July 21, 2015

Amec Foster Wheeler File: LT154508

Public Works and Government Services Canada
1650, 635 - 8th Avenue, SW
Calgary, Alberta T2P 3M3

**Attention: Mr. Mark Burke, P.Eng.**
**Project Manager, Southern Alberta**

**RE: GEOTECHNICAL INVESTIGATION**
**Proposed Utility Replacements & Surfacing Upgrades**
**Waterton Lakes National Park (Townsite), Alberta**

## 1.0 INTRODUCTION

At the request of Public Works and Government Services Canada, Amec Foster Wheeler Environment & Infrastructure (Amec Foster Wheeler) has carried out a geotechnical investigation to support the design and construction of proposed watermain, sanitary sewer and surfacing upgrades along the following streets in Waterton, Alberta:

- Evergreen Avenue;
- Columbine Avenue;
- Fern Street;
- Firgrove Street;
- Waterton Avenue; and
- A watermain along the west side of Cameron Creek.

In addition to installation of pipes for underground utility replacement, it is understood that a lift station is proposed near the south end of Evergreen Avenue (near TP15-06), and that the lift station will extend to a depth of about 4 m below grade.

This report summarizes the results of the field work and laboratory testing, and provides geotechnical discussion and recommendations to support the proposed project.

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# 2.0 METHODOLOGY AND RESULTS

## 2.1 Methodology

In order to assess the subsurface soil and groundwater conditions at the various streets indicated, Amec Foster Wheeler visited the sites on June 10, 2015 and monitored the excavation of a series of seven test pits. The test pits were excavated at the locations denoted on Figure 1 as TP15-01 to TP15-07, inclusive, at generally the following locations.

- TP15-02, TP15-05 and TP15-06 were excavated along Evergreen Avenue;
- TP15-01 was excavated along Fern Street just east of Evergreen Avenue;
- TP15-03 was excavated along Columbine Avenue just east of Evergreen Avenue;
- TP15-04 was excavated adjacent to Cameron Creek just north of Columbine Avenue;
- TP15-07 was excavated along Waterton Avenue just south of the trailer park.

The test pits were excavated using a John Deere 410J Loader/Backhoe operated by Biantco Environmental Services, and extended to depths ranging between about 2.7 m and 3.0 m below existing grade. During the excavations, representative samples of the subsurface strata were recovered from the excavated material. Upon completion of the excavations, the test pits were backfilled with the excavated material.

The test pit excavations were carried out under the supervision of an Amec Foster Wheeler technician, who collected the soil samples and logged the subsurface conditions. The recovered soil samples were transported to Amec Foster Wheeler’s Lethbridge laboratory for further review by a geotechnical engineer and selected laboratory classification testing. Laboratory testing for this project consisted of routine moisture content determinations, with results presented on the attached Test Pit Summary Table.

Samples remaining will be stored for a period of three months following issuance of this report at which time they will be discarded unless we are requested otherwise by the Client.

## 2.2 Soil and Groundwater Conditions

The subsurface conditions encountered are detailed on the attached Test Pit Summary Table and summarized in the following paragraphs.

*Pavement Structure*

The test pits advanced in pavement areas were generally surfaced with a 100 mm thick layer of asphalt. At these locations, the asphalt was generally underlain by a thin layer (100 mm to 200 mm) of crushed gravel.

*Topsoil*

TP15-04 and TP15-06 were both surfaced with a 150 mm thick layer of topsoil.

*Sand and Gravel*

The predominant natural mineral soil encountered in each of the test pits was gravel. The gravel was described as sandy with occasional cobbles and boulders, brown, and compact (based on tactile observations and observed excavation resistance). At TP15-01, some shale layering was observed below about 1.5 m depth.

Based on laboratory testing, the *in situ* water content of the gravel ranged between about 1 percent and 8 percent, generally indicative of damp to very moist soil conditions.

To further assess the sand and gravel, a sample from TP15-06 was subjected to a laboratory grain size analysis. The results are presented on Figure 2. It is noted that material larger than about 40 mm was not collected as part of the field sampling.

*Sloughing and Groundwater Conditions*

During the test pit excavations, some sloughing of the vertical test pit walls was observed in about half of the test pits, generally below about depth of 1.5 m.

The test pits were generally dry upon completion of the excavation, with the exception of TP15-06 where rapid groundwater recovery was observed to a depth of about 1.75 m below grade. It is noted that the groundwater conditions are expected to fluctuate seasonally in response to spring thaw and periods of heavy precipitation, and may differ at the time of construction.

## 3.0 GEOTECHNICAL DISCUSSION AND RECOMMENDATIONS

As indicated previously, it is understood that watermain, sanitary sewer and surface upgrades are proposed along the following streets in Waterton:

- Evergreen Avenue;
- Columbine Avenue;
- Fern Street;
- Firgrove Street;
- Waterton Avenue; and
- A watermain along the west side of Cameron Creek.

In addition to installation of pipes for underground utility replacement, it is understood that a lift station is proposed near the south end of Evergreen Avenue (near TP15-06), and that the lift station will extend to a depth of about 4 m below grade.

It is anticipated that the underground utility pipe installation will be by conventional open cut.

In general, the existing soil and groundwater conditions along the subject streets will support conventional open cut construction for the proposed pipe installation. However, some challenging conditions will be encountered near the south end of Evergreen Avenue where free groundwater was encountered below about 1.7 m depth.

Based on our understanding of the proposed development as discussed above in conjunction with the results of the current investigation, the following paragraphs provide geotechnical discussion and recommendations pertaining to site preparation, excavations, frost protection requirements, roadway reconstruction, and pavement construction.

### 3.1 Excavations and Dewatering

All excavations should conform to Part 32 of the 2009 Alberta Occupational Health and Safety Code.

Where spatial restrictions do not allow for the required safe trench sideslope inclinations, conventional shoring (i.e., trench boxes) can be considered. For shoring design, the following parameters can be used for the upper fill and native soils:

**Table 1: Parameters for Shoring Design**

| Parameter | Natural Sand & Gravel Soils |
|---|---|
| Total Unit Weight, $\gamma$, kN/m³ | 22 |
| Active Earth Pressure Coefficient, $k_a$ | 0.29 |

The weight of the adjacent structures must also be considered in the calculation of the lateral earth pressures where these structures fall within a line drawn up at 45° from the base of the excavations. Where trench boxes or shoring are used, adjacent structures should be inspected prior to and following construction to ensure damage has not occurred to the foundations.

Based on the results of the investigation, groundwater accumulation is not generally anticipated within service trenches above 3.0 m depth, with the exception of the south end of Evergreen Ave (the proposed lift station) where groundwater was encountered at about 1.7 m depth (TP15-06).

While minor groundwater accumulations within the services trenches can likely be accommodated by conventional sump pumping techniques, more extensive dewatering measures, such as the use of well points, will likely be required at the proposed lift station in order to facilitate an excavation to install the lift station.

### 3.2 Proposed Lift Station

As indicated above, more extensive dewatering measures will likely be required to achieve a successful excavation for the proposed lift station. In order to assist in assessing the permeability of the sand and gravel for design of a dewatering system, a laboratory grain size analysis was carried out on a sample of the sand and gravel from the lower portion of TP15-06. The results of the grain size analysis indicate a permeability in the order of 1 cm/sec.

The natural on-site excavated sand and gravel can be generally used as backfill for the lift station, provided the material is screened of boulders larger than about 150 mm, and moisture conditioned to within three percent of the optimum moisture content as determined by the Standard Proctor test. In this regard, some moisture conditioning of the soils should be anticipated. The backfill should be placed in maximum 300 mm thick lifts, and compacted to at least 98 percent of SPMDD.

The lift station will also need to be designed to withstand uplift by buoyancy (groundwater) forces. In this regard, the design groundwater depth should be taken as 0.5 m below grade. Typically, the uplift forces on the lift station would be resisted by the dead weight of the structure, the dead weight of a base slab which extends out beyond the edges of the lift station, and the weight of backfill soils over the lateral protrusion of the base slab beyond the edge of the lift station. Where the natural sand and gravel soils are used as backfill around the structure, a unit weight of 22 $kN/m^3$ can be used for the sand and gravel, with an effective unit weight of 12 $kN/m^3$ below the design water table.

### 3.3 Service Construction and Backfill

Bearing problems are not anticipated for pipes founded on the natural sand and gravel deposits.

The trenches above the service pipes should be backfilled with inorganic on-site soils placed in maximum 300 mm thick lifts and compacted to at least 98 percent of SPMDD. Bedding sand or gravel will be required for the pipe installations in accordance with the manufacturer's recommendations.

The natural on-site excavated sand and gravel can be generally used as trench backfill, provided the material is screened of boulders larger than about 150 mm, and moisture conditioned to within three percent of the optimum moisture content as determined by the Standard Proctor test. In this regard, some moisture conditioning of the soils should be anticipated.

### 3.4 Roadway Reconstruction

It is understood that the excavations will generally encompass the full width of the various roadways. Accordingly, full width reconstruction of the roadway has been indicated.

Prior to placement of granular fill or asphalt, areas to be paved should be stripped of all existing deleterious material, scarified and moisture conditioned to 300 mm depth, and be recompacted to a minimum of 98 percent of SPMDD at a moisture content within two percent of optimum. Any soft spots revealed by this or any other observations should be over-excavated and backfilled with approved material.

Provided the preceding recommendations are followed, the pavement thickness design requirements given in the following table are recommended for the anticipated traffic loading and subgrade conditions.

**Table 2: Recommended Pavement Structure Thicknesses**

| Pavement Layer | Compaction Requirements | Medium Duty Pavement Structure Thicknesses |
|---|---|---|
| Asphaltic Concrete | 93% Maximum Theoretical Density | 100 mm Type III* |
| Granular Base Course* | 100% SPMDD | 75 mm |
| Reclaimed asphalt* | 100% SPMDD | 75 mm |
| *Notes: | * City of Lethbridge Specification<br>* The reclaimed asphalt (millings) should be well graded with a maximum size of 25 mm.<br>The subgrade must be moisture conditioned to a depth of 300 mm and compacted to 98% SPMDD. | |

The recommended pavement structure provided in the above table is based on the natural subgrade soil properties determined from visual examination and textural classification of the soil samples. Consequently, the recommended pavement structures should be considered for preliminary design purposes only, and should be verified during construction based on actual site subgrade conditions.

If construction is undertaken under adverse weather conditions (i.e., wet or freezing conditions) subgrade preparation and granular base requirements should be reviewed by the geotechnical engineer. As well, if only a portion of the pavement will be in place during construction, the granular base may have to be thickened, and/or the subgrade improved with a geotextile separator.

Samples of both the granular base aggregates and asphaltic concrete paving materials should be checked for conformance to the City of Lethbridge specifications prior to use on site, and during construction.

Good drainage provisions will optimize pavement performance. The pavement subgrade and the finished pavement surface should be free of depressions and should be sloped (preferably at a minimum grade of two percent) to provide effective surface drainage toward catchbasins. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas.

A program of in situ density testing must be carried out to verify that satisfactory levels of compaction are being achieved.

## 4.0 CLOSURE

The recommendations given in the above sections are based upon interpreted conditions found within the seven test pits excavated at this site. Should subsurface conditions other than those presented in this report be encountered during construction, the Client should notify our office so that these recommendations can be reviewed.

Soil conditions, by their nature, can be highly variable across a site. A contingency should be included in the construction budget to allow for the possibility of variations in soil conditions, which may result in modification of the design, and/or changes in the construction procedures.

Amec Foster Wheeler requests the opportunity to review the design drawings and the installation of the foundations (lift station) to confirm that the recommendations in this report have been correctly interpreted and implemented. If not afforded the opportunity to conduct this review, Amec Foster Wheeler will not accept responsibility for the interpretation of this report. Amec Foster Wheeler would be pleased to provide any further information that may be needed during design and to advise on the geotechnical aspects of specifications for inclusion in contract documents.

This report has been prepared for the exclusive use of Public Works and Government Services Canada and their designers for the specific application to the development described in this report. Any use that a third party makes of this report, or any reliance or decisions based on this report are the sole responsibility of those parties. This report has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty, express or implied, is made.

Yours truly,

**Amec Foster Wheeler Environment & Infrastructure**
**A division of Amec Foster Wheeler Americas Ltd.**

PROFESSIONAL ENGINEER
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July 21/15

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Attachments: Figure 1: Test Pit Location Plan
Figure 2: Grain Size Analysis
Test Pit Summary Table
Explanation of Symbols and Terms


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Public Works and Government Services Canada

| | | | |
|---|---|---|---|
| TITLE: TEST PIT LOCATION PLAN | DWN BY: BJ | DATUM: NA | DATE: JUNE 2015 |
| PROJECT: Proposed Utilities Replacement & Surface Upgrades<br>Waterton Townsite Streetworks<br>Waterton Lakes National Park, Alberta | CHK'D BY: JS<br>SCALE: NTS | PROJECT NO: LT154508 | FIGURE 1 |

# GRAIN SIZE DISTRIBUTION

**Amec File:** LT154508
**Project:** Waterton Service Upgrades

469, 40th Street South
Lethbridge, Alberta
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**Location:** TP15-06 - S3
2.25m Depth

**Date Sampled:** 10-Jun-15

| SIEVE SIZE (um) | PERCENT PASSING |
|---|---|
| | |
| 40 000 | 100 |
| 25 000 | 80 |
| 20 000 | 69 |
| 16 000 | 65 |
| 10 000 | 53 |
| 5 000 | 38 |
| 2 500 | 26 |
| 1 250 | 17 |
| 630 | 9 |
| 315 | 5 |
| 160 | 3.2 |
| 80 | 2.6 |

Notes:
*Material larger than 40mm screened off during field sampling*

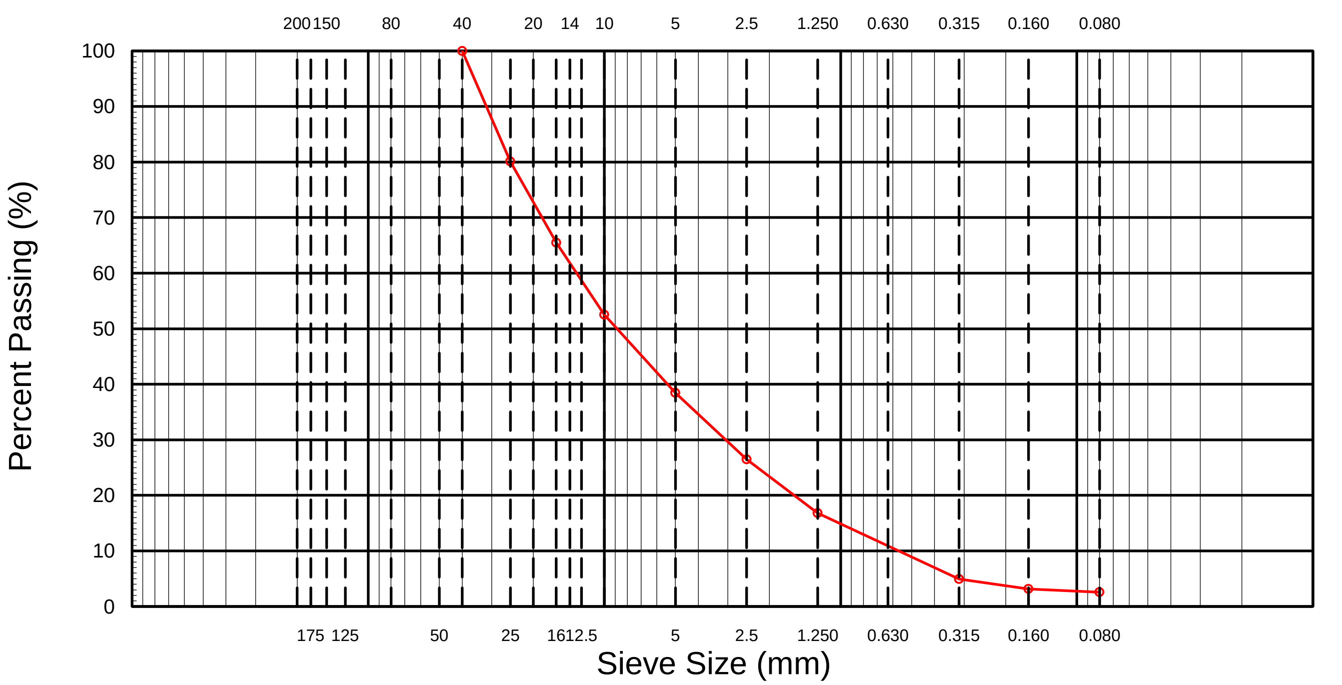


Figure 2

# TEST PIT SUMMARY TABLE

Amec Foster Wheeler File: LT154508
Public Works and Government Services Canada
Proposed Utilities Replacement & Surface Upgrades, Waterton Lakes National Park, Alberta

| TP15-01 | | |
|---|---|---|
| *Depth:* | | |
| 0.0 – 2.7 | **SAND & GRAVEL –** occasional cobbles and boulders, compact, brown, moist | *0.75m depth:*<br>Moisture: 2.5% |
| 1.5 – 2.7 | … moist to very moist, shale layers | *1.5m depth:*<br>Moisture: 7.4% |
| 2.7 | **End of Test Pit at 2.7 m depth**<br>*-sloughing below 1.5 m depth.*<br>*-test pit backfilled with excavated material.* | *2.25m depth:*<br>Moisture: % |

| TP15-02 | | |
|---|---|---|
| *Depth:* | | |
| 0.0 – 3.0 | **SAND & GRAVEL –** occasional cobbles and boulders, compact, brown, moist | *0.75m depth:*<br>Moisture: 2.2% |
| 1.5 – 3.0 | … moist to very moist | *1.5m depth:*<br>Moisture: 2.5% |
| 3.0 | **End of Test Pit at 3.0 m depth**<br>*-sloughing below 1.5 m depth.*<br>*-test pit backfilled with excavated material.* | *2.25m depth:*<br>Moisture: 3.9% |

| TP15-03 | | |
|---|---|---|
| *Depth:* | | |
| 0.0 – 0.1 | **ASPHALT** | |
| 0.1 – 0.2 | **GRAVEL FILL** | *0.75m depth:*<br>Moisture: 3.6% |
| 0.2 – 3.0 | **SAND & GRAVEL –**occasional cobbles and boulders, compact, brown, moist | *1.5m depth:*<br>Moisture: 1.4% |
| 3.0 | **End of Test Pit at 3.0 m depth**<br>*-dry and open upon completion of excavation.*<br>*-test pit backfilled with excavated material.* | *2.25m depth:*<br>Moisture: 0.7% |

| TP15-04 | | |
|---|---|---|
| *Depth:* | | |
| 0.0 – 0.15 | **TOPSOIL** | *0.75m depth:*<br>Moisture: 1.5% |
| 0.15 – 3.0 | **SAND & GRAVEL –** occasional cobbles and boulders, compact, brown, moist | *1.5m depth:*<br>Moisture: 1.9% |
| 3.0 | **End of Test Pit at 3.0 m depth**<br>*-dry and open upon completion of excavation.*<br>*-test pit backfilled with excavated material.* | *2.25m depth:*<br>Moisture: 1.4% |

| TP15-05 | | |
|---|---|---|
| *Depth:* | | |
| 0.0 – 0.1 | **ASPHALT** | |
| 0.1 – 0.3 | **GRAVEL FILL** | *0.75m depth:* Moisture: 2.2% |
| 0.3 – 2.7 | **SAND & GRAVEL –** occasional cobbles and boulders, compact, brown, moist | *1.5m depth:* Moisture: 3.2% |
| 1.5 | …moist to very moist | *2.25m depth:* Moisture: 3.0% |
| 2.7 | **End of Test Pit at 2.7 m depth**<br>*-sloughing below 1.9 m depth.*<br>*-test pit backfilled with excavated material.* | |

| TP15-06 | | |
|---|---|---|
| *Depth:* | | |
| 0.0 – 0.15 | **TOPSOIL** | *0.75m depth:* Moisture: 8.5% |
| 0.15 – 3.0 | **SAND & GRAVEL –** occasional cobbles and boulders, compact, brown, moist | *1.5m depth:* Moisture: 6.3% |
| 1.75 | … free water, hole filled with water from 1.75 m to 3.0 m depth | *2.25m depth:* Moisture: 6.3% |
| 3.0 | **End of Test Pit at 3.0 m depth** *-excessive seepage and sloughing below 1.75 m depth.* *-test pit backfilled with excavated material.* | |

| TP15-07 | | |
|---|---|---|
| *Depth:*<br><br>0.0 – 3.0<br><br>3.0 | **SAND & GRAVEL –** occasional cobbles and boulders, compact, brown, moist<br><br>**End of Test Pit at 2.7 m depth**<br>*-dry and open upon completion of excavation.*<br>*-test pit backfilled with excavated material.* | *0.75m depth:*<br>Moisture: 3.6%<br><br>*1.5m depth:*<br>Moisture: 5.5%<br><br>*2.25m depth:*<br>Moisture: 2.0% |

*Table Notes:*
-test pit information to be read in conjunction with Amec Foster Wheeler report LT154508.
-test pits excavated on June 10, 2015 using a John Deere 410J Loader/.
-see Figure 1 for test pit locations