the Contract Lump Sum Price for the "Supply and Install Distributed Galvanic Anode System" which price shall be payment in full for supplying all materials and for performing all operations herein described and all other items incidental to the Work included in this Specification and accepted by the Contract Administrator.

E68. DRILLING AND PLACING DOWELS

E68.1 Description

E68.1.1 This Specification shall cover all operations related to drilling and preparation of dowel holes, supply and placing epoxy grout and installation of the applicable anchorages.

E68.1.2 Dowels shall include the following post-installed anchorages and reinforcing bars:

(a) Threaded rod in diaphragms;

(b) Reinforcing dowels for abutment modifications;

(c) SU 3 pier cap Hilti Anchorage System;

(d) Threaded rod in piercap at bearing retaining plate location as shown in Drawings.

E68.2 Materials

E68.2.1 Epoxy grout shall be Hilti HIT-RE 500-V3 or equivalent as approved by the Contract Administrator. The epoxy grout shall be suitable for horizontal, vertical or overhead dowel grouting application as required.

E68.3 Construction Methods

E68.3.1 In diaphragms and piercap the Contractor shall core holes and place dowels at the locations and in accordance with the details as shown on the Drawings. Holes for dowels shall be cored.

E68.3.2 In abutments the Contractor shall drill and place dowels at the locations and in accordance with the details as shown on the Drawings. Holes for dowels shall be drilled.

E68.3.3 The Contractor shall predetermine the locations of existing steel bars prior to drilling or coring, using an effective reinforcing steel bar locator. Dowel hole locations as shown on the Drawings, shall be relocated as required to avoid conflicts with existing reinforcing steel bars as approved by the Contract Adminstrator.

E68.3.4 Dowel hole diameters shall be in accordance with the recommendations of the epoxy adhesive grout manufacturer.

E68.3.5 All holes shall be thoroughly cleaned prior to the installation of grout and dowels.

E68.3.6 The epoxy adhesive grout shall be prepared, placed and cured in accordance with the recommendations of the epoxy adhesive grout manufacturer.

E68.4 Measurement and Payment

E68.4.1 Drilling and placing dowels will not be measured and will be paid for at the Contract Lump Sum Price for :

(a) “Miscellaneous Metal” for threaded rods in diaphragms and pier cap;

(b) “Supply of Reinforcing Steel” for reinforcing dowels in abutment modifications.

which price shall be payment in full for performing all operations herein described and all other items incidental to the Work included in this Specification and accepted by the Contract Administrator.

E69. SELF CONSOLIDATING CONCRETE REPAIRS

E69.1 Description

(a) The Work covered under this item shall include all operations relating to refacing of the abutment seats and pier concrete surface repairs as shown on the Drawings and in the locations as directed by the Contract Administrator.

(b) The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Work as hereinafter specified.

E69.2 Materials

E69.2.1 General

(a) Unless otherwise listed herein, materials shall be in accordance with E55 Structural Concrete.

E69.2.2 Concrete

(a) The Contractor shall be responsible for the design and performance of all concrete mixes supplied under this specification. Either ready mix concrete or proprietary repair mortars, where applicable, may be used having the following minimum properties in accordance with CSA A23.1:

(i) Class of Exposure : C-1;

(ii) Compressive Strength @ 28 days = 35 MPa;

(iii) Maximum Aggregate Size = 10mm;

(iv) Air Content: Category 1 per Table 4 of latest CSA A23.1; and,

(v) Slump Flow = 550-600mm

(b) The concrete mix shall meet the latest edition CSA A23.1 Cl. 8.9.2 Low Shrinkage requirements.

(c) The concrete mix shall have an electrical conductivity less than 15,000 ohm-cm.

(d) Mix design for ready mix concrete shall be submitted to Contract Administrator at least two (2) weeks prior to concrete placing operations.

(e) The workability of the concrete mix shall be consistent with the Contractor's placement operations.

(f) Any proposed proprietary repair mortar shall be subject to the approval of the Contract Administrator and must meet or exceed the properties of the ready mix concrete.

(g) The temperature of all types of concrete shall be between fifteen degrees Celsius (15˚C) and twenty-five (25˚C) at discharge. Temperature requirements for concrete containing silica fume shall be between ten degrees Celsius (10˚C) and eighteen degrees Celsius (18˚C) at discharge unless otherwise approved by the Contract Administrator.

(h) Concrete materials susceptible to frost damage shall be protected from freezing.

(i) Concrete repair material shall be compatible with the concrete substrate and the Contractor's method of placement. The Contractor may choose to use a proprietary repair mortar subject to the approval of the Contract Administrator.

E69.3 Equipment

E69.3.1 General

(a) Equipment shall be in accordance with E55 Structural Concrete.

E69.4 Construction Methods

E69.4.1 General

(a) The Contractor may consider form and pour, pressure grouting or low velocity spraying as application methods for girder end concrete repairs. Other methods shall be subject to the approval of the Contract Administrator.

E69.4.2 Removal of Existing Concrete and Concrete Surface Preparation

(a) All areas requiring repair shall have their perimeters sawcut to a depth of 20 mm. The only exception to sawcutting will be in areas where there is no room for a concrete saw.

(b) Remove all concrete in the repair area to a minimum depth

(i) 20 mm beyond the exposed rebar;

(ii) 6 mm larger than the largest size aggregate in the repair material beyond the exposed rebar;

(iii) to the depth of delamination;

(iv) whichever is greater.

(c) In locations where anodes or post-installed rebar will be present, remove concrete to provide a minimum of 50 mm cover.

(d) Concrete removal may be undertaken by mechanical means with chipping hammers of appropriate size so as not to damage the substrate concrete as accepted by the Contract Administrator. Alternatively, hydrodemolition may be used.

(e) Clean all resulting concrete and steel surfaces by grit-blasting. All unsound and stained concrete shall be fully removed. Exposed rebar shall be cleaned to a near-white condition.

(f) If recommended by the mortar/grout manufacturer's directions, pre-wet the patch surfaces for the duration recommended.

E69.4.3 Form Work and Shoring

(a) Formwork and shoring shall be in accordance with with E55 Structural Concrete.

E69.4.4 Formliner

(a) Formliner shall be used on all exposed formed surfaces.

E69.4.5 Bonding New Concrete to Existing Concrete

(a) The Contractor is responsible to create a bond between the new mortar/concrete and the existing substrates. This may be done by either the application of a suitable bonding agent or grout or by using a self-bonding mortar or concrete. The Contract Administrator will check all repaired areas for bond using a hammer "sounding" method after form removal. Place mortar or concrete by trowelling, pumping, spraying, or into forms ensuring that all entrapped air is removed.

(b) Should a bonding grout be used, it shall be applied immediately before concrete placement. It shall be thoroughly brushed onto the existing hardened concrete surface in a thin and even coating that will not puddle.

E69.4.6 Mixing and Placing Concrete

(a) Mixing and placing concrete shall be in accordance with E55 Structural Concrete. Where proprietary repair mortars are used, they shall be prepared in accordance with the manufacturer's instructions.

E69.4.7 General Curing

(a) Concrete Curing shall be in accordance with E55 Structural Concrete. Where proprietary repair mortars are used, they shall be cured in accordance with the manufacturer's instructions.

(b) Refer to Clauses E55 Structural Concrete for cold weather and hot weather curing requirements, respectively.

E69.4.8 Form Removal

(a) Form Removal shall be in accordance with E55 Structural Concrete.

E69.4.9 Patching of Formed Surfaces

(a) Patching of Formed Surfaces shall be in accordance with E55 Structural Concrete.

E69.4.10 Cold Weather Concreting

(a) Cold Weather Concreting shall be in accordance with E55 Structural Concrete.

E69.4.11 Hot Weather Concreting

(a) Hot Weather Concreting shall be in accordance with E55 Structural Concrete.

E69.5 Measurement and Payment

E69.5.1 Abutment Seat Refacing

(a) "Abutment Seat Refacing" will be measured and paid for at the Contract Unit Price per cubic meter which price shall be payment in full for supplying all materials and for performing all operations herein described and all other items incidental to the Work included in this Specification.

E69.5.2 Pier Surface Repairs

(a) The Contract Administrator will identify and measure, on site, the pier surface areas to be repaired in accordance with this Specification.

(b) "Pier Surface Repairs" will be measured and paid for at the Contract Unit Price per square meter which price shall be payment in full for supplying all materials and for performing all operations herein described and all other items incidental to the Work included in this Specification.

E70. ALUMINUM PEDESTRIAN HANDRAIL/BICYCLE RAIL

E70.1 Description

E70.1.1 This Specification shall cover all operations relating to the supply and installation of the aluminum pedestrian handrail/bicycle rail as specified herein and as shown on the Drawings.

E70.1.2 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all other things necessary for and incidental to the satisfactory completion of all Work as hereinafter specified.

E70.2 Referenced Specifications and Drawings

E70.2.1 The latest edition and subsequent revisions of the following:

(a) ASTM B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate;

(b) ASTM B221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes;

(c) ASTM B276 – Standard Specification for Stainless Steel Bars and Shapes;

(d) ASTM D1187 – Standard Specification for Asphalt-Base Emulsions for use as Protective Coatings and Metal;

(e) CAN/CSA W47.2 – Certification of Companies for Fusion Welding of Aluminum;

(f) CAN/CSA W59.2 – Welded Aluminum Construction;

(g) CAN/CSA S157 – Strength Design in Aluminum.

E70.3 Scope of Work

E70.3.1 The Work under this Specification shall involve:

(a) Supplying and installing aluminum pedestrian handrail / bicycle rail;

(b) Supplying and installing life preserver hook;

(c) Supplying and installing all miscellaneous steel items and other items associated with the Work.

E70.4 Submittals

E70.4.1 The Contractor shall submit to the Contract Administrator for review and approval, at least ten (10) Business Days prior to the commencement of any scheduled Work on the Site, a proposed schedule, including methods and sequence of operations.

E70.4.2 The Contractor shall submit to the Contract Administrator for review and approval, at least twenty (20) Business Days prior to the scheduled commencement of any fabrication, the proposed Shop Drawings showing all fabrication details of the aluminum pedestrian handrail/bicycle rail. Fabrication shall take place as shown on the Drawings.

E70.4.3 The Contractor shall submit to the Contract Administrator for review and approval, at least ten (10) Business Days prior to the scheduled commencement of any fabrication, the operator's qualifications detailed in B7"Substitutes" and mill certificates.

E70.4.4 The Contractor shall submit to the Contract Administrator for review and approval, at least twenty (20) Business Days prior to the scheduled commencement of any fabrication, the proposed welding procedures and welding consumable certificates. The Contractor shall submit copies of the welding procedures which he intends to use, for examination and acceptance by the Contract Administrator.

(a) The Contractor shall submit copies of the welding procedures which he intends to use, for examination and acceptance by the Contract Administrator.

(b) Such procedures shall be accompanied by documentary proof that they have been qualified previously by the Canadian Welding Bureau at the plant where the Work is to be carried out.

(c) The procedures shall include the following information: joint type, welding process, welding position, base metal specification, welding consumable specification and size, preheat requirements, amperage and voltage requirements, speed, polarity, and welding equipment, including a description of travel for automatic welding.

E70.5 Materials

E70.5.1 General

(a) All materials supplied under this Specification shall be of a type acceptable to the Contract Administrator, and shall be subject to inspection and testing by the Contract Administrator.

(b) The Contractor shall be responsible for the supply, safe storage and handling of all materials as set forth in this Specification. All materials shall be handled in a careful and workmanlike manner, to the satisfaction of the Contract Administrator.

E70.5.2 Material for the Aluminum Pedestrian Handrail/Bicycle Rail

(a) Extruded Shapes or Drawn Tubing for Rails and Posts: shall conform to the latest edition and all subsequent revisions of CAN/CSA Aluminum Alloy and Temper HA.5 SG 11 R-T6 (ASTM B221 Alloy 6351-T6), or HA.7 GA 11 M-T6 (ASTM B221 Alloy 6061-T6).

(b) Aluminum sheet, bar, support pin, angle, and plate shall conform to the latest edition and all subsequent revisions of ASTM B221- Alloy 5083, ASTM B209 Alloy 6061-T6 or Alloy 6351-T6.

(c) Bolts and cap screws, nylon lock nuts, and washers - stainless steel conforming to ASTM A276, Type 316.

E70.5.3 Bituminous Paint

(a) Bituminous paint shall be an alkali-resistant coating and conform to the requirements of ASTM D1187. Supply of bituminous paint shall be considered incidental to the supply of aluminum pedestrian handrail.

E70.5.4 Handrail Anchorage System

(a) The handrail anchorage system is specified and paid for in accordance with E58, “Miscellaneous Metal”.

E70.5.5 Aluminum Shims

(a) Aluminum shims shall conform to ASTM Standard B221, Alloy 6061-T6, and shall be supplied as required to facilitate the installation of the rail posts as shown on the Drawings. Supply of shims will be considered incidental to the supply of aluminum pedestrian handrail.

E70.5.6 Aluminum Filler Alloys for Welded Construction

(a) Aluminum filler alloys for welded construction shall be one (1) of the following: ER4043, ER5183, ER5356, ER5554, ER5556, or ER5654.

E70.5.7 Hinges

(a) Hinges shall be stainless steel and manufactured by Angama, Type STBB 460, or equal as approved by the Contract Administrator in accordance with B7, “Substitutes”.

E70.6 Equipment

(a) All equipment shall be of a type acceptable to the Contract Administrator and shall be in good working order.

E70.7 Construction Methods

E70.7.1 Layout

(a) Before fabrication and/or installation of the aluminum pedestrian handrail, the Contractor shall satisfy himself of all required aluminum rail and enclosure section dimensions, by field measurements.

E70.7.2 Fabrication

(a) General

(i) No fabrication shall commence until permission to do so has been received from the Contract Administrator.

(ii) All fabrication shall be carried out in accordance with this Specification and the Drawings.

(iii) The Fabricator shall fabricate the entire aluminum pedestrian handrail/bicycle rail in sections, to permit the installation of the rail sections onto the concrete.

(iv) The punching of identification marks on the members will not be allowed.

(v) Any damage to members during fabrication shall be drawn to the attention of the Contract Administrator in order that the Contract Administrator may accept remedial measures.

(vi) Dimensions and fabrication details which control the field matching of parts shall receive very careful attention in order to avoid field adjustment.

(vii) Components of the railings and enclosures shall be joined by means of bolt, cap screws, and welds as called for on the Drawings.

(b) Sample Panel

(i) The Contractor shall be required to supply the Contract Administrator with one (1) completely fabricated handrail/bicycle rail sample panel, including at least two (2) posts, prior to proceeding with the fabrication of the remainder. The sample, once accepted, shall be identifiable for the duration of the Project, but may be incorporated into the rail system. It shall become the standard for acceptance of all aluminum pedestrian handrail/bicycle rail panels.

(c) Cutting

(i) Material 13 mm thick or less may be sheared, sawn, or cut with a router. Materials more than 13 mm thick shall be sawn or routed. Cut edges shall be true and smooth and free from excessive burrs or ragged breaks. Re-entrant cuts shall be avoided whenever possible. If used, they shall be filleted by drilling prior to cutting. Flame cutting of aluminum alloys is not permitted.

(d) Welding

(i) Welded construction shall conform to the requirements of the latest edition and all subsequent revisions of CAN/CSA W59.2, Welded Aluminum Construction and W47.2, Certification of Companies for Fusion Welding of Aluminum.

(ii) Welding will be done by qualified welders using the Metal Inert Gas (MIG) process. All areas to be welded should be thoroughly cleaned with a suitable solvent followed by wire brushing if surfaces are heavily oxidized. The size of fillet for equal leg fillet welds is defined as the leg length of the largest isosceles right angle triangle which can be inscribed within the fillet weld section. Welds must penetrate into the root corner. All butt welds should have full penetration to ensure maximum strength. Defective welds should be repaired by chipping out the defective area and rewelding. Particular care must be paid to the elimination of craters and cold starts.

(iii) Welders and procedure should be qualified as agreed between the Contract Administrator and the Fabricator. The minimum requirements for mechanical test results of joints butt welded with Alcan 56S filler alloy shall be 259 MPa for Alcan D45S-H1 1A and 165 MPa for Alcan B51S-T4 alloy. In addition to the mechanical tests, soundness tests should be made as follows:

¨ Guided Bend Test: All bend tests should be fully guided through an angle of 1800. Root, face, and side bend tests in Alcan D54S parent alloy welded in Alcan 56S filler wire require a bend radius of 2T where T

is the thickness of the material. For Alcan B51S parent alloy welded with 56S filler wire, a bend radius of 4T is required. Root bend and face bend specimens on material 10 mm thick and less should be 305 mm long and a minimum of 25 mm in width and cut from a plate having a minimum butt weld length of 450 mm. No test piece should be taken within 25 mm of the ends of the weld. Side bend tests should be carried out on material over 10 mm in thickness.

- Specimens should be 10 mm in width. Longitudinal edges should be given in 2 mm radius. There should be no crack greater than 3 mm in length. If a crack starts from an edge, the specimen should be disregarded.
- Fracture Test: The butt-welded joint shall have a notch not exceeding 2 mm in depth sawn on the four (4) sides of the weld bend and the weld broken. Inspection of the fracture should reveal no gas pockets or inclusions greater than 2 mm in diameter and the area lost due to scattered gas, porosity or voids should not exceed three percent (3%) of the area under inspection.

(e) Bolting

(i) Bolt holes in 10 mm or thinner material may be drilled or punched to finished size. In material thicker than 10 mm, the holes shall be drilled to finished size or subpunched smaller than the normal diameter of the fastener and reamed to size.

(ii) The finished diameter of the holes shall be not more than seven percent (7%) greater than the nominal diameter of the fastener, except:

- Slotted holes for expansion purposes shall be provided as required on the Drawings.
- Holes for anchor bolts may be up to 50 percent greater than the nominal bolt diameter with a maximum of 13 mm greater than the nominal bolt diameter.
- Holes shall not be drilled in such a manner as to distort the metal, but holes only slightly misaligned may be reamed to render a reasonable fit.
- In all bolts, the finished shank shall be long enough to provide full bearing, and washers shall be used under the nuts to give full grip when the nuts are tightened.

E70.7.3 Installation of Aluminum Pedestrian Handrail/Bicycle Rail

(a) The aluminum pedestrian handrail/bicycle shall be brought on-site and accurately installed as shown on the Drawings.

(b) The rails shall be set true to the line and grade as shown on the Drawings or as required by the Contract Administrator.

(c) The material shall be carefully handled so that no parts will be bent, broken or otherwise damaged. Hammering which will injure or distort the member is not permitted. The Contractor shall report to the Contract Administrator any corrective measures.

(d) Except where shown on the Drawings, field welding shall not be permitted unless acceptable to the Contract Administrator. The rail posts shall be set on aluminum shims, as required, to achieve the correct elevation and grade. Additional aluminum shims shall be installed as required to achieve the correct elevation and grade. The surface of the bottom shim that is in contact with concrete shall be separated with a minimum of two (2) coats of bituminous paint. A minimum 3 mm aluminum shim shall be installed under each post.

E70.8 Quality Control

(a) All workmanship and all materials furnished and supplied under this Specification are subject to close and systematic inspection and testing by the Contract Administrator including all operations from the selection and production of materials through to final acceptance of the Work. The Contractor shall be wholly responsible for the control of all operations incidental thereto notwithstanding any inspecting or acceptance that may have been previously given. The Contract Administrator reserves the right to reject any materials or works which are not in accordance with the requirements of this Specification.

(b) The Contractor shall be wholly responsible for the control of all operations incidental thereto, notwithstanding any inspection or acceptance that may have been previously given. The Contract Administrator reserves the right to reject any materials or Works, which are not in accordance with the requirements of this Specification.

E70.8.1 Access

(a) The Contractor shall allow the Contract Administrator free access to all parts of the Work at all times. The Contractor shall supply samples to the Contract Administrator or his inspector for testing purposes as required. There will be no charge to the City for samples taken.

E70.8.2 Testing

(a) All materials supplied under this Specification shall be subject to inspection and testing by the Contract Administrator or by the Testing Laboratory designated by the Contract Administrator. There shall be no charge to the City for any materials taken by the Contract Administrator for testing purposes.

E70.9 Measurement and Payment

E70.9.1 Aluminum Pedestrian Handrail/Bicycle Rail

(a) Supplying and Installing the aluminum pedestrian handrail/bicycle rail shall be measured on a length basis and paid for at the Contract Unit Price per metre for "Supply and Install Aluminum Pedestrian Handrail/Bicycle Rail", which price shall be paid in full for supplying all materials and for performing all operations herein described and all other items incidental to the Work included in this Specification, accepted and measured by the Contract Administrator.

E71. BRIDGE ALUMINUM BARRIER RAIL

E71.1 Description

E71.1.1 The specification shall amend and supplement City of Winnipeg specification CW 3650.

E71.2 Scope of Work

E71.2.1 The Work under this Specification shall involve:

(a) Supply and installation of the bridge aluminum barrier rails and posts on the new concrete traffic barriers;

(b) Supply and installation of the anchors for the bridge aluminum barrier rails on the concrete traffic barriers.

E71.3 Submissions

E71.3.1 At least fourteen (14) days prior to the scheduled commencement of any fabrication, the qualifications of Contractor, the qualifications of operator, the shop drawings, mill certificates, welding procedures, and welding consumable certificates shall be submitted to the Contract Administrator for his acceptance.

E71.3.2 The shop drawings shall clearly show shapes, dimensions, detail, connection (including proper CSA welding identification), bolt holes, and accessories.

E71.4 Materials

E71.4.1 Rail posts for the aluminum barrier rail on the concrete traffic barriers shall be fabricated in accordance with the Drawings and E58 “Miscellaneous Metal”.

E71.4.2 The anchors for the aluminum balance barrier on the concrete traffic barriers shall be in accordance with the Drawings and E58 “Miscellaneous Metal”.

E71.5 Measurement and Payment

E71.5.1 Supplying and installing the bridge aluminum barrier rail shall be measured per linear metre and will be paid for at the Contract Unit Price per linear metre for “Supply and Install Bridge Aluminum Barrier Rail”, measured as specified herein, which price shall be payment in full for performing all operations herein described and all other items incidental to the Work included in this Specification and accepted by the Contract Administrator.

E71.5.2 Supplying and installing the bridge aluminum barrier posts and anchors shall be measured unit basis and will be paid for at the Contract Unit Price for “Supply and Install Bridge Aluminum Barrier Posts”, measured as specified herein, which price shall be payment in full for performing all operations herein described and all other items incidental to the Work included in this Specification and accepted by the Contract Administrator.

E72. ASPHALTIC CONCRETE PAVING ON BRIDGE

E72.1 Description

(a) This Specification shall cover all operations relating to the supply of labour, equipment, tools and material necessary for the application of tack coat and the placing and compaction of the asphaltic hot mix overlay on the bridge deck and approach slabs. The thickness of the overlay shall be as specified on the Drawings.

(b) The work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, handling and storage, and all things necessary for and incidental to the satisfactory performance and completion of all Work as herein specified and as indicated on the Drawings.

(c) Scope of Work:

a) Surface preparation of the bridge deck and approach slabs;

b) Supplying and applying the tack coat;

c) Supplying, hauling, placing and compacting of asphaltic hot mix (overlay) on the bridge deck and approach slabs, including all work at the joints;

d) The quality control (QC) testing of all materials.

E72.2 References

(a) All related Specifications and reference Standards are in accordance with the most current issue or latest revision:

a) City of Winnipeg’s Specification CW 3410 (latest edition) - Asphaltic Concrete Pavement Works;

b) E59 Hot-Poured Rubberized Asphalt Waterproofing with Protection Board.

E72.3 Submittals

(a) In addition to Specification CW 3410 - Asphaltic Concrete Pavement Works, the Contract shall submit the following to the Contract Administrator fourteen (14) days prior to the Work, the proposed mix design and test results for verification and approval.

E72.4 Materials

(a) The Contractor shall be responsible for the supply, safe storage, and handling of all materials set forth in this Specification. All materials shall be handled in a careful and workmanlike manner, to the satisfaction of the Contract Administrator.

E72.4.1 Tack Coat and Bituminous Pavement

(a) The tack coat and bituminous pavement for the class specified on the Drawings shall conform to the requirements of the Specification CW 3410-R12 - Asphaltic Concrete Pavement Works;

(b) Asphalt shall be Type 1A.

E72.4.2 Caulking Compound and Miscellaneous Joint Materials

(a) Caulking compound and miscellaneous joint materials shall be as shown on the Drawings or approved by the Contract Administrator.

E72.5 Construction Methods

E72.5.1 Surface Preparation

(a) Surfaces to receive asphalt concrete paving shall be thoroughly cleaned by means of a power broom and compressed air. All surfaces to which the tack coat is to be applied shall be dry and fee from scale, dirt, grime, grease, oil or other contaminants.

E72.5.2 Application of Tack Coat

(a) Tack coat shall be applied to the entire surface of the deck and approach slabs. The quantity used shall not exceed 550 mL/m^2. Curbs and all other like appurtenances having a vertical face shall receive a brushed-on application of tack coat to the height of the compacted asphalt mat. All puddles or other excess of the tack coat shall be thoroughly spread out by brushing the material over the surrounding surface.

(b) The vertical surfaces of the curbs and all other like appurtenances and the bridge deck areas within one (1) foot of such abutting surfaces, shall receive a further coating of paving grade (150/200 penetration) asphalt cement.

(c) The treated surface shall be allowed to cure until it becomes tacky before applying the asphalt mix.

E72.5.3 Distribution

(a) The distributor used in applying the liquid bituminous tack coat shall be of a type, size and equipped as to meet the following requirements:

(i) It shall be capable of applying bituminous tack coat on the deck and approach slabs in accurately measured quantities.

(ii) It shall be equipped with:

- A heating unit capable of maintaining the asphalt in the tank at the specified temperature;
- A thermometer so placed as to accurately measure the temperature of the material in the tank;
- A tachometer operated by an independent wheel, or a similar suitable device, that will allow the operator to determine the correct travel speed for applying the specified quantity of asphaltic material;
- A pressure gauge to indicate to the operator that the required nozzle pressure is being maintained;
- Spray nozzles, with quick acting positive shutoff, of a design which will ensure a uniform fan-shaped spray;
- A strainer on the discharge line to prevent clogging;
- A spray bar of adjustable length that can be raised or lowered;
- A spray bar having a heating device, asphalt circulation system, or other device which will provide a uniform viscosity of material in all portions of the spray bar;
- A hose and nozzle attachment to be used for spraying, by hand, areas inaccessible to the distributor spray bar;

(iii) On smaller bridge decks, the use of manual spraying equipment suitable for applying the liquid bituminous material uniformly at the desired rate will be allowed.

E72.5.4 Transportation of Bituminous Pavement Mixture

(a) The mixture shall be transported from the mixing plant to the job site in vehicles with tight boxes having metal bottoms previously cleaned of all foreign materials. When directed by the Contract Administrator, the vehicles shall be suitably insulated. Each vehicle shall be equipped with a closely fitting tarpaulin of canvas or other suitable material of sufficient size to overhang the truck box on all sides when the vehicle is loaded. Tarpaulins shall be used to completely cover the mixture at all times, even during the placing of the load into the spreader.

(b) All loads not properly covered will be rejected.

E72.5.5 Placing Asphaltic Concrete Paving Mixture

(a) The Contractor shall spread the asphalt pavement mixture by means of a self-propelled mechanical paver complete with screed. The paver shall be equipped with both automatic and manual controls capable of adjusting the screed to produce the required profile, cross section and longitudinal joint matching. Unless otherwise permitted the paver shall be operated using automatic controls. The automatic control of profile shall be accomplished by reference to a floating beam or skid. The beam or skid shall have a minimum length of 9 metres. A floating beam shall be supported by wheels or skis in a floating tandem arrangement. The number and arrangement of wheels or skis and the nature of the beam or skid shall be subject to the Contract Administrator's approval. When paving adjacent to a newly laid lane on final lift or adjacent to a curb, control of profile may be accomplished by reference to a shoe on the adjacent final lift or curb.

(b) The paver shall produce a uniformly textured surface free from tearing, tracking or other objectionable surface irregularities. If the surface condition is not acceptable, spreading operations shall cease until equipment adjustments, repairs or replacement are made. Spreading operations shall not recommence without the approval of the Contract Administrator. Delays and expense entailed in adjustments, repairs or replacement of equipment shall be the responsibility of the Contractor.

(c) The paver shall proceed in the same direction as the lap of the protection board and the sequence of spreading operations with respect to lanes and lifts shall be approved by the Contract Administrator.

(d) The spreader shall be capable of spreading the mixture true to the elevations, grades and crown as shown on the Drawings. The allowable variation in the bituminous pavement surface shall not exceed 6 mm when measured using a 3 meter straight edge. Particular attention shall be paid to the setting of the spreader when laying the mixture in the areas adjacent to protruding joints in order to avoid bumps in the areas of such joints. In correcting the areas adjacent to a joint or when removing excess mixture, the material shall be picked up and not cast on the surface of the freshly spread bituminous pavement.

(e) Immediately after the course is screeded, and before roller compaction is started, the remainder of the surface shall be checked, all inequalities adjusted, and all high spots removed and replaced with satisfactory material. Irregularities in alignment and grade along the curb shall be corrected by the addition or removal of mixture before the edge is rolled.

(f) The speed of the spreader shall be maintained at a uniform rate that is in balance with the amount of bituminous pavement mixture being delivered to the bridge site.

(g) The Contractor shall apply a tack coat between successive lifts as approved by the Contract Administrator.

E72.5.6 Compaction of Asphalt Overlay Mixture

(a) The breakdown and finishing operations shall be carried out by a steel three (3)-wheeled or tandem roller. The intermediate rolling shall be done by a self-propelled pneumatic-type roller. Delays in rolling freshly-spread mixture will not be tolerated.

(b) All areas next to vertical curb median faces and protruding deck joints shall be worked with hot iron tampers, mechanical vibratory tempers or by other means satisfactory to the Contract Administrator.

E72.5.7 Construction Joints in Asphalt Overlay

(a) Longitudinal and transverse joints shall be made in a careful manner in order to assure a well-bonded, sealed and level joint. A transverse joint shall be cut back to its full depth perpendicular to the mat at the end of the run. On resuming laying of the paving mixture, the exposed edges shall be painted with a thin coat of hot asphalt cement.

(b) Before placing the paving mixture against them, all contact surfaces of longitudinal joints, curbs, leaders, etc., shall be painted with a thin coat of hat asphalt cement, as well as heated with a propane joint heater.

(c) The allowable variation in the surface across a transverse joint shall not exceed 6 mm when measured using a 3 m straight edge centred on the joint.

(d) In raking joints, excess mix material shall be picked up and removed from the surface of the freshly spread asphalt.

E72.5.8 Joints in Asphalt Overlay

(a) When called for on the Drawings, the Contractor shall, after the completion of the asphalt paving, saw-cut the asphalt in the transverse direction for the full roadway width at every pier and abutment to the dimensions as shown on the Drawings. The joints shall then be constructed in accordance with the Drawings.

E72.5.9 Weather

(a) Paving asphalt to be laid to a compacted thickness of less than 40 mm shall not be started unless the air temperature is at least ten degrees Celsius (10°C) and rising, and not until all frost or moisture has evaporated to leave a dry surface. For greater thicknesses of asphalt pavement, the temperature requirement may be reduced to five degrees Celsius (5°C), providing the temperature is rising.

E72.5.10 Protection of Exposed Bridge Surfaces

(a) Utmost care shall be taken to prevent the surfaces of the curbs above the compacted asphalt mat, as well as the newel posts and approach railing, from being disfigured by materials such as tack coating, caulking compound, cement and asphalt mixture.

(b) If the exposed surfaces are marred as a result of the Contractor's operations, restoration shall be made by the Contractor at his expense and to the satisfaction of the Contract Administrator.

E72.6 Quality Control and Quality Assurance

E72.6.1 Quality Control

(a) The quality control testing by the Contractor shall meet the requirements specified in the Specification CW 3410-R12 - Asphaltic Concrete Pavement Works.

E72.6.2 Quality Assurance

(a) All materials supplied by the Contractor to be permanently incorporated in the finished product are subject to the inspection and approval of the Contract Administrator.

(b) The Contractor shall take random field samples and conduct quality assurance tests on the materials, including the asphalt hot mix as directed by the Contract

Administrator. If any material or the asphalt hot mix is proven to be of inferior quality, the Contract Administrator will reject such material.

(c) In cases where bituminous pavements have already been laid and are proven in later tests to be inferior, the Contractor shall remove such material and replace it with proper material at his own expense.

E72.7 Measurement and Payment

(a) Asphalt paving will be paid for at the Contract Unit Price per tonne for "Asphalt Overlay on Bridge", measured as specified herein, which price shall be payment in full for supplying all materials and for performing all operations herein described and all other items incidental to the Work included in this Specification and accepted by the Contract Administrator.

E73. SURFACE PREPARATION AND METALLIZING OF STRUCTURAL STEEL

E73.1 Description

E73.1.1 General

(a) This Specification shall cover surface preparation and metallizing of all existing structural steel girders throughout the bridge.

(b) The quality control testing of all materials.

(c) The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies and all things necessary for and incidental to the satisfactory performance and completion of all Work as hereinafter specified.

E73.2 References

E73.2.1 Reference Standards

(a) Perform work in accordance with the requirements of the latest issue of the following specifications and standards:

(i) American Society of Testing Material

- ASTM D 4285, Standard Test Method for Indicating Oil or Water in Compressed Air;
- ASTM B833, Standard Specifications for Zinc Wire for Thermal Spraying (Metallizing);
- ASTM D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers;
- ASTM D4417, Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel.

(ii) Society of Protective Coatings;

- SSPC-AB 1, Mineral and Slag Abrasives;
- SSPC-AB 2, Specification for Cleanliness of Recycled Ferrous Metallic Abrasives;
- SSPC-AB 3, Newly Manufactured or Re-Manufactured Steel Abrasives;
- SSPC-PA 2, Measurement of Dry Coating Thickness with Magnetic Gages;
- SSPC-QP 1, Standard Procedure for Evaluating Painting Shop Contractors (Field Application to Complex Structures);
- SSPC-QP 2, Standard Procedure for Evaluating the Qualifications of Painting Shop Contractors to Remove Hazardous Paint;
- SSPC-SP 1, Solvent Cleaning;
- SSPC-SP 5/NACE No. 1, White Metal Blast Cleaning;
- SSPC-SP 11, Power Tool Cleaning to Bare Metal;

- SSPC-SP 12/NACE No. 5, Surface Preparation and Cleaning of Metals by Water Jetting Prior to Recoating;
- SSPC-SP 16, Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals;
- SSPC-PA 17, Procedure for Determining Conformance to Steel Profile/Surface Roughness/Peak Count Requirements;
- SSPC-VIS 1, Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning;
- SSPC-VIS 5, Guide and Reference Photographs for Steel Prepared by Wet Abrasive Blast Cleaning;
- SSPC-Guide 15, Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Surfaces;
- SSPC-CS 23.00/AWS C2.23M/NACE No. 12, Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc, and Their Alloys and Composites for the Corrosion Protection of Steel;
- SSPC-PA 18, Specification for Application of Thermal Spray Coatings to Steel Bridges.

(iii) American National Standards Institute/American Welding Society;

- ANSI/AWS C2.25/C2.25M, Specification for Thermal Spray Feedstock-Wire and Rods;
- AWS C2.16/C2.16M, Guide for Thermal-Spray Operator Qualification;
- S8.2-2017 Specification for Application of Thermal Spray Coating Systems to Steel Bridges.

(b) Metallizing wire and coating manufacturer’s application instructions, MSDS and product data sheets.

E73.3 Submittals

(a) At least twenty-one (21) Calendar Days prior to the scheduled commencement of any surface preparation and coating operations, the Contractor shall submit to the Contract Administrator, the proposed schedule, methods and sequence of operations for review.

(b) Drawings sealed by a Professional Engineer registered in the Province of Manitoba shall be submitted detailing the Contractor's proposed scaffolding, platforms, and swingstages to be employed. All scaffolding, platforms, and swingstages shall be designed, constructed, erected and operated in accordance with Workplace Safety and Health Division requirements. No Works shall commence without prior written approval of the Contract Administrator.

(c) The Contract Administrator will provide written notification to the Contractor when submittals are complete and acceptable. No surface preparation work shall begin until that notification is received.

(d) This acceptance shall not be construed to imply approval of any particular method or sequence for conducting the work, or for addressing health and safety concerns. Acceptance does not relieve the Contractor from the responsibility to conduct the work according to the requirements of Federal, Provincial, or Local regulations and this specification, or to adequately protect the health and safety of all workers involved in the project and any members of the public who may be affected by the Work.

(e) The Contractor remains solely responsible for the adequacy and completeness of the programs and work practices, and adherence to them.

E73.4 Materials

E73.4.1 General

(a) The Contractor shall be responsible for the supply, safe storage and handling of all materials set forth in this Specification. All materials supplied under this Specification shall be subject to inspection and acceptance by the Contract Administrator. There shall be no charge to the City for any material taken by the Contract Administrator for testing purposes.

(b) Materials called for under these Specifications and on the Drawings shall, unless otherwise specified, satisfy the testing procedures and be in strict accordance with the requirements set out in the latest edition of the standards identified.

E73.4.2 Metalizing Wire

(a) All thermal spray feedstock (metallizing wire) shall be the products of a single manufacturer, meet the requirements below, and meet the thermal spray equipment manufacturer's specifications:

(i) The metallizing wire shall consist of nintey-nine and nine tenths percent (99.9%) zinc complying with ASTM B-833 and ANSI/AWS C2.25/C2.25M.

(ii) The Contractor shall provide a certificate of chemical composition of the proposed metallizing wire from the metallizing wire manufacturer.

E73.4.3 Coating Material Supply Requirements

(a) All metallizing material shall be delivered in the original unopened spools with manufacturer's labels intact. Any material that has been damaged or otherwise deteriorated shall not be used. The Contractor shall provide, if and when requested by the Contract Administrator, a listing, updated weekly, of the weight and number of spools and the type of metallizing material (as identified by a mill test report and corresponding heat number for each spool) received from the metallizing manufacturer on this project.

(b) All material shall be stored under cover in a secured place as approved by the Contract Administrator and shall be kept within storage temperature limitations recommended by the manufacturer.

E73.4.4 Abrasive for Blast Cleaning

(a) The blast-cleaning abrasive shall be free of corrosion-producing contaminants. Acceptable angular shaped abrasives include, but are not limited to, aluminum oxide, steel grit, and crushed slag. Silica sand shall not be used. Steel shot and other abrasives producing a rounded surface profile are not acceptable, even if mixed with angular grit abrasives. The blast-cleaning abrasive and grit size employed shall be capable of achieving an average profile peak-to-valley height of at least 3.5 mils and not exceeding 4.5 mils.

(b) Abrasive suppliers shall provide written certification that expendable abrasives and recyclable steel grit abrasives meet the requirements of SSPC-AB 1 and AB 3, respectively. Abrasive suppliers shall certify that abrasives are not oil contaminated and shall have a water extract pH value within the range of 6 to 8.

E73.4.5 Incidental and Miscellaneous Materials

(a) Incidental and miscellaneous materials utilized in undertaking the surface preparation and coating Works shall be supplied strictly in accordance with the manufacturer's guidelines, as approved in advance by the Contract Administrator, and in accordance with these Specifications.

(b) This will include solvent mixtures associated with solvent cleaning operations, and any other incidental materials used in conjunction with the Works of this Specification.

(c) The use of all such materials shall be reviewed with the Contract Administrator to ensure conformance with the Specification, prior to the use of same in the Works. The Contract Administrator's decision in these matters shall be final.

E73.5 Surface Preparation and Metallizing Equipment

(a) All equipment shall be of a type approved by the Contract Administrator and capable of preparing the existing structural steelwork surfaces in accordance with these Specifications.

(b) The coating application equipment shall be designed such that the coating will be applied uniformly to all surfaces in the locations required as shown on the Drawings and approved by the Contract Administrator and shall be kept in good working order.

(c) The Contractor shall provide surface preparation, metallizing, and painting equipment as needed to perform the work as specified herein.

(d) Metallizing application equipment shall be portable electric arc thermal spray units that are set-up, adjusted and operated in accordance with the manufacturer's written instructions.

(e) All cleaning and painting equipment shall include gages capable of accurately measuring fluid and air pressures and shall have valves capable of regulating the flow of air, water or paint as recommended by the equipment manufacturer. The equipment shall be maintained in proper working order.

(f) Diesel or gasoline powered equipment shall be positioned or vented in a manner to prevent deposition of combustion contaminants on any part of the structure.

(g) Hand tools, power tools, pressure washing, water jetting, abrasive blast cleaning equipment, brushes, rollers, and spray equipment shall be of suitable size and capacity to perform the work required by this specification. Appropriate filters, traps and dryers shall be provided for the compressed air used for abrasive blast cleaning and conventional spray application.

E73.6 Water

(a) Water used for high pressure water washing shall be clean and free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances. It shall be equal to potable water in physical and chemical properties.

E73.7 Construction Methods

E73.7.1 General

(a) The surface preparation and metallizing shall be according to the SSPC Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc and their Alloys and Composites for the Corrosion Protection of Steel, SSPC-CS 23.00/AWS C2.23M/NACE No. 12 except as modified herein. In the event of a conflict, the requirements of this specification shall prevail.

(b) The Contractor shall notify the Contract Administrator twenty-four (24) hours in advance of beginning surface preparation operations.

E73.7.2 Access

(a) Access methods for workers and equipment to access all areas of the structure must be submitted by the Contractor and approved by the Contract Administrator at least ten (10) working days prior to the proposed commencement of construction.

E73.7.3 Test Areas (Sections)

(a) Prior to proceeding with production work on the project, the Contractor shall prepare test sections of at least 10 square feet (0.93 sq. m). More than one test section may be needed to represent the various design configurations of the structure. The test section(s) shall be blast cleaned, metallized and painted (if specified) in accordance with the requirements specified herein using the same equipment, materials and procedures that will be used for the production.

(b) During the blast cleaning, metallizing, and painting of the test section(s), in the presence of the Contract Administrator, the Contractor shall perform all quality control tests and inspections required by this specification including complete documentation.

In addition, the Contractor shall allow sufficient time for the Contract Administrator to perform any or all quality assurance tests and inspections desired.

(c) Production work shall not proceed until the Contract Administrator agrees that the blast cleaning, metallizing, and painting work, along with the quality control testing, inspection, and documentation are acceptable.

(d) No additional compensation will be paid for the preparation of the test section(s).

E73.7.4 Protective Coverings and Damage

(a) Prior to undertaking any Works, the Contractor shall take all necessary precautions to prevent blast-cleaning overspray and overspray/splatter/drift of the primer and coating, all in accordance with E73 Environmental Containment Collection and Disposal for Metallizing. All splatter, overspray, and spills shall be promptly removed by the Contractor at his own expense to the satisfaction of the Contract Administrator.

(b) The Contractor must provide adequate protection against sandblast or coating damage to the substructure, bearings, vehicles, water crafts, private property, and the public in the vicinity of the bridge. The Contractor will be held solely liable for any damages or claims resulting from the blast cleaning and coating operations.

E73.7.5 Ambient Conditions

(a) Surfaces prepared for metallizing or painting shall be free of moisture and other contaminants. The Contractor shall control operations to insure that dust, dirt, or moisture do not come in contact with surfaces on which work will take place.

(b) Under no circumstances shall the metallizing be applied until the surface preparation has been inspected and approved by the Contract Administrator immediately prior to commencement of metallizing application operations.

(c) Metallizing shall not be carried out:

(i) When the temperature of the air or steel is below five degrees Celsius (5°C);

(ii) Unless the temperature of the steel is at least five degrees Celsius (5°C) above the dewpoint;

(iii) If the temperature is expected to drop below zero degrees Celsius (0°C) during the metallizing drying period;

(iv) If the relative humidity exceeds the coating manufacturer's written recommendations.

(d) The manufacturers' published literature shall be followed for specific temperature, dew point, and humidity restrictions during the application of each paint coat.

(e) Metallizing or paint shall not be applied in rain, wind, snow, fog or mist. Ambient conditions shall be maintained during the drying period specified by the manufacturer.

E73.7.6 Compressed Air Cleanliness

(a) Prior to using compressed air for abrasive blast cleaning, blowing down surfaces, and metallizing or painting application, the Contractor shall verify that the compressed air is free of moisture and oil contamination according to the requirements of ASTM D 4285.

(b) The tests shall be conducted at least one (1) time per shift for each compressor system in operation. If air contamination is evident, the Contractor shall change filters, clean traps, add moisture separators or filters, or make other adjustments as necessary to achieve clean, dry air.

(c) The Contractor shall also examine the work performed since the last acceptable test for evidence of defects or contamination caused by the contaminated compressed air. Contaminated work shall be repaired at no additional cost to the City.

E73.7.7 Solvent Cleaning

(a) All traces of oil, grease, and other detrimental contaminants on the steel surfaces to be metallized shall be removed by solvent cleaning in accordance with SSPC-SP 1.

The brand name of proposed cleaning solvent(s) and/or proprietary chemical cleaners including manufacturers' product data sheet and MSDS shall be submitted for the Contract Administrator's acceptance prior to use.

(b) Under no circumstances shall blast cleaning be performed in areas containing surface contaminants or in areas where the Contract Administrator has not accepted the solvent cleaning. Rejected surfaces shall be re-cleaned to the specified requirements at no additional cost to the City.

E73.7.8 Abrasives

(a) Abrasive blast cleaning shall be performed using either expendable abrasives or recyclable steel grit abrasives. Expendable abrasives shall be used one (1) time and discarded. The abrasive shall be angular in shape.

(b) On a daily basis, the Contractor shall verify that recycled abrasives are free of oil and contamination by performing a vial test in accordance with SSPC-AB 2.

(c) All surfaces that are found to have been prepared using abrasives not meeting the SSPC-AB 1, AB 2, or AB 3 requirements, as applicable, are oil contaminated, or have a pH outside the specified range, shall be solvent cleaned or low pressure water cleaned, and re-blast cleaned at no cost to the City.

E73.7.9 Surface Preparation

(a) Before any blast cleaning operations or any coating applications commence, the following surface cleaning operations shall be undertaken on all structural steel members designated to receive a coating system.

(i) All organic materials such as bird droppings, and any other non-structural obstructions or pollutants attached to the steel are to be removed by hand cleaning operations.

(ii) All oil and grease shall be removed manually as per E73.7.7;

(iii) The entire area shall be washed clean by using high pressure water washing as per SSPC-SP12WJ4-NV2.

(b) The following method of surface preparation shall be used:

(i) Flame Cut Steel: Prior to blast cleaning, all flame cut edges shall be ground to remove hardened steel and any sharp or irregular shapes.

(ii) Near-White Metal Blast Cleaning: All steel surfaces to be metallized shall be near white metal blast cleaned in accordance with SSPC-SP 10 using dry abrasive blast cleaning methods.

(iii) Base Metal Irregularities: If hackles, burrs, or slivers in the base metal are visible on the steel surface after cleaning, the Contractor shall remove them by grinding followed by re-blast cleaning.

E73.7.10 Surface Profile

(a) Blast cleaning abrasives shall be of the size and grade that will produce a uniform angular surface profile depth of 3.5 to 4.5 mils (89 to 114 microns).

(b) If the metallizing wire manufacturer's profile requirements are more restrictive, the Contractor shall advise the Contract Administrator and comply with those requirements. For recycled abrasives, an appropriate operating mix shall be maintained in order to control the profile within these limits.

(c) The average surface profile shall be determined each work day with a minimum frequency of one (1) location per every 200 sq ft (18.6 sq m) per piece of equipment. All surfaces, including flame cut edges, shall be tested in accordance with SSPC-PA 17.

(d) Surface profile replica tape or electronic profilometer shall be used. The tape shall be retained and included with the daily QC report. Single measurements less than 3.5 mils (89 microns) are unacceptable. In that event, additional testing shall be done to

determine the limits of the deficient area and, if it is not isolated, work will be suspended.

(e) The Contractor shall submit a plan for making the necessary adjustments to insure that the specified surface profile is achieved on all surfaces. Work shall not resume until the Contract Administrator provides written acceptance.

(f) Any areas shielded or hidden from the effects of sandblasting shall be cleaned manually or by other means to the satisfaction of the Contract Administrator.

(g) The blasting shall be performed so as not to damage or contaminate any previously coated areas.

(h) Where the coating has been damaged or rejected, remove loose or rejected coating to meet surface preparation as specified in this specification. Cleaning shall be performed approximately 20 mm beyond the damaged areas in all directions or until soundly-adhered coating is obtained.

E73.7.11 Clean-up Operations

(a) Following all blast cleaning operations and prior to the Contract Administrator's inspection, all surfaces involved shall be blown off with compressed air or cleaned by vacuum for the purpose of removing any and all traces of blast products from the surface, and for the removal of abrasive from all pockets and corners.

(b) Following surface preparation clean-up operations, the Contractor shall immediately notify the Contract Administrator so that an inspection can be made prior to the application of coating.

(c) The coating shall be applied as soon as possible after the surface preparation clean-up operation as approved by the Contract Administrator.

E73.7.12 Surface Condition Prior to Metallizing

(a) The Contractor shall provide the Contract Administrator with a minimum of four (4) hours' notice prior to coating, to allow for testing and inspection of prepared surfaces.

(b) Prepared surfaces shall meet the requirements of SSPC-SP 10 immediately prior to metallizing, and shall be metallized within six (6) hours of blast cleaning. If rust appears or bare steel has been exposed for more than six (6) hours, the affected area shall be re-blasted at no additional cost to the City.

(c) All dust and surface preparation residue on steel surfaces shall be removed prior to metallizing.

(d) The quality of surface preparation and cleaning of surface dust and debris shall be accepted by the Contract Administrator prior to metallizing. No coating shall be applied to any prepared surface until written acceptance of complete surface preparation of an area has been given by the Contract Administrator.

(e) The Contract Administrator has the right to reject any work that was performed without adequate provision for quality assurance observations to accept the degree of cleaning. Rejected metallizing work shall be removed and replaced at no additional cost to the City.

E73.7.13 Daily Metallizing Operator-Equipment Qualification - Bend Tests

(a) Unless directed otherwise by the Contract Administrator, each day that metallizing will be applied, the Contractor shall perform bend testing prior to beginning production work.

(b) For each metallizing applicator, five (5) carbon steel coupons 50 mm x 200 mm x 1.3 mm thick shall be blast cleaned using the same equipment and abrasive used for the production work. Each applicator shall apply the metallizing to five (5) coupons in accordance with the requirements of this Specification to a dry film thickness of 8.0 to 12.0 mils (200 to 300 µm).

(c) 180 degree bend testing shall be performed on all five (5) coupons using a 13 mm mandrel in accordance with the requirements and acceptance criteria of SSPC-CS

23/AWS C2.23M/NACE 12. Minor cracks that cannot be lifted from the substrate with knife blade are acceptable. If lifting occurs on any coupon, the surface preparation and/or metallizing process shall be modified until acceptable results are achieved before proceeding with production work.

E73.7.14 Application of Metallizing

(a) Application shall be done in overlapping passes in a cross-hatch pattern (i.e., a second set of overlapping passes shall be applied at right angles to the first set of overlapping passes) to ensure uniform coverage.

(b) The gun shall be held at such a distance from the work surfaces that the metal is still molten on impact. The metallizing shall be applied as a continuous film of uniform thickness, firmly adherent, and free from thin spots, misses, lumps or blisters, and have a fine sprayed texture. Thin spots and misses shall be re-metallized.

(c) If touch up metallizing or the application of additional metallizing to previously applied metallizing does not occur within twenty-four (24) hours, the surface of the metallizing shall be brush off blast cleaned according to SSPC-SP7 to remove oxidation and surface contaminates prior to the application of additional metallizing.

(d) The final appearance of the metallizing when left un-top coated shall be uniform without excessive blotchiness or contrast in color. If the surface does not have a uniform appearance, remove and replace the metallizing at no cost to the City.

(e) If the configuration of the surface being metallized does not allow for a proper gun-to-work piece standoff distance, the Contractor shall notify the Contract Administrator.

(f) The existing metal shall not be heated to a temperature exceeding three hundred and fifty degrees Celsius (350ºC).

E73.7.15 Metallizing Thickness

(a) The thickness of the metallizing shall be 8.0 to 12.0 mils (200-300 microns). Thickness shall be measured as specified by SSPC-PA 2 (use a Type 2 Electronic Gauge only).

E73.7.16 Metallizing Adhesion

(a) Adhesion testing of metallizing applied each day shall be determined with a self-adjusting adhesion tester in accordance with ASTM D 4541.

(b) Unless otherwise directed by the Contract Administrator, a minimum of one (1) test shall be conducted for every 500 square feet (46 square metres) of metallized surface.

(c) The tests shall be conducted prior to application of any coating. If any of the tests exhibit less than 700 psi (4.83 MPa) for 85/15 or less than 500 psi (3.45 MPa) for zinc, additional tests shall be conducted to determine the extent of the deficient material.

(d) All deficient metallizing shall be removed by blast cleaning and re-applied at no additional cost to the City

(e) At the discretion of the Contract Administrator, a representative blast cleaned test panel (or steel companion panel approximately 12 inch x 12 inch x 1/4 inch thick) can be metallized at the same time each 500 square feet (46 square metres) of surface area, or portion thereof, is metallized. Adhesion testing can be performed on the companion panel rather than on the structure

(f) If the adhesion tests on the panels are acceptable, the metallizing on the structure is considered acceptable and testing on the structure is not required. If adhesion testing of the panels fails, testing shall be conducted on the structure.

(g) If adhesion testing on the structure is acceptable, the metallizing on the structure is considered to be acceptable.

(h) If tests on the structure are unacceptable, complete removal of the failing metallizing and re-metallizing in accordance with this Specification shall be performed at no additional cost to the City.

E73.8 Quality Control

(a) The Contractor performing the shop work shall perform first line, in process QC inspections. The Contractor shall implement the accepted QC Program to insure that the work complies with these specifications.

(b) The designated Quality Control inspector shall be onsite full time during any operations that affect the quality of the system (e.g., surface preparation, metallizing application, paint application, and final inspection at project completion).

(c) The Contractor shall use the Contractor Daily (QC) Metallizing & Painting Report form to record the results of quality control tests and inspections. The completed reports shall be given to the Contract Administrator before work resumes the following day.

(d) QC inspections shall include, but are not limited to the following:

(i) Ambient conditions;

(ii) Surface preparation (solvent cleaning, abrasive blast cleanliness, surface profile depth, etc.);

(iii) Metallizing application (specified materials used, bend test, continuity and coverage, adhesion, dry film thickness);

(iv) Verification that the MISTIC test ID number for the paint system has been issued when painting is specified;

(v) Paint Application (when specified)(specified materials used, continuity and coverage, dry film thickness, freedom from overspray, dry spray, pinholes, skips, misses, etc.).

(e) The personnel managing the QC Program shall possess a minimum classification as a NACE CIP Level 2, or shall provide evidence of successful inspection of three (3) projects of similar or greater complexity and scope completed in the last two (2) years. References shall include the name, address, and telephone number of a contact person employed by the facility owner.

(f) The personnel performing the QC tests shall be trained in all tests, inspections, and instrument use required for the inspection of surface preparation, metallizing and paint application. Documentation of training shall be provided. The QC personnel shall be solely dedicated to quality control activities and shall not perform any production work. QC personnel shall take the lead in all inspections, but applicators shall perform wet film thickness measurements during application of the coatings, with QC personnel conducting random spot checks. The Contractor shall not replace the QC personnel assigned to the project without advance notice to the Contract Administrator, and acceptance of the replacement(s), by the Contract Administrator.

(g) The Contractor performing the work shall supply all necessary equipment to perform the QC tests and inspections as specified. Equipment shall include the following at a minimum.

(i) Psychrometer or comparable equipment for measurement of dew point and relative humidity, including weather bureau tables or psychrometric charts;

(ii) Surface temperature thermometer;

(iii) SSPC Visual Standard VIS 1;

(iv) Surface profile replica tape and spring micrometer or electronic micrometer designed for use with replica tape; or electronic profilometer designed for measuring blast profile;

(v) Blotter paper for compressed air cleanliness checks;

(vi) Type 2 Electronic Dry Film Thickness Gage;

(vii) Calibration standards for dry film thickness gage;

(viii) Bend test coupons and bend test mandrel;

(ix) Adhesion testing instrument;

(x) Companion panels for adhesion testing (if that option is selected);

(xi) All applicable ASTM, ANSI, AWS, and SSPC Standards used for the work (reference list included).

(h) The instruments shall be verified for accuracy and adjusted by the Contractor's personnel in accordance with the equipment manufacturer's recommendations and the Contractor's QC Program. All inspection equipment shall be made available to the Contract Administrator for quality assurance observations as needed.

E73.8.2 Quality Assurance

(a) The Contract Administrator will conduct quality assurance observations of any or all phases of the work. The presence or activity of the Contract Administrator observations in no way relieves the Contractor of the responsibility to perform all necessary daily QC inspections of their own and to comply with all requirements of this Specification.

(b) The Contract Administrator has the right to reject any work that was performed without adequate provision for quality assurance observations.

E73.9 Measurement and Payments

(a) Surface preparation and coating of structural steel, as defined in this Specification, will not be measured. This item of work will be paid for at the Contract Lump Sum Price for "Surface Preparation and Metallizing of Structural Steel". The payment will be considered full payment for supplying all materials and for performing all operations herein described and all other items incidental to the Work.

E74. ENVIRONMENTAL CONTAINMENT COLLECTION AND DISPOSAL FOR METALLIZING

E74.1 Description

E74.1.1 This Specification shall cover environmental protection and capture systems during surface preparation and metallizing of structural steel components in the field, including the necessary enclosure system(s) as specified herein.

E74.1.2 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies and all things necessary for and incidental to the satisfactory performance and completion of all Work as hereinafter specified.

E74.2 Scope of Work

(a) The Work under this Specification shall include the following items, or as otherwise directed by the Contract Administrator:

a) It is intended that this Specification cover the following Works associated with environmental protection:

b) Containment, collection and disposal of spent sandblasting abrasive and new metallizing overspray (hazardous waste unless proven otherwise by the Contractor). Should the Contractor want to have this waste stream reclassified as non-hazardous waste, the Contractor shall provide additional testing to prove that at their own cost and submit test results to the Contract Administrator for acceptance. Until these test results are found acceptable to the Contract Administrator this waste stream shall be treated as hazardous waste.

c) Containment, collection and disposal of debris generated by concrete demolition Works as well as reinforcing steel and concrete surface preparation Works (non-hazardous waste unless contaminated with spent sandblasting abrasive and new metallizing overspray).

E74.3 Submittals

The Contractor shall submit the following to the Contract Administrator, in accordance with the Specification:

(a) At least fourteen (14) working days prior to scheduled commencement of any surface preparation and metallizing operations, the Contractor shall submit to the Contract Administrator for review the proposed environmental protection measures to be taken during surface preparation and metallizing of structural steel in the field. The detailed submission shall include a description of the environmental protection measures to be undertaken so as to ensure complete containment, collection and disposal of spent blasting abrasives, removed paint, all other debris products from surface preparation as well as new metallizing over spray. The detailed submission shall also include a detailed description of the proposed methods and procedures, sequence of operations, equipment, detailed drawings of the proposed enclosure system and all other applicable details relating to environmental protection measures during surface preparation and metallizing.

(b) Design drawings sealed by a Professional Engineer registered in the Province of Manitoba shall be submitted detailing the Contractor's proposed containment hoarding system. The details will not be accepted if not sealed by the Professional Engineer. The submission of such details to the Contract Administrator shall in no way relieve the Contractor of full responsibility for the safety and structural integrity of the containment hoarding system. The containment hoarding shall be designed, constructed, erected and operated in accordance with Workplace Safety and Health requirements. No Work shall commence before the Contract Administrator has completed the review and advised the Contractor. As part of his responsibilities, the design Engineer whose seal is on the documents will be required to inspect the containment hoarding on site to ensure conformity with the design. The design Engineer will certify this conformity in writing and submit this certification to the Contract Administrator.

E74.4 Materials

(a) General

a) The Contractor shall be responsible for the supply, safe storage and handling of all materials set forth in this Specification. All materials supplied under this Specification shall be subject to inspection and approval by the Contract Administrator.

E74.5 Construction Methods

E74.5.1 General

(a) In general the Contractor shall ensure that the debris from concrete demolition Works, surface preparation of structural steel, reinforcing steel and concrete surfaces and the overspray from metallizing application will not result in harmful effects or nuisance to river, land, buildings, vehicles, pedestrian and water craft in the vicinity of the Contract area.

(b) The Contractor shall conduct his operations in accordance with all current Federal, Provincial or other regulations with respect to environmental protection and pollution control. It shall be the Contractor's responsibility to be familiar with all applicable environmental regulations, to obtain all necessary approvals and permits for his operations and to ensure that all applicable environmental requirements are met and adhered to.

E74.5.2 Allowable Construction Loads

(a) The loading from all equipment, platforms, materials, work persons, etc. shall be restricted so that the total forces from these loadings in the steel superstructure and work platform are less than or equal to the total forces from the allowable forces.

(b) The environmental containment for surface preparation and metallizing shall not be installed until new deck is cast.

E74.5.3 Containment, Collection and Disposal

(a) Spent Sandblasting Abrasive and metallizing Overspray (Hazardous Waste)

(i) The Contractor is advised of the general concern regarding contamination of land areas and waterways by old paint, blasting abrasives and new metallizing

materials. The Contractor shall ensure that such contamination does not take place.

(ii) The Contractor shall provide for containment of the superstructure steel areas during all surface preparation and metallizing application operations. The containment shall be achieved by hoarding (tarps, scaffolding, etc.) so that the structure is enclosed in order to prevent spent blasting abrasives, cleaned-off paint residue and new metallizing material overspray from migrating to outside the enclosure.

(iii) The Contractor shall ensure that the amount of blasting medium to remove old paint and the amount of overspray from the application of new metallizing material is kept to the absolute minimum by conscientious efforts of his workforce and by efficient use of equipment.

(iv) The Contractor shall collect all spent blasting abrasives, cleaned-off paint residue and new metallizing material overspray from the Work area. All such materials shall be disposed of offsite by the Contractor in accordance with the appropriate regulations to the satisfaction of the appropriate environmental authority and the Contract Administrator.

(v) The Contractor is advised that the waste that will be generated will be classified as hazardous waste as determined by MR 282/87 respecting Classification Criteria for Products, Substances and Organisms Regulation under the Dangerous Goods Handling and Transportation Act. The Contractor in accordance with Manitoba Regulation 175/87 shall apply for and submit an initial Generator Registration Report to the Director of Environmental Approvals to obtain a Provincial Registration Number prior to beginning the rehabilitation Works. The Contractor shall employ a licensed Hazardous Waste Carrier to remove, transfer and dispose this hazardous waste at a facility licensed to receive hazardous waste in accordance with the requirements under the City's Provincial Registration Number 1001-195 including all costs for transportation, storage, and disposal of this hazardous waste.

(b) Non-Hazardous Waste

(i) The Contractor is advised of the general concern regarding contamination of land areas and waterways by the debris generated from concrete and wood removal Works. The Contractor shall ensure that such contamination does not take place.

(ii) The Contractor shall take necessary precautions to ensure that bridge materials do not fall onto the ground or into the water areas below during concrete and wood removal Works. The Contractor shall provide, erect and maintain platforms, hoarding and other structures as required to catch and retain all concrete and wood waste materials.

(iii) Any debris that falls off the bridge shall be immediately cleaned up by the Contractor at his own expense.

(iv) All waste material generated from the concrete and wood removal Works shall become the property of the Contractor. The Contractor shall promptly remove all debris generated by these Works off and away from the site. It shall be the Contractor's responsibility to find suitable disposal areas away from the site.

E74.6 Quality Control

(a) All workmanship and all materials furnished and supplied under this Specification are subject to close and systematic inspection and testing by the Contract Administrator including all operations from the selection and production of materials through to final acceptance of the Work. The Contractor shall be wholly responsible for the control of all operations incidental thereto notwithstanding any inspection or approval that may have been previously given.

(b) The Contract Administrator reserves the right to reject materials or Works which are not in accordance with the requirements of this Specification.

E74.7 Measurement and Payment

(a) Environmental containment, collection and disposal as defined in this Specification will not be measured. This item or work will be paid for at the Contract Lump Sum price for “Environmental Containment, Collection and Disposal for Metallizing”. The payment will be considered full payment for supplying all materials and for performing all operations herein described and all other items incidental to the Work.

(b) The Contractor shall provide and pay for monitoring within the enclosure to suit the requirements at Workplace Health and Safety. Any waste stream that is not contained, collected and disposed of shall be cleaned up immediately by the Contractor at their own cost.

E75. CONCRETE GIRDER SHEAR STRENGTHENING WITH FRP

E75.1 Description

(a) This Specification shall cover all operations relating to the design, supply and installation of the FRP shear strengthening system for the shear deficient areas as indicated on the Drawings.

(b) The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all other things necessary for and incidental to the satisfactory completion of all Work as hereinafter specified.

E75.2 Referenced Specifications and Drawings

(a) The latest edition and subsequent revisions of the following:

(i) CAN/CSA S6-14 - Canadian Highway Bridge Design Code;

(ii) CAN/CSA S808-14 - Specification for fibre-reinforced polymer (FRP) materials for externally reinforcing structures.

E75.3 Scope of Work

(a) The Work under this Specification shall involve:

(i) Epoxy injection of cracks (if any) prior to installation of the FRP strengthening system;

(ii) Designing and implementing a system to strengthen the shear deficient areas of the existing concrete girders using carbon FRP sheets (or other means as acceptable to the Contract Administrator) as indicated on the drawings.

E75.4 Submittals

(a) The Contractor shall submit the proposed design and installation procedures for the FRP strengthening system to be applied to the shear deficient areas of the concrete girders to the Contract Administrator for review and acceptance at least two (2) weeks prior to starting any strengthening work.

(b) The System design shall be in accordance with Section 16 of CSA S6 and shall incorporate a minimum design life of forty (40) years and shall account for the effects of humidity, temperature and exposure to de-icing salts and ultra-violet (UV) light as appropriate.

(c) The aforementioned design submission shall be sealed by a Contract Administrator registered in the Province of Manitoba. The Design submission shall include the following items at a minimum:

(i) Calculations;

(ii) Product data sheets;

(iii) History of successful product use in similar applications;

(iv) Detailed drawings and procedures, including anchorage / development requirements and details of any surface or corner preparation required.

(d) The contractor shall submit the Manufacturer's quality control test reports in accordance with CSA S808.

E75.5 Materials

(a) Fiber-reinforced polymer materials (FRP) shall meet the requirements of CSA Standard S6-14, Section 16 “Fibre-Reinforced Structures”.

E75.6 Equipment

(a) All equipment shall be of a type acceptable to the Contract Administrator and shall be in good working order.

E75.7 Construction Methods

(a) Prepare concrete substrate to receive the FRP strengthening system in accordance with the FRP manufacturer’s requirements. A representative of the FRP Manufacturer/Supplier shall inspect and approve the Contractor’s substrate preparation in the presence of the Contract Administrator.

(b) Install FRP strengthening system in accordance with the FRP Manufacturer’s/Supplier’s requirements. The FRP strengthening system shall be installed by a Manufacturer/Supplier Certified Applicator or by an Applicator approved by the FRP system Manufacturer/Supplier.

E75.8 Quality Control

(a) After installation is complete, the FRP Manufacturer/ Supplier shall submit written confirmation that the materials, surface preparation and installation were all completed in accordance with their requirements and that no deficiencies that could affect the proper performance of the system were noted.

E75.9 Measurement and Payment

(a) Supplying and Installing the FRP shall be paid for at the Contract Lump Sum Price for “Concrete Girder Shear Strengthening with FRP”, and will be considered full compensation for all labour, materials, tools, equipment and incidentals required to complete the work to the satisfaction Contract Administrator.

E76. UNDERPASS BASE

E76.1 Description

E76.1.1 This Specification shall cover supply, placement and all operations related to underpass base as indicated on the Drawings.

E76.1.2 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all other things necessary for and incidental to the satisfactory completion of all Work as hereinafter specified.

E76.2 Scope of Work

E76.2.1 The Work under this Specification shall involve:

(a) Preparation of subgrade;

(b) Supply and placement of Class 1 Heavy Duty Woven geotextile;

(c) Supply, placement and compaction of 350 mm thick sub-base;

(d) Supply, placement and compaction of 150 mm thick base course.

E76.3 Referenced Specifications

E76.3.1 All reference standards and related specifications shall be current issue or latest revision at the date of tender advertisement.

E76.3.2 Specifications

(a) CW 3130 – Supply and Installation of Geotextile Fabrics;

(b) CW 3110 – Sub-Grade, Sub-Base and Base Course Construction.

E76.4 Submittals

E76.4.1 The Contractor shall submit to the Contract Administrator for review and approval, at least ten (10) Business Days prior to the commencement of any scheduled Work on the Site, a proposed schedule, including methods and sequence of operations.

E76.4.2 The Contractor shall submit to the Contract Administrator for review and approval, at least ten (10) Business Days prior to the commencement of any scheduled Work on the Site, the proposed material(s) to undertake the Work.

E76.5 Materials and Construction Methods

E76.5.1 Geotextile

(a) The geotextile shall be Class 1 Heavy Duty Woven type, and supplied and placed in accordance with CW 3130 and approved by the Contract Administrator.

E76.5.2 Sub-Base

(a) The sub-base shall be 350 mm thick, and supplied and placed in accordance with CW 3110 and approved by the Contract Administrator.

E76.5.3 Base-Course

(a) The base- course shall be 150 mm thick, and supplied and placed in accordance with CW 3110 and approved by the Contract Administrator.

E76.6 Equipment

(a) General

a) All equipment shall be of a type acceptable to the Contract Administrator and shall be kept in good working order.

E76.7 Quality Control

(a) Inspection

a) All workmanship and materials furnished and supplied under this Specification are subject to the close and systematic inspection by the Contract Administrator including all operations from the selection and production of materials through to final acceptance of the specified Work.

b) The Contractor shall be wholly responsible for the control of all operations incidental thereto notwithstanding any inspection or approval that may have been previously given. The Contract Administrator reserves the right to reject any materials or works which are not in accordance with the requirements of this Specification.

(b) Access

a) The Contractor shall allow the Contract Administrator free access to all parts of the Work at all times.

E76.8 Measurement and Payment

E76.8.1 Underpass Base

(a) Preparation of subgrade, Supplying and Placing geotextile, sub-base and base course will not be measured and shall be paid for at the Contract Lump Sum Price per for the "Items of Work" listed here below, performed in accordance with this Specification and accepted by the Contract Administrator, which price shall be paid in full for supplying all materials and for performing all operations herein described and all other items incidental to the Work.

(b) Items of Work

(i) Class 1 (Heavy Duty Woven Geotextile);

(ii) 350 mm Sub-base – 50 mm;

(iii) 150 mm Base Course.

E77. BOARD INSULATION

E77.1 Description

E77.1.1 This Specification shall cover the supply and installation of board insulation.

E77.1.2 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Works as hereinafter specified.

E77.2 Referenced Specifications

E77.2.1 The latest edition and subsequent revisions of the following:

(a) ASTM D1621 – Standard Test Method for Compressive Properties of Rigid Cellular Plastics;

(b) CGSB 71 – Adhesive, Flexible, for Bonding Cellular Polystyrene Insulation;

(c) CAN/ULC-S701 – Thermal Insulation, Polystyrene, Boards and Pipe Coverings.

E77.3 Submittals

E77.3.1 The Contractor shall submit to the Contract Administrator for review and approval, at least ten (10) Business Days prior to the commencement of any scheduled Work on the Site, a proposed schedule, including methods and sequence of operations.

E77.3.2 The Contractor shall submit to the Contract Administrator for review and approval, at least ten (10) Business Days prior to the commencement of any scheduled Work on the Site, the proposed material(s) to undertake the Work.

E77.4 Materials

E77.4.1 General

(a) All materials supplied under this Specification shall be of a type approved by the Contract Administrator, and shall be subject to inspection and testing by the Contract Administrator.

(b) The Contractor shall be responsible for the supply, safe storage and handling of all materials as set forth in this Specification. All materials shall be handled in a careful and workmanlike manner, to the satisfaction of the Contract Administrator.

E77.4.2 Handling and Storage of Materials

(a) All materials shall be handled and stored in a careful and workmanlike manner, to the satisfaction of the Contract Administrator.

E77.4.3 Board Insulation

(a) Board insulation shall be moisture resistant closed cell extruded polystyrene designed for direct burial underground.

(i) Total insulation thickness shall be as specified on the Drawings.

(ii) Minimum compressive strength shall be 275 kPa (40 psi), in accordance with ASTM D1621.

E77.4.4 Adhesive for Insulation

(a) Adhesive (for polystyrene insulation): to CGSB 71 GP 24.

(i) Type: One (1) part polyurethane.

(ii) VOC emission: 0

E77.5 Equipment

(a) General

a) All equipment shall be of a type acceptable to the Contract Administrator and shall be kept in good working order.

E77.6 Construction Methods

(a) Insulation Installation

(i) Supply and install rigid insulation at locations identified on the Drawings or where directed by the Contract Administrator. Construct as noted on the Drawings.

(ii) Prior to installation of insulation boards, ensure that substrates are firm, straight, smooth, dry, free of snow, ice or frost and clean of debris. If necessary, install a levelling layer of sand to surface to achieve a smooth substrate.

(iii) Install installation to completely maintain the continuity of thermal protection.

(iv) Cut and trim insulation to fit all spaces. Butt joints tightly, offset vertical joints. Use only insulation boards free from chipped or broken edges. Use largest possible dimensions to reduce number of joints.

(v) Offset both vertical and horizontal joints in multiple layer applications.

(vi) In concealed spaces, do not cover insulation until it has been observed by the Contract Administrator.

(vii) At joints between rigid insulation boards and at other small voids, fill gaps with closed cell spray foam insulation to achieve a continuous insulated surface.

E77.7 Quality Control

(a) Inspection

(i) All workmanship and materials furnished and supplied under this Specification are subject to the close and systematic inspection by the Contract Administrator including all operations from the selection and production of materials through to final acceptance of the specified Work.

(ii) The Contractor shall be wholly responsible for the control of all operations incidental thereto notwithstanding any inspection or approval that may have been previously given. The Contract Administrator reserves the right to reject any materials or works which are not in accordance with the requirements of this Specification.

(b) Access

a) The Contractor shall allow the Contract Administrator free access to all parts of the Work at all times.

E77.8 Measurement and Payment

E77.8.1 Board Insulation

(a) Supplying and installing board insulation will not be measured. Supplying and installing board insulation shall be paid for at the Contract Lump Sum Price per for the "Items of Work" listed here below performed in accordance with this Specification and accepted by the Contract Administrator, which price shall be paid in full for supplying all materials and for performing all operations herein described and all other items incidental to the Work.

(b) Items of Work

(i) 125 mm thick Board Insulation

E78. SUPPLY AND INSTALLATION OF UNDERPASS LIGHTING

E78.1 Description

E78.1.1 This Specification shall cover all operations relating to the supply, fabrication, and erection of the electrical lighting system shown on the Drawings and as specified herein.

E78.1.2 Scope of Work

(a) Refer to Drawing CS-078 and CS-079.

E78.1.3 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all other things necessary for and incidental to the satisfactory performance and completion of all Work hereinafter specified.

E78.2 Materials

E78.2.1 General

(a) Refer to Drawing CS-078 and CS-079.

E78.3 Construction Methods

E78.3.1 General

(a) Refer to Drawing CS-078 and CS-079.

E78.4 Measurement and Payment

E78.4.1 Supply and installation of underpass lighting will not be measured and paid for at the Contract Lump Sum Price for “Supply and Installation of Underpass Lighting”, which price shall be payment in full for supplying all materials and for performing all operations herein described, and all other items incidental to the Work included in this Specification and accepted by the Contract Administrator.

E79. TRAFFIC BARRIER CATCHBASIN AND CATCH PIT

E79.1 Description

E79.1.1 General

(a) Further to CW 2130, this specification shall cover all operations related to the supply and installation of the 1200 mm diameter catch basin, catch pit, frames, covers, rungs, hoods, bases, construction of the roof slab, reinforcing steel, and other accessories and appurtenances as specified herein and as shown on the Drawing.

(b) The work done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Works as hereinafter specified.

E79.2 Scope of Work

E79.2.1 The work under this specification shall include:

(a) Supply and placing structural concrete for the 250 mm thick roof slab;

(b) Supply and placing reinforcing steel of the roof slab;

(c) Supply and installation of 1200 mm diameter catchbasin with City Approved Product grated manhole frame and cover (AP-011 and AP-012);

(d) Supply and installation of 1200 mm diameter catch pit with City Approved Product grated manhole frame and cover (AP-011 and AP-012).

E79.3 Reference

E79.3.1 All related Specifications and reference Standards are in accordance with the most current issue or latest revision.

(a) E55 Structural Concrete;

(b) E58 Miscellaneous Metal;

(c) CW 2130 – Gravity Sewers;

(d) CW 2030 Excavation, Bedding and Backfill;

(e) CAN/CSA 23.1 – Concrete Materials and methods of Concrete Construction/Methods of Test for Concrete;

(f) ASTM A1035 CM Grade 100 Low-Carbon Chromium Steel.

E79.4 Materials

(a) Some catch basins and catch pits shown the Drawing require a grouted barrier steel inlet with a double grated barrier frame and cover as a substitute for a standard frame and cover as shown on CU-61 detail for Catchbasin Roof Slab and Miscellaneous Metals.

(b) The Contractor shall be responsible for the supply, safe storage, and handling of all materials as set forth in this Specification. All materials shall be handled in a careful and workmanship like manner, to the satisfaction of the Contract Administrator.

E79.4.2 Bedding and Backfill

(a) Bedding and backfill in accordance with CW 2030.

E79.4.3 Manholes, Catch Basins and Catch Pit

(a) Materials supplied shall be as per CW 2130 Clause 2.7 and Clause 2.11.

E79.4.4 Grout, Mortar and Fibre Joint Filler

(a) Materials supplied shall be as per E55 Structural Concrete.

E79.4.5 Concrete

(a) Concrete materials susceptible to frost damage shall be protected from freezing.

(b) Concrete shall have nominal compressive strength (f'c) and meet the requirements for harden concrete as specification in following Table E79-12.

Table E79-12: Requirements for Hardened Concrete

Type of Concrete	Location	Nominal Compressive Strength (MPa)	Class of Exposure	Air Content Category	Max Aggregate Size	Special Requirements	Posted Residual Cracking Index
Type 3	Roof Slab at Traffic Median and Shoulder Barriers	35@ 28 Days	C-1	1	20 mm	Synthetic Fibres	0.15

E79.4.6 Reinforcing Steel

(a) All reinforcing steel shall conform to the requirements of ASTM A1035 CM Grade 100, Low-Carbon, Chromium Reinforcement.

E79.5 Construction Methods

E79.5.1 Manhole, Catchbasin and Catch Pit Installation

(a) Construction method for Manhole, Catchbasin and Catch Pit Installation shall be as per Specification CW 2130, Clause 3.8.

(b) Install to the line and grade as shown on Drawing or as determined by the Contract Administrator on-site in accordance with the limit as specified in CW 2130, Clause 3.6.

E79.5.2 Barrier Steel Inlet

(a) Fabrication and preparation of Barrier Steel Inlet shall conform to E58 Miscellaneous Metal.

E79.5.3 Reinforcing Steel

(a) Fabrication and preparation of ChromX reinforcing steel shall conform to E57 Supply and Placing Reinforcing Steel.

E79.5.4 Roof Slab Works

(a) The Contractor shall undertake roof slab Works, as shown on the Drawings.

E79.5.5 The supply, placing, installation and all operations necessary as specified in this Specification, pertaining to the roof slab Work, including placing reinforcing steel, grout and fibre joint fillers shall be considered incidental to the Work, and no additional measurement or payment shall be made for this Work.

E79.6 Measurement and Payment

E79.6.1 Measurement and payment for catchbasin and catch pit with a base diameter of 1200 mm will be paid for each unit.

E79.6.2 Measurement and payment for catchbasin and catch pit include base diameter and height, roof slab, hoods, frames and covers as indicated on the Drawings. No separate measurement will be paid for these components.

E79.6.3 Supply and installation of Traffic Barrier Catchbasin and Catch Pit will be measured on a unit bases for each type and paid for at the Contract Unit Price for, “Items of Work” listed here below. The number of units to be paid for will be the total number of catch basins and catch pits supplied, installed and measured as specified herein, which price shall be payment in full for supplying all materials and for performing all operations herein described and all others items incidental to the Work including in this Specification and accepted by the Contract Administrator.

E79.6.4 Items of Work

(a) Traffic Barrier Catchbasin and Catch Pit

(i) Type A – 1200 mm dia. Catch Basin;

(ii) Type B – 1200 mm dia. Catch Pit.

E79.6.5 Measurement and payment for the Barrier Steel Inlet will be paid for at the Contract Lump Sum Price for “Miscellaneous Metal”, which price shall be payment in full for performing all operations herein described and all other items incidental to the Work included in this Specification and accepted by the Contract Administrator.

E80. TRAFFIC MANAGEMENT FOR OVERHEAD SIGN SUPPORT STRUCTURES INSTALLATION

E80.1 Description

E80.1.1 Further to clauses 3.6 and 3.7 of CW 1130-R3, the following shall apply for any overhead sign support structure works:

(a) multiple lane closures, meaning the simultaneous closure of more than one (1) lane, shall be permitted as described herein, for the installation of overhead sign structures;

(b) multiple lane closures will not be permitted:

(i) 6:00 AM to 9:00 PM Monday through Saturday, unless otherwise approved by the Contract Administrator.

(c) complete directional or full closures, for the purpose of installing the bridge-type steel overhead sign support structure (S785) shall be limited to a maximum of ten (10) minutes;

(d) the Contractor shall submit the online Regional Street Lane Closure Form at least three (3) Business Days prior to beginning Work on any particular street;

(e) pedestrian and ambulance/emergency vehicle access must be maintained at all times;

(f) flagperson(s) shall be used to affect temporary lane closures during the lifting of structures over open lanes. Flagperson(s) shall meet all applicable Manitoba Workplace Safety and Health regulations;

(g) all traffic control shall be implemented in accordance with the City of Winnipeg's latest edition of the Manual of Temporary Traffic Control on City Streets.

E80.2 Submittals

E80.2.1 The Contractor shall submit detailed traffic management plans for each overhead sign structure location for review a minimum of fourteen (14) days prior to implementing the lane closure(s) or performing any work.

E80.2.2 The detailed traffic management plans shall be prepared in accordance with the current edition of the City of Winnipeg's Manual of Temporary Traffic Control on City Streets.

E80.2.3 The detailed traffic management plans shall:

(a) show a plan view of the area for each stage of construction or traffic control setup;

(b) show all applicable signage and traffic management devices to be used;

(c) provide all relevant dimensions and geometric layout of devices such as sign spacing, taper lengths, cone spacing, etc.;

(d) indicate the general sequence of device installation;

(e) indicate the date and time of implementation of the devices;

(f) indicate the expected date and time of the removal of the devices;

(g) confirm the work zones created by the closures are adequate for the operation of cranes, and other construction operations required for the work;

(h) all other information as deemed necessary by the Contract Administrator and/or other agencies reviewing the submitted traffic management plans.

E80.3 Measurement and Payment

(a) No measurement or payment will be made for the work described in this Specification. Traffic Management for Overhead Sign Support Structure Installation shall be incidental to the works in E84.

E81. REMOVAL AND SALVAGE OF TRAFFIC SIGNS

E81.1 Description

(a) This specification shall cover the removal and salvage of traffic signs.

E81.2 Construction Methods

E81.2.1 Removal and Salvage of Traffic Signs

(a) The Contractor shall remove and salvage traffic signs as indicated on the Construction Drawings or as directed by the Contract Administrator.

(b) The Contractor shall perform Removal and Salvage of Traffic Signs by a method acceptable to the Contract Administrator.

(c) The Contractor shall utilize methods to remove, store, transport and salvage the existing signs (including supports and associated hardware) that do not damage the existing signs or adjacent works. The Contractor shall be responsible to repairing and replacing signs or adjacent works damaged by its removal operation; repairs and/or replacements shall be completed at the expense of the Contractor.

(d) All signs, supports, and hardware shall be delivered to a City of Winnipeg Storage Yard as directed by the Contract Administrator. At the storage yard, the Contractor shall off-load the salvaged material with his own labour and equipment and place in

the designated location indicated by City of Winnipeg Personnel and as directed by the Contract Administrator.

(e) The City of Winnipeg will replace the traffic signs. The Contractor shall coordinate the replacement of the traffic signs with the City of Winnipeg and ensure that the City of Winnipeg has sufficient time to complete their works before the opening of the bridge to the public.

E81.3 Measurement and Payment

E81.3.1 Removal and Salvage of Traffic Signs

(a) The Removal and Salvage of Traffic Signs will not be measured and payment shall be considered incidental to the work.

E82. SALVAGE AND REINSTALLATION OF EXISTING ST. VITAL BIZ POLE

E82.1 Description

(a) The Work covered under this item shall include all operations related to the removal and reinstallation of the existing St. Vital Biz Pole at the designated location, in accordance with this Specification and as shown on the Drawings.

(b) The work to be done by the Contractor under this Specification shall include the furnishings of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all work as hereinafter specified.

E82.2 Equipment

(a) All equipment shall be of a type approved by the Contract Administrator and shall be kept in good working order.

E82.3 Materials

(a) Any addition required material will be incidental to work and shall be in accordance with E84.1 Supply and Installation of New Steel Overhead Sign Support Structures and as directed by the Contract Administrator.

E82.4 Removal of St. Vital Biz Pole

(a) Prior to dismantling the sign structure, the Contractor shall identify to the Contract Administrator any damaged or missing components and hardware or any other discrepancies and damage not indicated on the Drawings.

(b) The Contractor shall never lift the pole over traffic.

(c) The Contractor shall verify that there is no electrical power supply to the structure prior to removal of the structure, and if electrical cables are found in the structure, the Contract Administrator shall be notified, and removal shall be proceed as directed by the Contract Administrator.

(d) The Contractor shall remove the existing sign support structure carefully without damaging any adjacent property.

(e) Items marked for disposal shall be hauled off site and disposed at an appropriate facility at the Contractor’s expense. No separate payment will be made for disposal of the marked items.

(f) All items marked for salvage, including hardware, shall be safely stored on Site by the Contractor until such time the items are required for reinstallation. Storage of the structure is considered incidental to the Work and no separate payment will be made.

E82.5 Construction Methods

(a) Construction methods shall be in accordance with E84.4 Supply and Installation of New Steel Overhead Sign Support Structures and as directed by the Contract Administrator.

E82.6 Measurement and Payment

E82.6.1 Salvage and Reinstallation of St. Vital Biz Pole

(a) Relocation of St. Vital Biz Pole will not be measured and will be paid for at the Contract Lump Sum Price for "Salvage and Reinstallation of St. Vital Biz Pole" which price shall be payment in full for performing all operations herein described and all other items incidental to the Work included in this Specification and accepted by the Contract Administrator.

E83. CAST-IN-PLACE CONCRETE PILE FOUNDATIONS FOR STEEL OVERHEAD SIGN SUPPORT STRUCTURES

E83.1 Description

E83.1.1 General

(a) The Work covered under this Item shall include all concreting operations related to construction of cast-in-place concrete pile foundations for new steel overhead sign support structures in accordance with this Specification and as shown on the Drawings.

(b) The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Works as hereinafter specified.

E83.2 Materials

E83.2.1 General

(a) The Contractor shall be responsible for the supply, safe storage and handling of all materials set forth in this Specification. All materials supplied under this Specification shall be subject to inspection and acceptance by the Contract Administrator.

E83.2.2 Handling and Storage of Materials

(a) All materials shall be handled and stored in a careful and workmanlike manner, to the satisfaction of the Contract Administrator. Storage of materials shall be in accordance with CSA Standard A23.1.

E83.2.3 Testing and Approval

(a) All materials supplied under this Specification shall be subject to inspection and testing by the Contract Administrator or by the Testing Laboratory designated by the Contract Administrator. There shall be no charge to the City for any materials taken by the Contract Administrator for testing purposes.

(b) All materials shall be approved by the Contract Administrator at least seven (7) days before any construction is undertaken. If, in the opinion of the Contract Administrator, such materials in whole or in part, do not conform to the Specifications detailed herein or are found to be defective in manufacture or have become damaged in transit, storage, or handling operations, then such materials shall be rejected by the Contract Administrator and replaced by the Contractor at their own expense.

E83.2.4 Patching Mortar

(a) The patching mortar shall be made of the same cementitious material and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than one (1) part cement to two (2) parts sand by damp loose volume. White Portland Cement shall be substituted for a part of the grey Portland Cement on exposed concrete in order to produce a colour matching the colour of the surrounding concrete, as determined by a trial patch. The quantity of mixing water shall be no more than necessary for handling and placing.

E83.2.5 Cement

(a) Cement shall be Type HS or HSb, high-sulphate-resistant hydraulic cement, conforming to the requirements of the latest CSA Standard A23.1.

E83.2.6 Concrete

(a) General

(i) Concrete repair material shall be compatible with the concrete substrate.

(b) The Contractor shall be responsible for the design and performance of all concrete mixes supplied under this specification. Either ready mix concrete or proprietary repair mortars, where applicable, may be used having the following minimum properties in accordance with the latest CSA A23.1:

(i) Class of Exposure: S-1;

(ii) Compressive Strength @ 56 days = 35 MPa;

(iii) Water / Cementing Materials Ratio = 0.4;

(iv) Air Content: Category 2 per Table 4 of CSA A23.1-14 (4-7%);

(v) Cement – shall be as specified in E83.2.5.

(c) Mix design for ready mix concrete shall be submitted to Contract Administrator at least two (2) weeks prior to concrete placing operations.

(d) The workability of each concrete mix shall be consistent with the Contractor's placement operations. Self-compacting concrete may be used for pile foundations.

(e) Any proposed proprietary repair mortar shall be subject to the approval of the Contract Administrator and must meet or exceed the properties of the ready mix concrete.

(f) The temperature of all types of concrete shall be between fifteen degrees Celsius (15˚C) and twenty-five degrees Celsius (25˚C) at discharge. Temperature requirements for concrete containing silica fume shall be between ten degrees Celsius (10˚C) and eighteen degrees Celsius (18˚C) at discharge unless otherwise approved by the Contract Administrator.

(g) Concrete materials susceptible to frost damage shall be protected from freezing.

E83.2.7 Aggregate

(a) The Contractor shall be responsible for testing the fine and coarse aggregates to establish conformance to these specifications, and the results of these tests shall be provided to the Contract Administrator if requested. All aggregates shall comply with the latest CSA A23.1.

(b) Coarse Aggregate

(i) The maximum nominal size of coarse aggregate shall be sized to suit the Contractor's mix design. Gradation shall be in accordance with the latest CSA A23.1, Table 11, Group 1. The coarse aggregate shall satisfy the Standard Requirements specified in the latest CSA A23.1, Table 12, "Concrete Exposed to Freezing and Thawing".

(ii) Coarse aggregate shall consist of crushed stone or gravel or a combination thereof, having hard, strong, durable particles free from elongation, dust, shale, earth, vegetable matter or other injurious substances. Coarse aggregate shall be clean and free from alkali, organic or other deleterious matter; and shall have an absorption not exceeding two and a quarter percent (2.25%).

(iii) The aggregate retained on the 5 mm sieve shall consist of clean, hard, tough, durable, angular particles with a rough surface texture, and shall be free from organic material, adherent coatings of clay, clay balls, and excess of thin particles or any other extraneous material.

(iv) Coarse aggregate when tested for abrasion in accordance with the latest ASTM C131 shall not have a loss greater than thirty percent (30%).

(v) Tests of the coarse aggregate shall not exceed the limits for standard for requirements prescribed in the latest CSA A23.1, Table 12, for concrete exposed to freezing and thawing.

(c) Fine Aggregate

(i) Fine aggregate shall meet the grading requirements of the latest CSA A23.1, Table 10, Gradation FA1.

(ii) Fine aggregate shall consist of sand, stone, screenings, other inert materials with similar characteristics or a combination thereof, having clean, hard, strong, durable, uncoated grains free from injurious amounts of dust, lumps, shale, alkali, organic matter, loam, or other deleterious substances.

(iii) Tests of the fine aggregate shall not exceed the limits for standard requirements prescribed in the latest CSA A23.1, Table 12.

E83.2.8 Cementing Materials

(a) Cementing materials shall conform to the requirements of the latest CSA A3001.

E83.2.9 Silica Fume

(a) Should the Contractor choose to include silica fume in the concrete mix design, it shall not exceed eight percent (8%) by mass of cement.

E83.2.10 Fly Ash

(a) Fly ash shall be Type C1 or Type F and shall not exceed twenty-five percent (25%) by mass of cement.

E83.2.11 Cementitious materials shall be stored in a suitable weather-tight building that shall protect these materials from dampness and other destructive agents. Cementitious materials that have been stored for a length of time resulting in the hardening or formation of lumps shall not be used in the Work.

E83.2.12 Admixtures

(a) Air entraining admixtures shall conform to the requirements of the latest ASTM C260.

(b) Chemical admixtures shall conform to the requirements of the latest ASTM C494 or C1017 for flowing concrete.

(c) All admixtures shall be compatible with all other constituents. The addition of calcium chloride, accelerators, and air-reducing agents will not be permitted, unless otherwise approved by the Contract Administrator.

(d) Appropriate low range water reducing and/or superplasticizing admixtures shall be used in concrete containing silica fume. Approved retarders or set controlling admixtures may be used for concrete containing silica fume.

(e) An aminocarboxylate based migrating corrosion inhibitor admixture shall be used in concrete that will be used as a repair material that will either be in contact with or adjacent to reinforcing steel in existing concrete. Proposed admixtures shall be subject to the approval of the Contract Administrator.

E83.2.13 Water

(a) Water used for mixing concrete shall be clean and free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances. It shall be equal to potable water in physical and chemical properties.

E83.2.14 Concrete Supply

(a) Concrete shall be proportioned, mixed, and delivered in accordance with the requirements of the latest CSA A23.1, except that the transporting of ready mixed concrete in non-agitating equipment will not be permitted unless prior written approval is received from the Contract Administrator.

(b) Unless otherwise directed by the Contract Administrator, the discharge of ready mixed concrete shall be completed within (ninety) 90 minutes after the introduction of the mixing water to the cementing materials and aggregates.

(c) The Contractor shall maintain all equipment used for handling and transporting the concrete in a clean condition and proper working order.

E83.2.15 Reinforcing Steel

(a) Reinforcing steel shall be deemed to include all reinforcing bars, tie-bars, and dowels.

(b) All reinforcing steel shall conform to the requirements of the latest CSA Standard G30.18, Grade 400 W, Billet-Steel Bars for Concrete Reinforcement. All reinforcing steel shall be new deformed billet steel bars. All bars, including ties, shall be hot-dip galvanized in accordance with the latest ASTM A767 for a minimum net retention of 610 g/m^2. Reinforcing steel supply and installation will be incidental to construction of concrete pile foundation and no separate payment will be made.

E83.2.16 Anchor Bolts, Nuts, and Washers

(a) Anchor bolts, nuts, and washers shall be in accordance with the latest ASTM F1554 (Grade 55), and shall be hot-dip galvanized full length in accordance with the latest ASTM F2329 for a minimum net retention of 610 g/m^2, for the entire length of the anchor bolts. The top threaded portion of the anchor bolts shall be 300 mm long and the bottom threaded portion of the anchor bolts shall be 100 mm long. Anchor bolt supply and installation will be incidental to construction of concrete pile foundation and no separate payment will be made.

E83.2.17 Anchor Bolt Templates

(a) Anchor bolt templates shall be the latest CSA G40.21 Grade 300W, minimum 10 mm thick, and will be incidental to construction of new concrete pile foundation and no separate payment will be made.

E83.2.18 Miscellaneous Materials

(a) Miscellaneous materials shall be of the type specified on the Drawings or approved by the Contract Administrator.

E83.3 Construction Methods

E83.3.1 Location and Alignment of Piles

(a) Pile construction shall not commence until the Contractor has obtained clearance from the appropriate Utility Authorities including but not limited to Manitoba Hydro, MTS and City of Winnipeg Water and Waste.

(b) Piles shall be placed in the positions shown on the Drawings and as directed by the Contract Administrator in the field.

(c) The deviation of the axis of any finished pile shall not differ by more than one percent (1%) from the vertical.

E83.3.2 Buried Utilities

(a) The Contractor shall exercise extreme caution when constructing the pile foundations in the vicinity of existing buried utilities and buildings. The Drawings show the approximate locations of existing buried utilities. The Contractor shall be responsible for obtaining the exact location of the buried utilities from the appropriate Utility Authorities prior to installing the piles.

(b) The proposed locations of the pile foundations may be changed by the Contract Administrator if they interfere with the buried utilities.

(c) The Contractor shall be responsible for all costs that may be incurred for repair/rectification of any damage caused to the existing buried utilities as a result of the Contractor's operations in constructing cast-in-place concrete piles, as determined by the Contract Administrator.

E83.3.3 Abandonment of Existing Piles

(a) Remove and dispose of the existing pile at the existing Old St. Vital Biz sign location. Backfill and compact the pile location to the underside of the proposed roadway base as shown on the Drawings.

E83.3.4 Excavation

(a) Pile excavation shall be achieved by auguring (i.e. drilling) or hydro-jet excavation for the full depth of all piles unless noted otherwise on the Drawings.

(b) It may be necessary to hydro-jet excavate utilities adjacent to a pile location to adequately ascertain the location or provide enough “slack” in conduits to move them slightly to avoid interference with the pile locations. The Contract Administrator may elect to alter the location of a pile if hydro-jet excavation shows that utilities cannot be avoided.

(c) Upon reaching the required elevation, the bottom of the excavation shall be cleaned as directed by the Contract Administrator in the field.

(d) All excavated material from the piles shall be promptly hauled away from the Site to an approved disposal area as located by the Contractor.

(e) Upon completion of the cleaning out of the bottom to the satisfaction of the Contract Administrator, the reinforcement and anchor bolts shall be set in place and the concrete poured immediately. Under no circumstances shall a hole be left to stand open after excavation has been completed.

(f) If any hole is condemned because of caving, it shall be filled with lean-mix concrete and a new hole excavated as near as possible to the location shown on the Drawings. In locations where underground utilities have been exposed, the underground utilities shall be covered with clean sand to 300 mm minimum cover around the utility. Payment will not be made for condemned piles.

E83.3.5 Sleeving

(a) Steel or corrugated metal pipe sleeving shall be used if required to temporarily line the excavation to prevent bulging or caving of the walls.

(b) The sleeving shall be designed by the Contractor and constructed to resist all forces that may tend to distort it.

(c) The sleeving shall be withdrawn as the concrete is placed in the excavation. The sleeving shall extend at least 1 m below the top of the freshly deposited concrete at all times.

(d) The clearance between the face of the excavation and the sleeving shall not exceed 75 mm.

(e) The sleeving may remain cast in place if required to protect nearby utilities at the direction of the Contract Administrator. The top of sleeving shall be 300 mm below the top of finished grade.

E83.3.6 Inspection of Excavations

(a) Concrete shall not be placed in an excavation until the excavation has been inspected and approved by the Contract Administrator.

(b) The Contractor shall have available suitable light for the inspection of each excavation throughout its entire length.

(c) Any improperly set sleeving or improperly prepared excavation shall be corrected to the satisfaction of the Contract Administrator.

E83.3.7 Placing Reinforcing Steel

(a) Reinforcement shall be:

(i) placed in accordance with the details shown on the Drawings;

(ii) rigidly fastened together;

(iii) lowered into the excavation intact before concrete is placed.

(b) Spacers shall be utilized to properly locate the reinforcing steel cage in the excavation.

E83.3.8 Placing Anchor Bolts

(a) The anchor bolts shall be aligned with the steel templates matching the bolt holes in the sign structure base plate. The setting templates shall be held in place by the top and bottom nuts of the anchor bolts. The anchor bolts shall be plumb. Extreme care shall be used in this operation. Placement of anchor bolts without the steel template will not be permitted.

(b) The threaded portion of the anchor bolts projecting above the top surface of pile shall be coated with oil, before the concrete is poured, to minimize the fouling of threads splattered by concrete residue.

E83.3.9 Forms

(a) For hydro-jet excavated piles, the top of the piles shall be formed with tubular forms (Sonotube) to a minimum depth of 1500 mm below final grade.

(b) For bored piles the top of the piles shall be formed with tubular forms (Sonotube) to a minimum depth of 1000 mm below final grade.

(c) In locations of caving, the tubular form (Sonotube) should extend a minimum of 500 mm below where the shaft becomes uniform. The minimum depth of the tubular forms (Sonotube) shall be as specified by E83.3.9(a) and E83.3.9(b).

(d) The forms shall be sufficiently rigid to prevent lateral or vertical distortions from the loading environment to which they shall be subjected. Forms shall be set to the design grades, lines, and dimensions, as shown on the Drawings.

E83.3.10 Placing Concrete

(a) Care shall be taken to ensure that anchor bolts are vertically aligned and that anchor bolts and conduits are properly positioned prior to placement of concrete.

(b) Concrete shall not have a free fall of more than 2.0 m and shall be placed so that the aggregates will not separate or segregate. The slump of the concrete shall not exceed 110 mm. The concrete shall be vibrated throughout the entire length of the pile.

(c) Concrete shall be placed to the elevations as shown on the Drawings. The top surface of the pile shall be finished smooth with a hand float and provided with a one percent (1%) slope for drainage away from the centreline of the pile.

(d) The shaft shall be free of water prior to placing of concrete. Concrete shall not be placed in or through water unless authorized by the Contract Administrator. In the event that tremie concrete is allowed by the Contract Administrator, the concrete shall be placed as specified herein.

(e) All concrete, during and immediately after deposition, shall be consolidated by mechanical vibrations so that the concrete is thoroughly worked around the reinforcement, around embedded items, and into the corners of forms; eliminating all air or stone pockets that may cause honeycombing, pitting, or planes of weakness.

E83.3.11 Tremie Concrete

(a) The shaft of the pile shall be pumped clear of water so that the bottom can be cleaned. Pumping shall then be stopped and water shall be allowed to come into the excavation until a state of equilibrium is reached. Concrete shall then be placed by means of a tremie pipe. The tremie pipe shall have a suitable gate in the bottom to prevent water from entering the pipe. The bottom of the pipe shall be maintained below the surface of the freshly placed concrete. The pipe shall be capable of being raised or lowered quickly in order to control the flow of concrete.

(b) Tremie concrete shall be poured up to a depth of 600 mm or as the Contract Administrator directs. Pumps shall then be lowered into the excavation and the

excess water pumped out. The laitance that forms on top of the tremie shall then be removed and the remainder of the concrete shall be placed in the dry excavation.

E83.3.12 Protection of Newly Placed Concrete

(a) Newly laid concrete threatened with damage by rain, snow, fog, or mist shall be protected with a tarpaulin or other approved means.

E83.3.13 Curing Concrete

(a) The top of the freshly finished concrete piles shall be covered and kept moist by means of wet polyester blankets immediately following finishing operations and shall be maintained at above ten degrees Celsius (10ºC) for at least seven (7) consecutive days thereafter.

(b) After the finishing is completed, the surface shall be promptly covered with a minimum of a single layer of clean, damp polyester blanket.

(c) Concrete shall be protected from the harmful effects of sunshine, drying winds, surface dripping or running water, vibration, and mechanical shock. Concrete shall be protected from freezing until at least twenty-four(24) hours after the end of the curing period.

(d) Changes in temperature of the concrete shall be uniform and gradual and shall not exceed three degrees Celsius (3º C) in one (1) hour or twenty degrees Celsius (20ºC) in twenty-four (24) hours.

E83.3.14 Form Removal

(a) Forms shall not be removed for a period of at least twenty-four (24) hours after the concrete has been placed. Removal of forms shall be done in a manner to avoid damage to, or spalling of, the concrete.

(b) The minimum strength of concrete in place for safe removal of forms shall be 20 MPa.

(c) Field-cured test specimens, representative of the in-place concrete being stripped, will be tested to verify the concrete strength.

E83.3.15 Patching of Formed Surfaces

(a) Immediately after forms around top of pile have been removed, but before any repairing or surface finishing is started, the concrete surface shall be inspected by the Contract Administrator. Any repair of surface finishing started before this inspection may be rejected and required to be removed.

(b) All formed concrete surfaces shall have bolts, ties, struts, and all other timber or metal parts not specifically required for construction purposes cut back fifty (50) mm from the surface before patching.

(c) Minor surface defects caused by honeycomb, air pockets greater than 5 mm in diameter, and voids left by strutting, and tie holes shall be repaired by removing the defective concrete to sound concrete, dampening the area to be patched and then applying patching mortar. A slurry grout consisting of water and cement, shall be well-brushed onto the area to be patched. When the slurry grout begins to lose the water sheen, the patching mortar shall be applied. It shall be struck-off slightly higher than the surface and left for one (1) hour before final finishing to permit initial shrinkage of the patching mortar and it shall be touched up until it is satisfactory to the Contract Administrator. The patch shall be cured as specified in this Specification, and the final colour shall match the surrounding concrete.

E83.3.16 Cold Weather Concreting

(a) Protection of concrete shall be considered incidental to its placement. The temperature of the concrete shall be maintained at or above ten degrees Celsius (10ºC) for a minimum of three (3) days or till the concrete has reached a minimum compressive strength of 20 MPa, by whatever means are necessary. Concrete damaged as a result of inadequate protection against weather conditions shall be

removed and replaced by the Contractor at their own expense. Also, concrete allowed to freeze prior to the three (3) days will not be accepted for payment.

E83.3.17 Removal and Restoration of Adjacent Surface Treatments

(a) If the new pile being constructed is located in a concrete sidewalk/median slab, the existing slab shall be removed to the nearest existing joints. If the nearest existing joint is more than 600 mm beyond the perimeter of the pile, the Contractor shall remove a square section of the existing slab that is 300 mm beyond the pile perimeter. The surface of the slab shall be saw-cut to a depth of 50 mm around the perimeter of the square section. Care shall be taken to ensure that the saw-cut edge of the section is not chipped or broken during the removal of the concrete. Concrete slabs damaged beyond the specified limits shall be replaced at the Contractor's cost to the satisfaction of the Contract Administrator. After the pile has been constructed, the concrete sidewalk/median slab shall be restored flush with the adjacent surface level.

(b) If the pile being constructed is located in grass boulevard/median, following pile construction disturbed areas shall be backfilled and restored with sod around the new pile as directed by the Contract Administrator.

(c) If the pile being constructed is located in a paving stone surface, the paving stones shall be temporarily removed to the extent required for new pile construction and appropriately stored by the Contractor. Following pile construction, the Contractor shall cut as required and re-set the salvaged paving stones around the new pile flush with the adjacent surface level, as directed by the Contract Administrator.

(d) The removal and restoration of surface treatments will be considered incidental to pile construction works at each Site and no separate payment will be made.

E83.4 Quality Control

E83.4.1 All workmanship and all materials furnished and supplied under this Specification are subject to close and systematic inspection and testing by the Contract Administrator, including all operations from the selection and production of materials, through to final acceptance of the Work. The Contractor shall be wholly responsible for the control of all operations incidental thereto notwithstanding any inspection or approval that may have been previously given. The Contract Administrator reserves the right to reject any materials or Works that are not in accordance with the requirements of this Specification.

E83.4.2 The Contractor shall be responsible for making a thorough inspection of materials to be supplied under this Contract. All material shall be free of surface imperfections and other defects.

E83.5 Measurement and Payment

E83.5.1 Construction of New Cast-in-Place Concrete Pile Foundations

(a) Construction of new cast-in-place concrete pile foundations including supply and installation of anchor bolts complete with nuts, washers and steel templates will be measured on a unit basis and paid for at the Contract Unit Price for "Items of Work" listed here below, which price shall be payment in full for supplying all materials and for completing all operations herein described and all other items incidental to the work included in this Specification, accepted and measured by the Contract Administrator.

(b) Items of Work:

(i) Cast-in-Place Concrete Pile Foundations:

- 915 mm Diameter, 7 m Long Pile;
- 610 mm Diameter, 5 m Long Pile;
- 1219 mm Diameter, 11 m Long Pile.

(c) Supplying and installing all the listed materials, concrete design requirements, equipment, construction methods, and quality control measures associated with this

Specification and the Drawings shall be considered incidental to "Cast-in-Place Concrete Pile Foundations", unless otherwise noted herein. No measurement or payment shall be made for this Work unless indicated otherwise.

(d) Abandonment of existing piles will be measured on a unit basis and paid for at the Contract Unit Price per pile per Site for the "Abandonment of Existing Piles" for abandoned piles in accordance with this Specification and accepted by the Contract Administrator.

E84. SUPPLY AND INSTALLATION OF NEW STEEL OVERHEAD SIGN SUPPORT STRUCTURES

E84.1 Description

(a) The Work covered under this item shall include all operations related to the supply, fabrication, delivery, and erection of new steel overhead sign support structures.

(b) The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of the Work as hereinafter specified.

E84.2 Materials

E84.2.1 General

(a) The Contractor shall be responsible for the supply, safe storage, and handling of all materials set forth in this Specification.

(b) All materials used for fabrication of overhead sign support structures shall be new, previously unused material.

E84.2.2 Handling and Storage of Materials

(a) All materials shall be handled in a careful and workmanship-like manner, to the satisfaction of the Contract Administrator.

E84.2.3 Structural Steel

(a) Structural steel for all components of the overhead sign support structures shall be in accordance with CSA Standard G40.21 M, to the grades indicated on the Drawings. For purposes of hot-dip galvanizing, the silicon content in the steel shall be controlled within zero to three hundredths of a percent (0 to 0.03%) or fifteen hundredths to twenty–two hundredths of a percent (0.15 to 0.22%) for monotubular shafts and arms, and to less than three tenths of a percent (0.3%) for all other steel components.

(b) The Contractor is advised that copies of mill test certificates showing the chemical and physical properties of all structural steel to be supplied under this Specification must be supplied to the Contract Administrator and be found acceptable prior to commencement of fabrication.

(c) Steel shall not be acceptable unless the mill test certificate states the grade to be as indicated on the Drawings. Lower grade steel shall not be acceptable (despite favourable published mill test results). Items fabricated without steel certification shall be rejected.

E84.2.4 Flange Bolts, Nuts, and Washers

(a) Flange bolts, nuts, and washers shall be in accordance with ASTM F3125 Grade A325, Type 1, hot-dip galvanized in accordance with ASTM F2329.

E84.2.5 Mounting Bracket Fasteners (Bracket-to-Bracket)

(a) Mounting bracket fasteners (connecting two (2) clamp brackets) shall be all-thread rod conforming to one (1) of the following:

(i) SAE Grade 2 hot dip galvanized;

(ii) ASTM A307 Grade B hot dip galvanized;

(iii) ASTM F1554 Grade 55 hot dip galvanized.

(b) Hot-dip galvanizing shall be in accordance with ASTM F2329. Plated coatings will not be accepted.

(c) Two (2) nuts, two (2) washers and one (1) lock washer (all hot dip galvanized) shall be provided for each segment of threaded rod.

(d) The Contractor is permitted to field cut the threaded rod to suit the required length. If so, apply Zinga zinc rich galvanizing touch up paint to cut ends.

E84.2.6 Mounting Bracket Fasteners (Bracket to Panel)

(a) Mounting bracket fasteners connecting the bracket to the aluminum backing bars of the sign panel shall be stainless steel all-thread hex bolts conforming to ASTM F593 Grade 304 or 316.

(b) One (1) nut, one (1) washer, and one (1) lock washer shall be furnished with each bolt.

E84.2.7 Fasteners for Handhole Covers

(a) Fasteners for handhole covers shall be in accordance with ASTM A276 Type 316 stainless steel.

E84.2.8 Hot-Dip Galvanizing

(a) Hot-dip galvanizing of structural steel shall be in accordance with ASTM A123 for a minimum net retention of 610 g/m^2.

E84.2.9 Galvanizing Touch-up and Field-Applied Galvanizing

(a) Only approved products listed below shall be used for field-applied galvanizing, to touch-up damaged hot-dip galvanizing on-site and to galvanize field welds.

(b) Approved products for self-fluxing, low temperature, zinc-based alloy rods in accordance with ASTM A780-09(2015) for “Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings” are as follows:

(i) Galvalloy as manufactured by Metalloy Products Company, P.O. Box No. 3093, Terminal Annex, Los Angeles, California, available from Welder Supplies Limited, 150 McPhillips Street, Winnipeg;

(ii) Welco Gal-Viz Galvanizing Alloy, as manufactured by Thermocote Welco, Highway 161, York Road, Kings Mountain, North Carolina, available from Welder Supplies Limited, 150 McPhillips Street, Winnipeg.

E84.2.10 Cold Applied Galvanizing Compound

(a) Approved cold-applied galvanizing compound is as follows:

(i) ZINGA, as manufactured by ZINGAMETALL, Ghent, Belgium, available from Pacific Evergreen Industries Ltd. Vancouver, BC, Ph. (604) 926-5564, and Centennial Mine & Industrial Supply, Saskatoon, Sask., Ph. (306) 975-1944.

E84.2.11 Rodent Screen

E84.2.12 Rodent screens shall be ½” – 18F stainless steel (316L) expanded metal sheet or approved equal in accordance with B7 Aluminum T-Bars.

(a) The Contractor shall supply and deliver aluminum T-bars to the City of Winnipeg Traffic Services Branch Sign Shop a minimum of three (3) weeks in advance of the Contractor’s intended date for pick-up. The City will install the sign plates/panels on the supplied T-bars.

(b) Aluminum T-Bars shall be in accordance with ASTM B221 6061-T6.

E84.2.13 Sign Plates/Panels

(a) Sign plates/panels will be supplied by the City of Winnipeg Traffic Services Branch. The Contractor will be responsible for pick-up of all sign plates and panels at the City of Winnipeg Traffic Services Branch Sign Shop and will be responsible for installation of all sign plates and panels on the sign support structures.

E84.2.14 Welding Consumables

(a) Welding consumables for all processes shall be certified by the manufacturer to be complying with the requirements of CSA Standard W59 and the following Specifications:

(i) manual shielded metal arc welding (SMAW): All electrodes shall be basic-type electrodes conforming to CSA W48, classification E480XX, or imperial equivalent;

(ii) gas metal arc welding (GMAW): All electrodes shall conform to CSA W48, classification ER480S-X, or imperial equivalent;

(iii) flux cored arc welding (FCAW): All electrodes shall conform to CSA W48, classification E480XT-X or imperial equivalent. Electrodes shall be controlled by hydrogen (CH) designation;

(iv) submerged arc welding (SAW): All electrodes shall conform to CSA W48, classification F480X-EXXX or imperial equivalent;

(v) shielding gas shall be welding grade carbon-dioxide with a guaranteed dew point of negative forty-six degrees Celsius (-46ºC);

(vi) all electrodes, wires, and fluxes used shall be of a classification requiring a minimum impact of 27 joules at minus eighteen degrees Celsius(-18ºC).

(b) The proposed welding procedures and welding consumable certificates shall be submitted to the Contract Administrator for their approval at least two (2) Calendar Days prior to the scheduled commencement of any fabrication.

E84.2.15 Miscellaneous Materials

(a) Miscellaneous material incidental to this Work shall be as approved by the Contract Administrator.

E84.3 Equipment

E84.3.1 All equipment shall be of a type approved by the Contract Administrator and shall be kept in good working order.

E84.4 Construction Methods

E84.4.1 General Requirements

(a) Holes in the base plates shall be sized as shown on the Drawings, and provisions made for field erection must be accurate within plus or minus 13 mm between supports, without affecting final installation and load capacity.

(b) The base plates for the sign support structures shall be constructed to be fully compatible and mountable on the anchor bolts, provided in the foundations by the Contractor.

(c) Sufficient reinforced handholes and wiring holes shall be provided for lighting of the signs as shown on the Drawings. All wiring holes shall have threaded couplings. All unused coupling holes shall be capped with a threaded galvanized plug.

(d) The sign support structure shall be so fabricated that erection can be achieved by means of bolted connections.

(e) Each sign structure shall be provided with a "raised" structure identification number with a welding electrode in accordance with the details shown on the Drawings. The sign structure identification number shall be placed before hot-dip galvanizing.

(f) Adequate venting and drainage holes shall be provided in enclosed sections for hot-dip galvanizing. The galvanizing facilities shall be consulted regarding the size and location of these holes.

(g) Prior to fabrication, the dimensional limitations on the size and shape imposed by the galvanizing facilities shall be determined for hot-dip galvanizing the sign structures.

E84.4.2 Fabrication

(a) All fabrication shall be carried out in accordance with this Specification and the Contract Drawings, as well as AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals - 2015 – 1st Edition, plus all subsequent revisions.

(b) The punching of identification marks on the members will not be allowed, except for the structure identification number.

(c) Any damage to members during fabrication shall be drawn to the attention of the Contract Administrator in order that the Contract Administrator may approve remedial measures.

(d) Dimensions and fabrication details that control the field matching of parts shall receive very careful attention in order to avoid field adjustment.

(e) All portions of the Work shall be neatly finished. Shearing, cutting, clipping, and machining shall be done neatly and accurately. Finished members shall be true to line, free from twists, bends, sharp corners, and edges.

(f) Cut edges shall be true and smooth and free from excessive burrs or ragged breaks. Re-entrant cuts shall be avoided wherever possible. If used, they shall be filleted by drilling prior to cutting.

(g) All holes shall be free of burrs and rough edges.

E84.4.3 Welding

(a) Welding of steel structures shall be in accordance with CSA W59, "Welded Steel Construction".

(b) All seams shall be continuously welded and free from any slag and splatter. Longitudinal welds shall be a minimum of sixty percent (60%) penetration, except those within 200 mm of baseplates, flanges, and circumferential welds, which shall be one hundred percent (100%) penetration. All circumferential groove welds shall be one hundred (100%) penetration, and where circumferential welds are used at a butt joint, an internal backup strip shall be provided.

(c) Longitudinal seam welds in horizontal supports shall be located at the top of the horizontal members.

(d) All welds shall be ground smooth and flush with the adjacent surface prior to hot-dip galvanizing.

E84.4.4 Surface Preparation and Cleaning

(a) Surface preparation and cleaning of materials prior to hot-dip galvanizing shall be in accordance with ASTM A123 and SSPC Specification SP:6, "Commercial Blast Cleaning," unless otherwise specified herein. The Contractor shall ensure that all exterior and interior surfaces of vertical support members of sign structures are blast cleaned prior to pickling to achieve the minimum zinc coating mass of 610 g/m^2. All welding and provision of holes is to be completed prior to surface preparation and cleaning, except where shown on the Drawings.

(b) The sandblasting and cleaning of sign structures shall be done in the shop.

(c) After the structures have been sandblasted they shall be thoroughly cleaned of all sandblasting abrasive grit and debris, with special attention paid to areas of the structure where sand and debris collect, including but not limited to, behind the gusset plates, handholes and base plate.

(d) After the sign structures have been sandblasted and cleaned, the Contract Administrator will carry out a visual inspection of the structures in the shop before they are shipped to the galvanizing plant.

E84.4.5 Hot-Dip Galvanizing

(a) The hot-dip galvanizing plant shall be a Regular Member of the American Galvanizers Association, Inc.

(b) All outside surfaces of the overhead sign support structures shall be hot-dip galvanized in accordance with ASTM A123 to a minimum net retention of 610 g/m^2.

(c) Adequate venting and drainage holes shall be provided in enclosed sections for hot-dip galvanizing. The galvanizing facility shall be consulted regarding the size and location of these holes. Holes shall be provided by drilling not burning.

(d) The galvanizing coating on outside surfaces of overhead sign support structures shall be generally smooth and free of blisters, lumpiness and runs. In particular, the outside surfaces of the bottom 2.5 m of the vertical support members shall have a smooth finish equal to the finish on hot-dipped galvanized handrails.

(e) In addition to the provision of corrosion protection by the galvanized coating, the aesthetic appearance of the structure after hot-dip galvanizing will also be a criterion in the acceptance or rejection of the galvanized coating. The galvanized coating on the entire structure shall have a uniform “silver” colour and lustre. Galvanizing with parts of the structure having dull grey coating or streaks or mottled appearance will not be acceptable. If the galvanizing is rejected for aesthetic reasons, the Contractor shall rectify the appearance by applying spray-on molten zinc metallizing with 85/15 zinc/aluminum alloy. The metallizing shall be carried out in the shop before the structure is installed.

(f) Minor defects in the galvanizing coating shall be repaired as specified here below for “Field-Applied Touch-Up Galvanizing”. The Contract Administrator shall be consulted before repairs are made.

(g) Other defects and contaminants in the galvanizing coating, such as heavy dross protrusions, flux inclusions and ash inclusions shall be grounds for rejection of the galvanizing coating system.

(h) The Contractor shall verify the thickness of galvanized coatings as part of their own quality control testing and make their results available to the Contract Administrator.

(i) All threaded couplings shall be rethreaded after the sign structures have been hot-dip galvanized.

(j) The sign structures shall be stored on timber blocking after hot-dip galvanizing.

E84.4.6 Delivery and Erection

(a) The Contractor shall notify the Contract Administrator at least two (2) Working Days in advance of the anticipated delivery to the Site and erection of the overhead sign support structures.

(b) The sign structures shall be lifted and secured with nylon ropes or other approved methods. Use of steel chains and steel hooks against hot-dip galvanized or powder coated surfaces will not be permitted. The structure components (shaft and arm etc.) shall be placed on timber blocking and secured with nylon ropes during their transportation to the Site.

(c) Refer to E80 or Traffic Management requirements during erection.

E84.4.7 Attachment of Structure to Anchor Bolts

(a) Each anchor bolt shall be provided with four (4) galvanized nuts: two (2) nuts at the bottom of the anchor bolt to secure the anchor bolt assembly template, one (1) nut below the base plate for levelling the structure, and one (1) nut above the base plate for anchoring the structure.

(b) The anchor bolts shall have a minimum projection of 25 mm above the anchoring nuts.

(c) The distance between the top of the concrete pile and the underside of the levelling nut shall not exceed one (1) anchor bolt diameter.

(d) The threaded portions of the anchor bolts and nuts shall be treated with a wax based lubricant.

(e) The Contractor shall plumb the shaft by adjusting the levelling and anchor nuts.

(f) Levelling nuts and anchor nuts shall be tightened to a snug tight condition, defined as the full effort of an ironworker using an ordinary wrench, or a few impacts of an impact wrench.

(g) The Contractor shall tighten the top anchoring nuts in an alternating "star" type pattern as follows:

(i) for anchor bolts less than or equal to 38 mm diameter: 1/3 of a turn (+20°, -0°) past a snug tight condition;

(ii) for anchor bolts greater than 38 mm diameter: 1/6 of a turn (+20°, -0°) past a snug tight condition.

E84.4.8 Structural Bolt Installation

(a) Structural bolts for flange and splice connections shall be tightened in accordance with the turn-of-nut method as follows:

(i) alternately tighten all bolts to achieve a snug tight condition. The mating surfaces shall be in firm contact;

(ii) tighten all bolts in accordance with Table 74-1;

(iii) following tightening, check all bolts in the joint by hand using an ordinary wrench.

Table E84-13: Required Turns Past Snug Tight for Turn-of-Nut Method

Bolt Diameter *D* (inches)	**Bolt Length up to 4*D***		**Bolt Length over 4*D* to 8*D***		**Bolt Length over 8*D* to 12*D***	
	Length up to	**Required Turns**	**Length Range**	**Required Turns**	**Length Range**	**Required Turns**
1/2"	2"	1/3 ± 30°	2 to 4"	1/2 ± 30°	4 to 6"	2/3 ± 45°
5/8"	2.5"	1/3 ± 30°	2.5 to 5"	1/2 ± 30°	5 to 7.5"	2/3 ± 45°
3/4"	3"	1/3 ± 30°	3 to 6"	1/2 ± 30°	6 to 9"	2/3 ± 45°
7/8"	3.5"	1/3 ± 30°	3.5 to 7"	1/2 ± 30°	7 to 10.5"	2/3 ± 45°
1"	4"	1/3 ± 30°	4 to 8"	1/2 ± 30°	9 to 13.5"	2/3 ± 45°
1 1/8"	4.5"	1/3 ± 30°	4.5 to 9"	1/2 ± 30°	10 to 15"	2/3 ± 45°
1 1/4"	5"	1/3 ± 30°	5 to 10"	1/2 ± 30°	11 to 16.5"	2/3 ± 45°

E84.4.9 Installation of Sign Plates/Panels

(a) The Contractor will be responsible for installation of sign plates/panels on the sign support structures, unless otherwise noted on the Drawings.

(b) The Contractor shall take great care when handling existing or new plates. Any damage to sign plates will be repaired by the City of Winnipeg Traffic Services. All costs and delays associated with the repair shall be borne by the Contractor.

(c) The Contractor shall install the sign plates/panels on the sign support structures immediately following erection of the support structures (same day). In no case will a sign support structure be allowed to be erected and left for a significant amount of time (greater than one (1) day) without having the sign plates/panels installed.

(d) Sign panels shall be installed such that the panels are level to ground after all support structure deflection has occurred.

(e) Sign panels shall not be twisted or warped following installation.

E84.4.10 Rodent Screens

(a) Rodent screens that will prevent vermin and debris from entering the gap between the bottom of the base plate and the top of the concrete foundation shall be installed in lieu of grout pads at all overhead sign structure bases.

(b) The entire gap shall be covered with an expanded stainless steel metal screen, in accordance with E84.2.11, "Rodent Screen". The bottom edge of the expanded

stainless steel screen shall be in full contact with the surface of the concrete foundation. The top edge of the expanded stainless steel screen shall not extend beyond the top surface of the structure base plate.

(c) The rodent screen shall be made of one (1) continuous piece of expanded stainless steel with only one (1) overlapping splice where the ends come together and lap a minimum of 75 mm.

(d) The rodent screen shall be attached to the vertical side of the structure baseplate with self-tapping stainless steel screws (#8-1/2" long) complete with stainless steel washers. Pilot holes shall first be drilled into the baseplate to facilitate screw installation. Screws shall be installed at 200 mm on center maximum and at least one (1) screw shall be installed through the overlapping splice to clamp the two (2) layers of rodent screen together.

(e) The two (2) overlapping layers of rodent screen shall also be clamped just above the concrete foundation with a stainless steel fastener assembly consisting of a machine screw (#8-5/8" long) complete with a nut, two (2) flat washers and a lock washer. The rodent screen shall be tightly clamped between the flat washers.

E84.4.11 Field-Applied Touch-up Galvanizing

(a) Any areas of damaged galvanizing on the sign structures shall receive field-applied touch-up galvanizing.

(b) Surfaces to receive touch-up galvanizing shall be cleaned using a wire brush, a light grinding action, or mild blasting to remove loose, scale, rust, paint, grease, dirt, or other contaminants.

(c) For self-fluxing, low temperature, zinc based alloy rods, preheat the surface to three hundred and fifteen degrees Celsius (315°C) and wire brush the surface during preheating. Rub the cleaned preheated area with the repair stick to deposit an evenly distributed layer of zinc alloy. Spread the alloy with a wire brush, spatula, or similar tool. Field-applied galvanizing shall be blended into existing galvanizing of surrounding surfaces and shall be buffed and polished if required to match the surrounding surfaces. Care shall be taken to not overheat surfaces beyond four hundred degrees Celsius (400°C) and to not apply direct flame to the alloy rods.

(d) For cold applied galvanizing compound, the approved product shall be applied by either a brush or roller. The compound shall be applied in three (3) coats, with each coat having a dry film thickness of 60 µm (2.36 mils). Each coat shall be left to dry for a minimum of one (1) hour before the application of the next coat.

E84.5 Quality Control

E84.5.1 General

(a) All workmanship and all materials furnished and supplied under this Specification are subject to close and systematic inspection and testing by the Contract Administrator, including all operations from the selection and production of materials, through to final acceptance of the Work. The Contractor shall be wholly responsible for the control of all operations incidental thereto notwithstanding any inspection approval that may have been previously given. The Contract Administrator reserves the right to reject any materials or Works that are not in accordance with the requirements of this Specification.

(b) The Contractor shall be responsible for making a thorough inspection of materials to be supplied under this Contract. All material shall be free of surface imperfections and other defects.

E84.5.2 Welding Qualifications

(a) The Contractor shall produce evidence that the plant has recently been fully approved by the C.W.B. to the requirements of CSA W47.1 Division 2.1 for welding of steel structures.

(b) Approved welding procedures shall be submitted to the Contract Administrator prior to fabrication of any steel items.

E84.5.3 Testing

(a) In addition to the Contractor's own quality control testing of all materials, welding procedures and steel fabrication including hot-dip galvanizing will be inspected and tested by the Contract Administrator to ascertain compliance with the Specifications and Drawings.

(b) The Contract Administrator will hire a testing agency certified by the Canadian Welding Bureau to carry out shop fabrication inspection and testing before the overhead sign support structures are approved ready for installation of coating system. The inspector shall have access to all of the fabricator's normal quality control records for this Contract, specified herein. Inspection and testing will include:

(i) visual inspection of one hundred percent (100%) of welds;

(ii) ultrasonic testing of one hundred percent (100%) of full penetration sections of longitudinal seam welds and circumferential butt welds;

(iii) magnetic particle testing of a random ten percent (10%) of partial penetration sections of longitudinal seam welds;

(iv) ultrasonic testing of twenty-five percent (25%) of base plate and flange plate welds;

(v) inspection of hot-dip galvanizing and coating thickness.

(c) Welds that are found by any of the inspection and testing methods to be inadequate and unsatisfactory shall be repaired in accordance with CSA W59 and then retested. The cost of the repairs and the cost of the retest shall be paid for by the Contractor.

(d) No repair shall be made until agreed to by the Contract Administrator.

(e) Defects in hot-dip galvanizing shall be rectified as directed by the Contract Administrator.

E84.5.4 Unacceptable Work

(a) Any Work found to be unacceptable shall be corrected in accordance with CSA W59;

(b) No repair shall be made until agreed to by the Contract Administrator.

E84.6 Measurement and Payment

E84.6.1 Supply and installation of new steel overhead sign support structures will be measured on a unit basis per new steel overhead sign support structure supplied and installed, and paid for at the Contract Lump Sum Price for "Items of Work" listed here below, which price shall be payment in full for supplying all materials and for completing all operations herein described and all other items incidental to the Work included in this Specification, accepted and measured by the Contract Administrator.

E84.6.2 Items of Work:

(a) Supply and Installation of New Steel Overhead Sign Support Structures:

(i) S787 - NB St. Anne's;

(ii) S788 - SB St. Anne's;

(iii) S789 - WB Fermor;

(iv) S790 - EB Fermor.

UNDERGROUND WORKS

E85. TRENCHLESS EXCAVATION

E85.1 Further to Clause 3.4.1 of CW 2130, all underground utilities to be installed by trenchless methods unless indicated otherwise in the Drawings. All pipes under the existing roadways and parking lots are to be installed by trenchless methods.

E85.2 Verification of Utility Elevations

(a) Prior to construction, the Contractor shall verify all buried utility elevations at proposed crossing locations. Verification shall occur in a minimum of fourteen (14) Calendar Days prior to any construction on the land drainage sewer such that any required grade adjustments can be made. Contractor shall arrange for all required utility locations, safety watches and other required notifications. Contractor shall provide a minimum of five (5) Calendar Days' notice to the Contract Administrator of conducting utility exposures.

E85.3 Minimize the time period associated with trenchless installations.

E85.4 Selection of excavation equipment for installation of sewers by trenchless methods shall be the responsibility of the Contractor and shall be made based on the basis of expected soil conditions outlined in the Geotechnical Report as per Appendix 'A' and as detailed on the soil logs. The Contractor shall make allowances in the choice of equipment to account for reasonable and minor deviations in ground conditions and shall have contingency plans for the removal of boulders and other minor changes in ground conditions. Contractor shall continuously visually monitor trenchless excavations for increases in silt content and soft clay in the excavated material. Notify Contract Administrator if silt contents or soft clay in excavated material increase.

E85.5 In the event that there is a substantial change in the character or nature of the subsurface conditions or that obstructions are encountered, which adversely impact the Contractor's production or construction procedure, the Contractor shall immediately notify the Contract Administrator.

E85.6 The notice shall provide details of the change in subsurface soil conditions or obstructions encountered, any proposed construction procedure revision that the Contractor intends to undertake, as well as any other relevant supporting information.

E85.7 The Contract Administrator shall review the notice as expeditiously as possible to assess whether the change in conditions and revised construction procedures amount to a Change in Work. In the case of obstructions due to boulders in the silt/till or hardpan strata where that stratum is evident in the soils logs, no consideration will be made for a Change in Work as boulder obstructions can be reasonably anticipated when working in this stratum. Obstructions such as "random boulders" in the clay strata well above the till interface may be considered as a Change in Work dependent on the level of effort required to facilitate their removal.

E85.8 Where the Contract Administration deems that a Change in Work is necessary, it shall be valued in accordance with the provisions of C7 and the supplementary requirements of E88.

E86. TRENCHLESS EXCAVATION OBSTRUCTIONS

E86.1 Contingency plans for removal of the obstructions encountered in trenchless excavations must be approved by the Contract Administrator and may consist of, but not limited to, one (1) of the following:

E86.2 Drill or excavate a shaft at the location of the obstruction and remove the obstruction.

E86.3 Remove the obstruction through the jacking head or core hole following drilling, splitting or breaking the obstruction into smaller components as required.

E86.4 Other removal methods approved by Contract Administrator.

E86.5 Where the Contract Administrator deems that the obstruction encountered represents a Change in Work, it shall be valued in accordance with C7.4 (c) and the following supplemental requirements:

E86.6 The first four (4) hours of handling obstructions for each occurrence shall be the responsibility of the Contractor.

E86.7 Equipment rates for equipment required in support of the obstruction removal shall be compensated at the MHCA rental rates. Equipment not listed in the MHCA rate schedule shall have their rates established by the Contractor prior to the commencement of Work in accordance with the procedure documented in the MHCA rental guide for establishing equipment rental rates and shall be subject to the approval of the Contract Administrator.

E86.8 Standby equipment that cannot reasonably be deployed elsewhere during the duration of the obstruction removal shall be compensated at fifty percent (50%) of its established rate as noted in E86.7 above.

E86.9 Labour rates and material costs associated with obstruction removal shall be compensated as per C7.4 (c) and C7.4.1 with the provision that any removal and replacement of pavements shall be compensated at the Contract Unit Price for such Work.

E87. EXCAVATION, BEDDING AND BACKFILL

E87.1 Submittals

(a) Submit shoring designs, in accordance to CW 2030.

E87.2 Existing Utilities

(a) Arrange and pay for any required safety watches around existing utilities as per CW1120.

E87.3 Disposal of Unsuitable or Surplus Excavated Material

(a) The Contractor is responsible for arranging for a disposal site for all excavated material off of Site, including all associated works including transportation and payment of tipping fees. Disposal of all excavated material shall be considered incidental to the Works.

E87.4 Pipe in a Trench Foundation, Bedding, Haunching, Initial Backfill and Final Backfill

(a) Pipe installations in a trench between will be permitted for the ditch culvert to the river outfalls on the NE and SE quadrants of the bridge.

(b) Pipe foundation, bedding, haunching and initial backfill shall be constructed with non-frozen materials according to Drawing details for rigid and flexible pipe;

(c) When construction proceeds during freezing conditions, Contractor shall either heat and protect all materials from freezing or use open graded Type 3 materials that do not require free moisture for compaction for constructing foundation, bedding and initial backfill for pipes in a trench. Type 3 material shall be wrapped in a non-woven geotextile;

(d) Cement-Stabilized Fill shall be used below the pipe in the foundation zone extending to undisturbed soil where the pipe infringes on the open shaft excavation;

(e) Final backfill for pipe in a trench shall be Class 2 using non-frozen materials:

(i) Placing frozen final backfill material during final backfilling operations will result in considerable consolidation of the final backfill material when it thaws;

(ii) Obtain the necessary approvals from Contract Administrator prior to utilizing frozen or potentially frozen material as final backfill material. If frozen material is approved for use, the Contractor is solely responsible for repairing the final backfill to the depth necessary as subsequent damage due to excessive consolidation of the material;

(iii) Contractor shall take all reasonable precautions to limit the amount of frozen backfill material and not contaminate or mix non-frozen final backfill with frozen materials;

(iv) Contract Administrator will withhold a deficiency amount consistent with the estimated value of subsequent damage repair required of Contractor.

E87.5 Shaft and Manhole Foundation and Final Backfill

(a) All shaft and manhole foundation and final backfill shall be constructed with non-frozen materials;

(b) All shafts shall be backfilled to within the top 300 mm of the ground surface with Class 2 backfill as per SD-002 except as modified herein including shafts for watermains;

(c) When construction proceeds during freezing conditions, Contractor shall choose one (1) of the following two (2) options for backfilling the shafts:

(i) Class 2 backfill according to SD-002 using a non-frozen Type 1 material;

(ii) Class 2 backfill according to SD-002 using an open graded Type 3 material, free of moisture and/or ice that do not require free moisture for compaction. The Type 3 material shall be used instead of the Type 1 material.

(d) The top 300 mm of all shafts shall be constructed with Cement-Stabilized Fill;

(e) Cement-Stabilized Fill shall be used below the pipe in the foundation zone extending to undisturbed soil where the pipe infringes on the open shaft excavation;

(f) Shafts to accommodate a tunnelling or jacking machine shall be constructed with a concrete foundation of sufficient cross section and trueness to adequately support and align the machine during tunnelling operations.

E87.6 Measurement and Payment

(a) Excavation, shoring, and backfilling for pipe installation will not be measured for payment. Costs for excavation and shoring shall be included in the price for installation of the pipe. No separate measurement or payment will be made:

(b) There will be no separate measurement and payment for Pavement Removals according to CW 2030 or removals according to CW 2130. All Pavement Removals shall be considered incidental to the Contract.

E88. CONNECTING TO EXISTING SEWERS

E88.1 Description

(a) This Specification supplements and amends City of Winnipeg Standard Construction Specification CW 2130 Gravity Sewers, and shall cover connect to existing sewers.

E88.2 Materials

E88.2.1 Formwork, Reinforcing Steel and Concrete

(a) As per City of Winnipeg CW 2160.

E88.2.2 Concrete Mix Design

(a) Concrete Mix Design as per Table CW 2160, Type A mix.

E88.3 Submittals

E88.3.1 Submit shoring design, reinforcing steel Shop Drawings and concrete mix design in accordance to CW 2160.

E88.4 Construction Methods

E88.4.1 Cast–in-place concrete as per CW 2160.

E88.5 Method of Measurement and Basis of Payment

E88.5.1 Connections to existing sewers shall be measured on a unit basis and paid for at the Contract Unit Price for “Connecting to Existing Sewer”. The unit price shall include but not be limited to concrete coring for the pipe opening, required piping and structural connection collar to the existing sewer, shoring, backfill, cast-in-place concrete works and performing all operations necessary to complete the Works as specified and as indicated on the Drawings including all items incidental to the Works.

E89. MAINTAINING EXISTING SEWER FLOWS, FLOW CONTROL, DIVERSIONS AND BYPASS PUMPING

E89.1 Maintaining Existing Sewer Flows, Flow Control, Diversions and Bypass Pumping required to complete the Works in the Contract shall be incidental to the Contract as per Clause 4.16.1 of CW 2130.

E90. CONCRETE COLLAR CONNECTION

E90.1 Description

(a) This Specification shall cover the construction of the Concrete Collar Connection between the 750 mm Polyvinyl Pipe (PVC) and the 750 mm Corrugated Steel Pipe (CSP).

E90.2 Materials

E90.2.1 Formwork, Reinforcing Steel and Concrete

(a) As per City of Winnipeg CW 2160.

E90.2.2 Concrete Mix Design

(a) Concrete Mix Design as per Table CW 2160, Type A mix.

E90.3 Measurement and Payment

E90.3.1 The concrete collar connection shall be paid for at the Contract Lump Sum Price for "Concrete Collar Connection between the 750 mm PVC and 750 mm CSP".

E91. ADJUSTMENT AND RELOCATION OF EXISTING HYDRANTS

E91.1 Description

E91.1.1 This Specification shall supplement CW 2110 for the adjustment and relocation of existing hydrants.

E91.2 Construction Methods

E91.2.1 Hydrant adjustments and re-locations shall be Type A according to CW 2110 but could require a lead extension or shortening and there will be no measurement and payment for lead extensions less than 3.0 m or shortening of any length.

E91.2.2 Contractor shall also plug the drain on all hydrants indicated on the Drawings to be adjusted and relocated.

E91.2.3 Contractor shall vertically adjust the position of the hydrant such that the bottom flange is 50 mm -150 mm above the proposed surface elevation or as indicated by Contract Administrator.

E91.2.4 Contractor shall horizontally re-locate the hydrant to the position as shown on the Drawings.

E91.2.5 Contractor shall review the final position of the lead valve with the Contract Administrator and agree on a suitable valve location prior to executing the re-location.

E91.3 Measurement and Payment

E91.3.1 Measurement and payment shall be according to CW 2110 and also include all Work necessary to plug the existing hydrant drain, excavation, Class 2 backfill, re-location of the valve, existing pipe cutting and removal, pipe extensions, fittings, restrained couplers and all Work required to re-locate the valve and hydrant as specified.

E92. PLUGGING AND ABANDONING EXISTING SEWERS AND SEWER SERVICES

E92.1 Description

E92.1.1 This Specification shall add to CW 2130 for plugging and abandoning existing sewers and sewer services.

E92.2 Construction Methods

E92.2.1 Abandon all sewers and sewer services where indicated on the Drawings.

E92.2.2 Where indicated on the Drawings, Contractor shall abandon all sewers and sewer services, regardless of diameter, with cement-stabilized flowable fill.

E92.2.3 Be aware, there may be proposed LDS pipes that will be in direct conflict at the same elevation with existing sewers and sewer services to be abandoned in accordance with Contract. Contractor is solely responsible for staging their installations and developing their means and methods to meet the requirements of the Contract for successfully installing the proposed LDS and as well as the requirements associated with abandoning the existing sewers and sewer services.

E92.3 Measurement and Payment

E92.3.1 Abandoning existing sewers and sewer services with cement-stabilized flowable fill for all diameters and materials will be measured for payment on a volume basis and paid for at the Contract unit Price for “Abandoning Existing Sewers with Cement-Stabilized Flowable Fill” according to CW 2130 4.14.2.

E93. REMOVAL OF MANHOLES, CATCHBASINS AND CATCH PITS

E93.1 Description

E93.1.1 This Specification shall supplement CW 2130 for the complete removal of existing manholes, catchbasins and catch-pits form the ground.

E93.2 Construction Methods

E93.2.1 Final backfill shall be Class 2 backfill according to CW 2030.

E93.3 Measurement and Payment

E93.3.1 Measurement and payment shall be according to CW 2130 and also include all Work necessary to perform the removal.

E94. CATCHBASINS AND CATCH PITS

E94.1 Description

E94.1.1 This Specification shall supplement CW 2130 for catchbasins complete with Beehive Ditch Inlet, as specified on Drawing CU-009 and applicable standard frame and covers.

E94.2 Materials

E94.2.1 Cast-iron frames and covers as per CW 2130, Clause 2.7.

E94.3 Construction Methods

E94.4 Installation of Manhole, Catchbasin and Catch Pit

(a) Construction method for Manhole, Catchbasin and Catch Pit Installation shall be as per Specification CW 2130, Clause 3.8.

E94.5 Installation of Beehive Ditch Inlet

E94.5.1 Install Beehive Ditch Inlet according to SD-025 except as modified in CU-009 detail for Beehive Ditch Inlet.

E94.5.2 Install grouted stone rip rap according to CW 3615.

E94.5.3 Install fiber roll according to manufacturer's recommendations.

E94.6 Measurement and Payment

E94.6.1 Measurement and payment for Beehive Ditch Inlet shall be according to CW 2130 4.4 except payment shall also include the grouted stone rip rap and fibre roll. There will be no separate measurement and payment for grouted stone rip rap and fibre roll associated with Beehive Ditch Inlets.

E94.6.2 Measurement and payment for catchbasin and catch pit shall be in accordance with CW 2130 and paid for at the Contract Unit Price for, "Items of Work" listed here below. The number of units to be paid for will be the total number of catch basins and catch pits supplied, installed and measured as specified herein, which price shall be payment in full for supplying all materials and for performing all operations herein described and all others items incidental to the Work including in this Specification and accepted by the Contract Administrator.

E94.6.3 Items of Work

(a) Catchbasin
  (i) SD – 024 (AP-011 - Barrier Curb and Gutter Frame);
  (ii) SD – 024 (AP-015 – Mountable Curb and Gutter);
  (iii) SD – 024 (AP-018 – Modified Barrier Curb and Gutter Frame);
  (iv) SD – 024 (AP-009 – Beehive Grate).

(b) Catch Pit
  (i) SD – 023 ((AP-011 - Barrier Curb and Gutter Frame);
  (ii) SD – 023 (AP-015 – Mountable Curb and Gutter);
  (iii) SD – 023 (AP-018 – Modified Barrier Curb and Gutter Frame).

E95. MANHOLES

E95.1 Description

E95.1.1 This Specification shall supplement CW 2130 for manholes.

E95.2 Materials

E95.2.1 Some manholes shown on the Drawings require a beehive inlet cover as a substitute for a standard frame and cover, grouted stone rip-rap and fiber roll as shown on CU-009 detail for Beehive Ditch Inlet.

E95.3 Construction Methods

E95.3.1 The construction of a New Manhole on an Existing Sewer splits an existing sewer segment into two (2) segments and cleaning and inspection of both sewer segments is required. The upstream and downstream manhole to manhole sewer segments connecting to the constructed a New Manhole on an Existing Sewer shall be cleaned and inspected according to CW2140 and CW2145, respectively.

E95.4 Measurement and Payment

E95.4.1 Measurement and payment for manholes shall include the base diameter and height, transition slabs, all stubs, connections and plugs as indicated on the Drawings. No separate measurement and payment will be made for these components.

E95.4.2 Measurement and payment for Beehive Inlet Cover for Manholes will be made per unit for each manhole where the beehive lid, grouted rip-rap and fiber roll are installed as detailed to a manhole. Measurement and payment shall include substituting a standard manhole lid and frame with a beehive lid and frame and include supply and installation of the grouted stone rip-rap and fiber roll and all other features detailed.

E96. DITCH INLET GRATE

E96.1 Description

E96.1.1 This specification covers the supply and installation of ditch inlet grates, typically used in open swales or ditches as an alternative to City of Winnipeg Approved Product grated manhole cover AP-006.

E96.2 Materials and Equipment

E96.2.1 As per Contract Drawings.

E96.2.2 All steel shall be supplied in accordance with details on the Contract Drawings. All steel shall be hot dip galvanized after fabrication and all hardware shall be stainless steel.

E96.2.3 Cover to be Shopost Iron Works MK-A1 or approved equal in accordance with B7.

E96.3 Construction Methods

E96.3.1 Contractor to securely affix ditch inlet grates to manhole reducer or riser utilizing stainless steel hardware.

E96.3.2 Any galvanized surfaces that are damaged shall be coated with a galvanizing compound approved by the Contract Administrator

E96.4 Measurement and Payment

E96.4.1 The supply and installation of ditch inlet grate covers will not be measured for payment and shall be included in the payment for supply and installation of standard pre-cast concrete catchbasin (SD-025) as a replacement for the standard grated cover (AP-006).

E97. FRENCH DRAINS

E97.1 Description

E97.1.1 General

(b) This specification pertains to the construction of French Drains adjacent to the road structure as shown on the Drawings.

E97.2 Materials

E97.2.1 Drainage material will consist of natural gravel, crushed stone or other materials of similar characteristics having clean, hard, strong, durable, uncoated particles free from injurious amounts of soft, friable, thin, elongated or laminated pieces, alkali, organic or other deleterious matter.

E97.2.2 Drainage material will meet the follow requirements:

Table E97-14: Drainage Material Grading Requirements

Canadian Metric Sieve Size	Percent of Total Dry Weight Passing Each Sieve
40 000	100%
25 000	50% - 80%
20 000	5% - 20%
12 500	0% - 5%
80	0% - 3%

E97.2.3 Soundness – Drainage material when subject to five (5) cycles of soundness test will have a weighted loss of not more than thirteen percent (13%) in accordance with ASTM Standard C88, test for soundness of Aggregates by Use of Magnesium Sulphate.

E97.2.4 Abrasion – Drainage material when subject to abrasion test will have a loss of not more than thirty percent (30%) when tested in accordance with grading A of ASTM C131, Test for Resistance to Degradation of Small-Size Aggregate by Abrasion and Impact in the Los Angeles Machine.

E97.2.5 Drainage Fabric will be non-woven and meet or exceed the requirements of Separation Geotextile Fabric in Clause 2.5 of CW 3130.

E97.3 Construction Methods

E97.3.1 Installation of the French Drains shall not take place until installation of the sub-base materials is complete and the ditch slopes have been backfilled and compacted and clay capped adjacent to the road structure.

E97.3.2 Excavate a trench to the grade and dimensions shown on the Drawings or as directed by the Contract Administrator. Excavate into the road structure as shown to ensure a physical connection between the sub-grade and the French drain.

E97.3.3 Dispose of trench excavation material in accordance with Section 3.4 of CW 1130 or as directed by the Contract Administrator.

E97.3.4 Repair any non-conforming trenches as directed by the Contract Administrator.

E97.3.5 Compact sub-grade in the base of the trench to a minimum standard proctor of ninety percent (90%).

E97.3.6 Place separation geotextile fabric such that it overlaps above the geotextile fabric in the road structure a minimum of 300 mm. Ensure adequate geotextile fabric is placed to allow for wrapping the drainage material, including overlap joints above and at the ends of the French Drain.

E97.3.7 Overlap joints in the geotextile fabric a minimum of 500 mm.

E97.3.8 Backfill the trench with the drainage material in 300 mm lifts and compact to the satisfaction of the Contract Administrator. Place drainage material to the grade and dimensions shown on the Drawings or as directed by the Contract Administrator.

E97.3.9 Place drainage material to ensure no damage occurs to the separation geotextile fabric.

E97.3.10 Backfill above the French Drain with suitable Site material and compact to a standard proctor of ninety percent (90%) to the grade and dimensions shown on the Drawings or as directed by the Contract Administrator. Ensure this material does not cover the ends as to block the flow of water into the ditch.

E97.4 Measurement and Payment

E97.4.1 Construction of French Drains, and all related appurtenances will be measured on a unit basis and paid for per French Drain at the Contract Unit Price in accordance with this Specification, accepted and measured by the Contract Administrator.

E97.4.2 The construction of French Drains shall be paid for at the Contract Unit Price per French Drain for “Installation of French Drains”, measured as specified herein, which price shall be payment in full for performing all operation herein described and other items incidental to the Work included in this Specification.

E97.4.3 The supply and installation of geotextile fabrics will be considered incidental to the works, and no separate measurement and payment will be made.

APPENDIX ‘A’

GEOTECHNICAL REPORT

September 7, 2017 File No. 0022 033 00

Dr. Mike Lau, P.Eng.
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R3T 0Y4

RE Fermor Avenue over the Seine River Bridge Rehabilitation
Detailed Design Geotechnical Recommendations – REV1

This letter report provides geotechnical recommendations for the detailed design of bridge rehabilitation works and retaining walls for the Fermor Avenue crossing of the Seine River in Winnipeg, Manitoba. TREK Geotechnical Inc. (TREK) was retained by Dillon Consulting to provide geotechnical engineering services for Detailed Design for the project. The terms of reference for this assignment are included in our proposal to Dillon Consulting Ltd. (Dillon), dated March 19, 2017. The scope of work includes a stability analysis of the final design geometry, lateral earth pressure distributions for sheet pile walls, and detailed design and construction recommendations to supplement TREK's preliminary design report dated September 14, 2017.

The current letter has been revised (1st revision) from previous a version (dated Septemebr 7, 2017) for the following reasons:

- updated girder jacking loads provided by Dillon
- corrected location of the jacking load relative to the bridge abutments
- additional analysis case eliminating a wall at Sta. 6+900 (north side slope)
- provision of frost insulation recommendations

Background and Existing Information

The existing Fermor Avenue bridge over the Seine River is a three-span mixed steel and precast concrete girder structure with cast-in-place concrete (CIPC) deck, barriers and sidewalks. The bridge was originally constructed in 1953, widened in 1969, and rehabilitated in 1984. Recent inspections of the bridge have identified that it is in fair to poor condition and requires rehabilitation or reconstruction to meet current design standards and to accommodate a new Active Transportation Pathway (ATP).

TREK undertook a sub-surface investigation for the preliminary design to supplement existing information from previous bridge construction. Details of the sub-surface investigation are summarized in TREK's Preliminary Design Report, and results of a roadway subsurface investigation performed by TREK (as part of the overall project) along Fermor Avenue between St. Anne's Road and Archibald Street was summarized in a separate report (appended to our Preliminary Design report).

TREK's Preliminary Design Report includes recommendations relative to embankments, foundations, excavations and shoring. All recommendations from our previous preliminary design report remain applicable except for those noted herein.

Proposed Works

Our understanding of the proposed works are based on drawings provided by Dillon (Appendix A). The bridge over the Seine river will be rehabilitated, and the existing foundation and abutments will remain with minor modifications to accommodate the rehabilitation. An underpass structure crossing Fermor Ave. will provide a north-south active transportation pathway (ATP) connection approximately 230 m west of the existing bridge. An east-west ATP connection over the Seine River will be accommodated by an ATP running along and up the north sideslope of Fermor Avenue, crossing the Seine River along the north edge of the rehabilitated bridge. A more detailed description of the major components of work is provided below.

Bridge Rehabilitation

The proposed bridge works involve rehabilitating the existing abutments, piers and girders, and reconstructing the bridge deck and approach slabs. The eastbound sidewalk will be removed, and traffic lanes will be shifted to the south to accommodate the new ATP north of the westbound lanes.

The rehabilitation includes jacking (lifting) the bridge girders approximately 150 mm at the abutments to allow for bearing replacement and concrete repairs. Jacking will be undertaken in two stages: the northern half of the bridge will be rehabilitated in the summer of 2018, and the southern half in the summer of 2019. The proposed works do not include modifying the existing river channel beneath the bridge structure, although recommendations for scour protection will be provided by TREK in a separate report. Headslopes will be maintained at the west abutment, and will be flattened to between 5 horizontal to 1 vertical (5H:1V) and 6H:1V at the east abutment.

Sideslopes

The north sideslope will be regraded to accommodate the ATP, and where necessary to achieve target factors of safety. A portion of the north sideslope within the project area has experienced historical slope instabilities and will be repaired as part of this work. The south sideslope will be stabilized to achieve target factors of safety with a combination of regrading and cantilevered (sheet pile) retaining walls.

Active Transportation Path

An underpass will be constructed beneath Fermor Avenue to connect ATPs to the south and north of Fermor Ave. The concrete box underpass will be founded on a shallow (mat) foundation bearing on stiff to very stiff clay. The underpass will be constructed in two stages, and temporary shoring (to be designed by the Contractor) will be required to accommodate the construction staging. The entrances/exits to the underpass will consist of cantilevered sheet pile headwalls.

North of Fermor Ave., the ATP will climb the north sideslope and cross the Seine River along the north edge of the bridge. A retaining wall will run along the downslope edge of the ATP, and will be constructed as either a mechanically stabilized earth (MSE) wall or a shallow sheet pile retaining wall.

Embankments

Slope Stability Analysis

The stability of the east and west head slopes, and select sections on the embankment side slopes were evaluated to assess detailed design geometry and bridge jacking surcharge loading during construction. Stability model methods, assumptions, parameters, results and recommendations are provided below.

Model Development

The slope stability analysis was conducted using a 2-dimensional limit-equilibrium slope stability model (Slope/W) from the GeoStudio 2016 software package (Geo-Slope International Inc.). The slope stability model used the Morgenstern-Price method of slices with a half-sine inter-slice force function to calculate factors of safety (FS) along potential slip surfaces. A minimum factor of safety (FS) of 1.30 was selected based on the assumed groundwater levels (which are higher than measured levels). Groundwater conditions were represented in the model using a static piezometric line.

Headslopes

The headslope geometry considered in the analysis was provided by Dillon. The river channel beneath the bridge is skewed to the bridge alignment, so the headslope length varies across the width of the bridge. Therefore, three distinct cross-sections were analyzed: the north edge of the bridge, the bridge centerline, and the south edge of the bridge. The headslope analysis considered the proposed final geometry, and the effect of superstructure jacking loads.

Jacking loads and locations were provided by Dillon, and were applied in the model as surcharge loads on the headslopes downslope of the abutments. The loads are greatest at the north and south edges of the bridge to lift the heavier concrete girders, and are reduced in the middle of the bridge to lift the steel girders. TREK modeled both an extreme loading scenario at each abutment which incorporated the highest jacking loads distributed over the width of the concrete girders, and an average loading scenario which distributed all jacking loads over the full width of the bridge. As per discussions with Dillon, it was determined that the jacking loads would be distributed to the foundation soils using timber cribbing and 0.3 m thick by 2.4 m wide rigid timber crane mats of varying length (typically 6 m to 9 m). Table 1 summarizes the range of jacking forces for either concrete or steel girders, and the extreme and average jacking surcharge pressures considered in the analysis. The granular backfill upslope of the abutment was neglected in the analysis, since the abutment will be exposed in an open excavation during the superstructure jacking.

Table 1 – Jacking Forces and Modeled Surcharge Loads

Case	No. of Girders and applicable width	Jacking Force per Girder (kN)	Jacking Pressure (kPa)
Extreme	3 concrete girders over 5 m (at both north and south edges of bridge)	301 to 393 kN	77 kPa
Average	3 concrete girders + 7 steel girders over 25.3 m (full bridge width)	185 to 393 kN	57 kPa

The extreme (upper bound) loading scenario was modeled at the headslope section at which the river was closest to the abutment to assess a lower bound factor of safety for each headslope; at a cross section coincident with the south edge of the east abutment, and the north edge of the west abutment. The average loading scenario was applied to the centerline cross-section.

Sideslopes

The cross-sections used in the sideslope stability models were generated from a combination of ground survey provided by Dillon, and bathymetric survey conducted along the Seine River by Bruce Harding Consulting Ltd. in 2016. The cross-sections reference stationing provided by Dillon, which is shown on Figure 1. The south sideslope cross-sections reference the eastbound Fermor Ave. control line stationing, and the north sideslope cross-sections reference the ATP control line stationing. All cross-sections were cut perpendicular to the sideslopes.

The existing failure along the north sideslope extends from approximately station 6+905 to 6+960. A cross-section at station 6+940 was back-analyzed to assess the observed instability, and a cross-section just outside the failure (Sta. 6+964) was used to estimate the pre-failure slope geometry used in the back-analysis. The observed instability was likely triggered by near-surface saturation and loss of soil suction, which was simulated using a piezometric line at ground surface (i.e. fully saturated) within and downslope of the instability. It should be noted that the fully saturated piezometric line is considered applicable only to shallow slip surfaces and is not considered appropriate for deep-seated global slip surfaces. Residual clay parameters within the failed soil mass were determined based on the back-analysis of pre-failure slope geometry and a slope repair detail (granular ribs) was designed. Additional cross-sections at stations 6+990 and 6+900 were analyzed to assess stability with the ATP at the top of the slope and at mid-slope, respectively, and determine if any stabilization works or deep sheet pile walls are required.

On the south sideslope, the critical cross-section at station 4+850 was analyzed where the Seine River is located in closest proximity to Fermor Avenue. A deep sheet pile wall combined with slope regrading was considered in the analysis for slope stabilization. A cross-section at station 4+910 was modeled to determine the extents of sheet piles required for global stability.

The soil stratigraphy and material parameters assumed in the model is consistent with TREK's Preliminary Design Report, as summarized in Table 2.

Table 2. Material Parameters used in Slope Stability Analysis

Material	Unit Weight (kN/m3)	Cohesion (kPa)	Friction Angle (degrees)
Clay Fill	18	3	20°
Silty Clay	17.5	5	15°
Residual Clay	17.5	2.5	12
Till	20	5	27°
Granular Fill	21	0	35
Lightweight Fill	4.5	500	0
Granular Ribs (50% replacement ratio)	19.25	1.25	28.5

A traffic surcharge load of 2 kPa was incorporated into the embankment side slope analysis.

Piezometric Conditions

Piezometric conditions considered in the analysis are consistent with our Preliminary Design Report, except for the fully saturated level used for back analysis of the existing side slope instability. The piezometric level was modeled at Elev. 227.0 m sloping down to meet the river level at Elev. 225.3 m. The sideslope repair back analysis was modeled with a fully saturated piezometric line downslope of and within the observed instability.

Analysis Results

Results of the stability analysis are summarized in Tables 3 and 4 for head and side slopes, respectively, with stability results shown in the attached figures.

Headslopes

Model outputs for the proposed (final) headslope geometries at the north edge, centerline and south edge of the bridge are shown on Figures 2 to 8. All proposed headslopes met the target factors of safety with granular backfill except the west abutment at the north edge of the bridge, which had a factor of safety of 1.22. Using lightweight fill as backfill behind the abutment (Figure 3) raised the safety factor at this section to 1.31. The factors of safety for all headslope analyses are summarized in Table 3.

The superstructure jacking analyses are shown on Figures 9 to 12. A bench cut (offloading) down to Elev. 229.25 m at the jacking location is required to achieve an adequate factor of safety. In the average loading scenario, all slip surfaces exceeded the target factor of safety. In the extreme loading scenario, two potential slip surfaces on the west headslope did not meet the stability target; slip surfaces originating upslope of the jacking pad and behind the abutment have safety factors of 1.19 and 1.28, respectively (Figure 10). However, because the load for the extreme case is applied

over a narrow width (approximately 5 m of timber mat) in comparison with the length of the slip surfaces (between 18 and 36 m long), we anticipate a loading scenario tending toward the average value would be more appropriate. The extreme loading scenario does, however, serve as a check to show that the factor of safety remains above unity for worst-case loading conditions.

Table 3. Summary of Calculated Factors of Safety for Headslopes

Stability Case	Loading Scenario	Headslope	Cross-Section	Slip Surface	Factor of Safety	Figure No.
Final Geometry	N/A	West	North	Critical	1.31**	3
			Centerline	Critical	1.33	4
			South	Critical	1.44	5
		East	North	Critical	1.45	6
			Centerline	Critical	1.38	7
			South	Critical	1.33	8
Superstructure Jacking	Extreme	East	South	Downslope edge of mat	1.55	9
				Upslope edge of mat	1.32	
				Global	1.37	
		West	North	Downslope edge of mat	1.52	10
				Upslope edge of mat	1.19	
				Global	1.28	
	Average	West	Centerline	Downslope edge of mat	1.90	11
				Upslope edge of mat	1.48	
				Global	1.38	
		East	Centerline	Downslope edge of mat	1.63	12
				Upslope edge of mat	1.37	
				Global	1.41	

Meets target factor of safety

Does not meet target factor of safety

** Lightweight fill used to backfill behind abutment

Sideslopes

Sideslope stability analysis cases and associated factors of safety are summarized in Table 4.

The stability analysis showed deep sheet pile retaining walls are not required to achieve the target global factor of safety along the north side slope. Adequate levels of stability can be achieved at station 6+990 through a combination of regrading and a 1.8 m high retaining wall (either MSE or shallow sheet piles) downslope of the ATP (Figure 13). The factor of safety at the retaining wall shown in the model is 1.24 without any strength offered by cantilevered wall or MSE reinforcements. The cross-section at station 6+900 is stable with a 3H:1V slope downslope of the ATP to intersect existing grade (Figure 14).

The existing instability on the north bank was back-analyzed to determine the conditions at failure, and then a slope repair analysis was undertaken. Figure 15 shows the back-analysis of pre-failure conditions using a hybrid section of station 6+940 (downslope of the instability) and 6+964 (within the embankment side slope). The slip surface shown was selected to match the failed geometry, which is shown in red. The post-failure geometry was then modeled using residual strength parameters of c'= 2.5 kPa and ϕ'=12° to achieve a factor of safety of unity, as shown in Figure 16. To repair the instability, granular ribs extending below the anticipated depth of the instability were modeled using a 50% replacement ratio and the slope was re-graded to a 4H:1V slope. The slope repair was analyzed for two groundwater levels: a surficial groundwater level as used in the back-analysis (Figure 17) and applicable to shallow slip surfaces, and the global piezometric level for deep-seated slip surfaces (Figure 18). In both cases, the factor of safety for the proposed repairs meets the design target.

At the critical section on the south sideslope (station 4+850), sheet piles embedded to Elev. 217 m (approximately 15.5 m below the edge of roadway) achieves the target factor of safety of 1.3 (Figure 19), provided the slope is re-graded to 4.5H:1V downslope of the wall. The minimum sheet pile embedment is required to push the slip surface deeper and improve the factor of safety for global slip surfaces. At station 4+910, the target factor of safety can be achieved without deep sheet piles, however re-grading is required along with a 1.6 m high retaining wall (Figure 20). We understand the portion of wall east of Sta. 4+910 will be designed as a moment slab on top of a sheet pile wall.

Table 4. Summary of Calculated Factors of Safety for Sideslopes

Cross-Section and Analysis Case	Sideslope	Groundwater Level	Slip Surface	Factor of Safety	Figure No.
6+990 5H:1V Regrading, 1.8 m Retaining Wall	North	227.0 m	Critical	1.29	13
6+900 Existing slope, mid-bank pathway, 3H:1V fill downslope	North	227.0 m	Critical	1.52	14
6+940 Observed Instability Back Analysis	North	Fully Saturated	Observed	1.14	15
		Fully Saturated	Observed	1.02 **	16
6+940 Granular Ribs, 4H:1V Regrading, No Wall	North	Fully Saturated	Critical	1.29	17
		227.0 m	Critical	1.54	18
4+850 4.5H:1V Regrading 2.0 m Wall with 0.8 m Moment Slab Minimum Sheet Pile Tip Elev. 217 m	South	227.0 m	Global	1.30	19
			Downslope of Sheet Piles	1.34	
4+910 5H:1V Regrading, 1.6 m wall No embedment requirement for global stability		227.0 m	Critical	1.29	20

Meets target factor of safety

Does not meet target factor of safety

** Lightweight fill used to backfill behind abutment

Stability Recommendations

Based on the slope stability analysis, TREK recommends the following:

1. The north half of the west abutment be backfilled with lightweight fill. TREK should be consulted to confirm that the selected lightweight fill geometry is consistent with the assumptions of our analysis.

2. The headslope should be bench cut such that the load transfer platform for the girder jacks is founded at elevation 229.25 m. The load transfer platform should be at least 2.4 m wide (in the east-west direction) as shown in the model outputs, and the jacking loads should not exceed those provided for this analysis.

3. Sheet piles are not required on the north sideslope to achieve adequate global stability. Where walls are required, sheet piles may be used and designed based on the lateral earth pressure recommendations provided herein.

4. External stability of retaining walls on the north sideslope should be checked. Typically, adequate external stability can be achieved using a minimum reinforcement length for MSE

walls of 80% of the exposed wall height, or using a minimum embedment depth for shallow sheet piles of two to three times the exposed wall height. Internal wall stability should also be evaluated (to be completed by others).

5. Granular ribs should be installed to stabilize the north side slope instability with a 50% replacement ratio in plan view from station 6+905 to 6+960, and based on the rib geometry in cross-section shown on Figure 17. The slope should be regraded to a slope of 4H:1V prior to the construction of the ATP along the slope. Granular ribs should be constructed using 100 to 150 mm down crushed limestone rockfill topped with a 0.6 m thick clay cap to prevent infiltration. The rockfill should be placed in lifts and compacted using vibratory techniques (e.g. hoe-pack) to achieve a maximum apparent density. The lift thickness and compaction duration should be determined by a field trial at the time of construction.

6. At locations along the north sideslope west of station 6+960 where the ATP is above existing grade, fill may be placed downslope of the ATP at a slope of 3H:1V (as shown in Figure 14). A shallow retaining wall may also be utilized.

7. Vegetation should be established on any regraded slopes to prevent saturation of the near surface soils.

8. Sheet piles are required for global slope stability on the south sideslope from station 4+850 to 4+910. The sheet piles should have a minimum tip elevation of 217 m, and the ground should be regraded such that a 4.5H:1V slope angle and a 2.8 m cantilever is achieved. The sheet piles should be designed using the lateral earth pressure recommendations noted herein.

Settlement

Upon review of the proposed final grade, minimal fill is planned and therefore settlement is not considered to be a concern for the proposed works.

Permanent Cantilevered Walls

Permanent cantilevered sheet pile retaining walls are proposed along the south sideslope of the west approach embankment from station 4+850 to 4+910, and at either end of the pedestrian-cyclist underpass. Table 5 provides the recommended earth pressure coefficients and bulk unit weights of each soil layer for calculation of lateral earth pressures. Surcharge loads and hydrostatic water pressure below the groundwater table should be incorporated into the design of cantilevered walls, as well as an adequate factor of safety against instability. Figure 21 shows the recommended earth pressure diagram for preliminary design of the sheet pile wall. The surcharge pressure should be selected by the structural engineer for any sustained loads.

An active earth pressure coefficient (K_a) should be used to calculate lateral loads against cantilevered walls which are free to translate horizontally away from the retained soil by more than 0.2% of the wall height. A passive earth pressure coefficient (K_p) should be used if the wall is free

to translate horizontally towards the retained soil by more than 2% of the wall height. An at-rest earth pressure coefficient (K_o) should be used if the walls undergo less than 2% movement of the wall height towards the retained soil and less than 0.2% of the wall height away from the retained soil. The table below provides K_a, K_p, and K_o values for calculation of lateral earth pressures acting on below grade walls.

Table 5. Recommended Design Parameters for Cantilevered Walls

Design Parameter	Granular Fill	Clay Fill	Silty Clay	Till
Active Earth Pressure Coefficient (K_a)	0.2	0.5	0.6	0.4
Passive Earth Pressure Coefficient (K_p)	4.6	2.0	1.7	2.7
At-Rest Earth Pressure Coefficient (K_o)	0.4	0.7	0.7	0.5
Bulk Unit Weight, Y (kN/m³)	21.0	18.0	17.5	20.0
Effective Unit Weight, Y' (kN/m³)	11.2	8.2	7.7	10.2

Underpass Mat Foundation

Our previous foundation recommendations, provided in our PD report, should be supplemented with the following design and construction recommendations:

1. A minimum thickness of 0.3 m of granular base course should be used to limit frost penetration (150 mm of sub-base and 150 mm of base material). Base layers should be compacted to 98% SPMDD.
2. A minimum thickness of 125 mm of rigid polystyrene insulation should be placed on top of the base course and beneath the concrete slab. The insulation should extend a minimum distance of 2.4 m beyond the edges of the slab and should be buried a minimum of 0.3 m below final grade.

Closure

The geotechnical information provided in this report is in accordance with current engineering principles and practices (Standard of Practice). The findings of this report were based on information provided (field investigation, laboratory testing, geometries). Soil conditions are natural deposits that can be highly variable across a site. If subsurface conditions are different than the conditions previously encountered on-site or those presented here, we should be notified to adjust our findings if necessary.

All information provided in this report is subject to our standard terms and conditions for engineering services, a copy of which is provided to each of our clients with the original scope of work or standard engineering services agreement. If these conditions are not attached, and you are not already in possession of such terms and conditions, contact our office and you will be promptly provided with a copy.

If you have any questions regarding the findings or recommendations presented, please contact the undersigned at your earliest convenience.

Kind Regards,

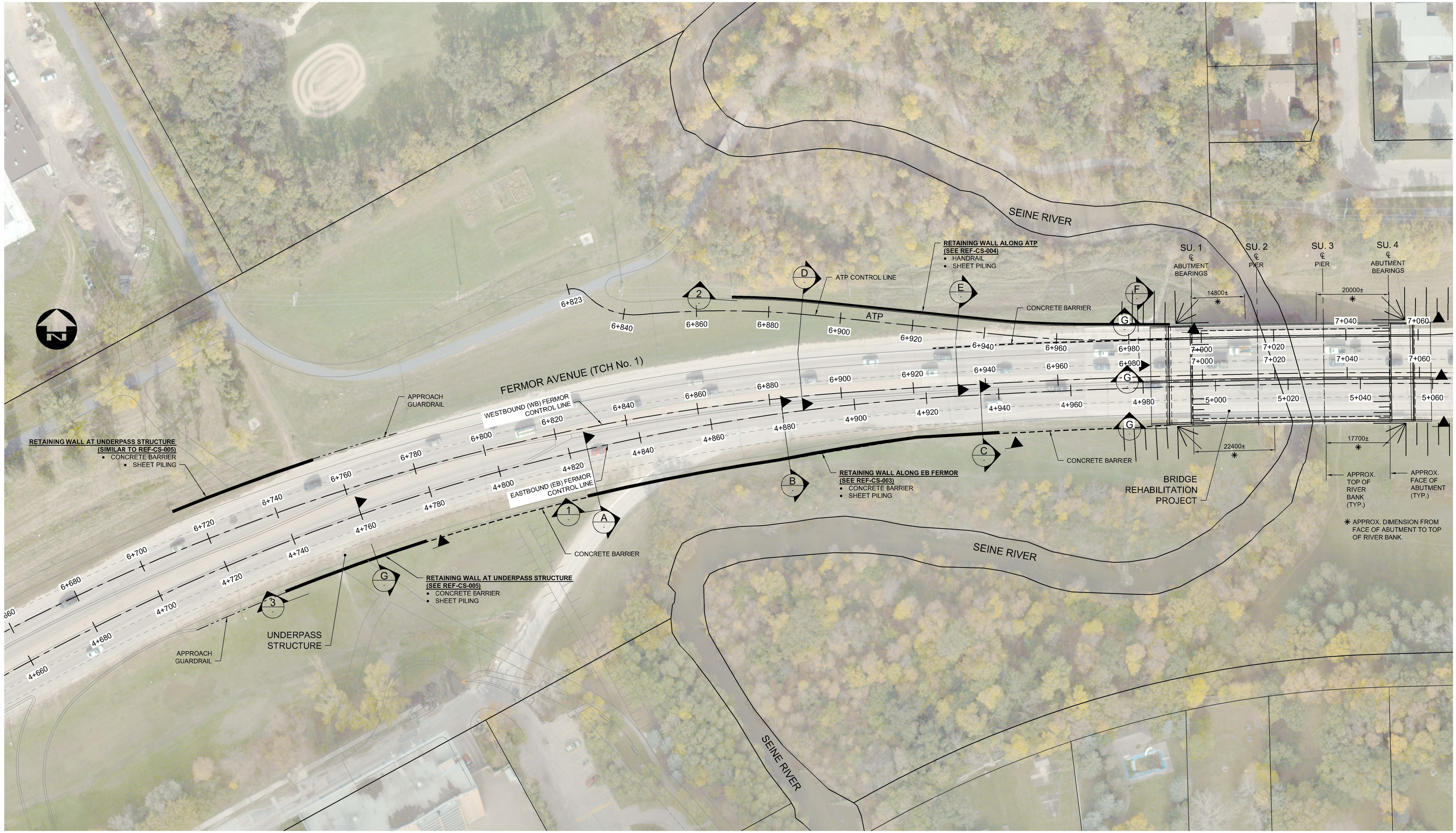
TREK Geotechnical
Per:

Michael Van Helden, Ph.D., P.Eng.
Geotechnical Engineer

Reviewed By:

for **Ken Skaftfeld, M.Sc., P.Eng.**
Senior Geotechnical Engineer

APEGM
Certificate of Authorization
Trek Geotechnical Inc.
No. 4877 Date: Sep 22/17



PLAN OF PROPOSED RETAINING WALLS
1:500

NOTE:

ADDITIONAL CROSS SECTIONS PROVIDED EVERY 10m ALONG THE EASTBOUND (EB) FERMOR AND ATP ALIGNMENTS, SEE REF-CS-007 TO REF-CS-010.

Figure 1

DILLON CONSULTING SCALE: AS NOTED	TITLE RETAINING WALLS LAYOUT PLAN	DRAWING NO. REF-CS-002

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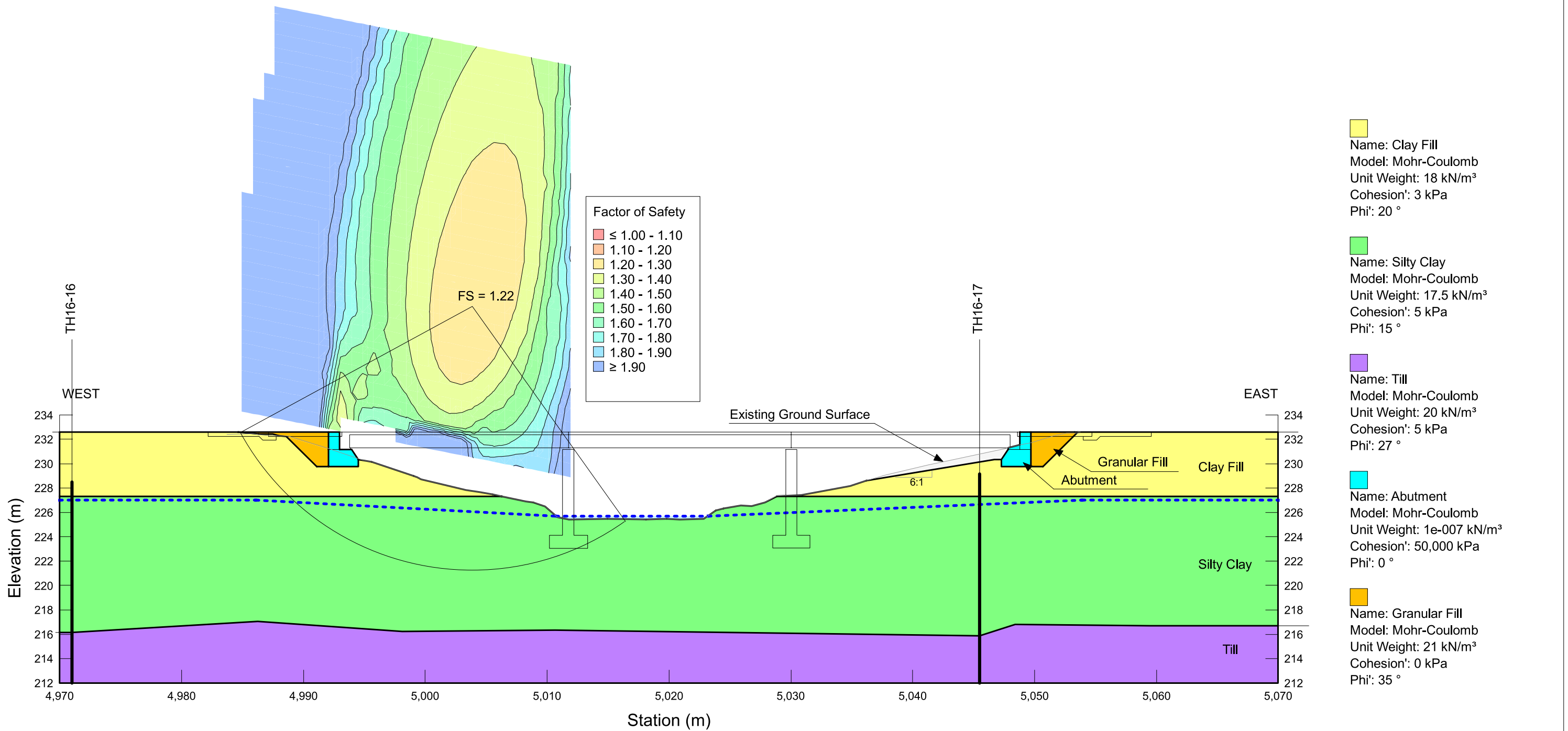

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Figure 2
Proposed Geometry
North Edge West Headslope

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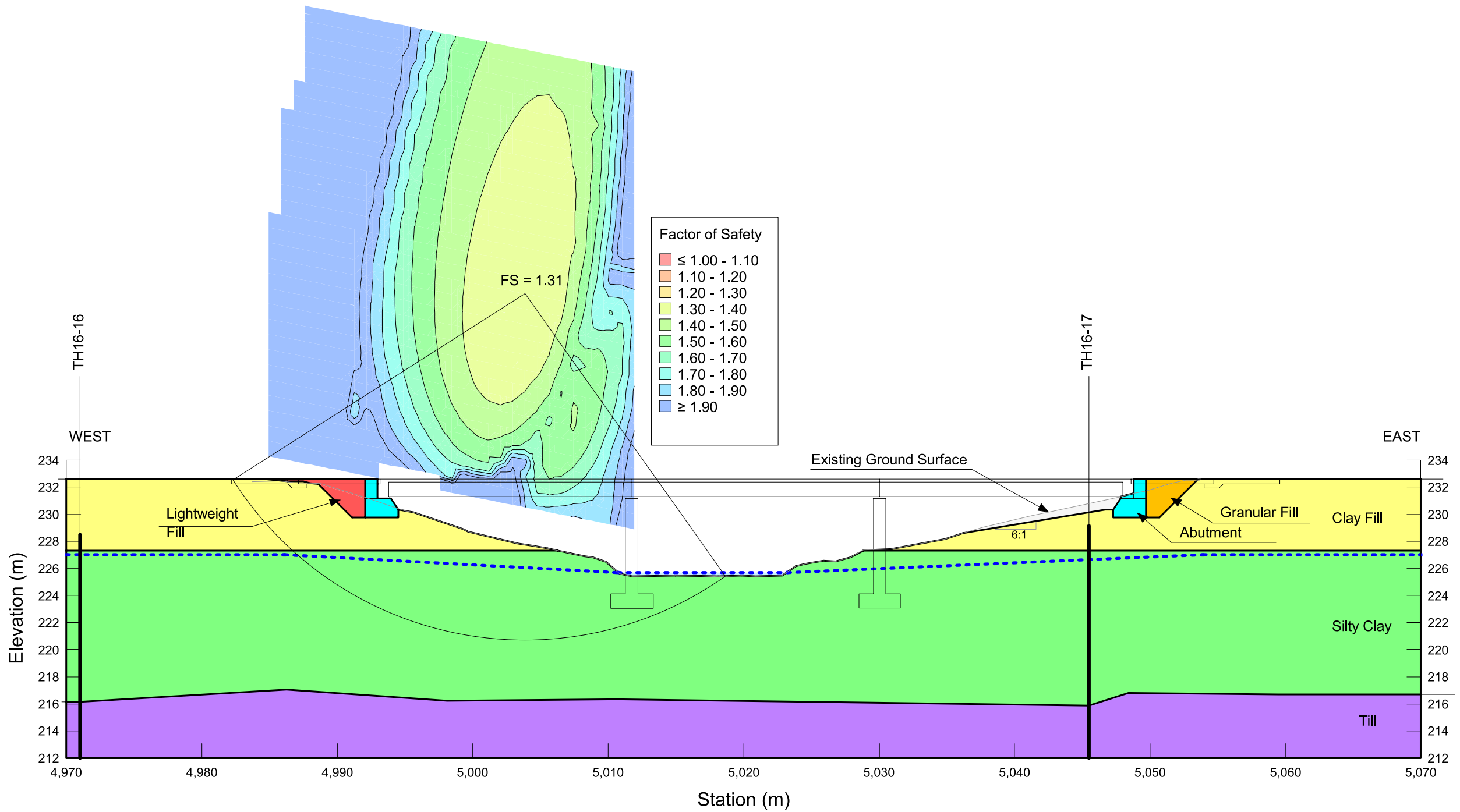

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Unit Weight: 18 kN/m³
Cohesion': 3 kPa
Phi': 20 °

Name: Silty Clay
Model: Mohr-Coulomb
Unit Weight: 17.5 kN/m³
Cohesion': 5 kPa
Phi': 15 °

Name: Till
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion': 5 kPa
Phi': 27 °

Name: Abutment
Model: Mohr-Coulomb
Unit Weight: 1e-007 kN/m³
Cohesion': 50,000 kPa
Phi': 0 °

Name: Granular Fill
Model: Mohr-Coulomb
Unit Weight: 21 kN/m³
Cohesion': 0 kPa
Phi': 35 °

Name: Lightweight Fill
Model: Mohr-Coulomb
Unit Weight: 4.5 kN/m³
Cohesion': 500 kPa
Phi': 0 °

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Figure 3
Lightweight Fill
North Edge West Headslope

Tabloid (279mm x 432mm)

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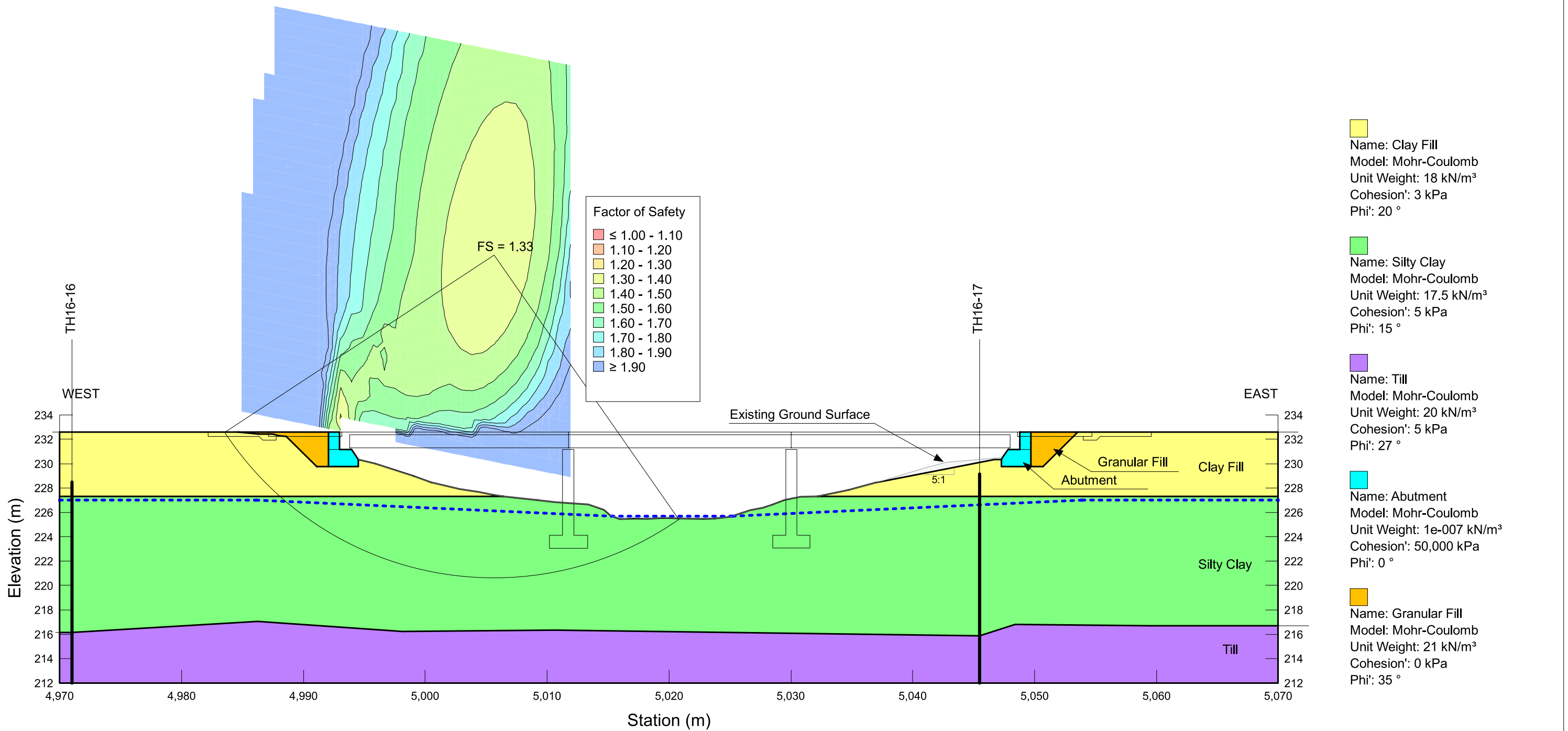

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Figure 4
Proposed Geometry
Centerline West Headslope

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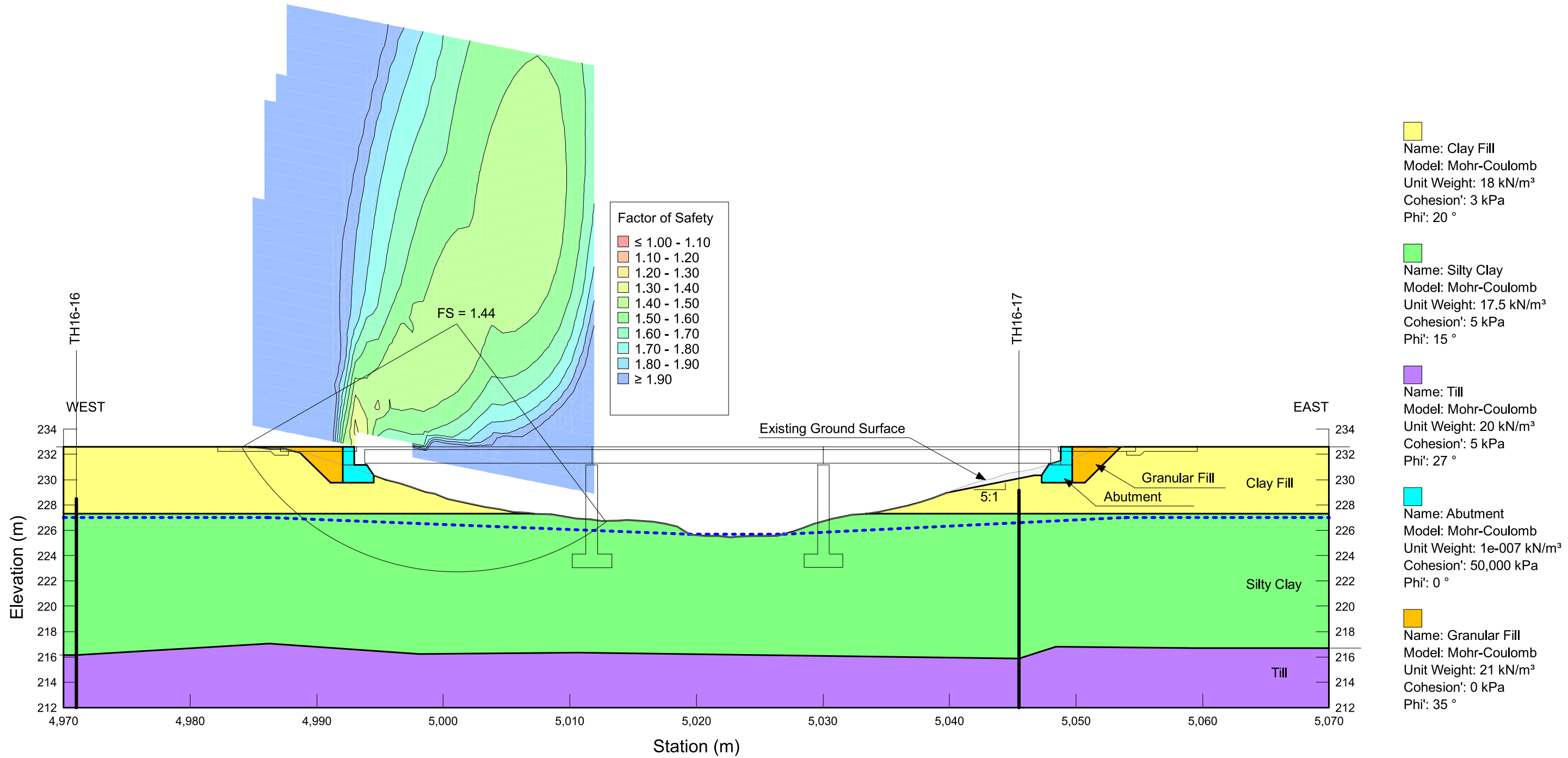

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Figure 5
Proposed Geometry
South Edge West Headslope

Tabloid (279mm x 432mm)

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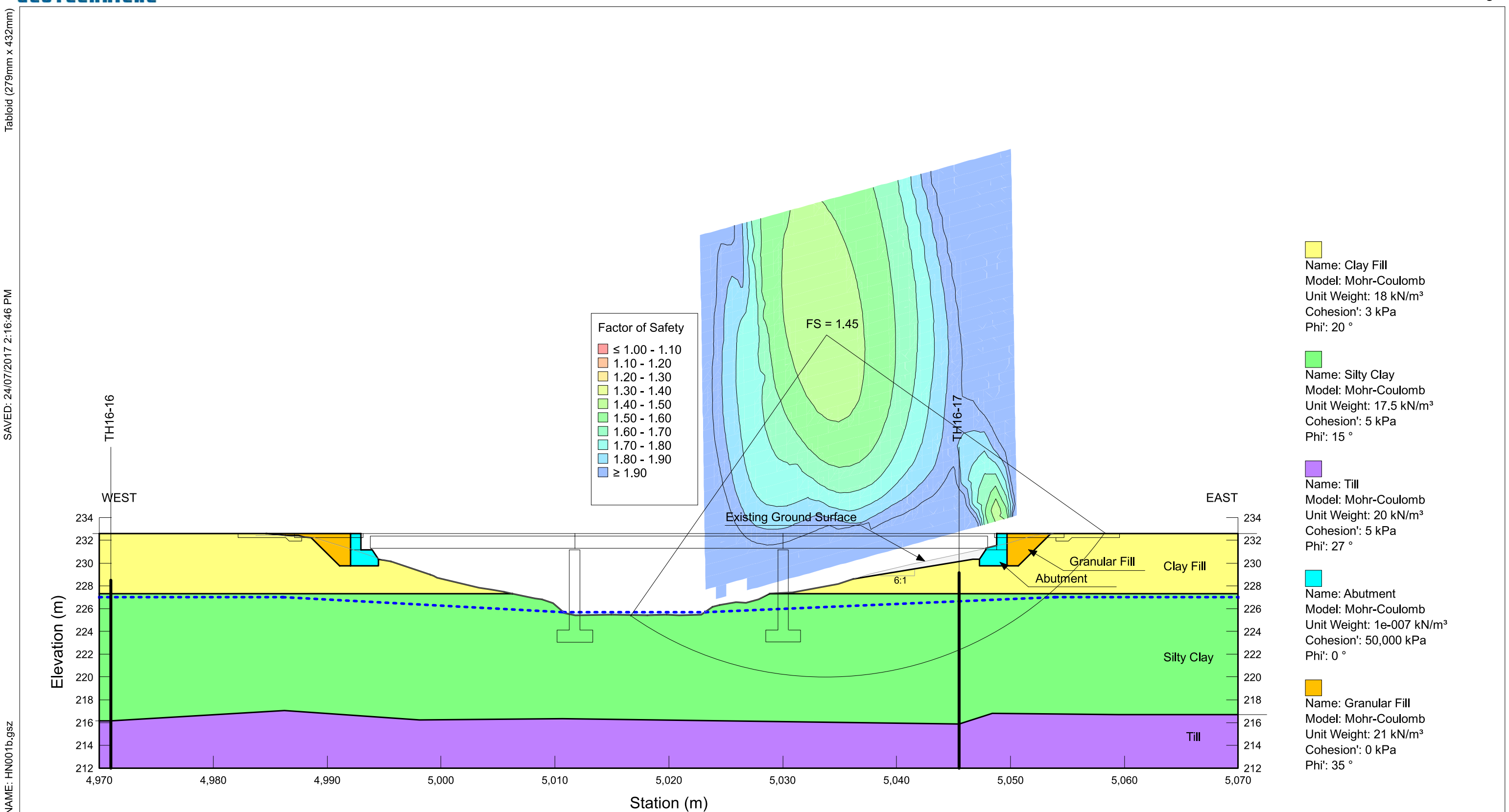

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Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion': 3 kPa
Phi': 20 °

Name: Silty Clay
Model: Mohr-Coulomb
Unit Weight: 17.5 kN/m³
Cohesion': 5 kPa
Phi': 15 °

Name: Till
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion': 5 kPa
Phi': 27 °

Name: Abutment
Model: Mohr-Coulomb
Unit Weight: 1e-007 kN/m³
Cohesion': 50,000 kPa
Phi': 0 °

Name: Granular Fill
Model: Mohr-Coulomb
Unit Weight: 21 kN/m³
Cohesion': 0 kPa
Phi': 35 °

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Figure 6
Proposed Geometry
North Edge East Headslope

Tabloid (279mm x 432mm)

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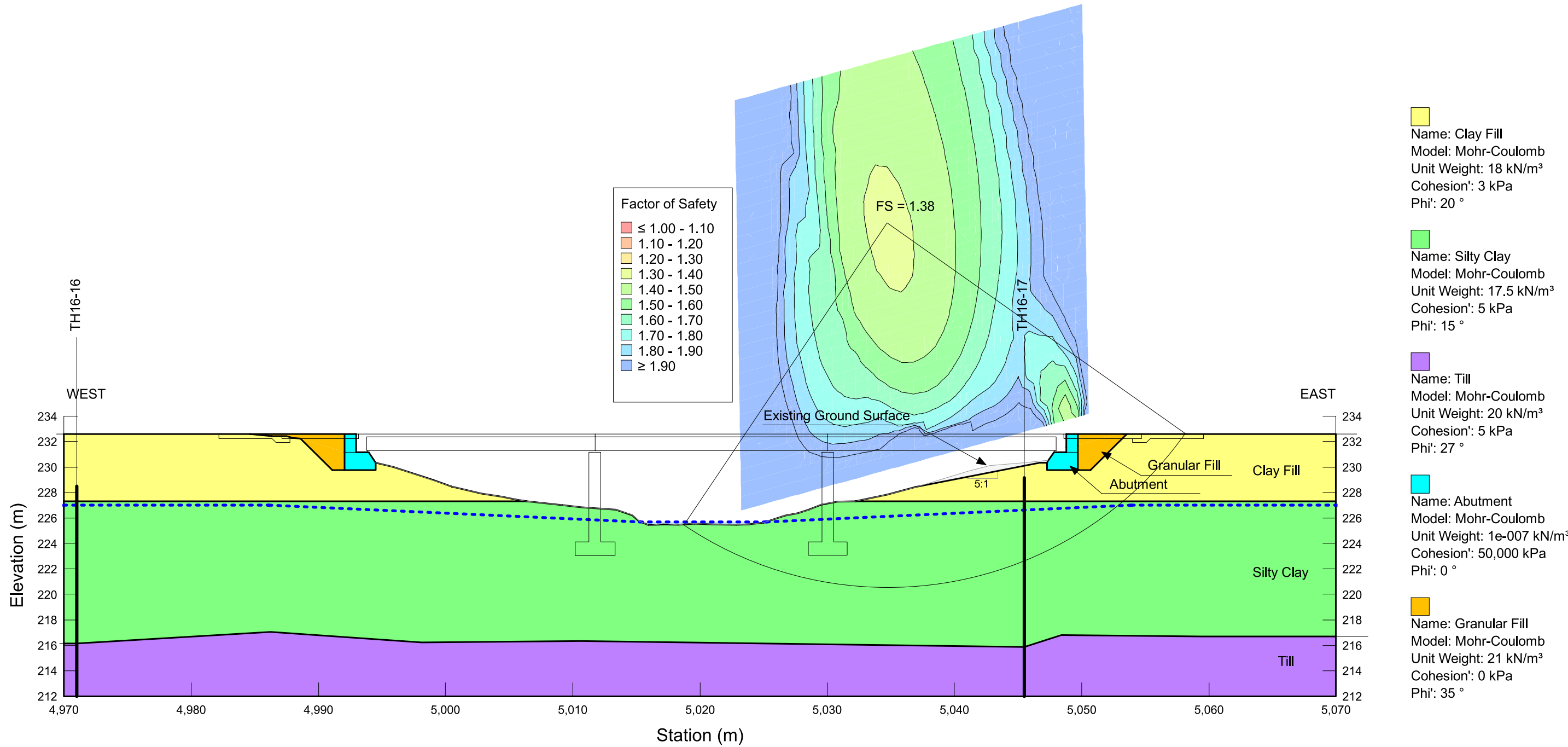

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Figure 7
Proposed Geometry
Centerline East Headslope

Tabloid (279mm x 432mm)

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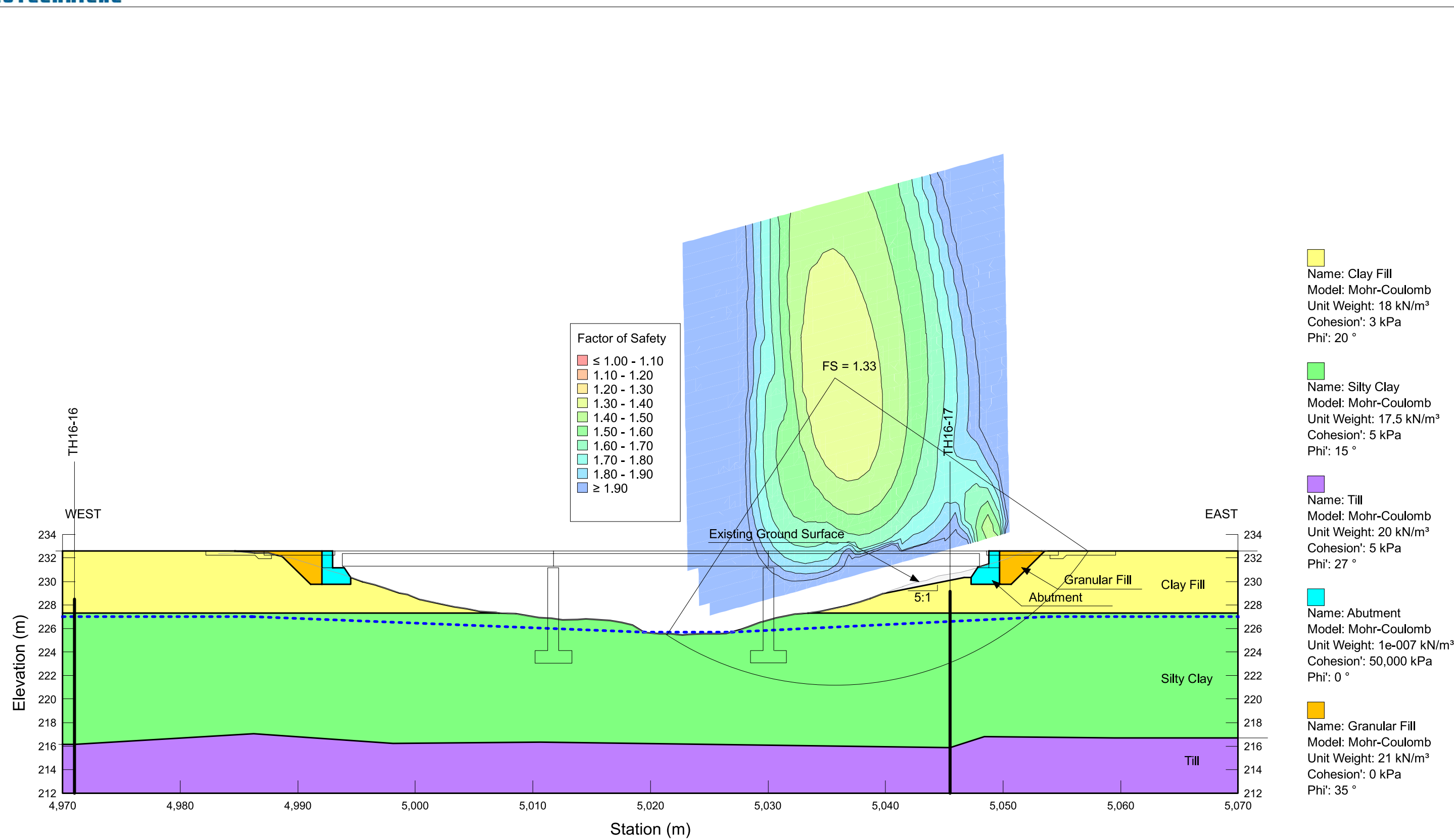

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Figure 8
Proposed Geometry
South Edge East Headslope

Tabloid (279mm x 432mm)

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Jacking Pressure: 46.9 kPa
2.4 m wide jacking mat at 229.25 m

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	B-bar
	Clay Fill	Mohr-Coulomb	18	3	20	0
	Silty Clay	Mohr-Coulomb	17.5	5	15	0
	Till	Mohr-Coulomb	20	5	27	0

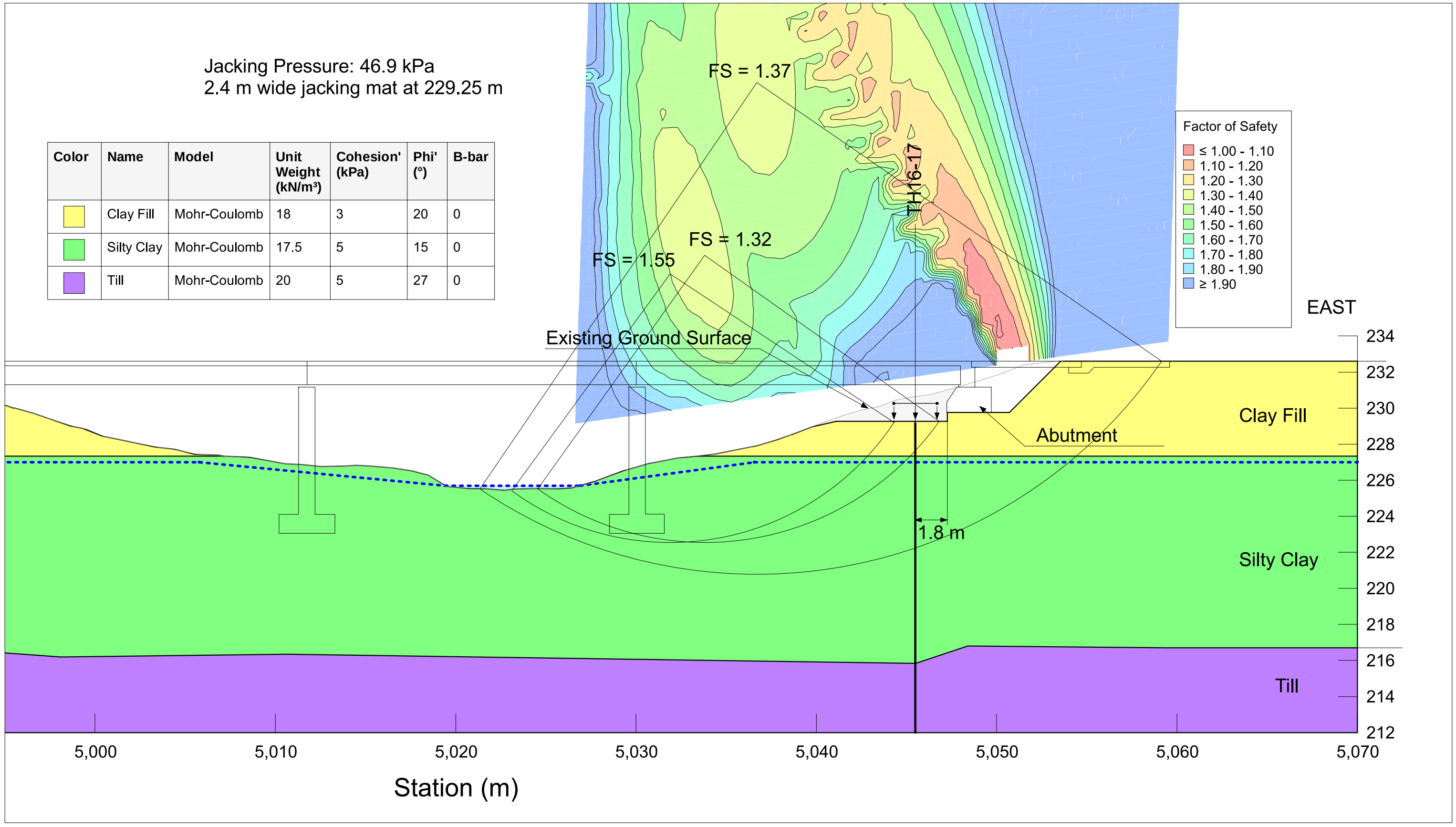

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Figure 9
Jacking Loads (Extreme)
South Edge of Bridge (East Headslope Worst Case)

Tabloid (279mm x 432mm)

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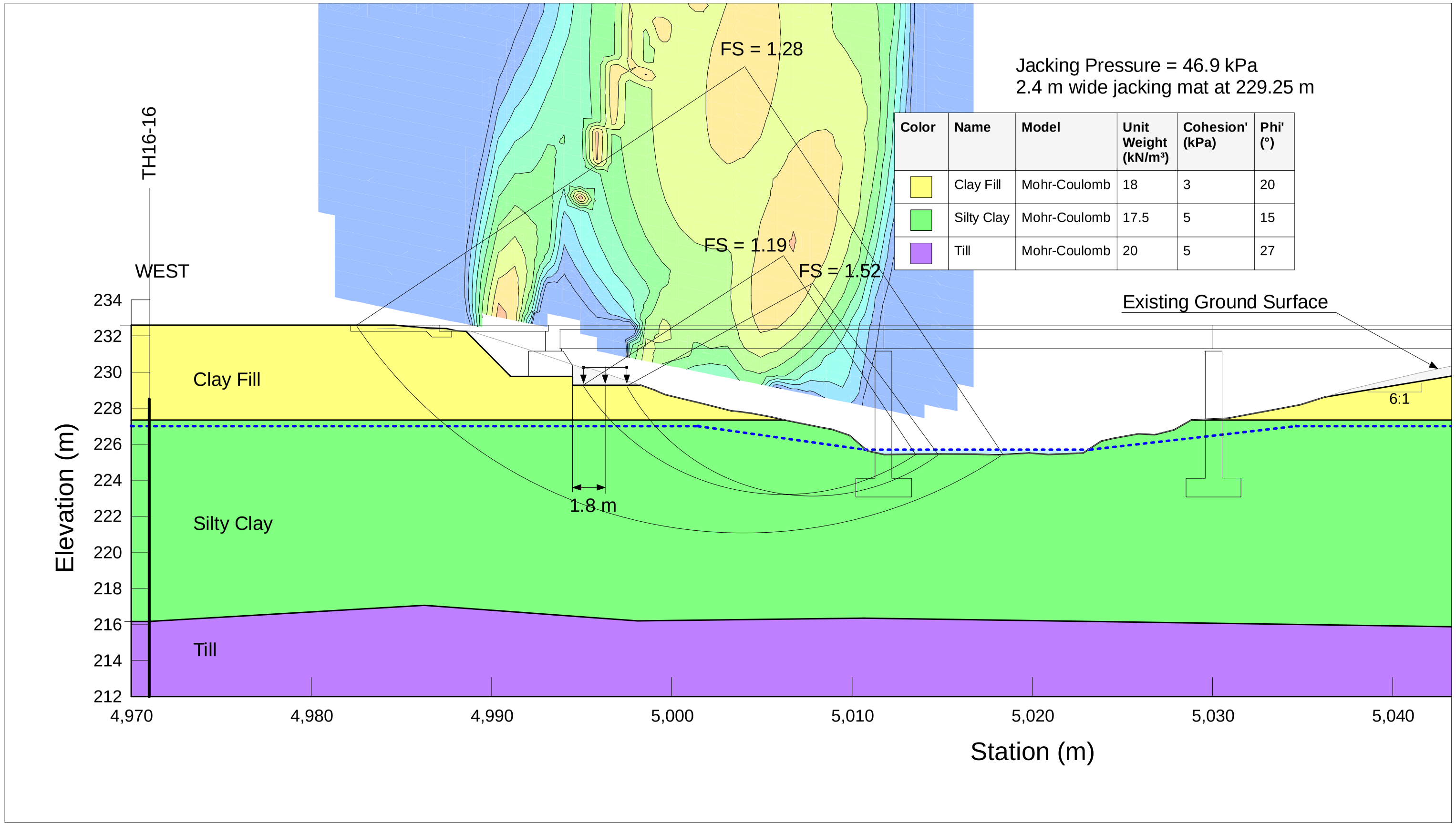


Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Clay Fill	Mohr-Coulomb	18	3	20
	Silty Clay	Mohr-Coulomb	17.5	5	15
	Till	Mohr-Coulomb	20	5	27

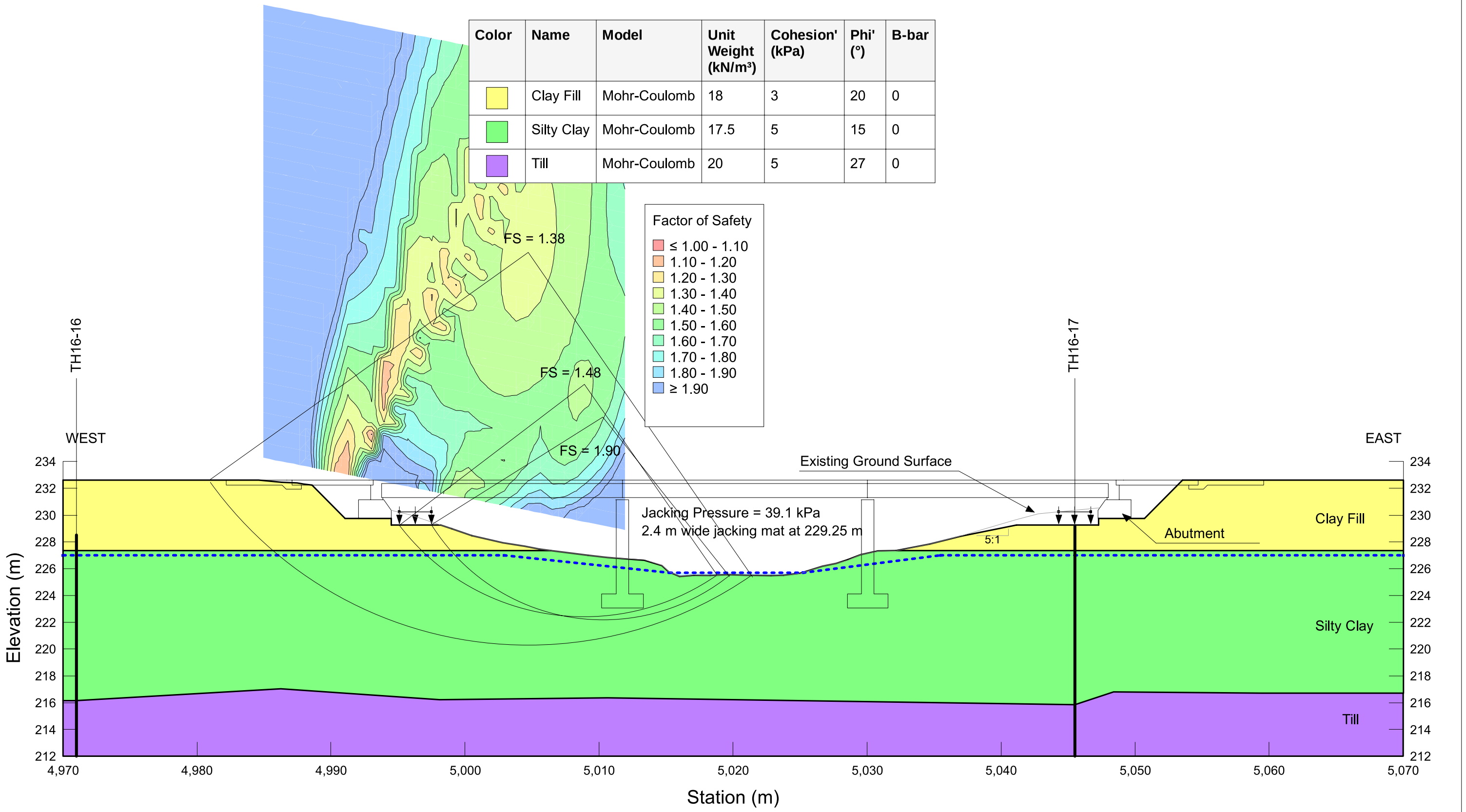
SCALE: 1:200 (279mm x 432mm)

Figure 10
Jacking Loads (Extreme)
North Edge of Bridge (West Headslope Worst Case)

Tabloid (279mm x 432mm)

SAVED: 18/09/2017 12:27:03 PM

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	B-bar
	Clay Fill	Mohr-Coulomb	18	3	20	0
	Silty Clay	Mohr-Coulomb	17.5	5	15	0
	Till	Mohr-Coulomb	20	5	27	0



FILE NAME: HC003.gsz

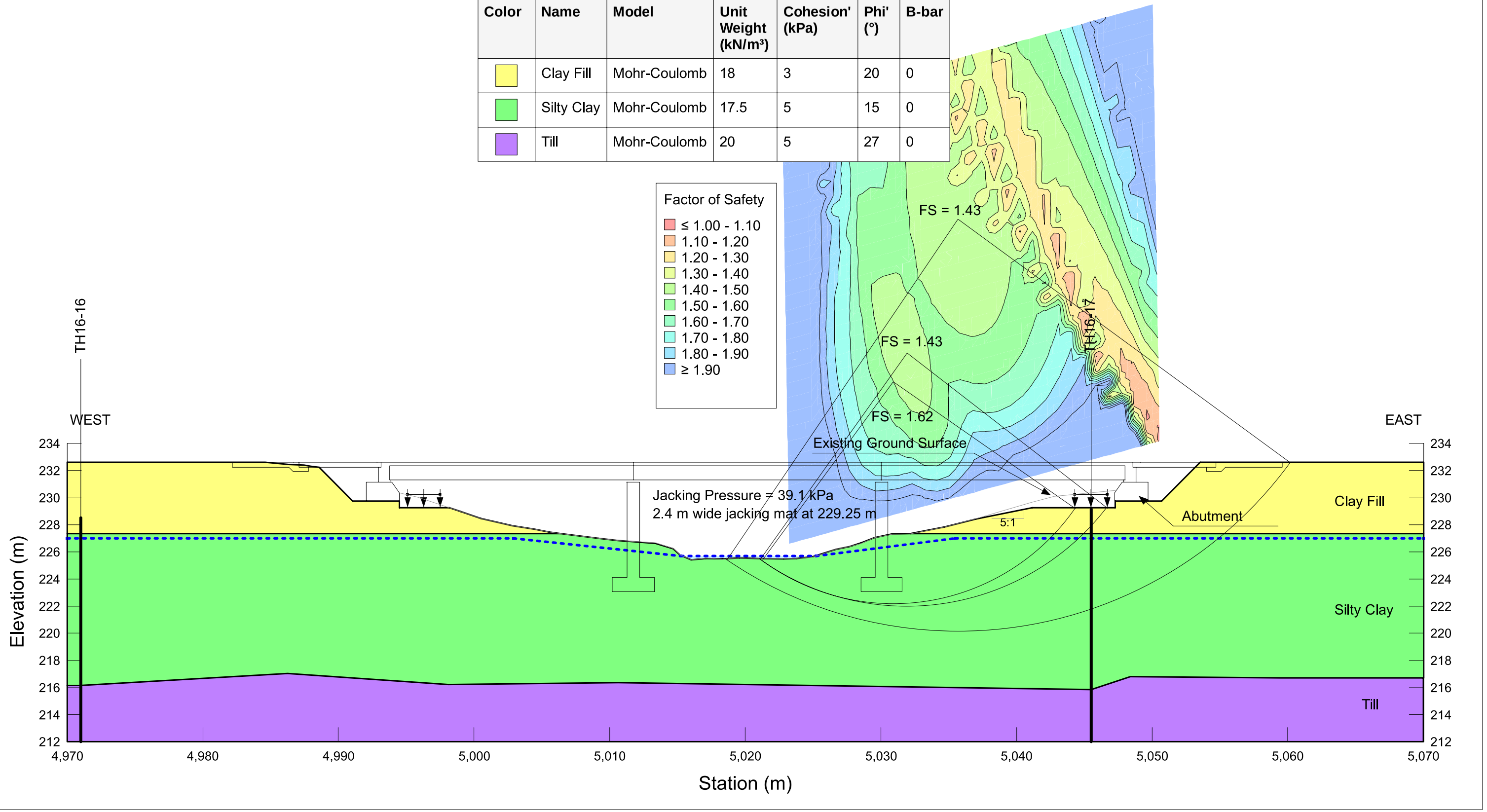
SCALE: 1:275 (279mm x 432mm)

Figure 11
Jacking Loads (Average)
Bridge Centerline (West Abutment)

Tabloid (279mm x 432mm)

SAVED: 18/09/2017 12:27:03 PM

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	B-bar
	Clay Fill	Mohr-Coulomb	18	3	20	0
	Silty Clay	Mohr-Coulomb	17.5	5	15	0
	Till	Mohr-Coulomb	20	5	27	0



FILE NAME: HC003.gsz

SCALE: 1:275 (279mm x 432mm)

Figure 12
Jacking Loads (Average)
Bridge Centerline (East Abutment)

Tabloid (279mm x 432mm)

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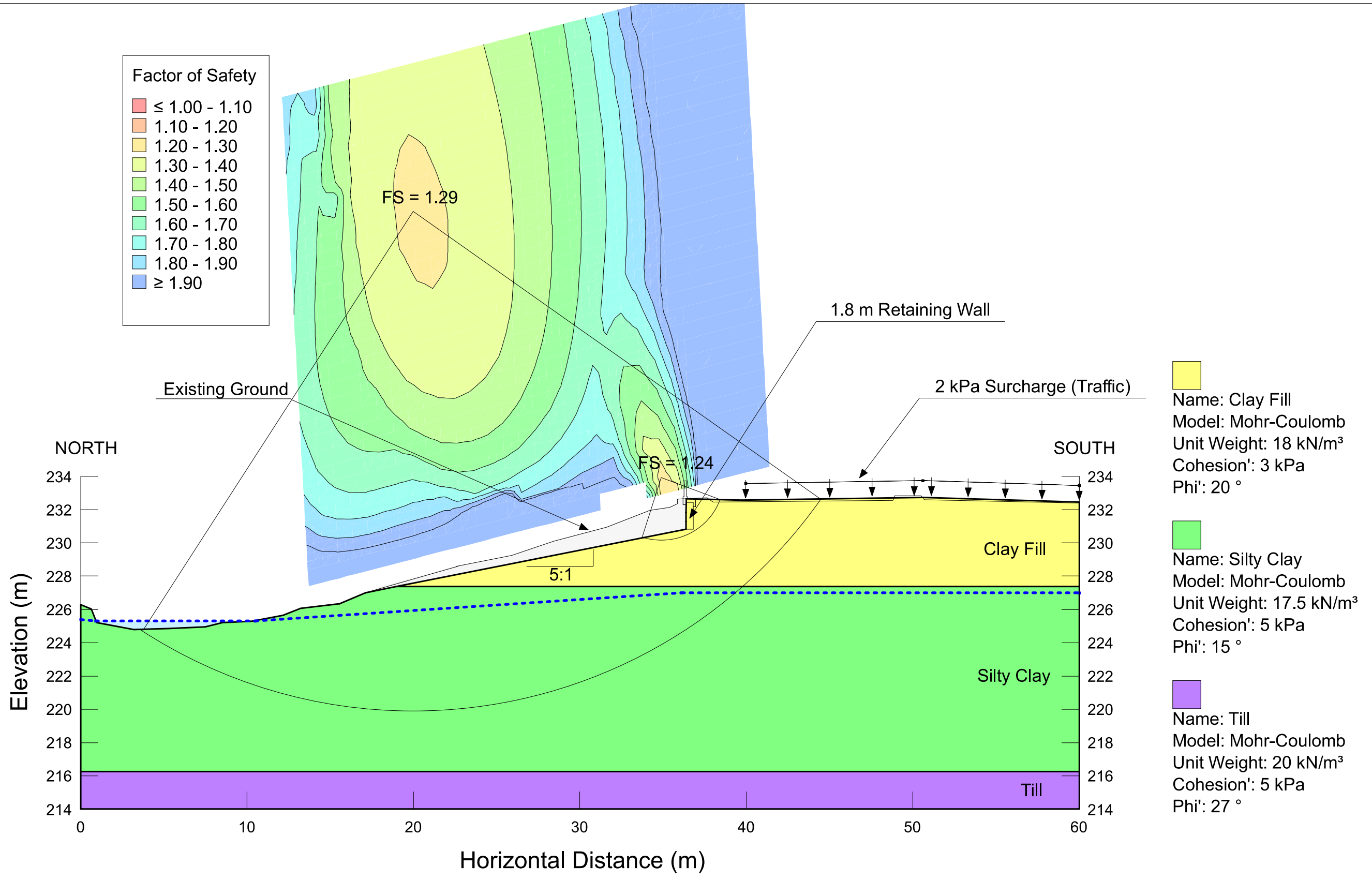
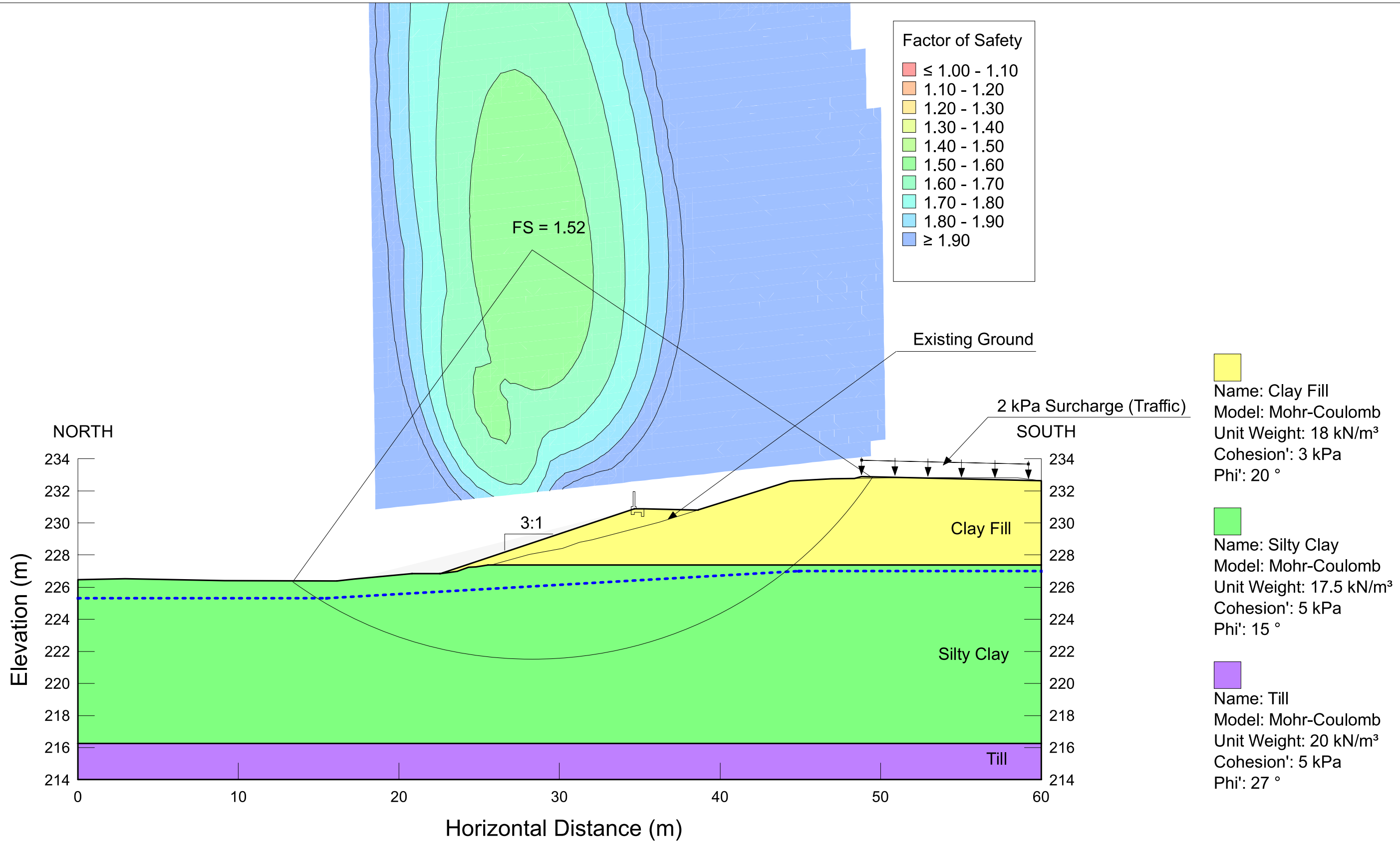
FILE NAME: 6990 - S003.gsz



SCALE: 1:235 (279mm x 432mm)

Figure 13
Sta. 6+990
Modified Geometry



SCALE: 1:235 (279mm x 432mm)

Figure 14
Sta. 6+900
Modified Geometry

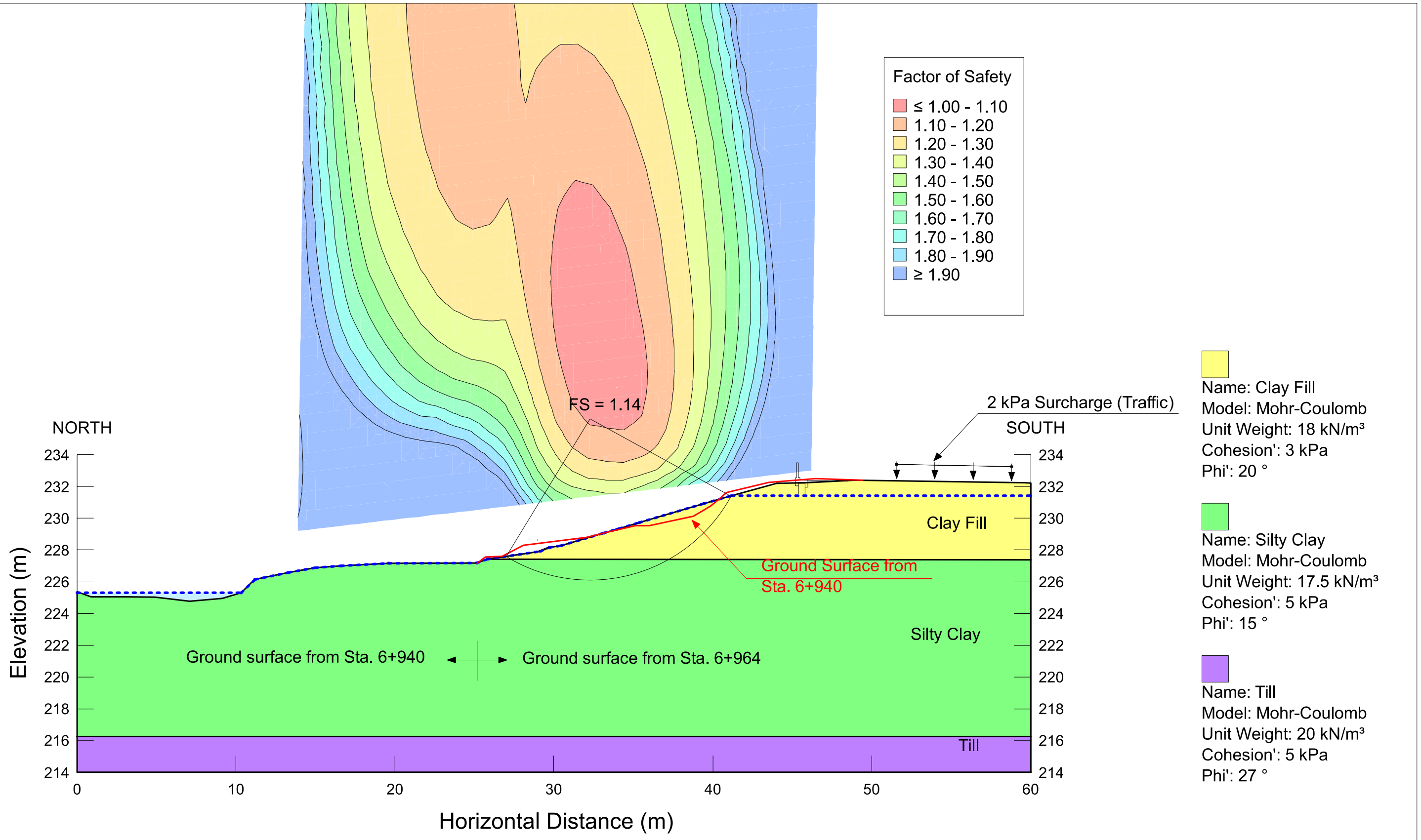
TREK GEOTECHNICAL

0022 033 00
Dillon Consulting Ltd.
Fermor Avenue over Seine River Bridge

Tabloid (279mm x 432mm)

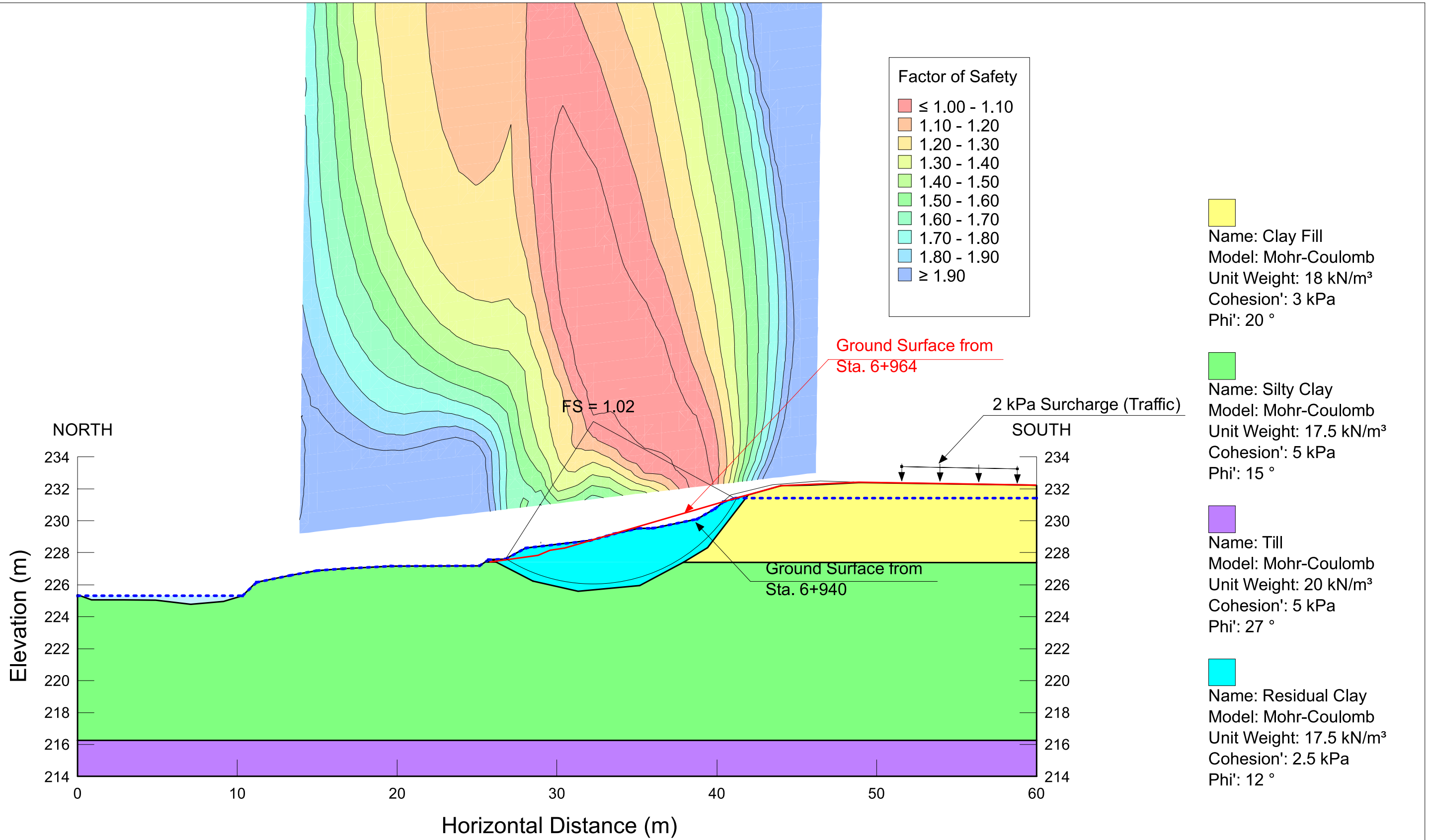
SAVED: 28/07/2017 3:55:22 PM

FILE NAME: 6964 - S006.gsz



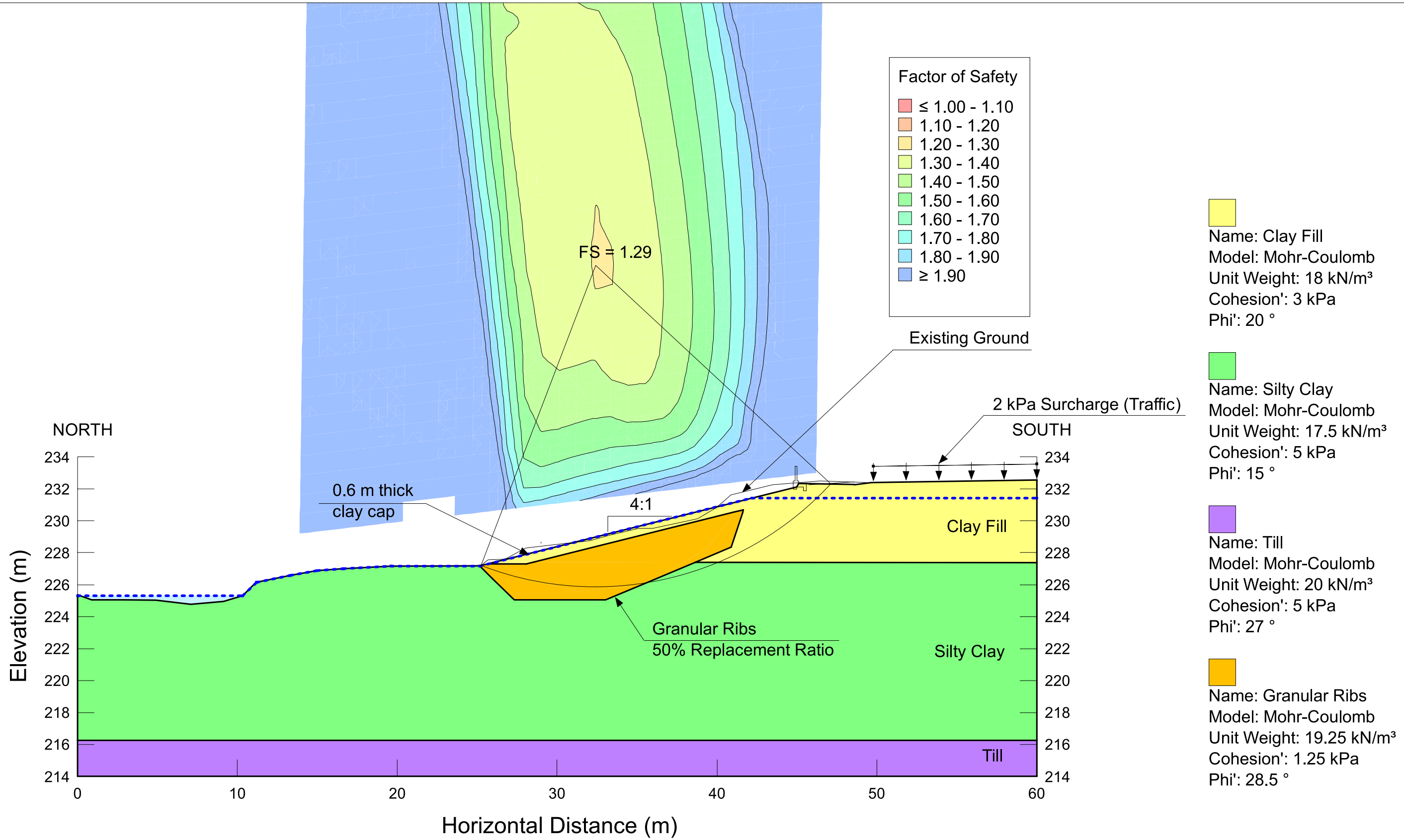
SCALE: 1:235 (279mm x 432mm)

Figure 15
Hybrid Cross-Section
Pre-Failure Back-Analysis



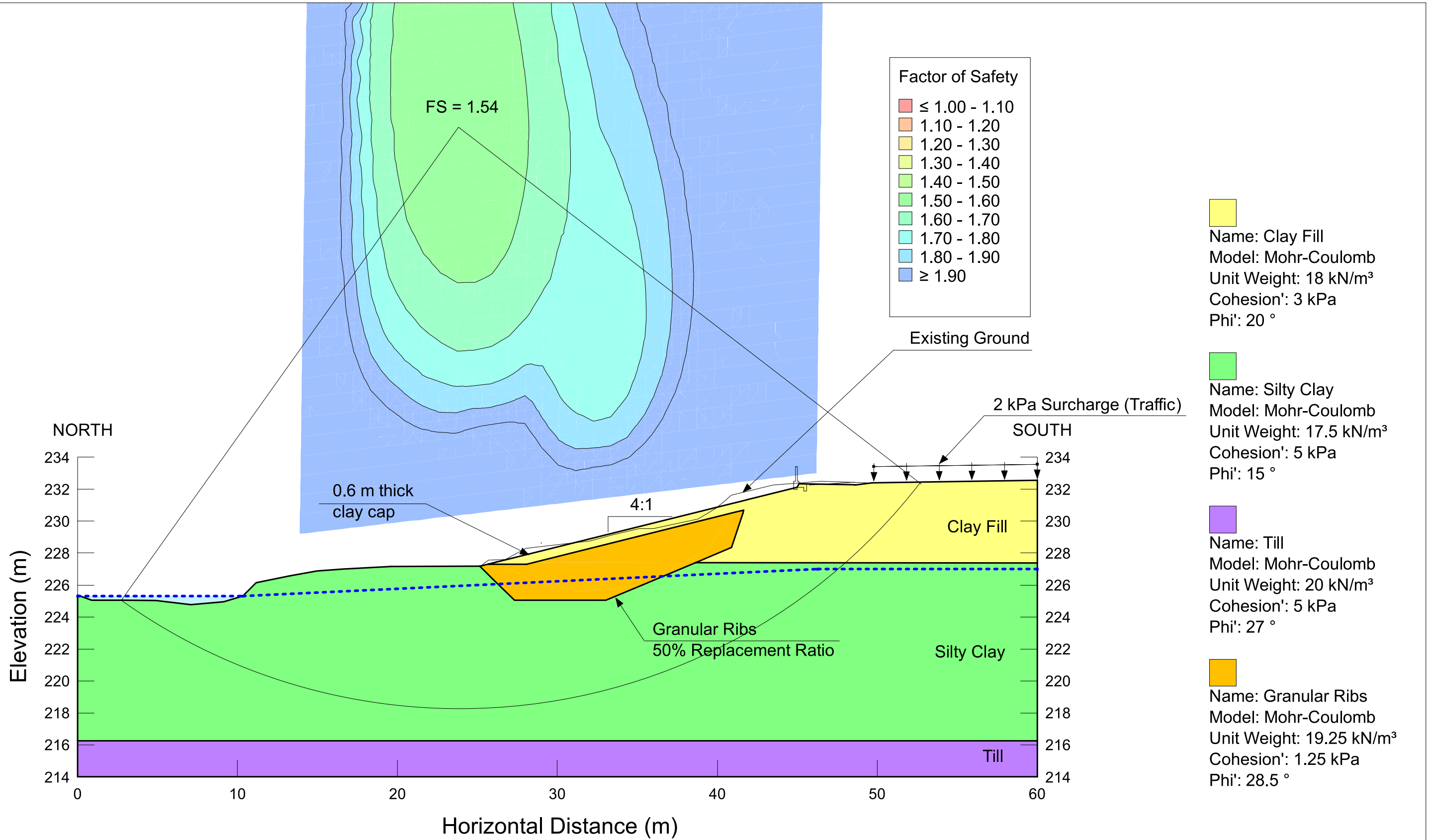
SCALE: 1:235 (279mm x 432mm)

Figure 16
Hybrid Cross-Section
Residual Parameter Back-Analysis



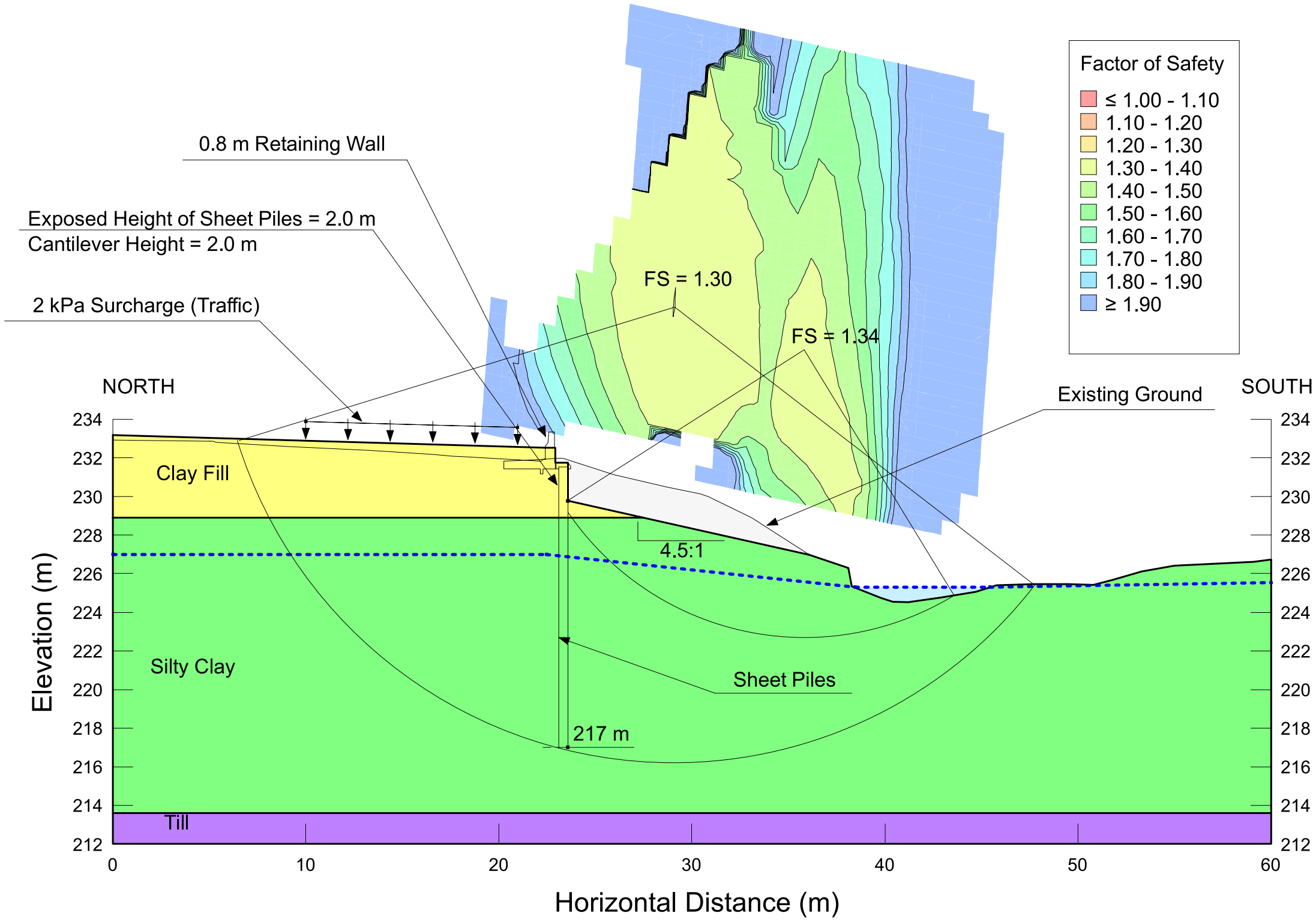
SCALE: 1:235 (279mm x 432mm)

Figure 17
Sta. 6+940
Slope Repair - Shallow Failure



SCALE: 1:235 (279mm x 432mm)

Figure 18
Sta. 6+940
Slope Repair - Normal GWL



Factor of Safety
- ≤ 1.00 - 1.10
- 1.10 - 1.20
- 1.20 - 1.30
- 1.30 - 1.40
- 1.40 - 1.50
- 1.50 - 1.60
- 1.60 - 1.70
- 1.70 - 1.80
- 1.80 - 1.90
- ≥ 1.90

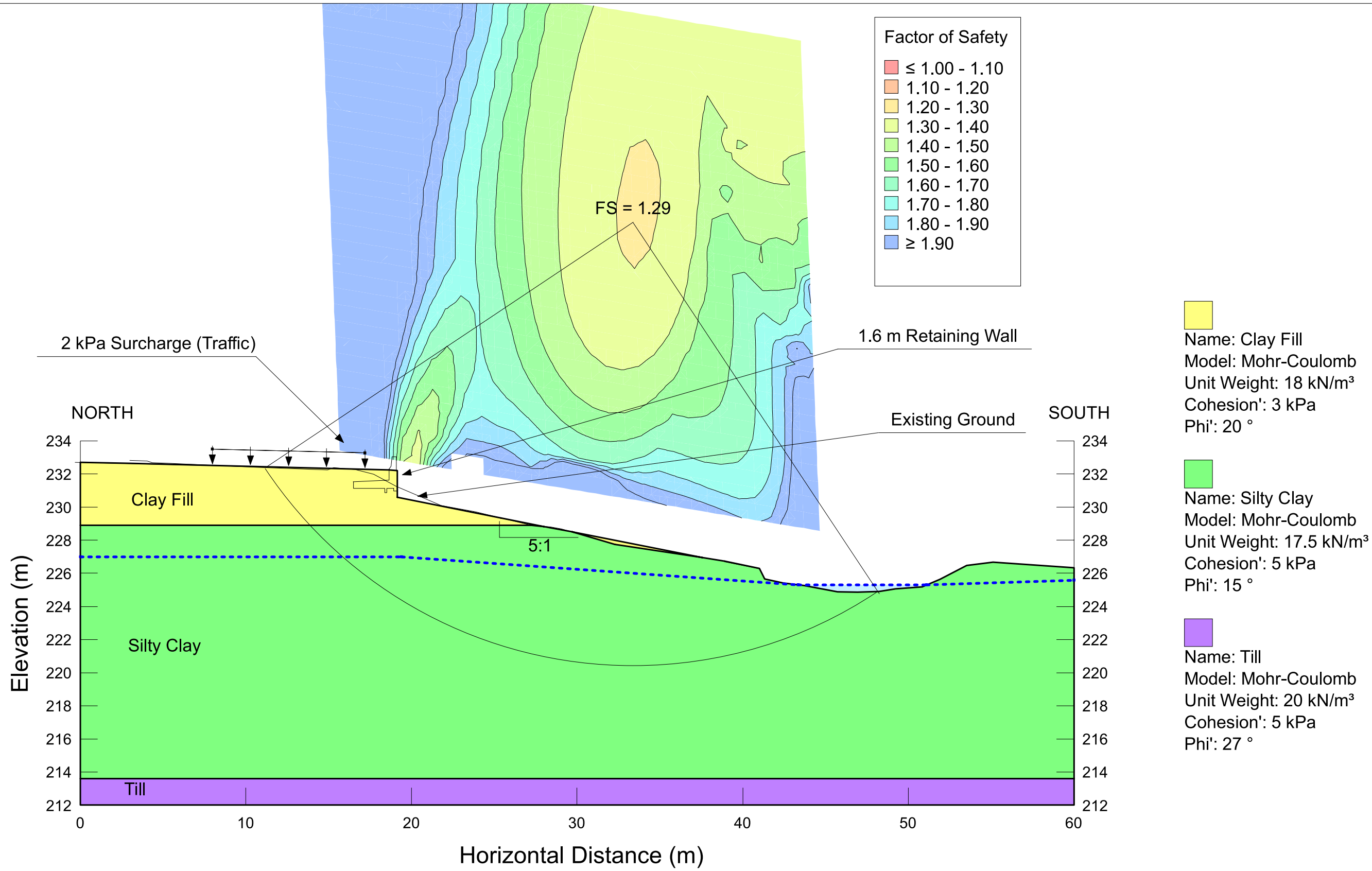
Name: Clay Fill
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion': 3 kPa
Phi': 20 °

Name: Silty Clay
Model: Mohr-Coulomb
Unit Weight: 17.5 kN/m³
Cohesion': 5 kPa
Phi': 15 °

Name: Till
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion': 5 kPa
Phi': 27 °

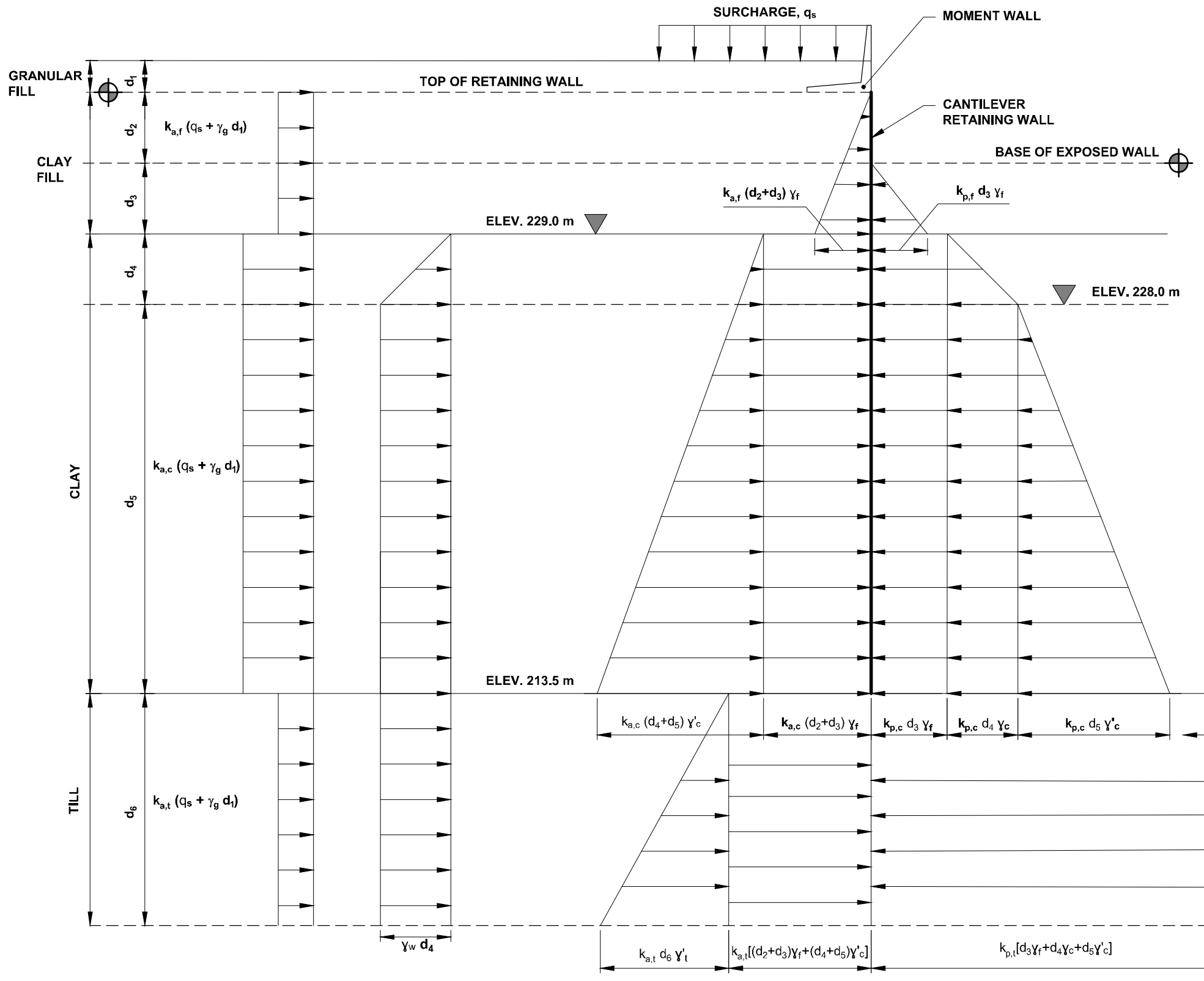
SCALE: 1:235 (279mm x 432mm)

Figure 19
Sta. 4+850
Modified Geometry



SCALE: 1:235 (279mm x 432mm)

Figure 20
Sta. 4+910
Modified Geometry



NOTES:

1. **WALL DRAINAGE TO BE PROVIDED TO BASE OF EXPOSED WALL**
2. γ'_c = 7.7 kN/m³
   γ'_t = 10.2 kN/m³
   γ_c = 17.5 kN/m³
   γ_f = 18.0 kN/m³
   γ_g = 21.0 kN/m³
   γ_w = 9.81 kN/m³
   $k_{a,f}$ = 0.5
   $k_{a,c}$ = 0.6
   $k_{a,t}$ = 0.4
   $k_{p,f}$ = 2.0
   $k_{p,c}$ = 1.7
   $k_{p,t}$ = 2.7
   q_s = SURCHARGE SELECTED BY WALL DESIGNER
3. **SHEET PILE EMBEDMENT IN TILL SHOULD BE EVALUATED FOR PILE DRIVEABILITY**

Figure 21
Lateral Earth Pressure Distribution Figure

APPENDIX ‘B’

GEOTECHNICAL SUB-SURFACE INVESTIGATION

Quality Engineering | Valued Relationships

Dillon Consulting Ltd.

Fermor Avenue Over Seine River – St. Anne's Road to Archibald Street – Sub Surface Investigation

Prepared for:

Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, MB R3T 0Y4
Attention: Mike Lau

Distribution:

Mike Lau, Ph.D., P.Eng.

Project Number:
0022-033-00

Date:
July 11, 2016
Final Report

www.trekgeotechnical.ca
1712 St. James Street | Winnipeg, Manitoba R3H 0L3 | Tel 1.204.975.9433 | Fax 1.204.975.9435

TREK GEOTECHNICAL Quality Engineering | Valued Relationships

July 11, 2016 Our File No. 0022-033-00

Mike Lau, Ph.D., P.Eng.
Dillon Consulting Ltd.
1558 Willson Place
Winnipeg, MB R3T 0Y4

RE: Sub-Surface Investigation Report for Fermor Avenue Over Seine River – St. Anne's Road to Archibald Street (REVISED)

TREK Geotechnical Inc. is pleased to submit our report for the sub-surface investigations for Fermor Avenue Rehabilitation and Roadworks – St. Anne's Road to Archibald Street.

Please contact the undersigned if you have any questions. Thank you for the opportunity to serve you on this assignment.

Sincerely,

TREK Geotechnical Inc.
Per:

Nelson John Ferreira, M. Sc., P. Eng.
Geotechnical Engineer, Principal
Tel: 204.975.9433 ext. 103

cc:

Revision History

Revision No.	Author	Issue Date	Description
0	JN	June 17, 2016	Final Report
1	PB	July 11, 2016	Revised Final Report

Authorization Signatures

Prepared By:

Paul Bevel, B.Sc., Lab and Field Services Manager

Reviewed By:

PROVINCE OF N.S. N.J. FERREIRA Member 2492 REGISTERED PROFESSIONAL ENGINEER

July 11, 2016

Nelson John Ferreira, M. Sc., P.Eng.
Geotechnical Engineer

APEGN Certificate of Authorization
Trek Geotechnical Inc.
No. 4877 Date: July 11, 2016

Table of Contents

List of Figures

List of Appendices

List of Tables

1.0 Introduction

This report summarizes the results of the sub-surface investigation completed for the Fermor Ave. Rehabilitation and Roadworks. Information regarding the asphalt, concrete, road base for the existing road and the soil stratigraphy beneath the pavement structure is provided.

2.0 Sub-Surface Investigation and Laboratory Program

A total of 14 test holes were drilled on Fermor Avenue from St. Anne's Road to Archibald Street at the locations shown on Figure 01. The test holes were drilled in order to determine sub-surface conditions for design and reconstruction of the road segment.

The sub-surface investigation was conducted on May 20, 2016. The test holes were drilled to depths ranging from 2.3 m to 3.1 m below the road surface by Maple Leaf Drilling Ltd. using their CME-75 truck mounted drill rig equipped with 125 mm diameter solid stem augers. The pavement structure (asphalt or concrete) was cored by Paul Bevel, B.Sc. of TREK Geotechnical Inc. (TREK) using a portable coring press equipped with a hollow 150 mm diameter diamond core drill bit. The sub-surface conditions were observed during drilling and visually classified by Jodi Neumann, of TREK. Other pertinent information such as groundwater and drilling conditions were also recorded during the drilling investigation. Disturbed (auger cuttings) and relatively undisturbed (Shelby tube) samples retrieved during the sub-surface investigation were transported to TREK's material testing laboratory for further testing. Pavement core samples were also retrieved and logged at TREK's material testing laboratory.

The laboratory testing program consisted of moisture content determination, Atterberg limits, grain size analysis (mechanical sieve and hydrometer methods), and bulk unit weight measurements and unconfined compressive strength testing on Shelby tube samples. The results of the laboratory testing are included on the test hole logs in Appendix A. The laboratory testing results are also summarized and reported separately in Appendix B. Photos of the concrete and asphalt cores are included in Appendix C. Test hole locations noted on the test hole logs and shown on Figure 01 were determined using a handheld GPS.

Undrained shear strength results from unconfined compressive strength testing are summarized in Table 1.0. The undrained shear strength values have been used to estimate a corresponding CBR value based on published relationships.

Table 1.0 Estimated CBR Values from Undrained Shear Strength

Test Hole ID	Sample No.	Location	Soil Type	Depth (m) Below Top of Pavement	Undrained Shear Strength (kPa)	Estimated CBR (%)
TH16-01	T99	U14 5524304m N, 636321m E	SILT	1.9 – 2.0	38.7	1.7
TH16-04	T15	U14 5524460m N, 636522m E	CLAY	1.9 – 2.10	29.3	1.3
TH16-05	T86	U14 5524520m N, 636601m E	ORGANIC CLAY & SILT	1.5 – 1.8	15.7	0.7
TH16-08	T29	U14 5524571m N, 636891m E	CLAY & SILT	1.7 – 1.8	10.3	0.4
TH16-09	T72	U14 5524586m N, 636985m E	CLAY	1.8 – 1.9	26.8	1.2
TH16-12	T44	U14 5524498m N, 637269m E	CLAY	1.8 – 1.9	19.9	0.9
TH16-13	T58	U14 5524468m N, 637364m E	CLAY & SILT	1.8 – 2.0	32.1	1.4

3.0 Closure

The information provided in this report is in accordance with current engineering principles and practices (Standard of Practice). The findings of this report were based on information provided (field investigation, laboratory testing, geometries). Soil conditions are natural deposits that can be highly variable across a site. If sub-surface conditions are different than the conditions previously encountered on-site or those presented here, we should be notified to adjust our findings if necessary.

All information provided in this report is subject to our standard terms and conditions for engineering services, a copy of which is provided to each of our clients with the original scope of work, or a mutually executed standard engineering services agreement. If these conditions are not attached, and you are not already in possession of such terms and conditions, contact our office and you will be promptly provided with a copy.

This report has been prepared by TREK Geotechnical Inc. (the Consultant) for the exclusive use of Dillon Consulting (the Client) and their agents for the work product presented in the report. Any findings or recommendations provided in this report are not to be used or relied upon by any third parties, except as agreed to in writing by the Client and Consultant prior to use.

Figures

KEY PLAN
SCALE: N.T.S.

0 50 100 150 m
SCALE = 1 : 3 000 (279 mm x 432 mm)

LEGEND: TEST HOLE (TREK, MAY 20, 2016)

NOTES:
1. AERIAL IMAGE FROM GOOGLE EARTH AUGUST 24, 2015

FIGURE 01
Test Hole Location Plan

Appendix A

Test Hole Logs

EXPLANATION OF FIELD AND LABORATORY TESTING

GENERAL NOTES

1. Classifications are based on the United Soil Classification System and include consistency, moisture, and color. Field descriptions have been modified to reflect results of laboratory tests where deemed appropriate.
2. Descriptions on these test hole logs apply only at the specific test hole locations and at the time the test holes were drilled. Variability of soil and groundwater conditions may exist between test hole locations.
3. When the following classification terms are used in this report or test hole logs, the primary and secondary soil fractions may be visually estimated.

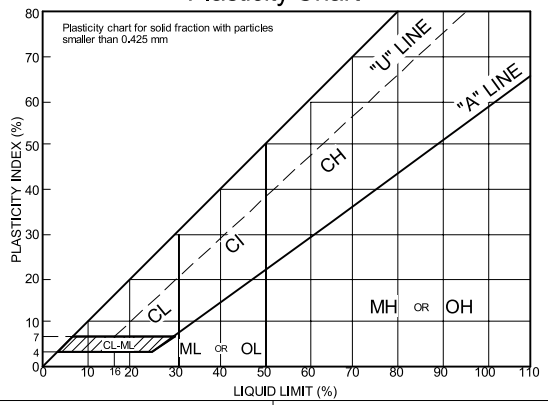
Major Divisions			USCS Classification	Symbols	Typical Names
Coarse-Grained soils (More than half the material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than 4.75 mm)	Clean gravel (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines
			GP		Poorly-graded gravels, gravel-sand mixtures, little or no fines
		Gravel with fines (Appreciable amount of fines)	GM		Silty gravels, gravel-sand-silt mixtures
			GC		Clayey gravels, gravel-sand-silt mixtures
	Sands (More than half of coarse fraction is smaller than 4.75 mm)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines
			SP		Poorly-graded sands, gravelly sands, little or no fines
		Sands with fines (Appreciable amount of fines)	SM		Silty sands, sand-silt mixtures
			SC		Clayey sands, sand-clay mixtures
Fine-Grained soils (More than half the material is smaller than No. 200 sieve size)	Silts and Clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock floor, silty or clayey fine sands or clayey silts with slight plasticity
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL		Organic silts and organic silty clays of low plasticity
	Silts and Clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or distomaceous fine sandy or silty soils, organic silts
			CH		Inorganic clays of high plasticity, fat clays
			OH		Organic clays of medium to high plasticity, organic silts
	Highly Organic Soils		Pt		Peat and other highly organic soils

Laboratory Classification Criteria

Determine percentages of sand and gravel from grain size curve, depending on percentage of fines (fraction smaller than No. 200 sieve) coarse-grained soils are classified as follows:
Less than 5 percent..... GW, GP, SW, SP
More than 12 percent..... GM, GC, SM, SC
6 to 12 percent..... Borderline case4s requiring dual symbols*

$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
Not meeting all gradation requirements for GW	
Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
Atterberg limits above "A" line or P.I. greater than 7	
$C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
Not meeting all gradation requirements for SW	
Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
Atterberg limits above "A" line or P.I. greater than 7	

Plasticity Chart



Von Post Classification Limit	Strong colour or odour, and often fibrous texture

Particle Size			Material
ASTM Sieve sizes	mm		
	> 300		Boulders
> 12 in.	75 to 300		Cobbles
3 in. to 12 in.	19 to 75		Gravel
3/4 in. to 3 in.	4.75 to 19		Coarse
#4 to 3/4 in.	2.00 to 4.75		Fine
#10 to #4	0.425 to 2.00		Sand
#40 to #10	0.075 to 0.425		Coarse
#200 to #40	< 0.075		Medium
< #200			Fine
			Silt or Clay

* Borderline classifications used for soils possessing characteristics of two groups are designated by combinations of groups symbols. For example; GW-GC, well-graded gravel-sand mixture with clay binder.

Other Symbol Types

	Asphalt		Bedrock (undifferentiated)		Cobbles
	Concrete		Limestone Bedrock		Boulders and Cobbles
	Fill		Cemented Shale		Silt Till
			Non-Cemented Shale		Clay Till

TREK GEOTECHNICAL

EXPLANATION OF FIELD AND LABORATORY TESTING

LEGEND OF ABBREVIATIONS AND SYMBOLS

LL - Liquid Limit (%)
PL - Plastic Limit (%)
PI - Plasticity Index (%)
MC - Moisture Content (%)
SPT - Standard Penetration Test
RQD - Rock Quality Designation
Qu - Unconfined Compression
Su - Undrained Shear Strength
VW - Vibrating Wire Piezometer
SI - Slope Inclinometer

▽ Water Level at Time of Drilling

▼ Water Level at End of Drilling

▼ Water Level After Drilling as Indicated on Test Hole Logs

FRACTION OF SECONDARY SOIL CONSTITUENTS ARE BASED ON THE FOLLOWING TERMINOLOGY

TERM	EXAMPLES	PERCENTAGE
and	and CLAY	35 to 50 percent
"y" or "ey"	clayey, silty	20 to 35 percent
some	some silt	10 to 20 percent
trace	trace gravel	1 to 10 percent

TERMS DESCRIBING CONSISTENCY OR COMPACTION CONDITION

The Standard Penetration Test blow count (N) of a non-cohesive soil can be related to compactness condition as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very loose	< 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	> 50

The Standard Penetration Test blow count (N) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	SPT (N) (Blows/300 mm)
Very soft	< 2
Soft	2 to 4
Firm	4 to 8
Stiff	8 to 15
Very stiff	15 to 30
Hard	> 30

The undrained shear strength (Su) of a cohesive soil can be related to its consistency as follows:

Descriptive Terms	Undrained Shear Strength (kPa)
Very soft	< 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to 100
Very stiff	100 to 200
Hard	> 200

Sub-Surface Log

Test Hole TH16-01
1 of 1

Client:	Dillon Consulting Ltd.	**Project Number:**	0022-033-00
Project Name:	Fermor Over Seine River	**Location:**	Fermor Ave. Between Archibald St. and St. Anne's Rd.
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Street Level
Method:	125 mm Solid Stem Auger, CME-75 Truck Mount	**Date Drilled:**	20 May 2016

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
		ASPHALT - (55mm thick)		
		CONCRETE - (215mm thick)		
		SAND AND GRAVEL (FILL) - <25mm dia. gravel, trace silt - brown, moist, compact, well graded rounded to sub angular		G95
0.5		SAND (FILL) - some clay, some silt, trace gravel (<25mm dia.) - brown - moist, firm to stiff - low plasticity		G96
1.0		- wet below 0.9m		G97
		CLAY - silty, trace silt inclusions (<10mm dia.), trace sand, trace oxidaton - brown - moist, stiff to very stiff - high plasticity		G98
1.5		SILT - some clay, trace sand - brown - moist, frim to stiff - intermediate plasticity		T99
2.0				

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21
Particle Size (%): 0 20 40 60 80 100
PL MC LL: 0 20 40 60 80 100
Undrained Shear Strength (kPa): 0 50 100 150 200 250
Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

End of Hole at 2.3m in CLAY

Notes:
1) No sloughing.
2) Seepage below 0.9m from top of pavement.
3) Test hole backfilled with auger cuttings, gravel, and cold patch asphalt.
4) Test hole open to 1.5m at completion of drilling.
5) Water level measured at 1.5m at completion of drilling
6) Test hole located in left turning lane at the intersection of Fermor Ave. and St. Anne's Rd. (U14 5524304m N, 636321m E).

Logged By: Jodi Neumann **Reviewed By:** Nelson Ferreira **Project Engineer:** Michael Van Helden

SUB-SURFACE LOG LOGS 2016-05-25 FERMOR OVER SEINE LOGS 0_A_JN 0022-033-00.GPJ TREK GEOTECHNICAL.GDT 11/7/16

Sub-Surface Log

Test Hole TH16-02

Client:	Dillon Consulting Ltd.	**Project Number:**	0022-033-00
Project Name:	Fermor Over Seine River	**Location:**	Fermor Ave. Between Archibald St. and St. Anne's Rd.
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Street Level
Method:	125 mm Solid Stem Auger, CME-75 Truck Mount	**Date Drilled:**	20 May 2016

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
		ASPHALT - (25mm thick)		
		CONCRETE - (210mm thick)		
0.5		SAND AND GRAVEL (FILL) - <25mm dia. gravel, trace silt - brown - moist, compact - well graded rounded to sub angular		G01
		SAND (FILL) - some clay, some silt, trace gravel (<25mm dia.) - brown - moist, firm to stiff - low plasticity		G02
1.0		CLAY - silty, trace silt inclusions (<10mm dia.) - brown - moist, very stiff - high plasticity		G03
1.5		CLAY AND SILT - trace sand, trace gravel (<20mm dia.) - grey - moist, firm - intermediate plasticity		G05 G06
2.0		CLAY - silty, trace silt inclusions (<10mm dia.) - brown - moist, very stiff - high plasticity		G07
		- stiff below 2.1m		G08
2.5		- firm to stiff below 2.6m		G09
3.0		End of Hole at 3.0m in CLAY		

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

Notes:
1) No seepage.
2) Sloughing between 1.4m to 1.8m below top of pavement.
3) Test hole backfilled with auger cuttings, gravel, and cold patch asphalt.
4) Test hole open to 1.5m at completion of drilling.
5) Test hole located in the east bound median lane, between St. Anne's Rd. and Archibald St. (U14 5524333m N, 636377m E).

Logged By: Jodi Neumann **Reviewed By:** Nelson Ferreira **Project Engineer:** Michael Van Helden

SUB-SURFACE LOG LOGS 2016-05-25 FERMOR OVER SEINE LOGS 0_A_JN 0022-033-00.GPJ TREK GEOTECHNICAL.GDT 11/7/16

Sub-Surface Log

Test Hole TH16-03

Client:	Dillon Consulting Ltd.	**Project Number:**	0022-033-00
Project Name:	Fermor Over Seine River	**Location:**	Fermor Ave. Between Archibald St. and St. Anne's Rd.
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Street Level
Method:	125 mm Solid Stem Auger, CME-75 Truck Mount	**Date Drilled:**	20 May 2016

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) 0 50 100 150 200 250 — Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○
		ASPHALT - (96mm thick)				
		CONCRETE - (193mm thick)				
0.5		SAND AND GRAVEL (FILL) - <25mm dia. gravel, trace silt - brown - moist, compact - well graded rounded to sub angular		G87	●	
		SAND (FILL) - some clay, some silt, trace gravel (<25mm dia.) - brown - moist, firm to stiff - low plasticity		G88	●	
1.0				G89	●	△ ✤
				G90	●	△ ✤
1.5				G91	●	△ ✤
		SILT - trace clay, trace sand, trace oxidation - brown - moist, soft - no to low plasticity		G92	●	
2.0				G93	●	
2.5		CLAY - silty, trace silt inclusions (<5mm dia.) - brown - moist, stiff to very stiff - high plasticity		G94	●	✤ △
3.0		End of Hole at 3.0m in CLAY				

Notes:
1) No seepage.
2) Squeezing below 0.6m from top of pavement.
3) Sloughing below 1.1m from top of pavement.
4) Test hole backfilled with auger cuttings, gravel, and cold patch asphalt.
5) Test hole open to 1.1m at completion of drilling.
6) Test hole located in the west bound curb lane, between St. Anne's Rd. and Archibald St. (U14 5524415m N, 636434m E).

Logged By: Jodi Neumann **Reviewed By:** Nelson Ferreira **Project Engineer:** Michael Van Helden

Sub-Surface Log

Test Hole TH16-04

Client:	Dillon Consulting Ltd.	**Project Number:**	0022-033-00
Project Name:	Fermor Over Seine River	**Location:**	Fermor Ave. Between Archibald St. and St. Anne's Rd.
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Street Level
Method:	125 mm Solid Stem Auger, CME-75 Truck Mount	**Date Drilled:**	20 May 2016

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type: △ Torvane △ ✿ Pocket Pen. ✿ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
		ASPHALT - (91mm thick)				
		CONCRETE - (214mm thick)				
		SAND AND GRAVEL (FILL) - <25mm dia. gravel, trace silt - brown, moist, compact, well graded rounded to sub angular		G10	●	
0.5		SAND (FILL) - some clay, some silt, trace gravel (<25mm dia.) - brown, moist, stiff, low plasticity		G11	●	✿
		ORGANIC CLAY AND SILT - trace sand, trace gravel (<10mm dia), trace rootlets - black, moist, very stiff, high plasticity		G12	●	△ ✿
1.0		- no gravel below 9.1m - stiff to very stiff below 1.1m		G13	●	△ ✿
1.5		CLAY - silty, trace sand, trace rootlets - grey - moist, stiff to very stiff - high plasticity - firm to stiff below 1.5m		G14	●	△ ✿
2.0				T15	● □	☒ ✿ △

End of Hole at 2.3m in CLAY

Notes:
1) No sloughing or seepage.
2) Test hole backfilled with auger cuttings, gravel, and cold patch asphalt.
3) Test hole open to 2.3m at completion of drilling.
4) Test hole located in the east bound curb lane, between St. Anne's Rd. and Archibald St. (U14 5524460m N, 636522m E).

Logged By: Jodi Neumann **Reviewed By:** Nelson Ferreira **Project Engineer:** Michael Van Helden

Sub-Surface Log

Test Hole TH16-05

Client:	Dillon Consulting Ltd.	**Project Number:**	0022-033-00
Project Name:	Fermor Over Seine River	**Location:**	Fermor Ave. Between Archibald St. and St. Anne's Rd.
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Street Level
Method:	125 mm Solid Stem Auger, CME-75 Truck Mount	**Date Drilled:**	20 May 2016

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type △ Torvane △ ✿ Pocket Pen. ✿ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
		ASPHALT - (75mm thick)				
		CONCRETE - (230mm thick)				
		SAND AND GRAVEL (FILL) - <25mm dia. gravel, trace silt - brown, moist, compact, well graded rounded to sub angular		G81	●	
0.5		CLAY - silty, trace sand - brown - moist, very stiff - low plasticity		G82	●	△ ✿
				G83	●	△ ✿
		- some silt inclusions (<30mm dia.), trace rootlets, mottled black and brown below 0.8m				
1.0				G84	●	✿
		ORGANIC CLAY AND SILT - trace rootlets, trace oxidation - black - moist, very stiff - high plasticity		G85	●	△ ✿
1.5		- trace silt inclusions, stiff below 1.5m				
				T86	□ ●	☒ △ ✿
2.0						

End of Hole at 2.3m in CLAY

Notes:
1) No sloughing or seepage.
2) Test hole backfilled with auger cuttings, gravel, and cold patch asphalt.
3) Test hole open to 2.3m at completion of drilling.
4) Test hole located in the west bound median lane, between St. Anne's Rd. and Archibald St. (U14 5524520m N, 636601m E).

Logged By: Jodi Neumann **Reviewed By:** Nelson Ferreira **Project Engineer:** Michael Van Helden

Sub-Surface Log

Test Hole TH16-06
1 of 1

Client:	Dillon Consulting Ltd.	**Project Number:**	0022-033-00
Project Name:	Fermor Over Seine River	**Location:**	Fermor Ave. Between Archibald St. and St. Anne's Rd.
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Street Level
Method:	125 mm Solid Stem Auger, CME-75 Truck Mount	**Date Drilled:**	20 May 2016

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
		ASPHALT - (126mm thick)				
		CONCRETE - (214mm thick)				
		SAND AND GRAVEL (FILL) - <25mm dia. gravel, trace silt - brown, moist, compact, well graded rounded to sub angular		G16	●	
0.5		ORGANIC CLAY AND SILT (FILL) - trace rootlets - black - moist, stiff to very stiff - high plasticity		G17	●	△ ✤
				G18	●	✤
		- mottled grey and black below 0.5m		G19	●	
		CLAY AND SILT (FILL) - trace sand - grey - moist, stiff - intermediate plasticity		G20	●	△ ✤
1.0						
		CLAY - silty, trace oxidation - dark grey - moist, stiff to very stiff - high plasticity		G21	●	✤
1.5		- mottled grey and black below 1.5m		G22	●	△ ✤
		ORGANIC CLAY AND SILT - trace rootlets - black - moist, very stiff - high plasticity		G23	●	△ ✤
2.0				G24	●	△ ✤
2.5		CLAY AND SILT - trace sand - grey - moist, firm - intermediate plasticity		G25	●	
3.0		CLAY - silty, grey, moist, very stiff, high plasticity, no sample recovery				

End of Hole at 3.0m in CLAY

Notes:
1) No seepage.
2) Sloughing below 2.4m from top of pavement.
3) Test hole backfilled with auger cuttings, gravel, and cold patch asphalt.
4) Test hole open to 2.4m at completion of drilling.
5) Test hole located in the east bound median lane, between St. Anne's Rd. and Archibald St. (U14 5524547m N, 636699m E).

Logged By: Jodi Neumann **Reviewed By:** Nelson Ferreira **Project Engineer:** Michael Van Helden

SUB-SURFACE LOG LOGS 2016-05-25 FERMOR OVER SEINE LOGS 0_A_JN 0022-033-00.GPJ TREK GEOTECHNICAL.GDT 11/7/16

Sub-Surface Log

Test Hole TH16-07

Client:	Dillon Consulting Ltd.	**Project Number:**	0022-033-00
Project Name:	Fermor Over Seine River	**Location:**	Fermor Ave. Between Archibald St. and St. Anne's Rd.
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Street Level
Method:	125 mm Solid Stem Auger, CME-75 Truck Mount	**Date Drilled:**	20 May 2016

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL	Undrained Shear Strength (kPa) 0 50 100 150 200 250 / Test Type: △ Torvane △, ✿ Pocket Pen. ✿, ☒ Qu ☒, ○ Field Vane ○
		ASPHALT - (81mm thick)				
		CONCRETE - (204mm thick)				
		GRAVEL (FILL) - <25mm dia. gravel, sandy, trace silt - brown, moist, compact, well graded rounded to sub angular		G73	●	
0.5		CLAY (FILL) - silty, trace sand - mottled black and brown - moist, very stiff - high plasticity		G74	●	△ ✿
1.0		- trace rootlets below 0.9m		G75	●	△ ✿
		- trace gravel (<10mm dia.) beolw 1.2m		G76	●	✿
1.5				G77	●	✿ △
		- trace silt inclusions (<25mm dia.), no gravel below 1.8m		G78	●	✿
2.0		ORGANIC CLAY AND SILT - trace rootlets - black - moist, very stiff - high plasticity		G79	●	✿ △
2.5				G80	●	△ ✿
3.0		End of Hole at 3.0m in CLAY				

Notes:
1) No seepage.
2) Sloughing below 1.8m from top of pavement.
3) Test hole backfilled with auger cuttings, gravel, and cold patch asphalt.
4) Test hole open to 1.8m at completion of drilling.
5) Test hole located in the west bound curb lane, between St. Anne's Rd. and Archibald St. (U14 5524581m N, 636793m E).

Logged By: Jodi Neumann **Reviewed By:** Nelson Ferreira **Project Engineer:** Michael Van Helden

Sub-Surface Log

Test Hole TH16-08

Client:	Dillon Consulting Ltd.	**Project Number:**	0022-033-00
Project Name:	Fermor Over Seine River	**Location:**	Fermor Ave. Between Archibald St. and St. Anne's Rd.
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Street Level
Method:	125 mm Solid Stem Auger, CME-75 Truck Mount	**Date Drilled:**	20 May 2016

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
		CONCRETE - (260mm thick)		
		SAND AND GRAVEL (FILL) - <25mm dia. gravel, trace silt - brown, moist, compact, well graded rounded to sub angular		G25A
0.5		SAND (FILL) - some clay, some silt, trace gravel (<25mm dia.) - brown, moist, stiff, low plasticity		G26
		CLAY (FILL) - silty, trace silt inclusions (<10mm dia.), trace sand - brown - moist, stiff - high plasticity		G27
1.0				G28
1.5		CLAY AND SILT - trace sand - mottled grey and brown - moist, soft to firm - intermediate plasticity		T29
2.0				

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa)

Test Type: △ Torvane △ ✿ Pocket Pen. ✿ ☒ Qu ☒ ○ Field Vane ○

0 50 100 150 200 250

End of Hole at 2.3m in CLAY

Notes:
1) No sloughing or seepage.
2) Test hole backfilled with auger cuttings, gravel, and cold patch asphalt.
3) Test hole open to 2.3m at completion of drilling.
4) Test hole located in the east bound curb lane, between St. Anne's Rd. and Archibald St. (U14 5524571m N, 636891m E).

Logged By: Jodi Neumann **Reviewed By:** Nelson Ferreira **Project Engineer:** Michael Van Helden

Sub-Surface Log

Test Hole TH16-09

Client:	Dillon Consulting Ltd.	**Project Number:**	0022-033-00
Project Name:	Fermor Over Seine River	**Location:**	Fermor Ave. Between Archibald St. and St. Anne's Rd.
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Street Level
Method:	125 mm Solid Stem Auger, CME-75 Truck Mount	**Date Drilled:**	20 May 2016

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
		CONCRETE - (241mm thick)		
		SAND AND GRAVEL (FILL) - <25mm dia. gravel, trace silt - brown, moist, compact, well graded rounded to sub angular		G68
0.5		CLAY (FILL) - silty, trace rootlets - mottled brown and black - moist, stiff - high plasticity		G69
1.0				G70
		- firm below 1.1m - very stiff below 1.2m		G71
1.5		ORGANIC CLAY AND SILT - trace rootlets - black - moist, firm - high plasticity		
		CLAY - silty, trace sand, trace organics (rootlets) - grey - moist, firm to stiff - high plasticity		T72
2.0				

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ ✿ Pocket Pen. ✿ ☒ Qu ☒ ○ Field Vane ○

End of Hole at 2.3m in CLAY

Notes:
1) No sloughing or seepage.
2) Test hole backfilled with auger cuttings, gravel, and cold patch asphalt.
3) Test hole open to 2.3m at completion of drilling.
4) Test hole located in the west bound median lane, between St. Anne's Rd. and Archibald St. (U14 5524586m N, 636985m E).

Logged By: Jodi Neumann **Reviewed By:** Nelson Ferreira **Project Engineer:** Michael Van Helden

Sub-Surface Log

Test Hole TH16-10

Client:	Dillon Consulting Ltd.	**Project Number:**	0022-033-00
Project Name:	Fermor Over Seine River	**Location:**	Fermor Ave. Between Archibald St. and St. Anne's Rd.
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Street Level
Method:	125 mm Solid Stem Auger, CME-75 Truck Mount	**Date Drilled:**	20 May 2016

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL	Undrained Shear Strength (kPa) 0 50 100 150 200 250 / Test Type: △ Torvane △, ✤ Pocket Pen. ✤, ☒ Qu ☒, ○ Field Vane ○
		ASPHALT - (88mm thick)				
		CONCRETE - (202mm thick)				
		SAND AND GRAVEL (FILL) - <25mm dia. gravel, trace silt - brown, moist, compact, well graded rounded to sub angular		G30		
0.5		CLAY (FILL) - silty, trace sand, trace gravel (<10mm dia.) - brown -moist, very stiff - high plasticity		G31		
				G32		
1.0		- trace rootlets, no gravel, mottled black and grey below 0.9m - some silt inclusions (<50mm dia.) below 1.1m		G33		
		ORGANIC CLAY AND SILT - trace silt inclusions (<10mm dia.) - black - moist, very stiff - high plasticity		G34		
1.5				G35		
				G36		
2.0				G37		
		CLAY - silty, trace silt inclusions (<10mm dia.) - brown - moist, very stiff - high plasticity		G38		
2.5						
3.0						

End of Hole at 3.0m in CLAY

Notes:
1) No sloughing or seepage.
2) Test hole backfilled with auger cuttings, gravel, and cold patch asphalt.
3) Test hole open to 3.0m at completion of drilling.
4) Test hole located in the east bound median lane, between St. Anne's Rd. and Archibald St. (U14 5524567m N, 637084m E).

Logged By: Jodi Neumann **Reviewed By:** Nelson Ferreira **Project Engineer:** Michael Van Helden

Sub-Surface Log

Test Hole TH16-11
1 of 1

Client:	Dillon Consulting Ltd.	**Project Number:**	0022-033-00
Project Name:	Fermor Over Seine River	**Location:**	Fermor Ave. Between Archibald St. and St. Anne's Rd.
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Street Level
Method:	125 mm Solid Stem Auger, CME-75 Truck Mount	**Date Drilled:**	20 May 2016

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
		ASPHALT - (105mm thick)		
		CONCRETE - (165mm thick)		
		SAND AND GRAVEL (FILL) - <25mm dia. gravel, trace silt - brown, moist, compact, well graded rounded to sub angular		G59
0.5		SAND (FILL) - some clay, some silt, trace gravel (<25mm dia.) - brown, moist, very stiff, low plasticity		G60
		CLAY (FILL) - silty, trace silt inclusions (<30mm dia.), trace sand, trace organics (rootlets), trace oxidation - mottled black and brown - moist, very stiff - high plasticity		G61
1.0		- with organics, black below 1.1m		G62
				G63
1.5				G64
		CLAY - silty, trace rootlets - grey - moist, very stiff - high plasticity		G65
2.0				
		CLAY AND SILT - trace sand - grey - moist, firm - intermediate plasticity		G66
2.5				
3.0				G67

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ ✿ Pocket Pen. ✿ ☒ Qu ☒ ○ Field Vane ○

End of Hole at 3.0m in CLAY

Notes:
1) No sloughing or seepage.
2) Test hole backfilled with auger cuttings, gravel, and cold patch asphalt.
3) Test hole open to 3.0m at completion of drilling.
4) Test hole located in the west bound curb lane, between St. Anne's Rd. and Archibald St. (U14 5524556m N, 637181m E).

Logged By: Jodi Neumann **Reviewed By:** Nelson Ferreira **Project Engineer:** Michael Van Helden

SUB-SURFACE LOG LOGS 2016-05-25 FERMOR OVER SEINE LOGS 0_A_JN 0022-033-00.GPJ TREK GEOTECHNICAL.GDT 11/7/16

Sub-Surface Log

Test Hole TH16-12

Client:	Dillon Consulting Ltd.	**Project Number:**	0022-033-00
Project Name:	Fermor Over Seine River	**Location:**	Fermor Ave. Between Archibald St. and St. Anne's Rd.
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Street Level
Method:	125 mm Solid Stem Auger, CME-75 Truck Mount	**Date Drilled:**	20 May 2016

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
		ASPHALT - (68mm thick)		
		CONCRETE - (207mm thick)		
		SAND AND GRAVEL (FILL) - <25mm dia. gravel, trace silt - brown, moist, compact, well graded rounded to sub angular		G39
0.5		SAND (FILL) - some clay, some silt, trace gravel (<25mm dia.) - brown, moist, stiff, low plasticity		G40
		CLAY (FILL) - silty, trace sand - mottled black and brown - moist, stiff - high plasticity		G41
1.0				G42
				G43
1.5		CLAY - silty, trace sand, trace organics (rootlets) - grey - soft to stiff - high plasticity		T44
2.0				

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○

End of Hole at 2.3m in CLAY

Notes:
1) No sloughing or seepage.
2) Test hole backfilled with auger cuttings, gravel, and cold patch asphalt.
3) Test hole open to 2.3m at completion of drilling.
4) Test hole located in the east bound curb lane, between St. Anne's Rd. and Archibald St. (U14 5524498m N, 637269m E).

Logged By: Jodi Neumann **Reviewed By:** Nelson Ferreira **Project Engineer:** Michael Van Helden

SUB-SURFACE LOG LOGS 2016-05-25 FERMOR OVER SEINE LOGS 0_A_JN 0022-033-00.GPJ TREK GEOTECHNICAL.GDT 11/7/16

Sub-Surface Log

Test Hole TH16-13

Client:	Dillon Consulting Ltd.	**Project Number:**	0022-033-00
Project Name:	Fermor Over Seine River	**Location:**	Fermor Ave. Between Archibald St. and St. Anne's Rd.
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Street Level
Method:	125 mm Solid Stem Auger, CME-75 Truck Mount	**Date Drilled:**	20 May 2016

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	Bulk Unit Wt (kN/m³) 16 17 18 19 20 21 / Particle Size (%) 0 20 40 60 80 100 / PL MC LL 0 20 40 60 80 100	Undrained Shear Strength (kPa) Test Type: △ Torvane △ ✤ Pocket Pen. ✤ ☒ Qu ☒ ○ Field Vane ○ 0 50 100 150 200 250
		ASPHALT - (103mm thick)				
		CONCRETE - (202mm thick)				
		SAND AND GRAVEL (FILL) - <25mm dia. gravel, trace silt - brown, moist, compact, well graded rounded to sub angular		G53	●	
0.5		SAND (FILL) - some clay, some silt, trace gravel (<25mm dia.) - black, moist, very stiff, low plasticity		G54	●	✤
		CLAY (FILL) - silty, trace rootlets - mottled grey and black - moist, very stiff - high plasticity - ORGANIC CLAY AND SILT seam (<100mm thick) at 0.7m		G55	●	△ ✤
1.0				G56	●	✤ △
				G57	●	△ ✤
1.5					●	
		CLAY AND SILT - trace sand, trace orgainics (rootlets) - grey - moist, firm - intermediate plasticity		T58	● □	☒ ✤
2.0						

End of Hole at 2.3m in CLAY

Notes:
1) No sloughing or seepage.
2) Test hole backfilled with auger cuttings, gravel, and cold patch asphalt.
3) Test hole open to 2.3m at completion of drilling.
4) Test hole located in the west bound median lane, between St. Anne's Rd. and Archibald St. (U14 5524468m N, 637364m E).

Logged By: Jodi Neumann **Reviewed By:** Nelson Ferreira **Project Engineer:** Michael Van Helden

Sub-Surface Log

Test Hole TH16-14
1 of 1

Client:	Dillon Consulting Ltd.	**Project Number:**	0022-033-00
Project Name:	Fermor Over Seine River	**Location:**	Fermor Ave. Between Archibald St. and St. Anne's Rd.
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	Street Level
Method:	125 mm Solid Stem Auger, CME-75 Truck Mount	**Date Drilled:**	20 May 2016

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
		ASPHALT - (50mm thick)		
		CONCRETE - (195mm thick)		
		SAND AND GRAVEL (FILL) - <25mm dia. gravel, trace silt - brown, moist, compact, well graded rounded to sub angular		G45
0.5		SAND (FILL) - some clay, some silt, trace gravel (<25mm dia.) - black, moist, stiff, low plasticity		G46
1.0		ORGANIC CLAY AND SILT - trace rootlets, trace oxidation - black - moist, very stiff - high plasticity		G47
				G48
1.5		- trace silt inclusions (<10mm dia.) below 1.5m		G49
				G50
2.0		CLAY - silty, trace silt inclusions (<10mm dia.), trace rootlets, trace oxidation - brown - moist, very stiff - high plasticity		G51
2.5		SILT - trace clay, trace sand - brown - moist, soft - no to low plasticity		G52
3.0		End of Hole at 3.0m in SILT		

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa): 0 50 100 150 200 250

Test Type: △ Torvane △ ✿ Pocket Pen. ✿ ☒ Qu ☒ ○ Field Vane ○

Notes:
1) No sloughing or seepage.
2) Test hole backfilled with auger cuttings, gravel, and cold patch asphalt.
3) Test hole open to 2.1m at completion of drilling.
4) Test hole located in the east bound curb lane, between St. Anne's Rd. and Archibald St. (U14 5524428m N, 637392m E).

Logged By: Jodi Neumann **Reviewed By:** Nelson Ferreira **Project Engineer:** Michael Van Helden

SUB-SURFACE LOG LOGS 2016-05-25 FERMOR OVER SEINE LOGS 0_A_JN 0022-033-00.GPJ TREK GEOTECHNICAL.GDT 11/7/16

Appendix B

Lab Testing Summary and Lab Testing Results

Fermor Ave. Over Seine River
Sub-Surface Investigation
Road Holes

Test Hole No.	Test Hole Location	Pavement Surface		Pavement Structure Material		Subgrade Description	Sample Depth (m)		Moisture Content (%)	Grain Size Analysis				Atterberg Limits		
		Type	Thickness (mm)	Type	Thickness (mm)		Top (m)	Bottom (m)		Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Plastic	Liquid	Plasticity Index
TH16-01	U14 (5524304m N, 636321m E). West bound, left turning lane.	Asphalt	55	Concrete	215											
						SAND & GRAVEL (FILL)	0.3	0.4	15							
						SAND (FILL)	0.6	0.8	9							
						SAND (FILL)	0.9	1.1	9							
						CLAY	1.2	1.4	32							
						SILT	1.5	2.3	24							
TH16-02	U14 (5524333m N, 636377m E). East bound median lane.	Asphalt	75	Concrete	210											
						SAND & GRAVEL (FILL)	0.3	0.6	7							
						SAND (FILL)	0.6	0.8	8							
						CLAY	1.0	1.2	34							
						CLAY AND SILT	1.4	1.5	20							
						CLAY AND SILT	1.7	1.8	25							
						CLAY	1.8	2.0	33							
						CLAY	2.1	2.3	46							
						CLAY	2.6	2.7	51							
TH16-03	U14 (5524415m N, 636434m E). West bound curb lane.	Asphalt	96	Concrete	193											
						SAND & GRAVEL (FILL)	0.3	0.6	6							
						SAND (FILL)	0.6	0.8	8							
						SAND (FILL)	0.9	1.1	9	7	57	20	16	11	26	15
						SAND (FILL)	1.2	1.4	10							
						SAND (FILL)	1.5	1.7	16							
						SILT	1.8	2.0	19							
						SILT	2.3	2.4	23							
						CLAY	2.6	2.7	31							
TH16-04	U14 (5524460m N, 636522m E). East bound curb lane.	Asphalt	91	Concrete	214											
						SAND & GRAVEL (FILL)	0.3	0.5	12							
						SAND (FILL)	0.5	0.6	29							
						ORGANIC CLAY & SILT	0.8	0.9	33							
						ORGANIC CLAY & SILT	1.1	1.2	43	0	5	37	58	31	67	35
						CLAY	1.4	1.5	35							
						CLAY	1.5	2.3	31							
TH16-05	U14 (5524520m N, 636601m E). West bound median lane.	Asphalt	75	Concrete	230											
						SAND & GRAVEL (FILL)	0.3	0.5	7							
						CLAY	0.5	0.6	27							
						CLAY	0.6	0.8	25							
						CLAY	0.9	1.1	30							
						ORGANIC CLAY & SILT	1.2	1.4	33							
						ORGANIC CLAY & SILT	1.5	2.3	35							

Fermor Ave. Over Seine River
Sub-Surface Investigation
Road Holes

Test Hole No.	Test Hole Location	Pavement Surface		Pavement Structure Material		Subgrade Description	Sample Depth (m)		Moisture Content (%)	Grain Size Analysis				Atterberg Limits		
		Type	Thickness (mm)	Type	Thickness (mm)		Top (m)	Bottom (m)		Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Plastic	Liquid	Plasticity Index
TH16-06	U14 (5524547m N, 636699m E). East bound median lane.	Asphalt	126	Concrete	214											
						SAND & GRAVEL (FILL)	0.3	0.5	6							
						ORGANIC CLAY & SILT (FILL)	0.5	0.6	30							
						ORGANIC CLAY & SILT (FILL)	0.6	0.8	28							
						CLAY AND SILT (FILL)	0.7	0.9	26							
						CLAY AND SILT (FILL)	1.1	1.2	28	0	4	47	49	17	51	34
						CLAY	1.4	1.5	34							
						CLAY	1.5	1.7	33							
						ORGANIC CLAY & SILT	1.8	2.0	34							
						ORGANIC CLAY & SILT	2.1	2.3	33							
						CLAY AND SILT	2.6	2.7	27							
TH16-07	U14 (5524581m N, 636793m E). West bound curb lane.	Asphalt	81	Concrete	204											
						GRAVEL (FILL)	0.3	0.4	5							
						CLAY (FILL)	0.6	0.8	30							
						CLAY (FILL)	0.9	1.1	33							
						CLAY (FILL)	1.2	1.4	32							
						CLAY (FILL)	1.5	1.7	30							
						CLAY (FILL)	1.8	2.0	30							
						ORGANIC CLAY & SILT	2.1	2.3	33							
						ORGANIC CLAY & SILT	2.6	2.7	37							
TH16-08	U14 (5524571m N, 636891m E). East bound curb lane.	--	--	Concrete	260											
						SAND AND GRAVEL (FILL)	0.2	0.5	6							
						SAND (FILL)	0.5	0.6	8							
						CLAY (FILL)	0.9	1.1	35							
						CLAY (FILL)	1.2	1.4	29							
						CLAY AND SILT	1.5	2.3	26							
TH16-09	U14 (5524586m N, 636985m E). West bound median lane.	--	--	Concrete	245											
						SAND & GRAVEL (FILL)	0.3	0.5	7							
						CLAY (FILL)	0.6	0.8	28							
						CLAY (FILL)	0.9	1.1	29							
						CLAY (FILL)	1.2	1.4	31							
						CLAY	1.5	2.3	32							
TH16-10	U14 (5524567m N, 637084m E). East bound median lane.	Asphalt	88	Concrete	202											
						SAND & GRAVEL (FILL)	0.3	0.5	5							
						CLAY (FILL)	0.5	0.6	26							
						CLAY (FILL)	0.8	0.9	26	0	6	34	60	21	67	46
						CLAY (FILL)	1.1	1.2	25							
						ORGANIC CLAY & SILT	1.4	1.5	33							
						ORGANIC CLAY & SILT	1.5	1.7	28							
						ORGANIC CLAY & SILT	1.8	2.0	29							
						ORGANIC CLAY & SILT	2.1	2.3	29							
						CLAY	2.6	2.7	32							

Fermor Ave. Over Seine River
Sub-Surface Investigation
Road Holes

Test Hole No.	Test Hole Location	Pavement Surface		Pavement Structure Material		Subgrade Description	Sample Depth (m)		Moisture Content (%)	Grain Size Analysis				Atterberg Limits		
		Type	Thickness (mm)	Type	Thickness (mm)		Top (m)	Bottom (m)		Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Plastic	Liquid	Plasticity Index
TH16-11	U14 (5524556m N, 637181m E). West bound curb lane.	Asphalt	105	Concrete	165											
						SAND & GRAVEL (FILL)	0.3	0.4	5							
						SAND (FILL)	0.5	0.6	19							
						CLAY (FILL)	0.6	0.8	23							
						CLAY (FILL)	0.9	1.1	32							
						CLAY (FILL)	1.2	1.4	35							
						CLAY (FILL)	1.5	1.7	35							
						CLAY	1.8	2.0	33							
						CLAY AND SILT	2.3	2.4	28							
						CLAY AND SILT	2.9	3.0	24							
TH16-12	U14 (5524498m N, 637269m E). East bound curb lane.	Asphalt	68	Concrete	207											
						SAND & GRAVEL (FILL)	0.3	0.5	4							
						SAND (FILL)	0.5	0.6	11							
						CLAY (FILL)	0.6	0.8	29							
						CLAY (FILL)	0.9	1.1	26	4	9	33	54	20	63	43
						CLAY (FILL)	1.2	1.4	28							
						CLAY	1.5	2.3	31							
TH16-13	U14 (5524468m N, 637364m E). West bound median lane.	Asphalt	103	Concrete	202											
						SAND & GRAVEL (FILL)	0.3	0.5	5							
						SAND (FILL)	0.5	0.6	21							
						CLAY (FILL)	0.8	0.9	38							
						CLAY (FILL)	1.1	1.2	33							
						CLAY (FILL)	1.2	1.4	34							
						CLAY AND SILT	1.5	1.6	29							
						CLAY AND SILT	1.6	2.3	24							
TH16-14	U14 (5524428m N, 637392m E). East bound curb lane.	Cold Patch	50	Concrete	195											
						SAND & GRAVEL (FILL)	0.2	0.4	5							
						SAND (FILL)	0.6	0.8	10							
						ORGANIC CLAY & SILT	0.9	1.1	28							
						ORGANIC CLAY & SILT	1.2	1.4	28							
						ORGANIC CLAY & SILT	1.5	1.7	35							
						ORGANIC CLAY & SILT	1.8	2.0	34							
						CLAY	2.1	2.3	27							
						SILT	2.6	2.7	24							

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Moisture Content Report
ASTM D2216-98

Project No. 0022-033-00
Client Dillon Consulting Ltd.
Project Fermor Over Seine River

Sample Date 20-May-16
Test Date 25-May-16
Technician LI/JB

Test Pit	TH16 - 02	TH16 - 02	TH16 - 02	TH16 - 02	TH16 - 02	TH16 - 02
Depth (m)	0.3 - 0.6	0.6 - 0.8	1.1 - 1.2	1.4 - 1.5	1.7 - 1.8	1.8 - 2.0
Sample #	G01	G02	G03	G05	G06	G07
Tare ID	W41	F127	H12	N49	AA10	W12
Mass of tare	8.6	8.4	8.8	8.4	6.6	8.4
Mass wet + tare	307.1	433.3	377.9	310.5	473.5	309.8
Mass dry + tare	286.7	402.2	283.4	261.3	381.2	235.2
Mass water	20.4	31.1	94.5	49.2	92.3	74.6
Mass dry soil	278.1	393.8	274.6	252.9	374.6	226.8
Moisture %	7.3%	7.9%	34.4%	19.5%	24.6%	32.9%

Test Pit	TH16 - 02	TH16 - 02	TH16 - 04	TH16 - 04	TH16 - 04	TH16 - 04
Depth (m)	2.1 - 2.3	2.6 - 2.7	0.5 - 0.6	0.5 - 0.6	0.8 - 0.9	1.1 - 1.2
Sample #	G08	G09	G10	G11	G12	G13
Tare ID	E90	F69	AC08	Z30	A1	C4
Mass of tare	8.7	8.5	6.5	8.5	8.0	8.5
Mass wet + tare	332.9	358.8	187.7	349.9	292.7	325.9
Mass dry + tare	230.9	240.9	168.5	273.7	222.4	229.9
Mass water	102.0	117.9	19.2	76.2	70.3	96.0
Mass dry soil	222.2	232.4	162.0	265.2	214.4	221.4
Moisture %	45.9%	50.7%	11.9%	28.7%	32.8%	43.4%

Test Pit	TH16 - 04	TH16 - 06	TH16 - 06	TH16 - 06	TH16 - 06	TH16 - 06
Depth (m)	1.4 - 1.5	0.4 - 0.5	0.5 - 0.6	0.6 - 0.8	0.8 - 0.9	1.1 - 1.2
Sample #	G14	G16	G17	G18	G19	G20
Tare ID	P85	N65	F27	F50	F48	K20
Mass of tare	8.6	8.5	8.4	8.6	8.4	8.5
Mass wet + tare	320.3	381.5	337.4	282.5	323.4	308.7
Mass dry + tare	239.6	360.0	261.3	222.1	257.6	242.4
Mass water	80.7	21.5	76.1	60.4	65.8	66.3
Mass dry soil	231.0	351.5	252.9	213.5	249.2	233.9
Moisture %	34.9%	6.1%	30.1%	28.3%	26.4%	28.3%

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Moisture Content Report
ASTM D2216-98

Project No. 0022-033-00
Client Dillon Consulting Ltd.
Project Fermor Over Seine River

Sample Date 20-May-16
Test Date 25-May-16
Technician LI/JB

Test Pit	TH16 - 06	TH16 - 06	TH16 - 06	TH16 - 06	TH16 - 06	TH16 - 08
Depth (m)	1.4 - 1.5	1.5 - 1.7	1.8 - 2.0	2.1 - 2.3	2.6 - 2.7	0.3 - 0.5
Sample #	G21	G22	G23	G24	G25	G25A
Tare ID	AC09	AC29	AA05	N08	W104	F133
Mass of tare	6.7	6.7	6.5	8.7	8.9	8.5
Mass wet + tare	397.9	307.9	279.3	322.5	363.8	347.0
Mass dry + tare	299.8	232.9	210.8	244.6	288.1	326.9
Mass water	98.1	75.0	68.5	77.9	75.7	20.1
Mass dry soil	293.1	226.2	204.3	235.9	279.2	318.4
Moisture %	33.5%	33.2%	33.5%	33.0%	27.1%	6.3%

Test Pit	TH16 - 08	TH16 - 08	TH16 - 08	TH16 - 10	TH16 - 10	TH16 - 10
Depth (m)	0.5 - 0.6	0.9 - 1.1	1.2 - 1.4	0.3 - 0.5	0.5 - 0.6	0.8 - 0.9
Sample #	G26	G27	G28	G30	G31	G32
Tare ID	Z32	D50	F147	C10	H66	Z70
Mass of tare	9.1	8.4	8.3	8.5	8.4	8.6
Mass wet + tare	363.0	319.1	333.3	399.6	352.5	335.5
Mass dry + tare	336.9	238.1	260.8	379.7	281.5	268.9
Mass water	26.1	81.0	72.5	19.9	71.0	66.6
Mass dry soil	327.8	229.7	252.5	371.2	273.1	260.3
Moisture %	8.0%	35.3%	28.7%	5.4%	26.0%	25.6%

Test Pit	TH16 - 10	TH16 - 10	TH16 - 10	TH16 - 10	TH16 - 10	TH16 - 10
Depth (m)	1.1 - 1.2	1.4 - 1.5	1.5 - 1.7	1.8 - 2.0	2.1 - 2.3	2.6 - 2.7
Sample #	G33	G34	G35	G36	G37	G38
Tare ID	F144	E15	H26	D29	W51	N115
Mass of tare	8.8	8.6	8.3	8.2	8.4	8.6
Mass wet + tare	327.7	304.9	320.7	360.8	350.1	321.6
Mass dry + tare	264.4	232.0	251.7	282.2	274.0	246.3
Mass water	63.3	72.9	69.0	78.6	76.1	75.3
Mass dry soil	255.6	223.4	243.4	274.0	265.6	237.7
Moisture %	24.8%	32.6%	28.3%	28.7%	28.7%	31.7%

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Moisture Content Report
ASTM D2216-98

Project No. 0022-033-00
Client Dillon Consulting Ltd.
Project Fermor Over Seine River

Sample Date 20-May-16
Test Date 25-May-16
Technician LI/JB

Test Pit	TH16 - 12	TH16 - 12	TH16 - 12	TH16 - 12	TH16 - 12	TH16 - 14
Depth (m)	0.3 - 0.5	0.5 - 0.6	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	0.2 - 0.4
Sample #	G39	G40	G41	G42	G43	G45
Tare ID	N60	W56	E75	F90	A101	W63
Mass of tare	8.4	8.5	8.5	8.3	8.7	8.4
Mass wet + tare	320.1	344.5	334.1	336.7	302.4	319.5
Mass dry + tare	307.3	310.9	261.3	268.1	239.1	304.7
Mass water	12.8	33.6	72.8	68.6	63.3	14.8
Mass dry soil	298.9	302.4	252.8	259.8	230.4	296.3
Moisture %	4.3%	11.1%	28.8%	26.4%	27.5%	5.0%

Test Pit	TH16 - 14	TH16 - 14	TH16 - 14	TH16 - 14	TH16 - 14	TH16 - 14
Depth (m)	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7	1.8 - 2.0	2.1 - 2.3
Sample #	G46	G47	G48	G49	G50	G51
Tare ID	H10	AC07	H47	E84	D8	F91
Mass of tare	8.5	6.6	8.8	8.5	8.5	8.3
Mass wet + tare	286.1	344.2	301.5	309.0	316.9	331.0
Mass dry + tare	261.1	270.1	237.1	231.0	238.0	263.0
Mass water	25.0	74.1	64.4	78.0	78.9	68.0
Mass dry soil	252.6	263.5	228.3	222.5	229.5	254.7
Moisture %	9.9%	28.1%	28.2%	35.1%	34.4%	26.7%

Test Pit	TH16 - 14	TH16 - 13	TH16 - 13	TH16 - 13	TH16 - 13	TH16 - 13
Depth (m)	2.6 - 2.7	0.3 - 0.5	0.5 - 0.6	0.8 - 0.9	1.1 - 1.2	1.2 - 1.4
Sample #	G52	G53	G54	G55	G56	G57
Tare ID	E105	E36	W48	F64	F19	H79
Mass of tare	8.5	8.5	8.5	8.6	8.4	8.4
Mass wet + tare	479.1	380.9	302.8	323.0	312.3	305.9
Mass dry + tare	388.7	364.0	252.6	236.2	236.7	231.0
Mass water	90.4	16.9	50.2	86.8	75.6	74.9
Mass dry soil	380.2	355.5	244.1	227.6	228.3	222.6
Moisture %	23.8%	4.8%	20.6%	38.1%	33.1%	33.6%

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Moisture Content Report
ASTM D2216-98

Project No. 0022-033-00
Client Dillon Consulting Ltd.
Project Fermor Over Seine River

Sample Date 20-May-16
Test Date 25-May-16
Technician LI/JB

Test Pit	TH16 - 11	TH16 - 11	TH16 - 11	TH16 - 11	TH16 - 11	TH16 - 11
Depth (m)	0.3 - 0.4	0.5 - 0.6	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7
Sample #	G59	G60	G61	G62	G63	G64
Tare ID	Z93	P08	K13	AC03	AB16	AB11
Mass of tare	8.4	8.7	8.5	6.5	6.7	6.7
Mass wet + tare	404.4	333.5	371.8	331.6	302.6	301.3
Mass dry + tare	384.5	282.2	305.1	252.5	225.8	224.9
Mass water	19.9	51.3	66.7	79.1	76.8	76.4
Mass dry soil	376.1	273.5	296.6	246.0	219.1	218.2
Moisture %	5.3%	18.8%	22.5%	32.2%	35.1%	35.0%

Test Pit	TH16 - 11	TH16 - 11	TH16 - 11	TH16 - 09	TH16 - 09	TH16 - 09
Depth (m)	1.8 - 2.0	2.3 - 2.4	2.9 - 3.0	0.3 - 0.5	0.6 - 0.8	0.9 - 1.1
Sample #	G65	G66	G67	G68	G69	G70
Tare ID	E125	AB18	E46	E63	H6	Z66
Mass of tare	8.4	6.6	8.8	8.6	8.5	8.4
Mass wet + tare	264.5	407.6	444.1	350.9	340.1	354.6
Mass dry + tare	200.4	320.5	360.4	328.7	267.5	276.2
Mass water	64.1	87.1	83.7	22.2	72.6	78.4
Mass dry soil	192.0	313.9	351.6	320.1	259.0	267.8
Moisture %	33.4%	27.7%	23.8%	6.9%	28.0%	29.3%

Test Pit	TH16 - 09	TH16 - 07	TH16 - 07	TH16 - 07	TH16 -07	TH16 - 07
Depth (m)	1.2 - 1.4	0.3 - 0.4	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4	1.5 - 1.7
Sample #	G71	G73	G74	G75	G76	G77
Tare ID	F146	F142	E2	E28	E66	H17
Mass of tare	8.5	8.8	8.4	8.4	8.6	8.4
Mass wet + tare	342.2	322.9	344.5	340.7	319.8	331.4
Mass dry + tare	263.7	308.0	267.3	258.6	245.2	256.0
Mass water	78.5	14.9	77.2	82.1	74.6	75.4
Mass dry soil	255.2	299.2	258.9	250.2	236.6	247.6
Moisture %	30.8%	5.0%	29.8%	32.8%	31.5%	30.4%

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Moisture Content Report
ASTM D2216-98

Project No. 0022-033-00
Client Dillon Consulting Ltd.
Project Fermor Over Seine River

Sample Date 20-May-16
Test Date 25-May-16
Technician LI/JB

Test Pit	TH16 - 07	TH16 - 07	TH16 - 07	TH16 - 05	TH16 - 05	TH16 - 05
Depth (m)	1.8 - 2.0	2.1 - 2.3	2.6 - 2.7	0.3 - 0.5	0.5 - 0.6	0.6 - 0.8
Sample #	G78	G79	G80	G81	G82	G83
Tare ID	E31	N107	W80	N85	AC12	AC13
Mass of tare	8.4	8.4	8.45	8.4	6.55	6.7
Mass wet + tare	310.6	360.9	326.6	248.3	360.6	362.1
Mass dry + tare	240.5	273.0	241.2	232.5	285.6	290.1
Mass water	70.1	87.9	85.4	15.8	75.0	72.0
Mass dry soil	232.1	264.6	232.8	224.1	279.1	283.4
Moisture %	30.2%	33.2%	36.7%	7.1%	26.9%	25.4%

Test Pit	TH16 - 05	TH16 - 05	TH16 - 03	TH16 - 03	TH16 - 03	TH16 - 03
Depth (m)	0.9 - 1.1	1.2 - 1.4	0.3 - 0.6	0.6 - 0.8	0.9 - 1.1	1.2 - 1.4
Sample #	G84	G85	G87	G88	G89	G90
Tare ID	D39	W27	F128	Z39	E95	F9
Mass of tare	8.3	8.3	8.5	8.5	8.4	8.7
Mass wet + tare	332.2	324.5	306.4	366.0	392.3	417.7
Mass dry + tare	257.2	245.3	290.8	339.5	359.5	379.5
Mass water	75.0	79.2	15.6	26.5	32.8	38.2
Mass dry soil	248.9	237.0	282.3	331.0	351.1	370.8
Moisture %	30.1%	33.4%	5.5%	8.0%	9.4%	10.3%

Test Pit	TH16 - 03	TH16 - 03	TH16 - 03	TH16 - 03	TH16 - 01	TH16 - 01
Depth (m)	1.5 - 1.7	1.8 - 2.0	2.3 - 2.4	2.6 - 2.7	0.3 - 0.4	0.6 - 0.8
Sample #	G91	G92	G93	G94	G95	G96
Tare ID	Z77	K16	D3	N59	Z57	N114
Mass of tare	8.3	8.5	8.2	8.3	8.4	8.5
Mass wet + tare	397.2	377.2	361.7	334.7	245.2	313.1
Mass dry + tare	342.5	318.0	295.8	257.8	215.3	287.6
Mass water	54.7	59.2	65.9	76.9	29.9	25.5
Mass dry soil	334.2	309.5	287.6	249.5	206.9	279.1
Moisture %	16.4%	19.1%	22.9%	30.8%	14.5%	9.1%

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Moisture Content Report
ASTM D2216-98

Project No. 0022-033-00
Client Dillon Consulting Ltd.
Project Fermor Over Seine River

Sample Date 20-May-16
Test Date 25-May-16
Technician LI/JB

Test Pit	TH16 - 01	TH16 - 01				
Depth (m)	0.9 - 1.1	1.2 - 1.4				
Sample #	G97	G98				
Tare ID	F26	W23				
Mass of tare	8.3	8.4				
Mass wet + tare	408.7	316.3				
Mass dry + tare	375.2	242.5				
Mass water	33.5	73.8				
Mass dry soil	366.9	234.1				
Moisture %	9.1%	31.5%				

Test Pit						
Depth (m)						
Sample #						
Tare ID						
Mass of tare						
Mass wet + tare						
Mass dry + tare						
Mass water						
Mass dry soil						
Moisture %						

Test Pit						
Depth (m)						
Sample #						
Tare ID						
Mass of tare						
Mass wet + tare						
Mass dry + tare						
Mass water						
Mass dry soil						
Moisture %						

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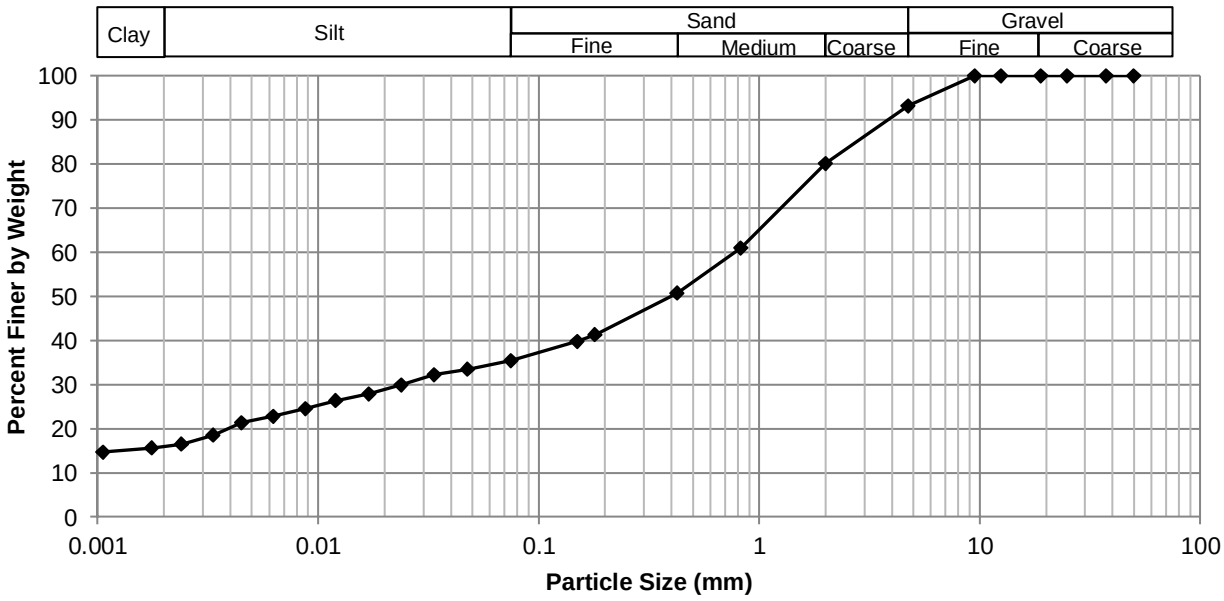
Grain Size Analysis (Hydrometer Method)
ASTM D422

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16-03
Sample #	G89
Depth (m)	0.9 - 1.1
Sample Date	20-May-16
Test Date	2-Jun-16
Technician	LI

Gravel	6.8%
Sand	57.7%
Silt	19.5%
Clay	16.0%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	93.21	0.0750	35.49
37.5	100.00	2.00	80.17	0.0476	33.51
25.0	100.00	0.825	61.02	0.0337	32.24
19.0	100.00	0.425	50.75	0.0238	29.95
12.5	100.00	0.180	41.33	0.0170	27.91
9.50	100.00	0.150	39.82	0.0120	26.38
4.75	93.21	0.075	35.49	0.0088	24.60
				0.0063	22.82
				0.0045	21.42
				0.0033	18.54
				0.0024	16.50
				0.0018	15.65
				0.0011	14.74

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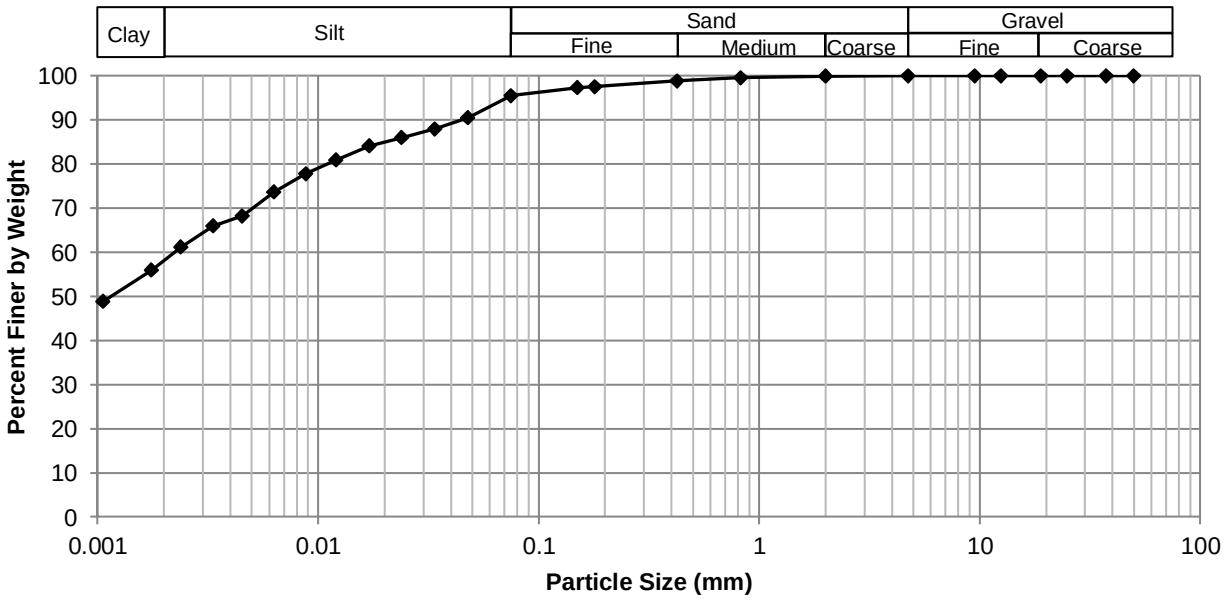
Grain Size Analysis (Hydrometer Method)
ASTM D422

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16-04
Sample #	G13
Depth (m)	1.1 - 1.2
Sample Date	10-May-16
Test Date	2-Jun-16
Technician	LI

Gravel	0.0%
Sand	4.5%
Silt	37.5%
Clay	58.0%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	100.00	0.0750	95.51
37.5	100.00	2.00	99.95	0.0479	90.50
25.0	100.00	0.825	99.61	0.0338	87.96
19.0	100.00	0.425	98.89	0.0239	86.05
12.5	100.00	0.180	97.58	0.0171	84.15
9.50	100.00	0.150	97.32	0.0121	80.97
4.75	100.00	0.075	95.51	0.0088	77.80
				0.0063	73.67
				0.0045	68.28
				0.0033	66.02
				0.0024	61.19
				0.0018	56.01
				0.0011	48.85

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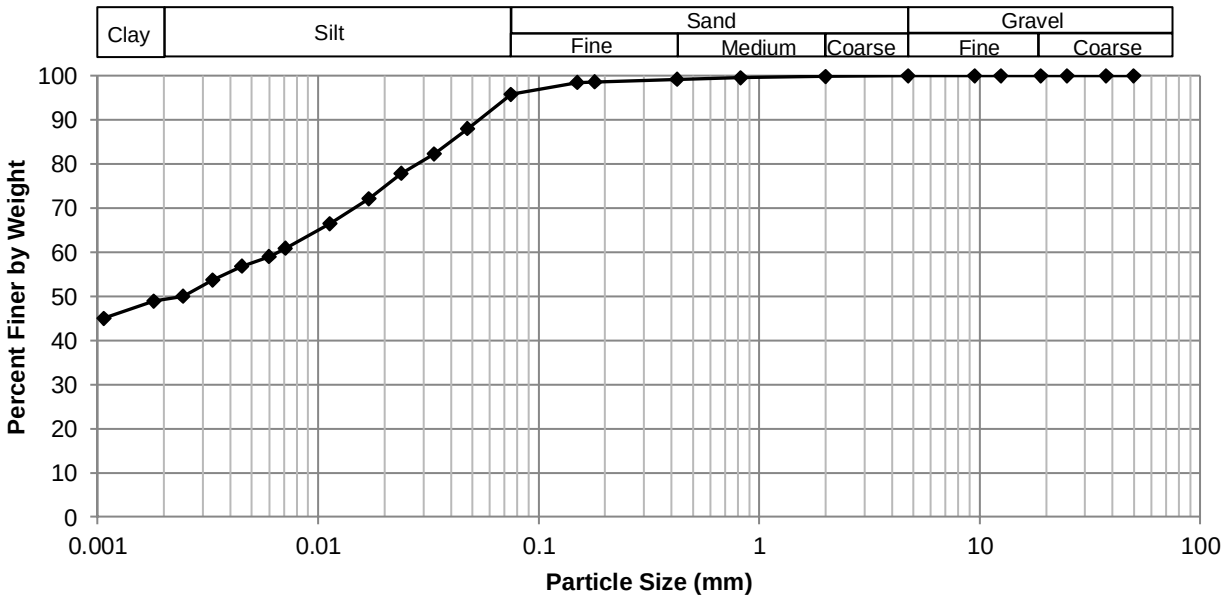
Grain Size Analysis (Hydrometer Method)
ASTM D422

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16-06
Sample #	G20
Depth (m)	1.1 - 1.2
Sample Date	20-May-16
Test Date	2-Jun-16
Technician	LI

Gravel	0.0%
Sand	4.2%
Silt	46.5%
Clay	49.3%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	100.00	0.0750	95.80
37.5	100.00	2.00	99.86	0.0476	88.04
25.0	100.00	0.825	99.57	0.0337	82.33
19.0	100.00	0.425	99.23	0.0238	77.89
12.5	100.00	0.180	98.62	0.0170	72.19
9.50	100.00	0.150	98.46	0.0113	66.48
4.75	100.00	0.075	95.80	0.0071	60.92
				0.0060	59.02
				0.0045	56.86
				0.0033	53.76
				0.0024	50.04
				0.0018	48.98
				0.0011	45.00

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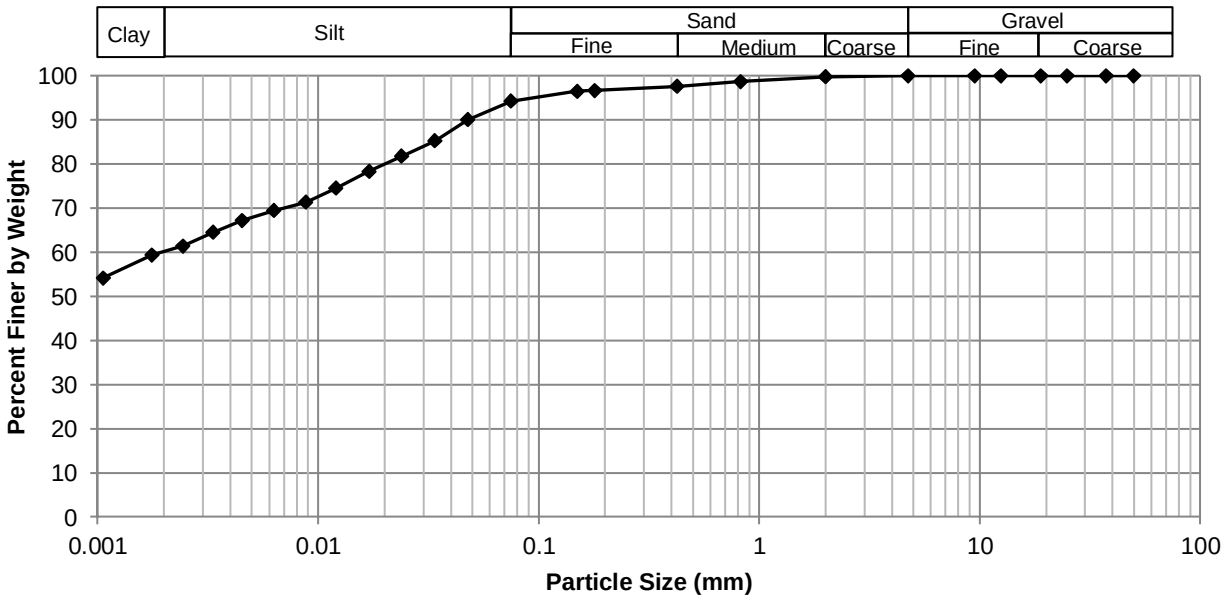
Grain Size Analysis (Hydrometer Method)
ASTM D422

Project No.	0022-033-00
Client	Dillon Consulting Inc.
Project	Fermor Over Seine River
Test Hole	TH16-10
Sample #	G32
Depth (m)	0.8 - 0.9
Sample Date	20-May-16
Test Date	2-Jun-16
Technician	LI

Gravel	0.0%
Sand	5.7%
Silt	34.2%
Clay	60.1%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	100.00	0.0750	94.32
37.5	100.00	2.00	99.83	0.0479	90.08
25.0	100.00	0.825	98.72	0.0338	85.32
19.0	100.00	0.425	97.63	0.0239	81.83
12.5	100.00	0.180	96.71	0.0171	78.35
9.50	100.00	0.150	96.50	0.0121	74.54
4.75	100.00	0.075	94.32	0.0088	71.37
				0.0063	69.47
				0.0045	67.25
				0.0033	64.57
				0.0024	61.44
				0.0018	59.43
				0.0011	54.18

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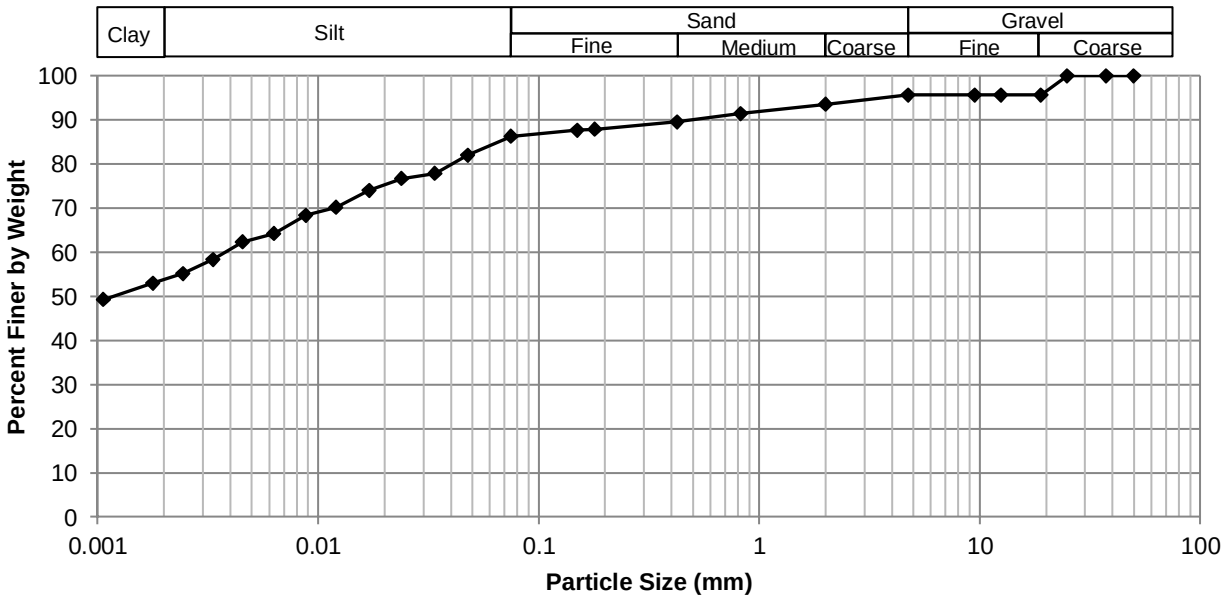
Grain Size Analysis (Hydrometer Method)
ASTM D422

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16-12
Sample #	G42
Depth (m)	0.9 - 1.1
Sample Date	20-May-16
Test Date	2-Jun-16
Technician	LI

Gravel	4.4%
Sand	9.3%
Silt	32.6%
Clay	53.8%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**	**Particle Size (mm)**	**Percent Passing**
50.0	100.00	4.75	95.65	0.0750	86.32
37.5	100.00	2.00	93.59	0.0479	82.06
25.0	100.00	0.825	91.46	0.0338	77.90
19.0	95.65	0.425	89.61	0.0239	76.71
12.5	95.65	0.180	87.93	0.0171	74.04
9.50	95.65	0.150	87.71	0.0121	70.17
4.75	95.65	0.075	86.32	0.0088	68.39
				0.0063	64.23
				0.0045	62.35
				0.0033	58.41
				0.0024	55.22
				0.0018	53.04
				0.0011	49.30

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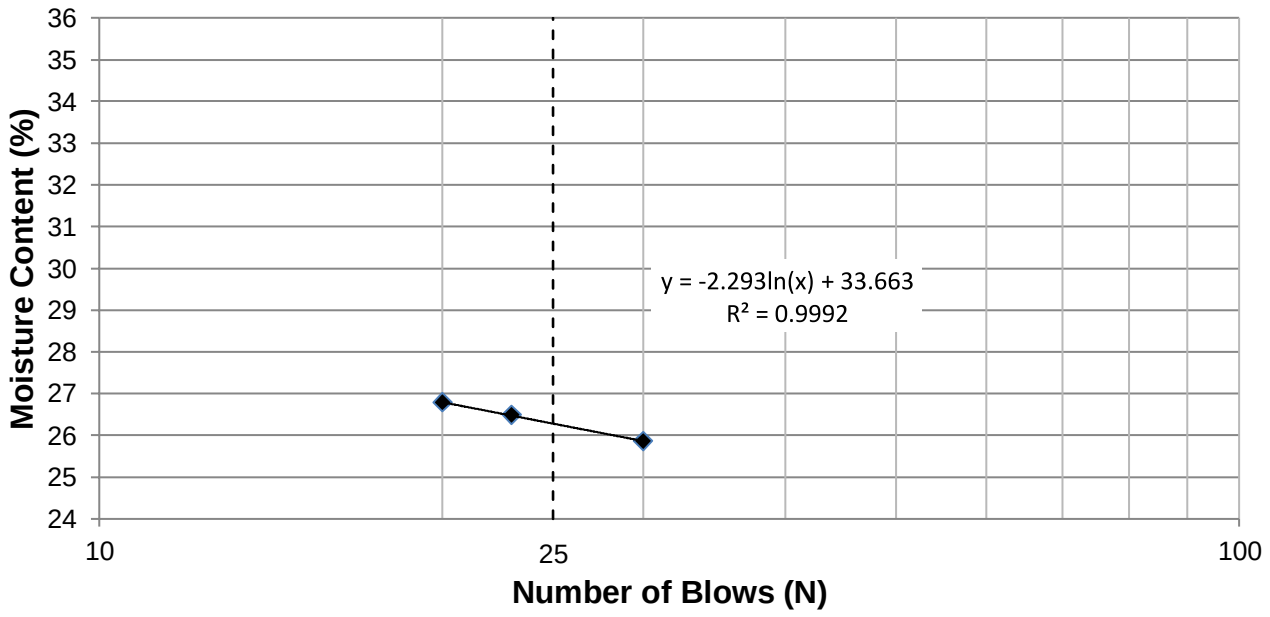
Atterberg Limits
ASTM D4318

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16-03
Sample #	G89
Depth (m)	0.9-1.1
Sample Date	20-May-16
Test Date	09-Jun-16
Technician	LI

Liquid Limit	26
Plastic Limit	11
Plasticity Index	15

Liquid Limit

Trial #	1	2	3	4	5
Number of Blows (N)	20	30	23		
Mass Wet Soil + Tare (g)	24.278	23.962	25.462		
Mass Dry Soil + Tare (g)	22.108	21.936	23.063		
Mass Tare (g)	14.006	14.101	14.006		
Mass Water (g)	2.170	2.026	2.399		
Mass Dry Soil (g)	8.102	7.835	9.057		
Moisture Content (%)	26.784	25.858	26.488		



Plastic Limit

Trial #	1	2	3	4	5
Mass Wet Soil + Tare (g)	17.298	17.207			
Mass Dry Soil + Tare (g)	16.974	16.918			
Mass Tare (g)	13.999	14.200			
Mass Water (g)	0.324	0.289			
Mass Dry Soil (g)	2.975	2.718			
Moisture Content (%)	10.891	10.633			

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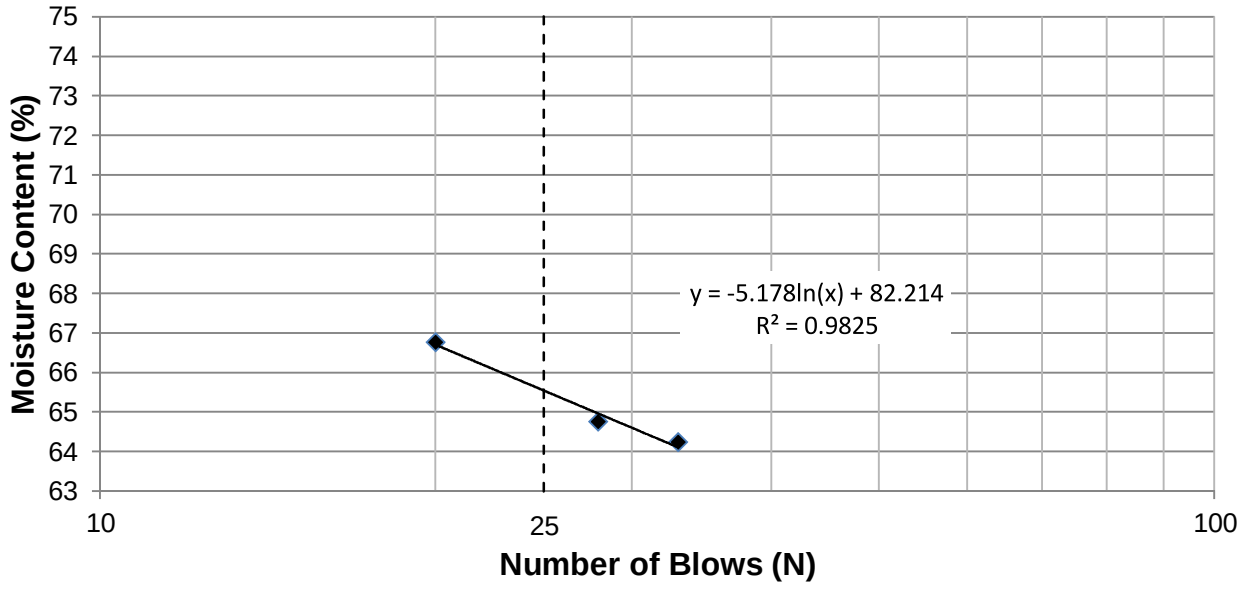
Atterberg Limits
ASTM D4318

Project No.	0022-033-00
Client	Dillion Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16 - 04
Sample #	G13
Depth (m)	1.1 - 1.2
Sample Date	20-May-16
Test Date	02-Jun-16
Technician	JB

Liquid Limit	66
Plastic Limit	31
Plasticity Index	35

Liquid Limit

Trial #	1	2	3	4	5
Number of Blows (N)	20	28	33		
Mass Wet Soil + Tare (g)	21.409	21.988	21.984		
Mass Dry Soil + Tare (g)	18.524	18.864	18.901		
Mass Tare (g)	14.203	14.040	14.102		
Mass Water (g)	2.885	3.124	3.083		
Mass Dry Soil (g)	4.321	4.824	4.799		
Moisture Content (%)	66.767	64.760	64.243		



Plastic Limit

Trial #	1	2	3	4	5
Mass Wet Soil + Tare (g)	24.543	24.646			
Mass Dry Soil + Tare (g)	22.000	22.076			
Mass Tare (g)	13.872	13.932			
Mass Water (g)	2.543	2.570			
Mass Dry Soil (g)	8.128	8.144			
Moisture Content (%)	31.287	31.557			

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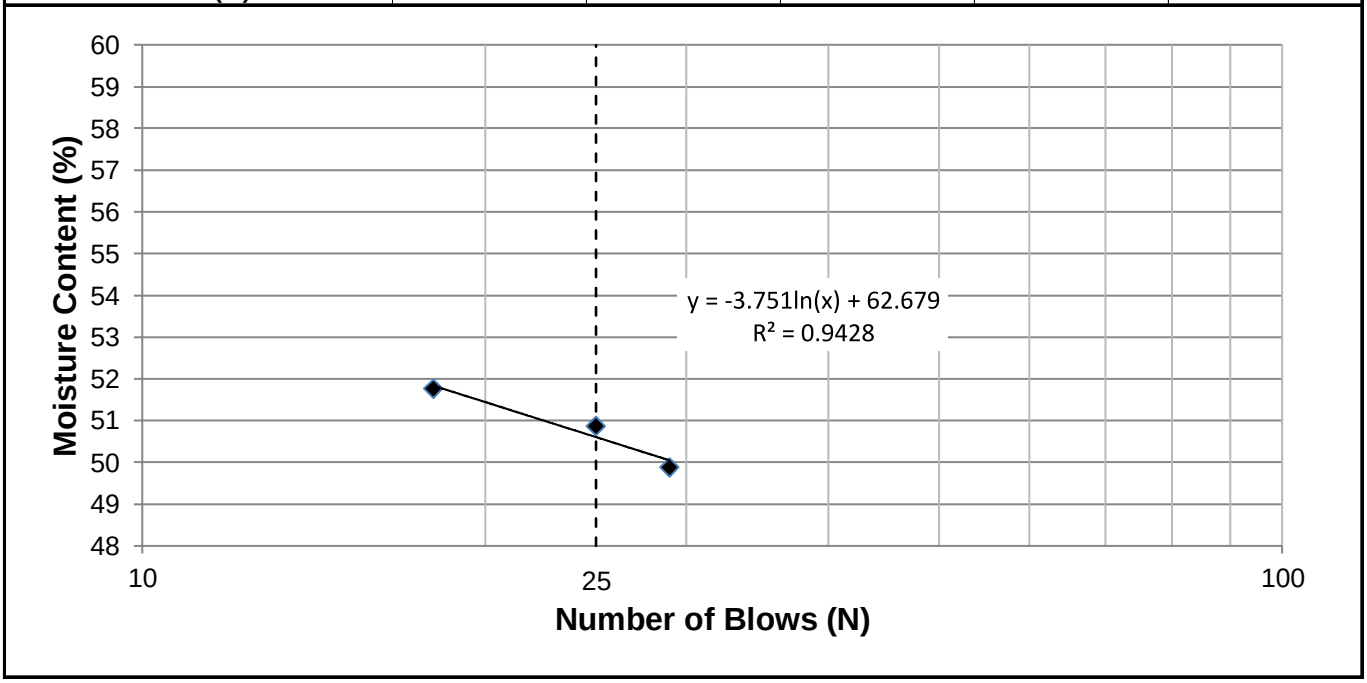
Atterberg Limits
ASTM D4318

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16-06
Sample #	G20
Depth (m)	1.1-1.2
Sample Date	20-May-16
Test Date	08-Jun-16
Technician	JB

Liquid Limit	51
Plastic Limit	17
Plasticity Index	34

Liquid Limit

Trial #	1	2	3	4	5
Number of Blows (N)	29	25	18		
Mass Wet Soil + Tare (g)	22.379	21.309	23.718		
Mass Dry Soil + Tare (g)	19.614	18.885	20.363		
Mass Tare (g)	14.070	14.119	13.881		
Mass Water (g)	2.765	2.424	3.355		
Mass Dry Soil (g)	5.544	4.766	6.482		
Moisture Content (%)	49.874	50.860	51.759		



Plastic Limit

Trial #	1	2	3	4	5
Mass Wet Soil + Tare (g)	16.482	16.624			
Mass Dry Soil + Tare (g)	16.115	16.276			
Mass Tare (g)	13.983	14.266			
Mass Water (g)	0.367	0.348			
Mass Dry Soil (g)	2.132	2.010			
Moisture Content (%)	17.214	17.313			

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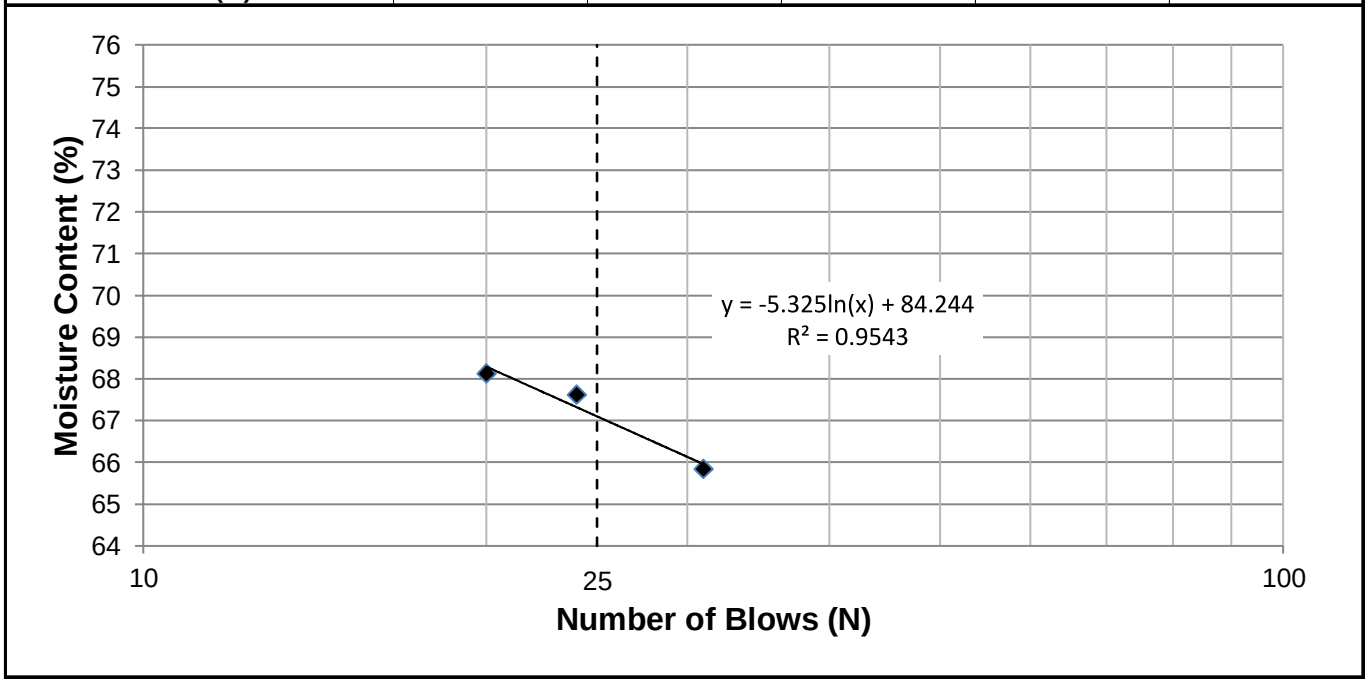
Atterberg Limits
ASTM D4318

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16-10
Sample #	G32
Depth (m)	0.8-0.9
Sample Date	20-May-16
Test Date	08-Jun-16
Technician	LI

Liquid Limit	67
Plastic Limit	21
Plasticity Index	46

Liquid Limit

Trial #	1	2	3	4	5
Number of Blows (N)	31	24	20		
Mass Wet Soil + Tare (g)	24.847	24.680	26.158		
Mass Dry Soil + Tare (g)	20.544	20.477	21.282		
Mass Tare (g)	14.008	14.261	14.124		
Mass Water (g)	4.303	4.203	4.876		
Mass Dry Soil (g)	6.536	6.216	7.158		
Moisture Content (%)	65.835	67.616	68.120		



Plastic Limit

Trial #	1	2	3	4	5
Mass Wet Soil + Tare (g)	15.919	16.484			
Mass Dry Soil + Tare (g)	15.634	16.097			
Mass Tare (g)	14.239	14.219			
Mass Water (g)	0.285	0.387			
Mass Dry Soil (g)	1.395	1.878			
Moisture Content (%)	20.430	20.607			

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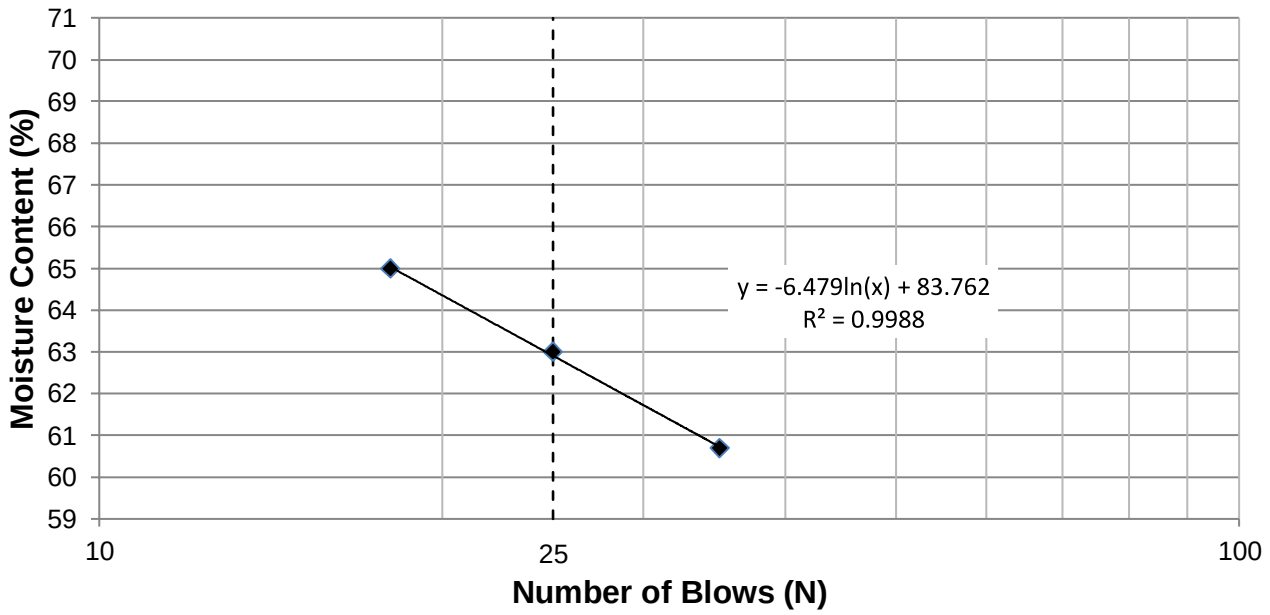
Atterberg Limits
ASTM D4318

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16-12
Sample #	G42
Depth (m)	0.9-1.1
Sample Date	20-May-16
Test Date	09-Jun-16
Technician	LI

Liquid Limit	63
Plastic Limit	20
Plasticity Index	43

Liquid Limit

Trial #	1	2	3	4	5
Number of Blows (N)	25	18	35		
Mass Wet Soil + Tare (g)	24.461	23.270	24.512		
Mass Dry Soil + Tare (g)	20.464	19.711	20.724		
Mass Tare (g)	14.119	14.235	14.482		
Mass Water (g)	3.997	3.559	3.788		
Mass Dry Soil (g)	6.345	5.476	6.242		
Moisture Content (%)	62.994	64.993	60.686		



Plastic Limit

Trial #	1	2	3	4	5
Mass Wet Soil + Tare (g)	16.009	16.035			
Mass Dry Soil + Tare (g)	15.685	15.699			
Mass Tare (g)	14.058	14.016			
Mass Water (g)	0.324	0.336			
Mass Dry Soil (g)	1.627	1.683			
Moisture Content (%)	19.914	19.964			

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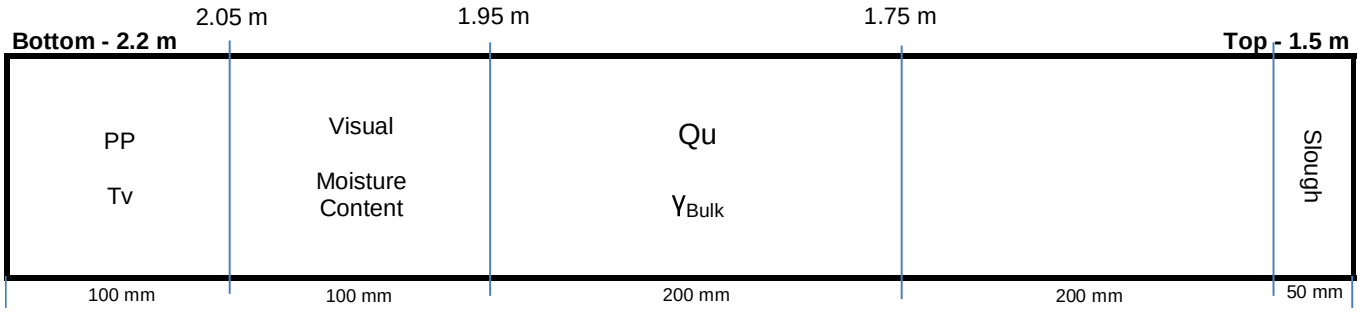
Shelby Tube Visual

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16-01
Sample #	T99
Depth (m)	1.5 - 2.2
Sample Date	20-May-16
Test Date	06-Jun-16
Technician	JB

Tube Extraction

Recovery (mm) 650



Visual Classification

Material	SILT
Composition	some clay
trace sand	
Color	brown
Moisture	moist
Consistency	firm to stiff
Plasticity	intermediate plasticity
Structure	varved
Gradation	-

Torvane

Reading	0.53
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	52.0

Pocket Penetrometer

Reading	**1**	1.50
	2	1.25
	3	1.50
	Average	1.42
Undrained Shear Strength (kPa)		69.5

Moisture Content

Tare ID	F132
Mass tare (g)	8.7
Mass wet + tare (g)	520.8
Mass dry + tare (g)	421.1
Moisture %	24.2%

Unit Weight

Bulk Weight (g)		1292.0
Length (mm)	**1**	151.13
	2	150.14
	3	150.45
	4	151.36
Average Length (m)		0.151
Diam. (mm)	**1**	72.36
	2	71.10
	3	72.30
	4	71.96
Average Diameter (m)		0.072
Volume (m^3)		6.13E-04
Bulk Unit Weight (kN/m^3)		20.7
Bulk Unit Weight (pcf)		131.7
Dry Unit Weight (kN/m^3)		16.7
Dry Unit Weight (pcf)		106.0

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Unconfined Compressive Strength

ASTM D2166

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16-01
Sample #	T99
Depth (m)	1.5 - 2.2
Sample Date	20-May-16
Test Date	6-Jun-16
Technician	JB

Unconfined Strength

	kPa	ksf
Max q_u	77.5	1.6
Max S_u	38.7	0.8

Specimen Data

Description SILT - some clay, trace sand, brown, moist, firm to stiff, intermediate plasticity, varved

Length	150.8	(mm)	**Moisture %**	24%	
Diameter	71.9	(mm)	**Bulk Unit Wt.**	20.7	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	16.7	(kN/m^3)
Initial Area	0.00406	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.53	52.0	1.09

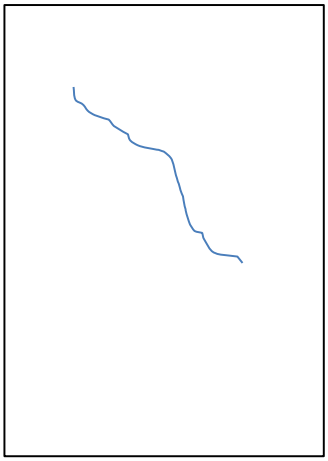
Vane Size
m

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	1.50	73.6	1.54
	1.25	61.3	1.28
	1.50	73.6	1.54
Average	**1.42**	**69.5**	**1.45**

Failure Geometry

Sketch:



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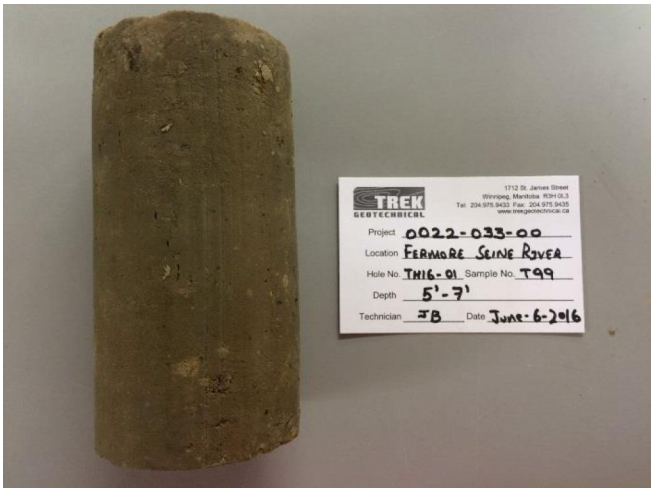

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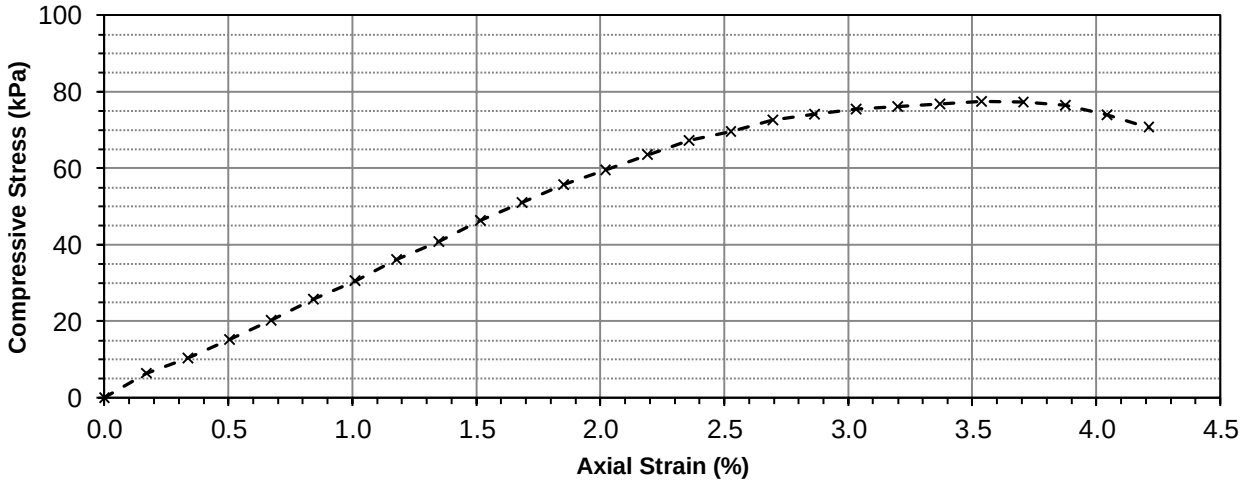
Unconfined Compressive Strength

ASTM D2166

Project No. 0022-033-00
Client Dillon Consulting Ltd.
Project Fermor Over Seine River

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004064	0.0	0.00	0.00
10	8	0.2540	0.17	0.004070	26.2	6.43	3.21
20	13	0.5080	0.34	0.004077	42.5	10.43	5.22
30	19	0.7620	0.51	0.004084	62.2	15.23	7.62
40	25	1.0160	0.67	0.004091	82.4	20.15	10.07
50	32	1.2700	0.84	0.004098	105.5	25.75	12.87
60	38	1.5240	1.01	0.004105	125.3	30.52	15.26
70	45	1.7780	1.18	0.004112	148.3	36.08	18.04
80	51	2.0320	1.35	0.004119	168.1	40.82	20.41
90	58	2.2860	1.52	0.004126	191.2	46.35	23.17
100	64	2.5400	1.68	0.004133	211.0	51.06	25.53
110	70	2.7940	1.85	0.004140	230.8	55.74	27.87
120	75	3.0480	2.02	0.004147	247.3	59.62	29.81
130	80	3.3020	2.19	0.004155	263.8	63.49	31.75
140	85	3.5560	2.36	0.004162	280.2	67.34	33.67
150	88	3.8100	2.53	0.004169	290.2	69.60	34.80
160	92	4.0640	2.70	0.004176	303.3	72.63	36.32
170	94	4.3180	2.86	0.004183	309.9	74.08	37.04
180	96	4.5720	3.03	0.004191	316.5	75.53	37.77
190	97	4.8260	3.20	0.004198	319.8	76.19	38.09
200	98	5.0800	3.37	0.004205	323.1	76.84	38.42
210	99	5.3340	3.54	0.004213	326.4	77.48	38.74
220	99	5.5880	3.71	0.004220	326.4	77.35	38.67
230	98	5.8420	3.87	0.004227	323.1	76.43	38.22

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Unconfined Compressive Strength

ASTM D2166

Project No. 0022-033-00
Client Dillon Consulting Ltd.
Project Fermor Over Seine River

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	95	6.0960	4.0432	0.004235	313.2	73.96	36.98
250	91	6.3500	4.21	0.004242	300.0	70.72	35.36

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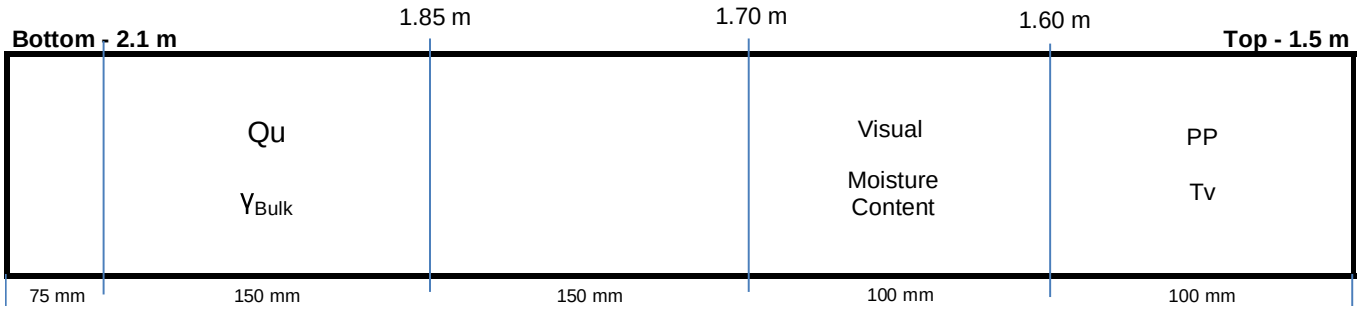
Shelby Tube Visual

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16-04
Sample #	T15
Depth (m)	1.5 - 2.1
Sample Date	20-May-16
Test Date	27-May-16
Technician	LI

Tube Extraction

Recovery (mm) 575



Visual Classification

Material	CLAY
Composition	sitly
trace sand	
trace organics (rootlets)	
Color	grey
Moisture	moist
Consistency	firm to stiff
Plasticity	high plasticity
Structure	homogeneous
Gradation	-

Torvane

Reading	0.28
Vane Size (s,m,l)	s
Undrained Shear Strength (kPa)	68.6

Pocket Penetrometer

Reading	**1**	1.50
	2	1.00
	3	1.00
	Average	1.17
Undrained Shear Strength (kPa)		57.2

Moisture Content

Tare ID	W28
Mass tare (g)	8.6
Mass wet + tare (g)	337.5
Mass dry + tare (g)	259.7
Moisture %	31.0%

Unit Weight

Bulk Weight (g)		1137.5
Length (mm)	**1**	145.59
	2	143.80
	3	144.62
	4	146.01
Average Length (m)		0.145
Diam. (mm)	**1**	72.55
	2	72.54
	3	71.76
	4	72.17
Average Diameter (m)		0.072
Volume (m^3)		5.95E-04
Bulk Unit Weight (kN/m^3)		18.8
Bulk Unit Weight (pcf)		119.4
Dry Unit Weight (kN/m^3)		14.3
Dry Unit Weight (pcf)		91.2

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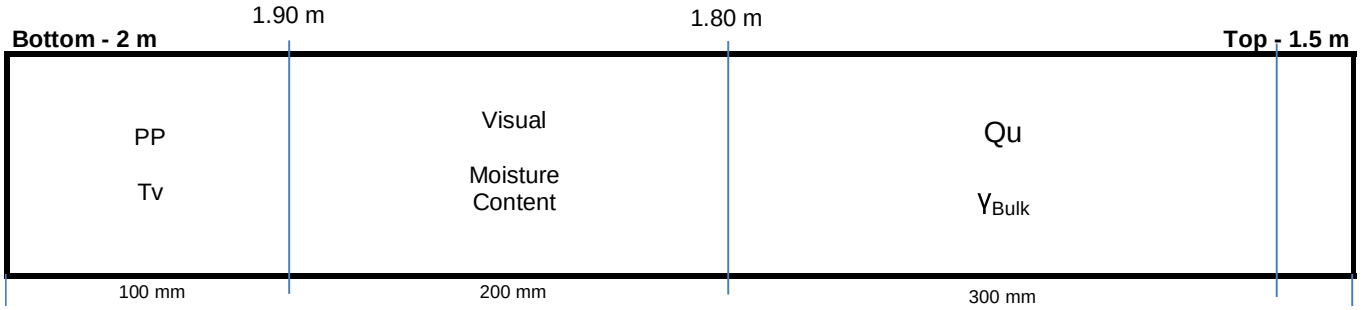
Shelby Tube Visual

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16-05
Sample #	T86
Depth (m)	1.5 - 2.0
Sample Date	20-May-16
Test Date	06-Jun-16
Technician	JB

Tube Extraction

Recovery (mm) 500



Visual Classification

Material	CLAY
Composition	sitly
trace silt inclusions (~<9 mmØ)	
trace oxidation	
trace organics (rootlets)	
Color	black
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	homogeneous/fissures
Gradation	-

Torvane

Reading	0.59
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	57.9

Pocket Penetrometer

Reading	**1**	2.30
	2	1.75
	3	1.75
	Average	1.93
Undrained Shear Strength (kPa)		94.8

Moisture Content

Tare ID	W26
Mass tare (g)	8.4
Mass wet + tare (g)	383.7
Mass dry + tare (g)	286.9
Moisture %	34.8%

Unit Weight

Bulk Weight (g)		1191.2
Length (mm)	**1**	154.40
	2	154.40
	3	153.30
	4	154.05
Average Length (m)		0.154
Diam. (mm)	**1**	75.10
	2	75.57
	3	75.19
	4	75.04
Average Diameter (m)		0.075
Volume (m^3)		6.85E-04
Bulk Unit Weight (kN/m^3)		17.1
Bulk Unit Weight (pcf)		108.6
Dry Unit Weight (kN/m^3)		12.7
Dry Unit Weight (pcf)		80.6

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Unconfined Compressive Strength

ASTM D2166

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16-05
Sample #	T86
Depth (m)	1.5 - 2.0
Sample Date	20-May-16
Test Date	6-Jun-16
Technician	JB

Unconfined Strength

	kPa	ksf
Max q_u	31.3	0.7
Max S_u	15.7	0.3

Specimen Data

Description CLAY - sitly, trace silt inclusions (~<9 mmØ), trace oxidation, trace organics (rootlets), black, moist, stiff, high plasticity, homogeneous/fissures

Length	154.0	(mm)	**Moisture %**	35%	
Diameter	75.2	(mm)	**Bulk Unit Wt.**	17.1	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	12.7	(kN/m^3)
Initial Area	0.00444	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.59	57.9	1.21
Vane Size		
m		

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	2.30	112.8	2.36
	1.75	85.8	1.79
	1.75	85.8	1.79
Average	**1.93**	**94.8**	**1.98**

Failure Geometry

Sketch:

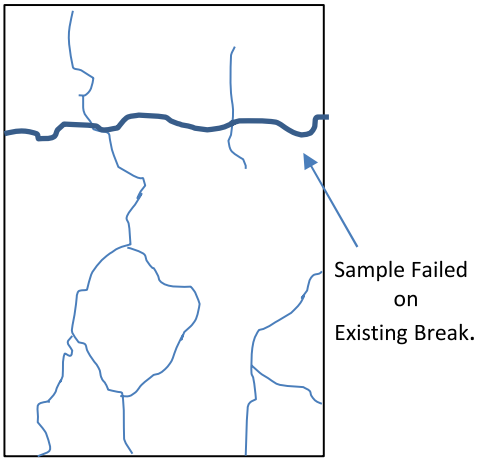

Photo:

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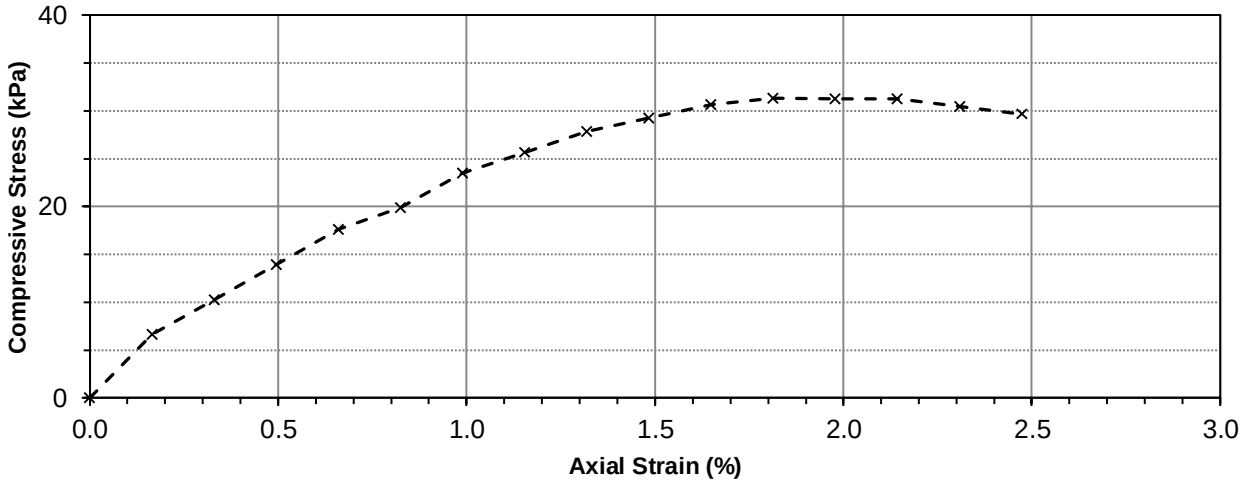
Unconfined Compressive Strength

ASTM D2166

Project No. 0022-033-00
Client Dillon Consulting Ltd.
Project Fermor Over Seine River

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004444	0.0	0.00	0.00
10	9	0.2540	0.16	0.004452	29.4	6.61	3.31
20	14	0.5080	0.33	0.004459	45.8	10.27	5.14
30	19	0.7620	0.49	0.004467	62.2	13.93	6.96
40	24	1.0160	0.66	0.004474	78.6	17.58	8.79
50	27	1.2700	0.82	0.004481	89.0	19.86	9.93
60	32	1.5240	0.99	0.004489	105.5	23.51	11.75
70	35	1.7780	1.15	0.004496	115.4	25.66	12.83
80	38	2.0320	1.32	0.004504	125.3	27.82	13.91
90	40	2.2860	1.48	0.004511	131.9	29.24	14.62
100	42	2.5400	1.65	0.004519	138.5	30.64	15.32
110	43	2.7940	1.81	0.004527	141.8	31.32	15.66
120	43	3.0480	1.98	0.004534	141.8	31.27	15.63
130	43	3.3020	2.14	0.004542	141.8	31.21	15.61
140	42	3.5560	2.31	0.004549	138.5	30.44	15.22
150	41	3.8100	2.47	0.004557	135.2	29.66	14.83

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Unconfined Compressive Strength

ASTM D2166

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16-04
Sample #	T15
Depth (m)	1.5 - 2.1
Sample Date	20-May-16
Test Date	27-May-16
Technician	LI

Unconfined Strength

	kPa	ksf
Max q_u	58.6	1.2
Max S_u	29.3	0.6

Specimen Data

Description CLAY - sitly, trace sand, trace organics (rootlets), grey, moist, firm to stiff, high plasticity, homogeneous

Length	145.0	(mm)	**Moisture %**	31%	
Diameter	72.3	(mm)	**Bulk Unit Wt.**	18.8	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	14.3	(kN/m^3)
Initial Area	0.00410	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

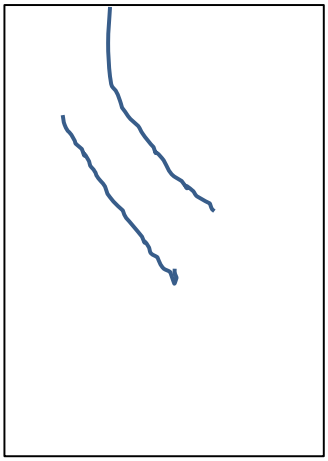
Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.28	68.6	1.43
Vane Size		
s		

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	1.50	73.6	1.54
	1.00	49.1	1.02
	1.00	49.1	1.02
Average	**1.17**	**57.2**	**1.20**

Failure Geometry

Sketch:



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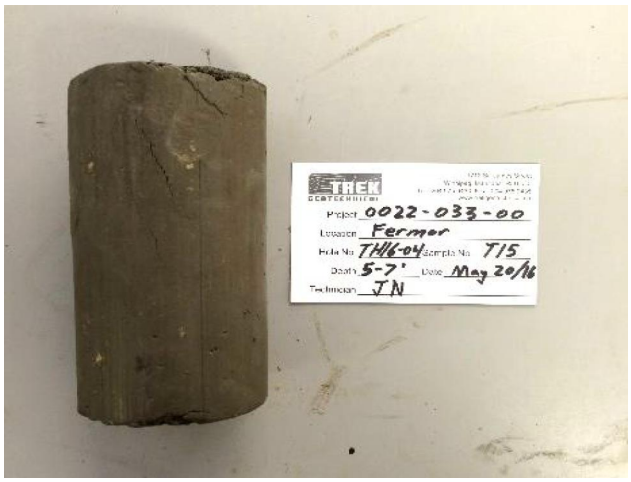

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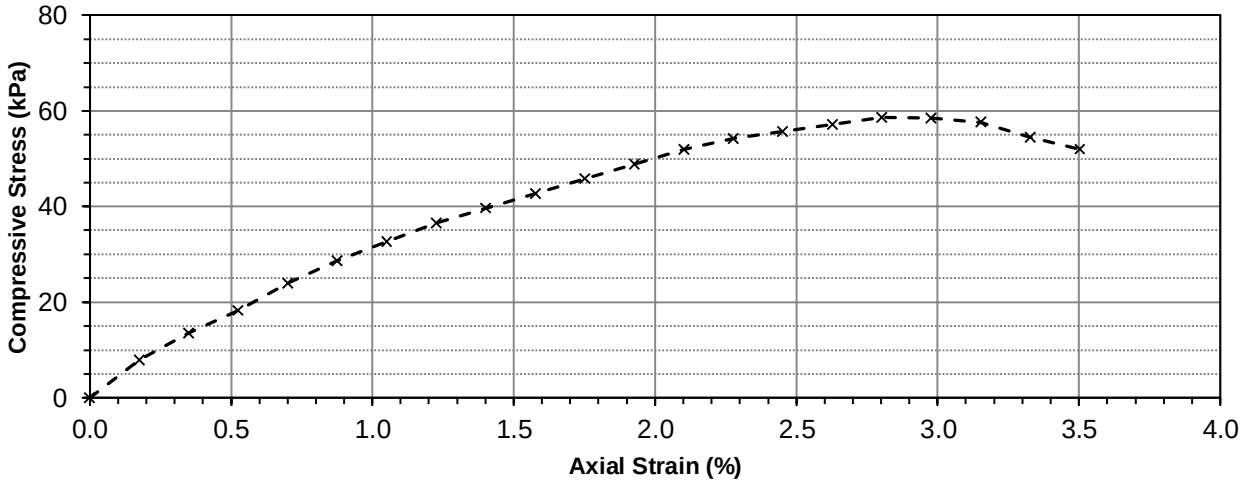
Unconfined Compressive Strength

ASTM D2166

Project No. 0022-033-00
Client Dillon Consulting Ltd.
Project Fermor Over Seine River

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004100	0.0	0.00	0.00
10	10	0.2540	0.18	0.004108	32.7	7.96	3.98
20	17	0.5080	0.35	0.004115	55.7	13.52	6.76
30	23	0.7620	0.53	0.004122	75.3	18.28	9.14
40	30	1.0160	0.70	0.004129	98.9	23.96	11.98
50	36	1.2700	0.88	0.004137	118.7	28.69	14.34
60	41	1.5240	1.05	0.004144	135.2	32.62	16.31
70	46	1.7780	1.23	0.004151	151.7	36.54	18.27
80	50	2.0320	1.40	0.004159	164.9	39.64	19.82
90	54	2.2860	1.58	0.004166	178.0	42.73	21.37
100	58	2.5400	1.75	0.004174	191.2	45.82	22.91
110	62	2.7940	1.93	0.004181	204.4	48.89	24.44
120	66	3.0480	2.10	0.004188	217.6	51.95	25.98
130	69	3.3020	2.28	0.004196	227.5	54.21	27.11
140	71	3.5560	2.45	0.004203	234.1	55.69	27.85
150	73	3.8100	2.63	0.004211	240.7	57.16	28.58
160	75	4.0640	2.80	0.004219	247.3	58.62	29.31
170	75	4.3180	2.98	0.004226	247.3	58.51	29.25
180	74	4.5720	3.15	0.004234	244.0	57.63	28.81
190	70	4.8260	3.33	0.004242	230.8	54.41	27.20
200	67	5.0800	3.50	0.004249	220.9	51.99	25.99

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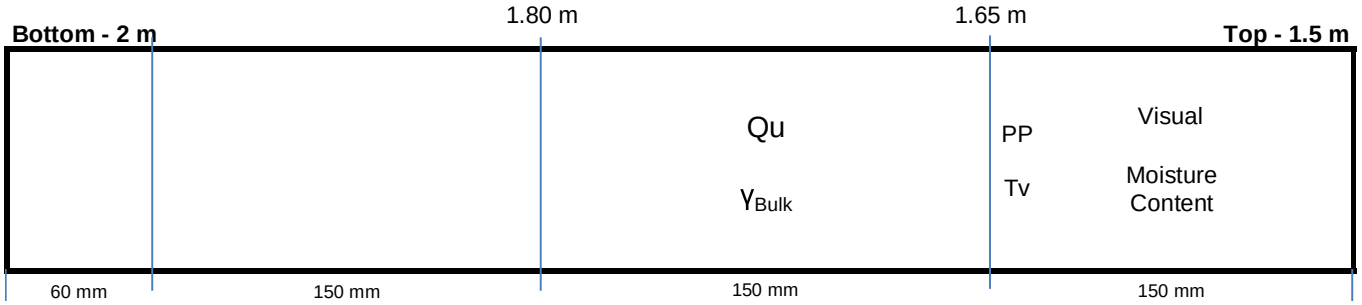
Shelby Tube Visual

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16-08
Sample #	T29
Depth (m)	1.5 - 2.0
Sample Date	20-May-16
Test Date	27-May-16
Technician	LI

Tube Extraction

Recovery (mm) 510



Visual Classification

Material	SILT
Composition	clayey
trace sand	
Color	mottled grey and brown
Moisture	moist
Consistency	soft to firm
Plasticity	intermediate plasticity
Structure	blocky
Gradation	-

Torvane

Reading	0.10
Vane Size (s,m,l)	s
Undrained Shear Strength (kPa)	24.5

Pocket Penetrometer

Reading	**1**	0.50
	2	0.50
	3	0.60
	Average	0.53
Undrained Shear Strength (kPa)		26.2

Moisture Content

Tare ID	AB100
Mass tare (g)	6.6
Mass wet + tare (g)	425.9
Mass dry + tare (g)	338.3
Moisture %	26.4%

Unit Weight

Bulk Weight (g)		1151.3
Length (mm)	**1**	146.12
	2	145.25
	3	146.51
	4	146.31
Average Length (m)		0.146
Diam. (mm)	**1**	71.47
	2	72.31
	3	71.96
	4	71.56
Average Diameter (m)		0.072
Volume (m^3)		5.92E-04
Bulk Unit Weight (kN/m^3)		19.1
Bulk Unit Weight (pcf)		121.5
Dry Unit Weight (kN/m^3)		15.1
Dry Unit Weight (pcf)		96.1

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Unconfined Compressive Strength

ASTM D2166

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16-08
Sample #	T29
Depth (m)	1.5 - 2.0
Sample Date	20-May-16
Test Date	27-May-16
Technician	LI

Unconfined Strength

	kPa	ksf
Max q_u	20.6	0.4
Max S_u	10.3	0.2

Specimen Data

Description SILT - clayey, trace sand, mottled grey and brown, moist, soft to firm, intermediate plasticity, blocky

Length	146.0	(mm)	**Moisture %**	26%	
Diameter	71.8	(mm)	**Bulk Unit Wt.**	19.1	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	15.1	(kN/m^3)
Initial Area	0.00405	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.10	24.5	0.51
Vane Size		
s		

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	0.50	24.5	0.51
	0.50	24.5	0.51
	0.60	29.4	0.61
Average	**0.53**	**26.2**	**0.55**

Failure Geometry

Sketch:

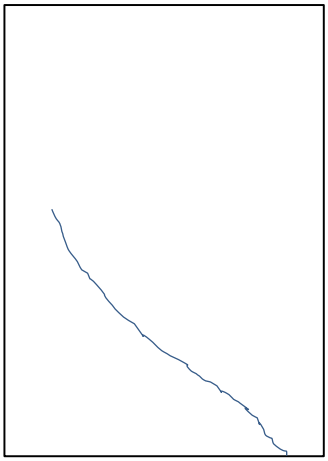

Photo:

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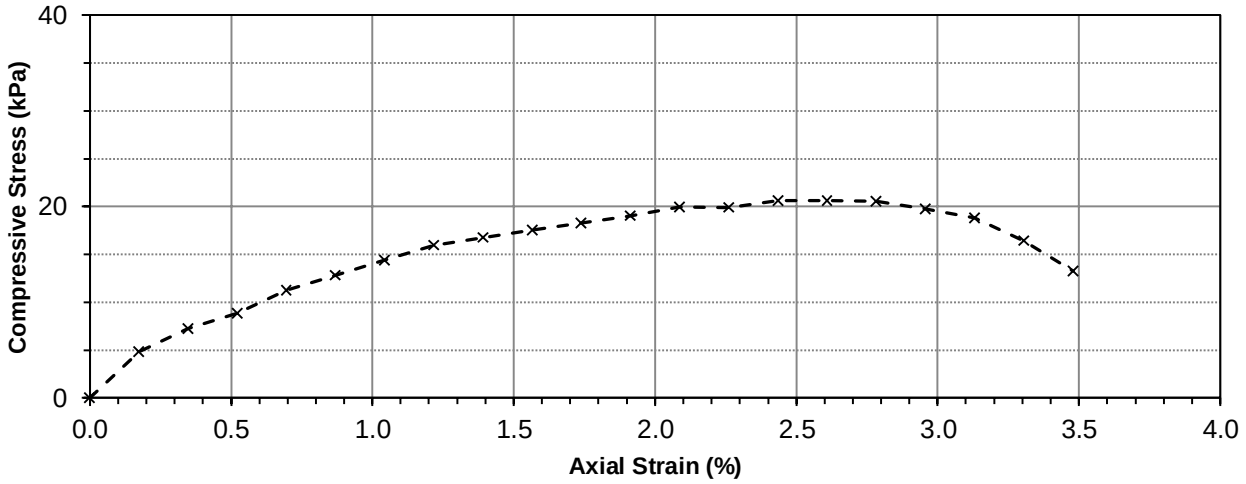
Unconfined Compressive Strength

ASTM D2166

Project No. 0022-033-00
Client Dillon Consulting Ltd.
Project Fermor Over Seine River

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004052	0.0	0.00	0.00
10	6	0.2540	0.17	0.004059	19.6	4.83	2.42
20	9	0.5080	0.35	0.004066	29.4	7.24	3.62
30	11	0.7620	0.52	0.004073	36.0	8.83	4.42
40	14	1.0160	0.70	0.004080	45.8	11.23	5.61
50	16	1.2700	0.87	0.004087	52.4	12.81	6.41
60	18	1.5240	1.04	0.004094	58.9	14.39	7.20
70	20	1.7780	1.22	0.004102	65.5	15.97	7.98
80	21	2.0320	1.39	0.004109	68.8	16.74	8.37
90	22	2.2860	1.57	0.004116	72.1	17.51	8.75
100	23	2.5400	1.74	0.004123	75.3	18.27	9.14
110	24	2.7940	1.91	0.004131	78.6	19.04	9.52
120	25	3.0480	2.09	0.004138	82.4	19.92	9.96
130	25	3.3020	2.26	0.004145	82.4	19.88	9.94
140	26	3.5560	2.43	0.004153	85.7	20.64	10.32
150	26	3.8100	2.61	0.004160	85.7	20.60	10.30
160	26	4.0640	2.78	0.004168	85.7	20.57	10.28
170	25	4.3180	2.96	0.004175	82.4	19.74	9.87
180	24	4.5720	3.13	0.004183	78.6	18.80	9.40
190	21	4.8260	3.30	0.004190	68.8	16.41	8.21
200	17	5.0800	3.48	0.004198	55.7	13.26	6.63

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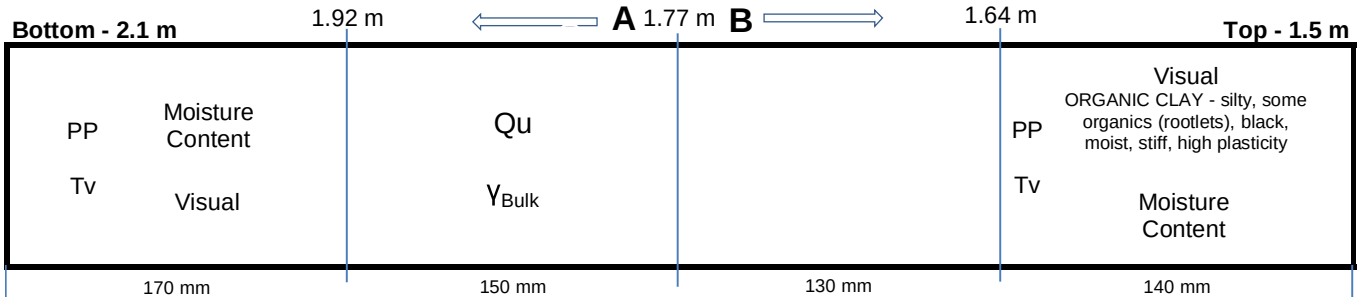
Shelby Tube Visual

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16-09
Sample #	T72
Depth (m)	1.5 - 2.1
Sample Date	20-May-16
Test Date	31-May-16
Technician	LI

Tube Extraction

Recovery (mm) 590



Visual Classification - **A**

Material	CLAY
Composition	silty
trace sand	
some organics (rootlets)	
Color	grey
Moisture	moist
Consistency	firm to stiff
Plasticity	intermediate plasticity
Structure	blocky
Gradation	-

Torvane

	B	A
Reading	0.24	0.20
Vane Size (s,m,l)	s	s
Undrained Shear Strength (kPa)	58.8	49.0

Pocket Penetrometer

Reading	**1**	1.200	1.90
	2	1.300	1.80
	3	1.200	1.75
	Average	1.23	1.82
Undrained Shear Strength (kPa)		60.5	89.1

Moisture Content

	B	A
Tare ID	H53	Z24
Mass tare (g)	8.7	8.5
Mass wet + tare (g)	321.6	365.8
Mass dry + tare (g)	240	279.6
Moisture %	35.3%	31.8%

Unit Weight

		B	A
Bulk Weight (g)			1187.4
Length (mm)	**1**		150.34
	2		151.05
	3		150.87
	4		150.55
Average Length (m)			0.151
Diam. (mm)	**1**		72.70
	2		72.48
	3		72.66
	4		72.19
Average Diameter (m)			0.073
Volume (m^3)			6.22E-04
Bulk Unit Weight (kN/m^3)			18.7
Bulk Unit Weight (pcf)			119.1
Dry Unit Weight (kN/m^3)			14.2
Dry Unit Weight (pcf)			90.4

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Unconfined Compressive Strength

ASTM D2166

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River

Test Hole	TH16-09
Sample #	T72
Depth (m)	1.5 - 2.1
Sample Date	20-May-16
Test Date	31-May-16
Technician	LI

Unconfined Strength

	kPa	ksf
Max q_u	53.6	1.1
Max S_u	26.8	0.6

Specimen Data

Description CLAY - silty, trace sand, some organics (rootlets), grey, moist, firm to stiff, intermediate plasticity, blocky

Length	150.7	(mm)
Diameter	72.5	(mm)
L/D Ratio	2.1	
Initial Area	0.00413	(m^2)
Load Rate	1.00	(%/min)

Moisture %	32%	
Bulk Unit Wt.	18.7	(kN/m^3)
Dry Unit Wt.	14.2	(kN/m^3)
Liquid Limit	-	
Plastic Limit	-	
Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.20	49.0	1.02
Vane Size		
s		

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	1.90	93.2	1.95
	1.80	88.3	1.84
	1.75	85.8	1.79
Average	**1.82**	**89.1**	**1.86**

Failure Geometry

Sketch:

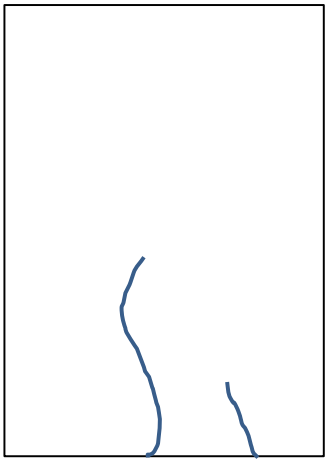

Photo:

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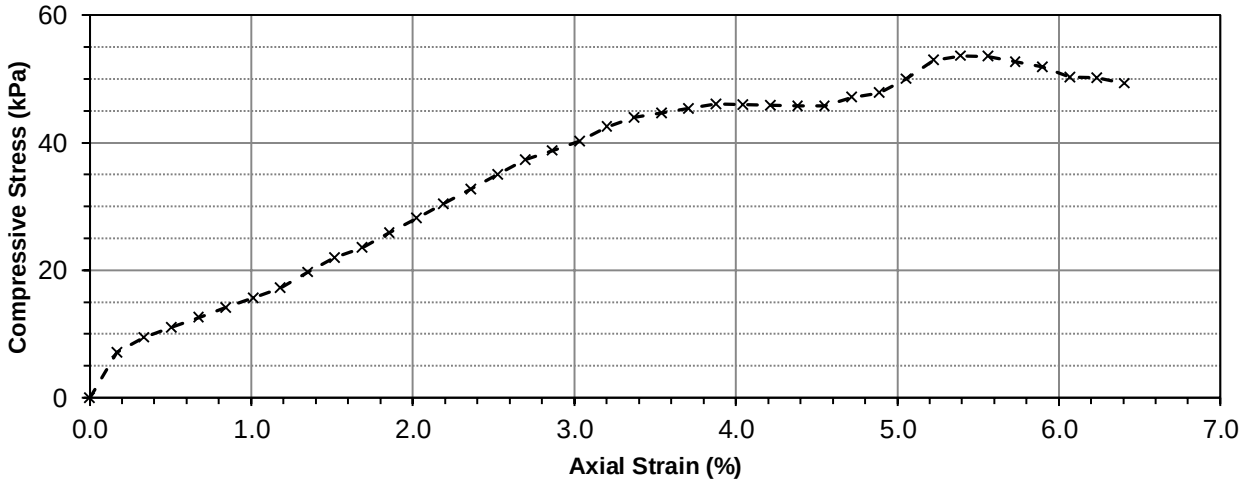
Unconfined Compressive Strength

ASTM D2166

Project No. 0022-033-00
Client Dillon Consulting Ltd.
Project Fermor Over Seine River

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004129	0.0	0.00	0.00
10	9	0.2540	0.17	0.004136	29.4	7.12	3.56
20	12	0.5080	0.34	0.004143	39.3	9.48	4.74
30	14	0.7620	0.51	0.004150	45.8	11.04	5.52
40	16	1.0160	0.67	0.004157	52.4	12.60	6.30
50	18	1.2700	0.84	0.004164	58.9	14.15	7.08
60	20	1.5240	1.01	0.004171	65.5	15.70	7.85
70	22	1.7780	1.18	0.004178	72.1	17.25	8.62
80	25	2.0320	1.35	0.004186	82.4	19.69	9.85
90	28	2.2860	1.52	0.004193	92.3	22.01	11.01
100	30	2.5400	1.69	0.004200	98.9	23.56	11.78
110	33	2.7940	1.85	0.004207	108.8	25.86	12.93
120	36	3.0480	2.02	0.004214	118.7	28.16	14.08
130	39	3.3020	2.19	0.004222	128.6	30.46	15.23
140	42	3.5560	2.36	0.004229	138.5	32.74	16.37
150	45	3.8100	2.53	0.004236	148.3	35.02	17.51
160	48	4.0640	2.70	0.004244	158.3	37.30	18.65
170	50	4.3180	2.87	0.004251	164.9	38.78	19.39
180	52	4.5720	3.03	0.004258	171.4	40.26	20.13
190	55	4.8260	3.20	0.004266	181.4	42.51	21.26
200	57	5.0800	3.37	0.004273	187.9	43.98	21.99
210	58	5.3340	3.54	0.004281	191.2	44.67	22.34
220	59	5.5880	3.71	0.004288	194.5	45.36	22.68
230	60	5.8420	3.88	0.004296	197.8	46.05	23.02

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Unconfined Compressive Strength

ASTM D2166

Project No. 0022-033-00
Client Dillon Consulting Ltd.
Project Fermor Over Seine River

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	60	6.0960	4.0451	0.004303	197.8	45.97	22.98
250	60	6.3500	4.21	0.004311	197.8	45.89	22.94
260	60	6.6040	4.38	0.004318	197.8	45.81	22.90
270	60	6.8580	4.55	0.004326	197.8	45.73	22.86
280	62	7.1120	4.72	0.004334	204.4	47.17	23.58
290	63	7.3660	4.89	0.004341	207.7	47.85	23.93
300	66	7.6200	5.06	0.004349	217.6	50.04	25.02
310	70	7.8740	5.22	0.004357	230.8	52.97	26.48
320	71	8.1280	5.39	0.004364	234.1	53.64	26.82
330	71	8.3820	5.56	0.004372	234.1	53.54	26.77
340	70	8.6360	5.73	0.004380	230.8	52.69	26.34
350	69	8.8900	5.90	0.004388	227.5	51.84	25.92
360	67	9.1440	6.07	0.004396	220.9	50.25	25.13
370	67	9.3980	6.24	0.004404	220.9	50.16	25.08
380	66	9.6520	6.40	0.004412	217.6	49.33	24.66

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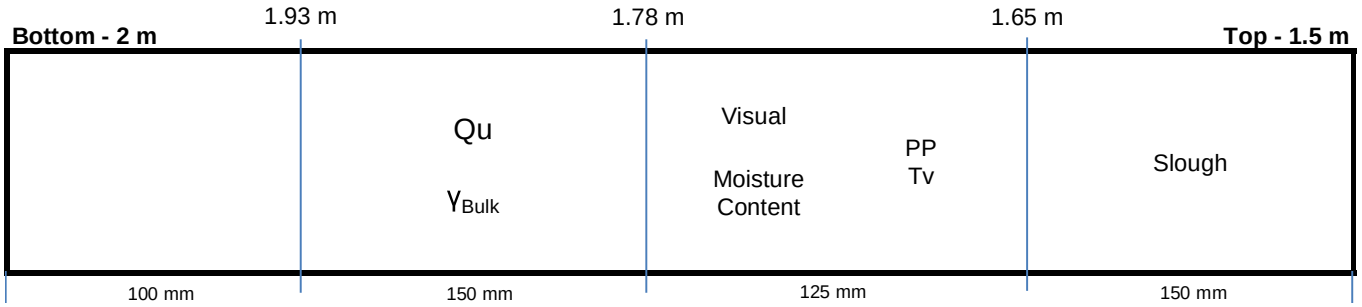
Shelby Tube Visual

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16-12
Sample #	T44
Depth (m)	1.5 - 2.0
Sample Date	20-May-16
Test Date	27-May-16
Technician	LI

Tube Extraction

Recovery (mm) 525



Visual Classification

Material	CLAY
Composition	silty
trace sand	
trace organics	
Color	grey
Moisture	moist
Consistency	soft to stiff
Plasticity	high plasticity
Structure	homogeneous
Gradation	-

Torvane

Reading	0.20
Vane Size (s,m,l)	s
Undrained Shear Strength (kPa)	49.0

Pocket Penetrometer

Reading	**1**	1.50
	2	1.25
	3	1.50
	Average	1.42
Undrained Shear Strength (kPa)		69.5

Moisture Content

Tare ID	F150
Mass tare (g)	8.2
Mass wet + tare (g)	361.3
Mass dry + tare (g)	278.3
Moisture %	30.7%

Unit Weight

Bulk Weight (g)		1132.5
Length (mm)	**1**	152.82
	2	153.18
	3	153.10
	4	151.75
Average Length (m)		0.153
Diam. (mm)	**1**	72.72
	2	72.74
	3	72.23
	4	72.97
Average Diameter (m)		0.073
Volume (m^3)		6.33E-04
Bulk Unit Weight (kN/m^3)		17.5
Bulk Unit Weight (pcf)		111.6
Dry Unit Weight (kN/m^3)		13.4
Dry Unit Weight (pcf)		85.4

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Unconfined Compressive Strength

ASTM D2166

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16-12
Sample #	T44
Depth (m)	1.5 - 2.0
Sample Date	20-May-16
Test Date	27-May-16
Technician	LI

Unconfined Strength

	kPa	ksf
Max q_u	39.9	0.8
Max S_u	19.9	0.4

Specimen Data

Description CLAY - silty, trace sand, trace organics, grey, moist, soft to stiff, high plasticity, homogeneous

Length	152.7	(mm)	**Moisture %**	31%	
Diameter	72.7	(mm)	**Bulk Unit Wt.**	17.5	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	13.4	(kN/m^3)
Initial Area	0.00415	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.20	49.0	1.02
Vane Size		
s		

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	1.50	73.6	1.54
	1.25	61.3	1.28
	1.50	73.6	1.54
Average	**1.42**	**69.5**	**1.45**

Failure Geometry

Sketch:

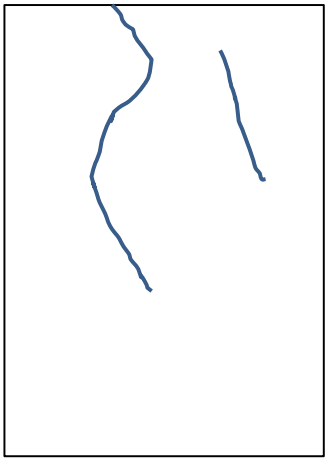

Photo:

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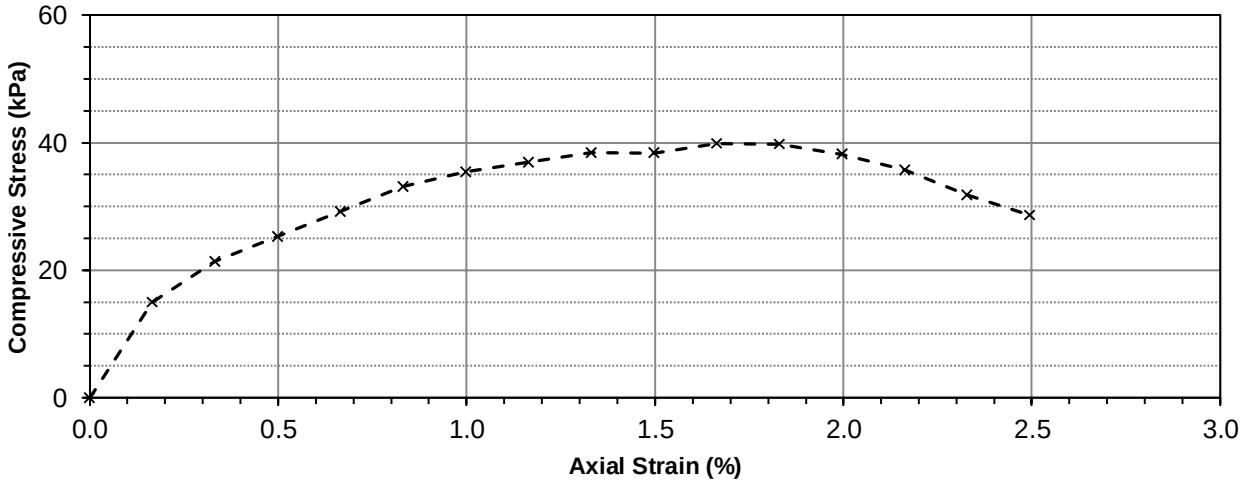
Unconfined Compressive Strength

ASTM D2166

Project No. 0022-033-00
Client Dillon Consulting Ltd.
Project Fermor Over Seine River

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004147	0.0	0.00	0.00
10	19	0.2540	0.17	0.004154	62.2	14.98	7.49
20	27	0.5080	0.33	0.004161	89.0	21.39	10.70
30	32	0.7620	0.50	0.004168	105.5	25.32	12.66
40	37	1.0160	0.67	0.004175	122.0	29.22	14.61
50	42	1.2700	0.83	0.004182	138.5	33.11	16.56
60	45	1.5240	1.00	0.004189	148.3	35.41	17.71
70	47	1.7780	1.16	0.004196	155.0	36.93	18.47
80	49	2.0320	1.33	0.004203	161.6	38.44	19.22
90	49	2.2860	1.50	0.004210	161.6	38.37	19.19
100	51	2.5400	1.66	0.004217	168.1	39.87	19.94
110	51	2.7940	1.83	0.004224	168.1	39.80	19.90
120	49	3.0480	2.00	0.004232	161.6	38.18	19.09
130	46	3.3020	2.16	0.004239	151.7	35.79	17.89
140	41	3.5560	2.33	0.004246	135.2	31.84	15.92
150	37	3.8100	2.49	0.004253	122.0	28.68	14.34

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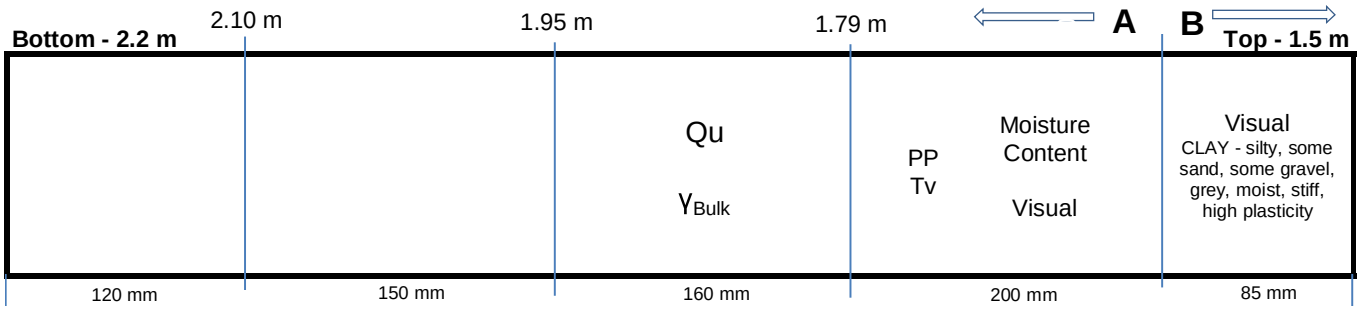
Shelby Tube Visual

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16-13
Sample #	T58
Depth (m)	1.5 - 2.2
Sample Date	20-May-16
Test Date	31-May-16
Technician	LI

Tube Extraction

Recovery (mm) 715



Visual Classification - **A**

Material	SILT
Composition	clayey
trace sand	
trace organics (rootlets)	
Color	grey
Moisture	moist
Consistency	firm
Plasticity	intermediate plasticity
Structure	blocky
Gradation	-

Torvane

	B	A
Reading	0.36	0.13
Vane Size (s,m,l)	s	s
Undrained Shear Strength (kPa)	88.3	31.9

Pocket Penetrometer

Reading	**1**	1.600	0.60
	2	1.750	0.90
	3	1.200	1.10
	Average	1.52	0.87
Undrained Shear Strength (kPa)		74.4	42.5

Moisture Content

	B	A
Tare ID	H69	P04
Mass tare (g)	8.65	8.4
Mass wet + tare (g)	400	418.1
Mass dry + tare (g)	313	339.4
Moisture %	28.6%	23.8%

Unit Weight

		B	A
Bulk Weight (g)			1337.7
Length (mm)	**1**		153.31
	2		153.52
	3		154.32
	4		153.57
Average Length (m)			0.154
Diam. (mm)	**1**		73.18
	2		74.87
	3		73.74
	4		72.39
Average Diameter (m)			0.074
Volume (m^3)			6.53E-04
Bulk Unit Weight (kN/m^3)			20.1
Bulk Unit Weight (pcf)			127.9
Dry Unit Weight (kN/m^3)			16.2
Dry Unit Weight (pcf)			103.3

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Unconfined Compressive Strength

ASTM D2166

Project No.	0022-033-00
Client	Dillon Consulting Ltd.
Project	Fermor Over Seine River
Test Hole	TH16-13
Sample #	T58
Depth (m)	1.5 - 2.2
Sample Date	20-May-16
Test Date	31-May-16
Technician	LI

Unconfined Strength

	kPa	ksf
Max q_u	64.2	1.3
Max S_u	32.1	0.7

Specimen Data

Description SILT - clayey, trace sand, trace organics (rootlets), grey, moist, firm, intermediate plasticity, blocky

Length	153.7	(mm)	**Moisture %**	24%	
Diameter	73.5	(mm)	**Bulk Unit Wt.**	20.1	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	16.2	(kN/m^3)
Initial Area	0.00425	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.13	31.9	0.67
Vane Size		
s		

Pocket Penetrometer

	Reading	Undrained Shear Strength	
	tsf	**kPa**	**ksf**
	0.60	29.4	0.61
	0.90	44.1	0.92
	1.10	54.0	1.13
Average	**0.87**	**42.5**	**0.89**

Failure Geometry

Sketch:

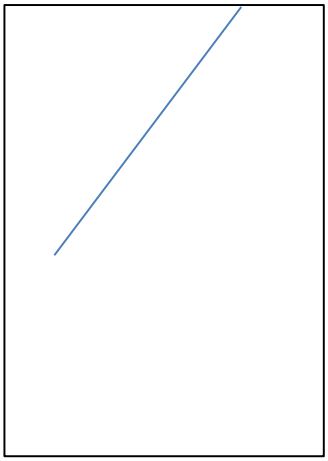
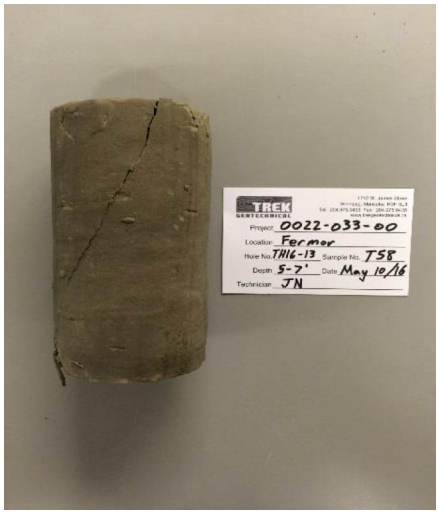


Photo:



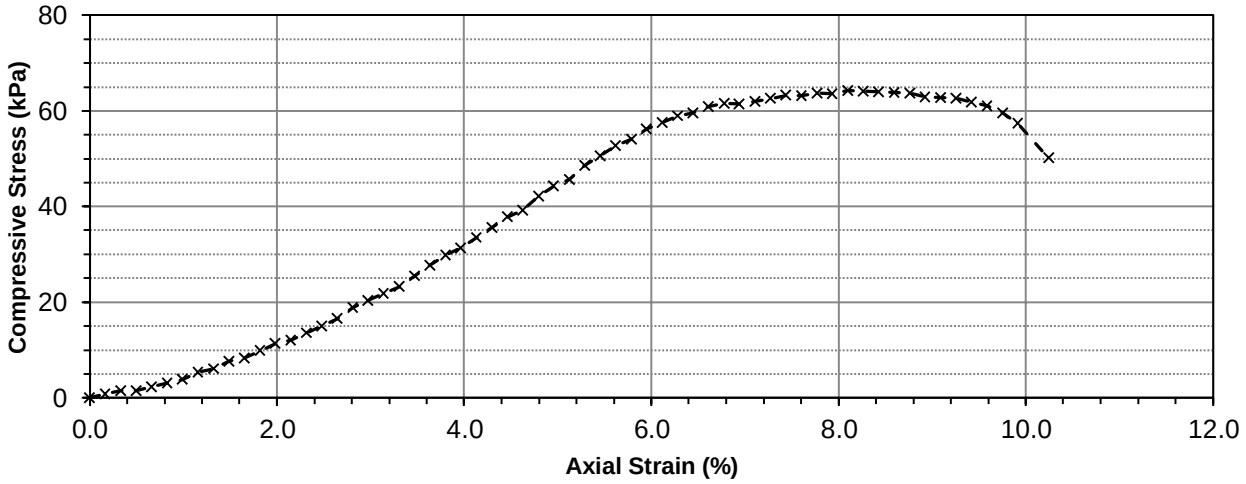
www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Unconfined Compressive Strength

ASTM D2166

Project No. 0022-033-00
Client Dillon Consulting Ltd.
Project Fermor Over Seine River

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004248	0.0	0.00	0.00
10	1	0.2540	0.17	0.004255	3.3	0.77	0.38
20	2	0.5080	0.33	0.004262	6.5	1.53	0.77
30	2	0.7620	0.50	0.004269	6.5	1.53	0.77
40	3	1.0160	0.66	0.004276	9.8	2.29	1.15
50	4	1.2700	0.83	0.004284	13.1	3.05	1.53
60	5	1.5240	0.99	0.004291	16.3	3.81	1.90
70	7	1.7780	1.16	0.004298	22.9	5.33	2.66
80	8	2.0320	1.32	0.004305	26.2	6.08	3.04
90	10	2.2860	1.49	0.004312	32.7	7.58	3.79
100	11	2.5400	1.65	0.004320	36.0	8.33	4.17
110	13	2.7940	1.82	0.004327	42.5	9.83	4.92
120	15	3.0480	1.98	0.004334	49.1	11.33	5.66
130	16	3.3020	2.15	0.004341	52.4	12.06	6.03
140	18	3.5560	2.31	0.004349	58.9	13.55	6.78
150	20	3.8100	2.48	0.004356	65.5	15.04	7.52
160	22	4.0640	2.64	0.004364	72.1	16.51	8.26
170	25	4.3180	2.81	0.004371	82.4	18.86	9.43
180	27	4.5720	2.98	0.004378	89.0	20.33	10.16
190	29	4.8260	3.14	0.004386	95.6	21.80	10.90
200	31	5.0800	3.31	0.004393	102.2	23.27	11.63
210	34	5.3340	3.47	0.004401	112.1	25.47	12.74
220	37	5.5880	3.64	0.004408	122.0	27.67	13.83
230	40	5.8420	3.80	0.004416	131.9	29.87	14.93

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Unconfined Compressive Strength

ASTM D2166

Project No. 0022-033-00
Client Dillon Consulting Ltd.
Project Fermor Over Seine River

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	42	6.0960	3.9667	0.004424	138.5	31.30	15.65
250	45	6.3500	4.13	0.004431	148.3	33.48	16.74
260	48	6.6040	4.30	0.004439	158.3	35.66	17.83
270	51	6.8580	4.46	0.004447	168.1	37.81	18.91
280	53	7.1120	4.63	0.004454	174.7	39.23	19.61
290	57	7.3660	4.79	0.004462	187.9	42.12	21.06
300	60	7.6200	4.96	0.004470	197.8	44.26	22.13
310	62	7.8740	5.12	0.004478	204.4	45.65	22.82
320	66	8.1280	5.29	0.004485	217.6	48.52	24.26
330	69	8.3820	5.45	0.004493	227.5	50.63	25.31
340	72	8.6360	5.62	0.004501	237.4	52.74	26.37
350	74	8.8900	5.78	0.004509	244.0	54.11	27.06
360	77	9.1440	5.95	0.004517	253.9	56.20	28.10
370	79	9.3980	6.12	0.004525	260.4	57.56	28.78
380	81	9.6520	6.28	0.004533	267.1	58.92	29.46
390	82	9.9060	6.45	0.004541	270.4	59.54	29.77
400	84	10.1600	6.61	0.004549	276.9	60.88	30.44
410	85	10.4140	6.78	0.004557	280.2	61.50	30.75
420	85	10.6680	6.94	0.004565	280.2	61.39	30.69
430	86	10.9220	7.11	0.004573	283.5	62.00	31.00
440	87	11.1760	7.27	0.004581	286.8	62.61	31.30
450	88	11.4300	7.44	0.004589	290.2	63.22	31.61
460	88	11.6840	7.60	0.004598	290.2	63.11	31.55
470	89	11.9380	7.77	0.004606	293.4	63.71	31.86
480	89	12.1920	7.93	0.004614	293.4	63.60	31.80
490	90	12.4460	8.10	0.004622	296.7	64.20	32.10
500	90	12.7000	8.26	0.004631	296.7	64.08	32.04
510	90	12.9540	8.43	0.004639	296.7	63.96	31.98
520	90	13.2080	8.59	0.004648	296.7	63.85	31.92
530	90	13.4620	8.76	0.004656	296.7	63.73	31.87
540	89	13.7160	8.93	0.004664	293.4	62.91	31.46
550	89	13.9700	9.09	0.004673	293.4	62.80	31.40
560	89	14.2240	9.26	0.004681	293.4	62.68	31.34
570	88	14.4780	9.42	0.004690	290.2	61.87	30.93
580	87	14.7320	9.59	0.004699	286.8	61.05	30.52
590	85	14.9860	9.75	0.004707	280.2	59.53	29.77
600	82	15.2400	9.92	0.004716	270.4	57.33	28.67
620	72	15.7480	10.25	0.004733	237.4	50.16	25.08

Appendix C

Photographs of Pavement Core Samples

Photo 1: Pavement Core Sample at Test Hole TH16-01

Photo 2: Pavement Core Sample at Test Hole TH16-02

Photo 3: Pavement Core Sample at Test Hole TH16-03

Photo 4: Pavement Core Sample at Test Hole TH16-04

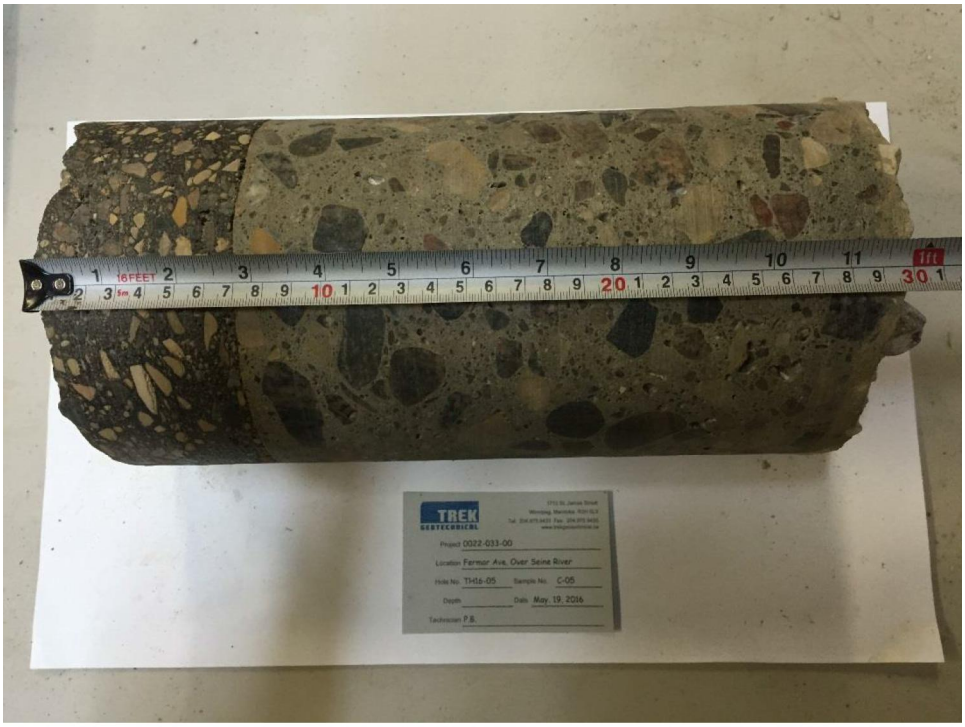


Photo 5: Pavement Core Sample at Test Hole TH16-05

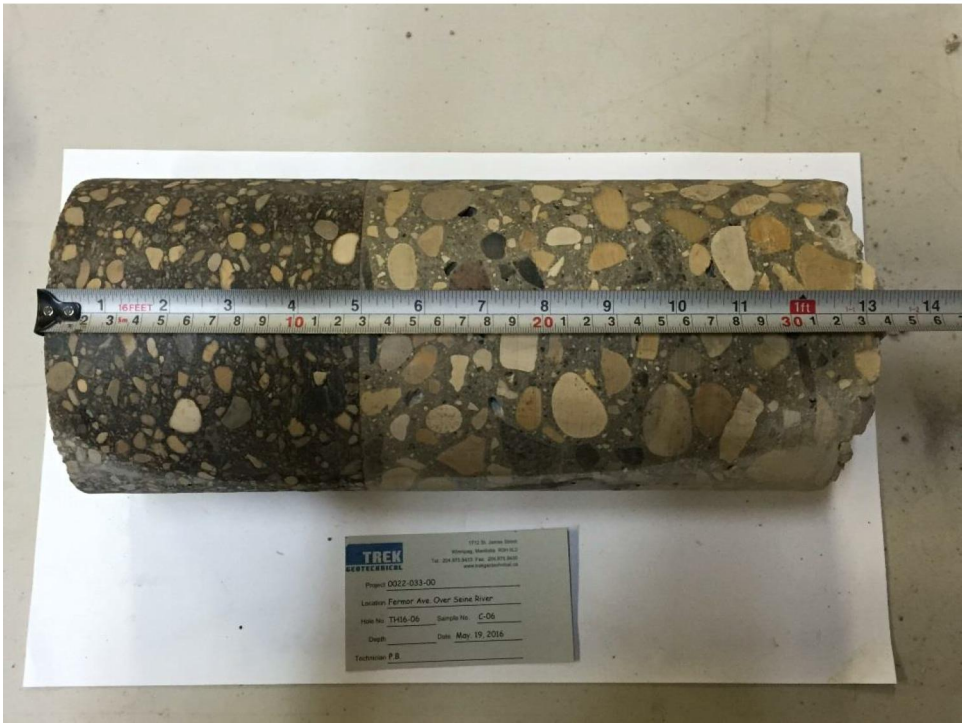


Photo 6: Pavement Core Sample at Test Hole TH16-06

Photo 7: Pavement Core Sample at Test Hole TH16-07

Photo 8: Pavement Core Sample at Test Hole TH16-08

Photo 9: Pavement Core Sample at Test Hole TH16-09

Photo 10: Pavement Core Sample at Test Hole TH16-10

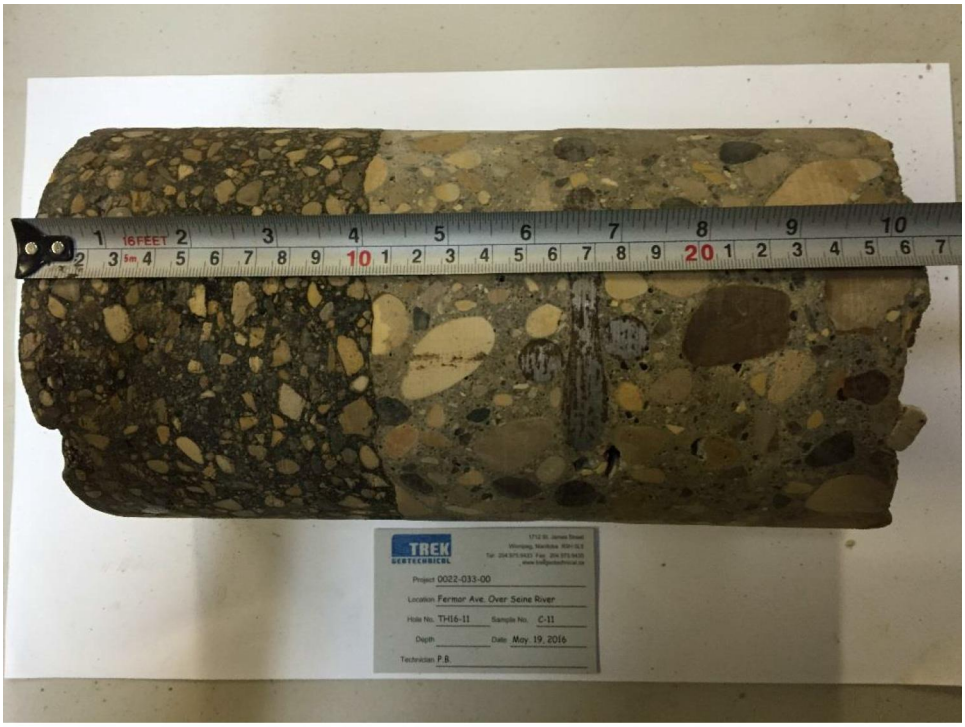


Photo 11: Pavement Core Sample at Test Hole TH16-11

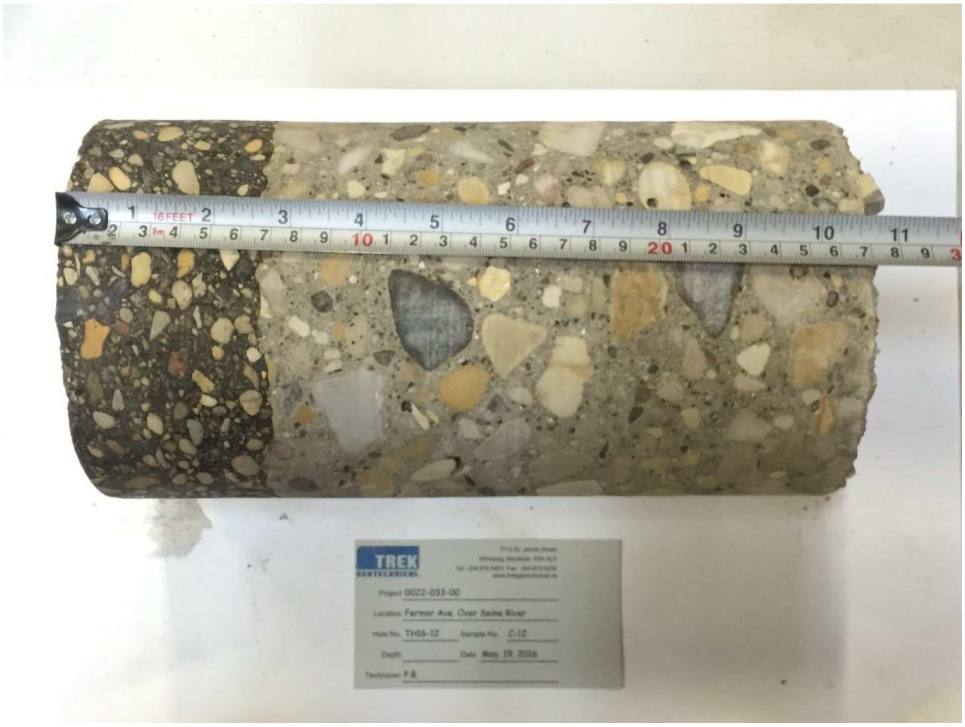


Photo 12: Pavement Core Sample at Test Hole TH16-12

Photo 13: Pavement Core Sample at Test Hole TH16-13

Photo 14: Pavement Core Sample at Test Hole TH16-14

APPENDIX ‘C’

PAVEMENT CORES BRIDGE DECK AND SUBSTRUCTURE

Stantec Consulting Ltd.
199 Henlow Bay, Winnipeg MB R3Y 1G4

June 9, 2016
File: 123312551

Attention: Mr. Mike Lau
1558 Willson Place
Winnipeg, MB R3T 0Y4

Good day Mike,

Reference: Fermor Avenue Bridge Over Seine River

On May 18th and 25th, 2016, Stantec Consulting Ltd. was retained to recover a total of twenty-eight (28) core samples from the Fermor Avenue Bridge over the Seine River in Winnipeg, Manitoba. Twelve (12) core samples were obtained from the bridge deck, which the remaining sixteen (16) core samples were recovered from the substructure. The purpose of the coring program was to determine the compressive strength, air-void parameters, and chloride content of the concrete. As instructed by Dillon Consulting, all testing conducted on the deck concrete was performed below the high density concrete overlay. Photographs of the core samples are attached to this report. The testing performed and the corresponding results for each core sample are identified below.

Unit Weight

Ten (10) core samples (2 from the bridge deck and 8 from the substructure) were tested for unit weight in accordance with section 9.1.1 of *ASTM C1084, Standard Test Method for Portland-Cement of Hardened Hydraulic Concrete*.

The unit weight results for the bridge deck were 2381 and 2298 kg/m³ with an average of 2340 kg/m³. The unit weight results for the substructure ranged from 2351 to 2402 kg/m³ with an average of 2371 kg/m³. A summary of the unit weight results are provided in the attached Table 1.

Compressive Strength

Ten (10) core samples (2 from the bridge deck and 8 from the substructure) were tested for compressive strength in accordance with *CSA A23.2-14C, Obtaining and Testing Drilled Cores for Compressive Strength*. The core samples were conditions in water at room temperature for 48 hours prior to testing.

The compressive strength results for the bridge deck were 45.5 and 22.7 MPa with an average of 34.0 MPa. The compressive strength for the substructure ranged from 34.7 to 75.2 MPa with an average of 52.3 MPa. A summary of the compressive strength results are provided in the attached Table 1.

Reference: Fermor Avenue Bridge Over Seine River

Chloride Content

Thirteen (13) core samples (5 from the bridge deck and 8 from the substructure) were prepared for chloride content determination by trimming 10 mm slices at prescribed depths from the surface of the core sample. Testing of the 10 mm slices were performed in accordance with *CSA A23.2-4B, Sampling and Determination of Water-Soluble Chloride Ion Content in Hardened Grout or Concrete*. The chloride content results are summarized in the attached Table 2.

The chloride threshold necessary to permit corrosion in the reinforcing steel with the presence of oxygen and moisture has to be greater than 0.025% by mass of concrete (in accordance with OSRM manual, April 2007). The chloride results that exceed this threshold are highlighted in Table 2.

Hardened Air-Void Parameters

Five (5) core samples obtained from the bridge deck were tested for air-void parameters in accordance with the modified linear point count method outlined in *ASTM C457, Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete*. The air void parameters for the concrete core samples testing are summarized in the attached Table 3.

The air-void parameter results for core nos. D2, D4, and D6 (as highlighted in Table 3) do not meet CSA A23.1 specification limits for frost resistant concrete. It should be noted that the concrete represented by these three core samples was obtained from the original construction of the bridge deck.

We appreciate the opportunity to assist you on this project. Please contact the undersigned if you have any questions regarding this report.

Regards,

STANTEC CONSULTING LTD.

Jason Thompson, C.E.T.
Senior Associate - Team Lead
Manager, Materials Testing Services
Phone: (204) 928-4004
Jason.Thompson@stantec.com

Attachment: Table 1 – Unit Weight & Compressive Strength Test Data
Table 2 – Chloride Content Test Data
Table 3 – Air Void Parameter Test Data

Reference: Fermor Avenue Bridge Over Seine River

TABLE 1
UNIT WEIGHT & COMPRESSIVE STRENGTH TEST DATA

Core No.	Core Identification		Unit Weight (kg/m³)	Compressive Strength (MPa)
	Structure	Location		
D3	Deck	Eastbound curb lane, 8.9 m east of west expansion joint, 4.5 m south of median	2381	45.5
D9	Deck	Eastbound shoulder, 3.9 m east of west expansion joint, 2.4 m north of traffic barrier	2298	22.7
P2	East Pier	East face of pier, 1.5 m south of 2nd girder from north side, 0.7 m below top of pier	2387	34.7
P4	East Pier	East face of pier, 1.1 m south of 7th girder from north side, 0.4 m below top of pier	2382	68.8
P6	West Pier	West face of pier, 0.7 m south of 2nd girder from north side, 0.4 m below top of pier	2337	42.1
P8	West Pier	West face of pier, below 7th girder from north side, 0.8 m below top of pier	2351	52.5
A2	East Abutment	West face of abutment, 1.7 m south of 1st girder from north side, 0.2 m from bearing seat area	2402	46.6
A3	East Abutment	West face of abutment, 0.6 m south of 6th girder from north side, 0.4 m from bearing seat area	2366	75.2
A6	West Abutment	East face of abutment, 1.5 m south of 1st girder from north side, 0.5 m from bearing seat	2381	38.7
A8	West Abutment	East face of abutment, 1 m south of 6th girder from north side, 0.4 m from bearing seat	2360	60.0

Notes:
1. Core nos. D3, P4, P8, A3, and A8 were obtained from the portion of the bridge that is noted as the original construction.
2. Core nos. D9, P2, P6, A2, and A6 were obtained from the portion of the bridge that was added on during widening of the bridge structure.

Reference: Fermor Avenue Bridge Over Seine River

TABLE 2
CHLORIDE CONTENT TEST DATA

Core No.	Core Identification		Depth from Surface (mm)	Chloride Content (% by mass of concrete)
	Structure	Location		
D1	Deck	Eastbound curb lane, 2.9 m east of west expansion joint, 4.6 m south of median	120 to 130	**0.030**
			150 to 160	0.016
			180 to 190	0.014
D5	Deck	Eastbound curb lane, 27.8 m east of west expansion joint, 4.9 m south of median	105 to 115	**0.042**
			145 to 155	0.015
			190 to 200	0.014
D7	Deck	Eastbound curb lane, 3 m west of east expansion joint, 4.7 m south of median	135 to 145	0.014
			165 to 175	0.014
			195 to 205	0.017
D8	Deck	Eastbound shoulder, 3.3 m east of west expansion joint, 2.5 m north of traffic barrier	125 to 135	0.011
			155 to 165	0.019
			190 to 200	**0.028**
D12	Deck	Eastbound shoulder, 3.1 m west of east expansion joint, 2.2 m north of traffic barrier	125 to 135	0.013
			150 to 160	0.013
			175 to 185	0.018
P1	East Pier	East face of pier, 1.5 m south of 2nd girder from north side, 0.7 m below top of pier	85 to 95	0.021
P3	East Pier	East face of pier, 1.1 m south of 7th girder from north side, 0.4 m below top of pier	85 to 95	0.016
P5	West Pier	West face of pier, 0.7 m south of 2nd girder from north side, 0.4 m below top of pier	85 to 95	0.007
P7	West Pier	West face of pier, below 7th girder from north side, 0.8 m below top of pier	85 to 95	**0.036**
A1	East Abutment	West face of abutment, 1.4 m south of 1st girder from north side, 0.3 m from bearing seat area	50 to 60	**0.226**
A4	East Abutment	West face of abutment, 1.2 m south of 6th girder from north side, 0.3 m from bearing seat area	50 to 60	**0.202**
A5	West Abutment	East face of abutment, 1.3 m south of 1st girder from north side, 0.3 m from bearing seat	50 to 60	**0.322**

Reference: Fermor Avenue Bridge Over Seine River

TABLE 2 (Cont'd)
CHLORIDE CONTENT TEST DATA

Core No.	Core Identification		Depth from Surface (mm)	Chloride Content (% by mass of concrete)
	Structure	Location		
A7	West Abutment	East face of abutment, 1.1 m south of 6th girder from north side, 0.4 m from bearing seat	50 to 60	**0.292**

Notes:

1. Core nos. D1, D5, D7, P3, P7, A4 and A7 were obtained from the portion of the bridge that is noted as the original construction.
2. Core nos. D8, D12, P1, P5, A1, and A5 were obtained from the portion of the bridge that was added on during widening of the bridge structure.
3. The chloride threshold necessary to permit corrosion in the reinforcing steel with the presence of oxygen and moisture has to be greater than 0.025% by mass of concrete (in accordance with OSRM manual, April 2007). The chloride results that exceed this threshold are highlighted in Table 2 above.

Reference: Fermor Avenue Bridge Over Seine River

TABLE 3
AIR VOID PARAMETER TEST DATA

Core No.	Core Identification		Air Content (%)	Specific Surface (mm^{-1})	Paste Content (%)	Spacing Factor (µm)
	Structure	Location				
D2	Deck	Eastbound curb lane, 4.2 m east of west expansion joint, 4.7 m south of median	**2.1**	11.0	20.0	**562**
D4	Deck	Eastbound curb lane, 27.5 m west of east expansion joint, 4.9 m south of median	3.4	6.8	21.4	**753**
D6	Deck	Eastbound curb lane, 9.1 m west of east expansion joint, 4.8 m south of median	**2.8**	6.8	23.7	**873**
D10	Deck	Eastbound shoulder, 8.8 m east of west expansion joint, 2.4 m north of traffic barrier	6.9	24.2	19.0	114
D11	Deck	Eastbound shoulder, 9.2 m west of east expansion joint, 2.3 m north of traffic barrier	9.2	15.5	17.0	119
CSA A23.1 specification limits for frost resistant concrete			**3.0 min.**	**no limit**	**no limit**	**260 max.**

Notes:
1. Core nos. D2, D4, and D6 were obtained from the portion of the bridge that is noted as the original construction.
2. Core nos. D10 & D11 were obtained from the portion of the bridge that was added on during widening of the bridge structure.
3. Core nos. D2, D4, and D6, as highlighted in the table above, did not comply with CSA A23.1 specification limits for frost resistant concrete.

Reference: Fermor Avenue Bridge Over Seine River

Figure 1 – Core no. D1, eastbound curb lane

Figure 2 – Core no. D2, eastbound curb lane

Reference: Fermor Avenue Bridge Over Seine River

Figure 3 – Core no. D3, eastbound curb lane

Figure 4 – Core no. D4, eastbound curb lane

Reference: Fermor Avenue Bridge Over Seine River

Figure 5 – Core no. D5, eastbound curb lane

Figure 6 – Core no. D6, eastbound curb lane

Reference: Fermor Avenue Bridge Over Seine River

Figure 7 – Core no. D7, eastbound shoulder

Figure 8 – Core no. D8, eastbound shoulder

Reference: Fermor Avenue Bridge Over Seine River

Figure 9 – Core no. D9, eastbound shoulder

Figure 10 – Core no. D10, eastbound shoulder

Reference: Fermor Avenue Bridge Over Seine River

Figure 11 – Core no. D11, eastbound shoulder

Figure 12 – Core no. D12, eastbound shoulder

Reference: Fermor Avenue Bridge Over Seine River

Figure 13 – Core no. P1, east pier

Figure 14 – Core no. P2, east pier

Reference: Fermor Avenue Bridge Over Seine River

Figure 15 – Core no. P3, east pier

Figure 16 – Core no. P4, east pier

Reference: Fermor Avenue Bridge Over Seine River

Figure 17 – Core no. P5, west pier

Figure 18 – Core no. P6, west pier

Reference: Fermor Avenue Bridge Over Seine River

Figure 19 – Core no. P7, west pier

Figure 20 – Core no. P8, west pier

Reference: Fermor Avenue Bridge Over Seine River

Figure 21 – Core no. A1, east abutment

Figure 22 – Core no. A2, east abutment

Reference: Fermor Avenue Bridge Over Seine River

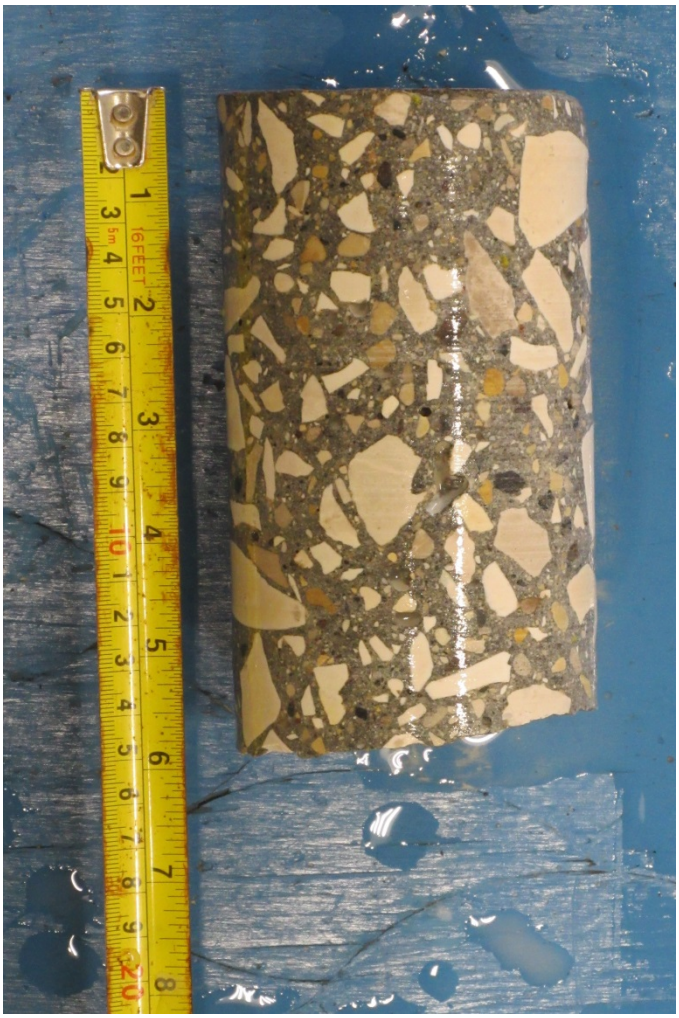


Figure 23 – Core no. A3, east abutment

Figure 24 – Core no. A4, east abutment

Reference: Fermor Avenue Bridge Over Seine River

Figure 25 – Core no. A5, west abutment

Figure 26 – Core no. A6, west abutment

Reference: Fermor Avenue Bridge Over Seine River

Figure 27 - Core no. A7, west abutment

Figure 28 - Core no. A8, west abutment

APPENDIX ‘D’

ENVIRONMENTAL PROTECTION PLAN

M Forster Enterprises
mforster3@outlook.com
204-471-1477

November 30, 2017

David Amorim, M.Sc., P.Eng.
Dillon Consulting Limited
1558 Willson Place
Winnipeg, Manitoba, R3T 0Y4

Re: Fermor Avenue Bridge Rehabilitation over the Seine River – Environmental Protection Plan – Barn Swallow

Dear David

As discussed, this letter outlines the mitigation measures to be conducted at the Fermor Bridge site to protect barn swallows. Note that this information should be included as part of the Environmental Protection Plan for the works. The barn swallow (*Hirundo rustica*) is a migratory bird species that is protected under the federal *Migratory Birds Convention Act* and is currently listed as a 'threatened' species on Schedule 1 of the federal *Species At Risk Act* (SARA). These Acts provide legal protection to barn swallows, and contravention of these Acts can result in legal actions and monetary fines.

The "*Recommended Development Setback Distances from Birds*" (http://www.gov.mb.ca/sd/cdc/pdf/mbcdc_bird_setbacks.pdf) developed by the Manitoba Conservation Data Centre (MBCDC, 2015) indicates a Restricted Activity Period from May 15 - September 30 of each year for barn swallows, with a setback of 50 meters (m) from a nest site for low disturbance activities, and a setback distance of 100 m from a nest site for medium to high disturbance activities, including construction activities.

Regulatory agents from MBCDC and the regional Permit Coordinator for SARA were contacted to confirm the appropriate mitigation measures to be applied to protect barn swallows at the bridge site. The following information summarises the recommendations provided by the MBCDC and SARA agencies.

Pre-Construction Mitigation Activities

1. The existing nests located under the bridge can be removed between the period of October 15 to May 1, and shall be removed no later than May 1.
2. The area where the birds were nesting shall be covered by netting or other appropriate materials to prevent returning barn swallows from building a new nest within 100 m of the bridge rehabilitation activities. The netting shall be in place by May 1.
3. The bird netting shall remain in place until the bridge rehabilitation activities are completed.

During Construction Mitigation Activities

1. The area where the barn swallows were nesting shall be monitored on a daily basis to ensure that the birds have not returned and are not trying to build a new nest within 100 m of the bridge rehabilitation activities.
2. The daily monitoring will be documented and shall include date, time, location and photographs.

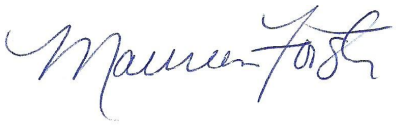
Post-Construction Mitigation Activities

1. The bird netting shall be removed once the bridge rehabilitation activities are completed and the Restricted Activity Period (May 15 to September 30) for barn swallows has passed.
2. The daily barn swallow monitoring log will be held by the Proponent as part of the project documentation, and to demonstrate that all recommended mitigation measures were followed and recorded.

Closure

Please contact the undersigned at your convenience if you require any other information at this time.

Best regards,



Maureen Forster, M.Sc., EP - Fisheries & Wildlife

APPENDIX ‘E’

CRASH ATTENUATION BARRIERS PRODUCT INFORMATION

QuadGuard® II

Assembly Manual

Part No. 115270B

Revision A December 2012

TRINITY
HIGHWAY PRODUCTS
ENERGY ABSORPTION SYSTEMS

QuadGuard® II

Assembly Manual

TRINITY HIGHWAY PRODUCTS
ENERGY ABSORPTION SYSTEMS

2525 Stemmons Freeway
Dallas, Texas 75207

Important: These instructions are to be used only in conjunction with the assembly, maintenance, and repair of QuadGuard® II systems. These instructions are for standard assembly specified by the appropriate highway authority only. In the event the specified system assembly, maintenance, or repair would require a deviation from standard assembly parameters, contact the appropriate highway authority engineer. This system has been accepted for use by the Federal Highway Administration for use on the national highway system under strict criteria utilized by that agency. Energy Absorption Systems representatives are available for consultation if required.

This Manual must be available to the worker overseeing and/or assembling the product at all times. For additional copies, contact Energy Absorption Systems at (888) 323-6374 or download from websites below.

The instructions contained in this Manual supersede all previous information and Manuals. All information, illustrations, and specifications in this Manual are based on the latest QuadGuard® II system information available to Energy Absorption Systems at the time of printing. We reserve the right to make changes at any time. Please contact Energy Absorption Systems to confirm that you are referring to the most current instructions.

Part No. 115270B
Revision A December 2012

Table of Contents

Customer Service Contacts

Energy Absorption Systems (a Trinity Highway Products company) is committed to the highest level of customer service. Feedback regarding the QuadGuard® II system, its assembly procedures, supporting documentation, and performance is always welcome. Additional information can be obtained from the contact information below:

Energy Absorption Systems:

Telephone:	(888) 323-6374 (USA Only) (214) 589-8140 (USA or International)
E-mail:	customerservice@energyabsorption.com
Internet: Energy Absorption Systems Trinity Highway Products, LLC	http://www.energyabsorption.com http://www.highwayguardrail.com

Important Introductory Notes

Proper assembly of the QuadGuard® II is essential to achieve performance of the system under appropriate federal and state criteria. These instructions should be read in their entirety and understood before assembling the QuadGuard® II. These instructions are to be used only in conjunction with the assembly of the QuadGuard® II and are for standard assemblies only as specified by the applicable highway authority. In the event your system assembly requires or involves deviation from standard parameters or, during the assembly process a question arises, please contact the appropriate highway authority that specified this system at this particular location for guidance. Energy Absorption Systems is available for consultation with that agency. These instructions are intended for an individual who is qualified to both read and accurately interpret them as written. They are intended for the individual who is experienced and skilled in the assembly of highway products which are specified and selected by the highway authority.

A set of product and project shop drawings will be supplied by Energy Absorption Systems. The shop drawings will be for each section of the assembly. These drawings should be reviewed and studied thoroughly by a qualified individual who is skilled in interpreting them before the start of any assembly.

Important: Read safety instructions thoroughly and follow the assembly directions and suggested safe practices before assembling, maintaining, or repairing the QuadGuard® II system. Failure to follow this warning can result in serious injury or death to workers and/or bystanders. It further compromises the acceptance of this system by the FHWA. Please keep these instructions for later use.

Warning: Ensure that all of the QuadGuard® II system Warnings, Cautions, and Important statements within the QuadGuard® II Manual are completely followed. Failure to follow this warning could result in serious injury or death in the event of a collision.

Recommended Safety Rules for Assembly

*** Important Safety Instructions ***

This Manual must be kept in a location where it is readily available to persons who assemble, maintain, or repair the QuadGuard® II system. Additional copies of this Manual are immediately available from Energy Absorption Systems by calling (888) 323-6374. Please contact Energy Absorption Systems if you have any questions concerning the information in this Manual or about the QuadGuard® II system. This Manual may also be downloaded directly from the websites indicated below.

Always use appropriate safety precautions when operating power equipment, mixing chemicals, and when moving heavy equipment or QuadGuard® II components. Gloves, apron, safety goggles, steel toe boots, and back protection shall be used.

Safety measures incorporating traffic control devices specified by the highway authority must be used to provide safety for personnel while at the assembly, maintenance, or repair site.

Safety Symbols

This section describes the safety symbols that appear in this QuadGuard® II Manual. Read the Manual for complete safety, assembly, operating, maintenance, repair, and service information.

Symbol	Meaning
	**Safety Alert Symbol:** Indicates Danger, Warning, or Caution. Failure to read and follow the Danger, Warning, Safety, or Caution indicators could result in serious injury or death to the workers and/or bystanders.

Warnings and Cautions

Read all instructions before assembling, maintaining, or repairing the QuadGuard® II system.

Warning: Do not assemble, maintain, or repair the QuadGuard® II system until you have read this Manual thoroughly and completely understand it. Ensure that all Warnings, Cautions, and Important Statements within the Manual are completely followed. Please call Energy Absorption Systems at (888) 323-6374 if you do not understand these instructions. Failure to follow this warning could result in serious injury or death in the event of a collision.

Warning: Safety measures incorporating appropriate traffic control devices specified by the highway authority must be used to protect all personnel while at the assembly, maintenance, or repair site. Failure to follow this warning could result in serious injury or death in the event of a collision.

Warning: Use only Energy Absorption Systems parts that are specified herein for the QuadGuard® II for assembling, maintaining, or repairing the QuadGuard® II system. Do not utilize or otherwise comingle parts from other systems even if those systems are other Energy Absorption Systems or Trinity Highway Products systems. Such configurations have not been tested, nor have they been accepted for use. Assembly, maintenance, or repairs using unspecified parts or accessories is strictly prohibited. Failure to follow this warning could result in serious injury or death in the event of a vehicle impact with an UNACCEPTED system.

Warning: Do NOT modify the QuadGuard® II system in any way. Failure to follow this warning could result in serious injury or death in the event of a collision.

Warning: Ensure that the QuadGuard® II system and delineation used meet all federal, state, specifying agency, and local specifications. Failure to follow this warning could result in serious injury or death in the event of a collision.

Warning: Ensure that your assembly meets all appropriate Manual on Uniform Traffic Control Devices (MUTCD) and local standards. Failure to follow this warning could result in serious injury or death in the event of a collision.

Limitations and Warnings

Energy Absorption Systems, in compliance with the National Cooperative Research Highway Program 350 (NCHRP Report 350) “Recommended Procedures for the Safety Performance of Highway Safety Features”, contracts with FHWA approved testing facilities to perform crash tests, evaluation of tests, and submittal of results to the Federal Highway Administration for review.

The QuadGuard® II system has been accepted by FHWA as meeting the requirements and guidelines of NCHRP Report 350* TL-1 (2 Bay narrow system), TL-2 (2 Bay narrow system and 3 Bay wide system) and TL-3 (5 Bay system). The NCHRP Report indicates that these tests typically evaluate product performance by closely simulating actual impacts involving a typical range of vehicles on our roadways, from lightweight cars (approx. 820kg [1800 lb.]) to full size pickup trucks (approx. 2000 kg [4400 lb.]) as specified by the FHWA. A product can be certified for multiple Test Levels. The QuadGuard® II has been accepted to the Test Level(s) as shown below:

Test Level 1: 50 km/h [31 mph]
Test Level 2: 70 km/h [44 mph]
Test Level 3: 100 km/h [62 mph]

These FHWA directed tests are not intended to represent the performance of systems when impacted by every vehicle type or every impact condition existing on the roadway. This system is tested only to the test matrix criteria of NCHRP 350 as approved by FHWA.

These tests are not intended to represent the performance of products when impacted by every vehicle type or every impact condition.

Energy Absorption Systems does not represent nor warrant that the results of these controlled tests show that vehicle impacts with the products in other conditions would necessarily avoid injury to person(s) or property. Impacts that exceed criteria capabilities of the product may not result in acceptable impact performance as outlined in NCHRP Report 350, relative to structural adequacy, occupant risk and vehicle trajectory. Energy Absorption Systems expressly disclaims any warranty or liability for injury or damage to persons or property resulting from any impact, collision, or harmful contact with products, other vehicles, or nearby hazards or objects by any vehicle, object or person, whether or not the products were assembled by or in the presence of Energy Absorption Systems representatives or by third parties.

The QuadGuard® II system is intended to be assembled, delineated, and maintained in accordance with specific state and federal guidelines. It is important to select the most appropriate product configuration for a site. The customer should be careful to properly select, assemble, and maintain the product. Careful evaluation of the site geometry, vehicle population type, speed, traffic direction, and visibility are some of the elements that require evaluation in the proper selection of a safety appurtenance. For example, curbs could cause an untested effect on an impacting vehicle. Before deployment of this system at any location, these issues need to be fully discussed with the appropriate highway authority planning and specifying the assembly.

After an impact occurs, the product should be restored to its original condition as soon as possible. When a potentially reusable safety product is impacted, it is still necessary to restore the product to its original length and inspect all the components as necessary.

System Overview

The QuadGuard® II is a potentially reusable, re-directive, non-gating crash cushion for hazards ranging in width from 610 mm to 3200 mm (24" to 126"). It consists of energy-absorbing cartridges surrounded by a framework of Quad-Beam™ Panels.

The QuadGuard® II system utilizes two types of cartridges in a “staged” configuration to address both lighter cars and heavier, high center-of-gravity vehicles. Its modular design allows the system length to be tailored to the design speed of a site. See the QuadGuard® II Product Manual to determine the appropriate number of Bays for a given speed.

Impact Performance

The 5 Bay QuadGuard® II systems have successfully passed the requirements stipulated in NCHRP Report 350, Test Level 3 tests with both the light car and pickup at speeds of up to 100 km/h [62 mph] at angles up to 20 degrees.

During head-on impacts, within NCHRP Report 350 criteria, the QuadGuard® II telescopes rearward and crushes to absorb the energy of impact. When impacted from the side, within the applicable NCHRP 350 criteria, it safely redirects the vehicle back toward its original travel path and away from the hazard.

Recommended Tools

Documentation

- Manufacturer's Assembly Manual
- Manufacturer's Drawing Package

Cutting equipment

- Rotary Hammer Drill
- Rebar cutting bit
- Concrete drill bits – 22 mm [7/8"] (*Two Fluted)
- Grinder, Hacksaw or Torch (optional)
- Drill motor
- Drill bits 1/16" through 7/8"

*Energy Absorption Systems recommends using two fluted drill bits to achieve optimum tensile strength when applying the MP-3® anchoring system.

Hammers

- Sledgehammer
- Standard hammer

Wrenches

- Heavy duty impact wrench
- Standard adjustable wrench
- 1/2" drive sockets: 9/16", 11/16", 3/4", 15/16", 1 1/8", 1 1/4"
- 1/2" drive Deep sockets: 15/16", 1 1/4"
- 1/2" drive Ratchet and attachments
- 1/2" drive Breaker bar – 24" long
- 1/2" drive Torque wrench: 200 ft-lb
- Crescent wrench: 300 mm [12"]
- Allen wrench: 3/8"
- Impact Wrench: 1/2"

Personal Protective equipment

- Safety Glasses
- Gloves
- Apron for MP-3® application

Miscellaneous

- Traffic control equipment
- Lifting and moving equipment (A lifting device is preferred although a forklift can be used.) Minimum 5,000 lb. capacity required.
- Air Compressor (100 psi minimum) and Generator (5 kW)
- Long pry bar
- Drift pin 300 mm [12”]
- Center punch
- Tape measure 7.5 m [25’]
- Chalk line
- Concrete marking pencil
- Nylon bottle brush for cleaning 7/8” drilled holes
- Rags, water, and solvent for touch-up

Note: The above list of tools is a general recommendation. Depending on specific site conditions and the complexity of the assembly specified by the appropriate highway authority, additional or fewer tools may be required. Decisions as to what tools are needed to perform the job are entirely within the discretion of the specifying highway authority and the authority’s selected contractor performing the assembly of the system at the authority’s specified site.

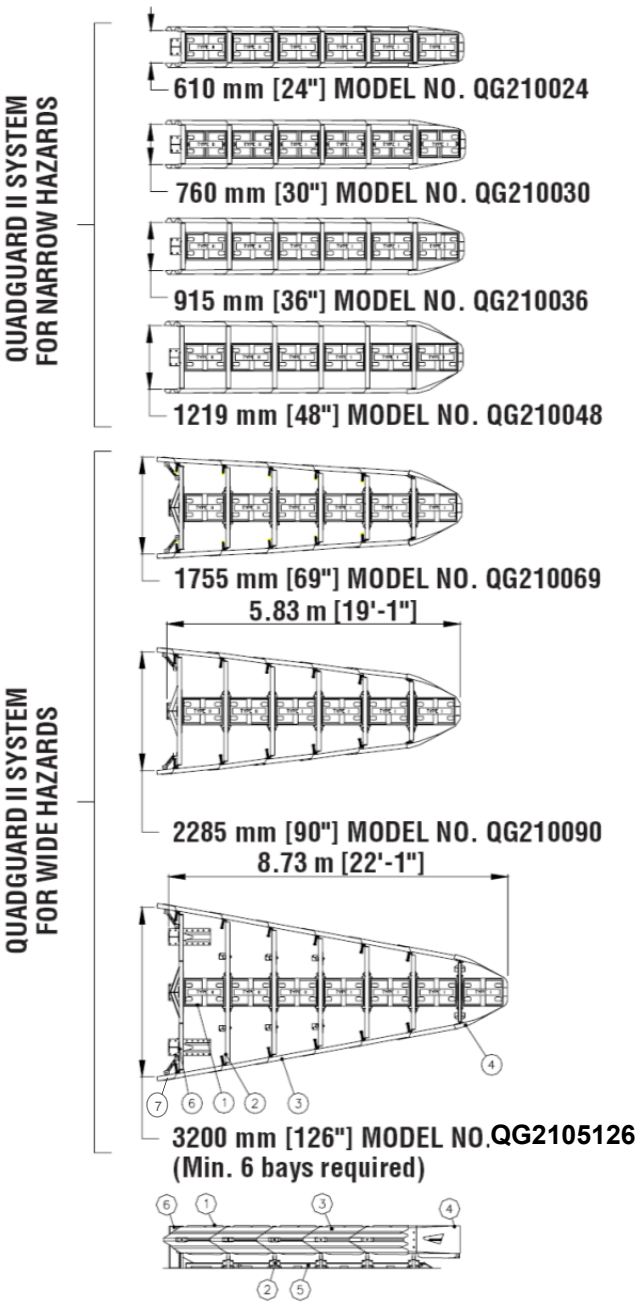


Figure 1 Plans & Elevation
(Five Bay systems with Tension Strut Backups shown, except as noted)

Key

1) Cartridge
2) Diaphragm
3) Quad-Beam™ Fender Panel
4) Nose Cover
5) Monorail
6) Backup
7) Side Panel

How to Determine Left/Right

To determine left from right when ordering parts, stand in front of the system facing the hazard. Your left is the system's left and your right is the system's right.

Counting the Number of Bays

One Bay consists of one Cartridge, one Diaphragm, two Fender Panels, etc. The Nose section is not considered a Bay, though there is a Cartridge in the Nose of each system. Note that this means there will always be one more Cartridge in the system than the number of Bays in the system. To determine number of Bays, count Fender Panels on one side (See Figure 2). Five Bay system shown.

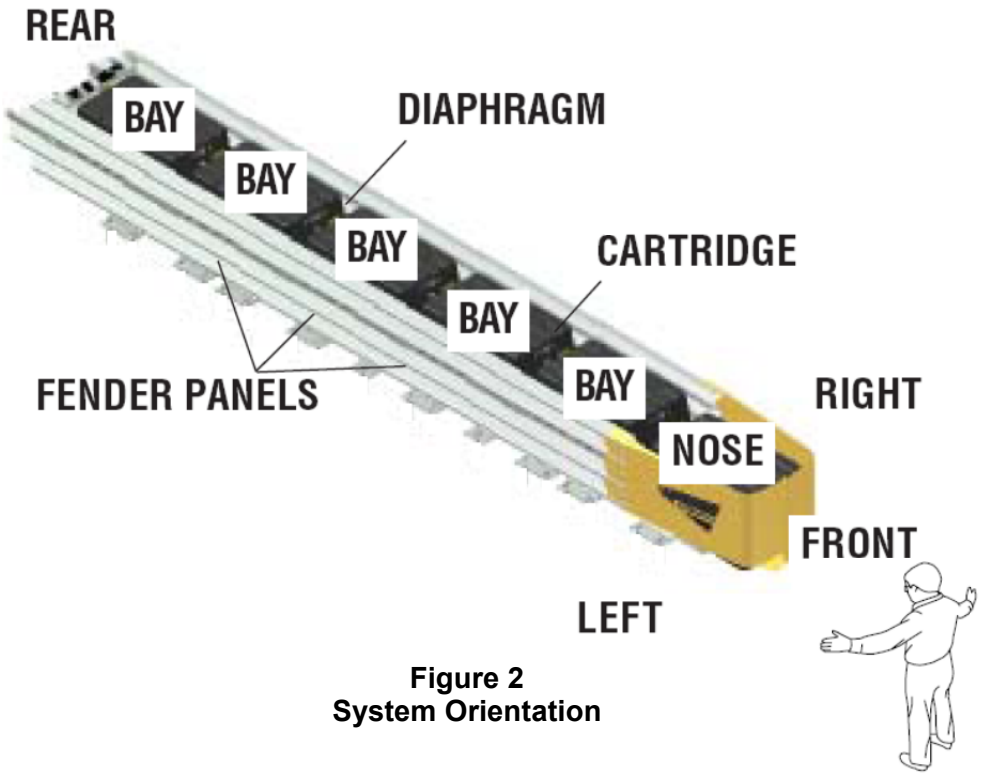


Figure 2
System Orientation

Measuring the Width

The QuadGuard® II system is available in seven nominal widths:

- 610 mm [24”]
- 760 mm [30”]
- 915 mm [36”]
- 1219 mm [48”]
- 1755 mm [69”] ┐
- 2285 mm [90”] ┘ (Minimum 3 Bays Required)
- 3200 mm [126”] — (Minimum 6 Bays Required)

The nominal width of a system with Tension Strut Backup is the width between Side Panels behind the Backup (See Figure 3).

The nominal width of a system with Concrete Backup is the width of the Concrete Backup at location shown in Figure 4.

The outside width of the system is approximately 150 mm [6”] to 230 mm [9”] wider than the nominal width. The width of the system is not the same as the width of the Backup.

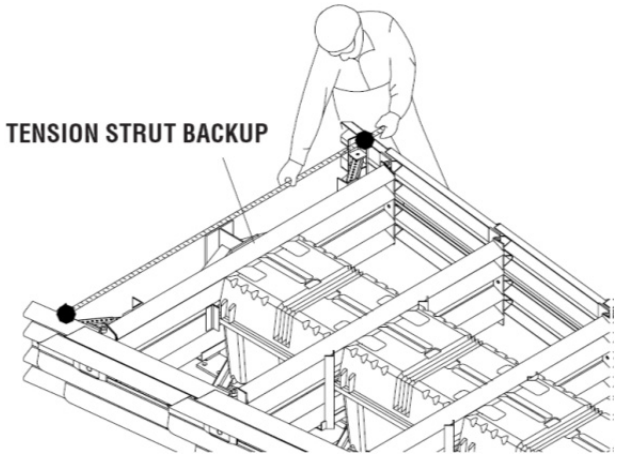


Figure 3
Width of system with Tension Strut Backup

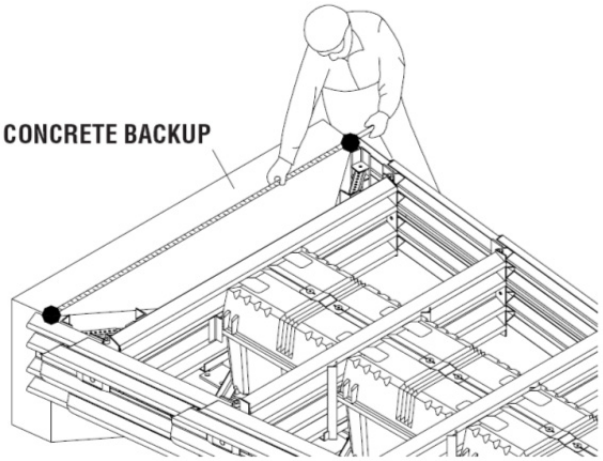


Figure 4
Width of system with Concrete Backup

System Assembly for Narrow Hazards

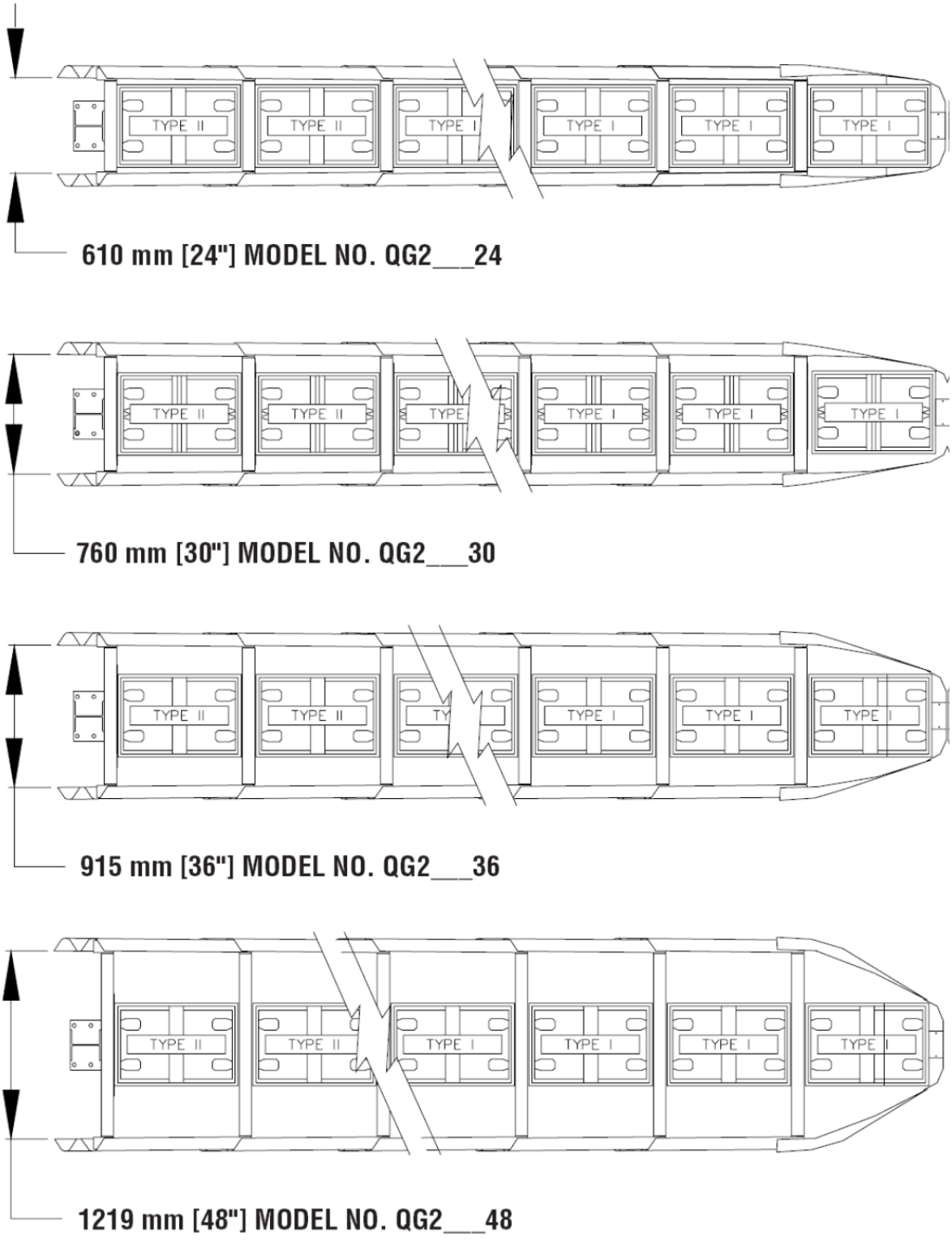


Figure 5
Narrow System and Model Numbers

Site Preparation/Foundation

A QuadGuard® II should be assembled only on an existing or freshly placed and cured concrete base (28 MPa [4000 psi] minimum). Location and orientation of the concrete base and attenuator must comply with project plans or as otherwise determined by the resident project engineer.

Recommended dimension and reinforcement specifications for new concrete foundations are provided in Energy Absorption Systems concrete foundation drawings, supplied with the system. The system may be assembled on a non-reinforced concrete roadway (minimum 200 mm [8”] thick). Deployment cross-slope shall not exceed 8% and should not twist more than 2% over the length of the system; the foundation surface shall have a light broom finish.

Caution: Accurate placement of all steel rebar is critical to avoid interference with the concrete anchor bolts.

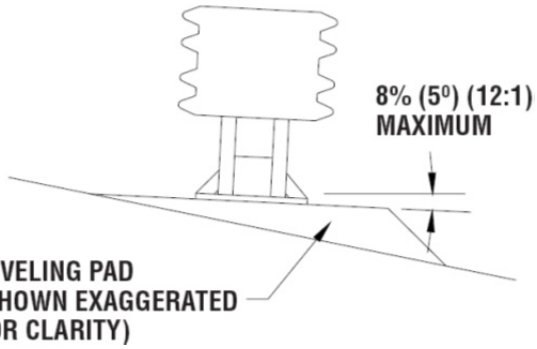


Figure 6
Cross-Slope

Warning: Location of the Backup in relation to nearby objects will affect the operation of the attenuator. Upon impact, the Fender Panels telescope rearward and extend beyond the rigid Backup as much as 876.3 mm [34.5”]. Position the Backup so that the rear ends of the last Fender Panels are a minimum of 760 mm [30”] forward of objects that would otherwise interfere with movement of the rearmost Fender Panels. Failure to comply with this requirement will result in impaired system performance offering motorists less protection and causing component damage.

Inspect Shipping

Before deploying the QuadGuard® II system, check the received parts against the shipping list supplied with the system. Make sure all parts have been received.

Assembly Procedures

Note: The Drawing Package supplied with the QuadGuard® II system must be used with these instructions for proper assembly and should take precedence over these general instructions.

1) Determine Backup & Transition Type

The QuadGuard® II system is available with a Tension Strut Backup or a Concrete Backup. See Figure 7 and 8, along with the Backup Assembly drawing, to determine which type of Backup is being deployed.

A Transition Panel or Side Panel must be used on each side of the Backup. A Side Panel is not needed when a Transition Panel is used. Several types of Transitions are available for use with the QuadGuard® II system. See Figures 9 through 14 and the Drawing Package to determine which type of Panels to attach.

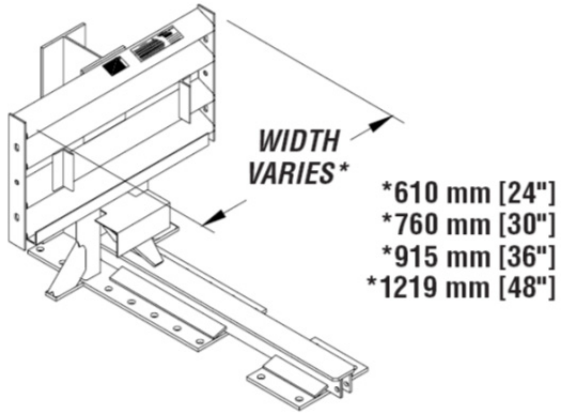


Figure 7
Tension Strut Backup

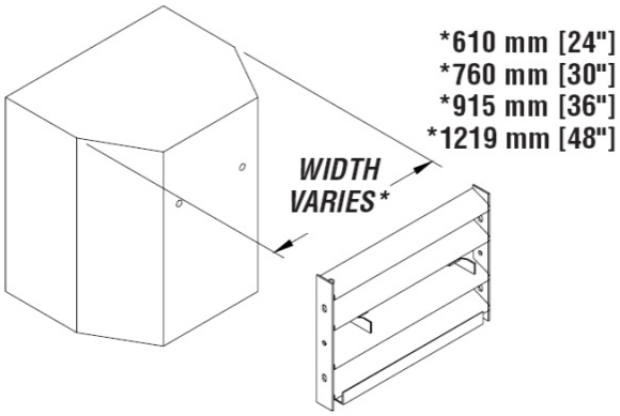


Figure 8
Concrete Backup

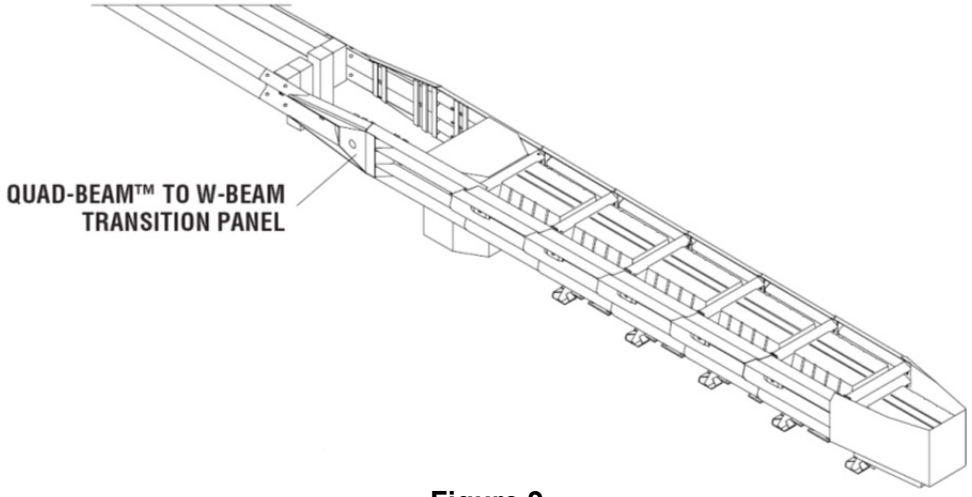


Figure 9
Transitioning the QuadGuard® II System

Transition Panel Types

Note: The proper Transition Panel or Side Panel must be used for impact performance of the system. The correct Panel(s) to use will depend on the direction of traffic and what type of barrier or hazard the QuadGuard® II system is shielding. Contact the Customer Service Department prior to deployment if you have any questions.

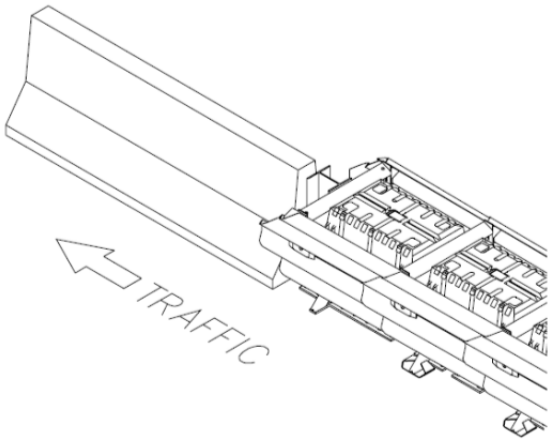


Figure 10
No Transition

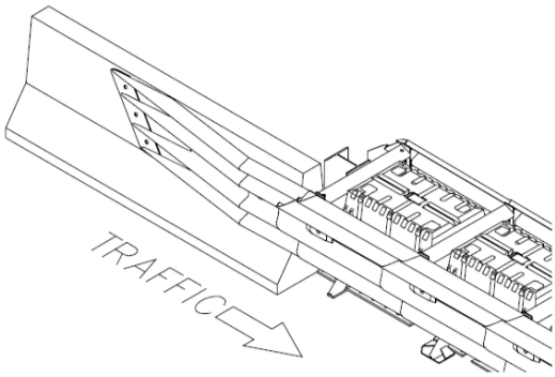


Figure 11
Quad-Beam™ to Safety Shape Barrier Transition Panel

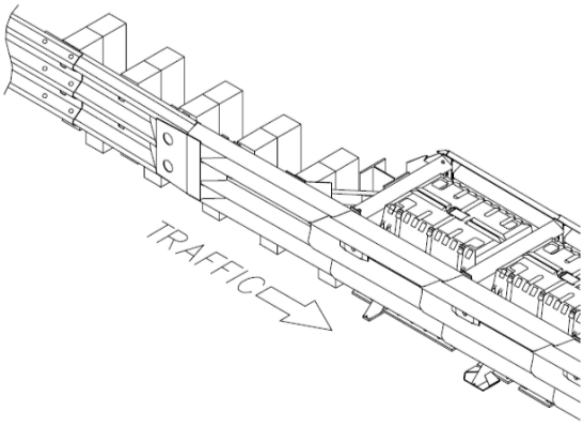


Figure 12
Quad-Beam™ to Thrie-Beam Transition Panel

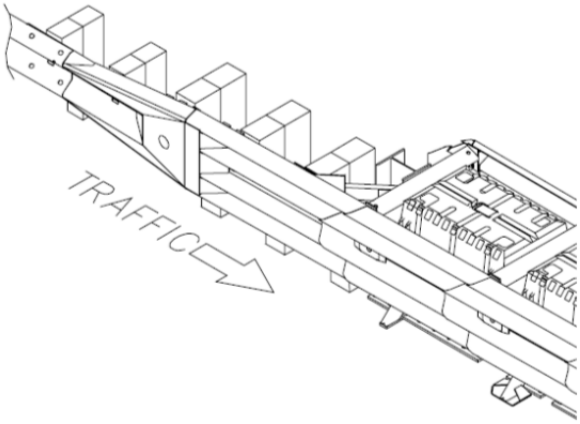


Figure 13
Quad-Beam™ to W-Beam Transition Panel

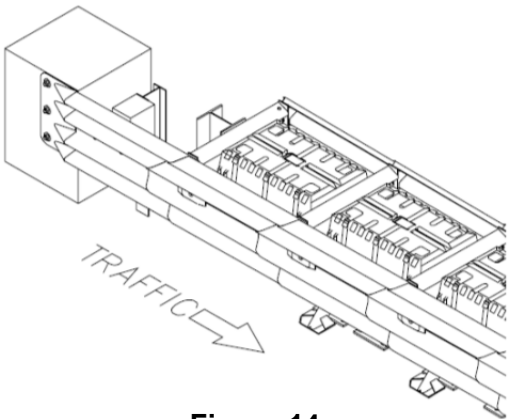


Figure 14
Quad-Beam™ End Shoe Transition Panel

2) Mark System Location

Locate the centerline of the system by measuring the proper offset from the hazard. See the Drawing Package supplied with the system. Place chalk line to mark the centerline of the system. Mark a construction line parallel to the center line and offset 165 mm [6.5”] to one side as shown in Figure 15. The edge of the Monorail will be positioned on this line.

Note: The concrete foundation shall comply with the project plans supplied with the system.

Warning: Location of system with respect to the hazard is critical and dependent on the type of Transition Panel used. See the Project Plans supplied with the system for details.

Figure 15
(Top view of concrete foundation)

3) Anchor the Backup

A) Concrete Backup Construction (Figure 16)

Locate Backup Face Plate using the Backup Assembly drawing. Verify that any applicable Transition Panels fit properly before anchoring the Face Plate. Drill anchor holes in the Concrete Backup using the Face Plate as a template. Anchor the Face Plate to the Concrete Backup using the MP-3® Anchoring system (horizontal kit) supplied with the QuadGuard® II system (See "MP-3® Polyester Anchoring System" section on Page 51).

Warning: Every hole and slot in Backup and Monorail must be anchored by an MP-3® stud.

B) Tension Strut Backup Assembly (Figure 17)

Locate Tension Strut Backup and Monorail on foundation with side of Monorail on the construction line (See Figure 20 on Page 20). Verify that any applicable Transition Panels fit properly before anchoring Backup. Drill anchor holes in foundation using the Backup as template. Anchor the Backup to the concrete foundation using the MP-3® Anchoring system (Vertical kit) supplied with the QuadGuard II system (See "MP-3® Polyester Anchoring System" section on Page 51).

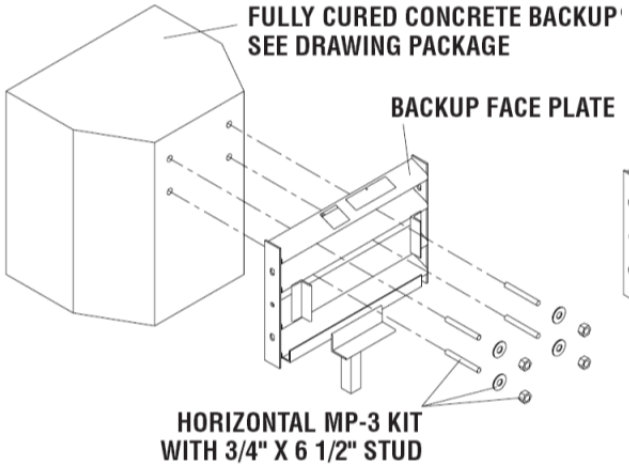


Figure 16
Anchoring Backup Face Plate to Concrete Backup

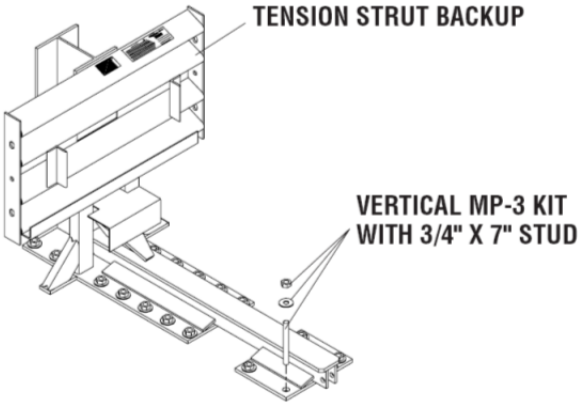


Figure 17
Anchoring Tension Strut Backup to Foundation

4) Anchor the Monorail

A) Monorail Construction for Concrete Backup (Figure 19)

Locate Monorail on foundation with side of Monorail on the construction line and rear edge of Monorail foot 10” forward of front face of Concrete Backup (See Figure 19).

Orient the Monorail so that the Monorail tongues face Backup (See Figure 19).

Drill 140 mm [5 1/2"] deep anchor holes using the Monorail as a template. Do not drill through foundation.

Warning: Every hole and slot in Backup and Monorail must be anchored by an MP-3® stud.

Anchor each Monorail section using the MP-3® vertical kits provided. See Figure 18 and the MP-3® Polyester Anchoring System Instructions included with this Manual. It is important to attach each segment of Monorail in alignment from the back to the front of the system (± 6 mm [1/4”]).

Warning: Improper alignment at the Monorail Sections will prevent proper system collapse during an impact.

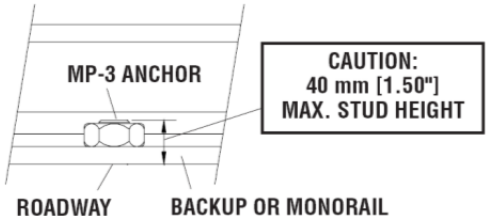


Figure 18
Proper Stud Height

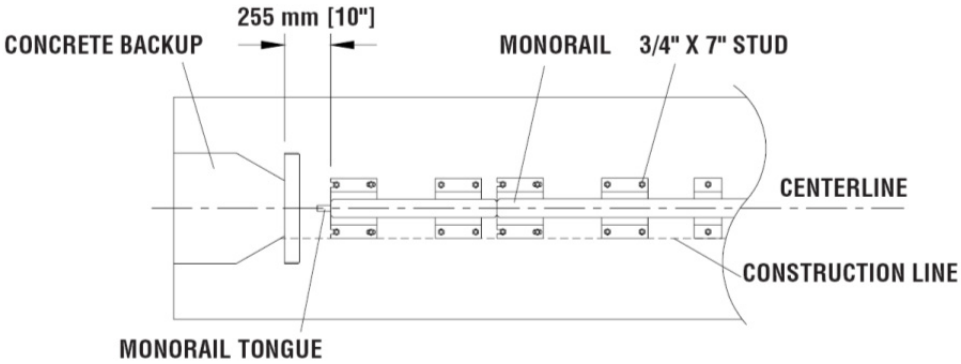


Figure 19
Monorail Location for Concrete Backup

B) Monorail Construction for Tension Strut Backup (Figure 20)

Locate Monorail on foundation with side of Monorail on the construction line and rear edge of Backup foot 4” forward of edge of foundation (See Figure 20).

Orient the Monorail so that the Monorail tongues face the Backup (See Figure 19 on Page 19).

Drill 140 mm [5 1/2"] deep anchor holes using the Monorail as a template. Do not drill through foundation.

Warning: Every hole and slot in Backup and Monorail must be anchored by an MP-3® stud.

Anchor each Monorail section using the MP-3® vertical kits provided. See Detail 20a and the MP-3® Polyester Anchoring System Instructions included with this Manual. It is important to attach each segment of Monorail in alignment from the back to the front of the system (± 6 mm [1/4”]).

Warning: Improper alignment at the Monorail splice joints will prevent proper system collapse during an impact.

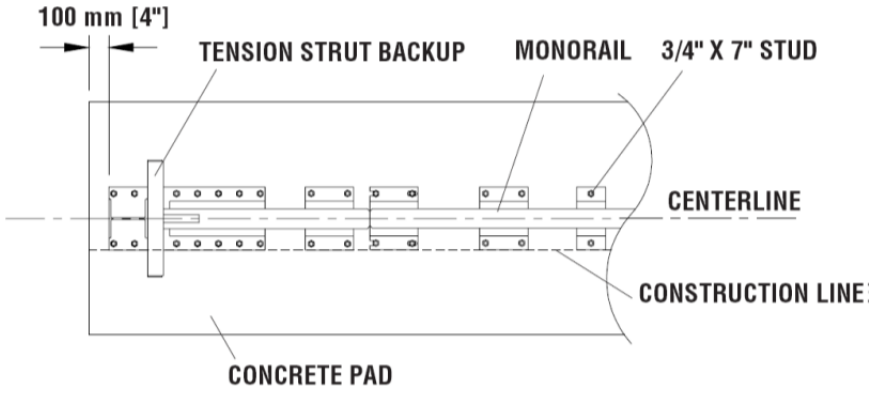
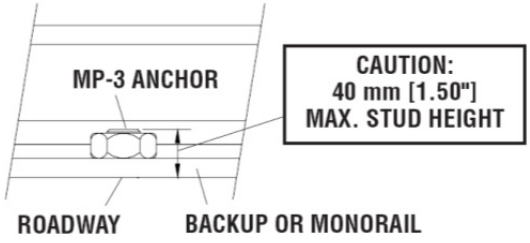


Figure 20
Backup and Monorail Location for Tension Strut Backup



Detail 20a
Proper Stud Height

5) Attach Side Panels and/or Transition Panels to Backup Assembly

Attach Transition Panel or Side Panel to side of Backup using 5/8" hex bolt and 5/8" rail nut (two places - top and bottom holes only). See Figure 21 and Backup Assembly drawing.

Note: A Side Panel is not needed when a Transition Panel is used.

Construction tip:

Use drift pin to align the center hole of the Panel with the center hole of the Backup before inserting the rail bolts.

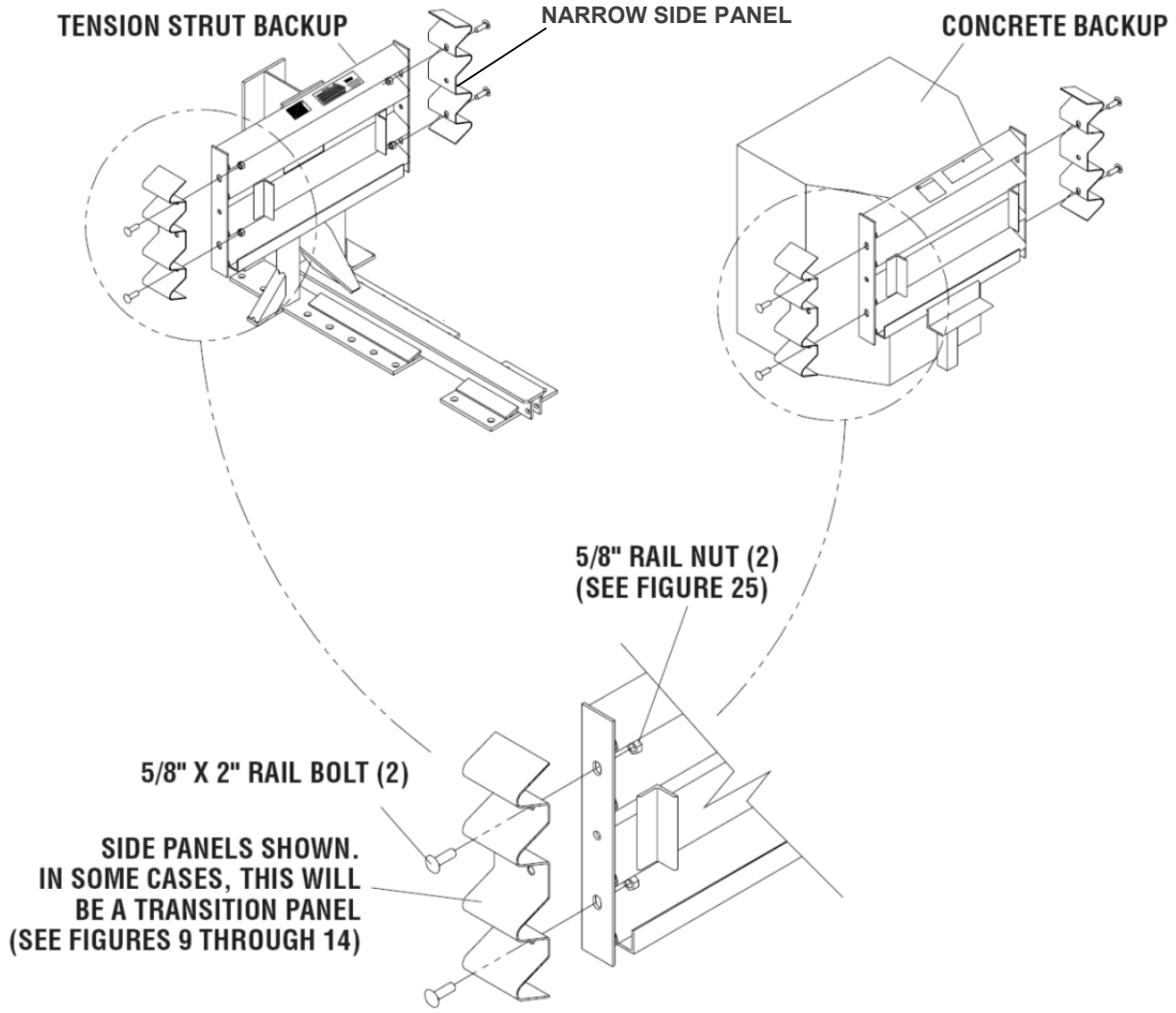


Figure 21
Side Panel/Transition Panel Attachment

6) Attach Monorail Guides

Attach Monorail guides to Diaphragm as follows:

Insert 3/4" x 2” G8 hex bolt through Monorail guide and Diaphragm, oriented as shown in Figure 22. Secure with 3/4" lock washer and 3/4" hex nut (typical 4 places). See also Diaphragm Assembly drawing. Shims are sandwiched between the Rail Guide and Diaphragm.

Repeat process for each Diaphragm.

7) Attach Diaphragms

Orient a Diaphragm so that the front face of the Diaphragm shape faces toward the Nose of the system as shown in Figure 23. Slide one Diaphragm all the way to the Backup to ensure the system is able to collapse properly during impact. Once this has been verified, slide the Diaphragm forward to approximately 915 mm [36”] in front of the Backup. Orient and slide all other Diaphragms onto Monorail and position each approximately as shown in Figure 24.

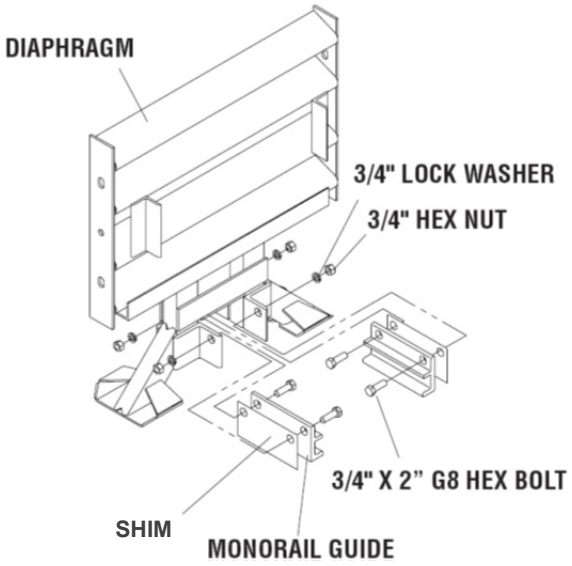


Figure 22
Monorail Guide Attachment

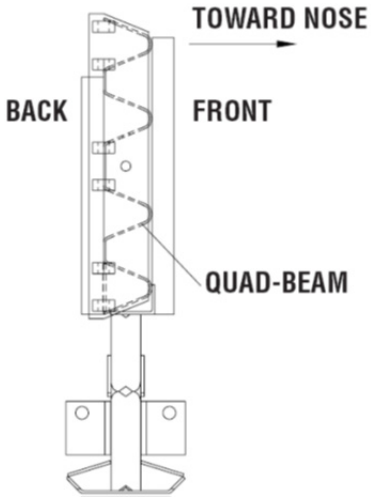


Figure 23
Diaphragm Orientation

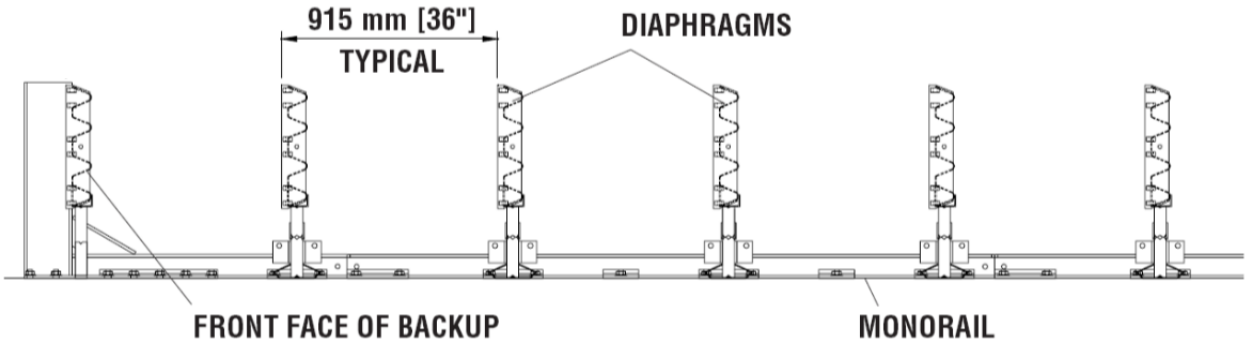


Figure 24
Diaphragm Spacing

8) Attach Fender Panels

Note: Do not mix the 5/8” rail nuts (large) with the 5/8” hex nuts (small) (See Figure 25).

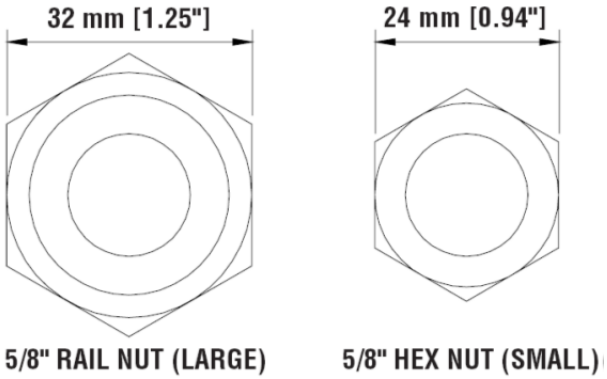


Figure 25
Rail Nuts are Oversize

Starting at the Backup, attach left and right Fender Panels shown on Page 24 and Fender Panel Assembly drawing.

Step 1

Place the Fender Panel so that the center of the slot of the rearward Diaphragm is lined up with the approximate center of the slot in the Fender Panel.

Attach Mushroom Washer Assembly as shown in Figure 26 and Detail 26a and Detail 26b, but do not torque at this time. This (Step 1) helps to balance the Fender Panel.

Step 2

Slide the Fender Panel forward until the holes in the Fender Panel line up with the holes in the forward Diaphragm.

Step 3

Use a drift pin to align the center hole of the Fender Panel with the center hole of the Diaphragm.

Step 4

Attach the front of the Fender Panels to the next Diaphragm using two rail bolts and large hex nuts per side. Use only the top and bottom holes; leave the center hole open until the next Fender Panel is attached.

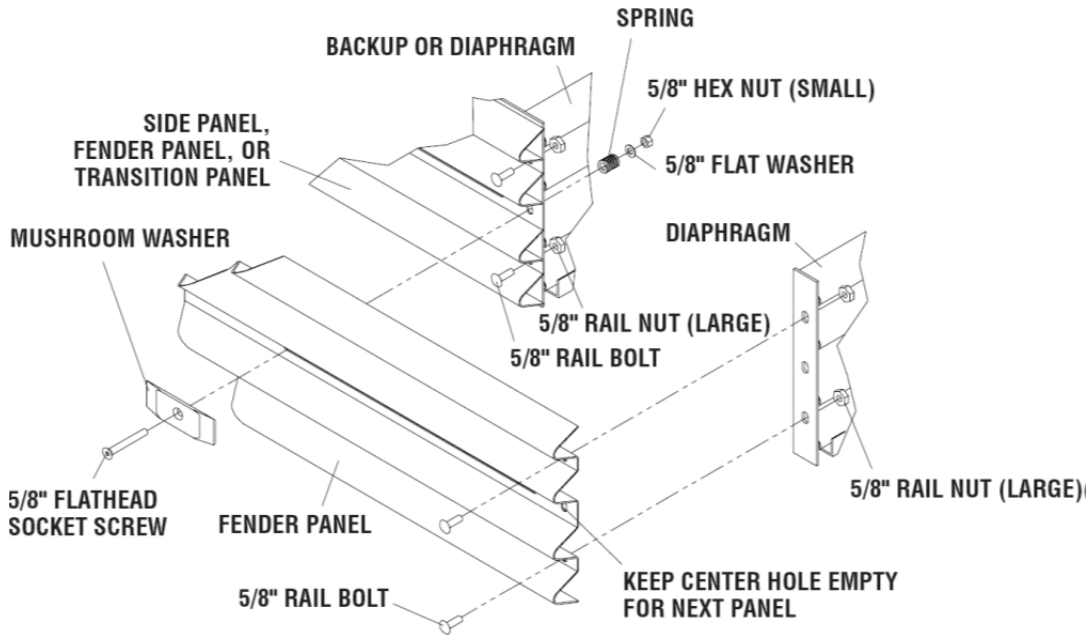
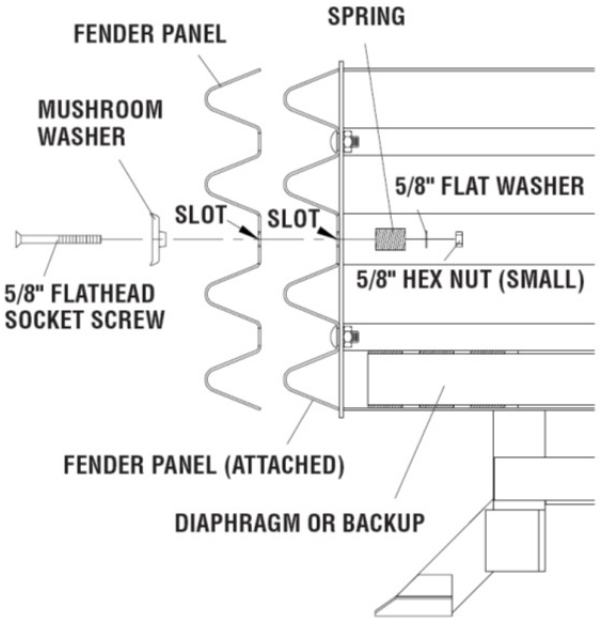


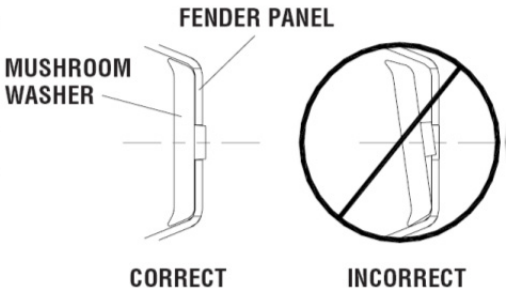
Figure 26
Fender Panel Assembly

Step 5

Be sure Mushroom Washer lays flat against the Fender Panel as shown in Figure 26b. Standoff on Mushroom Washer must be seated completely through slot.



Detail 26a
Mushroom Washer Attachment



Detail 26b
Mushroom Washer Orientation

Step 6

Check Diaphragm spacing to ensure 915 mm [36”] between rear faces of consecutive Diaphragms as shown in Figure 27 and Fender Panel Assembly drawing.

Step 7

Once proper spacing has been achieved, torque the Mushroom Washer Assembly (small hex) nut until it reaches the end of the threads.

Assemble the remaining Diaphragms and Fender Panels following the same procedures.

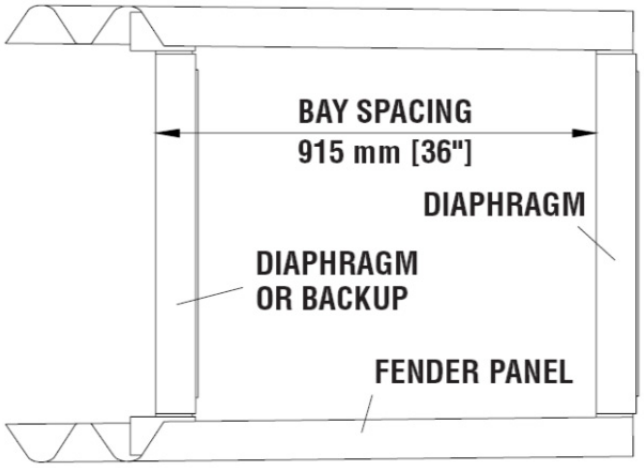


Figure 27
Proper Spacing Between Diaphragms

9) Attach End Cap

Using 5/8” x 3 1/2" G5 hex bolt, 5/8” hex nut and 5/8” lock washer, attach the End Cap to the front of the first Monorail segment as shown in Figure 28 and Monorail Assembly drawing.

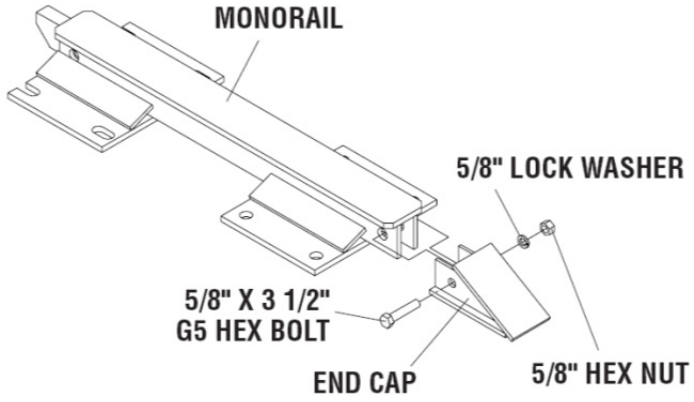


Figure 28
Monorail End Cap Assembly

10) Attach Cartridge Support Brackets

Attach lower Cartridge Support Bracket to front and back of all Diaphragms and front of Backup, as shown in Figures 30 to 32 Diaphragm Assembly drawings, and Backup Assembly drawings.

Note: 610 mm [24”] wide systems do not have Side Cartridge Support Brackets: 762 mm [30”], 914 mm [36”] and 1219 mm [48”] wide systems have Side Cartridge Support Brackets welded to the Backup and Diaphragms.

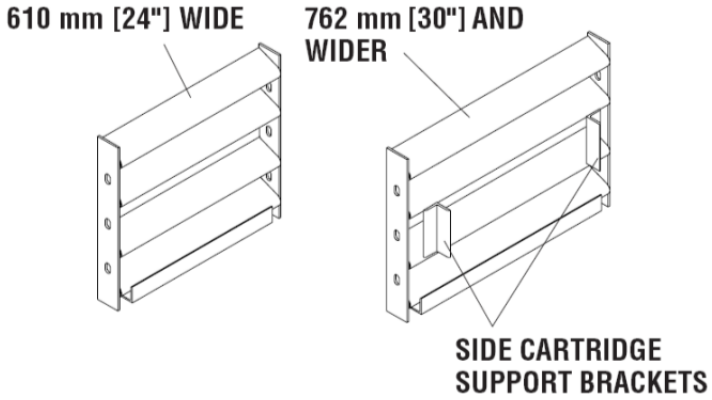


Figure 29
Side Cartridge Support Brackets

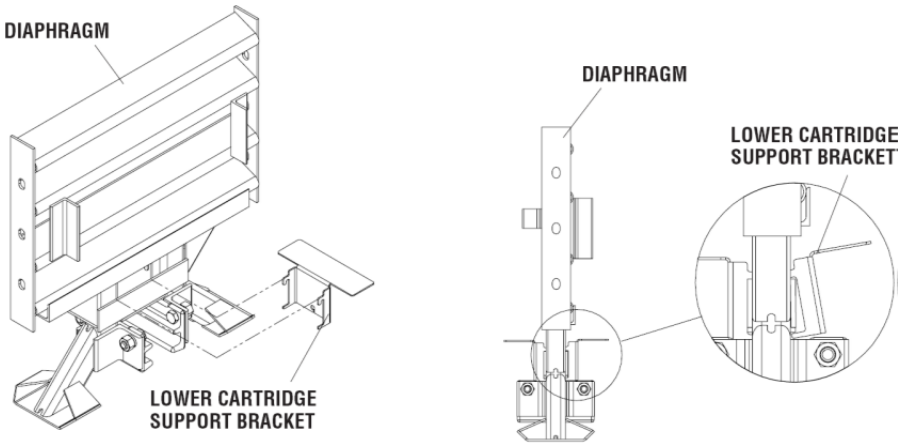


Figure 30
Lower Cartridge Support Bracket Assembly

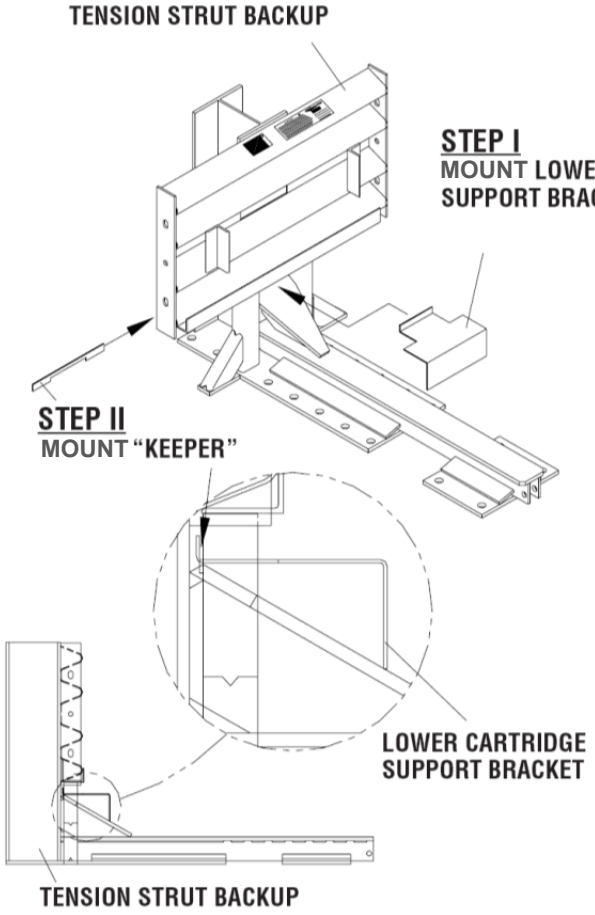


Figure 31
Lower Cartridge Support Bracket Assembly
(Tension Strut Backup)

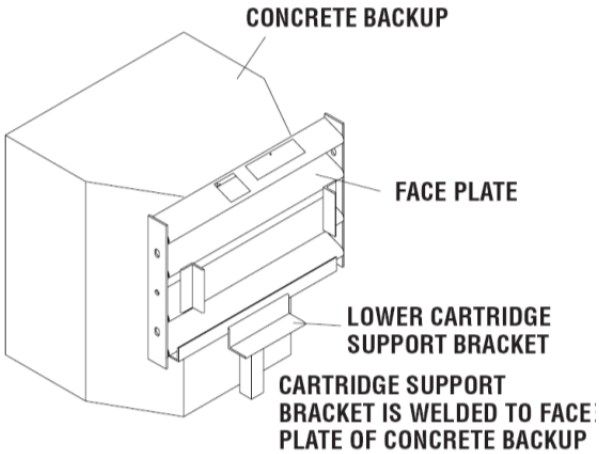


Figure 32
Lower Cartridge Support Bracket
(Concrete Backup)

11) Attach Nose Assembly

Bolt the Nose directly to the front Diaphragm, as shown in Figures 33a through 33c and the Nose Assembly drawing, using six threaded rods and four rail nuts per rod.

Place Pullout Brackets under center bolts.

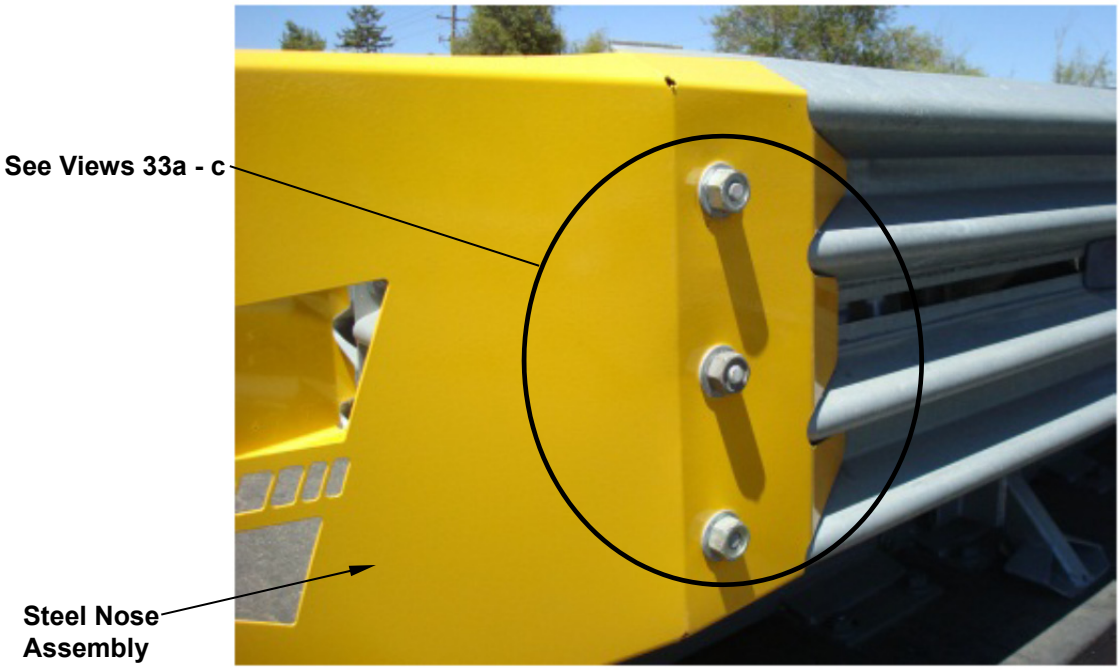
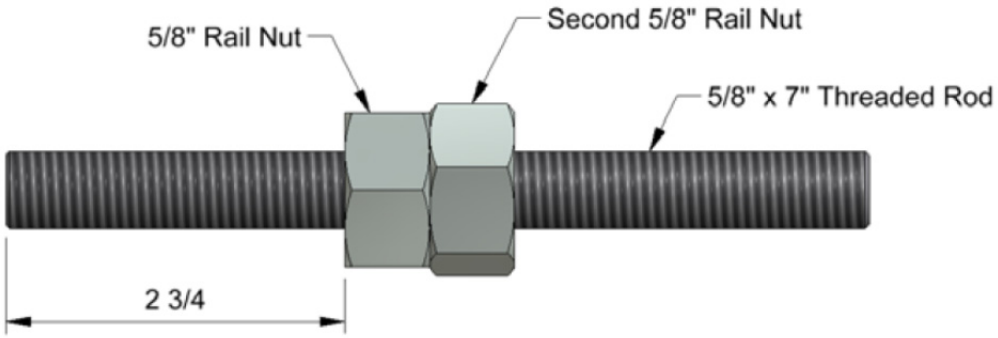


Figure 33

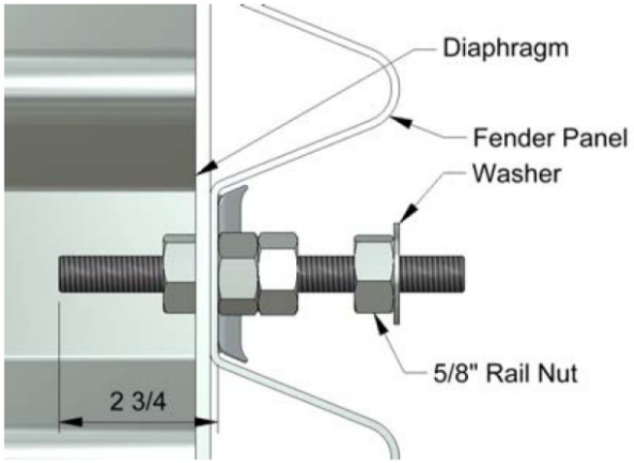
1. Position a 5/8” Rail Nut 2-3/4"from the end of the 5/8” Threaded Rod. Tighten a second 5/8” Rail Nut against the first (See Figure 33a). Repeat this step for all six fasteners.



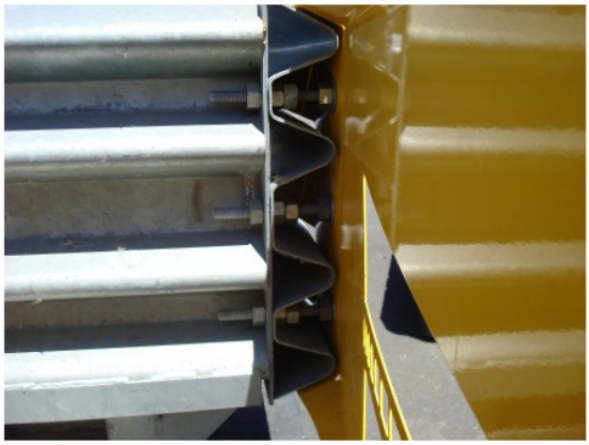
Detail 33a
Fastener Assembly

2. Using the fastener, assemble the Fender Panel to the Diaphragm. The 2 3/4” sections of threads should pass through the Diaphragm (See Figure 33b).
3. Position a 5/8” Rail Nut and washer flush with the outer edge of the Fender Panel (See Figure 33b). Repeat this step in all six locations.

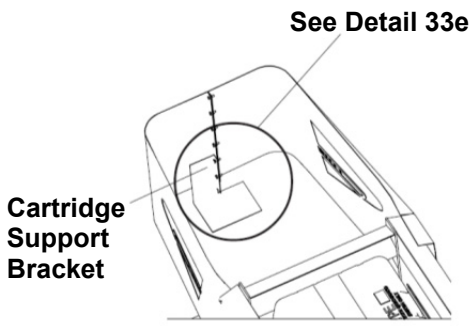
4. Assemble the Nose Assembly to the QuadGuard II system using the 5/8” Rail Nuts and washer. Verify the 5/8” outward nut is flush with the Fender Panel (See Detail 33b). Adjust as necessary (See Figure 33 and 33c).



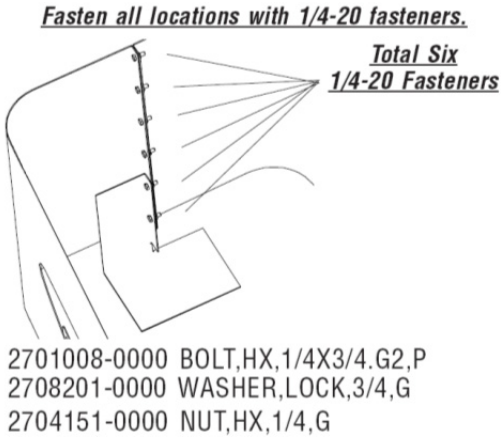
Detail 33b
End View with no Nose Cover



Detail 33c
End View With Nose Cover

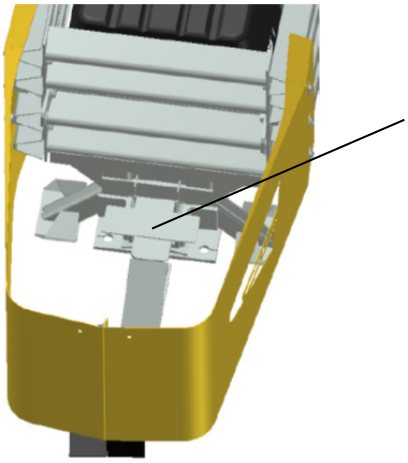


Detail 33d



Detail 33e

Detail 33e shows proper placement of front Cartridge Support Bracket.



Note difference of front Diaphragm Bracket. The Cartridge sits lower on this Bracket than the Bays to the rear.

Detail 33g

12) Checking the System Assembly

At this point recheck to ensure that all fasteners are properly tightened throughout the system (anchor bolts, etc.). See warning below. Check all Fender Panels. If they do not fit tightly against the underlying Panel, system realignment may be necessary (See Figure 34).

Warning:	
Anchor Studs	Torqued to 165 N-m [120 ft-lb] Should NOT protrude above nuts (See Figure 18, page 19)
All Other Bolts	Tightened
Fender Panel	Maximum gap allowed: **Narrow Systems – 20 mm [0.78”]**

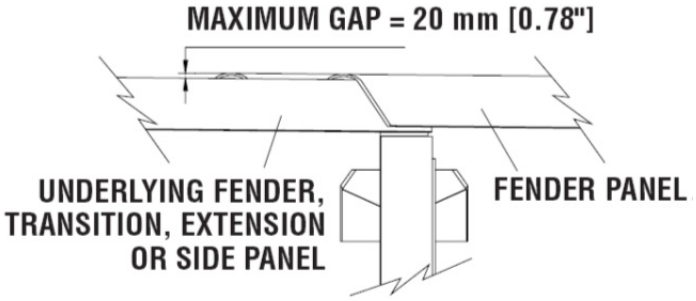


Figure 34
Fender Panel Gap for Narrow Systems

13) Cartridge Assembly

Be sure the Adjustable Cartridge Support in the Nose is attached correctly. See “Attach Nose Assembly” in Step 11 on Page 28. The top surface of the Nose Cartridge should be horizontal.

To complete the assembly of a QuadGuard® II system, place the appropriate Cartridge in each Bay and Nose section of the system. Type 1 Cartridges are placed toward the front (Nose) of the system; Type 2 Cartridges are placed toward the rear (Backup) of the system (See Figures 35 and 36).

Warning: Placing the wrong Cartridge in the Nose or any Bay has not been crash tested pursuant to the NCHRP 350 criteria. Accordingly, this is likely to result in unacceptable crash performance as described in NCHRP 350.

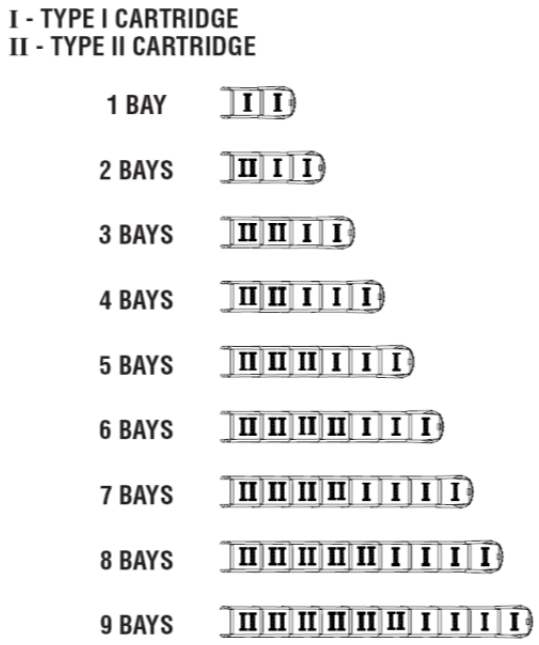


Figure 35
Cartridge Placement

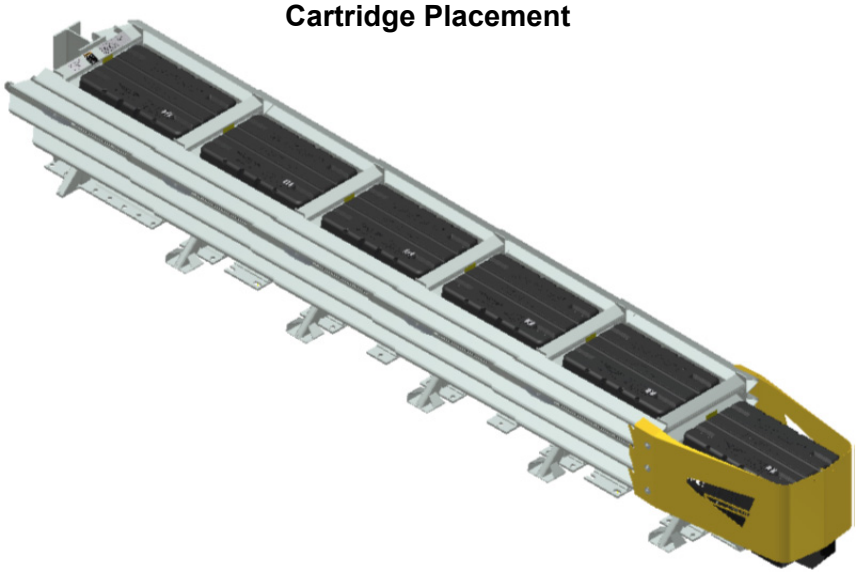
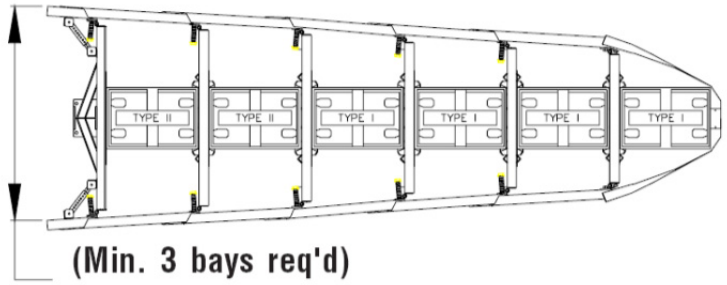


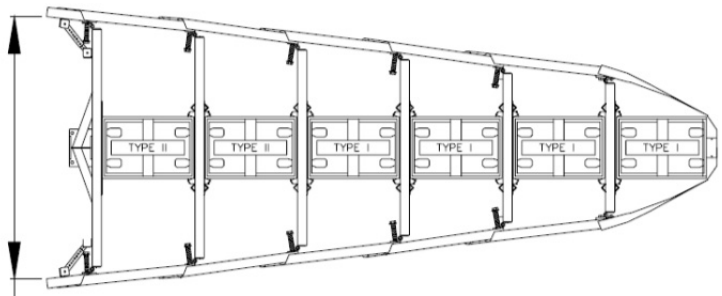
Figure 36
Typical Cartridge Layout 5 Bay System Shown

System Assembly for Wide Hazards

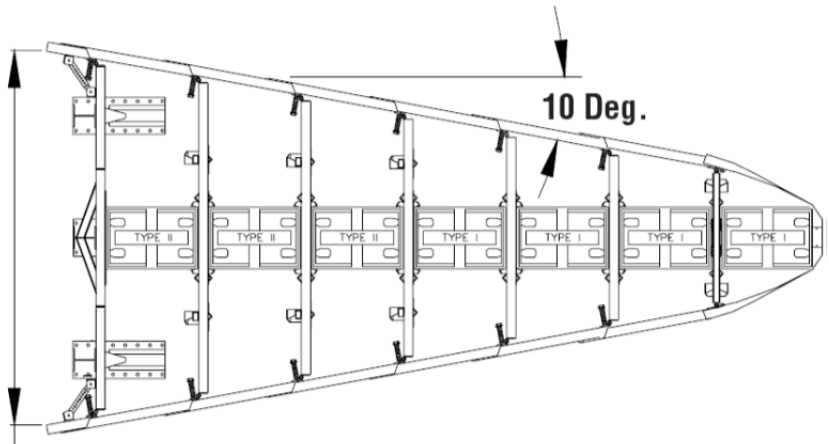


(Min. 3 bays req'd)

1755 mm [69"] MODEL NO. QG2_ _69



(Min. 3 bays req'd)2285 mm [90"]
MODEL NO. QG2_ _90



Varies - Min. 6 Bays Required:
3200 mm [126"] MODEL NO. QG2100126

Figure 37
Wide Systems and Model Numbers

Site Preparation/Foundation

A QuadGuard® II system should be constructed only on an existing or freshly placed and cured concrete base (28 MPa [4000 psi] minimum). Location and orientation of the concrete base and attenuator must comply with project plans or as otherwise determined by the resident project engineer.

Recommended dimension and reinforcement specifications for new concrete foundations are provided in Energy Absorption Systems concrete foundation drawings, supplied with the system. The system may be assembled on a non-reinforced concrete roadway (minimum 200 mm [8”] thick). Deployment cross-slope shall not exceed 8% and should not twist more than 2% over the length of the system; the foundation surface shall have a light broom finish.

Caution: Accurate placement of all steel rebar is critical to avoid interference with the concrete anchor bolts.

Warning: Location of the Backup in relation to nearby objects will affect the operation of the attenuator. Upon impact, the Fender Panels telescope rearward and extend beyond the rigid Backup as much as 876.3 mm [34.5”] from their pre-impact location. Position the Backup so that the rear ends of the last Fender Panels are a minimum of 760 mm [30”] forward of objects that would otherwise interfere with movement of the rearmost Fender Panels. Failure to comply with this requirement is likely to result in system performance which has not been crash tested pursuant to NCHRP 350 criteria and may also cause component damage which will necessitate maintenance or replacement of the system.

Inspect Shipping

Before deploying the QuadGuard® II system, check the received parts against the shipping list supplied with system. Make sure all the parts have been received.

Assembly Procedures

Note: The Drawing Package supplied with the QuadGuard® II system must be used with these instructions for proper assembly and should take precedence over these general instructions.

1) Determine Backup and Transition Type

The QuadGuard® II is available with a Tension Strut Backup or a Concrete Backup. See Figures 38 and 39, along with the Backup assembly drawing, to determine which type of Backup is being deployed.

A Transition Panel or Side Panel must be used on each side of the Backup. A Side Panel is not needed when a Transition Panel is used. Several types of transitions are available for use with the QuadGuard® II system. See Figures 40 through 45 and the drawing package to determine which types of panels to attach.

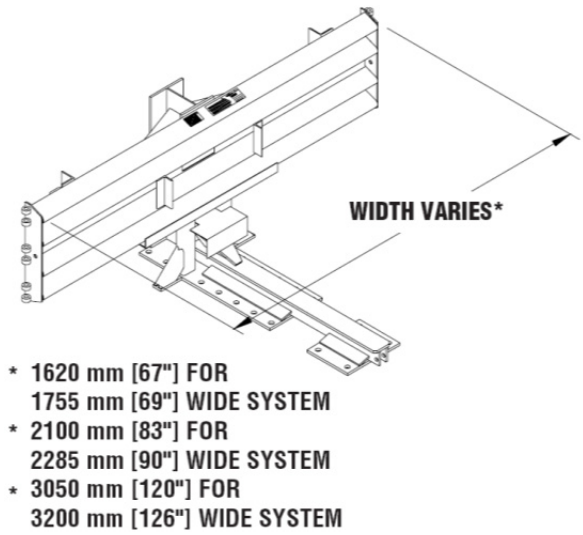


Figure 38
Tension Strut Backup

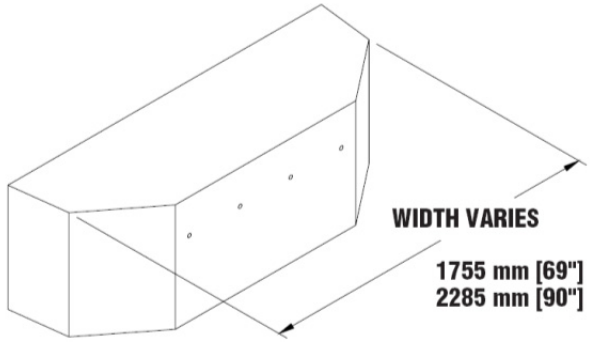


Figure 39
Concrete Backup

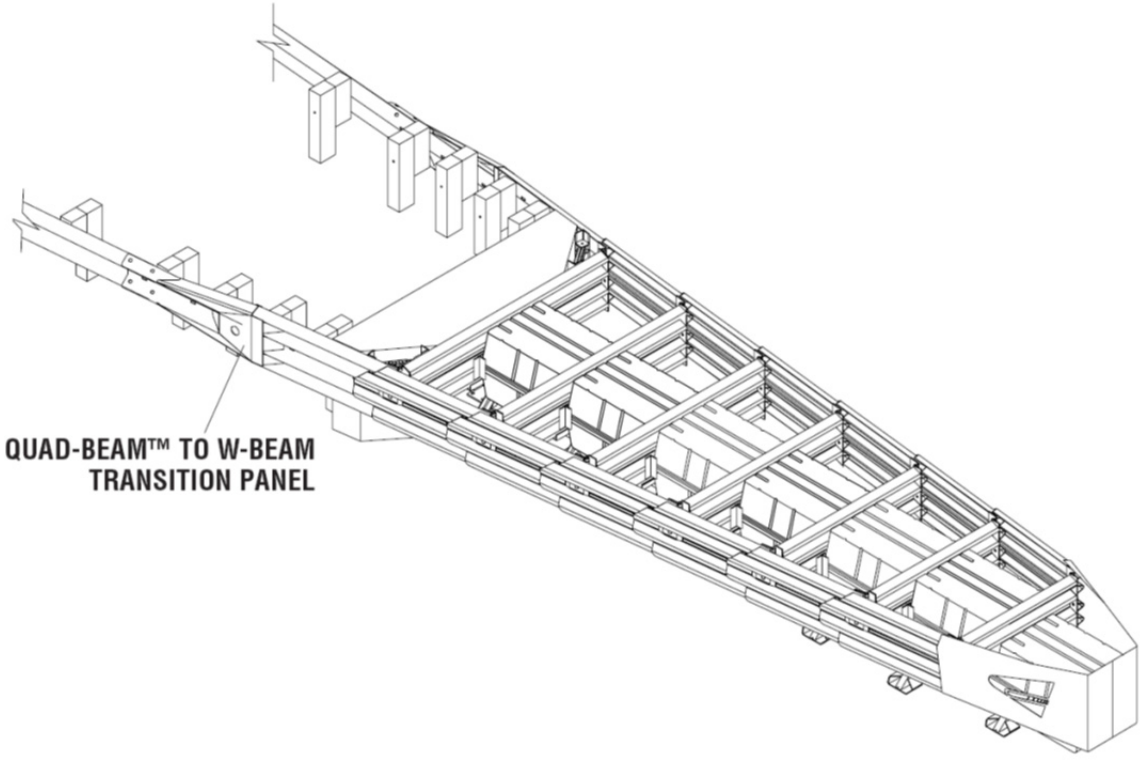


Figure 40
Transitioning the QuadGuard® II System

Transition Panel Types

Note: The proper Transition Panel or Side Panel must be used to perform as crash tested. The correct Panel(s) to use will depend on the direction of traffic and what type of barrier or hazard the QuadGuard® II system is shielding (See Page 16). Contact the Customer Service Department prior to deployment if you have any questions.

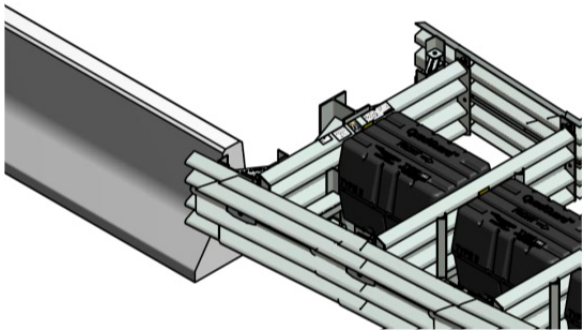


Figure 41
No Transition

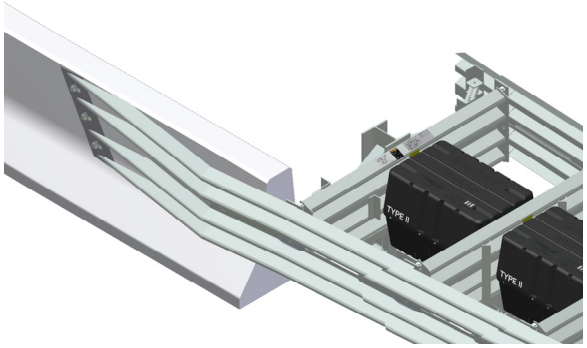


Figure 42
Quad-Beam™ to Safety Shape Barrier

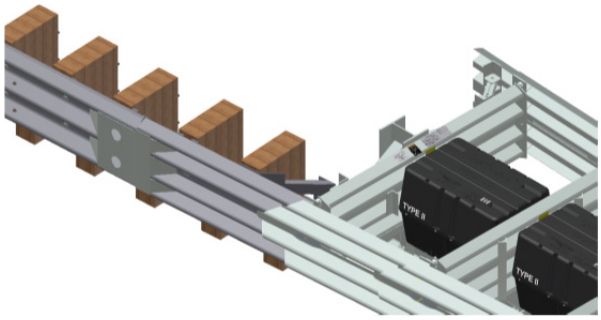


Figure 43
Quad-Beam™ to Thrie-Beam

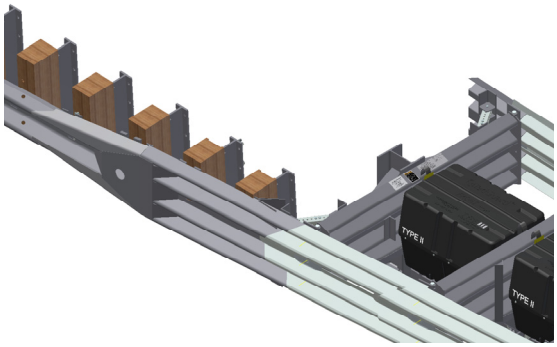


Figure 44
Quad-Beam™ to W-Beam

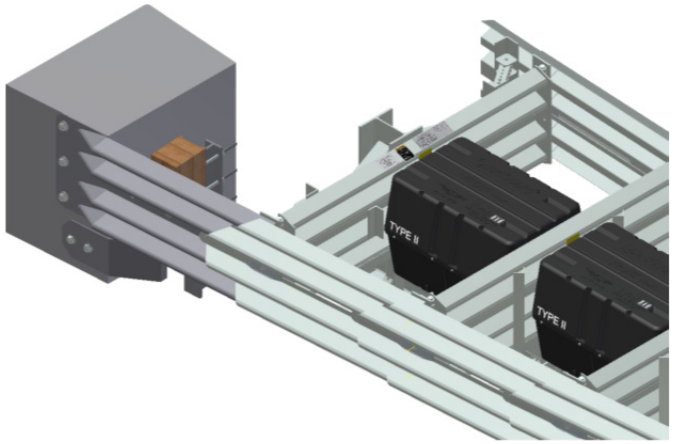


Figure 45
Quad-Beam™ End Shoe

2) Mark System Location

Locate the centerline of the system by measuring the proper offset from the hazard. See the Drawing Package supplied with the system. Place chalk line to mark the centerline of the system. Mark a construction line parallel to the center line and offset 165 mm [6.5”] to one side as shown in Figure 46. The edge of the Monorail will be placed on this line.

Note: The concrete foundation shall comply with the project plans supplied with the system.

Warning: Location of system with respect to the hazard is critical and dependent on the type of Transition Panel used. See the Project Plans supplied with the system for details.

Figure 46
(Top view of concrete foundation)

3) Anchor the Backup

A) Concrete Backup Construction (Figure 47)

Locate Backup Face Plate using the Backup assembly drawing. Drill anchor holes in the Concrete Backup using the Face Plate as a template. Anchor the Face Plate to the Concrete Backup using the MP-3® Anchoring system (horizontal kit) supplied with the QuadGuard® II system (See “MP-3® Polyester Anchoring System” section on Page 51).

Warning: Every hole and slot in Backup and Monorail must have an MP-3® stud anchoring it.

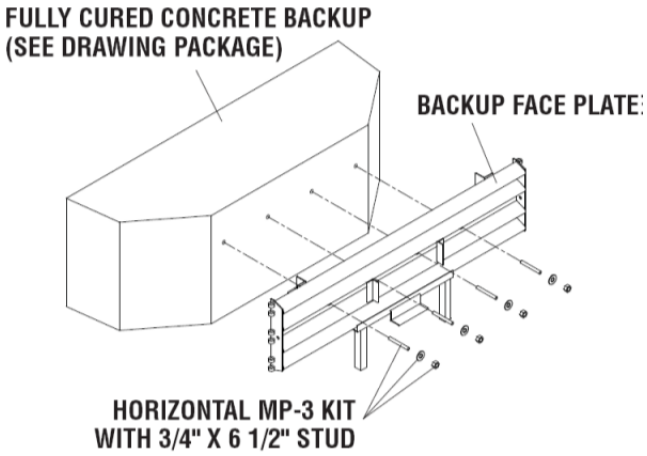


Figure 47
Anchoring Backup Face Plate to Concrete Backup

B) **Tension Strut Backup Assembly**

Locate the Tension Strut Backup and Monorail on foundation with side of Monorail on the construction line (See Figure 52 on Page 39). Verify that any applicable Transition Panels fit properly before anchoring Backup. Drill anchor holes in foundation using the Backup as template. Anchor the Backup to the concrete foundation using the MP-3® Anchoring System (vertical kit) supplied with the QuadGuard® II system (See "MP-3® Polyester Anchoring System" section on Page 51).

Caution: Every hole and slot in Backup and Monorail must be anchored by an MP-3® stud.

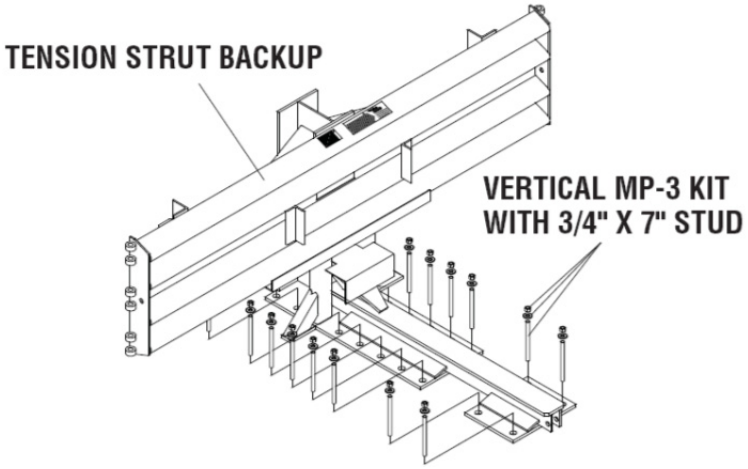


Figure 48
Anchoring Tension Strut Backup to Foundation

C) Extra-Wide Tension Strut Backup Assembly (Figure 49)

Locate the Extra-Wide Tension Strut Backup center section and Monorail on foundation with side of Monorail on the construction line (See Figure 52 on Page 39).

Locate the Extra-Wide Tension Strut Backup left section on the left side of the center section, aligning the three holes in the side plates.

Locate the Extra-Wide Tension Strut Backup right section on the right side of the center section, aligning the three holes in the side plates.

Secure the Backup sections to each other using 5/8” x 2” hex bolt, 5/8” x 1 3/4" flat washer (2), 5/8” lock washer and 5/8” hex nut (6 places) as shown in Figure 49 and Detail 49a.

Verify that any applicable Transition Panels fit properly before anchoring Backup. Drill anchor holes in foundation using the Backup as template. Anchor the Backup to the foundation using the MP-3® vertical kits supplied with the QuadGuard® II system (See “MP-3® Polyester Anchoring System” on Page 51).

Warning: Every hole and slot in Backup and Monorail must be anchored by an MP-3® stud.

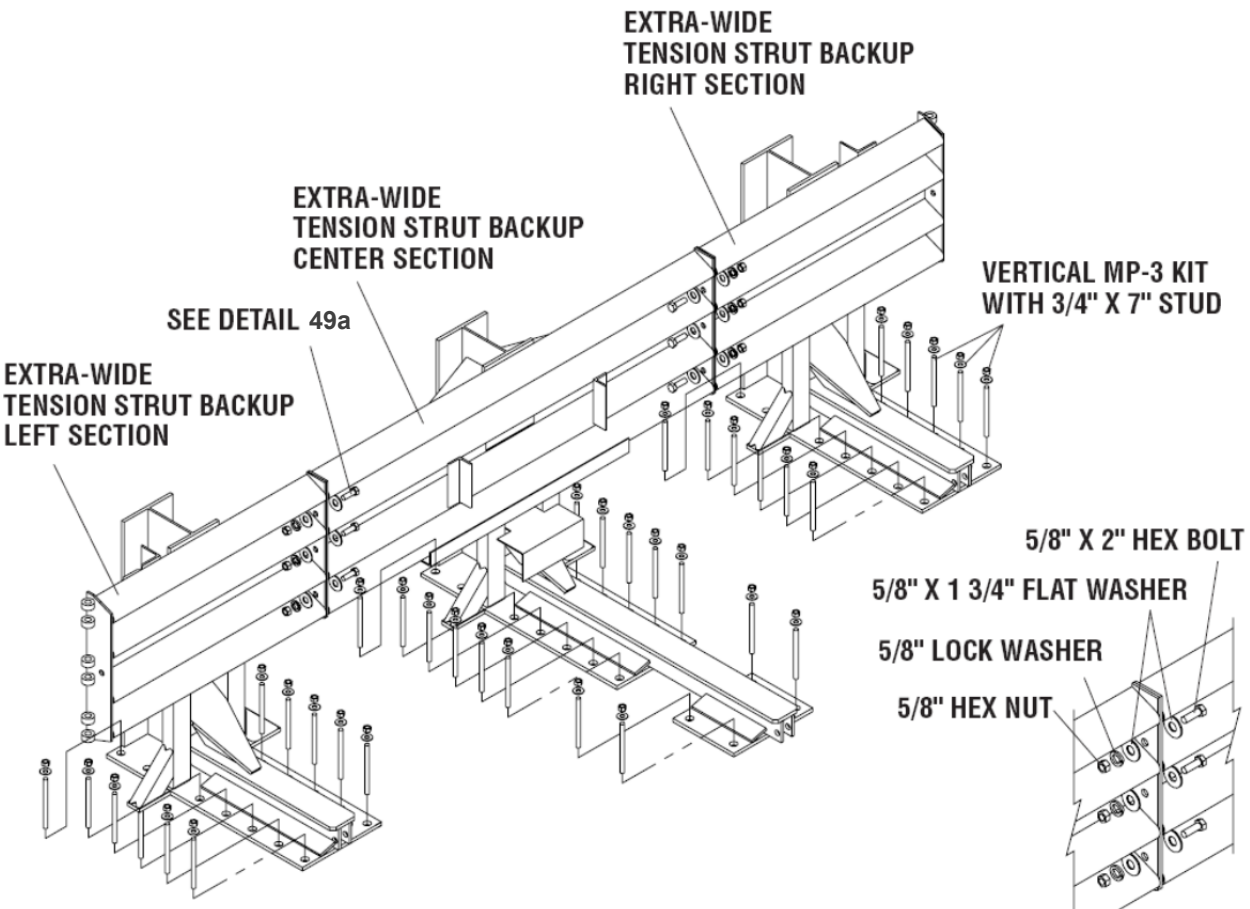


Figure 49
Anchoring Extra-Wide Tension Strut Backup to Foundation See Drawing Package

Detail 49a

4) Anchor the Monorail

A) Monorail Construction for Concrete Backup (See Figure 51).

Locate Monorail on foundation with side of Monorail on the construction line and rear edge of Monorail 10” forward of front face of Concrete Backup (See Figure 51).

Orient the Monorail so that the Monorail tongues face Backup (See Figure 51).

Drill 140 mm [5 1/2"] deep anchor holes using the Monorail as a template. Do not drill through foundation.

Warning: Improper alignment at the Monorail Splice Joints may prevent proper system collapse during an impact.

Warning: Every hole and slot in Backup and Monorail must be anchored by an MP-3® stud.

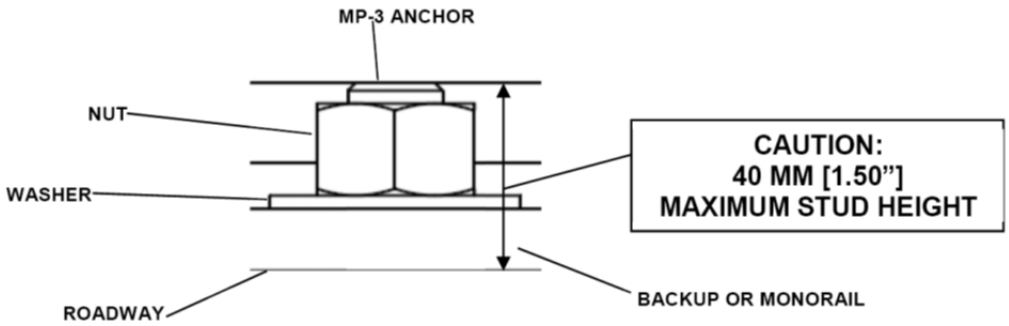


Figure 50
Proper Stud Height

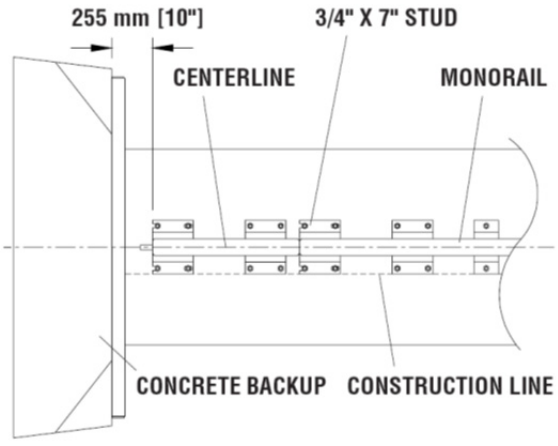


Figure 51
Monorail Location for Concrete Backup

B) Monorail Construction for Tension Strut Backup (See Figure 52).

Locate Monorail on foundation with side of Monorail on the construction line and rear edge of Backup 4” forward of edge of foundation (See Figure 52).

Orient the Monorail so that the Monorail tongues face the Backup (See Figure 52).

Drill 140 mm [5 1/2"] deep anchor holes using the Monorail as a template. Do not drill through foundation.

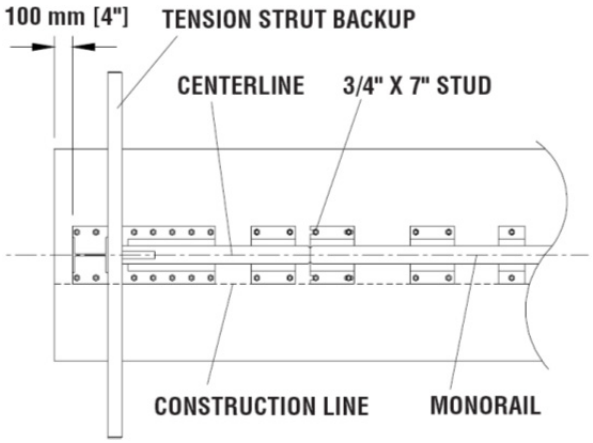


Figure 52
Backup and Monorail Location for Tension Strut Backup

5) Attach Side Panels and/or Transition Panels to Backup Assembly

a. Attach Hinge Plate to the Transition Panel or Side Panel using 5/8” rail bolt and 5/8” rail nut (two places – top and bottom holes only).

b. Attach Transition Panel or Side Panel assembly to side of Backup using 5/8” hex bolt, 5/8” lock washer and 5/8” hex nut (three places each side of Backup). See illustration on Page 41.

c. Attach diagonal brace to Fender Panel and Backup using 3/8” hex bolt, 3/8” lock washer and 3/8” hex nut (two places per brace: 4 places per side).

d. Secure each diagonal brace with a 3/8” hex bolt; 3/8” lock washer, and 3/8” hex nut (two places per brace) as shown in Figure 53.

Note: A Side Panel is not needed when a Transition Panel is used. Diagonal braces not used with some Transition Panels (See drawing package).

Assembly tip:

Use drift pin to align the center hole of the Panel with the center hole of the Backup before attaching the rail bolts.

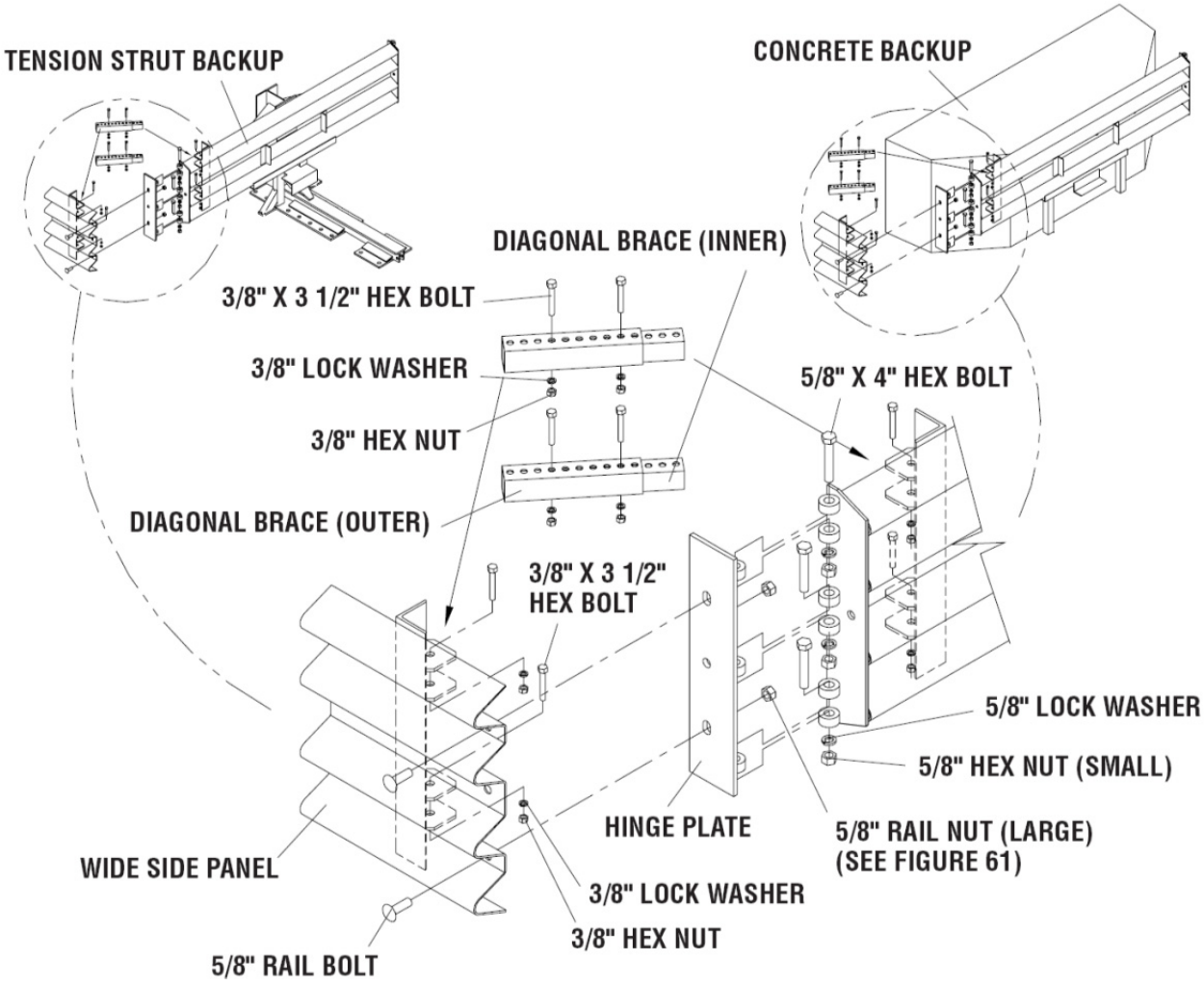


Figure 53
Side Panel/Transition Panel Attachment

6) Attach Monorail Guides

Attach Monorail guides to Diaphragm as follows:

Insert 3/4" x 2” G8 hex bolt through Monorail guide and Diaphragm, oriented as shown in Figure 54. Secure with 3/4" lock washer and 3/4" hex nut (typical two places per guide). See also Diaphragm assembly drawing. Shims are sandwiched between Monorail guides and Diaphragm.

Repeat process for each Diaphragm.

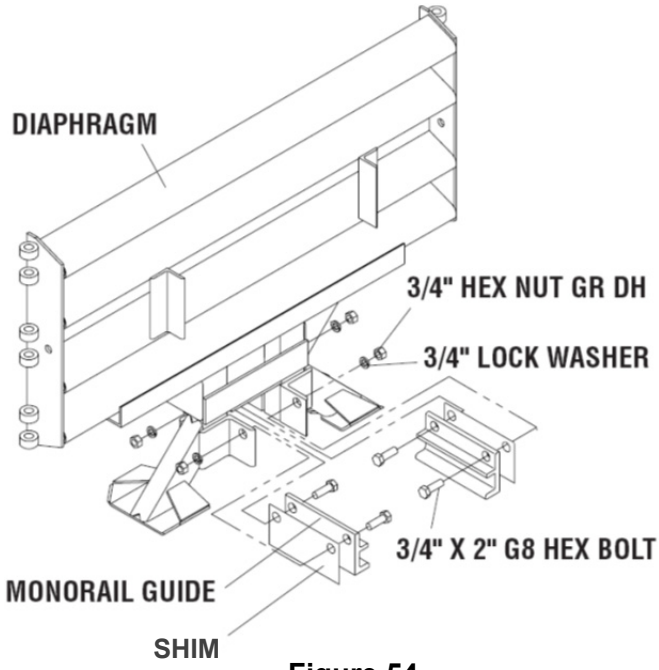


Figure 54
Monorail Guide Attachment

7) Attach Diaphragms

Orient the widest Diaphragm so that the front face of the Diaphragm shape faces toward the Nose of the system as shown in Figure 55. **The widest Diaphragm must be attached closest to the Backup with each subsequent Diaphragm being progressively narrower.**

Slide the widest Diaphragm onto the Monorail and all the way to the Backup to ensure system is able to collapse properly during impact. Once this has been verified, slide the Diaphragm forward to approximately 915 mm [36”] in front of the Backup.

Orient and slide all other Diaphragms onto Monorail and position each approximately as shown in Figure 56.

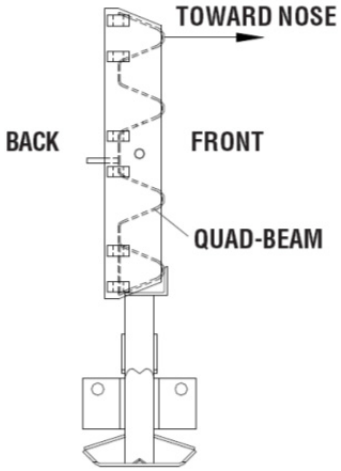


Figure 55
Diaphragm Orientation

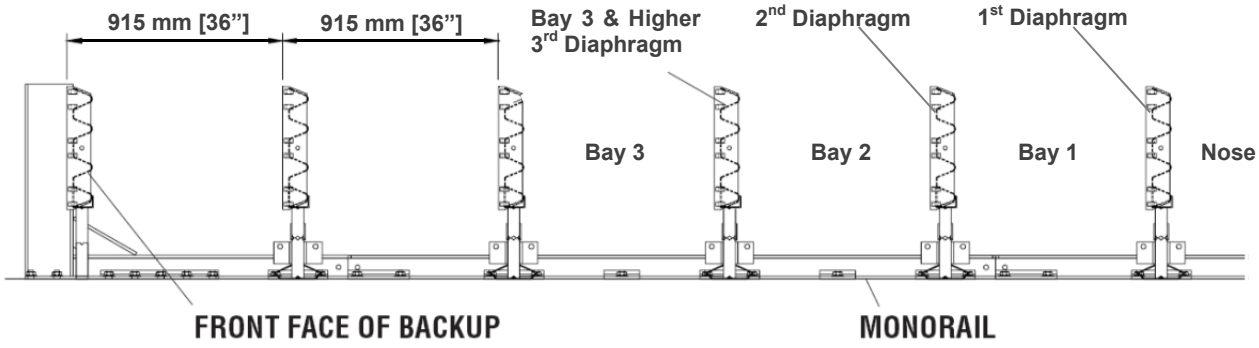


Figure 56
Diaphragm spacing

8) Attach Hinge Plate onto Fender Panels

Note: Do not mix the 5/8” rail nuts (large) with the 5/8” hex nuts (small).

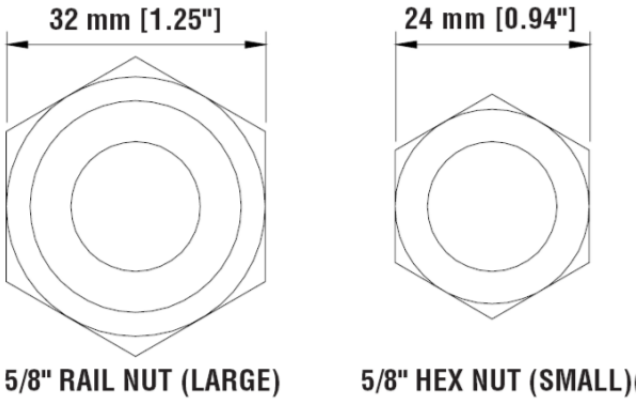


Figure 57
Rail Nuts are Oversize

Note: For proper impact performance, Systems for wide hazards must have Hinge Plates.

Attach Hinge Plate on each Fender Panel using two 5/8” rail bolts and two 5/8” rail nuts, using top and bottom holes only, leaving the center-hole open as shown in Figure 58.

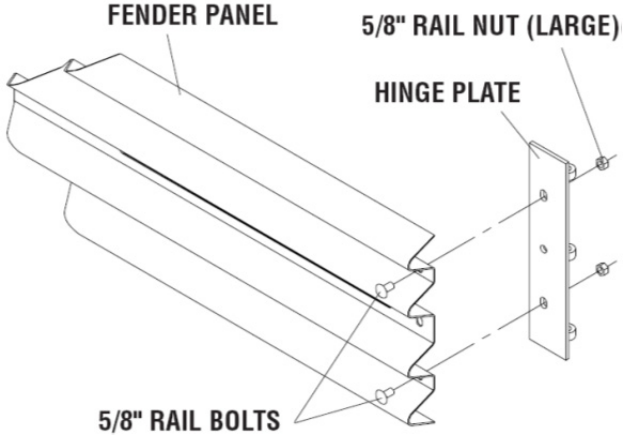


Figure 58
Hinge Plate Assembly

9) Attach Fender Panels

Starting at the Backup, attach left and right Fender Panels as shown in Figure 59.

Attach Mushroom Washer Assembly as shown in Figure 59 and Detail 59a but do not torque at this time.

Step 1

Place the Fender Panel so that the center of the slot of the rearward Diaphragm is lined up with the approximate center of the slot in the Fender Panel.

Attach Mushroom Washer Assembly as shown in Figure 59 and Detail 59a and Detail 59b and do not torque at this time. This (Step 1) helps to balance the Fender Panel.

Step 2

Slide the Fender Panel forward until the holes in the Fender Panel line up with the holes in the forward Diaphragm.

Step 3

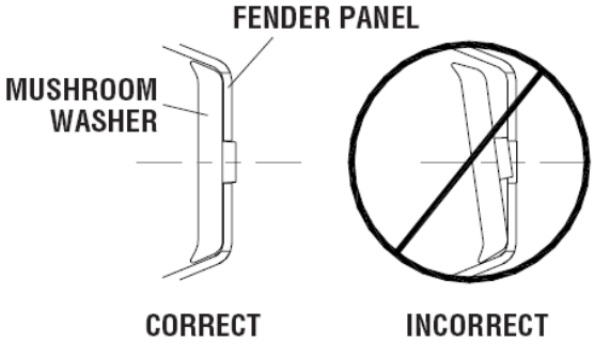
Use a drift pin to align the center hole of the Fender Panel with the center hole of the Diaphragm.

Step 4

Attach the front of the Fender Panels to the next Diaphragm using 5/8” x 4” bolts, 5/8” lock washer and 5/8” hex nut (small) in three places on the Hinge Plate per side.

Step 5

Be sure Mushroom Washer lays flat against the Fender Panel as shown in Detail 59a. Standoff on Mushroom Washer must be seated completely through slot.



Detail 59a
Mushroom Washer Orientation

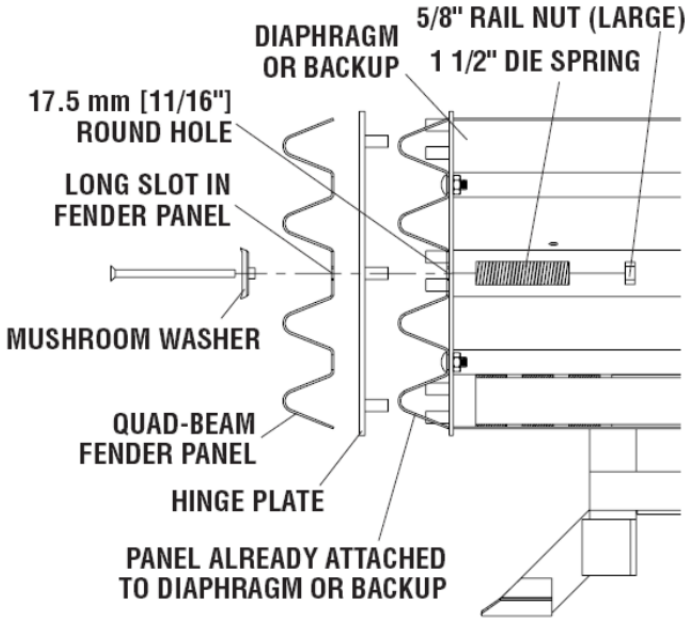


Figure 59
Mushroom Washer Attachment

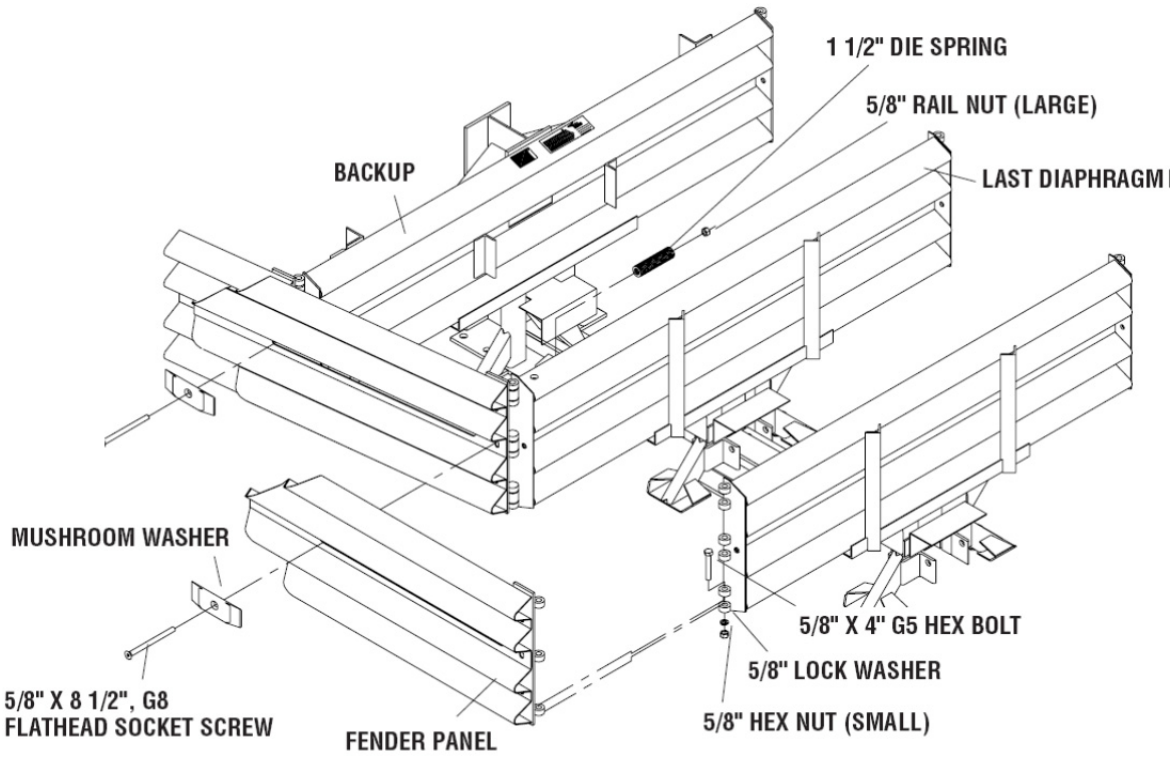


Figure 60
Fender Panel Assembly

Step 6

Check Diaphragm spacing to endure 915 mm [36”] between rear faces of consecutive Diaphragms as shown in Figure 61 and Fender Panel Assembly drawing.

Step 7

Once the proper spacing has been achieved, torque the Mushroom Washer Assembly (small hex nut) until it reaches the end of the threads. Assemble the remaining Diaphragms and Fender Panels following the same procedures.

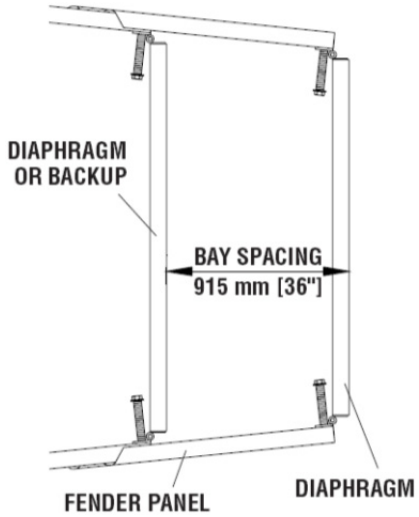


Figure 61
Proper Spacing Between Diaphragms

10) Attach End Cap

Using 5/8” x 3 1/2” G5 hex bolt, 5/8” hex nut and 5/8” lock washer, attach the End Cap to the front of the first Monorail segment as shown in Figure 62 and the Monorail Assembly drawing.

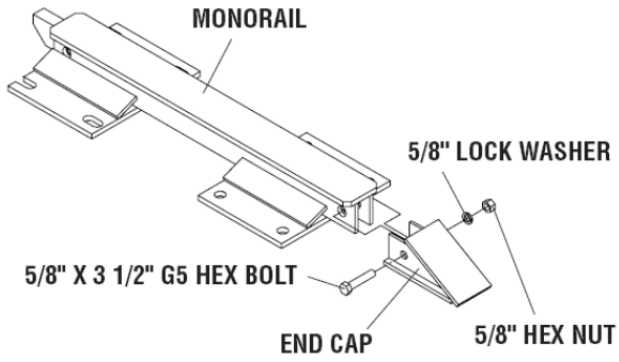


Figure 62
Monorail End Cap Assembly

11) Assemble Cartridge Support Brackets

Attach Cartridge Support Bracket to all Diaphragms and Backup as shown in Figures 63 - 66, the Backup Assembly drawing, and the Diaphragm Assembly drawing.

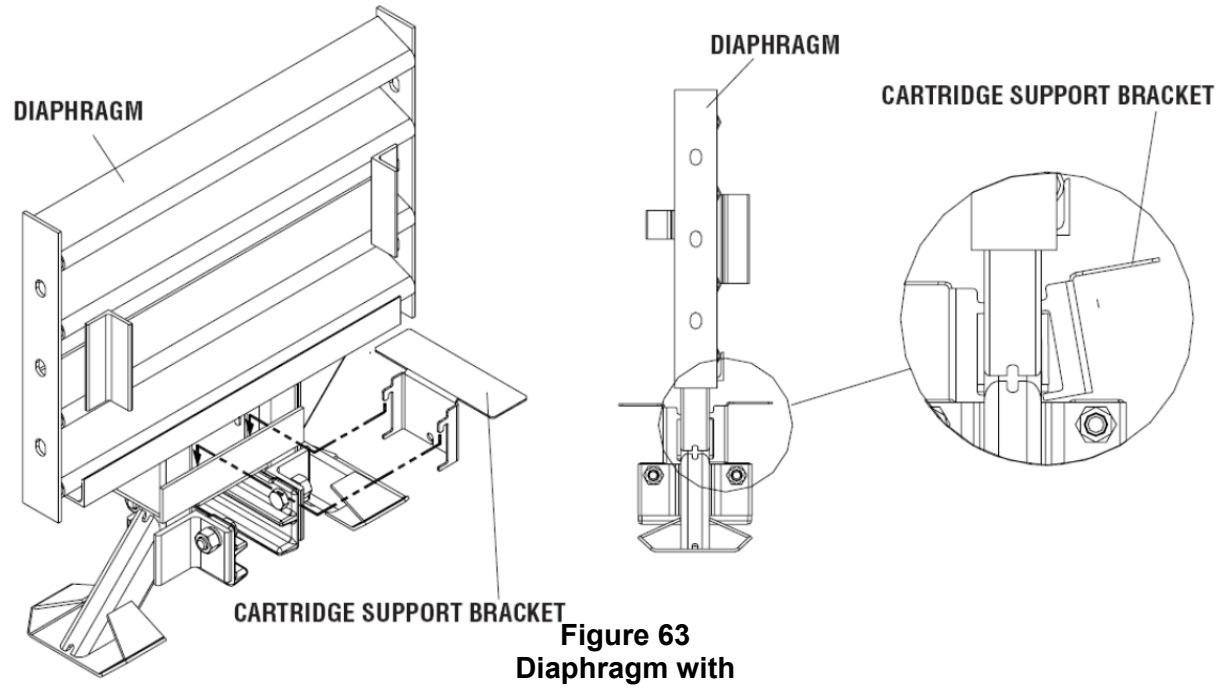


Figure 63
Diaphragm with
Cartridge Support Bracket

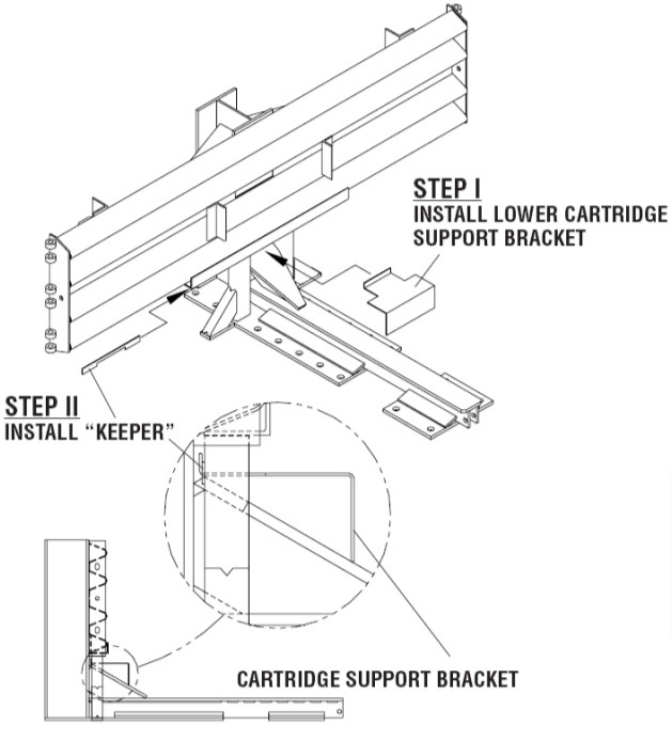


Figure 64
Cartridge Support Bracket
(Tension Strut Backup)

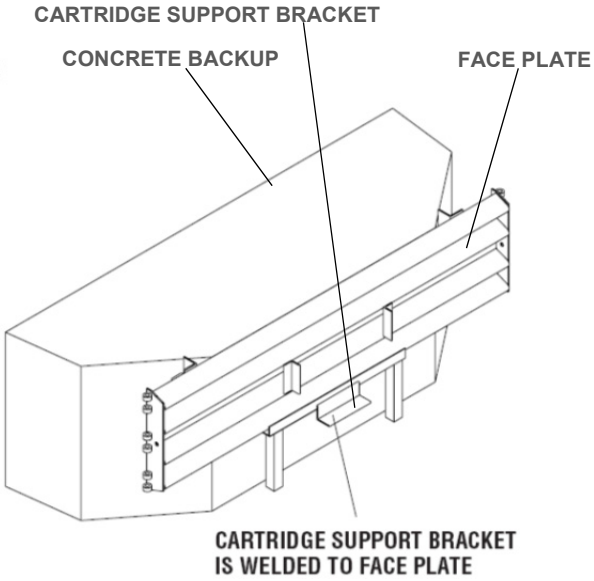


Figure 65
Cartridge Support Bracket
(Concrete Backup)

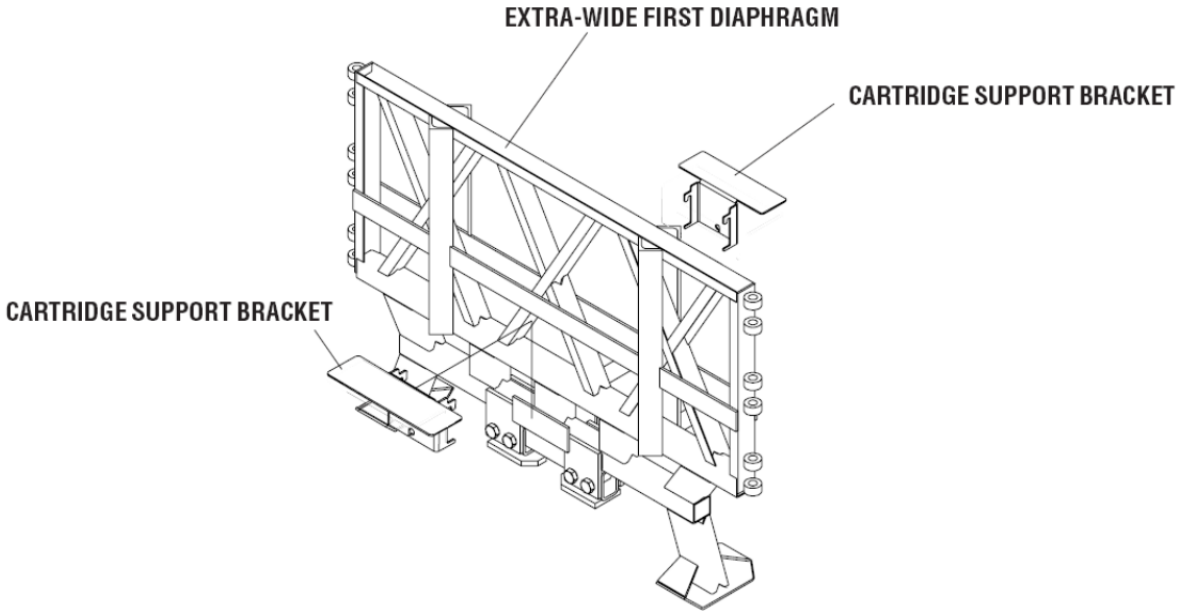


Figure 66
Extra-Wide First Diaphragm With Cartridge Support Bracket
(See Drawing Package)

12) Attach Nose Assembly

(See Pages 28 and 29 for Nose Assembly instructions.)

13) Checking the System Assembly

At this point recheck to ensure that all fasteners are properly tightened throughout the system (anchor bolts, etc.). See warning below. Check all Fender Panels. If they do not fit tightly against the underlying Fender Panels, system realignment may be necessary (See Figure 67).

Warning:	
Anchor Studs	Torqued to 165 N-m [120 ft-lb] Should NOT protrude above nuts (See Figure 18 on Page 19).
All Other Bolts	Tightened
Fender Panel	Maximum Gap Allowed: **Wide Systems – 25 mm [1.00”]**

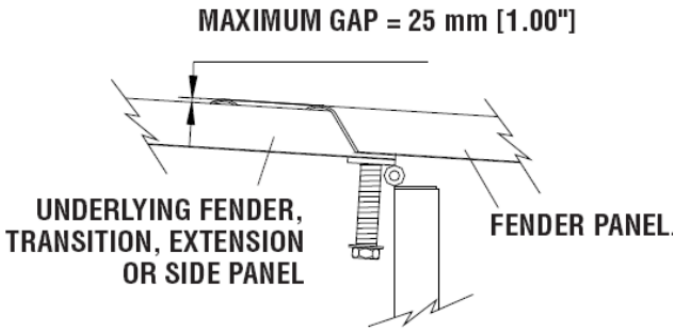


Figure 67
Fender Panel Gap for <u>Wide Systems</u>

14) Cartridge Attachment

Be sure the Adjustable Cartridge Support in the Nose is attached correctly. See “Attach Nose Assembly” in Step 11 on Page 28. The top surface of the Nose Cartridge should be horizontal.

To complete the assembly of a QuadGuard® II system, place the appropriate Cartridge in each Bay and Nose section of the system. Type I Cartridges are placed toward the front (Nose) of the system; Type II Cartridges are placed toward the rear (Backup) of the system (See Figures 68 and 69).

Warning: Placing the wrong Cartridge in the Nose or any Bay may result in unacceptable crash performance as describe in NCHRP Report 350 as other configurations have not been crash tested.

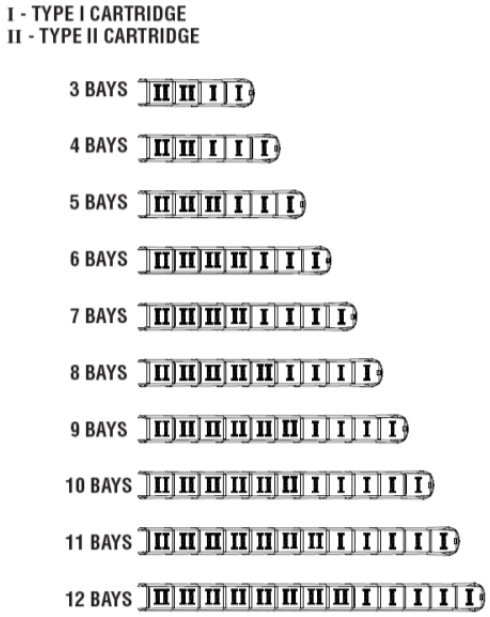


Figure 68
Cartridge Placement

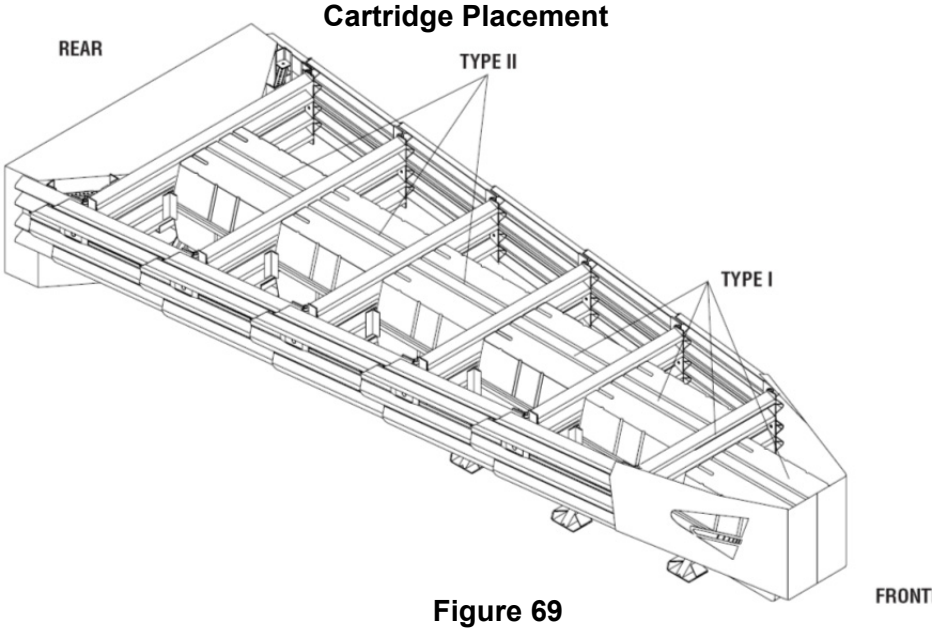


Figure 69
Typical Cartridge Layout (5 Bay System Shown)

MP-3® Polyester Anchoring system

The MP-3® Polyester Anchoring System is a quick and easy way to securely anchor crash cushions and other common highway devices. MP-3® features high pullout strength, superior vibration resistance, and exceptional durability.

Each MP-3® kit contains a can of MP-3® resin, hardener, cold weather promoter, studs, and washers. The cold weather promoter shortens hardening time by as much as seven hours. Both vertical and horizontal assemblies are possible using the MP-3® system.

Vertical Assemblies

Note: Read MP-3® Instructions before starting.

1) Prepare the Concrete Foundation

Warning: Do not allow the MP-3® resin or hardener to contact skin or eyes. See material safety data sheet supplied with the MP-3® kit for first-aid procedures. Use only in well-ventilated area. Do not use near open flame.

Warning: Wear safety goggles, apron, and gloves during construction.

The anchor bolts (studs) that anchor the QuadGuard® II system Backup and/or Monorail sections to the concrete foundation must be those shipped in the kit or of high strength steel (830 MPa [120,000 psi] minimum tensile strength or equal). These studs must be set in minimum 28 MPa [4000 psi] concrete. Allow the concrete to cure a minimum of seven days before applying MP-3®.

2) Drill Holes

Note: Energy Absorption Systems recommends using two fluted drills to achieve optimum tensile strength when applying the MP-3® anchoring system.

Use the part that is to be anchored as a drilling template. Drill the holes 3 mm [1/8”] larger than the stud diameter to the recommended depth, using a rotary percussive drill. If a diamond drill is used, the surface will be too smooth for the MP-3® to adhere and full strength will not be achieved. See the MP-3® assembly instructions provided with your kit. Check to be sure all the holes are drilled to the proper depth and aligned with the part to be anchored (See Table A).

Table A

MP-3® Anchoring Information

Stud Size:	Concrete Bit Size	Minimum Depth	Recommended Torque
3/4”x 6 1/2"	22 mm [7/8”]	125 mm [5”]	165 N-m [120 ft-lb]
3/4”x 7"	22 mm [7/8”]	140 mm [5” 1/2"]	165 N-m [120 ft-lb]
3/4”x 18"	22 mm [7/8”]	420 mm [16 1/2”]	<15 N-m [<10 ft-lb]

3) Clean the Holes

Blow the concrete dust from the hole using oil-free compressed air. Thoroughly brush it with a stiff-bristled brush and then blow it out again. If the hole is wet, completely flush it with water while brushing. Then blow it clean using oil-free compressed air.

4) Mix the Resin and Hardener

Wearing gloves, apron and safety goggles, remove the lids from the MP-3® Part A-resin and Part B-hardener containers. Pour Part B into Part A, then mix vigorously for 30 seconds to form MP-3® grout (an anchor stud may serve as a stirring rod).

5) Add Cold Weather Promoter (in Cold Weather)

For faster hardening in cold weather, promoter may be used. Add the entire contents of the partially filled promoter container to the MP-3® grout, then mix for an additional 30 seconds. Use immediately because the MP-3® grout will thicken quickly. See Table B for hardening times.

Warning: Do not use promoter when the temperature is above 15 degrees Celsius (60 degrees Fahrenheit). Grout will harden too quickly. Use only in well-ventilated area. Do not use near open flame.

6) Pour Grout into Holes

Crimp the mouth of the can to form a sprout, and pour the MP-3® grout mixture down into the hole through the part. Fill the hole to 1/3 - 1/2 full.

Caution: Do not overfill or underfill the hole. If the hole is overfilled, there will not be enough grout to use all of the anchor studs/kit. If hole is underfilled, the grout may not develop the required pull out strength.

7) Add the Washers and Nuts

Place a flat washer onto the stud, then thread a nut on until **1 or 2 threads of the NUT** are left exposed.

8) Insert Studs in Holes and Wait for Grout to Harden

Push the stud down through the part to be anchored and into the hole. Give the stud several twists in the MP-3® to wet the threads.

Caution: Do not disturb or load the stud until the MP-3® material has hardened (See Table B).

9) Torque the Nuts

Once the grout has hardened, torque the nut to the recommended values (See Table A on Page 51).

Table B
Approximate Hardening Times (hours)

Temperature Concrete Bit Size		Hardening Times (hours) Recommended Torque	
(C)	(F)	No Promoter	With Promoter
>26	>80	1/2	N/R*
22-26	70-79	1	N/R
16-21	60-69	2	N/R
10-15	50-59	4	3/4
4-9	40-49	8	1
-1-3	30-39	N/R	1 1/2
<-1	<30	N/R	N/R**
*Not recommended **Contact Customer Service Department for more information			

Horizontal Assemblies

The horizontal MP-3® kit is the same as the vertical kit except that a Cartridge for a standard caulking gun is supplied in the horizontal kits and the resin for the horizontal kits is a thixotropic (TX) resin. The TX-Resin is a gelled resin intended to keep the grout in place in horizontal holes during application.

When using the horizontal MP-3® kits, follow the vertical instructions with the following exceptions:

1) Thread Dispensing Tip onto Dispenser

Prior to mixing the grout, carefully thread the dispensing tip onto the dispenser.

2) Pour Mixed Grout into Dispenser

Once the grout is mixed, crimp the mouth of the can to form a spout and pour the MP-3® grout into the open end of the dispenser (use mixing stud to scrape out the portion remaining in the can). You may use the box to hold the dispenser upright. Close the box lid and poke the dispenser tip into the top of it. Seal the dispenser with the plunger provided.

3) Place Dispenser in Caulking Gun and Dispense Grout

Cut the small end of the dispenser tip off. Place the dispenser into a caulking gun and dispense until MP-3® TX grout reaches the tip of the dispenser, then release pressure. Push the dispenser tip through the part to the bottom of the hole and dispense while slowly withdrawing the tip.

Caution: Do not over fill or under fill the hole. Fill hole approximately 1/3 to 1/2 full. If the hole is overfilled, there will not be enough grout to use all of the anchor studs/kit. If hole is underfilled the grout may not develop the required pull out strength.

4) Add the Washers and Nuts

Put washer and nut on stud leaving nut flush with end of stud (See Figure 70).

5) Insert Studs into Holes

Push stud through part to be anchored and into hole. Twist the stud in the MP-3® grout to wet the threads.

Note: In horizontal applications the stud should be flush with the top of the nut (See Figure 70).

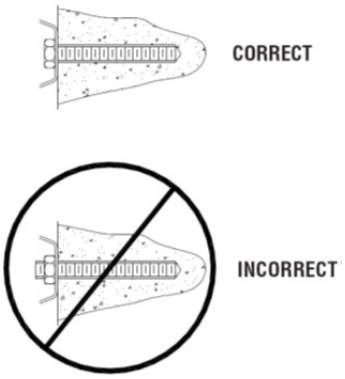


Figure 70
MP-3® Horizontal Application

Caution: Do not disturb or load the stud until the MP-3® material has hardened (See Table B for hardening times).

6) Torque the nuts

Once the grout has hardened, torque the nut to 165 N-m [120 ft-lb].

MP-3® Assembly Cautions

1) Shelf life

If the shelf life of the MP-3® has expired (See MP-3® kit for expiration information), mix a small amount of MP-3® in the proportions of one part A to two parts B by volume. If the material does not set according to the instructions, contact Energy Absorption Systems for guidance (See Page 3).

Warning: Do not use the MP-3® if: the material fails to set up, Part A-Resin had gelled (for vertical applications), or TX-Resin is NOT gelled (for horizontal applications).

2) Steel rebar

If steel rebar is encountered while drilling an MP-3® anchor bolt hole, apply one of the following solutions:

A) Using a diamond core drill or rebar drilling tool, drill through the rebar only, then switch back to the concrete bit and drill into the underlying concrete until the proper hole depth is reached.

Caution: Do not drill through rebar without first obtaining permission to do so from the local project engineer.

B) Drill a new hole down at an angle past the rebar to the proper depth. Anchor the stud by completely filling both holes with MP-3®.

Maintenance and Repair

Inspection Frequency

Inspections are recommended as needed based upon volume of traffic and impact history. Visual Drive-By Inspections are recommended at least once a month. Walk-Up Inspections are recommended at least once a year for QuadGuard® II systems on asphalt.

Visual Drive-By Inspection

1) Check to see if there is evidence of a hit. If so, a walk-up inspection will be necessary.
2) Check to see if the Cartridges appear to be off the Support Brackets. Any damaged Cartridges will need to be replaced.

Warning: See Cartridge placement instructions on Pages 31 and 50.

3) Be sure the Steel Nose is in place.
4) Note the location and condition of the QuadGuard® II system and the date of visual drive-by inspection.

Walk-Up Inspection

1) Clear and dispose of any debris on the site.
2) Be sure all bolts are tight and rust free.
3) Be sure concrete anchor bolts are securely anchored.
4) Be sure Diaphragm Legs are straight.
5) Be sure all Mushroom Washer Assemblies are properly aligned and positioned.
6) Fender Panels and Transition Panels should nest tightly against the system.

Warning:	
Fender Panel	Maximum gap allowed:
	Narrow Systems – 20 mm [0.78”]
	Wide Systems – 25 mm [1.00”]

See Figures 74 and 75 on Page 60.

7) Be sure Cartridges have not been damaged and are properly positioned on their Support Brackets. Replace crushed or sagging Cartridges. To ensure 100% of the intended speed characteristics, partially crushed Cartridges (due to slow speed impacts) shall be replaced.

Warning: See Cartridge placement instructions on Pages 31 and 50.

8) Make all necessary repairs as described above. See Post-Impact Instructions, Page 58, for more information.

9) Note the location and condition of the QuadGuard® II system and any work done in the Impact Attenuator Inspection Logbook under the date of this inspection. If further repair is necessary, note repair request date in logbook. See Post-Impact Instructions, Page 58, and assembly section of this Manual for more information.

Post-Impact Instructions

Narrow Systems

1) Deploy the appropriate **traffic-control** devices for protection.
2) Check to see that all **anchor bolts** have remained firmly anchored in the roadway surface. Replace any that are loose, broken, or pulled out.

   If the system is anchored to asphalt, up to 20% of the total anchors may be replaced if damaged. If more than 20% of the anchors are damaged, the system should be relocated to fresh, undisturbed asphalt and redeployed using the 460 mm [18”] threaded rods.

   The proper performance of the system during an angle impact depends on the Monorail anchors being properly anchored.
3) Clear and dispose of any **debris** on the site.
4) Check the system to be certain that the **Mushroom Washer Assemblies** holding the Fender Panels together are still intact and that the system has not been deformed in a way that would prevent pulling it back to its original position.
5) Be sure that the **Diaphragm Support Legs** are all properly attached to the Monorail.

Wide Systems

1) Deploy the appropriate **traffic-control** devices for protection.
2) Check to see that all **anchor bolts** have remained firmly anchored in the roadway surface. Replace any that are loose, broken, or pulled out.

   The proper performance of the system during an angle impact depends on the Monorail Anchors being properly anchored.

Note: QuadGuard® II systems for Wide Hazards should never be anchored to asphalt.

3) Clear and dispose of any **debris** on the site.
4) Check the system to be certain that the **Mushroom Washer Assemblies** holding the Fender Panels together are still intact and that the system has not been deformed in a way that would prevent pulling it back to its original position.
5) Be sure that the **Diaphragm Support Legs** are all properly attached to the Monorail.

Caution: Use safety goggles and gloves when refurbishing the Mushroom Spring Assembly. Do not place fingers underneath an assembled Mushroom Washer. Parts may suddenly shift and fingers may be pinched. If the spring is still under compression as the nut is nearing the end of the bolt, to prevent injury, make sure that the spring is restrained with a clamp so it does not suddenly release when nut is removed from the Mushroom Washer Bolt.

6) Attach chain to **Pullout Brackets** on first Diaphragm (See Figure 71). Attach both ends of chain to a heavy vehicle (such as a 1 ton pickup.)

Warning: Stand clear in case chain breaks or becomes disconnected.

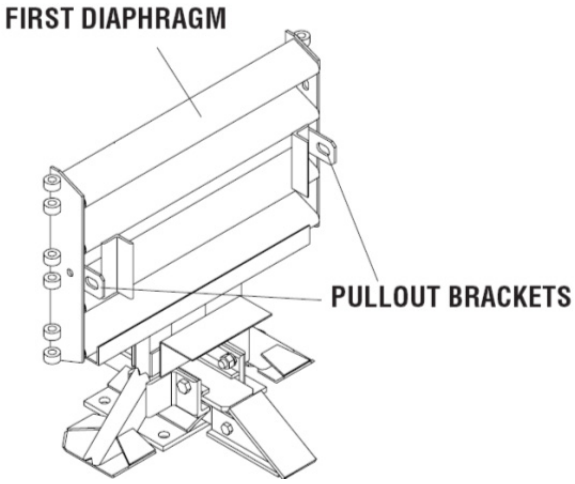


Figure 71
Pullout

Pull the QuadGuard® II system forward slowly until the system reaches its original length. Have someone watch the system during repositioning to be certain previously undetected damage does not cause the Diaphragms to bind or pull out improperly.

7) Remove all **crushed Cartridges** from within the system.

8) Check to see that the **Diaphragms** are in usable condition. Diaphragms which are bowed or have bent legs must be replaced.

9) Check that the **Fender Panels** are properly attached with the **Mushroom Washer Assemblies**. Damaged Fender Panels and Transition Panels must be replaced. Often, **Cartridge Support Brackets** with minor damage can be straight-ended and reused by doing the following:

   a. Remove damaged Cartridge Support Bracket from Diaphragm.

   b. Clamp Cartridge Support Bracket to Backup and begin bending using pipe wrench as shown in Figure 72.

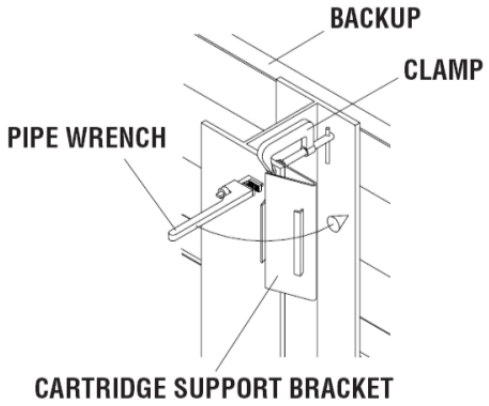


Figure 72
Straighten Cartridge Support Bracket

c. Then, using a sledge hammer and Quad-Beam™ Panel on Backup as an anvil, straighten Cartridge Support Bracket back into 90° shape (See Figure 73).

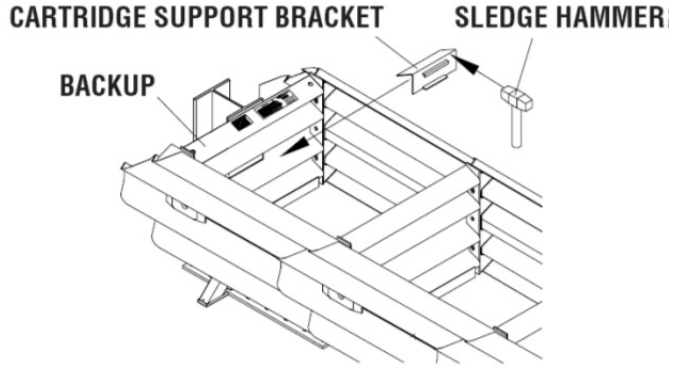


Figure 73
Form Cartridge Support Bracket

Warning:	
Fender Panel	Maximum gap allowed:
	Narrow Systems – 20 mm [0.78”]
	Wide Systems – 25 mm [1.00”]

10) Check the **gaps between Fender Panels**. The maximum gap allowed for these overlapping parts (including Fender Panels overlapping Panels behind the system) is 20 mm [.78”] for **narrow systems** and 25 mm [1.00”] for **wide systems**. Be sure the Mushroom Washer Assemblies are torqued to the end of the threads. If the gaps between the Fender Panels are still too large, it may be necessary to replace bent parts.

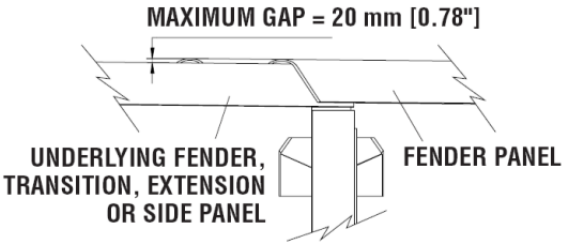


Figure 74
Fender Panel Gap for <u>Narrow Systems</u>

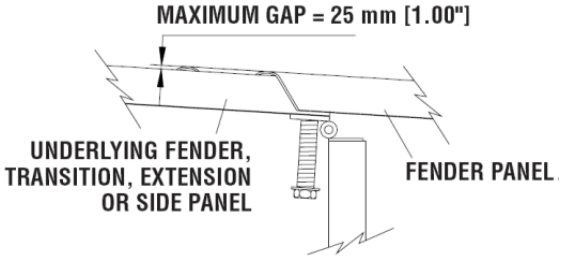


Figure 75
Fender Panel Gap for <u>Wide Systems</u>

11) Replace all crushed Cartridges. See **Cartridge Placement** on Pages 31 and 50.

12) Remove damaged **Nose Assembly**. Attach the new Nose to the first Diaphragm, using the six threaded rods and four rail nuts per rod. See Pages 28 and 29 for the Nose Assembly.

Table C

Warning:	
Anchor Studs	Torqued to 165 N-m [120 ft-lb] Should NOT Protrude Above Nuts (See Figure 50 on Page 39).
All Other Bolts	Tightened
Fender Panel	Maximum Gap Allowed
Narrow Systems	**20 mm [.78”](See Figure 74)**
Wide Systems	**25 mm [1.00](See Figure 75)**

13) Check the **torque of all bolts** on the system.

14) Check to be certain that the site is free from **any debris**. The QuadGuard® II system is once again ready for use.

Parts Ordering Procedure

Make a list of all damaged parts using part descriptions shown on Pages 63 and 64 of the system images. Answer the following questions in the spaces provided. This information is necessary to receive the proper parts.

Table D

QuadGuard® II System Ordering Information Chart

Description:	Choices	Fill in this section
What is the Width of System? (See "Measuring the Width" Page 12.)	610 mm [24"] 760 mm [30"] 915 mm [36"] 1219 mm [48"] 1755 mm [69"] 2285 mm [90"] 3200 mm [126"]	
What is the Number of Bays? (See "Counting The Number of Bays" Page 11.)	Narrow Hazards: 1 through 9 Wide Hazards: 3 through 9	
What Type of Backup Does the System Have? (See Figure 3 and 4 on Page 12.)	Concrete Tension Strut	
What Type of Transition Panel? (See "Side Panel and Transition Panel Types" Pages 15 and16.) Be sure to note right side, left side, both sides, (See "How to Determine Left/Right" Page 11) or no Transitions.	• Quad to W • Quad to Thrie • Quad to Safety Shape Barrier • Quad to End Shoe • 4" Offset Panel	

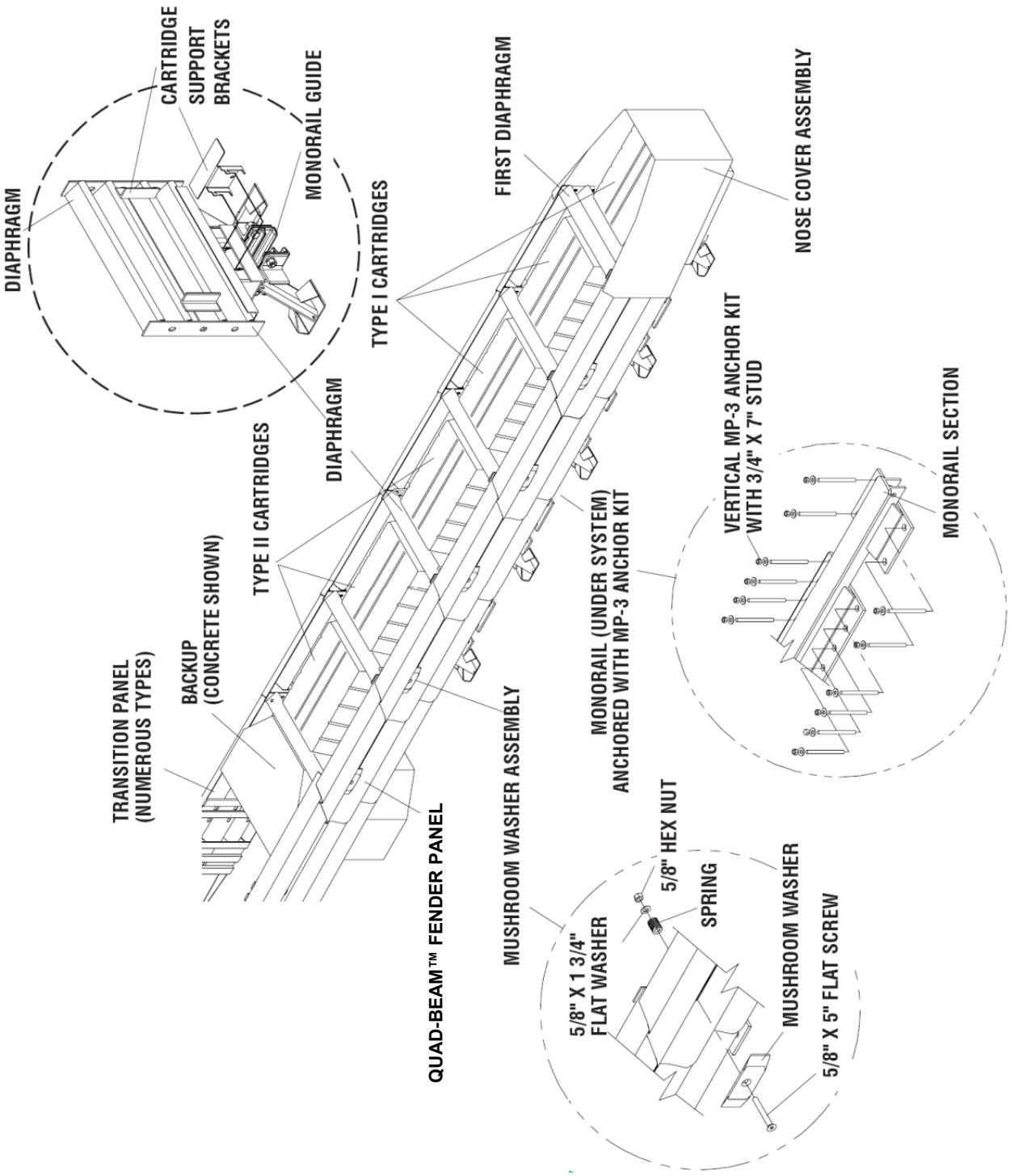


Figure 76
QuadGuard® II for Narrow Hazards

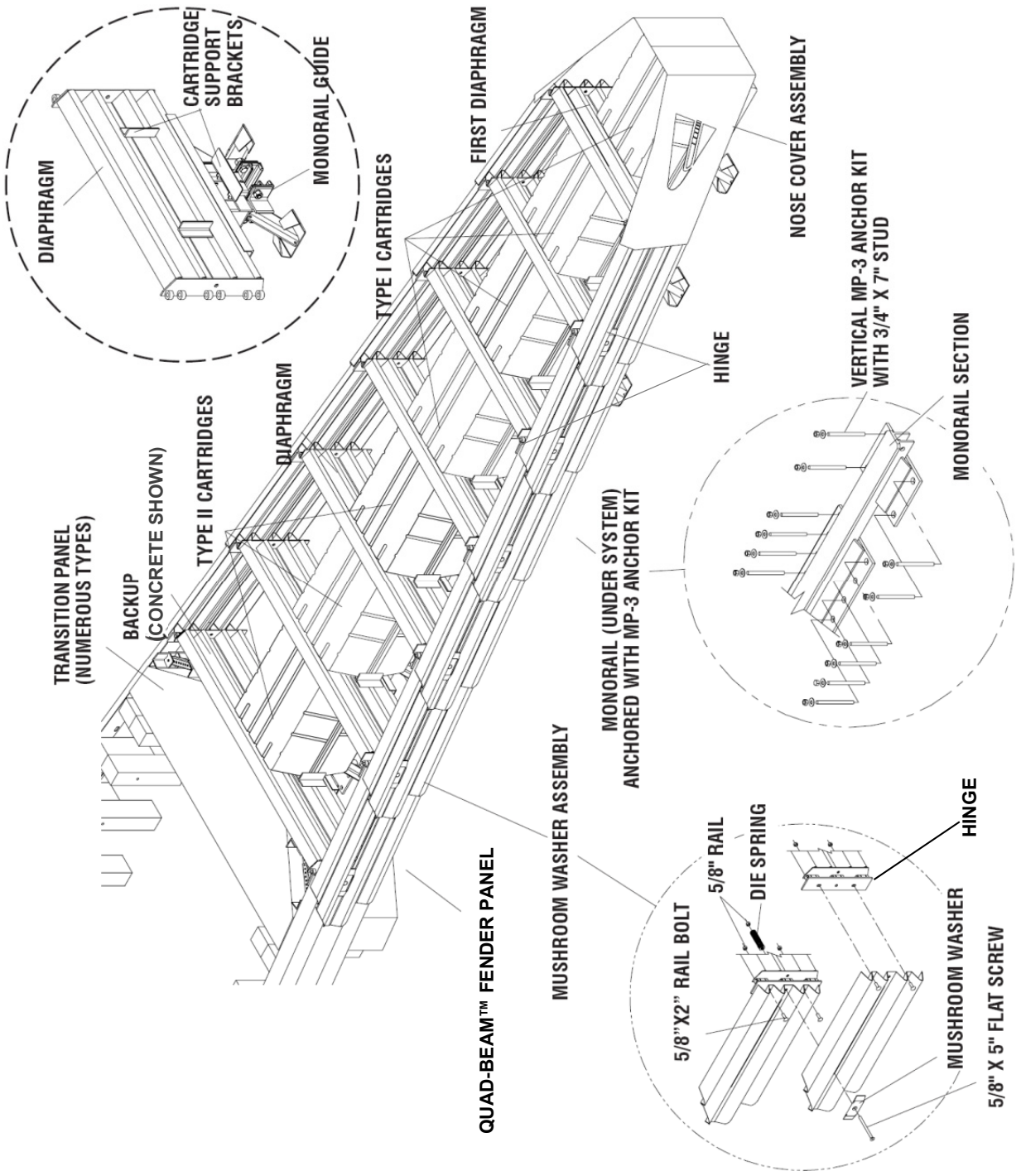


Figure 77
QuadGuard® II for Wide Hazards

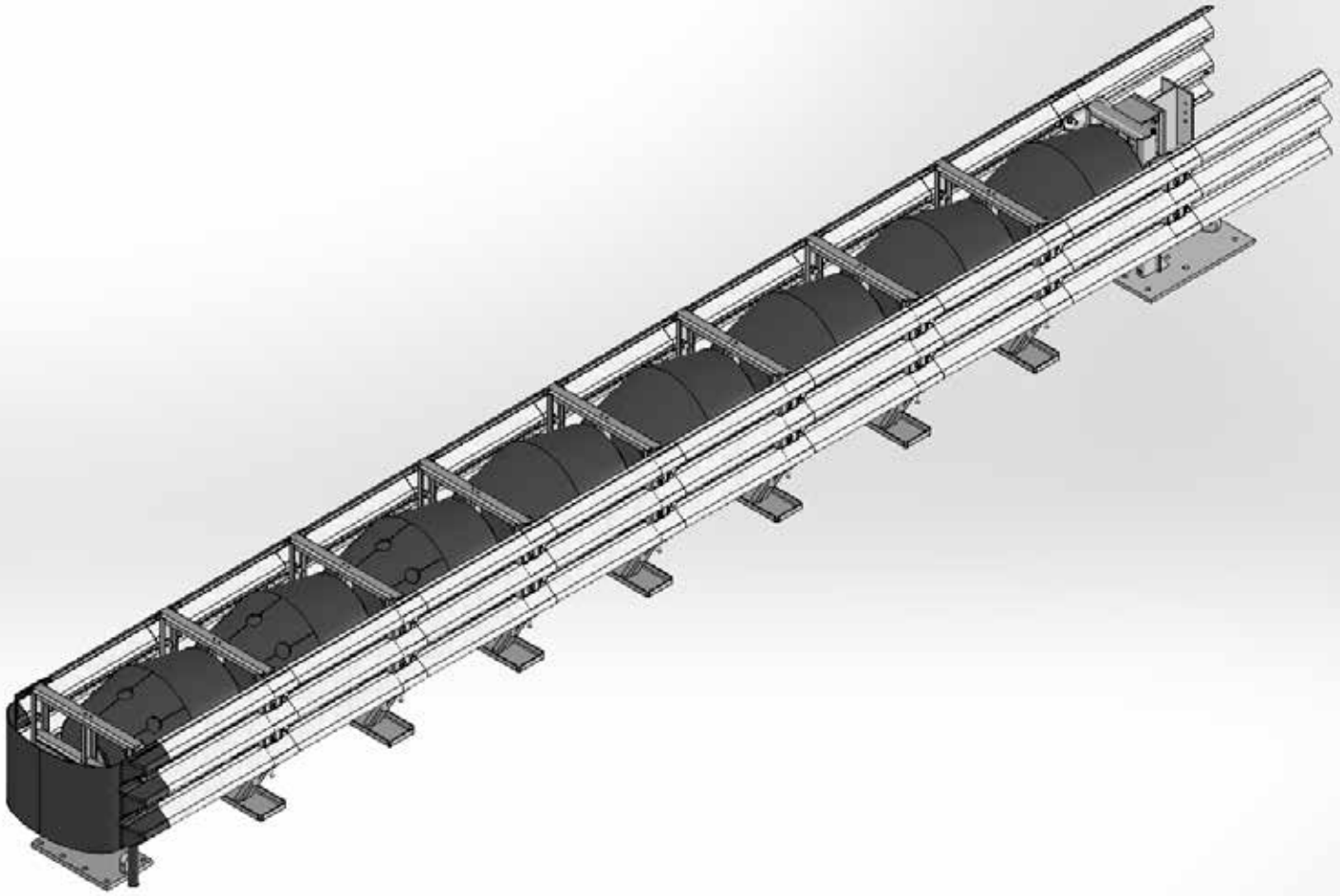
Notes:

Notes:

2525 Stemmons Freeway
Dallas, Texas 75207
888-323-6374 (USA only)
214-589-8140 (Outside USA)
www.energyabsorption.com
www.highwayguardrail.com

UNIVERSAL TAU-II®

NCHRP 350 TL-3 Redirective, Non-Gating, Crash Cushion



BARRIER SYSTEMS®
BY LINDSAY

LINDSAY™ TRANSPORTATION SOLUTIONS

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TABLE OF CONTENTS

PARALLEL SYSTEM INSTALLATION

TAPERED SYSTEM INSTALLATION

APPENDIX

PREFACE

The Barrier Systems, Inc. (BSI), Universal TAU-II crash cushion system incorporates the newest roadside safety materials and engineering processes.

As with any roadside safety device, the Universal TAU-II system must be installed properly to insure proper performance. Thoroughly review and fully understand the installation instructions and product limitations before starting the installation. Do not start the installation without the proper plans and tools required for installation.

If you need additional information, or have questions about the Universal TAU-II Crash Cushion, please call the BSI Customer Service Department at (888) 800-3691 (U.S. toll free) or (707) 374-6800.

INTRODUCTION

The TAU-II system has been tested to meet the rigorous requirements of NCHRP Report 350, Test Levels 2 and 3. The systems will be provided in lengths and capacities for both low speed and high speed applications.

The TAU-II system is redirective and non-gating, and is ideally suited for narrow hazards such as the ends of rigid barriers, tollbooths, utility poles and more. Ease of installation, numerous transition options, low maintenance requirements, and reusability of system components make the TAU-II system ideal for treating many roadside hazards.

Redirective, non-gating crash cushions are highway safety devices whose primary function is to improve the safety for occupants of errant vehicles that impact the end of rigid or semi-rigid barriers or fixed roadside hazards by absorbing the kinetic energy of impact or by allowing controlled redirection of the vehicle. These devices are designed to safely decelerate an errant vehicle to a safe stop or redirect an errant vehicle away from roadside or median hazards. These types of systems are typically applied to locations where head-on and angled impacts are likely to occur and it is desirable to have the majority of post impact trajectories on the impact side of the system.

SYSTEM OVERVIEW

The Universal TAU-II system is designed and constructed to provide acceptable structural adequacy, minimal occupant risk and safe vehicle trajectory as set forth in NCHRP 350 for redirective, non-gating crash cushions. Refer to Figure 1 to familiarize yourself with the basic parts and part names of the system.

The Universal TAU-II system is designed to shield the ends of median barriers and other fixed objects likely to be struck head-on, by absorbing and dissipating the kinetic energy of impacting vehicles. Universal TAU-II systems utilize disposable Energy Absorbing Cartridges (EACs) to absorb the kinetic energy of the impacting vehicle. The EACs are separated by diaphragms and held in place with a framework of thrie-beam corrugated steel rail panels that “telescope” rearward during head-on impacts. As the vehicle compresses the cushion, it exerts a force on the first bay containing an EAC. The diaphragms distribute the impact forces uniformly to all the remaining cartridges in each bay until the vehicle eventually stops. The depth of penetration is dependent upon both the original impact speed and the mass of the impacting vehicle. Only the Energy Absorbing Cartridges are expended after most head-on impacts.

When hit at an angle along the side, the system is restrained laterally by guidance cables that run the length of the system and attach to the bottoms of the diaphragms and terminate at the anchors at each end of the system. The front and rear cable anchors are attached to the foundation as described in Appendix A Foundation Requirements.

BEFORE TAU-II INSTALLATION

Placement and use of the TAU-II system should be accomplished in accordance with the guidelines and recommendations set forth in the “AASHTO Roadside Design Guide,” FHWA memoranda and other state and local standards.

Depending on the application and circumstances at the job site, installation and assembly of a Test Level 3 system should take a two-person crew less than 3 hours.

The TAU-II is a highly engineered safety device made up of a relatively small amount of parts. Before

starting the assembly, become familiar with the basic elements that make up the TAU-II system. The TAUII system components are illustrated separately in Figure 1 (Pages 6-7).

Limitations and Warnings

The Universal TAU-II system has been rigorously tested and evaluated per the recommendations in the NCHRP Report 350 Guidelines for terminals and crash cushions. The impact conditions recommended in NCHRP 350 are intended to address typical in-service collisions.

When properly installed and maintained, the system is capable of stopping or containing and redirecting impacting vehicles in a predictable and safe manner under the NCHRP 350 impact conditions. Vehicle impacts that vary from the NCHRP 350 impact conditions described for redirective, nongating, crash cushions may result in significantly different results than those experienced in testing.

Vehicle impact characteristics different than or in excess of those encountered in NCHRP 350 testing (speed and angle) may result in system performance that may not meet the NCHRP 350 evaluation criteria.

If you need additional information, or have questions about the Universal TAU-II Crash Cushion, please call the BSI Customer Service Department at (888) 800-3691 (U.S. toll free) or (707) 374-6800.

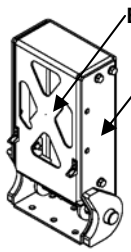
PROVIDED TOOLS

- Long bolt for nested slider panel installation
- Allen socket for the slider bolt assembly
- Cable socket

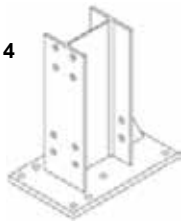
REQUIRED TOOLS

- ½" [12 mm] drive deep sockets:
  - 7⁄16 [11 mm]
  - 9⁄16 [14 mm]
  - ¾ [19 mm]
  - 13⁄16 [21 mm]
  - ⅞ [22 mm]
  - 15⁄16 [24 mm]
  - 1 ⅛ [29 mm]
  - 1 ¼ [32 mm]
- 3/4" [19mm] combination end wrench
- ½" (12 mm) drive ratchet with extensions
- Rotohammer for drilling holes in concrete:
- 7/8" [22 mm] X 10" [250 mm] bit for chemical anchors
- ½" Torque wrenchs:
- 20 ft-lbs [27 N-m] and 500 ft-lbs [680 N-m] capacity
- Measuring tape
- Safety Equipment: Glasses, Gloves
- ½" (12 mm) Air impact wrench (Optional)

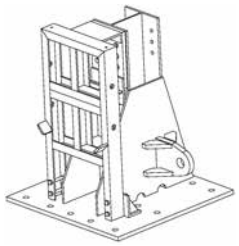
Note: The tools list is a general recommendation. Depending on the specific characteristics of the job site, more or less tools may be necessary.



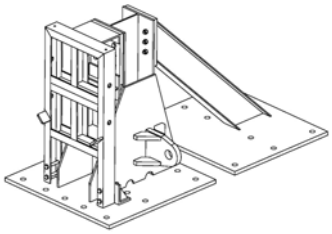
Flush Mount Backstop



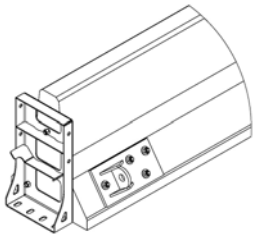
Wide Flange Backstop
Pt# B030668



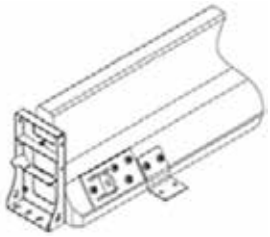
Compact Backstop
Pt# B040430



Compact Backstop with Asphalt Support



PCB Backstop
Pt# B040425



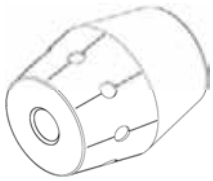
PCB Backstop with Cable Anchor and Barrier Support

Nose Piece – (wide)
Pt# K001034 Y (Black)
with rivet Kit

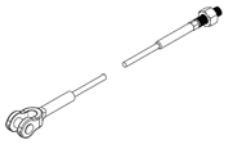
Nose Piece Only (Parallel)
Pt# B030516 (Black)

Hardware Kit
Pt# K001013

Energy Absorbing Cartridge - Type B
Pt# B010722



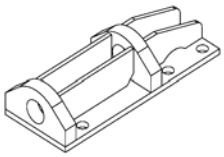
Energy Absorbing Cartridge - Type A
Pt# B010802



Wide Cable

Parallel Cable

Flush Mount

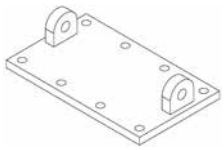


Front Cable Anchor (Reverse) Pt# B040412

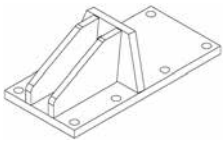
Wide Flange

Front Cable Anchor, Universal Cable
Pt# B030935

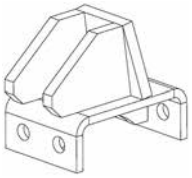
Compact or PCB



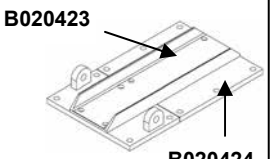
Front Cable Anchor, Compact Cable
Pt# B010248



Rear Cable Anchor, (Independent) Pt# B030938



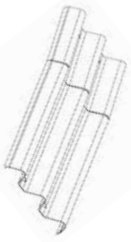
Rear Cable Anchor (Backstop Mount)
Pt# B031020



Front Cable Anchor Asphalt Anchor
Pt# B020425

Sliding Panel
Pt# B010202

End Panel
Pt# B010659

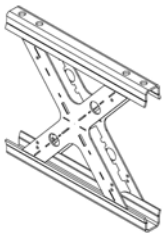


Angled End Panel
Pt# B040203

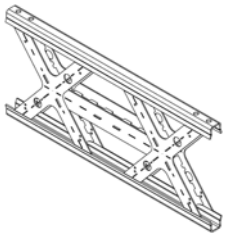
Cable Key Front
Pt# B040501

Cable Key
Pt# B030942

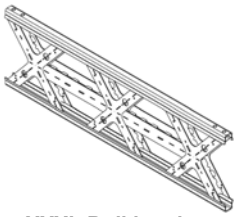
Figure 1. Illustrated parts list



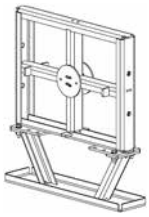
XL Bulkhead
Pt# B030521



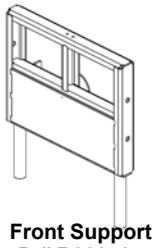
XXL Bulkhead
Pt# B030528



XXXL Bulkhead
Pt# B030529

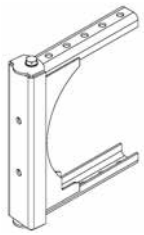


Middle Support
Pt# B030703

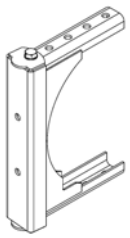


Front Support
Pt# B030704

Leg Kit Pt# K001005

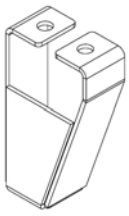


Wing Assembly
Pt# B030509

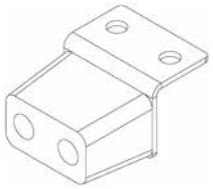


Transition Wing Assy.
Pt# B030910

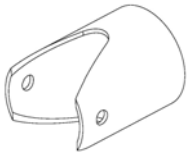
36 Inch Adapter Assy
Pt# B031201



Leg (wide)
Pt# B030425

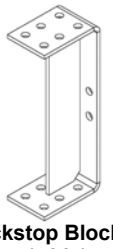


Bumper Assembly
(wide)
Pt# B031035

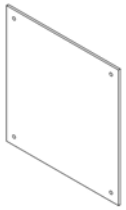


Pipe Panel Mount
Pt# B010651

Hardware Kit
Pt# K001017

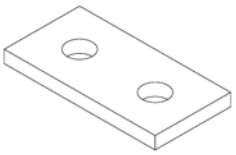


Backstop Blockout
(wide)
Pt# B030713

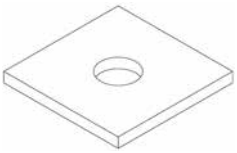


Front Collision Plate
(wide)
Pt# B030801

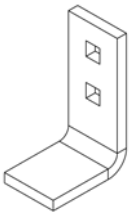
Wing Brace
(wide)
Pt# B030821



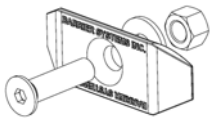
Spacer - Wing Brace
(wide)
Pt# B030823



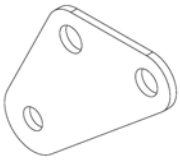
Level Spacer
Pt# B030551



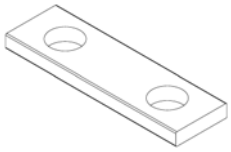
EAC Locator Kit (X4)
Pt# K001028



Slider Assembly Kit (x4)
Pt# K001003



Leg Adapter
(wide)
Pt# A040223

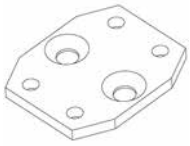


Backing Plate
(wide)
Pt# B030543

Lateral support Mount,
(Backstop Mount - wide)
Pt# B031011

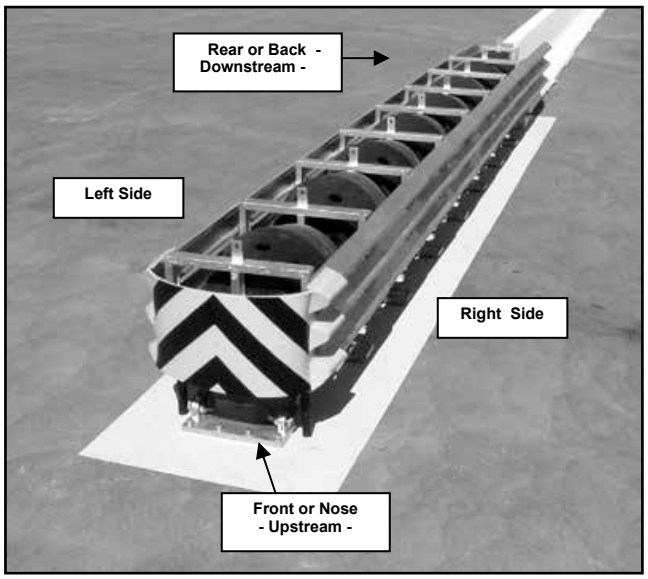
Lateral Support
Cable Assembly Kit
Pt# K001031

Bulkhead Mount,
Lateral Support – (wide)
Pt# B031010



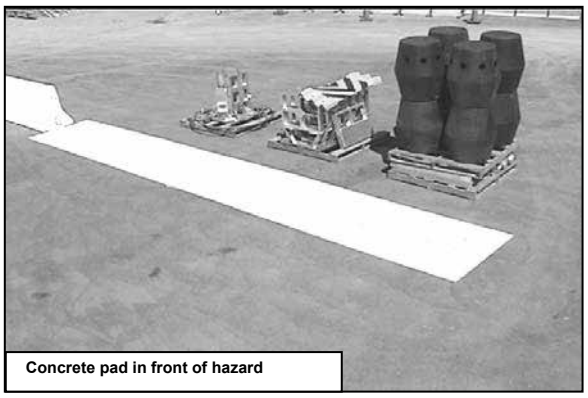
Cable Guide Mounting
Plate – (wide)
Pt# B030411

Cable Guide Assembly
Kit (x4)
Pt# K001004

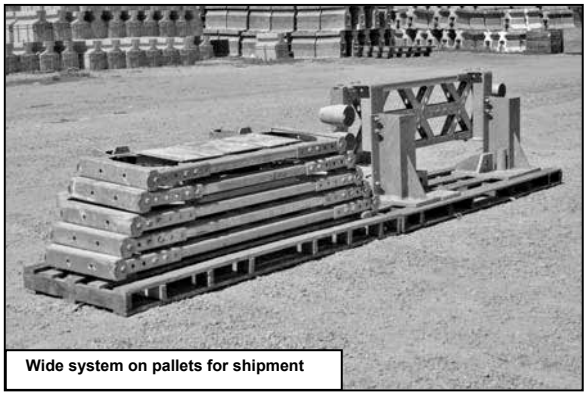


Sign Conventions

The picture of the TAU-II system above is labeled to show the descriptive terms that will be used throughout this manual.



Concrete pad in front of hazard



Wide system on pallets for shipment

Preparing for installation

Depending on the size of the system ordered, the parts will be shipped on two to five pallets. Assembly of the TAU-II system is typically done at the worksite. (If preferred, the system can be assembled "off-site" and set into position as one piece, with a forklift or crane.)

Before beginning the assembly of the TAU-II system, check the packing list to be certain that all of the system components were included in the shipment.

The TAU-II Crash Cushion system has been designed to attach to concrete or asphalt foundations. BSI recommends that at a minimum, the system be anchored to standard six-inch reinforced 4,000 psi (28 MPa) Portland Cement Concrete (PCC) pad or roadway, or 8" (200 mm) AR-4000 Asphalt Concrete. When installing to concrete, care must be taken when building the concrete pad to space the rebar so as to minimize interference with the anchor bolt holes.

(See Appendix "C", Page 47, for BSI recommended foundation options and material specifications.)

NOTE:
It is important to determine the system's installation position and angle, to optimize proper function and transition.

This system is available in two configurations:

1) The system can be attached directly to the end of a concrete barrier, utilizing the "PCB Backstop" (BSI part # B040425) or the "Flush Mount Backstop" (BSI part # B040219).

2) The second configuration utilizes a "Compact Backstop" (BSI part # B010537) which is a free standing back support.

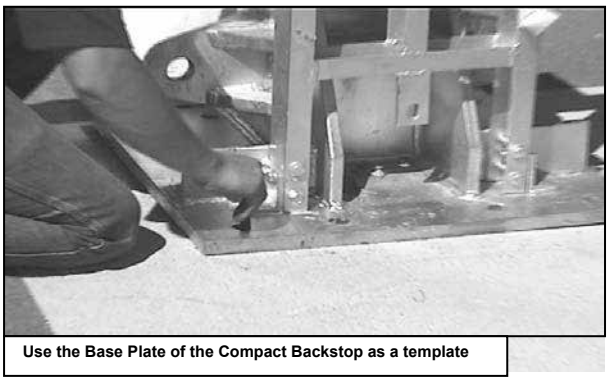
This manual describes the installation procedure for an 8 bay (Test Level 3) system.

(See the System Configuration Chart in Appendix "A", Page 44, for guidelines on choosing a system length to accommodate different traffic criteria.)

Depending on the installation design, transition hardware may be necessary. Because each transition is unique, BSI recommends that the transition hardware be properly fitted before anchoring the system. Pre-assemble the transition hardware before setting the system base plates to assure the proper spacing between the system and the object being treated.

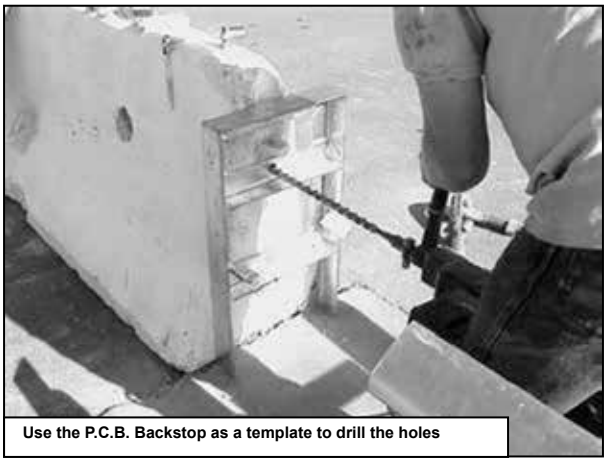
(NOTE: See Appendix "D", Page 63, for some recommended transition types)

CONCRETE PAD INSTALLATION



Use the Base Plate of the Compact Backstop as a template

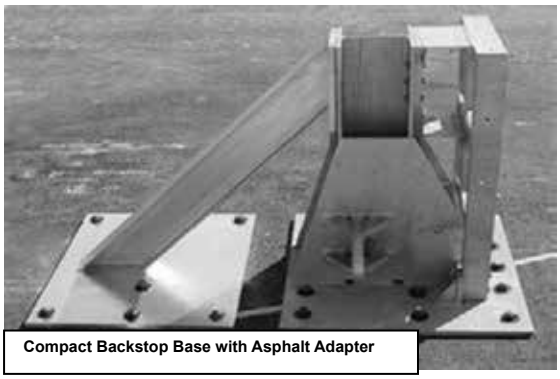
Step 1. (Compact Backstop to Concrete Foundation)
Place the Compact Backstop in the desired final installation position. Use the holes in the base plate as a template to mark the location of the anchor points. Remove the backstop and drill the anchor bolt holes. The holes should be 6" (150 mm) deep and 7/8" (22 mm) diameter. Install the anchors into the pad following the instructions included with the anchor epoxy. When the epoxy is fully cured, install the nuts and flat washers. Tighten to 120 ft-lbs (160 N-m).



Use the P.C.B. Backstop as a template to drill the holes

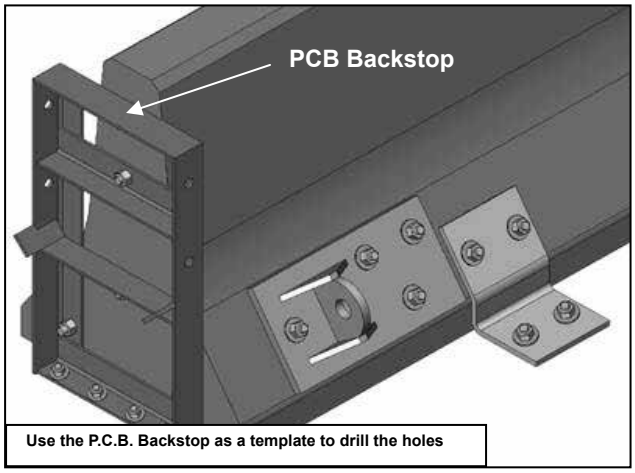
Step 1. (PCB Backstop to Concrete Foundation)
Place the PCB Backstop in the desired final installation position. Use the holes in the backstop as a template to mark the location of the anchor points. The holes should be 6" (150 mm) deep and 7/8" (22 mm) diameter. Use a caulking gun and gun insert filled with anchoring compound to secure the ¾" x 8 ¼" (20 mm x 610 mm) galvanized anchors. Torque to 120 ft-lbs (160 N-m).

ASPHALT INSTALLATION



Compact Backstop Base with Asphalt Adapter

Step 1. (Compact Backstop to Asphalt)
If the unit is being installed on asphalt, the Asphalt Adapter must be attached to the Compact Backstop. Use the base as a template to mark the anchor point locations. All holes should be 15 to 16½" (380 to 420 mm) deep. Use 18" (460 mm) anchors for the Compact Backstop and the Asphalt Adapter. Install the anchors into the foundation following the instructions included with the anchor epoxy. When the epoxy is fully cured, install the nuts and flat washers. Tighten to 120 ft-lbs (160 N-m).



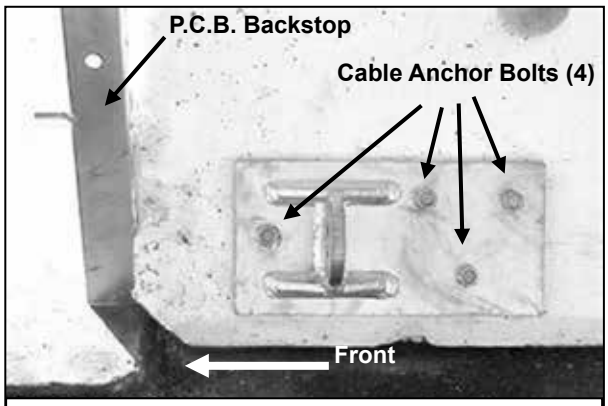
Use the P.C.B. Backstop as a template to drill the holes

Step 1. (PCB Backstop to Asphalt Foundation)
Place the PCB Backstop in the desired final installation position. Use the holes in the backstop as a template to mark the location of the anchor points. The holes should be 6" (150 mm) deep and 7/8" (22 mm) diameter. Use a caulking gun and gun insert filled with anchoring compound to secure the ¾" x 8 ¼" (20 mm x 610 mm) galvanized anchors. Torque to to 5 ft-lbs (8 N-m).

CONCRETE PAD INSTALLATION

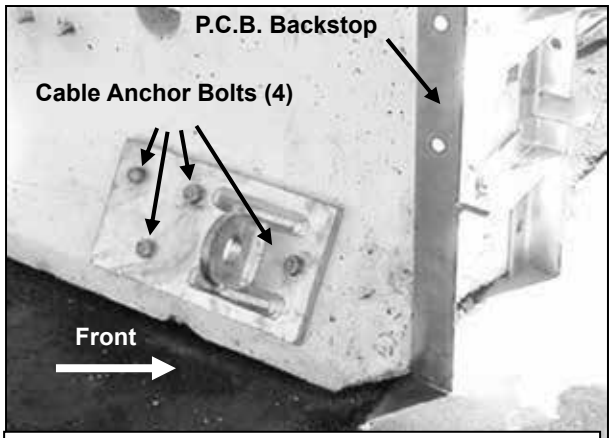
Step 2. (Concrete Rear Cable Anchors)

NOTE: IF YOU ARE USING THE COMPACT BACKSTOP, SKIP TO STEP 3.



Use the Cable Anchor Plate as a template for the bolt holes (Right Side)

Use the holes in the plate as a template to mark the location of the holes for the anchor studs. (There is one Cable Anchor for each side of the P.C.B.). The holes should be drilled 6" (150 mm) deep and 7/8" (22 mm) in diameter. Install the (all thread) studs into the PCB following the instructions included with the anchor epoxy. When the epoxy is fully cured, install the nuts and flat washers. Tighten to 120 ft-lbs (160 N-m).



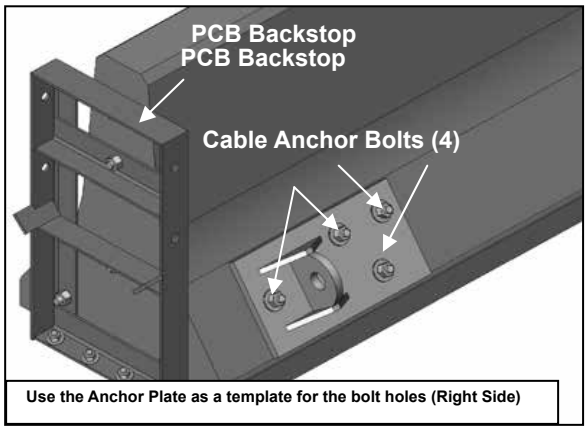
Use the Cable Anchor Plate as a template for the bolt holes (Left Side)

NOTE: For proper system performance, the concrete barrier must be rigidly attached to an adequate foundation. See Appendix "C" for Anchor Foundation Options and Page 24 for anchoring material options..

ASPHALT INSTALLATION

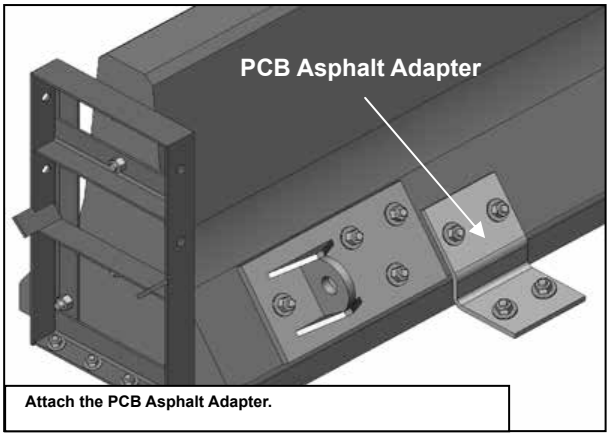
Step 2. (Asphalt Rear Cable Anchors)

NOTE: IF YOU ARE USING THE COMPACT BACKSTOP, SKIP TO STEP 3.



Use the Anchor Plate as a template for the bolt holes (Right Side)

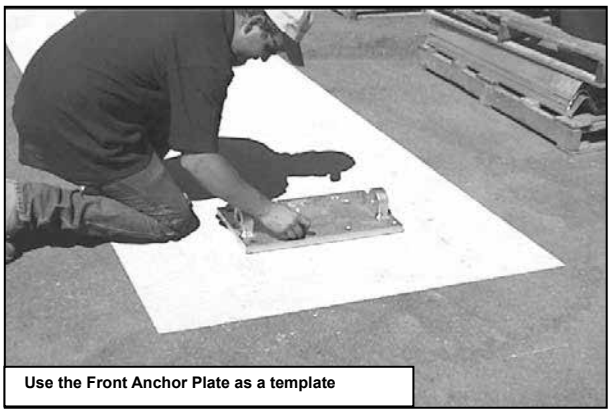
Refer to the Installation Drawings in Appendix "C" to determine the correct Cable Anchor installation position. Use the holes in the plate as a template to mark the location of the holes for the anchor studs. (There is one Cable Anchor for each side of the P.C.B.). The holes should be drilled 6" (150 mm) deep and 7/8" (22 mm) in diameter. Install the (all thread) studs into the PCB following the instructions included with the anchor epoxy. When the epoxy is fully cured, install the nuts and flat washers. Tighten to 120 ft-lbs (160 N-m)



Attach the PCB Asphalt Adapter.

Attach the PCB Asphalt Adapter. Drill holes 6" (150 mm) deep and 7/8" (22 mm) in diameter in the concrete barrier. Drill 15 to 16 ½" (380 to 420 mm) in the foundation and install 18" (460 mm) anchors following the instructions included with the anchor epoxy. When the epoxy is fully cured, install the nuts and flat washers. Tighten to 120 ft-lbs (160 N-m).

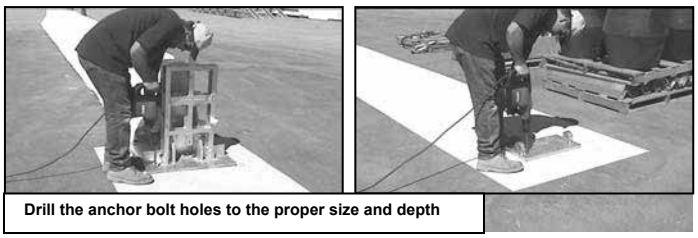
CONCRETE PAD INSTALLATION



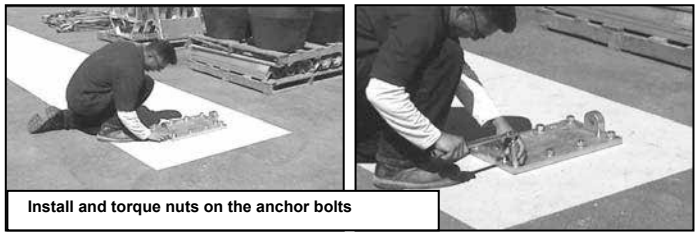
Use the Front Anchor Plate as a template

Step 3. (Concrete Front Cable Anchor)

Place the Front Cable Anchor in the desired final installation position. Use **Appendix C** for layout dimensions. Use the holes in the plate as a template to mark the location of the anchor points. Remove the plate and drill the anchor bolt holes to the desired size and depth. The holes should be 6" (150 mm) deep and 7/8" (22 mm) diameter.



Drill the anchor bolt holes to the proper size and depth

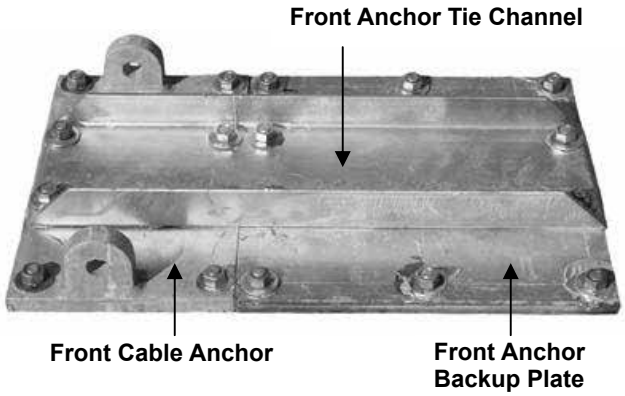


Install and torque nuts on the anchor bolts

NOTE:

It is important that the holes are drilled straight and in the correct position so that the plate will fit back over the bolts after they have been set with anchoring material. If the total hole depth cannot be reached due to rebar interference, a "diamond tip" drill or equivalent should be used to reach the total hole depth.

ASPHALT INSTALLATION



Step 3. (Asphalt Front Cable Anchor)

The Asphalt Front Cable Anchor is a three piece unit. Place the Front Cable Anchor and the Front Anchor Backup Plate in the desired final installation position. Use the holes in the plates as a template to mark the location of the anchor points. Remove the plates and drill the anchor bolt holes to the desired size and depth. The holes should be 15 to 16 ½" (380 to 420 mm) deep and 7/8" (22 mm) diameter. **Install the cable and clevis pin before installing the Front Anchor Tie Channel.** Install the Front Anchor Tie Channel on top of the Front Cable Anchor and the Front Anchor Backup Plate.

NOTE:

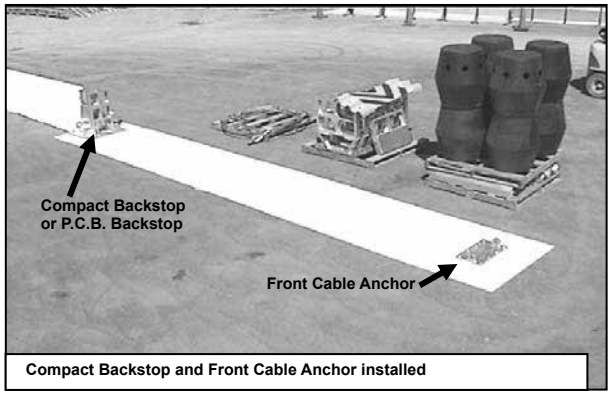
It is important that the holes are drilled straight and in the correct position so that the plate will fit back over the bolts after they have been set with anchoring material. If the total hole depth cannot be reached due to interference, a "diamond tip" drill or equivalent should be used to reach the total hole depth.

ALL FOUNDATIONS

After the anchoring epoxy is properly cured, install a nut and washer on each of the anchor bolts extending through the base plates of the Backstop and Front Cable Anchor plate.

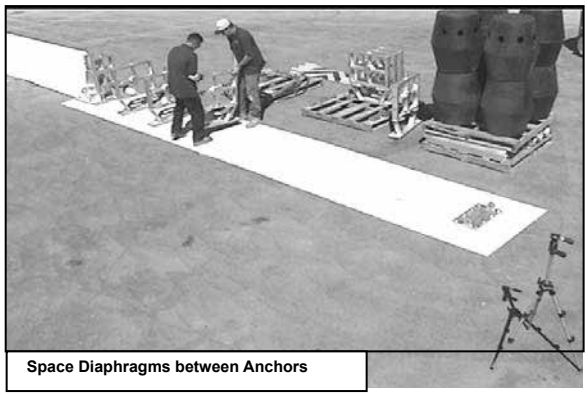
For PC Concrete foundations, torque the nuts to 120 ft-lbs (160 N-m).

For Asphaltic Concrete foundations, torque the nuts to 5 ft-lbs (8 N-m).



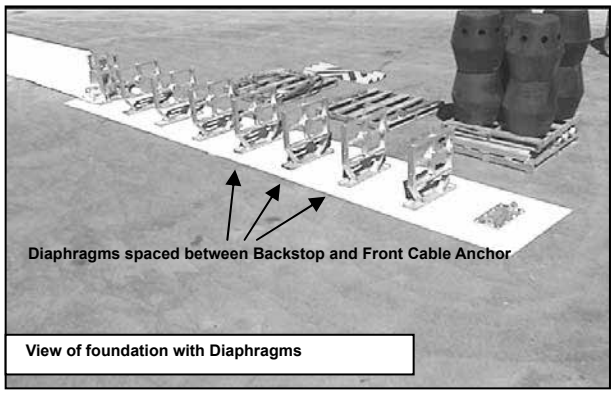
Compact Backstop and Front Cable Anchor installed

This photo shows a view of how the installation would look after the Backstop and Front Cable Anchor are securely fastened.


Space Diaphragms between Anchors

Step 4.

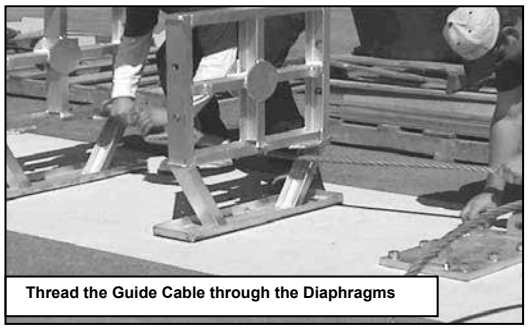
The Diaphragms should be spaced (one by one) evenly between the Front Cable Anchor and the Backstop. It is not important that they be exactly spaced at this point as they can easily be moved into the desired final assembly position when necessary.

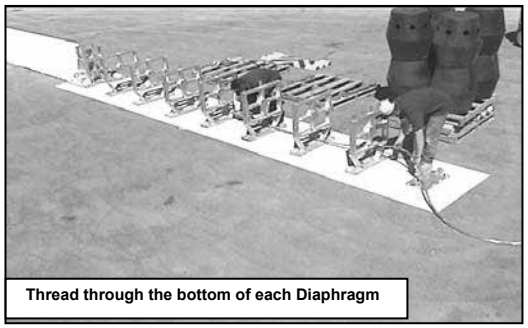


View of foundation with Diaphragms

The photo above shows what the installation would look like after the diaphragms have been placed between the Backstop and the Front Cable Anchor.

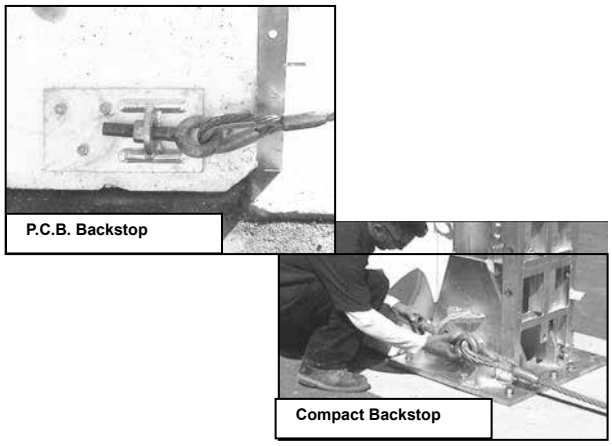
NOTE: Do not install the Front Support Assembly and nose piece at this time, it will be installed later.


Thread the Guide Cable through the Diaphragms


Thread through the bottom of each Diaphragm

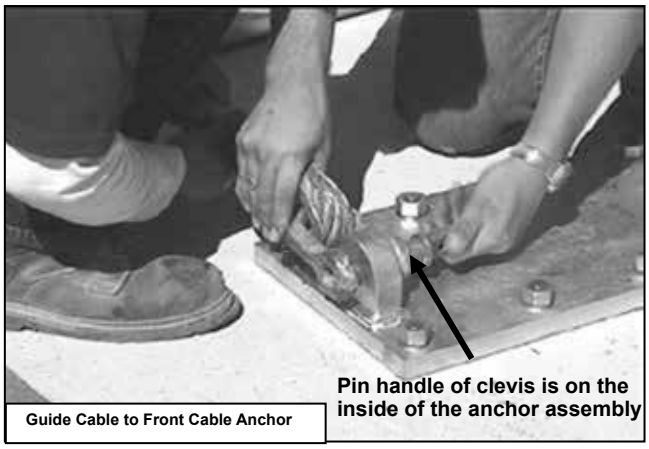
Step 5.

Starting at the upstream end of the system, thread the Guide Cable through the space in the bottom of the Diaphragms. Make sure to pull the threaded cable end through first so that it will end up at the back of the unit. (Make sure that the Guide Cable is threaded through the bottom of each Diaphragm.)



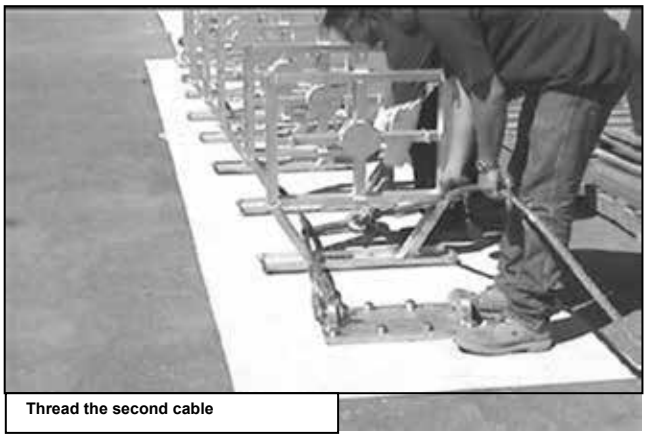
Push the threaded end of the cable through the hole in the anchor tab on the left side of the Compact Backstop. Install the nut on the end of the adjusting screw.

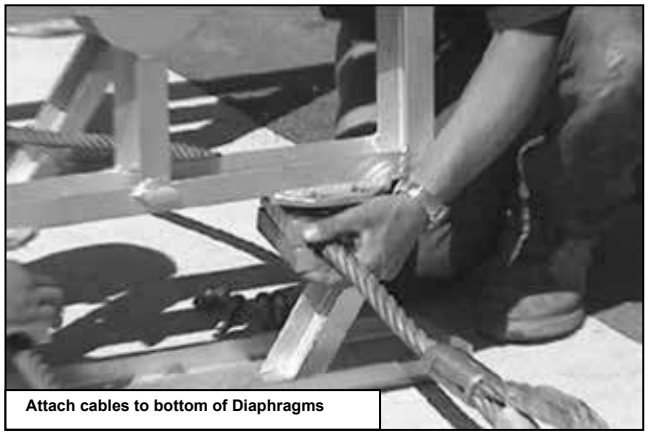
NOTE: Do not thread the nut beyond the end of the adjusting screw at this time. The nut will be tightened later.



Attach the other end of the Guide Cable to the left side of the Front Cable Anchor by first removing the pin from the clevis (shackle). Place the clevis over the anchor eye and re-install the pin through the eye, making sure that the handle portion of the pin is on the inside of the anchor assembly. Firmly tighten the pin.

For asphalt installations, the cable and clevis pin have been attached in Step 3 (Page 12). Repeat the process outlined in steps 6, 7, and 8, for the other cable. Install the second cable along the right side of the system without crossing the first cable.





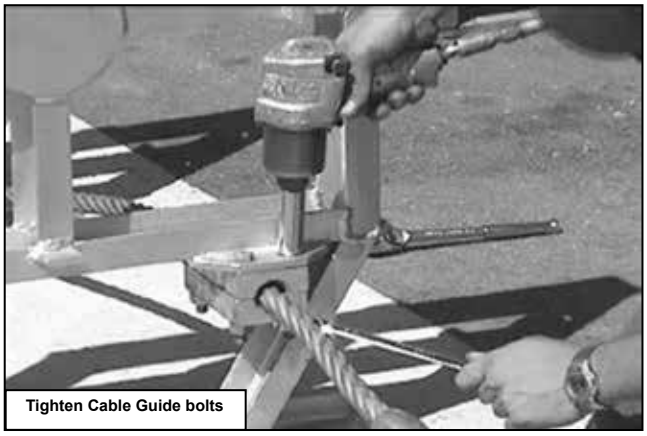
Use the Cable Guide Assembly blocks to attach the Guide Cable to the bottom cross rail of the Diaphragms. The cable blocks consist of two grooved halves that, when put together, provide a path for the Guide Cable to move through.

It is easiest to install the Cable Guides by first placing the two halves of the blocks together around the cable. Next, hold the blocks and cable up to the plate on the bottom of the Diaphragm. Push the bolt from the top down through the plate and then through the blocks.

NOTE: See Page 28, Figure 9 for cable guide positions for wide flange systems.

Install a lock washer and nut to secure the bolt. Continue the process until all four of the attachment bolts are installed on each Cable Guide Assembly.

NOTE: If properly installed, the Guide Cable should slide freely through the Cable Guide blocks and the Diaphragm should slide freely along the cable.

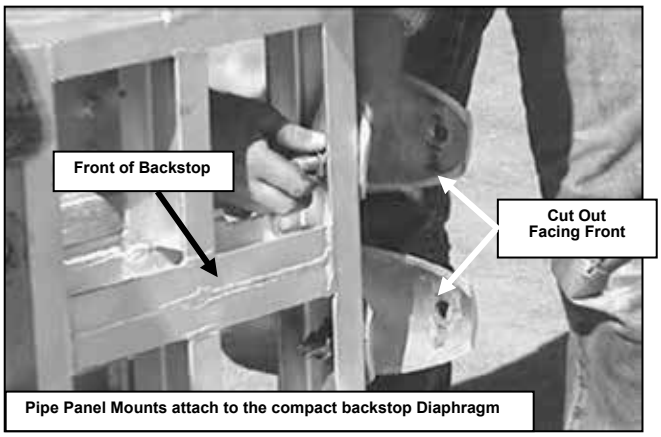


Tighten Cable Guide bolts

Use an impact wrench (or hand tools) to securely tighten the (4) bolts holding the Cable Guide blocks to the plate on the bottom of each Diaphragm. Use the Cable Guide Hardware Kit #K001004.

Compact Cables run thru the Cable Guide blocks on the Diaphragm bottoms

The photo above shows what the Diaphragms should look like after the Cable Guide blocks have been installed.



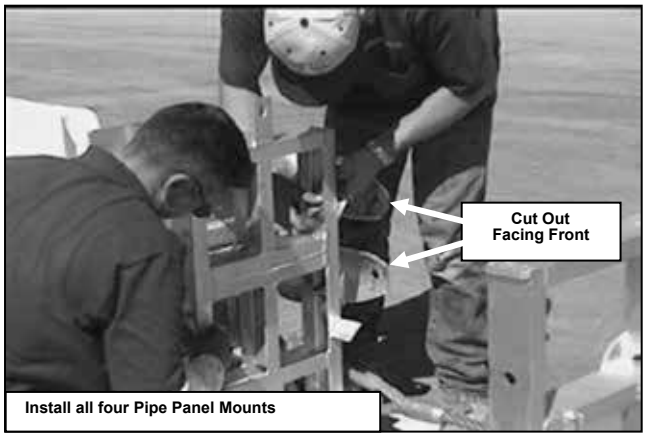
Pipe Panel Mounts attach to the compact backstop Diaphragm

Step 6.

Attach the Pipe Panel Mounts to the sides of the Backstop. (The End Panels are not attached directly to the Backstop Diaphragm.) The Pipe Panel Mount attaches between the Backstop Diaphragm and the End Panel to facilitate proper system performance during side impacts in this area.

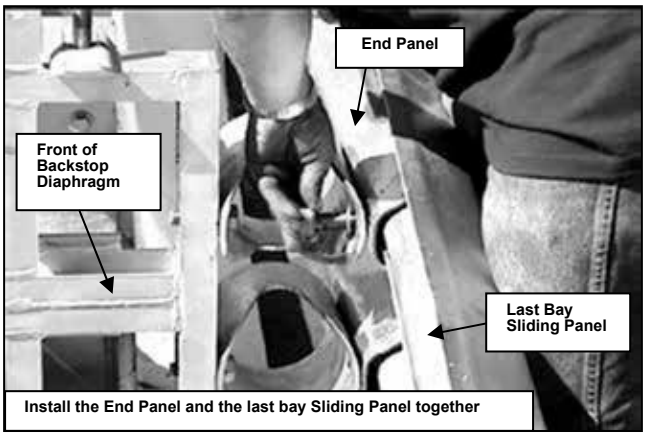
The Pipe Panel Mount is made from a piece of 6" (150 mm) diameter galvanized pipe with angles of material cut out of the top and bottom of one end.

NOTE: It is important that the end of the mount that is cut flat be facing the back (downstream) end of the system and that the cut out end of the Pipe Panel Mount be facing toward the front (upstream).



Install all four Pipe Panel Mounts

To attach the Pipe Panel Mount to the Backstop Diaphragm, place a washer on the attachment bolt and push the bolt through the inside hole on the Pipe Panel Mount and continue the bolt through the hole located on the side of the Diaphragm that is a part of the Backstop as shown in the photo above. Use the Pipe Panel Hardware Kit #K001017.

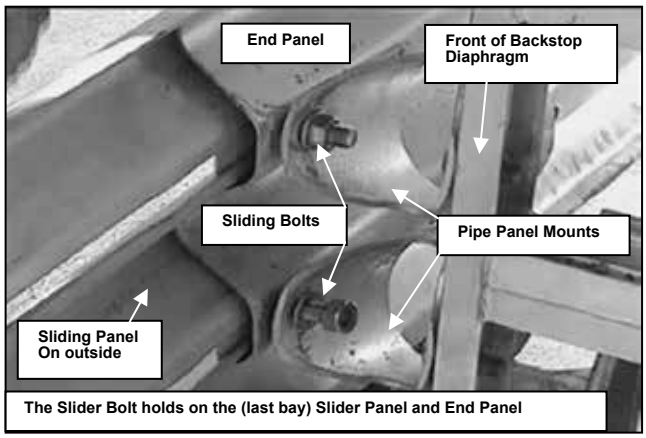


Install the End Panel and the last bay Sliding Panel together

Step 7.
At this point you will start assembling the sides of the system. The first two side panels are installed together as the Sliding Bolt attaches both of the panels to the Pipe Panel Mount located on the side of the Backstop Diaphragm. Attach the right side End Panel and right side rear-most Sliding Panel to the Pipe Panel Mount using the Sliding Bolt.

Insert the Slider Bolt through the slotted portion of the last bay Sliding Panel. Continue the bolt through the front hole of the End Panel. Continue the bolt through the bolt hole in the outside of the Pipe Panel Mount as shown in the photo above.

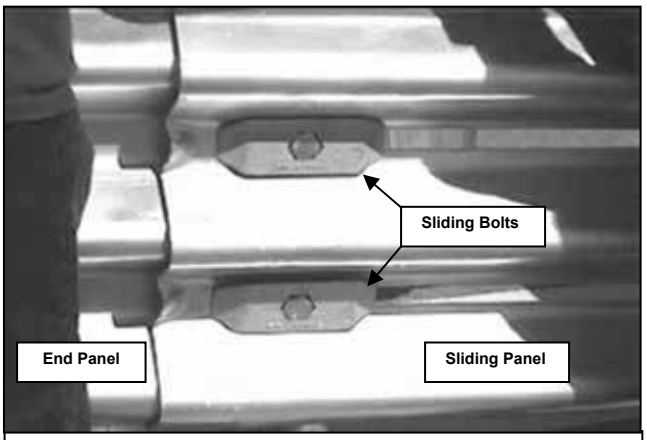
NOTE: For the system to telescope properly, the slotted Sliding Panel <u>MUST</u> be on the outside of the End Panel.



The Slider Bolt holds on the (last bay) Slider Panel and End Panel

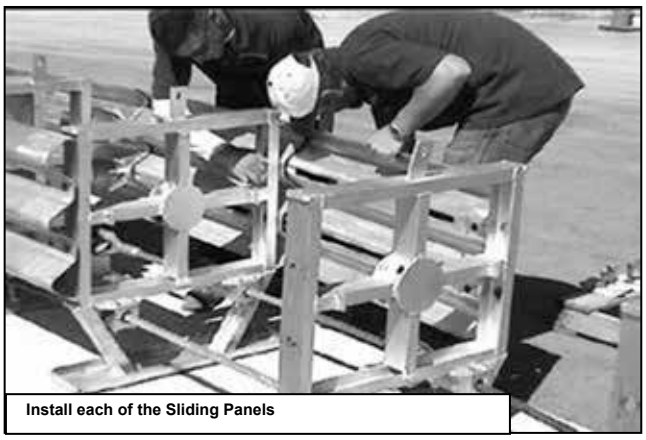
The photo above shows the end of the Slider Bolt coming through (from the outside) the slot in the last left bay side Sliding Panel, through the front hole of the End Panel and through the outer hole of the Pipe Panel Mount.

NOTE: See configuration chart to determine if you have "stacked" or "nested" slider panels in some locations.



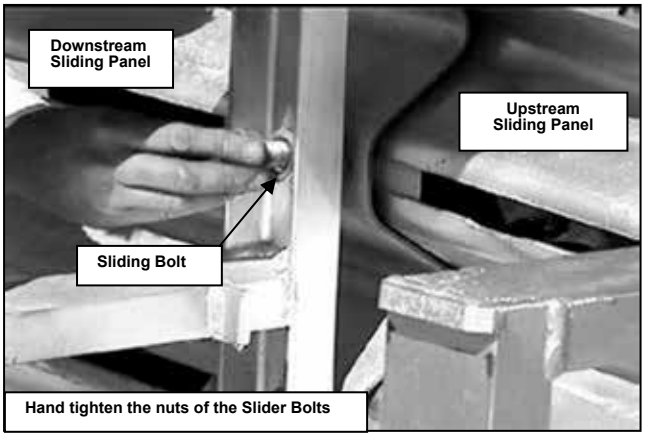
View from outside showing the End Panel and Sliding Panel attached with the Slider Bolt.

NOTE: For ease in assembly of the rest of the system, hand tighten the nut on the Slider Bolts. The bolts will be tightened in a later step. Use Slider Bolt Hardware Kit #K001003.


Install each of the Sliding Panels

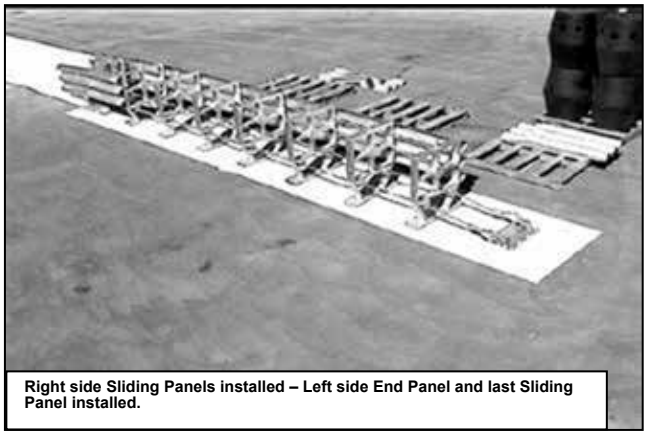
You will now attach the right side panels one-by-one, moving towards the front of the system. Attach the rear bay and second-to-last bay Sliding Panels to the first diaphragm using Sliding Bolts. Insert the Sliding Bolt through the slot in the second-to-last bay Sliding Panel. Continue pushing the bolt through the hole in the front of the last Sliding Panel and finally push the bolt through the hole in the side of the corresponding Diaphragm.

NOTE: For the system to telescope properly, the forward most slotted Sliding Panel M<u>UST be on</u> the outside.



Hand tighten the nuts of the Slider Bolts

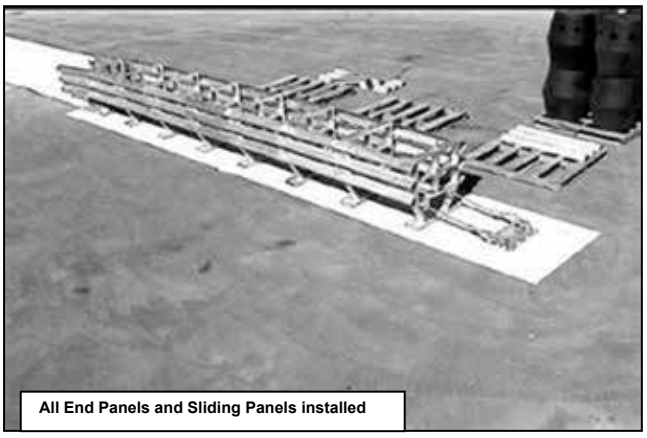
Repeat this step until all Sliding Panels have been mounted to the Diaphragms. The forward-most Sliding Panel must always be on the outside of the system (next to the mushroom head of the sliding bolt).


Right side Sliding Panels installed – Left side End Panel and last Sliding Panel installed.

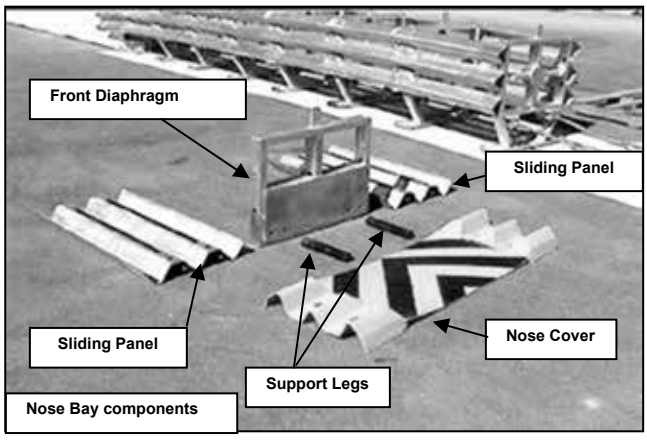
The photo above shows what the system will look like after the End Panel and all of the Sliding Panels have been installed on the right side as well as the End Panel and rear-most Sliding Panel on the left side.

Continue attaching the Sliding Panels along the left side of the system until all of the Sliding Panels are installed.

NOTE: For the system to telescope properly, the forward most slotted Sliding Panel MUST be on the outside.

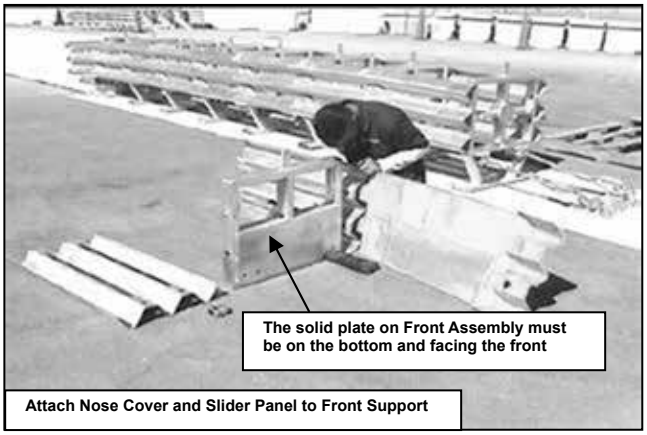

All End Panels and Sliding Panels installed

The photo above shows what the system will look like after both of the End Panels and all of the Sliding Panels have been installed.



Nose Bay components

The final bay will be assembled separately from the rest of the system and then installed as a complete unit. The components that make up the final bay are two Sliding Panels, the Front Diaphragm, the Nose Cover and the Leg Supports.



Attach Nose Cover and Slider Panel to Front Support


Bolt the Support Legs to the bottom of the Front Support Assembly.

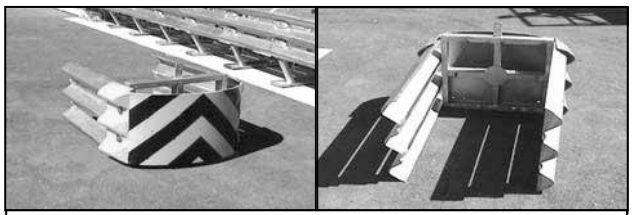
Step 8.
Attach the Nose Cover and left Slider Panel to the Front Support. Install the bushing in the hole of the nose piece. Install the fender washer on the machine bolt (Slider Bolt not used) and push the bolt through the bushing in the Nose Cover hole. Continue the bolt through the hole in the front edge of the last-bay Slider Panel and finally push the bolt through the hole in the Front Diaphragm. Install the washer and hand tighten the nut. (The nut will be tightened later.) Use Nose Piece Hardware Kit #K001013.

The final step in the assembly of the nose bay is to install the Support Legs. Place the nose assembly on its side. Push one of the leg support machine bolts and washer through the hole in the bottom rail of the Front Support. Screw the Leg Support onto the bolt and tighten the bolt with a wrench or socket.
Warning: DO NOT OVER-TIGHTEN THIS BOLT.
Use the Front Support Leg Hardware Kit #K001005.


Repeat with the right side

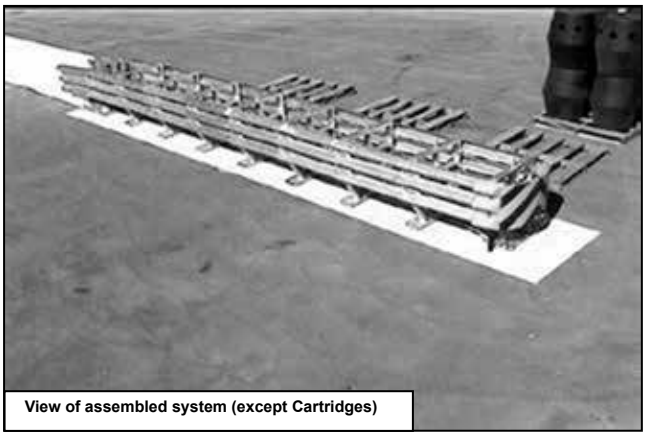

Carry the assembled Front Support Assembly into position to attach.

Repeat the process outlined in Step 8 with the right side of the assembly.


Front View of Assembled Nose Assembly Rear View

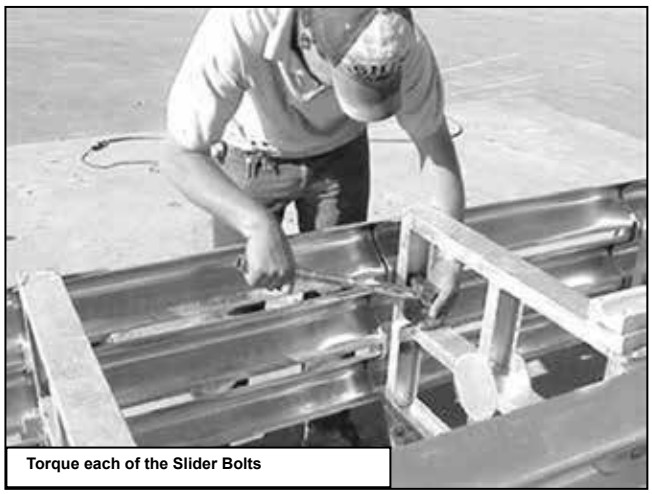
Carry the complete nose bay assembly to the front of the system. Attach the Slider Panels to the diaphragm by pushing the Slider Bolt through the slots in the final bay Slider Panels and then through the hole in the front of next bay Slider Panel. Finally, push the Slider Bolt through the hole in the side of the Diaphragm and attach the flat washer and nut.

NOTE: For the system to telescope properly, the forward most slotted Sliding Panel MUST be on the outside.



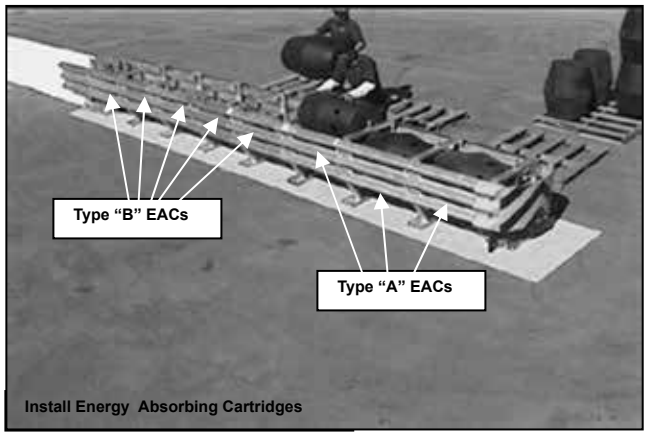
View of assembled system (except Cartridges)

It is important to make sure that the system bays are fully extended to ensure that the Energy Absorbing Cartridges will fit properly. Pull the Slider Panels of each bay until fully extended, working from the base toward the nose assembly.



Torque each of the Slider Bolts

Torque all of the Sliding Bolts to 20 ft-lbs (27 N-m). Torque the Front Panel Bolts (holding nose cover) to 200 ft-lbs (270 N-m). Do not overtighten.



Install Energy Absorbing Cartridges

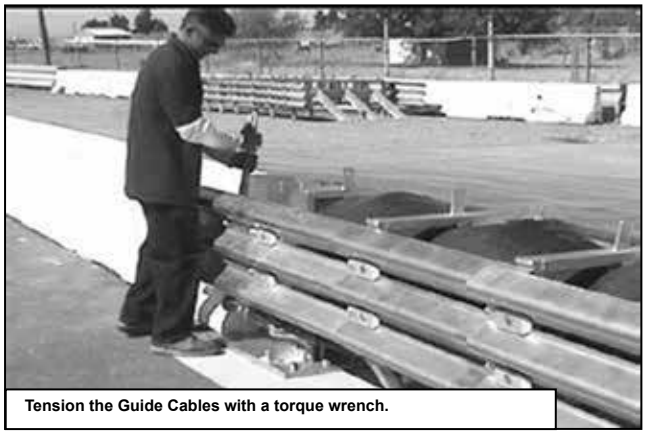
Step 9.

Insert a Type "A" Energy Absorbing Cartridge into each of the first three (3) bays of the 8 bay (TL-3) system. The Type "A" cartridges have holes and slots on the sides toward the end of the cartridge. Install each cartridge on its side with the holes and slots facing the front (upstream) of the system.

Insert a Type "B" Energy Absorbing Cartridge into the remaining five (5) bays. The Type "B" Cartridges have three holes on one end of the cartridge. Install each cartridge on its side with the holes facing the back (downstream) of the system.

Refer to the matrix in Appendix "A" for proper cartridge configurations.

NOTE: For proper system performance, the Energy Absorbing Cartridges must be installed in the proper order and in the proper direction as shown in Appendix "A".



Tension the Guide Cables with a torque wrench.

Step 10.
The final step in the installation of the TAU-II system is to apply tension to the Guide Cables that run underneath the system.

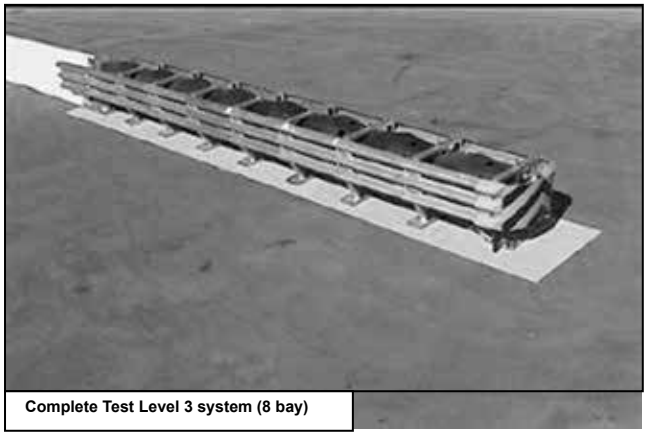
CONCRETE INSTALLATION:
Torque the nut on the end of the threaded cable end to 500 ft-lbs (680 N-m).

Torque the nut on the end of the adjustable Eye Bolt to 120 ft-lbs (160 N-m).

NOTE: For proper performance, the cables must be tensioned properly.

Step 11.
Use the check list on page 43 to confirm that all of the installation steps have been completed.

ASPHALT INSTALLATION



Complete Test Level 3 system (8 bay)

The above photo shows what a completely installed Test Level 3 TAU-II system with a compact backstop will look like.

INTRODUCTION

This manual is organized in steps that address each of the different installation options that are available. The Universal TAU-II system is very versatile and also easy to assemble and install if these basic guidelines are followed.

The Universal TAU-II system has been tested to meet the rigorous requirements of NCHRP Report 350, Test Levels 2 and 3. The systems are provided in lengths and capacities for both low speed and high speed applications and hazard widths up to 8.5 feet [2.6m].

The Universal TAU-II system is redirective, non-gating, and is ideally suited for hazards such as the ends of rigid barriers, tollbooths, utility poles, and more. Ease of installation, numerous non-proprietary transition options, low maintenance requirements, very low life cycle costs and reusability of system components make the Universal TAU-II system ideal for treating many roadside hazards.
Redirective, non-gating crash cushions are highway safety devices whose primary function is to improve the safety for occupants of errant vehicles that impact the end of rigid or semi-rigid barriers or fixed roadside hazards by absorbing the kinetic energy of impact or by allowing controlled redirection of the vehicle. These devices are designed to safely decelerate an errant vehicle to a safe stop or redirect an errant vehicle away from roadside or median hazards. These types of systems are typically applied to locations where head-on and angled impacts are likely to occur and it is desirable to have the majority of post impact trajectories on the impact side of the system.

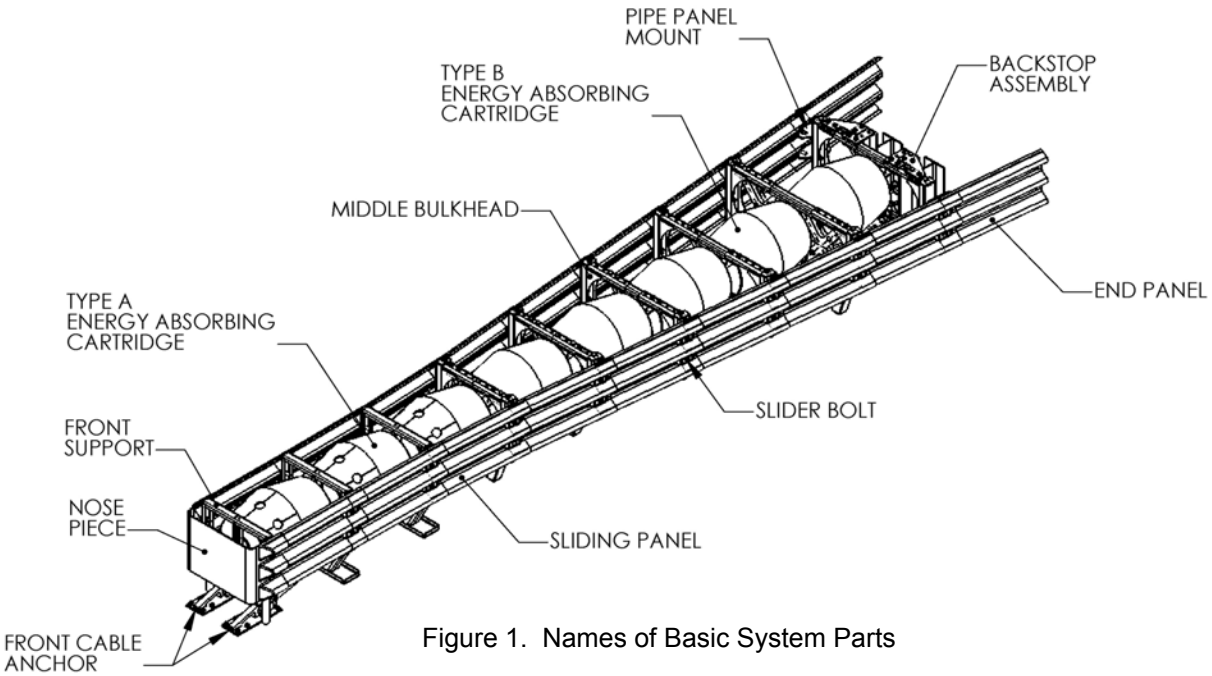


Figure 1. Names of Basic System Parts

SYSTEM OVERVIEW

The Universal TAU-II system is designed and constructed to provide acceptable structural adequacy, minimal occupant risk and safe vehicle trajectory as set forth in NCHRP 350 for redirective, non-gating crash cushions. Refer to Figure 1 to familiarize yourself with the basic parts and part names of the system.

The Universal TAU-II system is designed to shield the ends of median barriers and other fixed objects likely to be struck head-on, by absorbing and dissipating the kinetic energy of impacting vehicles. Universal TAU-II systems utilize disposable Energy Absorbing Cartridges (EACs) to absorb the kinetic energy of the impacting vehicle. The EACs are separated by diaphragms and held in place with a framework of thrie-beam corrugated steel rail panels that "telescope" rearward during head-on impacts. As the vehicle compresses the cushion, it exerts a force on the first bay containing an EAC. The diaphragms distribute the impact forces uniformly to all the remaining cartridges in each bay until the vehicle eventually stops. The depth of penetration is dependent upon both the original impact speed and the mass of the impacting vehicle. Only the Energy Absorbing Cartridges are expended after most head-on impacts.

When hit at an angle along the side, the system is restrained laterally by guidance cables that run the length of the system and attach to the bottoms of the diaphragms and terminate at the anchors at each end of the system. The front and rear cable anchors are attached to the foundation as described in Appendix "C" Foundation Requirements.

STEP 1

FOUNDATION REQUIREMENTS

The Universal TAU-II crash cushion is designed to be compatible with a variety of foundations. If an existing foundation is present, verify dimensions and system layout. If modification is required, use the BSI specifications as a guideline and adapt accordingly. If no foundation is present or currently does not meet the system requirements, construct the foundation per these BSI specifications.

There are different foundation configurations depending on the system used and the type of backstop selected. Systems up to 36" [910mm] can have a P.C.B. (Portable Concrete Barrier) Backstop, Flush Mount Backstop or a stand-alone Compact Backstop. PCB and Compact Backstop systems are compatible with the optional Asphalt Anchoring Kits. Systems 42" [1070mm] and greater use a Wide Flange Backstop and require a PCC (Portland Concrete) foundation and anchoring kit.

NOTE: Recommended maximum 8% cross slope on all foundation options.

Foundation options for all configurations are specified in the following drawings contained in APPENDIX "C", Page 47:

- General Foundation and Anchorage Specs. Drawing No. A040113…….. **Page 48**
- Universal TAU-II Foundation, **PCB Backstop**-PCC Concrete Pad: Drawing No. A040105 ……. **Page 49**
- Universal TAU-II Foundation **PCB Backstop**-PCC Block: Drawing No. A040117 ……. **Page 50**
- Universal TAU-II Foundation **PCB Backstop**-Asphalt Anchoring: Drawing No. A040112 ……..… **Page 51**
- Universal TAU-II Foundation **Compact Backstop**-PCC Concrete Pad: Drawing No. A040102 ….…… **Page 52**
- Universal TAU-II Foundation **Flush Mount Backstop**-PCC Pad: Drawing No. A040420 ……..… **Page 53**
- Universal TAU-II Foundation **Compact Backstop**-PCC Blocks: Drawing No. A040115 …… **Page 54**
- Universal TAU-II Foundation **Compact Backstop**-Asphalt Anchor: Drawing No. A040110 …… **Page 55**
- Universal TAU-II Foundation **Wide Flange Backstop**-PCC Concrete Pad: Drawing No. A040108 ……. **Page 56**
- Universal TAU-II Foundation **Dimensions – US Standard Units** – Inches: Chart 1 …… **Page 57-59**
- Universal TAU-II Foundation **Dimensions – Metric Units** – Millimeters: Charts ……**Pages 60-62**

Variations of these foundations may be reviewed and determinations made as to equivalence by the project engineer.

If you need additional information, or have questions about the Universal TAU-II Crash Cushion, please call the BSI Customer Service Department at (888) 800-3691 (U.S. toll free) or (707) 374-6800.

STEP 2

Anchor System to Foundation

With the proper foundation in place, anchor the Backstop, Rear Cable Anchors, and Front Cable Anchors according to the particular foundation detail (refer to Step 1).

The anchorage of the system must be in accordance with BSI foundation specifications found in Appendix "C".

To anchor the Universal TAU-II system:

1.) Determine the backstop components and Front Cable Anchor positions about the centerline of the system. The foundation drawings show positioning.

2.) Using the actual parts as templates, either mark the holes to be drilled or drill through the parts acting as guides.

3.) Hole diameter and depth depends on the foundation and the anchoring compound used. See chart below for the hole diameter as specified by the anchoring compound manufacturer. Reference BSI Foundation and Anchorage Specifications in APPENDIX "C" for specific embedment depths.

4.) Prepare the holes as specified by the anchoring compound manufacturer.

5.) With the Front Cable Anchor and backstop components in place, apply the anchoring compound to the holes as specified by the manufacturer. Insert the anchors into the holes with the nuts and washers attached.

6.) Allow anchoring compound to cure before tightening the anchors.

The anchoring package supplied with the Universal TAU-II system contains the necessary threaded rods and anchoring compound needed to install the system. Follow the instructions on the supplied package and reference the guidelines outlined below.

Anchor holes should be drilled using air-flushed or water-flushed rotary percussive drilling equipment. If diamond core or non-percussive drills are used, the hole must be thoroughly scoured using a coarse wire flue brush.

Other anchoring materials can be used if they comply with the following specifications: material should meet the ASTM C307 tensile strength of 2,000 psi (14 Mpa) and compressive strength of 10,000 psi (70 Mpa) per ASTM C109 or C579. The anchoring compound should provide a pull out strength of 20,000 lbf (89 kN) minimum in 4,000 psi (28 Mpa) concrete. Products such as HILTI HIT HY150 injection Adhesive Anchor, RE500 injection Adhesive Anchor or HVA Adhesive Anchoring System fit these criteria. Refer to Table 1 below for required hole size for recommended anchor compounds.

Mechanical / Removable Anchors

When standard chemical anchors cannot be used to secure Barrier System products as a result of state, local, site or other requirements, mechanical anchors may be used. Various mechanical anchors are available that use wedge, self-undercutting, or expansion coils to establish the locking bond with the concrete. A minimum of 18,000 lbf [80kN] ultimate load in the tension (pull out) and a shear of 22,000 lbf [98kN] is required for use with BSI products. One product recommended is the Hilti HCA item number 00252018 HCA 3/4" x 6".

Torque anchors set in PCC concrete to 120 ft-lbf [160 N-m]. Torque anchors set in asphalt to 5 ft-lbf [8 N-m].

IMPORTANT: FOLLOW MANUFACTURER'S SPECIFICATIONS FOR HOLE SIZE AND PREPARATION

ANCHORING COMPOUND	HOLE DIAMETER
US Anchor Ultra Bond Speed Set	7/8" [22 mm]
HILTI - HIT HY 150	13/16" [20.5mm]
HILTI - HVA Adhesive Anchor System	7/8" [22 mm]
HILTI - RE 500	13/16" [20.5 mm] to 1" [25 mm]

STEP 3
Assemble Bulkheads

The Universal TAU-II is comprised of multiple bulkheads assembled to create a variety of different system lengths and widths. Systems are constructed with different bulkheads depending on the size of the system that is needed.

As illustrated in Figure 2, systems can be fully parallel, fully tapered or a combination.
Every system requires a Front Support, a series of Middle Bulkhead Assemblies and a Backstop Assembly.

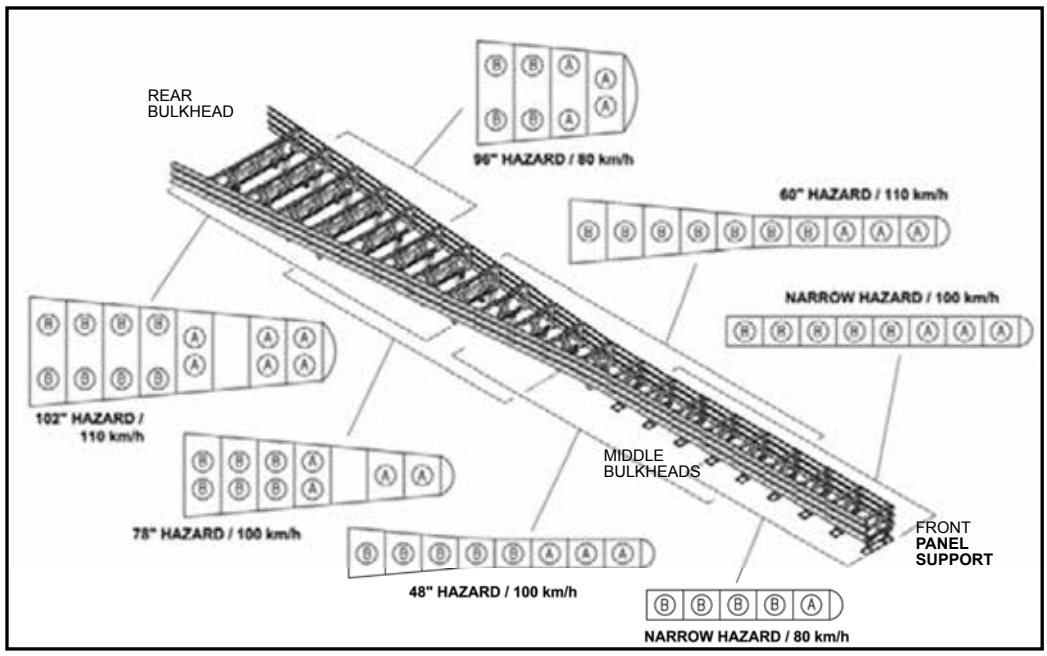
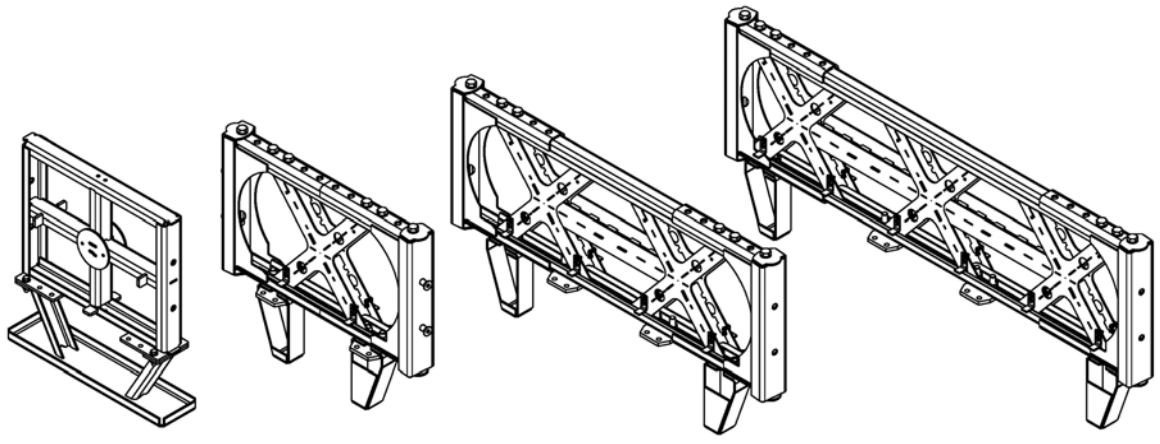


Figure 2.



Front Panel Support (1X) (2X) (3X)

Figure 3. Middle Bulkheads

The Front Support

The Front Support is different from a bulkhead in that it has polymer front support Legs and it doesn't attach to the cables underneath the system. The Front Support also has metal plates called Collision Plates, attached in the impact area on the front of the assembly. The Front Support can be built in different variations depending on the system size.

Using a Front Support:
(parallel and combination systems)

Parallel and combination systems use the Front Support (Figure 4). A tapered system designed with a large nose section may use a modified 1X, 2X or 3X bulkhead for the Front Support (Figure 5).

The polymer front support legs bolt directly to the bottom of the Front Support using the hardware provided. All fasteners use a lock washer or Locktite.

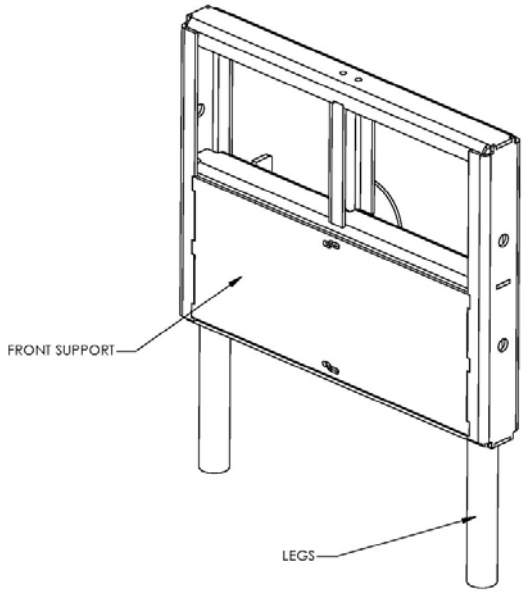


Figure 4. Use the Front Support for a parallel or combination systems.

Using a modified Bulkhead for Front Support
(Tapered systems)

An X style bulkhead can also be used as a Front Panel Support. The X style bulkheads are assembled according to the specific system requirements (Figure 5). Refer to the system drawing for the front bulkhead size needed. The Wing Assemblies slide over the ends of the bulkhead weldment and adjust to the width needed.

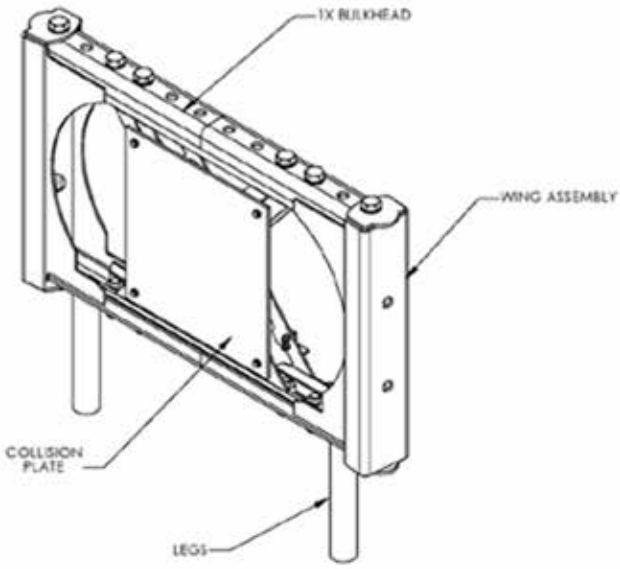


Figure 5. A 1X Style Middle Bulkhead converted into a Front Support

A Single X Bulkhead (1X) provides for Front Support widths of 30" [760] (using Transition Wing Assembly), 36" [910], 42" [1070], and 48" [1220].

A Double X Bulkhead (2X) provides for Front Support widths of 54" [1370], 60" [1525], 66" [1680], and 72" [1830].

A Triple X Bulkhead (3X) provides for Front Support widths of 78" [1980], 84" [2130], 90" [2290], and 96" [2440].

The Wing Assemblies are bolted in the appropriate location using Backing Plates and the hardware provided. All fasteners use a lock washer or Locktite (Figure 5).

The polymer front support legs bolt directly to the bottom of the assembly using free holes on the Wing Assemblies and the hardware provided (Figure 4,5). Some configurations require a leg adapter (Figure 6).

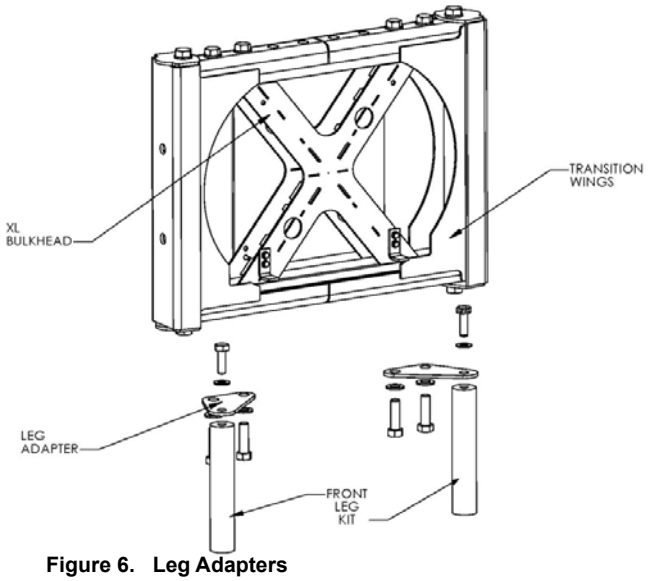


Figure 6. Leg Adapters

EAC Locating Tabs are bolted to the back of the assembly and Front Collision Plates are bolted to the front of the assembly. All fasteners use a lock washer and Locktite.

Middle Bulkhead Assemblies

The Middle Bulkheads come in two different styles: fixed and adjustable X-style. Depending on the system's cable location, the Cable Guide Mounting plates bolt to the bottom of the assembly at one of three positions.

Parallel Middle Bulkhead

The width of the Parallel Middle Bulkhead is not adjustable and is used in systems that are totally parallel or systems that start out parallel and finish with a rear taper (Figure 7).

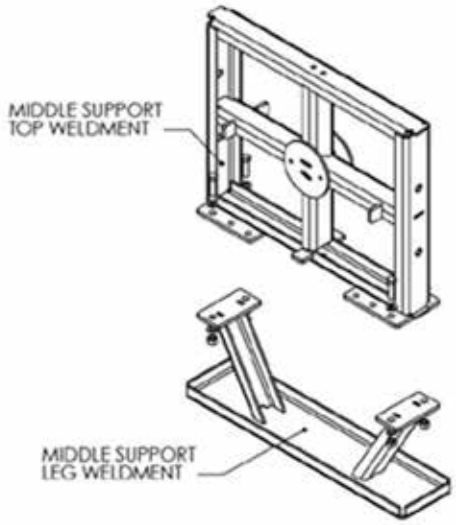


Figure 7. Parallel Middle Bulkhead

Adjustable Middle Bulkheads

The Adjustable Middle Bulkheads come in three different widths and are designated by the number of X patterns on the face of the bulkhead (Figure 3). The narrowest has a single X in its structure, the double X has two and the largest bulkhead has three X's.

All of the bulkheads have adjustable wings that are rigidly bolted on to each side (Figure 8). Using the adjustable wings, the different sized bulkheads can accommodate hazard widths up to 102" [2.6m]. The bulkheads can descend in 6" [150mm] increments until reaching the desired width.

The adjustable Middle Bulkheads are assembled according to the specific system requirements. Refer to the system drawing for the middle bulkhead sizes needed. The Wing Assemblies slide over the ends of the bulkhead and adjust to the width needed.

Single X (1) Middle Bulkheads provide for assembly widths of 30" [760] (using Transition Wing Assembly), 36" [910], 42" [1070], and 48" [1220].

Double X (2X) Middle Bulkheads provide for assembly widths of 54" [1370mm], 60" [1520mm], 66" [1680mm], and 72" [1830mm].

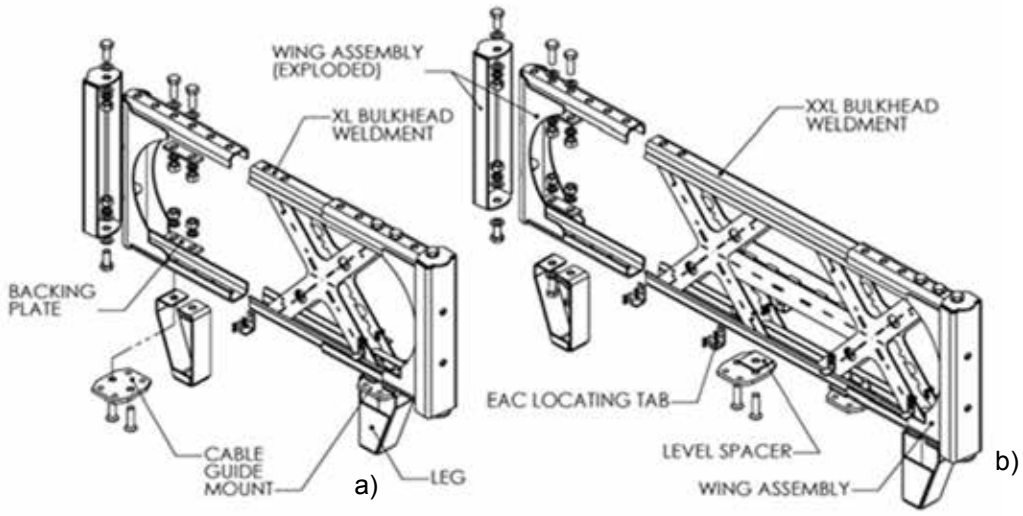


Figure 8. Adjustable Middle Bulkheads a) Single X (1X) b) Double X (2X)

Triple X (3X) Middle Bulkheads provide for assembly widths of 78" [1980mm], 84" [2130mm], 90" [2290mm], 96" [2440mm], 102" [2.6m].

The Wing Assemblies are bolted in the appropriate location using Backing Plates and the hardware provided. The Legs bolt directly to the bottom of the assembly where the Wing Assemblies attach using the same hardware. All fasteners use a lock washer or Locktite.

Cable Guide Mounts

If a parallel or 1X bulkhead is used as the Front Bulkhead Assembly, the cable is in the 1st position (Figure 9) and the Cable Guide Mounts would bolt in the corresponding location.
If a 2X or 3X bulkhead is used as the Front Bulkhead Assembly, the cable is in position 2 or 3 (Figure 9) respectively and the Cable Guide Mounts attach accordingly. If said cable position alignswith the leg mounting position the Cable Guide Mount bolts through the leg using the hardware provided for the Cable Guide Mount.

Backing Plates are used on all Leg, Wing Assembly, and Cable Guide fastenings. A Level Spacer is used when attaching components across the step between the Bulkhead

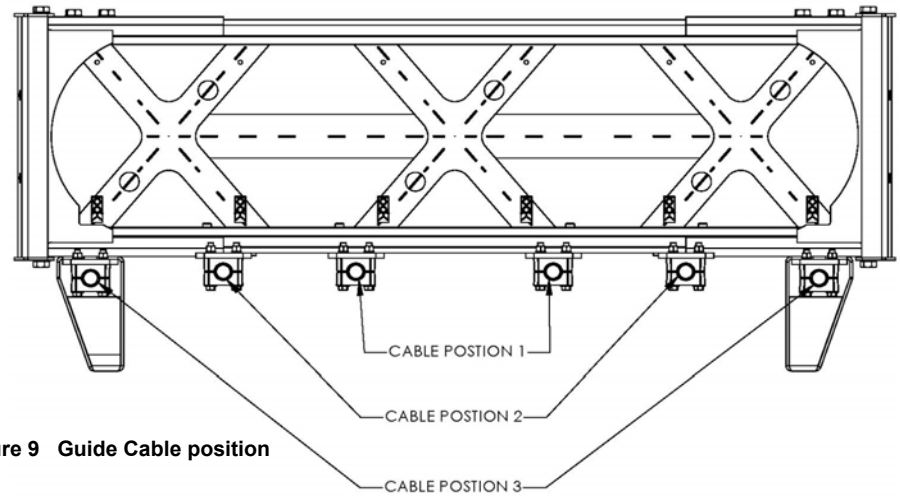


Figure 9 Guide Cable position

Weldment and the Wing Assembly.

EAC Locating Tabs

EAC Locating Tabs are bolted to the front and back of each Middle Bulkhead Assembly. All fasteners use a lock washer or Locktite (Figure 8).

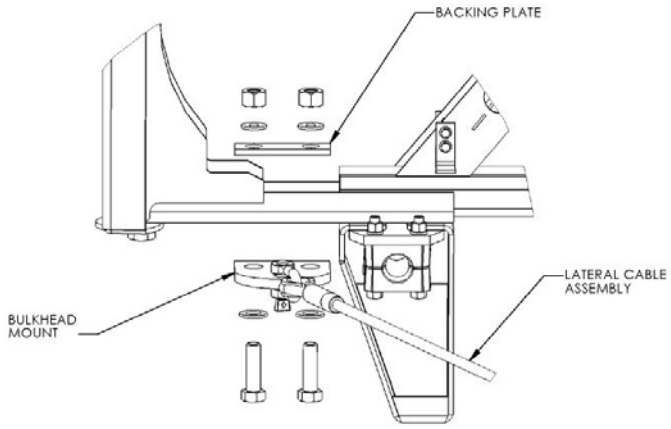


Figure 10. Lateral Cable Support

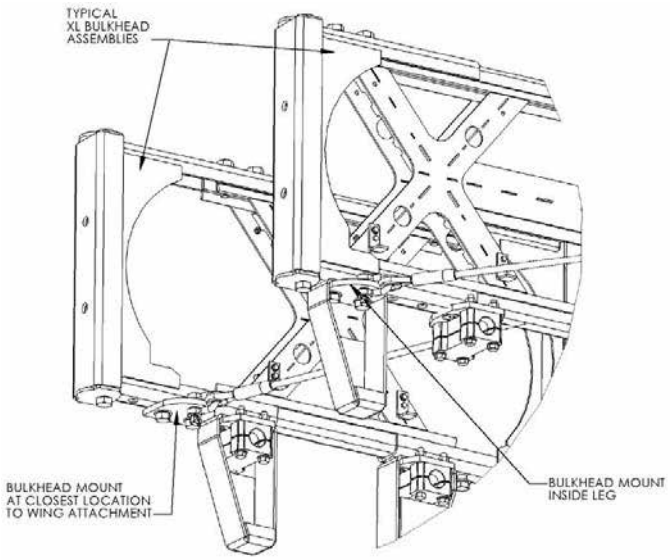


Figure 11. Lateral Cable Supports mounted inside and outside the leg

Lateral Cable Support

Some systems require a Lateral Cable Support Kit (Refer to Step 10 of this manual). The Lateral Cable Support Kit contains Bulkhead Mounts that attach to the last two bulkhead assemblies of required systems. They bolt to the outermost free holes in the Wing Assemblies (Figure 10). They do fit inside the Legs if necessary (Figure 11).

NOTE: Refer to the System Configuration chart in Appendix "A" to determine if Lateral Cable supports are required.

Empty Bay Bumpers

Some systems require an empty bay (no Energy Absorbing Cartridges). These systems utilize a Bumper Kit to minimize damage in an impact (Figure 12). The kit includes (4) Bumpers that mount to the rear bulkhead assembly of the empty bay. Two Bumpers mount to the top of the assembly at the Wing to Bulkhead joint using the same hardware. The other two Bumpers mount through the Leg to the Wing – Bulkhead joint.

NOTE: Refer to the System Configuration chart in Appendix "A" to determine if empty bays are required.

Following complete assembly of the Front, Middle, and Backstop Bulkhead assemblies, position them in order. Space them at approximately 34" [860mm] apart, center to center. Also, align them through the centerline of the system. Accuracy and care taken here will improve ease of assembly and reduce efforts to straighten the system.

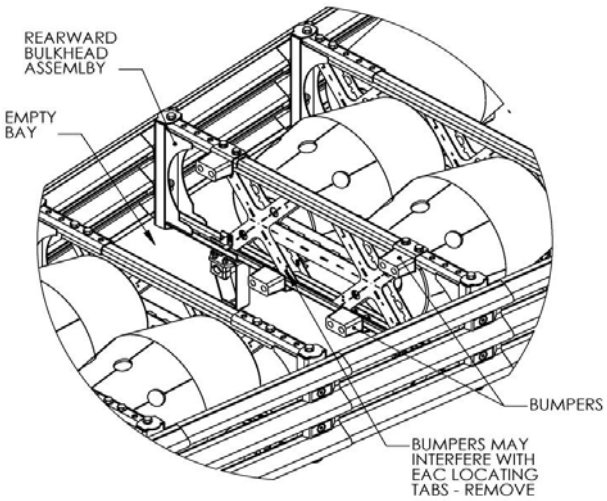


Figure 12 Empty Bay Bumpers

STEP 4

Backstop Assemblies

The Backstop Assembly is selected per application and can be configured to protect hazards up to 8.5' [2.6m] in width. Backstops can either be attached directly to a barrier wall or a suitable structure (Portable Concrete Barrier (PCB) Backstop, Flush Mount Backstop) or installed as a stand-alone system (Compact Backstop, Wide Flange Backstop). All backstops require minimum assembly if they are not pre-assembled.

PCB Backstop

The PCB Backstop (Figure 13) is configured from parts anchored directly to an existing concrete barrier wall. Refer to Step 1 and Step 2 for PCB Backstop layout and anchorage details. Pipe Panel Mounts bolt to the sides of the backstop and provide a mounting point for the Slider and End Panels.

Refer to the System Configuration Chart in Appendix "A" to determine system widths and Capacity Limitations.

If a 36" [910mm] Backstop is desired, attach the 36" [910mm] Backstop Adapters (Figure 14) to the sides of the backstops and bolt the Pipe Panel Mounts to the pivoting sections.

If the system is installed on an asphalt foundation, the portable concrete barrier must be anchored using the supplied brackets.

For additional information or questions about the Universal TAU-II Crash Cushion, please call the BSI Customer Service Department at (888) 800-3691 (U.S. toll free) or (707) 374-6800.

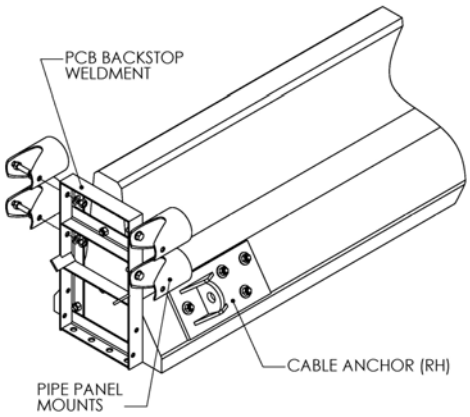


Figure 13 PCB Backstop (Parallel System)

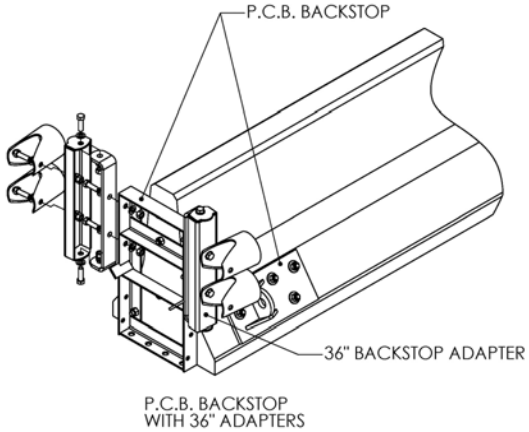


Figure 14 PCB Backstop (Tapered System)

Compact Backstop

The Compact Backstop (Figure 15) is bolted together in two halves and is usually pre-assembled. The Backstop is a stand alone design is not anchored to the hazard being protected.

Refer to Step 1 and Step 2 for Backstop layout and anchorage details.

Pipe Panel Mounts bolt to the sides of the backstop and provide a mounting point for the Slider and End Panels. Refer to the system drawing for the backstop assembly size needed.

If a 36” [910mm] Backstop is desired, attach the 36” [910mm] Backstop Adapters (Figure 16) to the sides of the backstops and bolt the Pipe Panel Mounts to the pivoting sections.

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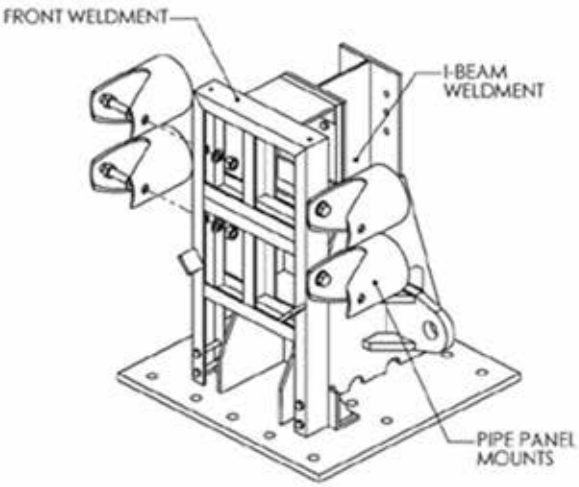


Figure 15 Compact Backstop (Parallel Systems)

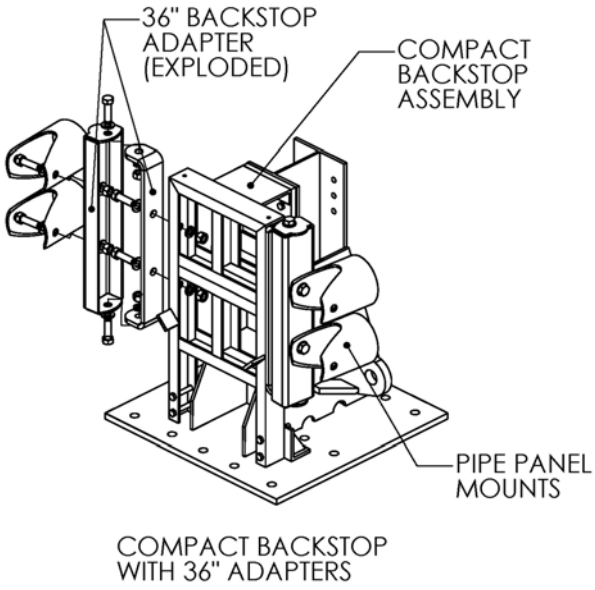


Figure 16 Compact Backstop (Tapered Systems)

Flush Mount Backstop

The Flush Mount Backstop system (Figure 17) is intended for applications where the hazard width exceeds the limitations of the PCB Backstop and are applicable in locations with limited foundation size. The Flush Mount Backstop can be attached to reinforced safety shape or vertical concrete structures up to 36" [910mm]. Systems over 24" [610mm] wide require the 36" [910mm] adapter. Edges of vertical concrete may require chamfer according to local standards.

The Cable Tensioning is moved to the front of the system so the rear cable anchors do not protrude outside of the rear extension panels.

The backstop is attached to the foundation and to the concrete backstop. Install anchors in accordance with BSI specifications. Vertical slots on the backstop allow removal replacement of the backstop. Anchors must be placed at the top of said slots to be effective. Flush Mount Backstop systems use the same cable used in all parallel systems. The cable is installed with the threaded tensioning end forward. The looped end is pinned in place at the backstop. The Front Cable Anchor uses an inserted key to keep the threaded stud from rotating during tensioning.

For additional information or questions about the Universal TAU-II Crash Cushion, please call the BSI Customer Service Department at (888) 800-3691 (U.S. toll free) or (707) 374-6800.

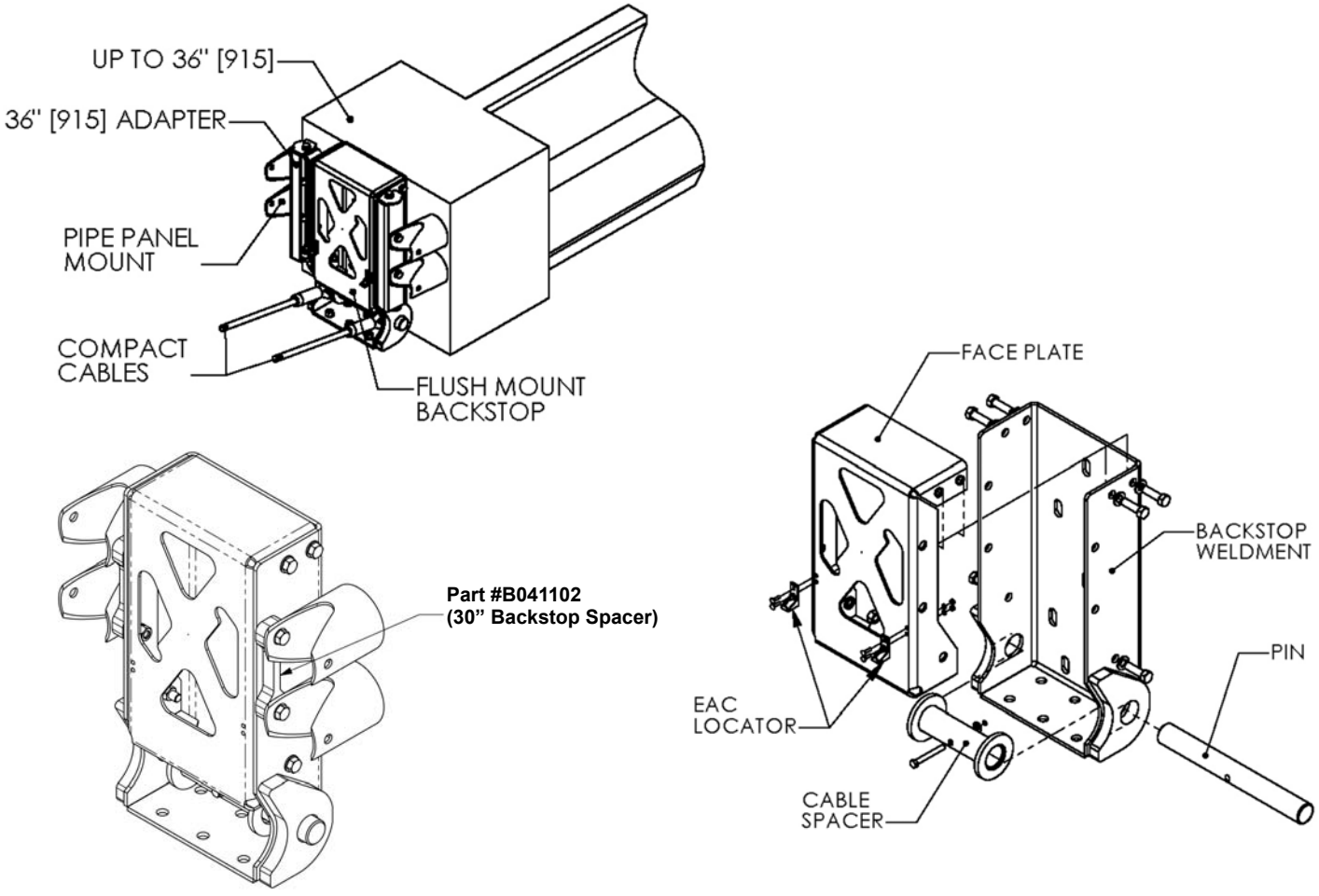


Figure 17 Flush Mount Backstop

Wide Flange Backstop

The Wide Flange Backstop (Figure 18) uses a combination of backstop elements to protect wide hazards.

The Wide Flange Backstop incorporates XL, XXL, or XXXL bulkhead assemblies attached to two Wide Flange Backstop Weldments.

The backstop bulkheads are assembled according to the specific system requirements. The Wing Assemblies slide over the ends of the bulkhead weldment and adjust to the width needed.

XL Bulkheads provide for backstop bulkhead assembly widths of 42" [1070] (using Transition Wing Assembly), 48" [1220], 54" [1370], and 60" [1525].
XXL Bulkheads provide for backstop bulkhead assembly widths of 66" [1680], 72" [1830], 78" [1980], and 84" [2130].

XXXL Bulkheads provide for backstop bulkhead assembly widths of 90" [2290], 96" [2440], and 102" [2290].

Backstop Block-outs mount to the bulkhead assemblies at the Wing Assembly to Bulkhead Weldment joint. The block-outs are bolted through the Wing Assemblies and bulkhead weldment and fastened using Backing Plates and the hardware provided. The bulkhead assembly and block-outs are then bolted to the Wide Flange Backstop Weldments. Pipe Panel Mounts are fastened to the pivoting section of the Wing Assemblies. EAC Locating Tabs bolt to the front of the bulkhead assembly. All fasteners use a lock washer or Locktite.

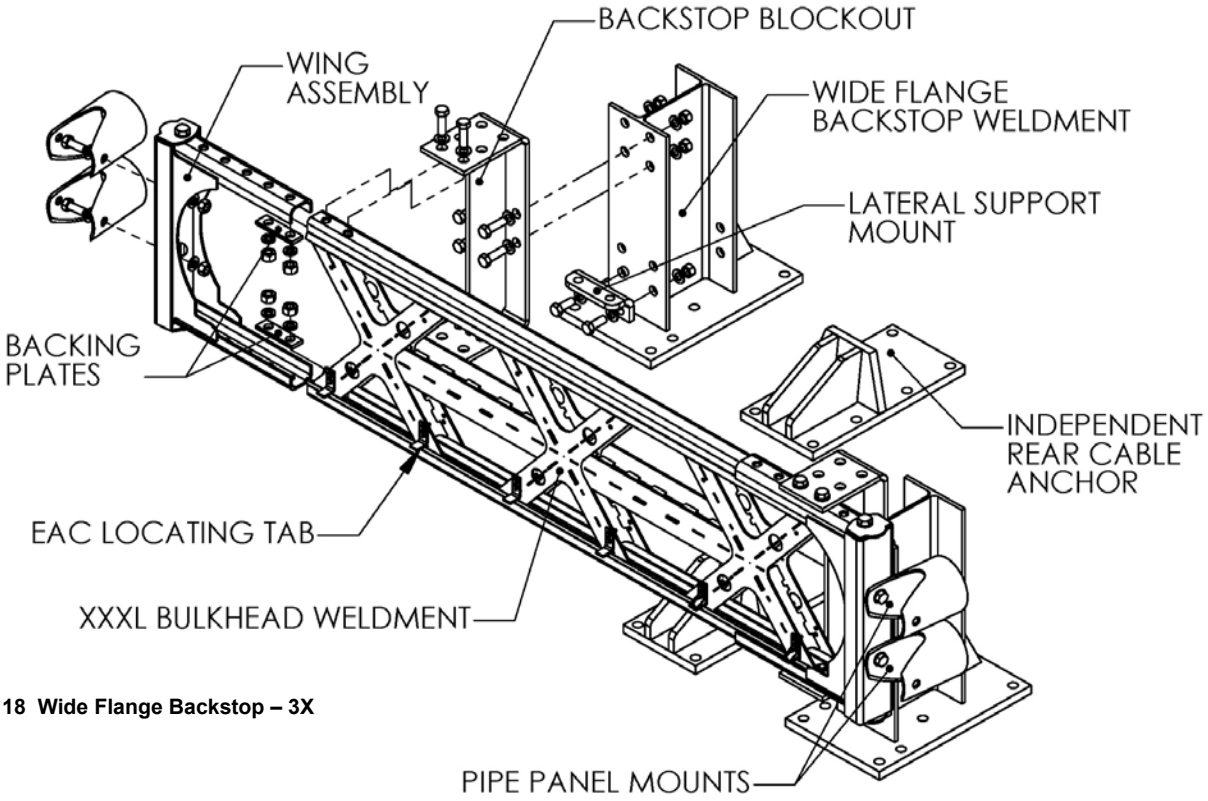


Figure 18 Wide Flange Backstop – 3X

Depending on the position of the cables in reference to the Wide Flange Backstop positioning, either an independent rear cable anchor (Figure 18) or a backstop mounted rear cable anchor (Figure 19) will be used. The independent rear cable anchor stands alone and requires no assembly. (Reference Step 1 and Step 2 for layout and anchorage specifications). The backstop mounted rear cable anchor bolts between the flanges of the Wide Flange Backstop. They are mounted to the interior of the system. All fasteners use a lock washer or Locktite. When the front support bulkhead and backstop utilize the same bulkhead, the rear cable anchors are mounted to the backstops. When the front support bulkhead and backstop bulkheads are different, the system is supplied with independent rear cable anchors mounted on the pad surface.

Some systems require a Lateral Cable Support Kit. The Lateral Cable Support Kit contains Lateral Support Mounts that attach to the backstop assembly of required systems. They bolt to the front of the Wide Flange Backstop Weldments in the lowest hole set. If backstop mounted rear cable anchors are used, one of the bolts will be shared. All fasteners use a lock washer or Locktite.
Refer to the System Configuration Chart in Appendix "A" to determine if Lateral Cable supports are required.

If the Wing Assemblies of the particular backstop are adjusted to one of their two most extended positions (54" [1370mm], 60" [1525mm], 78" [1980mm], 84" [2130mm], and 102" [2290mm] backstops), Wing Braces and Spacers are required (Figure 19). The Wing Braces attach to the Wing Assemblies and the Backstop Block-outs on the top and bottom. The Spacers level their mounting surfaces. All fasteners use a lock washer or Locktite.

For additional information or questions about the Universal TAU-II Crash Cushion, please call the BSI Customer Service Department at (888) 800-3691 (U.S. toll free) or (707) 374-6800.

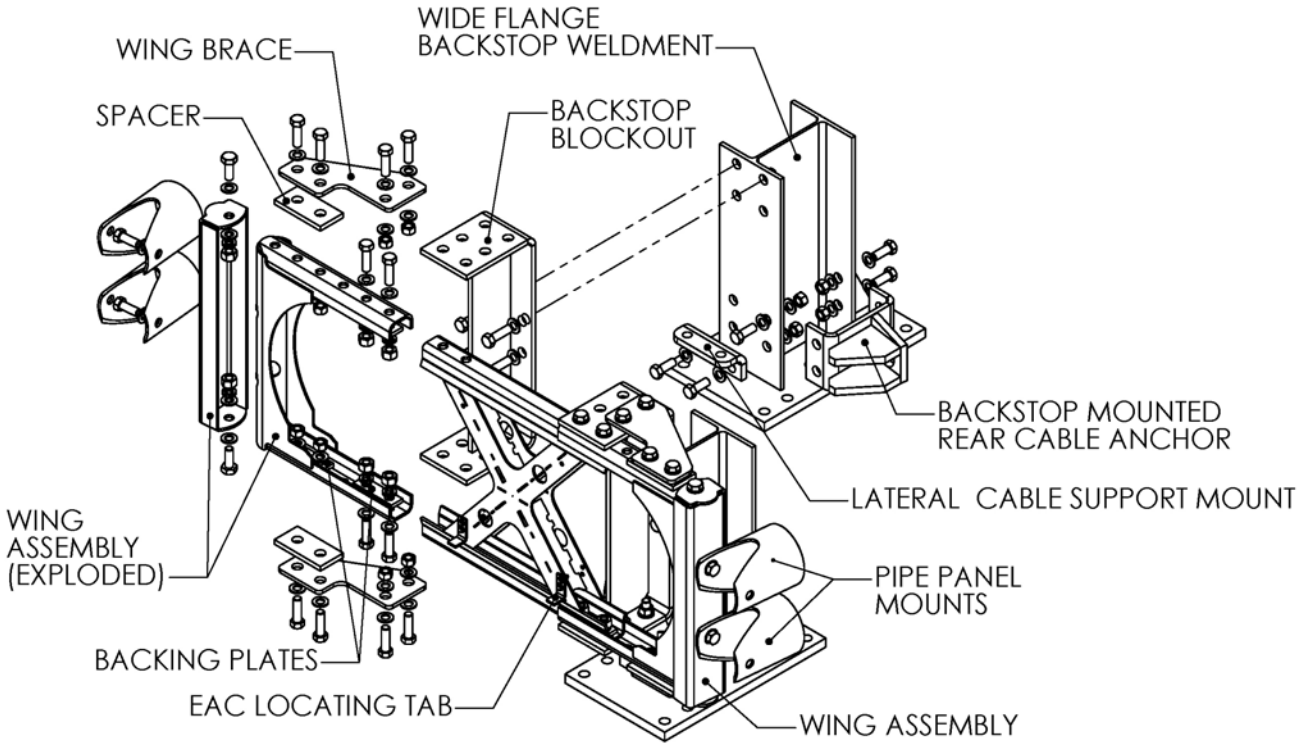


Figure 19 Backstop – 1X with Wing Braces

STEP 5

Attach Panels

The Universal TAU-II system uses two types of panels: Sliding Panels (Figure 20) and End Panels (Figure 21). Sliding Panels have a pair of holes forward and two long slots running the length of the panels. End Panels have a pair of holes at each end and do not have slots. Sliding panels are used on all collapsing bays. End panels are attached to the backstop only (Call BSI for non-proprietary transition options). Slider Bolts hold the panels to the bulkheads. Some systems require nested panels (doubled) on rearward bays.

NOTE: Refer to the System Configuration Chart in Appendix "A" to determine if/where nested panels are required. A long bolt is supplied to assist in the assembly to nest the panels.

Install the panels from back to front staggering from each side. Place the End Panels first. While holding the End Panel in place, lap the forward Sliding Panel over it and bolt through the slot, End Panel, and Pipe Panel Mount (Figure 22). Leave the nuts of the Slider Bolts loose and perform on both sides. Lap the next forward Sliding Panel and bolt through the slot, hole set in rearward Sliding Panel, and bulkhead. Leave the Slider Bolt nuts loose and progress forward alternating sides (Figure 23). If the bay requires nested panels, perform procedure with (2) panels, one nested inside the other.

The last panels to be installed will be on the first bay of the system, the Front Support. These panels lap the rearward panel and fasten to the 2nd bulkhead from the front as instructed above. The front of these panels will mount to the Front Support through the Nose Piece. Refer to Section 6 for this connection (Figure 26).

Leave the Slider Bolt nuts loose until the system is almost completely assembled and installed.

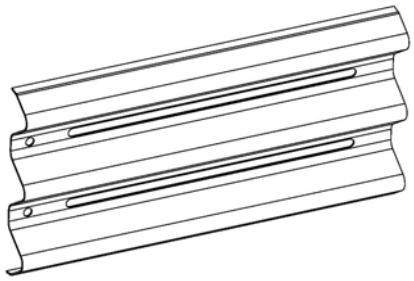


Figure 20 Slider Panel

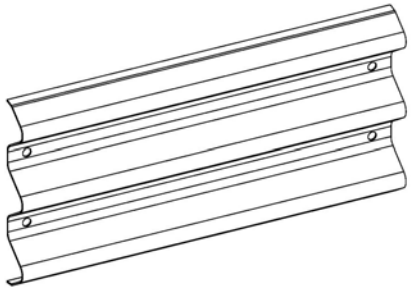


Figure 21 End Panel (no slots)

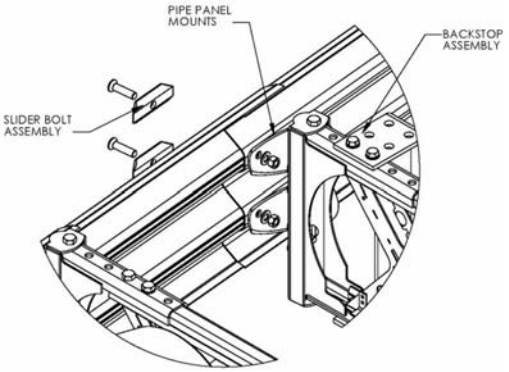


Figure 22 Attach Rear Panel

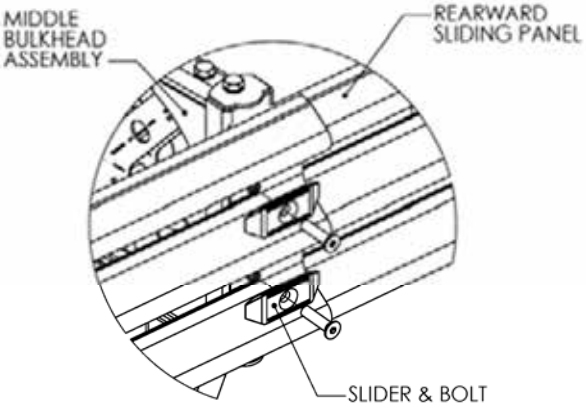


Figure 23 Attach Side Panels

STEP 6
Attach Nose Piece / Delineation Marker

Narrow systems (up to 36” [910mm] Front Support) use a one-piece polyurethane nose (Figure 24) with molded thrie beam corrugations on both ends. Wider Front Support Assemblies (42” [1070mm] and above) use two polyurethane parts (Figure 25) riveted together. The two part nose pieces have thrie beam corrugations on one side and a series of holes through the flat section. Guide Cable Torque

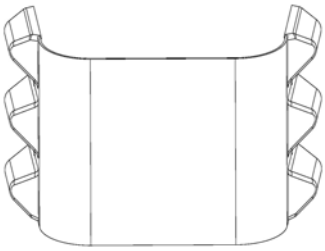


Figure 24 Nose Piece (up to 36”)

The Nose Piece attaches to the Front Support assembly through the Sliding Panels (Figure 26). Thick flat round washers are inserted in the mounting holes of the nose piece to limit compression of the polyurethane. Two ¾” [20mm] bolts with fender washers clamp the nose piece and Sliding Panel to the Front Support on each side. Fasteners use lock washers or Locktite.

Torque to 200 ft-lbf [270 N-m].

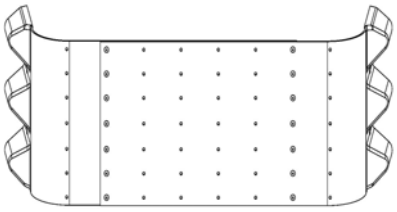


Figure 25 Nose Piece (wide)

The two part nose pieces overlap across the width of the system. Adjust to desired profile and align holes. Using the supplied pop-rivets and washers, rivet two columns of holes. Rivets should pass through the overlapping nose pieces at the furthest possible columns apart (Figure 26).

Apply delineation markings as required (not supplied).

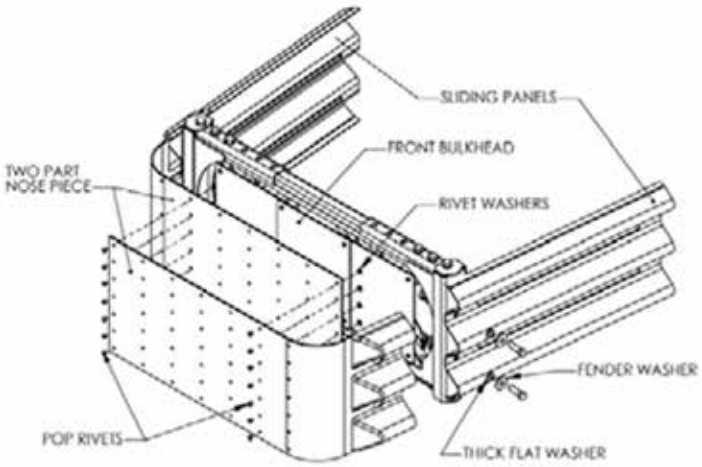


Figure 26 Wide Nose Piece Assembly

STEP 7

Install Cables and Cable Guides

Cable Location

Every system has a set of cables that run through the cable guides that attach underneath each bulkhead. The Cable Guides clamp around the cable and bolt to the bottom of the bulkheads. The Cable Guide is universal and fits all bulkhead and cable configurations. Two Cable Guide assemblies are used on every middle bulkhead assembly (Figure 27).

The cables are tentioned between the Backstop and Front Cable Anchor. The Front Cable Anchor is mounted under the first bay.

IMPORTANT NOTE: The Front Support Assembly is not attached to the cable.

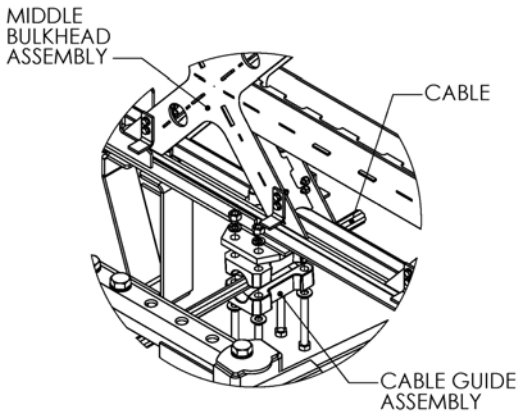


Figure 27 Cable Guide Clamp

Systems using a PCB, Compact Backstop or Flush Mount Backstop.

Systems using a PCB, Flush Mount or Compact Backstop use 1" [25mm] diameter cable (Figure 28). These Cables are identified by the loop and shackle on one end and a threaded stud swaged to the other end. (The shackle is not used on the Flush Mount Backstop).

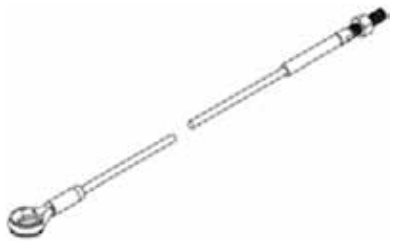


Figure 28 Compact Cable

Systems with Wide Flange Backstops

Systems with Wide Flange Backstops use a 1 1/8" [28mm] diameter cable (Figure 29). These cables have a threaded stud swaged to the rear end and a large "open swage socket" on the front end. A Key is also included which limits rotation of the cable during tensioning at the Rear Cable Anchor.

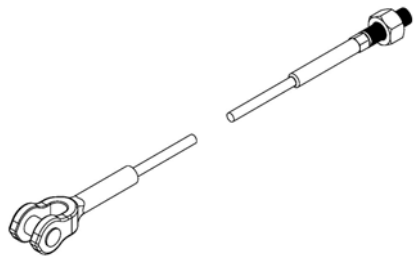


Figure 29 Universal Cable

The cables are fed through the bulkheads from the front. On parallel style bulkheads, the cables thread between the legs. On XL-XXXL bulkheads, the cables can go between the legs or through the legs, depending on the configuration. Lead with the rear of the cable. Place the rear cable end through the Rear Cable Anchor, PCB Backstop, or Compact Backstop.
Start the tensioning nut with about 1" [25mm] of thread.

Without pinning the Front Cable Anchor, attach the Cable Guides to the bulkheads. Start from the last bulkhead and move forward. Cable Guides attach with ½" [12mm] hardware provided. Fasteners use lock washers or Locktite.

When all the Cable Guides are installed, pin the front cable end to the Front Cable Anchor. On Wide Flange Backstop configurations, install the Key to the Rear Cable Anchor (Figure 30).

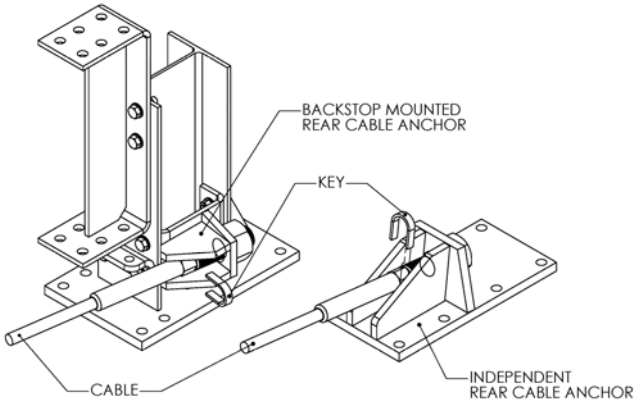


Figure 30 Backstop Cable Mount

STEP 8

Stretch and Align the System

This step can be avoided or reduced if care is taken to align and space the bulkheads properly during assembly.

Attach a pair of chains or straps to the Front Bulkhead assembly. Using a truck or other tow vehicle, pull the system forward to fully extend the bays. The bays are fully extended when the Slider Bolts are bottomed out in the slots of the Sliding Panels.

If necessary, bump or nudge the system into alignment. Each bulkhead should be aligned along the centerline of the system.

Recommended attachment points for straps or chains are at the corners of Front Support on the top and bottom horizontal channels. When attaching to XL-XXXL bulkheads, secure as close to the Wing Assembly attachment points as possible.

NOTE: Be sure not to jerk or pull on the backstop anchors before the anchoring compound has cured and the backstop is secured to the foundation.

STEP 9

Tension Cables and Torque Slider Bolts

Tension the Cables. Torque the cables in 50 ft-lbf [65 N-m] increments alternating between the two. Reference Torque Chart below (Table 2) for torque requirements. Use the deep socket provided.

Tighten Slider Bolts to approximately 100 ft-lbf [130 N-m], loosen, and then torque to 20 ft-lbf [27 N-m]. This procedure ensures proper nesting of the panels and torque accuracy.

NOTE: Care must be taken to not over tighten the sliders. Follow the procedure outlined above.

STEP 10

Install Lateral Support Cables

Skip this section if the system does not require a Lateral Cable Support Kit.

NOTE: Refer to the System Configuration chart in Appendix "A" to determine if Lateral Support Cables are required.

If the system requires a Lateral Cable Support Kit, the cable mounts should be installed on the last two bulkhead assemblies and the Wide Flange Backstops. Refer to Figure 9 and Figure 10 of Step 3.

The Lateral Support Cables are ½" [12mm] diameter and have a ½" [12mm] shackle on one end. There are eight (8) cable assemblies in the kit. The shackles pin to the cable mounts on the bulkheads and Wide Flange Backstops (Figure 31, 32, 33, 34, 35). The two cables from each backstop are routed to the opposite sides of the last two bulkheads (Figure 35).

These cables are attached to the cables pined to the bulkheads with cable clamps. Six cable clamps are used in series of three. Place the clamps at the furthest extents of the overlapping cables. The first cable clamp should be approximately 3" [75mm] from the cable end. Subsequent clamps should be spaced at 3" [75mm] (Figure 33).

Cables should be taught with minimal slack, but do not require tensioning. Routing above or below the main system cables is acceptable. Bundle access cable and use provided plastic wrap ties to secure the bundles to the suspended cables.

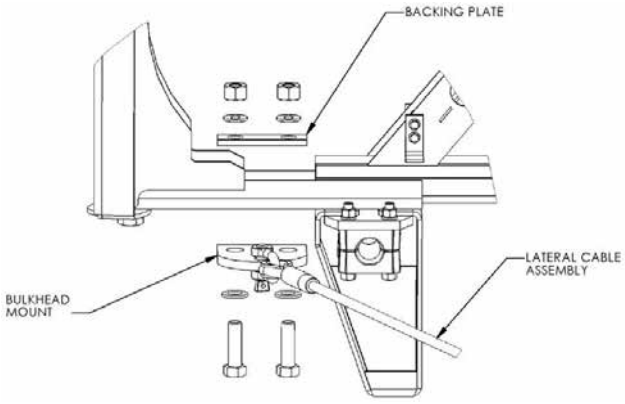


Figure 31 Lateral Support Cable

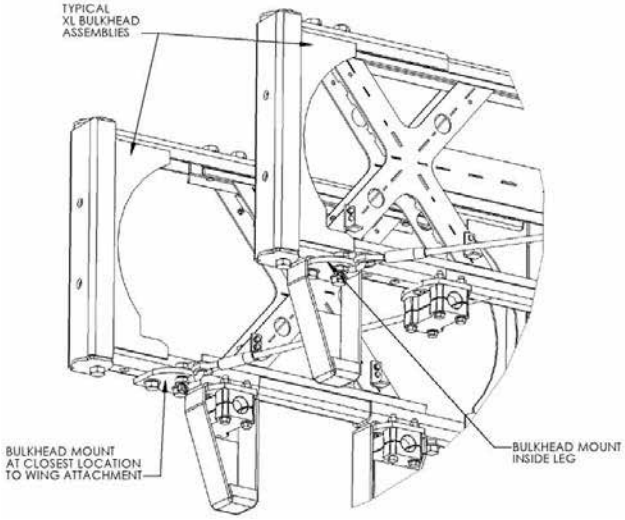


Figure 32 Lateral Support Cables

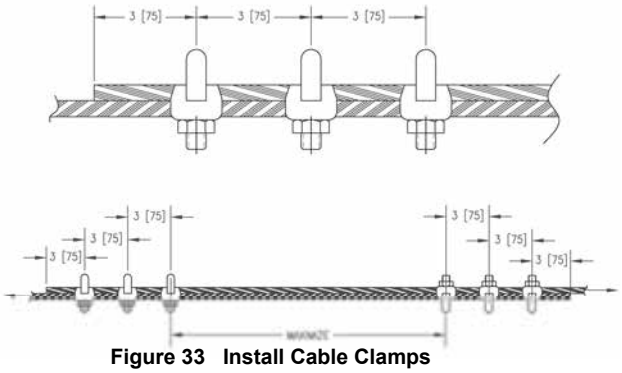


Figure 33 Install Cable Clamps

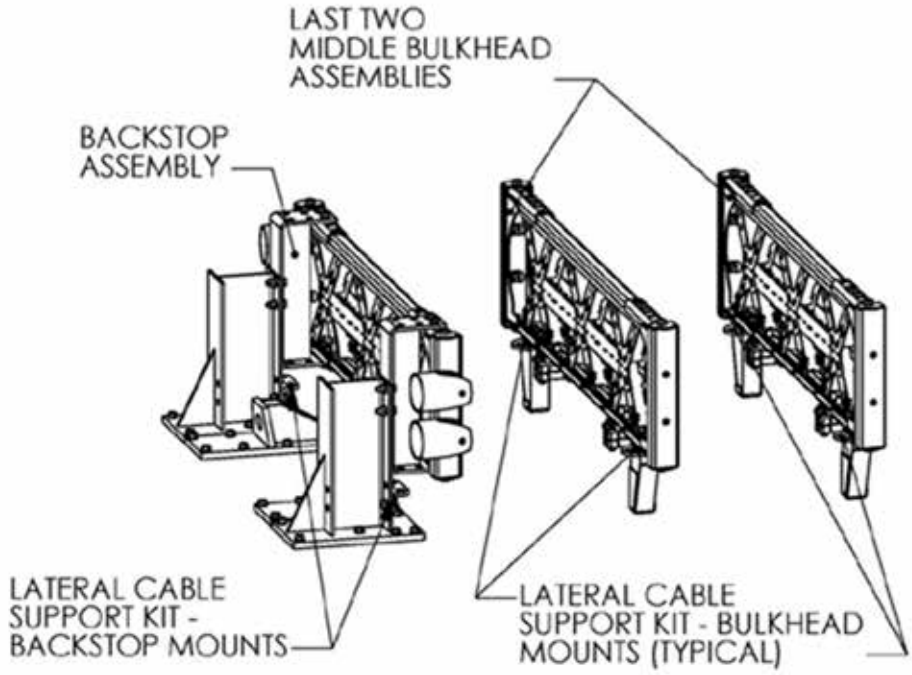


Figure 34 Cable Mounts

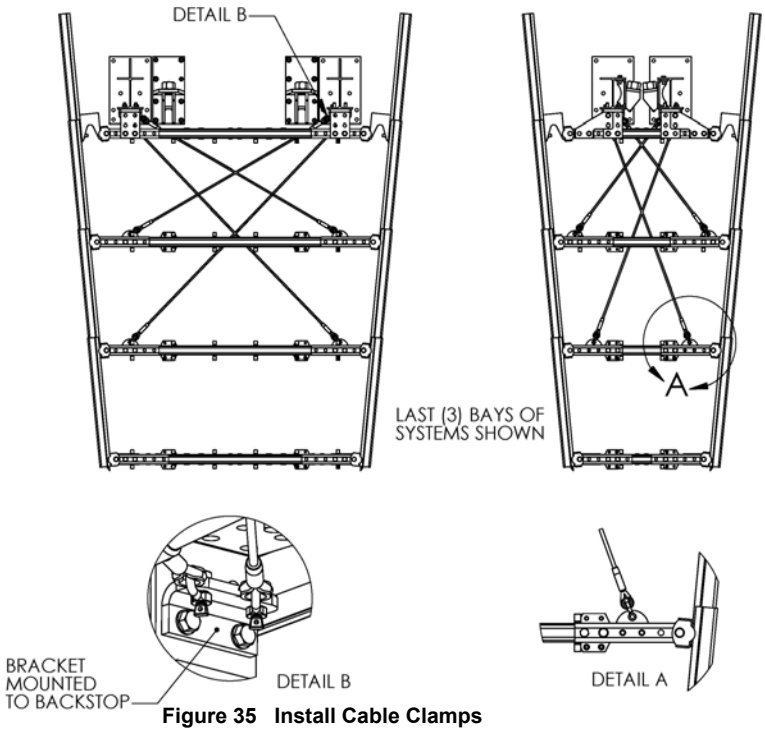


Figure 35 Install Cable Clamps

STEP 11

Insert Energy Absorbing Cartridges

There are two types of Energy Absorbing Cartridges (EAC). Each EAC has a forward and rearward end. Type “A” EAC’s (Figure 36) have eight (8) 3” [75mm] diameter holes around the circumference of the front half of the cylinder. Type “B” EAC’s (Figure 37) have a solid cylinder wall with three (3) vent holes on the rearward end.

When installing the EAC’s in a system it is important to ensure that they are placed according to manufacturer specification.

NOTE: Refer the System Configuration Chart in Appendix “A” for proper EAC placement.

When placed in the system, the front of the EAC will face the front of the system (narrow end). Text on the EAC reading “This Side Up” should be legible and at the top of the inserted EAC. The EAC should rest on the EAC Locating Tabs.

Note that bays capable of holding (2) EAC’s will always use (2) EAC’s except in specified empty bays. They will also always be placed in the widest locations available.

NOTE: A single bay will never have more than (2) EAC’s in it. Refer the System Configuration Chart in Appendix “A” for proper placement.

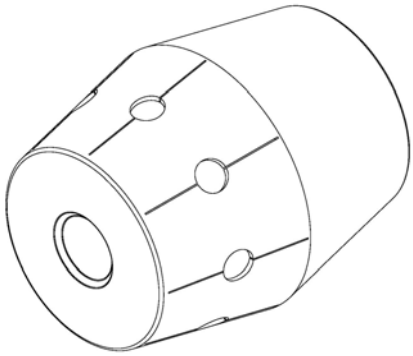


Figure 36 Energy Absorbing Cartridge – Type A

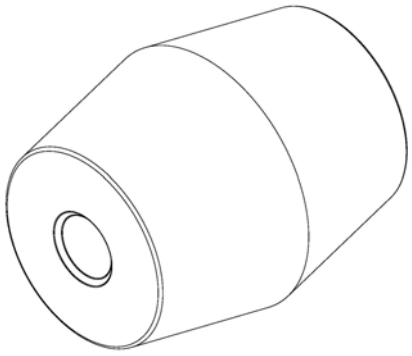


Figure 37 Energy Absorbing Cartridge – Type B

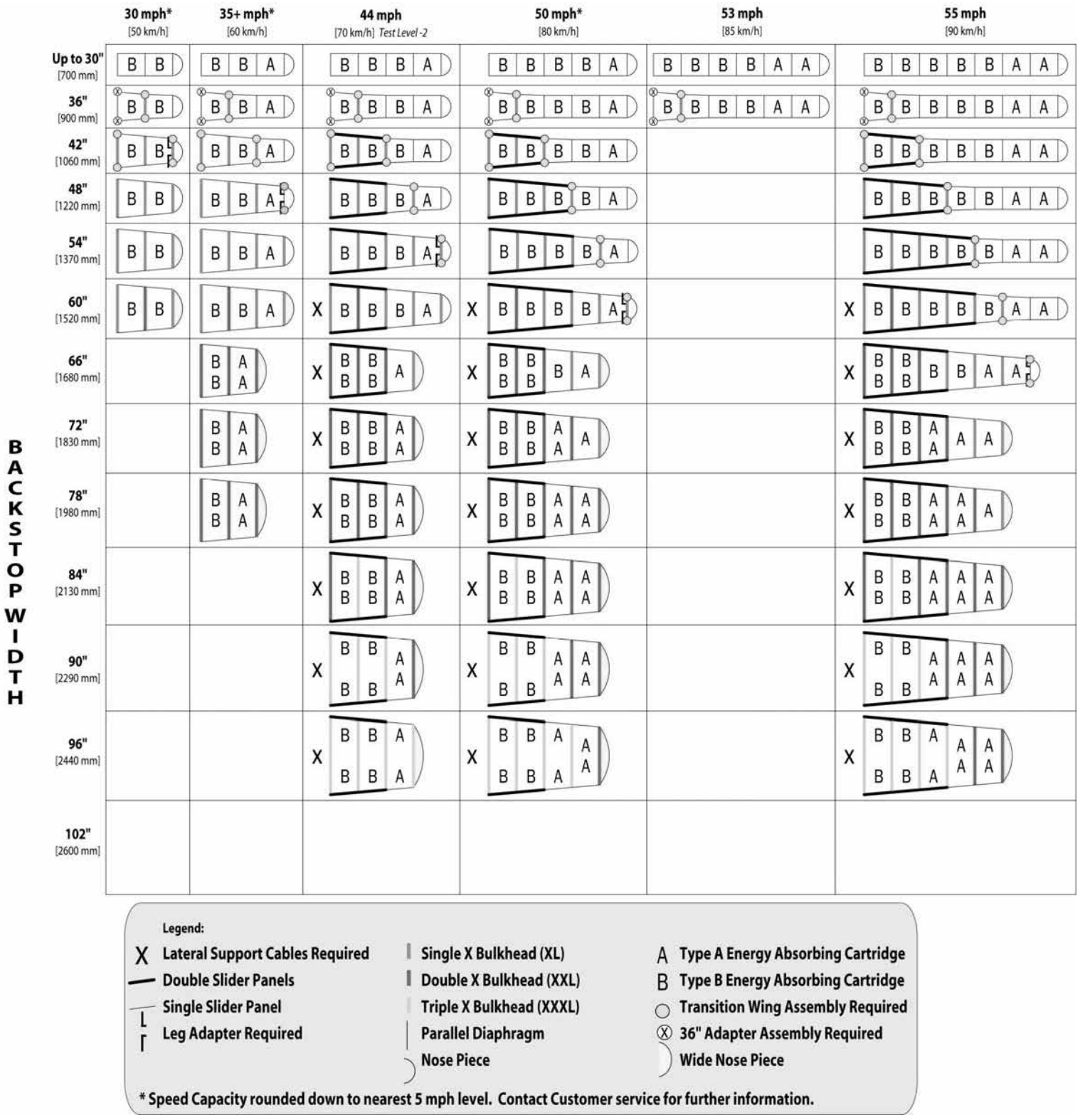
STEP 12

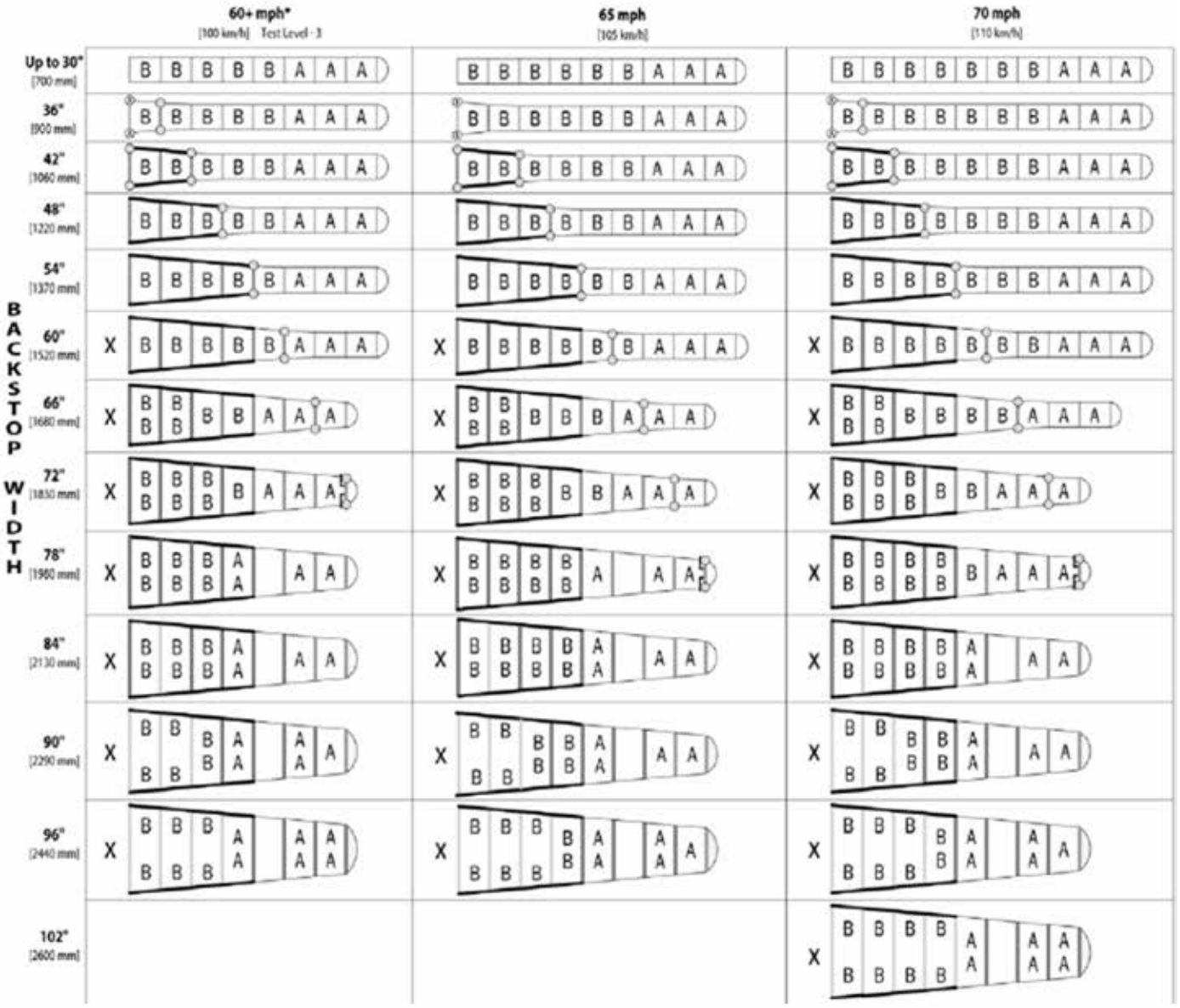
Final Inspection

Use the check list below to confirm that all of the in-stallation steps have been completed.

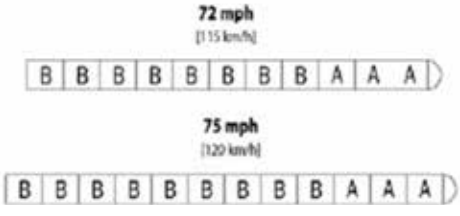
Inspection Date	Inspection By:	Item
		All front cable anchor plate and backstop anchor bolts in place and epoxy cured.
		Clevis and pin, mounted to the front cable anchor, is installed with the handle portion of the pin on the inside of the anchor assembly, firmly tightened. *(This may be different depending on the type of foundation, ie, asphalt or PCC.)*
		All cable guide assemblies securely fastened.
		System cables tightened to meet torque specifications.
		Pipe panel mounts positioned properly, flat end facing back, cut out facing forward.
		Sliding panels installed properly to allow for stacking.
		Sliding panels should have no more than a ¾" (19mm) gap between stacked panels.
		Nose cover properly installed with thick spacer and tightened to specifications.
		Torque Sliding Bolt assemblies to specifications. Do NOT over tighten.
		Energy Absorbing Cartridges (EAC) installed in proper A-B position and sequence. See Configuration Chart.
		EAC air discharge holes positioned properly. Rotate cast ID to the top of the cartridge.
		Asphalt adapter installed on both sides of portable concrete barrier when applicable.
		Torque all fasteners to meet specifications.

APPENDIX A - System Configuration Chart





ADDITIONAL HIGHER SPEED SYSTEMS



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email: rkeener@barriersystemsinc.com

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www.barriersystemsinc.com

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APPENDIX B - System Torque Chart

CONCRETE INSTALLATION

Compact Backstop Anchors.....	120 ft-lbs (160 N-m)
PCB Backstop Anchors.....	120 ft-lbs (160 N-m)
Cable Anchor (Rear).....	120 ft-lbs (160 N-m)
Cable Anchor (Front).....	120 ft-lbs (160 N-m)
Cable Adj. Eye Bolt.....	500 ft-lbs (675 N-m)

ASPHALT INSTALLATION

Compact Backstop Anchors.....	5 ft-lbs (8 N-m)
PCB Backstop Anchors.....	5 ft-lbs (8 N-m)
PCB Asphalt Adapter	5 ft-lbs (8 N-m)
Cable Anchor (Front).....	5 ft-lbs (8 N-m)
Cable Adj. Eye Bolt.....	120 ft-lbs (160 N-m)

SYSTEM COMPONENT INSTALLATION

Sliding Bolt Assembly.....	20 ft-lbs (27 N-m)
Front Panel Holding Nose Cover.....	200 ft-lbs (270 N-m)
Pipe Panel Mount to Backstop.....	70 ft-lbs (95 N-m)
Cable Guide Bolts	30 ft-lbs (48 N-m)

The Universal TAU-II Crash Cushion has been successfully tested in various configurations having the cable torque ranging from 120 ft-lbs for asphalt installation, to 500 ft-lbs of torque for concrete applications. The system will function properly under this full range of torque. If a torque wrench is not available, refer to the table below for an alternate method of reaching the desired torque range.

Ways of creating approximately 500 ft-lbs of torque:

- 6 ft. [1. 8 m] wrench extension with entire weight of 100 lbs [45 kg] applied 12” from the end
- 42 in. [1.1 m] wrench extension with entire weight of 200 lbs [90 kg] applied 12” from the end
- Use free weights or human weight

These methods should ensure torque within tested range and manufacturer tolerances.

APPENDIX C

Anchoring Foundation Options

There are three approved anchoring foundation configurations for the TAU-II system. The first method utilizes a solid concrete pad over the length of the system. The second utilizes concrete blocks at the Backstop and Front Cable Anchor locations. The third is on Asphaltic Concrete foundation.

(Variations of these foundations may be reviewed and determinations made as to equivalence by the Project Engineer.)

There are different foundation configurations depending on which backstop you are using (Compact or P.C.B.). Foundation options for both of the Backstop systems are shown in the following drawings.

DRAWINGS

FOUNDATION SPECIFICATIONS:

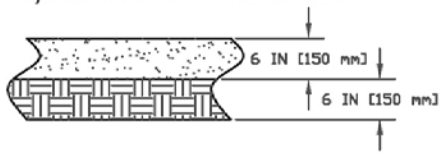
THE TAU-II CRASH CUSHION SYSTEM HAS BEEN DESIGNED TO ATTACH TO CONCRETE OR ASPHALT FOUNDATIONS. USE THE ANCHORAGE SPECIFIED BELOW DEPENDING ON THE FOUNDATION AT THE JOB SITE. REFERENCE UNIVERSAL TAU-II FOUNDATION DRAWINGS FOR FURTHER DETAIL.

1.) CONCRETE PAD

FOUNDATION: MINIMUM 6 IN. [150 mm] REINFORCED PCC PAD OR 8 IN. [200 mm] NONREINFORCED PCC PAD

ANCHORAGE: 3/4 IN. [20 mm] X 8 1/4 IN. [210 mm] GALVANIZED ANCHOR WITH 6 IN. [150 mm] EMBEDMENT

2.) ASPHALT OVER SUBBASE



FOUNDATION: MINIMUM 6 IN [150 mm] AC OVER 6 IN. [150 mm] COMPACTED DGA SUBBASE

ANCHORAGE: 3/4 IN. [20 mm] X 18 IN. [460 mm] GALVANIZED ANCHORS WITH 16 IN. [410 mm] EMBEDMENT

ASPHALT ANCHORING KIT REQUIRED

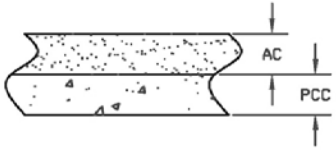
3.) ASPHALT ONLY

FOUNDATION: MINIMUM 8 IN. [200 mm] AC

ANCHORAGE: 3/4 IN. [20 mm] X 18 IN. [460 mm] GALVANIZED ANCHORS WITH 16 IN. [410 mm] EMBEDMENT

ASPHALT ANCHORING KIT REQUIRED

4.) ASPHALT OVER P.C. CONCRETE

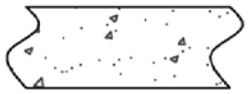


FOUNDATION: AC OVER PCC.

ANCHORAGE: 3/4 IN. [20 mm] GALVANIZED ANCHORS WITH MINIMUM 6 IN. [150 mm] EMBEDMENT IN PCC - ASPHALT ANCHORING KIT NOT REQUIRED
OR
IF 6 IN. [150 mm] EMBEDMENT IN PCC IS NOT POSSIBLE USE
3/4 IN. [20 mm] X 18 IN. [460 mm] GALVANIZED ANCHORS WITH 16 IN. [410 mm] EMBEDMENT - ASPHALT ANCHORING KIT REQUIRED

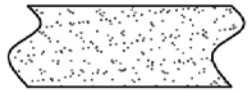
MATERIAL SPECIFICATIONS

PORTLAND CEMENT CONCRETE (PCC)



STONE AGGREGATE CONCRETE MIX, 4,000 PSI [28 MPa] MINIMUM COMPRESSIVE STRENGTH (SAMPLING PER ASTM C31-84 OR ASTM C42-84A, TESTING PER ASTM C39-84)

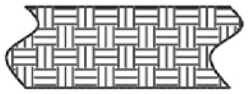
ASPHALTIC CONCRETE (AC)



AR-4000 A.C. (PER ASTM D3381 '83) .75" MAXIMUM, MEDIUM (TYPE A OR B) AGGREGATE

SIEVE SIZE	% PASSING
1"	100
3/4"	95-100
3/8"	65-80
No. 4	49-54
No. 8	36-40
No. 30	18-21
No. 200	3-8

COMPACTED SUBBASE (DGA)



6 IN. [150 mm] MINIMUM DEPTH, 95% COMPACTION, CLASS 2 AGGREGATE

SIEVE SIZE	% PASSING
3"	100
2 1/2"	90-100
No. 4	40-90
No. 200	0-25

REV.	CHANGES	DATE	BY
A	SEE ECN 00589	03/02/04	GAD

REQ'D	NEXT ASSY.	ITEM

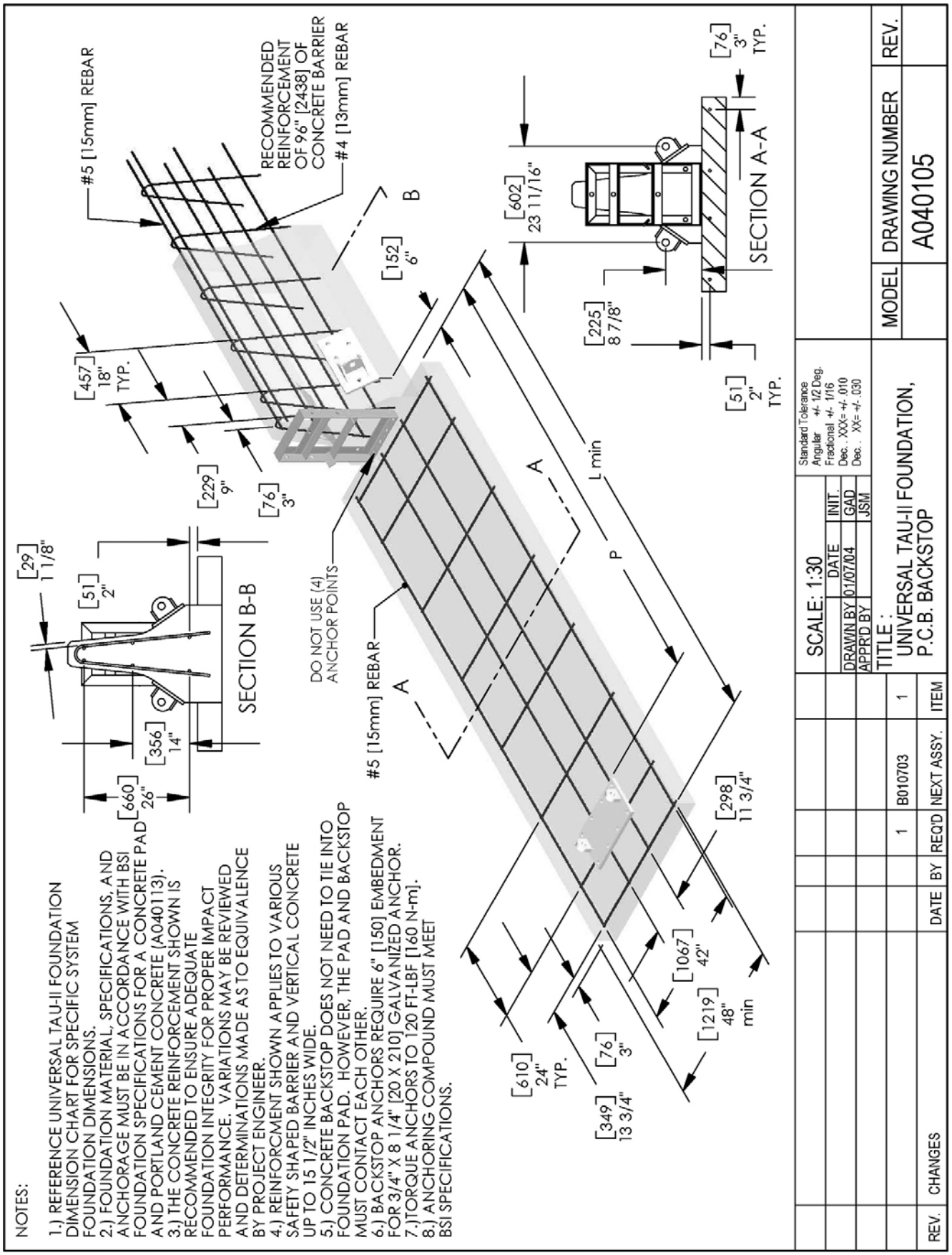
SCALE: FULL

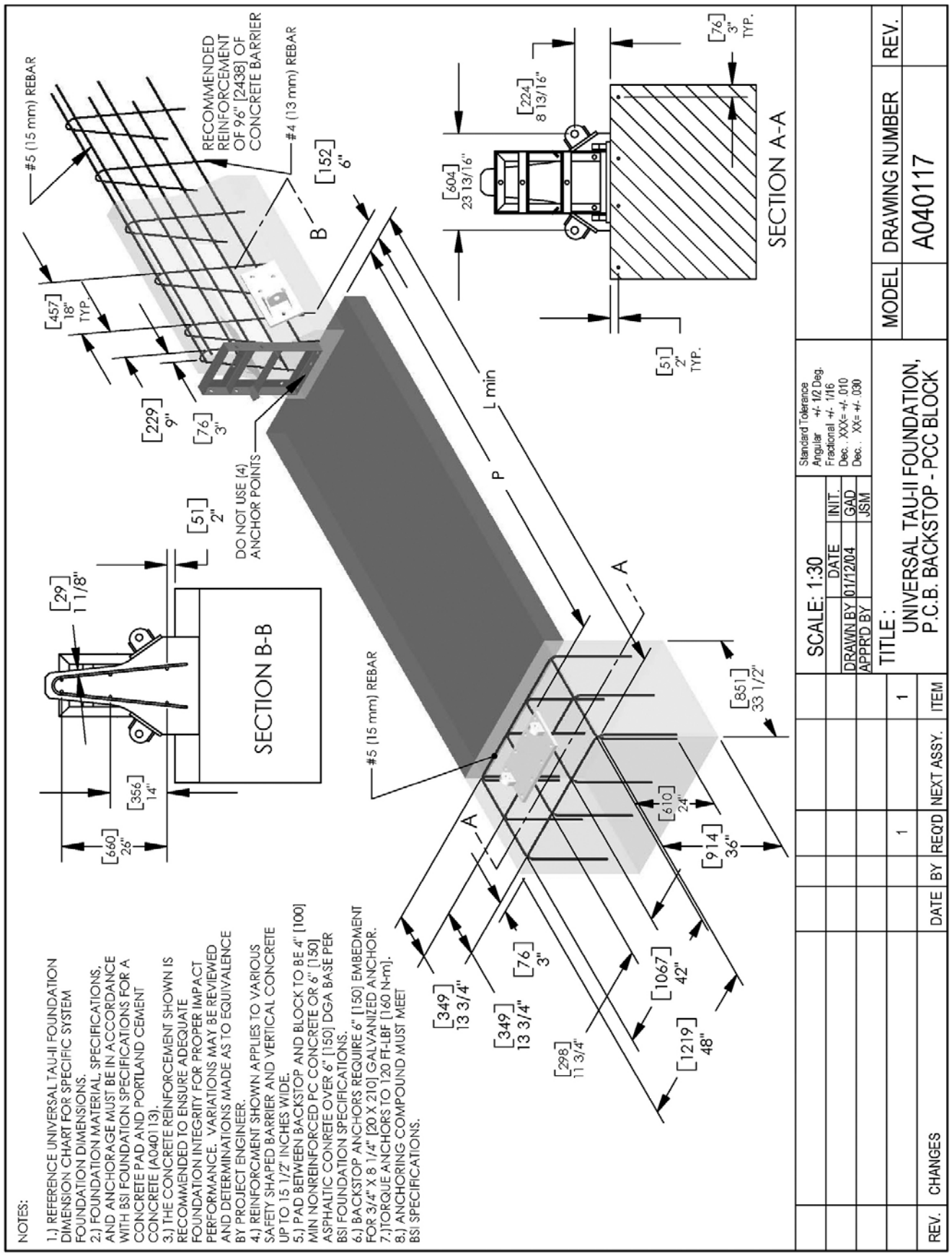
	DATE	INIT.
DRAWN BY	01/09/04	GAD
APPR'D BY		JSM

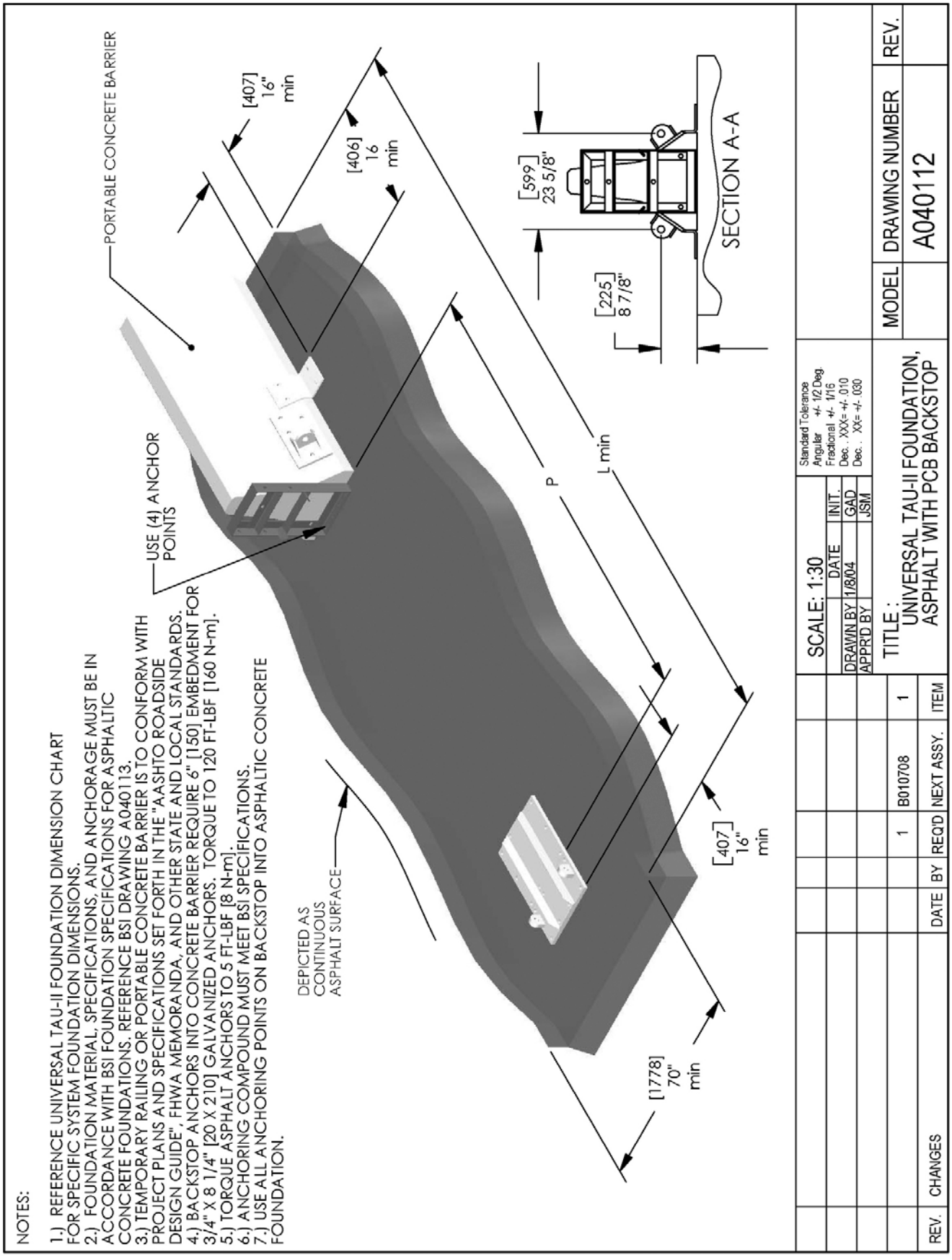
Standard Tolerance
Angular ± 1/2"
Fractional ± 1/16
Dec .XXX= ± .010
Dec .XX= ± .030

TITLE :
FOUNDATION SPECIFICATIONS

MODEL	DRAWING NUMBER	REV.
	A040113	A

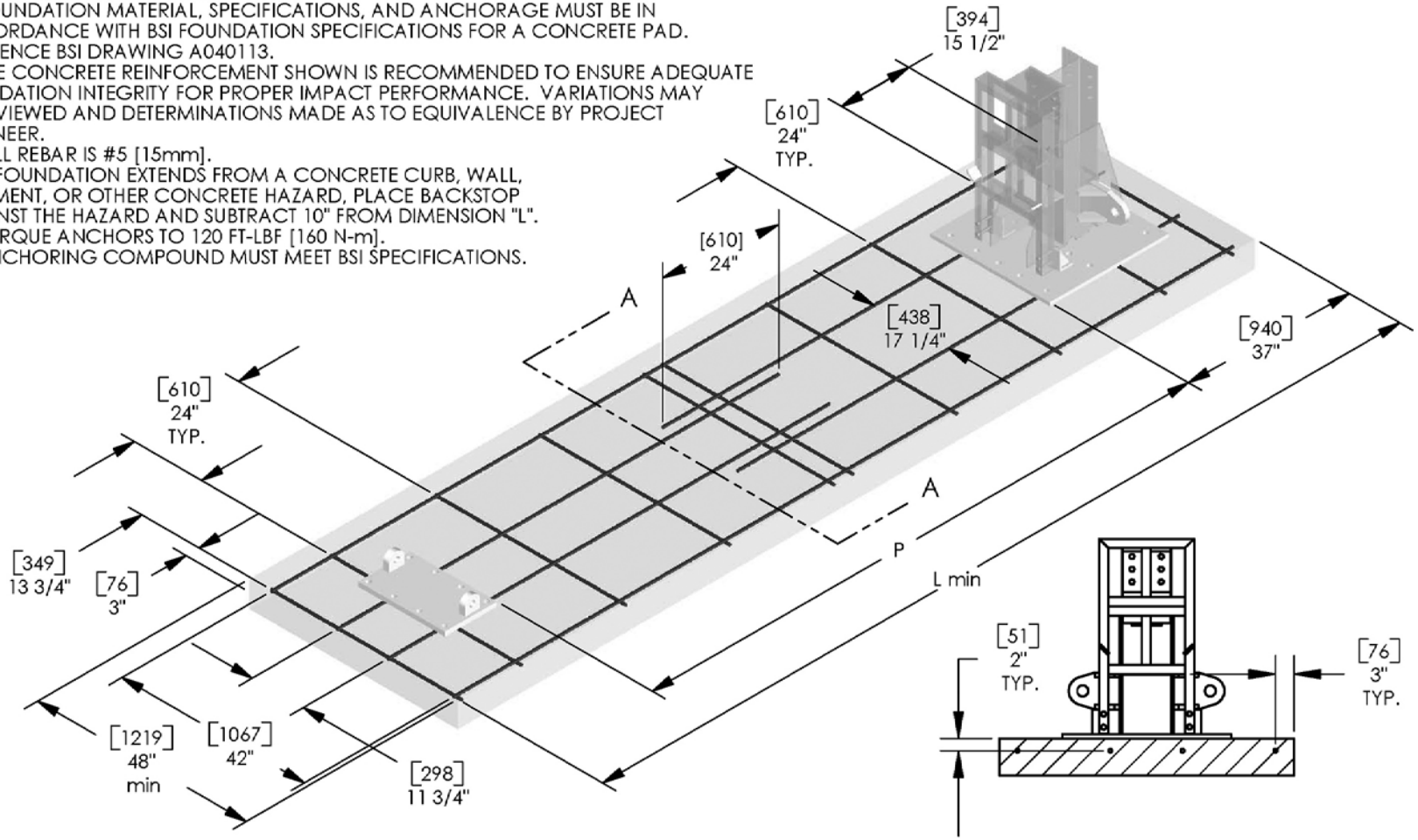

NOTES:
1.) REFERENCE UNIVERSAL TAU-II FOUNDATION DIMENSION CHART FOR SPECIFIC SYSTEM FOUNDATION DIMENSIONS.
2.) FOUNDATION MATERIAL, SPECIFICATIONS, AND ANCHORAGE MUST BE IN ACCORDANCE WITH BSI FOUNDATION SPECIFICATIONS FOR A CONCRETE PAD AND PORTLAND CEMENT CONCRETE (A040113).
3.) THE CONCRETE REINFORCEMENT SHOWN IS RECOMMENDED TO ENSURE ADEQUATE FOUNDATION INTEGRITY FOR PROPER IMPACT PERFORMANCE. VARIATIONS MAY BE REVIEWED AND DETERMINATIONS MADE AS TO EQUIVALENCE BY PROJECT ENGINEER.
4.) REINFORCMENT SHOWN APPLIES TO VARIOUS SAFETY SHAPED BARRIER AND VERTICAL CONCRETE UP TO 15 1/2" INCHES WIDE.
5.) CONCRETE BACKSTOP DOES NOT NEED TO TIE INTO FOUNDATION PAD. HOWEVER, THE PAD AND BACKSTOP MUST CONTACT EACH OTHER.
6.) BACKSTOP ANCHORS REQUIRE 6" [150] EMBEDMENT FOR 3/4" X 8 1/4" [20 X 210] GALVANIZED ANCHOR.
7.)TORQUE ANCHORS TO 120 FT-LBF [160 N-m].
8.) ANCHORING COMPOUND MUST MEET BSI SPECIFICATIONS.
SECTION B-B
SECTION A-A
#5 [15mm] REBAR
#4 [13mm] REBAR
RECOMMENDED REINFORCEMENT OF 96" [2438] OF CONCRETE BARRIER
DO NOT USE (4) ANCHOR POINTS
L min
P
A
B
[29] 1 1/8"
[51] 2"
[660] 26"
[356] 14"
[229] 9"
[76] 3"
[457] 18" TYP.
[152] 6"
[602] 23 11/16"
[225] 8 7/8"
[51] 2" TYP.
[76] 3" TYP.
[610] 24" TYP.
[349] 13 3/4"
[76] 3"
[1067] 42"
[1219] 48" min
[298] 11 3/4"
SCALE: 1:30
DRAWN BY 01/07/04 GAD
APPR'D BY JSM
Standard Tolerance
Angular +/- 1/2 Deg.
Fractional +/- 1/16"
Dec. . XXX= +/- .010
Dec. . XX= +/- .030
TITLE :
UNIVERSAL TAU-II FOUNDATION, P.C.B. BACKSTOP
MODEL
DRAWING NUMBER
A040105
REV.
CHANGES
DATE BY REQ'D NEXT ASSY. ITEM
1 B010703 1


NOTES:
1.) REFERENCE UNIVERSAL TAU-II FOUNDATION DIMENSION CHART FOR SPECIFIC SYSTEM FOUNDATION DIMENSIONS.
2.) FOUNDATION MATERIAL, SPECIFICATIONS, AND ANCHORAGE MUST BE IN ACCORDANCE WITH BSI FOUNDATION SPECIFICATIONS FOR A CONCRETE PAD AND PORTLAND CEMENT CONCRETE (A040113).
3.) THE CONCRETE REINFORCEMENT SHOWN IS RECOMMENDED TO ENSURE ADEQUATE FOUNDATION INTEGRITY FOR PROPER IMPACT PERFORMANCE. VARIATIONS MAY BE REVIEWED AND DETERMINATIONS MADE AS TO EQUIVALENCE BY PROJECT ENGINEER.
4.) REINFORCEMENT SHOWN APPLIES TO VARIOUS SAFETY SHAPED BARRIER AND VERTICAL CONCRETE UP TO 15 1/2" INCHES WIDE.
5.) PAD BETWEEN BACKSTOP AND BLOCK TO BE 4" [100] MIN NONREINFORCED PC CONCRETE OR 6" [150] ASPHALTIC CONCRETE OVER 6" [150] DGA BASE PER BSI FOUNDATION SPECIFICATIONS.
6.) BACKSTOP ANCHORS REQUIRE 6" [150] EMBEDMENT FOR 3/4" X 8 1/4" [20 X 210] GALVANIZED ANCHOR.
7.) TORQUE ANCHORS TO 120 FT-LBF [160 N-m].
8.) ANCHORING COMPOUND MUST MEET BSI SPECIFICATIONS.
#5 (15 mm) REBAR
#4 (13 mm) REBAR
RECOMMENDED REINFORCEMENT OF 96" [2438] OF CONCRETE BARRIER
DO NOT USE (4) ANCHOR POINTS
SECTION B-B
SECTION A-A
L min
P
A
B
[457] 18" TYP
[229] 9"
[76] 3"
[152] 6"
[51] 2"
[29] 1 1/8"
[356] 14"
[660] 26"
[604] 23 13/16"
[224] 8 13/16"
[76] 3" TYP.
[51] 2" TYP.
[610] 24"
[914] 36"
[851] 33 1/2"
[349] 13 3/4"
[298] 11 3/4"
[1067] 42"
[1219] 48"
SCALE: 1:30
DRAWN BY 01/12/04 GAD
APPR'D BY JSM
DATE INIT.
Standard Tolerance
Angular +/- 1/2 Deg.
Fractional +/- 1/16
Dec. .XXX= +/- .010
Dec. .XX= +/- .030
TITLE :
UNIVERSAL TAU-II FOUNDATION, P.C.B. BACKSTOP - PCC BLOCK
MODEL
DRAWING NUMBER
A040117
REV.
REV. CHANGES DATE BY
1 REQ'D
NEXT ASSY.
ITEM
1


NOTES:
1.) REFERENCE UNIVERSAL TAU-II FOUNDATION DIMENSION CHART FOR SPECIFIC SYSTEM FOUNDATION DIMENSIONS.
2.) FOUNDATION MATERIAL, SPECIFICATIONS, AND ANCHORAGE MUST BE IN ACCORDANCE WITH BSI FOUNDATION SPECIFICATIONS FOR ASPHALTIC CONCRETE FOUNDATIONS. REFERENCE BSI DRAWING A040113.
3.) TEMPORARY RAILING OR PORTABLE CONCRETE BARRIER IS TO CONFORM WITH PROJECT PLANS AND SPECIFICATIONS SET FORTH IN THE "AASHTO ROADSIDE DESIGN GUIDE", FHWA MEMORANDA, AND OTHER STATE AND LOCAL STANDARDS.
4.) BACKSTOP ANCHORS INTO CONCRETE BARRIER REQUIRE 6" [150] EMBEDMENT FOR 3/4" X 8 1/4" [20 X 210] GALVANIZED ANCHORS. TORQUE TO 120 FT-LBF [160 N-m].
5.) TORQUE ASPHALT ANCHORS TO 5 FT-LBF [8 N-m].
6.) ANCHORING COMPOUND MUST MEET BSI SPECIFICATIONS.
7.) USE ALL ANCHORING POINTS ON BACKSTOP INTO ASPHALTIC CONCRETE FOUNDATION.
PORTABLE CONCRETE BARRIER
USE (4) ANCHOR POINTS
DEPICTED AS CONTINUOUS ASPHALT SURFACE
[407] 16" min
[406] 16 min
[1778] 70" min
[407] 16" min
P
L min
[599] 23 5/8"
[225] 8 7/8"
SECTION A-A
REV. CHANGES DATE BY
1 B010708 1
REQ'D NEXT ASSY. ITEM
SCALE: 1:30
DATE INIT.
DRAWN BY 1/8/04 GAD
APPRD BY JSM
Standard Tolerance
Angular +/- 1/2 Deg
Fractional +/- 1/16
Dec. XXX= +/- .010
Dec. . XX= +/- .030
TITLE :
UNIVERSAL TAU-II FOUNDATION, ASPHALT WITH PCB BACKSTOP
MODEL DRAWING NUMBER REV.
A040112

NOTES:

1.) REFERENCE UNIVERSAL TAU-II FOUNDATION DIMENSION CHART FOR SPECIFIC SYSTEM FOUNDATION DIMENSIONS.
2.) FOUNDATION MATERIAL, SPECIFICATIONS, AND ANCHORAGE MUST BE IN ACCORDANCE WITH BSI FOUNDATION SPECIFICATIONS FOR A CONCRETE PAD. REFERENCE BSI DRAWING A040113.
3.) THE CONCRETE REINFORCEMENT SHOWN IS RECOMMENDED TO ENSURE ADEQUATE FOUNDATION INTEGRITY FOR PROPER IMPACT PERFORMANCE. VARIATIONS MAY BE REVIEWED AND DETERMINATIONS MADE AS TO EQUIVALENCE BY PROJECT ENGINEER.
4.) ALL REBAR IS #5 [15mm].
5.) IF FOUNDATION EXTENDS FROM A CONCRETE CURB, WALL, ABUTMENT, OR OTHER CONCRETE HAZARD, PLACE BACKSTOP AGAINST THE HAZARD AND SUBTRACT 10" FROM DIMENSION "L".
6.) TORQUE ANCHORS TO 120 FT-LBF [160 N-m].
7.) ANCHORING COMPOUND MUST MEET BSI SPECIFICATIONS.



REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM
				1	B010708	1

SCALE: 1:24

	DATE	INIT.
DRAWN BY	01/08/04	GAD
APPR'D BY		JSM

Standard Tolerance
Angular +/- 1/2 Deg.
Fractional +/- 1/16
Dec. . XXX= +/- .010
Dec. . XX= +/- .030

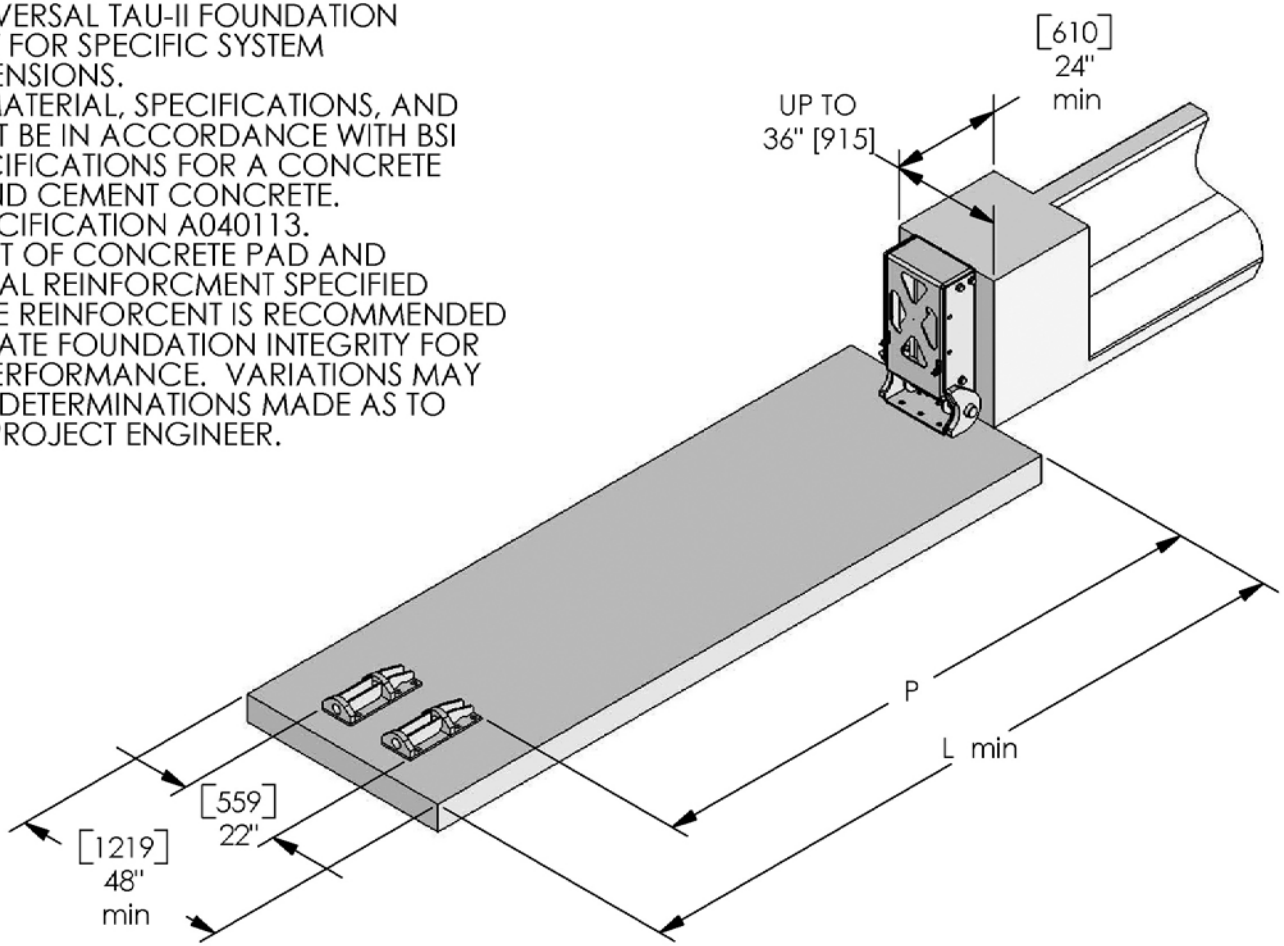
TITLE :
UNIVERSAL TAU-II FOUNDATION, COMPACT BACKSTOP

SECTION A-A

MODEL	DRAWING NUMBER	REV.
	A040102	

NOTES:

1.) REFERENCE UNIVERSAL TAU-II FOUNDATION DIMENSION CHART FOR SPECIFIC SYSTEM FOUNDATION DIMENSIONS.
2.) FOUNDATION MATERIAL, SPECIFICATIONS, AND ANCHORAGE MUST BE IN ACCORDANCE WITH BSI FOUNDATION SPECIFICATIONS FOR A CONCRETE PAD AND PORTLAND CEMENT CONCRETE. REFERENCE BSI SPECIFICATION A040113.
3.) REINFORCEMENT OF CONCRETE PAD AND BACKSTOP TO EQUAL REINFORCMENT SPECIFIED IN BSI A040105. THE REINFORCENT IS RECOMMENDED TO ENSURE ADEQUATE FOUNDATION INTEGRITY FOR PROPER IMPACT PERFORMANCE. VARIATIONS MAY BE REVIEWED AND DETERMINATIONS MADE AS TO EQUIVALENCE BY PROJECT ENGINEER.



REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM
				1	B040239	1

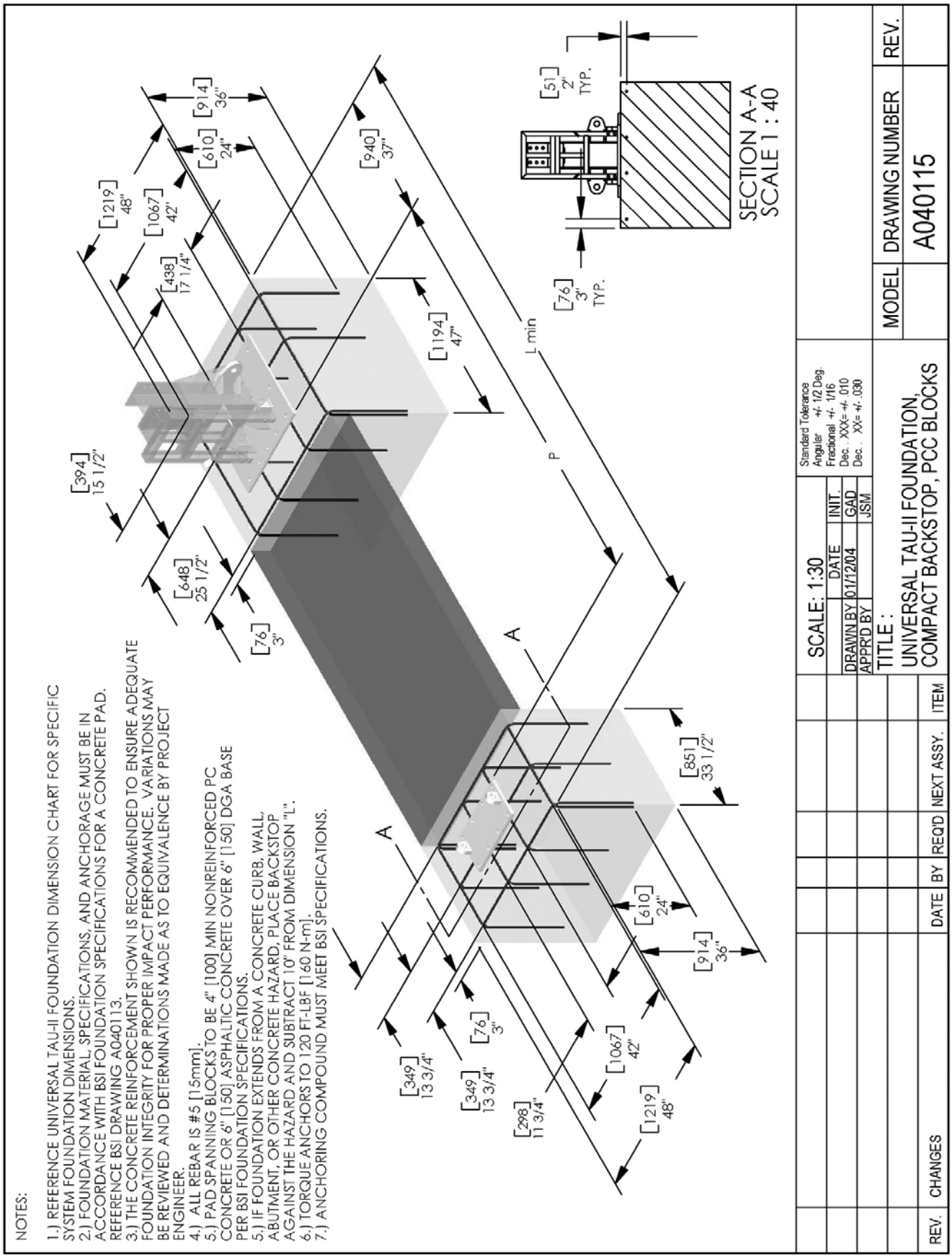
SCALE: 1:30

	DATE	INIT.
DRAWN BY	04/28/04	GAD
APPR'D BY		OSD

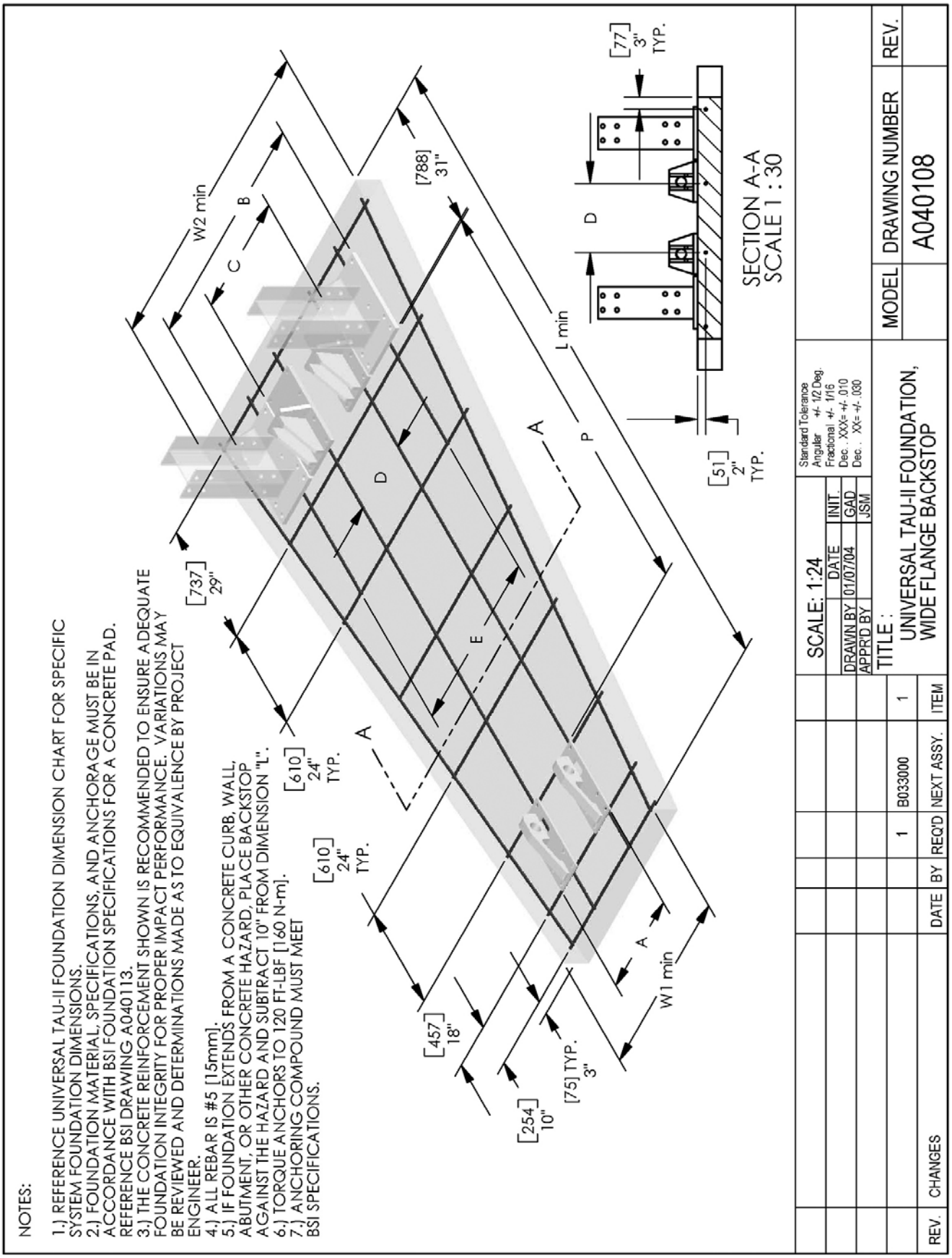
Standard Tolerance
Angular +/- 1/2 Deg.
Fractional +/- 1/16
Dec. . XXX= +/- .010
Dec. . XX= +/- .030

TITLE: UNIVERSAL TAU-II FOUNDATION, FLUSH MOUNT BACKSTOP - PCC PAD

MODEL	DRAWING NUMBER	REV.
	A040420	


NOTES:
1.) REFERENCE UNIVERSAL TAU-II FOUNDATION DIMENSION CHART FOR SPECIFIC SYSTEM FOUNDATION DIMENSIONS.
2.) FOUNDATION MATERIAL, SPECIFICATIONS, AND ANCHORAGE MUST BE IN ACCORDANCE WITH BSI FOUNDATION SPECIFICATIONS FOR A CONCRETE PAD. REFERENCE BSI DRAWING A040113.
3.) THE CONCRETE REINFORCEMENT SHOWN IS RECOMMENDED TO ENSURE ADEQUATE FOUNDATION INTEGRITY FOR PROPER IMPACT PERFORMANCE. VARIATIONS MAY BE REVIEWED AND DETERMINATIONS MADE AS TO EQUIVALENCE BY PROJECT ENGINEER.
4.) ALL REBAR IS #5 [15mm].
5.) PAD SPANNING BLOCKS TO BE 4" [100] MIN NONREINFORCED PC CONCRETE OR 6" [150] ASPHALTIC CONCRETE OVER 6" [150] DGA BASE PER BSI FOUNDATION SPECIFICATIONS.
5.) IF FOUNDATION EXTENDS FROM A CONCRETE CURB, WALL, ABUTMENT, OR OTHER CONCRETE HAZARD, PLACE BACKSTOP AGAINST THE HAZARD AND SUBTRACT 10" FROM DIMENSION "L".
6.) TORQUE ANCHORS TO 120 FT-LBF [160 N-m].
7.) ANCHORING COMPOUND MUST MEET BSI SPECIFICATIONS.
[394] 15 1/2"
[648] 25 1/2"
[76] 3"
[1219] 48"
[1067] 42"
[438] 17 1/4"
[610] 24"
[914] 36"
[940] 37"
[1194] 47"
L min
P
A
A
[349] 13 3/4"
[349] 13 3/4"
[76] 3"
[298] 11 3/4"
[1067] 42"
[1219] 48"
[610] 24"
[914] 36"
[851] 33 1/2"
[51] 2" TYP.
[76] 3" TYP.
SECTION A-A
SCALE 1 : 40
SCALE: 1:30
DATE
DRAWN BY 01/12/04
APPR'D BY
INIT.
GAD
JSM
Standard Tolerance
Angular +/- 1/2 Deg.
Fractional +/- 1/16
Dec. XXX= +/- .010
Dec. XX= +/- .030
TITLE :
UNIVERSAL TAU-II FOUNDATION,
COMPACT BACKSTOP, PCC BLOCKS
MODEL
DRAWING NUMBER
A040115
REV.
REV.
CHANGES
DATE
BY
REQ'D
NEXT ASSY.
ITEM

NOTES:
1.) REFERENCE UNIVERSAL TAU-II FOUNDATION DIMENSION CHART FOR SPECIFIC SYSTEM FOUNDATION DIMENSIONS.
2.) FOUNDATION MATERIAL, SPECIFICATIONS, AND ANCHORAGE MUST BE IN ACCORDANCE WITH BSI FOUNDATION SPECIFICATIONS FOR ASPHALTIC CONCRETE FOUNDATIONS. REFERENCE BSI DRAWING A040113.
3.) TORQUE ANCHORS TO 5 FT-LBF [8 N-m].
4.) ANCHORING COMPOUND MUST MEET BSI SPECIFICATIONS.
[407] 16" min
[1432] 56 3/8"
[407] 16" min
P
L min
DEPICTED AS CONTINUOUS ASPHALT SURFACE
[407] 16" min
[1511] 59 1/2" min
SCALE: 1:30
DATE
INIT.
DRAWN BY 01/08/04 GAD
APPR'D BY JSM
Standard Tolerance
Angular +/- 1/2 Deg.
Fractional +/- 1/16
Dec. .XXX= +/- .010
Dec. .XX= +/- .030
TITLE :
UNIVERSAL TAU-II FOUNDATION, ASPHALT WITH COMPACT BACKSTOP
MODEL
DRAWING NUMBER
A040110
REV.
1 B010708 1
REV. CHANGES DATE BY REQ'D NEXT ASSY. ITEM


NOTES:
1.) REFERENCE UNIVERSAL TAU-II FOUNDATION DIMENSION CHART FOR SPECIFIC SYSTEM FOUNDATION DIMENSIONS.
2.) FOUNDATION MATERIAL, SPECIFICATIONS, AND ANCHORAGE MUST BE IN ACCORDANCE WITH BSI FOUNDATION SPECIFICATIONS FOR A CONCRETE PAD. REFERENCE BSI DRAWING A040113.
3.) THE CONCRETE REINFORCEMENT SHOWN IS RECOMMENDED TO ENSURE ADEQUATE FOUNDATION INTEGRITY FOR PROPER IMPACT PERFORMANCE. VARIATIONS MAY BE REVIEWED AND DETERMINATIONS MADE AS TO EQUIVALENCE BY PROJECT ENGINEER.
4.) ALL REBAR IS #5 [15mm].
5.) IF FOUNDATION EXTENDS FROM A CONCRETE CURB, WALL, ABUTMENT, OR OTHER CONCRETE HAZARD, PLACE BACKSTOP AGAINST THE HAZARD AND SUBTRACT 10" FROM DIMENSION "L".
6.) TORQUE ANCHORS TO 120 FT-LBF [160 N-m].
7.) ANCHORING COMPOUND MUST MEET BSI SPECIFICATIONS.
W2 min
B
C
[737] 29"
[788] 31"
[610] 24" TYP.
[610] 24" TYP.
A
D
E
A
L min
P
A
W1 min
[457] 18"
[254] 10"
[75] TYP. 3"
[77] 3" TYP.
D
[51] 2" TYP.
SECTION A-A
SCALE 1 : 30
SCALE: 1:24
DRAWN BY 01/07/04 INIT.
APPR'D BY GAD
JSM
Standard Tolerance
Angular +/- 1/2 Deg.
Fractional +/- 1/16
Dec. . XXX= +/- .010
Dec. . XX= +/- .030
TITLE :
UNIVERSAL TAU-II FOUNDATION, WIDE FLANGE BACKSTOP
MODEL
DRAWING NUMBER
A040108
REV.
1 B033000 1
REV. CHANGES DATE BY REQ'D NEXT ASSY. ITEM

UNIVERSAL TAU-II FOUNDATION DIMENSIONS

US STANDARD UNITS - INCHES

SYSTEM WIDTH (IN)	SYSTEM SPEED CAPACITY (MPH) 30	35	40 TL-2	50	53	55	60 TL-3	65	70	72	75	DRAWING NUMBER
UP TO 30" PCB BACKSTOP	30T050PBC	30T060PBC	30T070PBC	30T080PBC	30T085PBC	30T090PBC	30T100PBC	30T105PBC	30T110PBC	30T115PBC	30T120PBC	A040105 A040117
	30T050PYC	30T060PYC	30T070PYC	30T080PYC	30T085PYC	30T090PYC	30T100PYC	30T105PYC	30T110PYC	30T115PYC	30T120PYC	
L (in)	85 1/2	119 1/2	154	188	222	256	290 1/2	324 1/2	358 1/2	392 1/2	426 1/2	
P (in)	62 3/4	96 7/8	131	165 1/8	199 1/4	233 3/8	267 1/2	301 1/2	335 3/4	369 7/8	404	
UP TO 30" COMPACT BACKSTOP	30T050CBC	30T060CBC	30T070CBC	30T080CBC	30T085CBC	30T090CBC	30T100CBC	30T105CBC	30T110CBC	30T115CBC	30T120CBC	A040102 A040115
	30T050CYC	30T060CYC	30T070CYC	30T080CYC	30T085CYC	30T090CYC	30T100CYC	30T105CYC	30T110CYC	30T115CYC	30T120PYC	
L (in)	115 1/2	149 1/2	183 1/2	217 1/2	252	286	320	354	388 1/2	422 1/2	456 1/2	
P (in)	55 1/2	89 5/8	123 3/4	157 7/8	192	226 1/8	260 1/4	294 1/4	328 1/2	362 5/8	396 3/4	
UP TO 30" ASPHALT PCB BACKSTOP	30T050PBA	30T060PBA	30T070PBA	30T080PBA	30T085PBA	30T090PBA	30T100PBA	30T105PBA	30T110PBA	30T115PBA	30T120PBA	A040112
	30T050PYA	30T060PYA	30T070PYA	30T080PYA	30T085PYA	30T090PYA	30T100PYA	30T105PYA	30T110PYA	30T115PYA	30T120PYA	
L (in)	139 3/4	173 3/4	208 1/4	242 1/4	276 1/4	310 1/4	344 3/4	378 3/4	412 3/4	446 3/4	480 3/4	
P (in)	62 3/4	96 7/8	131	165 1/8	199 1/4	233 3/8	267 1/2	301 1/2	335 3/4	369 7/8	404	
UP TO 30" ASPHALT COMPACT BACKSTOP	30T050CBA	30T060CBA	30T070CBA	30T080CBA	30T085CBA	30T090CBA	30T100CBA	30T105CBC	30T110CBA	30T115CBA	30T120CBA	A040110
	30T050CYA	30T060CYA	30T070CYA	30T080CYA	30T085CYA	30T090CYA	30T100CYA	30T105CYA	30T110CYA	30T115CYA	30T120CYA	
L (in)	156 1/2	190 1/2	224 1/2	258 1/2	293	327	361	394	429 1/2	463 1/2	497 1/2	
P (in)	55 1/2	89 5/8	123 3/4	157 7/8	192	226 1/8	260 1/4	294 1/4	328 1/2	362 5/8	396 3/4	
36" PCB BACKSTOP	36T050PBC	36T060PBC	36T070PBC	36T080PBC	30T085PBC	36T090PBC	36T100PBC	36T105PBC	36T110PBC	36T115PBC	36T120PBC	A040105 A040117
	36T050PYC	36T060PYC	36T070PYC	36T080PYC	30T085PYC	36T090PYC	36T100PYC	36T105PYC	36T110PYC	36T115PYC	36T120PYC	
L (in)	85 1/2	119 1/2	154	188	222	256	290 1/2	324 1/5	358 1/2	392 1/2	426 1/2	
P (in)	62 3/4	96 7/8	131	165 1/8	199 1/4	233 3/8	267 1/2	301 1/5	335 3/4	369 7/8	404	
36" COMPACT BACKSTOP	36T050CBC	36T060CBC	36T070CBC	36T080CBC	36T085CBC	36T090CBC	36T100CBC	36T105CBC	36T110CBC	36T115CBC	36T120CBC	A040102 A040115
	36T050CYC	36T060CYC	36T070CYC	36T080CYC	36T085CYC	36T090CYC	36T100CYC	36T105CYC	36T110CYC	36T115CYC	36T120CYC	
L (in)	115 1/2	149 1/2	183 1/2	217 1/2	252	286	320	354	388 1/2	422 1/2	456 1/2	
P (in)	55 1/2	89 5/8	123 3/4	157 7/8	192	226 1/8	260 1/4	294 1/4	328 1/2	362 5/8	396 3/4	
36" ASPHALT PCB BACKSTOP	36T050PBA	36T060PBA	36T070PBA	36T080PBA	36T085PBA	36T090PBA	36T100PBA	36T105PBA	36T110PBA	36T115PBA	36T120PBA	A040112
	36T050PYA	36T060PYA	36T070PYA	36T080PYA	36T085PYA	36T090PYA	36T100PYA	36T105PYA	36T110PYA	36T115PYA	36T120PYA	
L (in)	139 3/4	173 3/4	208 1/4	242 1/4	276 1/4	310 1/4	344 3/4	378 3/4	412 3/4	446 3/4	480 3/4	
P (in)	62 3/4	96 7/8	131	165 1/8	199 1/4	233 3/8	267 1/2	301 1/4	335 3/4	369 7/8	404	
36" ASPHALT COMPACT BACKSTOP	36T050CBA	36T060CBA	36T070CBA	36T080CBA	36T085CBA	36T090CBA	36T100CBA	36T105CBA	36T110CBA	36T115CBA	36T120CBA	A040110
	36T050CBA	36T060CYA	36T070CYA	36T080CYA	36T085CYA	36T090CYA	36T100CYA	36T105CYA	36T110CYA	36T115CYA	36T120CYA	
L (in)	156 1/2	190 1/2	224 1/2	258 1/2	293	327	361	394	429 1/2	463 1/2	497 1/2	
P (in)	55 1/2	89 5/8	123 3/4	157 7/8	192	226 1/8	260 1/4	294 1/4	328 1/2	362 5/8	396 3/4	
UP TO 36" PCC PAD FLUSH MOUNT BACKSTOP	36T050FBC	36T060FBC	36T070FBC	36T080FBC	36T085FBC	36T090FBC	36T100FBC	36T105FBC	36T110FBC	36T115FBC	36T120FBC	A040420
	36T050FYC	36T060FYC	36T070FYC	36T080FYC	36T085FYC	36T090FYC	36T100FYC	36T105CYC	36T110FYC	36T115FYC	36T120FYC	
L (in)	83 1/2	117 1/2	151 1/2	185 1/2	220	254	288	322	356 1/2	390 1/2	424 1/2	
P (in)	59 1/2	93 1/2	127 1/2	161 1/2	196	230	264	298	332 1/2	366 1/2	400 1/2	
42" WF BACKSTOP	42T050WBC	42T060WBC	42T070WBC	42T080WBC		42T090WBC	42T100WBC	42T105WBC	42T110WBC			A040108
	42T050WYC	42T060WYC	42T070WYC	42T080WYC		42T090WYC	42T100WYC	42T105WYC	42T110WYC			
L (in)	125	159	193	227		295	329	363	397			
W1 (in)	44	44	44	44		44	44	44	44			
W2 (in)	51	51	51	51		51	51	51	51			
P (in)	65	99	133	167		235	269	303	337			
A (in)	22	22	22	22		22	22	22	22			
B (in)	31	31	31	31		31	31	31	31			
C (in) *	NA	NA	NA	NA		NA	NA	NA	NA			
D (in)	16	16	16	16		16	16	16	16			
E (in) *	NA	NA	NA	NA		NA	NA	NA	NA			

SYSTEM WIDTH (IN)	SYSTEM SPEED CAPACITY (MPH)											DRAWING NUMBER
	30	35	40 TL-2	50	53	55	60 TL-3	65	70	72	75	
48" WF BACKSTOP	**48T050WBC**	**48T060WBC**	**48T070WBC**	**48T080WBC**		**48T090WBC**	**48T100WBC**	**48T105WBC**	**48T110WBC**			A040108
	48T050WYC	**48T060WYC**	**48T070WYC**	**48T080WYC**		**48T090WYC**	**48T100WYC**	**48T105WYC**	**48T110WYC**			
L (in)	125	159	193	227		295	329	363	397			
W1 (in)	44	44	44	44		44	44	44	44			
W2 (in)	51	51	51	51		51	51	51	51			
P (in)	65	99	133	167		235	269	303	337			
A (in)	22	22	22	22		22	22	22	22			
B (in)	31	31	31	31		31	31	31	31			
C (in) *	NA	NA	NA	NA		NA	NA	NA	NA			
D (in)	16	16	16	16		16	16	16	16			
E (in) *	NA	NA	NA	NA		NA	NA	NA	NA			
54" WF BACKSTOP	**54T050WBC**	**54T060WBC**	**54T070WBC**	**54T080WBC**		**54T090WBC**	**54T100WBC**	**54T105WBC**	**54T110WBC**			A040108
	54T050WYC	**54T060WYC**	**54T070WYC**	**54T080WYC**		**54T090WYC**	**54T100WYC**	**54T105WYC**	**54T110WYC**			
L (in)	125	159	193	227		295	329	363	397			
W1 (in)	44	44	44	44		44	44	44	44			
W2 (in)	51	51	51	51		51	51	51	51			
P (in)	65	99	133	167		235	269	303	337			
A (in)	22	22	22	22		22	22	22	22			
B (in)	31	31	31	31		31	31	31	31			
C (in) *	NA	NA	NA	NA		NA	NA	NA	NA			
D (in)	16	16	16	16		16	16	16	16			
E (in) *	NA	NA	NA	NA		NA	NA	NA	NA			
60" WF BACKSTOP	**60T050WBC**	**60T060WBC**	**60T070WBC**	**60T080WBC**		**60T090WBC**	**60T100WBC**	**60T105WBC**	**60T110WBC**			A040108
	60T050WYC	**60T060WYC**	**60T070WYC**	**60T080WYC**		**60T090WYC**	**60T100WYC**	**60T105WYC**	**60T110WYC**			
L (in)	125	159	193	227		295	329	363	397			
W1 (in)	44	44	44	44		44	44	44	44			
W2 (in)	51	51	51	51		51	51	51	51			
P (in)	65	99	133	167		235	269	303	337			
A (in)	22	22	22	22		22	22	22	22			
B (in)	31	31	31	31		31	31	31	31			
C (in) *	NA	NA	NA	NA		NA	NA	NA	NA			
D (in)	16	16	16	16		16	16	16	16			
E (in) *	NA	NA	NA	NA		NA	NA	NA	NA			
66" WF BACKSTOP		**66T060WBC**	**66T070WBC**	**66T080WBC**		**66T090WBC**	**66T100WBC**	**66T105WBC**	**66T110WBC**			A040108
		66T060WYC	**66T070WYC**	**66T080WYC**		**66T090WYC**	**66T100WYC**	**66T106WYC**	**66T110WYC**			
L (in)		125	159	193		261	295	329	363			
W1 (in)		69	44	44		44	44	44	44			
W2 (in)		75	75	75		75	75	75	75			
P (in)		65	99	133		201	235	269	303			
A (in)		48 5/8	22	22		22	22	22	22			
B (in)		54 3/4	54 3/4	54 3/4		54 3/4	54 3/4	54 3/4	54 3/4			
C (in) *		NA	27 3/4	27 3/4		27 3/4	27 3/4	27 3/4	27 3/4			
D (in)		42 5/8	16	16		16	16	16	16			
E (in) *		NA	NA	41 3/4		41 3/4	41 3/4	41 3/4	41 3/4			
72" WF BACKSTOP		**72T060WBC**	**72T070WBC**	**72T080WBC**		**72T090WBC**	**72T100WBC**	**72T105WBC**	**72T110WBC**			A040108
		72T060WYC	**72T070WYC**	**72T080WYC**		**72T090WYC**	**72T100WYC**	**72T105WYC**	**72T110WYC**			
L (in)		125	159	193		227	295	329	329			
W1 (in)		69	69	44		44	44	44	44			
W2 (in)		75	75	75		75	75	75	75			
P (in)		65	99	133		167	235	269	269			
A (in)		48 5/8	48 5/8	22		22	22	22	22			
B (in)		54 3/4	54 3/4	54 3/4		54 3/4	54 3/4	54 3/4	54 3/4			
C (in) *		NA	NA	27 3/4		27 3/4	27 3/4	27 3/4	27 3/4			
D (in)		42 5/8	42 5/8	16		16	16	16	16			
E (in) *		NA	NA	41 3/4		41 3/4	41 3/4	41 3/4	41 3/4			

SYSTEM WIDTH (IN)	SYSTEM SPEED CAPACITY (MPH)										DRAWING NUMBER
	30	35	40 TL-2	50	53	55	60 TL-3	65	70	72	75	
78" WF BACKSTOP		78T060WBC	78T070WBC	78T080WBC		78T090WBC	78T100WBC	78T105WBC	78T110WBC			A040108
		78T060WYC	78T070WYC	78T080WYC		78T090WYC	78T100WYC	78T105WYC	78T110WYC			
L (in)		125	159	193		227	295	329	329			
W1 (in)		69	69	69		44	44	44	44			
W2 (in)		75	75	75		75	75	75	75			
P (in)		65	99	133		167	235	269	269			
A (in)		48 5/8	48 5/8	48 5/8		22	22	22	22			
B (in)		54 3/4	54 3/4	54 3/4		54 3/4	54 3/4	54 3/4	54 3/4			
C (in) *		NA	NA	NA		27 3/4	27 3/4	27 3/4	27 3/4			
D (in)		42 5/8	42 5/8	42 5/8		16	16	16	16			
E (in) *		NA	NA	NA		41 3/4	41 3/4	41 3/4	41 3/4			
84" WF BACKSTOP			84T070WBC	84T080WBC		84T090WBC	84T100WBC	84T105WBC	84T110WBC			A040108
			84T070WYC	84T080WYC		84T090WYC	84T100WYC	84T105WYC	84T110WYC			
L (in)			159	193		227	295	329	329			
W1 (in)			69	69		69	44	44	44			
W2 (in)			75	75		75	75	75	75			
P (in)			99	133		167	235	269	269			
A (in)			48 5/8	48 5/8		48 5/8	22	22	22			
B (in)			54 3/4	54 3/4		54 3/4	54 3/4	54 3/4	54 3/4			
C (in) *			NA	NA		NA	27 3/4	27 3/4	27 3/4			
D (in)			42 5/8	42 5/8		42 5/8	16	16	16			
E (in) *			NA	NA		NA	41 3/4	41 3/4	41 3/4			
90" WF BACKSTOP			90T070WBC	90T080WBC		90T090WBC	90T100WBC	90T105WBC	90T110WBC			A040108
			90T070WYC	90T080WYC		90T090WYC	90T100WYC	90T105WYC	90T110WYC			
L (in)			159	193		227	295	329	329			
W1 (in)			69	69		69	44	44	44			
W2 (in)			99	99		99	99	99	99			
P (in)			99	133		167	235	269	269			
A (in)			48 5/8	48 5/8		48 5/8	22	22	22			
B (in)			78 5/8	78 5/8		78 5/8	78 5/8	78 5/8	78 5/8			
C (in) *			51 5/8	51 5/8		51 5/8	27 3/4	27 3/4	27 3/4			
D (in)			42 5/8	42 5/8		42 5/8	16	16	16			
E (in) *			65 5/8	65 5/8		65 5/8	65 5/8	65 5/8	65 5/8			
96" WF BACKSTOP			96T070WBC	96T080WBC		96T090WBC	96T100WBC	96T105WBC	96T110WBC			A040108
			96T070WYC	96T080WYC		96T090WYC	96T100WYC	96T105WYC	96T110WYC			
L (in)			159	193		227	295	329	329			
W1 (in)			93	69		69	69	69	44			
W2 (in)			99	99		99	99	99	99			
P (in)			99	133		167	235	269	269			
A (in)			72 5/8	48 5/8		48 5/8	48 5/8	22	22			
B (in)			78 5/8	78 5/8		78 5/8	78 5/8	78 5/8	78 5/8			
C (in) *			NA	51 5/8		51 1/3	51 5/8	27 3/4	27 3/4			
D (in)			66 5/8	42 5/8		42 5/8	42 5/8	16	16			
E (in) *			NA	65 5/8		65 5/8	65 5/8	65 5/8	65 5/8			
102" WF BACKSTOP									102T110WBC			A040108
									102T110WYC			
L (in)									329			
W1 (in)									69			
W2 (in)									99			
P (in)									269			
A (in)									48 5/8			
B (in)									78 5/8			
C (in) *									51 5/8			
D (in)									42 5/8			
E (in) *									65 5/8			

UNIVERSAL TAU-II FOUNDATION DIMENSIONS

METRIC UNITS - MILLIMETERS

SYSTEM WIDTH (mm)	SYSTEM SPEED CAPACITY (KPH) 50	60	70 TL-2	80	85	90	100 TL-3	105	110	115	120	DRAWING NUMBER
UP TO 760mm PCB BACKSTOP	30T050PBC	30T060PBC	30T070PBC	30T080PBC	30T085PBC	30T090PBC	30T100PBC	30T105PBC	30T110PBC	30T115PBC	30T120PBC	A040105 A040117
	30T050PYC	30T060PYC	30T070PYC	30T080PYC	30T085PYC	30T090PYC	30T100PYC	30T105PYC	30T110PYC	30T115PYC	30T120PYC	
L (mm)	2172	3035	3912	4775	5639	6502	7379	8242	9106	9970	10833	
P (mm)	1594	2461	3327	4194	5061	5928	6795	7661	8528	9395	10262	
UP TO 760mm COMPACT BACKSTOP	30T050CBC	30T060CBC	30T070CBC	30T080CBC	30T085CBC	30T090CBC	30T100CBC	30T105CBC	30T110CBC	30T115CBC	30T120CBC	A040102 A040115
	30T050CYC	30T060CYC	30T070CYC	30T080CYC	30T085CYC	30T090CYC	30T100CYC	30T105CYC	30T110CYC	30T115CYC	30T120CYC	
L (mm)	2934	3797	4661	5525	6401	7264	8128	8991	9868	10732	11595	
P (mm)	1410	2276	3143	4010	4877	5744	6610	7477	8344	9211	10077	
UP TO 760mm ASPHALT PCB BACKSTOP	30T050PBA	30T060PBA	30T070PBA	30T080PBA	30T085PBA	30T090PBA	30T100PBA	30T105PBA	30T110PBA	30T115PBA	30T120PBA	A040112
	30T050PYA	30T060PYA	30T070PYA	30T080PYA	30T085PYA	30T090PYA	30T100PYA	30T105PYA	30T110PYA	30T115PYA	30T120PYA	
L (mm)	3550	4413	5290	6153	7017	7880	8757	9620	10484	11347	12211	
P (mm)	1594	2461	3327	4194	5061	5928	6795	7661	8528	9395	10262	
UP TO 760mm ASPHALT COMPACT BACKSTOP	30T050CBA	30T060CBA	30T070CBA	30T080CBA	30T085CBA	30T090CBA	30T100CBA	30T105CBA	30T110CBA	30T115CBA	30T120CBA	A040110
	30T050CYA	30T060CYA	30T070CYA	30T080CYA	30T085CYA	30T090CYA	30T100CYA	30T105CYA	30T110CYA	30T115CYA	30T120CYA	
L (mm)	3975	4839	5702	6566	7442	8306	9169	10033	10909	11773	12637	
P (mm)	1410	2276	3143	4010	4877	5744	6610	7477	8344	9211	10077	
915mm PCB BACKSTOP	36T050PBC	36T060PBC	36T070PBC	36T080PBC	36T085PBC	36T090PBC	36T100PBC	36T105PBC	36T110PBC	36T115PBC	36T120PBC	A040105 A040117
	36T050PYC	33T060PYC	36T070PYC	36T080PYC	36T085PYC	36T090PYC	36T100PYC	36T105PYC	36T110PYC	36T115PYC	36T120PYC	
L (mm)	2172	3035	3912	4775	5639	6502	7379	8242	9106	9970	10833	
P (mm)	1594	2461	3327	4194	5061	5928	6795	7661	8528	9395	10262	
915mm COMPACT BACKSTOP	36T050CBC	36T060CBC	36T070CBC	36T080CBC	36T085CBC	36T090CBC	36T100CBC	36T105CBC	36T110CBC	36T115CBC	36T120CBC	A040102 A040115
	36T050CYC	36T060CYC	36T070CYC	36T080CYC	36T085CYC	36T090CYC	36T100CYC	36T105CYC	36T110CYC	36T115CYC	36T120CYC	
L (mm)	2934	3797	4661	5525	6401	7264	8128	8991	9868	10732	11595	
P (mm)	1410	2276	3143	4010	4877	5744	6610	7477	8344	9211	10077	
915mm ASPHALT PCB BACKSTOP	36T050PBA	36T060PBA	36T070PBA	36T080PBA	36T085PBA	36T090PBA	36T100PBA	36T105PBA	36T110PBA	36T115PBA	36T120PBA	A040112
	36T050PYA	36T060PYA	36T070PYA	36T080PYA	36T085PYA	36T090PYA	36T100PYA	36T105PYA	36T110PYA	36T115PYA	36T120PYA	
L (mm)	3550	4413	5290	6153	7017	7880	8757	9620	10484	11347	12211	
P (mm)	1594	2461	3327	4194	5061	5928	6795	7661	8528	9395	10262	
915mm ASPHALT COMPACT BACKSTOP	36T050CBA	36T060CBA	36T070CBA	36T080CBA	36T085CBA	36T090CBA	36T100CBA	36T105CBA	36T110CBA	36T115CBC	36T120CBC	A040110
	36T050CYA	36T060CYA	36T070CYA	36T080CYA	36T085CYC	36T090CYA	36T100CYA	36T105CBC	36T110CYA	36T115CYA	36T120CYA	
L (mm)	3975	4839	5702	6566	7442	8306	9169	10033	10909	11773	12637	
P (mm)	1410	2276	3143	4010	4877	5744	6610	7477	8344	9211	10077	
UP TO 915mm PCC PAD FLUSH MOUNT BACKSTOP	36T050FBC	36T060FBC	36T070FBC	36T080FBC	36T085FBC	36T090FBC	36T100FBC	36T105FBC	36T110FBC	36T115FBC	36T120FBC	A040420
	36T050FYC	36T060FYC	36T070FYC	36T080FYC	36T085FYC	36T090FYC	36T100FYC	36T105FYC	36T110FYC	36T115FYC	36T120FYC	
L (mm)	2121	2985	3848	4712	5588	6452	7315	8179	9055	9919	10782	
P (mm)	1511	2375	3239	4102	4978	5842	6706	7569	8446	9309	10173	
1070mm WF BACKSTOP	42T050WBC	42T060WBC	42T070WBC	42T080WBC		42T090WBC	42T100WBC	42T105WBC	42T110WBC			A040108
	42T050WYC	42T060WYC	42T070WYC	42T080WYC		42T090WYC	42T100WYC	42T105WYC	42T110WYC			
L (mm)	3175	4039	4902	5766		7493	8357	9220	10084			
W1 (mm)	1118	1118	1118	1118		1118	1118	1118	1118			
W2 (mm)	1295	1295	1295	1295		1295	1295	1295	1295			
P (mm)	1651	2515	3378	4242		5969	6833	7696	8560			
A (mm)	559	559	559	559		559	559	559	559			
B (mm)	787	787	787	787		787	787	787	787			
C (mm)	NA	NA	NA	NA		NA	NA	NA	NA			
D (mm)	406	406	406	406		406	406	406	406			
E (mm)	NA	NA	NA	NA		NA	NA	NA	NA			

SYSTEM WIDTH (mm)	SYSTEM SPEED CAPACITY (KPH)										DRAWING NUMBER
	50	60	70 TL-2	80	85	90	100 TL-3	105	110	115	120	
1220mm WF BACKSTOP	**48T050WBC**	**48T060WBC**	**48T070WBC**	**48T080WBC**		**48T090WBC**	**48T100WBC**	**48T105WBC**	**48T110WBC**			**A040108**
	48T050WYC	**48T060WYC**	**48T070WYC**	**48T080WYC**		**48T090WYC**	**48T100WYC**	**48T105WYC**	**48T110WYC**			
L (mm)	3175	4039	4902	5766		7493	8357	9220	10084			
W1 (mm)	1118	1118	1118	1118		1118	1118	118	1118			
W2 (mm)	1295	1295	1295	1295		1295	1295	1295	1295			
P (mm)	1651	2515	3378	4242		5969	6833	7696	8560			
A (mm)	559	559	559	559		559	559	559	559			
B (mm)	787	787	787	787		787	787	787	787			
C (mm)	NA	NA	NA	NA		NA	NA	NA	NA			
D (mm)	406	406	406	406		406	406	406	406			
E (mm)	NA	NA	NA	NA		NA	NA	NA	NA			
1370mm WF BACKSTOP	**54T050WBC**	**54T060WBC**	**54T070WBC**	**54T080WBC**		**54T090WBC**	**54T100WBC**	**54T105WBC**	**54T110WBC**			**A040108**
	54T050WYC	**54T060WYC**	**54T070WYC**	**54T080WYC**		**54T090WYC**	**54T100WYC**	**54T105WYC**	**54T110WYC**			
L (mm)	3175	4039	4902	5766		7493	8357	9220	10084			
W1 (mm)	1118	1118	1118	1118		1118	1118	118	1118			
W2 (mm)	1295	1295	1295	1295		1295	1295	1295	1295			
P (mm)	1651	2515	3378	4242		5969	6833	7696	8560			
A (mm)	559	559	559	559		559	559	559	559			
B (mm)	787	787	787	787		787	787	785	787			
C (mm)	NA	NA	NA	NA		NA	NA	NA	NA			
D (mm)	406	406	406	406		406	406	406	406			
E (mm)	NA	NA	NA	NA		NA	NA	NA	NA			
1525mm WF BACKSTOP	**60T050WBC**	**60T060WBC**	**60T070WBC**	**60T080WBC**		**60T090WBC**	**60T100WBC**	**60T105WBC**	**60T110WBC**			**A040108**
	60T050WYC	**60T060WYC**	**60T070WYC**	**60T080WYC**		**60T090WYC**	**60T100WYC**	**60T105WYC**	**60T110WYC**			
L (mm)	3175	4039	4902	5766		7493	8357	9220	10084			
W1 (mm)	1118	1118	1118	1118		1118	1118	118	1118			
W2 (mm)	1295	1295	1295	1295		1295	1295	1295	1295			
P (mm)	1651	2515	3378	4242		5969	6833	7696	8560			
A (mm)	559	559	559	559		559	559	559	559			
B (mm)	787	787	787	787		787	787	787	787			
C (mm)	NA	NA	NA	NA		NA	NA	NA	NA			
D (mm)	406	406	406	406		406	406	406	406			
E (mm)	NA	NA	NA	NA		NA	NA	NA	NA			
1675mm WF BACKSTOP		**66T060WBC**	**66T070WBC**	**66T080WBC**		**66T090WBC**	**66T100WBC**	**66T105WBC**	**66T110WBC**			**A040108**
		66T060WYC	**66T070WYC**	**66T080WYC**		**66T090WYC**	**66T100WYC**	**66T105WYC**	**66T110WYC**			
L (mm)		3175	4039	4902		6629	7493	8357	9220			
W1 (mm)		1753	1118	1118		1118	1118	1118	1118			
W2 (mm)		1905	1905	1905		1905	1905	1905	1905			
P (mm)		1651	2515	3378		5105	5969	6833	7696			
A (mm)		1235	559	559		559	559	559	559			
B (mm)		1391	1391	1391		1391	1391	1391	1391			
C (mm)		NA	705	705		705	705	705	705			
D (mm)		406	406	406		406	406	406	406			
E (mm)		NA	NA	1060		1060	1060	1060	1060			
1830mm WF BACKSTOP		**72T060WBC**	**72T070WBC**	**72T080WBC**		**72T090WBC**	**72T100WBC**	**72T105WBC**	**72T110WBC**			**A040108**
		72T060WYC	**72T070WYC**	**72T080WYC**		**72T090WYC**	**72T100WYC**	**72T105WYC**	**72T110WYC**			
L (mm)		3175	4039	4902		5766	7493	8357	8357			
W1 (mm)		1753	1753	1118		1118	1118	115	1118			
W2 (mm)		1905	1905	1905		1905	1905	1905	1905			
P (mm)		1651	2515	3378		4242	5969	6833	6833			
A (mm)		1235	1235	559		559	559	556	559			
B (mm)		1391	1391	1391		1391	1391	1391	1391			
C (mm)		NA	NA	705		705	705	705	705			
D (mm)		1083	1083	406		406	406	406	406			
E (mm)		NA	NA	1060		1060	1060	1060	1060			

SYSTEM WIDTH (mm)	SYSTEM SPEED CAPACITY (KPH)											DRAWING NUMBER
	50	60	70 TL-2	80	85	90	100 TL-3	105	110	115	120	
1980mm WF BACKSTOP		78T060WBC	78T070WBC	78T080WBC		78T090WBC	78T100WBC	78T105WBC	78T110WBC			A040108
		78T060WYC	78T070WYC	78T080WYC		78T090WYC	78T100WYC	78T105WYC	78T110WYC			
L (mm)		3175	4039	4902		5766	7493	8357	8357			
W1 (mm)		1753	1753	1753		1118	1118	1118	1118			
W2 (mm)		1905	1905	1905		1905	1905	1905	1905			
P (mm)		1651	2515	3378		4242	5969	6833	6833			
A (mm)		1235	1235	1235		559	559	559	559			
B (mm)		1391	1391	1391		1391	1391	1391	1391			
C (mm)		NA	NA	NA		705	705	705	705			
D (mm)		1083	1083	1083		406	406	406	406			
E (mm)		NA	NA	NA		1060	1060	1060	1060			
2135mm WF BACKSTOP			84T070WBC	84T080WBC		84T090WBC	84T100WBC	84T105WBC	84T110WBC			A040108
			84T070WYC	84T080WYC		84T090WYC	84T100WYC	84T105WYC	84T110WYC			
L (mm)			4039	4902		5766	7493	8357	8357			
W1 (mm)			1753	1753		1753	1118	118	1118			
W2 (mm)			1905	1905		1905	1905	1905	1905			
P (mm)			2515	3378		4242	5969	6833	6833			
A (mm)			1235	1235		1235	559	559	559			
B (mm)			1391	1391		1391	1391	1391	1391			
C (mm)			NA	NA		NA	705	705	705			
D (mm)			1083	1083		1083	406	406	406			
E (mm)			NA	NA		NA	1060	1060	1060			
2285mm WF BACKSTOP			90T070WBC	90T080WBC		90T090WBC	90T100WBC	90T105WBC	90T110WBC			A040108
			90T070WYC	90T080WYC		90T090WYC	90T100WYC	90T105WYC	90T110WYC			
L (mm)			4039	4902		5766	7493	8357	8357			
W1 (mm)			1753	1753		1753	1118	1118	1118			
W2 (mm)			2515	2515		2515	2515	2515	2515			
P (mm)			2515	3378		4242	5969	6633	6833			
A (mm)			1235	1235		1235	559	559	559			
B (mm)			1997	1997		1997	1997	1997	1997			
C (mm)			1311	1311		1311	705	705	705			
D (mm)			1083	1083		1083	406	406	406			
E (mm)			1667	1667		1667	1667	1667	1667			
2440mm WF BACKSTOP			96T070WBC	96T080WBC		96T090WBC	96T100WBC	96T105WBC	96T110WBC			A040108
			96T070WYC	96T080WYC		96T090WYC	96T100WYC	96T105WYC	96T110WYC			
L (mm)			4039	4902		5766	7493	8357	8357			
W1 (mm)			2362	1753		1753	1753	118	1118			
W2 (mm)			2515	2515		2515	2515	2515	2515			
P (mm)			2515	3378		4242	5969	6833	6833			
A (mm)			1845	1235		1235	1235	559	559			
B (mm)			1997	1997		1997	1997	1997	1997			
C (mm)			NA	1311		1305	1311	705	705			
D (mm)			1692	1083		1083	1083	406	406			
E (mm)			NA	1667		1667	1667	1667	1667			
2590mm WF BACKSTOP									102T110WBC			A040108
									102T110WYC			
L (mm)									8357			
W1 (mm)									1753			
W2 (mm)									2515			
P (mm)									6833			
A (mm)									1235			
B (mm)									1997			
C (mm)									1311			
D (mm)									1083			
E (mm)									1667			

APPENDIX D

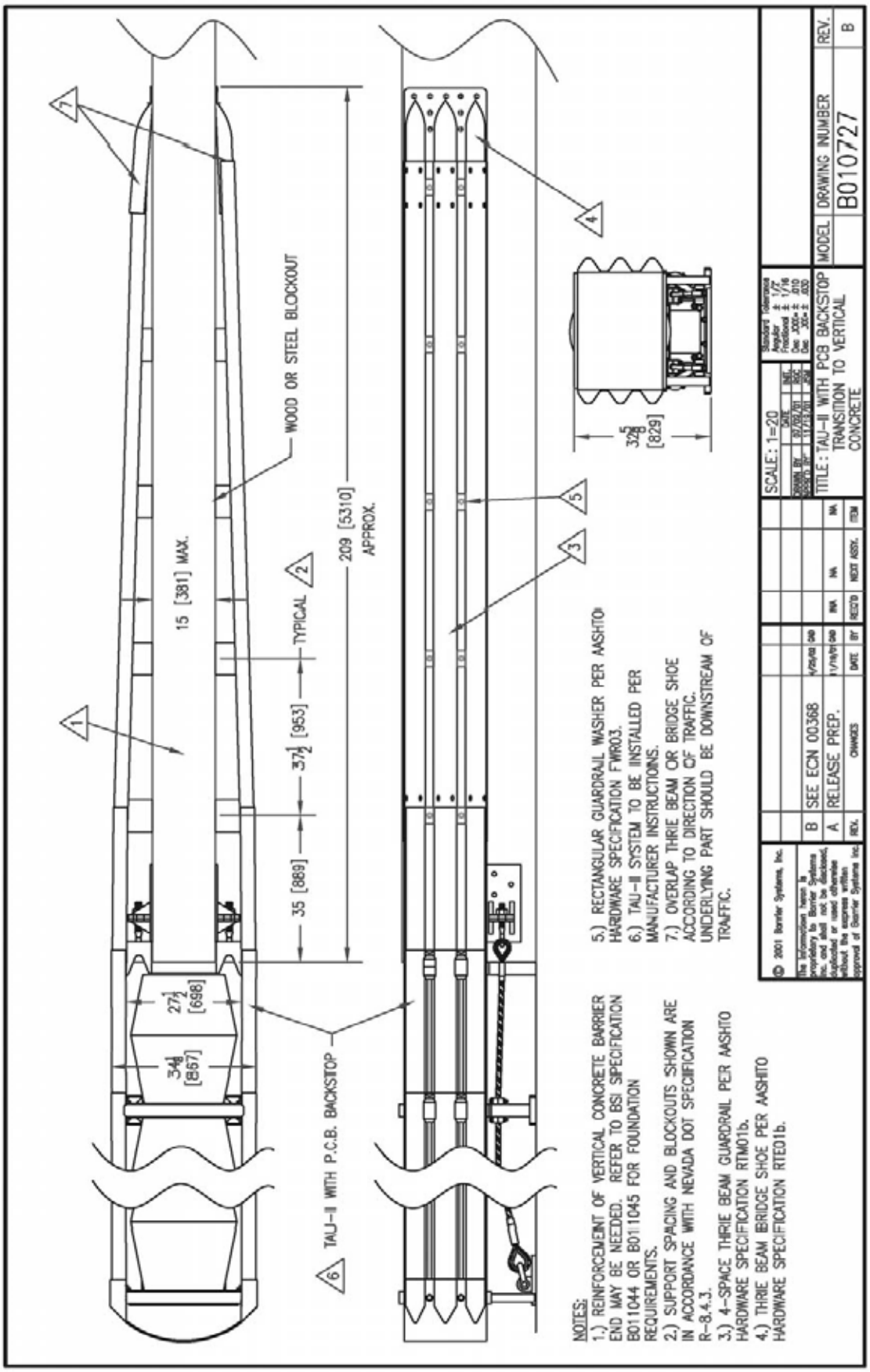
TRANSITIONS

There are a variety of transition options available for the TAU-II system. The system was designed to be compatible with a variety of generic transitions already available to the industry.

Placement and installation of the TAU-II system and transitions must be accomplished in accordance with the guidelines and recommendations set forth in the "AASHTO Roadside Design Guide," FHWA memoranda and other state and local standards.

There are different transition configurations depending on which backstop you are using (Compact or P.C.B.). Transition options for either of the backstop systems are shown in the following drawings.

DRAWINGS


WOOD OR STEEL BLOCKOUT
15 [381] MAX.
TYPICAL
209 [5310] APPROX.
35 [889]
37½ [953]
27½ [698]
34⅛ [867]
TAU-II WITH P.C.B. BACKSTOP
32⅝ [829]
NOTES:
1.) REINFORCEMENT OF VERTICAL CONCRETE BARRIER END MAY BE NEEDED. REFER TO BSI SPECIFICATION B011044 OR B011045 FOR FOUNDATION REQUIREMENTS.
2.) SUPPORT SPACING AND BLOCKOUTS SHOWN ARE IN ACCORDANCE WITH NEVADA DOT SPECIFICATION R-8.4.3.
3.) 4-SPACE THRIE BEAM GUARDRAIL PER AASHTO HARDWARE SPECIFICATION RTM01b.
4.) THRIE BEAM BRIDGE SHOE PER AASHTO HARDWARE SPECIFICATION RTE01b.
5.) RECTANGULAR GUARDRAIL WASHER PER AASHTO HARDWARE SPECIFICATION FWR03.
6.) TAU-II SYSTEM TO BE INSTALLED PER MANUFACTURER INSTRUCTIONS.
7.) OVERLAP THRIE BEAM OR BRIDGE SHOE ACCORDING TO DIRECTION OF TRAFFIC. UNDERLYING PART SHOULD BE DOWNSTREAM OF TRAFFIC.
SCALE: 1=20
TITLE: TAU-II WITH PCB BACKSTOP TRANSITION TO VERTICAL CONCRETE
MODEL
DRAWING NUMBER
B010727
REV.
B
B SEE ECN 00368
A RELEASE PREP.
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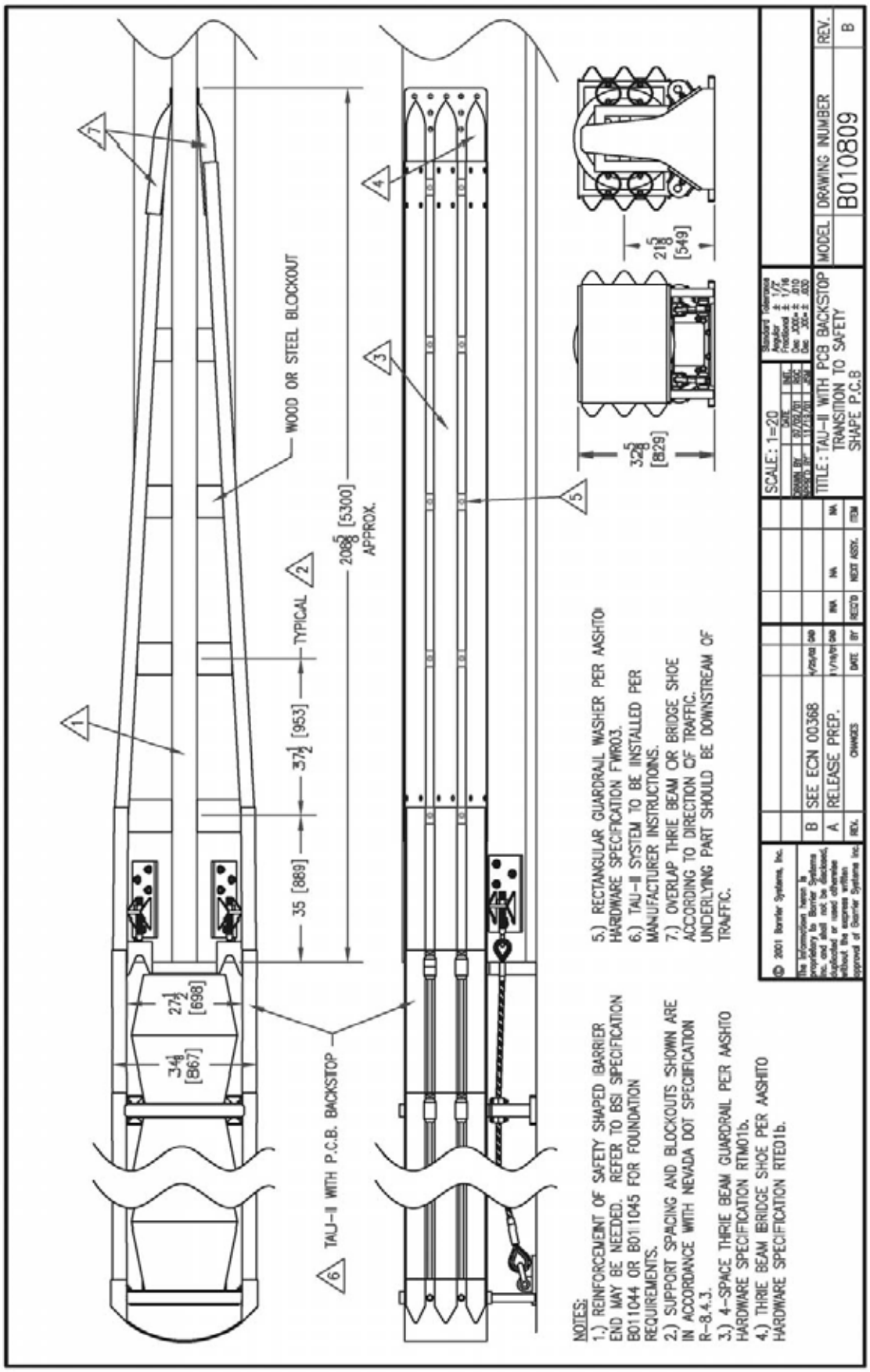
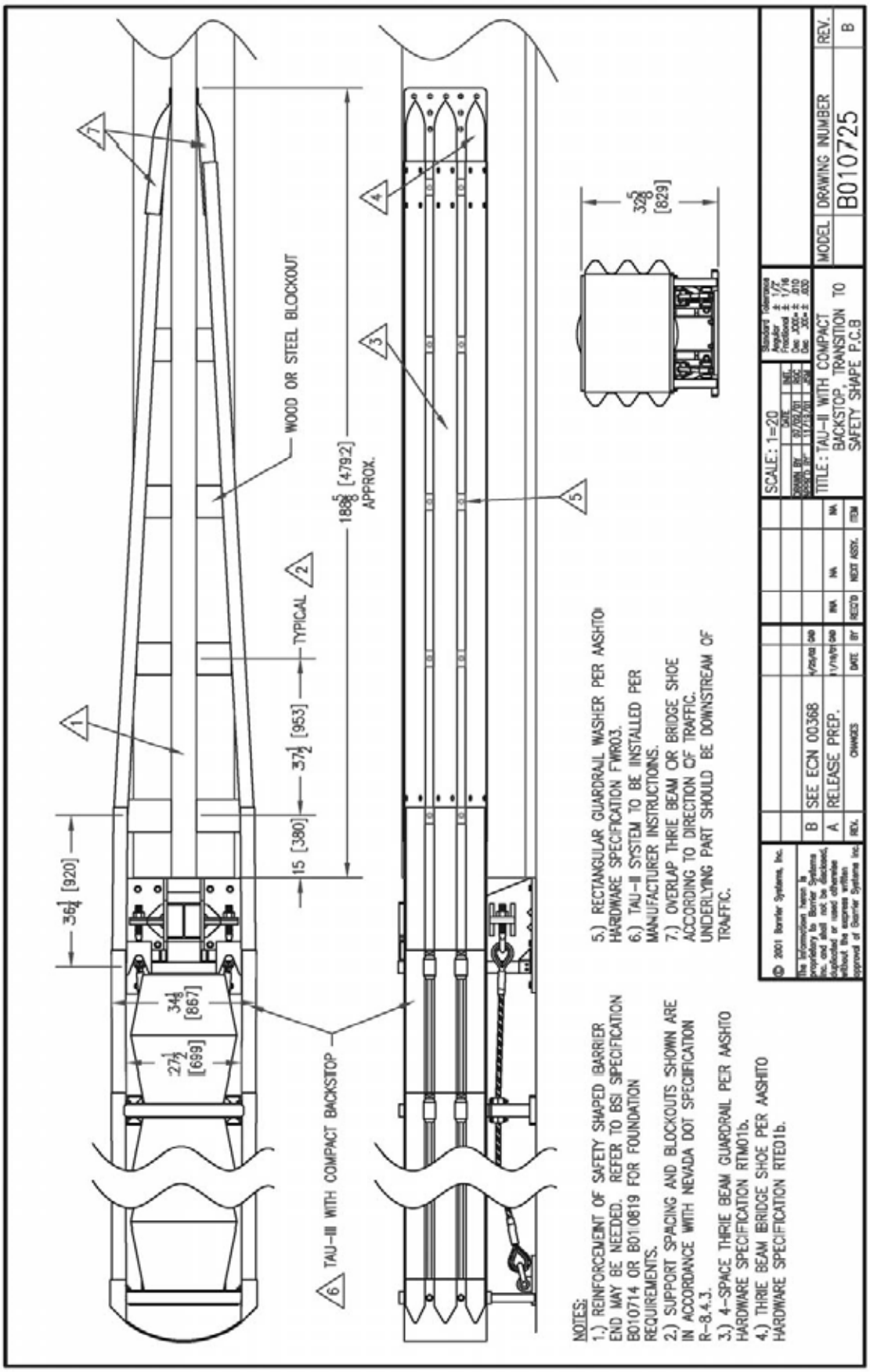
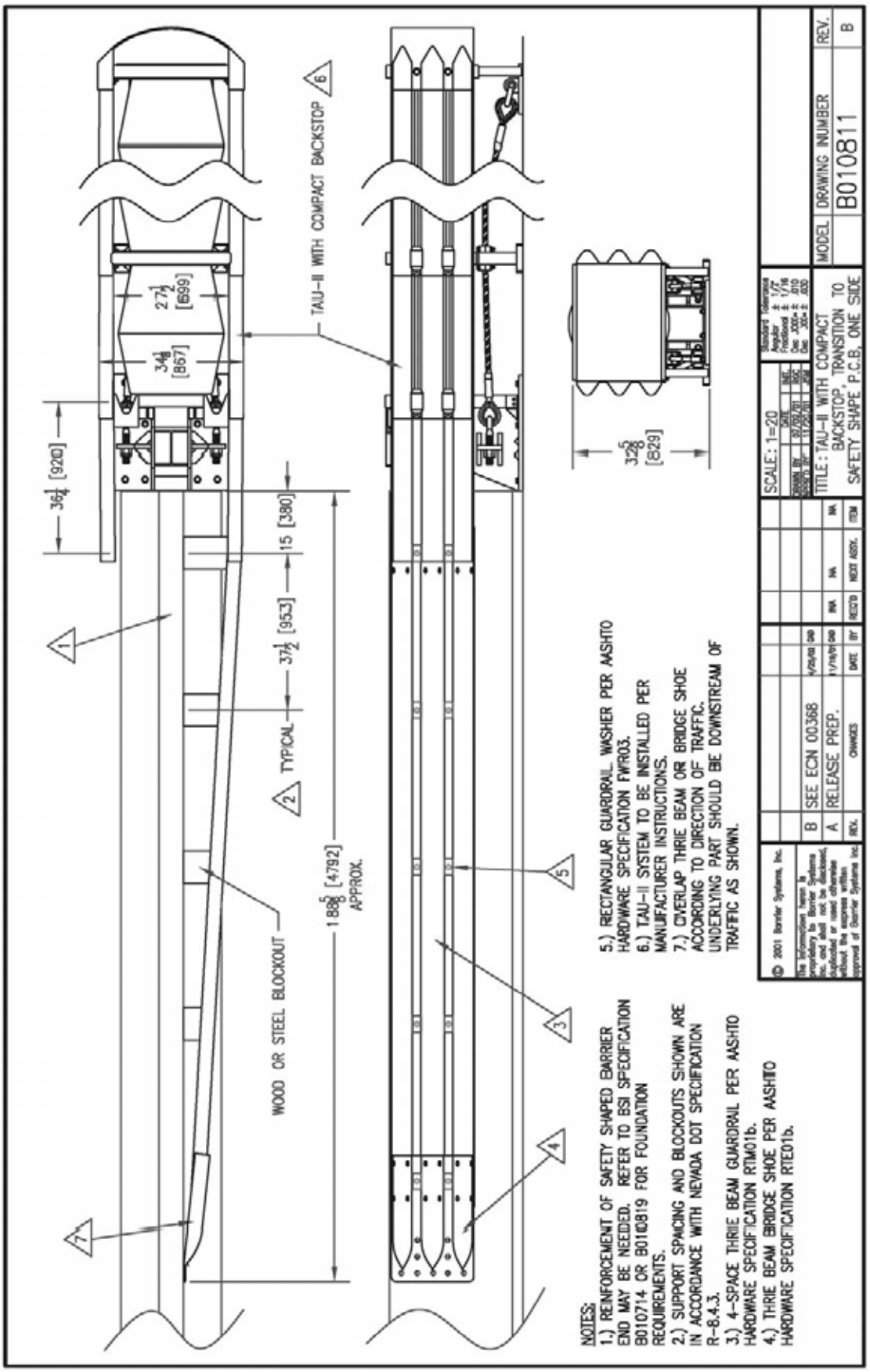
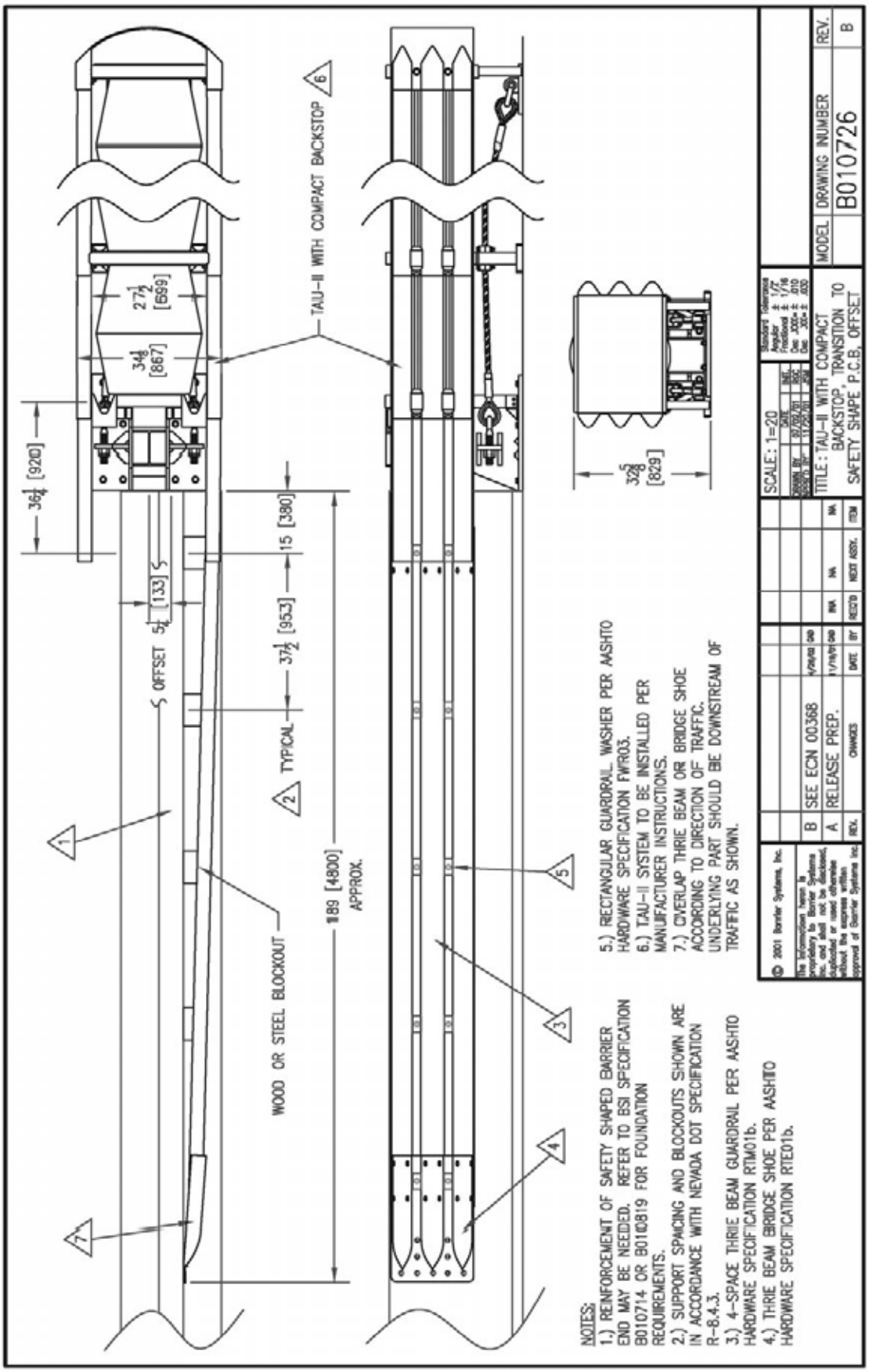
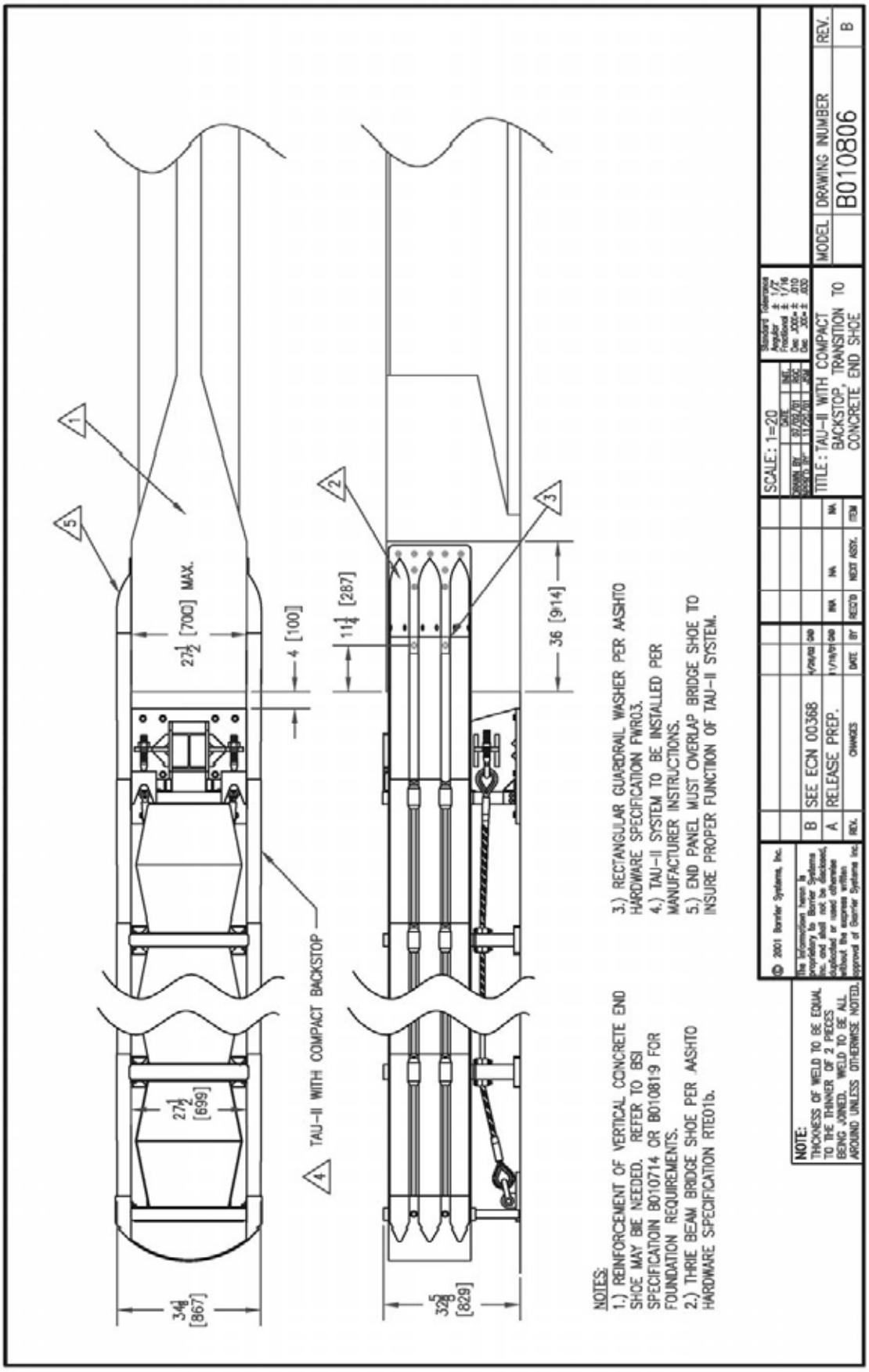

WOOD OR STEEL BLOCKOUT
TYPICAL
2088 [5300] APPROX.
35 [889]
37½ [953]
27½ [698]
34⅜ [867]
TAU-II WITH P.C.B. BACKSTOP
325 [829]
21⅝ [549]
NOTES:
1.) REINFORCEMENT OF SAFETY SHAPED BARRIER END MAY BE NEEDED. REFER TO BSI SPECIFICATION B011044 OR B011045 FOR FOUNDATION REQUIREMENTS.
2.) SUPPORT SPACING AND BLOCKOUTS SHOWN ARE IN ACCORDANCE WITH NEVADA DOT SPECIFICATION R-8.4.3.
3.) 4-SPACE THRIE BEAM GUARDRAIL PER AASHTO HARDWARE SPECIFICATION RTM01b.
4.) THRIE BEAM BRIDGE SHOE PER AASHTO HARDWARE SPECIFICATION RTE01b.
5.) RECTANGULAR GUARDRAIL WASHER PER AASHTO HARDWARE SPECIFICATION FWR03.
6.) TAU-II SYSTEM TO BE INSTALLED PER MANUFACTURER INSTRUCTIONS.
7.) OVERLAP THRIE BEAM OR BRIDGE SHOE ACCORDING TO DIRECTION OF TRAFFIC. UNDERLYING PART SHOULD BE DOWNSTREAM OF TRAFFIC.
B SEE ECN 00368
A RELEASE PREP.
SCALE: 1=20
TITLE: TAU-II WITH PCB BACKSTOP TRANSITION TO SAFETY SHAPE P.C.B
MODEL
DRAWING NUMBER
B010809
REV. B


WOOD OR STEEL BLOCKOUT
TYPICAL
188⅝ [4792] APPROX.
36¼ [920]
15 [380]
37½ [953]
34⅛ [867]
27½ [699]
TAU-III WITH COMPACT BACKSTOP
328 [829]
NOTES:
1.) REINFORCEMENT OF SAFETY SHAPED BARRIER END MAY BE NEEDED. REFER TO BSI SPECIFICATION B010714 OR B010819 FOR FOUNDATION REQUIREMENTS.
2.) SUPPORT SPACING AND BLOCKOUTS SHOWN ARE IN ACCORDANCE WITH NEVADA DOT SPECIFICATION R-8.4.3.
3.) 4-SPACE THRIE BEAM GUARDRAIL PER AASHTO HARDWARE SPECIFICATION RTM01b.
4.) THRIE BEAM BRIDGE SHOE PER AASHTO HARDWARE SPECIFICATION RTE01b.
5.) RECTANGULAR GUARDRAIL WASHER PER AASHTO HARDWARE SPECIFICATION FWR03.
6.) TAU-II SYSTEM TO BE INSTALLED PER MANUFACTURER INSTRUCTIONS.
7.) OVERLAP THRIE BEAM OR BRIDGE SHOE ACCORDING TO DIRECTION OF TRAFFIC. UNDERLYING PART SHOULD BE DOWNSTREAM OF TRAFFIC.
SCALE: 1=20
TITLE: TAU-II WITH COMPACT BACKSTOP, TRANSITION TO SAFETY SHAPE P.C.B
MODEL
DRAWING NUMBER
B010725
REV.
B
SEE ECN 00368
RELEASE PREP.
© 2001 Barrier Systems, Inc.


TAU-II WITH COMPACT BACKSTOP
WOOD OR STEEL BLOCKOUT
TYPICAL
APPROX.
NOTES:
1.) REINFORCEMENT OF SAFETY SHAPED BARRIER END MAY BE NEEDED. REFER TO BSI SPECIFICATION B010714 OR B010819 FOR FOUNDATION REQUIREMENTS.
2.) SUPPORT SPACING AND BLOCKOUTS SHOWN ARE IN ACCORDANCE WITH NEVADA DOT SPECIFICATION R-8.4.3.
3.) 4-SPACE THRIE BEAM GUARDRAIL PER AASHTO HARDWARE SPECIFICATION RTM01b.
4.) THRIE BEAM BRIDGE SHOE PER AASHTO HARDWARE SPECIFICATION RTE01b.
5.) RECTANGULAR GUARDRAIL WASHER PER AASHTO HARDWARE SPECIFICATION FWR03.
6.) TAU-II SYSTEM TO BE INSTALLED PER MANUFACTURER INSTRUCTIONS.
7.) OVERLAP THRIE BEAM OR BRIDGE SHOE ACCORDING TO DIRECTION OF TRAFFIC. UNDERLYING PART SHOULD BE DOWNSTREAM OF TRAFFIC AS SHOWN.
SCALE: 1=20
TITLE: TAU-II WITH COMPACT BACKSTOP, TRANSITION TO SAFETY SHAPE P.C.B., ONE SIDE
MODEL
DRAWING NUMBER
B010811
REV.
B


TAU-II WITH COMPACT BACKSTOP
WOOD OR STEEL BLOCKOUT
189 [4800] APPROX.
TYPICAL
OFFSET
NOTES:
1.) REINFORCEMENT OF SAFETY SHAPED BARRIER END MAY BE NEEDED. REFER TO BSI SPECIFICATION B010714 OR B010819 FOR FOUNDATION REQUIREMENTS.
2.) SUPPORT SPACING AND BLOCKOUTS SHOWN ARE IN ACCORDANCE WITH NEVADA DOT SPECIFICATION R-8.4.3.
3.) 4-SPACE THRIE BEAM GUARDRAIL PER AASHTO HARDWARE SPECIFICATION RTM01b.
4.) THRIE BEAM BRIDGE SHOE PER AASHTO HARDWARE SPECIFICATION RTE01b.
5.) RECTANGULAR GUARDRAIL WASHER PER AASHTO HARDWARE SPECIFICATION FWR03.
6.) TAU-II SYSTEM TO BE INSTALLED PER MANUFACTURER INSTRUCTIONS.
7.) OVERLAP THRIE BEAM OR BRIDGE SHOE ACCORDING TO DIRECTION OF TRAFFIC. UNDERLYING PART SHOULD BE DOWNSTREAM OF TRAFFIC AS SHOWN.
SCALE: 1=20
TITLE: TAU-II WITH COMPACT BACKSTOP, TRANSITION TO SAFETY SHAPE P.C.B. OFFSET
MODEL
DRAWING NUMBER
B010726
REV.
B
SEE ECN 00368
RELEASE PREP.


TAU-II WITH COMPACT BACKSTOP
27½ [700] MAX.
4 [100]
11¼ [287]
36 [914]
27½ [699]
34⅛ [867]
32⅝ [829]
NOTES:
1.) REINFORCEMENT OF VERTICAL CONCRETE END SHOE MAY BE NEEDED. REFER TO BSI SPECIFICATION B010714 OR B010819 FOR FOUNDATION REQUIREMENTS.
2.) THRIE BEAM BRIDGE SHOE PER AASHTO HARDWARE SPECIFICATION RTE01b.
3.) RECTANGULAR GUARDRAIL WASHER PER AASHTO HARDWARE SPECIFICATION FWR03.
4.) TAU-II SYSTEM TO BE INSTALLED PER MANUFACTURER INSTRUCTIONS.
5.) END PANEL MUST OVERLAP BRIDGE SHOE TO INSURE PROPER FUNCTION OF TAU-II SYSTEM.
NOTE:
THICKNESS OF WELD TO BE EQUAL TO THE THINNER OF 2 PIECES BEING JOINED. WELD TO BE ALL AROUND UNLESS OTHERWISE NOTED.
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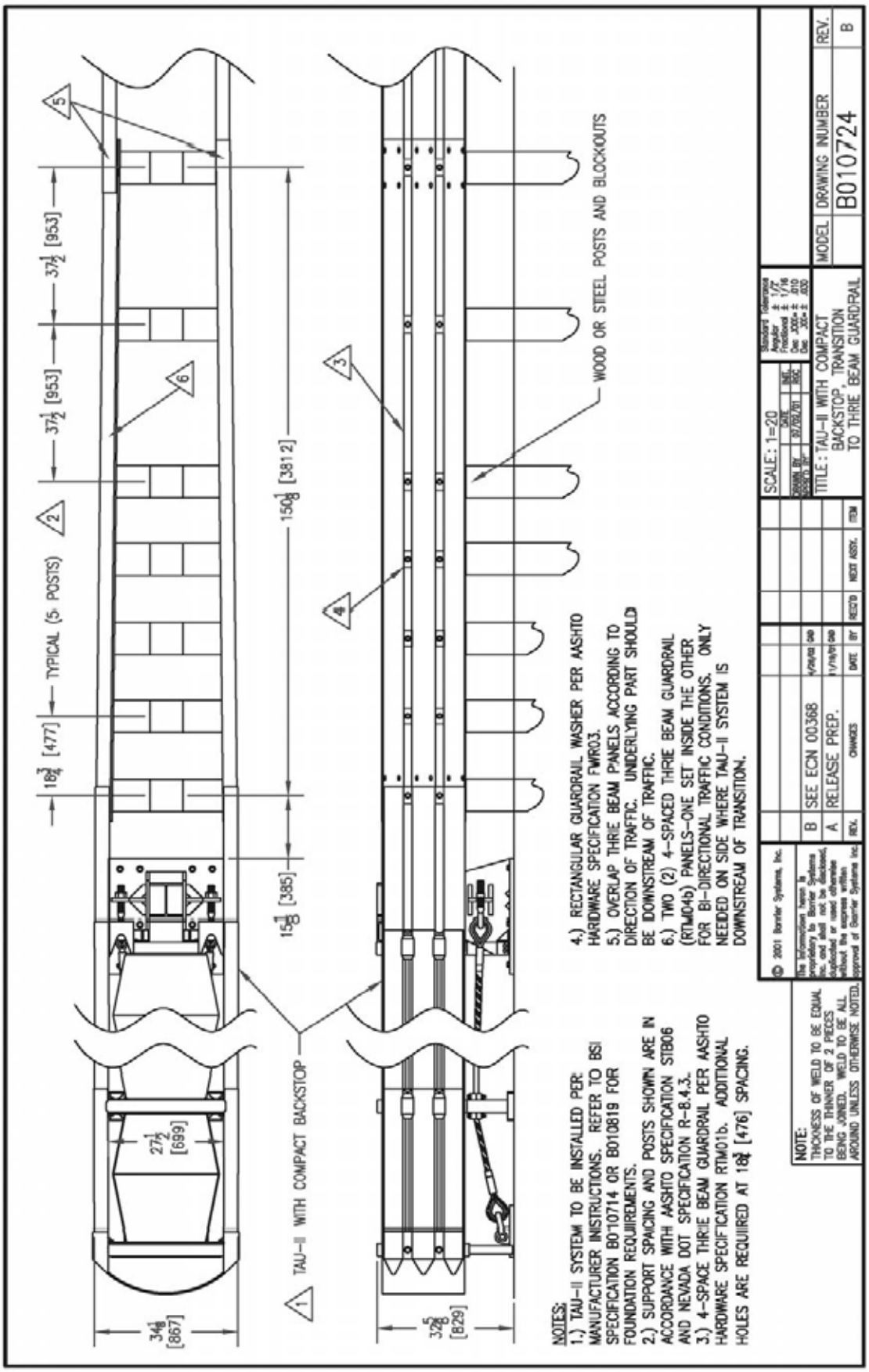
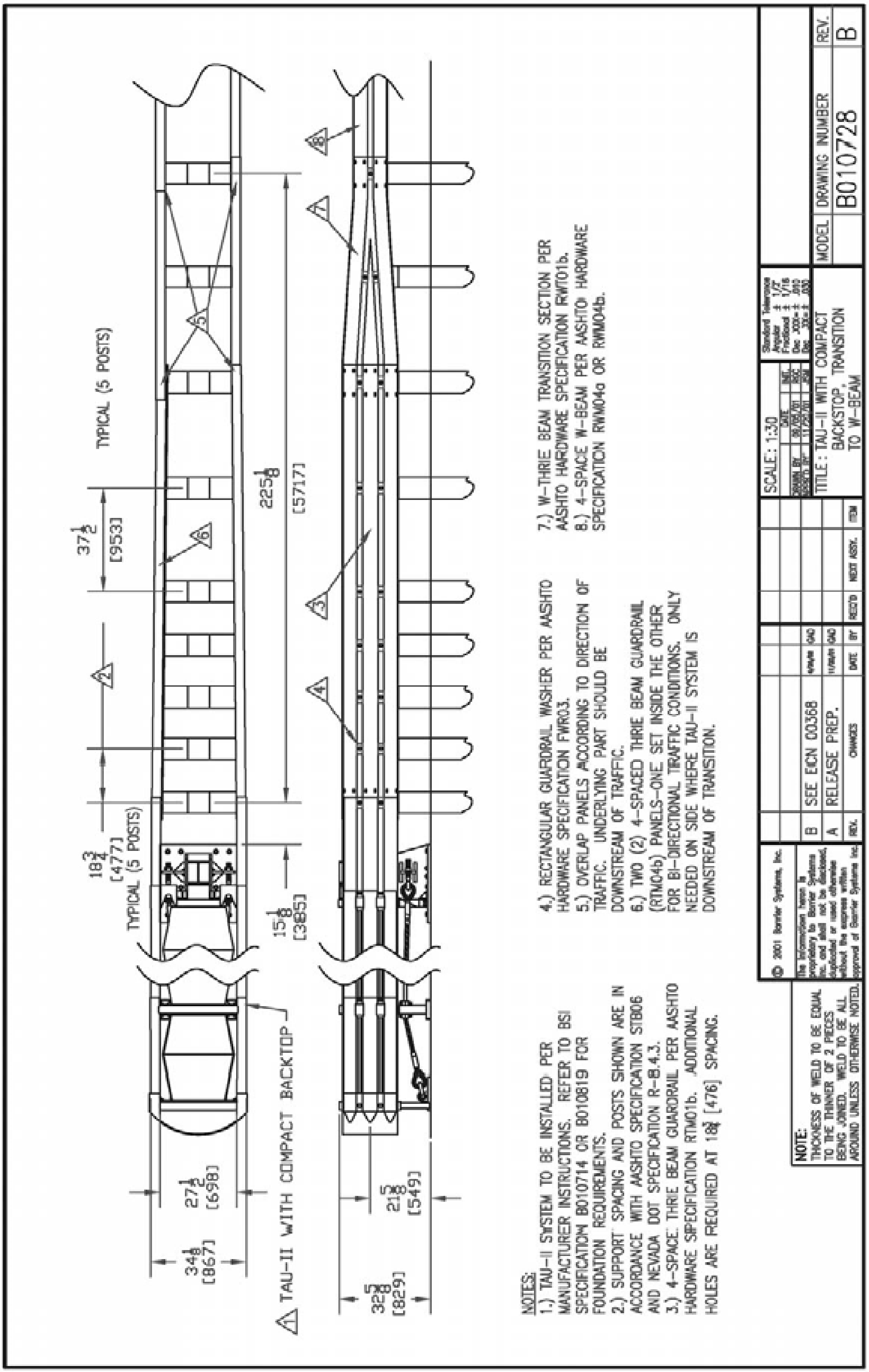
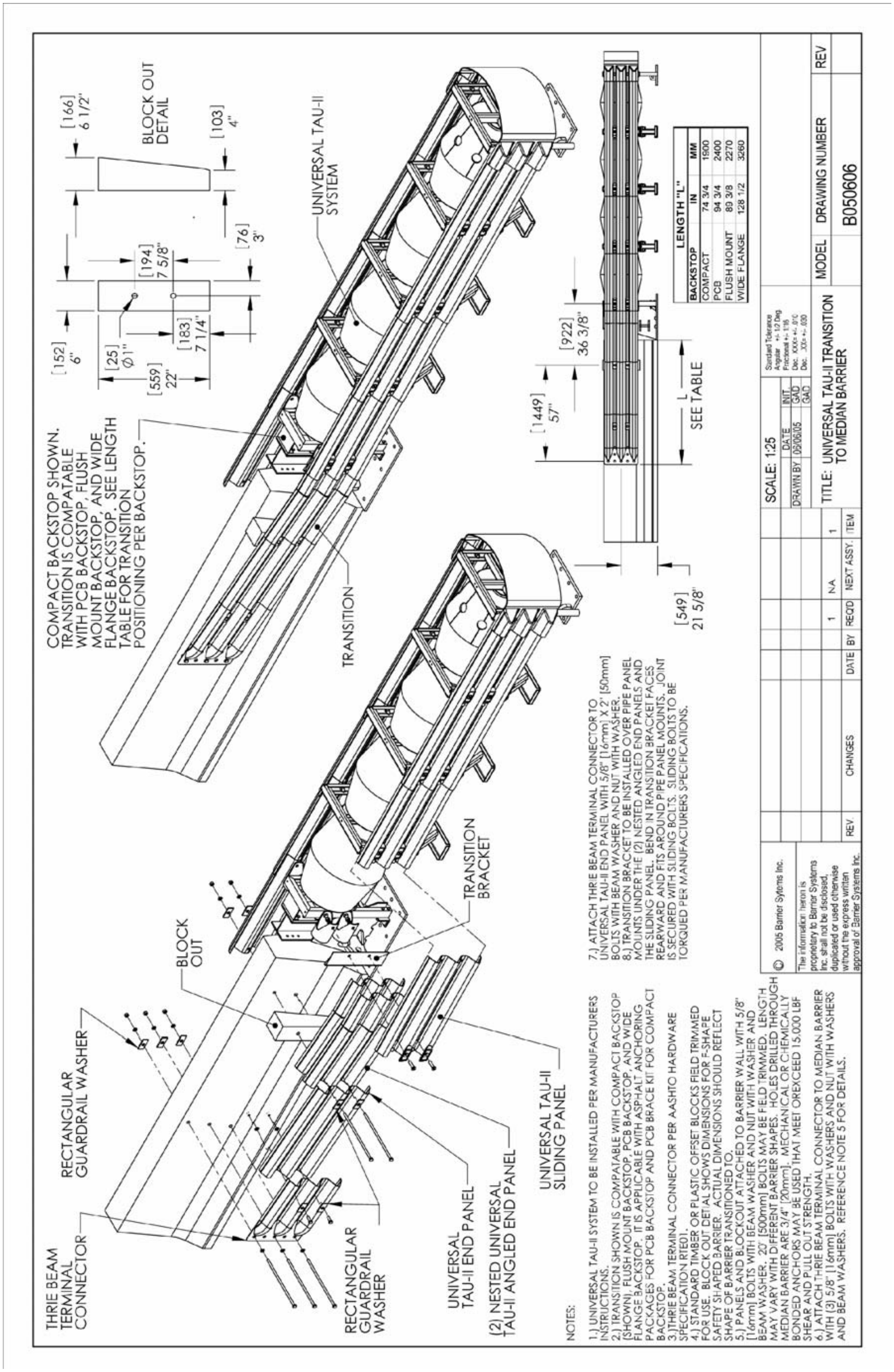
B SEE ECN 00368
A RELEASE PREP.
SCALE: 1=20
TITLE: TAU-II WITH COMPACT BACKSTOP, TRANSITION TO CONCRETE END SHOE
MODEL
DRAWING NUMBER
B010806
REV. B


TAU-II WITH COMPACT BACKSTOP
TYPICAL (5) POSTS
WOOD OR STEEL POSTS AND BLOCKOUTS
NOTES:
1.) TAU-II SYSTEM TO BE INSTALLED PER MANUFACTURER INSTRUCTIONS. REFER TO BSI SPECIFICATION B010714 OR B010819 FOR FOUNDATION REQUIREMENTS.
2.) SUPPORT SPACING AND POSTS SHOWN ARE IN ACCORDANCE WITH AASHTO SPECIFICATION STB06 AND NEVADA DOT SPECIFICATION R-8.4.3.
3.) 4-SPACE THRIE BEAM GUARDRAIL PER AASHTO HARDWARE SPECIFICATION RTM01b. ADDITIONAL HOLES ARE REQUIRED AT 18¾ [476] SPACING.
4.) RECTANGULAR GUARDRAIL WASHER PER AASHTO HARDWARE SPECIFICATION FWR03.
5.) OVERLAP THRIE BEAM PANELS ACCORDING TO DIRECTION OF TRAFFIC. UNDERLYING PART SHOULD BE DOWNSTREAM OF TRAFFIC.
6.) TWO (2) 4-SPACED THRIE BEAM GUARDRAIL (RTM04b) PANELS–ONE SET INSIDE THE OTHER FOR BI-DIRECTIONAL TRAFFIC CONDITIONS. ONLY NEEDED ON SIDE WHERE TAU-II SYSTEM IS DOWNSTREAM OF TRANSITION.
NOTE: THICKNESS OF WELD TO BE EQUAL TO THE THINNER OF 2 PIECES BEING JOINED. WELD TO BE ALL AROUND UNLESS OTHERWISE NOTED.
SCALE: 1=20
TITLE: TAU-II WITH COMPACT BACKSTOP TRANSITION TO THRIE BEAM GUARDRAIL
MODEL
DRAWING NUMBER
B010724
REV. B
B SEE ECN 00368
A RELEASE PREP.


TAU-II WITH COMPACT BACKTOP
TYPICAL (5 POSTS)
TYPICAL (5 POSTS)
34⅛ [867]
27½ [698]
32⅝ [829]
21⅝ [549]
15⅛ [385]
18¾ [477]
37½ [953]
225⅛ [5717]
NOTES:
1.) TAU-II SYSTEM TO BE INSTALLED PER MANUFACTURER INSTRUCTIONS. REFER TO BSI SPECIFICATION B010714 OR B010819 FOR FOUNDATION REQUIREMENTS.
2.) SUPPORT SPACING AND POSTS SHOWN ARE IN ACCORDANCE WITH AASHTO SPECIFICATION STB06 AND NEVADA DOT SPECIFICATION R-8.4.3.
3.) 4-SPACE THRIE BEAM GUARDRAIL PER AASHTO HARDWARE SPECIFICATION RTM01b. ADDITIONAL HOLES ARE REQUIRED AT 18¾ [476] SPACING.
4.) RECTANGULAR GUARDRAIL WASHER PER AASHTO HARDWARE SPECIFICATION FWR03.
5.) OVERLAP PANELS ACCORDING TO DIRECTION OF TRAFFIC. UNDERLYING PART SHOULD BE DOWNSTREAM OF TRAFFIC.
6.) TWO (2) 4-SPACED THRIE BEAM GUARDRAIL (RTM04b) PANELS-ONE SET INSIDE THE OTHER. FOR BI-DIRECTIONAL TRAFFIC CONDITIONS. ONLY NEEDED ON SIDE WHERE TAU-II SYSTEM IS DOWNSTREAM OF TRANSITION.
7.) W-THRIE BEAM TRANSITION SECTION PER AASHTO HARDWARE SPECIFICATION RWT01b.
8.) 4-SPACE W-BEAM PER AASHTO HARDWARE SPECIFICATION RWM04a OR RWM04b.
NOTE:
THICKNESS OF WELD TO BE EQUAL TO THE THINNER OF 2 PIECES BEING JOINED. WELD TO BE ALL AROUND UNLESS OTHERWISE NOTED.
© 2001 Barrier Systems, Inc.
B SEE EICN 00368
A RELEASE PREP.
SCALE: 1:30
TITLE: TAU-II WITH COMPACT BACKSTOP, TRANSITION TO W-BEAM
MODEL
DRAWING NUMBER
B010728
REV.
B


THRIE BEAM TERMINAL CONNECTOR
RECTANGULAR GUARDRAIL WASHER
RECTANGULAR GUARDRAIL WASHER
UNIVERSAL TAU-II END PANEL
(2) NESTED UNIVERSAL TAU-II ANGLED END PANEL
UNIVERSAL TAU-II SLIDING PANEL
BLOCK OUT
TRANSITION BRACKET
TRANSITION
COMPACT BACKSTOP SHOWN. TRANSITION IS COMPATABLE WITH PCB BACKSTOP, FLUSH MOUNT BACKSTOP, AND WIDE FLANGE BACKSTOP. SEE LENGTH TABLE FOR TRANSITION POSITIONING PER BACKSTOP.
UNIVERSAL TAU-II SYSTEM
BLOCK OUT DETAIL
[152] 6"
[25] Ø1"
[559] 22"
[183] 7 1/4"
[194] 7 5/8"
[76] 3"
[166] 6 1/2"
[103] 4"
[1449] 57"
[922] 36 3/8"
[549] 21 5/8"
L SEE TABLE
LENGTH "L"
BACKSTOP | IN | MM
COMPACT | 74 3/4 | 1900
PCB | 94 3/4 | 2400
FLUSH MOUNT | 89 3/8 | 2270
WIDE FLANGE | 128 1/2 | 3260
NOTES:
1.) UNIVERSAL TAU-II SYSTEM TO BE INSTALLED PER MANUFACTURERS INSTRUCTIONS.
2.) TRANSITION SHOWN IS COMPATABLE WITH COMPACT BACKSTOP (SHOWN), FLUSH MOUNT BACKSTOP, PCB BACKSTOP, AND WIDE FLANGE BACKSTOP. IT IS APPLICABLE WITH ASPHALT ANCHORING PACKAGES FOR PCB BACKSTOP AND PCB BRACE KIT FOR COMPACT BACKSTOP.
3.)THRIE BEAM TERMINAL CONNECTOR PER AASHTO HARDWARE SPECIFICATION RTE01.
4.) STANDARD TIMBER OR PLASTIC OFFSET BLOCKS FIELD TRIMMED FOR USE. BLOCK OUT DETAIL SHOWS DIMENSIONS FOR F-SHAPE SAFETY SHAPED BARRIER. ACTUAL DIMENSIONS SHOULD REFLECT SHAPE OF BARRIER TRANSITIONED TO.
5.) PANELS AND BLOCKOUT ATTACHED TO BARRIER WALL WITH 5/8" [16mm] BOLTS WITH BEAM WASHER AND NUT WITH WASHER AND BEAM WASHER. 20" [500mm] BOLTS MAY BE FIELD TRIMMED. LENGTH MAY VARY WITH DIFFERENT BARRIER SHAPES. HOLES DRILLED THROUGH MEDIAN BARRIER ARE 3/4" [20mm]. MECHANICAL OR CHEMICALLY BONDED ANCHORS MAY BE USED THAT MEET OR EXCEED 15,000 LBF SHEAR AND PULL OUT STRENGTH.
6.) ATTACH THRIE BEAM TERMINAL CONNECTOR TO MEDIAN BARRIER WITH (3) 5/8" [16mm] BOLTS WITH WASHERS AND NUT WITH WASHERS AND BEAM WASHERS. REFERENCE NOTE 5 FOR DETAILS.
7.) ATTACH THRIE BEAM TERMINAL CONNECTOR TO UNIVERSAL TAU-II END PANEL WITH 5/8" [16mm] X 2" [50mm] BOLTS WITH BEAM WASHER AND NUT WITH WASHER.
8.) TRANSITION BRACKET TO BE INSTALLED OVER PIPE PANEL MOUNTS UNDER THE (2) NESTED ANGLED END PANELS AND THE SLIDING PANEL. BEND IN TRANSITION BRACKET FACES REARWARD AND FITS AROUND PIPE PANEL MOUNTS. JOINT IS SECURED WITH SLIDING BOLTS. SLIDING BOLTS TO BE TORQUED PER MANUFACTURERS SPECIFICATIONS.
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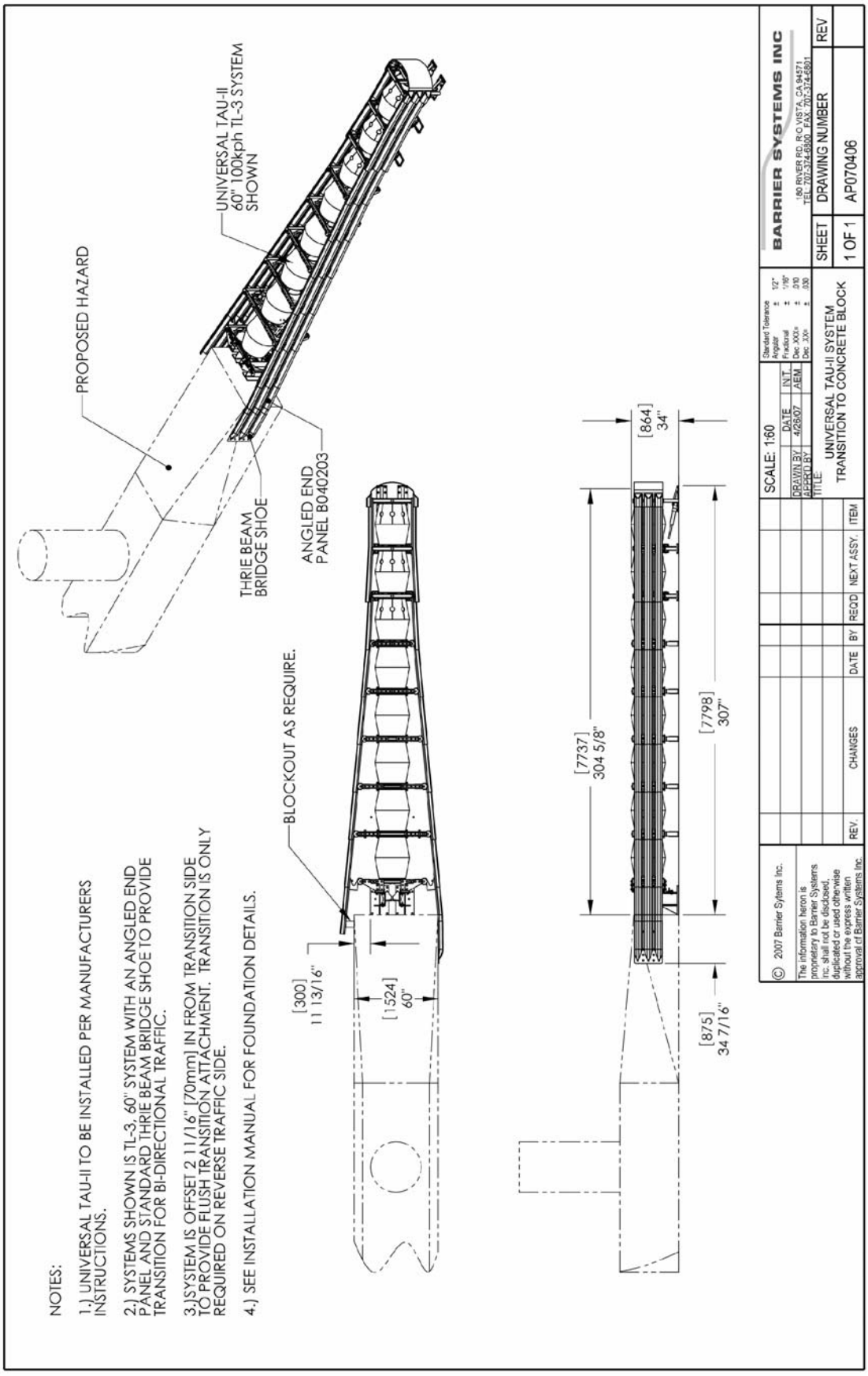
REV. | CHANGES | DATE | BY
REQ'D | NEXT ASSY. | ITEM
1 | N/A | 1
SCALE: 1:25
DRAWN BY | 05/06/05 | GAD
TITLE: UNIVERSAL TAU-II TRANSITION TO MEDIAN BARRIER
MODEL | DRAWING NUMBER | REV
B050606


PROPOSED HAZARD
UNIVERSAL TAU-II
60" 100kph TL-3 SYSTEM
SHOWN
THRIE BEAM
BRIDGE SHOE
ANGLED END
PANEL B040203
BLOCKOUT AS REQUIRE.
[300]
11 13/16"
[1524]
60"
[7737]
304 5/8"
[7798]
307"
[864]
34"
[875]
34 7/16"
NOTES:
1.) UNIVERSAL TAU-II TO BE INSTALLED PER MANUFACTURERS INSTRUCTIONS.
2.) SYSTEMS SHOWN IS TL-3, 60" SYSTEM WITH AN ANGLED END PANEL AND STANDARD THRIE BEAM BRIDGE SHOE TO PROVIDE TRANSITION FOR BI-DIRECTIONAL TRAFFIC.
3.)SYSTEM IS OFFSET 2 11/16" [70mm] IN FROM TRANSITION SIDE TO PROVIDE FLUSH TRANSITION ATTACHMENT. TRANSITION IS ONLY REQUIRED ON REVERSE TRAFFIC SIDE.
4.) SEE INSTALLATION MANUAL FOR FOUNDATION DETAILS.
REV. CHANGES DATE BY REQD NEXT ASSY. ITEM
SCALE: 1:60
DRAWN BY 4/28/07 INT
APPR'D BY AEM
TITLE: UNIVERSAL TAU-II SYSTEM TRANSITION TO CONCRETE BLOCK
Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16"
Dec .XXX± ± .010
Dec .XX± ± .030
BARRIER SYSTEMS INC
180 RIVER RD. P.O. VISTA, CA 94571
TEL: 707-374-6800 FAX: 707-374-6881
SHEET 1 OF 1
DRAWING NUMBER AP070406
REV
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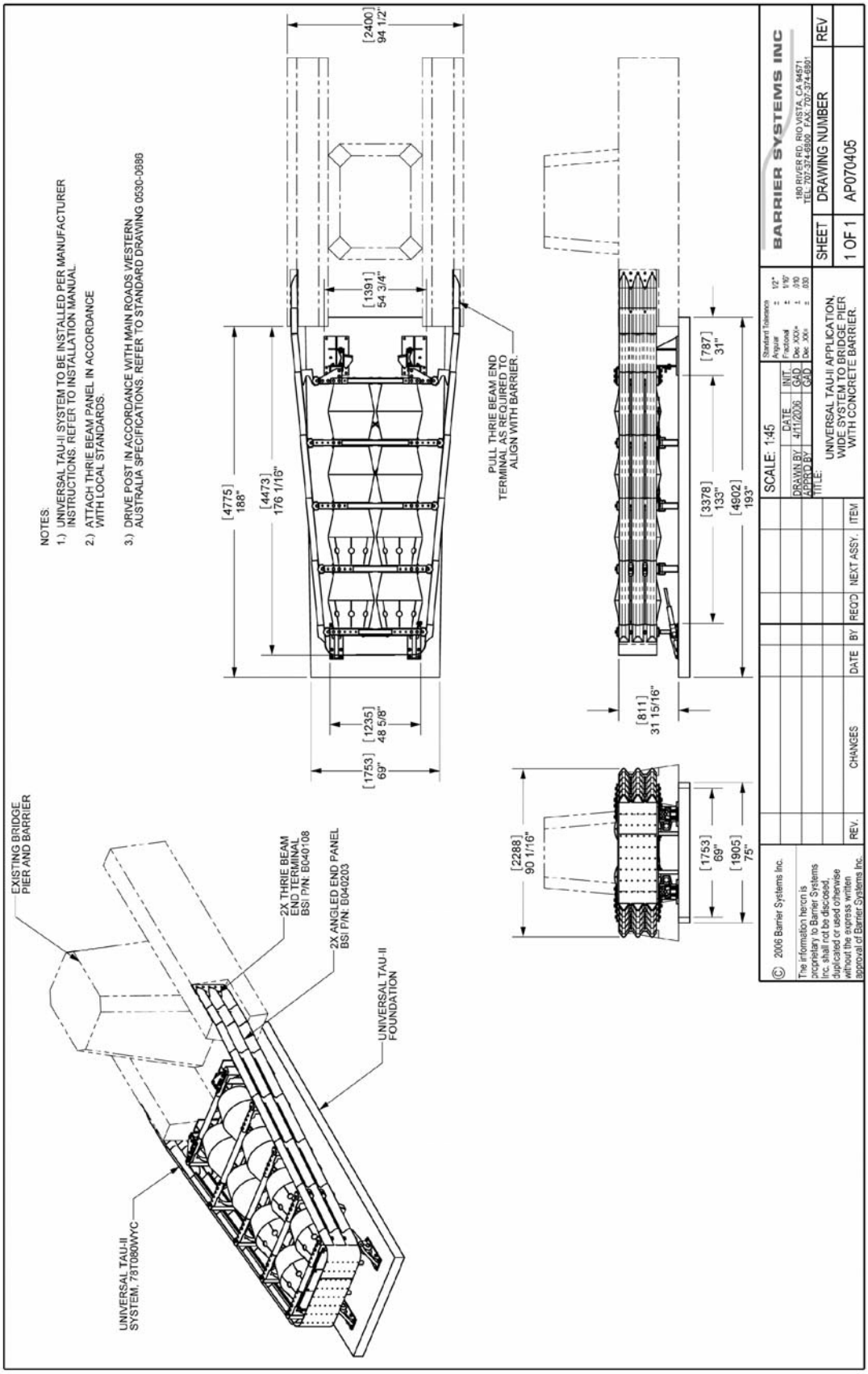
NOTES.
1.) UNIVERSAL TAU-II SYSTEM TO BE INSTALLED PER MANUFACTURER INSTRUCTIONS. REFER TO INSTALLATION MANUAL.
2.) ATTACH THRIE BEAM PANEL IN ACCORDANCE WITH LOCAL STANDARDS.
3.) DRIVE POST IN ACCORDANCE WITH MAIN ROADS WESTERN AUSTRALIA SPECIFICATIONS. REFER TO STANDARD DRAWING 0530-0086
[2400] 94 1/2"
[1391] 54 3/4"
[4775] 188"
[4473] 176 1/16"
[1753] 69"
[1235] 48 5/8"
PULL THRIE BEAM END TERMINAL AS REQUIRED TO ALIGN WITH BARRIER.
[787] 31"
[3378] 133"
[4902] 193"
[811] 31 15/16"
[2288] 90 1/16"
[1753] 69"
[1905] 75"
EXISTING BRIDGE PIER AND BARRIER
2X THRIE BEAM END TERMINAL BSI P/N: B040108
2X ANGLED END PANEL BSI P/N: B040203
UNIVERSAL TAU-II FOUNDATION
UNIVERSAL TAU-II SYSTEM. 78T080WYC
REV. CHANGES DATE BY REQ'D NEXT ASSY. ITEM
SCALE: 1:45
DRAWN BY: 4/11/2006 GAD
APPRD BY: GAD
TITLE: UNIVERSAL TAU-II APPLICATION, WIDE SYSTEM TO BRIDGE PIER WITH CONCRETE BARRIER.
Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16"
Dec .XXX± ± .010
Dec .XX± ± .030
BARRIER SYSTEMS INC
180 RIVER RD. RIO VISTA, CA 94571
TEL: 707-374-6800 FAX: 707-374-6891
SHEET 1 OF 1
DRAWING NUMBER AP070405
REV
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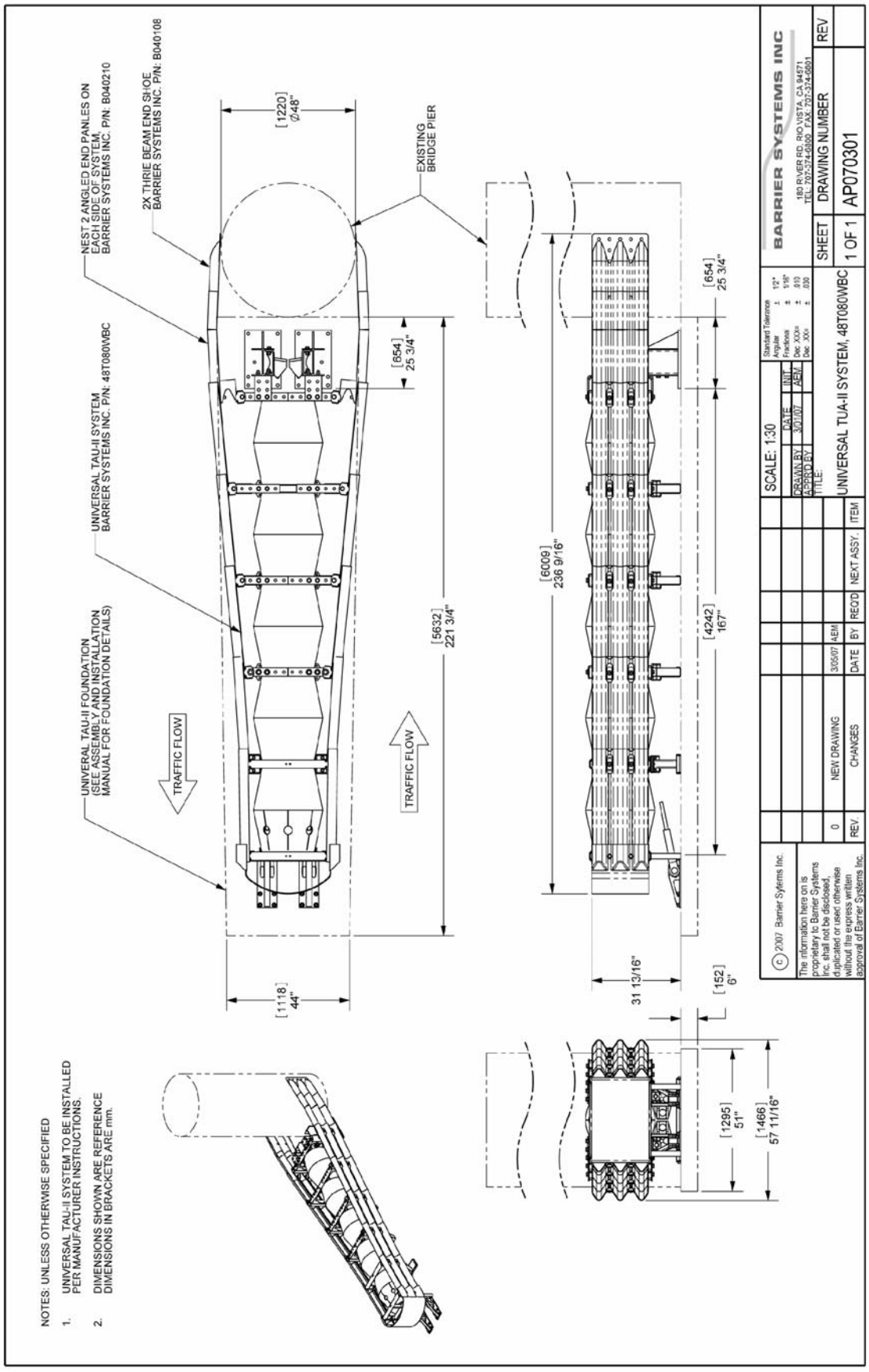
NEST 2 ANGLED END PANLES ON EACH SIDE OF SYSTEM. BARRIER SYSTEMS INC. P/N: B040210
2X THRIE BEAM END SHOE BARRIER SYSTEMS INC. P/N: B040106
UNIVERSAL TAU-II SYSTEM BARRIER SYSTEMS INC. P/N: 48T080WBC
UNIVERAL TAU-II FOUNDATION (SEE ASSEMBLY AND INSTALLATION MANUAL FOR FOUNDATION DETAILS)
EXISTING BRIDGE PIER
TRAFFIC FLOW
TRAFFIC FLOW
[1220] Ø48"
[654] 25 3/4"
[5632] 221 3/4"
[1118] 44"
[6009] 236 9/16"
[4242] 167"
[654] 25 3/4"
31 13/16"
[152] 6"
[1295] 51"
[1466] 57 11/16"
NOTES: UNLESS OTHERWISE SPECIFIED
1. UNIVERSAL TAU-II SYSTEM TO BE INSTALLED PER MANUFACTURER INSTRUCTIONS.
2. DIMENSIONS SHOWN ARE REFERENCE DIMENSIONS IN BRACKETS ARE mm.
REV
CHANGES
DATE
BY
REQD
NEXT ASSY.
ITEM
0
NEW DRAWING
3/06/07
AEM
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SCALE: 1:30
DRAWN BY
APPRD BY
DATE
3/01/07
INIT.
AEM
Standard Tolerance
Angular ± 1/2°
Fractions ± 1/16"
Dec .XXX= ± .010
Dec .XX= ± .030
TITLE:
UNIVERSAL TUA-II SYSTEM, 48T080WBC
BARRIER SYSTEMS INC
180 RIVER RD, RIO VISTA, CA 94571
TEL: 707-374-6800 FAX: 707-374-6801
SHEET
1 OF 1
DRAWING NUMBER
AP070301
REV

Universal TAU-II®
Attachment to BarrierGuard 800™
Installation Guide

Refer to the Universal TAU-II Installation and Maintenance Manual for more information, introduction, system overview, required tools, and other considerations for the Universal TAU-II systems.

The Universal TAU-II system is installed after the BarrierGuard 800 is fully deployed, installed, and anchored. Reference the BarrierGuard 800 Design, Installation, and Maintenance Manual for complete information on the BarrierGuard 800 barrier system implementation and installation.

The Universal TAU-II system utilizes a monolithic backstop that bolts directly in place of the terminal cover of the BarrierGuard 800. The front cable anchor remains as the only foundation anchorage required for the Universal TAU-II system. The front cable anchor is to be anchored to the same foundation type as the end of the BarrierGuard 800 that it is attached to (PC Concrete or Asphaltic Concrete). Anchorage shall be in accordance with
BSI specifications A040113.

Installation Procedure: *Each Procedure references a page number from the Universal TAU-II Installation Manual for further information –*

1.) Remove terminal cover from BarrierGuard 800 end section (if in place).

2.) Install and fasten Universal TAU-II BarrierGuard 800 Backstop in place. **(See diagram on next page).**

3.) Locate and position Front Cable anchor (see below). Drill and secure the appropriate anchors for the foundation used per BSI specification A040113. Use the Front Cable anchor as the drilling template. Use a BSI approved anchoring compound. See pages 12 &13.

4.) Place the Middle Bulkheads along the centerline of the system spaced approximately 34” [865mm] apart. See page 13.

5.) Thread the guide Cables through the legs of the Middle Bulkheads, threaded end first, starting from the front of the system. Loosely place the threaded end into the backstop lugs and spin the nut on to hold it in place. See pages 13 & 14.

6.) Pin the guide Cables to the Front Cable Anchor with the shackles. See page 14.

7.) Install Cable Guides. See pages 14 & 15.

8.) Attach Pipe Panel Mounts. See page 15.

9.) Install the End Panels and first Slider Panels starting at the Pipe Panel Mounts. If a transition is to be installed the End Panel will be replaced by the Angled End Panel. See page 16 & 72.

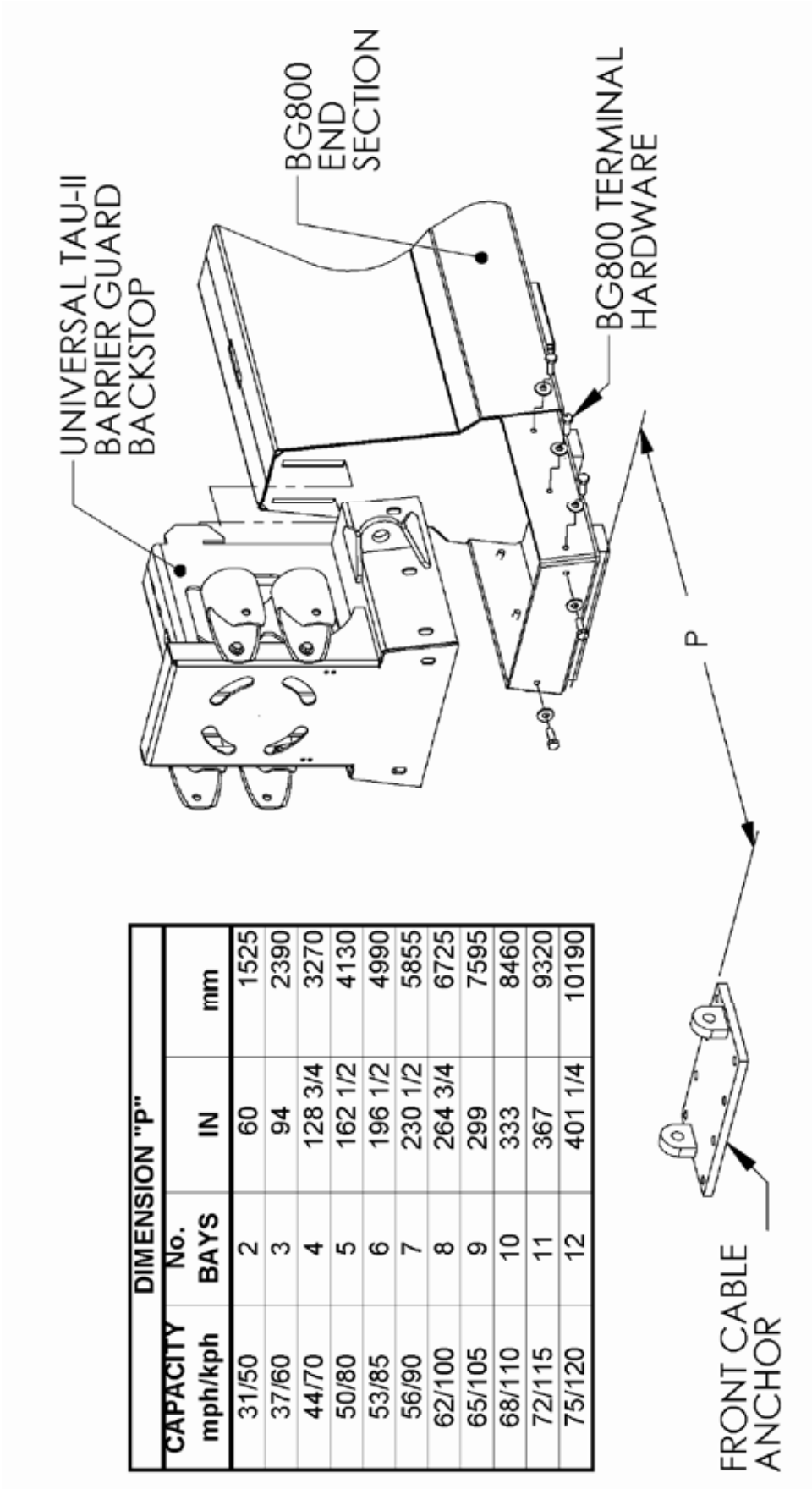
10.) Install Slider Panels. Start from the back of the system and move forward, overlapping the rearward panel. Secure the panels in place with the Slider Bolts. See pages 16 & 17.

11.) Install the Front Support, attach the Slider Panels, Nose Cover, and Leg Supports and connect to the first Middle Support with Slider Bolts. See page 18.

12.) Torque Slider Bolts and Front Panel Bolts and install Energy Absorbing Cartridges. See page 19.

13.) Apply tension to cables – Torque to specification. Ensure foundation anchors are properly cured. See page 20.

(See Installation Diagram on Next Page)



DIMENSION "P"			
CAPACITY mph/kph	No. BAYS	IN	mm
31/50	2	60	1525
37/60	3	94	2390
44/70	4	128 3/4	3270
50/80	5	162 1/2	4130
53/85	6	196 1/2	4990
56/90	7	230 1/2	5855
62/100	8	264 3/4	6725
65/105	9	299	7595
68/110	10	333	8460
72/115	11	367	9320
75/120	12	401 1/4	10190

Notes

Notes

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APPENDIX ‘F’

CRASH ATTENUATION BARRELS PRODUCT INFORMATION

Energite® III Fitch® Universal Module systems

Assembly and Maintenance Manual

Part No. 619488B

Revision E August 2012

TRINITY HIGHWAY PRODUCTS
ENERGY ABSORPTION SYSTEMS

Energite® III Fitch® Universal Module Systems

Assembly and Maintenance Manual

TRINITY HIGHWAY PRODUCTS
ENERGY ABSORPTION SYSTEMS
2525 Stemmons Freeway
Dallas, Texas 75207

Important: These instructions are to be used only in conjunction with the assembly, maintenance, and repair of the Energite® III/Fitch® Universal Module Systems. These instructions are for standard assembly specified by the appropriate highway authority only. In the event the specified system assembly, maintenance, or repair would require a deviation from standard assembly parameters, contact the appropriate highway authority engineer. This system has been accepted for use by the Federal Highway Administration for use on the national highway system under strict criteria utilized by that agency. Energy Absorption Systems representatives are available for consultation if required.

This Manual must be available to the worker overseeing and/or assembling the product at all times. For additional copies, contact Energy Absorption Systems at (888) 323-6374 or download from websites below.

The instructions contained in this Manual supersede all previous information and Manuals. All information, illustrations, and specifications in this Manual are based on the latest Energite® III/Fitch® Universal Module Systems information available to Energy Absorption Systems at the time of printing. We reserve the right to make changes at any time. Please contact Energy Absorption Systems to confirm that you are referring to the most current instructions.

Part No. 619488B
Revision E August 2012

Table of Contents

Customer Service Contacts

Energy Absorption Systems (a Trinity Highway Products company) is committed to the highest level of customer service. Feedback regarding the Energite® III/Fitch® Universal Module Systems, its assembly procedures, supporting documentation, and performance is always welcome. Additional information can be obtained from the contact information below:

Energy Absorption Systems:

Telephone:	(888) 323-6374 (USA Only) (214) 589-8140 (USA or International)
E-mail:	customerservice@energyabsorption.com
Internet: Energy Absorption Systems Trinity Highway Products, LLC Trinity Industries, Inc.	http://www.energyabsorption.com http://www.highwayguardrail.com http://www.trin.net

Important Introductory Notes

Proper assembly of the Energite® III/Fitch® Universal Module Systems is essential to achieve performance of the system under appropriate federal and state criteria. These instructions should be read in their entirety and understood before assembling the Energite® III/Fitch® Universal Module Systems. These instructions are to be used only in conjunction with the assembly of the Energite® III/Fitch® Universal Module Systems and are for standard assemblies only as specified by the applicable highway authority. In the event your system assembly requires or involves deviation from standard parameters or, during the assembly process a question arises, please contact the appropriate highway authority that specified this system at this particular location for guidance. Energy Absorption Systems is available for consultation with that agency. These instructions are intended for an individual who is qualified to both read and accurately interpret them as written. They are intended for the individual who is experienced and skilled in the assembly of highway products which are specified and selected by the highway authority.

A set of product and project shop drawings will be supplied by Energy Absorption Systems. The shop drawings will be for each section of the assembly. These drawings should be reviewed and studied thoroughly by a qualified individual who is skilled in interpreting them before the start of any assembly.

Important: Read safety instructions thoroughly and follow the assembly directions and suggested safe practices before assembling, maintaining, or repairing the Energite® III/Fitch® Universal Module Systems. Failure to follow this warning can result in serious injury or death to workers and/or bystanders. It further compromises the acceptance of this system by the FHWA. Please keep these instructions for later use.

Warning: Ensure that all of the Energite® III/Fitch® Universal Module Systems Warnings, Cautions, and Important statements within the Energite® III/Fitch® Universal Module Systems Manual are completely followed. Failure to follow this warning could result in serious injury or death.

Recommended Safety Rules for Assembly

*** Important Safety Instructions ***

This Manual must be kept in a location where it is readily available to persons who are skilled and experienced in the assembly, maintenance, or repair of the Energite® III/Fitch® Universal Module Systems. Additional copies of this Manual are available from Energy Absorption Systems by calling (888) 323-6374 or by email at customerservice@energyabsorption.com. This Manual may also be downloaded directly from the websites indicated below. Please contact Energy Absorption Systems if you have any questions concerning the information in this Manual or about the Energite® III/Fitch® Universal Module Systems.

Always use appropriate safety precautions when operating power equipment, mixing chemicals, and when moving heavy equipment or the Energite® III/Fitch® Universal Module Systems components. Gloves, safety goggles, steel toe boots, and back protection shall be used.

Safety measures incorporating traffic control devices specified by the highway authority must be used to provide safety for personnel while at the assembly, maintenance, or repair site.

Safety Symbols

This section describes the safety symbols that appear in this Energite® III/Fitch® Universal Module Systems Manual. Read the Manual for complete safety, assembly, operating, maintenance, repair, and service information.

Symbol	Meaning
	**Safety Alert Symbol:** Indicates Danger, Warning, or Caution. Failure to read and follow the Danger, Warning, Safety, or Caution indicators could result in serious injury or death to the workers and/or bystanders.

Warnings and Cautions

Read all instructions before assembling, maintaining, or repairing the Energite® III/Fitch® Universal Module Systems.

Warning: Do not assemble, maintain, or repair the barrier system until you have read this Manual thoroughly and completely understand it. Ensure that all Warnings, Cautions, and Important Statements within the Manual are completely followed. Please call Energy Absorption Systems at (888) 323-6374 if you do not understand these instructions. Failure to follow this warning could result in serious injury or death.

Warning: Safety measures incorporating appropriate traffic control devices specified by the highway authority must be used to protect all personnel while at the assembly, maintenance, or repair site. Failure to follow this warning could result in serious injury or death.

Warning: Use only Energy Absorption Systems parts that are specified herein for the Energite® III/Fitch® Universal Module Systems for assembling, maintaining, or repairing the Energite® III/Fitch® Universal Module Systems. Do not utilize or otherwise comingle parts from other systems even if those systems are other Energy Absorption Systems or Trinity systems. Such configurations have not been tested, nor have they been accepted for use. Assembly, maintenance, or repairs using unspecified parts or accessories is strictly prohibited. Failure to follow this warning could result in serious injury or death in the event of a vehicle impact with an UNACCEPTED system.

Warning: Do NOT modify the barrier system in any way. Failure to follow this warning could result in serious injury or death in the event of a collision.

Warning: Ensure that the barrier system and delineation used meet all federal, state, specifying agency, and local specifications. Failure to follow this warning could result in serious injury or death in the event of a collision.

Warning: Ensure that your assembly meets all appropriate Manual on Uniform Traffic Control Devices (MUTCD) and local standards. Failure to follow this warning could result in serious injury or death in the event of a collision.

Limitations and Warnings

The Energite® III/Fitch® Universal Module systems have been tested and evaluated per recommendations of the National Cooperative Highway Research Program (NCHRP) Report 350* for Test Level 3, gating, and non-redirective impact conditions. The Energite® III/Fitch® Universal Module systems, as currently designed with the proper array, have been shown in federally approved crash testing to be capable of decelerating and stopping light and heavy weight vehicles (820 to 2000 kg, 1810 to 4410 lbs.) when impacted head-on or at angles from 0 degrees to 15 degrees and at 100 km/h (62 mph). Tests were conducted on slopes less than 5% and without curbs.

The Energite® III/Fitch® Universal Module Systems are non-redirective crash cushions and should be used appropriately.

Curbs may create a vehicle ramping condition which could cause an untested effect on the impacting vehicle. Therefore, do not assemble this product on or near curbs.

Energy Absorption Systems, in compliance with the National Cooperative Research Highway Program 350 (NCHRP Report 350) “Recommended Procedures for the Safety Performance of Highway Safety Features”, contracts with FHWA approved testing facilities to perform crash tests, evaluation of tests, and submittal of results to the Federal Highway Administration for review.

The Energite® III/Fitch® Universal Module Systems was tested to meet the impact criteria, requirements, and guidelines of NCHRP Report 350. These tests, specifically set forth by FHWA, evaluate product performance by simulating those impacts outlined by NCHRP Report 350 involving a typical range of vehicles on our roadways, from lightweight cars (approx. 820kg [1800 lb.]) to full size pickup trucks (approx. 2000 kg [4400 lb.]) as specified by the FHWA. A product can be certified for multiple Test Levels. The Energite® III/Fitch® Universal Module Systems is certified to the Test Level(s) as shown below:

Test Level 3: 100 km/h [62 mph]

These FHWA directed tests are not intended to represent the performance of systems when impacted by every vehicle type or every impact condition existing on the roadway. This system is tested only to the test matrix criteria of NCHRP 350 as approved by FHWA.

Energy Absorption Systems does not represent nor warrant that the results of these controlled tests show that vehicle impacts with the products in other conditions would necessarily avoid injury to person(s) or property. Impacts that exceed the specifications of the system may not result in acceptable crash performance as outlined in NCHRP Report 350, relative to structural adequacy, occupant risk, and vehicle trajectory. Energy Absorption Systems expressly disclaims any warrant or liability for injury or damage to persons or property resulting from any impact, collision, or harmful contact with products, other vehicles, or nearby hazards or objects by any vehicle, object or person, whether or not the products were assembled by or under the direction of Energy Absorption Systems or by third parties.

Important Introductory Notes

Proper deployment and maintenance of the Energite® III/Fitch® Universal Module Systems is critical to achieve performance under appropriate state and federal guidelines. Take the time to thoroughly review this Manual, including the Limitations and Warnings section, before performing the necessary work. Do not attempt to assemble any Energite® III/Fitch® Universal Module Systems without the proper plans and assembly Manual from the manufacturer.

If you require additional information, or have questions about the Energite® III/Fitch® Universal Module Systems, please contact Energy Absorption Systems Customer Service Department. See Customer Service Contacts on Page 3 of this Manual.

System Overview

The Energite® III/Fitch® Universal Module systems are gating, non-redirective, and easy-to-assemble crash cushions consisting of a number of sand-filled modules that are assembled in a specific geometric array in front of a hazard.

Each module of the Energite® III consists of a one-piece barrel, a lid, and in some cases a cone insert. The cone insert is used to adjust the sand height or center-of-mass and the overall weight of the barrel. The barrel's weight requirement is determined by its place within the array.

Each module of the Fitch® Universal Module consists of one set of walls, one core, one lid and four zip strips. These components will make any weight module 90k 180, 320, 640, 960 kg (200, 400, 700, 1400 and 2,100 lb.) required.

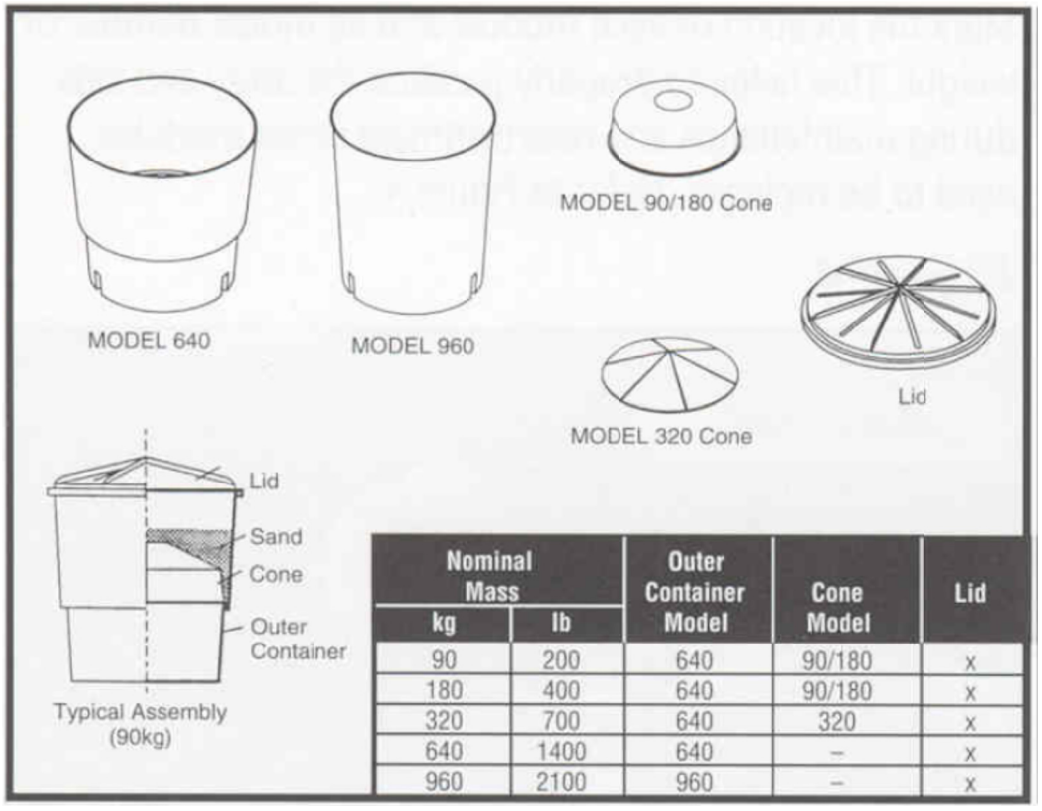
The Energite® III/Fitch® Universal Module Systems modules are available in 90, 180, 320, 640 and 960 kg (200, 400, 700, 1400 and 2,100 lb.) sizes. Refer to Figures 1A/B and 2A/B.

Recommended Tools

Before leaving for your site, be sure you have the following tools required for Energite® III/Fitch® Universal Module Systems Assembly.

- Sand truck
- Paint (to mark barrel locations on pavement)
- Shovel
- Broom
- Hammer and Nails (if required)
- Drill and Expansion Bolts (if required)

Note: The above list of tools is a general recommendation. Depending on specific site conditions and the complexity of the assembly specified by the appropriate highway authority, additional or fewer tools may be required. The decisions as to what tools are needed to perform the job are entirely within the discretion of the specifying highway authority and the authority's selected contractor performing the assembly of the system at the authority's specified assembly site.



Nominal Mass		Outer Container Model	Cone Model	Lid
kg	lb			
90	200	640	90/180	x
180	400	640	90/180	x
320	700	640	320	x
640	1400	640	–	x
960	2100	960	–	x

Figure 1A Energite® III

Site Preparation/Foundation

The Energite® III/Fitch® Universal Module Systems can be deployed on concrete or asphalt surfaces at sites with a maximum grade (lateral and longitudinal) of 5%. If the grade is greater than 5%, the site will require grading before assembly can begin.

All curbs and raised islands should be removed. Where this is not possible, a maximum of 100 mm (4”) high is recommended. The site must also be clear of debris and snow.

Inspect Shipment

Before assembling the Energite® III/Fitch® Universal Module Systems, check the inventory of parts against the shipping list supplied with the unit. Make sure that all parts have been received. In addition, verify that you have the array specifications provided by the manufacturer and responsible agency.

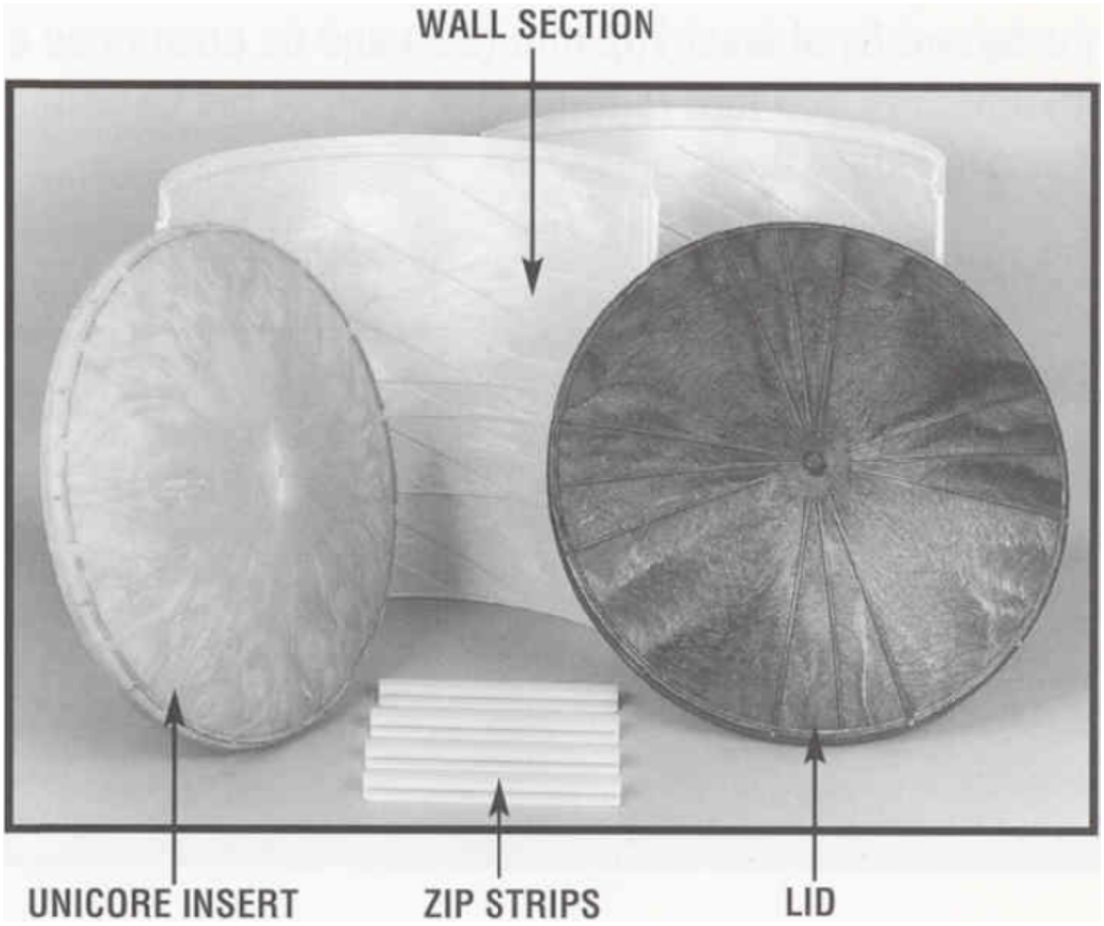


Figure 1B-Fitch® Universal Module System

Assembly

Caution: The Energite® III/Fitch® Universal Module Systems array should be designed and specified by a qualified engineer assigned this task by the appropriate highway authority. Improper placement could result in excessive "G" levels for errant vehicles and possible injuries to occupants.

The Energite® III/Fitch® Universal Module Systems should be assembled in order of the steps to follow.

1) **Place traffic control devices**

   Place traffic control devices to protect your crew and motorists.

2) **Review array specifications**

   Carefully review the array specification provided by a qualified engineer.

3) **Take measurements**

   Take measurements to properly position the first row of barrels (closest to the hazard) according to the specifications. These barrels must be laterally offset from the hazard by at least 762 mm (30") and be positioned a minimum of 305 mm (12") in front of the hazard (See Figure 2).

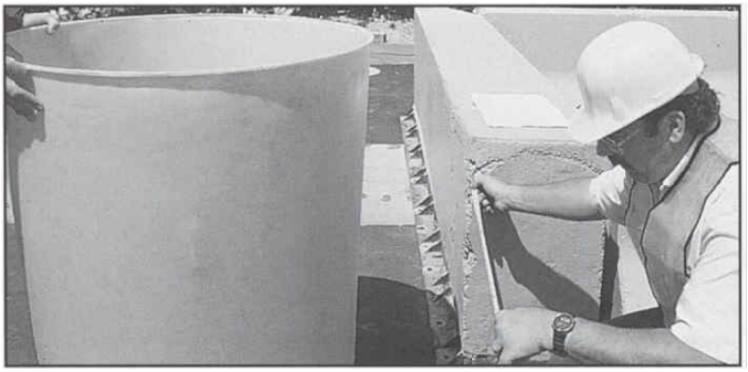


Figure 2

4) **Position the barrels**

   Position the barrels with approximately 152 mm (6") of space between them (measured at the top of the barrel) according to the array specifications (See Figure 3).

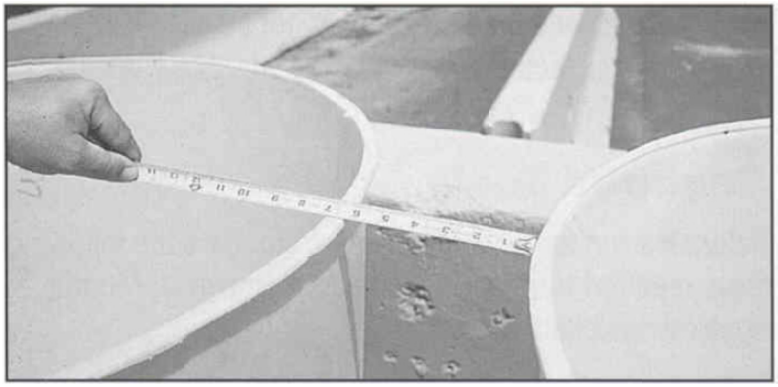


Figure 3

5) Trace its circumference

As each barrel is placed in its proper location, trace its circumference onto the pavement, then remove the barrel to allow for the next step.

6) Marking the location

Mark the location of each module and its model number or weight. This helps to properly position the array and aids during maintenance and refurbishment when modules need to be replaced (See Figure 4).

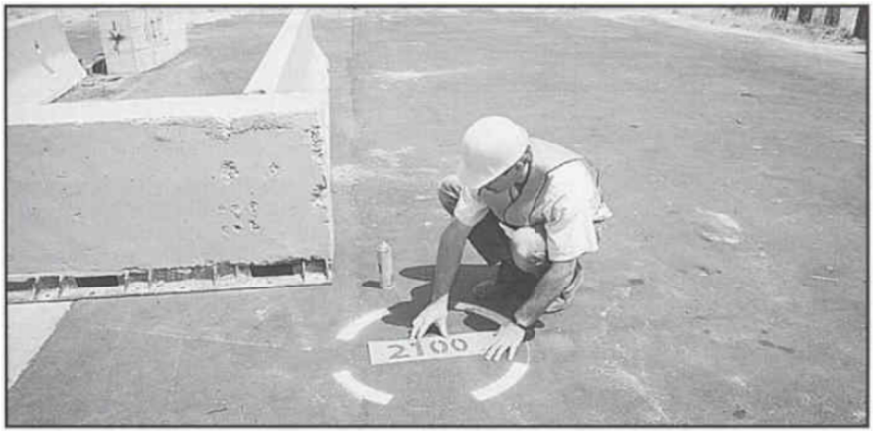


Figure 4

7) Moving barrels into position

After the location of each module is marked on the pavement, place the barrels back into their proper positions. Move the barrels into position one row at a time while they are empty (See Figure 5).

When Energite® III/Fitch® Universal Module Systems modules are placed on slopes or vibrating surfaces, the modules may be held into place on:

- Concrete by two expansion bolts through holes, 180 degrees apart in the bottom.
- Asphalt by four galvanized nails driven through the bottom, 90 degrees apart, 75 mm (3”) from the outside wall of the barrel with full penetration.

Figure 5

8) Placement of inner cones - Energite® III

Place the appropriate inner cones on the ledge inside the barrel for the 90, 180 and 320 kg (200, 400 and 700 lb.) modules. (The 640 and 960 kg modules do not require a cone insert.) Refer to Page 9 (Figure 1A) of this Manual for a drawing and description of the module components.

Note: The same Energite® III cone is used for the 90 and 180 kg (200 and 400 lb.) modules. Be sure that all cones are in the proper position (See Figure 6A).

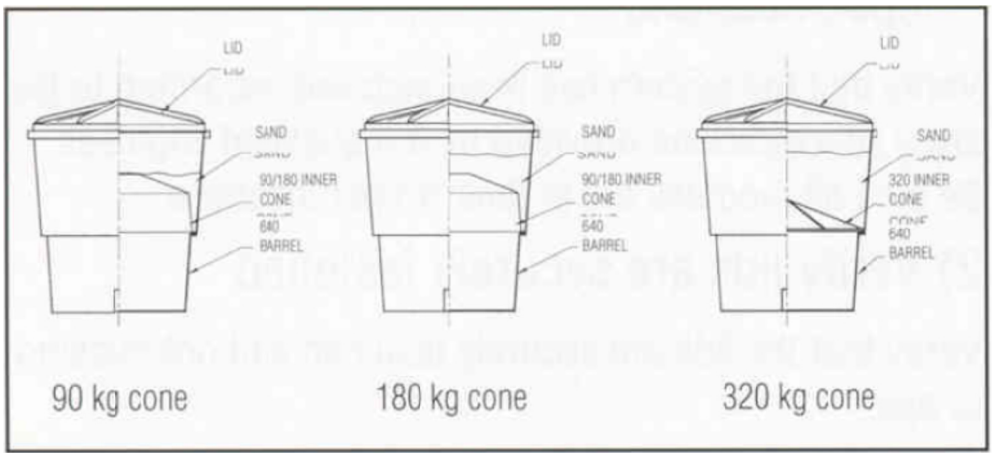


Figure 6A Energite® III System

9) Placement of inner cones – Fitch®

For a 200 lb. module place the Unicore on the top shelf (17”); fill to the scribe mark (FILL TO HERE FOR 200#) resulting in a 7” sand depth and a 12” void at top.

For a 400 lb. module place the Unicore on the top shelf (17”); fill to the scribe mark (FILL TO HERE FOR 400#) resulting in a 10.5” sand depth and a 8.5” void at top.

For a 700 lb. module place the Unicore on the second shelf from the top (14”); fill to the scribe mark (FILL TO HERE FOR 700#) resulting in a 16” sand depth and a 12” void at top.

For a 1400 lb. module place the Unicore on the third shelf from the top (8.5”); fill to the scribe mark (FILL TO HERE FOR 1400#) resulting in a 27.5” sand depth and no void at top.

For a 2100 lb. module place the Unicore on the bottom shelf (.5”); fill to the scribe mark (FILL TO TOP FOR 1400# + 2100#) resulting in a 35.5” sand depth and no void at top.

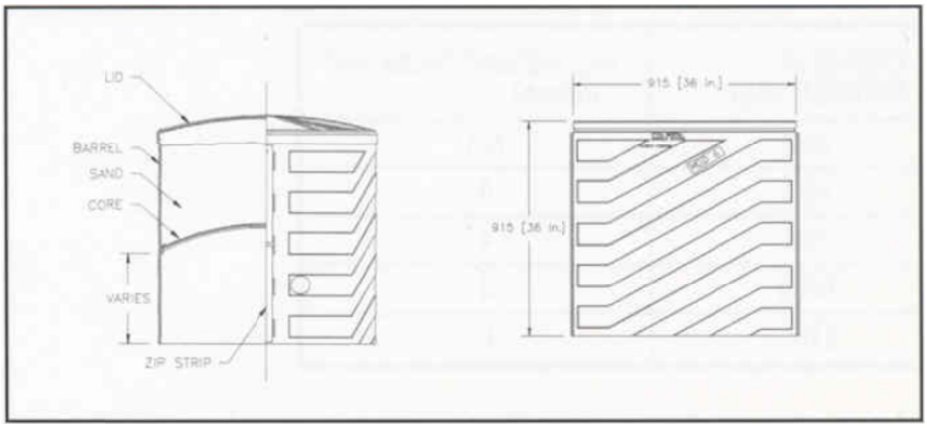


Figure 6B Fitch® Universal Module System

Note: Orient the zip strips towards oncoming traffic. A grazing impact now hits only side of the module. This leaves the zip strips and other side of the module intact, reducing cost of replacement parts and making for less clean-up (See Figure 6B).

10) Filling the barrels

Once the first row of modules (last row in array) is in place, they can be filled with the proper level of sand using a sand-filled cement truck (See Figure 7).

Figure 7

The sand must conform to ASTM C-33 (washed concrete sand or equal). The level is indicated on the decal located on the inside of the module. Fill heights marked on the decal are based on a sand density of 1600 kg/m3 (100 pcf). For other densities, see the “Fill Height” charts in Figures 8 and 9.

Caution: During the filling process, it is very important that the modules are filled with the proper level of sand. Refer to Figures 8 and 9, which show the correct Fill Heights for the sand.

Proper Sand Levels

FITCH® UNIVERSAL MODULE (lbs)	FILL HEIGHT FROM TOP (inches)
200	12
400	8.5
700	6
1400	Top
2100	Top

Figure 8-Fitch® Universal Module
Proper Sand Levels

ENERGITE® MODULE (lbs)	FILL HEIGHT FROM TOP (inches)
200	8.5
400	5
700	4
1400	3
2100	0

Figure 9 - Energite® III

Caution: If the modules are located where freezing temperatures might occur, mix the sand with 5% rock salt by weight to prevent the sand from freezing. Be sure the salt is evenly dispersed in the sand.

11) Lid Placement

The lids can be snapped firmly into place. After the first row is finished, the next row of modules can be positioned, filled, and the lids snapped on until all the rows are completed. Be sure the lids are snapped firmly into place to prevent water and debris from entering the barrels, which can adversely affect the system's performance.

Alternate Assembly Option

1) The Energite® Barrels feature a convenient one-piece design with a solid bottom. This allows the modules to be fully assembled and filled at a remote site and then transported to the deployment site. The fully-assembled modules can be lifted on and off the truck using a crane and lifting device.
2) Barrels may be placed on 100 mm (4") maximum height pallets for temporary assembly.

Checking the Assembled System

After assembling an array, it is important to check the system before leaving the site:

1) **Verify assembly according to array specifications**

   Verify that the system has been assembled according to the array specifications provided by the qualified engineer. Be sure all modules are in their proper locations.

2) **Verify lids are securely fastened**

   Verify that the lids are securely fastened and not missing or ajar.

3) **Clean up**

   Clean up any debris around the system that could cause ramping.

Maintenance Checklist

It is important to inspect the systems often because an impact can occur at any time. Two types of inspections should be performed regularly:

- Visual Drive-by Inspection
- Walk-up Inspection

Visual Drive-By Inspection Checklist

Drive-by inspections are recommended as needed based upon volume of traffic and frequency of impacts. If any of the following conditions are noticed, a walk-up inspection is warranted. Required corrections must be made as soon as possible.

1) **Check the modules**

   Check the modules for any visible damages.

2) **Check the lids**

   Check the lids to see if any are missing or ajar.

3) **Check for debris**

   Check for debris around the modules that could cause ramping.

4) **Check for objects**

   Check for objects on top of the modules

5) **Note the location**

   Note the location and condition of the Energite® III/Fitch® Universal Module systems array and date of the visual drive-by inspection in your maintenance log.

Walk-Up Inspections Checklist

Physical inspections are recommended as needed based upon volume of traffic and impact history. If system repairs are necessary, refer to the Refurbishment Instructions in the Manual. Complete the following steps during the walk-up inspection:

1) **Lids in place**

   Be sure all lids are firmly in place.

2) **Lids not inverted**

   Be sure lids are not inverted inwards.

3) **Modules**

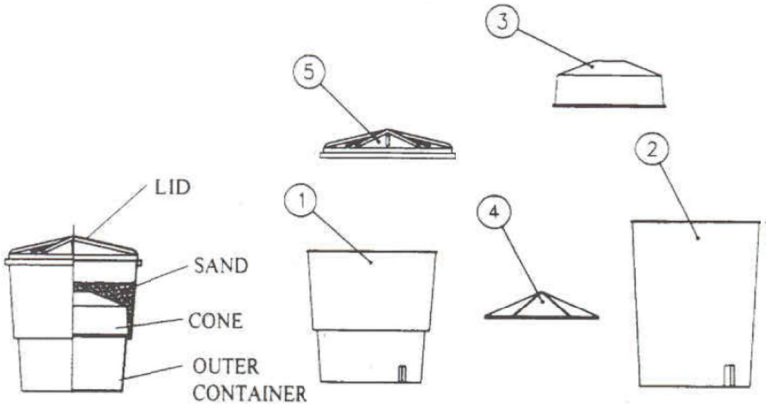
   Be sure modules are not tilted or leaning.

4) **Damaged modules**

   Be sure modules are not cracked and outer shells are not damaged

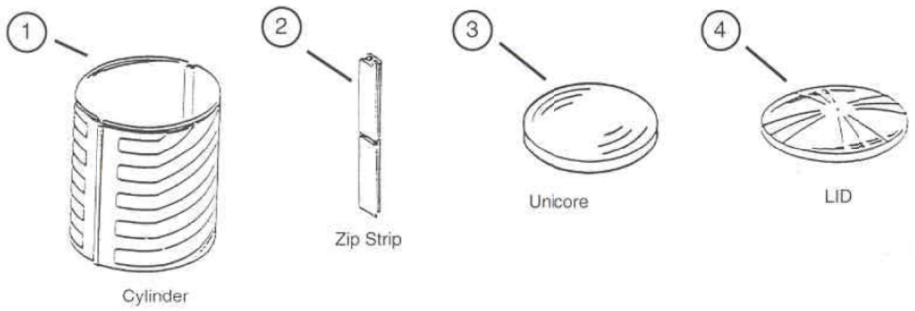
5) **Proper location**

   Be sure modules have not been moved from their proper locations.



ITEM	PART NO.	DESCRIPTION
1	2731191-0100	Energite® III, 640(1400), Outer Container
2	2731261-0100	Energite® III, 960(2100), Outer Container
3	2731201-0000	Energite® III, 90/180(200/400), Inner Cone
4	2731271-0000	Energite® III, 320(700), Inner Cone
5	2731241-0000	Energite® III, Lid, Black

Figure 10-Energite® III



ITEM	PART NO.	DESCRIPTION
1	2200	Fitch®, Wall Half
2	2510 2520	Fitch®, Zip Strip w/ Hole Fitch®, Zip Strip w/o Hole
3	2400	Fitch®, Unicore
4	2300	Fitch®, Lid

Figure 11-Fitch® Universal Module Systems

Refurbishment Procedures

Because much of the Energite® III/Fitch® Universal Module Systems are destroyed on impact, refurbishment usually involves replacing the damaged barrels, which is sometimes the entire system. When refurbishing the system, complete the following steps. Additional information is available in the Energite® III/Fitch® Universal Module Systems Assembly Manual if required.

Note: The Energite® III System has been enhanced. The Model 4 cone has been eliminated, reducing the number of parts. What was previously the Model 2 cone is now referred to as the Model 90/180 cone and is used for both the 90 and 180 kg modules. When upgrading or repairing arrays, it is recommended to replace cones to meet the current standards.

1) **Setting up traffic control**

   Set up traffic control to protect your crew as designated by the appropriate highway authority in their plans and specifications for this particular job.

2) **Removal of debris**

   Using brooms, shovels and other equipment, remove the sand and debris from the site. This sand may be used later for filling the replacement barrels, but it must first be cleared of all debris.

3) **Positioning of barrels**

   Place the first row (closest to the hazard) of new barrels in their proper positions using the markings on the roadway surface, which indicate the location of the new barrels.

Caution: At the time of assembly, a number indicating the location for each model type should have been painted on the roadway surface. Assemble the array following the markings at the site.

4) **Other surfaces**

When replacement modules are placed on slopes or vibrating surfaces, the modules may be held into place on:

- Concrete by two bolts through holes, 180 degrees apart in the bottom.
- Asphalt by four galvanized nails driven through the bottom, 90 degrees apart, 75 mm (3”) from the outside wall of the barrel with full penetration.

5) **Placement of inner cones**

Place the appropriate inner cones on the ledge inside the replacement barrels for the 90, 180 and 320 kg (200, 400 and 700 lb.) modules. (The 640 and 960 kg modules do not require a cone insert.)

Note: The same cone is used for the 90 and 180 kg (200 and 400 lb.) modules. Be sure that all cones are in the proper position and the module is filled to the proper sand level (See Page 13).

6) **Filling of sand**

Once the first row of modules is in place, they can be filled with the proper level of sand. (An efficient method of quickly filling the Energite® III/Fitch® Universal Module Systems modules is to use a sand filled cement mixer.)

The sand must conform to ASTM C-33 (washed concrete sand or equal). The level is indicated on the decal located on the inside of the module. Fill heights marked on the decal are based on a sand density of 1600 kg/m3 (100 pcf).

Caution: If the modules are located where freezing temperatures might occur, mix the sand with 5% rock salt by weight to prevent the sand from freezing. The rock salt should be evenly dispersed throughout the sand.

7) **Snap the lids**

Snap the lids firmly into place and begin working on the next row of modules using the same procedure until all rows are completed.

8) **Clean up**

Clean up any final debris at the site.

Alternate Refurbishment Option

The Energite® III barrels feature a convenient, one–piece design with a solid bottom. This allows the replacement modules to be fully assembled and filled at a remote site and then transported to the damaged site. The fully-assembled modules can be lifted on and off the truck using a crane and lifting device.

The Fitch® Universal Module design allows quick refurbishment on nuisance hits and may require one-half of the modules to be replaced.

Maintenance Log

Date	System Location	Type of Inspection		Comments
		Drive-By	Walk-Up	

Notes:

Notes:

2525 Stemmons Freeway
Dallas, Texas 75207
888-323-6374 (USA only)
214-589-8140 (Outside USA)
www.energyabsorption.com
www.highwayguardrail.com

Form No. 2050	**INSTALLATION INSTRUCTION TRAFFIX DEVICES SAND BARREL**	Approval Date: 10/1/99

1. ORDERING INSTRUCTIONS

1.1 Part Numbers – Barrels are normally ordered using part numbers 48210-0, 48140-0 and 48247-AB. These assemblies include the lid. For part number #48247-AB the assembly has two half barrels that lock together to form one barrel.

2. FIELD SITE CONDITIONS AND LAYOUT

2.1 Surface Conditions – Inspect the area where the sand barrels will be placed. Make sure that the surface is concrete or asphalt if specified in the plans. Also make sure that the grade is not more than 3 degrees and that the surface is smooth and on plane.

2.2 Array Layout – Review the plans and determine the center line for the rows of barrels. Mark the center line with a chalk line. Position the barrel lids centered on the line with the correct spacing between the lids. Mark around the lids with chalk to establish the barrel positions. Remove the lids and place the sand barrels in the correct position.

3. FIELD ASSEMBLY

3.1 Barrel Assembly – All part #48247S half barrels have six butyl caulk strips that are used as contact adhesives. When upper half barrels #48247S are installed on top of #48247P and rotated the two barrels will interlock and the two can be lifted without separation.

3.2 Barrel Disassembly – After half barrels #48247S and #48247P have been interlocked they will be difficult to separate unless the following procedure is followed. Use the barrel lifting ring to elevate the assembly and pry the half barrels apart along several locations around the circumference.

3.3 Sand Filling – All barrels are marked with the sand fill lines indicated on the outside of the barrels. Place all barrels in the correct location as designated in the site plans. Sand filling is best done by having a concrete truck deliver the sand and pouring the sand into the barrel. WARNING - sand used in barrels needs to disperse on impact do not use sand unless it has been washed and has less than 5% water content.

3.4 Lid Attachment – Lids are designed to fit tightly to prevent theft. Place lid on barrel with the lid fitted on the barrel at the inside of the array position. Apply pressure at the rim to snap the lid on. Work on each side up to the front. Push down for final set of lid.

3.5 Lid Removal – If the lid needs to be removed a pry-bar or fiberglass batten will easily remove the lid. Slip the pry-bar vertically between the lid and the rim of the barrel and start prying along rim.

4. LIFTING BARRELS

4.1 Work Zones – Check to see if wooden pallets are approved for work zones, if they are, move pallet into position with a fork lift. For work zones not using pallets, move barrels with the optional aluminum lifting ring.

4.2 Permanent Sites – For locations where the barrels are set on a prepared surface use the lifting ring to position barrels. Barrels use two different diameter lifting flanges. Use the aluminum insert in the lifting ring when lifting the smaller diameter flange found on the 700-400 lb. (320 – 180 kg.) capacity barrel.

5. INSPECTION

5.1 Sand Height – Sand barrels can be easily inspected using several methods. Refer to the marking on the barrel for the correct sand height. Hit the side of the barrel and view the barrel on the shaded side. A change of sound and a difference in light transmission should be noticed at the top of the sand.

APPENDIX ‘G’

ET-31 PRODUCT INFORMATION

ET-31™ Guardrail End Treatment

Product Description Assembly Manual

Part No. 620182B

Created January 2013

TRINITY HIGHWAY PRODUCTS
ENERGY ABSORPTION SYSTEMS

ET-31™ Guardrail End Treatment

Product Description
Assembly Manual

TRINITY HIGHWAY PRODUCTS
ENERGY ABSORPTION SYSTEMS

2525 Stemmons Freeway
Dallas, Texas 75207

Important: These instructions are to be used only in conjunction with the assembly, maintenance, and repair of the ET-31™ Guardrail End Treatment. These instructions are for standard assembly specified by the appropriate highway authority only. In the event the specified system assembly, maintenance, or repair would require a deviation from standard assembly parameters, contact the appropriate highway authority engineer. This system has been determined to meet the criteria for eligibility for reimbursement by the Federal Highway Administration for use on the national highway system under strict criteria utilized by that agency. A Trinity Highway Products, LLC representative is available for consultation if required.

This Manual must be available to the worker overseeing and/or assembling the product at all times. For additional copies, contact Trinity Highway Products at (888) 323-6374 or download from the website listed below.

The instructions contained in this Manual supersede all previous information and Manuals. All information, illustrations, and specifications in this Manual are based on the latest ET-31™ Guardrail End Treatment information available to Trinity Highway Products at the time of printing. We reserve the right to make changes at any time. Please contact Trinity Highway Products to confirm that you are referring to the most current instructions.

Part No. 620182B
Created January 2013

Table of Contents

Customer Service Contacts

Trinity Highway Products, LLC is committed to the highest level of customer service. Feedback regarding the ET-31™ Guardrail End Treatment, its assembly procedures, supporting documentation, and performance is always welcome. Additional information can be obtained from the contact information below.

Trinity Highway Products:

Telephone:	(888) 323-6374 (U.S. Calls) (214) 589-8140 (International Calls)
Fax:	(214) 589-8423
E-mail:	product.info@trin.net
Internet: Trinity Highway Products, LLC	http://www.highwayguardrail.com

Regional Telephone Contacts:

Dallas, Texas	(800) 527-6050
Centerville, Utah	(800) 772-7976
Elizabethtown, Kentucky	(800) 282-7668
Girard, Ohio	(800) 321-2755
Orangeburg, South Carolina	(800) 835-9307
International	+1 214-589-8140

Important Introductory Notes

Proper assembly of the ET-31™ Guardrail End Treatment is essential to achieve performance of the system under appropriate federal and state criteria. These instructions should be read in their entirety and understood before assembling the ET-31™ Guardrail End Treatment. These instructions are to be used only in conjunction with the assembly of the ET-31™ Guardrail End Treatment and are for standard assemblies only as specified by the applicable highway authority. In the event your system assembly requires or involves deviation from standard parameters or, during the assembly process a question arises, please contact the appropriate highway authority that specified this system at this particular location for guidance. Trinity Highway Products is available for consultation with that agency. These instructions are intended for an individual who is qualified to both read and accurately interpret them as written. They are intended for the individual who is experienced and skilled in the assembly of highway products which are specified and selected by the highway authority.

Important: Read safety instructions thoroughly and follow the assembly directions and suggested safe practices before assembling, maintaining, or repairing the ET-31™ Guardrail End Treatment. Failure to follow this warning can result in serious injury or death to workers and/or bystanders. It further compromises the acceptance of this system by the FHWA. Please have these instructions available for use and reference by anyone involved in the assembly of the product.

Warning: Ensure that all of the ET-31™ Guardrail End Treatment Warnings, Cautions, and Important Statements within the ET-31™ Guardrail End Treatment Manual are completely followed. Failure to follow this warning could result in serious injury or death in the event of a collision.

Recommended Safety Rules ET-31™ Guardrail End Treatment

* Important Safety Instructions *

This Manual must be kept in a location where it is readily available to persons who are skilled and experienced in the assembly, maintenance, or repair of the ET-31™ Guardrail End Treatment system. Additional copies of this Manual are immediately available from Trinity Highway Products by calling (888) 323-6374 or by email at product.info@trin.net. This Manual may also be downloaded directly from the websites indicated below. Please contact Trinity Highway Products if you have any questions concerning the information in this Manual or about the ET-31™ Guardrail End Treatment.

Always use appropriate safety precautions when operating power equipment and when moving heavy equipment or the ET-31™ Guardrail End Treatment components. Gloves, safety goggles, steel toe boots, and back protection should be used.

Safety measures incorporating traffic control devices specified by the highway authority must be used to provide safety for personnel while at the assembly, maintenance, or repair site.

Safety Symbols

This section describes the safety symbols that appear in this ET-31™ Guardrail End Treatment Manual. Read the Manual for complete safety, assembly, operating, maintenance, repair, and service information.

Symbol	Meaning
	**Safety Alert Symbol:** Indicates Danger, Warning, Important, or Caution. Failure to read and follow Danger, Warning, Safety, or Important Statement indicators could result in serious injury or death to workers and/or bystanders.

Warnings and Cautions

Read all instructions before assembling, maintaining, or repairing the ET-31™ Guardrail End Treatment.

Warning: Do not assemble, maintain, or repair the ET-31™ Guardrail End Treatment until you have read this Manual thoroughly and completely understand it. Ensure that all Warnings, Cautions, and Important Statements within the Manual are completely followed. Please call Trinity Highway Products at (888) 323-6374 if you do not understand these instructions. Failure to follow this warning could result in serious injury or death.

Warning: Safety measures incorporating appropriate traffic control devices specified by the highway authority must be used to protect all personnel while at the assembly, maintenance, or repair site. Failure to follow this warning could result in serious injury or death.

Warning: Use only Trinity Highway Products parts that are specified herein for the ET-31™ Guardrail End Treatment for assembling, maintaining, or repairing the ET-31™ Guardrail End Treatment. **Do not utilize or otherwise comingle parts from other systems** even if those systems are other Trinity Highway Products systems. Such configurations have not been tested, nor have they been accepted for use. Assembly, maintenance, or repairs using unspecified parts or accessories is strictly prohibited. Failure to follow this warning could result in serious injury or death in the event of a vehicle impact with an UNACCEPTED system.

Warning: Do NOT modify the ET-31™ Guardrail End Treatment in any way. Failure to follow this warning could result in serious injury or death.

Warning: Ensure that the ET-31™ Guardrail End Treatment and delineation used meet all federal, state, specifying agency, and local specifications. Failure to follow this warning could result in serious injury or death.

Warning: Ensure that your assembly meets all appropriate Manual on Uniform Traffic Control Devices (MUTCD) and local standards. Failure to follow this warning could result in serious injury or death.

Warning: Be aware of hazards of using compressed air (small objects may become projectiles). Failure to follow this warning can result in serious injury or death to the workers and/or bystanders.

Warning: DO NOT perform assembly, maintenance, or repair, if the ET-31™ Guardrail End Treatment site, shoulder, or traveled area is covered or encroached by road debris. Failure to follow this warning could result in serious injury or death in the event of a collision.

Warning: Ensure that the entire work zone site is well lighted at all times. Failure to follow this warning could result in serious injury or death to the workers and/or bystanders.

Warning: Use caution when working near public roads. Be mindful of vehicles in motion nearby. Failure to follow this warning could result in serious injury or death to the workers and/or bystanders.

Warning: Safety measures, incorporating traffic control devices, must be used to protect all personnel, while at the assembly, maintenance, or repair site. Failure to follow this warning could result in serious injury or death to the workers and/or bystanders. Trinity Highway Products offers an economical and effective truck mounted attenuator, the MPS-350, for the protection of workers in work zones. For more information on the MPS-350, call (888) 323-6374 or visit the Trinity Highway Products website at www.highwayguardrail.com.

Warning: Ensure that all guardrail products and delineation meet all federal, state or specifying agency, and local specifications. Failure to follow this warning could result in serious injury or death in the event of a collision.

Warning: DO NOT place a Steel Yielding Treatment Post (SYTP™) at location No. 1. Failure to follow this warning could result in serious injury or death in the event of a collision.

Warning: DO NOT place a Wood 6’ 0” long Controlled Release Terminal (CRT) post at location No. 1. Failure to follow this warning could result in serious injury or death in the event of a collision.

Warning: DO NOT bolt the Rail Panel in any fashion to the Post at location No. 1 in any of the ET-31™ Guardrail End Treatments. Doing so may impede the extrusion of the rail through the Head.

Note: The Head is attached to the No. 1 Post with an upper and lower 3/8” diameter fastener that has been shown to shear during impact within NCHRP 350 criteria.

Failure to follow this warning could result in serious injury or death in the event of a collision

Warning: Ensure that there is proper site grading for tube and post placement, as dictated by the state or specifying agency, pursuant to FHWA acceptance. Failure to follow this warning could result in serious injury or death in the event of a collision.

Warning: Ensure that the proper leaveout (the specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement for any posts. Surrounding posts with rigid pavement such as any thickness of concrete or asphalt will prevent post movement in the soil and is NOT allowed. Failure to follow this warning could result in serious injury or death in the event of a collision.

Warning: Ensure that all of the ET-31™ Guardrail End Treatment Warnings, Cautions, and Important Statements within the ET-31™ Guardrail End Treatment Manual are completely followed. Failure to follow this warning could result in serious injury or death in the event of a collision.

Warning: Always use safety precautions when performing assembly, maintenance or repair, mixing chemicals, and/or moving heavy equipment. Wear steel toe shoes, gloves, safety goggles, and back protection. Failure to follow this warning could result in serious injury or death to the workers and/or bystanders.

Warning: Ensure all Wood Blocks or Composite Blocks used with Steel Posts are routered to establish a fixed vertical orientation relative to the Posts. Failure to follow this warning could result in serious injury or death in the event of a collision.

Warning: Ensure that this assembly conforms with the guidance provided by the *AASHTO Roadside Design Guide*, including, but not limited to, those regarding placement on curbs or islands. Failure to follow this warning could result in serious injury or death in the event of a collision.

Warning: Any grout, backfill, or other materials (such as concrete, asphalt, or soil) must be low enough so as not to obstruct, constrain, or otherwise engage the Bearing Plate. Failure to eliminate the interaction of soil or materials with the Bearing Plate will hinder the performance of the ET-31™ Guardrail End Treatment and could result in serious injury or death in the event of a collision.

Caution: Ensure before assembling, maintaining, or repairing the ET-31™ Guardrail End Treatment that no parts are frayed, damaged, or broken. Failure to follow this warning could result in serious injury to the workers and/or bystanders.

Warning: Do not place anything under the rail to post bolt head that would prevent the bolt from pulling through the Rail Panel. Failure to follow this warning could result in serious injury or death in the event of a collision.

Know Your ET-31™ Guardrail End Treatment

ET-31™ Guardrail End Treatment
NCHRP Report 350 Test Level 3
System Length 34'-4 1/2" (10.48 m)

For specific assembly, maintenance, or repair details refer to the state or specifying agency's standard drawings and/or Trinity Highway Products standard layout drawings.

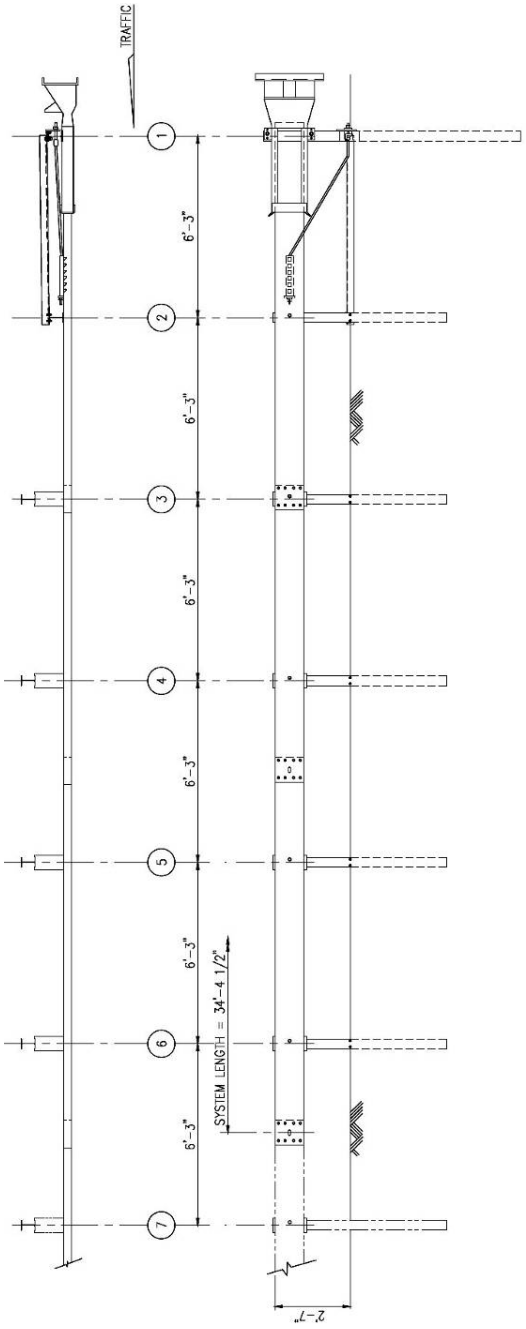


Figure 1 (TL-3)

[This drawing represents one version of the 34'-4 1/2" (10.48 m) system]

Alternative Post Combinations

At Post locations 1 and 2, the alternates to HBA Post at location 1 and 6' Steel Yielding Treatment Post (SYTP) at location 2 are:

	Post Location 1	**Post Location 2**
Option 1	HBA Post	Short Foundation Tube with SYT Post Insert
Option 2	Long Foundation Tube with Wood Post insert	6’ SYTP or short Foundation Tube with SYT Post Insert
Option 3	Long foundation Tube with Wood Post Inserts	Long foundation Tube with Wood Post Inserts
Option 4	Short Foundation Tube with Soil Plate and Wood Post Inserts	Short Foundation Tube with Soil Plate and Wood Inserts
Option 5	Long Foundation Tube with Wood Post Inserts or Short Foundation Tube with Soil Plate and Wood Post Inserts	6’ SYTP or Short Foundation Tube with SYT Post Insert

For post locations 3 through 6, alternates to 6’ SYT posts are:

- All Short Tubes with Wood Post Inserts
- All 6’ Wood CRT Posts
- All Short Foundation Tubes with SYT Post Insert
- Any combination of above options, as accepted by the FHWA and dictated by the state or specifying agency

ET-31™ Guardrail End Treatment
NCHRP Report 350 Test Level 3
System Length 40'-7 1/2" (12.35 m)

For specific assembly, maintenance, or repair details refer to the state or specifying agency's standard drawings and/or Trinity Highway Products standard layout drawings.

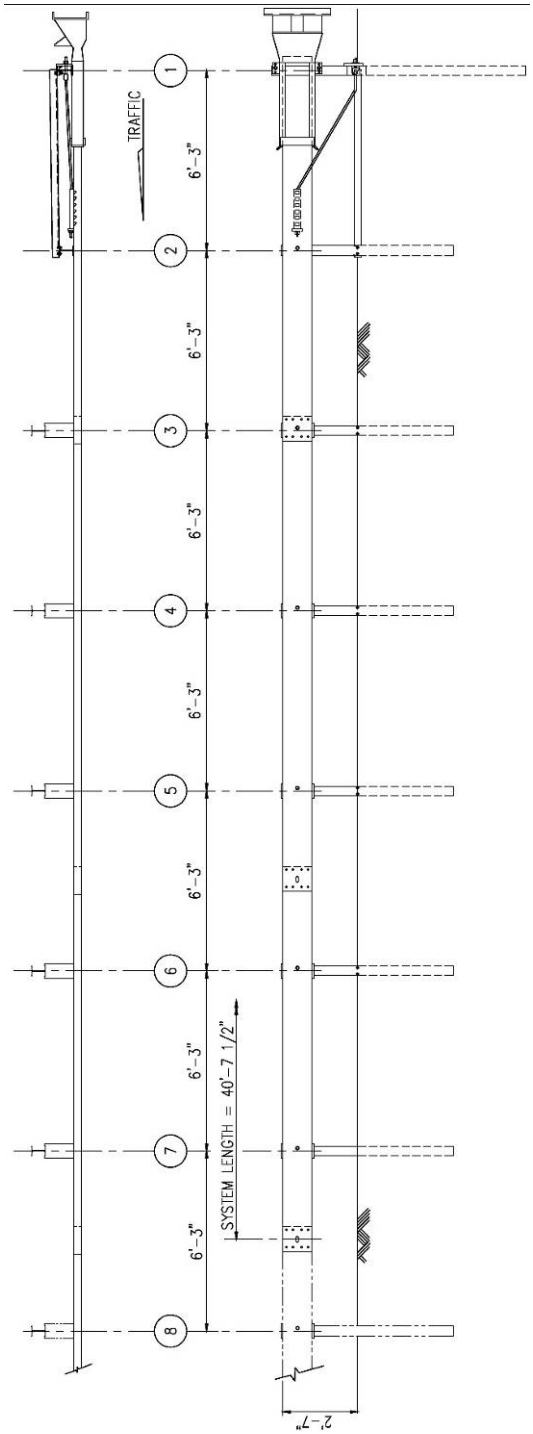


Figure 2 (TL-3)

[This drawing represents one version of the 40'-7 1/2" (12.38 m) system]

Alternative Post and Rail Panel Combinations

At Post locations 1 and 2, the alternates to HBA Post at location 1 and 6' Steel Yielding Treatment Post (SYTP) at location 2 are:

	Post Location 1	**Post Location 2**
Option 1	HBA Post	Short Foundation Tube with SYT Post insert
Option 2	Long Foundation Tube with Wood Post insert	6’ SYTP or short foundation Tube with SYT Post insert
Option 3	Long Foundation Tube with Wood Post Inserts	Long foundation Tube with Wood Post Inserts
Option 4	Short Foundation Tube with soil plates and Wood Post Inserts	Short Foundation Tube with soil plates and Wood Inserts
Option 5	Long foundation Tube with soil Post insert or Short Foundation Tube with soil plate and Wood Post Inserts	6’ SYTP or Short Foundation Tube with SYT Post insert

For Post locations 3 through 6, alternates to 6’ SYT Posts are:

- All Short Tubes with Wood Post Inserts
- All 6’ Wood CRT Posts
- All Short Foundation Tubes with SYT Post insert
- Any combination of above options as accepted by the FHWA and dictated by the state or specifying agency

For Post location 7:

- Steel or Wood line Post dictated by the state or specifying agency

ET-31™ Guardrail End Treatment
NCHRP Report 350 Test Level 3
System Length 46'-10 1/2" (14.29 m)

For specific assembly, maintenance, or repair details refer to the state or specifying agency's standard drawings and/or Trinity standard layout drawings.

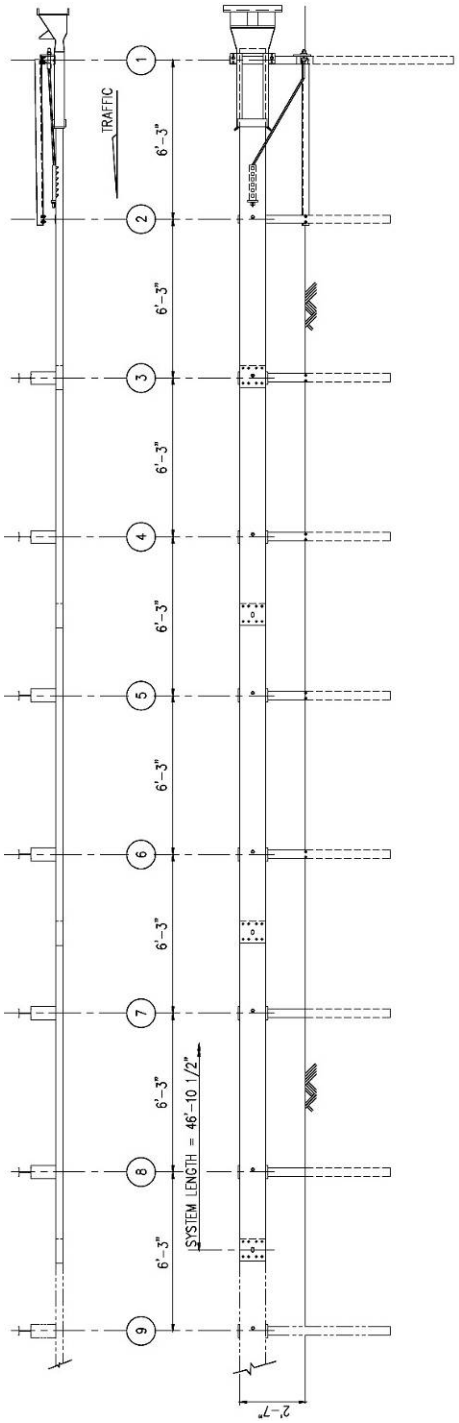


Figure 3 (TL-3)

[This drawing represents one version of the 46'-10 1/2" (14.29 m) system]

Alternative Post and Rail Panel Combinations

At Post locations 1 and 2, the alternates to HBA Post at location 1 and 6' Steel Yielding Treatment Post (SYTP) at location 2 are:

	Post Location 1	**Post Location 2**
Option 1	HBA Post	Short Foundation Tube with SYT Post insert
Option 2	Long Foundation Tube with Wood Post Insert	6’ SYTP or Short Foundation Tube with SYT Post Insert
Option 3	Long Foundation Tube with Wood Post Inserts	Long foundation Tube with Wood Post Inserts
Option 4	Short Foundation Tube with soil plates and Wood Post Inserts	Short Foundation Tube with Soil Plates and Wood Post Inserts
Option 5	Long Foundation Tube with Wood Post Inserts or Short Foundation Tube with Soil Plates and Wood Post Inserts	6’ SYTP or Short Foundation Tube with SYT Post Insert

The alternate to two 12’ 6” (3.81 m) long rail elements is one 25’ 0” (7.62 m) long rail element.

For Post locations 3 through 6, alternates to 6’ SYT Posts are:

- All Short Tubes with Wood Post Inserts
- All 6’ Wood CRT Posts
- All Short Foundation Tubes with SYT Post insert
- Any combination of above options, as accepted by the FHWA and dictated by the state or specifying agency

For Post location 7 and 8:

- Steel or Wood line Post dictated by the state or specifying agency

ET-31™ Guardrail End Treatment
NCHRP Report 350 Test Level 3
System Length 53'-1 1/2" (16.19 m)

For specific assembly, maintenance, or repair details refer to the state or specifying agency's standard drawings and/or Trinity standard layout drawings.

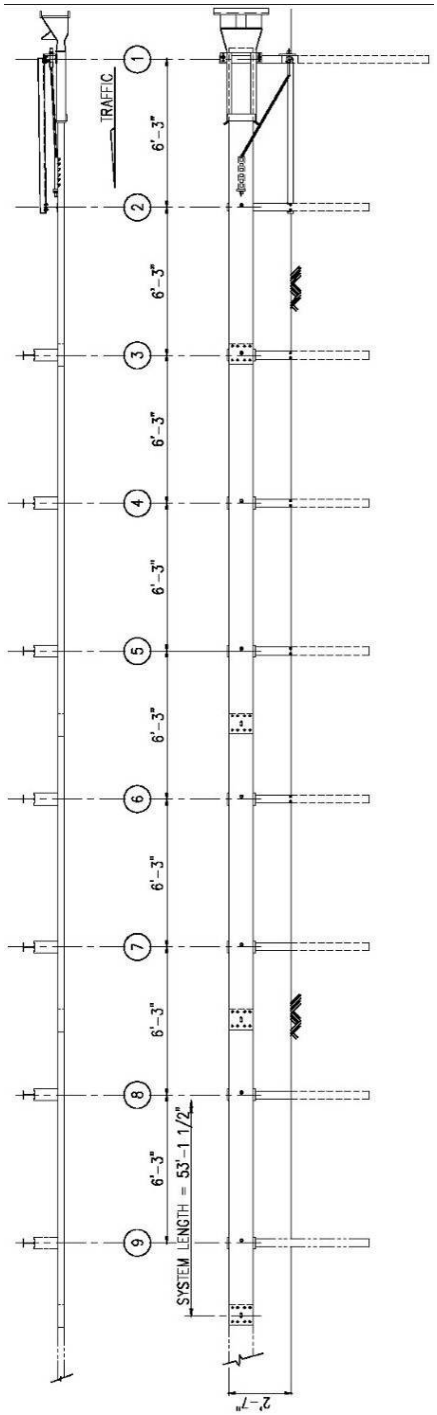


Figure 4 (TL-3)

[This drawing represents one version of the 53'-1 1/2" (16.19 m) system]

Alternative Post and Rail Panel Combinations

At Post locations 1 and 2, the alternates to HBA Post at location 1 and 6' Steel Yielding Treatment Post (SYTP) at location 2 are:

	Post Location 1	**Post Location 2**
Option 1	HBA Post	Short Foundation Tube with SYT Post insert
Option 2	Long Foundation Tube with Wood Post insert	6’ SYTP or Short Foundation Tube with SYT Post Insert
Option 3	Long Foundation Tubes with Wood Post Inserts	Long foundation Tubes with Wood Post Inserts
Option 4	Short Foundation Tubes with Soil Plates and Wood Post Inserts	Short Foundation Tubes with Soil Plates and Wood Post Inserts
Option 5	Long Foundation Tube with Wood Post Inserts or Short Foundation Tube with Soil Plates and Wood Post Inserts	6' SYTP or Short Foundation Tube with SYT Post Insert

The alternate to two 12’ 6” (3.81 m) long Rail Panel elements is one 25’ 0” (7.62 m) long Rail Panel element.

For Post locations 3 through 6, alternates to 6’ SYT Posts are:

- All Short Tubes with Wood Post Inserts
- All 6’ Wood CRT Posts
- All Short Foundation Tubes with SYT Post Insert
- Any combination of above options, as accepted by the FHWA and dictated by the state or specifying agency

For Post location 7 through 9:

- Steel or Wood line Post dictated by the state or specifying agency

ET-31™ Guardrail End Treatment
NCHRP Report 350 Test Level 2
System Length 21'-10 1/2" (6.68 m)

For specific assembly, maintenance, or repair details refer to the state or specifying agency's standard drawings and/or Trinity Highway Products standard layout drawings.

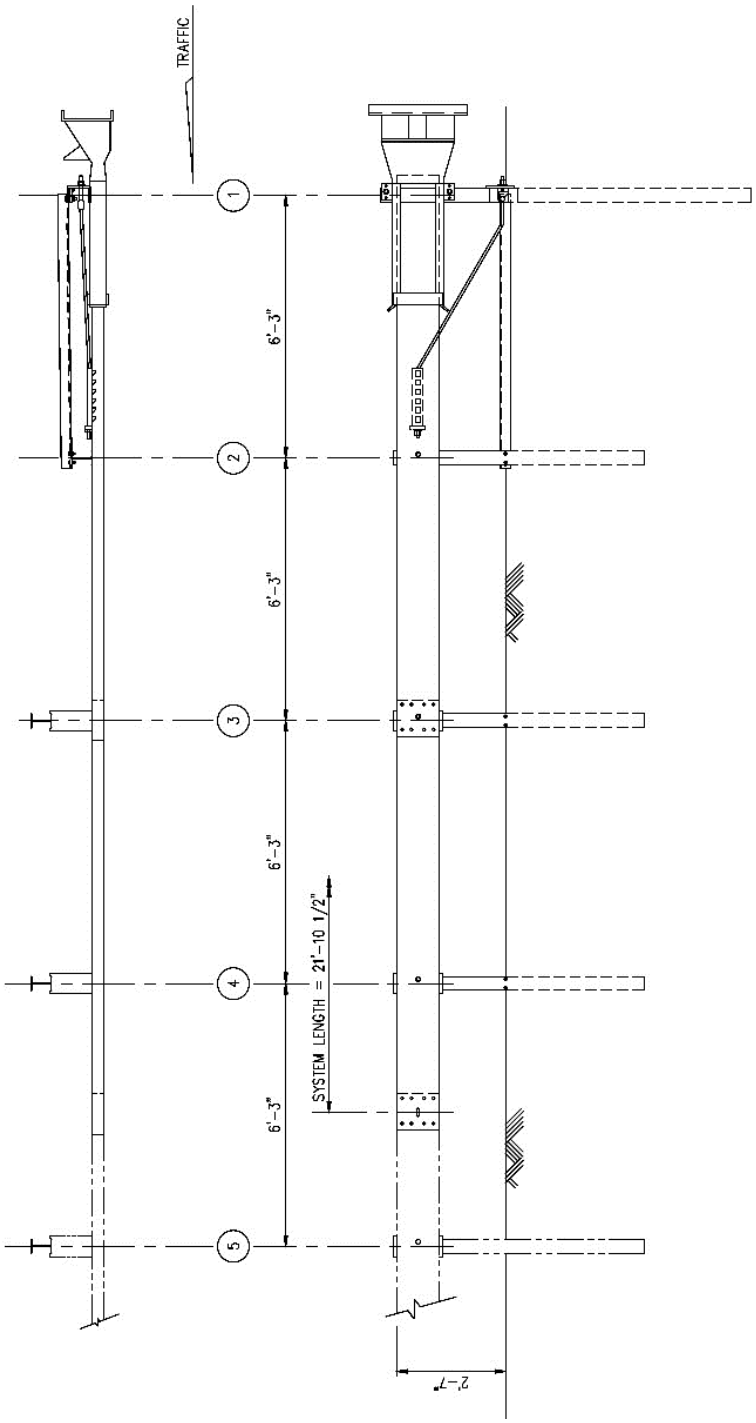


Figure 5 (TL-2)

[This drawing represents one version of the 21'-10 1/2" (6.68 m) system]

Alternative Post Combinations

At Post locations 1 and 2, the alternates to HBA Post at location 1 and 6' Steel Yielding Treatment Post (SYTP) at location 2 are:

	Post Location 1	**Post Location 2**
Option 1	HBA Post	Short Foundation tube with SYT Post Insert
Option 2	Long Foundation Tube with Wood Post Insert	6' SYTP or Short Foundation Tube with SYT Post Insert
Option 3	Long Foundation Tubes with Wood Post Inserts	Long Foundation Tubes with Wood Post Inserts
Option 4	Short Foundation Tubes with Soil Plates and Wood Post Inserts	Short Foundation Tubes with Soil Plates and Wood Post Inserts
Option 5	Long Foundation Tube with Wood Post Inserts or Short Foundation Tube with Soil Plates and Wood Post Inserts	6' SYTP or Short Foundation Tube with SYT Post Insert

For Post locations 3 and 4, alternates to 6’ SYT Posts are:

- All Short Foundation Tubes with Wood Post Inserts
- All 6’ Wood CRT Posts
- All Short Foundation Tubes with SYT Post Insert
- Any combination of above options, as accepted by the FHWA and dictated by the state or specifying agency

ET-31™ Guardrail End Treatment
NCHRP Report 350 Test Level 2
System Length 28’-1 1/2" (8.57 m)

For specific assembly, maintenance, or repair details refer to the state or specifying agency’s standard drawings and/or Trinity Highway Products standard layout drawings.

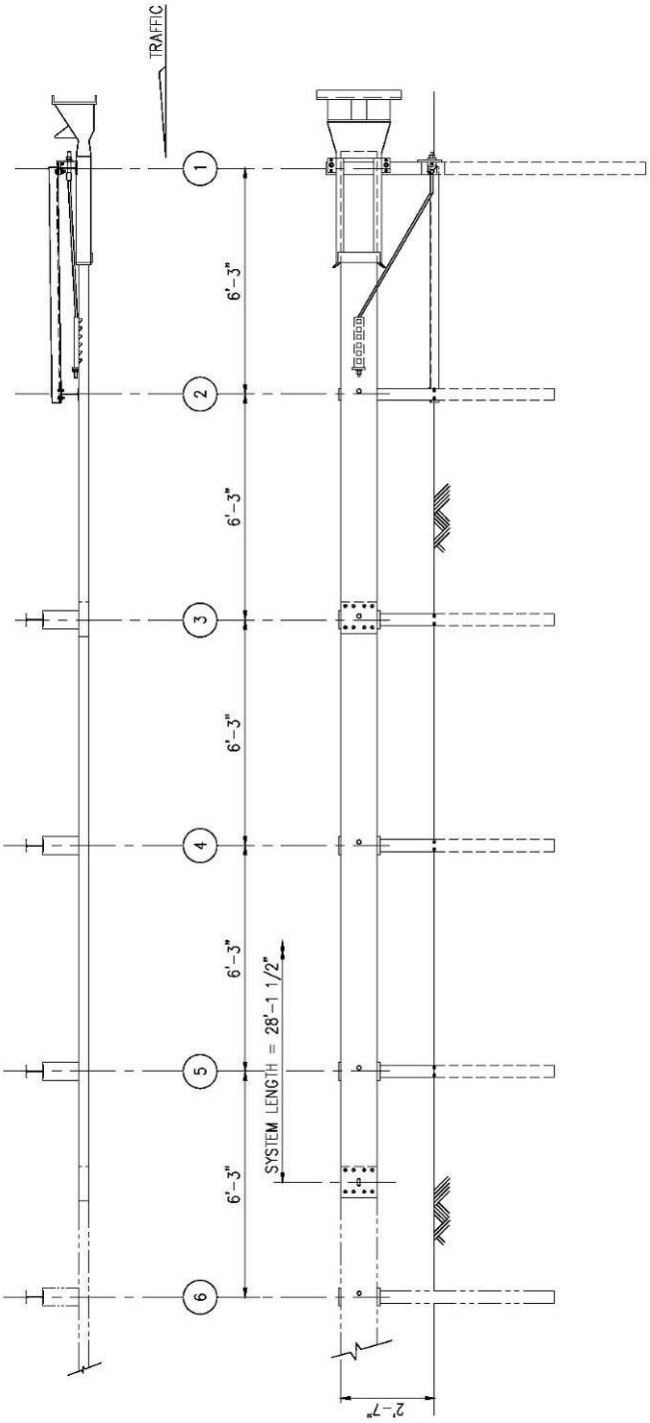


Figure 6 (TL-2)

[This drawing represents one version of the 28'-1 1/2” (8.57 m) system]

Alternative Post Combinations

At Post locations 1 and 2, the alternates to HBA Post at location 1 and 6' Steel Yielding Treatment Post (SYTP) at location 2 are:

	Post Location 1	**Post Location 2**
Option 1	HBA Post	Short Foundation Tube with SYT Post Insert
Option 2	Long Foundation Tube with Wood Post Insert	6' SYTP or short Foundation Tube with SYT Post Insert
Option 3	Long Foundation Tubes with Wood Post Inserts	Long Foundation Tubes with Wood Post Inserts
Option 4	Short Foundation Tubes with soil plates and Wood Post Inserts	Short Foundation Tubes with Soil Plates and Wood Post Inserts
Option 5	Long Foundation Tube with Wood Post Inserts or Short Foundation Tube with Soil Plates and Wood Post Inserts	6' SYTP or short Foundation Tube with SYT Post Insert

For Post locations 3 and 4, alternates to 6' SYT Posts are:

- All Short Foundation Tubes with Wood Post Inserts
- All 6' Wood CRT Posts
- All Short Foundation Tubes with SYT Post Insert
- Any combination of above options, as accepted by the FHWA and dictated by the state or specifying agency

For Post locations 5:

- Steel or Wood line Post dictated by the state or specifying agency

Bill of Materials English (Metric)

Warning: Use only Trinity Highway Products parts that are specified herein for the ET-31™ Guardrail End Treatment for assembling, maintaining, or repairing the ET-31™ Guardrail End Treatment. Do not utilize or otherwise comingle parts from other systems even if those systems are other Trinity Highway Products systems. Such configurations have not been tested, nor have they been accepted for use. Assembly, maintenance, or repairs using unspecified parts or accessories is strictly prohibited. Failure to follow this warning could result in serious injury or death in the event of a vehicle impact with an UNACCEPTED system.

ET-31™ Guardrail End Treatment

(For specific materials and quantities, see state or specifying agency's options and Trinity standard layout drawings)

PN	Description
11G	12/12.5'/3'-1.5"/S (2.67/3.81/0.952/S) (Guardrail)
32G	12/12.5"/6' 3"/S (2.67/3.81/1.905/S) ANC (Guardrail)
60G	12/25'/6' 3"/S (2.67/7.62/1.905/S) (Guardrail)
704A	Cable Anchor Bracket (unique to ET systems), with welded ears
705G	Pipe Sleeve - 2" STD Pipe x 51/2" (50 STD Pipe x 150 Pipe)
740G	6" x 8" x 4' 6" x 3/16 (152 x 203 x 1375 x 4.8) Tube Sleeve
749G	6" x 8" x 6' 0" x 3/16 (152 x 203 x 1830 x 4.8) Tube Sleeve (Alternate to using 740G and 766G)
758G	6" x 8" x 3'10"x 3/16" (252 x 203 x 1168 x 4.8) Tube Sleeve
766G	18" x 24" x 1/4" (460 x 610 x 16) Soil Plate
782G	8" x 8" x 5/8" (200 x 200 x 16) Bearing Plate **(For Wood Post)**
995A	ET-PLUS™ Extruder (Head)
3000G	Cable (Assembly) 3/4" x 6' 6" (19 x 1981)
3300G	5/8" (16) Round Washer
3340G	5/8" (16) HGR Nut
3391G	5/8" DIA. x 1 3/4" (16 DIA. x 45) Hex Head Bolt (High Strength)
3360G	5/8" DIA. X 1 1/4" (16 DIA. x 35) Splice Bolt (HGR)
3478G	5/8" DIA. x 7 1/2" (16 DIA. x 190) Hex Head Bolt
3497G	5/8" DIA. x 9 1/2" (16 DIA. x 240) Hex Head Bolt
3500G	5/8" DIA. x 10" (16 DIA. x 255) HGR Post Bolt
3580G	5/8" DIA. x 18" (16 DIA. x 460) HGR Post Bolt
3620G	5/8" DIA. x 22" (16 DIA. x 560) HGR Post Bolt
3700G	3/4" (19) Washer (F844)
3701G	3/4" (19) Washer (F436)
3704G	3/4" (19) Hex Nut
3717G	3/4" x 2 1/2" (19 x 75) Hex Head Bolt (High Strength)
3718G	3/4" x 3" (19 x 75) Hex Head Bolt (High Strength)
3900G	1" (25) Round Washer
3910G	1" (25) Hex Nut
4071B	Wood Post 6" x 8" x 6' 0" (150 x 200 x 1830) CRT

4075B	Wood Block 6" x 8" x 14" (150 x 200 x 355) DR
4076B	Wood Block 6” x 8” x 14” (150 x 200 x 355) DR Routed
4140B	Wood Post 5 1/2” x 7 1/2” x 4’-0 1/4" (140 x 190 x 1225)
4161B	HDPE spacer (SYTP™)
4228B	3/8” x 4" (10 x 100) Lag Screw
4254G	3/8” (10) Round Washer
4255G	3/8” (10) Fender Washer 1 1/2” OD (38)
4258G	3/8” (10) Lock Washer
4261G	3/8” DIA. X 1 1/2" (10 x 38) Hex Head Bolt (Grade 5)
4389G	7/16” (11) Round Washer
4390G	7/16” DIA. x 1 1/2” (11 x 38) GR. 5 Hex Head Bolt
4393G	7/16” (11) Lock Washer
4396G	7/16” (11) Hex Nut
4660B	Wood Block 6” x 12 3/8” x 14” (150 x 315 x 350) Routed
4699G	3/4” (19) Lock Washer
5148G	3/4” DIA. X 9 1/2” (19 DIA. x 240) Hex Head Bolt (High Strength)
5978B	Polymer Block 4 x 12 x 14 (100 x 305 x 350)
6120G	Wood Block 6” x 12” x 14” (150 x 305 x 350)
6321G	3/8” x 2’ (10 x 50) Hex Head Bolt (Grade 5)
6405G	3/8” (10) Hex Nut
6907B	Polymer Block 4” x 7 1/2” x 14” (100 x 187 x 350) [King Block]
10967G	12/9'4.5/3'1.5/S (2.67/2.85/0.952/S) (Guardrail)
14328G	3’ 9 7/8” Steel Yielding Treatment Post (SYTP™)
15000G	6’ Steel Yielding Treatment Post™ (SYTP™)
19258A	8" x 8" x 5/8” (200 x 200 x 16) Bearing Plate With Two Ears/Tabs **(For HBA Post)**
19948G	1 ¾” x 10 GA x 1 ¾” (44 x 3 x 44) Plate Washer
20442G	12/15'7.5/3'1.5:2@6'3/S (2.67/4.76/.952:2@1.905/S) (Guardrail)
49398A	ET HBA™ Post #1 Top
33873A	ET HBA™ Post #1 Bottom
9852A	Strut (and Yoke Assembly)
32922G	6' 6" (1980) Angle Strut HBA™ / SYTP™ / Wood
33875G	6' 6" (1980) Angle Strut ET HBA™ (6’-3 C/C Slots)
33795G	6’ 6” (1980) Angle Strut HBA™ / SYTP™
33730G	6’ 7 1/2” (2020) Angle Strut SYTP™ / Wood
33847G	6’ 9 1/8” (2060) Angle Strut SYTP™ / CRP

Delineation Options

PN	Description
6206B	Right Side 13” x 27 1/2” (325 x 700) Reflective Sheeting Amber
6207B	Left Side 13” x 27 1/2” (325 x 700) Reflective Sheeting Amber
6668B	Either Side 12” x 12” (305 x 305) Reflective Sheeting (Typically 2 required) Amber
3534B	Either Side 12” x 12” (305 x 305) Reflective Sheeting (Typically 2 required) Silver

Assembling the ET-31™ Guardrail End Treatment

Materials

As packaged, the NCHRP Report 350 ET-31™ Guardrail End Treatment includes all materials needed for a complete assembly. The pay limit will include a 34’ 4.5” (10.48 m) system, 40’ 7.5” (12.38 m) system, 46’ 10.5” (14.29 m) system, or 53’ 1.5” (16.19 m) system for TL-3 or 21’ 10.5” (6.68 m) or 28’ 1.5” (8.57 m) system for TL-2, unless otherwise specified in the contract plans.

Note: Concrete footings or foundations are not required.

Recommended Tools

- 9/16” (14 mm) Socket or wrench
- 15/16” (24 mm) Socket or wrench
- 1 1/4” (32 mm) Socket or wrench
- 1 1/2” (38 mm) Socket or wrench
- Augers
- Post pounders (commonly used in driving Posts)
- Locking pliers
- Tape measure

Recommend Tools for Repair

- Acetylene torch to cut off extruded rail
- Heavy-duty chain to remove the ET-PLUS™ Extruder (Head)
- Locking pliers or Channel Lock pliers
- Sledge hammer
- Post removal tool and other normal guardrail tools
- Eye bolts connected to heavy duty chain (to remove the Posts from Tubes)
- Vehicle to pull the Extruder (Head) from the damaged rail

Note: The above list(s) of tools is a general recommendation. Depending on specific site conditions and the complexity of the assembly specified by the appropriate highway authority, additional or fewer tools may be required. Decisions as to what tools are needed to perform the job are entirely within the discretion of the specifying highway authority, and the authority’s selected contractor performing the assembly of the system at the authority’s specified site. It is the province of the engineer working under the authority of the local highway authority that owns and has specified this product as to whether or not they wish to use the Extruder (Head) again after impact. Trinity makes no recommendation in this regard.

Site Preparation

When the Guardrail is placed in-line with edge of the shoulder (without any offset), a 25:1 or flatter straight flare over the length of the systems can be used to position the ET-PLUS™ Extruder (Head) further away from the edge of the shoulder. Site grading may be necessary for assemblies beyond the edge of the shoulder for the proper placement of the steel tubes and the CRT Posts. Use the state or specifying agency's standard specifications and drawings for the site grading. Trinity does not direct grading. Complete all grading before the start of the assembly of the ET-31™ Guardrail End Treatment. See *Assembly of the ET-31™ Guardrail End Treatment on a Curve* section for the layout of the ET-31™ Guardrail End Treatment on a curve on Page 24.

If the system is deployed on a curve, see *Assembly of the ET-31™ Guardrail End Treatment on a Curve* section on Page 24. When placing the ET-31™ Guardrail End Treatment outside or inside the curve, the ET-31™ Guardrail End Treatment must be straight over the length of the system. If there are special field conditions encountered when assembling the ET-31™ Guardrail End Treatment, contact the state or specifying agency's engineer. Trinity Highway Products LLC, at (888) 323-6374, is available for consultation with that agency.

Post Placed in Rigid Material

Provide the proper leaveout (the specified area of open space in the pavement) around a Post when assembling the Post in any thickness of concrete or asphalt. The top surfaces of any grout or other backfill placed in the rigid material leaveout **MUST be low enough** so that it does not restrict smooth release of the Anchor Cable Bearing Plate at Post 1 or otherwise obstruct or constrain the 3/8" shear bolts or the 3/4" hinge bolts of the HBA Post. The assembly shall not impede in any fashion the hinging-action or release mechanism of the No. 1 HBA post by burying it in rigid material (asphalt, concrete, rigid soil, etc.)

For leaveout information, please consult the applicable state or specifying agency. Additional source of leaveout information or details can be found in the U.S. Department of Transportation, Federal Highway Administration, Memorandum B 64-B, dated 3/10/04. Trinity can provide this FHWA memo upon request.

Assembling the ET-31™ Guardrail End Treatment on a Curve

When the ET-31™ Guardrail End Treatment is placed on a curve, use the following layouts. All offsets are measured to the face of the rail. Under no circumstances shall the guardrail within the ET-31™ Guardrail End Treatment pay limit be curved.

- Outside the curve: With the line guardrail placed parallel to the curve, the Treatment end is offset from the curve a distance equal to the line guardrail offset plus the value in Table 1. Consult state or specifying agency drawings for details.
- Inside the curve (radius greater than 1000 feet): With the line guardrail placed parallel to the curve, the Treatment end is offset from the curve a distance equal to the line guardrail offset plus the value in Table 1. Consult state or specifying agency drawings for details.
- Inside the curve (radius 1000 feet or less): With the line guardrail placed parallel to the curve, the Treatment end is offset from the curve a distance equal to the line guardrail offset plus one foot maximum in Table 1. Consult state or specifying agency drawings for details.

Table 1

ET-31™ Length	Outside the Curve Max Offset	Inside the Curve With a Radius Greater Than 1000 Feet Max Offset	Inside the Curve With a Radius 1000 Feet or Less Max Offset
53' 1.5"	24 Inches	24 Inches	12 Inches
46' 10.5"	18 Inches	18 Inches	12 Inches
40' 7.5"	18 Inches	18 Inches	12 Inches
34' 4.5"	12 Inches	12 Inches	12 Inches
28'-1 1/2"	12 Inches	12 Inches	12 Inches
21'-10 1/2"	12 Inches	12 Inches	9 Inches

Assembling the Posts

Complete the following steps when assembling HBA™ Posts, Steel Yielding Treatment Posts™ (SYTP™), foundation tube with wood Posts and wood CRT Posts. For non-breakaway posts, follow the agency's assembly instructions. For placing posts in rigid pavement, also see the Post Assembled in Rigid Material section.

Assembling HBA™ Post

Assembling HBA™ Bottom Post – Post Location 1

Complete the following steps to assemble the HBA™ Bottom Post:

Step	Actions
1.	Arrange the HBA™ bottom (PN-33873A) posts so that the large hole (13/16" [21 mm]) is placed downstream (away from the impact end of the system).
2.	Select Option A or Option B for this assembly.
Option A	Drive the HBA™ Bottom Post with an approved driving head to a depth of approximately 72" (1830 mm).
Option B	1. Drill a 12" (300 mm) maximum diameter pilot hole approximately 72" (1830 mm) deep. 2. Insert the bottom HBA™ Post in the hole. 3. Backfill the holes with compactable materials in 6" (150 mm) lifts and compact with pneumatic equipment to optimum compaction. **Note:** In either option, the optimum depth will have the 13/16" (21 mm) hole in the post plates (ears/tabs) even with the finished grade.

Assembling HBA™ Top Post

Complete the following steps to assemble the HBA™ Top Post, after the Bottom Post has been assembled:

Step	Actions
1.	Place the Top Post (PN-49398A) at Post 1, by aligning the holes of the post plates (ears) on the top and bottom posts. **Note:** The Top Post's post plates (ears) can be attached on either side of the Bottom Post's post plates (ears).
2.	Insert a 3/8" (10 mm) diameter x 2" (50 mm) hex head high strength bolt (PN-6321G) through the 7/16" (11 mm) holes of the post plates (ears) on the Top and Bottom Posts.
3.	Place a 3/8" (10 mm) washer (PN-4252G) and a 3/8" (10 mm) lock washer (PN-4258G) under a 3/8" (10 mm) hex nut (PN-6405G) on the inserted bolts to secure. **Note:** The bolts can be assembled so the nuts are on the inside or outside of the post plates (ears).
4.	Tighten the nuts to a snug position. The designer does not recommend a torque requirement for the HBA field assembly.
5.	Insert a 3/4" (19 mm) diameter x 2 1/2" (63 mm) hex head high strength bolt (PN-5148G) in the 13/16" (21 mm) hole of the HBA™ Post 1 post plates on the side opposite the strut. Do not assemble the 3/4" (19 mm) bolt on the strut side of Post 1, until the strut is ready to be assembled. **Note:** The bolts can be assembled so the nuts are on the inside or outside of the post plates (ears).
6.	Place a 3/4" (19 mm) washer (PN-3701G) and a 3/4" (19 mm) lock washer (PN-4699G) under a 3/4" (19 mm) hex nut on the inserted bolt to secure.
7.	Tighten the nuts to a snug position. The designer does not recommend a torque requirement for the HBA field assembly.

Assembling the Steel Yielding Treatment Post™ (SYTP™)

The SYTP™ can be driven or assembled in a tube. For SYTP™ assembly in a tube, see the *Assembling the SYTP™ in Tubes* section. The SYTP™ can be assembled at all locations EXCEPT at location 1. Complete the following step to assemble the SYTP™:

Warning: Do NOT assemble SYTP™ at location 1. Failure to follow this warning could result in serious injury or death in the event of a collision.

Placing the 6' (1.83 m) SYTP™

Step	Actions
1.	Drive all the 6' 0" SYTP™ (PN-15000G) to the optimum depth where the centers of the four yielding holes through the flange are at the ground line.
	**Warning:** DO NOT assemble SYTP™ at location 1. Failure to follow this warning could result in serious injury or death in the event of a collision.
	**Warning:** Ensure that the proper leaveout (the specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts assembled in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.

Assembling Foundation Tubes

Complete the following steps to assemble foundation tubes.

6’ 0” Foundation Tube (Post locations 1 and/or 2)

Step	Actions
1.	Assemble a 5/8” x 7 ½” (16 mm x 190 mm) hex head bolt (PN-3478G) and 5/8” (16 mm) HGR nut (PN-3340G) in the Foundation Tube (PN-749G) as a post stop. Use 2 bolts when the SYTP is assembled. Use 1 bolt when a Wood Post is assembled. **Note**: Do not over tighten the nuts and deform the tubes as this will complicate post replacement.
2.	The foundation tube can be assembled by driving or with a pilot hole. See *For Driven Foundation Tube Assembling* or *For Pilot Hole Foundation Tube Assembly* sections for assembly instructions.
3.	Assemble the foundation tubes at locations 1 and 2. Use the strut as a guide for the spacing of the tubes. **Note:** Do not drive Tubes with the Wood Post inserted; this will complicate post replacement.
	**Warning:** Ensure that the proper leaveout (the specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts assembled in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.

4’ 6” Foundation Tube with Soil Plate (Post locations 1 and/or 2)

Step	Actions
1.	Bolt the Soil Plate (PN-766G) to the Foundation Tube (PN-740G) with two 5/8" x 7 1/2" (16 mm x 190 mm) hex head bolts (PN-3478G) and 5/8" (16 mm) HGR nuts (PN-3340G) (no washers). **Note:** Do not over tighten the nuts and deform the tubes; this will complicate post replacement.
2.	The foundation tube can be placed by driving or with a pilot hole. See *For Driven Foundation Tube Assembly* or *For Pilot Hole Foundation Tube Assembly* sections for assembly instructions.
3.	Assemble the foundation tubes at locations 1 and 2. Use the strut as a guide for the spacing of the tubes. If the Soil Plate is utilized, position it on the downstream side of the post (away from the Impact Head). **Note:** Do not drive Tubes with the Wood Post inserted; this will complicate post replacement.
	**Warning:** Ensure that the proper leaveout (the specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts assembled in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.

4’ 6” Foundation Tube (Post locations 2 - 6, per state specifications):

Step	Actions
1.	Assemble a 5/8” x 7 ½” (16 mm x 190 mm) hex head bolt (PN-3478G) and 5/8” (16 mm) HGR nut (PN-3340G) in the Foundation Tube (PN-749G) as a post stop. Use 2 bolts where the SYTP is placed. Use 1 bolt when a wood post is attached. **Note:** Do not over tighten the nuts and deform the tubes as this will complicate post replacement.
2.	The foundation tube can be assembled by driving or with a pilot hole. See *For Driven Foundation Tube Assembly* or *For Pilot Hole Foundation Tube Assembly* sections for Assembly instructions.
3.	Assemble the foundation tubes. Use the strut as a guide for the spacing of the tube at location 2. **Note:** Do not drive tubes with the wood post inserted; this will complicate post replacement.
	**Warning:** Ensure that the proper leaveout (the specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts placed in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.

3’ 10” Foundation Tube (Post locations 2 - 6, per state specifications):

Step	Actions
1.	Assemble a 5/8” x 7 ½” (16 mm x 190 mm) hex head bolt (PN-3478G) and 5/8” (16 mm) HGR nut (PN-3340G) in the Foundation Tube (PN-758G) as a post stop. Use 2 bolts where the SYTP is deployed. Use 1 bolt when a wood post is deployed. **Note:** Do not over tighten the nuts and deform the tubes as this will complicate post replacement.
2.	The foundation tube can be assembled by driving or with a pilot hole. See *For Driven Foundation Tube Assembly* or *For Pilot Hole Foundation Tube Assembly* sections for Assembly instructions.
3.	Assemble the foundation tubes. Use the strut as a guide for the spacing of the tube at location 2. **Note:** Do not drive Tubes with the Wood Post inserted; this will complicate post replacement.
	**Warning:** Ensure that the proper leaveout (the specified area of open space in the pavement) around the Posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts placed in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.

Assembly Options for Foundation Tubes

Complete the following steps to place foundation tubes.

For Driven Foundation Tube Assembly

Step	Actions
1.	Drive the foundation tubes (with an appropriate driving head) to the optimum depth, where the top of the tube is 2 5/8” (67 mm) above the finished grade. **Note:** Take extra care to prevent settlement or lateral displacement of the tubes, to ensure the posts attach to the guardrail, correctly.
2.	Ensure that the finished guardrail height will be approximately 31" (787 mm) above the finished grade, or as the state or specifying agency plans indicate.
3.	Ensure that the tubes do not project more than 4" (100 mm) above the finished grade.
	**Warning:** Ensure that the proper leaveout (the specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts placed in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.

For Pilot Hole Foundation Tube Assembly

Step	Actions
1.	Drill a 12” (300 mm) maximum diameter pilot hole approximately 49” (1245 mm) deep for the 3’ 10” (1168 mm) long foundation tube, 57” (1450 mm) deep for the 4’ 6” (1370 mm) long foundation tube or 75” (1905 mm) for the 6’ 0” (1830 mm) long foundation tube. If the foundation tube has a soil plate, use Option A or B with this step.
Option A	Cut slots for the soil plates out by hand or by using a rock bar and then follow all of the steps of Option A for 4’ 6” tube with soil plate, above.
Option B	Drill three adjacent 12” (300 mm) maximum diameter holes or one 24” (610 mm) maximum diameter hole to accommodate the soil plate / tube assembly and then follow all of the steps of Option A for 4’ 6” tube with soil plate, above. **Note:** Take extra care to prevent settlement or lateral displacement of the tubes, to ensure the posts attach to the guardrail correctly.
	**Warning:** Ensure that the proper leaveout (specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts placed in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.
2.	Backfill the hole with compactable materials in 6" (150 mm) lifts and compact with pneumatic equipment to optimum compaction.
3.	Ensure that the finished guardrail height will be approximately 31" (787 mm) above the finished grade, or as the state or specifying agency plans indicate.
4.	Ensure that the tubes do not project more than 4" (100 mm) above the finished grade.

Assembling the SYTP™ in Tubes (Post Locations 2 through 6)

Step	Actions
1.	Attach the 3’ 9 7/8” (1.16 m) SYTP™ (PN-14328G) in tubes.
	**Warning:** DO NOT assemble SYTP™ at location 1. Failure to follow this warning could result in serious injury or death in the event of a collision.
	**Warning:** Ensure that the proper leave out (the specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts assembled in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.
2.	Follow the instructions in the *Assembling the Strut* section, Step 5.
3.	Except at Post 1, assemble the SYTP™ in a tube at locations required for the system with the four yielding holes (through the flange) at the top of the tube.
4.	From the embankment side of the tube, insert a 5/8” x 9 1/2” (16 mm x 240 mm) hex head bolt (PN-3497G) through the tube, the spacer (PN-4161), and the SYTP™
5.	Place a 5/8” (16 mm) HGR nut (PN-3340G) on the inserted bolt, to secure the SYTP™ to the tube. **Note:** Do not over tighten the nut and deform the tubes; this will complicate post replacement.

Assembling Wood Posts in Tubes

Complete the following steps to assemble wood posts in tubes:

Step	Actions
1.	Insert Pipe Sleeve (PN-705G) in post (PN-4140B) and assemble the wood post in the steel tube at location 1.
2.	Assemble Wood Post(s) (PN-4140B) in tubes at locations required for the system, as dictated by the state or specifying agency.
3.	Insert a 5/8” x 9 1/2” (16 mm x 240 mm) hex head bolt (PN-3497G) through the Foundation Tube and the Wood Post at all locations EXCEPT locations 1 and 2. **Note:** The bolt must be assembled from the embankment side, to aid in possible post replacement.
4.	Place a 5/8” (16 mm) HGR nut (PN-3340G) on the end of the inserted bolt.
5.	Tighten the nuts to a snug position. **Note:** Do not over tighten the bolts and deform the tubes; this will complicate post replacement.
	**Warning:** Ensure that the proper leaveout (the specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts assembled in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.

Assembling Wood CRT Posts

Complete the following steps to assemble the wood CRT posts:

Step	Actions
1.	Assemble the Wood Posts (PN-4071B) at locations required for the system, spaced at 6' 3" (1270 mm) apart. Select Option A or Option B to place the CRT posts.
Option A	Drive posts into the ground.
Option B	1. Drill 12” (300 mm) maximum diameter pilot holes approximately 44" (1120 mm) deep. 2. Insert the 6' 0" (1830 mm) Wood Posts into these holes. 3. Backfill the holes with compactable materials in 6" (150 mm) lifts and compact with pneumatic equipment to optimum compaction.
	Note: In either option within Step 1, the bottom of the upper 3 1/2" (90 mm) hole in the post is approximately at the finished grade.
	**Warning:** DO NOT assemble 6’ 0” CRT post at location 1 and 2. Failure to follow this warning could result in serious injury or death in the event of a collision.
	**Warning:** Ensure that the proper leaveout (the specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts assembled in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.

Assembling Foundation Tubes, HBA™ Posts, or SYTP™ when Encountering Rock

Complete the following steps to assemble foundation tubes, HBA™ posts or SYTP™ when encountering rock:

Step	Actions
1	Select Option A or Option B below when encountering rock, unless there is a more restrictive state or specifying agency specification.
Option A	If rock is encountered and 20 inches (510 mm) or less of the full length post or foundation tube remains to be embedded:
	1. Drill a 12" to 16" (300 mm to 400 mm) diameter hole into the rock.
	2. Drill holes 2" (50 mm) deeper than the required embedment depth.
	3. Place granular material or small pieces of the drilled rock in the bottom 2" (50 mm) of the hole for drainage.
	4. Assemble the tube or post into the hole. Backfill the hole with compactable materials in 6" (150 mm) lifts and compact with pneumatic equipment to optimum compaction. **Note:** If compactable, the material removed from the hole may be used for backfill.

Option B	If rock is encountered and more than 20 inches (510) of the full length post or foundation tube remains to be embedded: 1. Drill a 12" to 16" (300 mm to 400 mm) diameter hole 22" (560 mm) deep into the rock. 2. Cut off the embedded portion of the tube or post so the Guardrail will be at the proper mounting height. Cutting off the bottom of the embedded portion of full length post or foundation tube is permitted only when a minimum of 20” (510 mm) embedment into rock can be achieved. 3. Place granular material or small pieces of the drilled rock in the bottom 2" (50 mm) of the hole for drainage. 4. Assemble the tube or post in the hole. Backfill the hole with compactable materials in 6" (150 mm) lifts and compact with pneumatic equipment to optimum compaction. **Note:** If compactable, the material removed from the hole may be used for backfill.
	**Warning:** Ensure that the proper leaveout (the specified area of open space in the pavement) around the posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement, for any posts assembled in rigid pavement such as any thickness of concrete or asphalt. Failure to follow this warning could result in serious injury or death in the event of a collision.

Assembling the Strut

Complete the following steps when assembling the strut:

Note: For all strut assemblies, the assembler must provide a shallow valley or trough for assembly of the strut, since a portion of the angle strut will be below grade.

Assembling the Strut with HBA™ Post at Post 1 and SYTP™ at Post 2

Complete the following steps to assemble the strut.

At Post 1

Step	Actions
1.	Place the angle strut on the outside flanges of the HBA™ post. **Note:** The strut can be placed with one of the legs flat on the ground or with the leg edge on the ground. The strut may be attached either on the traffic side or the field side of the posts.
2.	Assemble a 3/4” (19 mm) diameter x 2 1/2” (63 mm) hex head high strength bolt (PN-3717G) in the 13/16” (21 mm) hole of the HBA™ Post 1 post plates. Place the bolt through the top and bottom post’s post plates and through the strut.
3.	Place a 3/4” (19 mm) washer (PN-3700G) and a 3/4” (19 mm) lock washer under a 3/4” (19 mm) hex nut on the end of the bolt to secure.
4.	Tighten the nuts to a snug position. (The designer does not recommend a torque requirement.)

For Angle Strut with 6' SYTP™ at Post 2

Step	Actions
1.	Place the Angle Strut (PN-33795G) on the embankment side of the SYTP™. (The strut can be placed with one of the legs flat on the ground or with the leg edge on the ground.)
2.	Place a 7/16" (11 mm) round washer (PN-4389G) on the two 7/16" (11 mm) diameter x 1 1/2" (38 mm) hex head high strength bolts (PN-4390G).
3.	Insert the two bolts through the two slotted holes of the strut and the yielding diameter holes of the SYTP™, at Post 2.
4.	Place a 7/16" (11 mm) lock washer (PN-4393G) and a plate washer (PN-19948G) under a 7/16" (11 mm) hex nut (PN-4388G) on the ends of inserted bolts. When in the correct position, plate washer is placed against yielding holes of the post and under the lock washer and nut.
5.	Tighten the nuts to a snug position. (The designer does not recommend a torque requirement.)

For Angle Strut with SYTP™ in Tube at Post 2

Step	Actions
1.	Place the Angle Strut (PN-33875G) on the embankment side of the tube. (The strut can be placed with one of the legs flat on the ground or with the leg edge on the ground.)
2.	Place a 3/4" (19 mm) washer (PN-3701G) on a 3/4" (19 mm) diameter x 9 1/2" (240 mm) hex head high strength bolt (PN-5148G).
3.	From the embankment side, insert the bolt through the Strut, Foundation Tube, spacer (PN-4161), and the SYTP™ at Post 2.
4.	Place a 3/4" (19 mm) washer (PN-3701G) under a 3/4" (19 mm) hex nut on the end of the inserted bolt.
5.	Tighten the nuts to a snug position. (The designer does not recommend a torque requirement.) **Note:** Do not over tighten the bolts and deform the tubes; this will complicate possible post replacement.

Assembling the Strut with Wood CRT Post in Tube at Post 1 and SYTP™ at Post 2

Complete the following steps to assemble the strut:

At Post 1

Step	Actions
1.	Place the Angle Strut on the embankment side of the Foundation Tube.
2.	Place a 3/4" (19 mm) washer (PN-3701G) on a 3/4" (19 mm) diameter x 9 1/2" (240 mm) hex head high strength bolt (PN-5148G).
3.	From the embankment side, insert the bolt through the Strut, the Foundation Tube, and the Wood Post.
4.	Place a second washer under a 3/4" (19 mm) hex nut (PN-3704G) on the end of the inserted bolt.
5.	Tighten the nuts to a snug position. (The designer does not recommend a torque requirement.)

For Angle Strut with 6' SYTP™ at Post 2

Step	Actions
1.	Place the Angle Strut (PN-33730G) on the embankment side of the SYTP™. (The Strut can be placed with one of the legs flat on the ground or with the leg edge on the ground.)
2.	Place a 7/16" (11 mm) round washer (PN-4389G) on the two 7/16" (11 mm) diameter x 1 1/2" (38 mm) hex head high strength bolts (PN-4390G).
3.	Insert the two bolts through the two slotted holes of the strut and the yielding diameter holes of the SYTP™, at Post 2.
4.	Place a 7/16" (11 mm) lock washer (PN-4393G) and a plate washer (PN-19948G) under a 7/16" (11 mm) hex nut (PN-4388G) on the ends of inserted bolts. When in the correct position, the plate washer is assembled against the yielding holes of the post and under the lock washer and nut.
5.	Tighten the nuts to a snug position. (The designer does not recommend a torque requirement)

For Angle Strut with SYTP™ in Tube at Post 2

Step	Actions
1.	Place the Angle Strut (PN-33875G) on the embankment side of the tube. (The Strut can be placed with one of the legs flat on the ground or with the leg edge on the ground.)
2.	Place a 3/4" (19 mm) washer (PN-3701G) on a 3/4" (19 mm) diameter x 9 1/2" (240 mm) hex head high strength bolt (PN-5148G).
3.	From the embankment side, insert the bolt through the Strut, Foundation Tube, spacer (PN-4161), and the SYTP™ at Post 2.
4.	Place a 3/4" (19 mm) washer (PN-3701G) under a 3/4" (19 mm) hex nut on the end of the inserted bolt
5.	Tighten the nuts to a snug position. (The designer does not recommend a torque requirement.) **Note:** Do not over tighten the bolts and deform the tubes; this will complicate possible post replacement

Assembling the Strut with Wood Posts in Soil Tubes (Post Locations 1 and 2)

Complete the following steps to assemble the strut:

For Angle Strut

Step	Actions
1.	Place the Angle Strut (PN-33875G) on the embankment side of the Foundation Tubes.
2.	Place a 3/4” (19 mm) washer (PN-3701G) on a 3/4” (19 mm) diameter x 9 1/2” (240 mm) hex head high strength bolt (PN-5148G).
3.	From the embankment side, insert the bolt through the Strut, the Foundation Tube, and the Wood Post.
4.	Place a second washer under a 3/4” (19 mm) hex nut (PN-3704G) on the end of the inserted bolt.
5.	Tighten the nuts to a snug position. (The designer does not recommend a torque requirement.)

For Channel Ground Strut

Step	Actions
1.	Place the slotted yokes of the Ground Strut (PN-9852A) over the Foundation Tubes.
2.	Place a 5/8" (16 mm) round washer (PN-3300G) on a 5/8" (16 mm) diameter x 9 1/2" (240 mm) hex head bolt (PN-3497G).
3.	From the embankment side, insert the bolt through the Strut, Foundation Tube, and the Wood Post.
4.	Place a second washer under a 5/8" (16 mm) HGR hex nut on the end of the inserted bolt.
5.	Tighten the nuts to a snug position. (The designer does not recommend a torque requirement.) **Note:** Do not over tighten the bolts and deform the tubes; this will complicate possible post replacement.

Assembling Offset Blocks and Rail Panels

The ET-31™ Guardrail End Treatment uses a 12’ 6” (3.81 m) Rail Panel (PN-32G). Depending on the state or specifying agency standards, a combination of the following Rail Panels will be used for their system: 9’ 4 1/2” (2.86 m) Rail Panel (PN-10967G), 15’ 7 ½” (4.76 m) Rail Panel (PN-20442G), 12’ 6” (3.81 m) Rail Panel (PN-11G), or 25’ (7.62 m) Rail Panel (PN-60G).

Warning: DO NOT bolt the Rail Panel to the post at location 1 in any of the ET-31™ Guardrail End Treatment. Failure to follow this warning could result in serious injury or death in the event of a collision.

Splicing the Rail Panels

Complete the following steps to splice the rail panels:

Step	Actions
1.	Lap the Treatment rail in the direction of traffic, unless the state or specifying agency's policy dictates otherwise. EACH RAIL PANEL MUST BE STRAIGHT WITH NO VISIBLE DISTORTIONS OR BLEMISHES SUCH AS CURVES, DENTS, CUTS, TEARS, EXTRA HOLES, CUT-OUTS, CORROSION OR SIGNS OF PAST REPAIRS. Rails with distortions that could compromise its ability to resist compressive load induced by the Head during head-on impacts shall not be used.
2.	Splice the Rail Panels together with eight 5/8" x 1 1/4" (16 mm x 32 mm), HGR splice bolts (PN-3360G), and 5/8" (16 mm) HGR hex nuts.
	**Warning: USE ONLY PROPER LENGTH SPLICE BOLTS** (1-1/4" LONG) which have Trinity's "TRN" identifying mark stamped into the top of the bolt head. Failure to follow this warning could result in serious injury or death in the event of a collision.
3.	Tighten the bolts. (There is no torque requirement.)

Assembling the Offset Block and Rail Panel to Wood Posts (Posts 3 through 6)

Complete the following steps to attach the Offset Blocks and Rail Panels to the Wood Posts:

Step	Actions
1.	1. At locations with Wood Posts and Wood Blocks, insert a 5/8" (16 mm) diameter 22" (560 mm) HGR post bolt (PN-3620G) through the Rail Panel, Offset Block (PN-4660B), and the Post. **Note:** Offset Blocks are NOT used at post locations 1 and 2, but are used at all other locations.
	**Warning:** Do NOT bolt the Rail Panel to the post at location 1 in any of the ET-31™ Guardrail End Treatment. Failure to follow this warning could result in serious injury or death in the event of a collision.
2.	Place a 5/8" (16 mm) round washer (PN-3300G) under a 5/8" (16 mm) HGR nut (PN-3340G).
3.	Tighten the bolts. (There is no torque requirement for these bolts.)
4.	Secure the Offset Block by toe nailing the Block to the Post or the Post to the Block, with two 16d hot-dipped galvanized nails approximately 3" (75 mm) from the top of the Post or Block, one on each side, to prevent it from rotating.

Assembling the Offset Block and Rail Panel to SYTP™ (Posts 3 through 6)

Complete the following steps to attach the Offset Blocks and Rail Panels to the SYTP™:

Step	Actions
1.	At locations with Steel Yielding Treatment Post™ (SYTP™) with Offset Blocks, insert a 5/8" (16 mm) diameter x 14" (355 mm) HGR post bolt (PN-3540G) through the Rail Panel, routered Wood (PN-4076B) or Composite (PN-6707B) Blockout, and the SYTP™. **Note:** Offset Blocks are NOT used at post locations 1 and 2. For SYTP™ Inserts, there are two sets of holes in the SYTP™ for attaching the rail. Use the holes in the SYTP™ that will place the rail at the correct height.
	**Warning:** DO NOT bolt the Rail Panel to the post at location 1 in any of the ET-PLUS™ systems. Failure to follow this warning could result in serious injury or death in the event of a collision.

	**Warning:** Ensure all Wood Blocks or Composite Blocks used with steel posts are routered. Failure to follow this warning could result in serious injury or death in the event of a collision.
2.	Place a 5/8” (16 mm) round washer (PN-3300G) under a 5/8” (16 mm) HGR nut (PN-3340G) on the inserted bolt.
3.	Tighten the bolts. (There is no torque requirement for these bolts.)

Assembling the Rail Panel to the Post without Offset Block at Post 2

Complete the following steps to attach the Rail Panel to the Post without Offset Block at Post 2:

Step	Actions
1.	Select Option A or Option B to attach the Rail Panel without Offset Block at Post 2:
Option A	**For Wood Post:** 1. Insert a 5/8” (16 mm) diameter x 10” (255 mm) HGR post bolt (PN-3500G) through the Rail Panel and the Wood Post at location 2. 2. Place a 5/8” (16 mm) round washer (PN-3300G) under a 5/8” (16 mm) HGR nut (PN-3340G) on the inserted bolt. Tighten the bolts. (There is no torque requirement for these bolts.)
Option B	**For SYTP™:** 1. Insert a 5/8” (16 mm) diameter x 1 1/4” (31 mm) HGR bolt (PN-3360G) through the Rail Panel and the hole in the SYTP™. **Note:** For SYTP™ Inserts use the hole in the SYTP™ that will place the Rail Panel at the correct height. (If there are two sets of holes in the SYTP™ for attaching the Rail Panel.) 2. Place a 5/8” (16 mm) round washer (PN-3300G) under a 5/8” (16 mm) HGR nut (PN- 3340G) on the inserted bolt.

Assembling the Cable Anchor Assembly

The Cable Anchor Bracket (PN-704A) is secured to the Rail Panel, by inserting the square protruding hooks / lugs on the bracket into the square slots in the rail panel. The Cable Anchor Bracket is locked into place, by pulling the bracket towards the impact end of the unit, making sure the hooks / lugs are well seated into the square holes.

Complete the following steps to assemble the Cable Anchor Bracket assembly:

Step	Actions
1.	Slide one end of the Cable (PN-3000G) into the Cable Anchor Bracket and the other end through Post 1.
2.	Place a 1" (25 mm) washer (PN-3900G) and 1” (25 mm) hex nut (PN-3910G) on the end of the cable that extends through the Cable Anchor Bracket. Turn the nut, until at least 2 threads are completely through the nut.
3.	Place the Bearing Plate (PN-19258A with two side ears/tabs on the steel post, PN-782G with no side ears/tabs on Wood Post) on the impact side of Post 1 where the Cable extends through the Post. The Cable Bearing Plate MUST BE oriented with the “long” dimension turned up. The hole in the Bearing Plate is off center (in the vertical direction), 5” (125 mm) from one edge and 3” (75 mm) from the opposite edge. The two ears/tabs on the Bearing Plate (PN-19258A) must straddle the left and right side of the HBA hinge assembly.
4.	If applying the Bearing Plate with no side ears/tabs (PN-782G) to a wood post at Post 1, drive two 16d hot-dipped **galvanized** nails along the top edge of the bearing plate and bend over to prevent the bearing plate from rotating.
	**Warning:** Any grout, backfill, or other materials (such as concrete, asphalt, or soil) must be low enough so as not to obstruct, constrain, or otherwise engage the Bearing Plate. Failure to eliminate the interaction of soil or materials with the Bearing Plate will hinder the performance of the ET-31™ Guardrail End Treatment and could result in serious injury or death in the event of a collision.
5.	Place a 1” (25 mm) washer under a nut on the end of the Cable extending through Post 1.
6.	Restrain the Cable with locking pliers at the end being tightened, to avoid twisting the Cable.
7.	Tighten the hex nuts on the Cable ends, until the Cable is taut. The Cable is considered taut when it does not deflect more than 1” (25 mm) when pressure is applied by hand in an up or down direction.
8.	The shank portion of the Anchor Cable MUST BE positioned so it bears on the bottom edge of the web of the HBA post. The shank portion of the Anchor Cable must also be centered so that the Bearing Plate bears uniformly on both flanges of Post 1.

Assembling the ET-PLUS™ Extruder (Head)

Complete the following steps to assemble the ET-PLUS™ Extruder (Head):

Step	Actions
1.	Place the ET-PLUS™ Extruder (Head) (PN-995A) over the end of the Rail Panel as the final piece to attach to the assembly. **Note:** The ET-PLUS™ Extruder (Head) can be used on the left or right hand shoulder.
2.	Push the ET-PLUS™ Extruder (Head) as far as it will go onto the front-most Rail Panel, making sure the Rail Panel is fully engaged into the full length of the channel guide attached to the Head until it stops.
3.	Assemble the ET-PLUS™ Extruder (Head) with channel guide attached to it approximately parallel to the ground. The upper and lower attachment tabs welded to the guide chute have three holes in each to provide a means to level the Head (See following steps).
4.	Select Option A or Option B for the ET-PLUS™ Extruder (Head) assembly.
Option A	**For Wood post:** 1. Place the ET-PLUS™ Extruder (Head) against the Wood Post, at location 1. 2. Choose the hole in the tab welded to the guide chute that is closest to the center of the Post. 3. Drill a 1/4” (6 mm) pilot hole to avoid breaking the lag screw during assembly. 4. Screw one 3/8” (10 mm) diameter x 4” (100 mm) lag screw (PN-4228B) through the top and bottom tab. The lag screw must be screwed into the Wood Post to prevent it from pulling out or cracking the post. DO NOT OVER TIGHTEN, causing the threads in the Wood Post to strip.
Option B	**For HBA™ post:** 1. Place the ET-PLUS™ Extruder (Head) against the HBA™ post, at location 1. 2. Place a 3/8” (10 mm) round washer (PN-4254G) onto a 3/8” (10 mm) diameter x 1 1/2” (38 mm) hex head bolt (PN-4261G). 3. Insert this bolt through the tab welded to the side of the guide channel attached to the ET-PLUS™ Extruder (Head) and then through the hole in the flange of HBA™ Post. 4. Place a 3/8” (10 mm) fender washer (PN-4255G) under a 3/8” (10 mm) nut (PN-6405G) onto the inserted bolt. A larger fender washer is used to cover the relatively large hole in the flange of the HBA Post. 5. Repeat this assembly step for the top and bottom tabs. When completed, the Head will be attached to the HBA post via an upper and lower 3/8” diameter hex head bolt (PN-4261G). 6. Tighten the nuts to a snug position. The designer does not recommend a torque requirement for the HBA field assembly.

Delineation Option for the ET-31™ Guardrail End Treatment

Apply High Intensity Reflective Sheeting (PN-6206B [Right Side] or PN-6207B [Left Side]) on the front face of the ET-PLUS™ Extruder (Head), per the state or specifying agency’s *Manual on Uniform Traffic Control Devices* (MUTCD) for options or proper delineation. Alternate Reflective Sheeting is PN-6668B. The Alternate Reflective Sheeting requires two pieces and may be rotated for proper right or left delineation.

Note: The Reflective Sheeting is an option to the ET-31™ Guardrail End Treatment and needs to be ordered separate from the ET-31™ Guardrail End Treatment package.

Assembly Checklist

State: _____Project: _____

Date: _____Location: _____

- ☐ The leaveout (the specified area of open space in the pavement) around the Posts is reserved and filled with state or specifying agency approved backfill material that will not prevent movement for any posts placed in rigid pavement such as any thickness of concrete or asphalt.
- ☐ The finished guardrail height is approximately 31” (787 mm) above the finished grade, or as the state or specifying agency plans indicate.
- ☐ Any site grading needed was completed, before the start of the assembly of the ET-31™ Guardrail End Treatment.
- ☐ The Steel Tubes or Post Plates (ears) to the HBA™ bottom post do not protrude more than 4” (100 mm) above the finished grade measured by the American Association of State Highway and Transportation Officials (AASHTO) 5’ (1.5 m) cord method. Site grading may be necessary to meet this requirement.
- ☐ The 3/4” (19 mm) bolts connecting the tops of the HBA™ Bottom Post to the bottom of the HBA™ Top Post are tightened to a snug position. The designer does not recommend a torque requirement for the HBA field assembly.
- ☐ The 3/8” (10 mm) bolts connecting the tops of the HBA™ Bottom Post to the bottom of the HBA™ Top Post are tightened to a snug position. The designer does not recommend a torque requirement for the HBA field assembly.
- ☐ The bolts at the top of the Steel Tubes are not over tightened. The walls of the Steel Tubes are not collapsed.
- ☐ If an Angle Strut was utilized, the bolts connecting the Angle Strut are 3/4” (19 mm) DIA. high strength.
- ☐ The ET-PLUS™ Extruder (Head) is pushed as far as it will go on the Rail Panel, ensuring the Rail Panel is fully engage into the channel guide that is welded to the Extruder (Head).
- ☐ The two 3/8” diameter bolts holding the ET-PLUS™ Extruder (Head) to Post 1 are snug and the channel guide welded to the Head is approximately parallel to the finished grade.
- ☐ The Cable Anchor Bracket is locked into place, by pulling the Bracket towards the impact end of the unit, making sure the hooks / lugs are well seated into the square holes.
- ☐ The shank portion of the Anchor Cable MUST BE positioned vertically flush against the bottom web of the top section of the HBA Post. The shank portion of the Cable MUST also be centered so that the Bearing Plate bears uniformly on both flanges of Post 1.
- ☐ Any grout, backfill, or other materials (such as concrete, asphalt, or soil) must be low enough so as not to obstruct, constrain, or otherwise engage the Bearing Plate.

- ☐ The hex nuts on the Cable ends are tightened, until the Cable is taut. The Cable is considered taut, when it does not deflect more than 1” (25 mm) when pressure is applied by hand in an up or down direction.
- ☐ Do not place anything under the rail to post bolt head that would prevent the bolt from pulling through the Rail Panel.
- ☐ The Bearing Plate is placed on the front of Post 1 where the Cable extends through the Post. The Cable Bearing Plate MUST BE oriented with the “long” dimension turned up. The hole in the Bearing Plate is off center (in the vertical direction), 5” (125 mm) from one edge and 3” (75 mm) from the opposite edge. If the Bearing Plate has two “ears/tabs”, these need to straddle the left and right side of the No. 1 Post and be on the upper side of the plate.
- ☐ The top surfaces of any grout or other backfill placed in the mow strip “leave out” must be low enough so that it does not engage the Bearing Plate or otherwise obstruct or constrain the 3/8” (10 mm) shear bolts or the 3/4” (19 mm) hinge bolts of the HBA Post
- ☐ Any Wood Offset Blocks used have been toe nailed to the Wood Posts.
- ☐ If backfilled, make sure the backfill material around the Posts is properly compacted.
- ☐ Each HBA™ Post has two bolts on either side of the Post with the larger bolt downstream of the smaller bolt (away from the Impact Head).
- ☐ The SYTP™ holes are at the finished grade.
- ☐ The Wood CRT Post has two 3 1/2” (90 mm) breakaway holes (checked prior to assembly). They are located parallel to the roadway with the top hole located approximately at the finished grade.
- ☐ The tube bolts are attached with the nuts on the pavement side of the Tube for ease of future removal.
- ☐ The Rail Panels are lapped correctly and not attached to the Posts at locations identified for the system.
- ☐ Each Rail Panel used in the ET-31™ pay length is straight, with no visible distortions or blemishes such as curves, dents, cuts, tears, extra holes, cut-outs, corrosion, or signs of past repairs.
- ☐ The Reflective Sheeting is correctly positioned on the Extruder face.
- ☐ Ensure that this assembly conforms with the guidance provided by the *AASHTO Roadside Design Guide*, including, but not limited to, those regarding placement on curbs.

Maintenance and Repair

Always keep the Manual in a location where it is easily accessed by persons who assemble, maintain, or repair the ET-31™ Guardrail End Treatment. If you have any questions concerning the information in this Manual or about the ET-31™ Guardrail End Treatment, contact Trinity Highway Products at 888-323-6374.

Maintenance

Complete the following steps, periodically, to check the safety of the system:

Step	Actions
1.	Ensure the nuts have not been removed from the Cable. Replace nuts, if needed.
2.	Ensure the end fitting on the Anchor Cable MUST BE positioned vertically, up flush against the bottom web of the top section of the Post. The end fitting of the Cable **MUST** be centered horizontally so that the Bearing Plate bears uniformly on both flanges of Post 1.
3.	Ensure the Cable is taut. The Cable is considered taut when it does not deflect more than 1 inch when pressure is applied by hand in an up or down direction. Tighten Cable if needed.
4.	Ensure the Bearing Plate has not rotated. **Note:** The Cable Bearing Plate MUST BE oriented with the "long" dimension turned up. The hole in the Bearing Plate is off center (in the vertical direction), 5" (125 mm) from one edge and 3" (75 mm) from the opposite edge.
5.	Ensure Wood Blocks are in place and in good condition, as defined by the state or specifying agency.
6.	Ensure the Block Outs have not rotated. Correct the Block Out position and reattach the 16d hot-dipped galvanized nails, if needed.

Repair

Complete the following steps to repair the ET-31™ Guardrail End Treatment:

Step	Actions
1.	Set up necessary traffic control at the accident site and then remove any debris that has encroached onto the traveled way or shoulder.
2.	Take inventory of the damaged system and determine what parts are reusable, as defined by the state or specifying agency and what parts need to be replaced.
3.	Check the ET-PLUS™ Extruder (Head) for damage. The determination as to whether or not the Head is reusable rests **entirely** within the discretion of the DOT or other appropriate highway authority. Before reusing a Head, please make sure that an experienced, trained engineer for the highway authority inspects the Head to his or her satisfaction and authorizes its reuse. For consideration of reuse of the Extruder Head, the rail guide chute must be fully intact and not distorted in any way; the slot that flattens the rail shall not be excessively distorted in any way; the slot that flattens the rail shall not be excessively distorted; the front impact face must not be excessively distorted, and all the original welds must be intact. Again before reusing a Head, a trained DOT or applicable highway authority engineer shall inspect it and authorize its reuse.
4.	Check the Anchor Cable and Cable Anchor Bracket for damage. (The Bearing Plate, nuts, washers, and Cable Anchor Bracket are rarely damaged.)
5.	Obtain the Trinity Highway Products parts that need to be replaced from Trinity Highway Products. (See *Tools Required* section for a list of recommended tools for the repair of the ET-31™ Guardrail End Treatment.)

6.	Return to the repair site with the replacement parts and tools needed.
7.	Cut off the extruded rail near the ET-PLUS™ Extruder (Head). Do not cut the ET-PLUS™ Extruder (Head) from the non-extruded rail.
8.	Secure a chain to the ET-PLUS™ Extruder (Head).
9.	Attach the chain to a truck frame while the other end of the Rail Panel is still connected to the downstream Posts (away from the Impact Head) to provide anchorage.
10.	Pull the ET-PLUS™ Extruder (Head) off the Rail Panel.
11.	Remove any damaged Rail Panel(s).
12.	Remove the broken Posts from the Steel Tubes.
13.	Remove all damaged CRT, SYTP™, or HBA™ Posts. Undamaged HBA™ Posts can be reset.
14.	Remove and discard any rubber bumpers or construction legs.
15.	Reconstruct the system following the assembly instructions after the site has been cleared of damaged debris.
16.	Attach proper delineation for the repaired system in accordance with the state or specifying agency's *Manual on Uniform Traffic Control Devices* (MUTCD).

Notes:

2525 Stemmons Freeway
Dallas, Texas 75207
888-323-6374 (USA only)
214-589-8140 (Outside USA)
www.energyabsorption.com
www.highwayguardrail.com

APPENDIX 'H'

2016 HYDROLOGIC AND HYDRAULIC ASSESSMENT

Seine River at Fermor Avenue
Bridge Crossing Replacement
Hydrologic and Hydraulic Assessment

May 2016

City of Winnipeg
Public Works

Bruce Harding Consulting Ltd

Seine River at Fermor Avenue
Bridge Replacement
Hydrologic and Hydraulic Assessment

APEGM
Certificate of Authorization
Bruce Harding Consulting Ltd.
No. 4652 Expiry: April 30, 2017

Prepared by: Bruce Harding, P.Eng.

May 2016

City of Winnipeg
Public Works

Table of Contents

1 Introduction

This report summarizes the results of our hydrologic analysis and hydraulic assessment of the Seine River for the replacement of the Fermor Avenue Bridge crossing in the City of Winnipeg. The location of the site is indicated on Figure 1. The existing three span bridge crossing has reached the end of its service life and requires replacement.

Pertinent features of the site are as follows:

- Jurisdiction - City of Winnipeg
- Watercourse - Seine River
- Flow Direction - Southeast
- Designation of Drain Map - No. 9
- UTM Coordinates - 636930E, 5524575N (Zone 14)

Fisheries and Oceans Canada has indicated that this reach of the Seine River near the site has Type A – complex habitat with indicator species[1] (refer to appended map) , therefore the design of the proposed crossings will adhere to the Manitoba Stream Crossing Guidelines[2] with respect to providing fish passage.

For this assessment it has been assumed that the waterway would be navigable therefore any proposed crossing will be subject to the specific requirements for vertical and horizontal clearances under the Navigable Water Protection Act. Note however that a request to Transport Canada to determine navigability for this location has not been undertaken to date.

The existing bridge crossing has been proposed to be replaced with twinned three span bridge structures on the same alignment. Additional details with respect to the hydrologic assessment and the hydraulic sizing of the replacement structure options are summarized in the following sections.

1 "Fish Habitat Classification for Manitoba Agricultural Watersheds", Map 062H14, March 2008, Fisheries and Oceans Canada.
2 "Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat", Manitoba Natural Resources –Fisheries Department and the Canadian Department of Fisheries and Oceans, May 1996.

2 Hydrology

2.1 Flood Hydrology

The Seine River watershed, which has a total drainage area of approximately 1470 km^2, is heavily regulated by diversions and as such the hydrology of the river is significantly altered particularly within the City of Winnipeg. The diversion of the Seine River flows at the Floodway has the most influence on the hydrology of the waterway through the City of Winnipeg. The flows into the City are restricted to the conveyance capacity of the Floodway inverted siphon, which has been estimated to be approximately 4.2 m^3/s. Additional inputs into the Seine River within the City occur from the Floodway downstream to the Red River from lateral drains, including the Navin Drain Bibeau Drain and Dugald Drain, along with numerous storm sewer outfalls.

The flood hydrology for the Seine River, downstream through the City was interpreted from the "Seine River Hydrology Study" Report[3] and the "Seine River, Riffle Site Development Plan" Report[4]. Table 1 summarizes the hydrology for the Seine River from the Floodway downstream to the Red River.

Table 1
Seine River - City of Winnipeg Reach
Flood Hydrology Estimates

Location	50% Discharge (m^3/s)	10% Discharge (m^3/s)	1% Discharge (m^3/s)
Seine River Siphon (Floodway)	4.2	4.2	4.2
At Prairie Grove Road	6.8	8.5	12.0
At Creek Bend Road	7.4	9.3	15.6
AtSouth Glen Boulevard	7.9	9.9	17.0
At Navin Drain (Fermor Avenue reach)	**10.8**	**13.6**	**21.2**
At Bibeau Drain	13.6	17.0	24.1

The 1% flood discharge of 21.2 m^3/s will be selected as the design discharge for the Fermor Avenue crossing replacement.

3 "Seine River Hydrology Study", for the City of Winnipeg prepared by Acres Consulting Services, 1978
4 "Seine River, Riffle Site Development Plan, Technical Report" for Save or Seine prepared by Denis Andrews Consulting. March 2000

2.2 Red River Backwater Influence

The backwater effect due to elevated levels on the Red River, have a large influence on the hydraulics of the Seine River including the hydraulics of the river at Fermor Avenue. The backwater influence from the Red River can extend as far upstream as the Perimeter Highway (PTH 101) as observed during the 1997 Flood. On that basis, the hydraulics of the Seine River will be assessed over a range of backwater conditions due to elevated Red River levels from the normal summer (controlled) levels of 223.8 m or 6.7 ft James Avenue Pumping Station Datum (JAPSD) up to the Flood Protection Level of 230.0 m or 27 ft JAPSD.

3 Hydraulic Assessment – Existing Conditions

The existing Fermor Avenue crossing of the Seine River is a three span 55 m long concrete girder bridge. The bridge is located at the end of a meander bend, with the channel skewed approximately 12^{o}, however the bridge is unskewed. The proposed roadway upgrades for Fermor Avenue, in addition to the fact that the existing bridge has reached the end of its service life, warrants replacement of the structure.

The Seine River within the study reach is for the most part a natural channel; however the river has been greatly impacted by urban development and transportation infrastructure. The main channel of the river is heavily meandering with a well defined main channel, with a predominately silty clay bottom. The channel grade through the study reach is approximately 0.08%. The overbank area is heavily vegetated with trees, bushes and shrubs. Although the Seine River through the City of Winnipeg does not experience severe flooding due to the diversion at the Floodway, the river does get affected by the backwater influence from elevated Red River levels during flood, which results in flooding into the overbank area. Photographs of the Seine River and the Fermor Avenue bridge are appended for reference.

A hydraulic assessment of the Seine River within the project area was undertaken to determine the hydraulic characteristics of the waterway and downstream structures which influence the hydraulics of the river and the Fermor Avenue bridge crossing. An existing HEC-RAS model of the Seine River previously developed for other hydraulic studies was used for the assessment. The steady-state backwater model of the Seine River within the study reach was developed using the US Army Corps of Engineers River Analysis System HEC-RAS model. The HEC-RAS model is a one-dimensional backwater model, which is considered to be the universal standard for computing steady-state water surface profiles. The backwater model extends approximately 26 km upstream from the Red River to the Floodway. The existing backwater model was assembled from cross-sections, channel profiles and details of the crossing structures surveyed by Acres Consulting (1978), Denis Andrews Consulting (2002), Bruce Harding Consulting (2005/2006), and GDS Surveys (2011). The model was further updated with additional detailed surveys within the Fermor Avenue study reach by GDS Surveys (May 2016).

The backwater model has been developed to the level of detail required to estimate the relative effect of the proposed replacement crossing at Fermor Avenue. The hydraulic parameters typically required for calibration within this lower reach, such as channel roughness, are within the standard range expected for the Seine River.

The estimated water surface profiles for the Seine River within the study area under existing conditions (circa May 2016), with the existing Fermor Avenue bridge structure are shown on Figure 2. Table 2 summarizes the hydraulic assessment for the existing Fermor Avenue bridge.

Table 2
Seine River at Fermor Avenue
Hydraulic Summary for Existing Bridge

Probability	Discharge (m^3/s)	Water Level Downstream of Crossing (m)	Water Level Upstream of Crossing (m)	Headloss (m)	Clearance to Underside of Girder * (m)	Bridge Opening Velocities (m/s)
Low Red River Levels (no backwater)						
50% Discharge	10.8	226.99	227.01	<0.05	4.19	0.55
10% Discharge	13.6	227.22	227.24	<0.05	6.96	0.55
1% Discharge	21.2	227.54	227.57	<0.05	3.63	0.65
Elevated Red River Levels (backwatered) - assumes 50% Discharge						
12' JAPSD**	10.8	227.03	227.05	<0.05	4.15	0.55
18' JAPSD**	10.8	227.47	227.48	<0.05	3.72	0.35
24.5' JAPSD**	10.8	229.24	229.24	<0.05	1.96	0.10
Elevated Red River Levels (backwatered) - assumes Flood Protection Level of 230.0						
50% Discharge	10.8	230.03	230.03	<0.05	1.17	0.10
1% Discharge	21.2	230.09	230.09	<0.05	1.11	0.15

* - underside of girder at approximately el 231.2 m

** - Red River at junction with Seine River referenced to James Avenue Pump Station Datum (JAPSD) of 727.586 ft

4 Hydraulic Assessment – Proposed Crossing Replacement

4.1 General

The existing bridge crossing has been proposed to be replaced with twinned three span bridge structures on the same alignment The proposed replacement crossings will continue to be bridge structures due to the site geometry and the flow conditions observed at this location, with the centre span clearing the main channel of the Seine River.

4.2 Hydraulic and Regulatory Design Criteria

The hydraulic design criterion selected for the replacement crossing is as follows:

- Design discharge – governing condition with either :
    - 1% discharge with low Red River levels (no backwater)
    - 1% discharge with Red River at Flood Protection Level (FPL) at 230.0 resulting in a backwater condition.
- Maximum headloss of 0.3 m during the passage of the design discharge. Due to the close proximity of these two structures, the headloss would the total due to both structures.
- Bridge opening velocities less than 1.5 m/s for discharges up to the design discharge
- Underside of girder elevation to remain minimum of 0.3 m above water surface during passage of design discharge.

The Seine River has been judged to be navigable by Transport Canada; therefore any proposed crossing will be subject to the specific requirements for vertical and horizontal clearances under the Navigable Water Protection Act. The following vertical and horizontal clearances for small watercraft (canoes, kayaks, etc.) were assumed to be provided:

- Provide a minimum vertical clearance of 1.5 m from the underside of girder to the water surface corresponding to the 50% (Q2) discharge.
- Provide a minimum clear horizontal width of 3 m within the bridge opening at the water surface corresponding to the 50% (Q2) discharge.

Bridge structures do not typically require the same strict limiting velocity requirements for fish passage as those of culvert type structures. The shape of the bridge opening with sloping banks at the abutments, provides lower velocity fringe zones to permit upstream fish passage. As such, the requirement for limiting velocity is typically not applied except under extenuating circumstances. On that basis, there are no concerns or design requirements with respect to fish passage with a bridge structure at this location.

4.3 Replacement Structures

It is proposed that the existing bridge be replaced with twinned structures, dividing the east and westbound lanes of traffic. The proposed replacement structures for this site are as follows:

- Three span 52 m long bridges. The 52 m long bridges consist of 15.6 m long approach spans with a 20.8 m long centre span.
- The proposed structures would be constructed without skew and would be offset slightly south and 2.4 m west relative to the existing bridge.
- The proposed underside of girder elevation of 231.2 has been selected to approximately match the existing underside of girder elevation. Typically a bridge is not lowered relative to the existing structures, however if judged necessary, then the minimum underside of girder elevation that should be considered would be 230.4 m.
- The proposed replacement structures will require the removal of the existing bridge and abutments. The channel slopes (headslopes) upstream, beneath the bridge and downstream, will be excavated with a slope of 4:1 extending down from the abutments to the channel base. The channel base and slopes would be armoured with a 0.525 m thickness of Class 350 rock placed over non-woven geotextile. The channel base would be reshaped with a width of 7.0 m and a finished elevation of 224.9.
- Rock armour to extend 10 m upstream and downstream of the outside faces of the replacement bridge structures.
- Channel reshaping to extend 24 m upstream and 47 m downstream of the outside faces of the replacement bridge structures.
- Refer to the detail sketches of the proposed bridge structure on Figures 3 and 4.

The backwater model of the Seine River was modified to incorporate the proposed bridge replacement structure. The estimated water surface profiles for the Seine River with the proposed replacement bridge structures are shown on Figure 5 while Table 3 summarizes the hydraulic assessment.

The proposed bridge structure length/configuration is governed primarily by standard bridge configurations for the site geometry and design discharge water level and not headloss or velocity. A slightly shorter bridge could be considered, however non-standard abutments and side slopes would be required which have a higher cost and may not be acceptable with respect to geotechnical stability.

Table 3
Seine River at Fermor Avenue
Hydraulic Summary for 52 m long 3 span Twin Span Bridges

Probability	Discharge (m^3/s)	Water Level Downstream of WBL Bridge (m)	Water Level Upstream of EBL Bridge (m)	Headloss (m)	Clearance to Underside of Girder * (m)	Bridge Opening Velocities (m/s)
Low Red River Levels (no backwater)						
50% Discharge	10.8	226.99	227.01	<0.05	4.19	0.35
10% Discharge	13.6	227.24	227.24	<0.05	3.96	0.4
1% Discharge	21.2	227.56	227.57	<0.05	3.63	0.45
Elevated Red River Levels (backwatered) - assumes 50% Discharge						
12' JAPSD**	10.8	227.04	227.05	<0.05	4.15	0.35
18' JAPSD**	10.8	227.47	227.48	<0.05	3.72	0.25
24.5' JAPSD**	10.8	229.24	229.24	<0.05	1.96	0.10
Elevated Red River Levels (backwatered) - assumes Flood Protection Level of 230.0						
50% Discharge	10.8	230.03	230.03	<0.05	1.17	0.10
1% Discharge	21.2	230.09	230.09	<0.05	1.11	0.15

* - underside of girder at approximately el 231.2 m

** - Red River at junction with Seine River reference to James Avenue Pump Station Datum of 727.586 ft

4.4 Erosion Control Measures

The velocities within the bridge opening of the proposed twinned bridge structures at Fermor Avenue and the reshaping of the channel will not adversely alter the hydraulics of the river. Velocities are not high, generally less than 0.6 m/s. As such, the requirements for the rock armoring within the bridge opening are not excessive. The proposed Class 350 rock will be more than adequate to resist erosive forces within the bridge opening for the velocities that would be encountered.

Note however there are areas along the meander bend adjacent to Fermor which have steep slopes and evidence of slope failures, Rock armouring may be necessary at these locations to minimize toe erosion which may be reducing slope stability.

5 Other Considerations

Best Management Practices for working near waterways including the appropriate implementation of sediment and erosion control measures should be followed. Exposed slopes not covered with rock should be revegetated and covered with erosion control blanket. Construction activities within the river shall not take place between April 1 and June 15 of any given year. An Environmental Management Plan should be prepared which details the specific environmental management requirements and sediment and erosion control.

Water management during construction can be an important aspect of any project and may influence the cost and scheduling for crossing replacement. Elevated water levels at the bridge would occur as a result of: increased flows in the Seine River during the spring runoff period and following a heavy summer rainfall event; or from the backwater influence of the Red River when that river is under flood which is typically a spring condition however summer flooding is not uncommon. Construction should take place in the late fall and winter period when the potential for runoff is reduced thereby minimizing water management requirements. All instream work should be completed no later than March 15th, with the schedule showing the majority of instream work completed by early March. Although minimal, flows continue throughout the winter and should be considered as part of the water management plan with appropriate measures taken to deal with the flow.

6 Ice Loadings

There are several modes of interaction between ice and bridge piers which may develop forces which have to be taken into consideration in the design of a pier. The potential modes of ice interaction on the piers may include:

- Dynamic forces due to moving sheets or floes of ice being carried by river currents.
- Static pressure due to thermal expansion movements of the ice cover.
- Pressures resulting from the formation of a hanging ice dam or by an ice jam
- Vertical loading resulting from the adhesion of ice to the pier in waters with fluctuating water level.

Section 3.12 – *Ice Loads* of the Canadian Highway Bridge Design Code[5] will be referenced to develop ice loading forces for the design of the piers.

6.1 Dynamic Ice Forces

Dynamic forces occur when a moving ice floe strikes a bridge pier. Forces imposed by the ice floe on a pier are dependent on the size of the individual ice floes (thickness, width and length), the internal strength of the ice and the geometry of the pier nose. For smaller rivers, like the Seine River, the governing ice loads are typically due to crushing and bending/flexure. Note however, the ice and resultant loadings that have been observed on the Seine River would not be excessive due to the reduced flows (upstream diversion) and the heavily meandering nature of the river which breaks up the ice floes.

The effective ice strength varies depending on the air temperatures and the integrity of the ice cover. The Code provides guidelines for estimating the effective crushing strength of the ice cover (Section 3.12.2.1). The value which best reflects the effective crushing ice strength is (b) “the ice breaks up at melting temperature and is somewhat disintegrated: 700 kPa”. The thickness of the ice cover has been assumed to be limited to 750 mm, although locally thinner and thicker sections could exist depending on the severity of the winter, the snow cover and flows throughout the winter period. A 750 mm thickness would be considered the upper limit on average for ice thickness within the river. The code provides equations for the estimation of the horizontal forces computed by both crushing and bending modes. The governing ice loading force, F, will be the smaller of either of these two estimates as the ice will fail in either crushing or flexure modes once it reaches the smaller of these two loadings.

5 “Canadian Highway Bridge Design Code”, Canadian Standards Association, November 2006, Section 3.12

The code recommends that the acting ice load or impact force for piers parallel to the flow, as would exist at the Fermor Avenue Bridge, be assessed for two load cases as indicated. During breakup, the ice would be confined to the main river channel which would be in alignment with the proposed bridge and the piers.

The resultant dynamic ice force should be applied at a given elevation which corresponds to the water level at the time of estimated breakup. The required water level elevation and top of ice elevation at the Fermor Avenue Bridges has been estimated to be 227.2 m. The elevation to apply the force can be taken as the centre of the ice cover which is approximately 226.8 m. Corresponding bridge opening velocities are estimated at 0.5 m/s.

Any remedial measures required for the piers should incorporate a rounded or bullet-shaped nose as that form reduces the ice loadings relative to pointed angular noses. The sloping of the upstream face of the pier can also decrease ice loadings by reducing the force necessary to fail the ice by flexure; however this may only be an advantage when the crushing strength is relatively high, however a sensitivity on the slope angle should be assessed to determine if a design advantage exists.

6.2 Static Ice Forces

Thermal expansion of an ice cover can induce significant loading on piers if the loading is unbalanced, acting only on one side. Generally thermal expansion is of greater concern within a lake environment where the ice is constrained on one shoreline and expands laterally out from the shore. The limited ice cover within the proposed bridge opening would not be large enough to generate sufficient static ice forces which would result in an imbalance in forces, therefore no allowance for static forces will be assumed.

6.3 Ice Jam Forces

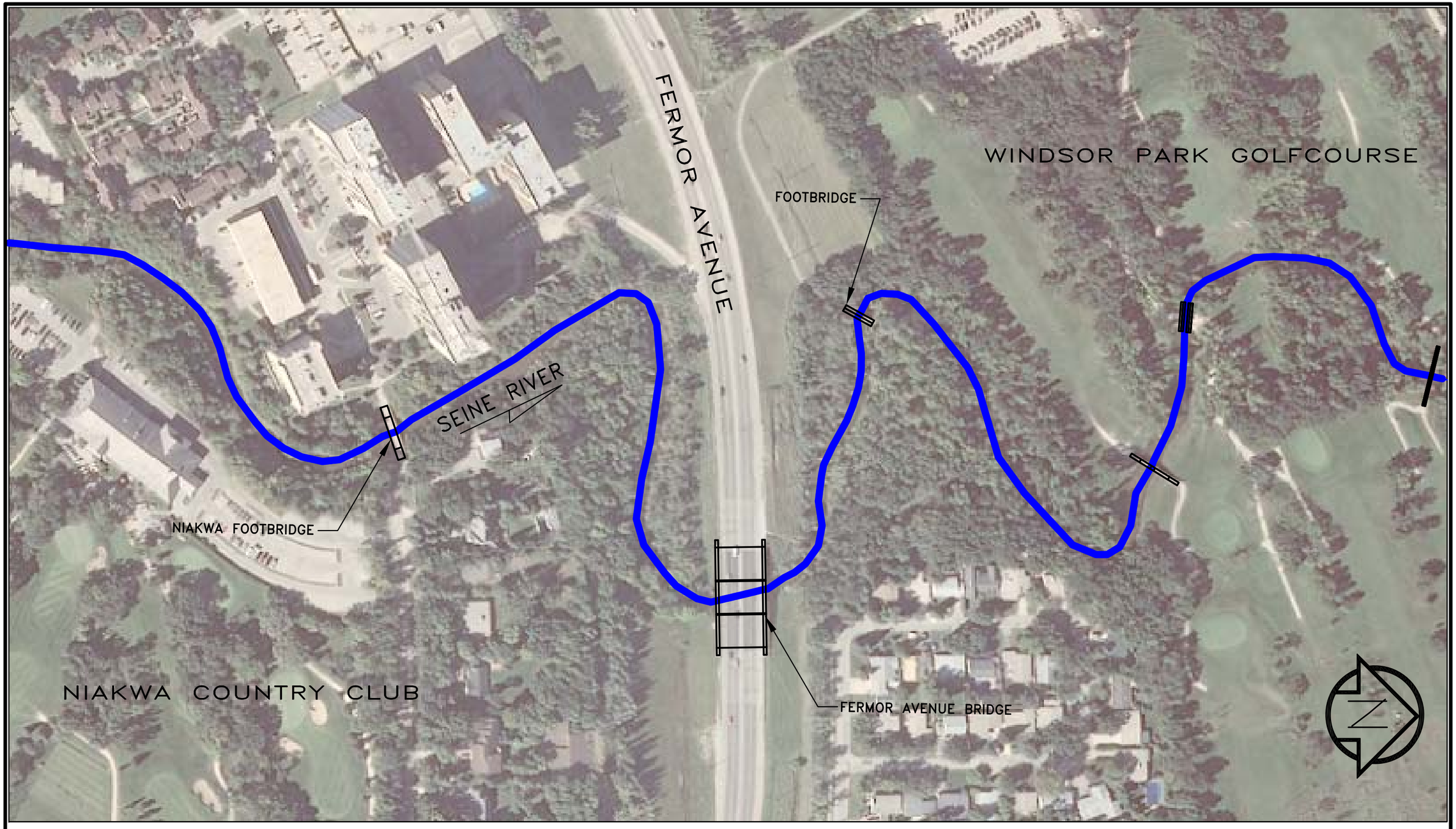
Dynamic forces occur when moving ice jams and hanging ice dams shed their internal forces to the river banks, to islands or to obstructions like bridge piers within a river. The code provides guidance with respect to estimating the loading of an ice jam on the bridge piers. For clear openings between piers less than 30 m, a pressure of 10 kPa can be assumed which acts on either one of the lateral faces or the upstream face of the pier over the thickness of the ice jam. Ice jams at this location would be unlikely, again due to the diversion of flows, however the sensitivity of the pier loadings should be assessed for a nominal ice jam

thickness. The estimated ice jam thickness is 1000 mm which would be assumed at a water level and corresponding ice surface elevation of 227.2 m.

6.4 Ice Adhesion Forces

Ice adhesion is generally of concern in areas where rapidly varying water levels can occur such as below a hydroelectric development during ice formation periods. River flows and corresponding water levels within the Seine River throughout the winter period remain relatively stable and would not typically result in significant vertical loadings.

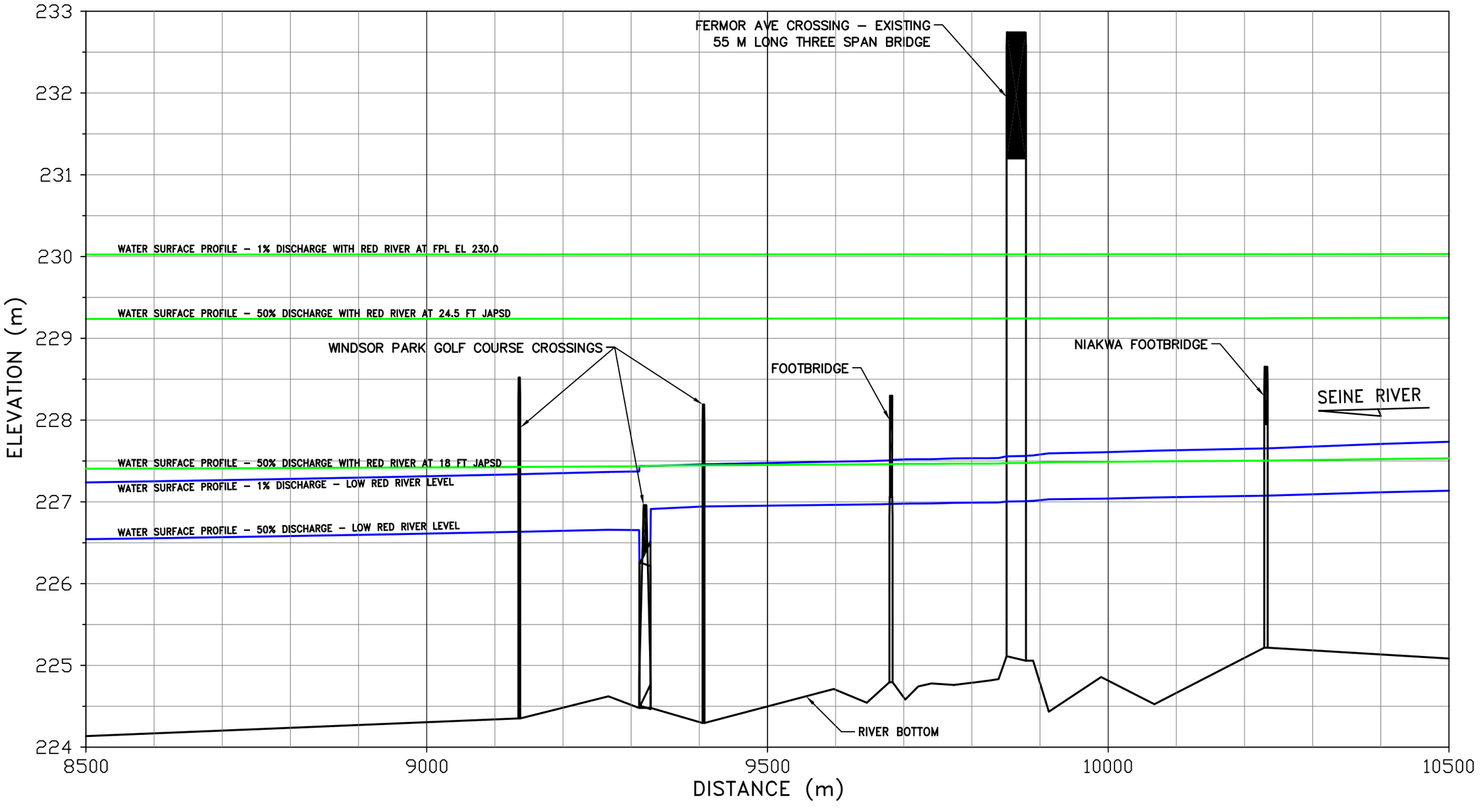
Figures



SCALE

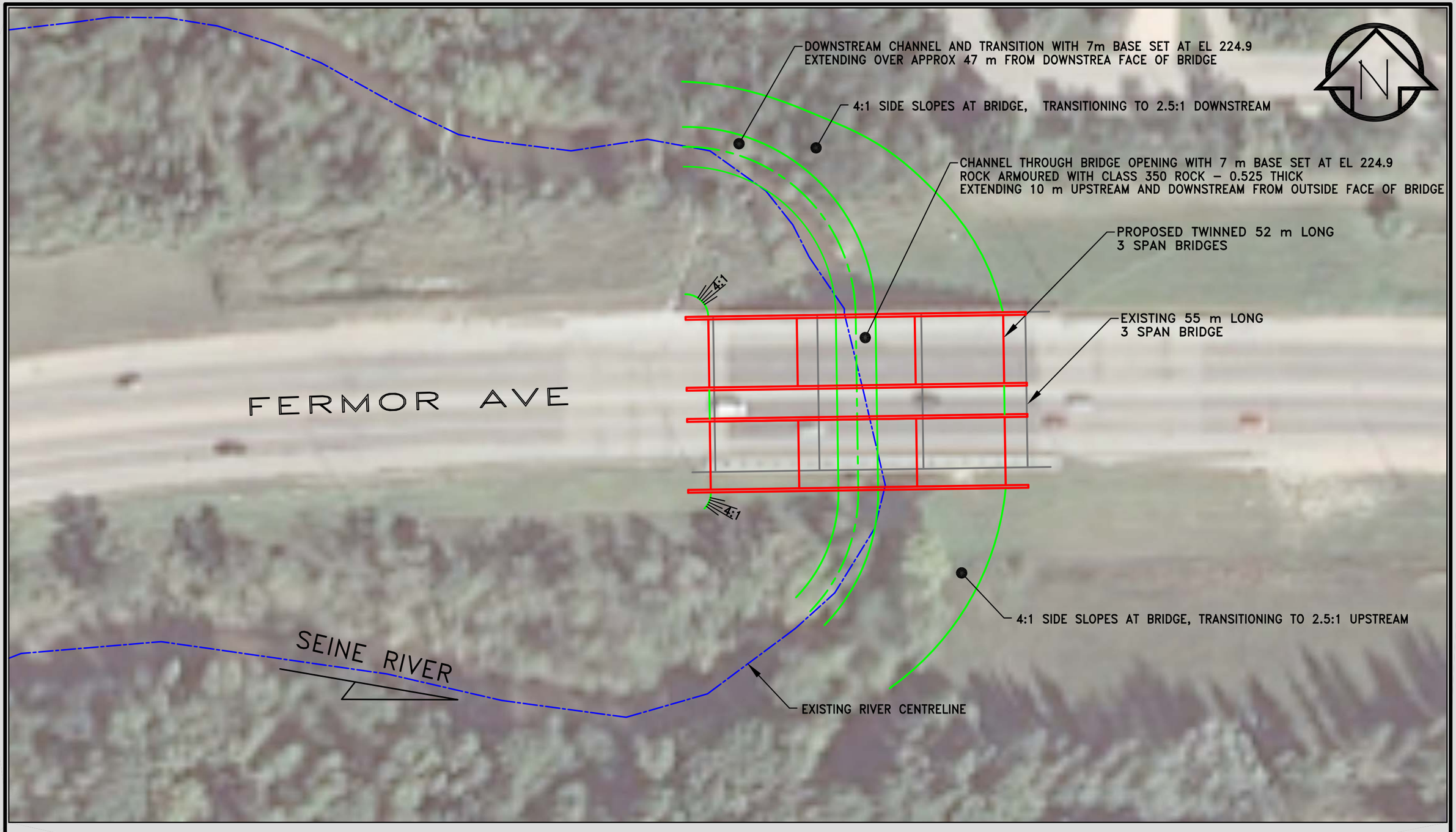
100 0 100 200

SEINE RIVER AT FERMOR AVENUE
CROSSING ASSESSMENT AND REPLACEMENT
LOCATION PLAN
FIGURE 1



NOTES:
1) HEC–RAS MODEL DEVELOPED FROM COMPREHENSIVE SEINE RIVER MODEL WITH ADDITIONAL DETAILED SECTIONS WITHIN PROJECT AREA SURVEYED MAY 2016
2) WATER SURFACE PROFILES REFLECT HYDRAULIC CONDITIONS WITH EXISTING 55 M LONG THREE SPAN CONCRETE BRIDGE AT FERMOR AVENUE

SEINE RIVER AT FERMOR AVENUE
WATER SURFACE PROFILES
EXISTING CONDITIONS
FIGURE 2

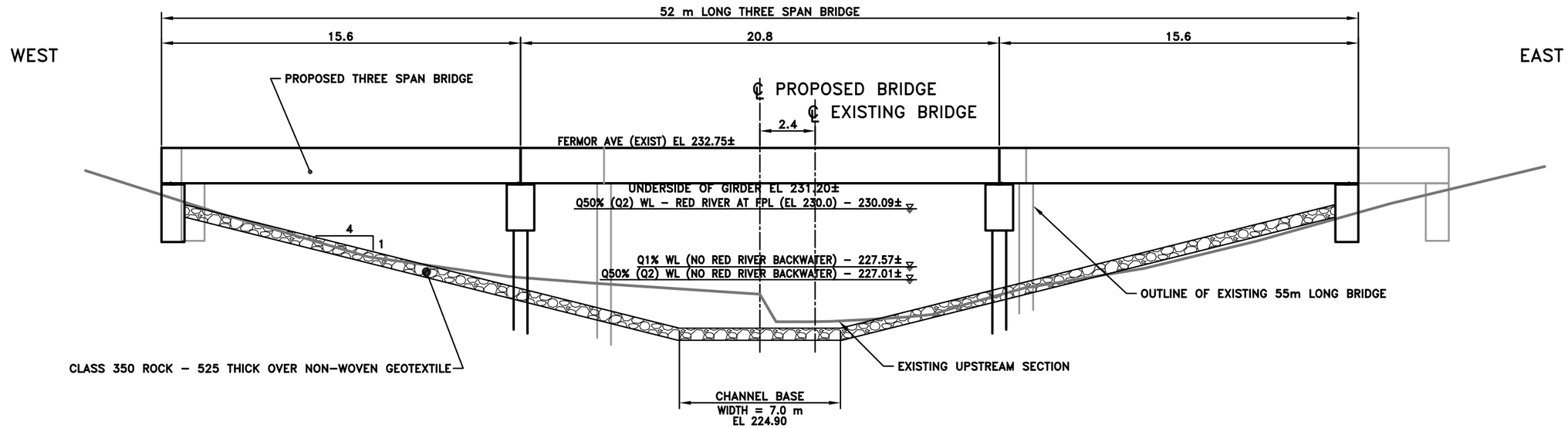


SCALE

25 0 25 50

SEINE RIVER AT FERMOR AVE
PROPOSED TWINNED BRIDGES
LAYOUT
FIGURE 3

TWINNED 3 SPAN 52 m LONG BRIDGES

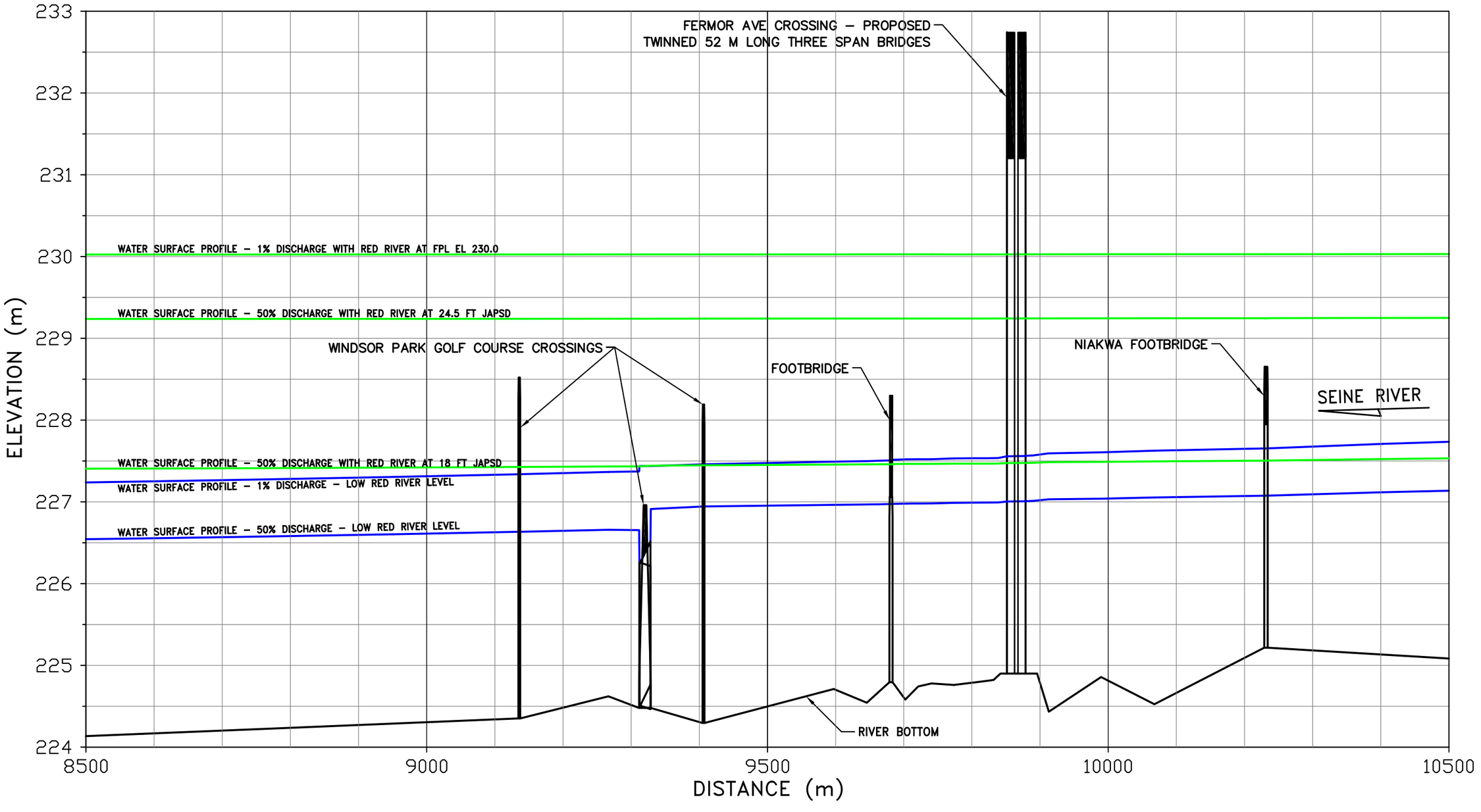


UPSTREAM ELEVATION – EASTBOUND LANE BRIDGE

SCALE

10 0 10 20

SEINE RIVER AT FERMOR AVE
PROPOSED TWINNED BRIDGES
UPSTREAM ELEVATION
FIGURE 4



NOTES:
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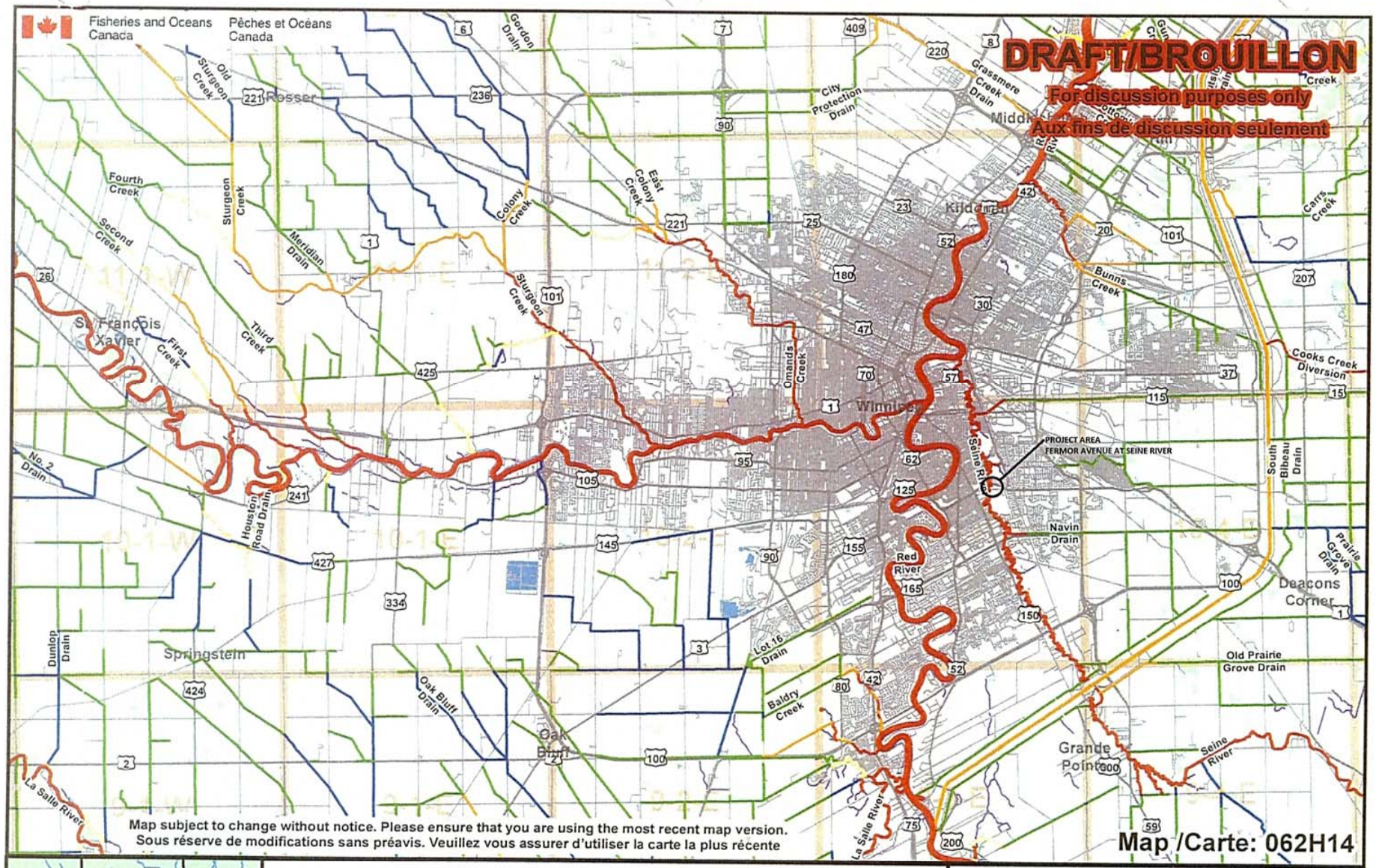
2) WATER SURFACE PROFILES REFLECT HYDRAULIC CONDITIONS WITH PROPOSED TWINNED 52 M LONG THREE SPAN BRIDGES AT FERMOR AVENUE

SEINE RIVER AT FERMOR AVENUE
WATER SURFACE PROFILES
PROPOSED REPLACEMENT CROSSING
FIGURE 5

Appendix A
Fish Habitat Classification Map



062I04	062I03	062I02
062H13	062H14	062H15
062H12	062H11	062H10

Kilometers 0 1 2 4 6 8 10 Kilomètres

Miles 0 1 2 4 6 Milles

Map not to be used for navigation/
Ne pas utiliser pour la navigation

Habitat Type/ Type d'habitat	Color/ Couleur
A	
B	
C	
D	
E	
Unclassified/ Non classifié	

Fish Habitat Classification for Manitoba Agricultural Watersheds/ Classification de l'habitat du poisson par rapport aux bassins hydrographiques agricoles au Manitoba

Version 1.0

Valid until March 31, 2008
Valide jusqu'au 31 mars 2008

Canada

Appendix B
Photographs

Photo No. 1 Seine River downstream of Fermor Avenue Crossing

Photo No. 2 Downstream side of Fermor Avenue Crossing

All photographs taken May 4, 2016

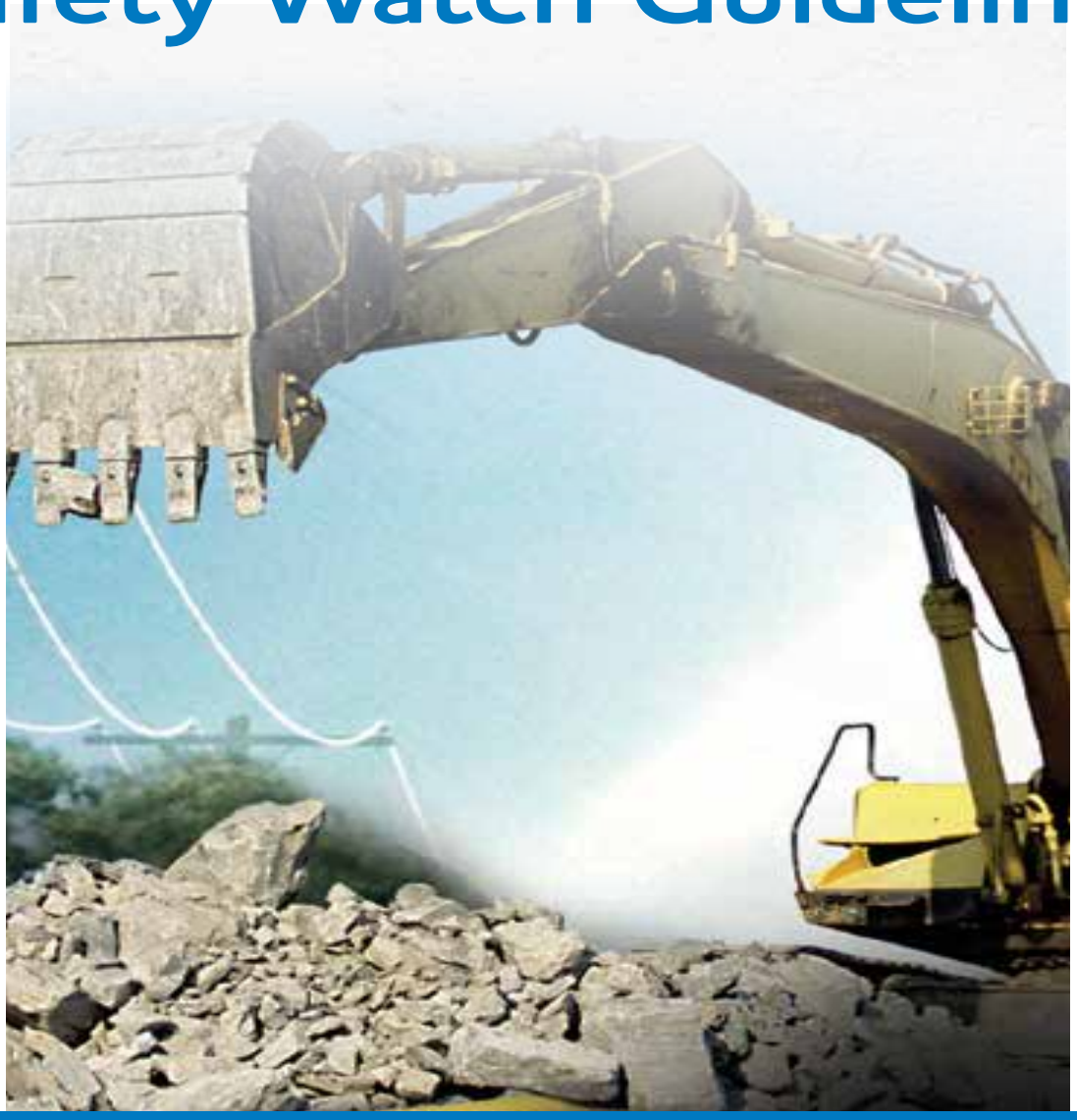
Photo No. 3 Upstream side of Fermor Avenue Crossing

Photo No. 4 Seine River upstream of Fermor Avenue Crossing

APPENDIX 'I'

MANITOBA HYDRO – SAFE EXCAVATION AND SAFETY WATCH GUIDELINES

Safe Excavation & Safety Watch Guidelines



For your SAFETY

ClickBeforeYouDigMB.com

Or call 1-800-940-3447

Manitoba Hydro

RELEASE OF NATURAL GAS

In the event of any damage to a natural gas pipeline (regardless of whether it is steel, plastic or aluminum) or to its protective pipe coating or tracer wire, however minor, call Manitoba Hydro immediately 204-480-5900 or 1-888-624-9376. In most cases there is no charge for minor repairs.

In case of damage causing a release of natural gas:

- Call 911 and Manitoba Hydro immediately.
- Clear people from the vicinity and prevent people from approaching the area of the leak.
- Shut off all vehicles and equipment. Remove or extinguish all sources of ignition. DO NOT smoke or allow open flame in the presence of natural gas.
- If a gas line has been punctured, do not remove the tool or equipment that punctured the line. This could result in a larger gas leak and pose a greater hazard.
- DO NOT attempt to backfill over a leaking natural gas line or attempt to stop the leak; it is safest to allow the gas to vent into the atmosphere.

Before you start to dig, contact ClickBeforeYouDigMB.com to request to have underground lines located. Manitoba Hydro will be notified and will contact you within three business days to advise of the date we will locate our electric and natural gas lines.

- Once the lines are marked we will provide you with a Facilities Locate form with specific instructions. You must obtain this form prior to excavation.
- If work has not started within 14 calendar days after the locate was provided by Manitoba Hydro, you must contact us to have the lines re-marked and receive an updated Facilities Locate form.
- Contractors must ensure that everyone on the worksite is aware of the presence of all gas and electric facilities and ensure that the Facilities Locate form is kept at the excavation site until the excavation and backfill are complete.
- The location markings must be maintained and kept visible by the person or contractor doing the excavation. Be careful that site operators do not remove the line location markings.

In addition to contacting ClickBeforeYouDigMB.com be sure to contact any other underground services that may be in the area.

This guideline applies to the crossing of Manitoba Hydro electrical conductors and natural gas pipelines only. When Manitoba Hydro fibre optic cables are present contractors will be referred by the Manitoba Hydro Facilities Locator to the Manitoba Hydro communications department for more information.

Manitoba Hydro only locates facilities that it owns and has no knowledge of or responsibility for privately owned facilities. Electric conductors or gas pipes installed past the meter are owned privately by the property owner, and at times are installed below ground before entering the building. Outbuildings that are heated or have electric power, wells, septic systems, pumps, pools and hot tubs are examples where privately owned buried facilities may exist.

This booklet has been prepared by Manitoba Hydro for Manitoba Hydro staff, contractors and homeowners involved with excavation and is available at hydro.mb.ca. Information on excavation and safety watch is included to inform excavators about basic requirements for excavation in the vicinity of buried electric power lines and gas pipelines. Unless otherwise indicated, gas pipelines and underground power cables will be called "lines".

Table of Contents

WHY YOU SHOULD PLAN AHEAD

When you contact ClickBeforeYouDigMB.com before you dig, we can identify buried lines so you can dig safely. This prevents injury or death, costly repairs, equipment damage, service outages, and environmental pollution.

It is YOUR responsibility to contact all owners of buried underground services.

PLANNING LARGE PROJECTS

Determining the location of existing Manitoba Hydro Underground Structures within the work area should be one of the first priorities of any work. Knowing the location of all utilities infrastructure allows the third party to plan work proactively, mitigating the need for costly design changes or delays during construction.

Gas
Manitoba Hydro requests that drawings be submitted for review for all projects involving ground disturbance. Drawings shall be submitted to: gasdesign@hydro.mb.ca.

Drawings will be reviewed by Manitoba Hydro at no cost and a letter providing details of any work restrictions, specific requirements or costs will be provided to the contractor.

Drawings should be submitted a minimum of 4 weeks before the start of any excavation work. Drawings shall include the details of the proposed work and include any gas or electrical line in the work area.

Electric
Contact Manitoba Hydro in Winnipeg at 204-480-5900 or outside Winnipeg at 1-888-MBHYDRO (1-888-624-9376)

You will be referred to the local district office for further instruction.

REGULATIONS

There are several federal and provincial agencies overseeing the operation of and around natural gas pipelines and electric cables. The following regulations and safe practice guides specify requirements for both the contractor and the utility:

- Manitoba Gas Pipeline Act, Regulation 140/92 – Provides the legal definition of an excavation and outlines Excavator and Utility responsibilities.
- National Energy Board Pipeline Damage Prevention Regulations:
  Authorizations, SOR/2016-124;
  Obligations of pipeline companies, SOR/2016-133
- Manitoba Workplace Safety and Health Act and Regulation M.R. 217/2006 including Part 26, Excavations and Tunnels - Describes legal responsibilities in regards to excavating safely.
- Guideline for Excavation Work, Manitoba Workplace Safety & Health Division.
- CSA Z247 Damage Prevention Standard.

DEFINITIONS

Daylighting – A term used to describe the uncovering and exposing of underground utilities to daylight without the use of mechanical excavation.

Excavation – includes digging, boring, pushing, ploughing, trenching, grading, post installation and breaking and displacement of soil or other material below the existing level of the ground that will disturb more than the top 150 mm (6 inches) of the ground.

High Pressure gas line – A natural gas line that operates in excess of 700 KPa (100psi).

Hydrovac – A truck or trailer that injects pressurized water from an onboard reservoir tank into the ground through a handheld wand. As the soil cover is liquefied, the resulting slurry is simultaneously extracted by a powerful vacuum and stored in an onboard debris tank for later disposal.

Large diameter pipeline – A natural gas pipeline that is 168.3 mm (6 inches) in diameter or larger, regardless of operating pressure.

Safety Watcher – A person designated by Manitoba Hydro to ensure that workers are not put at risk as a result of special hazards on the work site.

Sonde - A transmitter behind the bore head which registers angle, rotation, direction and temperature data.

Tolerance Zone – The space in which a line or facility is located, and in which special care is to be taken.

White lining – Designating the route and/or work area of the excavation using white paint, stakes and/or flags to outline the work area prior to the locator arriving on the site.

EXCAVATOR PRE-MARKING

Pre-marking your proposed work site allows excavators to accurately communicate to Manitoba Hydro's facility locators where the excavation is to occur. This may be accomplished either electronically or by white lining.

For excavator pre-marking, contact ClickBeforeYouDigMB.com or call 1-800-940-3447 to communicate where the excavation is to occur and:

- Attach a sketch or map that clearly identifies the excavation area via email or
- Pre-mark the excavation area by white lining

In either scenario you will be issued a reference number and notified of the day the locator will be on site.

When a project is too large for or not conducive to pre-marking, face-to-face meetings between Manitoba Hydro's facility locator and the excavators will be arranged at the proposed work site.

White Line
The excavator designates the route and/or area of the excavation using white paint, stakes and/or flags to outline the work area prior to the locator arriving on the site.

White paint, white stakes or white flags with the excavator's company identifier on them are permissible methods of marking.

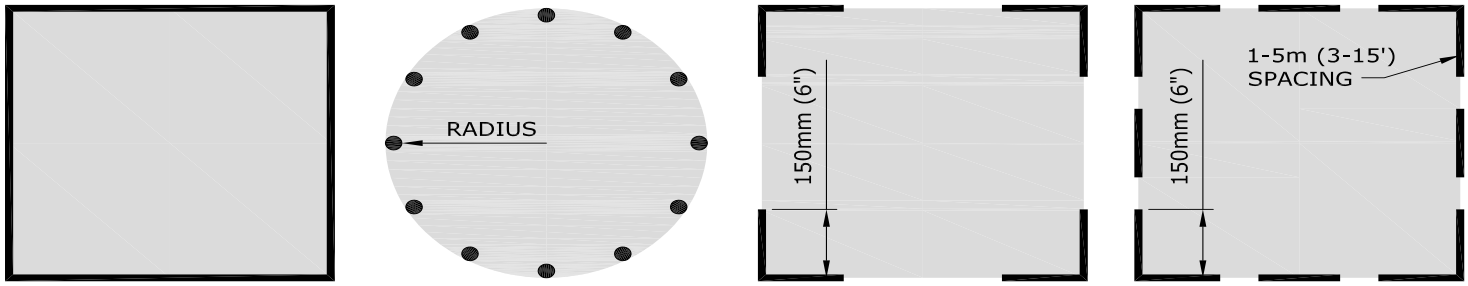
When using stakes or flags to mark the excavation work area, do not drive them into the ground deeper than 150 mm (6 inches). Any activity which disturbs more than 150 mm (6 inches) must have the facilities located.

Guidelines for excavation marking

The following marking illustrations are examples of how excavators may choose to mark their area of proposed excavation. The use of white marking products (e.g. paint, flags, stakes, or a combination of these) may be used to identify the excavation site.

Mark in white paint the proposed area of excavation through the use of a continuous line, dots marking the radius or arcs, dashes marking the four corners of the project, or dashes outlining the excavation project. The recommended size of each dash is approximately 150 – 300 mm (6-12 inches) in length and 20 mm (3/4 inch) in width with interval spacing approximately 1 – 5 metres (3-16 feet) apart. The maximum separation of excavation marks is to be reduced to a length that can be reasonably seen by the operator's locators when the terrain or excavation site conditions warrant it. Dots of approximately 20 mm (3/4 inch) diameter are typically used to define arcs or radii and may be placed at closer intervals in lieu of dashes.

SINGLE POINT EXCAVATION MARKINGS



STAKE IN CENTRE WITH COMPANY NAME & RADIUS OF CIRCLE

FULL LINE | **RADIUS OR ARC** | **FOUR CORNERS** | **DASH LINE**

If an excavation is contained within a 5 metre (16 feet) maximum radius then it can be marked with a single white stake at the centre of the excavation. The stake must clearly state the company identifier and the radius of the excavation in black lettering. This information must be conveyed to Manitoba Hydro.

After the area is Pre-Marked

On the appointed date, the locator will identify the Manitoba Hydro facilities that are located in the designated work area. They will document it using a sketch or map attached to the Electric and/or Natural Gas Facilities Locate Form.

When the locator has completed locating the facilities, they will advise the excavator and indicate whether there is a conflict. The Facilities Locate form will be available and must be on site prior to excavating.

The Manitoba Gas Pipeline Act, Regulation 140/92 and the Workplace Safety and Health Act, regulations M.R.217/2006, part 26.6 require that a valid Facilities Locate form be on the work site at all times until the project is complete.

If an excavation takes place without a current locate form on site, the locate is not valid. The excavator could face consequences which may include fines and/or sanctions by Manitoba Workplace Safety and Health and Manitoba Hydro.

APWA UNIFORM COLOUR CODE

Underground utility marking

WHITE – Proposed Excavation

PINK – Temporary Survey Markings

RED – Electric Power Lines, Cables, Conduit and Lighting Cables

YELLOW – Gas, Oil, Petroleum, or Gaseous Materials

ORANGE – Communication, Alarm or Signal Lines, Cables or Conduit

BLUE – Potable Water

PURPLE – Reclaimed Water, Irrigation and Slurry Lines

GREEN – Sewer and Drain Lines

GUIDELINES FOR EXCAVATION NEAR ELECTRICAL AND NATURAL GAS LINES

Hand Digging to Expose Lines

Mechanical excavation cannot be used within 1 metre (39 inches) of an electrical or gas line until the line is physically exposed by hand. Hand exposing means exposing a buried facility, whose location has been marked by Manitoba Hydro, using non-powered tools such as a Spade or shovel (hand augers are not acceptable). A water pressure/ vacuum system (hydrovac) is an acceptable alternative.

There are several things to remember when hand exposing:

- No one should ever jump on or use their entire body weight on a shovel when digging.
- Use a prying (rather than striking) motion to loosen hard dirt.
- Never probe for the facility using a sharp pointed tool such as a pick axe or pointed bar.
- Dig on an angle if possible, such that any contact with the facility is a glancing blow rather than a direct hit.

Once the line is visible, mechanical excavation equipment can be used in accordance with the guidelines for mechanical excavation.

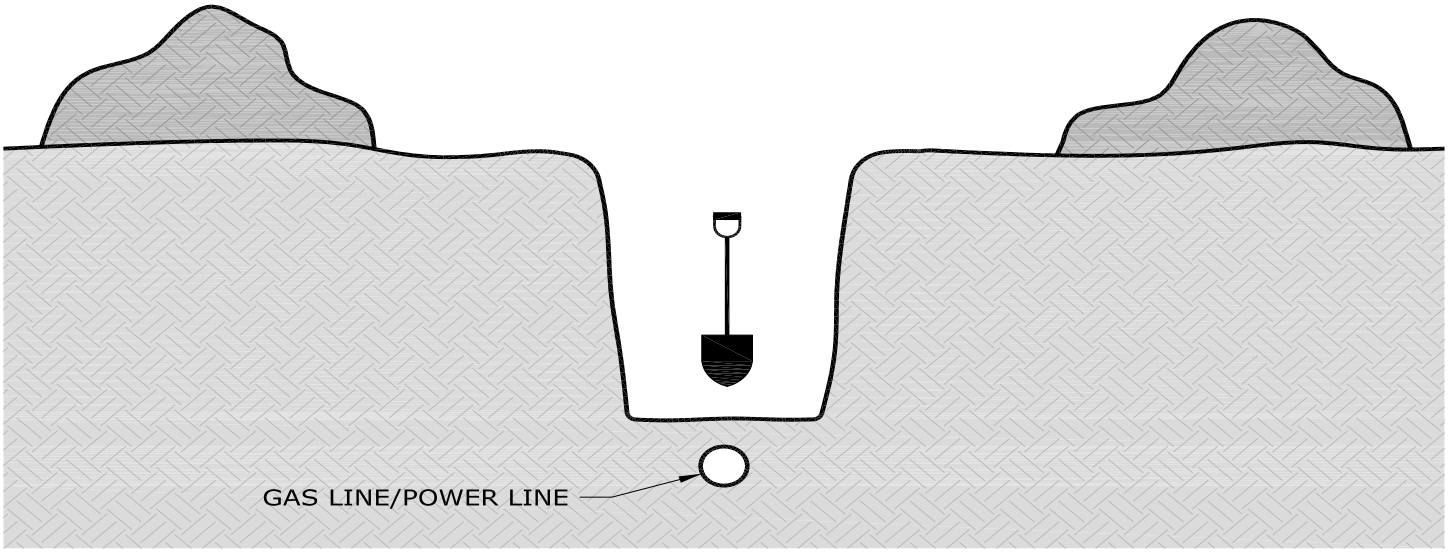
Water Pressure/Vacuum System (Hydrovac)

An alternative to exposing cables by hand digging is to use a water pressure/vacuum system capable of exposing Manitoba Hydro facilities without damage.

Only oscillating head type nozzles are to be used for the water wand. When excavating within 1 metre of a marked line the maximum setting of 38°C (100°F) water temperature and 10,342 Kpa (1,500 psi) must not be exceeded. The end of the vacuum tube shall be neoprene or equivalent. Expose the buried line by using a sweeping motion only, perpendicular to the locate markings, until the line is sighted. IMPORTANT: *After sighting, the line shall not be contacted by spray or vacuum to avoid damage to wraps and coatings.*

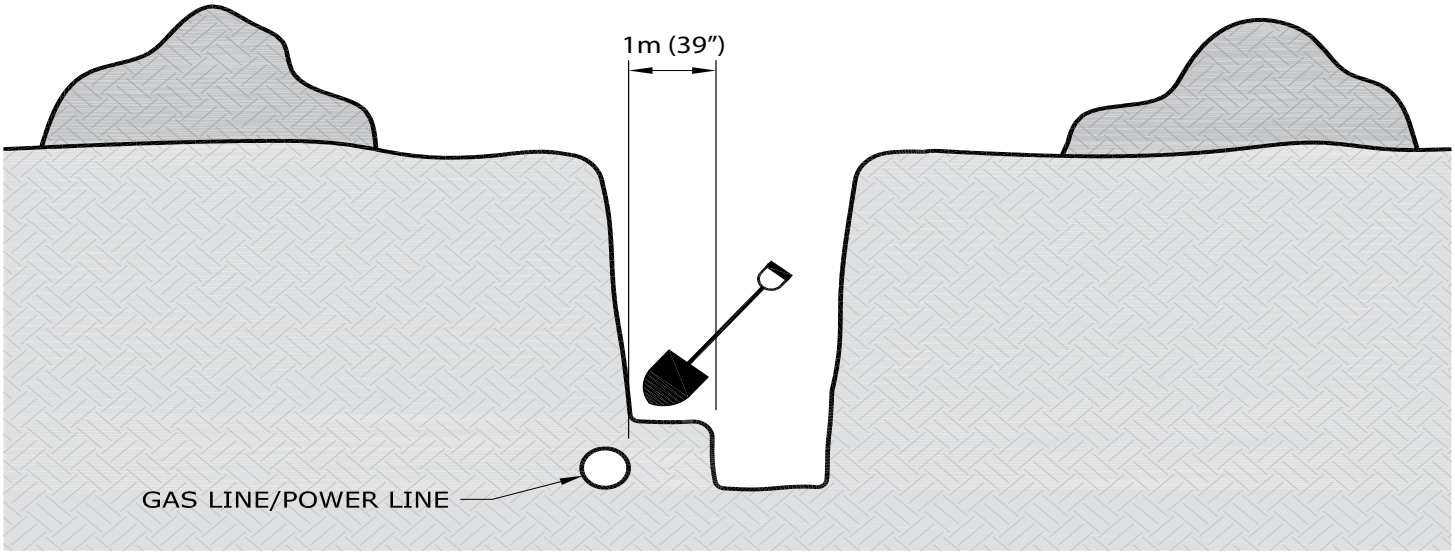
Some acceptable excavation methods:

a) Dig Vertically



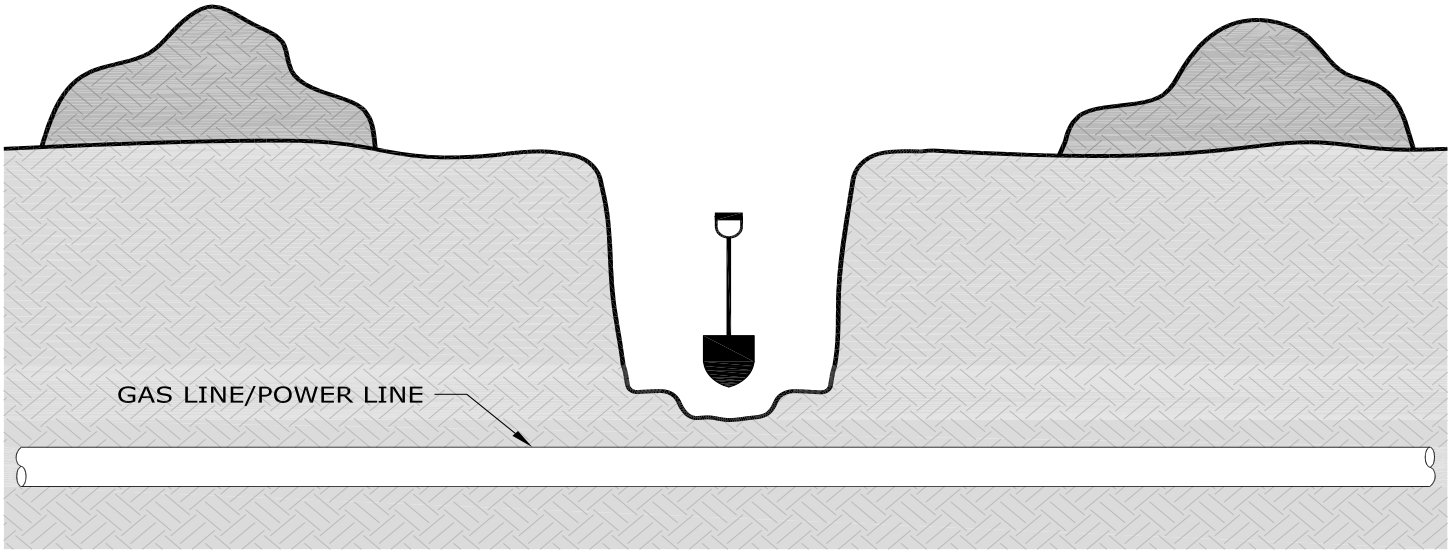
Dig a hole with a shovel directly above the line location until the line is exposed. Take care not to damage the line or coating. Mechanical excavation equipment MUST NOT be used to widen or deepen the hole before exposing the line.

b) Dig Laterally



Dig a trench or bell hole 1 metre (39 inches) from the line location, parallel to the line, then hand dig laterally to expose the line.

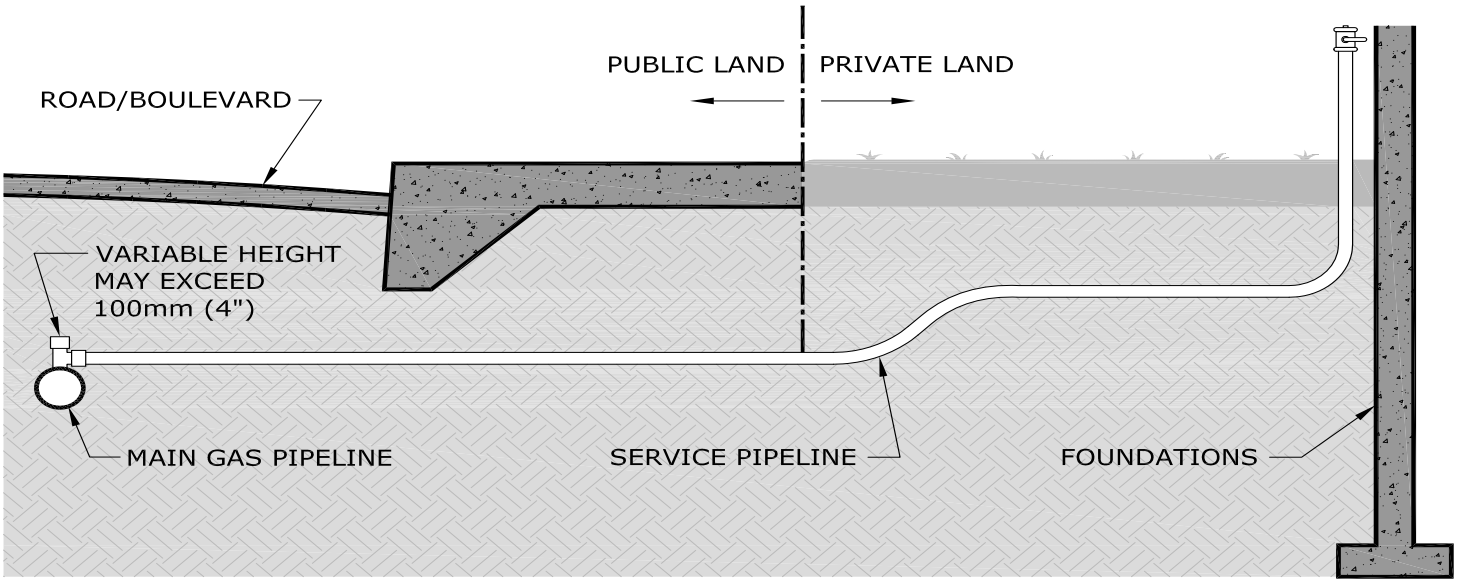
c) Dig Trench and excavate



Dig a trench by hand across the full width of the excavation (perpendicular to or "across from" the line). If the line is not uncovered, mechanically excavate to one half the depth of the trench. Repeat this process until the line is exposed.

Typical Gas Service Installation

(example only does not represent all installations)

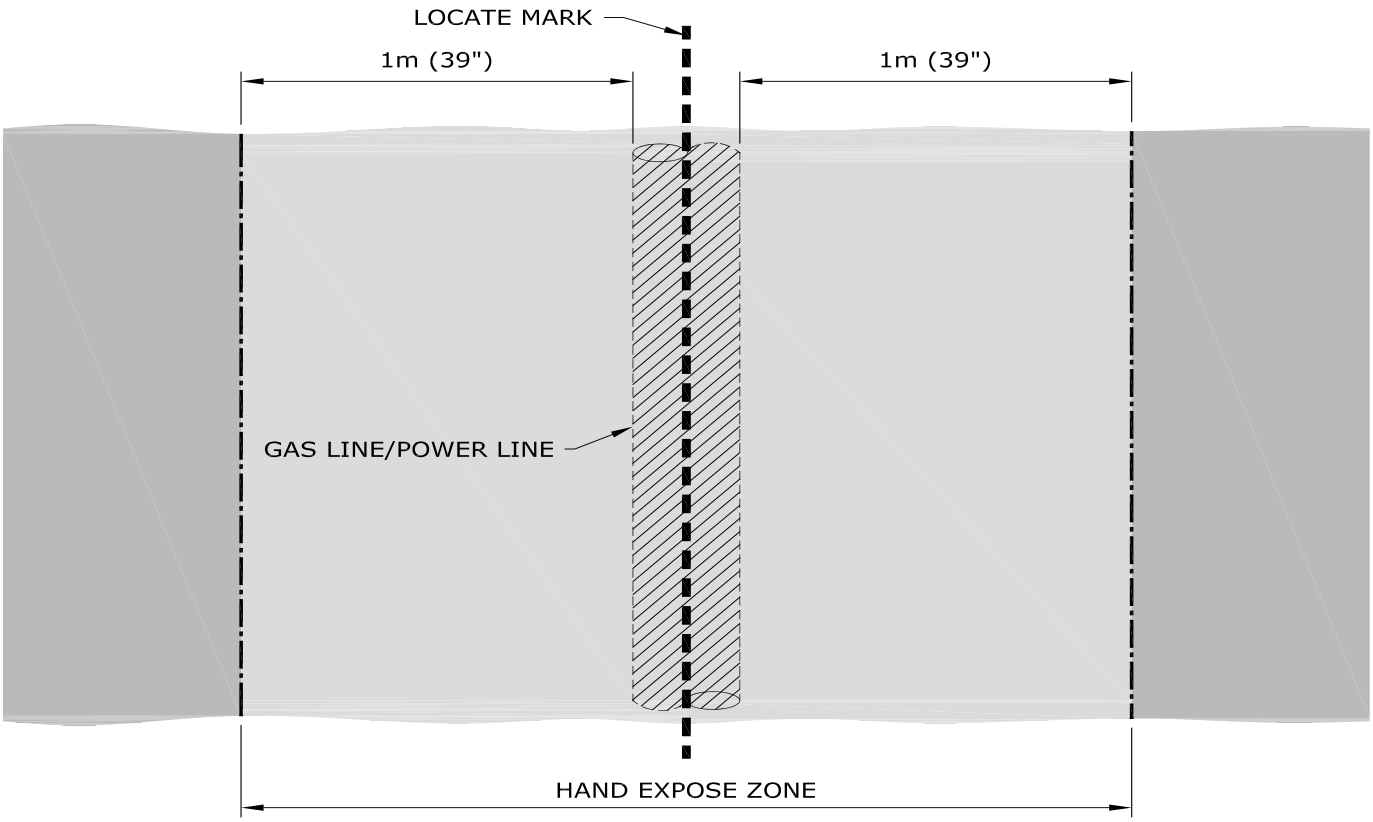


Fittings such as active or abandoned service tees may be present on gas pipelines, exercise care when excavating.

General Approach

- When the line is not visible, mechanical excavation shall not be used within 1 metre (39 inches) of an electrical or gas line.
- When the line is visible, mechanical excavation can be used no closer than 450 mm (18 inches) to natural gas lines and 600 mm (24 inches) to electrical lines.
- When soil conditions permit, a smooth edge bucket is preferred when excavating near gas and electrical lines.
- An observer (excavator staff) located near the line must maintain communication and control of the operator at all times by the use of hand signals and verbal communication. The observer is responsible for maintaining the minimum distance from the pipe. If at any point the observer or operator is unclear of the location or orientation of the line, no digging shall occur until this is confirmed and agreed upon by all on the worksite.

Before line is exposed



Crossing Lines

- When crossing a line, the line is to be exposed for the width of the excavation.
- After the line is daylighted, and provided there is space for excavator access, it is recommended that excavation near the line be performed parallel to the line.

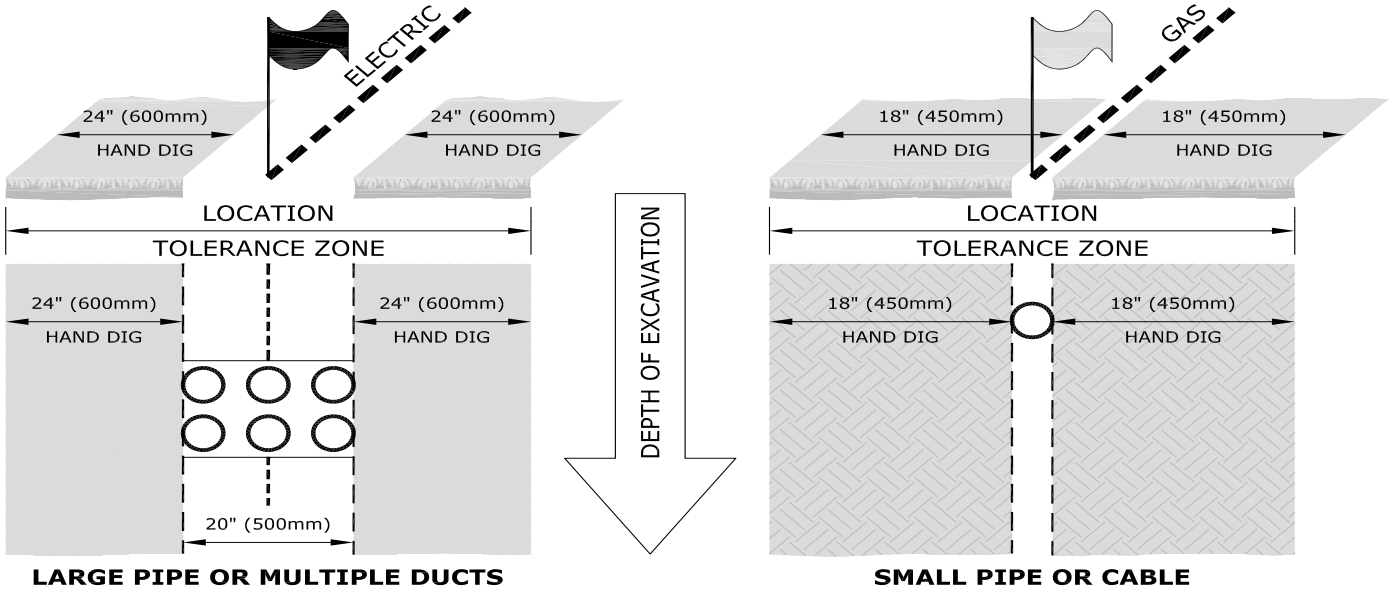
Working Parallel to Lines

- When working parallel to a line it is not necessary to expose the full length of the line to reduce the acceptable mechanical excavation separation. A series of daylight holes along the line is acceptable. The distance between daylight holes will be a maximum of 10 metres (33 feet) or as required to define the location of the line. Daylight holes must be large enough to expose the full width of the line or lines.
- After daylighting and previewing of the line, marks shall be placed a minimum of 450 mm (18 inches) from the outside of the line at each daylight hole for gas and 600 mm (24 inches)

for electrical lines. This tolerance zone should be marked along the entire length of the work area to ensure that the operator maintains proper alignment with the line. With the line daylighted and the tolerance zone marked, it is acceptable to use mechanical excavation on the outside of the marked line of the tolerance zone.

- If at any point the line becomes obscured, it shall be remarked immediately. The observer is responsible for maintaining the minimum distance from the pipe by confirming the machine's distance and alignment with the line. The operator will orient his machine parallel to the line so their bucket remains more than 450 mm (18 inches) away for gas and 600 mm (24 inches) away for electric lines. They must preview the work prior to entering their machine and prior to any trenching.

Once line is exposed



LARGE PIPE OR MULTIPLE DUCTS **SMALL PIPE OR CABLE**

Hard Surface Removal

- Mechanical equipment can be used to remove the asphalt or concrete road/sidewalk surface and should only be used to the depth of that surface.

- Avoid starting the pavement break directly over the marked facility.

- Start a few feet away from the marks and attempt to "peel off" the pavement or break it into small chunks for removal.

Line Exposed

When a length of line is exposed consult the utility for proper handling procedures. The line may need to be supported to prevent settling or sagging.

No Relocation

The line shall not be moved or relocated. No operation or work shall be done that would put stress on the line.

Inspect for Damage

Electric Power Lines – If you suspect a power cable has been damaged, contact Manitoba Hydro to inspect the cable. Do not contact the cable as it may be energized.

Gas Pipelines – Thoroughly clean (with water only) and inspect the exposed gas line for damage to the pipe, yellow plastic pipe covering or tracer wire (used on plastic pipe). If damage is found, notify Manitoba Hydro. They will repair minor damage to the pipe coating or tracer wire at no charge.

Report Contact or Damage – Any contact with or damage to any line or underground cable must be reported immediately to Manitoba Hydro.

Backfilling

To prevent settling or stress, the contractor is required to place clean fill under the power or gas line and compact the fill. The backfill material must be free of rocks, sharp objects or other material that could damage the line.

If the backfill material is frozen, it should be free of large frozen lumps of soil. The backfill material must be gradually placed, not dumped, on the line. Alternatively, the line may be hand padded with 300 mm (12 inches) of screened sand or soft fill before backfilling.

If mechanical protection is required, or if the backfill contains rocks, the cable or pipeline must be enclosed in a 150 mm (6 inches) envelope of screened sand.

Access

Manitoba Hydro utility personnel shall have access to the excavation to inspect the underground line at any time during construction.

Project Closeout

When the excavation project has been completed all flags and stakes used to mark gas and electric lines shall be removed from the site.

SAFETY WATCH

Safety Watch is a program where an employee qualified by Manitoba Hydro observes the excavation work in progress and determines actions to be taken by the contractor to prevent injury, property damage or damage to Manitoba Hydro facilities.

Safety Watch personnel work with the excavator to check that:

- the excavation is done safely;
- rules and procedures related to the excavation are followed;
- the plant is located accurately;
- all documentation is accurate and complete;
- Hydrovac guidelines are followed.

Safety Watch personnel shall be recognized as an authority on site with the ability to shut the job down.

When is a Safety Watch required?

Any excavation within 3 metres (10 feet) of a cable or pipeline may require a Safety Watch. The need for a safety watch will be assessed and identified on the Facilities Locate form. The decision to provide a Safety Watch will be based on the excavation proposed, the type of cable or pipeline, and the proximity of the excavation to the cable or pipeline.

Why is a Safety Watch done?

Safety Watch service is provided to ensure the safety of customers and their contractors when working in close proximity to either energized electrical or pressurized gas lines. In addition, this protects the integrity of the utility lines minimizing the chance of an outage.

NOTE: *Typically, Safety Watch personnel are not provided for low voltage conductors (under 750 volts) or distribution pressure gas mains and services under 168.3 mm (6 inches) diameter. However, Manitoba Hydro staff may assess the situation and choose to provide Safety Watch personnel where conditions warrant*.

Who pays for a Safety Watch?

Generally, Safety Watch service is provided at no cost to the homeowner for minor projects. For larger projects, the contractor may be charged at a cost shared rate. Contact the local district office for further information.

How to arrange for a Safety Watch.

When an underground line is located in response to a Click Before You Dig request, the Manitoba Hydro employee will indicate whether a Safety Watch is required. Call Manitoba Hydro to arrange for a Safety Watch appointment a minimum of three business days before any excavation is to occur.

DIRECTIONAL BORING – CONTRACTOR GUIDELINES

As with all ground disturbance activity, the excavator must first obtain a facilities locate from Manitoba Hydro.

The distance measured to Manitoba Hydro electrical conductor or gas pipeline must always be measured from the **outside** diameter or wall of the Manitoba Hydro facility to the outside diameter of the back reamer. The same measuring methodology must be used when paralleling Manitoba Hydro facilities.

When boring within the tolerance zone of a high pressure or large diameter gas pipeline or any critical distribution gas pipeline or electrical conductor, as identified by Manitoba Hydro's Facilities Locate personnel, qualified natural gas or electric Safety Watch personnel are required.

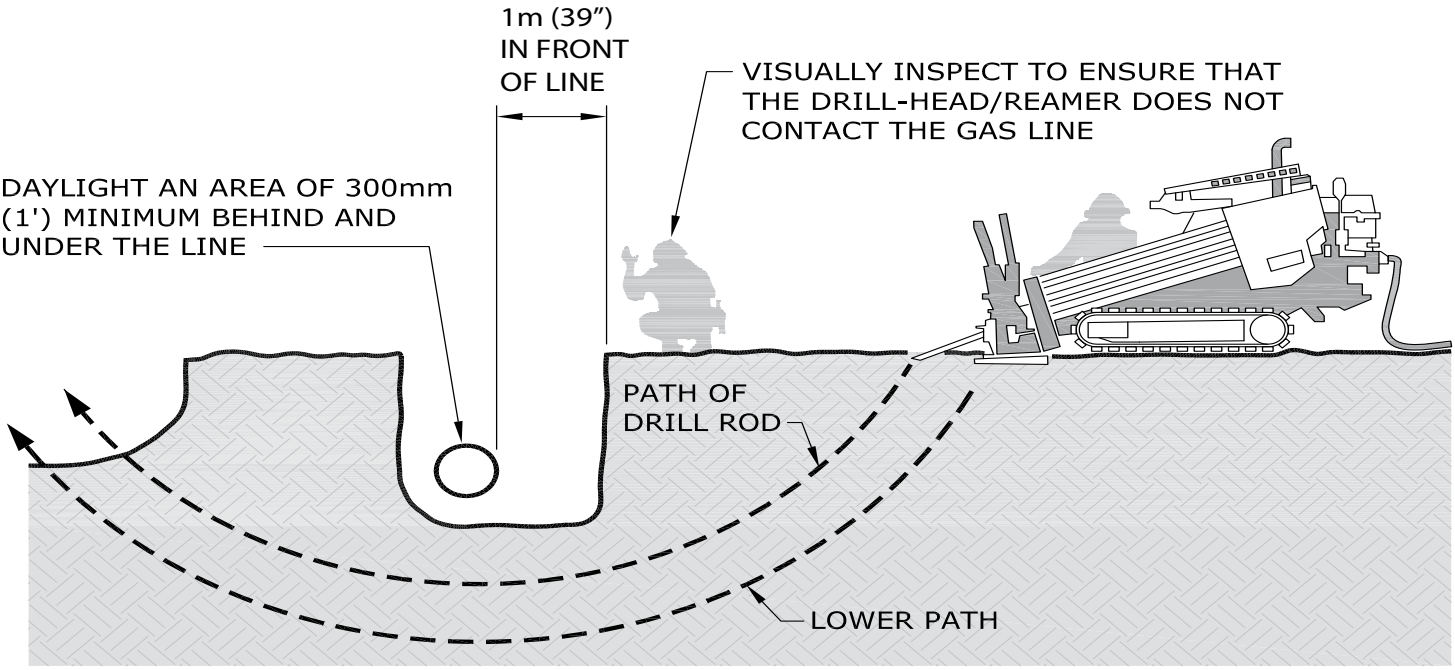
Electrical Conductors and Gas Pipelines

Prior to directional boring across Manitoba Hydro gas and electrical lines, the buried depth must be confirmed. Acceptable practice to verify line depth is to:

- Expose the line by hand digging, or
- Expose the line by water pressure/vacuum excavation; or
- Locate on the side wall of a trench that has been excavated 1 metre (39 inches) on either side of the surface locates; or
- Use reference measurements that are known to be accurate, for example: electrical duct lines.

The drill head and/or back reamer should at all times maintain a minimum of 1 metre (39 inches) clearance from all Manitoba Hydro lines.

Where underground facility congestion does not effectively allow a 1 metre (39 inches) clearance/separation from Manitoba Hydro lines, the contractor may consult with Manitoba Hydro Engineering for site specific direction. Any deviations in clearances/separations must be provided in writing and must be present on-site when the work is being performed.



Observation Hole Required When Crossing Any Manitoba Hydro Facility

The accuracy of the drill head location and depth must be visually verified 1 metre (39 inches) prior to crossing Manitoba Hydro facilities. An observation or discovery hole is required.

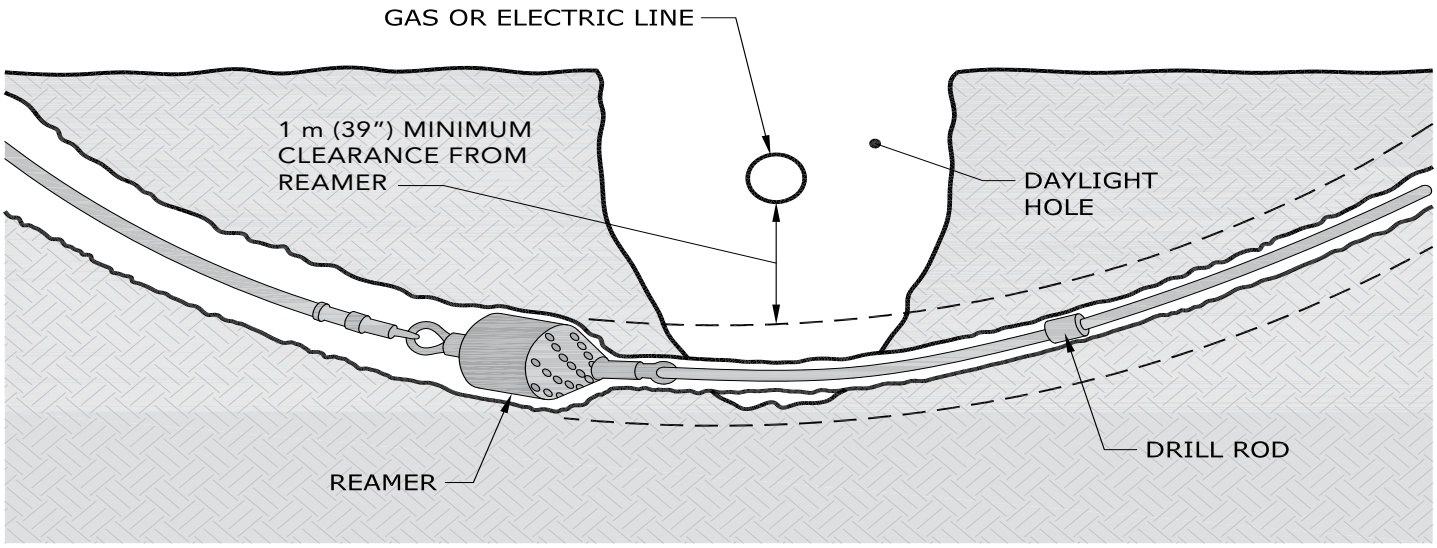
Acceptable practice for opening up the observation hole is using water pressure/vacuum or hand digging.

When boring head and/or back reamers path is crossing above a natural gas pipeline or electrical conductor the boring head and/or back reamer must be visually observed crossing the facility.

When the boring head and/or backreamer's path is crossing below a gas pipeline or electrical conductor an observer must verify that the bore head and/or reamer does not enter the observation hole within 1 metre of the line.

The minimum dimensions of the observation/discovery hole MUST BE:

- 1 metre (39 inches) in front of the gas pipeline or electrical conductor on the near side of the bore path;
- 300 mm (12 inches) on the far side of the bore path;
- 300 mm (12 inches) on each side of the bore path;
- 300 mm (12 inches) below natural gas pipeline or electrical conductor.



Drilling Parallel to Manitoba Hydro Facilities

Paralleling Electrical Conductors & Natural Gas Pipelines

There must be 1 metre (39 inches) of separation between the outside diameter of the back reamer assembly and the outside diameter of any Manitoba Hydro electrical conductors or natural gas pipelines.

NOTE: *When drilling within 1 metre (39 inches) horizontally, the drill must be kept at a depth either deeper or shallower than the existing electrical conductor or natural gas pipeline to maintain 1 metre (39 inches) separation when measured diagonally.*

If 1 metre (39 inches) horizontal separation cannot be maintained, the electrical conductor or natural gas pipeline adjacent to the bore path must be exposed. When it is not possible to de-energize electrical conductors, a Safety Hold-Off must be in place and qualified Safety Watch personnel must be on site.

When suspected of drilling within 1 metre (39 inches) of any gas or electrical lines determined by the boring head (sonde) position readings and the proximity to the locate marks, the location of the conductor or pipeline shall be verified; the electrical conductor or natural gas pipeline adjacent to the bore path must be hand exposed or exposed by water pressure/vacuum excavation as determined by Manitoba Hydro. The frequency of exposures depends on the consistency of the alignment of the existing facility.

Manitoba Hydro facilities must be exposed a minimum of once every 10 metres (33 feet), to confirm alignment. Where there is an alignment change indicated by the locator marks, the Manitoba Hydro facility shall be visually confirmed at each alignment deviation.

UNPLANNED CONTACT WITH ELECTRIC OR NATURAL GAS LINES

This guideline applies to people who come in contact with or simply expose a buried utility line while excavating.

Anyone who comes in contact with buried utility lines should contact the utility owner immediately. Although there may be no apparent external damage, the impact of striking a line can cause internal structural damage that can only be determined and repaired by qualified utility personnel. Generally, we do not charge for this inspection and coating repair.

Abrasions

Even if contact does not cause the utility line to stop working, a nick or cut to the outer, protective sheath of the utility line can allow ground water, laden with salts and other caustic substances, to corrode the line. Abrasions may compromise the sidewall strength of a plastic, steel or aluminum gas line.

Aerial

Cables suspended along utility poles can easily be damaged if struck by a vehicle or a mechanical implement like a hydraulic lift. Cable clamps and other attachments can be pulled apart and component housings may hide damage to the electronic equipment inside.

Stop Work

If any equipment is snared in the utility lines, it should be left in place. Trying to extract, flex or manipulate the line can compound the damage. Operations at the site shall stop immediately. Operators should stay in the equipment unless it is not safe (as in the case of a fire) and all others should be kept clear of the equipment as it may have become energized. If you must leave the equipment, jump clear with both feet together so you are not in contact with the equipment and the ground at the same time. Continue to hop or shuffle with your feet close together until you are a safe distance away.

Call It In

The person involved in the incident should call Manitoba Hydro immediately and report the location of the hit. (In Winnipeg at 204-480-5900 or outside of Winnipeg at 1-888-624-9376.) The exact address, or street intersection, along with what type of contact occurred, will help the utility respond in an appropriate manner.

Notes

ClickBeforeYouDigMB.com®

Or call 1-800-940-3447

In addition to contacting
ClickBeforeYouDigMB.com
be sure to contact other
underground services in the area.

For more information visit
hydro.mb.ca

Manitoba Hydro

Rev. 2016 07

APPENDIX ‘J’

HITEX CM PRIME AND PUMATRACK ROLLABLE ROAD SURFACE SYSTEM

Pavement Markings

HITEX
North America
Part of the Hitex International Group

Puma**Track**

MMA Cold Applied Surface Treatment

PumaTrack manually rollable surface treatment is engineered to achieve the highest levels of durabillity, adhesion and colour stabillity. PumaTrack is the ideal application for cycle tracks and walk ways.

Product specification and technical data

Puma**Track**

PumaTrack comprises an MMA binder system, lead / heavy metal free pigments, aggregates and fillers.

PumaTrack is available in a range of colours for different applications.

Why PumaTrack?

- Roller application ensures high quality, even finish
- Provides enhanced safety for cyclists and vulnerable road users
- Tough and durable with a long service life
- Catalyst controlled, rapid curing, typically 10 - 30 minutes
- Non-toxic binder system
- Fast and easy to apply
- Highly resistant to discolouration
- Can be adapted to suit particular climatic requirements

Typical uses:

- Cycle routes
- Paths/ walkways
- Smaller scale works e.g. car parks, factory markings

Compliances/approvals

Hitex design and develop road marking and surfacing products to the highest level of international or customer specific requirements.

The management system of Hitex Traffic Safety Ltd has been assessed and registered as meeting the requirements of ISO 9001 and ISO 14001.

Colors

PumaTrack is available in a range of colours. Standard colours are red, green, yellow and blue. Other colours available on request.

Application method

PumaTrack can be applied as follows:

- By squeegee to regulate surface, finished with a roller to achieve textured skid-resistant finish
- By hand screed

PumaTrack requires the use of a catalyst to enable curing of the system. Please refer to the relevant Installation Method Statement for full instructions on the application process.

Technical data

Table 1 Physical properties

Typical coverage rate	4.6 lb/yd^2 (2.5kg/m^2)
Pot life*	5–15 mins
Curing time*	10–30 mins
Road surface temperature range	32–104°F (0–40°C)

*** Dependant on ambient temperature and catalyst dosage**

Packaging & storage

PumaTrack is supplied in pre-weighed 22lb (10kg) or 44lb (20kg) pails. Other pack sizes available upon request. The catalyst (hardener) is supplied separately. Dosage of the catalyst varies according to material temperature.

It is recommended that PumaBrite and PumaSpray product should be kept totally dry and stored away from direct sunlight and areas of potential contamination.

The binder component must be stored away from any catalyst. Stable for 6 months when stored in a cool, dry place. Long periods of over-heating (e.g. external storage in summer) may lead to gelling of the material.

Health & safety

For further information consult the relevant Safety Data Sheet (SDS).

Disclaimer

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HITEX
North America
Part of the Hitex International Group

CM PRIMER

PRIMER FOR HITEX PUMA MMA SYSTEMS ON METAL AND CONCRETE SUBSTRATES

KEY BENEFIT SUMMARY

- Exhibits excellent adhesion to metal and concrete substrates
- Easy to apply

PRODUCT INFORMATION

Description

CM Primer is a low viscosity, colourless, 2 component reactive resin based on methyl methacrylate (MMA).

Usage

CM Primer is used as primer to give excellent bonding to concrete and metal substrates (e.g. iron, aluminium, stainless steel).
We strongly recommend with CM primer that curing and adhesion tests are conducted on the particular substrate prior to general use on site.

Packaging

180 kg steel drums, 20 kg pails

Shelf life

6 months when stored in a cool and dry place and in originally closed packaging. The optimal storage temperature is 15 - 20°C.

TECHNICAL INFORMATION

Technical characteristics (liquid state)

Viscosity, 25°C:	100-130 mPa*s	DIN 53018
Density, 25°C:	0.99 g/ml	ISO 2811
Pot life / processing time at 20°C:	approx. 15 min.	
Curing time at 20°C:	approx. 30 min.	
Flash point:	+ 11.5°C	ISO 1516

Technical characteristics (cured state)

Tensile strength:	13.8 N/mm²	ISO 527
Elongation at maximum strength:	1.3 %	
Elongation at fracture:	1.3 %	
Modulus of elasticity:	1500 N/mm²	
Density, 20°C:	1.16 g/cm³	ISO 1183

Please note that an objective comparison with other data is only possible if norms and parameters are identical.

USAGE GUIDELINES

Substrate preparation

All substrates must be dry, firm, solid and free of dust, fat and oil. Loose tiles and tiles over hollows must also be removed. Laitance and loose articles must be thoroughly removed. Steel substrates must be prepared to SA 2.5 (according to DIN 55929).
Surface structure shall allow the correct application of the primer.
-Surface tensile strength shall be min. 1.5 MPa.
-Mechanical preparation shall expose concrete aggregate.
-Visible pin holes and craters shall be filled separately using filled primer or suitable cement mortar.
For further details, see our Installation Method Statements for Hitex PUMA MMA systems.

Mixing

Prior to use CM Primer must be carefully stirred to achieve a uniform distribution of the paraffin contained in the product. CM Primer is thoroughly mixed together with the Catalyst (50% dibenzoyl peroxide), in accordance with the below guidelines. It should be noted that the amount of catalyst powder to be added depends upon the substrate temperature.

at 30°C add 1% by weight of resin
at 20°C add 2% by weight of resin
at 10°C add 4% by weight of resin
at 0°C add 6% by weight of resin

Note: Weight to Volumetric conversion of Catalyst.
1 cm³ of Catalyst weighs 0.64 g
1 g of Catalyst = 1.57 cm³

HITEX
Traffic Safety Materials

CM PRIMER

APPLICATION

-Substrate surface temperature may range from 0°C to 40°C.
-Do not apply when surface temperature is above 40°C and/or rapidly rising. Special care must be observed if area is under exposure to direct sunshine.
-Substrate temperature must be at least 3°C higher than the actual dew point.

After the catalyst has been stirred in, the primer is poured onto the substrate in stripes and distributed with a short-pile paint roller. A notched rubber squeegee can be used for fast distribution of large quantities. Apply at a rate of between 300 g/m² to 500 g/m² depending on density and porosity of the substrate. In any case, continue applying primer until saturation occurs to obtain a continuous resin film. On extremely porous substrates a second prime coat may be required. When a continuous resin film is obtained, broadcast fire-dried quartz sand (particle size 0.7 - 1.2 mm or 0.3 - 0.7 mm) into the still wet primer.
Consumption of this broadcast sand: approximately 0.3 kg/m^2.

For further details, see our Installation Method Statements for Hitex PUMA MMA marking and surfacing Systems.

HEALTH AND SAFETY PRECAUTIONS

Suitable protective clothing, gloves and safety goggles must be worn during mixing and application of CM Primer.
When the product is applied in enclosed areas without natural ventilation, forced ventilation must be arranged. Avoid strong concentration of vapour as well as direct contact with skin or eyes.
CM Primer is highly flammable; keep away from heat and all sources of ignition and do not smoke. The stirrer as well as all the other electric appliances used on the application site must be explosion-proof versions.
For further information see our Material Safety Data Sheet.

TECHNICAL SERVICE

Contact Hitex Traffic Safety Ltd

The information and recommendations herein are believed by Hitex International to be accurate and reliable.

HITEX International Group
Road Surface Innovation

PROPOSED METHOD STATEMENT FOR THE INSTALLATION AND QUALITY CONTROL OF PUMATRACK ROLLABLE ROAD SURFACING SYSTEM

1. General

1.1 The installation and composition of PumaTrack Rollable Road Surfacing System shall be as stated in the product specification and this installation method statement.

1.2 PumaTrack Rollable Road Surfacing System consists of a Methyl Methacrylate binder, blended fillers, pigment(s), aggregate, and property modifying additives.

1.3 A programme of work shall be agreed with the purchaser prior to commencement of installation. Requirements for the provision of sufficient working area, plant, safety and, if required, protection to the system shall be agreed.

1.4 The current installation method statement together with all the necessary Health & Safety data sheets and COSHH risk assessment shall be deposited with the purchaser and maintained on-site.

2. Quality Control

2.1 Every batch shall be subject to quality control checks to ensure compliance with the system specification.

2.2 Each component received on-site shall be logged and stored to prevent contamination or deterioration, in accordance with the manufacturer's instructions.

3. Suitability of the Road Surface

3.1 The system is deemed suitable for use on highways with concrete or bituminous surfaces.

3.2 The purchaser should ensure that the pavement structure is adequate to support the traffic without undue cracking or deformation during the expected life of the system

3.3 New bituminous substrates should be allowed to weather for at least 6-8 weeks prior to the installation of the system. This is because bituminous substrates can contain residues of oils, bitumen and additives which can inhibit adhesion and curing. Depending on the type of substrate, this can take even longer than 8 weeks, and tests should be carried out on a small area before the full application commences to ensure the adhesion is fine.

3.4 Concrete surfaces should be a minimum of 28 days old and must be primed using a CM Primer prior to the installation of the system.

4. Traffic Management

Traffic Management shall be in accordance with Department of Transport Traffic Signs Manual Chapter 8 current edition, or as agreed between the Purchaser and Installer.

5. Preparation of the Road Surface

5.1 The areas to which the system is to be applied shall be clearly defined and marked by the Purchaser prior to commencement of work on-site.

5.2 Any imperfections in the road surface not acceptable to the Installer shall be reinstated with a material approved by the Purchaser in consultation with the Installer.

5.3 The road surface shall be clean, dry and free from ice, frost, loose aggregate, oil, grease, road salt and other loose matter that may impair the adhesion of the system.

5.4 Where the road surface does not comply with Section 5.3 it shall be cleaned by the Installer or others, by grit blasting, high pressure water jetting, low pressure water/abrasive blast cleaning, scarifying, scabbling or other means approved by the Purchaser. To remove dust and other loose matter the road surface should be vigorously brushed or treated with hot compressed air. Any oil visible on the road surface shall be removed by washing and scrubbing with a suitable detergent solution followed by flushing with clean water or by other suitable means.

5.5 Existing road markings, ironwork, road edges of area to be treated and road studs shall be suitably masked.

5.6 On concrete substrates, CM primer shall be applied using a short pile paint roller or serrated edge squeegee at a typical coverage rate of 0.4kg/m², depending on the substrate texture and porosity. The road surface temperature shall be between 0 and 40°C. The CM primer needs to be catalysed according to the following table:

Table 1: Catalyst Addition Levels when using CM primer

Substrate temperature (ºC)	**Primer** pack (kg)	BPO powder catalyst required (g)
0 – 5	20	1,200
5 – 15	20	800
15 – 25	20	400
25 – 40	20	200

Primer choice is critical and should be approved by the certificate holder before use.

6. Weather Conditions

6.1 Installation of the system shall only be carried out with a road surface temperature of 0°C to 40°C and with a relative humidity of ≤85%. At temperatures below 5ºC, the pails should be warmed to above 5ºC

6.2 Ambient and road surface temperatures shall be recorded at the start and, if the weather is variable, during the installation process.

6.3 Road surfaces shall be dry before and during the installation of the system.

6.4 The curing period for the prevailing weather conditions shall be notified to the Purchaser.

7. Installation

7.1 System Installation Procedure:

7.1.1 The PumaTrack system is available as a single grade for use at substrate temperatures from 0°C to 40°C.

7.1.2 PumaTrack pails should be kept out of direct sunlight during storage and use. Storage at elevated temperatures can lead to degradation of the system. Application of hot PumaTrack material can lead to premature gelling or curing, which can adversely affect product performance.

7.1.3 PumaTrack rollable surfacing system is a two-component cold applied chemically curing Methyl Methacrylate compound, consisting of a pre-accelerated base resin, blended fillers, pigment(s), aggregate, trace amounts of property modifying additives and a powder catalyst (BPO), supplied in pre-weighed quantities ready for on-site mixing. For the amount of BPO powder catalyst required for the installation temperature, see the following table:

Table 2: Catalyst Addition Levels when using PumaTrack

Substrate temperature (ºC)	PumaTrack pack size (kg)	BPO powder catalyst required (g)
0 – 15	20	400
20	20	300
25	20	200
30 – 40	20	100

7.1.4 The catalyst level is critical – the minimum catalyst level is 100g per 20kg pail. Using less catalyst will cause partial curing and lead to product failure. Excessive levels of catalyst can lead to premature gelling and curing, which can lead to reduced adhesion to the substrate and product failure.

7.1.5 Immediately prior to use, stir the binder thoroughly using a mechanical mixer until the resin is fully homogenised. Add the correct amount of BPO powder catalyst and mix thoroughly for at least 30 seconds. Ensure that the binder at the bottom and sides of the container is completely mixed in. Do not delay once the catalyst has been added, a chemical reaction is occurring that if left in the pail will ruin the mix.

7.1.6 The mixed binder and catalyst shall then be immediately spread onto the dry prepared road surface uniformly with a serrated squeegee at the desired thickness. Typically a 4mm serrated squeegee will be used to give a uniform thickness of 2mm. For the highest levels of durability, a thicker squeegee may be required (e.g. 6mm). The binder should then be backrolled to give the desired texture depth. A short pile roller can be used to give a finer texture depth.

7.1.7 The applied material should be rolled as soon as possible after being squeegeed to avoid any gelling or partial curing before the texture has been rolled in.

7.1.8 If there is any delay to the work, the squeegee must be checked before work restarts to ensure that no cured material is left on the squeegee, which could lead to lower coverage rates, and thus reduced durability.

7.1.9 The squeegee should also be regularly inspected to ensure that there is no wear to the teeth, as this can also lead to lower coverage rates and reduced durability.

7.1.10 PumaTrack is made to tight quality tolerances. However, for larger areas, use material with the same batch number wherever possible. If different batch numbers are used on a single area, colour comparison checks should be made between each batch of product being used before any application starts.

7.1.10 On more open textured surfaces a greater material usage may be required to ensure adequate coverage of the surface.

7.1.11 The masking tape shall be removed promptly as the work progresses, before the binder begins to gel.

7.2 System Installation Checks by the Installer

7.2.1 A visual check shall be carried out for uniform surface texture, blemishes, and any discernible faults.

7.2.2 A check shall be made on completion of each site to determine the quantities of material used.

7.3 Sampling and Testing of Materials used on-site

If required, materials shall be sampled and tested at a frequency as requested and agreed between the Purchaser and Installer.

7.4 Maintenance and Repair

7.4.1 In the event that damage occurs during the installation or during service the system shall be repaired as follows:

7.4.1.1 The damaged and or de-bonded system shall be cut back to firmly adhering material, squaring off the area to be reinstated.

7.4.1.2 The area to be repaired shall be cleaned, dried and the perimeter masked, allowing a 50 mm overlap on the existing well adhered system.

7.4.1.3 The system shall then be applied in accordance with Section 7.1.

8. Aftercare

8.1 Any remaining masking shall be removed and the system allowed to fully cure. During the curing period, no disturbance or trafficking of the system shall be permitted.

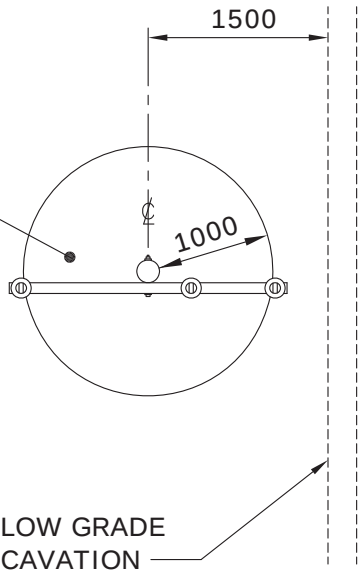
8.2 The Installer should endeavour to inspect the site after 24 hours and carry out any necessary remedial work.

End of Method Statement

APPENDIX ‘K’

Manitoba Hydro Standard Drawing - Allowable Excavation around Existing Poles CD 30-55

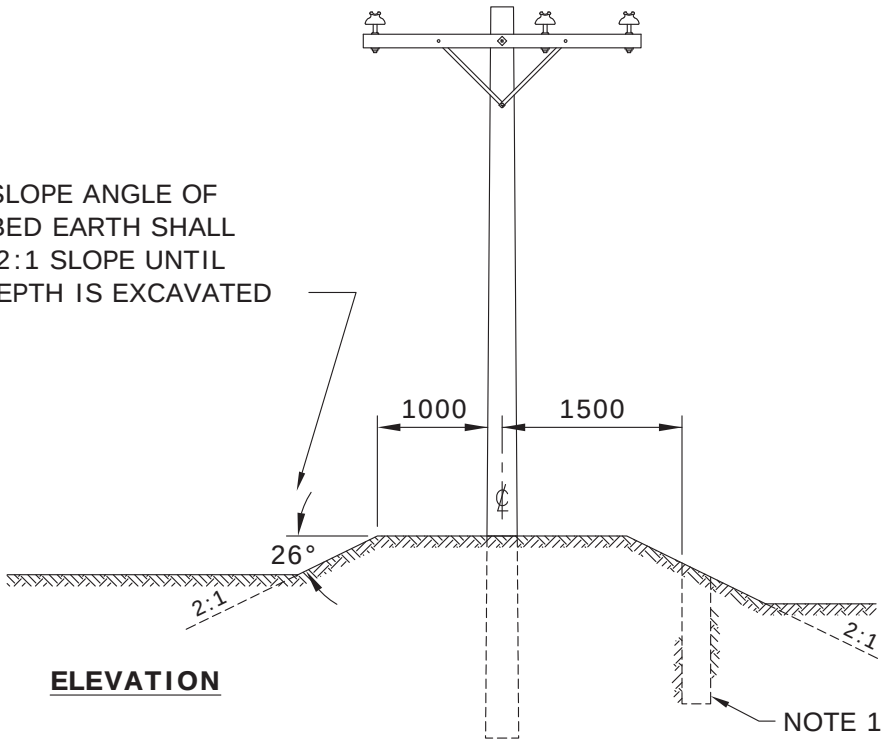
FOR CHANGES IN GRADE, THE MINIMUM AMOUNT OF UNDISTURBED EARTH TO BE LEFT ALL AROUND POLES SHALL BE 1000mm



PLAN

NOTE:
DIMENSIONS SHOWN ARE MILLIMETRES.

MAXIMUM SLOPE ANGLE OF UNDISTURBED EARTH SHALL BE 26° OR 2:1 SLOPE UNTIL DESIRED DEPTH IS EXCAVATED



ELEVATION

NOTE:

1. THE MINIMUM SEPARATION (TO ANY SIDE OF A POLE) FOR EXCAVATIONS DEEPER THAN 500mm WITHOUT REGIONAL ENGINEERING INVOLVEMENT SHALL BE 1500mm, EXCAVATIONS TO BE BACKFILLED & TAMPED TO MAINTAIN SLOPE.

APPROVED	REVISIONS			MANITOBA HYDRO DISTRIBUTION STANDARDS
ORIGINAL DRAWING SEALED BY E.H. WIEBE 94-07-11	06-02	2	REVISED SLOPE & ADDED MORE EXPLANATION TO NOTES	**ALLOWABLE EXCAVATIONS AROUND EXISTING POLES**
	95-04	1	MINIMUM SEPARATION ADDED	

DRAWN	CHECKED	DATE		SHT	REV
W.B./CAD	D.F.	93-03	**CD 30-55**	0001 OF 1	02

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