

**APPENDIX D**  
**GEO TECHNICAL INVESTIGATION REPORTS**



**THURBER** ENGINEERING LTD.

November 28, 2016

File: 17-123-970

Associated Engineering Alberta Ltd.  
500, 9888 Jasper Avenue  
Edmonton, Alberta  
T5J 5C6

Attention: Mr. Chad Maki, P.Eng.

**MOUNT EDITH CAVELL ACCESS ROAD AND PARKING LOT  
GEOTECHNICAL INVESTIGATION**

Dear Sir,

As requested by Mr. Arsenij Podolski, P.Eng., of Associated Engineering Alberta Ltd. (AEAL), Thurber Engineering Ltd. (Thurber) completed a geotechnical site investigation for the above referenced project near the town of Jasper, Alberta.

Thurber's scope of work was as described in our proposal letter dated April 8, 2016. It included the completion of five test pits within the footprints of the realigned section of the access road and the new parking lot.

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

**1. BACKGROUND**

Mount Edith Cavell, near the town of Jasper, is a tourist destination offering close view of the Cavell, Ghost and Angel Glaciers. In August 2012, a section of the access road leading to the visitors' area, a portion of the parking lot and parts of the trail system were washed out by a tidal wave generated by the detachment and sliding of a part of the Ghost glacier into the lake below.

Thurber completed a concept level study to evaluate key geotechnical issues associated with the proposed realignment/relocation of the impacted sections of the access road and parking lot. The findings of the study were presented to Associated Engineering Alberta Ltd (AEAL) in a report titled "Mount Edith Cavell, Jasper, Alberta, Access Road and Parking Lot Rehabilitation Geotechnical Assessment" dated January 20, 2016. Among others, the study recommended that a number of test pits be advanced within the footprints of the proposed road and parking lot to confirm the inferred subsurface soil conditions and to determine the depth to top of bedrock. The reconstruction of the proposed southern section of the access road will involve cuts up to 3.5 m deep and could be impacted by the presence of bedrock at shallow depths.

Following the request from AEAL, Thurber carried out a geotechnical site investigation to confirm the subsurface conditions at the site, as described in our proposal letter dated April 8, 2016.



## 2. FIELD WORK AND SITE OBSERVATIONS

The field investigation program was undertaken/directed by Mr. Oleksandr Lisoivan, E.I.T., of Thurber on October 17, 2016. It comprised a site visit and the excavation of six test pits.

At the time of the investigation, the area of the proposed access road and parking lot was cleared of trees, however, the stripping of surface organic material and the removal of tree trunks/stems off site were still in progress. The site was covered in relatively thick snow. It is understood that site grading and earthfill works will start early next year.

A total of six test pits were completed within the footprints of the proposed road and parking lot, including: three test pits (TH16-1C, TH16-2C and TH16-3C) in cut sections to a maximum depth of 4 m below existing ground surface and three test pits (TH16-4F, TH16-5F and TH16-6F) in fill sections to a maximum depth 1.5 m. The test pits were advanced by Chevallier Geo-Con Ltd. using an excavator, as directed by Thurber. The test pit locations were selected by Thurber in coordination with AEAL. The ground coordinates of the test pits were determined on site by Mr. Arsenij Podolski, P.Eng, of AEAL using a hand held GPS navigator to an accuracy of  $\pm 3$  m. Drawing 19-123-970-1B in Appendix A shows the approximate test pit locations.

Disturbed soil samples were collected from all test pits and transferred to Thurber's laboratory in Edmonton for detailed visual classification and laboratory testing.

Upon the completion of the field investigation, the test pits were backfilled with the excavated material and compacted at surface using the excavator bucket.

During our field visit, we noted that the watercourse at the south end of the site was blocked by timber and debris that was removed during site clearing. Water was flowing around the site in an uncontrolled manner. The contractor indicated to Mr. Oleksandr Lisoivan of Thurber that the debris will be removed and that the original flow channel will be restored when this initial phase of construction is completed at the end of 2016.

## 3. SUBSURFACE CONDITIONS

The subsurface conditions encountered at the test pit locations comprised generally a thin cover of organic material, over native granular material consisting of a mixture of gravel and sand with cobble stones, boulders, and occasional clay pockets.

At the test pit locations, the surficial organic material was mixed with some gravel and was up to about 0.3 m thick. The underlying granular material extended to the termination depths of the test pits. The top of bedrock was not encountered in any of the test pits. The results of six grain size analyses indicated that the native granular material comprise generally 46 to 67 percent gravel, 25 to 44 percent sand, and 6 to 13 percent fines (silt and clay fraction). It should be noted, however, that the results of these gradation tests do not reflect the presence of boulders and cobbles observed on site, which could not be incorporated in the test samples.

The test pits were generally dry, although minor seepage was noted in test pit TP16-6F at approximate depth of 0.7 m below existing ground surface. TP16-6F was located near a natural



watercourse at southern end of the site. In general, the moisture contents of samples recovered from test pits TP16-F through TP16-6F located on the flat plateau at the toe of the valley wall were higher than those of samples recovered from test pits TP16-1C through TP16-3C located further up the valley slope (refer to Drawing 19-123-970-1B for test pit locations).

The side walls of the deeper test pits (TP16-1C through TP16-3C) were generally stable to depths of about 3 m below existing ground. As the test pit excavations progressed deeper, extensive caving of the side walls occurred at depths in the order of 3.5 to 4.0 m below ground surface.

More detailed descriptions of the encountered subsurface conditions are provided on the test pit logs in Appendix B. The gradation curves of native granular soils are presented in Appendix C.

#### **4. ASSESSMENT AND RECOMMENDATIONS**

The results of the geotechnical site investigation indicated that subsurface soil conditions in the project area comprise granular moraine and colluvium deposits, and are consistent with those inferred based on geologic evidence during the design stage. As such, the recommendations presented in Thurber report dated January 20, 2016, remain applicable.

Discussions of geotechnical issues that have arisen since the initial report was issued are provided in the following subsections.

##### **4.1 Embankment Fill Construction**

Based on the results of the investigation, the native granular material at the site is considered to be suitable foundation for supporting the new access road and parking lot embankments. The material may also be used as fill material for embankment construction. All oversize rocks (larger than 75 mm) should, however, be removed prior to the material being used as fill. The contractor has indicated that a crusher may be brought to site to process native granular material to appropriate size/gradation suitable for embankment and granular base course (GBC) construction. The processed aggregate should be tested to confirm that its gradation meets the project requirements.

Fill material should be placed in lifts and compacted in accordance with the recommendations provided in our report dated January 20, 2016. Field density tests should be carried out on a regular basis to confirm the degree of compaction attained in the field. Frozen fill material should not be used in construction and unfrozen fill should not be placed over frozen ground.

Because of the relatively coarse gradation of native material and the remote location of the site, consideration may be given to the use of "control strip" method to verify the degree of compaction attained in the field. The control strip approach involves conducting initial field density tests at a number of locations within a given area. The area is then compacted and the tests are repeated after each passing of compaction equipment. The compaction equipment used should be in accordance with Alberta Transportation guidelines. As a minimum, a vibratory steel-wheeled roller of an appropriate size should be used. The number of compactor passes beyond which the measured field density remains constant or drops is determined. The same equipment, spreading technique and minimum required number of passes should be used by the contractor in the compaction of future fill lifts.



## 4.2 Cut and Fill Slopes

The results of the site investigation indicated that subsurface foundation soils comprise granular material. We also understand that the same material will be used for the construction of roadway and parking lot embankments. On that basis, it is expected that the proposed 2.5H:1V embankment side slopes should perform adequately. If seepage or natural springs are encountered in areas where embankment fill will be placed, drainage measures should be installed to minimize the risk of water pressure building up at the base of the fill. A typical detail of drainage measures in fill situations is presented in Figure 1 in Appendix A.

At the time of preparation of the initial geotechnical report, available design information indicated that the inclination of permanent cut slopes along the east side of the proposed access road would be 2.5H:1V. In an effort to reduce the depth of cuts (given the sloping natural terrain), the final design incorporated steeper cut slopes of 2H:1V. Available ground contours indicate that the inclination of the natural valley slope east of the access road ranges between 2.7H:1V to 3.2H:1V.

Preliminary slope stability analyses were performed based on the limited data available to obtain a general understanding of the factor of safety associated with the proposed 2H:1V cut slopes. Soil properties and groundwater level were assumed based on field observations from the site investigation program. The analysis results indicated that the factor of safety of a fully drained (i.e. low groundwater table) 2H:1V slope is in the order of 1.4. In cases where the groundwater level was assumed close to the slope face, the factor of safety dropped to unity indicating a high risk of failure.

As discussed in Section 3, test pits TP16-1C through TP16-3C in cut areas were dry. As such, it is anticipated that the factor of safety of the 2H:1V cut slopes should be in the range of 1.3 to 1.4, which is deemed acceptable for the proposed low traffic road. As discussed in our January 2016 report, two natural springs were identified in the general area of the access road, albeit further to the south of the proposed cuts (refer to Drawing 17-123-970-1B). Should springs or seepage zones be present within the cut slopes, they could trigger localized slumping which if, left untreated, could lead to larger instabilities. Areas of seepage should be sub-excavated to a minimum depth of 0.4 m. A heavy non-woven geotextile should be placed on the exposed base and the subcut backfilled using 0.4 m of 20 mm (or larger) washed angular rock. The base of the subcut should be graded towards the drainage swale along the east edge of the road. Figure 2 in Appendix A shows a typical drainage detail for cut situations. In addition, surface features that can promote the collection and accumulation of runoff water on the slope face should be avoided to reduce the rate of surface infiltration.

It is recommended that any identified seepage zones, either in cut or fill areas, be inspected by Thurber field personnel to confirm the extent of required drainage measures.

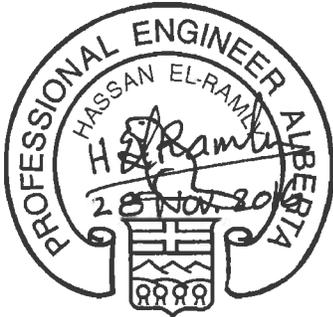
As discussed in Section 3, native soils in the project area contain 25 to 44 percent sand that will be prone to erosion by surface runoff, particularly during snow melt. Robust erosion protection measures should, therefore, be installed on cut and fill slopes immediately following the completion of construction.



## 5. CLOSURE

We trust that this letter report meets your present requirements. If you have any questions or comments on the contents of this report, please contact the undersigned.

Yours very truly,  
Thurber Engineering Ltd.  
Hassan El-Ramly, Ph.D., P.Eng.  
Review Principal



<p><b>PERMIT TO PRACTICE</b> THURBER ENGINEERING LTD.</p> <p>Signature <u>H. El-Ramly</u></p> <p>Date <u>20 Nov. 2016</u></p> <p><b>PERMIT NUMBER: P 5186</b></p> <p>The Association of Professional Engineers, Geologists and Geophysicists of Alberta</p>
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Oleksandr Lisoivan, E.I.T.  
Project Engineer  
/lg

### Attachments:

- Statement of Limitations and Conditions
- Appendix A – Drawing 17-123-970-1B and Figures 1 and 2
- Appendix B – Test Pit Logs
- Appendix C – Sieve Analysis Reports



## STATEMENT OF LIMITATIONS AND CONDITIONS

### 1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

### 2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

### 3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

### 4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

### 5. INTERPRETATION OF THE REPORT

- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.
- b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.
- c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.
- d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

### 6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

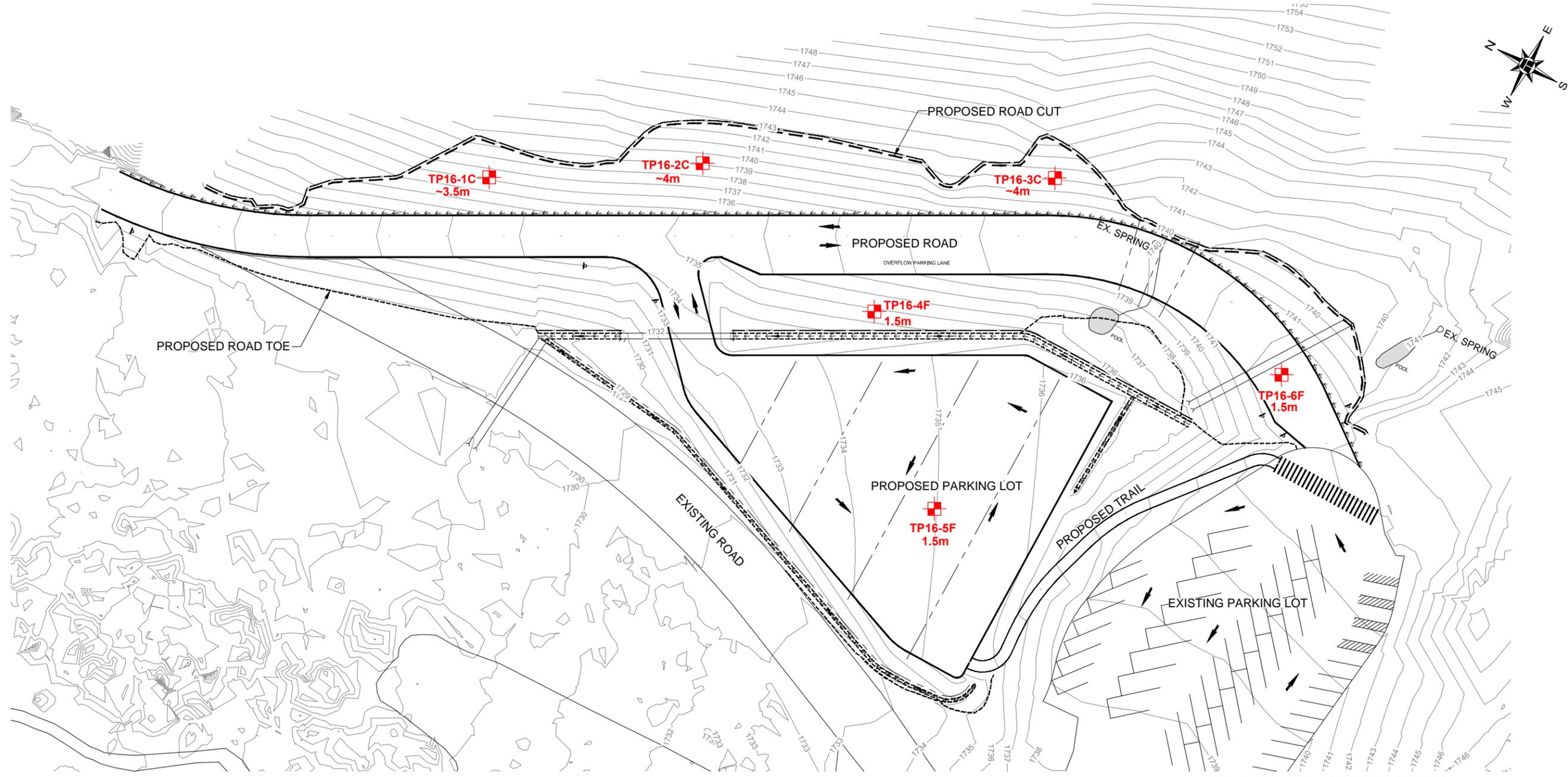
### 7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.



## **APPENDIX A**

Drawings and Figures



**LEGEND**

-  APPROXIMATE TEST PIT LOCATION
- C** CUT AREA
- F** FILL AREA
- 1.5m** DEPTH OF TEST PIT

**NOTE:** CONTOUR ELEVATIONS ARE IN METERS



BASE PLAN PROVIDED BY ASSOCIATED ENGINEERING



**MOUNT EDITH CAVELL - ACCESS ROAD AND  
PARKING LOT RESTORATION**

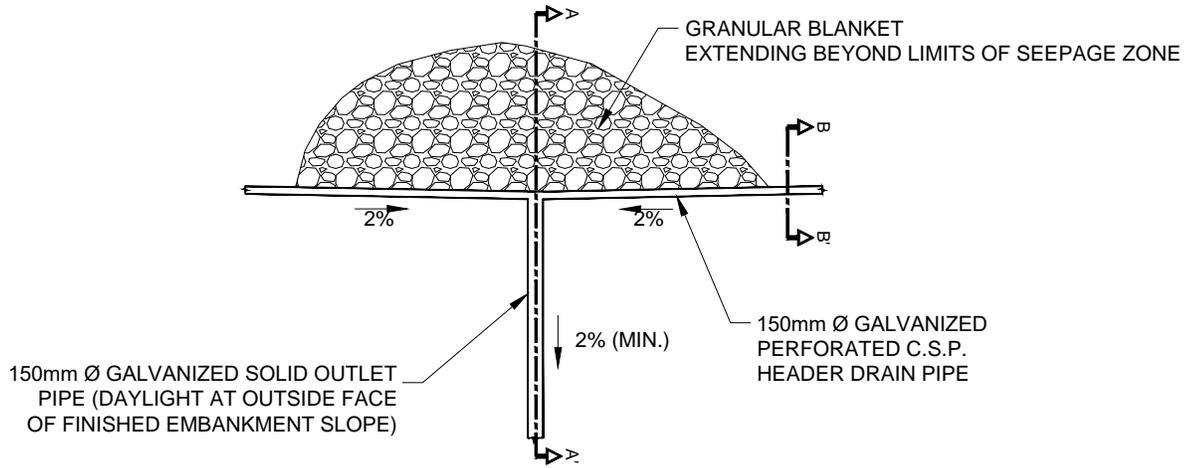
**SITE PLAN SHOWING APPROXIMATE  
TEST PIT LOCATIONS**

**DWG No. 17-123-970-1B**

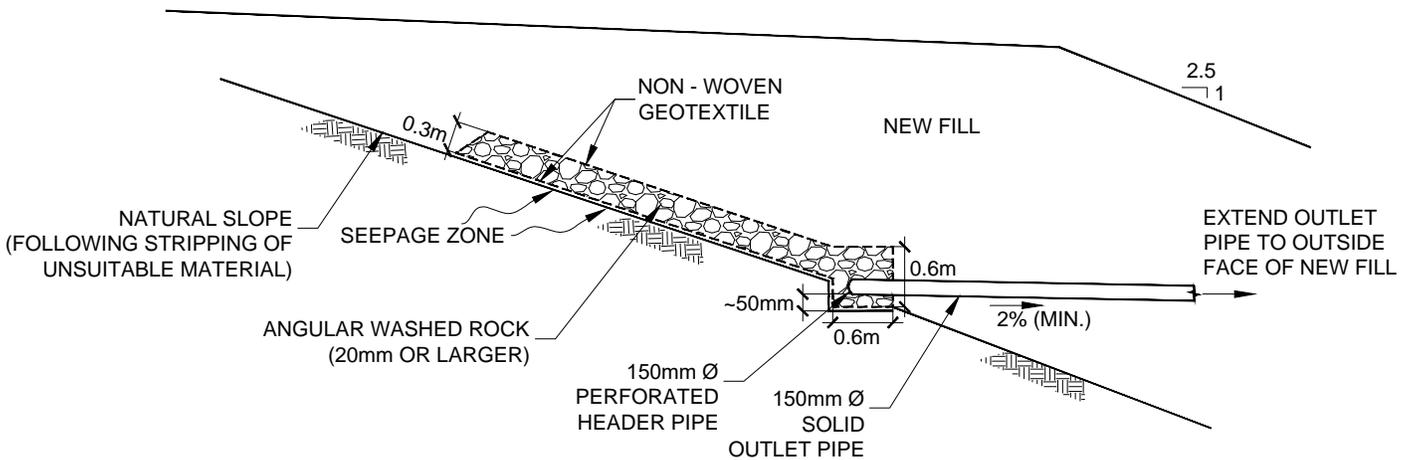
DRAWN BY	ML
DESIGNED BY	OVL
APPROVED BY	HER
SCALE	1:750
DATE	NOVEMBER 2016
FILE No.	17-123-970



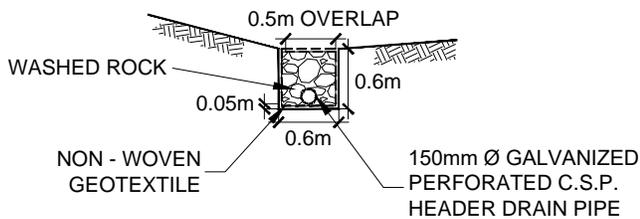
**THURBER ENGINEERING LTD.**



PLAN VIEW OF SUBDRAIN



CROSS - SECTION A - A'



CROSS - SECTION B - B'

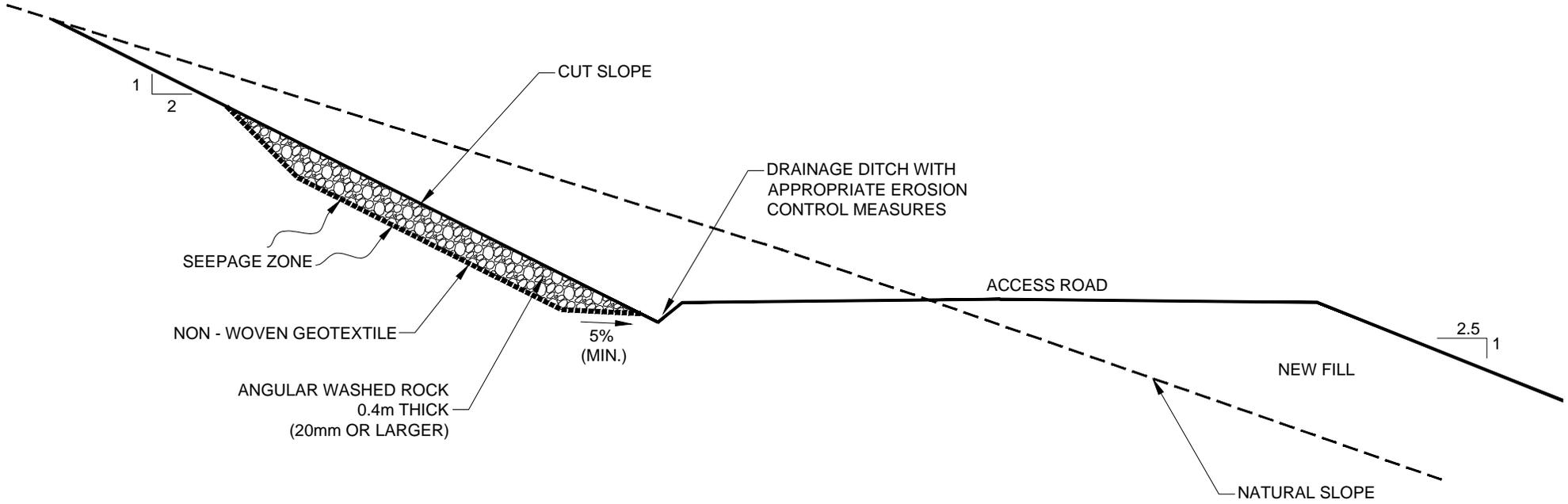
NOTES:

1. INVERT OF HEADER PIPE IS APPROXIMATELY 50mm ABOVE BASE OF WASHED ROCK.
2. HEADER PIPE SHALL BE SURROUNDED BY WASHED ROCK ENVELOPED IN GEOTEXTILE.
3. EROSION PROTECTION MEASURES MAY NEED TO BE INSTALLED AROUND THE DISCHARGE LOCATION OF OUTLET PIPE, DEPENDING ON AMOUNT OF SEEPAGE.
4. POSITIVE SURFACE DRAIN SHALL BE PROVIDED TO DRAIN WATER FROM THE OUTLET PIPE AWAY FROM THE NEW EMBANKMENT.

**SUBDRAIN DETAIL IN FILL AREAS**

N. T. S.

**FIGURE 1**

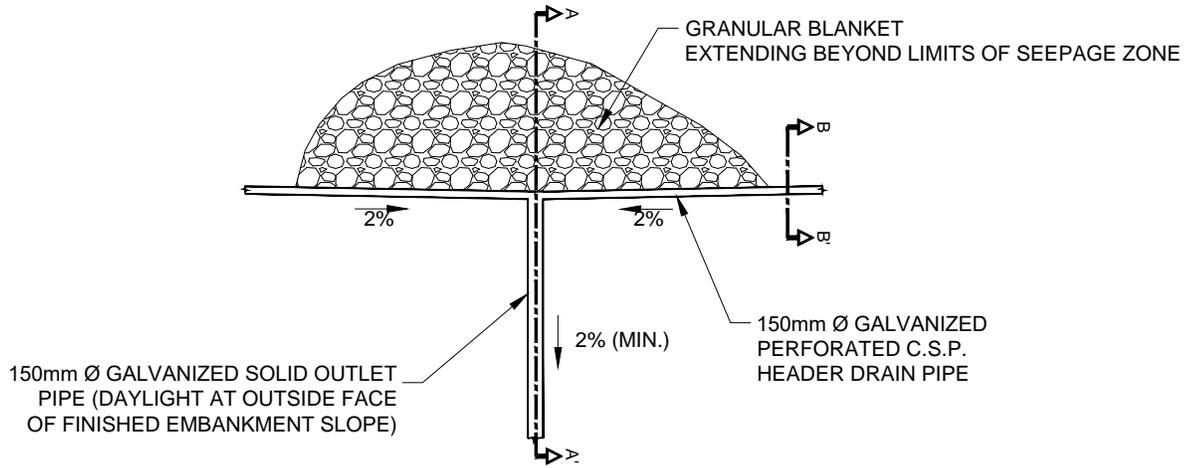


## SUBDRAIN DETAIL IN CUT AREAS

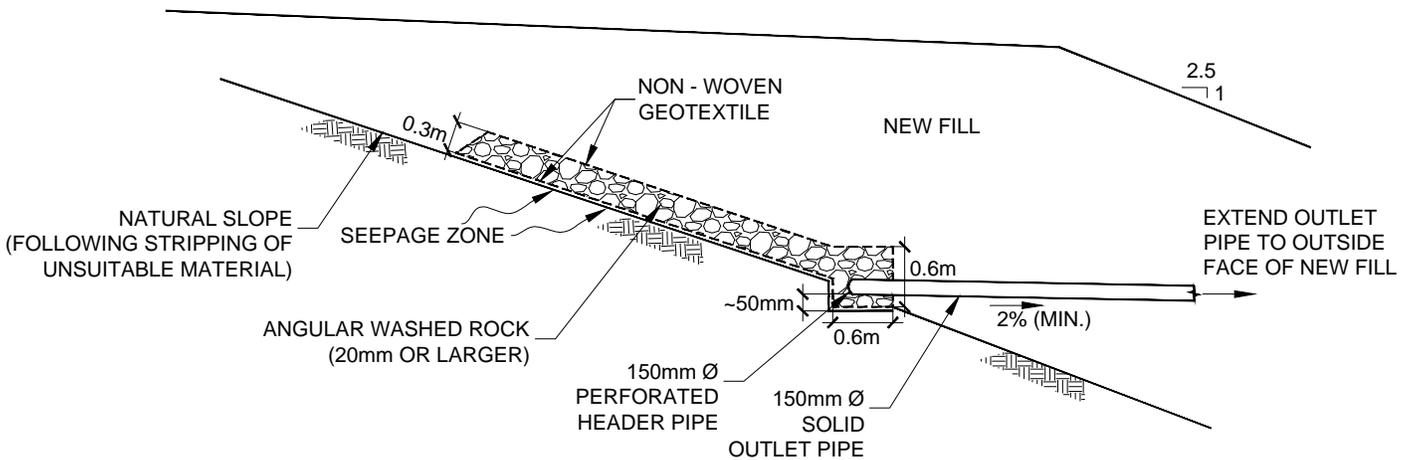
N. T. S.

**FIGURE 2**

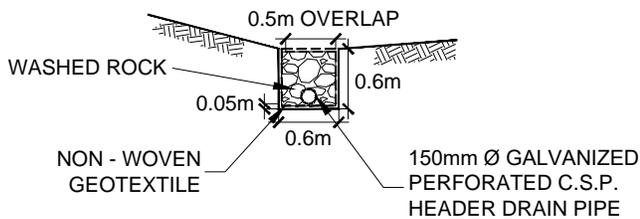
THURBER PROJECT #17-123-970



PLAN VIEW OF SUBDRAIN



CROSS - SECTION A - A'



CROSS - SECTION B - B'

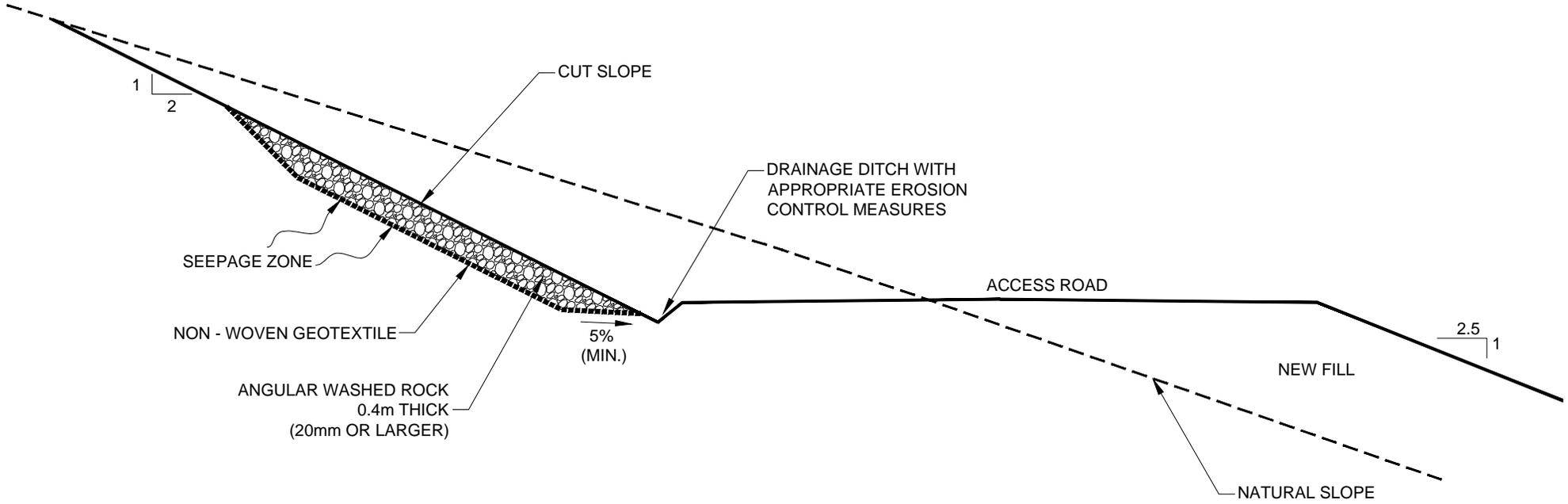
NOTES:

1. INVERT OF HEADER PIPE IS APPROXIMATELY 50mm ABOVE BASE OF WASHED ROCK.
2. HEADER PIPE SHALL BE SURROUNDED BY WASHED ROCK ENVELOPED IN GEOTEXTILE.
3. EROSION PROTECTION MEASURES MAY NEED TO BE INSTALLED AROUND THE DISCHARGE LOCATION OF OUTLET PIPE, DEPENDING ON AMOUNT OF SEEPAGE.
4. POSITIVE SURFACE DRAIN SHALL BE PROVIDED TO DRAIN WATER FROM THE OUTLET PIPE AWAY FROM THE NEW EMBANKMENT.

**SUBDRAIN DETAIL IN FILL AREAS**

N. T. S.

**FIGURE 1**



## SUBDRAIN DETAIL IN CUT AREAS

N. T. S.

**FIGURE 2**

THURBER PROJECT #17-123-970



## **APPENDIX B**

Test Pit Logs

CLIENT: ASSOCIATED ENGINEERING SERVICES LTD	PROJECT: Mount Edith Cavell - Access Road and Parking Lot Restoration	TEST PIT NO: <b>TP16-1C</b>
CONTRACTOR: CHEVALLIER GEO - CON LTD.	DATE EXCAVATED: October 17, 2016	PROJECT NO: 17-123-970
DRILL/METHOD: Excavator	LOCATION: See Drawing #17-123-970-1B	ELEVATION:

SAMPLE TYPE		REMARKS	SOIL DESCRIPTION
DEPTH (m)	SAMPLE TYPE		DEPTH (m)
0			0
1		-Moisture Content = 6.5%	1
		Gravel = 50.1%	
		Sand = 43.6%	
		Fines = 6.3%	
2		-Moisture Content= 10.1%	2
3			3
4			4
5			5

ORGANIC MATERIAL MIXED WITH GRAVEL

GRAVEL AND SAND  
brown, cobbles and boulders, trace silt and clay

-clay pocket, greyish brown, silty, sandy, gravelly, trace oxide deposits

END OF TEST PIT AT 3.5m  
Sides of test pit started to cave in at depth of 3.5m

BOREHOLE LOG 17-123-970-LIB17-123-970.GPJ THURBER\_AB.GDT 11/3/16-LIBRARY-17-123-970.GLB



FIELD LOGGED BY: OVL	COMPLETION DEPTH: 3.5 m
PREPARED BY: OVL	COMPLETION DATE: 10/17/16
REVIEWED BY: HER	

CLIENT: ASSOCIATED ENGINEERING SERVICES LTD	PROJECT: Mount Edith Cavell - Access Road and Parking Lot Restoration	TEST PIT NO: <b>TP16-2C</b>
CONTRACTOR: CHEVALLIER GEO - CON LTD.	DATE EXCAVATED: October 17, 2016	PROJECT NO: 17-123-970
DRILL/METHOD: Excavator	LOCATION: See Drawing #17-123-970-1B	ELEVATION:

SAMPLE TYPE		REMARKS	SOIL DESCRIPTION
DEPTH (m)	SAMPLE TYPE		DEPTH (m)
0			0
1			1
2			2
3			3
4			4
5			5

-Moisture Content = 8.3%

Gravel = 53.9%

Sand = 38.3%

Fines = 7.8%

ORGANIC MATERIAL MIXED WITH GRAVEL

GRAVEL AND SAND  
brown, cobbles and boulders, trace rootlets, silt, and clay

-brown to grey

END OF TEST PIT AT 4.0m  
Bucket of excavator hit a hard surface (or boulder) at 4m depth

BOREHOLE LOG 17-123-970-LIB17-123-970.GPJ THURBER\_AB.GDT 11/3/16-LIBRARY-17-123-970.GLB



FIELD LOGGED BY: OVL	COMPLETION DEPTH: 4.0 m
PREPARED BY: OVL	COMPLETION DATE: 10/17/16
REVIEWED BY: HER	

CLIENT: ASSOCIATED ENGINEERING SERVICES LTD	PROJECT: Mount Edith Cavell - Access Road and Parking Lot Restoration	TEST PIT NO: <b>TP16-3C</b>
CONTRACTOR: CHEVALLIER GEO - CON LTD.	DATE EXCAVATED: October 17, 2016	PROJECT NO: 17-123-970
DRILL/METHOD: Excavator	LOCATION: See Drawing #17-123-970-1B	ELEVATION:

SAMPLE TYPE		
DEPTH (m)	REMARKS	SOIL DESCRIPTION
0		ORGANIC MATERIAL MIXED WITH GRAVEL
		GRAVEL AND SAND brown, some silt and clay, trace clay pockets and rootlets
1		
	-Moisture Content = 7.3%	
	Gravel = 45.9%	
	Sand = 41.7%	
	Fines = 12.4%	
2		
3		-brown to grey
4		END OF TEST PIT AT 4.0m
5		

BOREHOLE LOG 17-123-970-LIB17-123-970.GPJ THURBER\_AB.GDT 11/3/16-LIBRARY-17-123-970.GLB



FIELD LOGGED BY: OVL	COMPLETION DEPTH: 4.0 m
PREPARED BY: OVL	COMPLETION DATE: 10/17/16
REVIEWED BY: HER	

CLIENT: ASSOCIATED ENGINEERING SERVICES LTD	PROJECT: Mount Edith Cavell - Access Road and Parking Lot Restoration	TEST PIT NO: <b>TP16-4F</b>
CONTRACTOR: CHEVALLIER GEO - CON LTD.	DATE EXCAVATED: October 17, 2016	PROJECT NO: 17-123-970
DRILL/METHOD: Excavator	LOCATION: See Drawing #17-123-970-1B	ELEVATION:

SAMPLE TYPE		
DEPTH (m)	REMARKS	SOIL DESCRIPTION
0		ORGANIC MATERIAL MIXED WITH GRAVEL
		GRAVEL AND SAND brown, cobbles, trace silt and clay
1	-Moisture Content = 6.7%  Gravel = 53.3% Sand = 40.7% Fines = 5.9%	
		END OF TEST PIT AT 1.5m
2		
3		
4		
5		

BOREHOLE LOG 17-123-970-LIB17-123-970.GPJ THRB AB.GDT 11/3/16-LIBRARY-17-123-970.GLB



FIELD LOGGED BY: OVL	COMPLETION DEPTH: 1.5 m
PREPARED BY: OVL	COMPLETION DATE: 10/17/16
REVIEWED BY: HER	

CLIENT: ASSOCIATED ENGINEERING SERVICES LTD	PROJECT: Mount Edith Cavell - Access Road and Parking Lot Restoration	TEST PIT NO: <b>TP16-5F</b>
CONTRACTOR: CHEVALLIER GEO - CON LTD.	DATE EXCAVATED: October 17, 2016	PROJECT NO: 17-123-970
DRILL/METHOD: Excavator	LOCATION: See Drawing #17-123-970-1B	ELEVATION:

SAMPLE TYPE		REMARKS	SOIL DESCRIPTION
DEPTH (m)	SAMPLE TYPE		
0			GRAVEL greyish brown, sandy, cobbles, some silt and clay, trace oxide deposits and rootlets, trace organic material on surface
1		-Moisture Content = 9.8%  Gravel = 56.4% Sand = 31.1% Fines = 12.5%	
2			END OF TEST PIT AT 1.5m
3			
4			
5			

BOREHOLE LOG 17-123-970-LIB17-123-970.GPJ THRB AB.GDT 11/3/16-LIBRARY-17-123-970.GLB



FIELD LOGGED BY: OVL	COMPLETION DEPTH: 1.5 m
PREPARED BY: OVL	COMPLETION DATE: 10/17/16
REVIEWED BY: HER	

CLIENT: ASSOCIATED ENGINEERING SERVICES LTD	PROJECT: Mount Edith Cavell - Access Road and Parking Lot Restoration	TEST PIT NO: <b>TP16-6F</b>
CONTRACTOR: CHEVALLIER GEO - CON LTD.	DATE EXCAVATED: October 17, 2016	PROJECT NO: 17-123-970
DRILL/METHOD: Excavator	LOCATION: See Drawing #17-123-970-1B	ELEVATION:

SAMPLE TYPE				
DEPTH (m)	SAMPLE TYPE	REMARKS	SOIL DESCRIPTION	DEPTH (m)
0			GRAVEL greyish brown, sandy, cobbles, trace clay pockets, oxide deposits, and rootlets, trace organic material on surface	0
1		-Minor seepage  -Moisture Content = 10.5%  Gravel = 67.2% Sand = 25.3% Fines = 7.5%		1
2			END OF TEST PIT AT 1.5m	2
3				3
4				4
5				5

BOREHOLE LOG 17-123-970-LIB17-123-970.GPJ THRR AB.GDT 11/3/16-LIBRARY-17-123-970.GLB



FIELD LOGGED BY: OVL	COMPLETION DEPTH: 1.5 m
PREPARED BY: OVL	COMPLETION DATE: 10/17/16
REVIEWED BY: HER	



## **APPENDIX C**

Grain Size Analysis Reports



# SIEVE ANALYSIS REPORT

**THURBER ENGINEERING LTD.**

4127 Roper Road Edmonton, Alberta T6B 3S5 P: 780.438.1460 F: 780.437.7125

**Client:** Associated Engineering

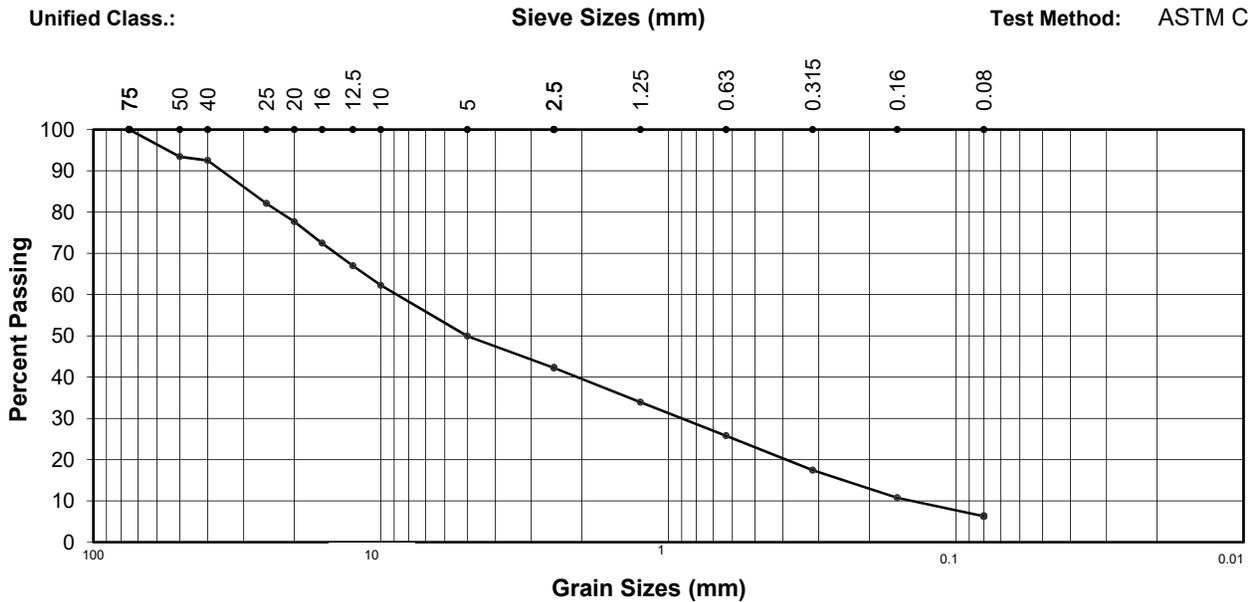
**Project No.:** 17-123-970

**Project:** Mount Edith Cavell - Access Road and Parking Lot Restoration

**Date:** 20-Oct-16

**Sample Source:** TP16-1C  
**Material Type:** Gravel and sand  
**Specification:**  
**Unified Class.:**

**Date Tested:** 20-Oct-16  
**Sampled by:** OVL (Thurber)  
**Date Sampled:** 17-Oct-16  
**Test Method:** ASTM C 136



GRAVEL				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits	
			Max	Min
	75	100.0		
	50	93.4		
	40	92.5		
	25	82.1		
	20	77.7		
	16	72.5		
	12.5	67.0		
	10	62.2		
	5	49.9		

SAND & FINES				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits	
			Max	Min
	2.5	42.2		
	1.25	33.9		
	0.63	25.8		
	0.315	17.4		
	0.16	10.8		
	0.08	6.3		

SILT AND CLAY			
Silt	-		
Clay	-		
Total Fines:	6.3%		

Gravel: 50.1%      Moisture Content  
 Sand: 43.6%      As Received: 6.5%  
 Fines: 6.3%      Percent Crush:  
                          Faces Counted: -

Computer File : 17-123-970,1C  
 Series No.: 5245

**Comments:** Gradation curve does not account for cobbles and boulders observed on site.

Checked By: OVL



# SIEVE ANALYSIS REPORT

**THURBER ENGINEERING LTD.**

4127 Roper Road Edmonton, Alberta T6B 3S5 P: 780.438.1460 F: 780.437.7125

**Client:** Associated Engineering

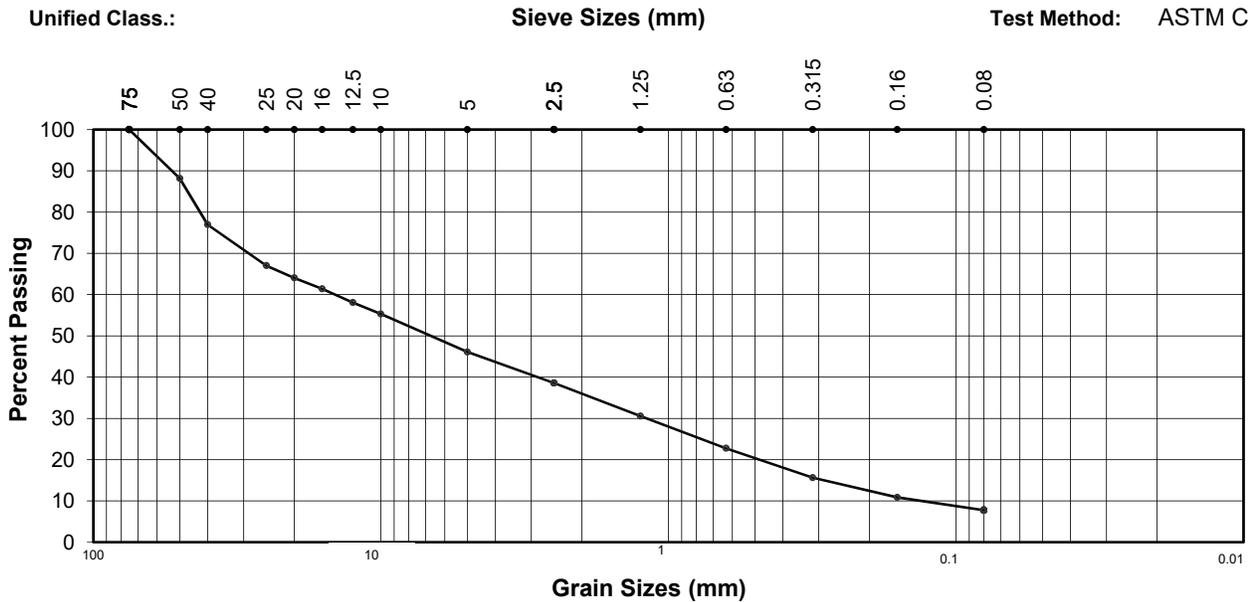
**Project No.:** 17-123-970

**Project:** Mount Edith Cavell - Access Road and Parking Lot Restoration

**Date:** 23-Oct-16

**Sample Source:** TP16-2C  
**Material Type:** Gravel and sand  
**Specification:**  
**Unified Class.:**

**Date Tested:** 21-Oct-16  
**Sampled by:** OVL (Thurber)  
**Date Sampled:** 17-Oct-16  
**Test Method:** ASTM C 136



GRAVEL				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits	
			Max	Min
	75	100.0		
	50	88.1		
	40	77.0		
	25	67.0		
	20	64.0		
	16	61.4		
	12.5	58.1		
	10	55.3		
	5	46.1		

SAND & FINES				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits	
			Max	Min
	2.5	38.6		
	1.25	30.6		
	0.63	22.7		
	0.315	15.6		
	0.16	10.9		
	0.08	7.8		

SILT AND CLAY			
Silt	-		
Clay	-		
Total Fines:	7.8%		

Gravel: 53.9%      Moisture Content  
 Sand: 38.3%      As Received: 8.3%  
 Fines: 7.8%      Percent Crush:  
                          Faces Counted: -

Computer File : 17-123-970,2C  
 Series No.: 5245

**Comments:** Gradation curve does not account for cobbles and boulders observed on site.

Checked By: OVL



# SIEVE ANALYSIS REPORT

**THURBER ENGINEERING LTD.**

4127 Roper Road Edmonton, Alberta T6B 3S5 P: 780.438.1460 F: 780.437.7125

**Client:** Associated Engineering

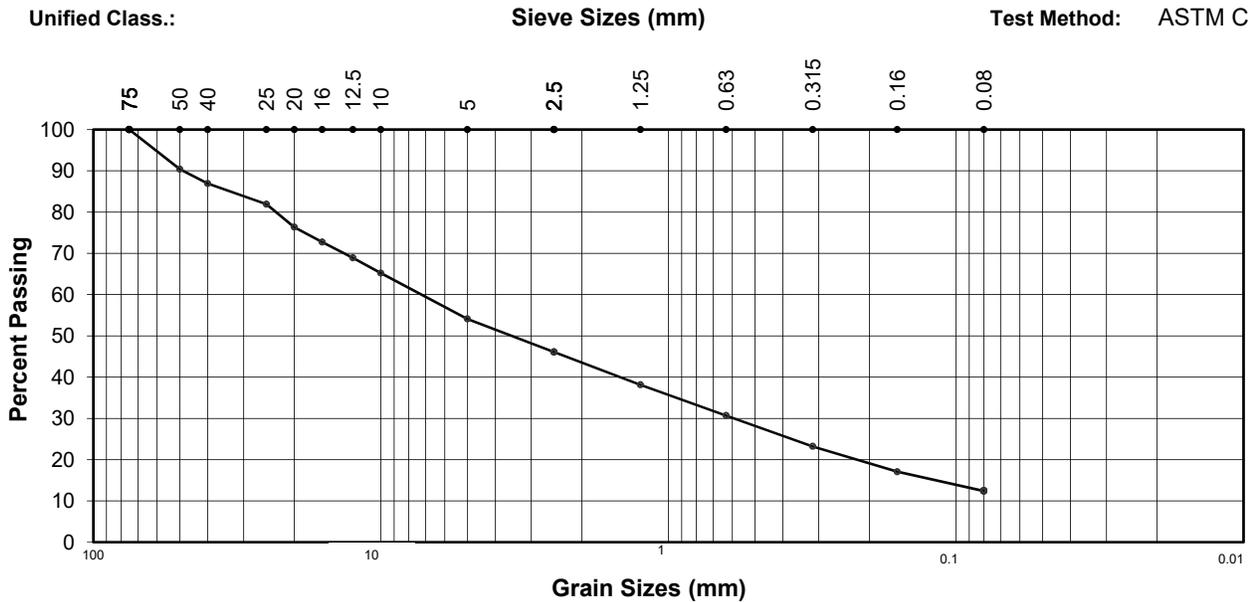
**Project No.:** 17-123-970

**Project:** Mount Edith Cavell - Access Road and Parking Lot Restoration

**Date:** 23-Oct-16

**Sample Source:** TP16-3C  
**Material Type:** Gravel and sand  
**Specification:**  
**Unified Class.:**

**Date Tested:** 21-Oct-16  
**Sampled by:** OVL (Thurber)  
**Date Sampled:** 17-Oct-16  
**Test Method:** ASTM C 136



GRAVEL				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits	
			Max	Min
	75	100.0		
	50	90.4		
	40	86.9		
	25	81.9		
	20	76.3		
	16	72.7		
	12.5	68.9		
	10	65.2		
	5	54.1		

SAND & FINES				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits	
			Max	Min
	2.5	46.1		
	1.25	38.1		
	0.63	30.7		
	0.315	23.2		
	0.16	17.1		
	0.08	12.4		

SILT AND CLAY			
Silt	-		
Clay	-		
Total Fines:	12.4%		

Gravel: 45.9%      Moisture Content  
 Sand: 41.7%      As Received: 7.3%  
 Fines: 12.4%      Percent Crush:  
                          Faces Counted: -

Computer File : 17-123-970,3C  
 Series No.: 5245

**Comments:** Gradation curve does not account for cobbles and boulders observed on site.

Checked By: OVL



# SIEVE ANALYSIS REPORT

**THURBER ENGINEERING LTD.**

4127 Roper Road Edmonton, Alberta T6B 3S5 P: 780.438.1460 F: 780.437.7125

**Client:** Associated Engineering

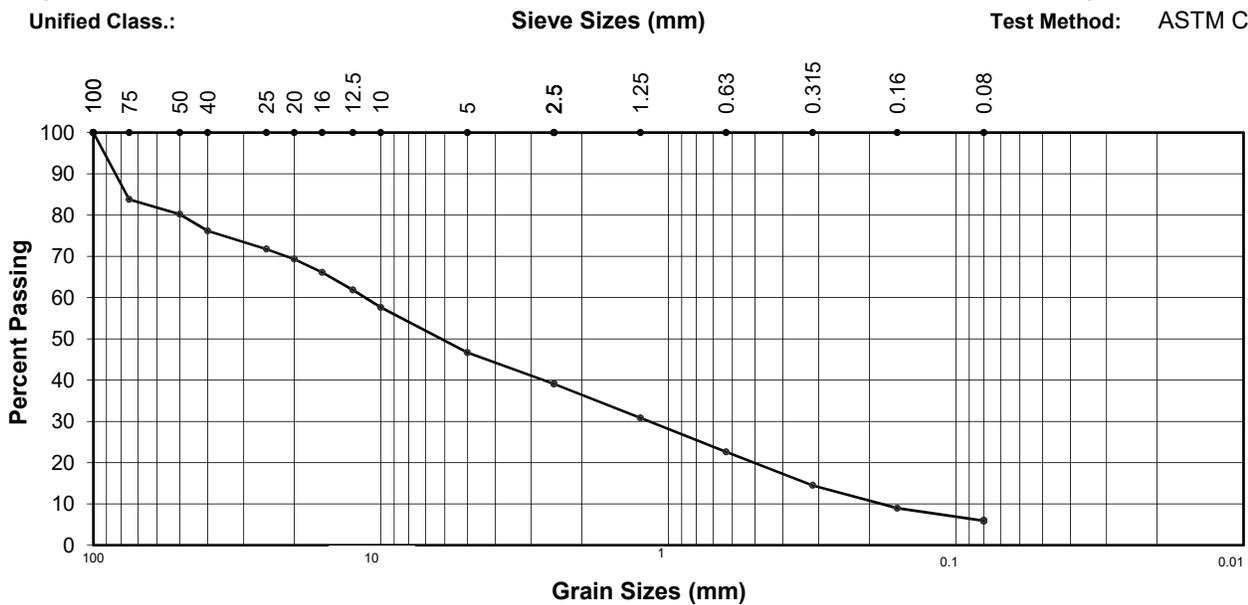
**Project No.:** 17-123-970

**Project:** Mount Edith Cavell - Access Road and Parking Lot Restoration

**Date:** 23-Oct-16

**Sample Source:** TP16-4F  
**Material Type:** Gravel and sand  
**Specification:**  
**Unified Class.:**

**Date Tested:** 22-Oct-16  
**Sampled by:** OVL (Thurber)  
**Date Sampled:** 17-Oct-16  
**Test Method:** ASTM C 136



GRAVEL				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits	
			Max	Min
	100	100.0		
	75	83.8		
	50	80.2		
	40	76.2		
	25	71.7		
	20	69.3		
	16	66.1		
	12.5	61.8		
	10	57.6		
	5	46.7		

SAND & FINES				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits	
			Max	Min
	2.5	39.1		
	1.25	30.8		
	0.63	22.6		
	0.315	14.5		
	0.16	9.0		
	0.08	5.9		

SILT AND CLAY			
Silt	-		
Clay	-		
Total Fines:	5.9%		

Gravel: 53.3%      Moisture Content  
 Sand: 40.7%      As Received: 6.7%  
 Fines: 5.9%      Percent Crush:  
                          Faces Counted: -

Computer File : 17-123-970,4F  
 Series No.: 5245

**Comments:** Gradation curve does not account for cobbles and boulders observed on site.

Checked By: OVL



# SIEVE ANALYSIS REPORT

**THURBER ENGINEERING LTD.**

4127 Roper Road Edmonton, Alberta T6B 3S5 P: 780.438.1460 F: 780.437.7125

**Client:** Associated Engineering

**Project No.:** 17-123-970

**Project:** Mount Edith Cavell - Access Road and Parking Lot Restoration

**Date:** 23-Oct-16

**Sample Source:** TP16-5F

**Date Tested:** 21-Oct-16

**Material Type:** Gravel, sandy, some silt and clay

**Sampled by:** OVL (Thurber)

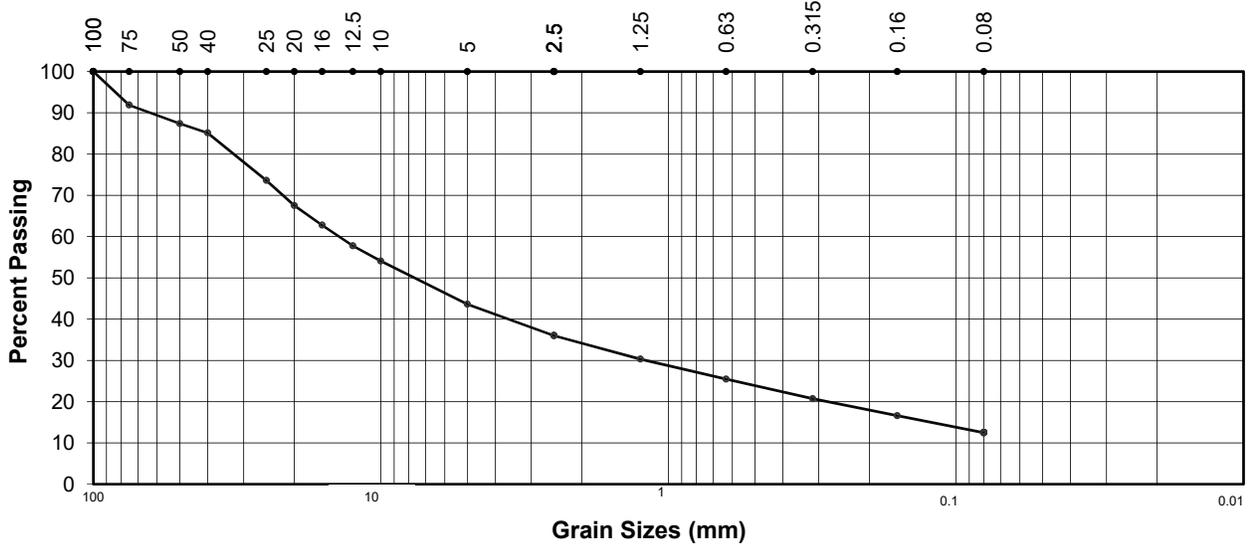
**Specification:**

**Date Sampled:** 17-Oct-16

**Unified Class.:**

**Sieve Sizes (mm)**

**Test Method:** ASTM C 136



GRAVEL				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits	
			Max	Min
	100	100.0		
	75	91.9		
	50	87.4		
	40	85.1		
	25	73.6		
	20	67.5		
	16	62.8		
	12.5	57.7		
	10	54.1		
	5	43.6		

SAND & FINES				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits	
			Max	Min
	2.5	36.0		
	1.25	30.3		
	0.63	25.5		
	0.315	20.7		
	0.16	16.6		
	0.08	12.5		

SILT AND CLAY			
Silt	-		
Clay	-		
Total Fines:	12.5%		

Gravel: 56.4%      Moisture Content  
 Sand: 31.1%      As Received: 9.8%  
 Fines: 12.5%      Percent Crush:  
                          Faces Counted: -

Computer File : 17-123-970,5F  
 Series No.: 5245

**Comments:** Gradation curve does not account for cobbles and boulders observed on site.

Checked By: OVL



# SIEVE ANALYSIS REPORT

**THURBER ENGINEERING LTD.**

4127 Roper Road Edmonton, Alberta T6B 3S5 P: 780.438.1460 F: 780.437.7125

**Client:** Associated Engineering

**Project No.:** 17-123-970

**Project:** Mount Edith Cavell - Access Road and Parking Lot Restoration

**Date:** 23-Oct-16

**Sample Source:** TP16-6F

**Date Tested:** 22-Oct-16

**Material Type:** Gravel, sandy, trace silt and clay, greyish brown

**Sampled by:** OVL (Thurber)

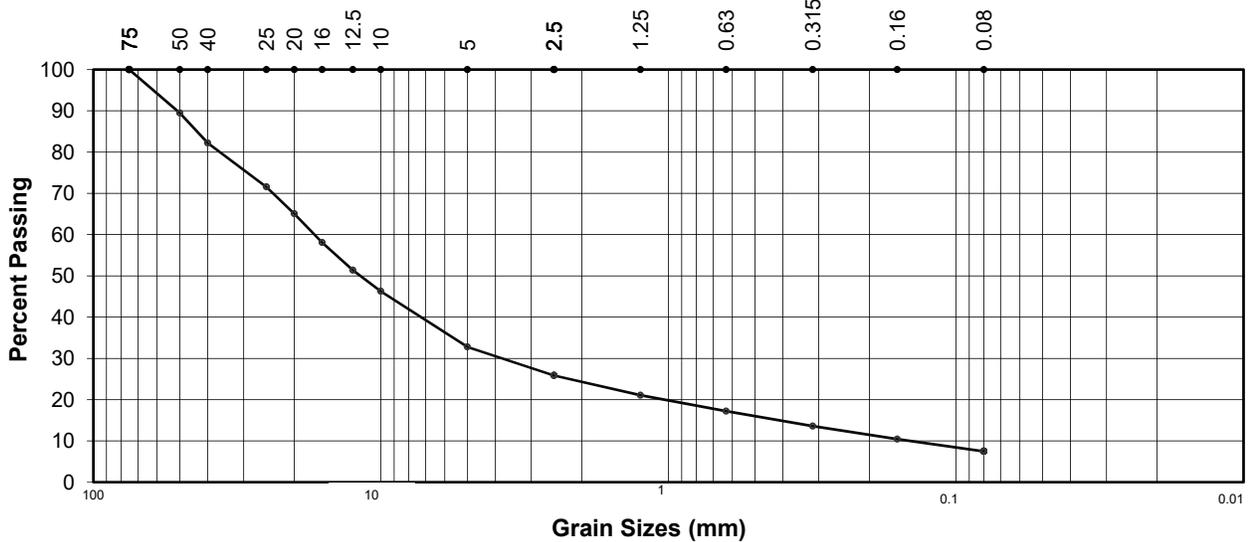
**Specification:**

**Date Sampled:** 17-Oct-16

**Unified Class.:**

**Sieve Sizes (mm)**

**Test Method:** ASTM C 136



GRAVEL				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits	
			Max	Min
	75	100.0		
	50	89.5		
	40	82.2		
	25	71.6		
	20	65.0		
	16	58.1		
	12.5	51.4		
	10	46.3		
	5	32.8		

SAND & FINES				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits	
			Max	Min
	2.5	25.9		
	1.25	21.1		
	0.63	17.2		
	0.315	13.6		
	0.16	10.4		
	0.08	7.5		

SILT AND CLAY			
Silt	-		
Clay	-		
Total Fines:	7.5%		

Gravel: 67.2%      Moisture Content  
 Sand: 25.3%      As Received: 10.5%  
 Fines: 7.5%      Percent Crush:  
                          Faces Counted: -

Computer File : 17-123-970,6F  
 Series No.: 5245

**Comments:** Gradation curve does not account for cobbles and boulders observed on site.

Checked By: OVL