THURBER ENGINEERING LTD.

LOT 3, BLOCK 1, PLAN 112252
RAILWAY AVENUE AND 54TH STREET
ELK POINT, ALBERTA
DESKTOP STUDY AND
GEOTECHNICAL ASSESSMENT

Report

to

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

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EXECUTIVE SUMMARY

Thurber Engineering Ltd. (Thurber) was retained by PWGSC to undertake a geotechnical desktop assessment to assess the potential for adverse geotechnical conditions for a property located in the southeast corner of the intersection of Railway Avenue and 54th Street in the town of Elk Point, Alberta.

The desktop study consider the previous environmental site assessments (ESA) undertaken at the site (Phase I ESA by AECOM in 2014 and Phase II ESA by AMEC in 2015) including the other environmental reports in the vicinity provided in the Phase I report and the results of the limited drilling investigation completed as part of the Phase II ESA. In addition, the results of geotechnical investigations conducted by Thurber within Elk Point were also considered.

The subsurface stratigraphy in Elk Point typically consists of 1 m to 2 m of sand overlying clay till. The clay till frequently contains wet sand layers and the water table appears to be within 3 m of ground surface. The test holes drilled at the site for the Phase II ESA confirm similar conditions at this property. The bedrock below the clay till is clay shale of the Lea Park Formation and estimated at a depth of between 20 m and 25 m below ground surface.

There were no regional geological or geotechnical unusual problematic conditions identified in this study that would adversely impact development of the property. The soil conditions appear to be suitable for either cast-in-place concrete piles (straight shaft or belled) or spread footings. Slab-on-grade construction may be suitable subject to the considerations following. The high groundwater table and wet sand layers may limit the depth of piles to avoid sloughing that would require casing. There has been some minor development on the property which included placement of up to 1.4 m of clay and gravel fill on portions of the site. It also appears that surficial organics were buried or incorporated into the fill in at least one location and these layers represent potential weak zones. There are several options to handle the fill: situate the development outside of the fill area (the western third of the property appears to be undisturbed), remove and replace the existing fill material with controlled fill, proof-roll the fill to determine uniformity and identify soft areas, ensure that foundations are based in undisturbed soil below the fill, or a combination of all of the above.

The presence of fill on the property is of only limited concern but should be considered during design and construction of the development. A site-specific geotechnical investigation is recommended and should include two to three test holes to at least 15 m depth for the building, three shallow test holes (3 m in depth) for the parking area, and consideration given to additional shallow test holes to delineate the extent and quality of the fill and buried organics.

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1. INTRODUCTION

1.1 General

This report presents the results of a geotechnical assessment based on a desktop study carried out by Thurber Engineering Ltd. (Thurber) in Elk Point, Alberta. The site is located at Railway Avenue and 54th Street in the southwest corner of Elk Point at legal description Lot 3, Block 1, Plan 1122524.

The scope of the geotechnical assessment was outlined in a proposal letter to Ms. Caja Hoffman of Public Works and Government Services Canada (PWGSC) dated March 9, 2015. Authorization to proceed with the investigation was received from Ms. Hoffman on March 13, 2015.

It is a condition of this report that Thurber's performance of it professional services will be subject to the attached Statement of Limitations and Conditions that is included at the end of the text of this report.

1.2 Scope of Work

As part of the due diligence process prior to acquiring the land, PWGSC has requested a desktop assessment of the property for potential geotechnical issues. Environmental site assessments have been completed at this site including limited subsurface drilling for the installation of groundwater monitoring wells.

This geotechnical desktop study will be based on a review of existing information and will not include a field investigation component. The intent of the assessment is to identify the potential for geotechnical issues at the site which might significant impact the development of the property.

It is understood that the proposed development will likely consist of a single-storey building with no basement and a slab-on-grade floor. Parking will be at surface.

2. DESKTOP STUDY

The geotechnical assessment of the subject property will be conducted using existing information such as reports already undertaken for the property (provided by PWGSC), aerial photography, publically-available mapping, and Thurber's in-house library. The sources of information used in the assessment are:

1. Phase I Environmental Site Assessment by AECOM Canada Ltd. dated August 28, 2014.

2. Phase II Environmental Site Assessment by AMEC Foster Wheeler Environment & Infrastructure dated January 29, 2015.

3. Elk Point Municipal Hospital – Foundation Investigation, Proposed Addition by Thurber July 10, 1990.

4. Elk Point School – Gymnasium Addition Foundation Investigation, 5218 – 51 Street, Elk Point, Alberta By Thurber dated December 14, 2011.

Several environmental site assessment projects in Elk Point were included as appendices to the Phase I environmental site assessment (ESA) undertaken by AECOM which were also considered in assessing the potential subsurface soil conditions and are listed in Section 8. Aerial photography was reviewed during the Phase 1 and 2 ESA's (by AECOM and AMEC, respectively) and the photographs were included in those respective reports.

3. SITE DESCRIPTION

3.1 Surface Conditions

Based on the description and site photographs provided by others, it is understood that the site is presently undeveloped. There is a treed zone along the north side of the property with a potentially wet zone in the central portion. The topography is relatively level with a slight poorly-drained depression in the northwest portion.

The site is located in the southwest corner of Elk Point and is bounded by Railway Avenue on the north with commercial and residential developments beyond, the Elk Point Fire Hall on the east, former CN Rail track on the south, and 54 Street on the west. Agricultural land is located to the south and west.

The site history, as reported by the Phase I ESA, is that there was some limited placement and movement of stockpiles on the site; however, there has been no formal commercial or residential development on this property.

3.2 Geological Setting

According to published mapping, the near-surface bedrock at this site is the Upper Cretaceous Lea Park Formation (Hathway et. al. 2013) which is clay shale containing thin fine-grained siltstone and sandstone layers and thin bentonite layers. The depth to the bedrock is estimated at 22 m (Atkinson and Lyster 2010). Surficial geology mapping indicates that surficial soils at this site are ice-contact fluvial deposits (sediments deposited within by moving water, such as a river, in direct contact with glacial ice) consisting of fine sand, silt, and clay. The terrain immediately to the north, and potentially within the northern portion of the Town of Elk Point, is clay till moraine deposits with some water-sorted material and the potential for local bedrock exposures (Shetsen 1990).

There is no record of coal mines in the Elk Point area according to the Energy Resource Conservation Board (ERCB) Coal Mine Map Viewer (ERCB 2010).

3.3 Subsurface Conditions

The reports reviewed to determine the potential subsurface conditions are listed in Section 2 and shown on Drawing 16-4-174-1. Note that the AECOM Phase I ESA report included several other environmental assessment reports and the locations of these reports are shown on the Drawing. These sites are located within 1 km to the north and east of the subject property.

Typically, the soil conditions in the Elk Point townsite appear to consist of 1 m to 2 m sand overlying clay till to a depth of at least 9.1 m (the maximum depth of investigation). The clay till was frequently inter-layered with sand up to 1 m in thickness. Seepage and groundwater were frequently encountered in the sand layers. The depth to groundwater measured in standpipes and monitoring wells was between 0.6 m and 2.9 m except for one well were a depth of 7.0 m to groundwater was measured.

Based on the test holes advanced by AMEC (attached as Appendix B), the subsurface soil and groundwater conditions at the subject property are in keeping with the general conditions discussed above. There were a total of five test holes drilled to 4.5 m to 6.1 m in depth. The soil layers encountered were, in descending order, with the Modified Unified Soil Classification System (MUSCS) taken from the AMEC test hole logs:

a) Topsoil

b) Fill (CL and GW)

c) Sand (SW)

d) Clay Till (CL to CI) with Sand Layers (SM).

Topsoil was encountered at the ground surface at two locations (BH14-04 and MW14-05) at the west portion of the site. At the remaining locations, there was fill located at the ground surface:

asphalt and clay fill extending to 1.4 m depth in the northeast corner next to Railway Avenue, gravel fill with some organics extending to 1.5 m depth in the southeast corner, and 0.6 m of clay fill over 0.4 m of topsoil south central portion of the site. The locations of the test holes that encountered fill indicate that minor grading has taken place on the eastern two-third's of the site and the variability of the fill is in agreement with the intermittent usage history of this site.

Sand was encountered above the clay till at one location (MW14-05) and was 0.8 m in thickness. Sand was encountered within or below the clay till at MW14-01 and BH14-04 and was inter-bedded with the clay till at MW14-05. The depth and thickness of these clay layers was somewhat variable which is consistent with the other test holes reviewed as part of this study. The sand was noted to have compact density.

The clay till was typically low to medium plastic, and contained variable amounts of silt, sand, gravel, and iron staining. The consistency noted on the logs was from stiff to very stiff which corresponds to undrained shear strengths from 50 kPa to 200 kPa. There were silt, clay, and sand layers noted within the clay till in MW14-01 which were described as soft in consistency (corresponding undrained shear strength of 10 kPa to 25 kPa); however, this layer was only 0.5 m thickness. Geotechnical investigations conducted for the Elk Point Hospital and School expansions by Thurber determined that the Standard Penetration Test (SPT) N-values for the clay till increased with depth ranging from 11 to 53 blows per 300 mm. The corresponding consistency is from stiff to hard which is in agreement with the descriptions provided on the AMEC test hole logs.

3.4 Groundwater Levels

Seepage, water, and slough levels at the completion of drilling were not provided on the AMEC test hole logs. Interpreting the relatively moisture contents from the logs indicates that seepage was likely encountered between 1.7 m to 4.3 m below ground surface which was typically associated with sand layers and lenses. Water levels measured in the monitoring wells installed by AMEC one month after drilling are summarized in Table 3.1 below.

TABLE 3.1
MEASURED GROUNDWATER LEVELS

Test Hole	Location	Monitoring Well Tip Depth (m)	Water Level Below Ground Surface (m)
MW14-01	NE corner	6.0	2.2
MW14-03	S central	6.0	5.9
MW14-05	West side	5.4	1.8

These water levels were read in late December 2014 at a time when the groundwater table would be expected to be at or near the annual low point. The groundwater levels can vary in response to seasonal factors and precipitation, hence the actual groundwater conditions at the time of construction could vary from those recorded during this investigation.

3.5 Frost Effects

The clay till present at this site is considered to have moderate frost susceptibility. The sand, when present near surface, is expected to be moderately to highly frost susceptible given the relatively shallow groundwater table and silty composition. Frost heave, if not properly addressed, may be a concern for grade-supported slabs, shallow foundations, tanks, and roadways. In addition, uplift forces on piles will also have to be considered.

The expected depths of frost penetration have been estimated using averaged estimated thermal parameters. The frost penetration has been estimated for (a) the mean annual air freezing index of 1500 degree-Celsius day and (b) for a 50 year return period annual freezing index (AFI) of 2400 degree Celsius day. The estimated frost penetrations are provided in Table 3.2 and are estimated for a uniform soil type with no snow cover. If the area is covered with significant snow cover the depth of frost penetration will be less.

TABLE 3.2
ESTIMATED DEPTH OF FROST PENETRATION

MATERIAL	ESTIMATED DEPTH OF FROST PENETRATION (m)	
	MEAN AFI	50-YEAR RETURN AFI
Clay Fill/Clay Till	1.6	2.3
Gravel/Sand	2.4	3.2

In general, the estimated depths of frost penetration provided for clay fill or clay till are expected to be representative of most of the site conditions and may be used for design purposes.

The 50 year return estimated frost penetration depth is generally used for design of foundations and underground utilities, while the average annual value could be used for construction with some risk.

4. GEOTECHNICAL EVALUATION AND RECOMMENDATIONS

4.1 General Evaluation

The results of this desktop study indicate that the site should be suitable for the proposed development. The presence of variable fill across the site will have implications for site preparation depending on the location of the building and the type of foundation selected and the suitability of slab-on-grade construction. The subsurface soils are suitable for standard foundation types and design although complicated slightly by the presence of fill material and the potential for shallow groundwater and sloughing which will limit the depth to which excavation can occur. Potential problematic geological or geotechnical conditions that could affect the proposed development were not identified in the references reviewed during this study. The soil conditions appear typical for the area.

The depth of existing fill on the portions of the site is up to 1.4 m. The presence of buried topsoil indicates that some of the fill was placed without stripping the organics. The buried organic layers could represent weak layers depending on how long it has been compressed under the fill and the additional loading that may be added depending on site development. It is recommended that prior to selecting a location for the detachment building, the extent of the fill and buried organics be delineated through a targeted drilling program which could include drilling numerous shallow test holes as part of a foundation investigation. Consideration should be given to placing the building, if portions will be grade-supported, on area that is not underlain by buried organics although such areas may be acceptable for parking lots, subjected to inspection and proof-rolling. In areas where the fill is not present and below the fill, the soil conditions are suitable for standard foundations.

4.2 Site Preparation

4.2.1 General

Site preparation should include the removal of all deleterious material such as organic soils or debris from under the proposed building and parking areas. It is recommended that the prepared subgrade be proof-rolled to confirm uniformity of the subgrade. Soft or saturated areas should be subexcavated and removed. Alternatively, in parking areas, consideration could be given to using a geotextile to bridge weaker areas. The subgrade should be inspected prior to placement of any additional fill to ensure all organic soil has been removed.

All fill under the building, if using a grade-supported floor slab, should be placed in 150 mm maximum lifts compacted thickness and compacted to at least 98 percent Standard Proctor

Maximum Dry Density (SPMDD) within at to 2 percent wet of Optimum Moisture Content (OMC). The density of compacted fills should be confirmed by field density test measurements during construction.

The fill should consist of low to medium plastic clay or clay till or imported granular material (maximum aggregate top size of 75 mm). The uniformity and compactive effort of the backfill are important in minimizing the potential for differential settlement.

Proper drainage should be provided at the early stage of construction outside the building footprint to direct surface water away from the building. The finished subgrade and finished grade should be sloped at a minimum gradient of 1 percent toward catch basins or ditches to drain any surface water away from the roadways and structures. Adjacent to buildings, it is recommended that the minimum slope should be of 2 percent extending outward beyond the foundations by at least 2 m but preferably 5 m.

4.2.2 Excavation and Drainage

Excavations for building development and utility installation are expected to encounter mainly clay fill and clay till. As noted previously, there is the potential for surficial sand above the clay till and wet sand layers within which could be intercepted by excavations. Groundwater seepage may therefore be encountered during excavation.

Groundwater seepage from the clay till is expected to occur at a relatively slow rate and should be of a magnitude that can be handled by normal excavation grading and the use of sump and pump drainage where required. Where thick, water-bearing sand layers are encountered, groundwater flow may be initially greater but is not anticipated to be prolonged given the discontinuous nature of the sand layers.

Temporary excavations in the surficial stiff clay or clay till up to a depth of about 3 m are expected to remain stable for a normal construction period at a slope of 1H:1V. Local flattening of slopes may be required if softer materials or granular layers are encountered during excavation. Deeper excavations should be evaluated on a site specific basis. Excavated material should be stockpiled no closer than 1.5 m to the excavation slopes, or the excavation depth, whichever is greater. Excavations in compact sand are expected to remain stable at a slope of 1.5H:1V providing adequate drainage of the sand occurs prior to excavation.

Occupational Health and Safety recommendations must be followed at all times. When personnel are required to enter the trench, the excavation slopes greater than 1.5 m deep should be cut back flatter or alternatively temporary trench bracing should be used.

Permanent structures placed below the long-term water table should be designed to resist hydrostatic uplift pressures or, alternatively, should have permanent subdrainage to maintain the groundwater levels below the base of the excavation.

Subdrains for permanent structures should typically consist of 100 mm diameter (or larger) perforated subdrain pipes surrounded by at least 300 mm of drainage gravel (such as 20 mm or 25 mm minus washed gravel) and enveloped by a non-woven geotextile. The subdrain pipes should drain by gravity toward a collection point.

4.3 Utility Installation

4.3.1 Pipe Bedding

All soft, loosened and disturbed material should be removed from the trench base before placement of bedding. The pipe should be bedded and installed according to the manufacturer's specifications. Care should be taken such that the pipe is not in contact with rigid objects such as cobbles or rocks as this will cause a stress concentration in the pipe and may result in breakage.

Where granular bedding is specified, it is recommended that a minimum thickness of 75 mm to 100 mm of granular bedding be placed below the pipe. The bedding material should also be extended to a width sufficient to permit compaction with base plate compactors on each side of the pipe with a minimum total trench width of 2 times the outside diameter of the pipe. The bedding material should be brought up evenly and simultaneously on both sides of the pipes in 150 mm minimum thick lifts, compacted to at least 95 percent of Standard Proctor Maximum Dry Density (SPMDD). The bedding material should also be extend at least 150 mm above the crown of the pipe.

The granular bedding should consist of well graded sand and gravel with less than 10 percent passing the 80 micron sieve (No. 200 sieve) and should be free from angular rocks (particularly near the pipe) and organics.

Based on the estimated groundwater elevation, utility trench bases may be situated below the water table. Recommendations for the control of groundwater are provided n Section 4.2.2 above.

4.3.2 Trench Backfill

The remainder of the trench above the bedding zone may be backfilled with the excavated on-site materials that are free of debris or organics. Under proposed roadways or parking areas, the backfill should be compacted to a minimum of 95 percent of SPMDD.

It should be recognized that even when compacted as discussed above, settlement of the trench backfill should be expected in the first one to two years and this should be considered in the design. Maintenance may therefore be required for trenches under roadways, including future patching or overlaying of the pavement.

The trench backfill should not be placed frozen, or placed at temperatures below freezing. Heavy compaction equipment should not be allowed to operate above the placed pipe until at least 1 m of backfill has been placed and compacted above the pipe.

4.3.3 Insulation

Utility lines that are subject to freezing should be buried below the minimum depth of frost penetration (50 year) as discussed in Section 3.5 considering the type of backfill (2.3 m depth for clay backfill). Alternatively, an insulation layer may be placed over the pipes to locally reduce the depth of frost penetration.

In general, a 150 mm thick layer of rigid Styrofoam placed 0.6 m below the ground surface can be expected to limit frost penetration to a depth of about 1.5 m below ground. These frost penetration depths assume the insulation layer extends a minimum distance of 2.4 m on either side of the pipe.

It should be noted that this depth of frost penetration is for clay backfill, and the depth can be greater if sand is used for backfill. Care should therefore be taken during backfilling to ensure that the backfill consists mainly of clay till and that sand is not used for backfilling of the trenches.

4.4 Building Foundations

4.4.1 General

There were no unusual problematic geotechnical conditions identified at this site based on the available information and the standard foundation types are considered feasible for the proposed building:

a) Cast-in-place concrete friction piles

b) Cast-in-place concrete end-bearing piles

c) Spread footings.

In general, both cast-in-place concrete friction and end-bearing piles are feasible at this location. Although due to the potential for a relatively high groundwater table and wet sand layers, skin friction cast-in-place concrete piles may require temporary casing during installation. Belled end-bearing piles installed at a shallow depth were recommended by Thurber to minimize the problems with sloughing and groundwater seepage conditions at the Elk Point Hospital expansion.

Piles foundations are less prone to settlement and seasonal moisture-related movements than spread footings but may be less economical for a lightly-loaded, single-storey building. Moisture-related movements could occur as a result of volume changes in surficial clay sediments due to a gain or loss of moisture from seasonal changes in the groundwater table or such things as the growth or removal of mature trees. The moisture sensitivity of the soils as this site are expected to be typical for the area and non-standard design or construction practices will not be required. As this is a desktop study, the recommendations provided herein should be considered preliminary.

Other foundation types may also be acceptable. Further detailed recommendations for design of the cast-in-place end-bearing piles and spread footings are provided in the following sections.

4.4.2 Limit States Design

The factored foundation capacities provided in Sections 4.3.3, 4.3.4, and 4.3.5 are based on the product of the estimated ultimate capacity and appropriate geotechnical resistance factors. The geotechnical resistance factors are prescribed in the National Building Code (NBC, 2010) and are dependent on the method of determination of the ultimate pile capacity, as summarized in Table 4.1. For the purposes of this desktop study report, it has been assumed that only a geotechnical investigation will be undertaken and that neither static nor dynamic field testing will be done.

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TABLE 4.1
RECOMMENDED GEOTECHNICAL RESISTANCE FACTOR
FOR LIMIT STATES DESIGN OF DEEP FOUNDATIONS
(NBC 2010)

DESCRIPTION	GEOTECHNICAL RESISTANCE FACTOR (GRF)
(a) Resistance to axial load	
(i) semi-empirical analysis using laboratory and in-situ test data	**0.4**
(ii) analysis using static loading test results	0.6
(iii) analysis using dynamic monitoring results	0.5
(iv) uplift resistance by semi-empirical analysis	**0.3**
(v) uplift resistance using loading test results	0.4
(b) Resistance to horizontal load	0.5

*Note: Use bolded values for design unless site-specific foundation load testing is conducted.

Pile load testing may be used to optimize pile capacities in advance of construction and enable use of higher geotechnical resistance factors for Limit States Design as noted in Table 4.1. However, the potential benefits of this will depend on the number of piles required for this project and the potential cost savings of undertaking such tests. Typically, for a small commercial building, it is not economical to undertaken pile load testing.

4.4.3 Cast-in-Place Concrete Friction Piles

Cast-in-place concrete friction piles should be designed and installed according to the recommendations given below.

a) Cast-in-place concrete friction piles are expected to have a factored ULS shaft resistance, in compression, between 12 kPa and 24 kPa (based on ultimate shaft resistance between 30 kPa and 60 kPa) at and below a depth of 1.5 m from ground surface.

b) End-bearing resistance should not be included in calculating the design load of a friction pile. A minimum pile shaft diameter of 400 mm is recommended to prevent voids from forming during pouring of the concrete.

c) Shaft adhesion should not be included in the upper 1.5 m below finished grade to allow for the possibility of soil drying and shrinking away from the pile shaft. Shaft friction should also be ignored to the depth of new fill, where greater than 1.5 m.

d) A minimum pile length of 7 m below finished site grade is required for lightly loaded friction piles to provide sufficient uplift resistance to frost heave forces in unheated areas.

e) A nominal percentage of longitudinal reinforcement should be provided throughout the pile shaft length to resist potential uplift forces on the pile due to frost action and seasonal moisture variations. If piles are designed as tension elements or are left exposed to subzero temperatures, the pile reinforcing should be designed to resist the anticipated uplift stresses.

f) A minimum pile spacing of three shaft diameters is recommended. Piles within five shaft diameters should not be constructed consecutively within the same 24-hour period in order to allow the concrete in the adjacent pile to set.

g) Cobbles and boulders were not encountered in the test holes drilled by AMEC at the subject property; however, they were encountered at other locations reviewed as part of this study. There is a potential for random cobbles and boulders in the clay till which could hamper augering if encountered in the pile hole.

h) Sand layers may be encountered within the clay till at varying depths which may result in deeper depths being required in certain areas. Temporary steel casings may be required to prevent seepage and sloughing during pile installations.

i) Concrete should be poured immediately after drilling of the pile hole to reduce the risk of groundwater seepage and sloughing soil. Groundwater seepage will likely occur during pile installation and therefore casing should be available during pile installation.

4.4.4 Cast-in-Place Concrete End-Bearing Piles

Cast-in-place concrete end bearing piles may be designed and installed as straight-shaft or belled in accordance with the following recommendations.

a) Cast-in-place concrete end bearing piles founded at or greater than 4 m below existing ground surface are expected to have a factored ULS bearing resistance between 240 kPa and 400 kPa based on an ultimate bearing capacity of between 600 kPa and 1,000 kPa and a Geotechnical Resistance Factor (Φ) of 0.4.

b) Pile bases should be founded at a minimum depth of 4 m below existing ground surface for frost protection. It should be noted that sand and silt layers with seepage may be present within the clay till. Where encountered, it may be necessary to use temporary casings and to extend the pile bases to greater depth to reduce sloughing during formation of the bell.

c) A minimum pile depth of 2.5 times the bell diameter has been assumed in calculation the above bearing capacity. If less cover is provided, the specified bearing capacity must be reduced.

d) The bell diameter to shaft diameter ratio should not exceed 3:1, and the bell should not be sloped at more than 30° to the vertical.

e) A minimum pile shaft diameter of 400 mm is recommended to prevent voids from forming during pouring of the concrete.

f) A nominal percentage of longitudinal reinforcement should be provided throughout the pile shaft length to resist potential uplift forces on the pile due to frost action and seasonal moisture variations. If piles are designed as tension elements or are left exposed to subzero temperatures, the pile reinforcing should be designed to resist the anticipated uplift stresses.

g) All pile excavations should be thoroughly cleaned and visually inspected prior to pouring of the concrete to ensure a satisfactory base has been achieved. No slough or disturbed material should be allowed to remain in the pile excavations.

h) Concrete should be poured immediately after drilling of the pile hole to reduce the risk of groundwater seepage and sloughing soil. Groundwater seepage will likely occur during pile installation and therefore casing should be available during pile installation.

i) Geotechnical inspection is recommended to confirm suitable bearing conditions have been achieved.

4.4.5 Spread Footings

Spread footings should be designed and constructed according to the following recommendations.

a) Exterior perimeter footings supporting heated structures should have a minimum soil cover of 1.6 m below finished grade to provide adequate protection against frost. Interior footings should be founded at a minimum depth of 1 m below site grade or on native, undisturbed soil, whichever is deeper. Footings in unheated structures should have a minimum foundation depth of 2.3 m (for clay) to minimize frost heave effects. Alternatively, the foundations may be placed at shallower depths and insulated with rigid Styrofoam (e.g. Styrofoam SM or equivalent).

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b) All footings should be founded on the undisturbed inorganic native clay till. Footings should not be placed on fill or organic soils. Where local soft zones are encountered in the footing trenches, it may be necessary to increase the size of the footings or to remove the soft material and replace with better quality fill. Disturbed soil should not be allowed to remain in the footing trenches.

c) Strip and square footings founded on the very stiff native clay till may be designed using factored ULS bearing resistance estimated from 110 kPa to 220 kPa and 130 kPa to260 kPa, respectively, based on ultimate bearing capacity between 220 kPa to 440 kPa, and 260 kPa to 520 kPa, respectively, and a geotechnical resistance factor (Φ) of 0.5.

d) Care should be taken to prevent excessive drying or wetting or freezing during construction and soils in the footing trenches that become dried or wetted should be subexcavated and replaced with lean concrete.

e) The excavated base of the foundation level should be protected from weathering and frost action to prevent the deterioration of the soil at footing level.

f) The footing excavations should be inspected by qualified geotechnical personnel to ensure that the footings are located in suitable clay soils.

4.5 Concrete Grade Beams

Where piles are used, grade beams and pile caps may be required along the top of the piles. Precautions should be taken to prevent heaving of the grade beams due to frost penetration or swelling of the underlying soil, where the grade beams will lie less than 1.6 m below the ground surface. As discussed in Section 4.1 above, problematic geotechnical soil conditions, such as swelling soils, were not identified at the project site. However, the typical near-surface lacustrine clay deposits found in much of Alberta can have some susceptibility to volume change due to changes in moisture content arising from exposure during construction or changes in the groundwater table regime. Typical construction practices in Alberta are adequate to address these potential concerns.

The recommended construction procedures for preventing heave under the grade beam are through use of a crushable non-degradable void form material. The grade beam must be designed in accordance with the crushing strength of the void filler used and the piles must be able to resist the resulting uplift load.

4.6 Concrete Floor Slab

Depending where on the property the detachment building will be constructed, a slab-on-grade may be feasible subject to the following recommendations:

1. It is recommended that proof rolling of the subgrade area under the floor slabs, particularly in areas where there is existing, uncontrolled fill, be undertaken in order to detect any soft areas that will require to be subexcavated and backfilled with compacted clay fill as recommended in Section 4.1.

2. The top 150 mm of the exposed subgrade or base of the excavation should be scarified, moisture conditioned at to 2 percent wet of Optimum Moisture Content (OMC) and compacted to 98 percent of Standard Proctor Maximum Dry Density (SPMDD).

3. Site raising fill, if required, should consist of low to medium plastic clay or imported granular fill, placed in 150 mm lifts and compacted to at least 95 percent of SPMDD within plus or minus 2 percent of OMC.

4. A granular leveling course of about 150 mm compacted thickness should be placed and compacted to a uniform dry density of about 100 percent of SPMDD. A recommended typical gradation is provided in Table 4.2.

TABLE 4.2
TYPICAL GRADATIONS UNDER SLAB-ON-GRADE

SIEVE	% PASSING
1 ½ (38 000 μm)	100
3/8 (10 000 μm)	65 - 100
No. 4 (5 000 μm)	50 - 90
No. 10 (2 000 μm)	35 - 75
No. 40 (400 μm)	10 - 45
No. 100 (150 μm)	0 - 20
No. 200 (75 μm)	0 - 5

5. It is important to prevent extreme drying, desiccation or freezing of the clay or clay till subgrade during construction. Such material that becomes over dried or frozen should be removed and replaced as noted above.

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6. The slab-on-grade should be designed to tolerate some movement, possibly in the order of about 25 to 35 mm due to long-term swelling or shrinking of the underlying clay.

7. Non-load bearing partition walls founded on the slab-on-grade should have a gap of at least 25 mm between the top plate and ceiling to accommodate potential heave movements. The slab-on-grade should be designed to float with no rigid connections to the walls of the foundation elements or grade beam, except for at doorways or access areas.

8. Surface grading and landscaping should be designed to shed water away from the building and slab-on-grade area to reduce ingress of water and swelling.

9. It is important that deciduous trees not be planted close to the building at a distance shorter than two times the mature height of the trees.

10. It is important that water and sewer lines be designed and installed to accommodate differential movements so as not to develop leaks and introduce moisture to near surface soils.

11. Insulation should be provided below floor slabs in unheated areas or sidewalks to prevent frost heave.

12. Exterior walkways and slabs should not be structurally connected to the buildings.

If the floor slabs are sensitive to movements, it is recommended to use a structure floor slab.

It should be recognized that slabs in non-heated areas (i.e. exterior slabs or unheated buildings) will be subject to frost heave. Where slabs on grade in unheated structures are movement sensitive, insulation will be required below the slab.

A modulus of subgrade reaction, k_{s1},may be used to represent the soil stiffness for design of heavily loaded slabs. Typical design values of modulus of subgrade reaction for the various soil types at this site are provided in Table 4.3 below. The values apply for a 1 m square rigid slab placed on the various soils. The design values should be corrected for the actual slab width based on the following formulae:

$$k_B = k_{s1} \times 1/B \ (MN/m^3)$$

Where

k_B = modulus of subgrade reaction for slab width (MN/m^3)

k_{s1} = modulus of subgrade reaction for 1 m square slab (MN/m^3)

B = effective slab width (m)

TABLE 4.3
MODULUS OF SUBGRADE REACTION FOR SLABS

SOIL TYPE	AVERAGE MODULUS OF SUBGRADE REACTION k_{s1} (MN/m^3)
Clay Fill (95% SPMDD)/Native Clay	12 – 24
Compacted Granular Fill (100% SPMDD)	64 – 128

4.7 Pavement Recommendations

4.7.1 Subgrade Preparation

As noted in Section 4.1, the existing fill soils are variable in composition and extent and extend to a maximum depth (based on the limited subsurface information available) to a depth of about 1.4 m below existing ground surface. If areas of fill are present in pavement areas, it is recommended that proof-rolling be undertaken early in the project to assess the need for partial or complete removal of the existing fill material and replacement with low to medium plastic clay or imported granular fill.

The roadway subgrade is expected to consist of stiff to very stiff, medium plastic clay fill or clay till. Depending on the conditions at the time of construction the subgrade may require moisture conditioning to achieve the required compaction.

The following additional recommendations apply to design and construction of pavements at this site:

a) The stripped ground surface below roadways should be proof rolled to detect any soft/wet zones. Soft materials should be sub-excavated and replaced with well compacted clay or cement modified as required. The depth of sub-excavation or cement application rate and cement dosage should be decided in the field at the time of construction. Proof-rolling is not required for the excavation to remove the existing fill soils within the demolished building footprint.

b) Subgrade areas that become softened as a result of construction traffic or weather conditions should also be sub-excavated and replaced with inorganic low to medium plastic clay or clean granular fill or cement modified as described in Item (a) above.

c) The upper 150 mm of the stripped ground surface should be scarified and compacted to 95 percent of the SPMDD of the material. Any additional fill required to raise the road to subgrade level may consist of inorganic low to medium plastic clay or clean granular fill. The backfill should be placed and compacted in 150 mm compacted lifts to at least 98 percent of the SPMDD. The upper 150 mm of subgrade under the proposed parking area should be compacted to 100 percent SPMDD within ±2 percent of OMC.

d) It is recommended that the finished subgrade surface be sloped at a minimum of 1 percent toward catch basins, gutters or perimeter ditches. The purpose of this is to drain any subsurface water from the subgrade and thereby prevent ponding of water on the pavement subgrade that could result in swelling, softening and/or possible frost heaving of the clay subgrade.

4.7.2 Pavement Design

A soaked California Bearing Ratio (CBR) value of 3 is considered applicable for compacted clay for design of the pavement structure on the types of subgrade materials encountered at this site. The design of pavement thickness will depend on the magnitude, frequency and distribution of traffic loading anticipated in the various areas of the site. In lieu of this information, the following guidelines presented in Table 4.4 below can be used for design of the pavement structures at the proposed roadway and parking lot areas.

TABLE 4.4
TYPICAL PAVEMENT STRUCTURES

PAVEMENT TYPE	PAVEMENT STRUCTURE
Light Duty (such as parking areas for light cars and pickup trucks)	75 mm Asphaltic Concrete over 250 mm Crushed Granular Base Course over 150 mm prepared subgrade
Heavy Duty (access routes for fire trucks and service vehicles)	100 mm Asphaltic Concrete over 300 mm Crushed Granular Base Course over 300 mm prepared subgrade

In areas subject to loading and unloading of heavy trucks, consideration should be given to an adequately design concrete pavement structure.

4.8 Cement Type

Site-specific soil testing for water-soluble sulphate ion (SO4) content of concentrations has not been undertaken at the subject property. However, based on test results from other Thurber projects in the area, there is negligible amounts of soluble sulphate ion present in the soil indicating that there is no potential for sulphate attack on the subsurface concrete. As a result, CSA Type GU (General Use hydraulic cement) may be used in the subsurface concrete at this project site.

The recommendations stated above for the subsurface concrete at this site may require further additions and / or modifications due to structural, durability, service life or other considerations which are beyond the geotechnical scope.

In addition, if imported material is required to be used at the site and will be in contact with concrete, it is recommended that the fill soil be tested for sulphate content to determine whether the above stated recommendations remain valid.

4.9 Seismicity

The site is located in a region of low seismic activity. The site classification as per Table 4.1.8.4A of the National Building Code (2010) should be based on a 30 m deep test hole. However, test holes have not been drilled to this depth in the reports reviewed as part of this desktop study. Based on the published geological information discussed above in Section 3.2, the site is likely underlain by about 20 m to 35 m of glacial till deposits over bedrock of the Lea Park Formation. This information combined with data from our geotechnical investigation indicates that the site can be classified as Class D.

5. FURTHER WORK

A site-specific geotechnical investigation will be required to finalize the recommendations contained herein. The number of test holes required will depend on the size of the building and parking area and other structures that may be included as part of the development. Typically, two to three test holes would be suitable for the likely size of the building with an additional three for the parking area. However, given that there is fill and buried organics present on the site, additional shallow test holes should be considered to delineate the extent of these deposits if the building will be located in areas where fill has been identified.

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The presence of fill and/or buried organics is not expected to be of concern for parking areas. However, the parking area should be proof-rolled at the time of construction to confirm that the subgrade support is relatively uniform.

6. LIMITATION AND USE OF THIS REPORT

There is a possibility that this report may form part of the design and construction documents for information purposes. This report was issued before any final design or construction details have been prepared or issued. Therefore, differences may exist between the report recommendations and the final design, in the contract documents, or during construction. In such instances, Thurber Engineering Ltd. should be contacted immediately to address these differences.

7. REFERENCES

AECOM Canada Ltd. 2014. Phase I Environmental Site Assessment, Railway Avenue and 54th Street, Elk Point, Alberta. Report to Public Works and Government Services Canada dated 28 August 2014. AECOM Project Number 60328532.

AMEC Foster Wheeler Environment & Infrastructure. 2015. Phase II Environmental Site Assessment, Railway Avenue and 54th Street, Elk Point, Alberta. Report to Public Works and Government Services Canada dated 29 January 29 2015. AMEC Project Number WX17562PRW.

Atkinson, N. and Lyster, S. 2010. Thickness of Quaternary and Neogene Sediment in Alberta, Canada. Energy Resources Conservation Board ERCB/AGS Map 551.

Biogénie Site Remediation Services. 2004. Environmental Assessment of the Bulk Plant and Fertilizer Site No. 88325 / 88001179, 5101 Railway Avenue, Elk Point, Alberta. Report to Imperial Oil Limited dated 18 February 2004. Biogénie Reference Number ES3210.

Cirrus Environmental Services Inc. 2005. Phase II Environmental Site Assessment – Elk Point (142) 4525 Railway Avenue, Elk Point, Alberta. Report to UFA Co-operative Limited dated 18 October 2005. Cirrus Reference Number 371-0805-02.

Energy Resources Conservation Board. 2010. Serial Publication ST45: Operating and Abandoned Coal Mines in Alberta. 4th Ed. Energy Resources Conservation Board, Calgary, Alberta. Available from http://mapview.ercb.ca/spatialdatabrowser/default.aspx?config=CoalMine.xml [accessed 24 March 2015].

Nichols Environmental (Canada) Ltd. 2000. Phase II Environmental Site Assessment – Former Tags Gas Bar and Convenience Store, Elk Point, Alberta. Report to The Grocery People Ltd., Edmonton, Alberta dated June 2000. Nichols Project Number M0075-TGP.

Prior, G.J., Hathway, B., Glombick, P.M., Pană, D.I., Banks, C.J., Hay, D.C., Schneider, C.L., Grobe, M., Elgr, R., and Weiss, J.A. 2013. Bedrock Geology of Alberta. Energy Resources Conservation Board, ERCB/AGS Map 600.

Shetsen, I. Quaternary Geology, Central Alberta. 1990. Alberta Research Council Map 213.

Stantec Consulting Ltd. 2001. Phase II Environmental Site Assessment PTMAA Site No. 895 Elk Point Tempo, 4921 48th Street, Elk Point, Alberta, SW 6-57-6 W4M. Report to Alberta Municipal Affairs dated February 2001. Stantec Project Number 1-02-15301.

Thurber Engineering Ltd. 1990. Elk Point Municipal Hospital – Foundation Investigation, Proposed Addition. Report to Duthie Newby, Weber, & Associates Ltd. dated 10 July 1990. Thurber Project Number 17-937-4.

Thurber Engineering Ltd. 2011. Elk Point School – Gymnasium Addition Foundation Investigation, 5218 – 51 Street, Elk Point, Alberta. Report to Alberta Infrastructure dated 14 December 2011. Thurber Project Number 15-85-112

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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

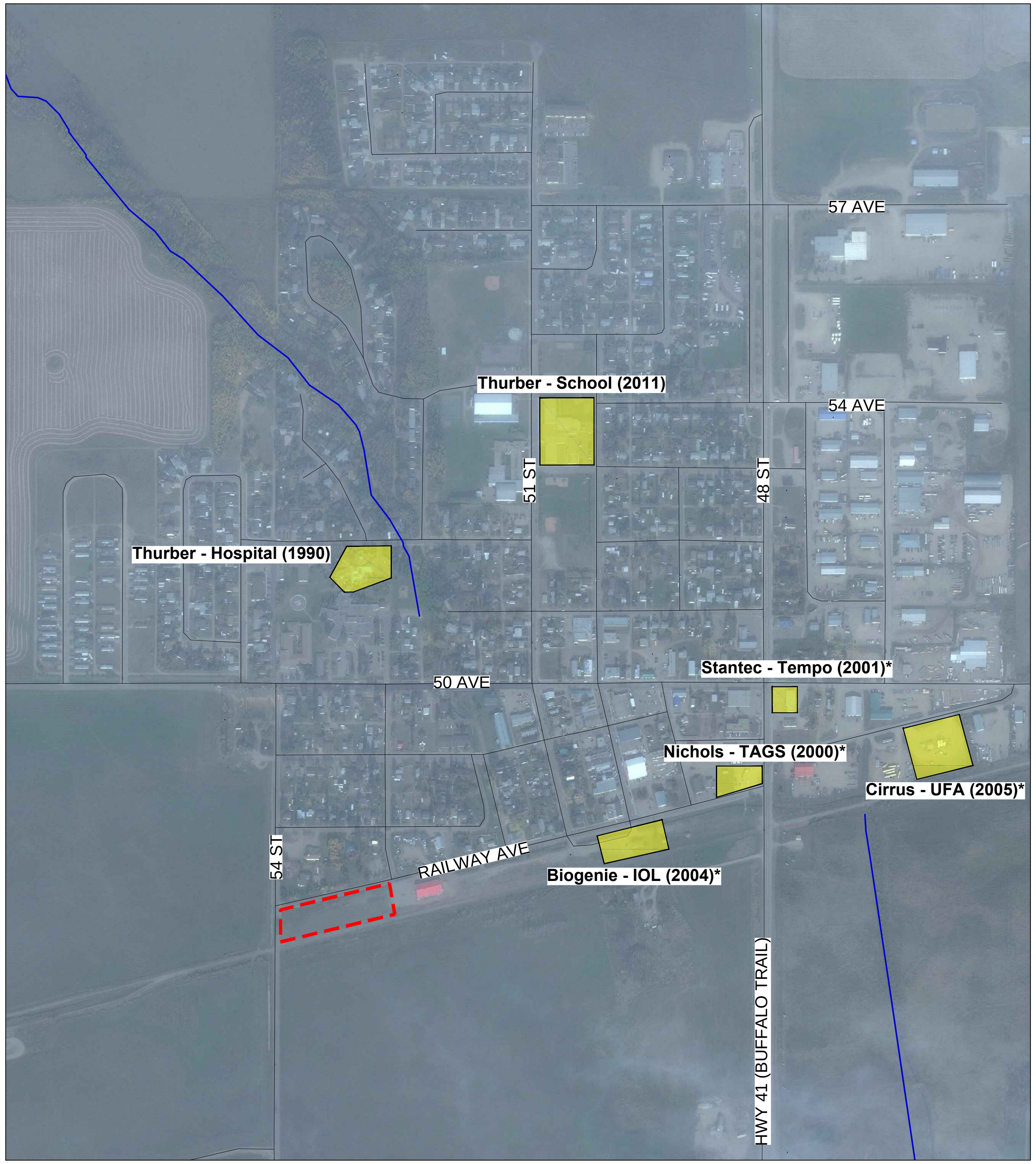
Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, 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

Drawing



SITE LOCATION PLAN

SCALE 1:10000

0 100 200 300 400 500 600m

SCALE 1:10000

N
W E
S

BOREHOLE LOCATION PLAN

SCALE 1:2000

0 20 40 60 80 100 120m

SCALE 1:2000

SATELLITE IMAGE FROM ESRI WORLD IMAGERY; STREET NETWORK FROM OPENSTREETMAP

LEGEND

- APPROXIMATE SUBJECT PROPERTY
- APPROXIMATE BOREHOLE LOCATION (AMEC 2015)
- APPROXIMATE MONITORING WELL LOCATION (AMEC 2015)
- PREVIOUS PROJECTS IN AREA
  * = FROM AMEC PHASE I ESA (2014)

PUBLIC WORKS CANADA

PROPOSED ELK POINT BUILDING
DESKTOP STUDY

SITE PLAN SHOWING APPROXIMATE TEST HOLE LOCATIONS

DWG No. 16-4-174-1

DRAWN BY	KLW
DESIGNED BY	KEF
APPROVED BY	RVC
SCALE	VARIES
DATE	MARCH 2015
FILE No.	16-4-174

THURBER ENGINEERING LTD.

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APPENDIX B

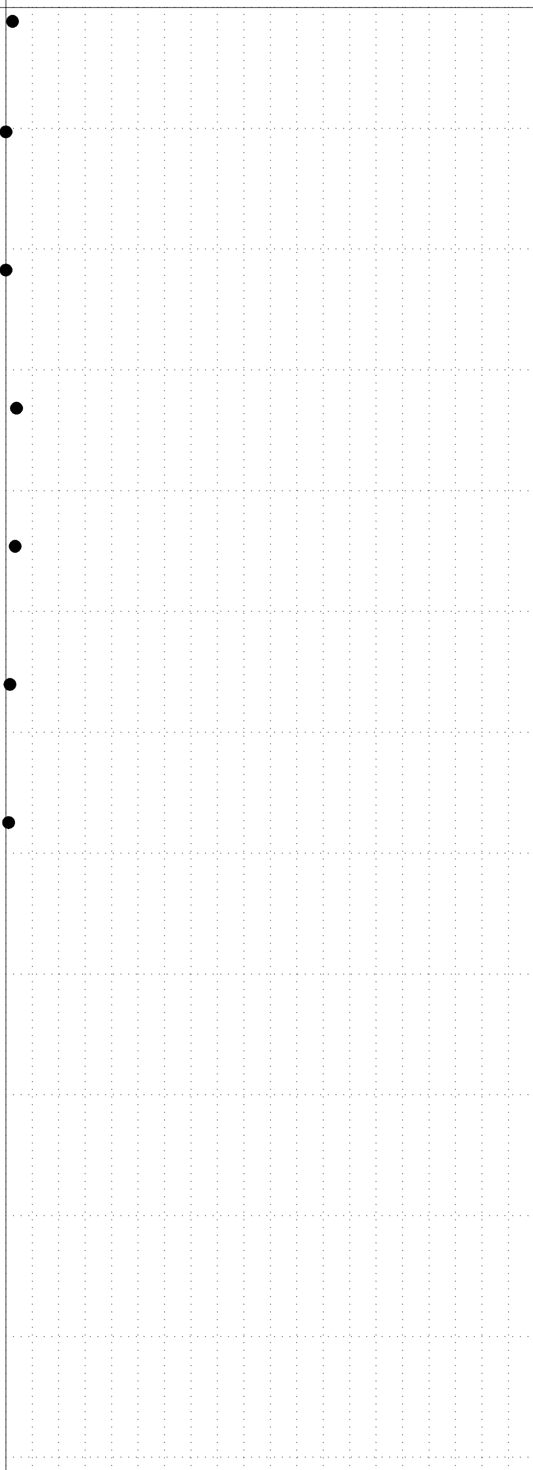
Test Holes (AMEC 2015)

PROJECT: Elk Point Drill Program	DRILLED BY: CP Drilling	TEST HOLE NO: **BH14-02**
CLIENT: City of Edmonton	DRILL RIG: Auger	PROJECT NO: WX17562PRW
LOCATION: Elk Point	DRILL TYPE: Solid Stem	ELEVATION:

SAMPLE TYPE	Shelby Tube	No Recovery	SPT Test (N)	Grab Sample	Split-Pen	Core
BACKFILL TYPE	Bentonite	Pea Gravel	Drill Cuttings	Grout	Bentonite Chips	Sand

● COMBUSTIBLE VAPOUR (ppm) ●

0 200 400 600 800 1000 3000 5000 7000 9000



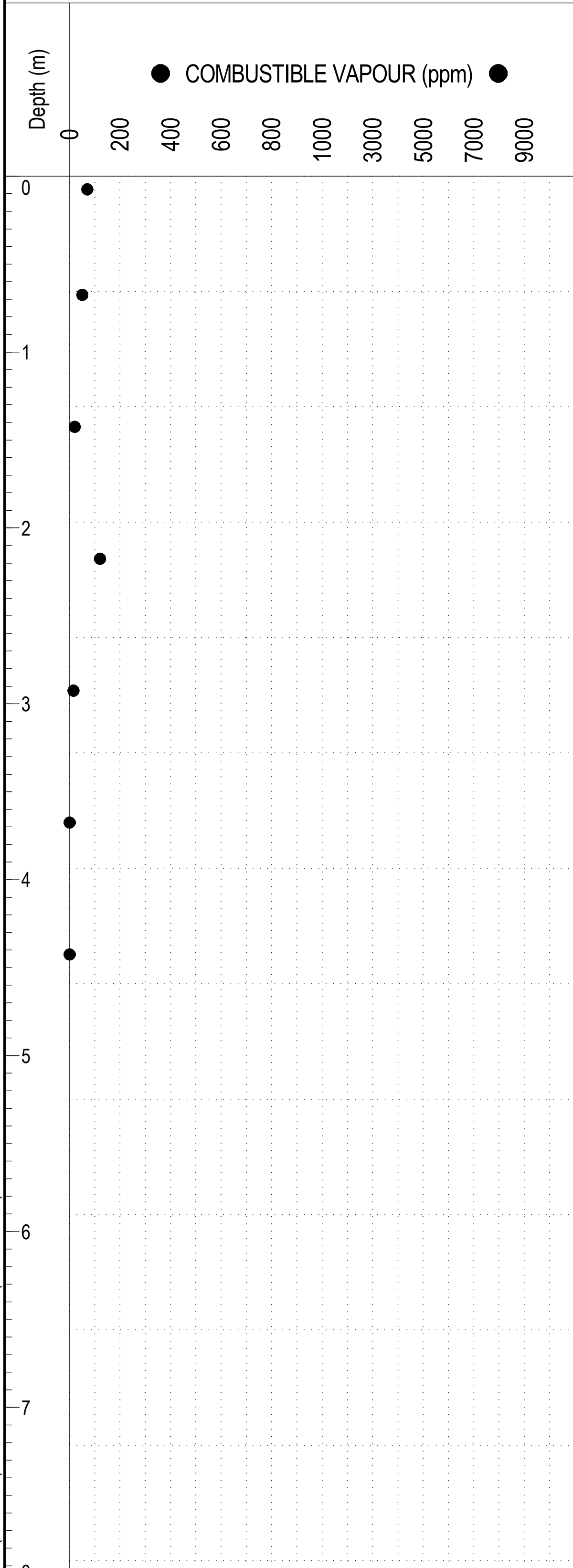
Depth (m)	SOIL SYMBOL	USCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	OTHER TESTS COMMENTS	Depth (m)
0		GW	GRAVEL, fill, random size gravel, some low plasticity clay, black, some random size sand, trace top soil, black to brown.	Grab Sample	1		
				Grab Sample	2		
1							1
				Grab Sample	3		
		CL	CLAY TILL, some silt, some fine grained sand, trace coarse grained sand, trace fine grained gravel, hard, damp, low plasticity, brown. SANDY, grey, random size sand below 2.3 m.				
2							2
				Grab Sample	4		
3				Grab Sample	5		3
				Grab Sample	6		
4							4
				Grab Sample	7		
5							5
6							6
7							7
8							

WX17562PRW.V4(28JAN15).GPJ 15/01/28 04:10 PM (CO-OP ENV)

AMEC Environment & Infrastructure	LOGGED BY: VR	COMPLETION DEPTH: 15 m
	REVIEWED BY: PW	COMPLETION DATE: 12 November 2014

PROJECT: Elk Point Drill Program	DRILLED BY: CP Drilling	TEST HOLE NO: **BH14-04**
CLIENT: City of Edmonton	DRILL RIG: Auger	PROJECT NO: WX17562PRW
LOCATION: Elk Point	DRILL TYPE: Solid Stem	ELEVATION:

SAMPLE TYPE	Shelby Tube	No Recovery	SPT Test (N)	Grab Sample	Split-Pen	Core
BACKFILL TYPE	Bentonite	Pea Gravel	Drill Cuttings	Grout	Bentonite Chips	Sand



Depth (m)	SOIL SYMBOL	USCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	OTHER TESTS COMMENTS
0			TOPSOIL, clayey, some silt, some random size sand, vegetation, black to brown, moist.	Grab Sample	1	
		CL	CLAY TILL, some silt, some random size sand, low plasticity, very stiff, damp, frozen, trace fine grained gravel, iron staining, mottled.	Grab Sample	2, 3, 4, 5	
3		SM	SILTY SAND, fine grained sand, trace coarse grained sand, compact, wet, brown.	Grab Sample	6, 7	

LOGGED BY: VR	COMPLETION DEPTH: 15 m
REVIEWED BY: PW	COMPLETION DATE: 12 November 2014

amec

AMEC Environment & Infrastructure

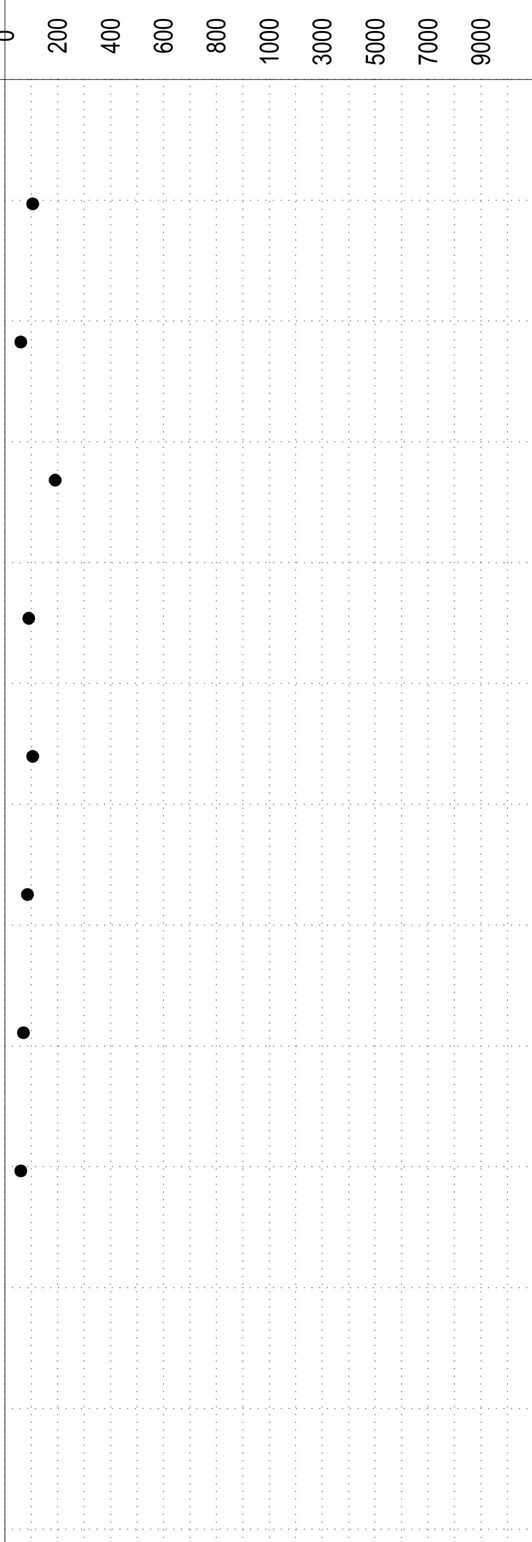
WX17562PRW.V4(28JAN15).GPJ 15/01/28 04:10 PM (CO-OP ENV)

PROJECT: Elk Point Drill Program	DRILLED BY: CP Drilling	TEST HOLE NO: **MW14-01**
CLIENT: City of Edmonton	DRILL RIG: Auger	PROJECT NO: WX17562PRW
LOCATION: Elk Point	DRILL TYPE: Solid Stem	ELEVATION:

SAMPLE TYPE	Shelby Tube	No Recovery	SPT Test (N)	Grab Sample	Split-Pen	Core
BACKFILL TYPE	Bentonite	Pea Gravel	Drill Cuttings	Grout	Bentonite Chips	Sand

Depth (m)

COMBUSTIBLE VAPOUR (ppm)



SOIL SYMBOL	USCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO
		ASPHALT, on surface	Grab Sample	1
	CL	CLAY FILL, silty, sandy, low plasticity clay, trace fine grained gravel, random size silt, hard, frozen, moist, brown to tan, iron staining.	Grab Sample	2
	CL	CLAY TILL, some silt, some random size sand, trace to some fine grained gravel, very stiff, low plasticity, brown, iron staining.	Grab Sample	3, 4, 5, 6
	SICL	SILT and CLAY, random size sand, some gravel, soft, moist to wet, tan.		
	SASI	SAND and SILT, saturated, random size sand, compact, light tan.	Grab Sample	7
	CL	CLAY TILL, some silt, some random size sand, trace fine grained gravel, low to medium plasticity, very stiff, grey.	Grab Sample	8, 9

Depth (m): 0, 1, 2, 3, 4, 5, 6, 7, 8

amec	LOGGED BY: VR	COMPLETION DEPTH: 20 m
AMEC Environment & Infrastructure	REVIEWED BY: PW	COMPLETION DATE: 12 November 2014

WX17562PRW.V4(28JAN15).GPJ 15/01/28 04:10 PM (CO-OP ENV)

PROJECT: Elk Point Drill Program	DRILLED BY: CP Drilling	TEST HOLE NO: **MW14-03**
CLIENT: City of Edmonton	DRILL RIG: Auger	PROJECT NO: WX17562PRW
LOCATION: Elk Point	DRILL TYPE: Solid Stem	ELEVATION:

SAMPLE TYPE: Shelby Tube, No Recovery, SPT Test (N), Grab Sample, Split-Pen, Core

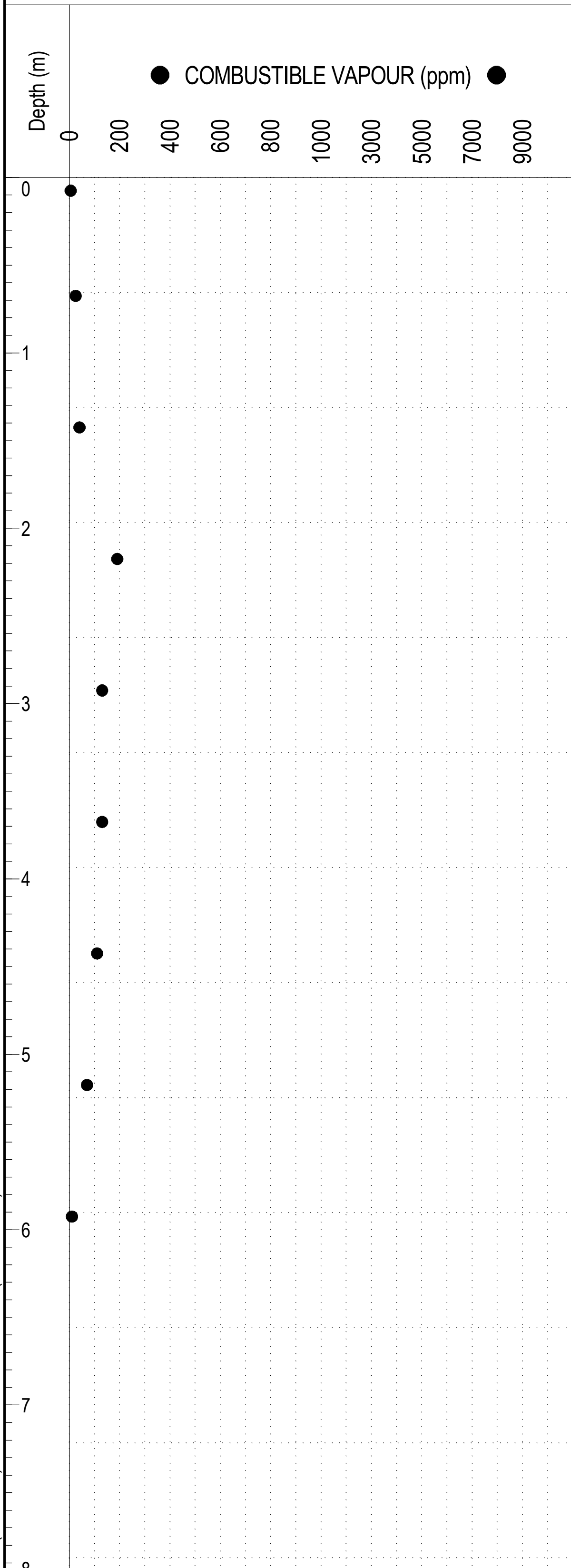
BACKFILL TYPE: Bentonite, Pea Gravel, Drill Cuttings, Grout, Bentonite Chips, Sand

USCS	SOIL DESCRIPTION	SAMPLE NO
CL	CLAY FILL, silty, sandy (random size sand), trace fine grained gravel, dark brown, frozen, moist, hard, low plasticity.	1
	TOPSOIL, soft, trace coarse grained sand, some silt, trace fine grained gravel, vegetation, moist, black.	2
CL	CLAY TILL, silty, sandy (fine grained), low plasticity, stiff, brown to tan, moist.	3
CI	CLAY TILL, some silt, some random size sand, trace fine grained gravel, low to medum plasticity, hard, moist, brown.	4, 5, 6
CI	CLAY TILL, some silt to silty, trace to some random size sand, trace fine grained gravel, low to medium plasticity, very stiff, grey.	7, 8, 9

AMEC Environment & Infrastructure	LOGGED BY: VR	COMPLETION DEPTH: 20 m
	REVIEWED BY: PW	COMPLETION DATE: 12 November 2014

PROJECT: Elk Point Drill Program	DRILLED BY: CP Drilling	TEST HOLE NO: **MW14-05**
CLIENT: City of Edmonton	DRILL RIG: Auger	PROJECT NO: WX17562PRW
LOCATION: Elk Point	DRILL TYPE: Solid Stem	ELEVATION:

SAMPLE TYPE	Shelby Tube	No Recovery	SPT Test (N)	Grab Sample	Split-Pen	Core
BACKFILL TYPE	Bentonite	Pea Gravel	Drill Cuttings	Grout	Bentonite Chips	Sand



SOIL SYMBOL	USCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO
		TOPSOIL, clayey, low plasticity clay, firm, some random size sand, trace fine grained gravel, black to brown, moist, vegetation and rootlets.	Grab Sample	1
	SM	SILTY SAND, random size sand, trace fine grained gravel, moist, compact, brown.	Grab Sample	2
	CL	CLAY TILL, low plasticity, had, sandy (random size), some silt, trace fine grained gravel, damp, brown, trace iron staining.	Grab Sample	3
	CL	INTERBEDDED CLAY TILL and SILTY SAND, clay till [low plasticity, hard, brown, moist, silty, some random size sand], silty sand [random size sand, wet, brown, silty, compact], average 20 centimeter thick bedding. ...wet below 2.5 m.	Grab Sample	4, 5
	CL	INTERBEDDED CLAY TILL and SILTY SAND, clay till [low plasticity, hard, grey, moist, silty, some random size sand], saturated sand [random size sand, wet, brown, silty, compact], average 20-30 centimeter thick bedding. INTERBEDDED SAND LENSES, coarse grained with fine grained sand, brown to grey, interbedded layers average 10 centimeters thick.	Grab Sample	6, 7, 8, 9

Depth (m): 0, 1, 2, 3, 4, 5, 6, 7

	LOGGED BY: VR	COMPLETION DEPTH: 20 m
amec — AMEC Environment & Infrastructure	REVIEWED BY: PW	COMPLETION DATE: 12 November 2014