TENDER AND CONTRACT PACKAGE

IN THE RURAL MUNICIPALITY OF ELDON NO. 471

FOR THE INSTALLATION OF AN ARCH CULVERT ON PROJECT 458 LOCATED AT S.E. of 16-49-22-W3

SASKATOON, SK
August 2016
AECOM 60336819 (450.1)

NOTICE TO BIDDERS

R.M. of Eldon No. 471

Bid for: **The Installation of an Arch Culvert on Project 458 Located at S.E. of 16-49-22-W3**

Sealed envelopes containing clearly marked **Tender for The Installation of an Arch Culvert on Project 458 located at S.E. of 16-49-22-W3** will be received in the office of the **R.M. of Eldon No. 471** until **11:00 A.M. Local Time** on **September 14, 2016**, and will be opened in public immediately thereafter.

Each bid package must be accompanied by a certified cheque or Bid Bond in the amount of five percent (5%) of the total bid.

Copies of the Specifications and Tender forms will be available on Sasktenders or at both the R.M. office and the Consulting Engineer office.

Inquiries regarding this Project shall be directed to:

AECOM Canada Ltd.
200 – 2100 8th Street East
Saskatoon, SK S7H 0V1
Telephone: (306) 657-8890

Attention: Qasim Shafi, P.Eng., Project Manager

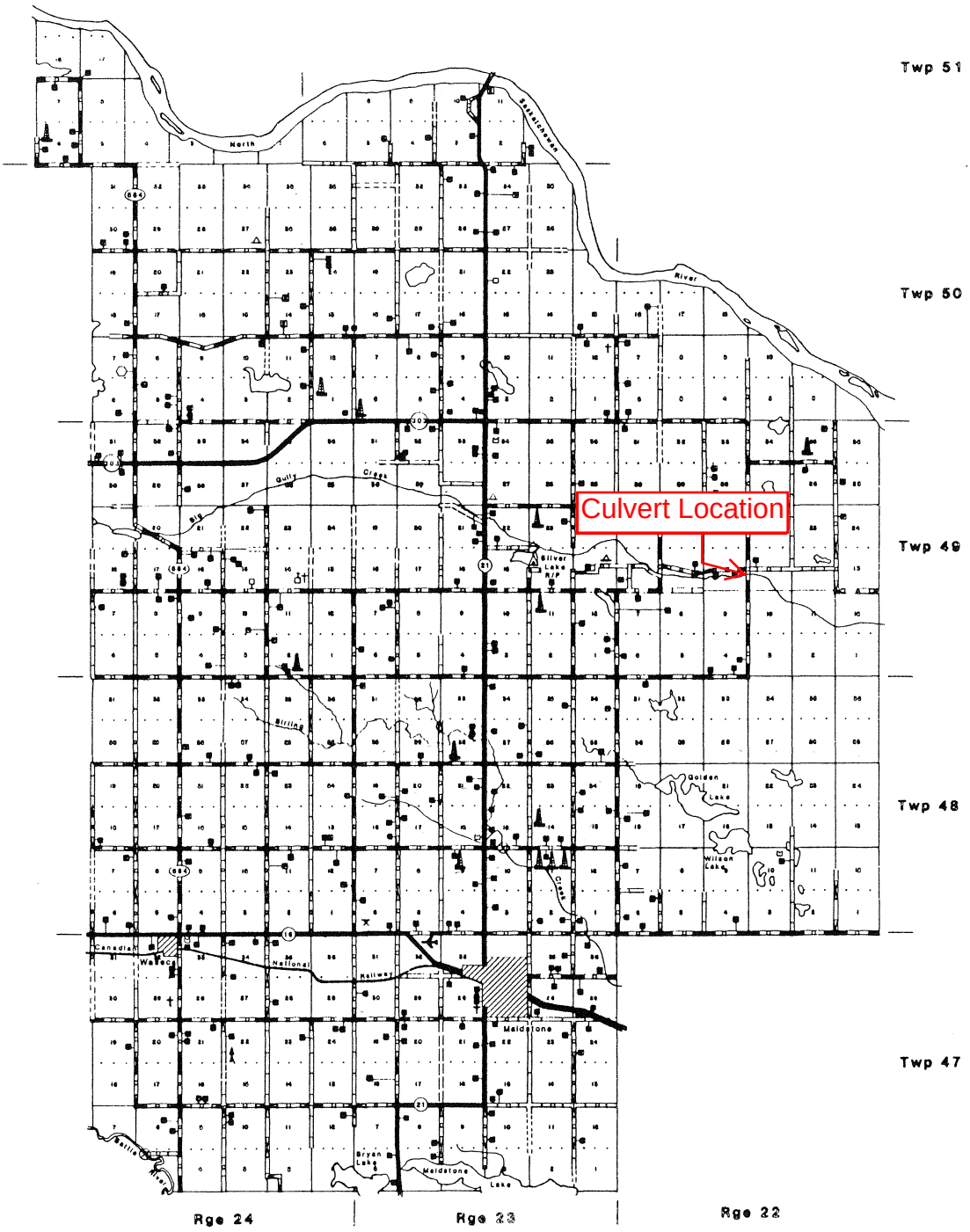
Or at the office of the undersigned:

Ken E. Reiter
Administrator
R.M. of Eldon No. 471
P.O. Box 130
Maidstone, SK S0M 1M0
Telephone: (306) 893-2391

Saskatchewan Highways and Transportation

Saskatchewan Inventory 1994

Rural Municipality of Eldon No. 471 W. of 3rd M.



Legend

- Divided Provincial Highway
- Provincial Highway

Municipal Road System

- Primary Grid Road
- Grid or Main Farm Access Road
- Graded and Drained Road
- Bladed and Undrained Road
- Prairie Trail
- Road Allowance-No Access
- Blind Line
- Railways
- Bridge
- Paved Surface
- Gravel Surface
- Urban Municipality
- Hamlet or Settlement
- Occupied Home
- Part-Time Occupied Home
- Number of Houses
- Business: Store, Garage, Motel, etc.
- Church
- School
- Cemetery
- Industry
- Resort Area
- Regional Park
- Picnic or Campsite
- Recreational or Community Centre
- Airstrip
- Tower
- Gravel Pit
- Grain Terminal
- Colony
- Corral
- Oil Battery
- Compressor Station
- Historical Site
- Trailer Court

Saskatchewan

TENDER PACKAGE

Tender Package
Installation of Arch Culvert
Municipal

R.M. of Eldon No. 471 Date: August 26, 2016

INSTRUCTION TO BIDDERS

1. Preparation of Tenders

Tenders must be made on a standard tender form as per Clause (5), of "Tender for Contract for The Installation of an Arch Culvert." Each bidder shall specify on the tender form the unit price in both words and figures for each of the separate items called for. In case of conflict between the unit price in words and the unit price in figures, the unit price in words shall govern.

The bidder shall sign his tender correctly in ink and his post office address must be shown.

2. Delivery of Tenders

Each tender must be submitted in a sealed envelope plainly marked "Tender for the Installation of an Arch Culvert on Project 458 Located at S.E. of 16-49-22-W3" and addressed to the Rural Municipality. Tenders may be delivered by mail or in person to the office of the Rural Municipality and will be received until 11:00 A.M Local Time on Wednesday, September 14, 2016. No tender received after this time will be considered.

3. Opening of Tenders

All tenders will be opened and read publicly at the office of the Rural Municipality at 11:05 A.M Local Time, on the date set in the Tender.

4. Award of Contract

No contract will be awarded except to responsible bidders capable of performing the class of work contemplated; and if so requested by the Rural Municipality, the bidder shall furnish a complete statement of his experience and of the amount of capital and equipment available for the proposed work.

The Rural Municipality further reserves to itself the right to reject any or all tenders.

The successful Bidder shall furnish a Performance Bond within fifteen (15) days following advice from the Municipality that the Tender has been accepted.

Following are some reasons for which tenders shall be rejected:

(a) if the bid is not submitted on the tender form furnished by the Rural Municipality or if the tender form is altered;

(b) if the tender form is not properly signed;

(c) if the tender form does not show a price for every contract item where quantities are indicated;

(d) if there are any unauthorized additions or erasures or irregularities of any kind which tend to make the tender incomplete, indefinite or ambiguous as to its meaning;

(e) if the list of equipment is not supplied or the list of equipment is not sufficient to perform the class of work contemplated;

(f) if the capability form is not completed or the surfacing capability of the contractor listed is not sufficient to perform the class of work contemplated by the required completion date.

R.M. No. 471

Tender for Contract
Installation of Arch Culvert
Municipal

R.M. No. 471

FOR THE INSTALLATION OF AN ARCH CULVERT

TENDER

For **The Installation of an Arch Culvert on Project 458**

Located: **S.E. of 16-49-22-W3**
in the Rural Municipality of **Eldon** No. **471**

THE UNDERSIGNED, (hereinafter called the **"Contractor"**) having read over and examined the current "General Provisions for the installation of an arch culvert", available on Sasktender or at the office of the Rural Municipality or at the office of the Consultant.

Having examined the plans, profiles (if any), specifications and special provisions furnished with this tender for the above-mentioned work and which are listed as follows:

1. List of General Provisions

2.(a) List of Standard Specifications

Specification Number	
2000	Temporary Works
2001	Structural Excavation
2002	Supplying and Placing Backfill
2003	Supplying and Driving Steel Bearing Piles
2004	Dynamic Testing of Piles
2005	Reinforced Cast-In-Place Concrete
2006	Supplying and Placing Concrete Reinforcement
2007	Supply, Fabrication and Erection of Miscellaneous Metal
2008	Supplying and Installation of Arch Culvert
2009	Stone Rip-Rap
2010	Supply and Installation of Geotextile Fabric

2011 Quality Control for Granular Backfill

2012 Demolition and Removal of Existing Structures

2013 Drainage Channel

2.(b) List of Standard Plans

Drawing Number	
S-0000	Cover Sheet
S-0001	General Arrangement
S-0002	Situation Plan
S-0003	Pile Layout
S-0004	Pile Cap Reinforcement Details
S-0005	Concrete Collar
C-0001	Erosion & Sedimentation Control Plan
C-0002	Erosion & Sedimentation Control Details

2.(c) Geotechnical Report

3. List of Special Provisions

Page 1 of 2	Clause (1)	Force Account Surcharge
	Clause (2)	Board Loss
	Clause (3)	Equipment Rental Rates
	Clause (4)	Description of Work
	Clause (5)	Diesel Fuel Adjustment
Page 2 of 2	Clause (6)	Definitions
	Clause (7)	Schedule

Clause (8) Addenda

Clause (9) Installation Instructions

Clause (10) Supplier Representative

4. Hereby Tenders and Agrees

1. To furnish all labour, materials, and equipment required to be furnished and to complete the work as outlined in the "General Provisions for the Installation of an Arch Culvert", and in accordance with the plans, profiles (if any) forming part hereof, all in accordance with the terms and conditions as set forth herein, at and for the unit prices as set forth in Clause (5) hereof.

2. That unless in the meantime the Rural Municipality shall have advised the undersigned that this tender has been rejected, the same shall remain firm and open to acceptance by the Municipality during a period of fifteen (15) days following the date fixed for the opening of tenders in respect to such a contract.

3. To furnish a performance bond in accordance with the provisions of Clause (13) of "General Provisions for the Installation of an Arch Culvert ", within fifteen (15) days following advice from the Municipality that this tender has been accepted.

4. That the quantities listed in Clause (5) hereof are estimates only and that the actual quantities may vary considerably from such estimates.

5. That payment will be made by the Municipality on the basis of the final quantities as determined by the Municipality according to the specifications pertaining to this contract.

6. The Council of the Rural Municipality, hereby appoints the following person(s) who shall administer the contract for the Municipality as required in Clause (4) of the General Provisions.

The person(s) appointed shall be:

Name	**Address**	**Phone No.**
Ken Reiter (Administrator)	Maidstone	306-893-2391
Garry Taylor (Reeve)	Maidstone	306-893-2856
Leslie Smith (Councillor)	Maidstone	306-893-4094

5. Unit Prices

5.(a) Unit Prices for Culvert Installation

ITEM	SPEC REF.	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENSION
1. Mobilization and Demobilization	2000	Lump Sum	100%	_____dollars & _____cents ($_____)	
2. Access Roads and Site Work Roads	2000	Lump Sum	100%	_____dollars & _____cents ($_____)	
3. Working Bridge and Working Platforms	2000	Lump Sum	100%	_____dollars & _____cents ($_____)	
4. Temporary Diversion Channel	2000	Lump Sum	100%	_____dollars & _____cents ($_____)	
5. Construct Drainage Channel from Oxbow to Big Gully Creek	2013	Lump Sum	100%	_____dollars & _____cents ($_____)	
6. Removal and Disposal of Existing Culvert	2012	Lump Sum	100%	_____dollars & _____cents ($_____)	
7. Structural Excavation	2001	Lump Sum	100%	_____dollars & _____cents ($_____)	
8. Supplying and Placing Backfill Material	2002/ 2011	Lump Sum	100%	_____dollars & _____cents ($_____)	
9. Supplying and Driving Steel Bearing Piles	2003/ 2004	Lump Sum	100%	_____dollars & _____cents ($_____)	
Supplying and Placing Reinforced Steel					
a) Pile Caps	2006	(kg) kilogram	15,500	_____dollars & _____cents ($_____)	
b) Culvert Collars	2006	(kg) kilogram	1,750	_____dollars & _____cents ($_____)	
Supply and Placing Concrete					
a) Pile Caps	2005	(m^3) cu. metre	149	_____dollars & _____cents ($_____)	

ITEM	SPEC REF.	UNIT	ESTIMATED QUANTITY	UNIT PRICE	EXTENSION
b) Culvert Collars	2005	(m^3) cu. metre	12	_____dollars & _____cents ($_____)	
10. Heating Concrete	2005	(m^3) cu. metre	161	_____dollars & _____cents ($_____)	
11. Installation of Arch Culvert	2008	Lump Sum	100%	_____dollars & _____cents ($_____)	
12. Supply and Placement of Geotextile Fabric, Non-Woven, Class III	2010	(m^2) sq. metre	2,860	_____dollars & _____cents ($_____)	
13. Supply and Fabricate Miscellaneous Metal	2007	(kg) kilogram	94	_____dollars & _____cents ($_____)	
14. Supply and Placement of Stone Rip Rap Class 350	2009	(m^3) cu. metre	1,716	_____dollars & _____cents ($_____)	
				TOTAL	

Note:

5.(b) The Contractor shall be entitled to payment of $50 per obstruction for those telephone and/or power poles and/or other permanent utility installations where backsloping requires work around the obstruction.

5.(c) Goods and Services Tax shall be in addition to the estimated total price shown in Clause (5).

6. **List of Equipment**

The Contractor proposes to provide the following items of equipment and machinery for the purpose of completing the work outlined in this contract and guarantees that the equipment will be available and used for the completion of the job in the best, workmanlike manner possible:

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

7. Contractor Capability

Contractor's commitment to date for equipment listed in Clause (6) of the "Tender for Contract".

Agency or Municipality	Type of Equipment	Completion Date
1.		
2.		
3.		
4.		
5.		

8. As evidence of good faith in the submission of this tender, enclosed herewith is a certified cheque payable to the Rural Municipality and drawn on one of the Chartered Banks of Canada, in the amount of not less than 10% of the Tender amount dollars as a bid deposit, or alternatively, a bid bond. The amount of the certified cheque or bid bond to be **"10% of the Tender amount"**.

This certified cheque or bid bond shall be retained by the Rural Municipality until the performance bond has been furnished and the contract signed by both parties.

9. And the Contractor agrees that should anything occur having the effect of a withdrawal or attempted withdrawal of this tender during the time the same is required to be held firm as set forth in Clause (4), Item (2) hereof, or if, after having advised the Rural Municipality of the acceptance of this tender the undersigned should for any reason be unable to provide a satisfactory performance bond within the time as fixed by Clause (4), Item (3) hereof, the Rural Municipality shall have the right, in addition to any other legal remedy available to it, to treat any contractual relationship arising out of this tender as being completely at an end and to retain as liquidated damages the money represented by such certified cheque or bid bond, and the same shall not be recoverable in any Court.

10. Liability Insurance

The successful bidder will be required to provide a record from his insurance agent that sufficient insurance is covered according to Clause (14) of the "General Provisions for the Installation of an Arch Culvert".

R.M. No. 471

11. Commencement and Completion

No work shall be done until the contract has been executed by both parties thereto and the performance bond has been filed by the Contractor and accepted by the Rural Municipality. The actual work must be commenced not later than October 14, 2016 and the Contractor shall perform the different parts of the work in the order as determined by the Rural Municipality. The rate of progress must be such that the whole contract will be completed on or before February 28, 2017, or such later date as the Rural Municipality may for any reason determine and which is confirmed by a resolution of the Council.

Name of Individual, Partnership or Corporation
(Type or Print)

Business Address
(Type or Print)

BY: _____ CORPORATE SEAL

Name of Authorized Signing Officer
(Type or Print)

Contractor's G.S.T. Registration Number

Contractor's Contact Phone Number

DATED AT _____

Signature of Authorized Signing Officer

This _____ day of _____, 2016.

SPECIAL PROVISIONS

Special Provisions
Municipal

R.M. No. 471

1. The force account surcharge will be an additional 70.0% of the total labour cost.

2. The rate for board loss will be $9.00 per hour.

3. The rental rates in the current "Equipment Rental Rates & Membership Roster" published by the Roadbuilders & Heavy Construction Association of Saskatchewan will apply to force account work.

4. Description of Work:

   The Contractor will install an Arch Culvert to Supplying and Installation of Arch Culvert Specifications.

   The road is located in: S.E. of 16-49-22 -W3 in the RM of Eldon No. 471.

5. Diesel Fuel Adjustment

   Adjustments for diesel fuel cost changes will be made to the Final Payment subject to the following conditions:

   (a) The Rural Municipality will establish a "Set Price" for diesel fuel for the Contract based on the most recent price for diesel fuel published by the Rural Municipality's supplier on the date the Tenders for the Contract are opened.

   (b) An "Actual Price" for diesel fuel will be established for the work based on the price of diesel fuel published by the Rural Municipality's Supplier at the start date of construction.

   (c) If the price of diesel fuel changes by more than 7% from the Set Price to the Actual Price, an adjustment for a diesel fuel cost change will come into effect. If the price of diesel fuel changes by less than 7%, no adjustment will be made.

   (d) If the Actual Price exceeds the Set Price by more than 7%, the adjustment paid to the Contractor by the Rural Municipality will be:

   (e) Adjustment = (Actual Price -1.07 X Set Price) X Bid Item Final

   (f) Quantity X Consumption Rate

   (g) If the Actual Price is less than 93% of the Set Price, the adjustment paid to the Rural Municipality by the Contractor will be:

(h) Adjustment = (0.93 X Set Price – Actual Price) X Bid Item Final

(i) Quantity X Consumption Rate

6. The Word “Engineer” shall mean Consultant, Engineer, Municipal Engineer.

7. Contractor to supply construction schedule before construction commences.

8. Addenda issued during the tender period will form part of the Tender for Contract document. The bidder must acknowledge receipt of all addenda issues (if any) in their Bid.

9. Contractor to follow the installation instructions provided by the arch culvert supplier as per specification 2008.

10. The Contractor shall provide full access to the supplier’s representative who is required to be present at site during the installation and backfill of the arch culvert.

AGREEMENT

R.M. No. 471

NOT TO BE FILLED OUT FOR TENDER

Agreement
Municipal

THIS AGREEMENT, dated this _____ day of _____, 2016

by and between:

_____

(hereinafter called the **"Contractor"**)

and

The **Rural Municipality of** Eldon No. 471

of the Province of Saskatchewan.

WITNESSETH THAT:

The Contractor and the Rural Municipality undertake and agree that:

1. The Contractor will construct to Arch Culvert Installation standards, the culvert located: S.E. of 16-49-22-W3 in accordance with the Tender, General Provisions, Specifications, Special Provisions and Plans furnished with and identified in the Tender;

2. The aforesaid Tender, General Provisions, Specifications, Special Provisions, Plans and addenda hereto attached, together with the Contractor's bond, are hereby made and shall be considered part of this Agreement the same as if herein fully set forth;

3. IN CONSIDERATION WHEREOF, and upon the Contractor constructing and fully completing by February 28, 2017 the works herein contracted for in accordance with the agreements herein set forth the Rural Municipality agrees to pay unto the Contractor for the actual amount of work done and materials in place at the unit prices stated in the Contractor's attached tender;

4. As a condition precedent to the complete execution of this Agreement, the Contractor will furnish to the satisfaction of the Rural Municipality a good and sufficient performance bond in the amount of _____ _____ dollars ($_____) to be conditioned upon the faithful performance of the covenants and agreements as herein set forth by it to be performed.

5. Neither party of the Contract shall assign, transfer or sublet the Contract, or any part thereof, without the written consent of the other.

This Contract shall ensure to the benefit of and be binding upon the parties hereto, and their successors, executors, administrators and assigns.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement on the date which is indicated first herein.

_____)
) SIGNED, SEALED
) AND DELIVERED
_____) SEAL
) in the presence of
_____)

Contractor _____
(Witness)

_____
Contractor's G.S.T. Registration Number

Rural Municipality of

Eldon No. 471

_____
Reeve

SEAL _____
(Witness)

_____
Rural Municipal Administrator

GENERAL PROVISIONS

General Provisions
Municipal

FOR THE INSTALLATION OF AN ARCH CULVERT

1. Definitions:

(a) Contractor:

The word "Contractor" shall, unless the content otherwise requires, include the authorized agents of the Contractor or the Foreman in charge of the work.

(b) Rural Municipality:

The word "Rural Municipality" shall mean the Rural Municipal Council or its designated representative(s).

(c) Interpretation:

Where there is any doubt as to the intention, or the correct interpretation of the specifications herein, the matter shall be referred to the Rural Municipality.

2. Times and Manner of Payment:

The Rural Municipality will well and truly pay or cause to be paid unto the Contractor for the said works at the price as shown in Clause (5) of the Tender. Payments will be made as follows:

Progress Payments

All progress payments for materials furnished and work performed will be based on estimates prepared and certified by the Engineer and submitted to the Council seven (7) days prior to the regular council meeting date. Progress payments to the Contractor will be made within ten (10) days after the regular council meeting date.

The monthly estimates and payments are approximate only but shall be as close to the actual value as is practicable and shall be subject to correction in the final estimate and payment.

Ten (10) percent of the monthly amount of each progressive estimate shall be retained as a holdback until the work is completed and has been accepted by the Rural Municipality.

Final Payment

Final payment will be made by resolution of the Council at the earliest practicable date following final inspection and acceptance of the work. The Contractor shall be paid the entire sum due after deducting all previous payments and all amounts to be retained or deducted under the provisions of the Contract. Such payment shall be known as the "Final Estimate".

Before making the final payment, the Rural Municipality may require the Contractor to submit a statutory declaration stating that all just claims against the Contractor or sub-contractor, as outlined in Clause (10) of the General Provisions have been paid or secured.

All payments are to be made according to measurements and records maintained by the Rural Municipality, and the decision of its Council in respect thereto shall be final.

The Rural Municipality shall, within thirty (30) days of the work, make payment of the account in accordance with the agreement. Should the Rural Municipality fail to pay the sum named in any certificate of the Engineer or in any award by arbitration, upon demand when due, the Contractor shall receive, in addition to the sum named in the certificate, interest thereon at the rate of two (2) percent per month.

The Contractor shall have thirty (30) days from receipt of the final quantity statement from the Rural Municipality or Engineer to advise the Rural Municipality of his non-acceptance of the quantities.

3. Materials:

No claim for damages shall be made against the Rural Municipality on account of delays on the part of the Rural Municipality in the delivery of materials or performance of the work. Should there be unduly prolonged delays on the part of the Rural Municipality in the delivery of any materials or the performance of work, the Contractor shall be entitled to a corresponding extension of time within which to complete the work.

4. Supervision and Acceptance of Work:

The person or persons appointed by the Rural Municipality in Clause (4), Section 6 of the tender form shall have duties, authority and responsibilities as follows:

(a) To supervise the works to ensure the work is being carried out according to the contract documents, and give the Contractor written points of instruction.

(b) To act on behalf of the Rural Municipality to expedite removal or relocation of obstructions to the work such as fences and utilities, and to ensure the prompt arrangement for purchase, lease or easement of right-of-way and borrow pits; and to expedite prompt delivery of materials and supplies to be supplied by the Rural Municipality.

(c) To arrange and conduct a pre-job meeting with the Rural Municipality, Engineers and Contractor to discuss scheduling of the Contractor's work, delivery of materials by Rural Municipality, schedules of utility location, relocation or removal.

(d) To act as "Judge of Performance" of the Contractor's work.

(e) To inspect the finished work of the Contractor and provide a written acceptance or a written list of deficiencies.

(f) To ensure that the Contractor's invoices or the Engineer's payment certificate for work completed are dealt with by the Rural Municipal Council in the times and manner prescribed elsewhere in the contract documents.

Portions of improved road completed to the satisfaction of the Rural Municipality or the Engineer will be accepted during the progress of the work in sections of not less than 1.6 kilometres (1 mile) in length in each case. Upon acceptance of any such portion, the Contractor shall thereafter be relieved of further responsibility for maintenance of such portion, provided always that at any time during the progress of the remaining work under this contract the Rural Municipality may require the Contractor to do specified maintenance work on any such accepted portion, on a "Force Account" basis as outlined in Clause (8) hereof.

5. <u>Liquidated Damages</u>:

The Contractor shall perform fully, entirely and in an acceptable manner the work contracted for and within the time stated in the contract. Should he fail to do so, the Rural Municipality may deduct any monies due or coming due to the Contractor, all costs and expenses incurred by the Rural municipality resulting in such failure by the Contractor, such costs to include the cost of maintaining the necessary force of engineers and inspectors on the work during the additional time required to complete the contract and the costs and expenses of convening meetings of the council for the purpose of dealing with all matters arising from such failure on the part of the Contractor and any and all other expenses incidental thereto. This amount shall be considered as reasonable liquidated damages due to the Rural Municipality from the Contractor for his failure to complete the contract within the specified time limit.

For purposes of this section, "the cost of maintaining the necessary force of engineers and inspectors on the work" shall be deemed to include the wages, salaries, board, sustenance and travelling expenses of any or all supervising engineers, resident engineers, engineering assistants, head checkers, scalemen, gravel checkers, employees used in materials testing, instrumentmen, rodmen, chainmen, and grading inspectors who are employed on, or in connection with the work.

Should the liquidated damages, calculated as herein provided for, exceed the amount of monies due or coming due to the Contractor under this contract, the Contractor and his sureties shall be jointly and severally liable to pay such excess to the Rural Municipality.

6. Extension of Contract Time of Completion:

If the satisfactory execution and completion of the contract shall require work or material in substantially greater amounts or quantities than those set forth in the contract, then contract times shall be increased in the same proportion as the additional work bears to the original work contracted for. No allowance shall be made for delay or suspension of the prosecution of the work due to the fault of the Contractor. Provided, however, that upon receipt of written notice from the Contractor of the existence of causes over which he has no control and which must delay the completion of the work, the Rural Municipality may at its discretion by resolution of its council extend the date specified for the completion of the said work. In such case the Contractor shall become liable for liquidated damages for failure to perform work within the time as so extended in accordance with the provisions of the immediately preceding paragraph.

7. Cancellation of Default:

If, in the opinion of the Rural Municipality, the rate of progress, at any time, is not such as to ensure the completion of the work by the completion date as provided in Clause (11) of the "Tender Contract" or within such extended time as may have been granted under Clause (7) hereof, or if the Contractor shall neglect or refuse or fail in any respect to comply with any other provisions of this contract, the Rural Municipality reserves and may exercise the right to cancel or annul this contract and make other provisions for the work being completed. The Contractor shall not be entitled to claim damages on account of anticipated profits or for other reasons.

If the Rural Municipality exercises its right of cancellation as provided for in this clause, the Contractor shall not be entitled to receive any further payment under this contract until the said work has been wholly completed. At such time, if the unpaid balance of the amount to be paid under this contract exceeds the expense incurred by the Rural Municipality in completing the work; then such excess shall be paid to the Contractor by the Rural Municipality. If such expense exceeds such unpaid balance, the Contractor and his sureties shall be jointly and severally liable to pay such excess to the Rural Municipality.

The Rural Municipality, if it considers it advisable, may use all or any part of the Contractor's appliances, tools, materials, and means of construction as may be found in connection with said work and which may be required for the completion of the contract.

The cost of any such materials used in the work shall be allowed for at prices shown by proper vouchers and receipts, and reimbursement for any plant or tools so used and for any additional plant required shall be made on the basis of depreciation for the time it is used on the work at a rate that will equal the actual cost of the plant in twelve (12) months' use, and ten (10) percent for organization, superintendence, etc.

8. Extra Work (Force Account):

If, during the performance of the contract, it shall become necessary or desirable for the proper completion of the work to order additional work done or materials furnished, which are not susceptible to classification under the prices set out in this contract, the Contractor shall, if ordered in writing by the Municipal Engineer, do and perform such work and furnish such materials. The extra work will be paid for at a unit price or lump sum to be agreed upon previously in writing by the Contractor, the Rural Municipality Municipal Engineer.

Provided that, in the absence of agreement between the parties as to the basis upon which the Contractor is to be paid for such extra work, the Rural Municipality may require him to do the same on a "Force Account" basis. The Force Account rates will be the current rental rates set out by the Department of Highways and Transportation.

Extra work performed on a Force Account basis will be paid for in the following manner:

a. **Labour**

For labourers, foremen:

1. The actual rate of wages paid by the Contractor, but at rates not to exceed those for comparable labour currently employed on the project as determined by the Engineer, plus an allowance as designated in the special provisions of the contract, which shall cover statutory holiday pay, holiday pay, Canada Pension Plan, Workers' Compensation, unemployment insurance, public liability insurance, property damage insurance and supervision and profit. The current force account surcharge is indicated in Clause (1) of the "Special Provisions".

2. The foreman's allowance (hours) will be negotiated with the municipality on the basis of time required to supervise the hourly work.

3. An allowance as designated in the special provisions of the contract shall be added to the total of the above labour cost to cover board loss where the Contractor does not charge the full cost of meals and accommodation back to the employee. The rate of board loss is indicated in Clause (2) of the "Special Provisions".

b. **Materials**

For all materials purchased by the Contractor and used on Force Account work which is accepted by the Engineer, the Contractor will receive the actual cost of the materials delivered on the work, including freight and hauling charges as shown by original receipted bills, to which costs shall be added a sum equal to ten (10) percent thereof.

c. **Tools and Equipment**

1. For any machinery and equipment used, the Contractor shall be paid rental rates in accordance with the current schedule of rental rates set out by the Saskatchewan Highways and Transportation. The schedule of rental rates shall apply to all work done on Force Account during the fiscal year from the first day of April in one calendar year and ending on the last day of March in the next calendar year, both dates inclusive. Current schedule rates will be applicable for each succeeding fiscal year. If a particular piece of equipment is not listed in the schedule of rental rates, a rate will be established by the Municipality before any work is carried out on Force Account. The rate established will then apply for the duration of the contract.

   The Contractor shall obtain approval in writing for equipment hired at rental rates exceeding those contained in the Schedule of Rental Rates prior to any work being done on Force Account. No allowance will be made for small tools and manual equipment. No percentage shall be added to the equipment rental rates.

2. Basic rental rates established from the schedule of equipment rental rates will be adjusted in accordance with the equipment model year as listed in Clause (3) of the "Special Provisions".

3. Equipment rental time will be recorded to the nearest one-half (1/2) hour.

4. Payment for transporting equipment to the job will be paid only for those units of equipment that are not normally required for the execution of the contract. The cost of transportation of equipment will be based on actual and reasonable out-of-pocket expenses. Self-propelled units will receive compensation of fifty (50) percent of the adjusted hourly rental rate plus the operator's wages.

5. No compensation will be paid for moving equipment required to complete portions of the contract which are advertised in the tender to be completed on an hourly basis.

d. **Records**

The following records shall pertain to Force Account work:

1. Work to be done on a Force Account basis must be authorized in writing by the Municipal Engineer before its commencement. The original and one copy of the authorization will be given to the Contractor.

   The original is to be retained by the Contractor and the copy attached to the Saskatchewan Highways and Transportation standard Force Account forms.

2. The Contractor shall furnish original receipted bills to verify the cost of materials purchased by him and used on the extra work.

3. The cost of labour and equipment rental charges shall be furnished by the Contractor on the standard Force Account forms provided by the Saskatchewan Highways and Transportation.

4. Accounts for Force Account work must be submitted to the Municipality for payment within thirty (30) days from the date on which such Force Account work was completed.

5. The Municipality, if it deems it necessary, shall provide and place a timekeeper or timekeepers on the work for the purpose of keeping records of the costs of such Force Account work.

6. The Contractor shall not be entitled to anticipated profits which men, machinery, or equipment might have earned through not having been employed on Force Account work.

9. Labour:

The Contractor agrees that all persons employed on the work by the Contractor and any sub-contractor of the Contractor will, in respect of the construction to be carried out under this contract, employ only residents of Canada. In employing persons, the Contractor will refrain from discriminating against any person by reason of his race, sex, religious or political affiliations.

The Contractor shall, at all times during his absence from the work, have a competent superintendent or foreman as his representative on the job, and who shall receive instructions from the Engineer.

The Contractor shall, at all times, provide adequate supervision and sufficient labour and equipment for prosecuting the several classes of work to full completion in the manner and within the time required by the contract.

The Contractor shall only employ foremen and workmen who have sufficient skill and experience to perform properly the work assigned to them. Any person employed on the work who, in the opinion of the Municipality, is careless, incompetent, obstructs the progress of work, acts contrary to instructions or conducts himself improperly shall, on the requisition of the Municipality, be immediately discharged. Such person shall not again be employed on the job without the permission of the Municipality.

10. Payment by Contractor for Labour, etc.:

The Contractor shall promptly pay for all labour expended, services given and materials and supplies used in, upon, in respect of, or about the construction of the work, or any portion thereof, including any sum due for the labour or services of any sub-contractor foreman, workman, labourer or other person. The Contractor shall also pay any sum due for insurance premiums, whether such payments or insurance premiums are due by the Contractor, or any sub-contractor. The payments in respect of such labour, services, materials and supplies to include without prejudice to the foregoing generality all sums for:

(a) The services of any person or persons performing any work or labour in repairing machinery and equipment

(b) The use, rent or hire of:

1. Vehicles or other plant or machinery;

2. Motor power equipment of any kind;

(c) The furnishing of any hand tools

(d) The materials or supplies for any camp maintained for the feeding or keeping of men

(e) Supplies used for machinery or motor power equipment (except repair parts).

And the Contractor further agrees that the contract bond shall be held to cover all such claims referred to in this clause. In case any such sum or sums remain unpaid which, in the opinion of the Municipality should be paid, the Municipality shall have the right to pay such sum or sums, whether due by the Contractor or sub-contractor, out of any monies that may then or thereafter be or become due to the Contractor from the Municipality. It is agreed that so long as any such sum or sums remain unpaid, the payrolls, timebooks, account books, invoices and vouchers of the Contractor or any sub-contractor relating to any such unpaid sum or sums shall be open to inspection by the Municipality for the purpose of ascertaining the true sum or sums remaining unpaid.

The Contractor shall supply to the Municipality when and as often as requested, a statement showing all claims incurred by the Contractor, including all obligations incurred by each sub-contractor on the work covered by the contract, remaining unpaid at the date of submission of such statement. The submission of each statement by the Contractor, when so requested, shall be a condition precedent to the payment by the Municipality of any monies due or to accrue due to the Contractor under the contract.

11. Accidents:

The Contractor shall at all times, until the work is completed and accepted by the Municipality, take all necessary and sufficient precautions and steps to prevent and avoid accidents to workmen or other persons, or to the work or other property. He shall provide and maintain at this own expense such fences, barriers, signs, lights and watchmen as may be necessary.

In the event of injury or damage being suffered by any workman or other person having the right of action thereafter against the Contractor or against the Municipality, the Contractor shall and will indemnify and save harmless the Municipality from any and all actions, causes of action, claims, demands and remedies whatsoever which the workman or other person may have or pretend to have against the Municipality in respect of such damages or injury under the Workers' Compensation Act, or otherwise howsoever.

In the event of one or more actions, claims, or demands being made or commenced by any workman or workmen or other person or persons in respect of any injury or damages alleged to have been suffered as aforesaid, the Municipality shall be entitled to retain out of any monies owing or accruing due to the Contractor, until such actions, claims or demands are satisfied, an amount equal to the total of the claim or claims.

12. Traffic and Detours:

The Contractor shall at all times carry on the work in a manner that will create the least interference with traffic, consistent with the faithful performance of the work. He shall not close any portion of the highway, nor divert traffic outside the limits of the highway, except by written order of the Municipality.

Warning signs, as outlined in the annexed specifications, are to be erected before the work is commenced and are not to be removed until the work has been completed. The Municipality or the Engineer may instruct the Contractor to cease construction operations until such time as proper signing has been erected. Failure by the Contractor to erect signs to the required specifications will render the Contractor liable for any action that may result due to his negligence.

13. Performance Bond:

The Contractor covenants and agrees that he will furnish a performance bond in the sum of not less than fifty (50) percent of the total estimated price as set forth in Clause (5) of "Tender for Contract" for the proper fulfilment of this contract (which shall include payment of any sums as required under Clause (10) hereof). Such performance bond shall be in a form approved by and satisfactory to the Municipality, and shall be issued by a company authorized to issue such bonds within the Province of Saskatchewan, in which the Contractor shall be the principal and the said company the surety, both (including their heirs, executors, administrators and assigns) to be jointly and severally bonded thereunder. Such bond shall be furnished prior to the final execution of this contract by the Municipality.

14. Liability Insurance:

The bidder whose tender has been accepted shall, prior to or at the time of the execution of the contract, file with the Municipality a written declaration by his insurance company as evidence that he carries the following insurance, as well as any additional insurance or special coverage that is indicated in the Special Provisions.

Public Liability and Property Damage Insurance

The Contractor shall maintain a comprehensive policy or policies of public liability and property damage insurance in the minimum amount of five million dollars ($5,000,000.00) inclusive, to protect him from all claims for damages, for bodily injury including death, and for property damage which may arise from any operation under the contract, whether such operations be by himself or by any sub-contractor or by anyone directly or indirectly employed by either of them.

The above described insurance shall include coverage for all owned and non-owned licensable vehicles employed under the contract.

Insurance shall not be cancelled by either party without notice by registered mail or personal delivery to the Municipality, and in no case until final acceptance of the work has been granted in writing. If any of the insurance is cancelled, the Contractor shall cease operations on the date of cancellation, and shall not resume operations until new insurance is in force.

The cost of the above described insurance, as well as the cost of any additional insurance or special coverage required by the Special Provisions, will be considered as incidental expense and no direct compensation will be made therefor.

15. Assignment of Contract:

The Contractor shall not, without the prior written consent of the Municipality, make any assignment of this contract or enter into any sub-contract for the execution of any of the works hereby contracted for, and no assignment or sub-contract, even though duly consented to, shall exonerate the Contractor from liability under this contract for the due performance of the works hereby contracted for, or for the fulfilment of any other term or terms of the contract. In such case, the Contractor shall be responsible for all acts, defaults, neglects and delays of any assignee or sub-contractor, or his servants, agents and employees, to the same extent as if no such assignment or sub-contract had been made or entered into.

16. Cancellation Without Fault of Contractor:

The Municipality shall have the right at any time to cancel this contract upon giving thirty (30) days notice in writing to the Contractor, in which event the Contractor shall be entitled to the full amount of the estimate for the work done by him under the terms and conditions of this contract up to the time of such cancellation.

The Contractor shall be reimbursed by the Municipality for such expenditures as in the judgement of the Council of the Municipality are not otherwise compensated for.

The Municipality shall have the right to make such reasonable alterations in the plans as it may consider necessary and such alterations shall not be considered as a waiver of any condition of the contract or as invalidating any provisions thereof, nor shall any change be made in the contract unit prices on account of such alterations.

17. Removal of Surplus Material and Refuse:

On the completion of the work entailed by the contract, or in the event of its cancellation, the Contractor shall promptly remove from the right-of-way of roads herein described, and from any adjoining road, all temporary structures, rubbish and waste materials resulting from his operations, and all equipment, supplies and surplus materials.

In the event of the Contractor failing to comply with this provision within a period of ten (10) days from the date of the completion or cancellation of this contract, the Municipality shall have the right to employ the necessary labour and do such work at the expense of the Contractor.

18. Purchases:

The Contractor agrees that all purchases of supplies, merchandise or equipment for use in connection with the work shall, when practicable, be purchased from residents of the Province of Saskatchewan.

19. Unacceptable and Unauthorized Work:

All work and materials which do not conform to the requirements of the contract shall be considered unacceptable.

Any unacceptable work found to exist prior to the final acceptance of the work shall be remedied or removed and replaced in an acceptable manner by the Contractor at his own expense, except that it shall be the Municipality's expense if the unacceptable work resulted from the use of defective material supplied by the Municipality.

Any work done by the Contractor prior to the execution of the contract by both parties, work done contrary to or regardless of the instructions of the Engineer, work done beyond the lines, grades and dimensions shown on the plans, or any extra work done without authority, may be considered as unauthorized work and may not be paid under the provisions of the contract.

If the Contractor fails to comply with an order for a corrective procedure, the Municipality may deduct from the contract price the difference in value between the unauthorized work as done and that called for by the contract.

20. Errors or Omissions:

The Contractor shall immediately report to the Engineer any omissions, inconsistencies or possible errors he may discover in the drawings, specifications or staking, and shall not proceed with any work in uncertainty.

21. Preservation of Construction Stakes and Land Monuments:

The Municipality will provide the Contractor with hub line stakes, one set of slope stakes and one set of re-grade stakes. Re-grade stakes that may be required to complete the grade to required road specifications as deemed necessary by the staff of the Department of Highways and Transportation shall be replaced at the Contractor's expense.

All such stakes, as well as legal survey pins and monuments, will be carefully preserved by the Contractor. If, in the opinion of the Municipality, the Contractor has been negligent in allowing the stakes to be destroyed, the cost of replacing such stakes shall be charged against the Contractor. This cost shall be calculated in the same manner as outlined under "Liquidated Damages".

22. Change of Location:

Major changes in the location as specified in the "Tender for Contract" cannot be made without consent of the Contractor.

If a minor location change is required, which results in a change in the character of the work, a negotiated price for the quantities involved in the area should be arrived at prior to the work being undertaken.

23. <u>Appeal Procedure:</u> (Arbitration)

(a) The parties agree that all disputes and differences between the parties bound by this contract concerning its interpretation, application, operation or alleged violation shall be finally and conclusively settled in accordance with the procedure hereinafter outlined, or shall be submitted for legal action.

(b) Either party to this contract may provide to the other party notice in writing of a dispute or difference between the parties to this contract concerning its interpretation, application, operation or alleged violation. Upon receipt of the notice, representatives of both the parties shall meet within three (3) working days of the receipt of such notice to discuss the dispute or difference as set out in such notice. Failing a satisfactory resolution of the dispute or difference within such period, or such longer time as the parties mutually agree in writing, then either of the parties may, after the expiration of such period, notify the other party in writing that he requires the matter to be submitted to arbitration.

(c) The Board of Arbitration shall consist of three persons constituted as follows:

1. The party desiring arbitration shall appoint a member to the Arbitration Board and shall notify the other party of its appointee concurrently with providing the notice to submit the difference or dispute to arbitration;

2. The party receiving the notice shall within five (5) days thereafter, appoint a member for the Board and notify the other party of its appointment in writing;

3. The two arbitrators so appointed shall confer to select a third person to be Chairman and failing agreement, within a period of three (3) working days from the appointment of the second of them, either party may, upon the expiration of such period, apply to the Chief Justice of the Court of Queen's Bench for the Province of Saskatchewan who shall appoint such arbitrator to be Chairman of the Arbitration Board.

(d) The Arbitration Board shall convene its hearing, hear the parties and counsel acting on their behalf, and any and all evidence adduced relating to the difference or dispute between the parties under the provisions of the contract, and shall make its award within fourteen (14) days after the hearing. The award of the Arbitration Board shall be final and binding upon the parties.

(e) The Arbitration Board may, within the consent of the parties, enlarge the time for the presentation of its award, and shall have such powers and exercise such authority as is provided for by the Arbitration Act for the Province of Saskatchewan, and the award of the Arbitration Board shall be enforceable as provided for by the Arbitration Act.

(f) Each party to the arbitration shall pay its own costs and expenses of arbitration, and one-half (1/2) of the costs and expenses of the Chairman and other expenses of the arbitration hearing.

(g) In view of the provisions of this Article, the parties agree that there shall be no termination or interruption of the work or the payments as provided for under the terms of this contract unless otherwise mutually agreed upon between the parties.

STANDARD SPECIFICATIONS

AND STANDARD PLANS

2000 – TEMPORARY WORKS

2000 - 1 DESCRIPTION

This specification describes the terms and conditions applicable to the following.

(1) Design, supply, fabrication, installation, maintenance and removal of temporary works, including but not limited to: access roads, Site Work Roads, work bridges, working platforms, cofferdams, shoring, silt fences/curtains, temporary stream diversions, and formwork/falsework for cast-in-place concrete.

(2) Mobilization and demobilization of Plant and Material required for the Work.

(3) Site restoration.

This specification details the responsibilities of the Contractor.

2000 - 2 REFERENCES AND RELATED SPECIFICATIONS

All reference standards and related specifications shall be current issue or latest revision at the first date of tender advertisement.

A. Related Specifications

- Specification 2001 Structural Excavation
- Specification 2002 Supplying and Placing Backfill
- Specification 2005 Reinforced Cast-in-Place Concrete

2000 - 3 SUBMITTALS

The Contractor shall submit the following to the Engineer:

(1) Detailed design notes and Shop Drawings for temporary works (access roads, Site Work Roads, work bridges, working platforms, cofferdams, temporary stream diversions, shoring and formwork/falsework for cast-in-place concrete) that are stamped, signed and dated by a Professional Engineer licensed to practice in the Province of Saskatchewan. The design shall be in accordance with the requirements of this Specification, the Drawings, and comply with Federal, Provincial, and Municipal Authorities Regulations.

(2) Proof that the above noted temporary works have been constructed in accordance with the Professional Engineer's Shop Drawings and specifications. This proof shall be in the form of a letter bearing the seal of the Professional Engineer certifying that the temporary works are in accordance with his design and that he has carried out a personal inspection of the temporary works.

(3) Proposed supplier(s) and location of quarry(ies) for supply of rockfill material for access roads, Site Work Roads and working platforms.

2000 - 4 MATERIALS

The Contractor shall be responsible for the supply, safe storage, and handling of all materials associated with this Work.

2000 - 5 CONSTRUCTION METHODS

A. General

Temporary works, as described above, shall be designed to support all construction loads. The temporary works shall be designed and constructed such that the Work can be properly constructed as required by the Specifications and Drawings. Sufficient clearances shall be provided by the temporary works to permit all required construction activities to proceed unhindered.

The Contractor shall construct the temporary works in accordance with the Shop Drawings. Variations in the construction will not be permitted, unless such variations are accepted by the Professional Engineer and the Engineer is provided with revised Shop Drawings.

Care shall be taken not to damage any portion of the permanent Work. Damage to the permanent Work during installation or removal of the temporary works shall be repaired by the Contractor at his own cost to the satisfaction of the Engineer.

Temporary works shall be in accordance with the environmental requirements of the Contract and to the satisfaction of the Engineer.

B. Access Roads and Site Work Roads

Access Roads and Site Work Roads shall be located as shown on the Drawings to minimize disturbance of vegetation.

Provincial Highways, Provincial Roads and Rural Municipal Roads shall not be used as Site Work Roads. These roads can only be used as haul roads.

The Contractor shall not disturb the channel and embankment slopes beyond the limits shown on the Drawings unless he has obtained written permission from the Engineer. Such written permission shall be granted only if it can be shown conclusively that there is no alternative to the cutting of the banks or slopes beyond the limits shown on the Drawings. If permission is granted, the Contractor shall be responsible for restoring the banks and slopes to the profile and compaction shown on the Drawings or as directed by the Contractor Administrator at his own expense.

Temporary stockpiling of the material required to construct the access roads and Site Work Roads may be permitted, subject to the approval of the Engineer. The locations and dimensions of all stockpiles shall not be a detriment to the stability of the existing channel. Any erosion and sedimentation control devices (eg. silt fence) deemed necessary by the Engineer to protect the temporary stockpile area shall be supplied, installed, maintained and removed at the Contractor's expense.

The Contractor is responsible for all snow removal within the limits of the Work. Temporary stockpiling of the cleared snow may be permitted at locations and to dimensions acceptable to the Engineer. All procedures for temporary stockpiling of snow shall consider the requirements for temporary sediment and erosion control measures and channel slope stability.

The Contractor shall return all access roads and Site Work Roads to pre-construction condition upon or before completion of the Work to the satisfaction of the Engineer.

C. Work Bridges and Working Platforms

The Contractor shall be responsible for maintaining the uninterrupted flow of water through the site for the duration of the Contract including the installation of silt fences/curtains as per drawings.

The use of creosoted timbers in contact within the water body will not be permitted.

D. Cofferdams and Shoring

Sheetpiling cofferdams shall be provided for all excavations:

(1) in excess of 1.5 meters in depth;

(2) in water course channels; and

(3) in areas of ground water seepage.

Sheetpiling cofferdams shall be as water tight as is necessary for the proper performance of the work that must be done inside them as approved by the Engineer. Sheetpiling shall be driven to a depth below the bottom of the excavation to preclude the possibility of a blow-up from the bottom of the excavation and shall be long enough to protect the interior of the cofferdam from flooding due to a sudden rising of water.

When excavating to a depth of 1.5 meters or less in water course channels or areas of groundwater seepage, shoring or other types of cofferdams may be used in place of a sheetpiling cofferdam, providing adequate alternative methods as approved by the Engineer are used to divert the water and all environmental requirements are met.

The Contractor shall install shoring prior to excavation. The shoring shall be installed in such a manner so as to not disturb or damage adjacent structures, railways and roadways.

Shored excavations and cofferdams shall be constructed to give sufficient clearances for:

(1) the construction and inspection of forms and their subsequent removal;

(2) the driving of piles; and

(3) the construction of cut-off trenches and sump pits to permit the pumping of water from outside of the forms, all without exceeding the excavation limits as shown on the Drawings.

Struts, bracing, or other material not shown on Shop Drawings, shall not extend into the culvert foundations without written permission from the Engineer. The bracing system of the shored excavation or sheetpiling cofferdam shall not be removed in part or in whole until the shoring or sheetpiling cofferdam is braced to the footing, the excavation is backfilled or the shoring or sheetpiling cofferdam is otherwise ready to be removed.

The Contractor shall insulate the walls of shoring and sheetpiling cofferdams constructed during winter, when it is not possible to seal off water leaks that may develop from thawing due to the introduction of heat.

Unless otherwise provided for, sheetpiling cofferdams or shoring, including sheeting and bracing, shall be removed after the completion of the substructure. Care shall be taken not to disturb or otherwise damage the finished concrete or foundation material of the permanent Work or adjacent

structures and roadways. Backfill required around the permanent work shall be placed prior to the removal of the sheetpiling cofferdams and shoring, and shall be supplied and placed in accordance with Specification 2002: Supplying and Placing Backfill.

Under extreme conditions where the ingress of water from the bottom of the excavation is impossible to stop, a seal of tremie concrete may be permitted. The Contractor shall use this tremie seal only on the written order of the Engineer.

E. Temporary Diversion Channel

The Contractor shall be responsible for maintaining the uninterrupted flow of water through the site for the duration of the Contract. The stream flow of Big Gully Creek shall be diverted around the construction site by means of a temporary diversion channel.

The temporary diversion shall be designed to accommodate the flood event with a 20% chance of occurrence in a given year. This flow has been calculated to be 9.3 m^3/s. The temporary diversion must be constructed as an open cut channel. The channel also must function to accommodate fish passage, therefore pipe and/or pumping diversions will not be accepted.

The channel shall be constructed such that it is isolated from the other construction works. Erosion and sedimentation control measures such as silt fence and silt curtains shall be used to prevent erodible material from entering the channel. The channel shall be lined with a plastic membrane or clean stone sufficient to prevent erosion of the channel material as approved by the Engineer.

The temporary diversion channel geometry and erosion and sedimentation control details shall be shown in the detailed design notes and shop drawings that are stamped, signed and dated by a Professional Engineer licensed to practice in the Province of Saskatchewan.

When the diversion channel is no longer required it shall be decommissioned to a state as near as possible to the original site conditions and to the satisfaction of the Engineer.

F. Formwork/Falsework for Cast-in-Place Concrete

Formwork/falsework for cast-in-place concrete shall meet the requirements specified in Specification 2005 Reinforced Cast-in-Place Concrete.

2000 - 6 QUALITY CONTROL / QUALITY ASSURANCE

The Contractor shall inspect temporary works on a daily basis to ensure that they are safe and have not been damaged due to construction, environmental exposure or vandalism.

Any damage or deficiencies in temporary works that could be perceived as unsafe or that may result in imminent danger shall be corrected immediately.

2000 - 7 MEASUREMENT

A. Access Roads and Site Work Roads

The design, supply, installation, maintenance and removal of access roads and Site Work Roads will be paid for on a Lump Sum Basis, and no measurement will be made for this work.

B. Work Bridges and Working Platforms

The design, supply, fabrication, installation, maintenance and removal of work bridges and working platforms will be paid for on a Lump Sum Basis, and no measurement will be made for this work.

C. Mobilization and Demobilization

Mobilization and demobilization will be paid for on a Lump Sum Basis, and no measurement will made of this work.

D. Cofferdams and Shoring

The design, supply, fabrication, installation, maintenance and removal of cofferdams and shoring will be considered incidental to all portions of the Work, and no measurement will be made for this work.

E. Temporary Diversion Channel

The design, supply, construction, maintenance and removal of temporary diversion channels will be paid for on a Lump Sum Basis, and no measurement will be made for this work.

F. Formwork/Falsework for Cast-in-Place Concrete

The design, supply, fabrication, installation, maintenance and removal of the formwork/falsework for cast-in-place concrete will be considered incidental to the Work and no measurement will be made for this work.

G. Site Restoration

Site restoration will be considered incidental to the Work and no measurement will be made for this work.

2000 - 8 PAYMENT

A. Access Roads and Site Work Roads

The design, supply, installation, maintenance and removal of all access roads and Site Work Roads will be paid for at the Contract Lump Sum Price for “Access Roads and Site Work Roads", measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

B. Work Bridges and Working Platforms

The design, supply, fabrication, installation, maintenance and removal of work bridges and working platforms will be paid for at the Contract Lump Sum Price for “Work Bridges and Working Platforms", measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

C. Mobilization and Demobilization

Mobilization and demobilization will be paid for at the Contract Lump Sum Price for “Mobilization and Demobilization", measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

Two-thirds of the Lump Sum Price will be paid when the Engineer is satisfied that the majority of the required equipment is mobilized on the project. The remaining one-third of the Lump Sum Price will be paid when the work has been substantially completed.

2001 – STRUCTURAL EXCAVATION

2001 - 1 DESCRIPTION

This specification describes the terms and conditions applicable to the following.

(1) Removing material for the placement of foundations, substructure units, approach slabs, transition slabs and culverts, including the disposal of surplus and unsuitable material, as shown on the Drawings and described in this Specification;

(2) Water control including dewatering the excavation and maintaining stream flow through the site;

(3) Preparing the base of excavation; and

(4) Supplying, placing, compacting, finishing and heating of a concrete working base.

Cofferdams and shoring shall be completed in accordance with the Specifications for Temporary Works.

This specification details the responsibilities of the Contractor.

2001 - 2 REFERENCES AND RELATED SPECIFICATIONS

All reference standards and related specifications shall be current issue or latest revision at the first date of tender advertisement.

A. References

- CSA A23.1, Concrete Materials and Methods of Concrete Construction
- Regulations of Provincial and Municipal authorities.
- National Building Code and the Canadian Construction Safety Code.

B. Related Specifications

- Specifications 2000 Temporary Works
- Specifications 2005 Reinforced Cast-In-Place Concrete

2001 - 3 SUBMITTALS

The Contractor shall submit the following to the Engineer:

(1) A detailed Excavation Staging Plan and schedule clearly illustrating the method and sequence by which he proposes to stage the excavation, cofferdam and shoring Works in accordance with the Drawings and this Specification.

(2) A detailed Water Control Plan and schedule clearly illustrating the method and sequence by which he proposes to handle dewatering the excavation, groundwater depressurization (if required) and maintaining the stream flow for the duration of the Work in accordance with the Drawings and this Specification.

2001 - 4 MATERIALS

A. Working Base Concrete

The strength of working base concrete shall be a minimum compressive strength of 20 MPa at 28 days.

2001 - 5 CONSTRUCTION METHODS

A. Excavation Requirements

The Contractor shall excavate only material that is necessary for the construction of the structure and shall not excavate outside the limits of excavation shown on the Drawings and in accordance with the following:

(1) EngineerEngineerExcavation for River Piers

Excavation shall be kept to the minimum. The limits of the excavation shall not extend more than 1.0 meter beyond the footprint of the footings.

Excavation for river piers shall be isolated from the watercourse using sheetpiling cofferdams. Sheetpiling cofferdams shall be shored as approved by the Engineer and shall meet the requirements of the Specifications for Temporary Works and the Saskatchewan Occupational Health and Safety Regulations and all other applicable codes and regulations.

B. Cofferdams and Shoring

The Contractor shall construct cofferdams and shoring in accordance with Specification 2000: Temporary Works, the Shop Drawings and as specified herein.

Variations from the Shop Drawings will not be permitted, unless such variations are approved by the Professional Engineer responsible for the design and the Engineer is provided with revised Shop Drawings.

C. Depth of Excavation and Condition of Base

Excavations shall be completed to the elevations and dimensions as shown on the Drawings, or to the elevations directed by the Engineer in the field in order to obtain firm, stable foundations. If the Engineer determines that the required depth of increased excavation exceeds 1.0 meter below the bottom of excavation elevation shown on the Drawings, the additional work shall be done and will be paid for as Extra Work in accordance with the General Provisions.

Neat trenches shall be excavated for footing keys.

Under winter conditions, the Contractor shall remove frost from the base of the excavation and maintain the base and concrete working base in an unfrozen condition until the structural concrete can be placed. Hoarding and heating requirements will then apply as specified in Specifications for Reinforced Cast-In-Place Concrete.

D. Dewatering

Excavations shall be dewatered and maintained dewatered so that the material is excavated in its natural state and construction of the foundations is completed in the dry. The bottom of the excavation shall be kept free from excessive moisture and free-flowing water.

Underwater excavation will not be allowed other than under extreme conditions where the ingress of water from the bottom of the excavation is impossible to stop.

Pumping from the interior of any excavation shall be done so that the water is diverted from the footing base. The level of any water inside of the excavation shall be below the bottom of the footing elevation so that the foundations are placed in the dry. Pumping water from the excavation shall not be discontinued until the substructure unit is completed and backfilled unless otherwise allowed by the Engineer.

Pumping to dewater a sheetpiling cofferdam sealed with tremie concrete shall not commence until the concrete has sufficient strength to withstand the hydrostatic pressure.

The Contractor shall ensure that the point of discharge from surface water pumped from any excavation is a minimum of 25 metres from the edge of a watercourse. The Contractor shall ensure that water discharge onto the vegetated channel bank or any other locations is done so in a manner that does not cause erosion of the ground and prevents water containing sediment from directly entering the watercourse. This shall be done to the satisfaction of the Engineer. Should the Engineer determine additional measures are required, the Contractor shall implement these measures immediately.

E. Maintaining Stream Flow

The Contractor shall maintain uninterrupted flow of water through the site during all stages of construction. The Contractor shall prepare and submit a Water Control Plan to the Rural Municipality a minimum of ten (10) calendar days prior to commencing any work at the site. The Water Control Plan shall clearly illustrate and detail the method, location, size, sequence of operation, and other specific requirements for the measures proposed by the Contractor to handle and provide for the uninterrupted flow of water in the watercourse for the duration of the Work. This operation may include but not be limited to, the complete diversion of the watercourse during construction. Hydraulic requirements for maintaining stream flow will be provided to the Contractor by the Rural Municipality.

The Water Control Plan shall also include specific measures for handling potentially sediment-laden water from excavation dewatering and groundwater depressurization activities to ensure that the turbid water is not discharged directly into the watercourse. These measures may include but not be limited to, the construction and maintenance of settling ponds for the duration of the Work.

F. Concrete Working Base

A concrete working base shall be placed in all excavations. The bottom of the excavation, with the exception of all cut-off trenches and sump pits, shall be covered with a layer of working base concrete having a minimum thickness of 75 mm. The concrete working base shall be placed immediately after the excavation is completed, and the Engineer has approved the depth of the excavation and the character and condition of the foundation material. The concrete shall be as dry as is practicable and shall be tamped and screeded to give a level working platform for setting up forms and placing reinforcing steel. The Contractor shall allow the concrete working base to cure for 24 hours before setting up forms or placing reinforcing steel.

G. Protection of Existing River Banks, Channel and Embankment Slopes

The Contractor shall not disturb the river banks, channel and embankment slopes outside of the excavation limits or beyond the profile shown on the Drawings.

The Contractor will not be allowed to dispose of excavated material within the project limits.

If the Contractor can demonstrate conclusively that there is no alternative to disturbing the banks, slopes, or channel, permission may be granted by the Engineer provided that the Contractor shall be responsible for restoring the banks, slopes and channel to the original profile and compaction at his own expense.

H. Excavated Material

Excavated material to be reused as backfill material shall be stockpiled within a suitable area approved by the Engineer. Examples of unsuitable areas include, but are not limited to, the following:

(1) In the flood plain;

(2) On the edge of an embankment creating slope stability issues; or

(3) Locations impeding sight lines of the travelling public through or around the site.

Excavated material that is unsuitable for, or surplus to, the backfill requirements, or any other debris within the construction limits, shall become the property of the Contractor and shall be removed from the project limits immediately. During freezing weather, the excess material shall be disposed of before it freezes.

2001 - 6 QUALITY CONTROL / QUALITY ASSURANCE

A. Quality Control

After each excavation is completed, the Engineer will inspect the base of the excavation before any further work can proceed. The Engineer can order test pits, test drilling, further excavation or other work as is necessary to obtain firm, stable foundations. The Contractor shall allow the Engineer unhindered access to the excavation and shall assist the Engineer in completing additional testing, drilling or any other work deemed necessary.

2001 - 7 MEASUREMENT

A. Structural Excavation

Structural excavation will be paid for on a lump sum basis, and no separate measurement will be made for this work.

Supplying, placing, compacting, finishing and heating the concrete working base will be considered incidental to the excavation and no separate measurement will be made of this work.

B. Water Control

Water control required to complete the Work will be considered incidental to the structural excavation and no separate measurement or payment will be made for this Work.

2001 - 8 PAYMENT

Structural excavation will be paid for at the Contract Lump Sum Price for "Structural Excavation", measured as specified herein, and will be payment in full for performing all operations herein described and all other items incidental to the Work.

2002 – SUPPLYING AND PLACING BACKFILL

2002 - 1 DESCRIPTION

This specification describes the terms and conditions applicable to the following.

(1) Processing, loading, hauling, unloading, placing and compacting backfill material;

(2) Protecting backfill material from freezing;

(3) The quality control (QC) testing of all backfill material; and

(4) Payment of royalties.

The quantity for supplying and placing backfill will be increased to include the quantity of additional backfill material required because of additional excavation to remove poor soils as described in Specification 2001: Structural Excavation.

This specification details the responsibilities of the Contractor.

2002 - 2 REFERENCES AND RELATED SPECIFICATIONS

All reference standards and related specifications shall be current issue or latest revision at the first date of tender advertisement.

A. Related Specifications

- National Building Code and the Canadian Construction Safety Code.
- ASTM D698 for Standard Proctor Density
- Specification 2001: Structural Excavation
- Specification 2011: Quality Control of Granular Backfill

2002 - 3 MATERIALS

A. General

All material used for backfill, including non-granular material, shall meet the following specifications and shall be of a quality acceptable to the Engineer. All backfill material shall be in a thawed state when placing and compacting, and be free from rocks, large or frozen lumps, wood, or other unsuitable material.

B. Types of Backfill

Backfill material shall conform to one of the following types:

(1) Type 1 –Backfill

Sieve Size	% Passing Standard Sieve	
	Granular	Limestone
37.5 mm	100	100
25.0mm	85 – 100	85 – 100
4.75 mm	25 – 80	25 – 80
4.25 mm	15 – 40	15 – 35
75 µm	8 – 18	0 - 10
Min. Crush Count	15%	-
Max. Los Angeles Abrasion Loss	40%	32%
Max. Shale Content	20%	-

(2) Type 2 – Coarse Granular Backfill

Sieve Size	% Passing Standard Sieve
53 mm	100
26.5 mm	60 – 85
13.2 mm	20 – 45
6.7 mm	0 - 3

(3) Type 3 – Non-Granular Cohesive Material

Non-granular material shall be non-organic soil such as clay. The material shall be free of rocks and stones.

2002 - 4 CONSTRUCTION METHODS

A. General

The Contractor shall backfill the excavated areas with the specified type of backfill material, unless otherwise directed by the Engineer, to the elevation of the ground surface existing immediately prior to the start of excavation or to the elevations specified on the Drawings. Backfill material shall be placed in accordance with the Drawings, this Specification, and to the satisfaction of the Engineer.

Backfill material shall be stockpiled within an area approved by the Engineer and in accordance with all applicable rules and regulations of governmental authorities.

During freezing weather, the Contractor shall protect all backfill material from freezing until it is placed to the satisfaction of the Engineer.

B. Granular and Coarse Granular Backfill

The granular backfill shall be placed in layers not to exceed 150 mm in depth and each layer shall be thoroughly compacted by means of packers or mechanical tampers to a relative compaction of not less than 95% Standard Proctor Density for the backfill material at optimum moisture content.

C. Non-Granular Cohesive Backfill

Cohesive backfill shall be deposited in horizontal layers not exceeding 200 mm in thickness. Every layer shall be tamped in place and well compacted by means of mechanical tampers before the next layer is deposited to a relative compaction of not less than 95% Standard Proctor Density for the backfill material at optimum moisture content.

In the event that local non-granular cohesive material is deemed unsuitable by the Engineer, the Contractor shall supply non-granular cohesive material approved by the Engineer.

D. Backfilling for Culverts, Abutments and Piers

Special precautions shall be taken to prevent wedging action against abutments or retaining walls.

Unless permitted by the Engineer, backfill shall not be placed against any concrete structure within a distance of 1.0 meter until the concrete has reached minimum 80% of the 28 day design strength.

2002 - 5 QUALITY CONTROL / QUALITY ASSURANCE

A. General

The Contractor shall submit a sample of the backfill material and test results fourteen (14) days prior to beginning backfilling operations.

B. Quality Control

The Contractor shall be responsible for all quality control testing and shall:

(1) Pay costs for required testing due to results indicating defective materials or workmanship regardless of the results of retesting.

(2) Tests are to be performed in accordance with ASTM D698 for Standard Proctor Density.

(3) Testing of compacted fill materials will be performed by an independent inspection and testing firm appointed and paid by the Contractor. Testing will be performed so as to least encumber the performance of work.

(4) Notify the Engineer when work of this Specification or portions of work are completed to own satisfaction. Do not proceed with additional portions of work until test results have been verified and approved by the Engineer.

(5) During work tests, if tests indicate that compacted materials do not meet specified required materials, remove defective work, replace and re-test at own expense; as directed by the Engineer.

(6) Ensure compacted fills are tested and approved before proceeding with placement of surface materials.

C. Quality Assurance

The Engineer, at his discretion, may complete random quality assurance testing on all materials incorporated into the Work. The Contractor shall allow the Engineer unhindered access to the materials and shall assist the Engineer in carrying out any sampling or testing, including the provision for necessary traffic control, suitable access and storage.

2002 - 6 MEASUREMENT

Supplying and placing all backfill material will be paid for on a Lump Sum Basis and no measurement will be taken for this Work.

Any heating and hoarding required to complete the work will be considered incidental to the backfilling and no separate measurement or payment will be made for this work

2002 - 7 PAYMENT

Supplying and placing all backfill will be paid for at the Contract Lump Sum Price for "Supplying and Placing Backfill Material", measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

2003 - SUPPLYING AND DRIVING STEEL BEARING PILES

2003 - 1 DESCRIPTION

This specification describes the terms and conditions applicable to the following.

(1) Supplying, handling, hauling, storing, aligning and driving steel bearing piles;

(2) Cutting off piles at the required elevations;

(3) Pre-boring of piles, if applicable;

(4) Splicing piles, if deemed necessary by the Contractor; and

(5) Supplying and installing pile tips, if shown on the Drawings or deemed necessary by the Contractor.

This specification details the responsibilities of the Contractor.

Steel bearing piles, steel "H" piles, and "H" Piles shall be considered one and the same for the Drawings and this Specification.

The Contractor shall be responsible for supplying piling of sufficient length to obtain the penetration and bearing value identified on the Drawings and in the Geotechnical Report. For the purpose of determining the length of piles required, the Contractor may, at his own expense, drive test piles, complete borings or make other such other investigations as deemed necessary.

2003 - 2 REFERENCES AND RELATED SPECIFICATIONS

All reference standards and related specifications shall be current issue or latest revision at the first date of tender advertisement.

A. References

- CAN/CSA G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steel
- CSA W59, Welded Steel Construction (Metal Arc Welding)

- AASHTO/AWS D1.5M/D1.5 Bridge Welding Code

B. Related Specifications

- Specification 2004: Dynamic Testing of Piles
- Specification 2007: Supply, Fabrication and Erection of Miscellaneous Metal

2003 - 3 SUBMITTALS

The Contractor shall submit the following to the Engineer:

(1) Copies of Mill Test Certificates showing chemical analysis and physical tests for piling material. Piling material without this certification will be rejected.

(2) Manufacturer's specifications and catalogue for all mechanical hammers to be used.

(3) Certificate of mass for gravity or drop hammers. If this certificate is not available, the gravity or drop hammers shall be weighed in the presence of the Engineer. Hammers so weighed shall have the exact mass marked on them. Gravity hammers shall weigh at least 1.5 ton but in no case shall the mass of the hammer be less than the combined mass of the pile and pile cap.

(4) Proof of certification for the welders conducting the Work (if applicable). All welders shall satisfy one of the following requirements:

(a) Welders qualified in accordance with the requirements of AASHTO/AWS D1.5M/D1.5,

(b) Valid Canadian Welding Bureau (CWB) Welding ticket, or

(c) Valid "Welder's Licence" as issued by the Province of Saskatchewan, with a minimum of 5 years of experience welding on steel structures.

(5) Welding procedures specific to the Work (if applicable).

(6) Detailed design notes and Shop Drawings for proposed splice connections and pile tip installations that are sealed, signed and dated by a Professional Engineer licensed to practice in the Province of Saskatchewan.

2003 - 4 MATERIALS

A. Steel Bearing Piles

Steel bearing piles shall conform to the requirements of CAN/CSA G40.21M, Grade 300W.

All piles crushed excessively or bent through negligence or carelessness in driving operations shall be replaced by the Contractor at his own expense unless, at the discretion of the Engineer, the damage is so slight that the pile can be repaired properly by the Contractor at his own expense.

B. Pile Tips

Pile tips shall conform to the requirements of CAN/CSA G40.21M, Grade 300W.
Pile tips must be Pruyn HP-75750, HP77750 manufactured by Pruyn or HPP-S-12 manufactured by Titus Steel Co. Ltd. and shall be to the satisfaction of the Engineer. Any other pile tips will be subject to approval by the Engineer.

C. Splice Plates

Splice Plates shall conform to the requirements of CAN/CSA G40.21M, Grade 300W.

D. Welding Materials

The Contractor is responsible for supplying all welding materials. All welding materials shall conform to the requirements of Specification 2007: Supply, Fabrication and Erection of Miscellaneous Metal.

2003 - 5 CONSTRUCTION METHODS

A. Handling and Storage

Piling shall be handled, hauled and stored in a manner that avoids damage to the piling materials. Loading and unloading shall be by crane, loader or other appropriate hoisting equipment.

The Contractor, in the handling and lifting of the piles, will not be permitted to drag them along the ground.

If piles are damaged due to the Contractor's handling operations, the Contractor shall, at his own expense, replace all damaged piles with piles meeting the requirements of this Specification and as shown on the Drawings.

B. Location and Alignment

The piles shall be driven in the positions shown on the Drawings or as directed by the Engineer. Piles shall be driven vertically unless shown otherwise on the Drawings, and shall not deviate more than 2 percent out-of-plumb. Batter piles shall be driven to the batter specified, and shall not deviate more than 2 percent from the batter specified. Piles shall not be more than 75 mm off center measured at cut-off elevation.

Piles shall not be jacked or pulled into their final positions.

C. Driving Steel Bearing Piles

Piles shall be driven to the depths and in accordance with the pile driving criteria indicated in the Geotechnical Report, on the Drawings or as directed by the Engineer. The Contractor shall remove any surface and/or shallow depth obstructions to obtain the required penetration of the piles.

Pile driving equipment to be used by the Contractor shall be of such capacity that the required bearing and penetration shall be obtained without damage being done to the piles. Driving of all piles shall be continuous and without interruption until the pile has been driven to cut-off elevation or the refusal criteria has been met.

If the Contractor can demonstrate conclusively that special methods, other than providing a higher capacity hammer, are necessary to advance the pile to the required penetration, such supplementary methods will be subject to the Engineer's approval and will be paid for as a Change in Work in accordance with the General Provisions.

Pile driver leads shall be used to support the piles while they are being driven and shall be braced to the supporting crane so as to hold the piles securely and accurately in the required position during driving. Leads shall be of sufficient length to be supported firmly on the ground. The use of hanging or swinging leads will not be allowed unless they can be held in a fixed position during the driving operations. Batter piles shall be driven with inclined leads.

The heads of steel bearing piles shall be squared and protected by a cap of a design approved by the Engineer. The cap shall be designed to hold the axis of the pile in line with the axis of the hammer. The top of the cap shall have a timber shock block.

The Contractor shall drive all piling in the sequence as shown on the Drawings or specified by the Engineer to minimize pile upheaval. If upheaval does occur, the Contractor shall re-drive the lifted piles to the specified elevations. The Contractor shall excavate material that has boiled up during pile driving operations. The elevation of all piles previously driven or redriven shall be confirmed to detect uplift. If uplift of 5 mm or more occurs in any pile, that pile shall be redriven to its original elevation and thereafter to the required final driving resistance. If cavities remain around the piles after driving, the cavities shall be filled with sand or other approved material to the satisfaction of the Engineer.

The Contractor shall ensure the safety of all personnel during pile driving operations. In particular, overhead protection shall be provided for all personnel located adjacent to the pile driving lead and under the pile driving hammer. The overhead protection shall be designed and constructed so as to safely withstand forces from falling debris or other matter.

Pre-boring will not be allowed unless it is specified in the Geotechnical Report, on the Drawings or approved in writing by the Engineer.

D. Pile Cut-Offs

The piles shall be cut off level at the required elevations as specified on the Drawings or as directed by the Engineer.

E. Splicing Piles and Installing Pile Tips

The Contractor shall splice piles and install pile tips in accordance with the Drawings, welding procedures, Shop Drawings and the following:

(1) The butting ends of the driven pile and its extension or the pile and the pile tip shall be cut square to give reasonable bearing between the mating surfaces.

(2) The butting surface shall be bevelled to facilitate a full penetration butt weld. Temporary clamping plates may be used as required.

(3) Before welding over previously deposited metal, the slag shall be removed. This requirement shall apply to successive layers, to successive beads, and to the cratered area when welding is resumed after any interruption.

(4) All butt welds shall have the root of the initial weld arc-air gouged, to sound metal and cleaned by grinding and wire brushing before welding is started from the second side.

(5) Material to be welded shall be preheated in accordance with CSA W59.

(6) The piles shall not have more than one splice per pile unless otherwise approved by the Engineer. The location of the splice(s) shall be approved by the Engineer.

(7) The pile ends to be spliced shall be flame cut using a steel guide to obtain a square and even cut. The bevel cut shall be made at 45°. Splice plates shall be welded to the upper pile before positioning. The upper pile shall then be positioned, and the splice plates welded to the lower pile. Butt welds shall then be completed.

2003 - 6 QUALITY CONTROL / QUALITY ASSURANCE

A. Quality Control

The Contractor shall provide a detailed survey of all of the pile locations for a pile cap (foundation) and provide that to the Engineer prior to cutting off any piles for that pile cap. The Contractor shall replace any piles, or add additional pile(s), for piles that do not meet the following tolerances: +/-2% out of alignment for battered piles, +/-2% out of plumb for vertical piles, and 75 mm off centre of the specified locations. Any modifications required to the pile cap, due to piles out of tolerance or due to required additional piles to compensate for out of tolerance piles, shall be carried out as detailed by the Engineer at the Contractor's own costs.

The Contractor shall replace any piles, or add additional pile(s), to compensate for piles that do not meet the specified refusal criteria. Any modifications required to the pile cap, required due to additional piles, shall be carried out as detailed by the Engineer at the Contractor's own costs.

B. Quality Assurance

All welds will be inspected visually by the Engineer. The Contractor shall allow the Engineer unhindered access to the piling and shall assist the Engineer in carrying out any inspection, including suitable access.

C. Pile Driving Records

(1) The Contractor and the Engineer will keep an independent record of each and every pile driven. The records shall give the date, time, diameter, length, location, type, total depth of penetration, rate of penetration, number of blows per 300 mm, penetration of the last five blows, steam, air or diesel pressure and the kind and size of hammer used in driving. Any unusual phenomena shall be noted and recorded, especially if they indicate possible damage to the pile.

(2) Energy output of driving equipment at the time of final set shall be carefully recorded by the Contractor, along with the final penetration readings, and reported immediately to the Engineer. The required set per blow will be subject to acceptance by the Engineer, showing regard to the specified driving equipment and piles permitted.

2003 - 7 MEASUREMENT

Supplying and driving steel bearing piles will be paid for on a Lump Sum Basis and no measurement will be taken for this Work.

Pre-boring of piles will be considered incidental to supplying and driving steel bearing piles and no separate measurement will be made of this work.

Supplying and installing pile tips will be considered incidental to supplying and driving steel bearing piles and no separate measurement will be made of this work.

Splicing of piles, including the supply of all materials, will be considered incidental to supplying and driving steel bearing piles and no separate measurement will be made of this work.

2003 - 8 PAYMENT

Supplying and driving steel bearing piles will be paid for at the Contract Lump Price for "Supplying and Driving Steel Bearing Piles", measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

2004 – DYNAMIC TESTING OF PILES

2004 - 1 DESCRIPTION

This specification describes the terms and conditions applicable to the following.

(1) The dynamic testing shall be performed to monitor and confirm hammer and driving system performance, assess pile installation stresses and integrity, as well as to evaluate pile capacity. An average of six (6), minimum four (4), dynamic tests shall be performed per structure on piles selected by the Engineer. The number of dynamic tests may be adjusted by the Engineer as test results become available during the project. Minimum 5 days notice is required by the Engineer to arrange for the testing company to conduct the dynamic testing work.

(2) Dynamic testing involves attaching two strain transducers and two accelerometers to the pile approximately 3 pile diameters below the pile head during initial driving and at a convenient location near the pile head during re-strike testing. A cable connects the gauges with the PDA located at ground level and at a safe place near the pile to collect the dynamic measurements. Forms and supporting falsework design Wood or steel forms for all cast-in-place concrete Special forms for architectural concrete formed finished

This specification details the responsibilities of the Contractor.

2004 - 2 REFERENCES AND RELATED SPECIFICATIONS

All reference standards and related specifications shall be current issue or latest revision at the first date of tender advertisement.

A. References

Complete all dynamic testing in accordance with:

- ASTM D-4945-00, “Standard Test Method for High Strain Dynamic Testing of Piles”.

2004 - 3 SUBMITTALS

The Contractor shall submit the following to the Engineer:

(1) At least 5 days prior to driving the test piles, the Contractor shall submit specifications for the pile driving equipment to the Engineer.

2004 - 4 MATERIALS

A. Equipment and Personnel

(1) The dynamic testing work will be carried out using the Contractor's pile driving equipment and the PDA equipment provided by the Dynamic Testing Consultant.

(2) The PDA testing equipment shall conform to the requirement of ASTM D-4945-00, "Standard Test Method for High Strain Dynamic Testing of Piles". An engineer with documented experience shall operate the PDA in the field. An engineer with at least five years related experience shall carry out the analysis of the PDA data and sign the engineering reports.

(3) The Contractor shall provide the pile driving equipment, operators, labor and power supply to the test pile locations for the duration of the dynamic testing. The Contractor shall provide a step ladder or other safe lifting means to enable attachment of cables to the pile head. The pile driving equipment shall be the same as that to be used for the pile driving work. The power supply shall consist of a regular power source (line power or portable generator) providing 1,800 watts of 115 volt AC power with a frequency of 60 Hz. Direct current welders or non-constant power sources are unacceptable.

2004 - 5 CONSTRUCTION METHODS

A. Construction Access

(1) Prior to lifting the pile to be dynamically tested, the Contractor shall provide a minimum of 1 m of clear access around the pile head for pile preparation. The Dynamic Testing Consultant shall then drill and prepare holes for gauge attachment.

(2) The Contractor shall drive the pile to the depth identified by the Dynamic Testing Consultant, whereupon the Dynamic Testing Consultant shall attach the gauges to the pile. Driving shall then continue using routine pile installation procedures. When the level of the gauges is within 0.3 m of the ground surface, water surface, or a pile template, driving shall be halted to remove the gauges from the pile. If additional driving is required, the

pile shall be spliced and the gauges shall be reattached to the head of the extension pile segment prior to the resumption of driving.

(3) The Contractor must take good care to ensure that no damage is done to the dynamic monitoring transducers, cables, or equipment.

B. Testing Procedures

(1) Preconstruction Wave Equation Analyses

a) After the Contractor had submitted specifications for the pile driving equipment to the Engineer. The Dynamic Testing Consultant shall use the submitted information to perform wave equation analysis and shall prepare a summary report of the wave equation results. The wave equation analyses shall be used to assess the ability of the proposed driving system to safely install the pile to the required capacity and/or desired penetration depth within the allowable driving stresses.

b) Approval of the proposed driving system by the Engineer shall be based upon the wave equation analyses indicating that the proposed driving system can drive the pile to achieve the required static pile capacity of at least 2.0 times the pile design capacity at a driving resistance not greater than 15 blows per 25 mm penetration, within allowable driving stress limits for the pile material.

−hall bum allowable driving stresses (tension and compression) for Steel Piles:

= 0.90 fy

c) A new pile driving system, modifications to existing system, or new pile installation procedures shall be proposed by the Contractor if the results of the wave equation analysis indicate that the required capacity is not achieved, excessive blows are required (i.e., greater than 15 blows per 25 mm) or driving stresses exceed the maximum allowable limits.

(2) Dynamic Testing Program

a) Approximately two days before the pile evaluation work is to be undertaken the Contractor and Engineer shall meet on-site to select the piles that will be evaluated. The selected piles shall be driven to attain static capacity of at least 2.0 times the pile

design capacity. Adjustments to the preliminary driving criteria may be made by the Engineer based upon the dynamic testing results. All or part of the tested piles as determined by the Engineer shall be restruck with dynamic testing after a waiting period of one to two weeks or longer, as directed by the Dynamic Testing Consultant, to evaluate the setup effect on pile capacity. The recommended setup waiting period will be determined from this testing program.

b) The re-strike driving sequence shall be performed with a warmed up hammer and shall consist of striking the piles for about 10 blows or until the pile penetrates an additional 50 mm, whichever occurs first.

c) For cast-in-place piles the PDA test should be conducted at least one week after the installation of the pile, as directed by the Dynamic Testing Consultant.

d) The piles selected for testing should be representative of other piles in the same structure. Where driven piles exhibit lower driving resistance and/or shorter penetrations than normal, or where cast in place piles experience extraneous soil, groundwater and/or installation conditions, additional tests over and above minimum number of tests specified earlier may be required. Further, additional tests should accompany changes in piling equipment, procedure and pile requirements.

C. Dynamic Testing Reports

(1) Within one day of pile testing the Dynamic Testing Consultant shall prepare a hand written daily field report summarizing the dynamic testing results. As a minimum, the daily reports shall include the calculated driving stresses, transferred energy, and estimated pile capacity at the time of testing. Variations from previous trends in the dynamic test data shall also be noted. Daily field reports shall be faxed or emailed to the Engineer.

(2) The Dynamic Testing Consultant will provide initial drive recommendations - blows per 0.25 m - that will achieve the desired capacities as indicated on the Drawings.

(3) The Dynamic Testing Consultant shall prepare and submit a written report not later than 7 days after the test completion. This report shall include the results of dynamic test(s) and shall contain a discussion of the pile capacity obtained from the dynamic testing. The report shall also discuss hammer and driving system performance, driving stress levels, and pile integrity. CAPWAP analyses shall be performed on dynamic testing data obtained from the end of initial driving and the beginning of re-strike of all tested piles or

as instructed by the Engineer. CAPWAP analyses shall be performed by an engineer with demonstrated experience.

(4) The Dynamic Testing Consultant will provide final drive recommendations - blows per 0.25 m - that will achieve the desired capacities as indicated on the Drawings.

(5) The Engineer may request additional analyses at selected pile penetration depths.

(6) All reports, daily and final, to be submitted to the Engineer for review.

2004 - 6 MEASUREMENT

Dynamic Testing of Piles will be considered incidental to Supplying and Driving Steel Bearing Piles and no separate measurement will be made of this work.

2005 - REINFORCED CAST-IN-PLACE CONCRETE

2005 - 1 DESCRIPTION

This specification describes the terms and conditions applicable to the following.

(1) Supplying of materials and the mixing and placing of reinforced cast-in-place concrete as shown and described on the Drawings and in this Specification, including placing, vibrating, finishing and curing;

(2) Supplying, fabricating, constructing, maintaining and removing temporary works, including falsework and formwork;

(3) Heating and cooling concrete, if necessary;

(4) Developing concrete mix design(s) that meets the performance requirements, including trial batches;

(5) The quality control (QC) testing of all materials; and

(6) Supplying and installing water seals and joint fillers (when applicable).

This specification details the responsibilities of the Contractor.

A. "Performance" Alternative

Concrete supplied under this Specification will be specified in accordance with the "Performance" alternative in Table 5 of CSA A23.1, with the exception that the Contractor shall submit the proposed concrete mix design(s) identifying the exact proportions of all constituent materials by mass or volume.

The Contractor shall:

(1) Work with the Supplier to establish the concrete mix properties to meet the performance criteria for the plastic and hardened concrete.

(2) Submit documentation to the satisfaction of the Engineer demonstrating that the proposed mix design(s) will satisfy the strength, durability, and performance requirements.

(3) Prepare and implement a quality management plan to ensure that the Rural Municipality's performance criteria will be met and submit documentation demonstrating the Rural Municipality's performance requirements have been met.

(4) Provide certification from a Professional Engineer registered or licensed to practice in Skaskatchewan that the concrete plant, equipment, and truck mixers comply with the requirements of CSA A23.1 and this Specification.

(5) Certify that all materials to be used in the concrete comply with the requirements of CSA A23.1 and this Specification.

(6) Certify that the concrete mix design(s) satisfy the requirements of CSA A23.1 and this Specification.

(7) Certify that the production and delivery of concrete will meet the requirements of CSA A23.1 and this Specification.

(8) Certify that the concrete complies with the performance criteria specified.

(9) Ensure that the concrete supplier prepares and implements a quality control plan to ensure that the Rural Municipality's and the Contractor's performance criteria will be met.

B. Rural Municipality's Performance Criteria

The Rural Municipality's basic performance criteria are provided in this Specification and identified on the Drawings.

C. Contractor's Performance Criteria

The submission shall include the Contractor's performance criteria for each mix design including:

- Placeability (i.e. pumping, buggies, truck chute, etc.);
- Workability;
- Proposed slump and slump retention time; and

- Set time.

2005 - 2 REFERENCES AND RELATED SPECIFICATIONS

All reference standards and related specifications shall be current issue or the latest revision at the date of tender advertisement.

A. References

- CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete
- CAN/CSA A3001, Cementitious Materials for Use in Concrete
- CSA G30.14, Deformed Steel Wire for Concrete Reinforcement
- CAN/CSA G30.18, Billet-Steel Bars for Concrete Reinforcement
- CAN/CSA G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steel
- CAN/CSA G164, Hot Dip Galvanizing of Irregularly Shaped Articles
- AASHTO T 176, Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test Nineteenth Edition
- ASTM C 29, Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
- ASTM C 40, Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
- ASTM C 42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
- ASTM C 70, Standard Test Method for Surface Moisture in Fine Aggregate
- ASTM C 88, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
- ASTM C 117, Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
- ASTM C 127, Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
- ASTM C 128, Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
- ASTM C 131, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- ASTM C 136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
- ASTM C 138, Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete

- ASTM C 142, Standard Test Method for Clay Lumps and Friable Particles in Aggregates
- ASTM C 260, Standard Specification for Air-Entraining Admixtures for Concrete
- ASTM C 289, Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
- ASTM C 295, Standard Guide for Petrographic Examination of Aggregates for Concrete
- ASTM C 309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
- ASTM C 457, Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete
- ASTM C 494, Standard Specification for Chemical Admixtures for Concrete
- ASTM C 535, Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- ASTM C 586, Standard Test Method for Potential Alkali Reactivity of Carbonate Rocks as Concrete Aggregates (Rock-Cylinder Method)
- ASTM C 1017, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
- ASTM C 1064, Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
- ASTM C 1084, Standard Test Method for Portland-Cement Content of Hardened Hydraulic-Cement Concrete
- ASTM C 1202, Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
- ASTM C 1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
- ASTM C 1583, Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)
- ASTM C 1602, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
- ASTM D 75, Standard Practice for Sampling Aggregates
- ASTM D 516, Standard Test Method for Sulfate Ion in Water
- ASTM D 4791, Standard Test Method for Flat Particles, Elongated Particles or Flat and Elongated Particles in Coarse Aggregate
- ASTM D 5821, Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
- ASTM D 6928, Standard Test Method for Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
- ASTM D 7428, Standard Test Method for Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus

B. Related Specifications

- Specifications for Supplying and Placing Concrete Reinforcement
- Specifications for Temporary Works

2005 - 3 SUBMITTALS

The Contractor shall submit the following to the Engineer:

(1) Copies of Mill Test Certificates showing chemical analysis and physical tests for piling Concrete mix design(s) that meets the minimum performance criteria for the various types of concrete(s) as shown on the Drawings and specified in this Specification. The concrete mix design shall be sealed, signed and dated by a Professional Engineer registered or licensed to practice in the Province of Saskatchewan. Any changes to the concrete mix design(s) shall be reviewed by the Engineer prior to the Contractor implementing the change.

The concrete mix design(s) for the required type(s) of concrete shall specify the following:

(a) Cementitious content in kilograms per cubic metre or equivalent units for each type of cementitious material.

(b) Designated size, or sizes, of aggregates, and the gradation.

(c) Aggregate source location(s).

(d) Weights of aggregates in kilograms per cubic metre or equivalent units. Mass of aggregates is saturated surface dry basis.

(e) Maximum allowable water content in kilograms per cubic metre or equivalent units and the design water/cementitious ratio.

(f) The limits for slump.

(g) The limits for air content.

(h) Quantity in millilitres per cubic meter or equivalent units and brand name for each type of admixture.

(i) Certification that all concrete constituents are compatible.

(j) Certification that the concrete mix(es) will meet the specified concrete performance criteria requirements.

The intended method of placement shall be taken into consideration in the development of the concrete mix design(s) as concrete to be pumped must be designed accordingly.

Any change in any one of the constituent materials of the concrete shall require a new concrete mix design. If, during the progress of the work, the mix design is found to be unsatisfactory for any reason, including poor workability, the Contractor shall revise the mix design(s) and submit the proposed changes to the Engineer for review.

The Contractor shall also submit test data showing that the concrete supplied will meet the performance criteria stated in this Specification for each concrete type. At a minimum, the test data shall prove that the minimum compressive strength, flexural strength (Fibre Reinforced Concrete only), rapid chloride permeability, density, air content, temperature and slump of the concrete to be supplied meets or exceeds the performance criteria. All tests shall be based on the concrete samples taken from the point of discharge into the form work. For example, at the concrete chute from the delivery truck if being placed by buggies, or at the end of the pump should the Contractor wish to pump the concrete into place.

Trial batches shall be tested and evaluated for the specified requirements. All specified properties shall be verified in accordance with the test methods specified herein. The trial batching shall be undertaken so that it replicates the actual batching practices and placing procedures at the site. If a concrete pump will be used to place concrete on site, then the concrete used in the trial batches will pass through a pump line equal to the longest pump line required during construction before sampling.

All testing of concrete and concrete constituents by the Contractor shall be done by an independent laboratory certified in accordance with CSA A283 for the appropriate category. As a minimum, the following material test results for the concrete and concrete constituent materials shall also be submitted:

(a) All aggregates shall comply with CSA A23.1, Clauses 4.2.3.1 to 4.2.3.6. Aggregate testing specified in CSA A23.1, Clauses 4.2.3.3, 4.2.3.4, 4.2.3.5.1, 4.2.3.6, 4.2.3.7,

and Tables 10, 11, and the Standard requirements for concrete exposed to freezing and thawing listed in Table 12.

(b) Abrasion and impact testing results for coarse aggregate in accordance with CSA A23.2-16A.

(c) Report on alkali-aggregate reactivity testing, CSA A23.2-27A.

(d) Report on aggregate petrographic examination, CSA A23.2-15A.

(e) Report on chloride ion penetrability test ASTM C 1202 for concrete mixes with a specified exposure class of C-XL or C-1.

(f) Report on the water soluble chloride ion content by mass of cementing material in the concrete, CSA A23.2-4B.

(g) Report on Air Content of Hardened Concrete tested in accordance with ASTM C 457 for all concrete mixes with a specified Category 1 air content.

(2) Concrete materials testing results shall not be more than 12 months old at time of submission, with the exception of CSA A23.2-2A and CSA A23.2-5A which shall not be older than 90 days at time of submission.

Qualified Ready Mix Concrete Supplier (Supplier) that he is proposing to use at least 21 days prior to placing concrete. The Engineer will verify acceptability of the Supplier. Acceptance of the Supplier and the concrete mix design(s) by the Engineer does not relieve or reduce the responsibility of the Contractor or Supplier from the requirements of this Specification.

If the Contractor proposes to use an on-site batch plant, the concrete batching plant shall be calibrated and certified in accordance with CSA A23.1 (latest edition).

The Contractor shall provide evidence that scales and calibrated weights have been certified for the current calendar year by the Weights and Measures Services of the Government of Canada before the scales will be accepted for use.

Where the scale has not been certified for the current calendar year, the Engineer may test the scale using procedures specified by Weights and Measures Inspection Services and approve the scale for use on the project.

(3) Detailed design notes, calculations and Shop Drawings for any temporary works, including falsework, formwork and hoarding, that are sealed, signed and dated by a Professional Engineer registered or licensed to practice in the Province of Saskatchewan. Shop Drawings are to be submitted to the Engineer prior to the Contractor proceeding with the work. Shop Drawings shall not be required for any temporary works that will be erected to a height less than 1.5 metres.

For timber falsework, formwork and hoarding, 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 and support members.

(4) A concrete pour plan for review and discussion at the first pre-pour meeting. The concrete pour plan shall be submitted to the Engineer three weeks prior to the first scheduled pour. As a minimum, the concrete pour plan shall identify the following items for each type of concrete:

(a) Type and class of concrete including specific reference to high performance or mass concrete where applicable;

(b) Compressive strength, slump and air content of concrete;

(c) Quality control plan identifying type and frequency of tests, as well as an action plan for dealing with non-conformances;

(d) Method of placement and any special considerations such as the requirement for use of high range water reducing admixtures (superplasticizers);

(e) Sequencing requirements for placement of concrete in walls or substructure units with heights in excess of 2.0 metres and lengths in excess of 20 metres;

(f) Formwork and shoring requirements;

(g) Temperature control requirements (ambient and concrete); and

(h) Any other pour-specific items that the Contractor or Engineer may need to address to ensure the successful completion of the pour

(5) A temperature management plan for all mass concrete. Mass concrete is defined as all structural concrete components or portions thereof with minimum dimensions of 1.0 metres or more in all three directions. The temperature management plan shall include the following minimum requirements for monitoring the ambient and concrete temperatures of each mass concrete pour:

(a) Thermocouple groupings that consist of three thermocouples installed at 1.0 metre below the top of the mass concrete component. The individual thermocouples shall be installed at the following depths:

i. Mid-depth,

ii. Inside face of the exterior mat of vertical reinforcement, and

iii. Within 10 mm of the concrete surface.

(b) Thermocouple groupings shall be installed at the following locations:

i. One group of thermocouples at mid-length in the pour for mass concrete components less than 20 metres in length;

ii. Two groups of thermocouples at third points in the pour for mass concrete components from 20 to 45 metres in length;

iii. Three groups of thermocouples at quarter points in the pour for mass concrete components greater than 60 metres in length;

(c) Thermocouple readings to monitor and record temperatures as per the following:

i. At completion of the pour,

ii. At one-hour intervals for the first 4 hours after completion,

iii. At four-hour intervals from 4 to 24 hours after completion,

iv. At daily intervals from 1 to 7 days after completion.

(d) Thermocouple readings (or calibrated thermometer) to monitor and record ambient temperatures adjacent to the top and side surfaces of the mass concrete at thermocouple group locations.

(6) Copies of all material quality control test results.

2005 - 4 MATERIALS

A. General

The Contractor is responsible for the supply, storage and handling of all materials set forth in this Specification. Materials are to be obtained from the same source of supply or Manufacturer for the duration of the contract. Storage of materials shall conform to CSA Standards A23.1 and A23.4.

Materials susceptible to frost damage shall be protected from freezing.

B. Materials Supplied by the Engineer

The following materials will be supplied by the Engineer:

(1) Benchmark plug(s), and

(2) Identification plaque and cadmium plated screws.

C. Concrete

The Contractor shall design and be responsible for the performance of all concrete mixes supplied under this Specification. Concrete shall be designed for the properties and exposure classes shown on the Drawings and as specified in this Specification.

Concrete shall meet the requirements for hardened concrete as specified in the following Table.

Table 4.1: Performance Requirements for Reinforced Cast-In-Place Concrete

Type of Concrete	Minimum Compressive Strength at 28 Days [MPa]	Class of Exposure	Air Content Category	Minimum Post-Cracking Residual Strength Index	Special Requirements
Substructure					
Cast-In-Place Piles, Pile Caps & Spread Footings	35	S-1	1		
Pier Shafts, Pier Tops & Abutments (headwalls, wingwalls, backwalls, & retaining walls)	35	C-1	1		
Cast-in-Place Concrete Culverts and All Other Miscellaneous Concrete	35	C-1	1		
Superstructure					
Diaphragms, Approach Slabs & Transition Slabs	*35	C-1	1		
Curbs & Barriers	45	C-1	1	0.15	Synthetic Fibres
Deck, Overlay & Sidewalk (Conventional Deck Design)	45	C-1	1	0.15	Synthetic Fibres
Deck, Overlay & Sidewalk (GFRP with External Strapping Design)	45	C1	1	0.25	Synthetic Fibres

* Structural design may require compressive strengths for diaphragms that are greater than the minimum compressive strength noted in this Specification. In these cases, the minimum compressive strength requirement noted on the Drawings shall govern.

The water soluble chloride ion content by mass of cementitious material in the concrete shall not exceed 0.15%.

The temperature of all types of concrete shall be between 10°C and 25°C at discharge. Temperature requirements for mass concrete and concrete containing silica fume shall be between 10°C and 18°C at discharge.

(1) Aggregates

(a) General

All aggregates shall be handled to prevent segregation and inclusion of any foreign substances, and to obtain uniformity of materials. The 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.

If either the coarse or the fine aggregate consists of a blend from more than one source, the aggregate sieve analysis shall show the gradation of the blended aggregates.

The potential for deleterious alkali-aggregate reactivity shall be assessed in accordance with CSA A23.2-14A and CSA A23.2-27A. Current test data evaluating the potential alkali-silica reactivity of aggregates tested in accordance with CSA A23.2-25A is required. Requirements to provide current test data evaluating the potential alkali-carbonate reactivity of aggregates tested in accordance with CSA A23.2-26A will be identified by the Engineer for specific projects.

Petrographic examination of the aggregate shall be done by an experienced petrographer employed by a CSA certified laboratory in accordance with CSA A23.2-15A. The petrographic report shall identify deleterious substances, harmful characteristics, or undesirable components of the aggregate in relation to the specified performance criteria, exposure class, and intended use. The report shall also identify potentially reactive constituents and provide recommendations on appropriate mitigation measures required. The report shall confirm that the aggregate is suitable for the specified performance criteria, exposure class, and intended use. The weighted petrographic number shall not exceed 125 for concrete with a specified exposure class C-XL or C-1. The weighted petrographic number shall not exceed 140 for all other exposure classes.

Alkali-aggregate reactivity and petrographic examination shall be done on a yearly basis.

(b) Coarse Aggregate

The maximum nominal size of coarse aggregate shall be 20 mm and meet the grading requirements of CSA A23.1, Table 11, Group I. Coarse aggregate shall be uniformly graded and not more than 1% 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 fractured faces; and shall have an absorption not exceeding 3 percent.

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.

Coarse aggregate when tested for abrasion in accordance with CSA A23.2-16A or A23.2-17A shall not have a loss greater than 28%.

When the thickness of deck overlay concrete is specified as 50 mm or less, the nominal maximum top size of aggregate shall be 14 mm.

Tests of the coarse aggregate shall not exceed the limits for standard requirements prescribed in CSA A23.1, Table 12, "Concrete exposed to freezing and thawing.

The shale content shall not exceed 0.5% measured by mass of dry coarse aggregate. The combined amount of ironstone, shale, chert, and/or mica shall not exceed 1% by mass of dry coarse aggregate.

(c) Fine Aggregate

Fine aggregate shall meet the grading requirements of CSA A23.1, Table 10, FA1, be graded uniformly and not more than 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.

Tests of the fine aggregate shall not exceed the limits for standard requirements prescribed in CSA A23.1, Table 12.

(2) Admixtures

Air-entraining admixtures shall conform to the requirements of ASTM C 260.

Chemical admixtures shall conform to the requirements of ASTM C 494 for conventional mixes and ASTM C 1017 for flowing concrete.

All admixtures shall be compatible with all other constituent materials. The addition of calcium chloride, accelerators and air-reducing agents, will not be permitted, unless otherwise approved by the Engineer.

Appropriate low range water reducing and/or superplasticizing admixtures shall be used in all concrete containing silica fume.

(3) Cementitious Materials

Cementitious materials shall conform to the requirements of CAN/CSA A3001 and shall be free from lumps. Normal portland cement, Type GU or GUb, or sulphate resistant, Type HS or HSb, shall be supplied unless otherwise specified on the Drawings.

Should the Contractor choose to include a silica fume admixture in the concrete mix design, the substitution of silica fume shall not exceed 8% by mass of normal portland cement. Condensed silica fume shall conform to CAN/CSA A3000 – Cementitious Material Compendium, Type SF, with a SiO_2 content of at least 85%, a maximum of 10% ignition loss and no more than 1% SO_3 content.

Should the Contractor choose to include fly ash in the concrete mix design, the fly ash shall be Class CI and the substitution shall not exceed 25% by mass of normal portland cement. Fly ash shall conform to CAN/CSA A3000 – Cementitious Material Compendium, Class CI.

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.

(4) Water

Water to be used for mixing and curing concrete or grout and saturating the substrate shall be potable, shall conform to the requirements of CSA A23.1 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.

Water of unknown quality shall satisfy the additional requirements listed in Table 9 of CSA 23.1.

(5) Synthetic Fibres

The synthetic fibres for the deck, overlay, sidewalk, curb and barrier concrete shall consist of 100% virgin polypropylene. The dosage shall be designed by the Contractor to meet the requirements for post-cracking residual strength as specified in Section 2005 - 4 - 4C, Table 4.1.

Synthetic fibres will be subject to approval by the Engineer.

D. Formwork

Forms for exposed surfaces shall be made of good quality plywood in "like-new" condition and uniform in thickness, with or without a form liner.

E. Non-Shrink and Non-Metallic Grout

Non-shrink and non-metallic grout must be:

- ST-432 manufactured by Sternson Construction Products
- Sika AnchoFix 3 and 4^{CA} manufactured by Sika Canada Inc.
- CPD two Component Polysulphide/Epoxy Adhesive manufactured by CPD

Any other non-shrink or non-metallic grout will be subject to approval by the Engineer.

F. Insulation

Insulation shall conform to the requirements of CAN/ULC S571, Type 4, minimum compressive strength 275 kPa, 50 mm thick polystyrene or as specified on the Drawings.

Insulation must be:

- Foamular 400 600 manufactored by Owens Corning
- Styrobar 16 and 22 manufactored by AMC Insulation Corp.
- Styrofoam HI-40 HI60 manufactored by DOW Chemical Canada Inc.

Any other insulation will be subject to approval by the Engineer.

G. Curing Compound

Curing compound shall conform to ASTM C 309, Type 1-D with fugitive dye or Type 2 white pigmented, as approved by the Engineer.

Type 2 white pigmented shall only be used on the surfaces of bridge decks, approach slabs, structural slabs, on surfaces that will not be exposed to view, or on surfaces where their use has been approved by the Engineer.

H. Evaporation Reducer

- Confilm manufactured by ChemRex (MBT Protection and Repair)

Any other evaporation reducer will be subject to approval by the Engineer.

I. Architectural Concrete Form Liner

Architectural concrete form liner shall be as specified on the Drawings or as approved by the Engineer.

J. Permeable Formwork Liner

Permeable formwork liner, required for both faces of the concrete barrier faces or as specified on the Drawings, must be:

- Drainoform or Zendrain II

Any other permeable formwork liner will be subject to approval by the Engineer.

K. Preformed Expansion Joint Filler

Preformed expansion joint filler as specified on the Drawings shall be asphalt impregnated fibreboard satisfying ASTM D 1751. Preformed expansion joint filler must be:

- CPD Asphalt Fiber Expansion Joint Filler manufactured by CPD Construction Products

- Flexcell manufactured by Knight-Celotex Fibreboard
- Sealtight Fibre Expansion Joint Filler manufactured by W.R. Meadows
- Sealtight "Snap-Cap" Expansion Joint Cap manufactured by W.R. Meadows

Any other preformed expansion joint will be subject to approval by the Engineer.

L. Preformed Contraction Joint Filler

Preformed contraction joint filler as specified on the Drawings shall be 13 mm thick polystyrene conforming to the requirements of CAN/ULC S571, Type 2, with a minimum compressive strength of 100 kPa. Preformed contraction joint filler must be approved by the Engineer.

M. Flexible Joint Sealant

Flexible joint sealant shall be grey polyurethane sealant. Flexible joint sealant must be approved by the Engineer.

N. Impregnated Expanding Foam Sealant

Impregnated expanding foam sealant must be approved by the Engineer. The Manufacturer's recommended top coat shall be used for traffic bearing applications.

O. Hot Poured Joint Sealer

Hot poured joint sealer must be approved by the Engineer.

P. Water Stops

Water stops shall be as specified on the Drawings or as approved by the Engineer, and shall be the correct grade for the location that they are to be used.

Q. Miscellaneous

Miscellaneous materials shall be as specified on the Drawings or as approved by the Engineer.

2005 - 5 CONSTRUCTION METHODS

A. Supplying Concrete

(1) Pre-Pour Meetings

The Contractor, his on-site construction superintendent and his concrete supplier shall attend the following pre-pour meeting(s) with the Engineer at a mutually agreed upon date(s) to review the concrete pour plan and to discuss general and specific issues affecting the proposed pours:

(a) Two weeks prior to the first scheduled pour on site; and

(b) Two weeks prior to the first scheduled pour using high performance concrete (fibre reinforced) for deck, curbs or barriers (if applicable).

The concrete pour plan may be revised at the request of the Contractor or Engineer based on discussions at the pre-pour meeting. The Contractor shall not proceed until a revised concrete pour plan has been submitted and written approval has been received from the Engineer.

(2) Proportions of Concrete Materials

Coarse and fine aggregate materials shall be separated and measured separately by weighing, except in cases where other methods are approved by the Engineer. The apparatus provided for weighing the aggregates and cement shall be suitably designed and constructed for this purpose. The course and fine aggregate and the cement shall be weighed separately. The accuracy of all weighing devices shall be such that successive quantities can be measured to within one percent of the desired amount. The mixing water shall be measured by volume or by weight and adjusted for retained moisture in the sand. The water measuring device shall be capable of control accurate to ± 0.5% of the design quantity. All measuring devices will be subject to approval by the Engineer. Unless otherwise approved, air entraining agent and other admixtures shall be added to the mix in a water-diluted solution. The dilution of the solution shall meet the Manufacturer's requirements. For mix adjustments at the site, the Contractor shall maintain facilities and equipment to control the amount of superplasticizer and air entrainment so that the required tolerances can be met.

The Contractor shall ensure that all scaling devices have been calibrated within one year. They shall be tested and approved for accuracy prior to the commencement of batching operations. Scaling devices shall be subject to testing by the Engineer at any time. The standard masses used

for the testing of scaling devices shall be supplied to the Engineer. No adjustments to scaling devices shall be made without the Engineer's approval.

When sacked cement is used, the quantities of the aggregates for each batch shall be exactly sufficient for one or more full sacks of cement and no batch requiring fractional sacks of cement shall be permitted.

When ice is used as part of the mixing water, the ice shall be measured by mass. The ice shall be completely melted by the time mixing is completed.

For concrete containing silica fume added separately from the cement, (that is, not a blended cement), the silica fume shall be added to the aggregate with the cement. Silica fume shall not be added to a truck mixer in pulpable bags.

Only trained personnel shall be allowed to introduce admixtures at the jobsite. The Contractor shall submit the proposed procedures for adding admixtures in approved doseages at the jobsite prior to concrete placement.

(3) Mixing Concrete

(a) General

Ready-mix concrete shall be mixed and delivered by one of the following operations:

i. Mixed completely in a stationary mixer and the mixed concrete transported to the point of delivery in a truck agitator or in a truck mixer operating at agitating speed, or

ii. Mixed completely in a truck mixer.

Continuous mixers used in conjunction with volumetric proportioning will not be approved. The use of non-agitating trucks for delivering concrete mixed off-site will not be permitted.

(b) Stationary Mixer

The mixing of concrete shall be done in a batch mixer of a size and type suitable for the intended use. Mobile continuous mixers or other such concrete supply equipment will not be approved for use.

Each mixer and agitator shall have attached by the Manufacturer in a prominent place, a metal plate or plates on which it is plainly marked the various uses for which the equipment is designed, the capacity of the drum or container in terms of the volume of concrete that can be mixed or agitated and the speed of rotation of the mixing drum or blades.

All concrete shall be mixed thoroughly until it is uniform in appearance, with all ingredients uniformly distributed. In no case shall the mixing time per batch be less than one minute for mixers of one cubic metre capacity or less. The “batch” is considered as the quantity of concrete inside the mixer. This figure shall be increased by 15 seconds for each additional half cubic metre capacity or part thereof. The mixing period shall be measured from the time all materials are in the mixer drum.

Stationary mixers shall be equipped with an acceptable timing device that will not permit the batch to be discharged until the specified mixing time has elapsed.

Batches shall be used that do not require fractional bags of cement.

Each batch shall be entirely discharged from the mixer before any of the ingredients for a following batch shall be placed in the drum of the mixer.

All water used for cleaning the inside of the drum of the mixer shall be entirely drained before ingredients for a batch of concrete shall be placed in the drum.

The Contractor shall in no case load the mixer above its rated capacity. The Contractor shall maintain the mixer in good condition. Inner surfaces of the mixer shall be kept free of hardened concrete and mortar. Mixer blades that are bent or worn down so as to affect the mixing efficiency shall be repaired. Any mixer leaking mortar or causing waste of materials through faulty charging shall be taken out of service until repaired. The Contractor shall, at all times, operate the mixer at the speed recommended by the Manufacturer and shall, if requested, supply the Manufacturer's certification of the mixing capacity of the machine in use.

The mixer shall be fitted with an accurate and dependable means for measuring the water added that is not affected by variation in pressure in the water supply line. All joints,

valves and other parts shall be maintained so that there is no leakage of water into the mixer drum. Failure of the Contractor to have an accurately working and dependable water gauge on a mixer shall be cause for the Engineer to prohibit the mixer to be used.

Water shall be released first and continue to flow while the solid materials are entering the mixer. The water discharge pipe shall be so arranged and be of such size that the flow into the mixer is completed within the first quarter of the mixing time, and the water is delivered well within the mixer where it will be quickly mixed with the entire batch.

Air entraining agents and admixtures shall be placed in the mixer after the initial water is in the mixer drum but before the remaining materials are added. Superplasticizer shall be added after initial mixing and as per the Manufacturer's recommendation.

A record of the actual proportions used for each batch shall be kept by the Contractor and a copy of this record shall be submitted to the Engineer after each pour.

The Engineer may, from time to time, make slump tests of individual batches in order to determine the uniformity of the concrete consistency at approximately one-quarter and three-quarter points of the load. If these tests indicate a variation in the slump exceeding 50 mm, the mixer or agitator shall not be used until the condition is corrected.

(c) Truck Mixing

Truck mixers shall be of the revolving drum type, watertight, and constructed so that the concrete can be mixed to ensure uniform distribution of materials throughout the mass. All materials for the concrete shall be accurately measured in accordance with Section 5A(2), and charged concurrently at the proportions that satisfy the approved mix design into the drum at the proportioning plant. Increases in water/cementitious ratio will not be permitted.

The maximum size of batch in truck mixers shall not exceed the maximum rated capacity of the mixer as stated by the Manufacturer and stamped in metal on the mixer. Truck mixing shall commence immediately upon introduction of ingredients into the drum and be continued for not less than 50 revolutions. The speed shall not be less than 4 revolutions per minute (rpm), nor more than a speed resulting in a peripheral velocity of the drum of 70 m per minute. Not more than 100 revolutions of mixing shall be at a speed in excess of 6 rpm.

When adjustment to the mix by adding water, air entrainment or superplasticizer at the site is approved by the Engineer, the mixer shall be run for a minimum of 20 additional revolutions to ensure homogeneity of the concrete before discharge. Adding water on route or on site will not be permitted once the design water content of the mix (w/c ratio) limit has been reached.

Discharge chutes shall be kept clean and free from hardened concrete and shall be wetted down prior to use.

(4) Time of Hauling

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 90 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, this requirement is reduced to 60 minutes.

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 90 minutes may be specified by the Engineer. The Contractor will be informed of this requirement 24 hours prior to the scheduled placing of concrete.

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.

Under no circumstances shall the Contractor add retarders to the concrete mix without first obtaining the written approval of the Engineer.

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.

A record of the actual proportions used for each concrete pour shall be kept by the Supplier and a copy of this record shall be submitted to the Engineer upon request.

(5) Delivery

The Contractor shall satisfy himself that the 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 re-handling, and without damage to the structure or the concrete.

The concrete production facility shall have radio or telephone communication with the placement operation personnel.

(6) Pour Schedules and Sequencing

The Contractor shall provide to the Engineer the proposed pour schedule for all concrete pours. If, in the opinion of the Engineer, the amount of a pour is deemed larger than can be poured with the facilities provided, the Contractor shall either:

(a) Limit the amount to be poured at any time (using adequate construction joints) as approved by the Engineer, or

(b) Augment his facilities and labour and equipment in order to complete the proposed pour, or

(c) In the case of continuous pouring, provide additional crews and have adequate lighting to provide for proper placing, finishing, curing and inspecting.

The Contractor shall adhere strictly to the concrete pouring schedule, if shown on the Drawings.

For monolithic fully formed components, concrete for columns, substructure units, culvert walls, and other similar vertical members shall be placed and allowed to set and settle for a period of time before concrete for integral horizontal members, such as caps or slabs, is placed. The time period shall be adequate to allow completion of settlement due to loss of bleed water and shall be not less than 12 hours for vertical members over 4.5 metres in height, not less than 4 hours for members between 3.0 and 4.5 metres in height, and not less than 2 hours for members between 1.5 metres and 3.0 metres in height. All walls greater than 2.0 metres in height shall be placed in lifts. Concrete placement of the lifts shall be sequenced to ensure that horizontal and/or vertical cold joints do not occur in the concrete.

Concrete shall not be placed in the superstructure until the substructure forms have been stripped sufficiently to determine the character of the supporting substructure concrete.

Concrete for cast-in-place deck girder spans whose depth is less than 1200 mm may be placed in one continuous operation or may be placed in two separate operations; first, to the top of the girder stems, and second, to completion. For cast-in-place deck girder spans more than 1200 mm in depth, the concrete shall be placed in two operations unless the falsework is non-yielding. At least five days shall lapse after placement of stems or the specified concrete strength has been attained before the top deck slab is placed.

For cast-in-place box culverts, the base slab shall be placed and allowed to gain 50% of the design compressive strength before the remainder of the culvert concrete is placed. For culverts with wall heights 1500 mm or less, the sidewalls and top slab may be placed on one continuous operation. For higher culvert walls, the requirements for vertical members described above shall apply.

B. Falsework and Formwork

(1) General

The Contractor shall construct the formwork and falsework in accordance with the submitted Shop Drawings. Variations from the formwork and falsework Shop Drawings will not be permitted unless the Engineer is provided with revised Shop Drawings that have been sealed, signed and dated by the Professional Engineer.

(2) Design

The design, fabrication, erection, and use of concrete formwork shall conform to the requirements of CAN/CSA S269.3 and CSA A23.1.

All forms shall be of wood, metal or other materials as approved by the Engineer, and shall be designed and built mortar-tight. The forms shall be sufficiently rigid to prevent distortion due to the pressure of vibrated concrete and other loads incidental to the construction operations. The forms shall be substantial and unyielding, and shall be designed so that finished concrete will conform to the design dimensions and contours. The shape, strength, rigidity, water tightness and inner surface smoothness of re-used forms shall be maintained at all times. Any warped or bulged formwork shall be not be used. Forms that are deemed unsatisfactory by the Engineer in any respect shall not be used. Form alignment shall be smooth and true to prevent misaligned

edges or corners. Concrete surfaces that are misaligned shall be repaired by the Contractor in a manner acceptable to the Engineer.

All forms shall be oiled or otherwise treated to facilitate stripping.

The tying of forms with wires or welded ties or the driving of bolts or nails by hand or by power tools into exposed and finished concrete surfaces will not be permitted.

For narrow walls and columns, where the bottom of the form is inaccessible, or wherever necessary, removable panels shall be provided in the bottom form panel to enable cleaning out of extraneous material immediately before placing the concrete.

The supporting of formwork on mudsills on the ground will not be permitted.

Falsework shall conform to CSA S269.1, Falsework for Construction Purposes. All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads without appreciable settlement or deformation.

Falsework shall be set to give the completed structure the camber specified on the Drawings, and allowance shall be made for dead load deflection and form crushing.

(3) Forms for Exposed Surfaces

All form material for exposed surfaces shall be full-sized sheets in good condition, and approved by the Engineer. The re-use of any forms shall be approved by the Engineer.

All forms for exposed surfaces shall be mortar-tight, filleted at all sharp corners, and given a bevel or draft in the case of all projections. At the top edges of exposed surfaces, the chamfers are to be formed by chamfer strips. Where fillets have been omitted, the concrete shall be thoroughly worked into the corners of the forms and, upon removal of the forms, the sharp edges of the concrete shall be carefully rubbed down to a 6 mm radius. The form lumber for filleted corners shall be a hard grade lumber which will leave a sharp, straight edge.

Metal bolts or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least 50 mm from the concrete surface. Break-back type form ties shall have all spacing washers removed and the tie shall be broken back a distance of at least 50 mm from the concrete surface. 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 color.

(4) Architectural Concrete Finish Form Liner

The Contractor shall supply and install the architectural concrete finish form liner as shown on the Drawings in accordance with the Manufacturer's recommended procedures.

Single use architectural concrete finish form liner shall be replaced after each use.

(5) Permeable Formwork Liner

The Contractor shall use an approved permeable formwork liner for all areas shown on the Drawings. The permeable formwork liner shall be replaced after each use unless otherwise approved by the Engineer.

(6) Removal of Falsework and Formwork

All formwork and falsework must be removed from the completed structure. Formwork and falsework shall not be removed without the approval of the Engineer.

The minimum period during which forms and supports for concrete structures must remain in place are listed in the following Table and are defined either by the "Time" or the "Strength" requirements. The time requirement is based on a minimum average concrete curing temperature of 15ºC. The strength requirement refers to the minimum strength of field cured cylinders as a percentage of the specified 28 day compressive strength.

Table 5.1: Minimum Requirements for Removal of Formwork, Placement of Superimposed Vertical Loads, and Placement of Backfill

Structural Element	Removal of Formwork		Placing Superimposed Vertical Dead Loads*		Placement of Backfill	
	Time (days)	Strength (% f'c)	Time (days)	Strength (% f'c)	Time (days)	Strength (% f'c)
Deck Slab and Diaphragms	7	50	14	85	n/a	n/a
Pier Soffits	14	50	14	85	n/a	n/a
Footing and Pile Cap	3	30	7	50	14	85
Retaining Wall, Headwall and Wingwall	3	30	7	50	14	85
Curb and Traffic Barrier	3	30	7	50	n/a	n/a
Abutment Backwall, Rigid Frame Wall and Box Culvert Walls	3	30	7	50	14	85

* Examples include: placement of column on footing or pile cap, girder on pier or pier cap, etc.

The days noted in the Table above do not include the day of casting the concrete.

In using the Table, consideration shall be given to the location and character of the structure, the weather and other conditions influencing the setting of the concrete, and the material used in the mix. The use of fly ash or set retarding admixtures shall require special consideration and may require additional curing time as specified by the Engineer.

Supports and forms may be removed from substructure units (SU's), diaphragms and traffic barriers earlier than the minimum curing periods specified, provided that the Contractor continues to cure the concrete in accordance with this Specification and the Engineer has granted approval. In seeking approval, the Contractor shall, at his own expense, furnish evidence satisfactory to the Engineer that the strength of the concrete in place has attained the specified percentage of the specified 28-day strength before removal. Removal of forms prior to the minimum curing periods does not remove the Contractor's obligation to cure the exposed concrete for the minimum time periods specified for curing as stated in this Specification. Each day the concrete remains in the forms with wet curing of the top surface at or above the minimum temperature will count towards one day of equivalent curing.

When the Contractor desires cylinder testing for other than 7 and 28 day testing, it shall be the responsibility of the Contractor to supply the field cured cylinders in accordance with CSA A23.1 and A23.2. Field cured cylinders cast for strength testing for form removal shall be cured in the field under the same conditions as the concrete they represent.

The "Strength" and "Time" requirements listed in the Table above are intended only for construction operations indicated and do not apply for the use of heavy equipment (e.g. concrete trucks) or other live loads on the structure. Before this type of loading can be applied to the structure, the field cured cylinder strength shall have attained 85% of the design compressive strength and the concrete shall be at least ten days old. Stockpiling of materials and the use of unauthorized equipment on the structure will not be permitted.

Methods of form removal likely to cause overstressing of the concrete shall not be used. Supports shall be removed in such a manner as to permit the concrete to take, uniformly and gradually, the stresses due to its own weight.

Upon removal of the forms or protection, surface cavity repairs, finishing, and curing of the exposed areas shall begin immediately.

Falsework under all deck spans shall be completely released before forms are constructed and concrete is placed for traffic barriers and curb.

Forms for substructure footings constructed within cofferdams or cribs may be left in place, when, in the opinion of the Engineer, their removal would endanger the safety of the cofferdam or crib, and when the forms so left intact will not be exposed to view in the completed structure or have any long-term detrimental impact to the completed structure.

C. Placing Preformed Expansion Joint Filler

Preformed expansion joint filler shall be installed at the joints indicated on the Drawings and retained in these positions during and after the depositing of concrete.

D. Placing Preformed Contraction Joint Filler

Preformed contraction joint filler shall be installed at the joints in the cast-in-place curb and barriers indicated on the Drawings and retained in these positions during and after the depositing of concrete.

E. Placing Pourable Joint Fillers

Pourable joint fillers shall be placed as detailed on the Drawings and in accordance with Manufacturer's specifications.

Two-component fillers shall be mixed by means of a mechanical mixer. Sand filler, if required, shall be placed by means of a funnel.

The concrete surfaces to which the joint filler is to adhere shall be clean, and when called for on the Drawings, shall be sand-blasted or shot-blasted.

F. Placing Water Stops

Water stops shall be placed at the joints as shown on the Drawings and retained in these positions during and after the depositing of concrete.

G. Placing Hardware and Anchor Bolts

Anchor bolts and hardware shall be placed in accordance with Clause 6.7 of CSA A23.1.

H. Insulation for Concrete Culverts

Insulation shall be placed as shown on the Drawings. For concrete culverts, the insulation shall be placed under the bottom slabs, wingwalls and cut-off walls as well as against the rear vertical face of the cut-off walls.

The insulating material shall be placed uniformly on top of the prepared bedding with the joints in a staggered pattern. The insulation shall be enclosed entirely in 6 mil (0.15 mm) polyethylene and all joints in the polyethylene shall be sealed with polyvinyl tape.

I. Labour Force

(1) General

The Contractor's crew shall include the following workers who are skilled and experienced in placing the type of concrete that they are working with:

- Superintendent;
- Concrete Finishers; and
- Operator of the concrete pump

The Engineer will have the authority to require the replacement of any particular worker not adequately skilled for his assigned task, and the addition of other workers, if necessary.

(2) Night Pouring of Concrete

Night pouring of concrete will not be allowed without the approval of the Engineer. The Contractor shall satisfy the Engineer that sufficient labour and equipment is available to carry out the Work as specified.

J. Handling and Depositing Concrete

(1) General

The Contractor shall give the Engineer a minimum of two days advance notice of a concrete pour date or a change to a pour date.

Concrete placing shall not be started until the Engineer has inspected and approved all forms, foundations, reinforcement, and methods of mixing, conveying, spreading, consolidating, finishing, curing, and protection of the concrete. Concrete shall not be placed at the job site if there is a possibility of damage to the concrete from vibration caused by other operations (ex. Pile driving). As a minimum, the concrete shall be allowed to cure for a period of 3 days from the time the concrete was deposited and has reached 30% of the specified 28 day compressive strength before these other operations can resume.

All equipment proposed for use in mixing, conveying, placing and compacting the concrete shall be approved by the Engineer prior to its use. All the necessary equipment for any particular pour shall be on site and proven to be in working condition before the pour commences, with backup equipment on site as determined by the Engineer. The equipment shall be well maintained, suitable in kind and adequate in capacity for the work.

In preparation for the placing of concrete, all sawdust, chips and other construction debris and extraneous matter shall be removed from the interior of forms. Struts, stays, and braces, serving temporarily to hold the forms in correct shape and alignment, pending the placing of concrete at their locations, shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. These temporary members shall be entirely removed from the forms and not buried in the concrete.

The concrete shall be deposited in a manner meeting with the approval of the Engineer, and the concrete placing shall not begin until the Engineer's approval has been obtained. The Engineer may stop the Contractor from placing concrete in the event of adverse or even threatening adverse weather conditions when, in the Engineer's opinion, these weather conditions may adversely influence the proper placing of the concrete. Concrete placing shall not be permitted when the air temperature is below 5°C or above 30°C or when the surface moisture evaporation rate is in excess of 0.75 kg/square metre per hour as determined by CSA A23.1, Appendix D, "Guidelines for Curing and Protection". The Engineer's decision in this matter will be final.

Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. When placing operations would involve free drop of concrete by more than 1.5 metres, it shall be deposited through metal or other pipes as approved by the Engineer. The use of chutes for the placing of concrete, except those forming a part of standard equipment on ready-mix concrete trucks, will not be permitted.

Concrete for the structure shall be deposited in the forms in the concrete placement sequence shown on the Drawings, and each portion placed between construction joints shall be placed in one continuous operation. No other order of pouring shall be undertaken unless otherwise approved by the Engineer.

The concrete shall be deposited in such frequent locations in the forms that there shall be no necessity for moving large quantities of concrete from place to place within the forms. Any movement of concrete required within the forms shall be done by shovelling and not with mechanical vibrators. The concrete shall be placed in layers not exceeding 600 mm in depth and each layer shall be vibrated by methods that will not permit the ingredients to separate. The Contractor shall provide and use different personnel for shovelling and for vibrating to ensure that each batch of concrete is properly placed and vibrated as it is being deposited.

Whenever possible, the depositing of concrete in each unit of the structure shall be a single continuous complete operation so that each unit shall be a monolith without joints.

Concrete placing operations shall not work off, or transport concrete directly over, concrete already placed, when this concrete is less than 48 hours old, no matter what system of runways, supports or protection is used on the surface of the concrete already placed, if it is subjected thereby to live or dead loads. Concrete more than 48 hours old but of less than the specified 28-day strength shall not be loaded without the approval of the Engineer.

(2) Vibration of Concrete

Concrete shall be compacted thoroughly and uniformly to obtain a dense, homogeneous structure, free of cold joints, fill planes, voids and honeycombing. Formed surfaces shall be smooth and free from large air and water pockets. The concrete shall be well bonded to all reinforcement, hardware anchors, water stops and other embedded parts.

Concrete, during and immediately after depositing, shall be thoroughly consolidated. The consolidation shall be done by mechanical vibration subject to the following conditions:

(a) Internal vibrators shall be used in all sections that are sufficiently large and they shall be supplemented by platform or screed-type vibrators in the event that satisfactory top surfaces cannot be obtained with the internal type alone. The internal vibrators may be supplemented with vibrators operated against the outside of the forms to improve vertical surfaces.

(b) The vibration shall be internal unless special authorization of other methods is given by the Engineer, or the Engineer requests the use of other methods.

(c) Vibrators shall be of a type and design approved by the Engineer. They shall be capable of transmitting vibrations to the concrete at frequencies of not less than 4500 impulses per minute.

(d) The Contractor shall provide a sufficient number of vibrators to properly compact each batch immediately after the concrete has been placed in the forms.

(e) At least one extra vibrator shall be on hand for emergency use.

(f) Vibrator operators shall be suitably instructed in the use of vibrators, and the importance of adequate and thorough vibration of the concrete.

(g) Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and imbedded fixtures and into the corners and angles of the forms. Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted vertically and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, but shall not be continued so as to cause segregation. Vibration shall not be continued at any point to the extent that localized areas of grout are formed. Application of vibrators shall be at points uniformly spaced and not farther apart than the radius over which the vibration is visibly effective.

(h) Vibration shall not be applied directly or through the reinforcement of sections or layers of concrete that have hardened to the degree that the concrete ceases to be plastic under vibration.

(i) Vibration shall not be used to make concrete flow in the forms over distances so great as to cause segregation, and vibrators shall not be used to transport concrete in the forms.

(j) Vibration shall be supplemented by such spading as is necessary to ensure smooth surfaces and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.

(k) Form vibrators shall be attached to the forms in such a manner as to transmit the vibration to the concrete effectively and the vibrators shall be raised in lifts as filling of the forms proceeds. The dimension of each lift shall not be more than the height of concrete visibly affected by the vibration. The form vibrators shall be placed horizontally apart at distances not greater than the radius through which the concrete is visibly affected.

(3) Additional Requirements

When concrete placing is discontinued, for whatever reason, all accumulations of mortar splashed on the reinforcement and the form surfaces shall be removed. Dried mortar chips and dust shall not be mixed into the plastic concrete. If the accumulations are not removed prior to the concrete hardening, care shall be exercised not to injure or break the concrete-reinforcement bond at and near the surface of the concrete, while cleaning the reinforcement.

Re-tempering of partially hardened concrete with additional water will not be permitted.

After initial set of the concrete, the forms shall not be jarred and strain shall not be placed on the projecting ends of reinforcement.

Until initial set has been achieved, concrete shall be protected from the presence of freestanding water on the surface. The Contractor shall take whatever steps may be necessary to prevent free water accumulating on the surface in the event of unexpected rainfall or similar occurrences.

Water used to clean equipment during and at the end of the pour shall be discharged clear of the structure and prevented from entering any watercourse.

(4) Pumping of Concrete

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 the 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.

K. Construction Joints

Constructions joints shall be constructed only as indicated on the Drawings or as shown in the pouring schedule, unless otherwise approved by the Engineer.

The sides of construction joints shall be formed as shown on the Drawings or as directed by the Engineer to produce even and straight lines on exposed concrete surfaces.

The surface of hardened concrete at construction joints shall be thoroughly cleaned. In accordance with CSA A23.1.20.1.3 and 19.5 regarding the bonding of fresh concrete to rock or hardened concrete where the concrete has hardened sufficiently so that the aggregate cannot be loosened from the surface and while the concrete is still soft enough, laitance shall be removed by exposing the surface of the concrete aggregates by either a brisk wire brooming, green cutting water blasting shortly after initial set or by a light bush hammer to expose the tops of the surface aggregate to create a bond acceptable to the Engineer. The surface of the construction joint shall then be kept damp until the new concrete is placed.

Before depositing new concrete on or against concrete that has hardened, the forms shall be re-tightened. To ensure the availability of mortar at the joint between the hardened and the newly deposited concrete, the cleaned and saturated surfaces, including vertical and inclined surfaces, shall first be covered thoroughly with a coating of neat cement grout against which the new concrete shall be placed before the grout has attained its initial set. (i.e grout w/c ratio to match concrete designed mix w/c ratio).

The grout shall have a slump of not less than 150 mm and the concrete placed against this grout shall be well vibrated in order to ensure that the concrete and the grout are intermixed.

At construction joints where concrete is only a few hours old and is still green, and if the surface is not dirty, dry, or covered with an appreciable layer of laitance, it will not be necessary to prepare such a surface before placing new concrete.

When called for on the Drawings, construction joints shall be coated with an epoxy resin in accordance with the Manufacturer's specifications immediately prior to the placing of the fresh concrete. The joint shall be free of all dirt, dust and loose or feathered concrete before the epoxy resin is applied.

L. Cold Weather Precautions

(1) General

When the ambient temperature falls below 5°C or when there is a probability of it falling below 5°C within 24 hours of placing the concrete, the Contractor shall make provisions for heating the water, aggregates and freshly deposited concrete.

(2) Aggregates

Aggregates shall be heated to a temperature of not more than 65°C. For concrete containing silica fume, the aggregate shall not be heated to more than 40°C. The heating apparatus and the housing for the aggregates shall be sufficient to heat the aggregates uniformly without the possibility of the occurrence of hot spots which may burn the materials.

(3) Water

The water shall be heated to a temperature of not more than 65°C. For concrete containing silica fume, the water shall not be heated to more than 40°C.

(4) Concrete

The temperature of the mixed concrete shall not be less than 15°C and not more than 25°C at the time of placing in the forms. Temperature requirements for concrete containing silica fume shall be between 10°C and 18°C at the time of placing in the forms.

(5) Heating Apparatus and Housing for Freshly Placed Concrete

Hoarding enclosures shall be constructed to withstand wind and snow loads and shall be reasonably airtight. The housing shall provide sufficient space between the concrete and the enclosure to permit free circulation of warmed air. The heating apparatus and housing shall be sufficient to enclose and protect the structure in such a way that the air surrounding the fresh concrete is kept at a temperature of not less than 15°C and not more than 25°C for 4 days, not

counting the day on which the concrete was deposited. During the next 3 days, the concrete shall be allowed to gradually cool to a temperature of not less than 5°C with the drop in temperature never exceeding 5°C over an 8 hour period.

The heating apparatus shall be so positioned that there is no direct discharge of heat on the concrete surfaces or form work containing concrete. The relative humidity within the enclosure shall be maintained at not less than 65%.

When the ambient temperature is below -15°C, the housing shall be constructed to allow the concrete to be placed without the housing having to be opened. If the mixing is done outside of the housing, the concrete shall be placed by means of hoppers installed through the housing. The hoppers are to be plugged when not in use.

When the ambient temperature is equal to or above -15°C, the Contractor will be permitted to open small portions of the housing for a limited time to facilitate the placing of the concrete.

Before depositing any of the concrete, the Contractor shall demonstrate that enough heating apparatus is available to keep the air temperature surrounding the forms within the specified range. This shall be accomplished by bringing the temperature inside of the housing to the specified 15°C at least 24 h prior to the start of the concrete placing. The temperature of formwork, reinforcement, previously placed concrete and/or soil shall be at least 10°C prior to the start of concrete placing.

The Contractor shall supply all required heating apparatus and the necessary fuel. When dry heat is used, a means of maintaining atmospheric moisture shall be provided.

Sufficient stand-by heating equipment must be available to allow for any sudden drop in outside temperatures and any breakdowns that may occur in the equipment.

Heating apparatus used to heat the housing shall be of a type that meets Provincial Acts and Regulations. Heating apparatus used in a housing that discharges or releases smoke or gas fumes, shall be adequately ventilated in such a manner as to carry away all such smoke or gas fumes from the housing.

The housing shall provide sufficient clearance to permit the placing of concrete to proceed unhindered. Where required, a housing shall also provide sufficient clearance to allow for the removal of forms in order that the finishing of the exposed concrete surfaces can be completed 3 days before the heating of the inside of the housing is discontinued.

The Contractor shall provide 24 hour surveillance to look after the heating operations. The Contractor shall provide two maximum-minimum type thermometers for each enclosure. The thermometers shall be installed as directed by the Engineer to monitor the temperature of the concrete and the surrounding air during placing and curing. The Contractor shall develop a schedule of temperature monitoring which includes time and temperatures inside and outside of the hoarding. The Contractor shall record the information and provide a copy to the Engineer within 24 hours of every 24 hour period. The methods of heating concrete materials and of maintaining the temperature of deposited concrete shall meet with the approval of the Engineer.

(6) Curing Requirements

Cold weather curing shall be in accordance with Section 2005 – 5L of these Specifications.

Water curing of concrete shall be terminated at least 12 hours before the end of the protection period during periods of freezing weather.

M. Curing

(1) General

Freshly deposited concrete shall be protected from freezing, abnormally high temperatures or temperature differentials, premature drying, excessive moisture, and moisture loss for the period of time necessary to develop the desired properties of the concrete.

(2) Curing Compound

All substructure concrete and culvert concrete with a specified exposure class of C-1 or S-1 shall receive a curing compound membrane covering.

Curing compound with fugitive dye shall be applied to all unformed horizontal and sloping concrete surfaces. The curing compound shall be applied as soon as practical after concrete placing is complete. The application of the concrete curing compound shall be stopped at least 150 mm short of all unfinished areas. Curing compound shall not be used on any construction joints.

The curing compound shall be water based membrane forming and of a type approved by the Engineer. It shall conform to the requirements of ASTM C 309 and be applied as directed by the

Manufacturer. The rate of each application shall not be less than the rate specified by the Manufacturer of the compound.

When curing compound is used, the exposed concrete shall be thoroughly sealed immediately after the free water has left the surface. Formed surfaces shall be sealed immediately after the forms are removed and necessary finishing has been completed. The curing compound shall be applied by power-operated atomizing spray equipment in one or two separate applications. Hand-operated sprayers may be used for coating small areas. Curing compound solutions containing pigment shall be thoroughly mixed prior to use and agitated during application. If the solution is applied in two applications, the second application shall follow the first within 30 minutes. Satisfactory equipment shall be provided, together with means to properly control and assure the direct application of the curing solution on the concrete surface so as to result in a uniform coverage rate of at least 0.27 litres per square metre.

If rain falls on the newly coated concrete before the film has dried sufficiently to resist damage, or if the film is damaged in any other manner during the curing period, a new coat of solution shall be applied to the affected portions equal in curing value to that specified above.

(3) Wet Curing

All superstructure concrete with a specified exposure class of C-XL or C-1 shall be wet cured for a minimum period of 7 days at a minimum temperature of 15°C and for the time necessary to attain 50% of the specified compressive strength. The Contractor shall cover the concrete surface with a single layer of clean, soaking wet white polyester fabric as soon as the surface will not be marred by so doing. The fabric shall be pre-soaked in water prior to placing. The white polyester fabric shall receive an additional cover of 4 mil white or opaque polyethylene as soon as surface conditions permit. The fabric shall be kept saturated with soaker hoses.

The curing system shall be kept in place for the minimum specified time periods, not counting the day on which the concrete was deposited. The length of the curing period is dependant upon the thoroughness of the Contractor in maintaining a saturated surface and may be increased at the discretion of the Engineer should the Contractor fail to satisfy the above requirements. Under no conditions is the curing cover to be removed in part or in full until such time as permission is given by the Engineer to do so.

(4) Curing Requirements for Concrete Slope Protection

Concrete slope protection shall receive 2 coats of a curing compound approved by the Engineer. The first coat is to be applied immediately after the concrete has been satisfactorily finished, and

the second coat is to be applied within 3 hours after the application of the first coat. In cases where premature drying is severe or is anticipated to be severe, then wet curing shall be required.

N. Concrete Finishing Under Bearings

Concrete bearing areas shall be brought to a smooth bearing surface at the elevations shown on the Drawings or determined by the Engineer.

When steel masonry plates are to be placed directly on the concrete or on filler material less than 5 mm thick, the surface shall be finished with a float finish. After the concrete has set, the contact area shall be ground as necessary to provide full and even bearing.

Surfaces under elastomeric bearings shall be finished by wood floating to a flat and even surface free of ridges.

The concrete bearing surface under the bearings shall be finished level. The maximum permitted deviation from level is 0.005 radians.

When called for on the Drawings, recesses shall be provided. These recesses shall be grouted to the elevations shown on the Drawings or set by the Engineer in the field. The grout shall be of a non-shrinkable, non-metallic type approved by the Engineer. The grouted surfaces shall be in true level plane that do not vary by more than 2 mm from a true, horizontal straight edge placed in any direction across the surfaces.

The grouted areas shall be allowed to set for at least 48 hours prior to any beam erection. During cold weather, the grouted areas shall be kept heated at a minimum temperature of 15°C for a minimum period of 48 hours.

O. Surface Finish

All exposed concrete surfaces shall receive an ordinary surface finish unless otherwise indicated on the Drawings or as directed by the Engineer. Ordinary surface finish shall be defined as smooth, even concrete surfaces, free of all honeycomb, objectionable fins, projections, offsets, streaks or other surface imperfections. No remedial measures will be required for satisfactory ordinary surface finish beyond the filling of the holes or cavities caused by the removal of the snap ties and tie rods.

Immediately after the removal of the forms, all defects in the concrete surfaces shall be brought to the Engineer's attention and such defects shall be repaired as herein specified or as the Engineer may approve.

Cavities or holes caused by removing snap ties and tie rods shall be filled carefully with a cement-sand grout of the same quality and mix as that used in the original concrete, eliminating all aggregates retained on a 2.36 mm sieve. Care shall be taken to ensure that the cavity or hole is filled to its entire depth.

All objectionable fins, projections, offsets, streaks or other surface imperfections shall be removed to the Engineer's acceptance by approved means. Cement washes of any kind shall not be used.

Honeycomb spots, if any, shall be repaired as soon as the forms are removed; and this shall be accomplished by:

(1) removing all aggregate that is loose or that is not bonded thoroughly to the surrounding concrete,

(2) washing the surface with clean water,

(3) using a wire brush to remove any loose particles; and

(4) applying a coating of approved epoxy resin to the surface to be patched immediately prior to applying the cement-sand grout.

Patched areas shall be rubbed flush with the surrounding surface after the cement-sand grout has hardened.

If, in the Engineer's opinion, the concrete surface does not fulfill adequately the requirements for an ordinary surface finish as described above, the Contractor shall, at his own expense and as may be directed by the Engineer, either:

(1) entirely remove certain designated portions, or all of the concrete, or

(2) give the entire surface or certain designated portions thereof a special surface finish as approved by the Engineer.

P. Installing Flexible Joint Sealant

Flexible joint sealant shall be installed in accordance with the Manufacturer's recommendations. The concrete surfaces to which the joint filler is to adhere shall be clean, and when called for on the Drawings shall be sand blasted.

Q. Concrete Strength Requirements

The Engineer reserves the right to reject any concrete that does not meet all the technical and finishing requirements for that type of concrete.

(1) Open to Traffic

The structure shall not be opened to traffic until the concrete has attained a minimum compression strength of 100% of the design strength. The Contractor shall be responsible for all costs associated with any additional testing that may be required to satisfy the strength requirement.

R. Bench Mark Plug and Identification Plaques

The Contractor shall install the bench mark plugs and identification plaques supplied by the Engineer in the following manner:

(1) Bench Mark Plug

The bench mark plug shall be installed in the top of the abutment curb in the north-east corner of a reinforced concrete bridge. It shall be positioned clear of the newel post. For reinforced concrete culverts, the bench mark plug shall be placed in the top of the headwall in the north-east corner of the structure. In all cases, it shall project approximately 3 mm above the concrete surface and shall be located as directed by the Engineer.

(2) Brass Identification Plaque

The Identification Plaque shall be installed on the outside face of the northeast wingwall of reinforced concrete bridges and culverts. It shall be placed in a position that will remain clearly visible above the ground line. The plaque shall be attached to the forms and cast into the concrete. Cadmium plated screws shall be set through the holes and also cast into the concrete to ensure that the identification plaque does not come loose.

2005 - 6 QUALITY CONTROL / QUALITY ASSURANCE

A. Quality Control

(1) General

Batches of concrete that do not meet the requirements of this Specification will be rejected by the Engineer and his/her decision to be final. The Engineer reserves the right to require immediate removal of any concrete from the rejected batches that may have already been placed in the structure.

The Contractor shall be responsible for all concrete testing, including but not limited to making test cylinders, transporting cylinders to an independent certified testing laboratory of his choice, storage, curing, breaking, and providing written reports of the concrete test results to the Engineer. The quality control testing shall meet the minimum testing requirements for the specified frequency and test procedure as described in Tables 1 and 2. All testing shall be completed by qualified personnel who are certified at the time of testing as ACI CSA-Based Concrete Field Testing Technician – Grade 1, and shall be conducted at the point of discharge into the forms.

If Ready Mix Concrete is being used, and loads are frequently being rejected, or strength results are not to specification, the Engineer, on 24 hour notice, may refuse permission for further use of the Ready Mix Supplier.

(2) Aggregate

The sample of the aggregates shall be current and fully represent the material to be used in production. Sampling shall be done no more than 90 days prior to concrete production. Additional samples shall be provided periodically if so determined by the Engineer.

If the fine aggregate consists of a blend from more than one source, the "Fine Aggregate Sieve" analysis shall show the gradation of the blended fine aggregates. Similarly in the case of blended coarse aggregates, the "Coarse Aggregate Sieve" analysis shall indicate the gradation of the blended coarse aggregates.

The Contractor shall make all the aggregates available for sampling by the Engineer at least 28 days prior to the first concrete pour.

The Contractor shall advise the Engineer of any changes in the aggregates subsequent to the Engineer obtaining the samples.

(3) Concrete

(a) Compressive Strength Tests

A "Strength Test" shall consist of the compression tests of four standard test specimens, sampled, made, cured, and tested in accordance with CSA Standard Specifications as referenced with modifications as indicated. One cylinder shall be tested at seven days. One cylinder shall be tested at fourteen days. The 28 day test result shall be the average of the strengths of the remaining two specimens. Additional cylinders may be cast, at the discretion of the Engineer or Contractor.

(b) Sampling

Sampling of concrete shall be carried out in accordance with CSA A23.2-1C.

When a concrete pump is used to place concrete, sampling shall be at the end of the discharge hose.

(c) Test Cylinders

Making and curing concrete test cylinders shall be carried out in accordance with CSA A23.2-3C, except that the time for cylinders to reach the testing laboratory shall be between 20 and 48 hours. The test cylinders shall be cast by the Contractor in standard CSA approved moulds. The Contractor shall provide properly designed temperature-controlled storage boxes for test cylinders, as specified in Section 7.3.2.1 of CSA A23.2-3C, for a period of at least 24 hours, and further protection from adverse weather and mishandling until removed from the site. The Contractor shall provide a max-min thermometer for each storage box and record site curing temperatures for all test cylinders. Storage in a site office trailer that is used by the Contractor's personnel or the Contractor Administrator’s representative during the first 24 hour storage period will not be permitted. Storage facilities shall be provided, installed, and approved by the Engineer before any concrete is placed.

The Contractor shall deliver the test cylinders to an independent CSA certified testing laboratory. Handling and transporting of the cylinders shall be in accordance with CSA

23.2-3C. No extra laboratory curing time will be allowed for cylinders that are delivered late to the laboratory. A copy of the test results shall be forwarded to the Engineer within 2 days of the break date.

If the test cylinders were allowed to freeze, or were otherwise mishandled resulting in unreliable strength test results, the Engineer may reject the affected portions of the Work, unless core-testing, at the Contractor's expense, confirms the in-situ strength of the concrete.

(d) Slump

Slump tests shall be completed in accordance with CSA A23.2-5C.

(e) Air Content

Air content tests shall be completed in accordance with CSA A23.2-4C.

(f) Testing Cylinders

Test cylinders will be tested in compression in accordance with CSA-A23.2-9C.

(g) Failure to Meet Slump or Air Content Specifications

In the event that slump and/or air content are outside the specified tolerance range, as determined by the Contractor's or the Engineer's testing, the Engineer may accept adjustments of the deficient condition as an alternate to rejection provided adjustments are made within the maximum time allowed as specified in 5.A(4). Concrete that does not meet the specifications will be rejected after the maximum time is exceeded.

(h) Coring for Compressive Strength Testing

Coring to confirm or contest low concrete strength test results shall be approved by the Engineer. When coring is approved, arrangements shall be made by the Contractor, through the Engineer, to employ an independent, certified testing service, all at the expense of the Contractor. The cores shall be taken and tested within seven days of the testing of the twenty-eight day cylinders representing the concrete in question. Where practical, three 100 mm cores shall be taken for each strength test previously taken, and there shall be no doubt that the cores taken, and the cylinders under consideration

represent the same batch of concrete. Cores may not be taken unless the Engineer is present. Cores shall be tested by an independent CSA certified laboratory and in accordance with the requirements of CSA A23.2-14C. The average strength of the cores as reported by the independent testing service shall constitute a test.

The foregoing procedure may be modified if the concrete in question was placed during weather conditions not suitable, in the opinion of the Engineer, to permit satisfactory curing. In the event the Contractor chooses to take cores after 7 days, they shall be taken as prescribed in the foregoing paragraph, transported to an approved laboratory, and cured for a period of time such that the total of curing time in place in the structure plus the curing time in the laboratory is equal to 28 days. The cores shall then be tested and reported as specified above.

In cases where the concrete strength, as indicated by the cores, is higher than the strength based on the concrete cylinder results, the core results shall be used as the basis for acceptance of and payment for the concrete. If the core strengths are lower than the strength from the concrete cylinder tests, the cylinder tests shall govern.

B. Quality Assurance

Quality assurance testing will be carried out by the Engineer and the costs for breaking and provision of concrete test cylinder reports will be paid for by the Rural Municipality.

The Engineer shall be afforded full facilities for the random quality assurance inspection and testing that may be carried on to the concrete itself and/or the constituent materials. This includes at the worksite and any plant used for the manufacture of concrete. The facilities shall be adequate in the opinion of the Engineer to permit proper sampling of but not limited to, making of test cylinders and testing slump and air content. The proper storage of all site cast concrete cylinders in accordance with the relevant specifications is the responsibility of the Contractor and shall be provided prior to any concrete pour.

The results of the quality assurance testing carried out by the Engineer will serve to monitor and review the quality control program of the Contractor.

Additional tests will be required if the results are borderline or widely variable. In case of an unacceptable result, one check test will be permitted.

All materials supplied by the Contractor to be permanently incorporated in the structure are subject to testing by the Engineer and subject to the Engineer’s approval prior to their use in construction.

Concrete cylinders, slump tests and all other field tests considered necessary shall be made by the Engineer. The Contractor shall assist the Engineer in the performance of these tests as often during the processes of mixing and depositing concrete as the Engineer shall direct. The Contractor shall be responsible for removing and replacing all defective concrete at his own expense.

There shall be no charge to the Rural Municipality for materials taken by the Engineer for testing purposes.

2005 - 7 MEASUREMENT

A. Cast-in-Place Concrete

The supplying and placing of cast-in-place concrete will be measured on a volume basis. The volume of cast-in-place concrete to be paid for will be the total number of cubic metres computed from the neat lines on the Drawings.

B. Architectural Finish Formwork

Architectural finish formwork shall be measured on an area basis. The area to be paid for will be the total number of square metres computed from the Drawing dimensions.

C. Insulation

Insulation will be measured on an area basis. The area to be paid for will be the total number of square metres computed from the Drawing dimensions.

D. Permeable Formwork Liner

Permeable Formwork Liner will be measured on an area basis. The area to be paid for will be the total number of square metres computed from the Drawing dimensions. No deductions or adjustments will be made for chamfered corners.

E. Heating Concrete

Heating of concrete will be measured on a volume basis. The volume of heating concrete to be paid for will be the total number of cubic metres computed from the neat lines on the Drawing.

2005 - 8 PAYMENT

A. Cast-in-Place Concrete

The supplying and placing of cast-in-place concrete will be paid for at the Contract Unit Price per cubic metre for “Supply and Place Concrete (Substructure)”, measured as specified herein, which price will be payment in full for performing all operations herein described and other items incidental to the Work.

B. Architectural Finish Formwork

Architectural finish formwork will be paid for at the Contract Unit Price per square metre for “Architectural Concrete Finish”, measured as specified herein, which price will be payment in full for performing all operations herein described, and all other items incidental to the Work.

C. Insulation

Supply and installation of insulation will be paid for at the Contract Unit Price per square metre for "Supply and Place Insulation", measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

D. Permeable Formwork Liner

Permeable Formwork Liner shall be paid for at the Contract Unit Price per square metre for “Permeable Formwork Liner”, measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

E. Heating Concrete

Heating concrete materials and maintaining the temperature of the deposited concrete will be paid for at the Contract Unit Price per cubic metre for “Heating Concrete, measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

If the prevailing temperature at the time of mixing and placing concrete is such that all heating operations are not considered necessary by the Engineer, the Contractor will be instructed in writing to carry out heating in part only. Partial heating will be paid for at a percentage of the Contract Unit Price per cubic metre for “Heating Concrete”, measured as specified herein.

These percentages shall be as follows:

- Heating water 10%
- Heating aggregates 30%
- Housing and heating deposited concrete 60%

Table 1
AGGREGATE TESTING REQUIREMENTS

TEST	STANDARD REFERENCE	MINIMUM FREQUENCY
Sampling	CSA A23.2-1A ASTM D 75	One test per hour of production or as directed by the Engineer.
Gradation Analysis	CSA A23.2-2A ASTM C 136	
Clay Lumps	CSA A23.2-3A ASTM C 142	
Low-Density Granular Material (Shale Content)	CSA A23.2-4A	
Material Finer than 80 μm	CSA A23.2-5A	
Soundness	CSA A23.2-9A ASTM C 88	
Bulk Density	CSA A23.2-10A ASTM C 29	
Potential Expansivity	CSA A23.2-14A	One test per material or as directed by the Engineer.
Petrographic Analysis	CSA A23.2-15A ASTM C 295	
Potential Alkali-Silica Reactivity	CSA A23.2-25A CSA A23.2-27A ASTM C 289 ASTM C 1567	
Potential Alkali-Carbonate Reactivity	CSA A23.2-26A CSA A23.2-27A ASTM C 586	As directed by the Engineer.
Coarse Aggregate Only:		
Relative Density and Absorption	CSA A23.2-12A ASTM C 127	One test per material or as directed by the Engineer.
Flat and Elongated Particles	CSA A23.2-13A ASTM D 4791	
Los Angeles Abrasion: Small Size	CSA A23.2-16A ASTM C 131	
Los Angeles Abrasion: Large Size	CSA A23.2-17A ASTM C 535	
Micro-Deval	CSA A23.2-29A ASTM D 6928	As directed by the Engineer.
Crush Count	ASTM D 5821	One test per hour of production or as directed by the Engineer.
Flakiness Index		
Dry-Rodded Unit Weight	ASTM C 29	
Fine Aggregate Only:		
Relative Density and Absorption	CSA A23.2-6A ASTM C 128	One test per material or as directed by the Engineer.
Organic Impurities	CSA A23.2-7A ASTM C 40	
Surface Moisture	CSA A23.2-11A ASTM C 70	
Micro-Deval	CSA A23.2-23A ASTM D 7428	As directed by the Engineer.

Table 2
CONCRETE TESTING REQUIREMENTS

TEST	STANDARD REFERENCE	MINIMUM FREQUENCY
Water		
Water	ASTM C 1602	As directed by the Engineer.
Cement		
Mill Certificate	CSA A5 CSA A362 Type 10E-SF/F (Silica Fume or Fly Ash)	As directed by the Engineer.
Admixtures		
Air Entraining	ASTM C 260	As directed by the Engineer.
Chemical	ASTM C 494	
Mix Design		
Proportioning	CSA A23.1 Alternative 1 or 2	At the beginning of the project, repeated as many times necessary to develop a suitable concrete mix design.
Density of Plastic Concrete	CSA A23.2-6C ASTM C 138	
Batch Plant		
Calibrated by Weights and Measures	CSA A23.1	MRMCA certification and calibrated within the last calendar year.
Ready-Mix Concrete		
Sampling	CSA A23.2-1c	One complete test and set of cylinders for compressive strength testing for one out of every three loads of concrete placed including temperature, air content and slump (one out of every two loads when silica fume used).
Temperature	ASTM C 1064	
Compressive Strength	CSA A23.2-3C CSA A23.2-9c	
Air Content by Pressure Method	CSA A23.2-4C	
Slump and Slump Flow	CSA A23.2-5C	
Flexural Strength	CSA A23.2-3C CSA A23.2-8c	As directed by the Engineer.
Air Content by Volumetric Method	CSA A23.2-7C	
Other Related Testing		
Core Compressive Strength	ASTM A23.2-14C ASTM C 42	As directed by the Engineer.
Petrographic Analysis of Aggregates in Concrete	ASTM C 295	
Sulphate Ion Content in Water	CSA A23.2-3B ASTM D 516	
Bond Tests	CSA A23.2-6B ASTM C 1583	
Cement Content	ASTM C 1084	
Rapid Chloride Permeability	ASTM C 1202	
Air Void Parameters	ASTM C 457	

2006 - SUPPLYING AND PLACING CONCRETE REINFORCEMENT

2006 - 1 DESCRIPTION

This specification describes the terms and conditions applicable to the following.

(1) Supplying, fabricating, delivery, handling, storing and placing of the specified type(s) of concrete reinforcement, including all bar supports and accessories; and

(2) The quality control (QC) testing of all materials.

This specification details the responsibilities of the Contractor.

Concrete reinforcement shall be supplied in the lengths and shapes, and installed as indicated on the Drawings. No substitutions of bars or changes to bar details on the Drawings will be allowed without prior acceptance of the Contract Administrator.

2006 - 2 REFERENCES AND RELATED SPECIFICATIONS

A. References

All reference standards and related specifications shall be current issue or latest revision at the date of tender advertisement.

B. Related Specifications

- CSA A23.1, Concrete Materials and Methods of Concrete Construction
- CAN/CSA G30.18, Billet-Steel Bars for Concrete Reinforcement
- ACI 117, Standard Tolerances for Concrete Construction and Materials
- ASTM A 615, Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement
- AASHTO M31, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement ASTM A 615/A 615M
- Reinforcing Steel Institute of Canada, (RSIC), Manual of Standard Practice
- Municipal's Approved Products List
- ISIS Canada's Specifications for Product Certification of FRPs as Internal Reinforcement in Concrete Structures

2006 - 3 SUBMITTALS

The Contractor shall submit the following to the Contract Administrator:

(1) Certification from the Manufacturer stating that the materials supplied meet the specified requirements.

2006 - 4 MATERIALS

A. Reinforcing Steel

Reinforcing steel shall conform to the requirements of CAN/CSA G30.18, Grade 400W and shall be deformed bar unless indicated otherwise on the Drawings.

Spiral reinforcement shall conform to Clause 6.6.3 of CSA 23.1.

B. Low Carbon Chromium Steel Bars (MMFX 2)

Deformed, low carbon chromium steel bars shall conform to the requirements of ASTM A 615, Grade 75 and ASTM A 1035. MMFX 2 (Microcomposite) is an approved product.

C. Fibre Reinforced Polymer (Glass or Carbon)

Fibre Reinforced Polymer Bars (GFRP and CFRP) shall conform to the requirements as specified on the Drawings and in accordance with ISIS Canada's Specifications for Product Certification of FRPs as Internal Reinforcement in Concrete Structures.

FRP reinforcement must be approved by the Contract Administrator.

D. Bar Supports and Accessories

Bar supports and accessories shall conform to the requirements of CSA A23.1 and shall be approved for use by the Contract Administrator. They shall be made from Type 316 stainless steel or hot-dipped galvanized steel, or in the case of chairs, from High Performance Concrete (HPC). An approved HPC rebar support is supplied by ConSys Inc. of Pinawa, Manitoba. They shall not stain, blemish or spall the concrete surface for the life of the concrete.

Tire wire shall be 16 gauge black annealed or coated wire as a minimum.

2006 - 5 CONSTRUCTION METHODS

A. Supply and Fabrication

(1) General

Any reinforcement with flaws in manufacture or fabrication shall be replaced with acceptable reinforcement.

(2) Reinforcing Steel and MMFX 2

Hooks and bends shall conform to the requirements listed for CSA G30.18, Grade 400W bars in Clause 6.6.2 of CSA A23.1-04.

Reinforcing steel and MMFX 2 reinforcement shall be bent to the proper shape in a plant that has suitable devices for bending as recommended in the Reinforcing Steel Institute of Canada (RSIC) Manual of Standard Practice. Reinforcing bars shall conform accurately to the dimensions shown on the Drawings and within the fabricating tolerance as shown in the RSIC Manual of Standard Practice.

Billet steel reinforcement bars shall be bent at temperatures between 10°C and 100°C.

MMFX 2 bars shall be cold bent. Heating of the bars to facilitate bending will not be permitted. Bar cutting shall be done by shearing or with a water-cooled saw. Torch cutting will not be permitted.

(3) FRP Reinforcement

FRP reinforcement shall be bent to the proper shape during fabrication. Absolutely no field bending of the bars is permitted. Should modifications to the FRP reinforcement be required, the Contractor shall notify the Contract Administrator immediately.

B. Handling and Storage

(1) General

The Contractor shall handle and store the concrete reinforcement in a manner that ensures it is not damaged or contaminated with dirt or other materials.

The concrete reinforcement shall not be placed directly on the ground. Timber pallets, platforms, skids or other supports shall be placed under the reinforcement to keep it free from dirt and mud and to provide easy handling.

Prior to concrete placement, the Contractor and Contract Administrator shall inspect the concrete reinforcement for surface damage.

(2) Reinforcing Steel and MMFX 2

All reinforcing steel and MMFX 2 reinforcement shall be clean and free from paint, oil, mill scale and other injurious defects.

Rust, surface seams or surface irregularities will not be cause for rejection, provided that the minimum dimensions, height of deformations, cross-sectional area and tensile properties of a hand-wire-brushed specimen are not less than the applicable specification requirements.

(3) FRP Reinforcement

The Contractor shall load, haul, store, and handle the FRP bars in accordance with the Manufacturer/Supplier's instruction to prevent damage. FRP bars are susceptible to surface damage; therefore, special care is required in the loading, hauling, storage and handling of these bars. Bundling bands shall be padded or suitable banding shall be used to prevent damage to the reinforcement.

If the FRP bars are to be stored on-site for more than 3 months, the FRP bars shall be covered with an opaque material to avoid UV radiation and exposure to chemical substances.

FRP bars are very light and flexible; therefore, hoisting bundles of FRP shall be performed with a strongback spreader bar or multiple supports to avoid excessively bending of the bars. The FRP reinforcement shall not be dropped or dragged.

C. Placing and Fastening

(1) General

The Contractor shall supply and place all necessary support accessories to ensure proper placement of concrete reinforcement. All concrete reinforcement shall be accurately placed in the positions shown on the Drawings, and firmly tied and chaired before placing the concrete.

Distances from the forms shall be maintained by means of stays, spacers, or other approved supports. Reinforcing cover shall not be less than the minimum specified on the Drawings. Reinforcement includes ties, stirrups, and main reinforcement. For textured architectural surfaces, the concrete cover shall be measured from the deepest point of the textured surface. Spacers and supports for holding reinforcement at the required location and ensuring the specified concrete cover over the reinforcement shall be made from precast concrete or non-rusting metal. Precast concrete supports of approved shape and dimensions, with compressive strengths equal to or exceeding the placed concrete, are acceptable. Any non-rusting metal chairs protruding through the surface of the hardened concrete shall be cut back at least 25 mm, and the holes filled. Non-rusting metal chairs shall not be used to support reinforcement on surfaces that are to be exposed. Where possible, this reinforcement is to be supported entirely from above. The use of pebbles, pieces of broken stone or brick, plastic, metal pipe, and wooden blocks, will not be permitted.

Immediately before placing, concrete reinforcement shall be free of all material that would reduce the bond to concrete, including but not necessarily limited to: dirt, detrimental rust, loose scale, and form oil.

(2) Placing Steel Reinforcement and MMFX 2

Bars shall be tied at all intersections, except where spacing is less than 250 mm in each direction, when alternate intersections shall be tied. Welding or tack welding of reinforcing steel and MMFX 2 will not be allowed. Unless otherwise shown on the Drawings, the minimum distance between bars shall be 40 mm.

Field bending of reinforcing steel and MMFX 2 bars will not be allowed unless approved by the Contract Administrator.

(3) Placing FRP Reinforcement

The Contractor shall place the FRP reinforcement in accordance with the Manufacturer/Supplier’s instructions.

All FRP reinforcement shall be secured to and supported within formwork as required to prevent displacement by concrete placement or workers. All FRP reinforcement shall be accurately

supported using concrete or non-corrosive chairs before concrete placement is started. The Contractor shall use chairs that incorporate a positive locking mechanism to restrain FRP reinforcement from floating during concrete placement.

The Contractor will be allowed to cut the FRP reinforcement with a high speed grinding cutter, fine blade saw, diamond blade or masonry blade with the prior approval of the Contract Administrator.

Shearing FRP reinforcement will not be allowed.

The Contractor shall place the FRP reinforcement within the tolerances as specified in ACI 117.

The Contractor shall remove form oil from FRP bars using a method approved by the Manufacturer before placing concrete.

D. Tying Reinforcement

(1) Reinforcing Steel and MMFX 2

For lapping steel reinforcing bars at the joints and intersection, an ample supply of annealed wire at least 1.5 mm in diameter shall be provided. Proper cutting pliers shall be used and the bending and tying of the wires done as neatly as possible. Twisted ends of the tie wire shall be bent away from forms and surfaces so that they do not project into the concrete cover over the reinforcement.

(2) FRP Reinforcement

For lapping FRP reinforcement at joints and intersections, the Contractor shall tie all intersections using plastic coated or nylon zip ties, or non-rusting material approved by the Contract Administrator.

E. Splicing

(1) General

Splices shall only be provided as shown on the Drawings. Splices other than as shown on the Drawings will not be permitted without the written approval of the Contract Administrator. Splices, where possible, shall be staggered.

(2) Reinforcing Steel and MMFX 2

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. If this information is not detailed on the Drawings, a minimum of 35 bar diameters lap length shall be provided.

Sheets of mesh or bar mat reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The edge lap shall not be less than one mesh in width.

(3) FRP Reinforcement

Lap slices shall be used wherever detailed or specified on the Drawings and where continuity is required in the reinforcement. The use of mechanical connection or welded splices is not permitted.

F. Bar Accessories in Bridge Deck Slabs

The Contractor shall supply and place a longitudinal row of high chairs as close as possible to each side of every girder in order to rigidly support the top transverse reinforcement in the deck slab.

All bar accessories in bridge deck slabs shall be a type approved by the Contract Administrator and shall be non-rusting. They shall be made from precast concrete or in the case of steel, Type 316 stainless steel or hot-dip galvanized steel.

All FRP reinforcement shall be tied and supported, as necessary, to prevent displacement by concrete placement operations and workers.

2006 - 6 QUALITY CONTROL / QUALITY ASSURANCE

A. Quality Control for FRP Reinforcement

The Contractor shall be responsible for all quality control testing of FRP reinforcement in accordance with *ISIS Canada's Specification for Product Certification of FRPs as Internal Reinforcement in Concrete Structures.*

B. Quality Assurance

After all concrete reinforcement has been placed, a final inspection by the Contract Administrator will be made prior to the placement of concrete to locate any damage or deficiencies. All visible damage or any deficiencies shall be repaired by the Contractor to the satisfaction of the Contract Administrator before concrete is placed. The Contractor shall allow the Contract Administrator unhindered access to the concrete reinforcement and shall assist the Contract Administrator in carrying out the inspection.

2006 - 7 MEASUREMENT

A. Reinforcing Steel

Supplying and placing of all reinforcing steel will be measured on a weight basis. The total weight to be paid for will be based on the actual length of reinforcing steel placed and the mass per unit of length as stated in CAN/CSA G30.18. The Contractor shall verify the total weight of placed reinforcing steel.

B. MMFX 2 (Microcomposite)

Supplying and placing of all MMFX 2 reinforcement will be measured on a weight basis. The total weight to be paid for will be based on the actual length of the MMFX 2 reinforcing placed and the mass per unit of length. The Contractor shall verify the total weight of placed MMFX 2 reinforcement.

C. FRP Reinforcement

Supplying and placing of all FRP reinforcement will be measured on a lineal length basis. The total length to be paid for will be determined based on the actual length of the FRP reinforcement placed. The Contractor shall verify the total length of placed FRP reinforcement.

D. Bar Supports and Accessories

Supplying and placing all bar supports and accessories will be considered incidental to the concrete reinforcement and no separate measurement will be made of this work.

2006 - 8 PAYMENT

A. Reinforcing Steel

Supplying reinforcing steel will be paid for at the Contract Unit Price per kilogram for Supply Reinforcing Steel (Black)", measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

Placing reinforcing steel will be paid for at the Contract Unit Price per kilogram for "Placing Reinforcing Steel", measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

B. MMFX 2 (Microcomposite)

Supplying MMFX 2 reinforcement will be paid for at the Contract Unit Price per kilogram for "Supply Reinforcing Steel (MMFX 2)", measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

Placing MMFX 2 reinforcement will be paid for at the Contract Unit Price per kilogram for "Placing Reinforcing Steel", measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

C. FRP Reinforcement

Supplying FRP reinforcement will be paid for at the Contract Unit Price per lineal metre for "Supplying FRP Reinforcement"", measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

Placing FRP reinforcement will be paid for at the Contract Unit Price per lineal metre for "Placing FRP Reinforcement", measured as specified herein, and will be payment in full for performing all operations herein described and all other items incidental to the Work.

2007 – SUPPLY, FABRICATION AND ERECTION OF MISCELLANEOUS METAL

2007 - 1 DESCRIPTION

This specification describes the terms and conditions applicable to the following.

(1) Supply, fabrication, and erection of miscellaneous metal as shown on the Drawings and described in this Specification;

(2) Galvanizing of miscellaneous metal; and

(3) Quality control (QC) testing of materials and fabrication, including magnetic particle testing of welds.

This specification details the responsibilities of the Contractor.

2007 - 2 REFERENCES AND RELATED SPECIFICATIONS

A. References

All reference standards and related specifications shall be current issue or latest revision at the date of tender advertisement.

B. Related Specifications

- CAN/CSA G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steel
- CAN/CSA W48, Filler Metals and Allied Materials for Metal Arc Welding
- CSA W59, Welded Steel Construction (Metal Arc Welding)
- CAN/CSA G164, Hot Dip Galvanizing of Irregularly Shaped Articles
- CSA W47.1, Certification of Companies for Fusion Welding of Steel
- ASTM A 36, Standard Specification for Carbon Structural Steel
- ASTM A 53, Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless
- ASTM A 108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
- ASTM A 123, Standard Specification for Zinc (Hot Dipped Galvanized) Coatings on Iron and Steel Products

- ASTM A 276, Standard Specification for Standard Specification for Stainless Steel Bars and Shapes
- ASTM A 320, Standard Specification for Alloy Steel and Stainless Steel Bolting Materials for Low Temperature Service
- ASTM A 325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
- ASTM A 404, Standard Specification for General Requirements for Stainless Steel Bars, Billets and Forgings
- ASTM A 449, Standard Specification for Quenched and Tempered Steel Bolts and Studs
- ASTM A 496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
- ASTM A 500, Standard Specification for Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- ASTM A 514, Standard Specification for High- Yield- Strength, Clenched and Tempered Alloy Steel Plate, Suitable for Welding
- ASTM A516, Standard Specification for Pressure Vessel Plates, Carbon Steel, For Moderate and Low Temperature Service
- ASTM A 517, Standard Specification for Pressure Vessel Plates, Alloy Steel, High Strength, Quenched and Tempered
- ASTM A 615, Standard Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement
- ASTM B 22, Standard Specification for Bronze Castings for Bridges and Turntables
- ASTM B 29, Standard Specification for Refined Lead
- ASTM B 100, Standard Specification for Wrought Copper-Alloy Bearing and Expansion Plates and Sheets for Bridge and Other Structural Use
- ANSI B46.1, Surface Texture (Surface Roughness, Waviness, and Lay)
- AASHTO/AWS D1.5M/D1.5, Bridge Welding Code
- AWS D1.1, Structural Welding Code – Steel

2007 - 3 SUBMITTALS

The Contractor shall submit the following to the Engineer:

(1) 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.

(2) Certification of chemical analysis and physical tests for all materials.

(3) Applicable welding procedures, stamped as approved by the Canadian Welding Bureau.

(4) Manufacturer's test reports of mechanical tests on high strength bolts, if requested by the Engineer.

2007 - 4 MATERIALS

A. General

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.

B. Miscellaneous Metals

Miscellaneous metals shall conform to the material grades specified on the Drawings, and meet the requirements and satisfy the testing procedures of CSA G40.20 M.

C. Welded Steel Construction

Welded steel construction (Metal Arc Welding) shall conform to the requirements and satisfy the testing procedures of CSA W59, AASHTO/AWS D1.5 Bridge Welding Code and Welded Highway & Railway Bridges - AWS D1.1 of The American Welding Society & Addendum (latest editions for all).

D. Shear Stud Connectors

Shear stud connectors shall conform to the requirements of ASTM A 108, Grades 1015, 1018 and 1020.

E. Zinc

Zinc for hot dipped, galvanized coatings shall conform to the requirements of ASTM A 123 and CAN/CSA G164.

F. Stainless Steel

Stainless steel bolts, nuts, washers, inserts, etc. as shown on the Drawings shall conform to the requirements of ASTM A 320, Class B8.

Stainless steel double headed studs and stainless steel dowels shall meet the requirements as shown on the Drawings and shall conform to the requirements of ASTM A 276, Type 304L (UNS S30403).

2007 - 5 CONSTRUCTION METHODS

A. Fabrication

(1) General

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.

All miscellaneous metal material shall be marking using steel marking tags. The punching of identification marks on members will not be allowed unless authorized in writing by the Engineer.

If damage occurs to the miscellaneous metal during fabrication, the Engineer shall be notified immediately to facilitate the implementation of remedial measures. Remedial repair measures are subject to the approval of the Engineer.

Dimensions and fabrication that control field matching of parts shall receive careful attention in order to avoid field adjustments.

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.

Cutting shall be in accordance with AWS D1.1 and CSA W59.

(2) Clean Material

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 Engineer's approval.

(3) Finish

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.

(4) Machining

(a) General

Machining shall be carried out as shown on the Drawings and described in this Specification 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.

(b) 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.....ANSI 1,000
Milled ends of compression members,
milled or ground ends of stiffeners and fillers.....ANSI 500

Care shall be taken that the completed surfaces are protected from damage from the time of machining until the installation in a structure.

(c) 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.

(d) Butting Joints

Butting joints in compression members shall be faced and brought to an even bearing by milling or other methods meeting the Engineer's approval.

(e) 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.

(f) 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 Engineer'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 Engineer. Flat machined surfaces shall be straight, true and smooth.

(g) Curved Machined Surfaces

Curved surfaces shall be machined carefully in accordance with the Drawings and this Specification in order to ensure correct fit of mating parts.

(5) Bending

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 Engineer. 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 3 mm.

(6) Stress Relieving

Stress relieving of the structure or any component parts attached to the structure shall be done only if called for on the Drawings. If stress relieving is called for, it shall conform to the requirements of AWS D1.1 and CSA W59.

(7) Holes

(a) General

Except where a specific method of holing materials is shown on the Drawings, 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.

(b) 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. The removal of these burrs and sharp edges shall not reduce the cross-section of the structural member. All holes shall be clean-cut without torn of ragged edges. The punching shall not distort the structural member. If required by the Engineer, a sample of the punching operation shall be carried out to the satisfaction of the Engineer prior to the start of fabrication.

(c) Drilled Holes

Drilling shall be done with twist drills, roto-broach drills or core drills, and all burrs and sharp edges shall be removed carefully. The removal of these burrs and sharp edges shall not reduce the cross-section of the structural member. 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.

(d) 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. The removal of these burrs shall not reduce the cross-section of the structural member. All reaming shall be done with twist reamers which shall be directed by mechanical means.

(e) 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 Engineer. The centre-to-centre distance between any two 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.

(8) Welding

(a) 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.

(b) 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 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 6 month period immediately prior to commencement of fabrication shall also be provided to the Engineer. The Contractor shall bear the whole cost and be fully responsible for the qualification of all welding operators.

(c) Welding Procedures, Specifications and Qualification

Welding procedures that conform in all respects to the approved procedures of AWS D1.1 and CSA W59 shall be deemed as pre-qualified.

Welding procedures that do not conform to approved procedures in AWS D1.1 and CSA W59 shall be qualified by tests carried out in accordance with AWS D1.1. The Engineer may accept previous qualifications of the welding procedure.

(d) Welding Materials

All welding materials shall be certified by CWB and meet the requirements of CSA W48.

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 -30°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 -30°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.

Every user shall demonstrate that each combination of electrode and shielding medium will produce weld metal having the above mechanical properties.

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.

The Engineer may accept evidence of record of a combination that has been satisfactory tested in lieu of the test required, provided the same electrode as in a CWB welding procedure is used.

Electrodes conforming to AWS A5.1 shall be purchased & delivered in hermetically sealed containers in accordance with CSA W59.

When non-certified welding consumables are used, the company may qualify them by following the provisions outlined in clause 118.8.2.1 in CSA W47.1.

The electrode or electrode-flux combination or grade of weld metal for butt joints using complete joint penetration groove welds shall be in accordance with Table 11.1 or 12.1 as applicable. In cases where the electrode, electrode-flux or gas combination are lower or higher strength than required by Table 11.1 or 12.1, then the conditions from CAN/CSA W59 Table 11.2 (a), 11.2 (b), 12.2 (a) or 12.2(b) as applicable shall be fully satisfied.

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 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 in accordance with CSA W59 before use.

(e) Preheat and Interpass Temperature

The minimum preheat and interpass temperatures for welding miscellaneous metal shall conform to AWS D1.1 and CSA W59.

(f) Welding Processes

Welding processes which do not conform to the provisions of AWS D1.1 or CSA W59 shall not be used without the written approval of the Engineer.

BASE METAL	WELDING PROCESS					BASE METAL
	SMAW		GMAW	FCAW	SAW	
CSA G40.21M	CSA W48.1 AWS A.5.1	CSA W48.3 AWS A5.5	CSA W48.4 AWS A5.18,5.28	CSA W48.5 AWS A5.20	CSA W48.6 AWS A5.17,5.23	ASTM
230G 260W,260T	E60XX E70XX		E70S-X E70U-X	E60T-X E70T-X	F6X-XXX F7X-XXXX	A53 Gr B A500 Gr A A516Gr55,60
300W 300T 350G[d] 350W	E70XX or E60XX	E70XX	E70S-X E70U-X	E70T-X[a] or F60T-X	F7X-XXXX or F6X-XXXX	A36 A441>4" A550GrB A501 A529 A570Gr D,E A572Gr42,45 A607Gr45
350R[b,c] 350A[b,c] 400A[b,c]	E70XX	E70XX	E70S-X E70U-X	E70T-X[a]	F7X-XXXX	A242[c] A441#4" A516Gr65,70 A570Gr50,55 588[c] A606 A607Gr50,55 A618 A633Gr,A,B,C,D
400G[d],400W 400T		E80XX	GrE80S	GrE80T	GrF80	A572Gr60,65
480W 480T		E90XX	GrE90S	Gr390T	GrF90	
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 Specification 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 Engineer'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.

(g) 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 120°C, if necessary in the estimation of the Engineer to prevent distortion or weld cracking. The provisions of AWS D1.1 and CSA W59 shall be followed in the control of distortion and shrinkage stresses.

(h) 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 Engineer.

(9) 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.

(10) Hot-Dip Galvanizing

Galvanizing, when called for on the Drawings, shall be done in accordance with CAN/CSA G164.

All metal surfaces to be galvanized shall be cleaned thoroughly of rust, rust scale, mill scale, dirt, paint and other foreign material by commercial 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.

B. Handling, Delivery and Storage of Materials

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. Damaged parts shall not be installed in the structure and may be rejected at the discretion of the Engineer.

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.

C. Erection

(1) Layout

Before erection of miscellaneous metal, the Contractor shall satisfy himself that the installation locations are in accordance with the Drawings and this Specification. All discrepancies discovered by the Contractor shall be brought immediately to the attention of the Engineer.

(2) Workmanship

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.

Hammering which will injure or distort the member is not permitted. Bolts in splices of butt joints or compression members and bolts in railings shall not be tightened until the span has been completed. Field splices shall have a minimum of 50% of the holes filled with high strength bolts or erection bolts and the remainder of the holes filled with cylindrical erection pins immediately after erection. Erection bolts shall be of the same nominal diameter as the high strength bolts and the cylindrical erection pins shall be 1 mm larger.

(3) Diaphragms

Diaphragms shall not be secured firmly in position until it has been determined to the satisfaction of the Engineer that the holes in the girder webs for high tensile bolting of

diaphragms are correctly aligned in a direction normal to road centreline, in order to ensure proper seating of diaphragm end plates.

(4) Drifting

Drifting will be permitted during assembly only to bring the components into position without enlarging or distorting the bolt holes, and without distorting, kinking or bending the metal of any unit. If, in the estimation of the Engineer, holes must be enlarged to admit the bolts, they shall be reamed.

Such reamed holes shall not exceed the size of the bolt used by more than 2 mm. Oversize bolts, with a diameter of up to 3 mm larger than that shown on the Drawings may be used if the Engineer approves the installation.

(5) Misfits and Field Fitting

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 Engineer, so informed, has given direct approval to accept the Contractor's proposed corrective measures. The Engineer’s decision as to the quantity of such work to be performed at the Contractor’s expense will be final and binding.

(6) Field Welding

All field welding shall be electric arc welding, and shall be carried out in accordance with the Drawings, AWS D1.1 and CSA W59.

(7) High-Strength Bolting

(a) General

i. Mating surfaces in joints to be bolted with heavy hexagon structural bolts shall be cleaned immediately prior to erection of parts. Such surfaces shall be free of dust, grease, oil, paint and all other foreign substances.

ii. Bolt holes in members shall not be enlarged nor damaged in any way.

iii. Two carburized washers per bolt shall be used at all times; one washer under the bolt head and one under the nut.

iv. High-strength bolts which have been tightened to full tension and released shall not be re-used.

v. Retightening previously tightened bolts which may have been loosened by the tightening of adjacent bolts shall not be considered as a re-use.

vi. Where an outer face of the bolted parts has a slope of more than 1:20 with respect to a plane normal to the bolt axis, a smooth bevelled washer shall be used to compensate for the slope.

(b) Bolt Tension

i. Turn-of-Nut Tightening

Unless otherwise specified, bolts shall be tightened by turn-of-the-nut method. Where necessary, the bolt may be turned while the nut is prevented from rotating.

After aligning the holes in a joint, sufficient bolts shall be placed and brought to a "snugtight" condition to ensure that the parts of the joint are brought into full contact with each other. "Snug-tight" shall be defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following the initial step, bolts shall be placed in all remaining holes in the connection and brought to snug-tightness. All bolts in the joint shall be tightened additionally by the applicable amount of nut rotation specified in Table 2 with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench. If this is not practical, the bolt and nut shall be match-marked to enable the amount of relative rotation to be determined.

Table 2: Nut Rotation* from Snug-Tight Condition

Disposition of Outer Faces of	Bolt Length [2]	Turn

Bolted Parts		
Both faces normal to bolt axis or one face normal to axis and other face sloped 1:20 (bevel washer not used) [1]	Up To and Including 4 Diameters	1/3
	Over 4 Diameters and Not Exceeding 8 Diameters or 200 mm	1/2
	Exceeding 8 Diameters or 200 mm	2/3
Both faces sloped 1:20 from normal to bolt axis (bevel washers not used)[1]	For all lengths of bolts	3/4

*Nut rotation is rotation relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation is 30^0 over or under for coarse thread heavy hex structural bolts of all sizes and lengths and heavy hex semi-finished nuts.

(1) Bevel washers are necessary when A490 bolts are used.
(2) Bolt length is measured from underside of head to extreme end of point.

All fasteners shall be tightened to give at least the required minimum bolt tension values, as shown in Table 3 on completion of the joint. At no time shall the bolt tension be in excess of the required minimum bolt tension by more than 15%.

Table 3: Minimum Bolt Tension

Nominal Bolt Diameter		**Minimum Bolt Tension (kN)**	
Inches	mm	A325	A490
1/2		53	67
5/8	M 16	85	107
3/4	M 20	125	156
7/8	M 22	174	218
1	M 24	227	285
1 1/8	M 27	249	356
1 1/4	M 30	316	454
1 3/8	M 36	378	538
1 1/2		458	658

ii. Checking and Testing

The Contractor shall provide equipment for purposes of checking bolt tension. This equipment shall include calibrated manual torque wrenches, and a calibrating device capable of measuring actual bolt tension.

The calibrating device shall be examined and calibrated by a testing firm approved by the Engineer. The certification and calibration results shall be forwarded to the Engineer. Calibration of the device shall be done immediately prior to torquing operations. The device shall be maintained at the site by the Contractor, who shall, in the presence of the Engineer, calibrate all torque wrenches prior to the torquing operation at least once each day during which high-strength bolts are to be torqued.

In calibrating the torque wrenches, the torque equivalent of the required tension shall be determined for at least three high-strength bolts and nuts for each size to be installed in any one day. The mean value of torque of each size shall be used. In all cases where manual torque wrenches are used, torque values shall be read while the high strength nut is in motion relative to the bolt.

The Contractor shall provide the necessary equipment and personnel to check bolt tension during torquing operations. The number of checks to be made will be at the discretion of the Engineer, but will not be less than one bolt in each connection.

All checking shall be done in the presence of the Engineer. In the event the torque values, obtained during checking of tension in high-strength bolts, are not considered acceptable by the Engineer, the Contractor shall then remove the bolts as directed by the Engineer and replace such bolts at his own expense.

(8) Final Cleaning

All metal surfaces shall be left free of dirt, dried concrete, debris or foreign matter to the satisfaction of the Engineer.

2007 - 6 QUALITY CONTROL / QUALITY ASSURANCE

A. Quality Control

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.

(1) Welding

All welding may be subject to inspection by Non-Destructive Testing. This inspection shall be carried out in a manner approved of the Engineer.

The Contractor shall provide sufficient access and shop area to permit the performance of the tests.

The Contractor shall give the Engineer not less than 24 hours notice of when work will be ready for testing and shall advise the Engineer of the type and quantity of work that will be ready for testing.

All defects revealed shall be repaired by the Contractor at his own expense and to the approval of the Engineer.

B. Quality Assurance

All materials will be subject to physical inspection by the Engineer and will be subject to rejection during the course of the Work, if, in the opinion of the Engineer, the materials involved do not meet the requirements of the Drawings and this Specification.

All materials shall be subject to testing by the Engineer and will be approved only if the requirements of the Drawings and this Specification are met. The Contractor shall supply the specimens for testing in accordance with the requests of the Engineer.

The Contractor shall furnish facilities for the inspection of material and workmanship in the mill, shop and field, and the Engineer shall be allowed free access to the necessary parts of the works.

2007 - 7 MEASUREMENT

A. Miscellaneous Metal

The supply, fabrication and erection of miscellaneous metal will be measured on a kilogram basis. The total mass of miscellaneous metal to be paid for shall the total mass supplied and installed in accordance with the Drawings and accepted by the Engineer.

The mass of all galvanizing material or other protective coatings, all deposited weld metal used for either shop or field welding, bolts, nuts and washers will not be included in the mass of material to be paid for.

2007 - 8 PAYMENT

A. Miscellaneous Metal

The supply and fabrication of miscellaneous metal will be paid for at the Contract Unit Price for "Supply and Fabricate Miscellaneous Metal", measured as specified herein, which price will be payment include payment in full for performing all operations herein described and all other items incidental to the Work.

The erection of miscellaneous metal will be paid for at the Contract Unit Price for "Placing Miscellaneous Metal", measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

2008 - SUPPLYING AND INSTALLATION OF ARCH CULVERT

2008 - 1 DESCRIPTION

This specification describes the terms and conditions applicable to the following.

(1) Design, supply, fabrication, and erection of the arch culvert as shown or described on the Drawings and in this Specification. Arch Culvert includes, but is not limited to, corrugated plates, fasteners, retaining channels, and anchor bolts.

(2) Quality control of materials, fabrication, and installation.

(3) Coating of all metal components.

This specification details the responsibilities of the Contractor.

2008 - 2 REFERENCES AND RELATED SPECIFICATIONS

A. References

All reference standards and related specifications shall be current issue or latest revision at the first date of tender advertisement.

B. Related Specifications

- CAN/CSA G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steel
- CAN/CSA S6, Canadian Highway Bridge Design Code
- CAN/CSA G164, Hot Dip Galvanizing of Irregularly Shaped Articles
- ASTM A36, Standard Specification for Carbon Structural Steel
- ASTM A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
- ASTM A123, Standard Specification for Zinc (Hot Dipped Galvanized) Coatings on Iron and Steel Products
- ASTM A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
- ASTM A449, Standard Specification for Quenched and Tempered Steel Bolts and Studs

- ASTM A500, Standard Specification for Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- ASTM A514, Standard Specification for High- Yield- Strength, Clenched and Tempered Alloy Steel Plate, Suitable for Welding
- ANSI B46.1, Surface Texture (Surface Roughness, Waviness, and Lay)
- AASHTO/AWS D1.5M/D1.5, Bridge Welding Code
- AWS D1.1, Structural Welding Code – Steel

2008 - 3 DESIGN

(1) Design of the Arch Culvert shall be wholly by the Contractor and shall be performed by a Professional Engineer registered in the Province of Saskatchewan. The design shall include all individual components including plates, fasteners, and anchorage, as well as any temporary loading conditions on the partially completed structure and the structure as a whole. The contractor is also responsible for the design of the transportation, assembly, and erection of all materials.

(2) The design shall be in accordance with the latest edition of the CAN/CSA S6 Canadian Highway Bridge Design Code.

(3) Live loading for the design shall be the following:

- CL-750 Truck Load
- CL-750 Truck and Lane Load

(4) Dynamic load allowance shall be applied to the Live Load in accordance with CAN/CSA S6.

(5) The structure design life shall be 75 years.

(6) At a minimum all steel material shall be hot dip galvanized (915 g/m2) and have a polymer coating (Armtec Strata-Cat coating or approved equal).

2008 - 4 SUBMITTALS

The Contractor shall submit the following to the Engineer:

(1) Complete design notes prior to the commencement of fabrication, prepared, sealed and signed by a Professional Engineer registered in the Province of Saskatchewan. The arch culvert design is to comply with the requirements outlined on the drawings and this specification. Design notes will be reviewed for compliance by the Engineer, fabrication is not to commence until the design notes have been reviewed and accepted by the Engineer.

(2) Copies of Mill Test Certificates showing chemical analysis and physical tests of all metal material prior to commencement of fabrication. Material without this certification will be rejected at the discretion of the Engineer.

(3) Certification of chemical analysis and physical tests for all materials.

(4) 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.

(5) Manufacturer's test reports of mechanical tests on high strength bolts, if requested by the Engineer.

2008 - 5 MANUFACTURER

(1) The manufacturer of the deep corrugated structural plate shall be Armtec Limited, or an equal approved by the Engineer.

(2) An “approved equal” manufacturer must have written approval from the Engineer prior to submitting a bid for the project. A manufacturer requesting approval from the Engineer must supply a list of similar projects for review.

2008 - 6 MATERIALS

(1) The chemical composition shall be such that it does not negatively impact galvanizing of the plates.

(2) The mechanical properties of the flat plates prior to corrugating shall be such that they will have a minimum yield strength of 275 MPa, a minimum tensile strength of 380 MPa, and a

minimum elongation of 25% in 50 mm. These properties normally provide a minimum design yield strength of 300 MPa after the plates are corrugated.

(3) Standard plate thickness' range from 3.0 mm to 7.0 mm in 1 mm increments. The minus tolerance on plate thickness is 0.3 mm. There is no over thickness tolerance.

2008 - 7 CONSTRUCTION METHODS

A. Fabrication

(1) Deep corrugated structural plate shall be formed from materials specified in the clauses under Section 2008 – 6 Materials.

(2) The plates shall be minimum three corrugations wide.

(3) The depth of the corrugation shall have a nominal dimension of 150 mm and shall be not less than 144 mm.

(4) The pitch of the corrugation shall have a nominal dimension of 400 mm and shall be not more than 413 mm.

(5) The inside radius of the corrugation shall have a nominal dimension of 81 mm and shall be not less than 74 mm.

(6) All plates shall be punched for bolting at both longitudinal and circumferential seams.

(7) The longitudinal seam shall be of the lap type of connection. The bolt hole arrangement shall consist of minimum three rows of holes spaced at maximum 100 mm on centres, with a hole located in the valley and crest of each corrugation. The centreline of the first row of holes shall be the greater of 40 mm or 1.75 bolt diameters from the end of the plate. All holes are 25 mm diameter unless noted. The three holes along each edge of the plate (the circumferential seam location) and two outside crest holes in the middle row of longitudinal seam holes are slotted holes measuring 24 mm wide by 29 mm long.

(8) Plate lengths shall be a multiple of the circumferential hole spacing to accommodate circumferential staggering of the longitudinal seam in adjacent rings of plates. The centreline of the row of holes shall be the greater of 40 mm or 1.75 bolt diameters from the

edge of the plate. All circumferential bolt holes are slotted holes measuring 24 mm wide by 29 mm long.

(9) The plates shall be accurately curved to suit the shape of the structure cross section. All members of a similar type, thickness and length shall be interchangeable.

B. Hardware and Accessories

(1) Bolts shall be 19 mm diameter or 22 mm diameter ANSI B18.2.1 Heavy Hex Head Bolts to ASTM A 449 with a zinc coating to ASTM A 153 or B 695, Class 55. They shall have the bearing surface shaped to a 25-mm radius spherical surface.

(2) Nuts shall be ANSI B18.2.2 Heavy Hex Nuts to ASTM A 563 Grade C with a zinc coating to ASTM A 153 or B 695, Class 55, and shall be sized to suit the bolts. They shall have the bearing surface shaped to a 25-mm radius spherical surface.

(3) Galvanized metal channels for the connection of arches to footings are required.

(4) Anchor bolts for head walls, collars and anchorage of arches to footings shall be minimum 19 mm diameter ANSI B18.2.1 Heavy Hex Head Bolts to ASTM A 307 with a zinc coating to ASTM A 153 or B 695, Class 55.

(5) Nuts for anchor bolts shall be 19 mm diameter ANSI B18.2.2 Heavy Hex Nuts to ASTM A 563 Grade A with a zinc coating to ASTM A 153 or B 695, Class 55, and shall be sized to suit the anchor bolts.

C. Coating

(1) The plates shall be galvanized after corrugating, punching and curving.

(2) Zinc shall conform to ASTM B 6 and shall be at least equal to “Prime Western” grade.

(3) The zinc coating mass (total on both sides) shall be not less than 915 g/m2 when tested by the triple spot test, or 825 g/m2 when tested by the single spot test.

(4) The test for coating mass acceptance shall be by nondestructive magnetic thickness test methods in accordance with ASTM E 376. In cases of dispute, the basis for rejection shall be a chemical weigh-strip-weight test as specified in CAN/CSA-G164.

(5) The 915 g/m2 zinc mass is equivalent to a 64 μm zinc thickness measured on one side by the magnetic test method. The 825 g/m2 zinc mass is equivalent to a 58 μm zinc thickness.

(6) The zinc coating shall be free from injurious defects such as blisters, excessive flux, storage stains, foreign inclusions, and uncoated areas more than 3 mm wide.

(7) Uncoated areas that are more than 3 mm wide and up to 50 mm in width shall be repaired by thorough cleaning followed by the application of a zinc-rich coating. The coating shall conform to CAN/CGSB-1.181 and shall be applied to a dry thickness of at least 50 μm.

D. Installation Instructions

(1) Assembly of Structure

(a) The culvert sections shall be assembled in accordance with plate assembly drawing and installation instructions provided and recommended by the supplier.

(b) Before backfilling all bolts shall be tightened to a torque of 200 N-m (150 Ft-Lbs) minimum, 350 N-m (250 Ft-Lbs) maximum.

(c) A regular check is to be made of the line and dimension of the structure while backfilling proceeds. This check shall be used as an evaluation of the influence of the compactive efforts on the shape of the structure. The plumb bob method of monitoring is recommended for this checking procedure. Compactive efforts may increase the rise of the structure.

(2) Backfill Material

(a) Material in the critical backfill zone (within a dimension from the outside of the assembly equal to half the span length) shall be granular with angular grains. Backfill shall be "Crushed Aggregate Material" meeting the requirements of the Specification 2002 – Specifications For Supply and Placing Backfill, table 4B(1) Type 1.

(b) pH of 5 to 10:

- resistivity not less than 3000 OHM-CMS
- chlorides not greater than 100 ppm
- sulphates not greater than 200 ppm

(3) Spreading

(a) Heavy equipment shall operate only as close to the structure as is allowed by the Engineer (as advised by the supplier's representative).

(b) Material is not to be dumped on top of the structure but shall be dumped on either side and then spread in layers suitable for the type of compaction equipment being used. Truck end-dumping or dozer placement against the side of the structure is not permitted.

(c) Backfill shall be placed in layers which shall not exceed 200 mm in depth before compaction. Heavy equipment shall veer away from the ends of the structure, so as to reduce horizontal pressures against the end of the barrel.

(d) Trucks can unload in rough layers starting no closer than 1500 mm from the sidewalls while moving out.

(e) Fill depth shall be maintained approximately equal on each side of the structure at all times. The maximum difference in elevation shall be 400 mm.

(4) Compaction

(a) Areas close to the structure shall be compacted using vibrating or tamping equipment running parallel with the length of the structure at all times.

(b) Granular fill material shall be at optimum moisture content during compaction.

(c) Each fill layer shall be compacted to a minimum of 95% standard proctor density.

(5) Crossing Over the Top

(a) When the backfill reaches an elevation of 2.5 m above the top of the footing, spreading and compaction over the crown must be made in a direction perpendicular to the length of the structure (ie. parallel to the corrugations) until the backfill reaches the finished grade.

(b) The initial covering of the top is the most critical loading situation and must be performed in the presence of the Supplier's Engineer or an authorized representative. 600mm of backfill must exist at all times between the equipment and the structure. This 600 mm cover (cushion arch) must be built up evenly from both sides. The equipment used shall not be heavier than a D-4 Caterpillar dozer (16,000 lbs) for spreading material and not heavier than a Buffalo-Bomag BW-75S for compaction.

(c) Design vehicles/highway traffic may only cross over the structure after fill is placed and compacted to finished height of cover as shown on the drawings.

2008 - 8 QUALITY CONTROL / QUALITY ASSURANCE

A. Quality Control

The Contractor shall be responsible for making a thorough inspection of materials to be supplied under this Work. All metal material shall be free of surface imperfections, porosity, laps, laminations and other defects.

B. Quality Assurance

All materials will be subject to physical inspection by the Engineer and will be subject to rejection during the course of the Work and for the length of time as specified in the General Provisions, if, in the opinion of the Engineer, the materials involved do not meet the requirements of the Drawings and this Specification.

All materials shall be subject to testing by the Engineer 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 Engineer.

The Contractor shall furnish facilities for the inspection of material and workmanship in the mill, shop and field, and the Engineer shall be allowed free access to the necessary parts of the works.

2008 - 9 MEASUREMENT

Design, supply, fabrication, and delivery of Arch Culvert will not be measured.

Installation of Arch Culvert will not be measured.

2008 - 10 PAYMENT

Design, supply, fabrication and delivery of Arch Culvert will be paid for on a Lump Sum basis and no measurement will be taken for this work. The contract lump sum price for "Supply of Arch Culvert" will be payment in full for design, supply, and fabrication operations herein described and all other items incidental to the Work.

Installation of Arch Culvert will be paid for on a Lump Sum basis and no measurement will be taken for this work. The contract lump sum price for "Installation of Arch Culvert" will be payment in full for delivering all material to the site, erection and installation of the culvert, and all other items incidental to the Work.

Backfill material and installation will be paid under Specification 2002 – Supplying and Placing Backfill.

2009 – STONE RIP-RAP

2009 - 1 DESCRIPTION

This specification describes the terms and conditions applicable to the following.

(1) Preparation of bed.

(2) The supply, loading, hauling, unloading, stockpiling and placing of stone rip-rap as a protective covering:

(a) Along the side slopes and bases of channels;

(b) Around piers, abutment footings and wing walls;

(c) On slopes around culvert inlets and outlets;

(d) On embankments; and/or

(e) Other locations indicated on the Drawings or designated by the Engineer.

This specification details the responsibilities of the Contractor.

2009 - 2 REFERENCES AND RELATED SPECIFICATIONS

All reference standards and related specifications shall be current issue or latest revision at the first date of tender advertisement.

A. References

- ASTM C88, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
- ASTM C127, Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
- ASTM C535, Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

B. Related Specifications

- Specification 2010: Supply and Installation of Geotextile Fabric

2009 - 3 SUBMITTALS

The Contractor shall submit the proposed supplier(s) and location of quarry sites for supply of riprap.

Representative samples of the rockfill riprap submitted for material testing purposes shall be completed as specified herein.

2009 - 4 MATERIALS

A. Quality

The Contractor shall supply field stone, quarried rock that is dense, durable, sound, resistant to the action of water and frost, free of fines, and suitable in all respects for the purpose intended.

Stone rip-rap shall be free from organics, fines (<1”), roots, silts, sand, clay, snow, ice, or any other material that would detract from the strength and drainage characteristics of clean rockfill prior to placement. Individual pieces of stone shall be free of defects such as seams or cracks that would cause rapid or excessive deterioration or degradation.

Individual particles shall be shaped such that no dimension is greater than two times the smallest dimension. Flat, elongated, or platy particle shapes will not be accepted.

Should the Contractor choose to use limestone, it shall be durable white crystalline limestone. Softer buff to yellow dolomite or dolostone will not be accepted.

B. Gradation

The stone rip-rap shall be well graded, having a full range and even distribution of sizes, and shall conform to the gradation for the various classes in the Table below.

SIZE, mm (smaller than)	CLASS 600	CLASS 450	CLASS 350
600	100%		
450		100%	
350	15 – 50%		100%
250		15 – 50%	
200	0 – 15%		15 – 50%
150		0 – 15%	
100			0 – 15%

Dependent on conditions and provided there is no additional cost, the Engineer may accept a larger class of stone rip-rap than what is called for on the Drawings.

2009 - 5 CONSTRUCTION METHODS

A. Preparation of Bed

All rockfill riprap shall be placed in the dry under dewatered condition, or in conjunction with the use of silt curtain, unless otherwise specified and accepted by the Engineer.

The ground surface shall be excavated and neatly shaped to the lines as shown on the Drawings or as staked by the Engineer in the field prior to the placing of any rip-rap.

B. Placing

Place geotextile as shown on the Drawings and in accordance with Specification 2010.

The stone rip-rap shall be placed in such a manner that the larger stones are uniformly distributed, the smaller rocks serve to fill the spaces between the larger stones, and that excessive segregation of the various stone sizes does not occur.

Sufficient placing and leveling shall be done to produce a firmly bedded, neat and uniform surface conforming to the thickness, shape, and dimensions shown on the Drawings.

The allowable fill tolerances shall be within ± 50 mm of the grades and thickness shown on the Drawings.

Provide a smooth uniform surface from the existing grade and new riprap when placing outside edges or transitions, as accepted by the Engineer.

Temporary stockpiling of the riprap material may be permitted, subject to the acceptance of the Engineer. The locations and dimensions of all stockpiles shall be such that there will be no detrimental impacts to stability of the existing channel. Any erosion and sedimentation control devices (e.g. silt fence) deemed necessary by the Engineer to protect any temporary stockpile areas shall be supplied and installed at the Contractor's cost.

2009 - 6 QUALITY CONTROL / QUALITY ASSURANCE

The procedures for preparation of all rockfill samples for use in material inspection and testing shall be subject to review and acceptance by the Engineer for individual tests. The samples may be obtained from crushed and processed material at the sizing necessary for specific tests if the material is deemed to be representative of the riprap that will be used, subject to the acceptance of the Engineer.

Representative samples of limestone rip-rap, from the intended source, crushed to maximum 75 mm aggregate size, shall be supplied by the Contractor to the Engineer for approval a minimum of fourteen (14) days prior to supply and placement.

All materials set forth in this Specification shall be subject to inspection and testing by the Engineer or by the testing laboratory designated by the Engineer. There shall be no charge for any materials taken by the Engineer for testing purposes.

The Engineer will visit proposed quarry sites for inspection of the proposed rockfill material and quarry faces a minimum of fourteen (14) days prior to supply and placement of riprap.

No supply and placement of riprap will be permitted prior to the Engineer reviewing the source.

The procedures for preparation of all rockfill samples for use in material inspection and testing shall be subject to review and acceptance by the Engineer for individual tests. The samples may be obtained from crushed and processed material at the sizing necessary for specific tests if the material is deemed to be representative of the riprap that will be used, subject to the acceptance of the Engineer.

The testing frequency necessary to confirm the material quality will be specified at the discretion of the Engineer.

2009 - 7 MEASUREMENT

Supply and placement of stone rip-rap will be measured on a volume or a mass basis.

A. Volume

Where the unit bid item for stone rip-rap is by volume, the volume to be paid for will be the number of cubic metres placed in the completed work as determined by multiplying the actual surface area by the thickness shown on the Drawings or by using the volume rated capacity of the hauling vehicle. The area to be rip-rapped shall not exceed the dimensions shown on the Drawings or as established by the Engineer.

B. Mass

Where the unit bid item for stone rip-rap is by mass, the mass to be paid for will be measured in tonnes of material placed in the completed work. All stone rip-rap paid on a per tonne basis shall be weighed on a certified scale in accordance with GR120.2.11.

The Contractor shall provide the weight tickets to the Engineer for the material supplied to the site at the time of delivery. No payment will be made for any weigh tickets which are not supplied at the time of delivery, or which are lost.

2009 - 8 PAYMENT

Supply and placement of stone rip-rap will be paid for at the Contract Unit Price for "Supply and Placement of Stone Rip-Rap", for each Class, measured as specified herein, which will be payment in full for performing all operations herein described and all other items incidental to the Work.

Specification – 2010
Supply and Installation of Geotextile Fabric Municipal

2010 – SUPPLY AND INSTALLATION OF GEOTEXTILE FABRIC

2010 - 1 DESCRIPTION

This specification describes the terms and conditions applicable to the following.

(1) Separation and reinforcement of granular material.

(a) Surface preparation and supply and installation of woven or non-woven geotextile fabrics.

(2) Filtration of stone rip-rap.

(a) Surface preparation, temporary anchoring and supply and installation of woven or non-woven geotextile fabrics.

(3) Reinforcement of bituminous pavements.

(a) Surface preparation, supply and application of tack coat and supply and installation of woven or non-woven geotextile fabrics.

This specification details the responsibilities of the Contractor.

2010 - 2 REFERENCES AND RELATED SPECIFICATIONS

All reference standards and related specifications shall be current issue or latest revision at the first date of tender advertisement.

A. References

- ASTM D3776, Standard Test Methods for Mass Per Unit Area (Weight) of Fabric
- ASTM D3786, Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics – Diaphragm Bursting Strength Tester Method
- ASTM D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
- ASTM D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextile

2010 - 3 SUBMITTALS

The Contractor shall submit product specification data sheets for all proposed geotextile.

2010 - 4 MATERIALS

A. General

The type and class of geotextile to be used will be identified on the Drawings.

Geotextile rolls shall be furnished with suitable wrapping for protection against moisture and extended ultra-violet exposure prior to placement. If stored outdoors, they shall be elevated and protected with a waterproof cover. The geotextile shall remain wrapped in a protective covering until it is used.

Each geotextile roll to be used shall be tagged to provide product identification for inventory and quality control processes.

For each type and class of geotextile fabric the following minimum specifications shall apply:

B. Non-Woven, Class I (Light Duty)

Property	Specification	Test Method
Mass	120 g/m^2	ASTM D5261
Grab Tensile Strength	330 N	ASTM D4632
Mullen Burst Strength	1000 kPa	ASTM D3786

C. Non-Woven, Class II (Medium Duty)

Property	Specification	Test Method
Mass	240 g/m^2	ASTM D5261
Grab Tensile Strength	600 N	ASTM D4632
Mullen Burst Strength	2000 kPa	ASTM D3786

D. Non-Woven, Class III (Heavy Duty)

Property	Specification	Test Method
Mass	406 g/m^2	ASTM D5261
Grab Tensile Strength	1330 N	ASTM D4632
Mullen Burst Strength	4135 kPa	ASTM D3786

E. Woven, Class I (Light Duty)

Property	Specification	Test Method
Mass	100 g/m^2	ASTM D3776
Grab Tensile Strength	500 N	ASTM D4632
Mullen Burst Strength	1500 kPa	ASTM D3786

F. Woven, Class II (Heavy Duty)

Property	Specification	Test Method
Grab Tensile Strength	1100 N	ASTM D4632
Puncture Strength	480 N	ASTM D4833
Trapezoid Tear	400 N	ASTM D4533
Mullen Burst Strength	3100 kPa	ASTM D3786
Apparent Opening Size	0.43 mm	ASTM D4751
Permittivity	0.050 sec^{-1}	ASTM D4491
UV Resistance	70% @ 500 hrs	ASTM D4355

G. Woven, Class III (Rock Fill)

Property	Specification	Test Method
Grab Tensile Strength	1400 N	ASTM D4632
Puncture Strength	650 N	ASTM D4833
Trapezoid Tear	530 N	ASTM D4533
Mullen Burst Strength	4100 kPa	ASTM D3786
Apparent Opening Size	0.43 mm	ASTM D4751
Permittivity	0.50 sec^{-1}	ASTM D4491
UV Resistance	70% @ 500 hrs	ASTM D4355

2010 - 5 CONSTRUCTION METHODS

A. Separation and Reinforcement of Granular Material

(1) General

All work related to the geotextile storage, handling, and installation shall comply with the procedures and recommendations of the manufacturers, and as accepted by the Engineer.

(2) Surface Preparation

The Contractor shall prepare the surface, in advance of placing the geotextile, to achieve a smooth, even surface, clear of any aggregates, snow, or debris, and constructed to the cross-section and profile indicated on the Drawings.

(3) Geotextile Placement

The geotextile shall be loosely laid onto the subgrade in order to allow conformity to the bedding surface and shall be free of wrinkles, rolls, or bulges. All seams shall be sewn by an approved method or overlapped a minimum of 600 mm.

Pins, nails, or weights shall be installed to hold the fabric in place such that the placement of fill material will not excessively stretch or tear the fabric and seam overlaps will be maintained.

The fabric shall be overlapped in a downstream direction (upstream panel overtop of downstream panel) at all joints a minimum of 600 mm. The overlap shall be pinned or secured as per the manufacturer's recommendations and as accepted by the Engineer.

The required width of geotextile indicated on the Drawings and the minimum overlap shall be maintained during road construction.

(4) Damage to Geotextile

If the geotextile is damaged, torn, or punctured during installation or placement of the fill material, the damaged section shall be repaired immediately at the Contractor's expense.

All fill material shall be cleared a minimum of 1 m around the damaged area. The damaged area shall be covered with a geotextile patch that shall be large enough to be sewn or overlapped a minimum of 600 mm onto the undamaged geotextile. Any fill material on the damaged area shall be replaced and compacted to the required standard as specified in this Specification.

(5) Fill Material

Fill material shall be placed, spread, and compacted on the geotextile in such a manner that the geotextile is not damaged, torn, excessively stretched, or punctured.

The fill material shall be levelled to a uniform lift thickness of no less than 150 mm or as directed by the Engineer.

Dumping of fill material directly on the geotextile will not be permitted.

Trucks, belly-dumps or any other vehicles will not be allowed directly on the geotextile.

A minimum of 300 mm of material shall be placed over the fabric prior to equipment passage.

B. Filtration of Stone Rip-Rap

(1) Surface Preparation

The ground surface shall be shaped neatly and trimmed to the lines as shown on the Drawings or as staked by the Engineer in the field prior to the placing of any geotextile.

(2) Geotextile Placement

The geotextile shall be placed and temporarily anchored in such a manner that placement of the stone riprap shall not excessively stretch or tear the fabric and seam overlaps shall be maintained.

All seams shall be sewn by an approved method or overlapped a minimum of 600 mm in the direction of the flow of water (shingle style). The perimeter of the geotextile shall be anchored as shown on the Drawings or as directed by the Engineer.

Riprap shall be placed on the geotextile in such a manner that the geotextile is not damaged, torn, excessively stretched, or punctured. Where applicable, riprap placement shall begin at the toe and shall proceed up the slope.

(3) Damage to the Geotextile

If the geotextile is damaged, torn, or punctured during installation or placement of the riprap material, the damaged section shall be repaired at the Contractor's expense.

The damaged section shall be exposed and a patch of geotextile placed over the damaged section. The patch shall be large enough to be sewn or overlapped 600 mm onto the undamaged geotextile. Any riprap material on the damaged area shall be replaced.

2010 - 6 QUALITY CONTROL / QUALITY ASSURANCE

Each geotextile roll shall be labelled or tagged to provide product identification sufficient for inventory and quality control purposes.

2010 - 7 MEASUREMENT

Supply and installation for each class of geotextile fabric will be measured in square metres based on the actual ground area covered from measurements made by the Engineer.

Where the Engineer specifies an overlap greater than 600 mm, the additional overlap area will be included in the measurements for payment.

Geotextile used for repairs shall be excluded from the final quantity paid.

2010 - 8 PAYMENT

Supply and installation for each type and class of geotextile fabric will be paid for at the Contract Unit Price for:

(1) "Supply and Placement of Geotextile Fabric, Non-Woven, Class I";

(2) "Supply and Placement of Geotextile Fabric, Non-Woven, Class II";

(3) "Supply and Placement of Geotextile Fabric, Non-Woven, Class III";

(4) "Supply and Placement of Geotextile Fabric, Woven, Class I";

(5) "Supply and Placement of Geotextile Fabric, Woven, Class II"; and

(6) "Supply and Placement of Geotextile Fabric, Woven, Class III".

measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

2011 – QUALITY CONTROL FOR GRANULAR BACKFILL

2011 - 1 DESCRIPTION

This specification describes the terms and conditions applicable to the following.

(1) Quality control testing in accordance with the frequency and test methods described in this Specification.

This specification details the responsibilities of the Contractor.

2011 - 2 REFERENCES AND RELATED SPECIFICATIONS

All reference standards and related specifications shall be current issue or latest revision at the first date of tender advertisement.

A. References

- ASTM C88, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
- ASTM C117, Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
- ASTM C131, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- ASTM C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
- ASTM D5821, Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
- ASTM C295, Standard Guide for Petrographic Examination of Aggregates for Concrete
- ASTM D698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))
- ASTM D2922, Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
- ASTM D3017, Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
- ASTM D4318, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- CSA A23.2-3A, Clay Lumps in Natural Aggregate
- CSA A23.2-9A, Test for Soundness of Aggregate

B. Related Specifications

- Specification 2002: Supplying and Placing Backfill

2011 - 3 SUBMITTALS

The Contractor shall submit the following to the Engineer:

(1) Results of all quality control tests shall be submitted to the Engineer as they become available. The Contractor shall bear the cost of all consulting services retained by them.

(2) The gradation tests for aggregate production shall be submitted as a "Summary of Test Results" for testing carried out during production. The Engineer shall have access to all tests, as requested.

2011 - 4 MATERIALS

A. Material Property and Testing Frequency

(1) Supplying and Placing Backfill

Property	**Testing Frequency**	**Test Method**
Gradation	Every 2 hours during aggregate production Weekly during placement	ASTM C136 ASTM C117
Crush Count	Daily during aggregate production Weekly during placement	ASTM D5821
Shale content	At the beginning of the project	ASTM C295
LA abrasion	At the beginning of the project	ASTM C131
Clay balls	At the beginning of the project	CSA A23.2-3A
Soundness	At the beginning of the project	CSA A23.2-9A ASTM C88
Plasticity Index	At the beginning of the project	ASTM D4318
Standard Proctor density	At the beginning of the project	ASDTM D698
Field density and moisture	One test per lane per 100 m per lift	ASTM D2922 ASTM D3017

2011 - 5 QUALITY CONTROL / QUALITY ASSURANCE

A. Quality Control

The tests must be accepted by the Engineer to be deemed part of the frequency requirements.

Only the applicable tests, for the corresponding material type or class, shall be carried out and submitted.

B. Quality Assurance

The Engineer may take random samples of each of the materials for testing to ensure compliance with the requirements of this Specification. The Engineer shall have access to the work at all time for taking samples.

The Contractor shall reinstate concrete layers or other structures to prior condition at the position where samples have been taken.

2011 - 6 MEASUREMENT

All quality control testing is incidental to the referenced specification therefore no measurement shall be made.

2011 - 7 PAYMENT

All quality control testing is incidental to the referenced specification therefore no payment shall be made.

2012 - DEMOLITION AND REMOVAL OF EXISTING STRUCTURES

2012 - 1 DESCRIPTION

This specification describes the terms and conditions applicable to the following.

(1) Demolition, removal and disposal of existing concrete, steel, or timber structures, including but not limited to abutments, piers, girders, deck, curbs and culverts.

(2) Design, supply, fabrication, installation, maintenance and removal of demolition catch platforms;

(3) Backfilling of cavities created; and

(4) Site restoration.

This specification details the responsibilities of the Contractor.

2012 - 2 REFERENCES AND RELATED SPECIFICATIONS

All reference standards and related specifications shall be current issue or latest revision at the first date of tender advertisement.

A. Related Specifications

- Specification 2000: Temporary Works
- Specification 2002: Supplying and Placing Backfill

2012 - 3 SUBMITTALS

The Contractor shall submit the following to the Engineer:

(1) A detailed plan and schedule clearly illustrating the method and sequence by which the Contractor proposes to demolish and remove the existing structures (in whole or in part), including a description of the measures that will be implemented to meet the environmental requirements. The demolition 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 Saskatchewan necessary to describe the following:

(a) Access roads, Site Work Roads, work bridges and working platforms in accordance with Specification 2000: Temporary Works.

(b) Type and capacity of equipment.

(c) Sequence of operation, including position of equipment.

(d) Proposed method of traffic accommodation and protection of the travelling public, when required.

(e) Design of demolition catch platforms.

(f) Description of the measures that will be implemented to meet all Environmental requirements, including all monitoring and reporting requirements.

(g) Details and schedule of site restoration.

(h) Measures to be taken to protect adjacent structures, adjacent grades and portions of existing structure to remain.

(2) Upon completion of the Work, a letter bearing the seal of the Registered Professional Engineer certifying that he has carried out a personal inspection of the Work and the method of demolition and removal, including any temporary works and the measures to meet the environmental requirements, have been completed in accordance with his sealed plans and procedures.

(3) A description of the quantity and location for the demolition waste that will be recycled and reused.

2012 - 4 CONSTRUCTION METHODS

A. Closing to Traffic

The Contractor shall not close any portion of the existing roadway detour to traffic or begin the demolition operations without prior written approval from the Engineer. The approval will not be given until all required traffic control devices have been erected and the requirements of the traffic control plan have been met to the satisfaction of the Engineer.

B. Demolition

(1) General

The Contractor shall be fully responsible for ensuring 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 his actions. The Contractor shall prevent movement, settlement or damage to adjacent structures, grades or portions of existing structures to remain. If the safety of the structure being removed, or adjacent structures or grades appear to be in danger, the Contractor shall cease operations and notify the Engineer immediately.

All culvert components, in whole or in part, that have been deemed non-salvable by the Engineer, shall not be reused in any other culvert or structure in the future, and shall be disposed of off-site

The Contractor shall obtain and pay for all licenses and permits, and shall comply with all Municipal, Provincial and Federal regulations related to demolition and disposal of these materials.

(2) Demolition Catch Platform

The demolition catch platform shall be designed and constructed as required to catch and retain all products of demolition, from falling onto roadway surfaces, railway right-of-way surfaces or open water during the Contractor's operations.

The demolition catch platform shall be designed and constructed so that the minimum vertical clearances over waterways, as required for navigation, are provided. The platform shall include, but not necessarily be limited to deck edge platforms and other catch platforms as required to collect and contain all products of demolition and all other debris.

C. Removal and Disposal of Demolished Materials

Any debris that falls off the structures onto the underlying ground shall be immediately cleaned up by the Contractor.

The Contractor shall remove all demolished materials and debris from the site as soon as possible. All material shall be deemed non-salvable unless noted otherwise on the Drawings or Special Provisions. Demolition debris shall become the property of the Contractor and shall be properly disposed of at an approved location, in accordance with the applicable Provincial and Municipal Regulations and Acts. Storage of non-salvable materials and debris will not be allowed on site without the written approval of the Engineer.

The Contractor shall recycle and reuse as much of the demolition debris as is reasonably practical.

D. Backfilling of Cavities

The Contractor shall backfill all cavities created by the demolition operations with suitable material approved by the Engineer and in accordance with the Drawings and Specification 2002: Supplying and Placing Backfill.

E. Site Restoration

The Contractor shall restore the site to the profile and grade as shown on the Drawings and to the approval of the Engineer.

2012 - 5 QUALITY CONTROL / QUALITY ASSURANCE

The Contractor shall allow the Engineer unhindered access to the demolition areas and shall assist the Engineer in carrying out inspections, including provision of access platforms.

Upon completion of demolition (in whole or in part), a final inspection will be made by the Engineer. For partial demolition, any damage to the existing structure shall be repaired to the satisfaction of the Engineer before further work is undertaken.

2012 - 6 MEASUREMENT

Demolition and removal of existing structures will be paid for on a Lump Sum Basis, and no measurement will be taken for this work.

2012 - 7 PAYMENT

Demolition and removal of existing structures will be paid for at the Contract Lump Sum Price for "Demolition and Removal of Existing Structures", measured as specified herein, which price will be payment in full for performing all operations herein described and all other items incidental to the Work.

2013 – DRAINAGE CHANNEL

2013 - 1 DESCRIPTION

This specification describes the terms and conditions applicable to the following.

(1) Construction of a drainage channel from an oxbow pond to Big Gully Creek, as shown on the Drawings and described in this Specification;

This specification details the responsibilities of the Contractor.

2013 - 2 REFERENCES AND RELATED SPECIFICATIONS

All reference standards and related specifications shall be current issue or latest revision at the first date of tender advertisement.

A. References

- Regulations of Federal, Provincial, and Municipal authorities.

B. Related Specifications

- Specifications 2000 Temporary Works

2013 - 3 SUBMITTALS

The Contractor shall submit the following to the Engineer:

(1) A detailed plan and schedule clearly illustrating the method and sequence by which he proposes to stage the Works related to the drainage channel in accordance with the Drawings and this Specification.

(2) Product specification sheets for erosion control blanket to be used in the construction of the drainage channel.

2013 - 4 MATERIALS

A. Erosion Control Blanket

Erosion Control Blanket (ECB) shall be a machine-produced mat of 100% agricultural straw with a functional longevity of up to 12 months. Suitable products include S150 manufactured by North American Green, S32 by Erosion Control Blanket, or approved equivalent.

The ECB shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. The blanket shall be covered on the top and bottom sides with lightweight photodegradable polypropylene netting having ultraviolet additives to delay breakdown and a maximum 1.27 x 1.27 cm mesh. The blanket shall be sewn together on 3.81 cm centres (maximum) with degradable thread.

ECB shall have the following properties:

(1) Matrix 100% straw fibre 0.27 kg/m².

(2) Netting top and bottom lightweight photodegradable (0.73 kg/100 m²).

(3) Degradable thread.

2013 - 5 CONSTRUCTION METHODS

A. Excavation Requirements

The Contractor shall excavate only material that is necessary for the construction of the drainage channel. The drainage channel only needs to be of sufficient size and depth to provide gravity drainage of the oxbow pond above the normal water level to Big Gully Creek. The final geometry of the drainage channel will be determined in the field and approved by the Engineer.

B. Erosion Control Blanket

(1) General

The Contractor shall supply, install and maintain all ECB's as shown on the drawings or as directed by the Engineer.

Actual alignment and location of the ECB may be adjusted in the field by the Engineer compared with the locations shown on the drawings.

(2) Erosion Control Blanket – Drainage Channel Installation

In general, the Contractor shall excavate a trench 150 mm deep by 150 mm wide at the upstream end of the drainage channel and leave 300 mm of ECB beyond the upslope portion of the trench. The Contractor shall anchor the Erosion blanket with 200 mm long staples in the trench drawings. Staples shall be a minimum of 300 mm apart. The Contractor shall backfill the trench with soil and compact. Seed shall be applied to compacted soil in the trench. The Contractor shall fold the remaining portion of blanket over seeded soil and secure with staples spaced 300 mm (minimum) apart across the width of the blanket.

Starting with the blanket on bottom of drainage channel, roll blanket out in direction of water flow. Securely fasten blanket against soil surface with staples. There shall be a minimum of 4 staples per square metre. Place blankets end over end in the downstream direction and secure overlaps with a double row of staples, staggered 100 mm (maximum) apart. There shall be a minimum 100 to 150 mm overlap between blankets in the downstream direction.

A staple check slot consisting of a double row of staples staggered 100 mm apart and 100 mm on centre over the entire width of the channel shall be installed at 10 m intervals along the length of the channel.

At the downstream end of the drainage channel, excavate a trench 150 mm deep by 150 mm wide and insert terminal end of ECB. Anchor blanket with a row of staples a maximum of 300 mm apart. Backfill trench with soil and compact. Apply seed to compacted soil in trench.

Repeat with blankets along the side slopes of the drainage channel. The overlap between adjacent blankets in the channel side slope direction shall be 150 mm (depending of blanket type). At the top of the side slope the full length edge of the blanket shall be anchored into a 150 mm deep by 150 mm wide anchor trench with staples spaced 300 mm apart (minimum). The anchor trench shall be backfilled and compacted upon completion of stapling.

(3) Erosion Control Blanket – Side Slope Installation

For erosion control blanket installation on side slopes, excavate a trench 150 mm deep by 15 cm wide at the top of slope area leave 300 mm of ECB beyond the upslope portion of the trench. Anchor blanket with 200 mm long staples in trench. Staples shall be a minimum 300 mm apart. Backfill trench with soil and compact. Apply seed to compacted soil. Fold remaining portion of blanket over seeded soil and secure with staples spaced 300 mm apart (maximum) across width of blanket.

Roll blanket down slope. Secure blanket to soil with staples. There shall be a minimum of 2 staples per square metre.

There shall be a minimum 150 mm overlap between blankets in the down slope direction. Staples through the overlap areas shall be a minimum 300 mm apart.

The edges of parallel blankets shall have a minimum overlap of 150 mm (depending on type) and a minimum staple spacing of 300 mm.

2013 - 6 QUALITY CONTROL / QUALITY ASSURANCE

A. Quality Control

The geometry of the drainage channel will be inspected by the Engineer and adjusted as required to meet the Engineer's approval before final acceptance.

2013 - 7 MEASUREMENT

A. Construct Drainage Channel from Oxbow to Big Gully Creek

The construction of the drainage channel and all related works and materials required will be paid for on a lump sum basis, and no separate measurement will be made for this work.

2013 - 8 PAYMENT

Construction of the drainage channel will be paid for at the Contract Lump Sum Price for "Construct Drainage Channel from Oxbow to Big Gully Creek".

R.M. OF ELDON NO. 471
PROJECT 458: S.E. OF 16-49-22-W3

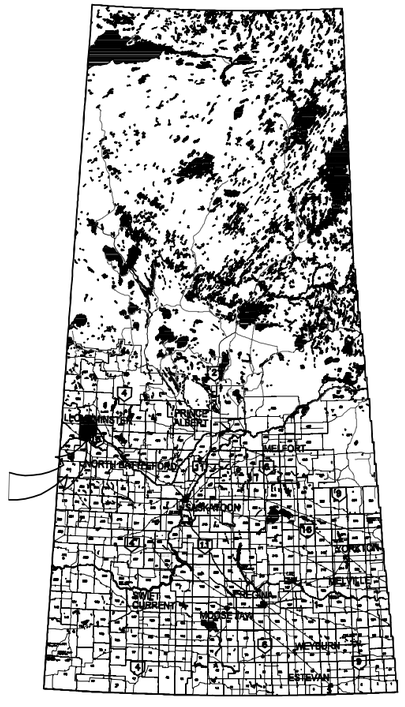
ISSUED FOR TENDER

LIST OF PROJECT DRAWINGS

Issue Date: 2016/08/19

AECOM

Saskatchewan



KEY MAP

PROFESSIONAL ENGINEER
F. TABET
MEMBER 30052
2016 08 19
YR. MN. DAY
SASKATCHEWAN

ASSOCIATION OF PROFESSIONAL ENGINEERS & GEOSCIENTISTS OF SASKATCHEWAN
CERTIFICATE OF AUTHORIZATION
AECOM Canada Ltd.
NUMBER C1667
PERMISSION TO CONSULT HELD BY:
DISCIPLINE | SASK. REG. No. | SIGNATURE
STRUCTURAL | 30052 | F. Tabet

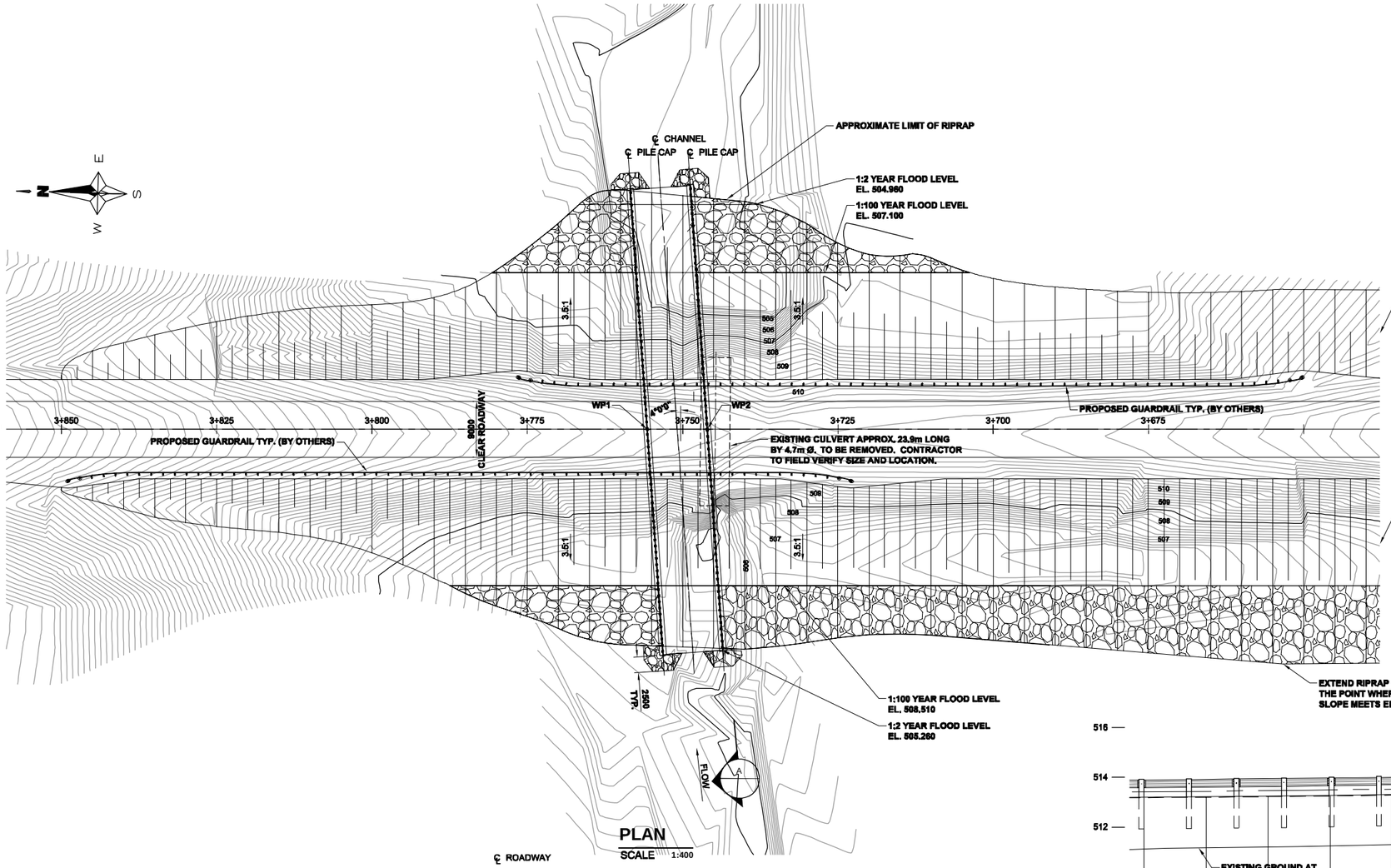
Set No.: _____

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
60336819	S-0000	1

NOTES:

1. DESIGN SPECIFICATION CHBDC CAN/CSA S6-14.
2. LIVE LOAD: CL-750 WITH DYNAMIC LOAD ALLOWANCE (DLA).
3. ROADWAY ELEVATION AT TOP OF CENTERLINE FINISHED CROWN.
4. ALL STATIONS AND ELEVATIONS ARE IN METRES, ALL OTHER DIMENSIONS ARE IN MILLIMETRES.

WORKING POINTS CO-ORDINATES C.S.R.S. (NAD 83) V.T.M. GRID			
WP	STATION	NORTHING	EASTING
WP1	3+755.716	5898840.611	623482.980
WP2	3+746.042	5898830.941	623483.220



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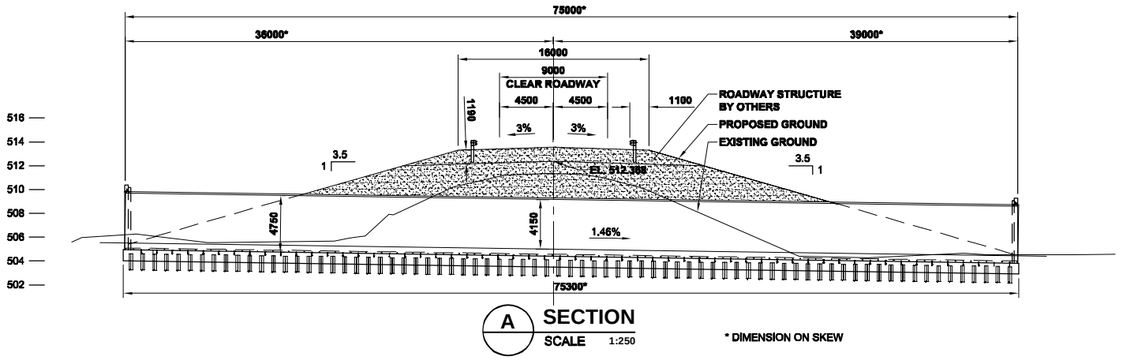
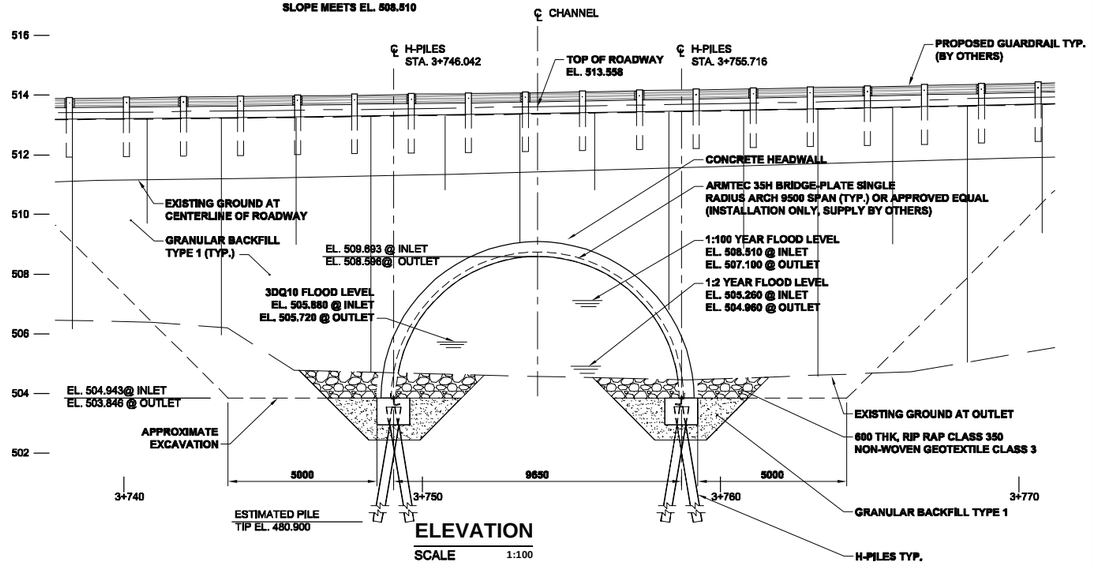


A SECTION
SCALE 1:250

* DIMENSION ON SKEW



ELEVATION
SCALE 1:100

PROFESSIONAL SEALS

PROFESSIONAL ENGINEER SASKATCHEWAN
F. TABET
MEMBER 30052
2016 08 19
YR. MN. DAY

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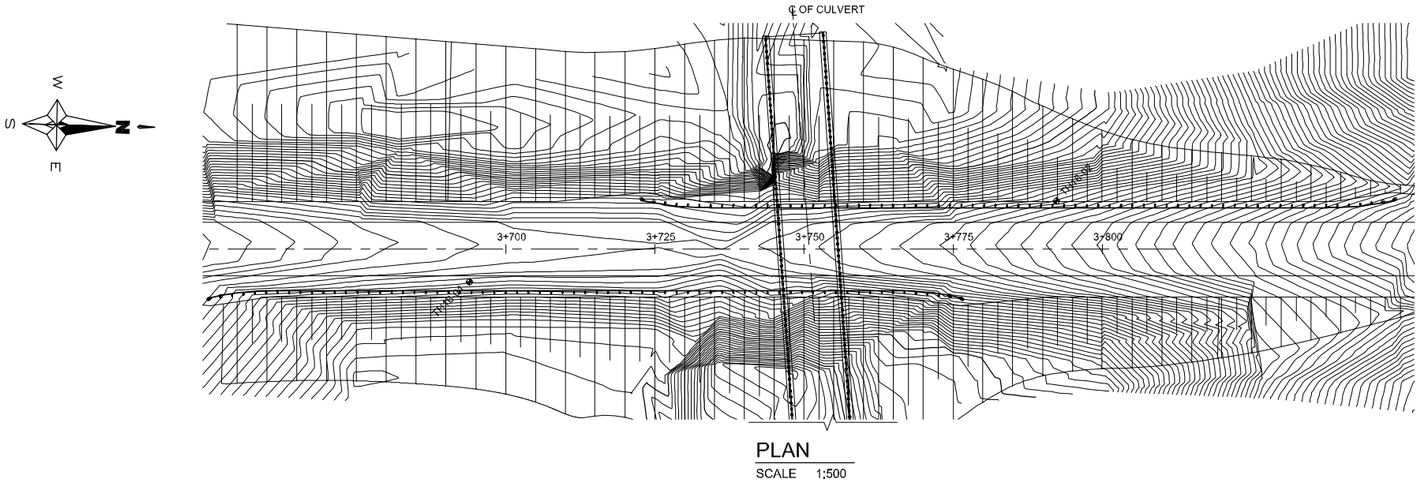
1	16/08/19	ISSUED FOR TENDER	KC	NGD	FT	FT	DKD	NGD
0	16/08/10	ISSUED FOR TENDER	KC	NGD	FT	FT	DKD	NGD

AECOM

R.M. OF ELDON NO. 471
PROJECT 458: S.E. OF 16-49-22-W3

GENERAL ARRANGEMENT

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
60336819	S-0001	1



PLAN
SCALE 1:500

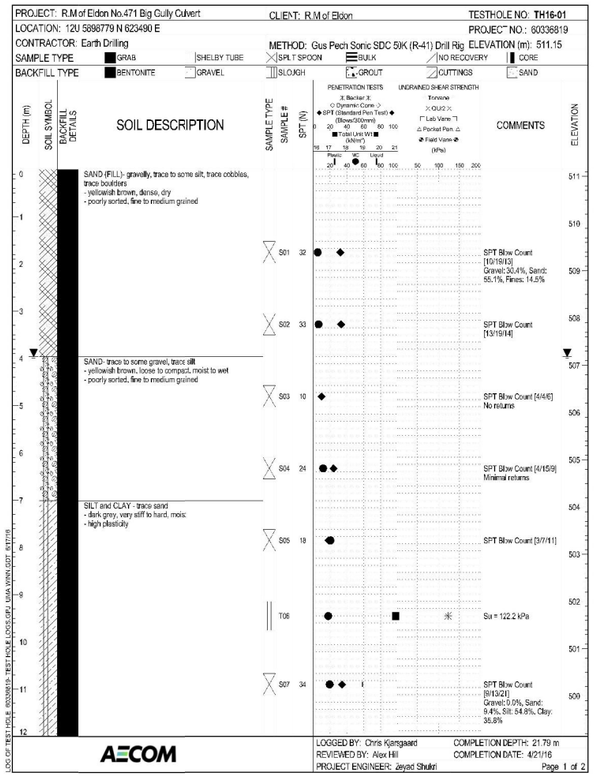
TEST HOLE COORDINATES		
C.S.R.S. (NAD83) U.T.M. GRID		
	NORTHING	EASTING
TH16-01	5898779	623490
TH16-02	5898877	623474

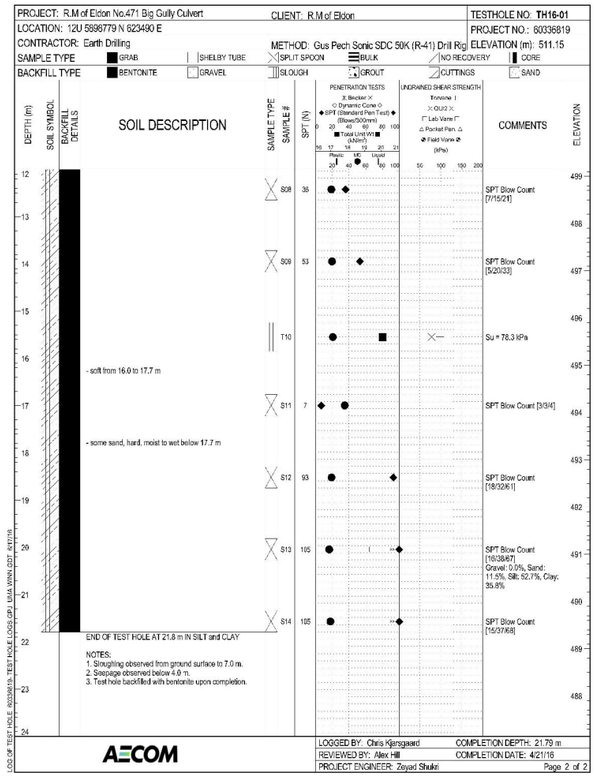
NOTES

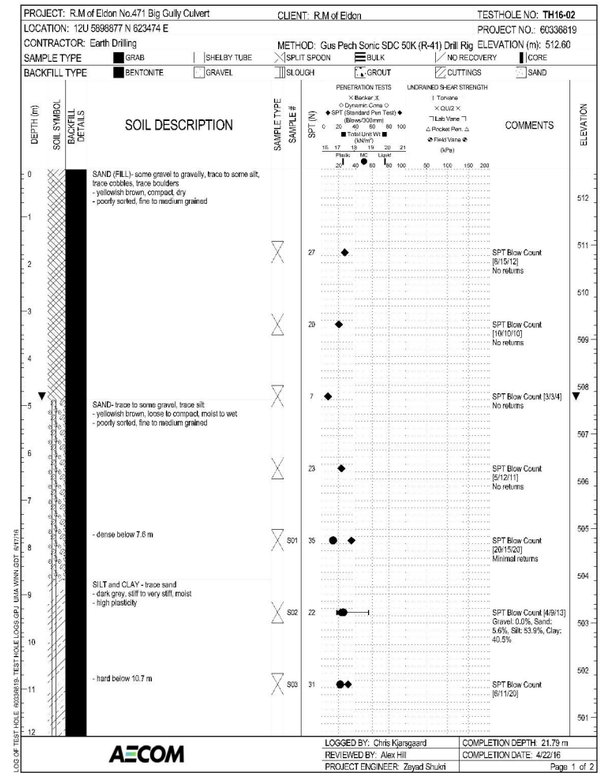
1. USE THIS DRAWING ONLY AS A GUIDE. ARRANGE FOR A SITE VISIT TO CONFIRM THE EXISTING CONDITIONS.
2. REFER TO GEOTECHNICAL REPORT FOR THE COMPLETE DESCRIPTION OF THE BORING LOGS.

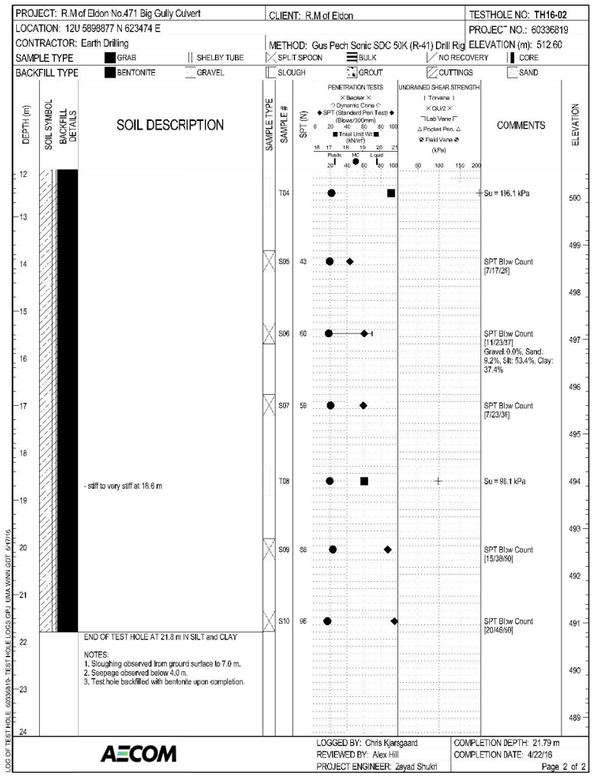
GEOTECHNICAL NOTES

"ALL GEOTECHNICAL INFORMATION PROVIDED IN THESE PLANS HAS BEEN PROVIDED FOR THE DESIGN AND CONSTRUCTION OF ARCH CULVERT FOR R.M. OF ELDON No.471 PROJECT 458: S.E. OF 16-49-22-W3. ANY THIRD PARTY USING THIS INFORMATION MAY USE THIS INFORMATION WITH THE FOLLOWING LIMITATION: WHILE IT IS BELIEVED TO CORRECTLY REPRODUCE OR SUMMARIZE OBSERVATIONS MADE DURING TESTING, IT IS ONLY VALID FOR THE PRECISE LOCATION(S) SHOWN, AND IS NOT TO BE CONSTRUED AS GUARANTEEING THE ACTUAL MATERIALS AND CONDITIONS EXISTING THROUGHOUT THE SITE. THE TESTING METHODS USED MAY NOT HAVE DETERMINED THE PRESENCE, ABSENCE OR EXTENT OF BOULDERS, HARD OR SOFT FORMATIONS, WATER TABLES, ARTESIAN CONDITIONS AND OTHER VARIABLES. IT IS THE RESPONSIBILITY OF OTHERS USING THIS INFORMATION TO ENSURE THAT IT IS ADEQUATE FOR THEIR PURPOSES, OR TO SUPPLEMENT IT WITH ADDITIONAL INFORMATION.









METRIC
WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

PROFESSIONAL SEALS

PROFESSIONAL ENGINEER SASKATCHEWAN F. TABET MEMBER 30052 2016 08 19 YR. MO. DAY

ASSOCIATION OF PROFESSIONAL ENGINEERS & GEOSCIENTISTS OF SASKATCHEWAN
CERTIFICATE OF AUTHORIZATION
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NUMBER C1667
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DISCIPLINE STRUCTURAL SASK. REG. No. 30052 SIGNATURE F. Tabet

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AECOM

R.M. OF ELDON NO. 471
PROJECT 458: S.E. OF 16-49-22-W3

SITUATION PLAN

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
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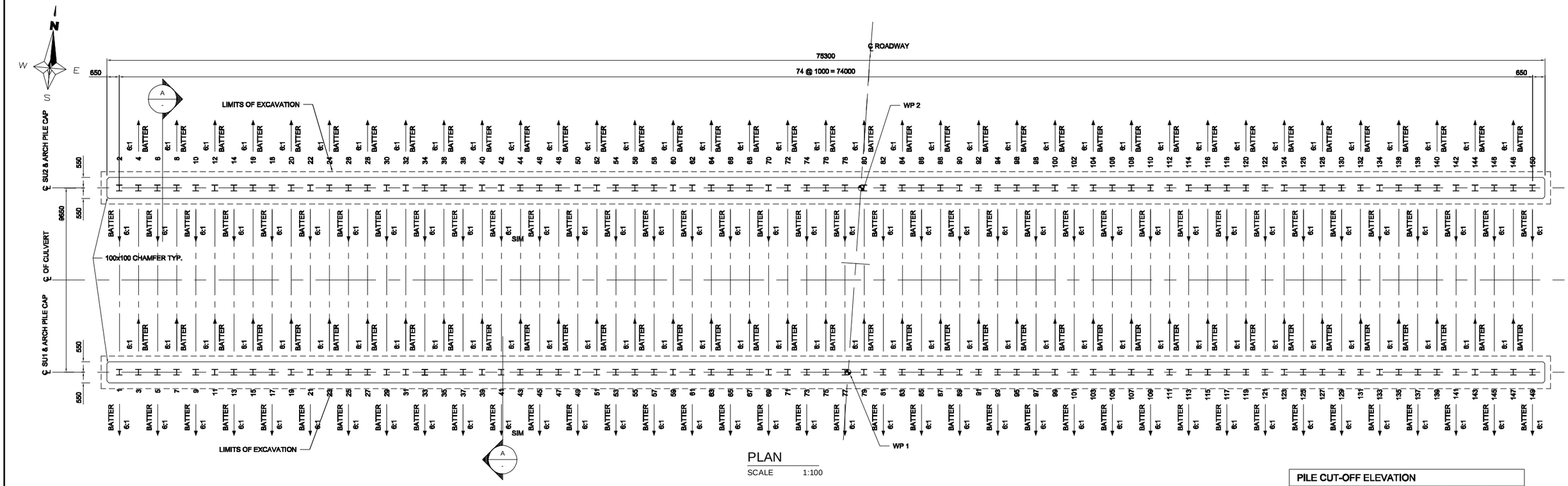

PLAN
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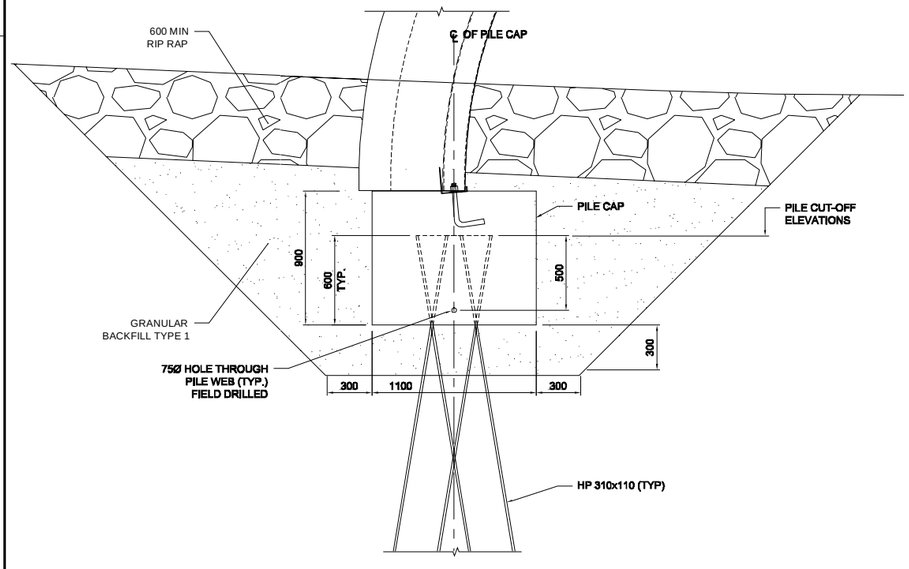
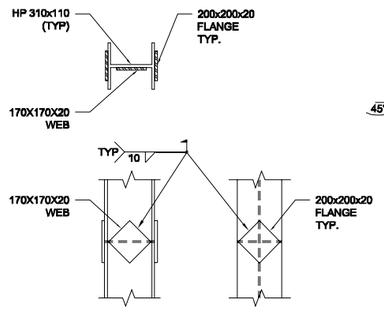


A - SECTION (SU1 & SU2)
SCALE 1:20



PILE SPLICE DETAIL
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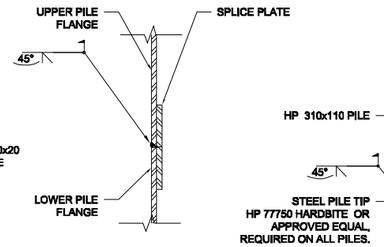

PILE SPLICE DETAIL
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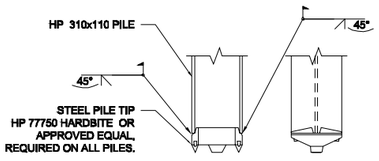

PILE TIP DETAIL
SCALE 1:10

PILE CUT-OFF ELEVATION

PILE	ELEVATION	PILE	ELEVATION	PILE	ELEVATION
1 & 2	504.634	51 & 52	504.269	101 & 102	503.905
3 & 4	504.619	53 & 54	504.255	103 & 104	503.891
5 & 6	504.604	55 & 56	504.240	105 & 106	503.876
7 & 8	504.590	57 & 58	504.226	107 & 108	503.861
9 & 10	504.575	59 & 60	504.211	109 & 110	503.847
11 & 12	504.561	61 & 62	504.196	111 & 112	503.832
13 & 14	504.546	63 & 64	504.182	113 & 114	503.818
15 & 16	504.532	65 & 66	504.167	115 & 116	503.803
17 & 18	504.517	67 & 68	504.153	117 & 118	503.789
19 & 20	504.502	69 & 70	504.138	119 & 120	503.774
21 & 22	504.488	71 & 72	504.124	121 & 122	503.759
23 & 24	504.473	73 & 74	504.109	123 & 124	503.745
25 & 26	504.459	75 & 76	504.095	125 & 126	503.730
27 & 28	504.444	77 & 78	504.080	127 & 128	503.716
29 & 30	504.430	79 & 80	504.065	129 & 130	503.701
31 & 32	504.415	81 & 82	504.051	131 & 132	503.687
33 & 34	504.400	83 & 84	504.036	133 & 134	503.672
35 & 36	504.386	85 & 86	504.022	135 & 136	503.657
37 & 38	504.371	87 & 88	504.007	137 & 138	503.643
39 & 40	504.357	89 & 90	503.993	139 & 140	503.628
41 & 42	504.342	91 & 92	503.978	141 & 142	503.614
43 & 44	504.328	93 & 94	503.963	143 & 144	503.599
45 & 46	504.313	95 & 96	503.949	145 & 146	503.585
47 & 48	504.298	97 & 98	503.934	147 & 148	503.570
49 & 50	504.284	99 & 100	503.920	149 & 150	503.555

BILL OF PILES
FOR BOTH ABUTMENTS

LOCATION	DESCRIPTION	No. OF PILES
SU1	STEEL PILES - HP 310 X 110	75
SU2	STEEL PILES - HP 310 X 110	75

NOTES:

1. PILE SPACING IS GIVEN AT THE BOTTOM OF THE PILE CAP.
2. FOR WORKING POINT COORDINATES REFER TO SHEET S-0001
3. FACTORED BEARING RESISTANCE OF PILES WITH PDA TESTING: 1226 kN
4. SERVICE BEARING RESISTANCE OF PILES: 925kN

PROFESSIONAL SEALS

PROFESSIONAL ENGINEER SASKATCHEWAN
F. TABET
MEMBER 30052
2016 08 10
YR. MN. DAY

ASSOCIATION OF PROFESSIONAL ENGINEERS & GEOSCIENTISTS OF SASKATCHEWAN
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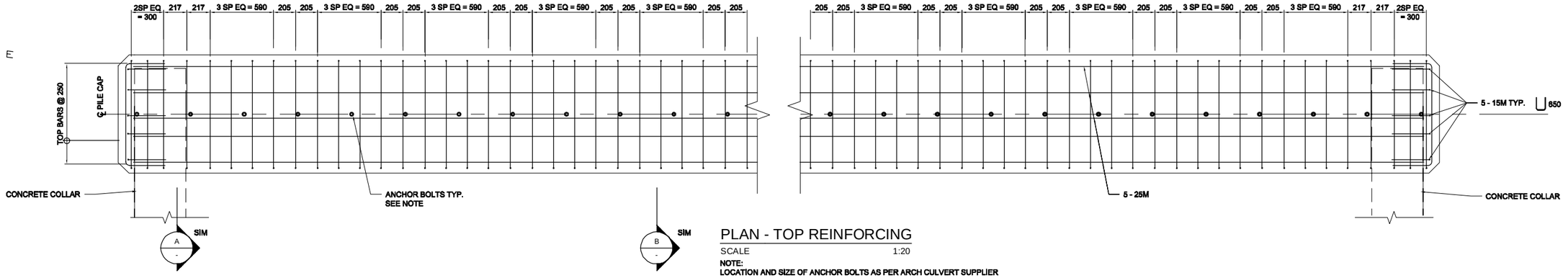
0	16/08/10	ISSUED FOR TENDER	KC	NGD	FT	FT	DKD	NGD

AECOM

R.M. OF ELDON NO. 471
PROJECT 458: S.E. OF 16-49-22-W3

PILE LAYOUT

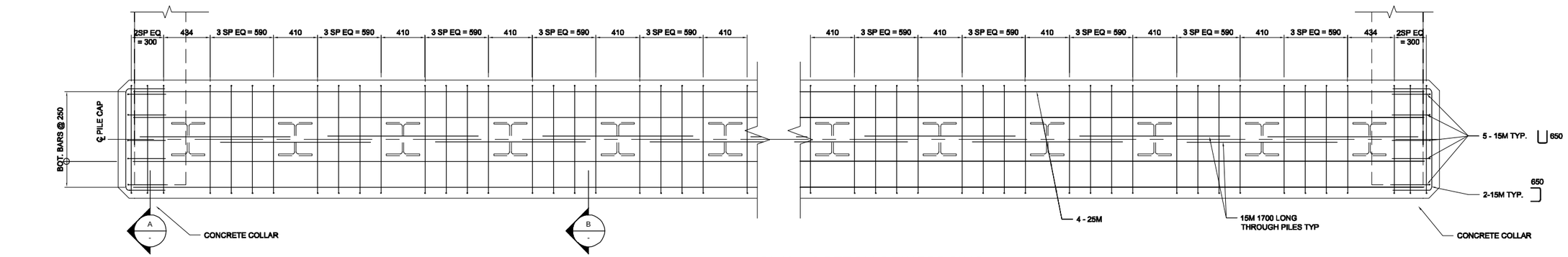
PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
60336819	S-0003	0



PLAN - TOP REINFORCING

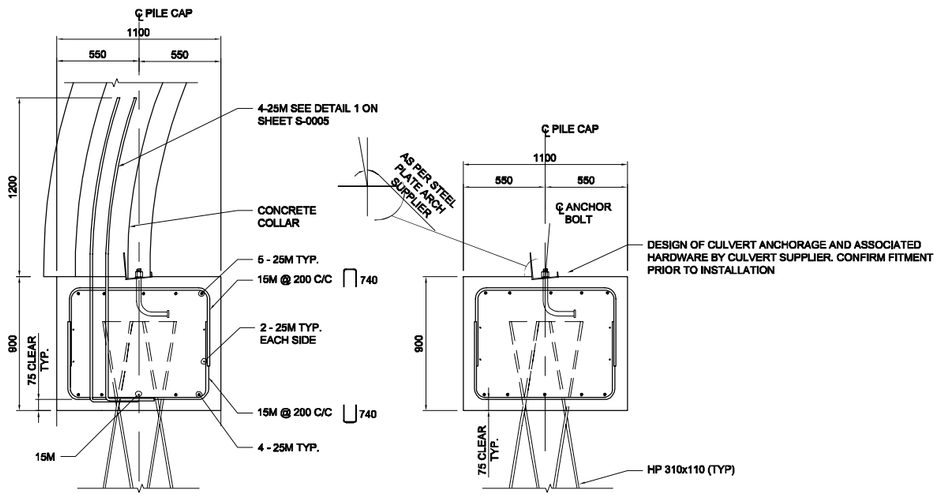
SCALE 1:20

NOTE:
LOCATION AND SIZE OF ANCHOR BOLTS AS PER ARCH CULVERT SUPPLIER



PLAN - BOTTOM REINFORCING

SCALE 1:20



A - SECTION
SCALE 1:20

B - SECTION
SCALE 1:20

GENERAL NOTES

1. USE 35 MPa CONCRETE FOR PILE CAP AND CULVERT COLLAR.
2. REINFORCING STEEL SHALL CONFORM TO CSA G30.18M, fy = 400 MPa.
3. ALL REINFORCING STEEL SHALL HAVE 50mm CLEAR COVER UNLESS NOTED OTHERWISE.
4. MINIMUM LAP LENGTH
   - 10M 450 mm
   - 15M 650 mm
   - 20M 800 mm
   - 25M 1200 mm
   - 30M 1550 mm
5. FOR HORIZONTAL REINFORCEMENT PLACED WITH MORE THAN 300mm FRESH CONCRETE BELOW IT, MULTIPLY LAP LENGTHS BY 1.30.
6. ALL CONCRETE EDGES SHALL HAVE A 20 mm CHAMFER OR FILLET UNLESS NOTED OTHERWISE.

PROFESSIONAL SEALS

PROFESSIONAL ENGINEER SASKATCHEWAN
F. TABET
MEMBER 30052
2016 08 10
YR. MN. DAY

ASSOCIATION OF PROFESSIONAL ENGINEERS & GEOSCIENTISTS OF SASKATCHEWAN
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NUMBER C1667
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DISCIPLINE SASK. REG. No. SIGNATURE
STRUCTURAL 30052 F. Tabet

I/R	YY/MM/DD	ISSUE/REVISION DESCRIPTION	DRN	CHK	DES	ENG	IDR	APP
0	16/08/10	ISSUED FOR TENDER	KC	NGD	FT	FT	DKD	NGD

AECOM

R.M. OF ELDON NO. 471
PROJECT 458: S.E. OF 16-49-22-W3

PILE CAP REINFORCEMENT DETAILS

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
60336819	S-0004	0

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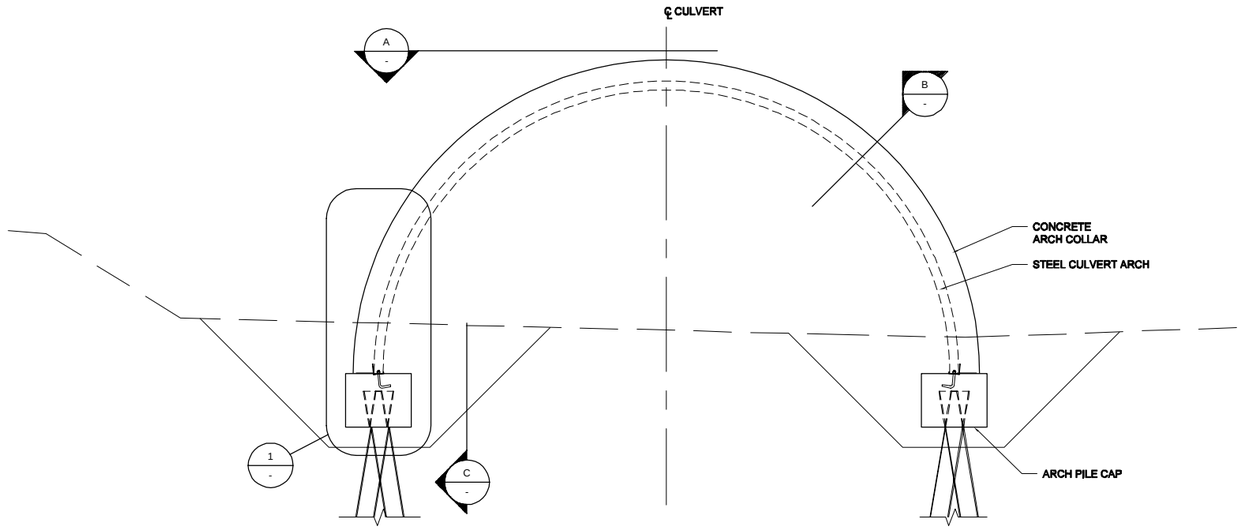

CONCRETE COLLAR ELEVATION
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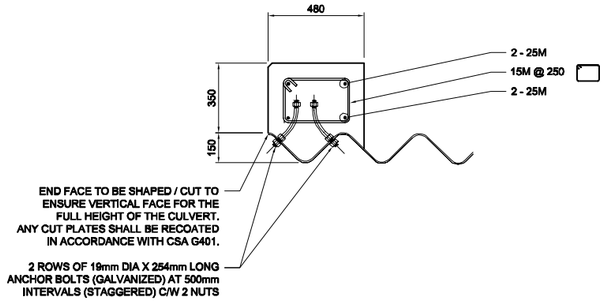

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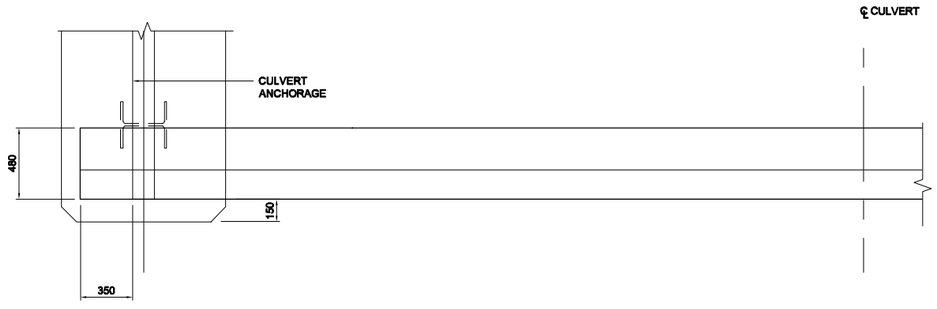

A - CONCRETE COLLAR PLAN
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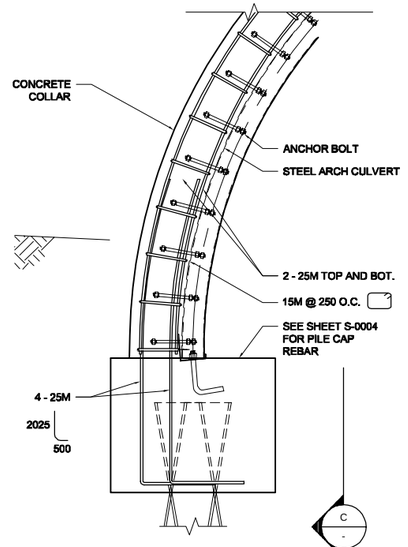

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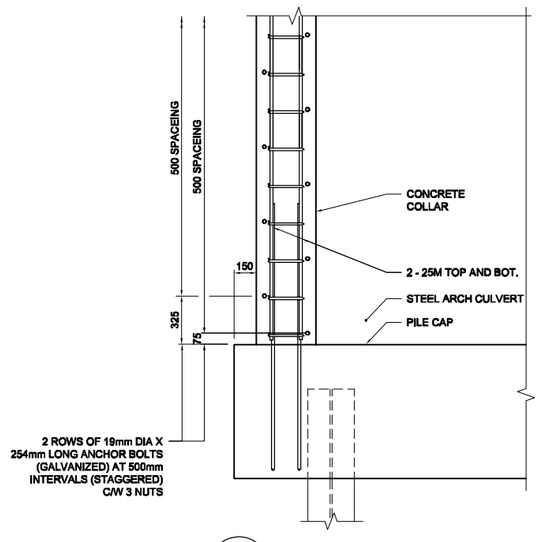
SCALE 1:20



C - SECTION
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PROFESSIONAL SEALS

PROFESSIONAL ENGINEER SASKATCHEWAN
F. TABET
MEMBER 30052
2016 08 10
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ASSOCIATION OF PROFESSIONAL ENGINEERS & GEOSCIENTISTS OF SASKATCHEWAN
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AECOM

R.M. OF ELDON NO. 471
PROJECT 458: S.E. OF 16-49-22-W3

CONCRETE COLLAR

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
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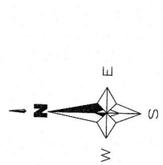
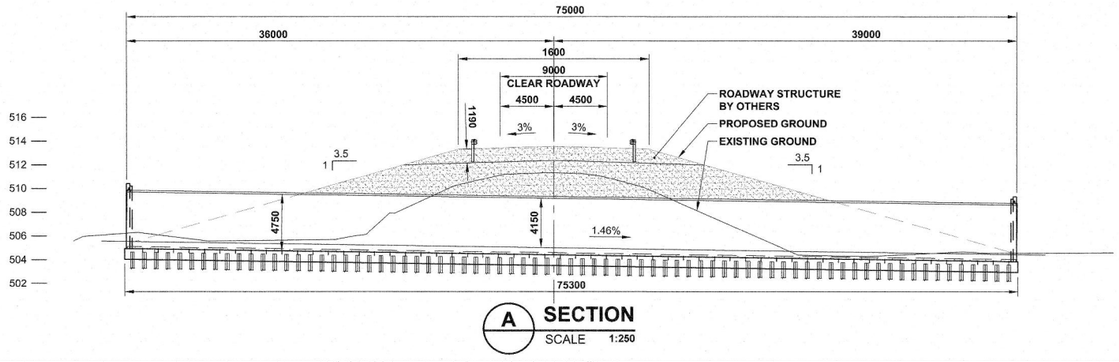


PLAN
SCALE 1:400

NOTES:

1. DESIGN SPECIFICATION CHBDC CAN/CSA S6-14.
2. LIVE LOAD: CL-750 WITH DYNAMIC LOAD ALLOWANCE (DLA).
3. ROADWAY ELEVATION AT TOP OF CENTERLINE FINISHED CROWN.
4. ALL STATIONS AND ELEVATIONS ARE IN METRES, ALL OTHER DIMENSIONS ARE IN MILLIMETRES.

WORKING POINTS CO-ORDINATES C.S.R.S. (NAD 83) V.T.M. GRID			
WP	STATION	NORTHING	EASTING
WP1	3+755.716	5898840.611	623482.980
WP2	3+746.042	5898830.941	623483.220



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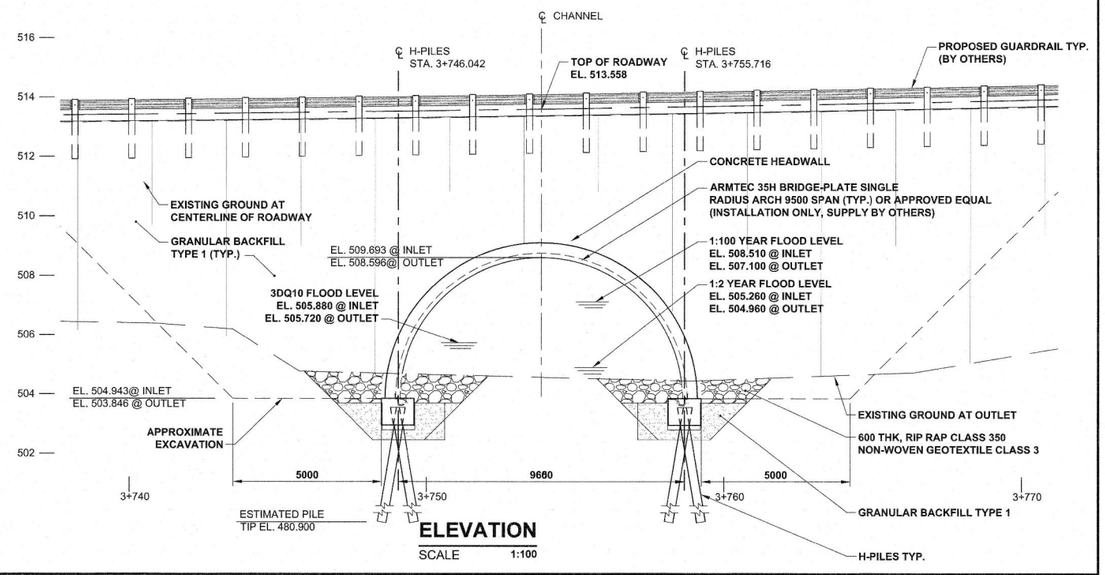

ELEVATION
SCALE 1:100

PROFESSIONAL SEALS

PROFESSIONAL ENGINEER — A.J. FRIESEN — MEMBER 15936 — 2016 08 25 YR. MN. DAY — SASKATCHEWAN

ASSOCIATION OF PROFESSIONAL ENGINEERS & GEOSCIENTISTS OF SASKATCHEWAN
CERTIFICATE OF AUTHORIZATION
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NUMBER C1667
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I/R	YY/MM/DD	ISSUE/REVISION DESCRIPTION	DRN	CHK	DES	ENG	IDR	APP
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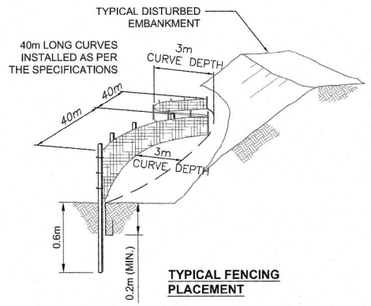
AECOM

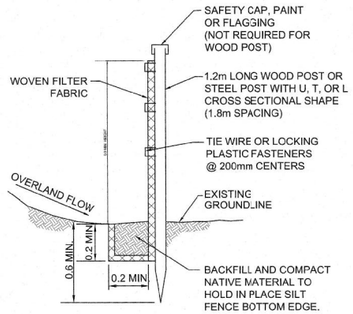
R.M. OF ELDON NO. 471
PROJECT 458: S.E. OF 16-49-22-W3

EROSION & SEDIMENTATION CONTROL PLAN

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
60336819	C-0001	0

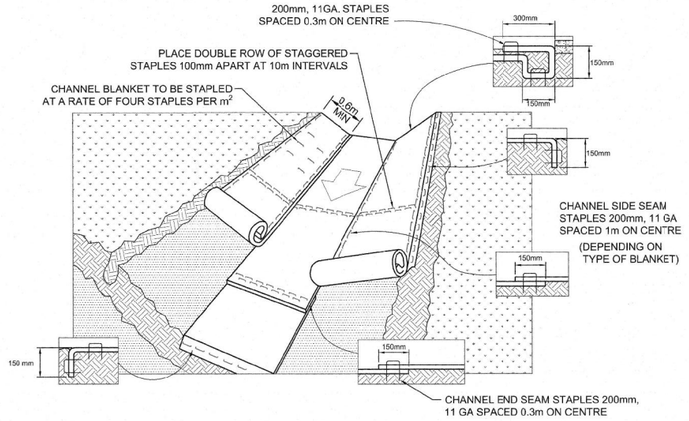


TYPICAL FENCING PLACEMENT

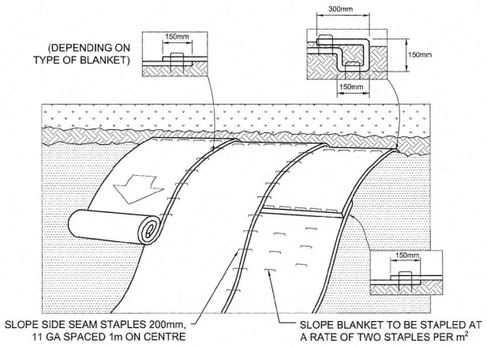


TYPICAL FENCE AND POST DETAIL

A TYPICAL SILT FENCE INSTALLATION **DETAIL** N.T.S.



TYPICAL DRAINAGE CHANNEL INSTALLATION

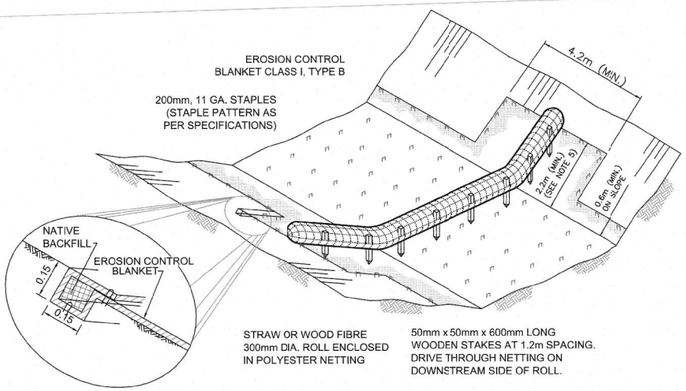


TYPICAL SLOPE INSTALLATION

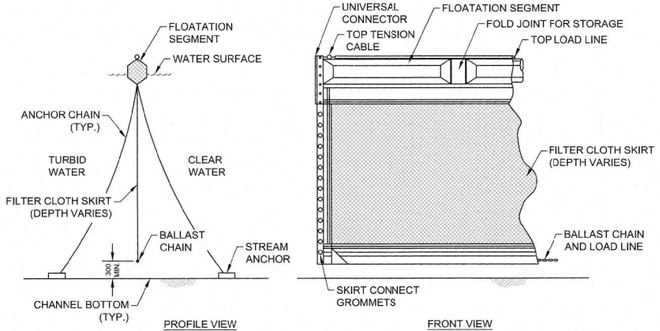
C EROSION CONTROL BLANKET **DETAIL** N.T.S.

NOTES:

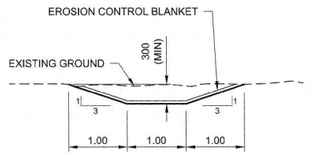
1. RE-SEED ALL DISTURBED AREAS.
2. SILT FENCE SHALL BE INSTALLED AT THE LOCATIONS SHOWN ON DRAWINGS, OR AS DIRECTED BY THE ENGINEER.
3. THE TOP OF STEEL POSTS SUPPORTING SILT FENCE POSTS SHALL BE MARKED WITH FLUORESCENT PAINT, FLAGGING TAPE, OR SAFETY CAPS.
4. THE STRAW ROLL DITCH CHECKS SHALL BE INSTALLED ACCORDING TO SPECIFICATIONS AND DETAIL DRAWINGS.
5. IF STRAW ROLL DITCH CHECKS ARE REQUIRED, EROSION CONTROL BLANKET SHALL BE PLACED UNDER THE STRAW ROLL DITCH CHECKS. ECB TO BE 4.2m MINIMUM LENGTH ALONG CHANNEL WITH LEADING EDGE ENTRENCHED AS SHOWN IN DETAIL. THE BLANKET SHALL BE PLACED TO A HEIGHT OF 2.2m UP THE DITCH SIDE SLOPE. WHERE SIDE SLOPE IS LESS THAN 2.2m THE BLANKET AND STRAW ROLL SHALL EXTEND TO TOP OF SLOPE
6. IF REQUIRED, EROSION CONTROL BLANKET SHALL BE INSTALLED IMMEDIATELY FOLLOWING GRADING AND SEEDING.
7. ALL MATERIAL AND INSTALLATION METHODS SHALL BE IN ACCORDANCE WITH THE SPECIFICATIONS.

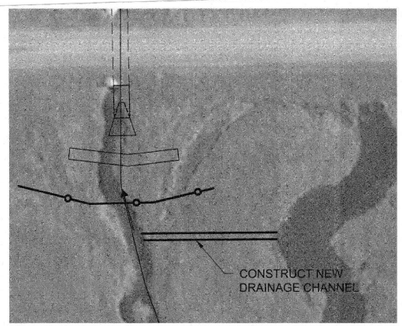


B TYPICAL STRAW ROLL DITCH CHECK **DETAIL** N.T.S.



D TYPICAL SILT CURTAIN **DETAIL** N.T.S.





E DRAINAGE CHANNEL - TYPICAL **DETAIL** 1:50

PROFESSIONAL SEALS

PROFESSIONAL ENGINEER A.J. FRIESEN MEMBER 15936 2016 08 25 YR. MN. DAY SASKATCHEWAN

ASSOCIATION OF PROFESSIONAL ENGINEERS & GEOSCIENTISTS OF SASKATCHEWAN
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0	16/08/22	ISSUED FOR TENDER	CLC	TE	GW	TE	JF	JF

AECOM

R.M. OF ELDON NO. 471
PROJECT 458: E. 4,9,16,21-49-22-W3

EROSION AND SEDIMENT CONTROL DETAILS

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
60336819	C-0002	0

GEOTECHINAL REPORT

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Memorandum

To	Felipe Tabet, P.Eng	Page	1
CC	Eric Loewen		
Subject	Rural Municipality of Eldon No. 471 Big Gulley Culvert- Geotechnical Investigation		
From	Alexander Hill		
Date	July 25, 2016	Project Number	60336819 (402)

1. Introduction

The Rural Municipality of Eldon (RM of Eldon) retained AECOM Canada Ltd. (AECOM) to provide geotechnical engineering services related to the design and construction of the proposed Big Gulley culvert situated along Range Road 3223 approximately 20 km northeast of Maidstone, Saskatchewan. It is understood that the existing drainage culvert located at the subject site consists of a corrugated steel pipe (CSP) orientated in an east-west alignment. Upgrade to the existing CSP culvert is deemed necessary due to the highway improvements to Range Road 3223.

The scope of engineering services included the completion of a geotechnical field program and preparation of a Technical Memorandum (TM). The field program consisted of two (2) test holes drilled within the existing highway embankment with the primary objective of characterising the subsurface ground and groundwater conditions to facilitate design of the highway embankment upgrade and construction of the proposed open bottom culvert.

This TM summarizes the geotechnical investigation completed in April 2016, material testing and geotechnical analysis. Based on the results of the geotechnical investigation, the TM provides geotechnical engineering recommendations specific to the improvement of the existing highway embankment and proposed culvert design upgrades.

2. Field Investigation

From April 21 to 22, 2016, two (2) test holes (TH16-01 and TH16-02) were drilled at the locations shown on the test hole location plan (Figure 1) attached in **Appendix A**.

Drilling was completed by Earth Drilling using a Gus Pech Sonic SDC 50K (R-41) drill rig equipped with a 150 mm casing and 100 mm drill stem. Subsurface conditions observed during drilling were visually classified and documented by AECOM geotechnical personnel. Other pertinent information such as groundwater and drilling conditions were also recorded during drilling. Samples retrieved during the field investigation were tested in AECOM's Materials Testing Laboratory in Winnipeg,

Manitoba. Geotechnical samples collected during the investigation included disturbed split spoon samples and relatively undisturbed Shelby tube samples.

Detailed test hole logs have been prepared for each test hole, and are attached in **Appendix B**. The test hole logs included description and elevation of the soil units encountered, sample type, sample location, results of field and available laboratory testing, and other pertinent information such as seepage and sloughing. Laboratory testing was conducted on select soil samples collected during the geotechnical field investigation. The soil testing program included the determination of moisture contents, grain size distributions (sieve analysis and hydrometer methods), Atterberg Limits, undrained shear strength and bulk density. The laboratory test results are presented in **Appendix C**.

Table 2.1 summarizes test hole information including surveyed location and ground surface elevations, as well as termination depth.

Table 2.1: Test Hole Summary

Test Hole	Northing (m)	Easting (m)	Ground Elevation (m)	Termination Depth (m)
TH16-01	5898779	623490	511.15	21.8
TH16-02	5898877	623474	512.60	21.8

All test holes were backfilled with auger cuttings and bentonite upon completion.

3. Subsurface Conditions

The following sections describe the subsurface conditions encountered during the geotechnical investigation. Subsurface conditions can vary across the site and the information provided in this section is a summary of the findings from the field investigation and laboratory testing program.

3.1 Subsurface Soil Profile

In descending order the soil profile consists of:

- Sand Fill;
- Sand; and
- Silt and Clay.

A summary of the index properties and measured SPT N values of the encountered subsurface soils are illustrated graphically on Figure 3.1 and Figure 3.2 respectively.

Figure 3.1: Profile of Moisture Content and Atterberg Limits with Elevation

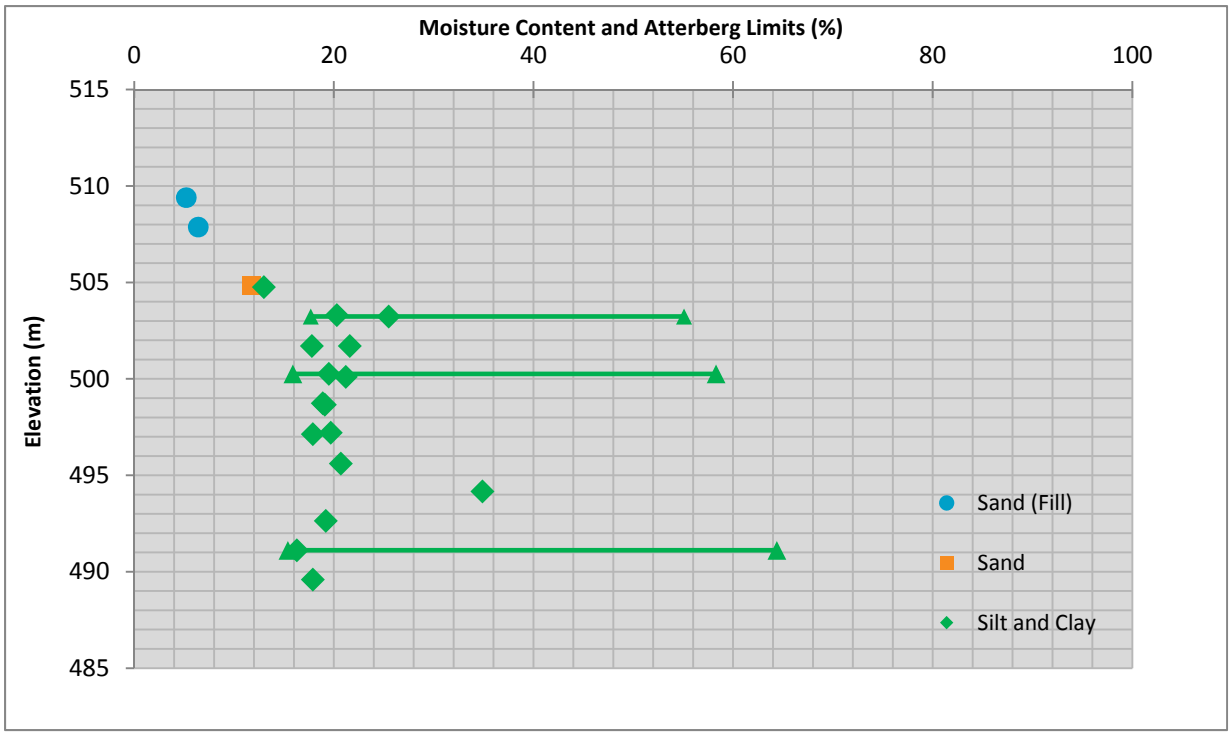
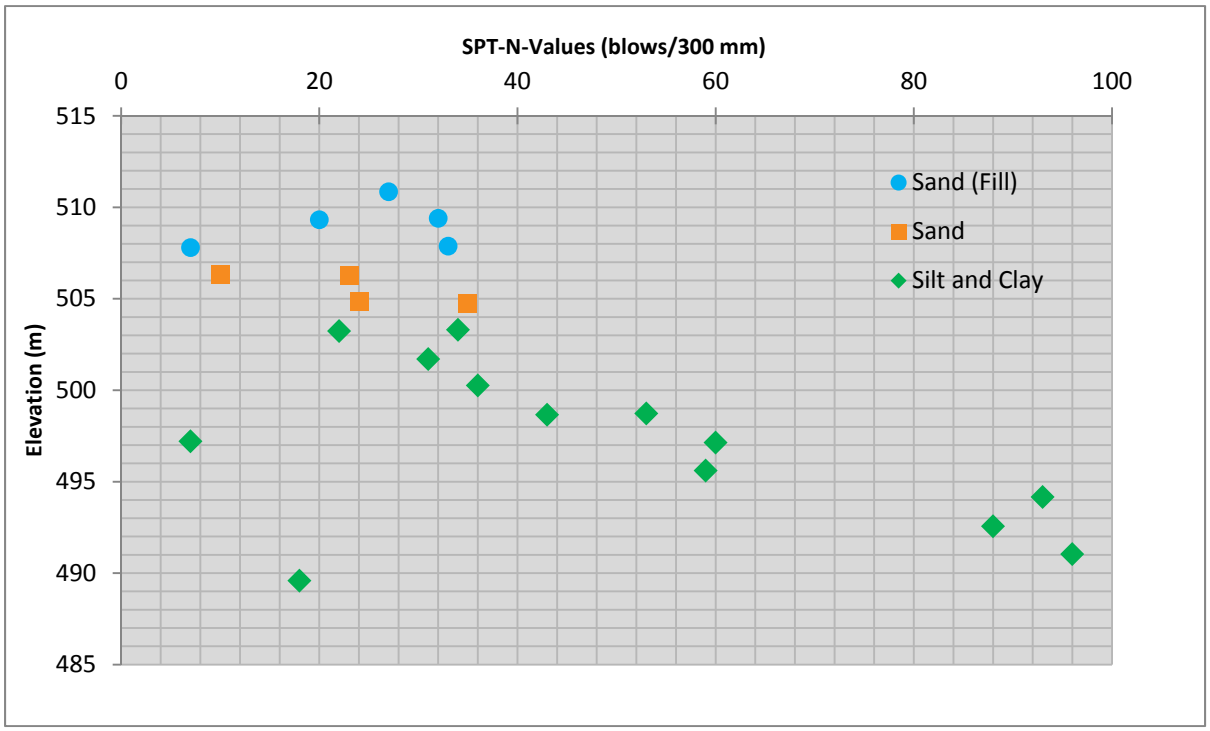


Figure 3.2: Profile of Measured SPT N Values



3.1.1 Sand Fill

A layer of sand fill was encountered in TH16-01 and TH16-02 immediately below ground surface with respective thicknesses of 4.0 m and 4.9 m. The sand fill contained some gravel to gravelly, trace to some silt, trace cobbles, trace boulders, and was yellowish-brown, compact to dense, dry, poorly sorted and fine to medium grained. Summary of index properties of sand fill is provided in table 3.1 below.

Table 3.1: Summary of Index Properties of Sand Fill

Test	Minimum Value	Maximum Value	Number of Tests
Moisture Content (%)	5.2	6.4	2
SPT 'N' Blow Counts (uncorrected)	20	33	2
Grain Size - Gravel (%)	30.4	30.4	1
Grain Size - Sand (%)	55.1	55.1	1
Grain Size - Fines (%)	14.5	14.5	1

3.1.2 Sand

A layer of sand was encountered in TH16-01 and TH16-02 beneath the sand fill layer, with respective thicknesses of 3.0 m and 3.8 m. The sand contained trace to some gravel, trace silt, yellowish-brown, loose to dense, moist to wet, poorly sorted and fine to medium grained. A summary of the index properties of the sand is presented in Table 3.2.

Table 3.2: Summary of Index Properties of Sand

Test	Minimum Value	Maximum Value	Number of Tests
Moisture Content (%)	11.7	13.0	2
SPT 'N' Blow Counts (uncorrected)	7	35	5

3.1.3 Silt and Clay

A layer of silt and clay was encountered in TH16-01 and TH16-02 beneath the sand layer, with respective thicknesses of 14.8 m and 13.1 m at test hole termination depth. The silt and clay contained trace to some sand, was dark grey, soft to hard, moist to wet and highly plastic. A summary of the index properties of the silt and clay is presented in Table 3.3.

Table 3-3: Summary of Index Properties of Silt and Clay

Test	Minimum Value	Maximum Value	Number of Tests
Moisture Content (%)	16.3	34.9	19
SPT 'N' Blow Counts (uncorrected)	7	105	15
Grain Size - Gravel (%)	0.0	0.0	4
Grain Size - Sand (%)	5.6	11.5	4
Grain Size - Silt (%)	40.5	54.8	4
Grain Size - Clay (%)	35.8	40.5	4
Atterberg - Plastic Limit (%)	15.4	17.7	4
Atterberg - Liquid Limit (%)	55.1	69.2	4
Undrained Shear Strength (kPa)	78.3	122.2	4
Bulk Density (kN/m^3)	19.0	20.9	4

3.2 Groundwater/Piezometric Conditions

Groundwater seepage and sloughing was encountered in both test holes. Seepage was encountered below 4.0 m, while sloughing was encountered at depths below existing ground at 7.0 m. Where sloughing was encountered, further details are provided on the test hole logs in **Appendix B**.

It should be noted that groundwater levels and subsequently sloughing may change seasonally, annually or as a result of construction activities.

3.3 Frost Penetration

Calculations based on a mean freezing index of 2000 °C days estimate the seasonal frost penetration depth in the site area to be approximately 2.9 m (9.5 ft) for the purpose of design. Factors such as snow cover, vegetation at surface, soil type, and groundwater conditions can all significantly impact the depth of frost penetration. The frost depth should be considered and addressed accordingly during design. However, given that the upper 3.0 m (approx) of the underlying soils consists of sandy gravels/gravelly sands (Frost Group F2/F3), frost susceptibility is considered low, and therefore the potential for ground heave is considered very low.

Fill materials beneath the culvert or other structures (subject to culvert invert) should be non-frost susceptible granular material to at least the depth of frost penetration. Insulation specified for underground use can be used as required to reduce the potential for frost penetration if required for components of the project sensitive to damage due to frost effects.

4. Geotechnical Engineering Recommendations

4.1 Geotechnical Concerns

Based on AECOM's understanding of the project, geotechnical concerns associated with these issues have been summarized in Table 4.1 below.

Table 4.1: Summary of Geotechnical Concerns

Observation	Geotechnical Concern	Comments
Highway widening	Slope stability performance and subgrade conditions	The proposed highway embankment widening and upgrade requires slope stability analysis to determine the allowable side slope geometries that achieve set Factor of Safety (FS) criteria for short and long term performance.
Culvert upgrade	Temporary works excavation and slope stability performance	Temporary excavations will likely be required for several operations including; pile cap construction, rip-rap placement, removal and replacement of existing culvert. Partially or fully supported excavations maybe required.
	Culvert foundations	Deep foundations are proposed to support the open bottom culvert with concrete headwall and arches. Ground conditions generally comprise of granular soils overlying silt and clay which have the potential to create sloughing conditions within the granular. Static pile analysis will be required to determine pile capacities.
	Temporary water diversion	To allow for the excavation of sub-soils and construction of the pile cap at the base of the culvert (i.e., beneath the arches), dry conditions will be required.

4.2 Highway Embankment Stability

Widening of both the highway and existing embankment footprint is proposed to facilitate the overall highway and culvert upgrades along Range Road 3223. For the purposes of slope stability analysis, survey station 3+725 has been used in analyzing slope stability performance, as shown on Figure 2 presented in **Appendix A**.

The primary objective of the slope stability analysis is determining the optimum side slope profile of the highway embankment under short and long term conditions.

4.2.1 Slope Stability Analysis

4.2.1.1 Embankment Geometry

Based on survey station 3+725, it is understood that the highway will be upgraded in both elevation and footprint. At survey station 3+725, the highway embankment will be increased from an approximate elevation of 511.0 m to 513.0 m (not accounting for crowning), as reflected in the slope stability analysis (Section 4.2.3). This equates to an equivalent total embankment height of approximately 6.0 m relative to original ground level (approximately 507.0 m).

4.2.1.2 Groundwater Conditions

Based on observations made during the geotechnical field investigation, groundwater within the slope stability analysis has been modelled at the interface between the existing granular fill and silty sand. Secondly, given that the invert elevations of the existing and proposed culvert correspond approximately to adjacent ground surface elevations, groundwater has been modelled at ground surface adjacent to the highway embankment.

4.2.1.3 Stability Analysis

The analysis approach consisted of a limit equilibrium analysis using Morgenstern-Price's general method of slices and effective stress soil parameters. Soil parameters used in the analysis were developed based on field/laboratory tests, previous experience and local knowledge and are summarized in Table 4.2. The ground model adopted in the analysis is based upon the discussion of the geotechnical investigation findings outlined in Section 3.1 of this report.

Slope stability analysis has been conducted for both the eastern and western side slopes owing to the slightly different ground conditions encountered at each slope orientation. Side slope geometries of 3.0(H):1.0(V), 3.5(H):1.0(V) and 4.0(H):1.0(V) were considered in the analysis to investigate the best embankment configuration that satisfies the design Factor of Safety (FS).

Table 4.2: Soil Strength Parameters

Material	Cohesion (c') [kPa]	Friction Angle (φ') [º]	Unit Weight (ɣ) [kN/m^3]
Proposed Granular Fill	0.0	34.0	18.0
Existing Granular Fill	0.0	34.0	18.0
Silty Sand	0.0	32.0	18.0
Silt and Clay	2.0	16.5	17.0

AECOM anticipates that locally sourced granular soils will likely be adopted as the upgrade fill material for the highway embankment reconstruction, which is reflected in Table 4.2 above.

Consistent with acceptable design practice, embankment stability was assessed under the following design conditions and the corresponding target factor of safety (FS) against slope instability:

- Long Term Condition (LT) at FS >= 1.50
- Short Term Condition- with Traffic Loading (ST) at FS >= 1.30

Short term analysis is inclusive of transient loading conditions reflective of vehicle traffic equal to a surcharge of 10 kPa.

4.2.2 Slope Stability Analysis Results

The results of the stability analysis are summarized in Table 4.3 below, and are presented graphically in **Appendix D.**

Table 4.3: Summary Stability Analysis Results

Proposed Slope Geometry	Analysis Type	Calculated FS			Figure Reference	Design Objective FS	Surcharge Load (kPa)
		Eastern Embankment	Figure Reference	Western Embankment			
3.0(H):1.0(V)	LT	1.54	D-01	1.44	D-02	1.5	-
	ST	1.51	D-03	1.42	D-04	1.3	10
3.5(H):1.0(V)	LT	1.63	D-05	1.51	D-06	1.5	-
	ST	1.59	D-07	1.48	D-08	1.3	10
4.0(H):1.0(V)	LT	1.70	D-09	1.57	D-10	1.5	-
	ST	1.67	D-11	1.54	D-12	1.3	10

Based on the slope stability results shown in Table 4.3, side slope geometries of 3.5(H):1.0(V) or flatter should be adopted for the design of the proposed highway embankment upgrades.

4.2.3 Sub-Grade Analysis and Preparation

4.2.3.1 Embankment Settlement

Placement of additional fill material in the form of engineered granular fill will result in ground settlement owing from elastic compression of the underlying granular native soils (i.e., immediate settlement), consolidation settlement within the clay and silt layer, and self-weight settlement within the newly placed engineered granular fill.

While it is likely that consolidation settlement of the underlying cohesive soils has taken place already (due to construction of the existing highway embankment), this portion of consolidation settlement cannot be accurately determined. However, further consolidation settlement will be induced within the clay and silt layer following fill placement. For the purposes of determining consolidation settlement parameters, empirical correlations based upon soil index testing have been referenced, and are summarized in Table 4.4 below.

Table 4.4: Consolidation Settlement Parameters

Soil Unit	Thickness (m)	Compression Index (C_c)	Recompression Index (C_r)	Initial Void Raton (e_o)	Unit Weight (kN/m^3)
Silt and Clay	15.0	0.34	0.08	1.17	17.0

Notes: Groundwater taken at existing ground surface (i.e., 0 m below ground level)

Values of immediate and consolidation settlement have been estimated for the proposed highway embankment upgrade for placement of a maximum fill thickness of 3.0 m (based on Sta. 3+725), and are summarized in Table 4.5 below.

Table 4.5: Embankment Settlement Summary

Settlement	Location within Embankment	
	Near the Toe	*Near Shoulder/Crest of Embankment*
Immediate/Elastic Compression	5- 10 mm	10- 15 mm
Consolidation Settlement	20- 30 mm	40 - 60 mm

Notes: Fill Placement Configuration Based on Sta. 3+725 and based on a maximum fill thickness of 3.0 m.

Self-weight settlement within the engineered granular fill is likely to be in the order of 1 percent of the total of the fill, and has not been included in the values shown in Table 4.5.

The rate at which consolidation settlement of the silt and clay layer will progress is a time dependent process that is influenced by the soils permeability, thickness and drainage conditions. Based on empirical correlations between the liquid limit and coefficient of consolidation (*NAVFAC DM 7.01 7.1-143 Table 4)* of the silt and clay layer, time to achieve ninety (90) percent consolidation is estimated to be twenty four (24) years. The rate of settlement is expected to be less than 50 mm for the first year following construction, and less than 25 mm subsequent to year one.

4.2.3.2 Fill Placement and Compaction

Following organic stripping along the embankment slope and footprint (including subgrade preparation), the fill can be placed in layers not exceeding 250 mm in loose thickness. Subgrade preparation near to the toe of the existing embankment should be sub-cut to a minimum of 0.3 m to expose competent ground conditions. The fill should be compacted to at least 95 percent of SPMDD at or slightly above the optimum moisture content. The fill should be placed in lifts that are compatible with the compaction equipment used. The ability of the compaction equipment to uniformly compact layers thicker than 250 mm should be confirmed with a test strip.

Soils used for the proposed embankment fill is anticipated to comprise of engineered granular fill (i.e., consistent with native inorganic sands). Granular soils used as general engineered embankment fill should consist of clean sand and gravel (maximum size 75 mm). Organic or cohesive soils should not be used for embankment fill. Geotechnical classification testing should be undertaken on any imported fill used for the purpose of embankment fill to ensure its conformance to the above requirements.

Structural fill used in areas where performance of fill is more critical, such as foundations, base and sub-base for road fill, etc. Structural fill should consist of well-graded sand and gravel having a maximum aggregate size of 25 mm, and contain less 10% fines. Structural fill may be obtained from screened pit run or crushed material depending on specific requirements. Structural fill should be compacted to 100 percent of SPMDD.

Fill materials should not be placed in a frozen state or placed on a frozen sub-grade. All lumps of materials should be broken down during placement. Fill material should not contain deleterious materials such as debris, organics, coal particles, wood chunks, etc.

Bonding should be provided between backfill lifts if the previous lift has become desiccated. For granular materials, the surface of the previous lift should be scarified to an approximate depth of 75 mm followed by proper moisture conditioning and re-compaction.

4.3 Culvert Foundation

4.3.1 General

It is understood that a deep foundation system is required to support the load transmitted by the concrete headwall structure of the open bottom culvert. It is also understood by AECOM that driven steel H piles are the preferred deep foundation option, specifically HP 310 x 110 kg/m pile type. Based upon the information known at the time of writing this TM, the culvert invert is at an approximate elevation of 503.7 m. The following sections discuss the use of driven steel H piles as part of the design.

4.3.2 Pile Foundation

Static analysis was carried out using DRIVEN 1.2 software to estimate capacities for driven steel H piles (HP 310 x 110). The detailed results of the analysis and the ultimate capacities versus depth for the pile types and sizes considered are provided in **Appendix E** and summarized in Table 4.6.

In estimating the pile capacities, results of undrained shear strength for cohesive soils have referenced from laboratory testing analysis report in Table 3.3 of Section 3.0 of this TM. In determining pile capacities, no contribution should be considered from the top 3 m along the pile shaft. However, as ground surface elevations near the toe of the existing embankment are between 507 and 508 m and the estimated culvert invert elevation is at 503.7 m, a reduction in pile capacities based on the loss of adhesion/friction (mostly due to soil weathering effect from freeze/thaw action) was not incorporated into the analysis. Estimated pile penetration was based on the assumption that pile driving surface at each culvert outfall location is level, and consistent with the test hole elevations.

In accordance with Limit States Design, resistance factors referenced from the Canadian Highway Bridge Design Code (CHBDC) 2014, Table 6.2 were applied to the nominal geotechnical pile capacities as shown in Table 4.6 below. For determining pile capacities at Ultimate Limit State (ULS) conditions, a resistance factor of 0.40 was adopted in the design for static analysis, based on a typical degree of understanding. The bearing resistance at service limit state (SLS), associated with a settlement of 25 mm excluding elastic shortening of the pile is also provided in Table 4.6. Regardless of the geotechnical capacity, the load applied to the pile should not exceed the allowable structural capacity of the pile section. Factored pile uplift resistance was estimated based on a resistance factor of 0.30 as per Table 6.2 of the Canadian Highway Bridge Design Code (CHBDC) 2014 LRFD, based on a typical degree of understanding as stated in the CHBDC 2014 Design Specification.

Costly delays from unexpected pile behaviour can be minimized by driving indicator piles and using PDA testing. Indicator piles can be used as production piles to support the structure. These piles are driven before or at the start of construction to provide information on the behaviour of the piles during their installation and to provide an assessment of the actual capacity of the piles. Two indicator piles are recommended for this site at locations determined by the geotechnical engineer. If employed, the bearing resistance at ultimate limit state (ULS) can be determined by using a resistance factor of 0.50 in place of a 0.40 resistance factor (see CHBDC LRFD 2014 Design Specification - Table No. 6.2) based on a typical degree of understanding as stated in the CHBDC 2014 Design Specification.

A Pile Driving Analyzer (PDA) should be employed while driving the piles to increase the reliability of wave equation analysis, measure pile stress, assess driving system and evaluate pile capacity. The piles should be restruck at a later time; e.g. 5 days after original driving of the pile to identify any significant changes in the soil resistance due to soil setup or relaxation.

A wave equation analysis should be performed to verify that the steel piles considered in the analysis (HP 310 x 110) can be driven to mobilize the capacities shown in Table 4.6 without over-stressing the piles or causing pile damage due to overdriving. Detailed analyses should be performed before construction begins using actual parameters of the selected driving system.

Table 4.6: Summary of Static Pile Analysis for HP 310 x 110 Pile Type

Pile Tip Elevation (m)	Pile Penetration (m)*	Nominal Geotechnical Capacity, (kN)			ULS Condition CAN/CSA-S6-14		SLS Condition	Factored Uplift Resistance (kN) (3)
		Total	Shaft	Toe	Factored Bearing Resistance (kN)- Static Analysis (1)	Factored Bearing Resistance (kN)- PDA Testing(2)	Bearing Resistance (kN)	
497.7	6.0	421	314	107	168	210	210	126
494.7	9.0	800	693	107	320	400	350	240
491.7	12.0	1270	1163	107	508	635	480	381
488.9	13.0	1480	1308	172	592	740	625	444
487.7	16.0	1805	1633	172	722	902	700	541
484.7	19.0	2130	1958	172	852	1065	825	639
481.7	22.0	2452	2280	172	980	1226	925	735

Notes: Surface Elevation taken as 507.0 m; *- Below invert of 503.7 m; (1) Resistance Factor of 0.40; (2) Resistance Factor of 0.50; (3) Resistance Factor of 0.30

The resistance factors associated with PDA testing (see Table 4.6) can be used provided that PDA testing on at least two percent of the total pile number, but not less than two piles at each culvert outfall location is carried out during production installation. Alternatively, a resistance factor with no PDA testing should be used.

4.3.3 Pile Lateral Capacity

Battered piles can provide lateral resistance equal to the horizontal component of its axial load. Where practical, primary horizontal forces on pile foundations should be resisted by battered piles.

4.3.4 Pile Downdrag

A pile down drag analysis is not deemed necessary since estimated consolidation settlement is relatively low within the clay and silt layer.

4.3.5 Pile Installation

The following additional recommendations are provided for driven steel H piles:

- Minimum thickness of metal in the flange or web of the HP section should be 9.5 mm;

- Pile spacing should be a minimum of three (3) pile diameters measured centre to centre;
- The pile cross section must be designed to withstand the design loads, handling stresses and the driving forces during installation;
- The weight of the embedded portion of the pile maybe neglected in the design;
- All piles driven within five (5) pile diameters of one another should be monitored for heave while driving adjacent piles. Where heave is observed, the piles should be re-driven to the specified set criteria;
- All piles should be provided with pile shoes to protect against pile tip damage;
- Any piles that are damaged, excessively out of alignment, or refuse prematurely may need to be replaced, pending a review of load carrying capacity by the structural and geotechnical engineers; and,
- The driving of all piles should be documented by experienced geotechnical personnel to confirm and record the acceptability of piles driven during installation. It is recommended that the geotechnical engineering firm of record be retained to perform foundation inspection services.

4.4 Lateral Earth Pressures

The lateral earth pressures transferred to the culvert will be a function of the backfill material, the method of placing and compacting the backfill, and the amount of horizontal deflection allowed by the culvert after the backfill is placed.

It is recommended that the culvert be backfilled with a free draining granular soil with a maximum of 5 percent fines (maximum of 5 percent finer than #200 sieve). Cohesive soils are not recommended for backfill behind retaining structures. The existing highway embankment fill and native granular soils are likely to contain greater than five percent fines, and may not be considered completely suitable as backfill around the culvert.

For coarse free draining granular soils, an active pressure coefficient (Ka) of 0.30 should be used to calculate lateral loads on retaining structures which are allowed to translate or deflect horizontal by at least 0.2 percent of the height of the culvert. For retaining structures which are not free to translate an at-rest earth pressure coefficient (K_o) of 0.5 should be used. Compaction of granular fill within about 1.5 m (5 ft) of the culvert should be conducted with a light hand operated vibrating plate compactor. Over-compaction of the backfill adjacent to the culvert may result in earth pressures that considerably higher than those predicted in design. Backfilling procedures should be reviewed during construction to verify that they are consistent with the design assumptions.

Buried or partially buried walls or structural elements designed to resist the at-rest lateral earth pressure should be designed based on the following conventional relationship:

$$P = K_o * (\gamma D + q)$$

Where:

P = Lateral earth pressure at depth D (kPa)
K_o = At-rest earth pressure coefficient = 0.50
γ = Soil / backfill unit weight
D = Depth from ground surface to point of pressure calculation (m)
q = Surcharge load within distance D from the wall edge (kPa)

Below the groundwater level, the hydrostatic pressure must be added and the submerged weight of soil / backfill should be used.

The culvert should be designed to resist lateral pressure from live load surcharges including traffic loading and anticipated construction activities.

4.5 Foundation Concrete

All concrete in contact with soils should be made using sulphate resistant Type HS cement (CSA Type 50).

4.6 Temporary Excavations

Excavations will be required to facilitate the upgrade of the existing culvert, and to allow for construction of the footings for the culvert structure. The method of excavation and safe support of excavation sidewalls and protection of the existing infrastructure are the responsibility of the contractor and subject to applicable regulations of Saskatchewan's Occupational Health and Safety Act.

Based on the available geotechnical information, the existing highway embankment comprises mostly of granular soils, and is classified as type 3 and 4 according to Saskatchewan's Occupational Health and Safety Regulations. Detailed stability assessments should be carried out for excavations greater than 3.0 m in depth, or if they are to remain open for an extended period of time. However, given the granular nature of the embankment soils, excavations are expected to be supported or partially supported. Partially supported excavation is a combination of a cut slope and an excavation support system (e.g. sheeting, solider piles and lagging). Excavation support systems should be designed based on the excavation dimensions, subsoil conditions and performance requirements. A perimeter ditch and associated pumping and/or dewatering system should be provided to intercept surface runoff and/or any groundwater from entering the excavation.

Surcharge loads (spoil pile, construction material, equipment, etc) should be at a minimum distance equal to the excavation depth away from the cut slope crest. Where a combination of open excavation and shoring is planned, the toe of the cut slope should be at least half the depth of the shored excavation from the shoring face. The shoring system should be designed for the lateral pressures from applicable surcharge. The wall must be embedded deeply enough to provide adequate resistance for the portion of the wall below the excavation. Ultimate passive resistance below the excavation level should be reduced to a factor of safety of 1.5. Passive resistance from the soil located in the upper 0.5 m below the excavation level should be ignored.

4.7 Temporary Water Diversion

A diversion will likely be required to temporarily isolate the location of the existing culvert inlet and outlet during the removal and in turn its replacement to be carried out in the dry. The hydraulic design of this diversion is beyond the scope of our investigation, although ideally this work would be carried out during low flow conditions. Temporary diversions should maintain base flow of the stream.

A cofferdam will be required to isolate the work area from the flow, particularly during excavation of the embankment fill to access the existing culvert. Cofferdams should be designed to handle anticipated changes in water levels during the construction period.

Seepage below the cofferdam should be expected. The seepage can be controlled by pumping from the base of the excavation using conventional construction equipment and/or by increasing the seepage path between the upstream and downstream sides of the cofferdam with a clay seal, e.g. placing additional clay in the upstream zone as required. However, difficulties in maintaining a stable base of excavation may result in the differential pressure developed from pumping becomes excessive.

5. Closure

The findings and recommendations of this report were based on the results of field and laboratory investigations, combined with an interpolation of soil and ground water conditions between the test hole locations. If conditions are encountered that appear to be different from those shown by the test holes drilled at this site and described in this report, or if assumptions stated herein are not in keeping with the design, this office should be notified in order that the recommendation can be reviewed and justified, if necessary.

Soil conditions, by their nature, can be highly variable across a site. The placement of waste fill and prior construction activities on a site can contribute to the variability especially near surface soil conditions. A contingency should be included in the construction budget to allow for possibility of variation in soil conditions, which may result in modifications of the design and construction procedures.

Please do not hesitate to contact the undersigned for any questions or further information.

Respectfully Submitted,
AECOM Canada Ltd.

Prepared by:

for

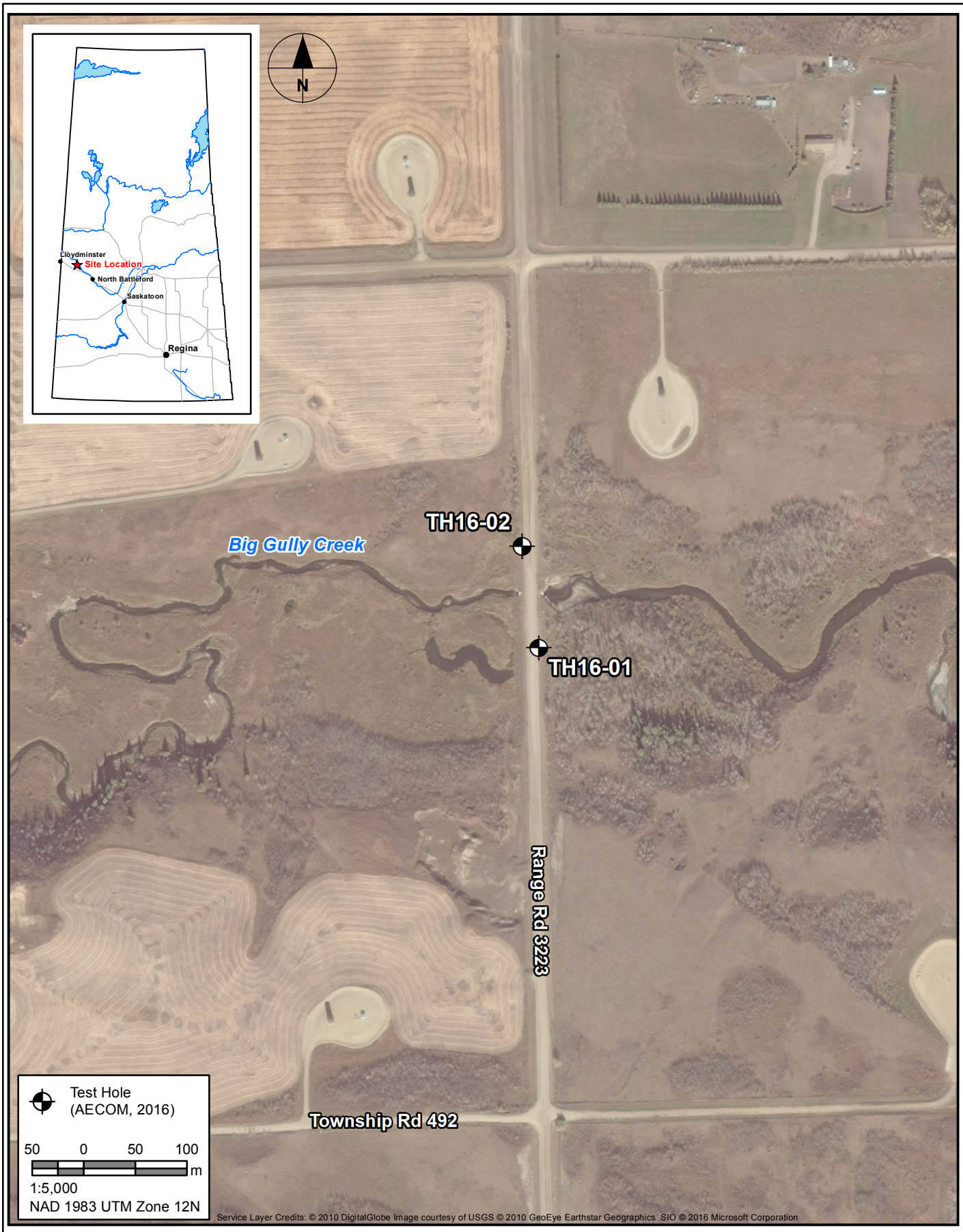
Alexander Hill, B.Sc. (Hons), FGS
Geotechnical Engineering
/cm

Reviewed by:

Zeyad Al-Hayazai, M.Sc., P.Eng,
Senior Geotechnical Engineer

Appendix A

Figures



ANSI A 215.9mm x 279.4mm

Approved:

Checked:

Designer:

Project Management Initials:

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Filename: P:\60336819\900-WORK\920-929 (GIS-GRAPHICS)\BIG001_60336819_01V1_TESTHOLELOCATIONPLAN.MXD

Big Gully Culvert

R.M. of Eldon

Test Hole Location Plan

AECOM

Figure: 01

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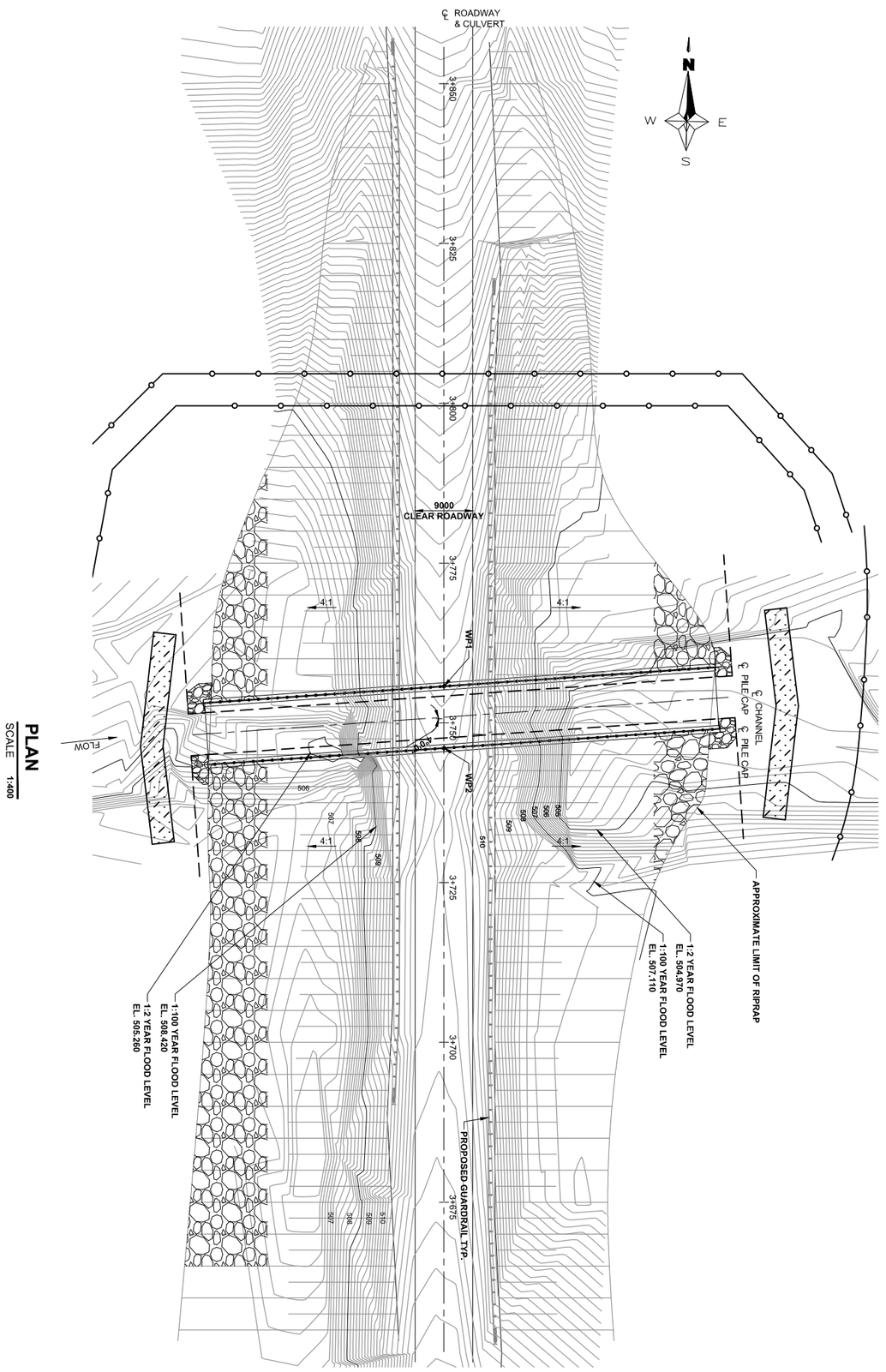
Project Management Initials: Designer: _____ Checked: _____ Approved: _____ ANSI D 558.8mm x 863.6mm



PLAN
SCALE 1:400

Big Gully Culvert

General Arrangement

R.M. of Eldon No. 471, Manitoba

AECOM

Figure: 2

Appendix B

Test Hole Logs

AECOM Canada Ltd.

GENERAL STATEMENT

NORMAL VARIABILITY OF SUBSURFACE CONDITIONS

The scope of the investigation presented herein is limited to an investigation of the subsurface conditions as to suitability for the proposed project. This report has been prepared to aid in the evaluation of the site and to assist the engineer in the design of the facilities. Our description of the project represents our understanding of the significant aspects of the project relevant to the design and construction of earth work, foundations and similar. In the event of any changes in the basic design or location of the structures as outlined in this report or plan, we should be given the opportunity to review the changes and to modify or reaffirm in writing the conclusions and recommendations of this report.

The analysis and recommendations presented in this report are based on the data obtained from the borings and test pit excavations made at the locations indicated on the site plans and from other information discussed herein. This report is based on the assumption that the subsurface conditions everywhere are not significantly different from those disclosed by the borings and excavations. However, variations in soil conditions may exist between the excavations and, also, general groundwater levels and conditions may fluctuate from time to time. The nature and extent of the variations may not become evident until construction. If subsurface conditions differ from those encountered in the exploratory borings and excavations, are observed or encountered during construction, or appear to be present beneath or beyond excavations, we should be advised at once so that we can observe and review these conditions and reconsider our recommendations where necessary.

Since it is possible for conditions to vary from those assumed in the analysis and upon which our conclusions and recommendations are based, a contingency fund should be included in the construction budget to allow for the possibility of variations which may result in modification of the design and construction procedures.

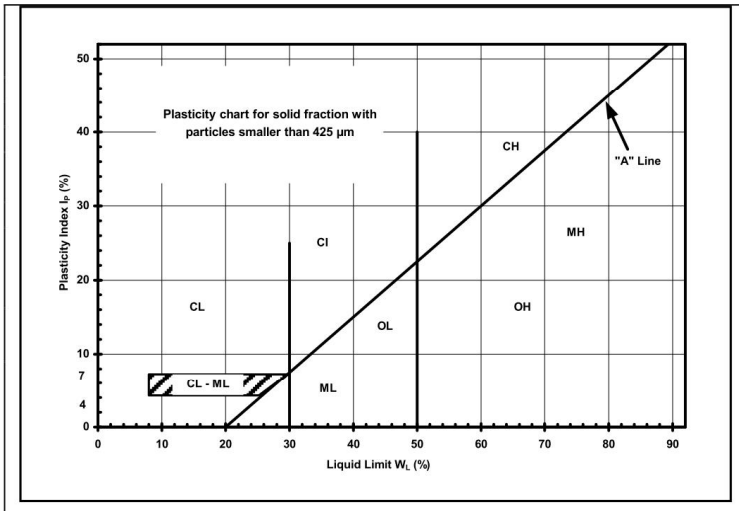
In order to observe compliance with the design concepts, specifications or recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated, we recommend that all construction operations dealing with earth work and the foundations be observed by an experienced soils engineer. We can be retained to provide these services for you during construction. In addition, we can be retained to review the plans and specifications that have been prepared to check for substantial conformance with the conclusions and recommendations contained in our report.

EXPLANATION OF FIELD & LABORATORY TEST DATA

Description				UMA Log Symbols	USCS Classification	Laboratory Classification Criteria			
						Fines (%)	Grading	Plasticity	Notes
COARSE GRAINED SOILS	GRAVELS (More than 50% of coarse fraction of gravel size)	CLEAN GRAVELS (Little or no fines)	Well graded gravels, sandy gravels, with little or no fines		GW	0-5	$C_U > 4$ $1 < C_C < 3$		Dual symbols if 5-12% fines. Dual symbols if above "A" line and $4<W_P<7$ $C_U = \frac{D_{60}}{D_{10}}$ $C_C = \frac{(D_{30})^2}{D_{10} x D_{60}}$
			Poorly graded gravels, sandy gravels, with little or no fines		GP	0-5	Not satisfying GW requirements		
		DIRTY GRAVELS (With some fines)	Silty gravels, silty sandy gravels		GM	> 12		Atterberg limits below "A" line or $W_P<4$	
			Clayey gravels, clayey sandy gravels		GC	> 12		Atterberg limits above "A" line or $W_P<7$	
	SANDS (More than 50% of coarse fraction of sand size)	CLEAN SANDS (Little or no fines)	Well graded sands, gravelly sands, with little or no fines		SW	0-5	$C_U > 6$ $1 < C_C < 3$		
			Poorly graded sands, gravelly sands, with little or no fines		SP	0-5	Not satisfying SW requirements		
		DIRTY SANDS (With some fines)	Silty sands, sand-silt mixtures		SM	> 12		Atterberg limits below "A" line or $W_P<4$	
			Clayey sands, sand-clay mixtures		SC	> 12		Atterberg limits above "A" line or $W_P<7$	
FINE GRAINED SOILS	SILTS (Below 'A' line negligible organic content)	$W_L<50$	Inorganic silts, silty or clayey fine sands, with slight plasticity		ML			Classification is Based upon Plasticity Chart	
		$W_L>50$	Inorganic silts of high plasticity		MH				
	CLAYS (Above 'A' line negligible organic content)	$W_L<30$	Inorganic clays, silty clays, sandy clays of low plasticity, lean clays		CL				
		$30<W_L<50$	Inorganic clays and silty clays of medium plasticity		CI				
		$W_L>50$	Inorganic clays of high plasticity, fat clays		CH				
	ORGANIC SILTS & CLAYS (Below 'A' line)	$W_L<50$	Organic silts and organic silty clays of low plasticity		OL				
		$W_L>50$	Organic clays of high plasticity		OH				
HIGHLY ORGAINIC SOILS			Peat and other highly organic soils		Pt	Von Post Classification Limit		Strong colour or odour, and often fibrous texture	

	Asphalt		Till				AECOM
	Concrete		Bedrock (Undifferentiated)				
	Fill		Bedrock (Limestone)				

When the above classification terms are used in this report or test hole logs, the designated fractions may be visually estimated and not measured.



FRACTION		SEIVE SIZE (mm)		DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS	
		Passing	Retained	Percent	Identifier
Gravel	Coarse	76	19	35-50	and
	Fine	19	4.75		
Sand	Coarse	4.75	2.00	20-35	"y" or "ey" *
	Medium	2.00	0.425		
	Fine	0.425	0.075	10-20	some
Silt (non-plastic) or Clay (plastic)		< 0.075 mm		1-10	trace

* for example: gravelly, sandy clayey, silty

Definition of Oversize Material

COBBLES: 76mm to 300mm diameter
BOULDERS: >300mm diameter

LEGEND OF SYMBOLS

Laboratory and field tests are identified as follows:

- q_u - undrained shear strength (kPa) derived from unconfined compression testing.
- T_v - undrained shear strength (kPa) measured using a torvane
- pp - undrained shear strength (kPa) measured using a pocket penetrometer.
- L_v - undrained shear strength (kPa) measured using a lab vane.
- F_v - undrained shear strength (kPa) measured using a field vane.
- γ - bulk unit weight (kN/m^3).
- SPT - Standard Penetration Test. Recorded as number of blows (N) from a 63.5 kg hammer dropped 0.76 m (free fall) which is required to drive a 51 mm O.D. Raymond type sampler 0.30 m into the soil.
- DPPT - Drive Point Pentrometer Test. Recorded as number of blows from a 63.5 kg hammer dropped 0.76 m (free fall) which is required to drive a 50 mm drive point 0.30 m into the soil.
- w - moisture content (W_L, W_P)

The undrained shear strength (Su) of a cohesive soil can be related to its consistency as follows:

Su (kPa)	CONSISTENCY
<12	very soft
12 – 25	soft
25 – 50	medium or firm
50 – 100	stiff
100 – 200	very stiff
200	hard

The resistance (N) of a non-cohesive soil can be related to compactness condition as follows

N – BLOWS/0.30 m	COMPACTNESS
0 - 4	very loose
4 - 10	loose
10 - 30	compact
30 - 50	dense
50	very dense

PROJECT: R.M of Eldon No.471 Big Gully Culvert	CLIENT: R.M of Eldon	TESTHOLE NO: **TH16-01**
LOCATION: 12U 5898779 N 623490 E		PROJECT NO.: 60336819
CONTRACTOR: Earth Drilling	METHOD: Gus Pech Sonic SDC 50K (R-41) Drill Rig	ELEVATION (m): 511.15

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	SOIL SYMBOL	BACKFILL DETAILS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS / UNDRAINED SHEAR STRENGTH	COMMENTS	ELEVATION
0			SAND (FILL)- gravelly, trace to some silt, trace cobbles, trace boulders - yellowish brown, dense, dry - poorly sorted, fine to medium grained						511
1									510
2					S01	32		SPT Blow Count [10/19/13] Gravel: 30.4%, Sand: 55.1%, Fines: 14.5%	509
3					S02	33		SPT Blow Count [13/19/14]	508
4			SAND- trace to some gravel, trace silt - yellowish brown, loose to compact, moist to wet - poorly sorted, fine to medium grained						507
5					S03	10		SPT Blow Count [4/4/6] No returns	506
6					S04	24		SPT Blow Count [4/15/9] Minimal returns	505
7			SILT and CLAY - trace sand - dark grey, very stiff to hard, moist - high plasticity						504
8					S05	18		SPT Blow Count [3/7/11]	503
9									502
10					T06			Su = 122.2 kPa	501
11					S07	34		SPT Blow Count [9/13/21] Gravel: 0.0%, Sand: 9.4%, Silt: 54.8%, Clay: 35.8%	500
12									

PENETRATION TESTS: ✳ Becker ✳ | ◇ Dynamic Cone ◇ | ◆ SPT (Standard Pen Test) (Blows/300mm) ◆ (0 20 40 60 80 100) | ■ Total Unit Wt ■ (kN/m^3) (16 17 18 19 20 21) | Plastic MC Liquid (20 40 60 80 100)

UNDRAINED SHEAR STRENGTH: + Torvane + | × QU/2 × | □ Lab Vane □ | △ Pocket Pen. △ | ✣ Field Vane ✣ (kPa) (50 100 150 200)

LOG OF TEST HOLE 60336819- TEST HOLE LOGS.GPJ UMA WINN.GDT 6/17/16

AECOM

LOGGED BY: Chris Kjarsgaard	COMPLETION DEPTH: 21.79 m
REVIEWED BY: Alex Hill	COMPLETION DATE: 4/21/16
PROJECT ENGINEER: Zeyad Shukri	Page 1 of 2

PROJECT: R.M of Eldon No.471 Big Gully Culvert	CLIENT: R.M of Eldon	TESTHOLE NO: **TH16-01**
LOCATION: 12U 5898779 N 623490 E		PROJECT NO.: 60336819
CONTRACTOR: Earth Drilling	METHOD: Gus Pech Sonic SDC 50K (R-41) Drill Rig	ELEVATION (m): 511.15

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	SOIL SYMBOL	BACKFILL DETAILS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	PENETRATION TESTS: ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100; ■ Total Unit Wt ■ (kN/m³) 16 17 18 19 20 21; Plastic MC Liquid 20 40 60 80 100	UNDRAINED SHEAR STRENGTH: + Torvane + × QU/2 × □ Lab Vane □ △ Pocket Pen. △ ✣ Field Vane ✣ (kPa) 50 100 150 200	COMMENTS	ELEVATION
12									499
					S08	36	● ◆		SPT Blow Count [7/15/21]	
13										498
					S09	53	● ◆		SPT Blow Count [5/20/33]	
14										497
15										496
					T10		● ■	× +	Su = 78.3 kPa	
16			- soft from 16.0 to 17.7 m							495
17					S11	7	◆ ●		SPT Blow Count [3/3/4]	494
			- some sand, hard, moist to wet below 17.7 m							
18										493
					S12	93	● ◆		SPT Blow Count [18/32/61]	
19										492
20					S13	105	● —I >> ◆		SPT Blow Count [16/38/67] Gravel: 0.0%, Sand: 11.5%, Silt: 52.7%, Clay: 35.8%	491
21										490
					S14	105	● >> ◆		SPT Blow Count [15/37/68]	
22			END OF TEST HOLE AT 21.8 m IN SILT and CLAY							489
			NOTES: 1. Sloughing observed from ground surface to 7.0 m. 2. Seepage observed below 4.0 m. 3. Test hole backfilled with bentonite upon completion.							
23										488
24										

AECOM

LOGGED BY: Chris Kjarsgaard	COMPLETION DEPTH: 21.79 m
REVIEWED BY: Alex Hill	COMPLETION DATE: 4/21/16
PROJECT ENGINEER: Zeyad Shukri	Page 2 of 2

LOG OF TEST HOLE 60336819- TEST HOLE LOGS.GPJ UMA WINN.GDT 6/17/16

PROJECT: R.M of Eldon No.471 Big Gully Culvert	CLIENT: R.M of Eldon	TESTHOLE NO: **TH16-02**
LOCATION: 12U 5898877 N 623474 E		PROJECT NO.: 60336819
CONTRACTOR: Earth Drilling	METHOD: Gus Pech Sonic SDC 50K (R-41) Drill Rig	ELEVATION (m): 512.60

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

DEPTH (m)	SOIL SYMBOL	BACKFILL DETAILS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS	ELEVATION
0			SAND (FILL)- some gravel to gravelly, trace to some silt, trace cobbles, trace boulders - yellowish brown, compact, dry - poorly sorted, fine to medium grained					512
1								
2						27	SPT Blow Count [8/15/12] No returns	511
3						20	SPT Blow Count [10/10/10] No returns	510
4								509
5			SAND- trace to some gravel, trace silt - yellowish brown, loose to compact, moist to wet - poorly sorted, fine to medium grained			7	SPT Blow Count [3/3/4] No returns	508
6						23	SPT Blow Count [5/12/11] No returns	507
7								506
8			- dense below 7.6 m		S01	35	SPT Blow Count [20/15/20] Minimal returns	505
9			SILT and CLAY - trace sand - dark grey, stiff to very stiff, moist - high plasticity					504
10					S02	22	SPT Blow Count [4/9/13] Gravel: 0.0%, Sand: 5.6%, Silt: 53.9%, Clay: 40.5%	503
11			- hard below 10.7 m		S03	31	SPT Blow Count [6/11/20]	502
12								501

PENETRATION TESTS: ✳ Becker ✳ | ◇ Dynamic Cone ◇ | ◆ SPT (Standard Pen Test) (Blows/300mm) ◆ — 0 20 40 60 80 100 | ■ Total Unit Wt ■ (kN/m^3) — 16 17 18 19 20 21 | Plastic MC Liquid — 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: + Torvane + | × QU/2 × | □ Lab Vane □ | △ Pocket Pen. △ | ✣ Field Vane ✣ (kPa) — 50 100 150 200

AECOM

LOGGED BY: Chris Kjarsgaard	COMPLETION DEPTH: 21.79 m
REVIEWED BY: Alex Hill	COMPLETION DATE: 4/22/16
PROJECT ENGINEER: Zeyad Shukri	Page 1 of 2

LOG OF TEST HOLE 60336819- TEST HOLE LOGS.GPJ UMA WINN.GDT 6/17/16

PROJECT: R.M of Eldon No.471 Big Gully Culvert	CLIENT: R.M of Eldon	TESTHOLE NO: **TH16-02**
LOCATION: 12U 5898877 N 623474 E		PROJECT NO.: 60336819
CONTRACTOR: Earth Drilling	METHOD: Gus Pech Sonic SDC 50K (R-41) Drill Rig	ELEVATION (m): 512.60

SAMPLE TYPE: GRAB | SHELBY TUBE | SPLIT SPOON | BULK | NO RECOVERY | CORE

BACKFILL TYPE: BENTONITE | GRAVEL | SLOUGH | GROUT | CUTTINGS | SAND

PENETRATION TESTS: ✳ Becker ✳ ◇ Dynamic Cone ◇ ◆ SPT (Standard Pen Test) ◆ (Blows/300mm) 0 20 40 60 80 100 ■ Total Unit Wt ■ (kN/m^3) 16 17 18 19 20 21 Plastic MC Liquid 20 40 60 80 100

UNDRAINED SHEAR STRENGTH: + Torvane + × QU/2 × □ Lab Vane □ △ Pocket Pen. △ ✣ Field Vane ✣ (kPa) 50 100 150 200

DEPTH (m)	SOIL SYMBOL	BACKFILL DETAILS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE #	SPT (N)	COMMENTS	ELEVATION
12					T04		Su = 196.1 kPa	500
13								
14					S05	43	SPT Blow Count [7/17/26]	499
15								498
16					S06	60	SPT Blow Count [11/23/37] Gravel: 0.0%, Sand: 9.2%, Silt: 53.4%, Clay: 37.4%	497
17					S07	59	SPT Blow Count [7/23/36]	496
18								495
19			- stiff to very stiff at 18.6 m		T08		Su = 98.1 kPa	494
20					S09	88	SPT Blow Count [15/38/50]	493
21								492
22					S10	96	SPT Blow Count [20/46/50]	491
23			END OF TEST HOLE AT 21.8 m IN SILT and CLAY					490
24								489

NOTES:
1. Sloughing observed from ground surface to 7.0 m.
2. Seepage observed below 4.0 m.
3. Test hole backfilled with bentonite upon completion.

AECOM

LOGGED BY: Chris Kjarsgaard	COMPLETION DEPTH: 21.79 m
REVIEWED BY: Alex Hill	COMPLETION DATE: 4/22/16
PROJECT ENGINEER: Zeyad Shukri	Page 2 of 2

LOG OF TEST HOLE 60336819- TEST HOLE LOGS.GPJ UMA WINN.GDT 6/17/16

Appendix C

Lab Results

AECOM
99 Commerce Drive
Winnipeg, MB, Canada R3P 0Y7
www.aecom.com

204 477 5381 tel
204 284 2040 fax

Memorandum

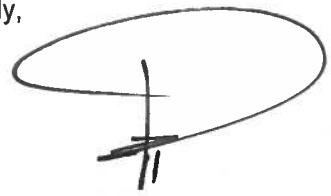
To	Alex Hill	Page	1
CC			
Subject	RM of Eldon – Big Gulley Culvert – Materials Testing Results		
From	Zeyad Shukri		
Date	May 05, 2016	Project Number	60336819

Please find attached the following material test result(s) on sample(s) submitted to the Winnipeg Geotechnical Laboratory:

- Twenty three (23) Moisture Content tests.
- Four (4) Atterberg Limits (3 points) tests.
- One (1) Grain Size Distribution (Sieve Analysis up to 19 mm) tests.
- Four (4) Grain Size Distribution (Hydrometer) tests.
- Four (4) Torvane, Pocket Penetrometer, Moisture Content, Bulk Density and Visual Description with Unconfined Compressive Strength, on Shelby tube samples.

If you have any questions, please contact the undersigned.

Sincerely,



Zeyad Shukri Al-Hayazai, M.Sc., P.Eng.
Senior Geotechnical Engineer

Att.

AECOM Canada Ltd.
Winnipeg Geotechnical Laboratory
99 Commerce Drive
Winnipeg, Manitoba
R3P 0Y7
Phone: 204 477 5381 Fax: 204 284 2040

Project Name:	Big Gulley Culvert	Supplier:	AECOM
Project Number:	60336819	Specification:	N/A
Client:	RM of Eldon	Field Technician:	CKjarsgaard
Sample Location:	Varies	Sample Date:	April 22, 2016
Sample Depth:	Varies	Lab Technician:	MLotecki
Sample Number:	Varies	Date Tested:	April 26, 2016

Moisture Content (ASTM D2216-10)

Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

Location	Sample	Depth (m)	Moisture Content (%)
TH16-01	S01	1.52 - 1.98 m	**5.2%**
	S02	3.05 - 3.51 m	**6.4%**
	S03	4.57 - 5.03 m	-
	S04	6.10 - 6.55 m	**11.7%**
	S05	7.62 - 8.08 m	**20.3%**
	T06	9.14 - 9.75 m	**17.8%**
	S07	10.67 - 11.13 m	**19.5%**
	S08	12.19 - 12.65 m	**18.9%**
	S09	13.72 - 14.17 m	**19.7%**
	T10	15.24 - 15.85 m	**20.7%**
	S11	16.76 - 17.22 m	**34.9%**
	S12	18.29 - 18.75 m	**19.2%**
	S13	19.81 - 20.27 m	**16.3%**
	S14	21.34 - 21.79 m	**17.9%**
TH16-02	S01	7.62 - 8.08 m	**13.0%**
	S02	9.14 - 9.60 m	**25.5%**
	S03	10.67 - 11.13 m	**21.6%**
	T04	12.19 - 12.80 m	**21.2%**
	S05	13.72 - 14.17 m	**19.1%**
	S06	15.24 - 15.70 m	**17.9%**
	S07	16.76 - 17.22 m	**20.1%**
	T08	18.29 - 18.90 m	**19.2%**
	S09	19.81 - 20.27 m	**22.8%**
	S10	21.34 - 21.79 m	**16.3%**

Location	Sample	Depth (m)	Moisture Content (%)

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Winnipeg Geotechnical Laboratory
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Phone: 204 477 5381 Fax: 204 284 2040

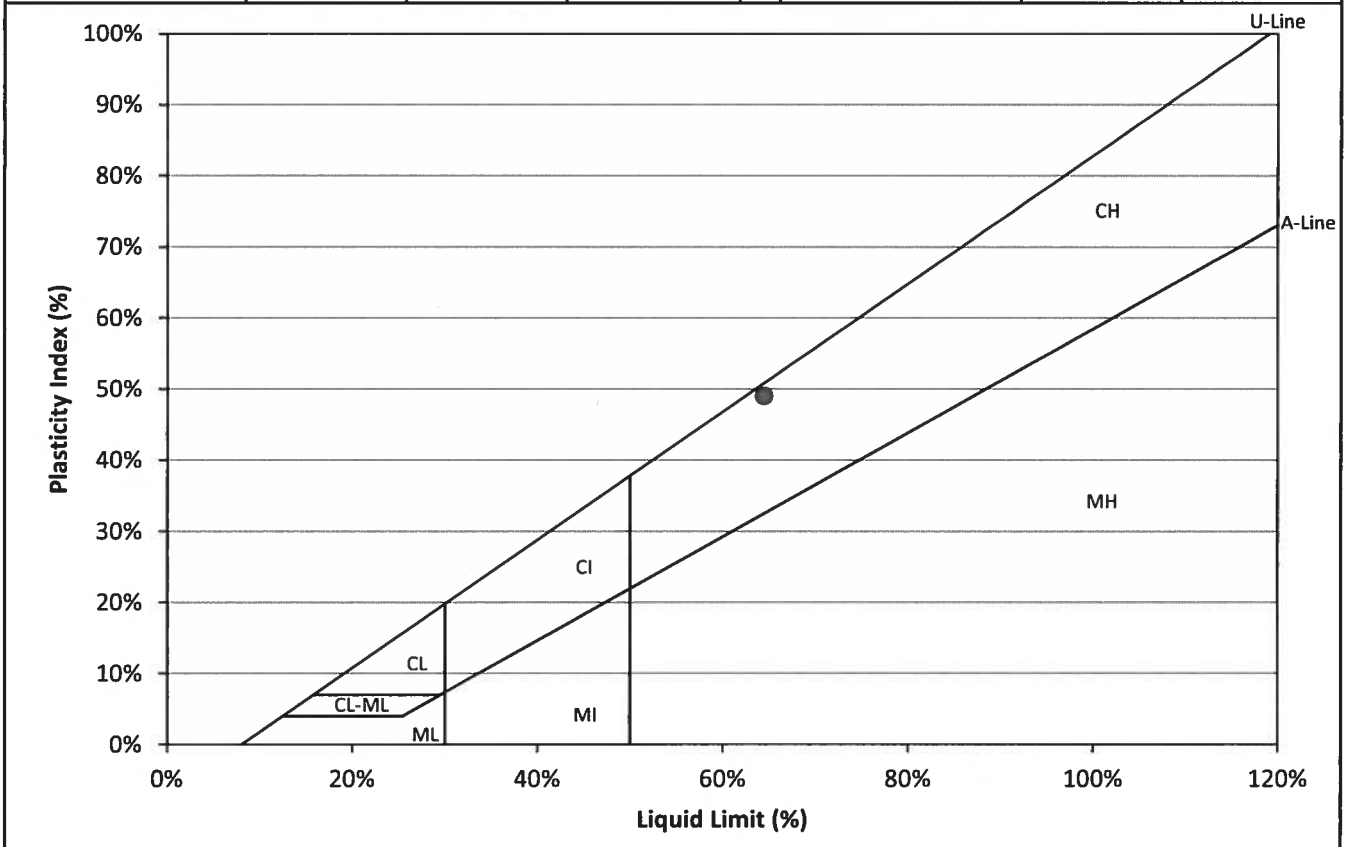
Project Name:	Big Gully Culvert	Supplier:	AECOM
Project Number:	60336819	Specification:	N/A
Client:	RM of Eldon	Field Technician:	CKjarsgaard
Sample Location:	TH16-01	Sample Date:	April 22, 2016
Sample Depth:	19.81 - 21.79 m	Lab Technician:	EManimbao
Sample Number:	S13 and S14	Date Tested:	April 28, 2016

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	34	25	17
Wet Sample (g)	7.1	6.8	6.9
Dry Sample (g)	4.4	4.1	4.1
Water Content (%)	63.0%	64.5%	66.5%

Plastic Limit		
Trial	1	2
Wet Sample (g)	6.2	6.1
Dry Sample (g)	5.3	5.2
Water Content (%)	15.2%	15.6%



Liquid Limit (%): 64.4%	Plastic Limit (%): 15.4%	Plasticity Index (%): 49.0%

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Winnipeg Geotechnical Laboratory
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Winnipeg, Manitoba
R3P 0Y7
Phone: 204 477 5381 Fax: 204 284 2040

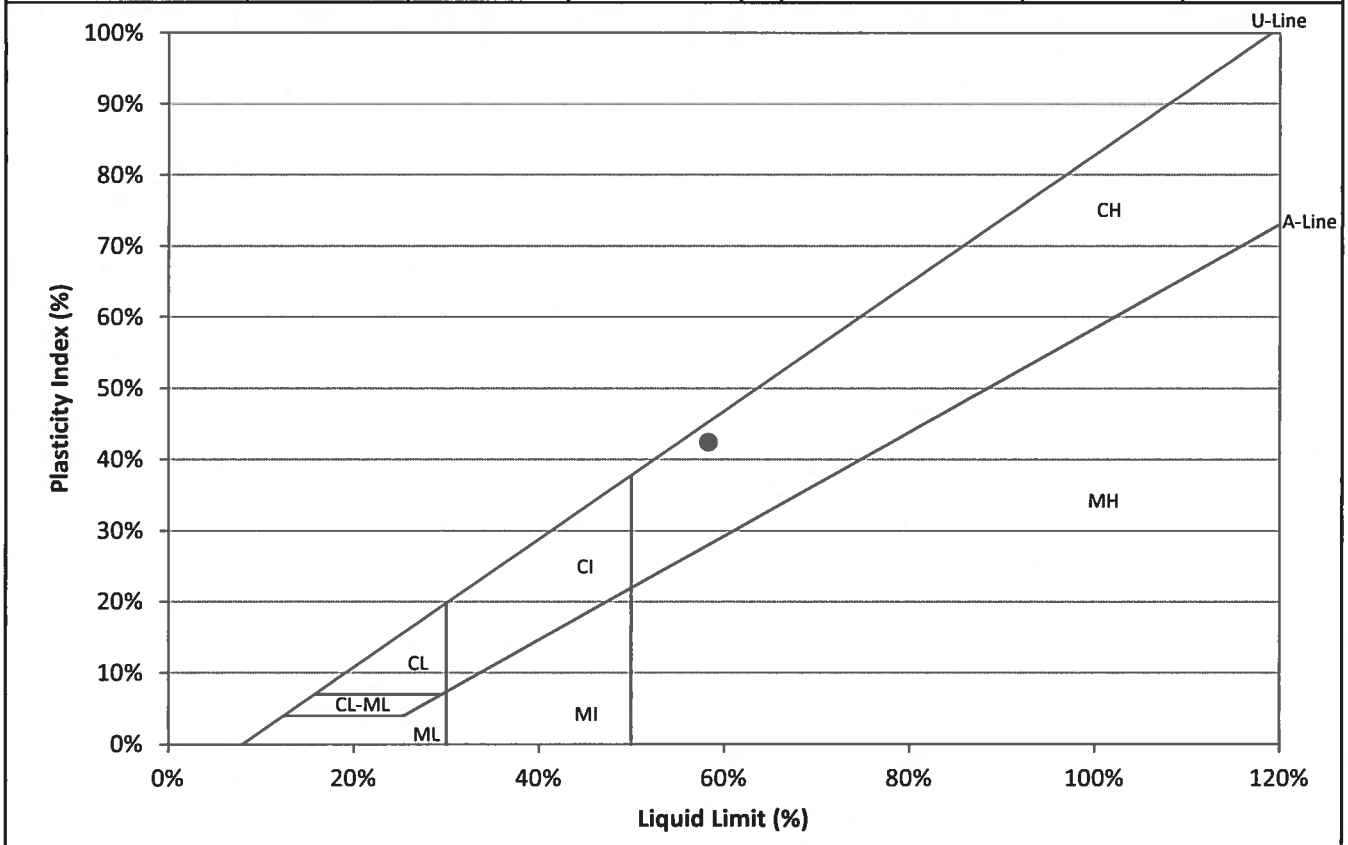
Project Name:	Big Gully Culvert	Supplier:	AECOM
Project Number:	60336819	Specification:	N/A
Client:	RM of Eldon	Field Technician:	CKjarsgaard
Sample Location:	TH16-01	Sample Date:	April 22, 2016
Sample Depth:	10.67 - 12.65 m	Lab Technician:	EManimbao
Sample Number:	S07 and S08	Date Tested:	April 28, 2016

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	33	24	18
Wet Sample (g)	7.5	7.2	7.8
Dry Sample (g)	4.8	4.5	4.9
Water Content (%)	56.8%	58.6%	59.6%

Plastic Limit		
Trial	1	2
Wet Sample (g)	7.2	7.9
Dry Sample (g)	6.2	6.8
Water Content (%)	15.6%	16.1%



Liquid Limit (%): 58.3%	Plastic Limit (%): 15.9%	Plasticity Index (%): 42.4%

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Winnipeg Geotechnical Laboratory
99 Commerce Drive
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R3P 0Y7
Phone: 204 477 5381 Fax: 204 284 2040

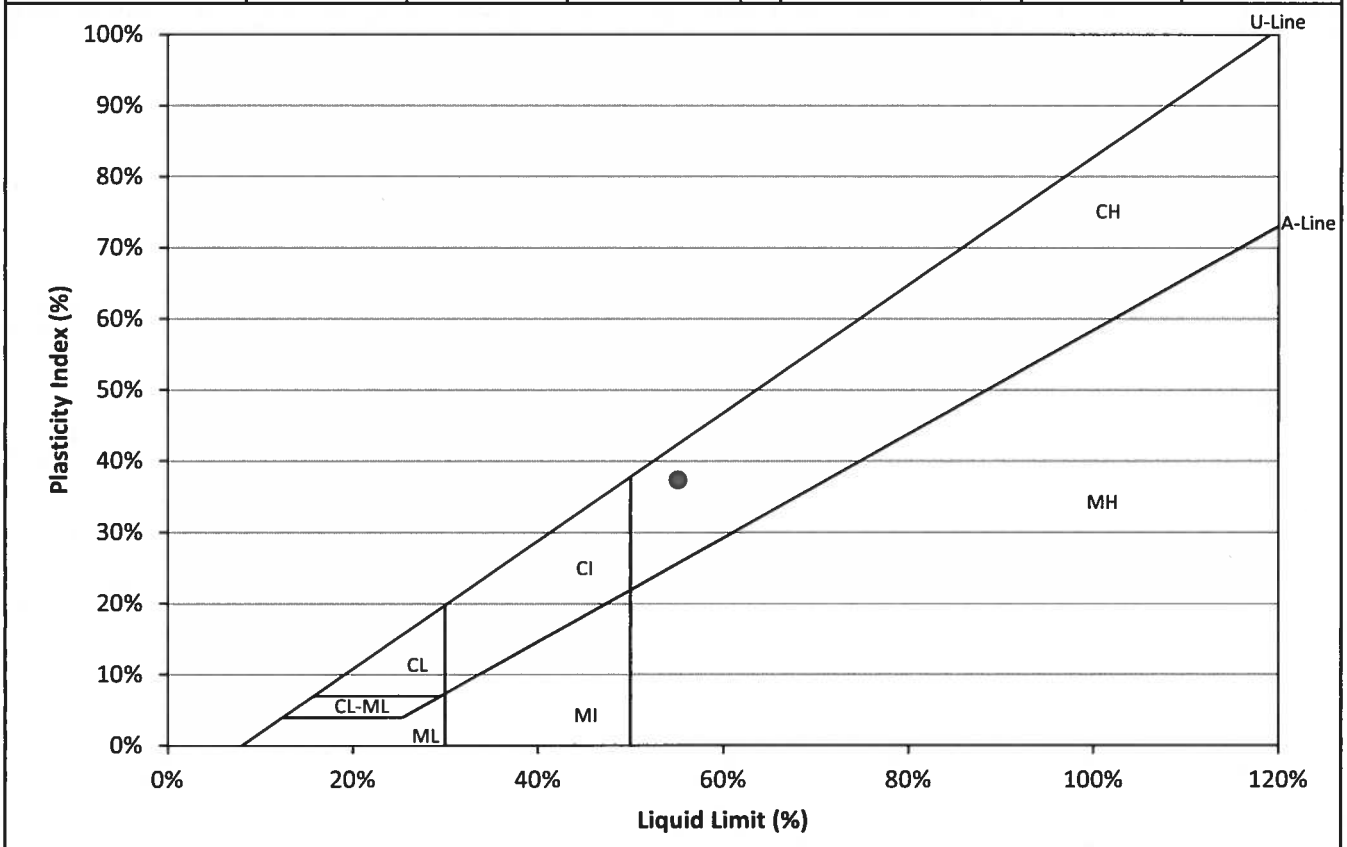
Project Name:	Big Gully Culvert	Supplier:	AECOM
Project Number:	60336819	Specification:	N/A
Client:	RM of Eldon	Field Technician:	CKjarsgaard
Sample Location:	TH16-02	Sample Date:	April 22, 2016
Sample Depth:	9.14 - 11.13 m	Lab Technician:	EManimbao
Sample Number:	S02 and S03	Date Tested:	April 28, 2016

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	28	22	17
Wet Sample (g)	6.6	8.1	9.0
Dry Sample (g)	4.3	5.2	5.7
Water Content (%)	54.2%	55.9%	57.2%

Plastic Limit		
Trial	1	2
Wet Sample (g)	8.0	7.2
Dry Sample (g)	6.7	6.1
Water Content (%)	18.2%	17.2%



Liquid Limit (%): 55.1%	Plastic Limit (%): 17.7%	Plasticity Index (%): 37.4%

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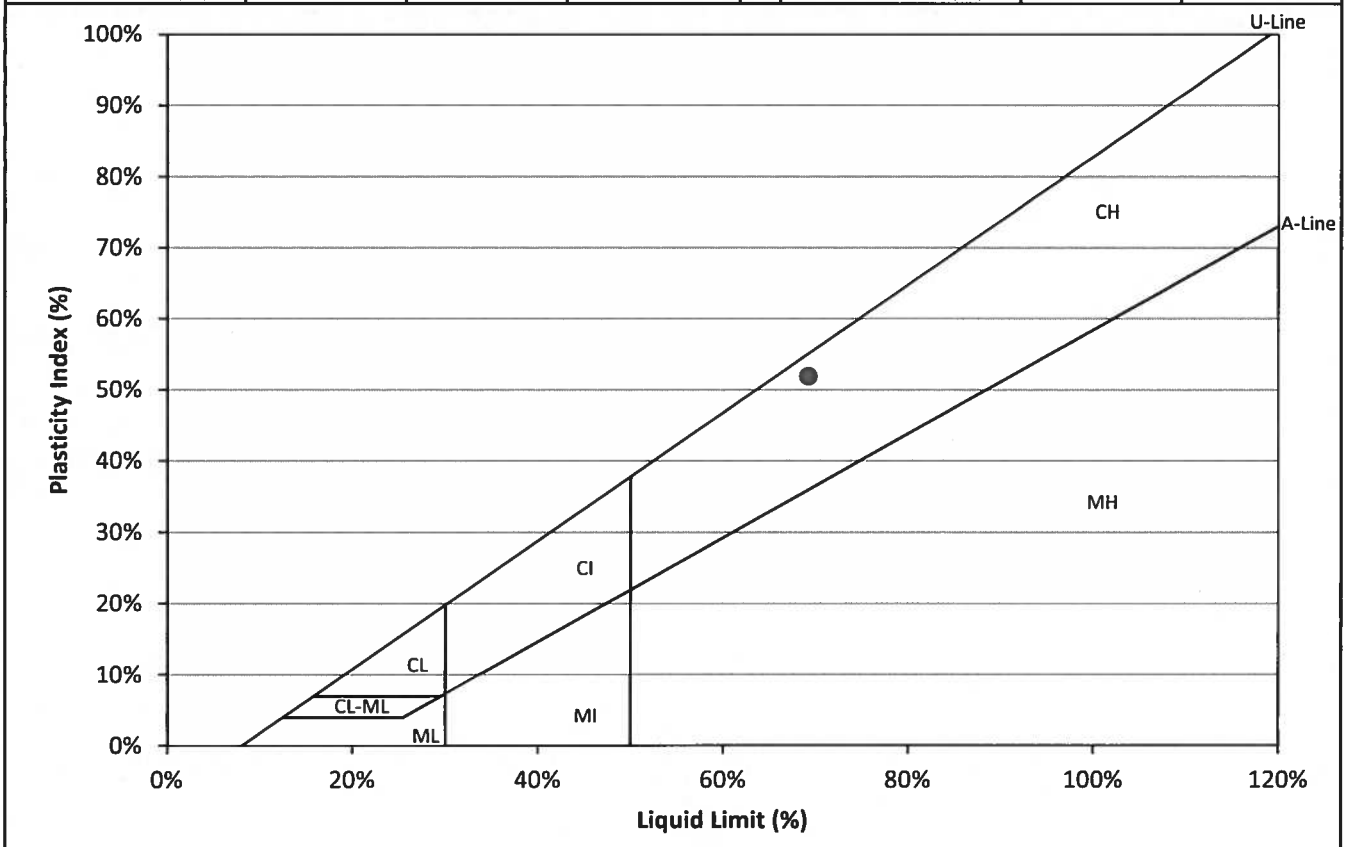
Project Name:	Big Gully Culvert	Supplier:	AECOM
Project Number:	60336819	Specification:	N/A
Client:	RM of Eldon	Field Technician:	CKjarsgaard
Sample Location:	TH16-02	Sample Date:	April 22, 2016
Sample Depth:	15.24 - 17.22 m	Lab Technician:	EManimbao
Sample Number:	S06 and S07	Date Tested:	April 28, 2016

Atterberg Limits (ASTM D4318)

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Liquid Limit			
Blows	35	26	23
Wet Sample (g)	7.0	7.5	7.0
Dry Sample (g)	4.2	4.4	4.1
Water Content (%)	67.9%	69.1%	69.3%

Plastic Limit		
Trial	1	2
Wet Sample (g)	6.7	6.5
Dry Sample (g)	5.7	5.5
Water Content (%)	17.3%	17.3%



Liquid Limit (%): 69.2%	Plastic Limit (%): 17.3%	Plasticity Index (%): 51.9%

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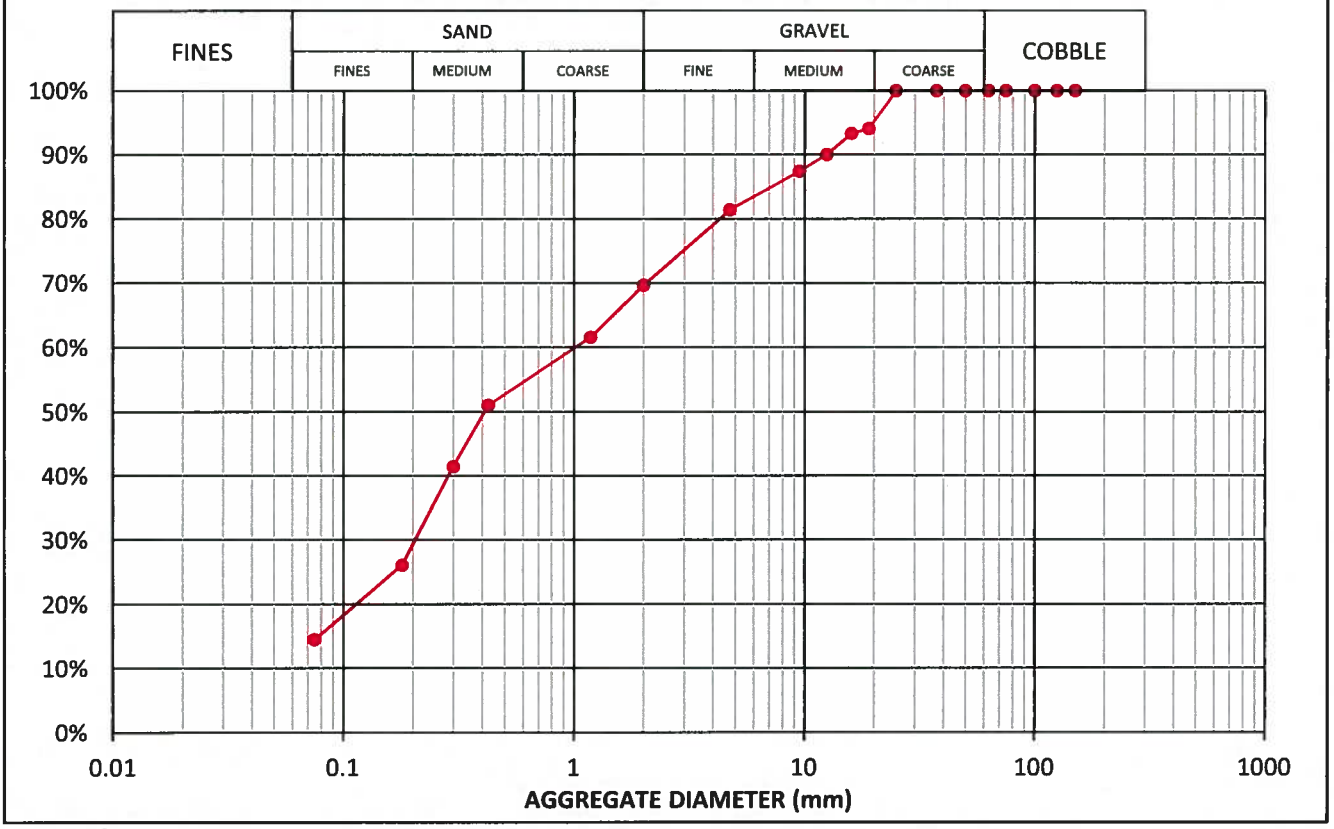
Project Name:	Big Gully Culvert	Supplier:	N/A
Project Number:	60336819	Specification:	N/A
Client:	RM of Eldon	Field Technician:	N/A
Sample Location:	TH16-01	Sample Date:	April 22, 2016
Sample Depth:	1.52 - 3.51	Lab Technician:	MLotecki
Sample Number:	S01 and S02	Date Tested:	April 29, 2016

Imperial Sieve (ASTM C136-06)

Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

Sieve Size (inches)	Total Percent Passing (%)	Specification (%)	
		Min	Max
6"	100.0%	-	-
5"	100.0%	-	-
4"	100.0%	-	-
3"	100.0%	-	-
2.5"	100.0%	-	-
2"	100.0%	-	-
1.5	100.0%	-	-
1"	100.0%	-	-
3/4"	94.1%	-	-
5/8"	93.4%	-	-

Sieve Size (inches)	Total Percent Passing (%)	Specification (%)	
		Min	Max
1/2"	90.0%	-	-
3/8"	87.4%	-	-
No. 4	81.4%	-	-
No. 10	69.6%	-	-
No. 16	61.6%	-	-
No. 40	51.0%	-	-
No. 50	41.4%	-	-
No. 80	26.0%	-	-
No. 200	14.5%	-	-



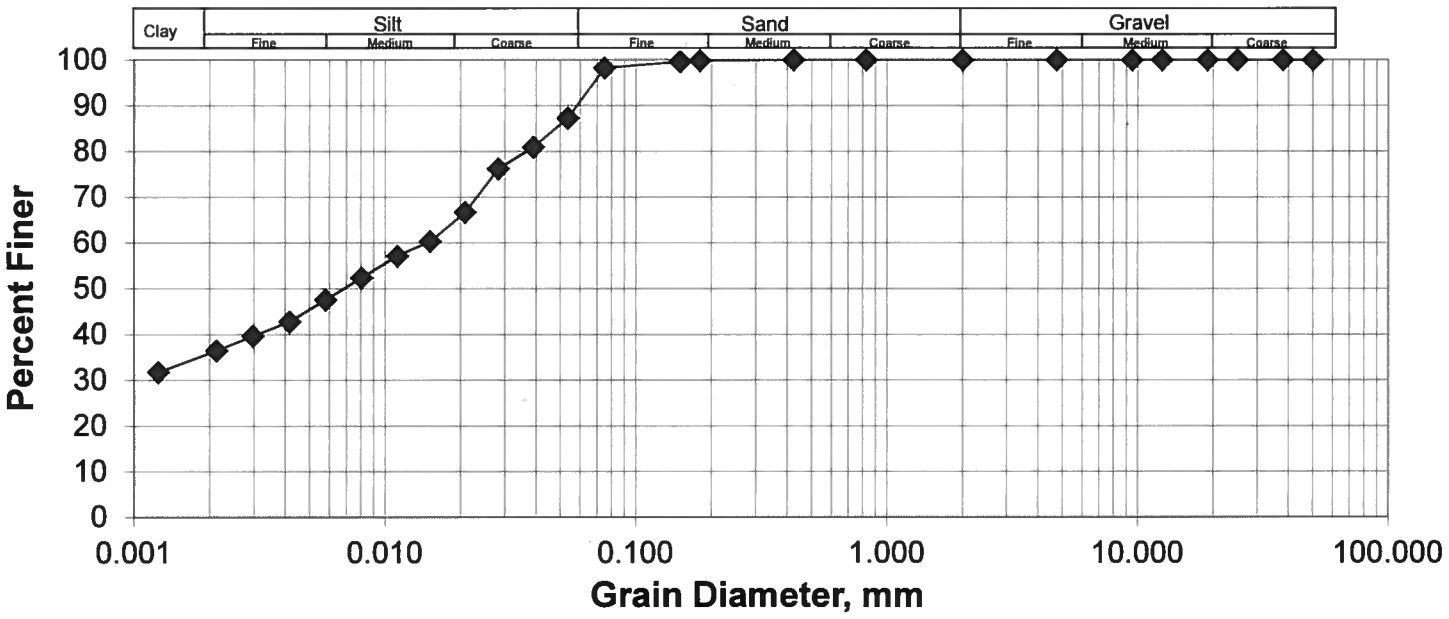
GRAIN SIZE DISTRIBUTION
(ASTM D422-63)

AECOM
MATERIALS LABORATORY
AECOM
99 Commerce Dr., Winnipeg, MB R3P 0Y7 Canada
tel (204) 477-5381 fax (204) 284-2040

Job No.:	60336819	Hole No.:	TH16-01
Client:	RM of Eldon	Sample No.:	S07 and S08
Project :	Big Gully Culvert	Depth:	10.67 - 12.65 m
Date Tested:	29-Apr-16	Date Sampled:	Varies
Tested By:	MLotecki	Sampled By:	AECOM

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	2.00	100.0	0.0750	98.2
38.0	100.0	0.83	100.0	0.0535	87.3
25.0	100.0	0.43	100.0	0.0391	80.9
19.0	100.0	0.18	99.8	0.0282	76.2
12.5	100.0	0.15	99.6	0.0208	66.6
9.5	100.0	0.075	98.2	0.0151	60.3
4.75	100.0			0.0112	57.1
2.00	100.0			0.0081	52.3
				0.0058	47.6
				0.0042	42.8
				0.0030	39.6
				0.0021	36.5
				0.0013	31.7

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.00%**	**Silt**	**54.83%**
Sand	**9.42%**	**Clay**	**35.75%**

** Note: Soil Classification based on Grain Size from Canadian Foundation Engineering Manual, 3rd edition (1992).

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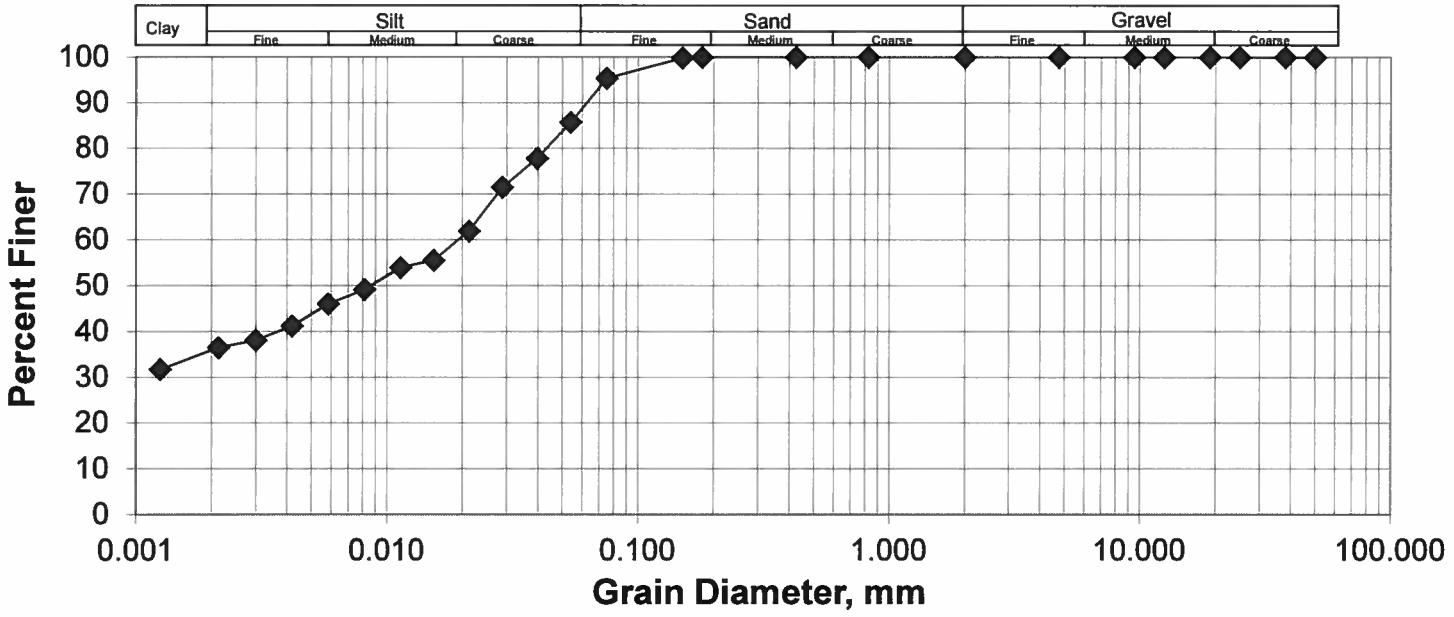
Job No.:	60336819	Hole No.:	TH16-01
Client:	RM of Eldon	Sample No.:	S13 and S14
Project :	Big Gully Culvert	Depth:	19.81 - 21.79 m
Date Tested:	29-Apr-16	Date Sampled:	Varies
Tested By:	MLotecki	Sampled By:	AECOM

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	2.00	100.0	0.0750	95.4
38.0	100.0	0.83	100.0	0.0539	85.7
25.0	100.0	0.43	100.0	0.0397	77.8
19.0	100.0	0.18	100.0	0.0289	71.4
12.5	100.0	0.15	99.8	0.0213	61.9
9.5	100.0	0.075	95.4	0.0154	55.5
4.75	100.0			0.0113	53.9
2.00	100.0			0.0082	49.2
				0.0058	46.0
				0.0042	41.2
				0.0030	38.1
				0.0021	36.5
				0.0013	31.7

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.00%**	**Silt**	**52.74%**
Sand	**11.51%**	**Clay**	**35.75%**

** Note: Soil Classification based on Grain Size from Canadian Foundation Engineering Manual, 3rd edition (1992).

GRAIN SIZE DISTRIBUTION
(ASTM D422-63)

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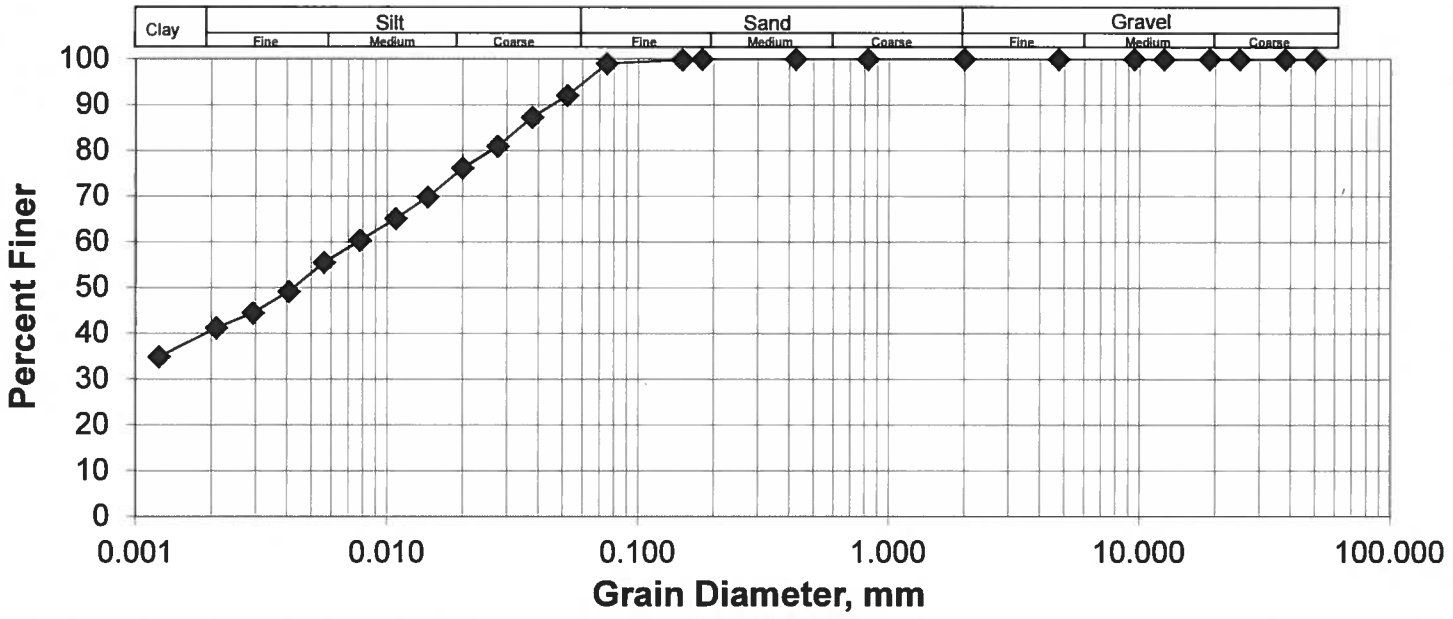
MATERIALS LABORATORY
AECOM
99 Commerce Dr., Winnipeg, MB R3P 0Y7 Canada
tel (204) 477-5381 **fax** (204) 284-2040

Job No.:	60336819	Hole No.:	TH16-02
Client:	RM of Eldon	Sample No.:	S02 and S03
Project :	Big Gully Culvert	Depth:	9.14 - 11.13 m
Date Tested:	29-Apr-16	Date Sampled:	Varies
Tested By:	MLotecki	Sampled By:	AECOM

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	2.00	100.0	0.0750	99.0
38.0	100.0	0.83	100.0	0.0522	92.1
25.0	100.0	0.43	100.0	0.0378	87.3
19.0	100.0	0.18	100.0	0.0276	80.9
12.5	100.0	0.15	99.8	0.0200	76.2
9.5	100.0	0.075	99.0	0.0145	69.8
4.75	100.0			0.0108	65.1
2.00	100.0			0.0078	60.3
				0.0056	55.5
				0.0041	49.2
				0.0029	44.4
				0.0021	41.2
				0.0012	34.9

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.00%**	**Silt**	**53.93%**
Sand	**5.57%**	**Clay**	**40.51%**

** Note: Soil Classification based on Grain Size from Canadian Foundation Engineering Manual, 3rd edition (1992).

GRAIN SIZE DISTRIBUTION
(ASTM D422-63)

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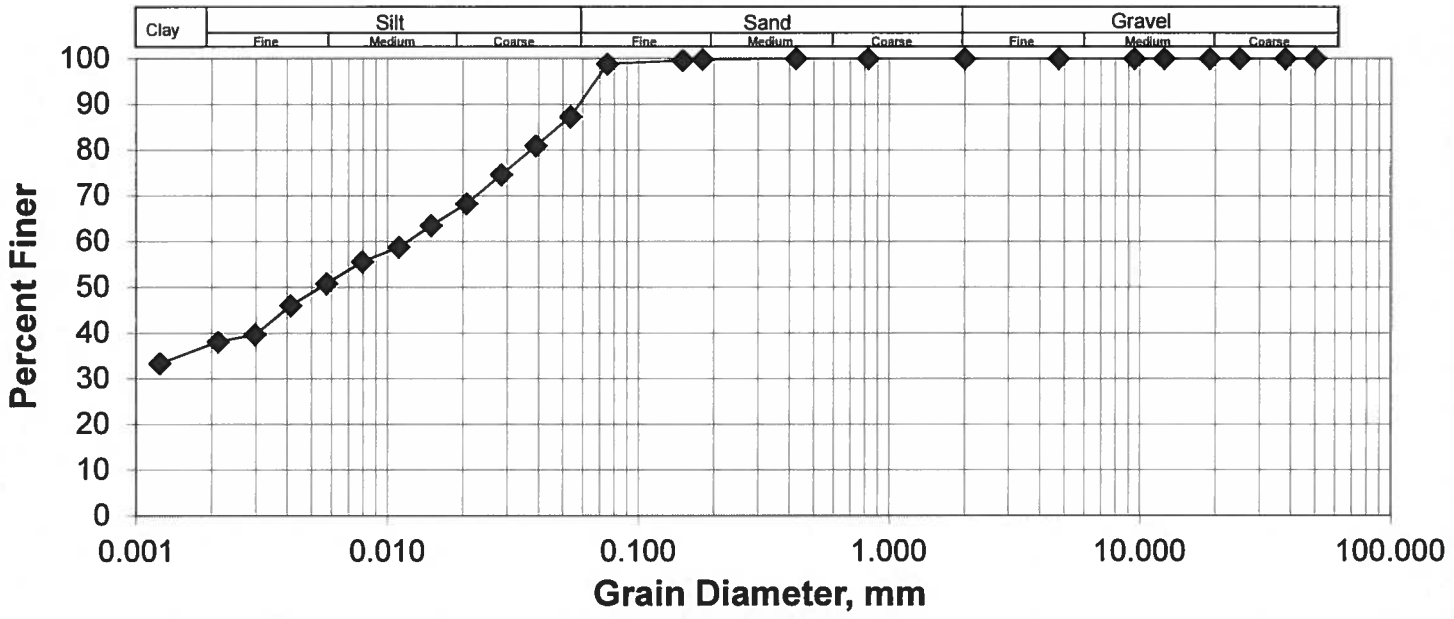
MATERIALS LABORATORY
AECOM
99 Commerce Dr., Winnipeg, MB R3P 0Y7 Canada
tel (204) 477-5381 fax (204) 284-2040

Job No.:	60336819	Hole No.:	TH16-02
Client:	RM of Eldon	Sample No.:	S06 and S07
Project :	Big Gully Culvert	Depth:	15.24 - 17.22 m
Date Tested:	29-Apr-16	Date Sampled:	Varies
Tested By:	MLotecki	Sampled By:	AECOM

GRAVEL SIZES		SAND SIZES		FINES	
Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing	Grain Size (mm.)	Total Percent Passing
50.0	100.0	2.00	100.0	0.0750	98.8
38.0	100.0	0.83	100.0	0.0535	87.3
25.0	100.0	0.43	100.0	0.0391	80.9
19.0	100.0	0.18	99.8	0.0285	74.6
12.5	100.0	0.15	99.6	0.0207	68.2
9.5	100.0	0.075	98.8	0.0149	63.5
4.75	100.0			0.0111	58.7
2.00	100.0			0.0080	55.5
				0.0057	50.8
				0.0041	46.0
				0.0030	39.6
				0.0021	38.1
				0.0012	33.3

GRAIN SIZE DISTRIBUTION CURVE



Gravel	**0.00%**	**Silt**	**53.37%**
Sand	**9.24%**	**Clay**	**37.40%**

** Note: Soil Classification based on Grain Size from Canadian Foundation Engineering Manual, 3rd edition (1992).

AECOM - SOILS LABORATORY
SHEAR STRENGTH, MOISTURE CONTENT & DENSITY CALCULATIONS

CLIENT: RM of Eldon
PROJECT: Big Gully Culvert
JOB NO.: 60336819

TEST HOLE NO.:	**TH16-01**
SAMPLE NO.:	**T6**
SAMPLE DEPTH:	9.14 - 9.75 m
DATE TESTED:	27-Apr-16
SHEAR STRENGTH TESTS	
TORVANE	
Reading	0.50
Vane Size (S, M, L)	S
Undrained Shear Strength (kPa)	**122.6**
Undrained Shear Strength (ksf)	2.56
POCKET PENETROMETER	
Reading - Qu (tsf)	MAX
Undrained Shear Strength (kPa)	**#VALUE!**
Reading - Qu (tsf)	MAX
Undrained Shear Strength (kPa)	**#VALUE!**
Reading - Qu (tsf)	MAX
Undrained Shear Strength (kPa)	**#VALUE!**
UNCONFINED COMPRESSIVE STRENGTH TEST	
Unconfined compressive strength (kPa)	**244.4**
Unconfined compressive strength (ksf)	**5.1**
Undrained Shear Strength (kPa)	**122.2**
Undrained Shear Strength (ksf)	**2.552**
MOISTURE CONTENT	
Tare Number	X2
Wt. Sample wet + tare (g)	301.4
Wt. Sample dry + tare (g)	257.2
Wt. Tare (g)	8.5
Moisture Content %	**17.8**
BULK DENSITY	
Sample Wt. (g)	1327.2
Diameter 1 (cm)	7.17
Diameter 2 (cm)	7.24
Diameter 3 (cm)	7.20
Avg. Diameter (cm)	**7.20**
Length 1 (cm)	15.32
Length 2 (cm)	15.30
Length 3 (cm)	15.32
Avg. Length (cm)	**15.31**
Volume (cm^3)	624.1
Moisture content (%)	17.8
Bulk Density (g/cm^3)	2.127
Bulk Density (kN/m^3)	**20.9**
Bulk Density (pcf)	**132.8**
Dry Density (kN/m^3)	**17.71**

AECOM - SOILS LABORATORY

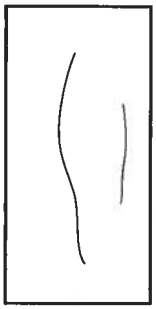
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS (ASTM D2166)

AECOM

CLIENT:	RM of Eldon
PROJECT:	Big Gully Culvert
JOB NO.:	60247924

TEST HOLE NO.:	TH16-01
SAMPLE NO.:	T6
SAMPLE DEPTH:	9.14 - 9.75 m
SAMPLE DATE:	
TEST DATE:	27-Apr-16

SOIL DESCRIPTION:	
CLAY, silty, trace sand, grey, moist, homogeneous, intermediate plasitcity	
hard	
MOISTURE CONTENT:	17.8



FAILURE SKETCH

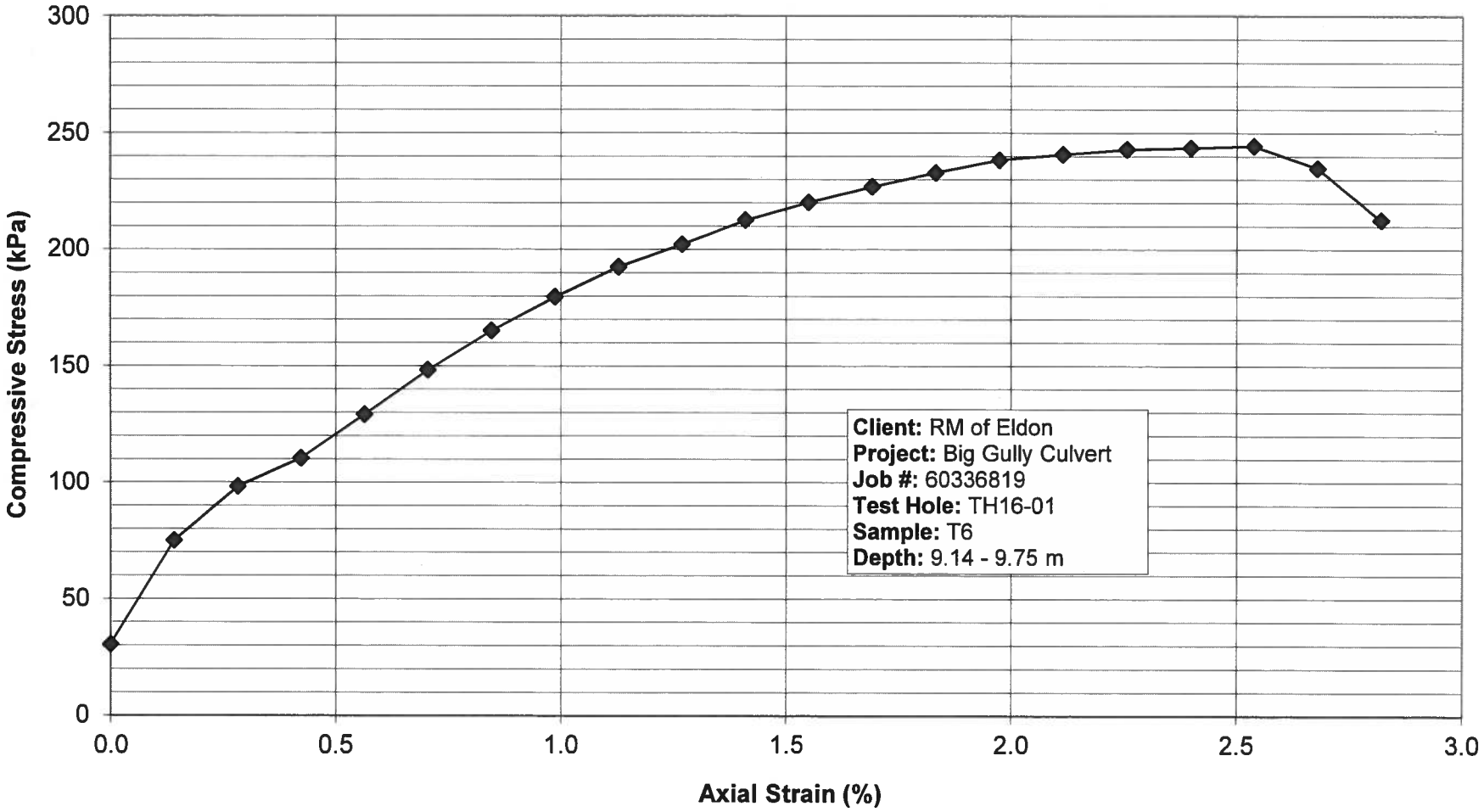
SAMPLE DIAM.(Do):	72.03	(mm)	INITIAL AREA, Ao:	4075.3	(mm^2)
SAMPLE LENGTH, (Lo):	153.13	(mm)	PISTON RATE:	0.051	(Inches / minute)
L / D RATIO:	2.13	(2 < L/D < 2.5)	AXIAL STRAIN RATE, R:	0.85	(0.5<R<2 % / minute)

TEST DATA - DIAL READINGS							
AXIAL COMPRESSION	PROVING RING	TOTAL AXIAL STRAIN, E_1	AVERAGE CROSS-SECTIONAL AREA, A	APPLIED AXIAL LOAD, P	COMPRESSIVE STRESS, σ_c		
(inches)	(inches)	(%)	(inches2)	(lbs)	(psi)	(ksf)	(kPa)
0.01	0.0030	0.00	6.32	27.92	4.42	0.637	30.5
0.02	0.0073	0.14	6.33	68.78	10.87	1.566	75.0
0.03	0.0096	0.28	6.33	90.23	14.24	2.051	98.2
0.03	0.0108	0.42	6.34	101.57	16.01	2.306	110.4
0.04	0.0127	0.56	6.35	119.00	18.73	2.697	129.2
0.05	0.0146	0.70	6.36	136.80	21.50	3.097	148.3
0.06	0.0163	0.85	6.37	152.64	23.96	3.450	165.2
0.07	0.0177	0.99	6.38	166.22	26.06	3.752	179.6
0.08	0.0190	1.13	6.39	178.40	27.92	4.021	192.5
0.09	0.0200	1.27	6.40	187.59	29.32	4.222	202.2
0.09	0.0211	1.41	6.41	197.52	30.83	4.439	212.6
0.10	0.0219	1.55	6.42	204.92	31.94	4.599	220.2
0.11	0.0226	1.69	6.43	211.48	32.91	4.740	226.9
0.12	0.0232	1.83	6.43	217.38	33.78	4.865	232.9
0.13	0.0238	1.97	6.44	222.82	34.58	4.979	238.4
0.14	0.0241	2.11	6.45	225.35	34.92	5.029	240.8
0.14	0.0243	2.26	6.46	227.69	35.23	5.074	242.9
0.15	0.0244	2.40	6.47	228.63	35.33	5.087	243.6
0.16	0.0245	2.54	6.48	229.75	35.45	5.105	244.4
0.17	0.0236	2.68	6.49	221.13	34.07	4.906	234.9
0.18	0.0214	2.82	6.50	200.52	30.85	4.442	212.7

UNCONFINED COMPRESSIVE STRENGTH, q_u:	244.41	kPa
(based on maximum q_u value)	5.105	ksf
UNDRAINED SHEAR STRENGTH, S_u:	122.21	kPa
(based on maximum q_u value)	2.552	ksf

NOTES:

AECOM
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS
(ASTM D2166)



AECOM - SOILS LABORATORY
SHEAR STRENGTH, MOISTURE CONTENT & DENSITY CALCULATIONS

AECOM

CLIENT: RM of Eldon
PROJECT: Big Gully Culvert
JOB NO.: 60336819

TEST HOLE NO.:	**TH16-01**
SAMPLE NO.:	**T10**
SAMPLE DEPTH:	15.24 - 15.85 m
DATE TESTED:	27-Apr-16
SHEAR STRENGTH TESTS	
TORVANE	
Reading	0.40
Vane Size (S, M, L)	S
Undrained Shear Strength (kPa)	**98.1**
Undrained Shear Strength (ksf)	2.05
POCKET PENETROMETER	
Reading - Qu (tsf)	MAX
Undrained Shear Strength (kPa)	**#VALUE!**
Reading - Qu (tsf)	MAX
Undrained Shear Strength (kPa)	**#VALUE!**
Reading - Qu (tsf)	MAX
Undrained Shear Strength (kPa)	**#VALUE!**
UNCONFINED COMPRESSIVE STRENGTH TEST	
Unconfined compressive strength (kPa)	**156.6**
Unconfined compressive strength (ksf)	**3.3**
Undrained Shear Strength (kPa)	**78.3**
Undrained Shear Strength (ksf)	**1.635**
MOISTURE CONTENT	
Tare Number	SG6
Wt. Sample wet + tare (g)	280.5
Wt. Sample dry + tare (g)	233.9
Wt. Tare (g)	8.5
Moisture Content %	**20.7**
BULK DENSITY	
Sample Wt. (g)	1267.4
Diameter 1 (cm)	7.20
Diameter 2 (cm)	7.16
Diameter 3 (cm)	7.20
Avg. Diameter (cm)	**7.19**
Length 1 (cm)	15.30
Length 2 (cm)	15.30
Length 3 (cm)	15.31
Avg. Length (cm)	**15.30**
Volume (cm^3)	620.8
Moisture content (%)	20.7
Bulk Density (g/cm^3)	2.042
Bulk Density (kN/m^3)	**20.0**
Bulk Density (pcf)	**127.5**
Dry Density (kN/m^3)	**16.59**

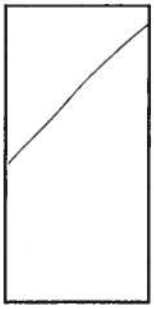
AECOM - SOILS LABORATORY
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS (ASTM D2166)

AECOM

CLIENT:	RM of Eldon
PROJECT:	Big Gully Culvert
JOB NO.:	60247924

TEST HOLE NO.:	TH16-01
SAMPLE NO.:	T10
SAMPLE DEPTH:	15.24 - 15.85 m
SAMPLE DATE:	
TEST DATE:	27-Apr-16

SOIL DESCRIPTION:	
CLAY; silty, trace sand, trace silt layers, grey, moist, homogeneous,	
intermediate plasitcity, hard	
MOISTURE CONTENT:	20.7



FAILURE SKETCH

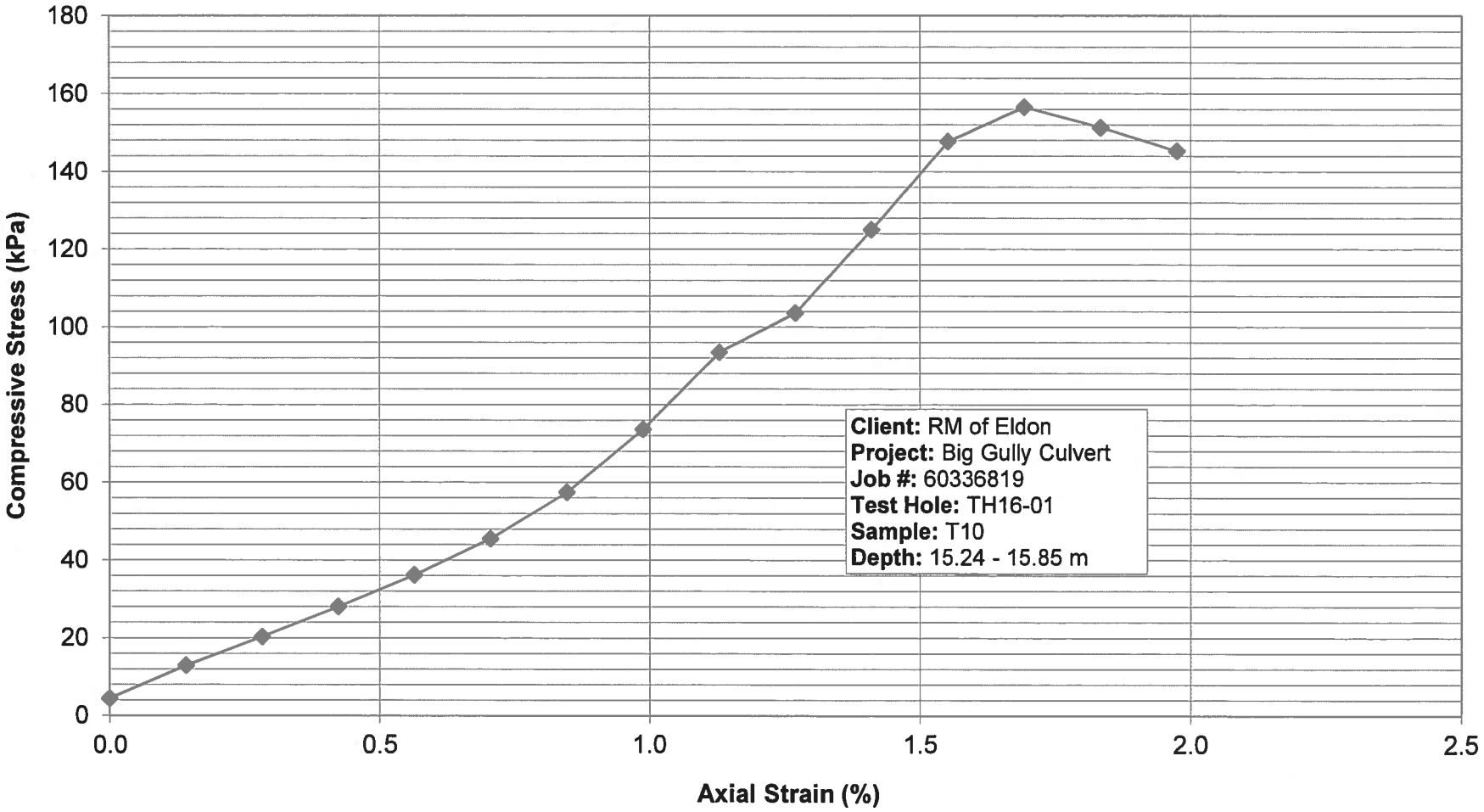
SAMPLE DIAM.(Do):	71.87	(mm)	INITIAL AREA, Ao:	4056.4	(mm^2)
SAMPLE LENGTH, (Lo):	153.03	(mm)	PISTON RATE:	0.051	(inches / minute)
L / D RATIO:	2.13	(2 < L/D < 2.5)	AXIAL STRAIN RATE, R:	0.85	(0.5<R<2 % / minute)

TEST DATA - DIAL READINGS							
AXIAL COMPRESSION	PROVING RING	TOTAL AXIAL STRAIN, E_1	AVERAGE CROSS-SECTIONAL AREA, A	APPLIED AXIAL LOAD, P	COMPRESSIVE STRESS, σ_c		
(inches)	(inches)	(%)	(inches2)	(lbs)	(psi)	(ksf)	(kPa)
0.01	0.0004	0.00	6.29	4.03	0.64	0.092	4.4
0.02	0.0013	0.14	6.30	11.81	1.88	0.270	12.9
0.03	0.0020	0.28	6.31	18.55	2.94	0.424	20.3
0.03	0.0027	0.42	6.31	25.67	4.07	0.586	28.0
0.04	0.0035	0.56	6.32	33.17	5.25	0.755	36.2
0.05	0.0045	0.71	6.33	41.79	6.60	0.950	45.5
0.06	0.0056	0.85	6.34	52.85	8.33	1.200	57.5
0.07	0.0072	0.99	6.35	67.84	10.68	1.538	73.7
0.08	0.0092	1.13	6.36	86.20	13.56	1.952	93.5
0.09	0.0102	1.27	6.37	95.67	15.02	2.163	103.6
0.09	0.0123	1.41	6.38	115.63	18.13	2.611	125.0
0.10	0.0146	1.55	6.39	136.80	21.42	3.085	147.7
0.11	0.0155	1.69	6.40	145.24	22.71	3.270	156.6
0.12	0.0150	1.83	6.40	140.55	21.94	3.160	151.3
0.13	0.0144	1.98	6.41	135.12	21.07	3.033	145.2

UNCONFINED COMPRESSIVE STRENGTH, q_u:	156.57	kPa
(based on maximum q_u value)	3.270	ksf
UNDRAINED SHEAR STRENGTH, S_u:	78.28	kPa
(based on maximum q_u value)	1.635	ksf

NOTES:

AECOM
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS
(ASTM D2166)



AECOM - SOILS LABORATORY
SHEAR STRENGTH, MOISTURE CONTENT & DENSITY CALCULATIONS

CLIENT: RM of Eldon
PROJECT: Big Gully Culvert
JOB NO.: 60336819

TEST HOLE NO.:	**TH16-02**
SAMPLE NO.:	**T4**
SAMPLE DEPTH:	12.19 - 12.80 m
DATE TESTED:	27-Apr-16
SHEAR STRENGTH TESTS	
TORVANE	
Reading	0.80
Vane Size (S, M, L)	S
Undrained Shear Strength (kPa)	**196.1**
Undrained Shear Strength (ksf)	4.10
POCKET PENETROMETER	
Reading - Qu (tsf)	MAX
Undrained Shear Strength (kPa)	**#VALUE!**
Reading - Qu (tsf)	MAX
Undrained Shear Strength (kPa)	**#VALUE!**
Reading - Qu (tsf)	MAX
Undrained Shear Strength (kPa)	**#VALUE!**
UNCONFINED COMPRESSIVE STRENGTH TEST	
Unconfined compressive strength (kPa)	**#VALUE!**
Unconfined compressive strength (ksf)	**#VALUE!**
Undrained Shear Strength (kPa)	**#VALUE!**
Undrained Shear Strength (ksf)	**#VALUE!**
MOISTURE CONTENT	
Tare Number	12
Wt. Sample wet + tare (g)	380.0
Wt. Sample dry + tare (g)	314.9
Wt. Tare (g)	8.1
Moisture Content %	**21.2**
BULK DENSITY	
Sample Wt. (g)	889.2
Diameter 1 (cm)	7.20
Diameter 2 (cm)	7.24
Diameter 3 (cm)	7.24
Avg. Diameter (cm)	**7.23**
Length 1 (cm)	10.32
Length 2 (cm)	10.32
Length 3 (cm)	10.34
Avg. Length (cm)	**10.33**
Volume (cm^3)	423.6
Moisture content (%)	21.2
Bulk Density (g/cm^3)	2.099
Bulk Density (kN/m^3)	**20.6**
Bulk Density (pcf)	**131.1**
Dry Density (kN/m^3)	**16.98**

AECOM - SOILS LABORATORY
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS (ASTM D2166)

AECOM

CLIENT:	RM of Eldon
PROJECT:	Big Gully Culvert
JOB NO.:	60247924

TEST HOLE NO.:	TH16-02
SAMPLE NO.:	T4
SAMPLE DEPTH:	12.19 - 12.80 m
SAMPLE DATE:	
TEST DATE:	27-Apr-16

SOIL DESCRIPTION:	
CLAY; silty, trace sand, trace silt layers, grey, moist, homogeneous,	
intermediate plasitcity, hard, DAMAGED TUBE	
MOISTURE CONTENT:	21.2

FAILURE SKETCH

SAMPLE DIAM.(Do):	72.27	(mm)	INITIAL AREA, Ao:	4101.7	(mm^2)
SAMPLE LENGTH, (Lo):	103.27	(mm)	PISTON RATE:	0.051	(inches / minute)
L / D RATIO:	1.43	(2 < L/D < 2.5)	AXIAL STRAIN RATE, R:	1.25	(0.5<R<2 % / minute)

TEST DATA - DIAL READINGS							
AXIAL COMPRESSION	PROVING RING	TOTAL AXIAL STRAIN, E_1	AVERAGE CROSS-SECTIONAL AREA, A	APPLIED AXIAL LOAD, P	COMPRESSIVE STRESS, σ_c		
(inches)	(inches)	(%)	(inches2)	(lbs)	(psi)	(ksf)	(kPa)
	0.0000	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!

UNCONFINED COMPRESSIVE STRENGTH, q_u:	#VALUE!	kPa
(based on maximum q_u value)	#VALUE!	ksf
UNDRAINED SHEAR STRENGTH, S_u:	#VALUE!	kPa
(based on maximum q_u value)	#VALUE!	ksf

NOTES:

AECOM - SOILS LABORATORY
SHEAR STRENGTH, MOISTURE CONTENT & DENSITY CALCULATIONS

CLIENT: RM of Eldon
PROJECT: Big Gully Culvert
JOB NO.: 60336819

TEST HOLE NO.:	**TH16-02**
SAMPLE NO.:	**T8**
SAMPLE DEPTH:	18.29 - 18.90 m
DATE TESTED:	27-Apr-16
SHEAR STRENGTH TESTS	
TORVANE	
Reading	0.40
Vane Size (S, M, L)	S
Undrained Shear Strength (kPa)	**98.1**
Undrained Shear Strength (ksf)	2.05
POCKET PENETROMETER	
Reading - Qu (tsf)	MAX
Undrained Shear Strength (kPa)	**#VALUE!**
Reading - Qu (tsf)	MAX
Undrained Shear Strength (kPa)	**#VALUE!**
Reading - Qu (tsf)	MAX
Undrained Shear Strength (kPa)	**#VALUE!**
UNCONFINED COMPRESSIVE STRENGTH TEST	
Unconfined compressive strength (kPa)	**#VALUE!**
Unconfined compressive strength (ksf)	**#VALUE!**
Undrained Shear Strength (kPa)	**#VALUE!**
Undrained Shear Strength (ksf)	**#VALUE!**
MOISTURE CONTENT	
Tare Number	F8
Wt. Sample wet + tare (g)	382.7
Wt. Sample dry + tare (g)	322.4
Wt. Tare (g)	8.8
Moisture Content %	**19.2**
BULK DENSITY	
Sample Wt. (g)	716.7
Diameter 1 (cm)	7.22
Diameter 2 (cm)	7.22
Diameter 3 (cm)	7.24
Avg. Diameter (cm)	**7.23**
Length 1 (cm)	9.01
Length 2 (cm)	9.02
Length 3 (cm)	9.04
Avg. Length (cm)	**9.02**
Volume (cm^3)	370.1
Moisture content (%)	19.2
Bulk Density (g/cm^3)	1.936
Bulk Density (kN/m^3)	**19.0**
Bulk Density (pcf)	**120.9**
Dry Density (kN/m^3)	**15.93**

AECOM - SOILS LABORATORY
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOILS (ASTM D2166)

AECOM

CLIENT:	RM of Eldon
PROJECT:	Big Gully Culvert
JOB NO.:	60247924

TEST HOLE NO.:	TH16-02
SAMPLE NO.:	T8
SAMPLE DEPTH:	18.29 - 18.90 m
SAMPLE DATE:	
TEST DATE:	27-Apr-16

SOIL DESCRIPTION:	
CLAY; silty, trace sand, trace silt layers, grey, moist, homogeneous,	
intermediate plasitcity, hard, DAMAGED TUBE	
MOISTURE CONTENT:	19.2

FAILURE SKETCH

SAMPLE DIAM.(Do):	72.27	(mm)	INITIAL AREA, Ao:	4101.7	(mm^2)
SAMPLE LENGTH, (Lo):	90.23	(mm)	PISTON RATE:	0.051	(inches / minute)
L / D RATIO:	1.25	(2 < L/D < 2.5)	AXIAL STRAIN RATE, R:	1.44	(0.5<R<2 % / minute)

TEST DATA - DIAL READINGS							
AXIAL COMPRESSION	PROVING RING	TOTAL AXIAL STRAIN, E_1	AVERAGE CROSS-SECTIONAL AREA, A	APPLIED AXIAL LOAD, P	COMPRESSIVE STRESS, σ_c		
(inches)	(inches)	(%)	(inches2)	(lbs)	(psi)	(ksf)	(kPa)
	0.0000	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!

UNCONFINED COMPRESSIVE STRENGTH, q_u:	#VALUE!	kPa
(based on maximum q_u value)	#VALUE!	ksf
UNDRAINED SHEAR STRENGTH, S_u:	#VALUE!	kPa
(based on maximum q_u value)	#VALUE!	ksf

NOTES:

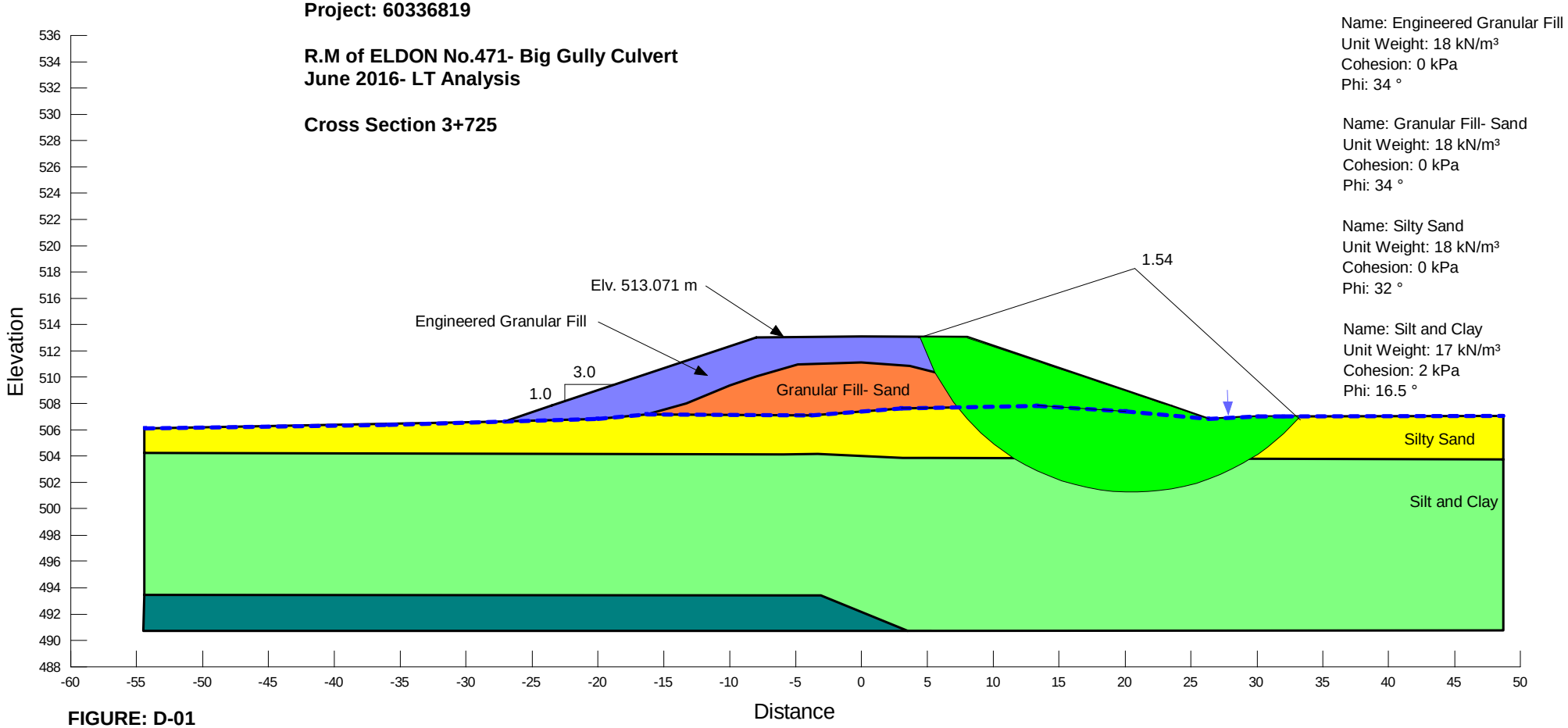
Appendix D

Slope Stability Outputs

Project: 60336819

R.M of ELDON No.471- Big Gully Culvert
June 2016- LT Analysis

Cross Section 3+725



Name: Engineered Granular Fill
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 34 °

Name: Granular Fill- Sand
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 34 °

Name: Silty Sand
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 32 °

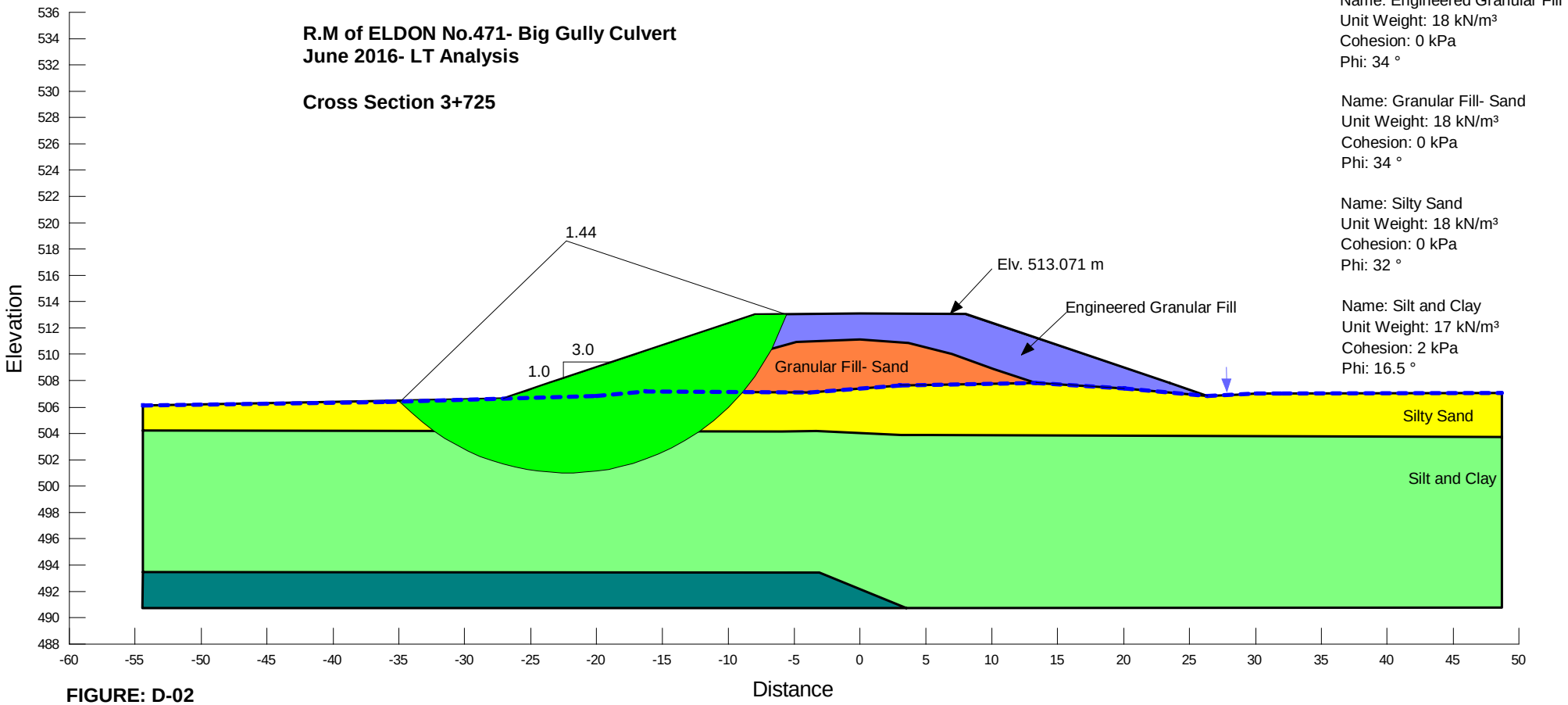
Name: Silt and Clay
Unit Weight: 17 kN/m³
Cohesion: 2 kPa
Phi: 16.5 °

FIGURE: D-01

Project: 60336819

R.M of ELDON No.471- Big Gully Culvert
June 2016- LT Analysis

Cross Section 3+725



Name: Engineered Granular Fill
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 34 °

Name: Granular Fill- Sand
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 34 °

Name: Silty Sand
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 32 °

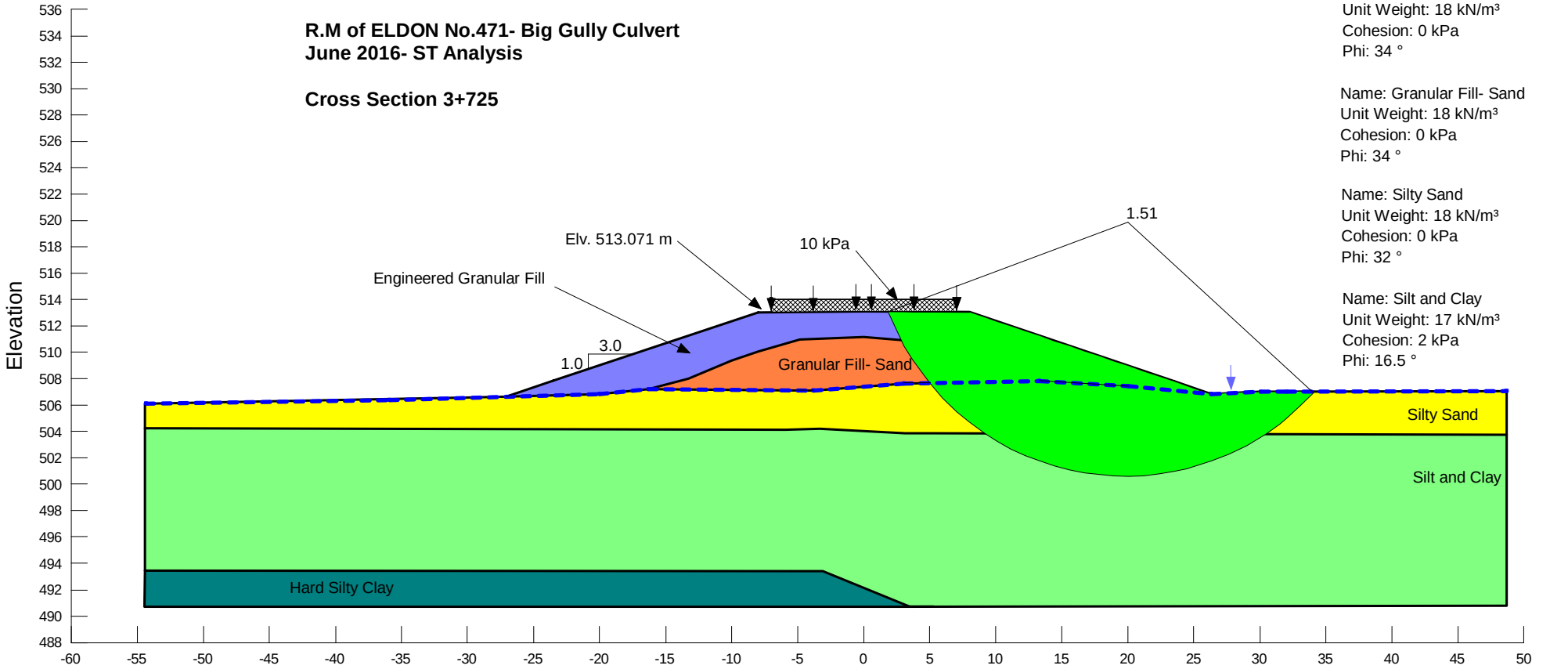
Name: Silt and Clay
Unit Weight: 17 kN/m³
Cohesion: 2 kPa
Phi: 16.5 °

FIGURE: D-02

Project: 60336819

R.M of ELDON No.471- Big Gully Culvert
June 2016- ST Analysis

Cross Section 3+725



Name: Engineered Granular Fill
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 34 °

Name: Granular Fill- Sand
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 34 °

Name: Silty Sand
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 32 °

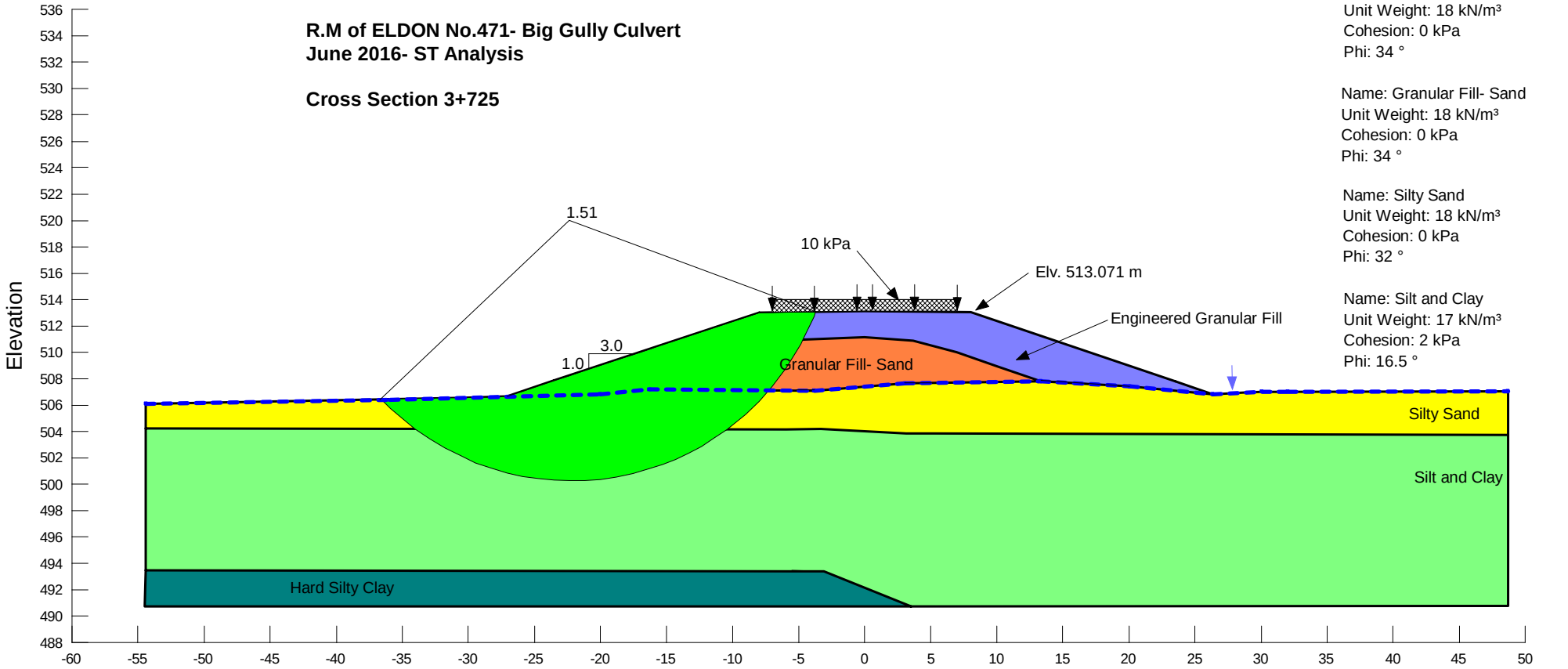
Name: Silt and Clay
Unit Weight: 17 kN/m³
Cohesion: 2 kPa
Phi: 16.5 °

FIGURE: D-03

Project: 60336819

R.M of ELDON No.471- Big Gully Culvert
June 2016- ST Analysis

Cross Section 3+725



Name: Engineered Granular Fill
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 34 °

Name: Granular Fill- Sand
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 34 °

Name: Silty Sand
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 32 °

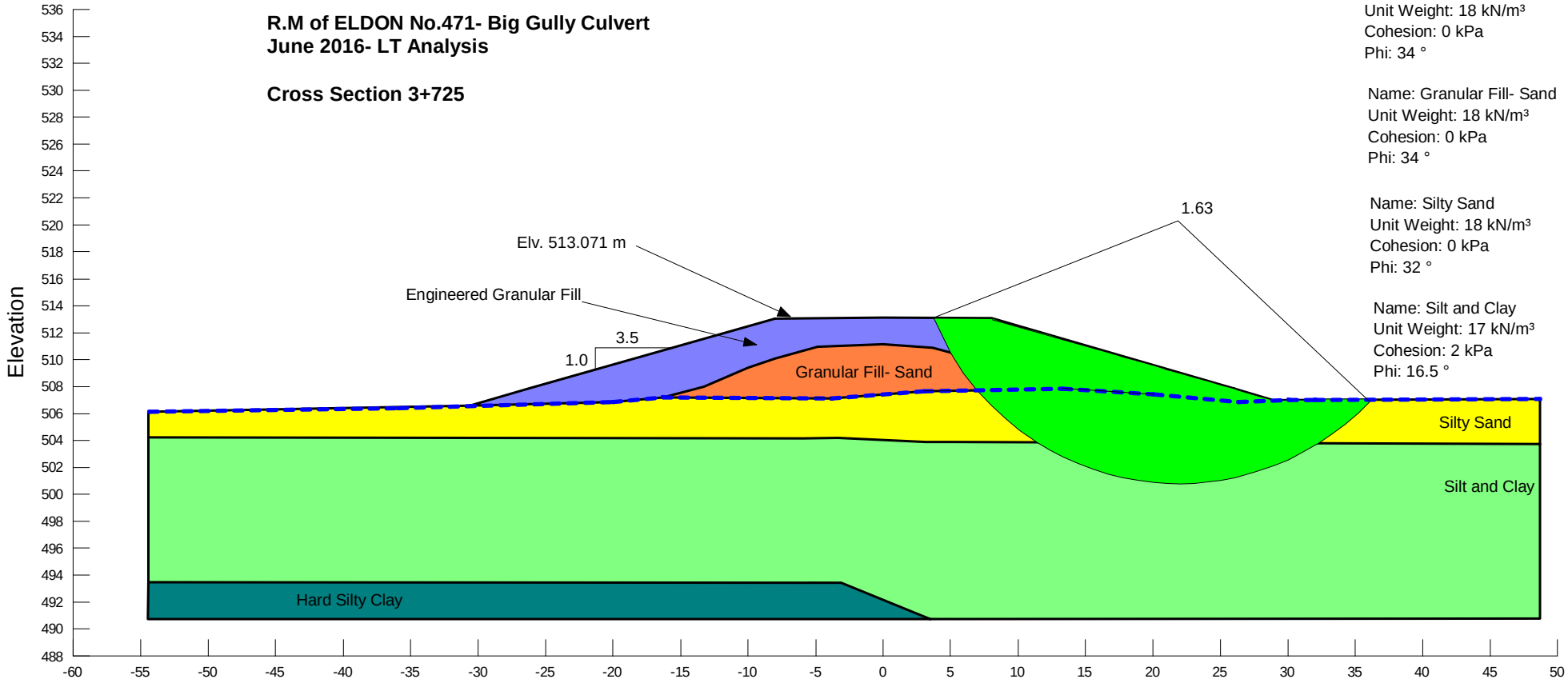
Name: Silt and Clay
Unit Weight: 17 kN/m³
Cohesion: 2 kPa
Phi: 16.5 °

FIGURE: D-04

Project: 60336819

R.M of ELDON No.471- Big Gully Culvert
June 2016- LT Analysis

Cross Section 3+725



Name: Engineered Granular Fill
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 34 °

Name: Granular Fill- Sand
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 34 °

Name: Silty Sand
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 32 °

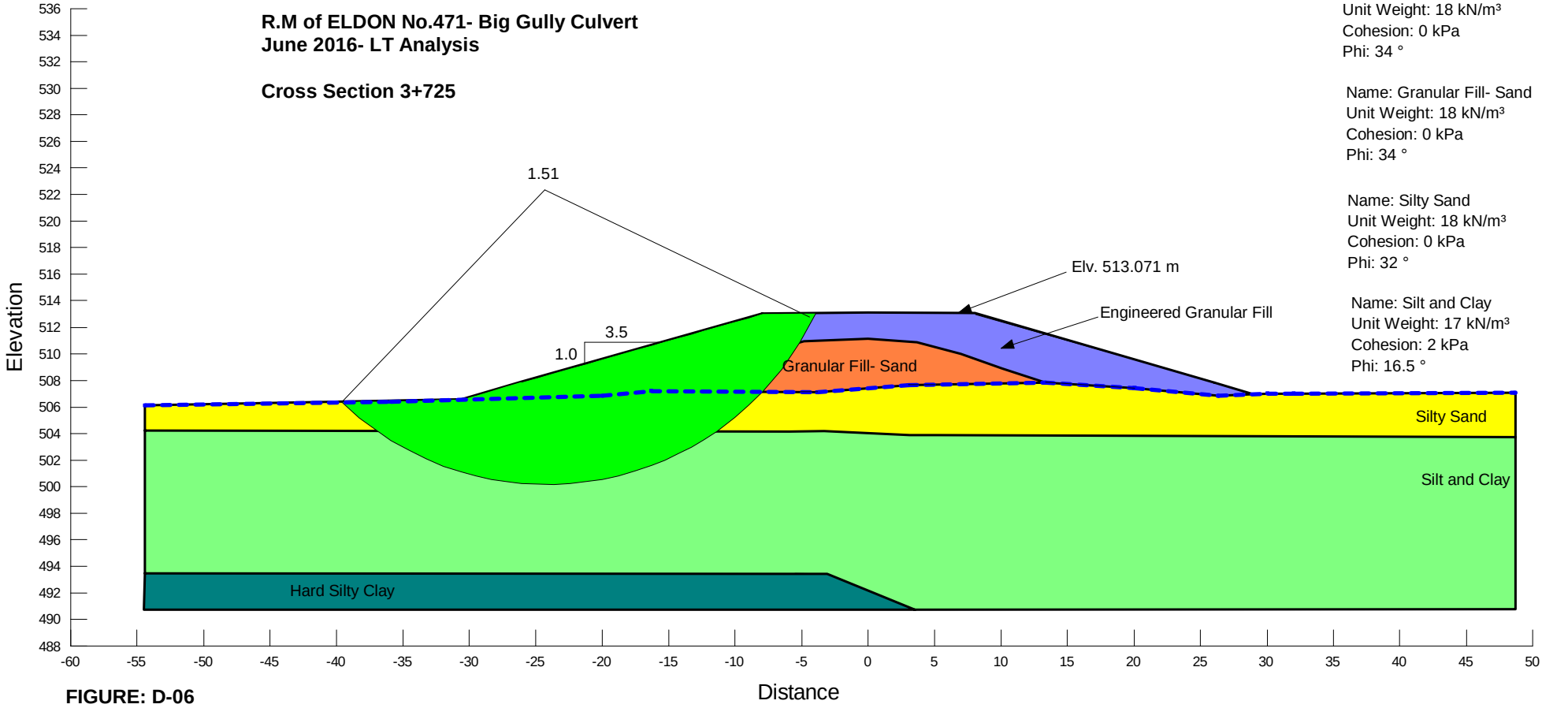
Name: Silt and Clay
Unit Weight: 17 kN/m³
Cohesion: 2 kPa
Phi: 16.5 °

FIGURE: D-05

Project: 60336819

R.M of ELDON No.471- Big Gully Culvert
June 2016- LT Analysis

Cross Section 3+725



Name: Engineered Granular Fill
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 34 °

Name: Granular Fill- Sand
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 34 °

Name: Silty Sand
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 32 °

Name: Silt and Clay
Unit Weight: 17 kN/m³
Cohesion: 2 kPa
Phi: 16.5 °

FIGURE: D-06

Project: 60336819

R.M of ELDON No.471- Big Gully Culvert
June 2016- ST Analysis

Cross Section 3+725

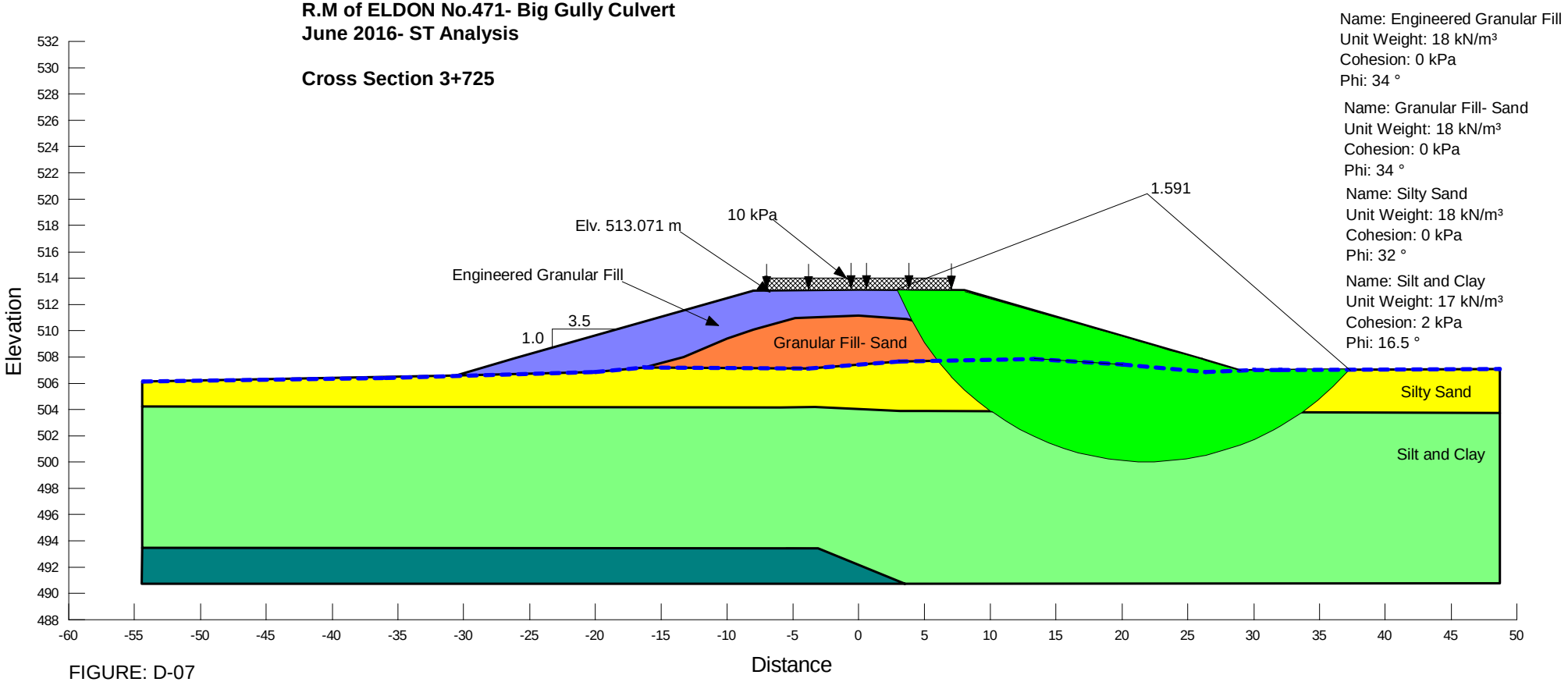


FIGURE: D-07

Project: 60336819

R.M of ELDON No.471- Big Gully Culvert
June 2016- ST Analysis

Cross Section 3+725

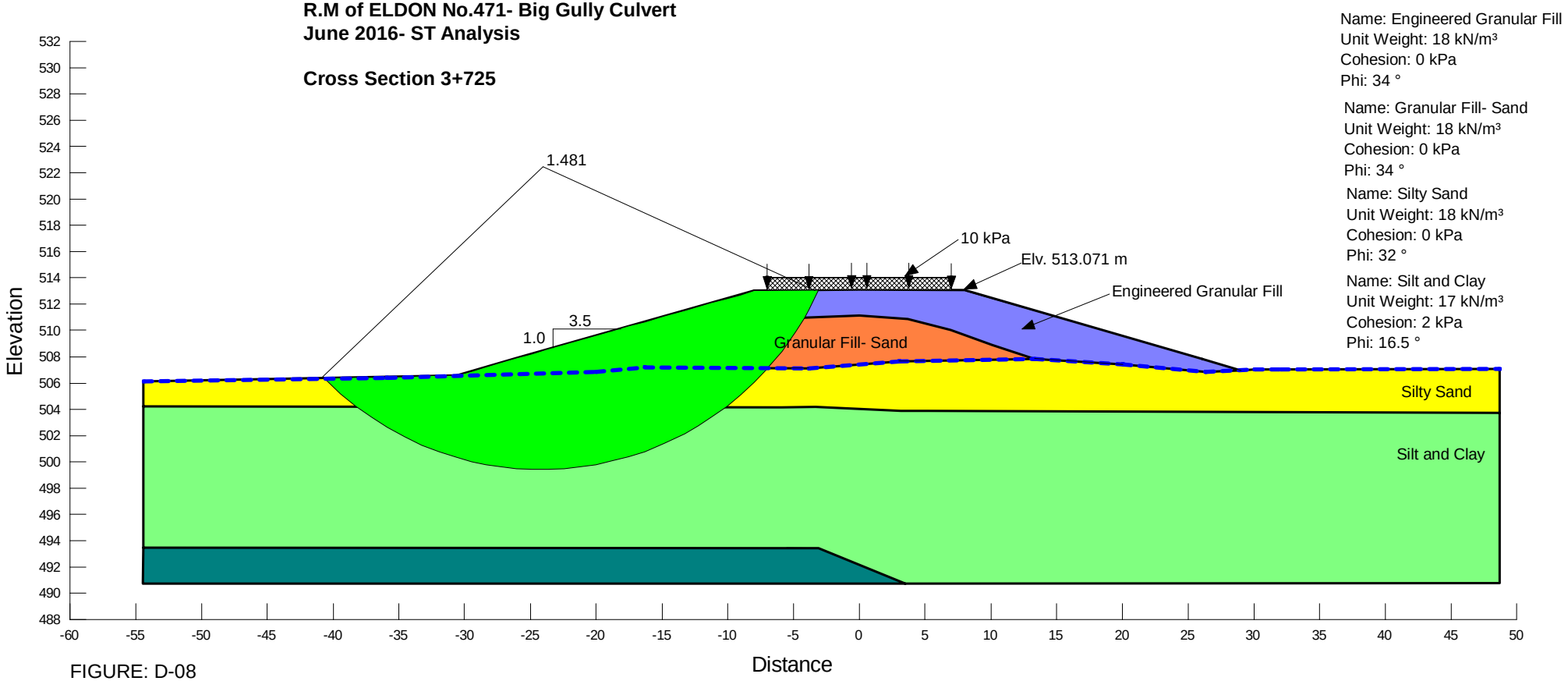


FIGURE: D-08

Project: 60336819

R.M of ELDON No.471- Big Gully Culvert
June 2016- LT Analysis

Cross Section 3+725

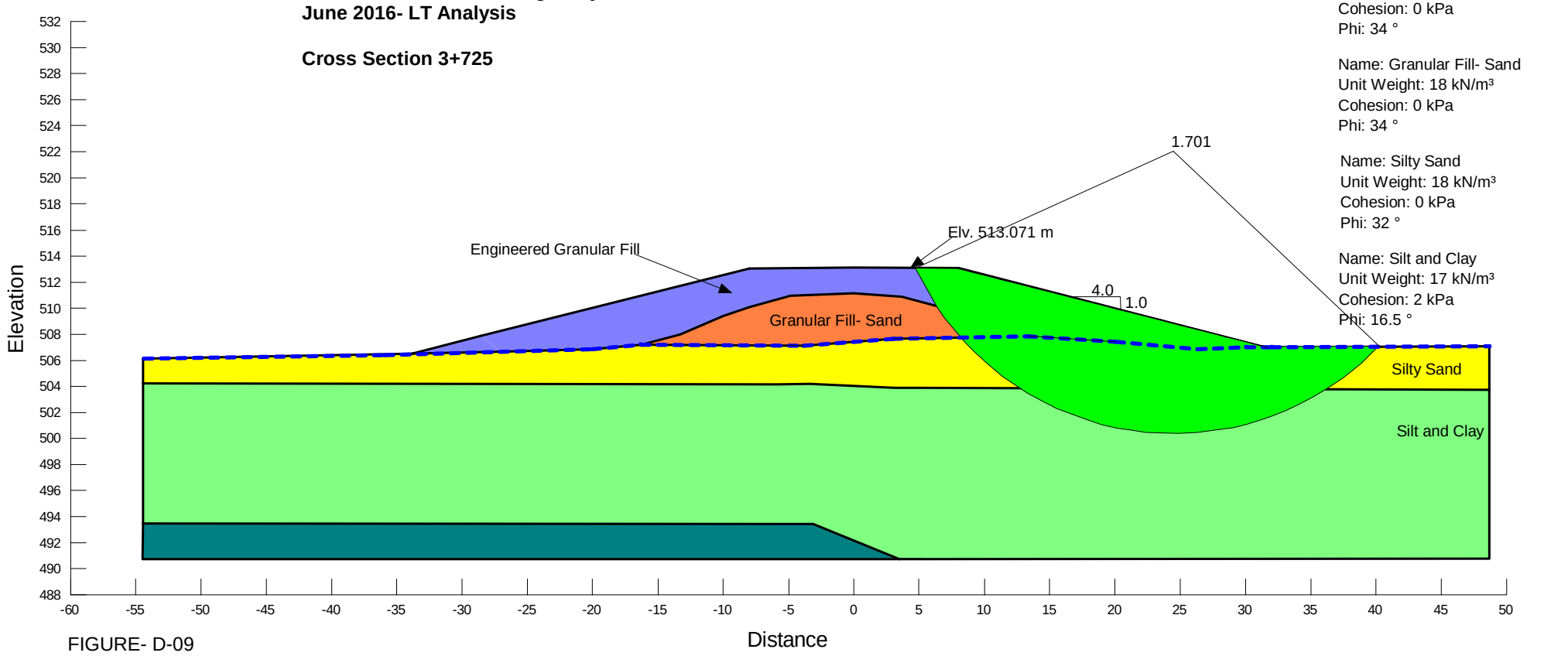
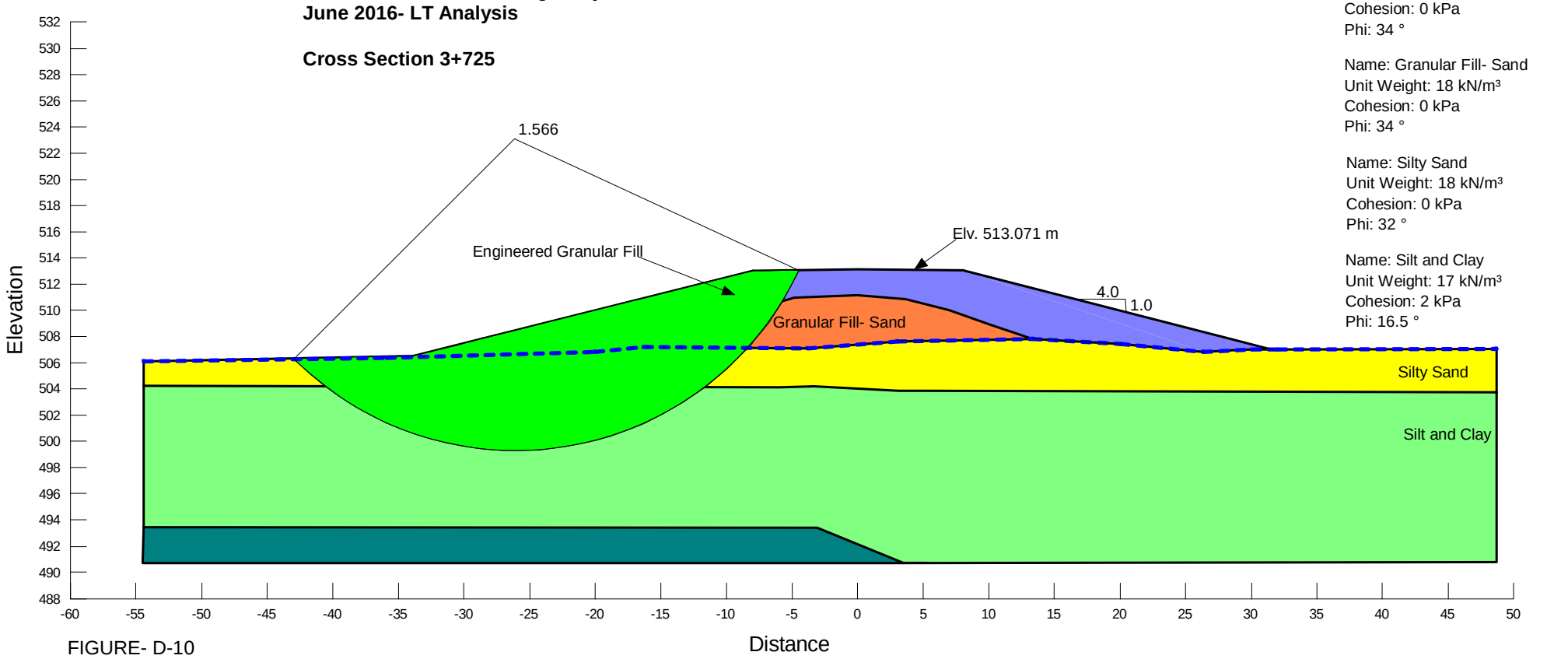


FIGURE- D-09

Project: 60336819

R.M of ELDON No.471- Big Gully Culvert
June 2016- LT Analysis

Cross Section 3+725



Name: Engineered Granular Fill
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 34 °

Name: Granular Fill- Sand
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 34 °

Name: Silty Sand
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 32 °

Name: Silt and Clay
Unit Weight: 17 kN/m³
Cohesion: 2 kPa
Phi: 16.5 °

FIGURE- D-10

Project: 60336819

R.M of ELDON No.471- Big Gully Culvert
June 2016- ST Analysis

Cross Section 3+725

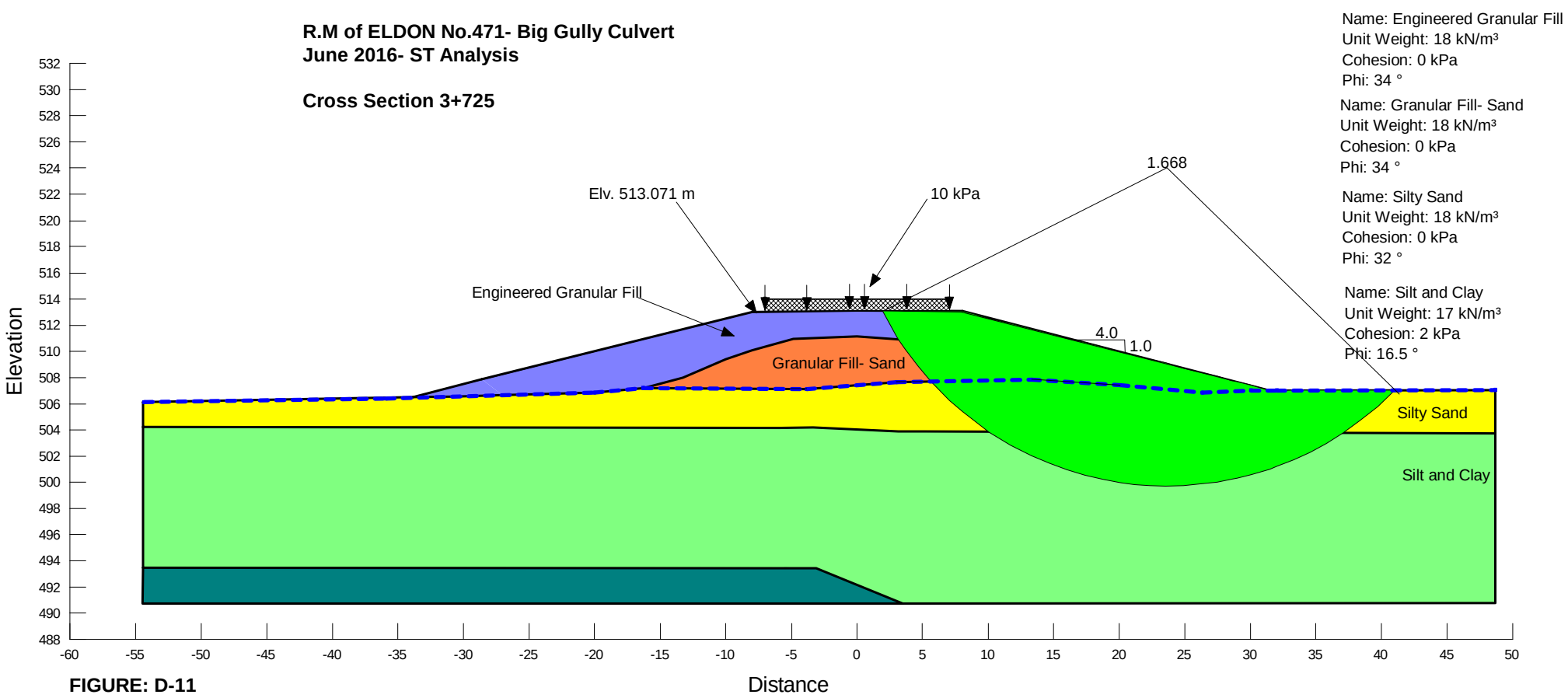
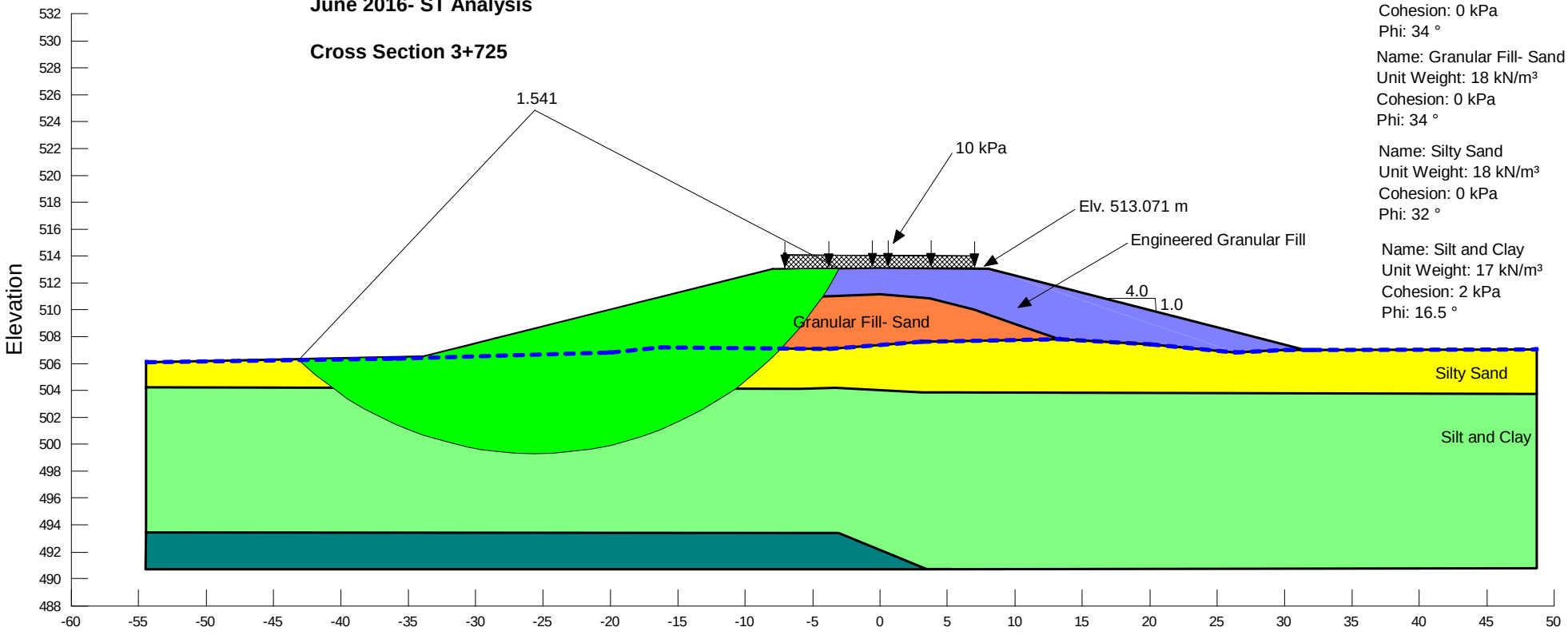


FIGURE: D-11

Project: 60336819

R.M of ELDON No.471- Big Gully Culvert
June 2016- ST Analysis

Cross Section 3+725



Name: Engineered Granular Fill
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 34 °

Name: Granular Fill- Sand
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 34 °

Name: Silty Sand
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 32 °

Name: Silt and Clay
Unit Weight: 17 kN/m³
Cohesion: 2 kPa
Phi: 16.5 °

FIGURE: D-12

Appendix E

Driven Pile Analysis

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\USERS\ADMINI~1\DESKTOP\BIGGUL~1\2.DVN
Project Name: Big Gully Culvert Project Date: 07/21/2016
Project Client: RM of Eldon
Computed By: Alex Hill
Project Manager: Zeyad Shukri

PILE INFORMATION

Pile Type: H Pile - HP310X110
Top of Pile: 0.00 m
Perimeter Analysis: Pile
Tip Analysis: Box Area

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	0.00 m
	- Driving/Restrike	0.00 m
	- Ultimate:	0.00 m
Ultimate Considerations:	- Local Scour:	0.00 m
	- Long Term Scour:	0.00 m
	- Soft Soil:	0.00 m

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	3.00 m	0.00%	17.00 kN/m^3	32.0/32.0	Nordlund
2	Cohesive	10.00 m	0.00%	17.00 kN/m^3	124.00 kPa	T-79 Steel
3	Cohesive	9.00 m	0.00%	17.00 kN/m^3	200.00 kPa	T-79 Steel

RESTRIKE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 m	Cohesionless	0.04 kPa	25.20	N/A	0.00 kN
2.99 m	Cohesionless	10.76 kPa	25.20	N/A	23.65 kN
3.01 m	Cohesive	N/A	N/A	45.73 kPa	24.63 kN
6.01 m	Cohesive	N/A	N/A	53.83 kPa	314.32 kN
9.01 m	Cohesive	N/A	N/A	62.18 kPa	693.86 kN
12.01 m	Cohesive	N/A	N/A	70.53 kPa	1163.23 kN
12.99 m	Cohesive	N/A	N/A	71.62 kPa	1306.61 kN
13.01 m	Cohesive	N/A	N/A	60.33 kPa	1308.97 kN
16.01 m	Cohesive	N/A	N/A	60.33 kPa	1633.47 kN
19.01 m	Cohesive	N/A	N/A	60.33 kPa	1957.96 kN
21.99 m	Cohesive	N/A	N/A	60.33 kPa	2280.29 kN

RESTRIKE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 m	Cohesionless	0.07 kPa	40.40	150.86 kN	0.17 kN
2.99 m	Cohesionless	21.52 kPa	40.40	150.86 kN	51.94 kN
3.01 m	Cohesive	N/A	N/A	N/A	106.55 kN
6.01 m	Cohesive	N/A	N/A	N/A	106.55 kN
9.01 m	Cohesive	N/A	N/A	N/A	106.55 kN
12.01 m	Cohesive	N/A	N/A	N/A	106.55 kN
12.99 m	Cohesive	N/A	N/A	N/A	106.55 kN
13.01 m	Cohesive	N/A	N/A	N/A	171.86 kN
16.01 m	Cohesive	N/A	N/A	N/A	171.86 kN
19.01 m	Cohesive	N/A	N/A	N/A	171.86 kN
21.99 m	Cohesive	N/A	N/A	N/A	171.86 kN

RESTRIKE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 m	0.00 kN	0.17 kN	0.17 kN
2.99 m	23.65 kN	51.94 kN	75.59 kN
3.01 m	24.63 kN	106.55 kN	131.18 kN
6.01 m	314.32 kN	106.55 kN	420.87 kN
9.01 m	693.86 kN	106.55 kN	800.41 kN
12.01 m	1163.23 kN	106.55 kN	1269.78 kN
12.99 m	1306.61 kN	106.55 kN	1413.16 kN
13.01 m	1308.97 kN	171.86 kN	1480.83 kN
16.01 m	1633.47 kN	171.86 kN	1805.33 kN
19.01 m	1957.96 kN	171.86 kN	2129.82 kN
21.99 m	2280.29 kN	171.86 kN	2452.15 kN

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 m	Cohesionless	0.04 kPa	25.20	N/A	0.00 kN
2.99 m	Cohesionless	10.76 kPa	25.20	N/A	23.65 kN
3.01 m	Cohesive	N/A	N/A	45.73 kPa	24.63 kN
6.01 m	Cohesive	N/A	N/A	53.83 kPa	314.32 kN
9.01 m	Cohesive	N/A	N/A	62.18 kPa	693.86 kN
12.01 m	Cohesive	N/A	N/A	70.53 kPa	1163.23 kN
12.99 m	Cohesive	N/A	N/A	71.62 kPa	1306.61 kN
13.01 m	Cohesive	N/A	N/A	60.33 kPa	1308.97 kN
16.01 m	Cohesive	N/A	N/A	60.33 kPa	1633.47 kN
19.01 m	Cohesive	N/A	N/A	60.33 kPa	1957.96 kN
21.99 m	Cohesive	N/A	N/A	60.33 kPa	2280.29 kN

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 m	Cohesionless	0.07 kPa	40.40	150.86 kN	0.17 kN
2.99 m	Cohesionless	21.52 kPa	40.40	150.86 kN	51.94 kN
3.01 m	Cohesive	N/A	N/A	N/A	106.55 kN
6.01 m	Cohesive	N/A	N/A	N/A	106.55 kN
9.01 m	Cohesive	N/A	N/A	N/A	106.55 kN
12.01 m	Cohesive	N/A	N/A	N/A	106.55 kN
12.99 m	Cohesive	N/A	N/A	N/A	106.55 kN
13.01 m	Cohesive	N/A	N/A	N/A	171.86 kN
16.01 m	Cohesive	N/A	N/A	N/A	171.86 kN
19.01 m	Cohesive	N/A	N/A	N/A	171.86 kN
21.99 m	Cohesive	N/A	N/A	N/A	171.86 kN

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 m	0.00 kN	0.17 kN	0.17 kN
2.99 m	23.65 kN	51.94 kN	75.59 kN
3.01 m	24.63 kN	106.55 kN	131.18 kN
6.01 m	314.32 kN	106.55 kN	420.87 kN
9.01 m	693.86 kN	106.55 kN	800.41 kN
12.01 m	1163.23 kN	106.55 kN	1269.78 kN
12.99 m	1306.61 kN	106.55 kN	1413.16 kN
13.01 m	1308.97 kN	171.86 kN	1480.83 kN
16.01 m	1633.47 kN	171.86 kN	1805.33 kN
19.01 m	1957.96 kN	171.86 kN	2129.82 kN
21.99 m	2280.29 kN	171.86 kN	2452.15 kN

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 m	Cohesionless	0.04 kPa	25.20	N/A	0.00 kN
2.99 m	Cohesionless	10.76 kPa	25.20	N/A	23.65 kN
3.01 m	Cohesive	N/A	N/A	45.73 kPa	24.63 kN
6.01 m	Cohesive	N/A	N/A	53.83 kPa	314.32 kN
9.01 m	Cohesive	N/A	N/A	62.18 kPa	693.86 kN
12.01 m	Cohesive	N/A	N/A	70.53 kPa	1163.23 kN
12.99 m	Cohesive	N/A	N/A	71.62 kPa	1306.61 kN
13.01 m	Cohesive	N/A	N/A	60.33 kPa	1308.97 kN
16.01 m	Cohesive	N/A	N/A	60.33 kPa	1633.47 kN
19.01 m	Cohesive	N/A	N/A	60.33 kPa	1957.96 kN
21.99 m	Cohesive	N/A	N/A	60.33 kPa	2280.29 kN

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 m	Cohesionless	0.07 kPa	40.40	150.86 kN	0.17 kN
2.99 m	Cohesionless	21.52 kPa	40.40	150.86 kN	51.94 kN
3.01 m	Cohesive	N/A	N/A	N/A	106.55 kN
6.01 m	Cohesive	N/A	N/A	N/A	106.55 kN
9.01 m	Cohesive	N/A	N/A	N/A	106.55 kN
12.01 m	Cohesive	N/A	N/A	N/A	106.55 kN
12.99 m	Cohesive	N/A	N/A	N/A	106.55 kN
13.01 m	Cohesive	N/A	N/A	N/A	171.86 kN
16.01 m	Cohesive	N/A	N/A	N/A	171.86 kN
19.01 m	Cohesive	N/A	N/A	N/A	171.86 kN
21.99 m	Cohesive	N/A	N/A	N/A	171.86 kN

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 m	0.00 kN	0.17 kN	0.17 kN
2.99 m	23.65 kN	51.94 kN	75.59 kN
3.01 m	24.63 kN	106.55 kN	131.18 kN
6.01 m	314.32 kN	106.55 kN	420.87 kN
9.01 m	693.86 kN	106.55 kN	800.41 kN
12.01 m	1163.23 kN	106.55 kN	1269.78 kN
12.99 m	1306.61 kN	106.55 kN	1413.16 kN
13.01 m	1308.97 kN	171.86 kN	1480.83 kN
16.01 m	1633.47 kN	171.86 kN	1805.33 kN
19.01 m	1957.96 kN	171.86 kN	2129.82 kN
21.99 m	2280.29 kN	171.86 kN	2452.15 kN