Geotechnical Investigation Report

for

Highfield Land Management Inc.

Type of Document
Final

Project Name
Hawkwood Lands

Project Number
CGY-00092055-00

Prepared By: Melodie Tang, P.Eng.

Reviewed By: Joel Kliner, M.Sc., P.Eng.

exp Services Inc.
375, 7220 Fisher Street SE.
Calgary, AB. T2H 2H8
Canada

Date Submitted
11.18.16

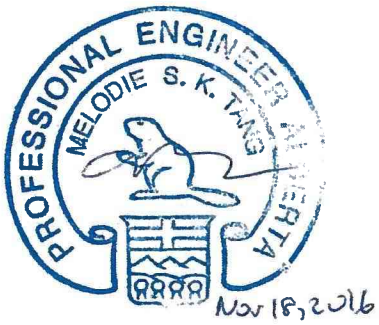
Geotechnical Investigation Report

Highfield Land Management Inc.

Type of Document:
Report

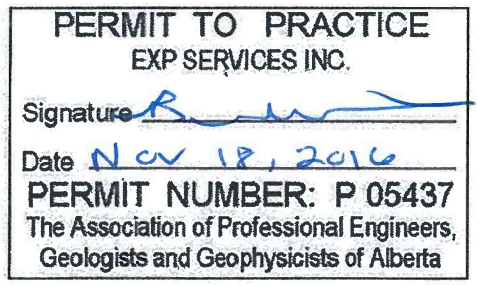
Project Number:
CGY-00092055-00

exp Services Inc.
375, 7220 Fisher Street SE.
Calgary, AB. T2H 2H8 Canada
T: +1.403.509.3030 www.exp.com



Prepared by:
Melodie Tang, P.Eng.
Geotechnical Engineer
Ph: 403.509.3030 ext.2288
melodie.tang@exp.com

Reviewed by:
Joel Kliner, M.Sc., P.Eng.
Senior Geotechnical Engineer
Ph. 403.509.3030 ext.2613
joel.kliner@exp.com



Date Submitted:
11.18.16

Legal Notification

This report is intended solely for Highfield Land Management Inc. and only for the issues addressed in the report. The material in this report represents the professional opinion of **exp** Services Inc. and its best judgment under the natural limitations imposed by the Scope of Work, in context of the information available to **exp** Services Inc. at the time of the report was prepared.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. **Exp** Services Inc. accepts no responsibility for damages of any kind, if any, suffered by a third party as a result of decisions made or actions taken on the basis of this report.

This report is limited in scope to only those elements that are specifically referenced in the report. There may be existing deficiencies in the project that were not apparent to us due to the limitations imposed by the scope of work. Therefore, **exp** can accept no liability for any costs or effects incurred by the Client for subsequent discovery, manifestation or rectification of such deficiencies.

Cost estimates, if any, provided in this report are approximations based in 2016 dollars, do not include engineering fees, and are the **exp** Services Inc. opinions of probable construction costs and quantities. These estimates do not reflect any unforeseen conditions that may require adjustments to work plans and scope when the work is done and the conditions are discovered. Any cost estimates provided are subject to confirmation or adjustment at the time competitive bids are obtained from contractors who specialize in the various items of work required. **Exp** Services Inc. makes no representation or warranty, express or implied, as to the accuracy or reliability of these cost estimates.

No part of this report may be extracted and used as a separate reference. The report has been written to be read in its entirety and for the exclusive use of the Client named.

Table of Contents

1.0 Introduction

As requested by Highfield Land Management Inc. (Highfield), **exp** Services Inc. (**exp**) has conducted a geotechnical assessment for the proposed Hawkwood Lands mixed-use development. The scope of work was outlined in the **exp** Proposal Ref. CGY-00092055-00, dated April 28, 2016. The geotechnical study is limited to the evaluation of the geotechnical characteristics of the site and does not include any environmental or chemical assessments of the soil and groundwater.

The following existing geotechnical information, as provided by the client (Highfield), was reviewed by **exp** and utilized as supplementary information for the proposed Hawkwood Lands mixed-use development:

- Report entitled "Geotechnical Evaluation, Hanewood Property Acquisition, M.D. of Rocky View, Alberta" dated August 15, 2007 prepared by McIntosh Lalani Engineering Ltd. (Reference No.: ML 3660).

This report presents the available subsurface exploration data and provides general geotechnical discussions and recommendations pertaining to the design and construction of the proposed development. An Interpretation & Use of Study and Report outlining the intended use and interpretation of this report is attached in ***Appendix A***. The Interpretation & Use of Study and Report forms an integral part of this report and should be included with any copies of the report.

2.0 Proposed Development

It is understood that the project site will be developed into a mixed use residential subdivision development with single and multi-family dwellings, as well as the potential for some small commercial retail structures and associated access roads.

The project will include the stripping and grading of the site, construction of the underground utilities, and construction of supporting roadways. This report serves to present the results of the field drilling program, laboratory soil testing and geotechnical design and construction recommendations for the general subdivision development.

Any commercial structures and some multifamily units (depending on the size) will require site specific geotechnical evaluations, once specific development design/locations are known.

3.0 Site Description

It is understood that the proposed site to be developed currently consists of 270 acres of land located in Rocky View County, AB within quarter sections SW 19-25-2-W5M and SE 19-25-2-W5M. The site is bound by Crowchild Trail and agricultural land to the north, 12 Mile Coulee Road (The City of Calgary boundary limits) and existing residential developments to the east, agricultural land to the west, and Township Road 253 to the south as shown on the Site Plan (***Figure 1*** in ***Appendix B***). The site is currently vacant farmland, with one farmstead located within the northeastern portion of the site. Topography of the site generally sloped from north to south and towards the natural drainage course at the centre of the site.

Based on review of surficial geology maps, the subsoil is expected to consist of Porcupine Hills formation sandstone and mudstone underlying silt and clay deposits, silt, sand and gravel deposits, and Spy Hill drift pebble loam till.

The site is understood to have a natural drainage course/coulee running north/south through the centre of the site, the slopes of which are anticipated to exceed fifteen percent. As per the City of Calgary Design Guidelines for Subdivision Servicing and Rocky View County Servicing Standards, a slope stability assessment for possible impacts on subdivision setbacks has been addressed in ***Section 6.0***.

4.0 Site Exploration Program

4.1 Field Exploration

The borehole drilling was carried out between October 17, 2016 and October 21, 2016. Prior to the fieldwork, the borehole locations were cleared of underground utilities by Alberta One-Call and a private locator. Twenty-nine (29) boreholes, denoted as BH16-01 through BH16-22 and MW16-01 through MW16-07 (completed as monitoring wells) were drilled at the approximate locations shown on the attached Borehole and Cross Section Location Plan (***Figure 2*** in ***Appendix B***). The boreholes were advanced to depths ranging from 4.0 m to 9.9 m below existing grade using a truck mounted drill rig equipped with 150 mm diameter solid stem augers owned and operated by Earth Drilling Co. Ltd. of Calgary, Alberta.

The subsurface soil conditions were continuously logged and visually classified in the field by **exp** personnel using the Modified Unified Soil Classification System. Soil stratigraphy was logged where changes in stratigraphy were noted, groundwater observed/encountered, and any other significant observations during borehole drilling and sample recovery. Representative soil samples were obtained at regular intervals from split spoon sampling and disturbed samples were collected from the auger flights for each soil stratum. Standard Penetration Tests (SPT's) were conducted at regular intervals to the maximum depth in each borehole. Pocket penetrometer tests were also performed at selected intervals on partially disturbed samples retrieved from the auger flights to determine an indication of the undrained shear strength of the cohesive soils.

Standpipe piezometers were installed in all boreholes in order to permit groundwater level monitoring. Seven (7) groundwater monitoring wells with 50 mm diameter standpipe were installed and constructed as per the recommendations of a hydrogeological consultant and as per the City of Calgary's LID Module 1 to assist in future hydrogeological studies.

The boreholes were backfilled to the surface grade elevation with drill cuttings and a bentonite chip seal as shown on the detailed borehole logs presented in ***Appendix C***.

4.2 Laboratory Testing

Laboratory testing was performed on selected samples, including:

- Natural moisture content determinations (158 tests);
- Atterberg Limits tests (12 tests);
- Hydrometer grain size tests on subsoil (12 tests) and hydrometer grain size analyses on topsoil (6 tests); and
- Water soluble sulphate (SO_4) content (8 tests).

The results of the laboratory testing are provided on the borehole logs in ***Appendix C*** and are discussed in the text of this report.

5.0 Subsurface Conditions

5.1 General

The subsurface strata and groundwater conditions encountered at each test location is described in detail on the borehole logs, with a more generalized description provided in this section for discussion purposes. The borehole logs are provided in ***Appendix C*** for reference.

The subsurface soil conditions encountered were generally found to consist of topsoil overlying lacustrine clay and/or clay till atop bedrock. A summary of the subsurface conditions observed at the borehole locations are presented in the following sections.

It should be noted that the soil boundaries indicated on the borehole logs are inferred from select sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change. The actual soil and groundwater conditions across the project site may vary between the boreholes.

It should be understood that geological conditions are naturally variable across any project site. Glacial tills are not typically homogenous and uniform across their stratigraphy. The geotechnical information within this report is based on the available subsurface information attained at the twenty-nine (29) discrete borehole and/or monitoring well locations. The precision of the subsurface conditions summarized depends on the methods used, frequency of sampling and the uniformity of the subsurface conditions. The spacing of the boreholes, frequency of soil sampling and the method of exploration have been selected to meet the needs of the project within constraints of the project plans, current exploration budget and schedule for geotechnical purposes. It is necessary to make some assumptions on the anticipated subsurface conditions across the project site between/surrounding the borehole locations to provide geotechnical recommendations for the proposed development. Adequate field reviews during construction should be undertaken to confirm that these assumptions are reasonably applicable for the specific development proposed.

5.2 Topsoil-Like Materials

Topsoil-like materials were encountered in all the boreholes, with thicknesses between 0.1 m to 0.6 m. The term “topsoil” in this report refers to a surficial soil layer with high organic content, and does not have any implications whatsoever as to the quality or suitability for re-use as a growing medium. The topsoil was generally described as having trace to some silt and sandy. The topsoil thicknesses have been determined at the borehole locations only. These thicknesses may not necessarily be representative across the project site as they may vary significantly between relatively widely spaced borehole locations. Additional shallow test locations would be needed to more accurately assess the topsoil thicknesses.

5.3 Clay Fill

Clay fill was encountered beneath the topsoil in BH16-07 with an approximate thickness of 1.6 m. The clay fill was generally described as silty, trace sand, damp to moist, low to medium plastic, and light brown in colour. A layer of buried topsoil was encountered below the clay fill at this borehole location.

5.4 Sand

Sand was encountered in BH16-20 below the topsoil layer to the termination depth of 6.6 m. The sand was described as silty, gravelly, occasional cobbles and boulders, dry to damp, fine grained, compact, and brown in colour.

5.5 Lacustrine Clay

Lacustrine clay was encountered beneath the topsoil in most boreholes with approximate thicknesses between 1.0 m to 7.0 m. The lacustrine clay was generally described as silty, trace sand, damp to moist, medium plastic (with high plastic clay identified in select boreholes), stiff to very stiff, and brown in colour.

5.6 Clay Till

Clay till was encountered beneath the topsoil or lacustrine clay in all boreholes. The clay till extended to depths between 2.7 m to greater than 9.6 m (where borehole termination depth was reached) below existing ground surface. The clay till was generally described as silty, trace sand, trace gravel, moist, low to medium plastic (with high plastic clay identified in select boreholes), stiff to very stiff, brown in colour, and contained traces of oxides and coal.

As per typical local till strata, sporadically distributed sand seams/pockets (potential source of perched/trapped groundwater) as well as cobbles and/or boulders may occur in the till soils; which were noted at specific borehole locations.

5.7 Bedrock

Sandstone or mudstone bedrock was encountered in boreholes BH16-3, BH16-5, BH16-6, BH16-8, BH16-9, BH16-14, BH16-15, BH16-17, BH16-18, and BH16-19. The depth to bedrock from existing ground surface ranged between 2.7 m to 7.9 m. The sandstone or mudstone bedrock encountered was generally described as extremely weak to very weak, highly to moderately weathered, dry, and light brown to grey in colour.

5.8 Groundwater

As discussed under ***Section 4.1*****,** standpipe piezometers were installed in all the boreholes in order to permit groundwater level monitoring. The groundwater level in each borehole was observed and recorded at the completion of drilling. As required for subdivision developments and as stated in the proposal, the groundwater levels will be monitored once a month over a six-month period. The standpipe piezometers were monitored on October 28, 2016.

Table 5-1 below presents a summary of our findings with respect to the groundwater levels encountered. In addition, the groundwater observations are presented on the borehole logs in ***Appendix C.***

TABLE 5-1: GROUNDWATER LEVELS, OCTOBER 28, 2016

Borehole Number	Groundwater Depth (below surface grade), m	
	@ Drilling Completion (October 17-21, 2016)	@ ≈ 1 Week after Drilling Completion (October 28, 2016)
BH16-01	Dry	Dry
BH16-02	Dry	Dry
BH16-03	Dry	Dry
BH16-04	Dry	Dry
BH16-05	Dry	8.95
BH16-06	Dry	Dry
BH16-07	Dry	Dry
BH16-08	Dry	Dry
BH16-09	Dry	7.86
BH16-10	Dry	4.95
BH16-11	9.45	8.64
BH16-12	Dry	6.22
BH16-14	Dry	5.10
BH16-15	Dry	5.32
BH16-16	Dry	Dry
BH16-17	Dry	Dry
BH16-18	Dry	Dry
BH16-19	Dry	5.90
BH16-20	Dry	Dry
BH16-21	Dry	Dry
BH16-22	6.55	6.64
MW16-01	Dry	Dry

Borehole Number	Groundwater Depth (below surface grade), m	
	@ Drilling Completion (October 17-21, 2016)	@ ≈ 1 Week after Drilling Completion (October 28, 2016)
MW16-02	9.45	3.5
MW16-03	1.22	2.20
MW16-04	3.05	1.54
MW16-05	4.88	4.64
MW16-06	Dry	Dry
MW16-07	Dry	4.85

It should be noted that the groundwater elevation varies with seasonal conditions including precipitation, surface drainage, localized hydrogeology and temperature (response to climatic conditions). Typically, groundwater conditions measured in late winter or early spring are often considered seasonal lows until the spring melt begins and localized groundwater response is affected. The long-term static groundwater table can fluctuate as much as 2.0 m over the course of one year in the general geographic area, with the peak groundwater levels generally occurring in June or July. Thus, groundwater levels should be measured periodically until the commencement of construction.

Based on the most recent groundwater depth readings as shallow as approximately 1.5 m across the project site, groundwater is anticipated to be encountered at shallow depths (< ≈ 4.0 m) associated with localized anticipated project site excavations for the proposed development. It is anticipated that a shallow groundwater table may pose some construction challenges during excavation and should be anticipated in localized areas. Permanent groundwater control/drainage should also be reviewed and provided as deemed necessary for the proposed development.

6.0 Slope Stability Analysis

Various global stability analyses for the existing elevation contours across the development site, corresponding to the representative cross-sections (as shown on ***Figure 3***, ***Figure 4*** and ***Figure 5***), were completed by **exp** utilizing the SLOPE/W software program. Six (6) representative cross-sections were created for review based on the geometry taken from the development/contour plans provided by **exp**'s Infrastructure division.

The results of the global stability analyses undertaken for the three most representative cross-sections are presented below and illustrated via the profiles associated with the SLOPE/W outputs as ***Figure 6***, ***Figure 7***, and ***Figure 8***.

Exp has not been provided any historic site-specific stripping and fill placement records across the project site; thus, it is assumed that the overall development site has not undergone any significant grading works over time. Proper site stripping and grading procedures should be undertaken to ensure that unsuitable organic or deleterious soils are not trapped at the base of any fill embankments that may be constructed. All general engineered fill soils for embankment fill should be compacted as per

Section 7.3. Fill placement for embankment fills should not be undertaken in a frozen state, as this could result is horizontal weak layer development within constructed fill embankments. Landscape slopes proposed across the development site should be limited to 5H:1V or flatter with proper drainage controls to prevent surficial erosion.

It is also recommended to consider methods such as notching the sideslopes of any cut slopes required prior to placing fill soils against a development cut slope. The notching with greatly improve bonding between the embankment fill and the underlying soil, reducing the risk of soil failure at the new/existing soil interface.

The global stability results refer to short-term stability during the initial stages of construction, which are generally considered to be the most critical case, due to pore pressure generation within overall development site grading, fill slope construction, and exposure of cut slopes prior to surficial vegetation taking root. The pore pressures will dissipate within the overall development site grading of fill slopes over the long-term and deep rooting of surface vegetation will protect against shallow surficial slumping/erosion, resulting in an improvement for the factor of safety against instability with the passage of time. The existing slopes are covered with mature vegetation; thus, these slopes, unless disturbed during development, have a strong surficial matting already intact for resistance to surficial erosion and sloughing.

The predominant soil strata utilized for SLOPE/W modelling was a silty clay surficial soil above a silty clay till overlying a highly weathered sandstone/mudstone bedrock (where encountered). The following soil parameters and groundwater conditions, which are interpreted to be reasonable and based on the most representative sections and existing slope conditions, have been assumed for the analysis as per ***Table 6-1*** below:

TABLE 6-1: SLOPE STABILITY PARAMETERS

SOIL TYPE	STRATA THICKNESS	UNIT WEIGHT (KN/M^3)	COHESION (KPA)	SOIL FRICTION ANGLE (^{O})
Stiff Silty Clay	≈3 m	18.0	1.0	26
Very Stiff Clay	≈9 m	19.0	2.0	28

Notes: An assumed piezometric line was applied at the bottom of the natural drainage course/coulee within the stiff and very stiff silty clay layers. Groundwater level readings on October 28, 2016 indicated the boreholes in the area were dry.

These analyses assumed that the existing elevation contours in the area of the natural drainage course/coulee site are not to be significantly altered via grading/lot development particulars and all development is carried out in accordance with the geotechnical recommendations contained in this letter report. As per the three specific analyses carried out, the following minimum global stability factors of safety (FoS) as shown in Table 6-2 were obtained for the existing elevation contours across the slopes, as well as for the assumed regulatory setback of 6.0 m:

TABLE 6-2: MINIMUM FACTOR OF SAFETY

SECTION	MINIMUM FOS	MINIMUM FOS (6M SETBACK)
B	1.309	1.517
C	1.857	1.989
D	1.399	1.757

A minimum global stability factor of safety greater than 1.5 for an assumed regulatory setback of 6.0 m was achieved for the most representative existing elevation contours and development configurations/profiles (typical lot development) analyzed, as illustrated in the SLOPE/W outputs as ***Figure 6***, ***Figure 7***, and ***Figure 8***.

As it is not recommended to develop right up to the crest of an existing slope with a gradient greater than 15%, especially those of significant vertical elevation difference, a development setback is recommended. An anticipated regulatory setback of 6.0 m was used in the slope stability analysis and was found to be acceptable with a minimum FOS of 1.5 or greater for all representative cross-sections. The slope crest can generally be defined as the transition of slope gradients from less than to steeper than 15%. The aforementioned minimum factors of safety will increase further upon adherence to the 6.0 m minimum development setback, as shown in ***Table 6-2***.

NOTE: Absolutely no development should be undertaken within the recommended 6.0 m minimum development setback (i.e.: building structures, cut/fill grading changes, retaining walls, etc.).

Exp has no geotechnical concerns with the proposed development of Hawkwood Lands from a slope stability perspective, provided that the recommendations of this report are implemented as development stages progress. Final overall cut/fill development plans should be reviewed by a qualified geotechnical engineer to determine if any additional slope stability concerns have arisen as a result of final development particulars such as proposed site grading (exposed cut slopes or proposed embankment fill slopes), individual lot development, roadway alignments, etc. (as these aspects were unknown at this stage of the development planning).

7.0 Discussions and Recommendations

7.1 Geotechnical Considerations

7.1.1 General

Based on the information obtained during our geotechnical explorations, the site soil and groundwater conditions are considered suitable for support of the proposed development, provided that the recommendations outlined within this report are adhered to. The following presents some geotechnical concerns that are based on the subsurface exploration.

7.1.2 Frost Susceptibility

The existing native lacustrine clay and clay till soils above the bedrock were noted to be silty in composition. Based on the laboratory results and our experience with similar silty clay soils, these soils are considered to be highly frost susceptible. Thus, a high potential for frost heave in the presence of water and freezing temperatures should be anticipated.

The measures provided in **Section 7.7** should be implemented to mitigate frost heave concerns for the proposed building structures. Any pavement designs will be aimed at providing commonly accepted levels of deflection for the design, and not for the purpose of fully mitigating the frost heave potential of the subgrade soils; therefore, there is some risk of heaving within the roadways and routine maintenance works may be required.

7.1.3 High Plastic Clay Soils

As high plastic clay soils were also identified sporadically across the project site from the limited Atterberg limits tests conducted, it is recommended to conduct verification testing of all bearing/subgrade soils at the time of construction to identify if high plastic clay soils have been encountered. Specific geotechnical recommendations may be required if high plastic clay soils are exposed in specific development areas.

7.1.4 Erodible Soils

As discussed under ***Section 7.1.2***, the existing native lacustrine clay and clay till soils above the bedrock were noted to have a high percentage of silt. Based on the laboratory results and our experience with similar silty clay soils, these materials are considered to be highly erodible.

7.1.5 Shallow Bedrock

As discussed under ***Section 5.7***, relatively shallow bedrock was encountered within the proposed development site in localized areas during the subsurface exploration. The depth to bedrock from existing ground surface ranged between 2.7 m (BH16-8 and BH16-19) to 7.9 m (BH16-14), where encountered. The shallow bedrock may be more difficult to excavate and may be encountered during deep utility installation within localized areas. Further discussion on construction issues due to the shallow bedrock is provided in ***Section 7.4*** of this report.

7.2 Site Preparation and Grading

Prior to placing any fill materials, the surface topsoil-like layer and any existing organic-rich soil, uncontrolled fill, soft or water softened soil should be removed from areas to be filled. Qualified geotechnical personnel should then review the subgrade prior to fill placement.

A minimum 50 mm depth of scarification is recommended in areas subject to additional fill placement (prior to fill placement) once initial stripping of deleterious materials has been undertaken. The depth of scarification should be moisture conditioned in the same manner as required for the subsequent fill

All fill soil placement should adhere to the Backfill and Compaction Specification report section. Organic soils should not be buried or mixed with general engineered or structural fill soils within the proposed building footprints, as this may lead to undesirable fill settlements or methane generation. Organic soils could be used for general landscape areas and it is recommended they be compacted with a reasonable amount of effort. Their value as a growing medium would need to be evaluated by others. High plastic clay soils are not recommended to be placed within 2.0 m laterally of any below grade foundation walls. Full-time monitoring and compaction testing during fill placement is recommended for subgrade construction by a qualified geotechnical engineer or technician independent of the contractor.

For areas requiring structural support, the fill materials for the grading works should consist of either structural fill or general engineered fill as defined in ***Section 7.3***. For all areas requiring structural support (building and road areas) in proposed fill areas, it is recommended that the exposed subgrade be graded to a 5H:1V gradient or flatter to mitigate differential settlements that may occur under any

key structures. Fill should not be placed on frozen subgrades and fill subgrade surfaces should not be allowed to freeze prior to placing subsequent lifts of fill. It is recommended that winter grading activities should be avoided.

Care should be taken to moisture condition, compact and document all grading activates. Deep fill assessments are recommended for all areas receiving 2.0m depth or more of fill.

7.3 Backfill Materials and Compaction

It is understood that some site grading may be required for the proposed development. The existing subsurface soils across the project site comprising the surficial silty clay (existing fill and native soils) within the upper approximate 4.0 m are suitable for use as general engineered fill on a limited basis. These soils, specifically the medium to high plastic clay soils, are considered to be highly frost susceptible and should not be used in areas exposed to frost penetration where subsequent frost heave is undesirable from a serviceability perspective. As well, areas prone to performance issues as a result of shrinkage or swelling potential of the medium to high plastic clay soils (e.g.: directly adjacent to below grade foundation walls, etc.) should also be avoided. Further verification testing is recommended during construction to identify if high plastic clay soils have been encountered. The proposed engineered fill soils for each specific construction aspect should be reviewed by the geotechnical engineer of record for the project site.

Moisture conditioning of the proposed backfill soils may be required prior to placement to achieve proper compaction results. The excavated site soils may be too wet or too dry at the time of construction; thus, moisture conditioning should be anticipated and carried out in a uniform manner to achieve a suitable moisture content range for the backfill soils during compaction.

All general engineered fill soils (cohesive or granular soils) are recommended to be compacted at a minimum Standard Proctor Maximum Dry Density (SPMDD) of 98% in maximum compacted lift thicknesses of 200 mm. All structural fill soils (well-graded granular soils with fines content generally less than 10% only) are recommended to be compacted at a minimum Standard Proctor Maximum Dry Density (SPMDD) of 100% in maximum compacted lift thicknesses of 200 mm. The site-specific excavated soils proposed for general engineered fill usage comprise of silty clay cohesive soils. Cohesive soils (silts, clays) should be uniformly moisture conditioned between the optimum moisture content (OMC) and 3% above the OMC prior to or during placement for compaction. Granular soils (sands, gravels) should be uniformly moisture conditioned between 3% below the OMC and 3% above the OMC prior to or during placement for compaction.

Structural fill may be required in special situations and should be used as directed by the geotechnical engineer. Structural fill can generally provide a higher bearing capacity than engineered fill and would be less settlement sensitive, and for example, may be desirable under building areas.

Where washing of fines is possible, fill material placed should be separated from coarser or finer backfill (comprising cohesive soils) material by a suitable geotextile.

Topsoil and soils containing organic manner or contamination should not be buried, mixed into, or used as general engineered fill soils. These soils should only be used as landscape fill soils due to their potential for methane generation and/or post-construction settlement potential. As well, all deleterious materials, contaminated soils (if encountered), and construction debris shall be removed prior to placement as a landscape fill soil.

The use of excavated bedrock soils as engineered fill soils is not recommended as these soils are prone to degradation over time and may exhibit large differential settlements. These soils may be utilized as landscape fill.

It should be recognized that it is difficult to compact soils during the winter unless the fill soils are placed and compacted in an unfrozen condition and the working area is prevented from freezing. Therefore, it should generally be avoided if at all practical. Any frost penetration that may have occurred should be thawed, scarified, and recompacted prior to fill placement. Fill soils should be free of any snow or ice lenses, should not be placed on a frozen or snow covered subgrade, and not be allowed to freeze following placement.

7.4 Construction Excavation and Temporary Dewatering

The composition and consistencies of the surficial soils at the site are such that conventional hydraulic excavators should be able to excavate the surficial soils. Though the bedrock has been classified as "extremely to very weak" from a geotechnical perspective, when excavations encounter bedrock, pneumatic rock breakers or ripper teeth may be required to break the stronger sandstone/ mudstone bedrock layers and possible hard inclusions.

Temporary excavations (durations of less than 2 months) will be required for utility trenches and footing or pile cap preparation. The excavations for this project site are anticipated to be primarily within the existing clay soils in the upper 3.0 m to 5.0 m. Conventional construction equipment (i.e.: hydraulic excavators, hydrovac, etc.) should be able to remove these subsurface soils without difficulty.

For the typical excavations anticipated at the site, short-term trench and excavation sideslopes through the clay soils may be cut back at sideslopes no steeper than 1H (Horizontal):1V (Vertical) to a maximum depth of 5.0 m. Vertical sideslopes must not exceed 1.5 m in height for shallow excavations where sloping of the sideslopes are not feasible due to space restrictions (vertical sideslopes should not be facilitated if groundwater seepage is encountered). Flatter slopes up to 2H:1V or flatter will be required where sand layers, soft and wet/saturated soils, or poor quality fill are encountered (i.e.: groundwater and soil instability are anticipated within a depth of approximately 1.5 m from the existing site grades in localized areas). The stability of excavated trench walls decrease with time; therefore, it is best to minimize the length of time that service trenches are left open. The applicable sections in the Occupational Health and Safety Act must be adhered to.

Deep excavations may encounter groundwater infiltration and require dewatering. Any groundwater seepage or surficial water influx encountered in the temporary excavations should be handled with a conventional sump pump application consisting of a system of ditches or perimeter trenches leading to sump pits (low points) with pumps to dewater the excavations.

Prior to allowing workers to enter the construction excavations, a thorough inspection should be undertaken for evidence of instability (cracks, bulging, sloughing, seepage, etc). Any loose/unstable soils or cobbles/boulders should be scaled from the excavations prior to worker entry. All unsupported excavations should be monitored on a daily basis for slope movements such as slumping, bulging, etc. Any such movements should be reported to **exp** and remedial stability measures undertaken immediately.

Stockpiles of construction materials, excavated soil, construction equipment, or traffic should be kept away from the slope crest/edge by a distance equal to the depth of excavation. The vibration created from heavy machinery operations or compaction processes can destabilize a slope; hence, use of heavy machinery within close proximity to excavated slopes should be minimized.

Temporary shoring design will be required for worker safety if the aforementioned safe excavation geometry cannot be facilitated (i.e.: due to proximity of adjacent property lines) or deeper excavations are required for construction aspects. **Exp** can provide these services as additional scope items, if requested.

7.5 Pipe Support

No difficulties are generally anticipated with regard to the pipe support; however, there could be some localized soft subgrade that may require some improvements for consistent pipe foundation support. Conventional methods for pipe support are considered feasible. Due to the presence of silty clay soils across the project site, **exp** recommends the use of compacted clay plugs at regular intervals. In addition, weep holes to direct groundwater into storm manholes should be used in these silty clay soils as per the City of Calgary detail (Sheet 59, file number 452.1005.006 entitled *Clay Plugs and Weeping Holes at Storm Manholes)*. This is to prevent erosion of the silts/clays and possible future subsidence due to loss of fine grained soils into the 40 mm washed drainage gravel. **Exp** should be notified during construction to provide on-site recommendations for the frequency of the clay plugs in the pipe zone.

7.6 Weeping Tile

Exp recommends subsurface weeping tile be installed for all below grade structures. The subsurface weeping tile should consist of minimum 100 mm diameter perforated PVC pipe and should be embedded in City of Calgary 40 mm diameter washed drainage gravel wrapped with a suitable filter fabric. The weeping tile should drain to a storm sewer or sump pump to overland drainage, subject to the approval of Rocky View County (the County).

7.7 Foundations

Based on the results of the geotechnical exploration, conventional strip and spread footings may be used for residential house structures within this development. It is anticipated that a factored geotechnical bearing resistance of 100 kPa should be attainable across the project site for the proposed residential structures.

Bearing certificates should be prepared by a qualified geotechnical engineer for all footings placed on fill or native soil. The surficial silty clay soils within the proposed development site may require some over-excavation (if soft saturated soils are encountered) and replacement with structural fill or engineered fill soils, to prepare adequate bearings surfaces.

All shallow foundation elements should be constructed on the undisturbed very stiff native clay till soils. Any pockets of existing fill soils, soft/wet/disturbed soils, or otherwise unsuitable bearing soils exposed at the foundation depth shall be subexcavated to acceptable bearing conditions and replaced with compacted structural fill (well-graded granular soils as per the Backfill and Compaction Specifications section of this report). The structural fill should extend laterally beyond the foundation footprint equal to the depth of subexcavation required. Alternately, the footings may be stepped down or the subexcavated depth below the proposed footing elevation may be backfilled with a low strength leancrete concrete.

Open excavations should be protected from any influx of precipitation from harsh weather and/or poor site grading prior to structural fill placement, concrete/leancrete placement, and/or backfill placement adjacent to the footings (i.e.: positive site grading away from open footing excavations and temporary covers are simple methods to consider prior to complete footing construction and backfill placement around the footings up to site grades, localized ditches and sumps to direct water away from footing

layouts, etc.). The exposed footing excavations should not be allowed to dry excessively or freeze prior to footing construction and cover fill placement up to final site grades. As well, it is not recommended to allow influx/accumulation of water adjacent to footings post-structural fill or concrete placement. Any standing water on the exposed bearing surfaces should be removed immediately. Additional bearing observations may be required if footing construction and structural fill and/or post-concrete placement is delayed and inclement weather arises or if the exposed bearing soils are prone to heavy disturbance during footing construction. It is recommended to protect the exposed bearing subgrades with an approximately 50 mm thick mudslab (leancrete concrete) after bearing observations have been conducted, if the foundation elements are not promptly constructed after excavation or unfavorable exposure conditions are anticipated.

Footings within heated structures should be founded at a depth of 1.4 m below grade and for unheated structures at a depth of 2.1 m below grade to protect against the effects of frost heaving. Appropriately designed ridged styrofoam insulation can be considered to reduce footing embedment depth. Exterior foundations such as deck footings and wing walls require 2.1 m of soil cover or equivalent insulation for frost protection.

Final grades around all permanent structures should be graded away from the foundation walls at a minimum 2 percent gradient. Downspout extensions should be used to direct roof water sufficiently away from the foundation walls.

7.8 Seismic Class

The seismic response of the site is classified according to the National Building Code of Canada 2010 (NBCC), which categorizes the soil conditions into six types - Class ‘A’ to ‘F’. This classification is based on the average shear wave velocity, energy-corrected SPT N values, or undrained shear strength over the top 30 m of the soil profile.

The site may be categorized as Class ‘D’ according to the NBCC 2010. Shear wave velocity data was not obtained from this site, and borings were not advanced to 30 m depth. Thus, the seismic classification is based on the SPT ‘N’ values within the depths drilled at the site, as well as on the assumption that the soil strength below the borehole termination depths is at least equivalent or greater.

7.9 Concrete Type

Eight (8) soil samples were selected at various depths for soluble sulphate testing to determine the water-soluble sulphate content of the subsurface soils. These tests yielded negligible to moderate degree of sulphate exposure. Therefore, it is recommended that the Canadian Standards Association (CSA) requirement of A23.1-09, **Table 2**, for Class S-3 exposure is adhered to as a minimum concrete specification. All concrete in contact with soils at this site can be made from CSA Type HS or HSb (Sulphate Resistant) Portland cement possessing a minimum compressive strength of 30 MPa at 56 days, a maximum water/cement ratio of 0.50, and air entrainment of 4-7% for concrete with nominal maximum coarse aggregate sizes of 14-20 mm. The structural engineer should make an independent determination of concrete specification requirements based on specific design function.

Any imported fill to be placed in contact with concrete should also be tested for water-soluble sulphate content and the above recommendations reevaluated.

7.10 Further Work and Geotechnical Review

Design recommendations presented in this report are based on the assumption that an adequate level of field reviews and testing will be provided during construction and that construction will be carried out

by a suitably qualified contractor experienced in underground utility installation and earthworks. An adequate level of field review is considered to be:

- For earthworks related to building pads, roads and paved areas - full time monitoring and compaction testing.
- For underground utility installation and backfilling - full time monitoring and compaction testing.

All geotechnical field reviews and testing should be carried out by a qualified geotechnical engineer or technician independent of the contractor. The purpose of providing an adequate level of field reviews is to check that recommendations, based on the data obtained at discrete borehole locations, are relevant to other areas of the site and confirm that the project requirements are adhered to.

8.0 Closure

Recommendations presented herein are based on a geotechnical evaluation of the findings at the five boreholes advanced at the site. If conditions other than those reported are noted during subsequent phases of the project, **exp** should be notified and given the opportunity to review the current recommendations in light of any new findings.

Soil conditions, by their nature, can be highly variable across a site. Recommendations presented herein may not be valid if an adequate level of field reviews and testing is not provided during construction, or if relevant building code requirements are not met.

A contingency amount 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 construction procedures. Contractors should make their own assessment of subsurface conditions and select the construction means and methods most appropriate to the site conditions. This geotechnical report should not be included in contract specifications without suitable qualifications and prior review by **exp**. However, the geotechnical report may be used as an attachment to contract specifications, for information purposes only.

This report has been prepared for the exclusive use of Highfield Land Management Inc. and their agents for specified application of this project. It has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

Appendix A –
Interpretation and Use of Study & Report

INTERPRETATION & USE OF STUDY AND REPORT

1. STANDARD OF CARE

This study and Report have been prepared in accordance with generally accepted engineering consulting practices in this area. No other warranty, expressed or implied, is made. Engineering studies and reports do not include environmental consulting unless specifically stated in the engineering report.

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 us by the Client, communications between us and the Client, and to any other reports, writings, proposals or documents prepared by us for the Client relative to the specific site described herein, all of which 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. WE CANNOT BE RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF THE REPORT

The Report has been prepared for the specific site, development, building, design or building assessment objectives and purpose that were described to us by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the document are only valid to the extent that there has been no material alteration to or variation from any of the said descriptions provided to us unless we are 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 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 OUR WRITTEN CONSENT. WE WILL CONSENT TO ANY REASONABLE REQUEST BY THE CLIENT TO APPROVE THE USE OF THIS REPORT BY OTHER PARTIES AS “APPROVED USERS”. The contents of the Report remain our copyright property and we authorise only the Client and Approved Users to make copies of the Report only in such quantities as are reasonably necessary for the use of the Report by those parties. The Client and Approved Users may not give, lend, sell or otherwise make the Report, or any portion thereof, available to any party without our written permission. Any use which a third party makes of the Report, or any portion of the Report, are the sole responsibility of such third parties. We accept no responsibility for damages suffered by any third party resulting from unauthorised use of the Report.

5. INTERPRETATION OF THE REPORT

a. Nature and Exactness of Descriptions: Classification and identification of soils, rocks, geological units, contaminant materials, building envelopment assessments, and engineering estimates 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 and even comprehensive sampling and testing programs, implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations, or building envelope descriptions, utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarising 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 all persons making use of such documents or records should be aware of, and accept, this risk. 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. Where 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 us. We have relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, we cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the report as a result of misstatements, omissions, misrepresentations or fraudulent acts of persons providing information.

c. To avoid misunderstandings, **exp** Services Inc. (**exp**) should be retained to work with the other design professionals to explain relevant engineering findings and to review their plans, drawings, and specifications relative to engineering issues pertaining to consulting services provided by **exp**. Further, **exp** should be retained to provide field reviews during the construction, consistent with building codes guidelines and generally accepted practices. Where applicable, the field services recommended for the project are the minimum necessary to ascertain that the Contractor’s work is being carried out in general conformity with **exp**’s recommendations. Any reduction from the level of services normally recommended will result in **exp** providing qualified opinions regarding adequacy of the work.

6.0 ALTERNATE REPORT FORMAT

When **exp** submits both electronic file and hard copies of reports, drawings and other documents and deliverables (**exp**’s instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by **exp** shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancy, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by **exp** shall be deemed to be the overall original for the Project.

The Client agrees that both electronic file and hard copy versions of **exp**’s instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except **exp**. The Client warrants that **exp**’s instruments of professional service will be used only and exactly as submitted by **exp**.

The Client recognizes and agrees that electronic files submitted by **exp** have been prepared and submitted using specific software and hardware systems. **Exp** makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

Appendix B – Figures

LEGEND:

- CITY LIMITS BOUNDARY LINE
- HAWKWOOD LANDS

PROJECT NAME:

HAWKWOOD LANDS

DATE: **2016.08.25**

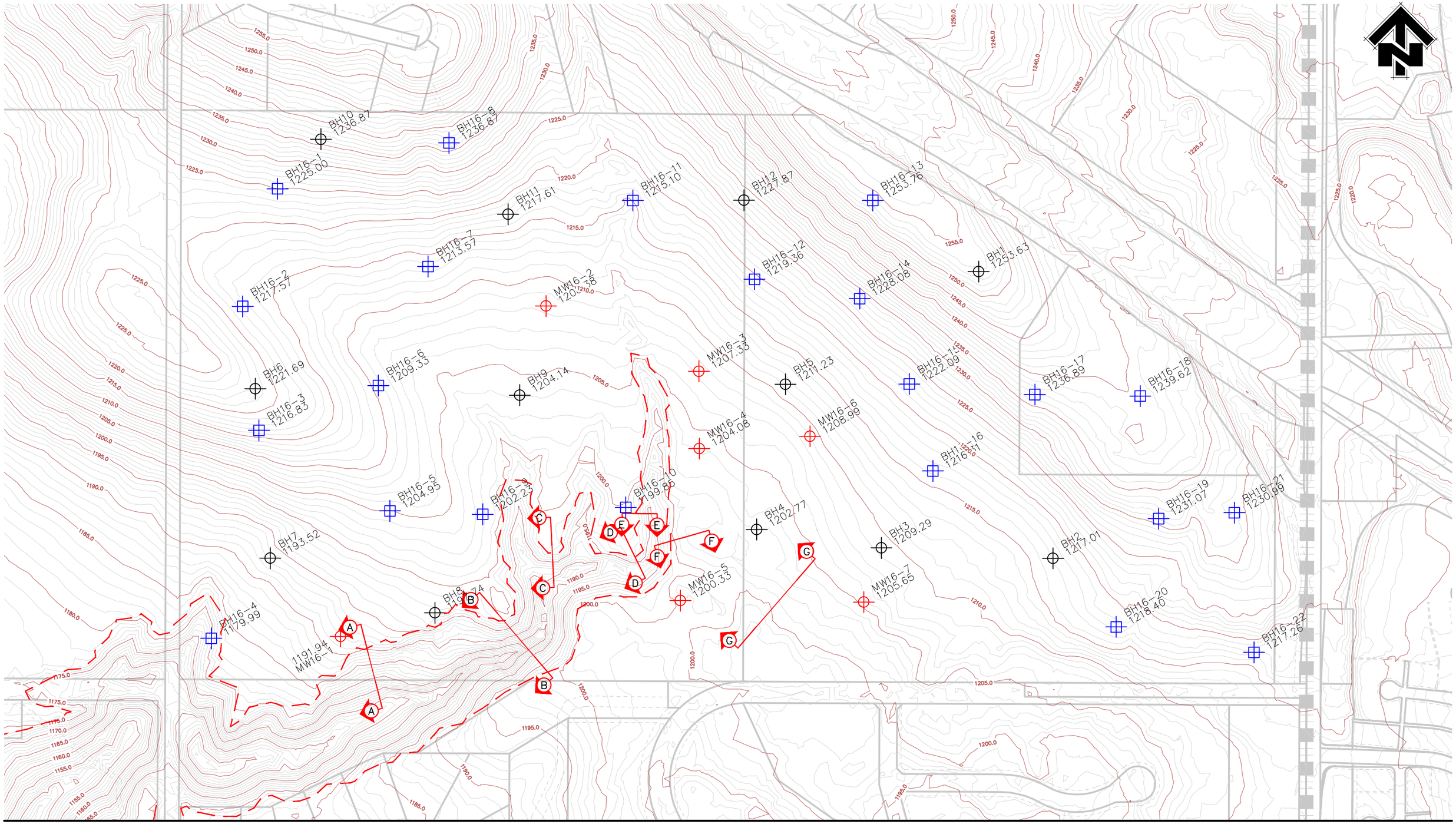
SCALE: **NTS**

TITLE:

SITE LOCATION PLAN

FIGURE NO.:

01



LEGEND:

- BH8 1197.741 — EXISTING MCINTOSH LALANI TEST HOLE (AUGUST 2007)
- EXP GEOTECHNICAL TEST HOLE
- EXP MONITORING WELL
- CREST OF SLOPE (20%)

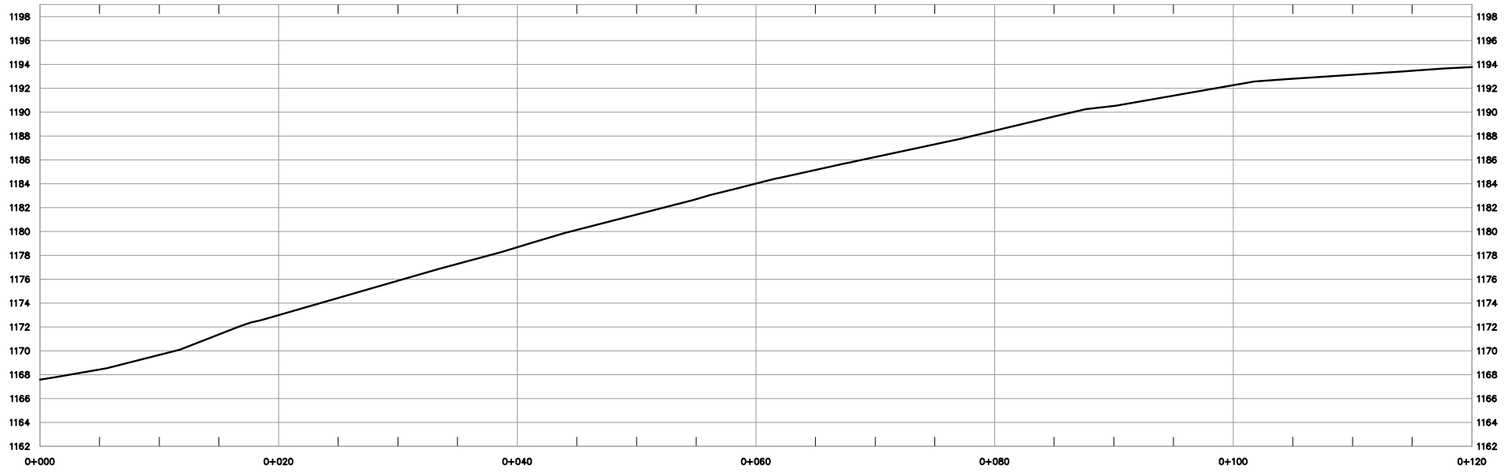
PROJECT NAME:
HAWKWOOD LANDS

PROJECT NO.: **CGY-00092055-00** DATE: **2016.11.15** SCALE: **1:5000**

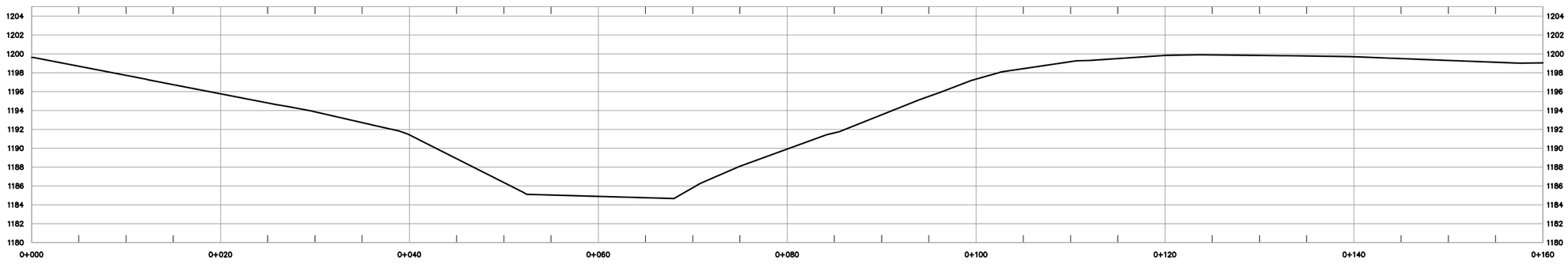
TITLE:
BOREHOLE & CROSS SECTION LOCATION PLAN

FIGURE NO.:
02

Section A



Section B



LEGEND:

ORIGINAL GROUND

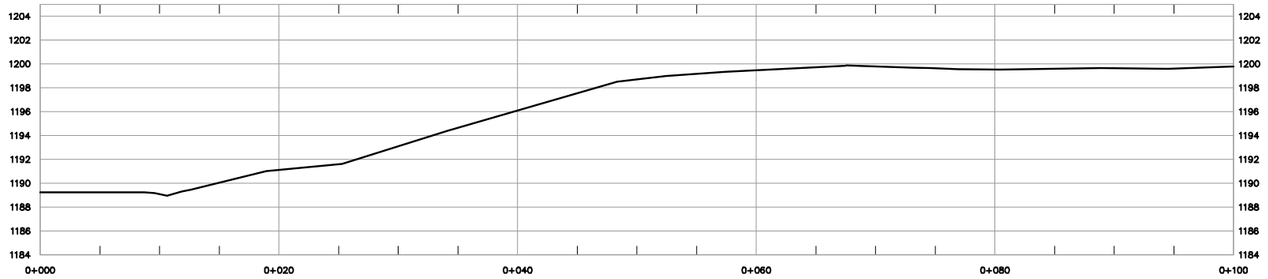
PROJECT NAME:
HAWKWOOD LANDS

PROJECT NO.: **CGY-00092055-00** DATE: **2016.11.15** SCALE: **1:500**

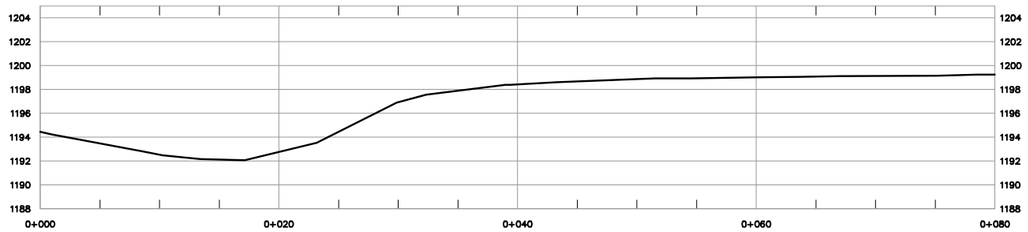
TITLE:
CROSS SECTIONS (A and B)

FIGURE NO.:
03

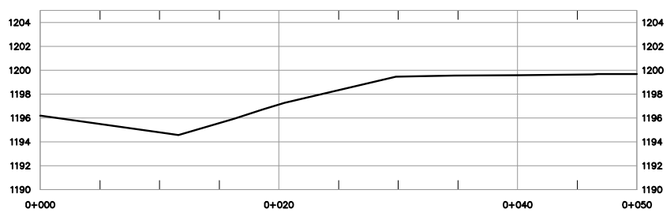
Section C



Section D



Section E



LEGEND:

ORIGINAL GROUND

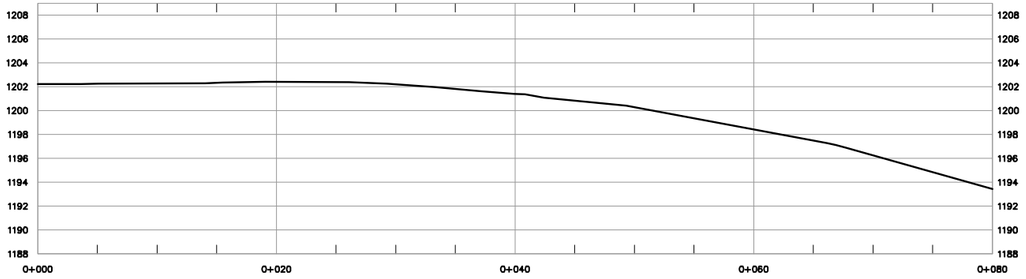
PROJECT NAME:
HAWKWOOD LANDS

PROJECT NO.: **CGY-00092055-00** DATE: **2016.11.15** SCALE: **1:500**

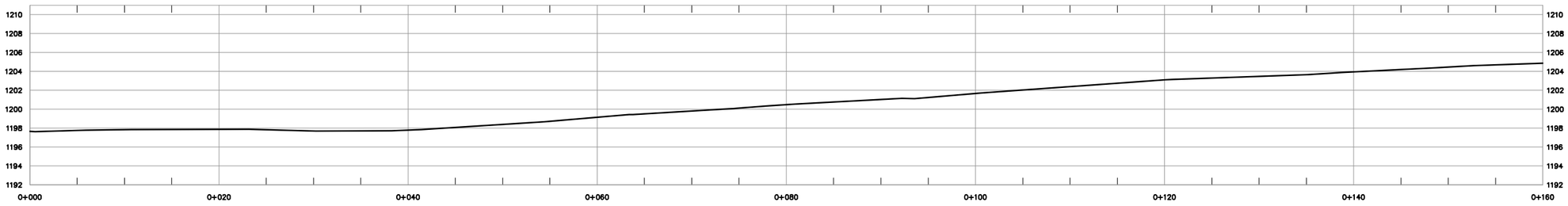
TITLE:
CROSS SECTIONS (C, D, and E)

FIGURE NO.:
04

Section F



Section G



LEGEND:

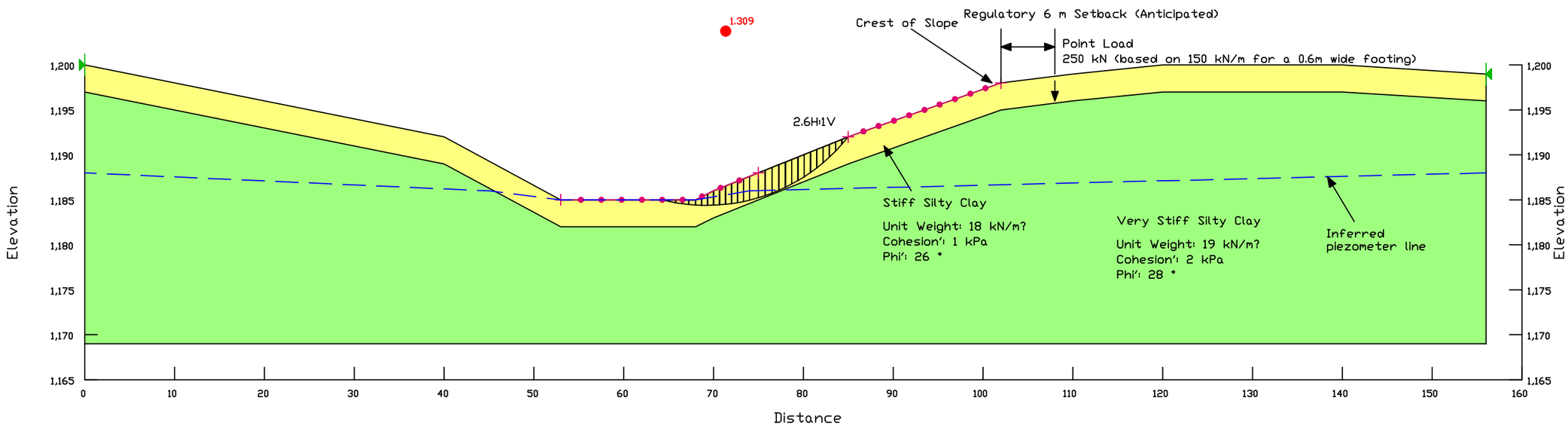
ORIGINAL GROUND

PROJECT NAME:
HAWKWOOD LANDS

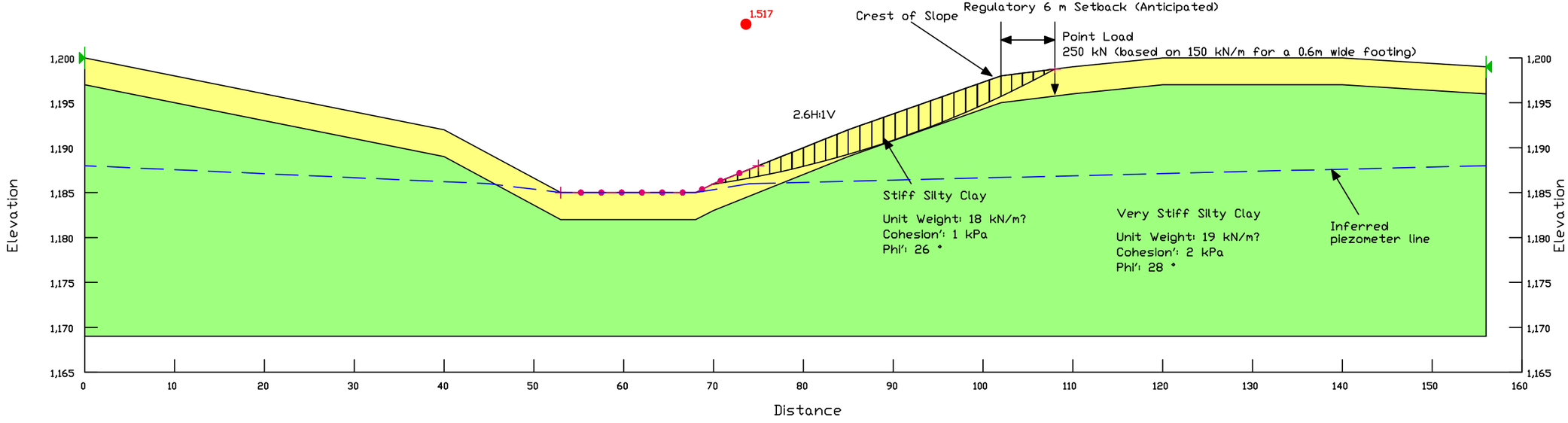
PROJECT NO.: **CGY-00092055-00** DATE: **2016.11.15** SCALE: **1:500**

TITLE:
CROSS SECTIONS (F and G)

FIGURE NO.:
05



SECTION B
SLOPE STABILITY ANALYSIS



SECTION B
(FORCED SLIP SURFACE AT 6m SETBACK)
SLOPE STABILITY ANALYSIS

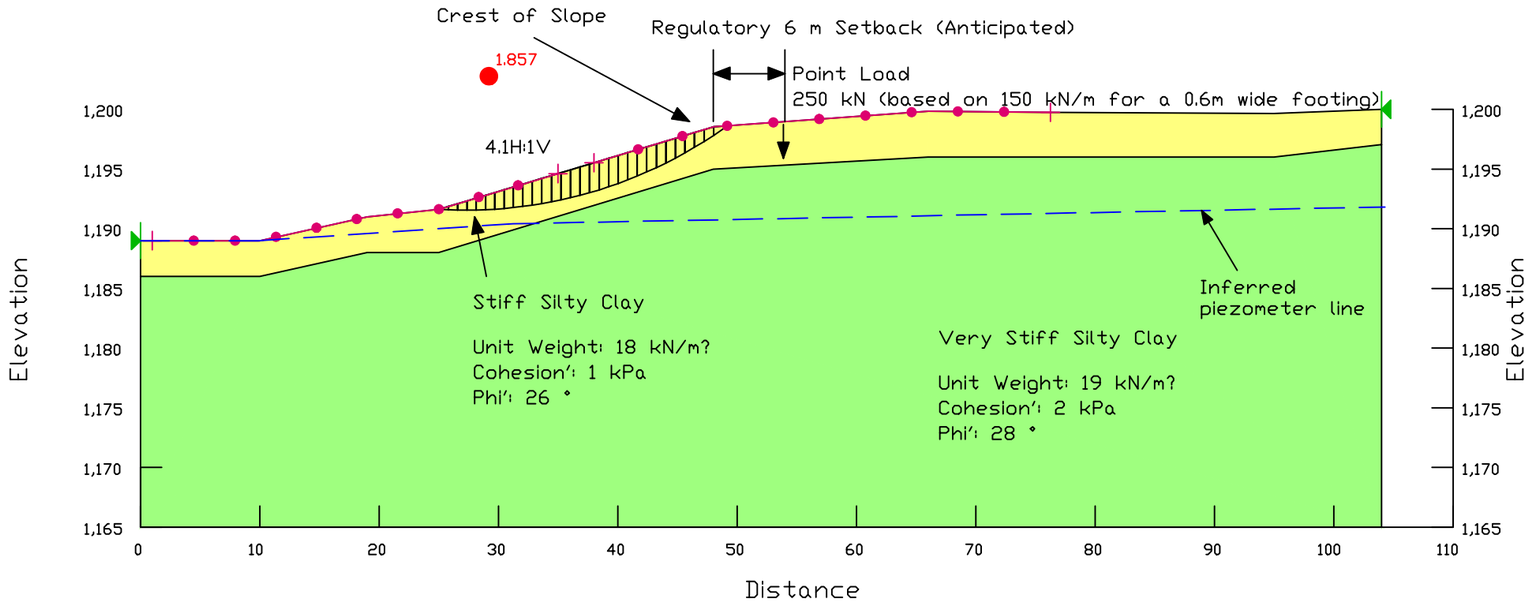
exp.

PROJECT NAME:
HAWKWOOD LANDS

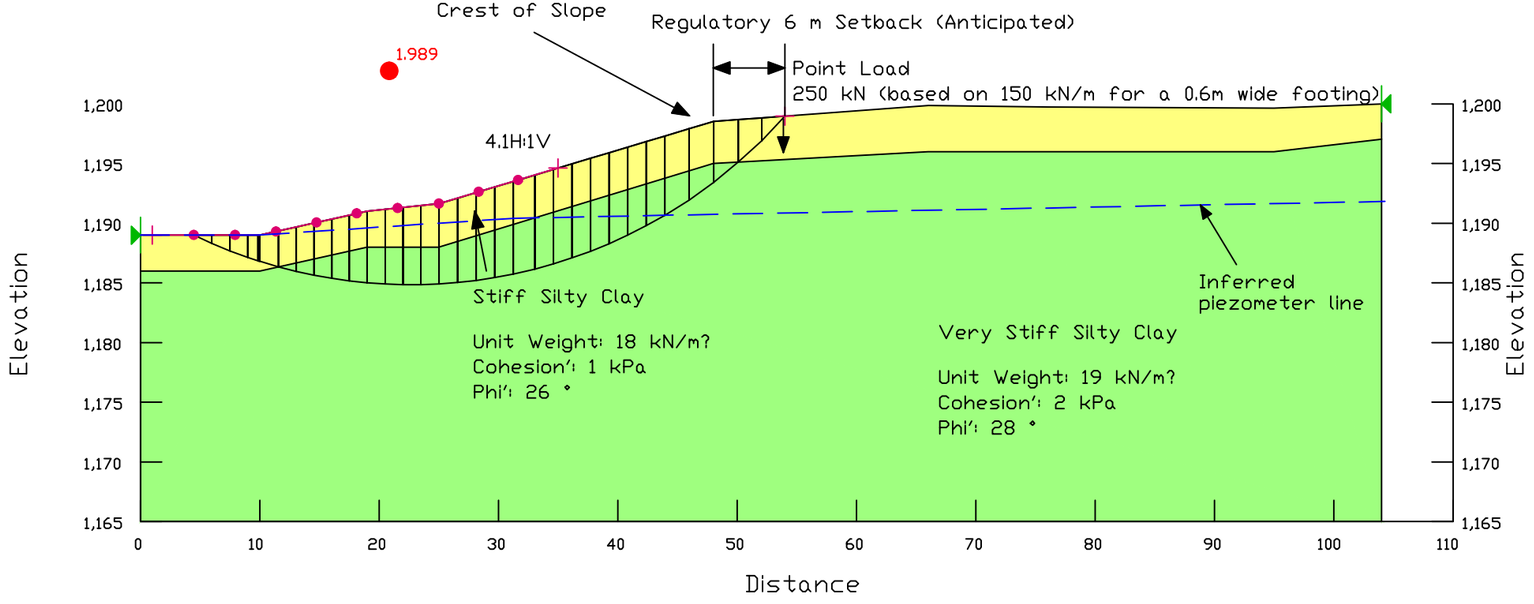
PROJECT NO.: **CGY-00092055-00** DATE: **2016.11.15** SCALE: **1:500**

TITLE:
EXISTING GROUND
SLOPE STABILITY SECTION B

FIGURE NO.:
06



SECTION C
SLOPE STABILITY ANALYSIS



SECTION C
(FORCED SLIP SURFACE AT 6m SETBACK)
SLOPE STABILITY ANALYSIS

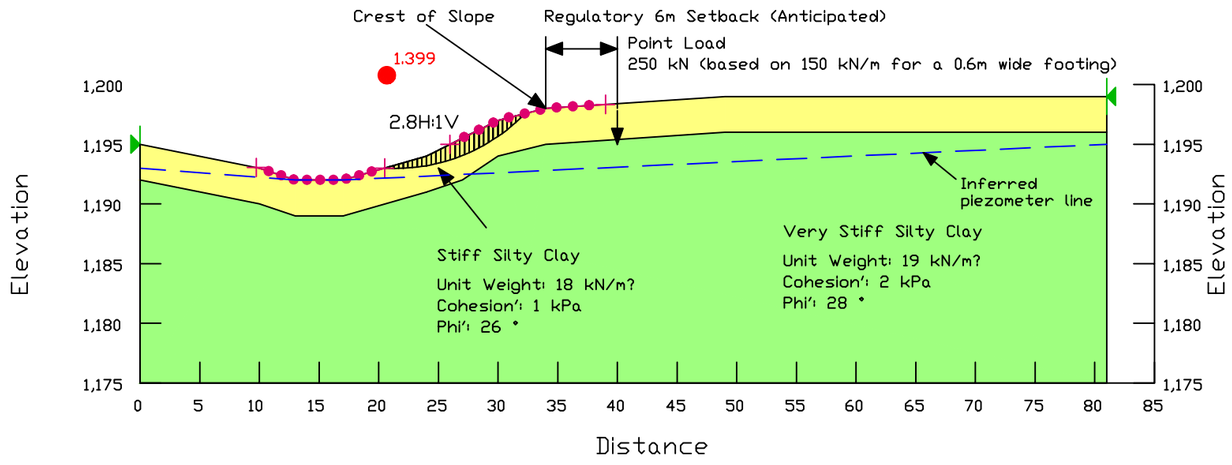
exp.

PROJECT NAME:
HAWKWOOD LANDS

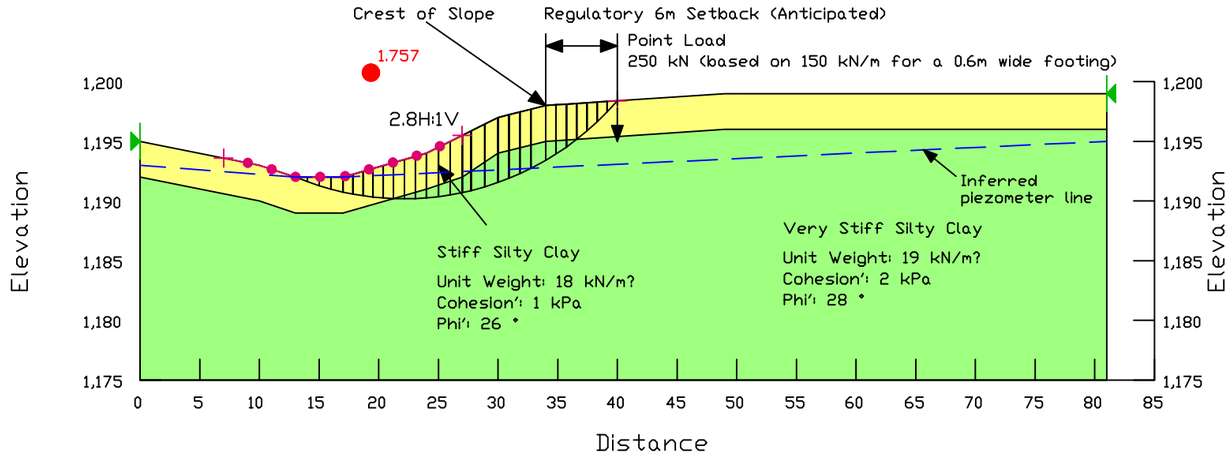
PROJECT NO.: **CGY-00092055-00** DATE: **2016.11.15** SCALE: **1:500**

TITLE:
EXISTING GROUND SLOPE STABILITY SECTION C

FIGURE NO.:
07



SECTION D
SLOPE STABILITY ANALYSIS



SECTION D
(FORCED SLIP SURFACE AT 6m SETBACK)
SLOPE STABILITY ANALYSIS

PROJECT NAME:
HAWKWOOD LANDS

PROJECT NO.: **CGY-00092055-00** DATE: **2016.11.15** SCALE: **1:500**

TITLE:
EXISTING GROUND SLOPE STABILITY SECTION D

FIGURE NO.:
08

Appendix C – Borehole Logs

RECORD OF BOREHOLE : BH16-01

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
CLIENT Highfield Land Management Inc.
PROJECT NAME Hawkwood Lands
PROJECT LOCATION Calgary, Alberta
DRILLING DATE 2016-10-20
BOREHOLE LOCATION
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
ELEVATION 1225.05m
DRILLING METHOD Solid Stem Auger
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
EQUIPMENT TYPE Truck Mounted Auger Drill
▼ **AT END OF DRILLING** --- Dry
LOGGED BY CS **CHECKED BY** MT
▼ **AFTER DRILLING** --- 28/10/2016 Dry

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY %	SPT N VALUE BLOWS/0.3m (20 40 60 80) / DYNAMIC CONE BLOWS/0.3m (20 40 60 80)	POCKET PEN. (kPa) (100 200 300 400) / FIELD VANE SHEAR (kPa) Peak Remold (40 80 120 160)	FINES CONTENT (%) (20 40 60 80) / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL (20 40 60 80)	WELL DIAGRAM Casing Top Elev: m
0		TOPSOIL, some clay, trace silt, sandy, some organics, dark brown, moist	1224.7	1	GB					Bentonite
			0.3							
1		CLAY, silty, trace sand, medium plasticity, stiff, greyish brown, damp to moist		2	GB				18	
			1223.2	3	SS	100	12	335	14	
2		CLAY (TILL), silty, trace to some sand, trace rounded to sub-rounded gravel, medium plasticity, stiff to very stiff, brown, moist -some coarse gravel, occasional coal fragments	1.9	4	GB					Cuttings
3		-some angular gravel fragments, occasional cobbles		5	SS	100	50/140mm		11	
4		-some gravel		6	GB					Sand
		-trace to some gravel, hard		7	SS	100	36	431		
5		-some gravel		8	GB				7	Screen
6				9	SS	30	30	431		
			1218.5							

Bottom of hole at 6.6m.

RECORD OF BOREHOLE : BH16-02

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
CLIENT Highfield Land Management Inc.
PROJECT NAME Hawkwood Lands
PROJECT LOCATION Calgary, Alberta
DRILLING DATE 2016-10-20
BOREHOLE LOCATION
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
ELEVATION 1217.57m
DRILLING METHOD Solid Stem Auger
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
EQUIPMENT TYPE Truck Mounted Auger Drill
▼ **AT END OF DRILLING** --- Dry
LOGGED BY CS **CHECKED BY** MT
▼ **AFTER DRILLING** --- 28/10/2016 Dry

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m / DYNAMIC CONE BLOWS/0.3m	POCKET PEN. (kPa) / FIELD VANE SHEAR (kPa) Peak Remold	FINES CONTENT (%) / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL	WELL DIAGRAM Casing Top Elev: m
		TOPSOIL, some clay, trace silt, sandy, some rootlets/organics, dark brown, moist	1217.1	1	GB					Bentonite
1		CLAY (TILL), silty, trace fine rounded to sub-rounded gravel, trace sand, trace sulphates, medium plasticity, firm, greyish brown, moist	0.5	2	GB				22	
			1216.0							
2		CLAY, silty, trace sand, trace sulphates, medium plasticity, firm to stiff, brown, moist -Sulphate Content <0.1% -soft Grain Size Analysis: Gravel = 0.0% Sand = 2.2% Silt = 84.1% Clay = 13.7% -minor oxidation	1.5	3	SS	100	9	239	23	
				4	GB				29 (22 / 48)	
3				5	SS	100	9	192	32	Cuttings
4				6	GB					
			1213.0							
5		CLAY (TILL), silty, some sand, trace rounded to sub-rounded gravel, medium plasticity, stiff, possible bedrock fragments, minor oxidation -trace to some gravel -boulder/cobble, sandy -bouncing SPT	4.6	7	SS	100	13	335	16	
6				8	GB				14	Sand
				9	SS					
7				10	GB				16	
8		-very stiff		11	SS	50	24	335		Screen
		-occasional cobbles		12	GB				14	
9		-occasional silt layers		13	SS	100	30	431	20	
			1208.0							

Bottom of hole at 9.6m.

EXP GEO CGY-00092055 LOGS.GPJ EXP STD.GDT 21/11/16

RECORD OF BOREHOLE : BH16-03

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
CLIENT Highfield Land Management Inc.
PROJECT NAME Hawkwood Lands
PROJECT LOCATION Calgary, Alberta
DRILLING DATE 2016-10-20
BOREHOLE LOCATION
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
ELEVATION 1216.27m
DRILLING METHOD Solid Stem Auger
GROUND WATER LEVELS: **AT TIME OF DRILLING** ---
EQUIPMENT TYPE Truck Mounted Auger Drill
AT END OF DRILLING --- Dry
LOGGED BY CS **CHECKED BY** MT
AFTER DRILLING --- 28/10/2016 Dry

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m / DYNAMIC CONE BLOWS/0.3m (20 40 60 80)	POCKET PEN. (kPa) / FIELD VANE SHEAR (kPa) Peak Remold (100 200 300 400 / 40 80 120 160)	FINES CONTENT (%) / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL (20 40 60 80)	WELL DIAGRAM Casing Top Elev: m
		TOPSOIL, some clay, silty, sandy, some organics, dark brown, moist Grain Size Analysis: Gravel = 2.3% Sand = 51.0% Silt = 33.6% Clay = 13.7%	1215.8 0.5	1	GB					Bentonite
1		CLAY, silty, trace to some sand, trace sulfates, medium plasticity, firm, light brown, moist		2	GB				26	
		-stiff, trace fine to coarse sub-rounded gravel		3	SS	100	9	192	27	Cuttings
2				4	GB				24	Sand
3		-greyish brown, occasional coal fragments	1213.1							
		SANDSTONE, extremely weak to very weak, highly to moderately weathered, brown, dry	3.2	5	SS	100	50 50/130mm			Screen
			1212.3	6	GB					

Refusal at 4.0m.

RECORD OF BOREHOLE : BH16-04

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
PROJECT NAME Hawkwood Lands
DRILLING DATE 2016-10-20
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
DRILLING METHOD Solid Stem Auger
EQUIPMENT TYPE Truck Mounted Auger Drill
LOGGED BY CS **CHECKED BY** MT

CLIENT Highfield Land Management Inc.
PROJECT LOCATION Calgary, Alberta
BOREHOLE LOCATION
ELEVATION 1183.78m
GROUND WATER LEVELS: **AT TIME OF DRILLING** ---
AT END OF DRILLING --- Dry
AFTER DRILLING --- 28/10/2016 Dry

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m / DYNAMIC CONE BLOWS/0.3m	POCKET PEN. (kPa) / FIELD VANE SHEAR (kPa) Peak, Remold	FINES CONTENT (%) / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL	WELL DIAGRAM Casing Top Elev: m
		TOPSOIL, some clay, some silt, sandy, some organics, dark brown, moist	1183.5 / 0.3	1	GB					Bentonite
1		CLAY, silty, trace to some sand, trace sulphates, medium plasticity, stiff, brown, moist		2	GB					
		-occasional grey mottling, occasional quartz crystals from 1.5 to 2.4m		3	SS	100	14	335	23	
2		-sand seams -Sulphate Content = 0.3%		4	GB					
3		-some sand to sandy, minor oxidation, occasional grey mottling		5	SS	100	11	383	30	Cuttings
		-medium to high plasticity, occasional quartz crystals Grain Size Analysis: Gravel = 5.7% Sand = 25.7% Silt = 57.6% Clay = 11.0% -trace fine sand, very stiff		6	GB				26 (20 – 50)	
4				7	SS	100	16	383	21	
		-occasional sandy seams -occasional trace coarse rounded gravel		8	GB					
5		-occasional silt seams and lenses		9	SS		17		16	
		-grey								
6		-occasional coal fragments		10	GB					Sand
			1176.5							
		CLAY (TILL), silty, some sand, trace rounded to sub-rounded gravel, occasional cobbles, medium plastic, very stiff, greyish brown, moist	7.3							
7		-trace bedrock fragments		11	SS	100	25	383	19	Screen
				12	GB					
8										
		-occasional silt and fine sand seams		13	SS	100	24		23	
9			1174.2							

Bottom of hole at 9.6m.

EXP GEO CGY-00092055 LOGS.GPJ EXP STD.GDT 21/11/16

RECORD OF BOREHOLE : BH16-05

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
PROJECT NAME Hawkwood Lands
DRILLING DATE 2016-10-20
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
DRILLING METHOD Solid Stem Auger
EQUIPMENT TYPE Truck Mounted Auger Drill
LOGGED BY CS **CHECKED BY** MT

CLIENT Highfield Land Management Inc.
PROJECT LOCATION Calgary, Alberta
BOREHOLE LOCATION
ELEVATION 1204.99m
GROUND WATER LEVELS: **AT TIME OF DRILLING** ---
AT END OF DRILLING --- Dry
AFTER DRILLING 8.9m 28/10/2016

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m / DYNAMIC CONE BLOWS/0.3m	POCKET PEN. (kPa) / FIELD VANE SHEAR (kPa) Peak Remold	FINES CONTENT (%) / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL	WELL DIAGRAM Casing Top Elev: m
		TOPSOIL, some clay, trace to some silt, sandy, some organics, dark brown, moist	1204.8 / 0.2	1	GB					Bentonite
1		CLAY, silty, trace sulphates, medium plasticity, firm to stiff, light brown, damp to moist		2	GB				26	
		-stiff, moist		3	SS	100	13	192	29	
2				4	GB				21	
		-trace rounded to sub-rounded gravel and cobbles								
3			1201.8	5	SS	100	13	239		Cuttings
		CLAY (TILL), silty, some sand, trace rounded to sub-rounded gravel, medium plasticity, stiff, light brown, moist	3.2	6	GB				17	
4		-trace to some gravel								
			1200.1	7	SS	100	27	335		
5		MUDSTONE, extremely weak, highly weathered, minor to major oxidation, light brown, some grey mottling, dry to damp	4.9	8	GB				17	
6		-crumbled		9	SS	100	57			Sand
				10	GB				9	
7										
				11	SS	100	66			Screen
8		-very weak, moderately weathered		12	GB				13	
9		-extremely weak, brown		13	SS	100	20			
			1195.2 / 9.8	14	GB					

Refusal at 9.9m.

EXP GEO CGY-00092055 LOGS.GPJ EXP STD.GDT 21/11/16

RECORD OF BOREHOLE : BH16-06

exp Services Inc.

PROJECT NUMBER CGY-00092055-00 **CLIENT** Highfield Land Management Inc.

PROJECT NAME Hawkwood Lands **PROJECT LOCATION** Calgary, Alberta

DRILLING DATE 2016-10-20 **BOREHOLE LOCATION**

DRILLING CONTRACTOR Earth Drilling Co. Ltd. **ELEVATION** 1209.41m

DRILLING METHOD Solid Stem Auger **GROUND WATER LEVELS:** ▽ **AT TIME OF DRILLING** ---

EQUIPMENT TYPE Truck Mounted Auger Drill ▼ **AT END OF DRILLING** --- Dry

LOGGED BY CS **CHECKED BY** MT ▼ **AFTER DRILLING** --- 28/10/2016 Dry

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m (▲) 20 40 60 80 / DYNAMIC CONE BLOWS/0.3m 20 40 60 80	POCKET PEN. (kPa) (⊙) 100 200 300 400 / FIELD VANE SHEAR (kPa) Peak Remold 40 80 120 160	FINES CONTENT (%) (□) 20 40 60 80 / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80	WELL DIAGRAM Casing Top Elev: m
0		TOPSOIL, some clay, sandy, trace silt, some rootlets, dark brown, moist	1209.2	1	GB					Bentonite
			0.2							
		CLAY, silty, trace fine sand, medium plasticity, stiff, light brown, moist		2	GB			192	29	
1										
		-occasional fine to medium sand seams		3	SS	60	11	287	26	
2										
		-trace coarse rounded gravel from 2.7 to 3.3m, medium to high plasticity Grain Size Analysis: Gravel = 0.0% Sand = 4.4% Silt = 84.2% Clay = 11.5% -minor oxidation		4	GB				31 (20 – 51)	Cuttings
3				5	SS	80	9	287	29	
		-occasional sand seams with trace gravel from 3.0 to 4.5m		6	GB					
4			1204.8							Sand
		CLAY (TILL), silty, some sand, trace sub-rounded sub-angular gravel, medium plastic, very stiff, occasional coal fragments, oxidation, brown, dry	4.6 1204.5	7	SS	100	26	335	16	
5			4.9							
		MUDSTONE, extremely weak, highly weathered, light brown, dry		8	GB				17	Screen
6										
			1202.9	9	SS	100	50			

Bottom of hole at 6.6m.

RECORD OF BOREHOLE : BH16-07

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
CLIENT Highfield Land Management Inc.
PROJECT NAME Hawkwood Lands
PROJECT LOCATION Calgary, Alberta
DRILLING DATE 2016-10-19
BOREHOLE LOCATION
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
ELEVATION 1213.57m
DRILLING METHOD Solid Stem Auger
GROUND WATER LEVELS: **AT TIME OF DRILLING** ---
EQUIPMENT TYPE Truck Mounted Auger Drill
AT END OF DRILLING --- Dry
LOGGED BY CS **CHECKED BY** MT
AFTER DRILLING --- 28/10/2016 Dry

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m (▲) 20 40 60 80 / DYNAMIC CONE BLOWS/0.3m 20 40 60 80	POCKET PEN. (kPa) (⊙) 100 200 300 400 / FIELD VANE SHEAR (kPa) Peak Remold 40 80 120 160	FINES CONTENT (%) (□) 20 40 60 80 / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80	WELL DIAGRAM Casing Top Elev: m
0		TOPSOIL, some clay, trace silt, sandy, some rootlets, dark brown, moist	1213.4 / 0.2	1	GB					Bentonite
1		CLAY (FILL), silty, trace sand, medium plasticity, light brown, damp to moist -Sulphate Content <0.1%		2	GB				20	
			1211.7	3	SS	100	5			
2		TOPSOIL, trace organics and rootlets, dark brown, moist	1.8 / 1211.4							
		CLAY, silty, trace sand, medium plasticity, stiff, brown, moist -grey	2.1	4	GB				25	Cuttings
3		-stiff to very stiff, occasional silt seams -minor oxidation, brown		5	SS	100	9	144	26	
4		-trace gravel		6	GB					
				7	SS	100	15	239	22	
5				8	GB					Screen Sand
6			1207.4							
		CLAY (TILL), silty, trace to some sand, trace gravel, medium plasticity, very stiff, brown, moist	6.1 / 1207.0	9	SS	100	16	287	15	

Bottom of hole at 6.6m.

RECORD OF BOREHOLE : BH16-08

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
PROJECT NAME Hawkwood Lands
DRILLING DATE 2016-10-20
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
DRILLING METHOD Solid Stem Auger
EQUIPMENT TYPE Truck Mounted Auger Drill
LOGGED BY CS **CHECKED BY** MT

CLIENT Highfield Land Management Inc.
PROJECT LOCATION Calgary, Alberta
BOREHOLE LOCATION
ELEVATION 1237.11m
GROUND WATER LEVELS: **AT TIME OF DRILLING** ---
AT END OF DRILLING --- Dry
AFTER DRILLING --- 28/10/2016 Dry

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m / DYNAMIC CONE BLOWS/0.3m	POCKET PEN. (kPa) / FIELD VANE SHEAR (kPa)	FINES CONTENT (%) / PLASTIC & LIQUID LIMIT MOISTURE CONTENT	WELL DIAGRAM Casing Top Elev: m
0		TOPSOIL, some clay, trace silt, sandy, trace cobbles, some organics, dark brown, moist	1236.9 / 0.3	1	GB					
1		CLAY, silty, trace sulphates, medium plasticity, stiff, brown with oxidation, moist		2	GB				19	Bentonite
2		-very stiff -Sulphate Content <0.1% -grey, minor oxidation, dry		3	SS	50	29			
		-light brown, dry	1234.4	4	GB				16	
3		MUDSTONE, completely weathered to residual soil, extremely weak, trace to some sand, greyish brown, dry to damp	2.7	5	SS	90	50/150mm		14	Cuttings
4				6	GB					Sand
5		-minor oxidation		7	SS	100	50/75mm		12	
				8	GB					Screen
6			1230.8	9	SS	100	50/50mm			

Bottom of hole at 6.3m.

RECORD OF BOREHOLE : BH16-09

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
PROJECT NAME Hawkwood Lands
DRILLING DATE 2016-10-20
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
DRILLING METHOD Solid Stem Auger
EQUIPMENT TYPE Truck Mounted Auger Drill
LOGGED BY CS **CHECKED BY** MT

CLIENT Highfield Land Management Inc.
PROJECT LOCATION Calgary, Alberta
BOREHOLE LOCATION
ELEVATION 1202.32m
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
▼ **AT END OF DRILLING** --- Dry
▼ **AFTER DRILLING** 7.9m 28/10/2016

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m / DYNAMIC CONE BLOWS/0.3m (20 40 60 80)	POCKET PEN. (kPa) / FIELD VANE SHEAR (kPa) Peak Remold (100 200 300 400 / 40 80 120 160)	FINES CONTENT (%) / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL (20 40 60 80)	WELL DIAGRAM Casing Top Elev: m
0		TOPSOIL, trace clay, silty, sandy, some rootlets, dark brown, moist	1202.0	1	GB					Bentonite
		Grain Size Analysis: Gravel = 0.0% Sand = 60.1% Silt = 28.8% Clay = 11.2%	0.3							
1		CLAY, silty, medium plasticity, soft to firm, trace sulphates, greyish brown, moist		2	GB					
		-stiff, some dark grey mottling		3	SS	100	8	192	25	
2				4	GB					
3		-occasional silt seams, firm, damp		5	SS	100	7	239	36	Cuttings
				6	GB				24	
4		-trace gravel, silt seams								
		-ocasional silt and sand seams, medium to high plasticity, soft to firm		7	SS	100	9	96	25	
5				8	GB				22	
		-occasional cobbles, trace gravel								
6										Sand
			1195.9	9	SS	100	14	192	28	
		CLAY (TILL), silty, some sand, trace rounded to sub-rounded gravel, occasional cobbles, very stiff, medium plastic, minor oxidation, brown, moist	6.4							
7				10	GB				14	Screen
			1194.5	11	SS		32/75mm			
		SANDSTONE/MUDSTONE, extremely weak, highly weathered, grey, dry	7.8 1194.5							
		Refusal at 7.8m.								

RECORD OF BOREHOLE : BH16-10

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
PROJECT NAME Hawkwood Lands
DRILLING DATE 2016-10-19
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
DRILLING METHOD Solid Stem Auger
EQUIPMENT TYPE Truck Mounted Auger Drill
LOGGED BY CS **CHECKED BY** MT

CLIENT Highfield Land Management Inc.
PROJECT LOCATION Calgary, Alberta
BOREHOLE LOCATION
ELEVATION 1199.83m
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
▼ **AT END OF DRILLING** --- Dry
▼ **AFTER DRILLING** 4.9m 28/10/2016

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m ▲ 20 40 60 80 / DYNAMIC CONE BLOWS/0.3m 20 40 60 80	POCKET PEN. (kPa) ⊙ 100 200 300 400 / FIELD VANE SHEAR (kPa) Peak ● Remold ○ 40 80 120 160	FINES CONTENT (%) □ 20 40 60 80 / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80	WELL DIAGRAM Casing Top Elev: m
0		TOPSOIL, some clay, sandy, trace silt, dark brown, moist	1199.6	1	GB					Bentonite
		CLAY, silty, trace sand, medium plasticity, trace sand, brown, damp to moist, firm	0.3	2	GB				31	
1										
				3	SS	67	7 ▲	192 ⊙		
2			1197.7							
		CLAY (TILL), silty, trace to some sand, trace rounded to sub-rounded gravel, medium plasticity, stiff, brown, damp to moist	2.1	4	GB				14	
3		Grain Size Analysis: Gravel = 0.9% Sand = 5.5% Silt = 84.2% Clay = 9.4%		5	SS	100	11 ▲	239 ⊙	25 16 38	Cuttings
		-trace grey mottling, moist		6	GB				19	
4										
		-silt seams, damp		7	SS	100	10 ▲	239 ⊙	26	
5				8	GB				24	
6		-very stiff		9	SS	100	18 ▲	192 ⊙		Sand
		-trace fine to coarse rounded gravel		10	GB				23	
7										
		-trace coal fragments		11	SS	100	15 ▲	287 ⊙	21	Screen
8				12	GB					
9										
			1190.2	13	GB	100	21 ▲	287 ⊙	21	

Bottom of hole at 9.6m.

RECORD OF BOREHOLE : BH16-11

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
PROJECT NAME Hawkwood Lands
DRILLING DATE 2016-10-19
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
DRILLING METHOD Solid Stem Auger
EQUIPMENT TYPE Truck Mounted Auger Drill
LOGGED BY CS **CHECKED BY** MT

CLIENT Highfield Land Management Inc.
PROJECT LOCATION Calgary, Alberta
BOREHOLE LOCATION
ELEVATION 1217.42m
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
▼ **AT END OF DRILLING** 9.45m
▼ **AFTER DRILLING** 8.6m 28/10/2016

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m (▲) 20 40 60 80	POCKET PEN. (kPa) (⊙) 100 200 300 400	FINES CONTENT (%) (□) 20 40 60 80	WELL DIAGRAM Casing Top Elev: m
							DYNAMIC CONE BLOWS/0.3m 20 40 60 80	FIELD VANE SHEAR (kPa) Peak ● Remold ○ 40 80 120 160	PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80	
0		TOPSOIL, some rootlets, trace to some clay, silty, sandy, dark brown, moist	1217.1	1	GB					
		Grain Size Analysis: Gravel = 0.2% Sand = 61.7% Silt = 24.4% Clay = 13.7%	0.3	2	GB				25	
1		CLAY, silty, medium plasticity, trace sand, brown, damp to moist, firm								
		-trace fine rounded gravel, moist	1215.6	3	SS	100	15	287		
2		CLAY (TILL), silty, some sand, trace rounded to sub-rounded gravel, occasional cobbles, medium plasticity, stiff, brown, damp to moist	1.8	4	GB				17	
3		-occasional sand lenses Grain Size Analysis: Gravel = 22.8% Sand = 16.8% Silt = 50.7% Clay = 9.7% -trace to some coarse gravel, silt layers		5	SS	100	36	311	15 16 43	
4				6	GB				15	
		-trace gravel, moist		7	SS	100	15	311		
5				8	GB				14	
6		-occasional coal fragments		9	SS	100	31	359		
7		-some coarse rounded gravel		10	GB				15	
8				11	SS	100	19	335		
9		-trace gravel		12	GB				14	
		-some gravel (rock in SPT), wet	1207.8	13	SS	50	50/150mm			

WELL DIAGRAM: Bentonite; Cuttings; Sand; Screen

Bottom of hole at 9.6m.

RECORD OF BOREHOLE : BH16-12

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
PROJECT NAME Hawkwood Lands
DRILLING DATE 2016-10-19
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
DRILLING METHOD Solid Stem Auger
EQUIPMENT TYPE Truck Mounted Auger Drill
LOGGED BY CS **CHECKED BY** MT

CLIENT Highfield Land Management Inc.
PROJECT LOCATION Calgary, Alberta
BOREHOLE LOCATION
ELEVATION 1219.42m
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
▼ **AT END OF DRILLING** --- Dry
▼ **AFTER DRILLING** 6.2m 28/10/2016

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m (▲) 20 40 60 80 / DYNAMIC CONE BLOWS/0.3m 20 40 60 80	POCKET PEN. (kPa) (⊙) 100 200 300 400 / FIELD VANE SHEAR (kPa) Peak ● Remold ○ 40 80 120 160	FINES CONTENT (%) (□) 20 40 60 80 / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80	WELL DIAGRAM Casing Top Elev: m
		TOPSOIL, some rootlets, trace to some clay, trace to some silt, sandy, dark brown, moist	1219.2	1	GB					Bentonite
			0.3							
1		CLAY, silty, trace sand, medium plasticity, stiff, brown, damp to moist		2	GB				26	
			1217.9							
		SAND, silty, trace clay, fine to medium, light brown, dry to damp, compact	1.5	3	SS	90	17	239		
2			1217.7							
		CLAY (TILL), silty, some sand, trace fine to coarse sub-rounded gravel, medium plasticity, stiff to very stiff, light brown, moist	1.7	4	GB				15	Cuttings
		-minor oxidation								
3		-very stiff		5	SS	0	16			
				6	GB				16	
4		-trace to some rounded gravel, occasional cobbles								Sand
		-hard		7	SS	80	33	431		
5				8	GB				15	Screen
6		-very stiff		9	SS	100	26	431	15	
			1212.9							

Bottom of hole at 6.6m.

RECORD OF BOREHOLE : BH16-13

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
PROJECT NAME Hawkwood Lands
DRILLING DATE 2016-10-20
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
DRILLING METHOD Solid Stem Auger
EQUIPMENT TYPE Truck Mounted Auger Drill
LOGGED BY CS **CHECKED BY** MT

CLIENT Highfield Land Management Inc.
PROJECT LOCATION Calgary, Alberta
BOREHOLE LOCATION
ELEVATION 1263.69m
GROUND WATER LEVELS: **AT TIME OF DRILLING** ---
AT END OF DRILLING --- Dry
AFTER DRILLING ---

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m / DYNAMIC CONE BLOWS/0.3m	POCKET PEN. (kPa) / FIELD VANE SHEAR (kPa) Peak Remold	FINES CONTENT (%) / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL
		TOPSOIL, some clay, trace to some silt, sandy, some organics, dark brown, moist	1263.4	1	GB				
		CLAY (TILL), silty, some sand to sandy, trace to some angular gravel, medium plasticity, stiff, brown, damp to moist	0.3	2	GB				8
1									
2		-layers of well graded sand and gravel, cobbles, some silt, occasional boulders, very stiff		3	SS	100	39		13
				4	GB				
3					SS	0			
4					GB				
		-some cobbles		5	SS	0	23		
5									
6									
				6	SS	2933	0 50/125mm		
			1257.0						

Refusal at 6.7m.

RECORD OF BOREHOLE : BH16-14

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
PROJECT NAME Hawkwood Lands
DRILLING DATE 2016-10-19
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
DRILLING METHOD Solid Stem Auger
EQUIPMENT TYPE Truck Mounted Auger Drill
LOGGED BY CS **CHECKED BY** MT

CLIENT Highfield Land Management Inc.
PROJECT LOCATION Calgary, Alberta
BOREHOLE LOCATION
ELEVATION 1228.18m
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
▼ **AT END OF DRILLING** --- Dry
▼ **AFTER DRILLING** 5.1m 28/10/2016

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m / DYNAMIC CONE BLOWS/0.3m	POCKET PEN. (kPa) / FIELD VANE SHEAR (kPa) Peak Remold	FINES CONTENT (%) / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL	WELL DIAGRAM Casing Top Elev: m
		TOPSOIL, some clay, some silt, sandy, some rootlets and organics, dark brown, moist	1227.7	1	GB					
		CLAY, silty, trace to some sand, medium plasticity, brown, damp to moist, firm	0.5	2	GB				18	
1			1226.7							
		CLAY (TILL), silty, trace to some sand, trace rounded to sub-rounded gravel, some sulphates, medium plasticity, very stiff, brown, moist -Sulphate Content <0.1%	1.5	3	SS	80	16	192		Bentonite
2				4	GB				15 (19 — 41)	
		-occasional cobbles, minor oxidation, trace sulphates Grain Size Analysis: Gravel = 0.0% Sand = 4.6% Silt = 83.9% Clay = 11.4% -trace to some coarse gravel, stiff		5	SS	67	12	383	16	
3				6	GB					
4		-dry								
		-some gravel, major oxidation, very stiff		7	SS	100	17		19	Cuttings
5		▼		8	GB					
		-minor grey mottling, minor oxidation								
6				9	SS	100	24	287	16	Sand
		-trace fine sub-rounded gravel, trace to some sand		10	GB					
7										
			1220.3	11	SS	100	49		17	Screen
8		MUDSTONE, completely weathered to residual soil, extremely weak, light brown to grey, dry	7.9	12	GB					
9										
			1218.6	13	GB		89		14	

Bottom of hole at 9.6m.

RECORD OF BOREHOLE : BH16-15

exp Services Inc.

PROJECT NUMBER CGY-00092055-00 **CLIENT** Highfield Land Management Inc.
PROJECT NAME Hawkwood Lands **PROJECT LOCATION** Calgary, Alberta
DRILLING DATE 2016-10-19 **BOREHOLE LOCATION**
DRILLING CONTRACTOR Earth Drilling Co. Ltd. **ELEVATION** 1222.07m
DRILLING METHOD Solid Stem Auger **GROUND WATER LEVELS:** ▽ **AT TIME OF DRILLING** ---
EQUIPMENT TYPE Truck Mounted Auger Drill ▼ **AT END OF DRILLING** --- Dry
LOGGED BY CS **CHECKED BY** MT ▼ **AFTER DRILLING** 5.3m 28/10/2016

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m (▲) 20 40 60 80 / DYNAMIC CONE BLOWS/0.3m 20 40 60 80	POCKET PEN. (kPa) (⊙) 100 200 300 400 / FIELD VANE SHEAR (kPa) Peak Remold 40 80 120 160	FINES CONTENT (%) (□) 20 40 60 80 / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80	WELL DIAGRAM Casing Top Elev: m
		TOPSOIL, some clay, trace silt, sandy, some organics, dark brown, moist	1221.5	1	GB				21	
1		CLAY, silty, trace sand, medium plasticity, stiff, brown, damp to moist	0.6	2	GB					
2		-occasional silt seams, minor oxidation		3	SS	80	7	192		
		-trace coarse sand, trace cobbles, trace gravel	1219.3	4	GB				23	Bentonite
3		CLAY (TILL), silty, some sand, trace rounded to sub-rounded gravel, minor oxidation, low to medium plasticity, very stiff, brown, damp to moist	2.7	5	SS	100	17			
4		-light brown, dry	1217.3	6	GB				15	
5		MUDSTONE, completely weathered to residual soil, extremely weak, light brown, minor oxidation, dry	4.7	7	SS	100	51			
				8	GB				12	Screen and Sand
6		-extremely weak, highly weathered	1215.5	9	SS		82			

Bottom of hole at 6.6m.

RECORD OF BOREHOLE : BH16-16

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
PROJECT NAME Hawkwood Lands
DRILLING DATE 2016-10-19
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
DRILLING METHOD Solid Stem Auger
EQUIPMENT TYPE Truck Mounted Auger Drill
LOGGED BY CS **CHECKED BY** MT

CLIENT Highfield Land Management Inc.
PROJECT LOCATION Calgary, Alberta
BOREHOLE LOCATION
ELEVATION 1216.30m
GROUND WATER LEVELS: **AT TIME OF DRILLING** ---
AT END OF DRILLING --- Dry
AFTER DRILLING --- 28/10/2016 Dry

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m / DYNAMIC CONE BLOWS/0.3m (20 40 60 80)	POCKET PEN. (kPa) / FIELD VANE SHEAR (kPa) Peak Remold (100 200 300 400 / 40 80 120 160)	FINES CONTENT (%) / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL (20 40 60 80)	WELL DIAGRAM Casing Top Elev: m
		TOPSOIL, some clay, sandy, trace silt, some organics, dark brown, moist	1216.0	1	GB					Bentonite
		CLAY, silty, trace sand, trace rootlets, medium plasticity, stiff, light brown, damp	0.3	2	GB					
1										
		-trace gravel	1214.6	3	SS	100	8	192	23	
2		CLAY (TILL), silty, trace sand, trace fine to coarse rounded to sub-rounded gravel, medium plasticity, stiff, brown, damp	1.7	4	GB					
		-moist								Cuttings
3				5	SS	90	13	239	18	
				6	GB					
4		-trace rounded gravel								Sand
		-silt seams, trace gravel, damp to moist		7	SS	100	19	287	16	
5				8	GB					Screen
		-trace fine to coarse rounded to sub-rounded gravel, sand seams								
6		-damp to moist		9	SS	100	25	335	16	
			1209.7							

Bottom of hole at 6.6m.

RECORD OF BOREHOLE : BH16-17

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
PROJECT NAME Hawkwood Lands
DRILLING DATE 2016-10-17
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
DRILLING METHOD Solid Stem Auger
EQUIPMENT TYPE Truck Mounted Auger Drill
LOGGED BY CS **CHECKED BY** MT

CLIENT Highfield Land Management Inc.
PROJECT LOCATION Calgary, Alberta
BOREHOLE LOCATION
ELEVATION 1236.97m
GROUND WATER LEVELS: **AT TIME OF DRILLING** ---
AT END OF DRILLING --- Dry
AFTER DRILLING --- 28/10/2016 Dry

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m / DYNAMIC CONE BLOWS/0.3m	POCKET PEN. (kPa) / FIELD VANE SHEAR (kPa) Peak Remold	FINES CONTENT (%) / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL	WELL DIAGRAM Casing Top Elev: m
		TOPSOIL, some clay, trace silt, sandy, some organics, dark brown, moist	1236.7 / 0.3	1	GB					Bentonite
1		CLAY (TILL), silty, some sand, trace fine sub-rounded to sub-angular gravel, trace sulphates, trace organics, medium plasticity, stiff, light brown, moist		2	GB				29	
2		-some fine to coarse sub-rounded to sub-angular gravel, occasional sulphates, minor oxidation, very stiff -Sulphate Content <0.1%		3	SS	100	22			
		-trace fine gravel, light brown/light grey with major oxidation, damp		4	GB				17	
3		-sulphates, rust stains, hard		5	SS	100	52			Cuttings
4		-some angular gravel, minor oxidation		6	GB				9	
5		-trace to some sand, trace gravel, occasional oxidation seams		7	SS	100	73			
		-some sand, medium to high plastic Grain Size Analysis: Gravel = 0.4% Sand = 18.4% Silt = 61.7% Clay = 19.5%		8	GB				16 20 — 52	
6				9	SS	67	81		14	Sand
7		-some sand to sandy, trace fine angular gravel,	1230.0 / 7.0	10	GB					
		SANDSTONE, extremely weak, highly weathered, brown, dry		11	SS	100	0 50/100mm			Screen
8				12	GB					
9		-very weak, moderately weathered	1227.5	13	SS		50/50mm			
				14	GB					
		Refusal at 9.4m.		15	SS		50/25mm			

RECORD OF BOREHOLE : BH16-18

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
CLIENT Highfield Land Management Inc.
PROJECT NAME Hawkwood Lands
PROJECT LOCATION Calgary, Alberta
DRILLING DATE 2016-10-17
BOREHOLE LOCATION
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
ELEVATION 1239.18m
DRILLING METHOD Solid Stem Auger
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
EQUIPMENT TYPE Truck Mounted Auger Drill
▼ **AT END OF DRILLING** --- Dry
LOGGED BY CS **CHECKED BY** MT
▼ **AFTER DRILLING** --- 28/10/2016 Dry

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY %	SPT N VALUE BLOWS/0.3m / DYNAMIC CONE BLOWS/0.3m (20 40 60 80)	POCKET PEN. (kPa) / FIELD VANE SHEAR (kPa) Peak Remold (100 200 300 400 / 40 80 120 160)	FINES CONTENT (%) / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL (20 40 60 80)	WELL DIAGRAM Casing Top Elev: m
		TOPSOIL, trace clay, some silt, sandy, some organics, dark brown, dry to moist Grain Size Analysis: Gravel = 0.7% Sand = 70.6% Silt = 22.4% Clay = 6.3%	1239.1 0.1	1	GB					Bentonite
1				2	GB				18	
		CLAY, silty, some sulphates, trace sand, low to medium plasticity, stiff, greyish brown, dry	1237.7							
		CLAY (TILL), silty, some sand, trace fine to coarse sub-angular to sub-rounded gravel, some sulphates, medium plasticity, very stiff, brown, damp to moist -some fine to coarse rounded to sub-rounded gravel, occasional coal fragments, greyish brown Grain Size Analysis: Gravel = 10.5% Sand = 17.1% Silt = 60.8% Clay = 11.6%	1.5	3	SS	100	18	431	14	
2				4	GB				14 17 40	Cuttings
3				5	SS	100	50/100mm	431	11	
		SILT, sandy, (fine sand), trace to some clay, non to low plasticity, light brown, minor oxidation, dry	1235.8 3.4 1235.2	6	GB					
4		CLAY, silty, trace sand, low to medium plasticity, light brown with major to minor oxidation, dry, hard, (possible extremely weak and completely weathered MUDSTONE bedrock) -trace to some sand, medium plasticity, minor oxidation	4.0	7	SS	100	50/125mm			Sand
5		-trace sand, occasional mudstone fragments		8	GB				7	Screen
6			1233.0	9	SS	100	50/125mm			

Refusal at 6.2m.

RECORD OF BOREHOLE : BH16-19

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
PROJECT NAME Hawkwood Lands
DRILLING DATE 2016-10-17
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
DRILLING METHOD Solid Stem Auger
EQUIPMENT TYPE Truck Mounted Auger Drill
LOGGED BY CS **CHECKED BY** MT

CLIENT Highfield Land Management Inc.
PROJECT LOCATION Calgary, Alberta
BOREHOLE LOCATION
ELEVATION 1231.14m
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
▼ **AT END OF DRILLING** --- Dry
▼ **AFTER DRILLING** 5.9m 28/10/2016

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m / DYNAMIC CONE BLOWS/0.3m	POCKET PEN. (kPa) / FIELD VANE SHEAR (kPa)	FINES CONTENT (%) / PLASTIC & LIQUID LIMIT MOISTURE CONTENT	WELL DIAGRAM Casing Top Elev: m
		TOPSOIL, clayey, silty, some sand, some organics and rootlets, trace gravel, dark brown, dry to moist	1230.9	1	GB					
			0.3							
1		CLAY (TILL), silty, some sand to sandy, trace fine to coarse rounded to sub-rounded gravel, some sulphates, medium plasticity, brown, damp to moist, very stiff		2	GB			383	18	
			1229.6							
		CLAY, silty, low to medium plasticity, hard, light brown to brownish grey, damp	1.5	3	SS	100	42			
2		-major oxidation from 1.8m		4	GB				15	
		-trace mudstone fragments	1228.4							
3		MUDSTONE, extremely weak, highly to completely weathered, occasional black lenses, grey to brownish grey, minor oxidation	2.7	5	SS	100	62			
				6	GB				12	
4										
				7	SS		86			
5				8	GB				14	
6										
		-grey, occasional oxidation seams, extremely to very weak, highly weathered	1224.7	9	SS		50/100mm			
				10	GB					

Refusal at 6.4m.

WELL DIAGRAM: Bentonite; Cuttings; Sand; Screen

RECORD OF BOREHOLE : BH16-20

exp Services Inc.

PROJECT NUMBER CGY-00092055-00 **CLIENT** Highfield Land Management Inc.

PROJECT NAME Hawkwood Lands **PROJECT LOCATION** Calgary, Alberta

DRILLING DATE 2016-10-17 **BOREHOLE LOCATION**

DRILLING CONTRACTOR Earth Drilling Co. Ltd. **ELEVATION** 1218.40m

DRILLING METHOD Solid Stem Auger **GROUND WATER LEVELS:** ▽ **AT TIME OF DRILLING** ---

EQUIPMENT TYPE Truck Mounted Auger Drill ▼ **AT END OF DRILLING** --- Dry

LOGGED BY CS **CHECKED BY** MT ▼ **AFTER DRILLING** --- 28/10/2016 Dry

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m (▲) 20 40 60 80 / DYNAMIC CONE BLOWS/0.3m 20 40 60 80	POCKET PEN. (kPa) (⊙) 100 200 300 400 / FIELD VANE SHEAR (kPa) Peak Remold 40 80 120 160	FINES CONTENT (%) (□) 20 40 60 80 / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80	WELL DIAGRAM Casing Top Elev: m
0		TOPSOIL, trace clay, some silt, sandy, some organics, trace gravel, dark brown, moist Grain Size Analysis: Gravel = 17.5% Sand = 59.5% Silt = 17.0% Clay = 6.0%	1218.2 0.2	1	GB					
1				2	GB				4	
2		SAND, silty, some sand, gravelly, rounded to sub-rounded gravel, occasional cobbles and boulders, brown, dry to damp, compact -cobbles and boulders, some gravel to gravelly		3	GB					Bentonite
3				4	GB				13	
		-coarse sand, trace to some gravel		5	GB					
4		-some gravel		6	GB				7	Cuttings
										Sand
5				7	SS	0	19			
		-well graded sand		8	GB				9	Screen
6										
				9	SS	40	20			
			1211.8							

Bottom of hole at 6.6m.

RECORD OF BOREHOLE : BH16-21

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
PROJECT NAME Hawkwood Lands
DRILLING DATE 2016-10-17
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
DRILLING METHOD Solid Stem Auger
EQUIPMENT TYPE Truck Mounted Auger Drill
LOGGED BY CS **CHECKED BY** MT

CLIENT Highfield Land Management Inc.
PROJECT LOCATION Calgary, Alberta
BOREHOLE LOCATION
ELEVATION 1231.00m
GROUND WATER LEVELS: **AT TIME OF DRILLING** ---
AT END OF DRILLING --- Dry
AFTER DRILLING --- 28/10/2016 Dry

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m / DYNAMIC CONE BLOWS/0.3m	POCKET PEN. (kPa) / FIELD VANE SHEAR (kPa) Peak Remold	FINES CONTENT (%) / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL	WELL DIAGRAM Casing Top Elev: m
		TOPSOIL, clayey, silty, some sand, some organics, trace gravel, dark brown, moist	1230.8	1	GB					Bentonite
			0.2							
1		CLAY (TILL), silty, some sand, some fine to coarse rounded to sub-rounded gravel, trace sulphates, medium plasticity, brown, damp to moist, stiff -occasional cobbles to 1.5m -Sulphate Content <0.1%		2	GB					
2				3	SS	0	16			
		-trace gravel, occasional sulphates		4	GB				14	
3		-sand layers from 3.0 to 4.6m		5	SS	25	8			Cuttings
4		-some gravel to gravelly, moist		6	GB				9	
		-some sand to sandy, very stiff		7	SS	60	30	335		
5				8	GB				11	
6		-cobbles and boulders		9	SS	32	22			Sand
7		-cobbles		10	GB				9	Screen
8			1222.9	11	SS	25	26			

Bottom of hole at 8.1m.

EXP GEO CGY-00092055 LOGS.GPJ EXP STD.GDT 21/11/16

RECORD OF BOREHOLE : BH16-22

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
PROJECT NAME Hawkwood Lands
DRILLING DATE 2016-10-17
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
DRILLING METHOD Solid Stem Auger
EQUIPMENT TYPE Truck Mounted Auger Drill
LOGGED BY CS **CHECKED BY** MT

CLIENT Highfield Land Management Inc.
PROJECT LOCATION Calgary, Alberta
BOREHOLE LOCATION
ELEVATION 1217.32m
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
▼ **AT END OF DRILLING** 6.55m
▼ **AFTER DRILLING** 6.6m 28/10/2016

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	TYPE	RECOVERY %	SPT N VALUE BLOWS/0.3m (20 40 60 80) / DYNAMIC CONE BLOWS/0.3m (20 40 60 80)	POCKET PEN. (kPa) (100 200 300 400) / FIELD VANE SHEAR (kPa) Peak Remold (40 80 120 160)	FINES CONTENT (%) (20 40 60 80) / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL (20 40 60 80)	WELL DIAGRAM Casing Top Elev: m
		TOPSOIL, trace to some clay, trace to some silt, , some sand to sandy, some organics, dark brown, moist	1216.7	1	GB					Bentonite
1		CLAY (TILL), silty, some sand, trace fine sub-rounded gravel,trace organics, occasional cobbles, medium plasticity, very stiff, brown, damp to moist	0.6	2	GB				12	
		-trace to some gravel		3	SS	20	30			
2		-gravelly, light brown, moist		4	GB				9	
3		-minor oxidation		5	SS	25	20			
				6	GB					Cuttings
4		-some gravel to gravelly, occasional coal fragments								
				7	SS	100	22		15	
5				8	GB				15	
6		-trace to some rounded to sub-rounded gravel								
				9	SS		22			
	▼	-gravelly		10	GB				19	
7		-cobbly, gravelly, grey, wet								
				11	SS	50	47			Sand
8				12	GB					Screen
9		-some gravel	1207.7	13	SS	50	26		17	

Bottom of hole at 9.6m.

RECORD OF TESTHOLE : MW16-01

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
PROJECT NAME Hawkwood Lands
DRILLING DATE 2016-10-17
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
DRILLING METHOD Solid Stem Auger
EQUIPMENT TYPE Truck Mounted Auger Drill
LOGGED BY CS **CHECKED BY** MT

CLIENT Highfield Land Management Inc.
PROJECT LOCATION Calgary, Alberta
BOREHOLE LOCATION
ELEVATION 1192.03m
GROUND WATER LEVELS: **AT TIME OF DRILLING** ---
AT END OF DRILLING --- Dry
AFTER DRILLING --- 28/10/2016 Dry

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m / DYNAMIC CONE BLOWS/0.3m	POCKET PEN. (kPa) / FIELD VANE SHEAR (kPa)	FINES CONTENT (%) / PLASTIC & LIQUID LIMIT MOISTURE CONTENT	WELL DIAGRAM Casing Top Elev: m
		TOPSOIL, some clay, trace to some silt, sandy, trace gravel, some organics, dark brown, moist	1191.8 / 0.2	1	GB					
1		CLAY, silty, trace fine sand, trace sulphates, trace rootlets, medium plasticity, light brown, moist, firm to stiff		2	GB				24	
		-trace rootlets, occasional silt layers		3	SS	100	7	287	19	
2		-some silt		4	GB				16	Cuttings
3		-occasional sand seams and layers	1188.9 / 3.1	5	SS	100	13			
		SAND, some silt to silty, trace clay, fine grained, brown, moist, compact	1188.4	6	GB				18	
4		CLAY, silty, some fine sand, medium plasticity, stiff to very stiff, brown, moist	3.7							
		-trace sand		7	SS	100	17			
5		-sandy								Bentonite
		-trace sand to sandy, stratified	1186.2	8	GB				20	
6		SAND, some silt to silty, trace clay, fine grained, brown, moist, loose to compact	5.8	9	SS	50	14		21	Sand
			1185.2	10	GB			239		
7		CLAY, silty, trace to some sand, low to medium plasticity, stiff, brown, moist	6.9							
		-occasional silt seams and lenses		11	SS	100	12	192	31	Screen
8		-occasional sandy seams and layers		12	GB					
9		-occasional sand lenses	1182.4	13	SS	100	15	168	22	

Bottom of hole at 9.6m.

RECORD OF TESTHOLE : MW16-02

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
PROJECT NAME Hawkwood Lands
DRILLING DATE 2016-10-19
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
DRILLING METHOD Solid Stem Auger
EQUIPMENT TYPE Truck Mounted Auger Drill
LOGGED BY CS **CHECKED BY** MT

CLIENT Highfield Land Management Inc.
PROJECT LOCATION Calgary, Alberta
BOREHOLE LOCATION
ELEVATION 1208.34m
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
▼ **AT END OF DRILLING** 9.45m
▼ **AFTER DRILLING** 3.5m 28/10/2016

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m / DYNAMIC CONE BLOWS/0.3m	POCKET PEN. (kPa) / FIELD VANE SHEAR (kPa) Peak Remold	FINES CONTENT (%) / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL	WELL DIAGRAM Casing Top Elev: m
		TOPSOIL, some rootlets, trace to some clay, trace to some silt, sandy, dark brown, moist	1208.1	1	GB					
			0.3							
1		CLAY, silty, trace sand, trace rootlets, medium plasticity, stiff, brown, moist		2	GB				33 / 26 41	
		Grain Size Analysis: Gravel = 0.0% Sand = 22.1% Silt = 67.0% Clay = 10.9%								
		-trace to some sand, trace sulphates	1206.5	3	SS	100	10	239	23	Cuttings
2		CLAY (TILL), silty, some sand, trace rounded to sub-rounded gravel, medium plastic, stiff, brown, moist	1.8	4	GB					
3			1205.3							
		SILT, trace to some sand, trace clay, non to low plasticity, brown with grey mottling, moist, stiff	3.0	5	SS	67	14	96	23	
4		-some clay, low to medium plasticity		6	GB				26	Bentonite
			1203.8							
		CLAY, silty, trace to some sand, medium plasticity, stiff, light brown, damp to moist	4.6	7	SS	40	12	144	24	
5		-trace fine rounded to sub-rounded gravel		8	GB					
6			1202.2							Sand
		CLAY (TILL), silty, some sand, trace rounded to sub-rounded gravel, medium plastic, stiff to very stiff, brown, moist	6.1	9	SS	100	15	287	18	
7				10	GB					
8				11	SS	33	15	239	19	Screen
		-trace coarse gravel		12	GB					
9		-cobble in SPT		13	SS	100	56	287	19	
			1198.7							

Bottom of hole at 9.6m.

EXP GEO CGY-00092055 LOGS.GPJ EXP STD.GDT 21/11/16

RECORD OF TESTHOLE : MW16-03

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
PROJECT NAME Hawkwood Lands
DRILLING DATE 2016-10-18
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
DRILLING METHOD Solid Stem Auger
EQUIPMENT TYPE Truck Mounted Auger Drill
LOGGED BY CS **CHECKED BY** MT

CLIENT Highfield Land Management Inc.
PROJECT LOCATION Calgary, Alberta
BOREHOLE LOCATION
ELEVATION 1208.90m
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
▼ **AT END OF DRILLING** 1.22m
▼ **AFTER DRILLING** 2.2m 28/10/2016

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m ▲ 20 40 60 80 / DYNAMIC CONE BLOWS/0.3m 20 40 60 80	POCKET PEN. (kPa) ⊙ 100 200 300 400 / FIELD VANE SHEAR (kPa) Peak ● Remold ○ 40 80 120 160	FINES CONTENT (%) □ 20 40 60 80 / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80	WELL DIAGRAM Casing Top Elev: m
0		TOPSOIL, clayey, some silt, sandy, some organics and rootlets, low/medium plasticity, dark brown, moist	1208.7 / 0.2	1	GB					
1		CLAY, some silt to silty, trace sand, medium to high plasticity, brown, moist, firm		2	GB				35	Cuttings
		-occasional silt seams, stratified layers of clay		3	SS	100	6	96	35	
2		-Sulphate Content <0.1%		4	GB					
3		-stiff Grain Size Analysis: Gravel = 0.2% Sand = 7.9% Silt = 84.5% Clay = 7.4% -trace to some sand, trace to some sub-rounded gravel		5	SS	100	9	120	17 / 20 32	Bentonite
4			1204.3	6	GB					
		CLAY (TILL), silty, some sand, trace gravel, medium plasticity, very stiff, brown, moist	4.6	7	SS	50	11	239	20	
5		-occasional coal fragments		8	GB					
6				9	SS	67	15	287	18	Sand
7				10	GB					
8		- some sand to sandy		11	SS	33	20	239	16	Screen
				12	GB					
9				13	SS	60	25	287	18	
		- sand seam, dark brown	1199.3							

Bottom of hole at 9.6m.

RECORD OF TESTHOLE : MW16-04

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
PROJECT NAME Hawkwood Lands
DRILLING DATE 2016-10-18
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
DRILLING METHOD Solid Stem Auger
EQUIPMENT TYPE Truck Mounted Auger Drill
LOGGED BY CS **CHECKED BY** MT

CLIENT Highfield Land Management Inc.
PROJECT LOCATION Calgary, Alberta
BOREHOLE LOCATION
ELEVATION 1204.05m
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
▼ **AT END OF DRILLING** 3.05m
▼ **AFTER DRILLING** 1.5m 28/10/2016

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m (20 40 60 80) / DYNAMIC CONE BLOWS/0.3m (20 40 60 80)	POCKET PEN. (kPa) (100 200 300 400) / FIELD VANE SHEAR (kPa) Peak Remold (40 80 120 160)	FINES CONTENT (%) (20 40 60 80) / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL (20 40 60 80)	WELL DIAGRAM Casing Top Elev: m
0		TOPSOIL, some clay, trace silt, sandy, some organics, dark brown, moist	1204.0 / 0.0	1	GB					
1		CLAY, silty, trace fine sand, trace sulphates, medium plasticity, stiff, light brown, moist -occasional grey mottling, trace rootlets to 1.8m		2	GB					
2				3	SS	100	8	287	27	
				4	GB					Cuttings
3		-occasional silt seams, wet		5	SS	100	8	96	32	
4			1199.5	6	GB					
5		CLAY (TILL), silty, some sand, trace fine to coarse sub-angular to sub-rounded gravel, medium plasticity, stiff, brown, moist	4.6	7	SS	100	10	215	25	
		-wet		8	GB					Bentonite
6		-occasional silt seams		9	SS	100	12	239	26	Sand
			1197.2	10	GB					
7		CLAY, some silt to silty, medium plasticity, stiff, brown, moist	6.9							
			1196.3	11	SS	100	11	287	20	Screen
8		CLAY (TILL), silty, some sand, trace fine to coarse rounded to sub-rounded gravel, medium plasticity, stiff, brown, moist	7.8	12	GB					
9		-some gravel		13	SS	100	19	335	19	
			1194.4							

Bottom of hole at 9.6m.

EXP GEO CGY-00092055 LOGS.GPJ EXP STD.GDT 21/11/16

RECORD OF TESTHOLE : MW16-05

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
PROJECT NAME Hawkwood Lands
DRILLING DATE 2016-10-18
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
DRILLING METHOD Solid Stem Auger
EQUIPMENT TYPE Truck Mounted Auger Drill
LOGGED BY CS **CHECKED BY** MT

CLIENT Highfield Land Management Inc.
PROJECT LOCATION Calgary, Alberta
BOREHOLE LOCATION
ELEVATION 1200.60m
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
▼ **AT END OF DRILLING** 4.88m
▼ **AFTER DRILLING** 4.6m 28/10/2016

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m / DYNAMIC CONE BLOWS/0.3m (20 40 60 80)	POCKET PEN. (kPa) / FIELD VANE SHEAR (kPa) Peak Remold (100 200 300 400 / 40 80 120 160)	FINES CONTENT (%) / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL (20 40 60 80)	WELL DIAGRAM Casing Top Elev: m
0		TOPSOIL, some clay, trace silt, sandy, some organics, dark brown, moist	1200.5 / 0.1	1	GB					Cuttings
1		CLAY (TILL), silty, some sand, trace fine to coarse sub-rounded gravel, trace rootlets, trace sulphates, low to medium plasticity, stiff, brown, damp		2	GB					
				3	SS	100	13	311	13	
2				4	GB				15 / PL 16 — 40	
3		Grain Size Analysis: Gravel = 3.7% Sand = 16.4% Silt = 67.1% Clay = 12.8%								
		-trace fine gravel, very stiff		5	SS	100	17	335	14	
4		-light brown		6	GB					Bentonite
5		-grey ▽ ▼		7	SS	100	18	263	14	
				8	GB					
6		-sandy, gravelly, medium plasticity, stiff		9	SS	80	14	192	15	Sand
7		-brown		10	GB				16	
			1192.8	11	SS	100	13	192	25	Screen
8		CLAY, some silt, trace coarse sand, medium plasticity, light brown, moist, stiff	7.8							
		- silty		12	GB				23	
9		- occasional silt seams, grey, occasional oxidation	1191.0	13	SS	90	17		22	

Bottom of hole at 9.6m.

EXP GEO CGY-00092055 LOGS.GPJ EXP STD.GDT 21/11/16

RECORD OF TESTHOLE : MW16-06

exp Services Inc.

PROJECT NUMBER CGY-00092055-00
PROJECT NAME Hawkwood Lands
DRILLING DATE 2016-10-18
DRILLING CONTRACTOR Earth Drilling Co. Ltd.
DRILLING METHOD Solid Stem Auger
EQUIPMENT TYPE Truck Mounted Auger Drill
LOGGED BY CS **CHECKED BY** MT

CLIENT Highfield Land Management Inc.
PROJECT LOCATION Calgary, Alberta
BOREHOLE LOCATION
ELEVATION 1209.00m
GROUND WATER LEVELS: ▽ **AT TIME OF DRILLING** ---
▼ **AT END OF DRILLING** --- Dry
▼ **AFTER DRILLING** --- 28/10/2016 Dry

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m (20 40 60 80) / DYNAMIC CONE BLOWS/0.3m (20 40 60 80)	POCKET PEN. (kPa) (100 200 300 400) / FIELD VANE SHEAR (kPa) Peak Remold (40 80 120 160)	FINES CONTENT (%) (20 40 60 80) / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL (20 40 60 80)	WELL DIAGRAM Casing Top Elev: m
0		TOPSOIL, trace to some clay, silty, sandy, some organics, dark brown, moist	1208.7	1	GB					
		Grain Size Analysis: Gravel = 0.2% Sand = 47.9% Silt = 40.5% Clay = 11.4%	0.3	2	GB				22	
1		CLAY, silty, trace sand, trace rootlets, medium plasticity, light brown, damp to moist								
		-occasional silt seams and lenses		3	SS	100	9			
2				4	GB				19	Cuttings
		-trace coarse round gravel, damp								
3		-very stiff		5	SS	100	15			
				6	GB				18	
4			1204.7							
		CLAY (TILL), silty, some sand, trace sub-angular to rounded gravel, medium plasticity, brown, damp to moist, stiff	4.3	7	SS	100	14			
5		-occasional grey lenses		8	GB				14	Bentonite
6										Sand
				9	SS	40	22			
				10	GB				15	
7		-occasional coal fragments								
				11	SS	50	19			Screen
8				12	GB				15	
		-occasional cobbles								
9				13	SS	100	24			
			1199.4							

Bottom of hole at 9.6m.

RECORD OF TESTHOLE : MW16-07

exp Services Inc.

PROJECT NUMBER CGY-00092055-00 **CLIENT** Highfield Land Management Inc.
PROJECT NAME Hawkwood Lands **PROJECT LOCATION** Calgary, Alberta
DRILLING DATE 2016-10-18 **BOREHOLE LOCATION**
DRILLING CONTRACTOR Earth Drilling Co. Ltd. **ELEVATION** 1205.68m
DRILLING METHOD Solid Stem Auger **GROUND WATER LEVELS:** ▽ **AT TIME OF DRILLING** ---
EQUIPMENT TYPE Truck Mounted Auger Drill ▼ **AT END OF DRILLING** --- Dry
LOGGED BY CS **CHECKED BY** MT ▼ **AFTER DRILLING** 4.8m 28/10/2016

DEPTH (m)	STRATA	SOIL DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY %	SPT N VALUE BLOWS/0.3m (20 40 60 80) / DYNAMIC CONE BLOWS/0.3m (20 40 60 80)	POCKET PEN. (kPa) (100 200 300 400) / FIELD VANE SHEAR (kPa) Peak Remold (40 80 120 160)	FINES CONTENT (%) (20 40 60 80) / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL (20 40 60 80)	WELL DIAGRAM Casing Top Elev: m
0		TOPSOIL, some clay, trace to some silt, sandy, some organics, dark brown, moist	1205.4 / 0.2	1	GB					
1		CLAY (TILL), silty, some sand to sandy, some rounded to angular gravel, medium plasticity, very stiff, brown, damp to moist		2	GB				11	Cuttings
2		-some rounded gravel, some sand		3	SS	40	23	239		
		-trace sand, trace sulphates Grain Size Analysis: Gravel = 9.1% Sand = 19.2% Silt = 64.5% Clay = 7.2%		4	GB				13 14 36	
3		CLAY, silty, sandy, low to medium plasticity, brown, occasional grey mottling, moist, very stiff	1202.6 / 3.0 / 1202.2	5	SS	50	19		18	
4		SILT, trace to some sand, trace to some clay, non to low plastic, stiff, brown with occasional grey mottling, moist to wet	3.5	6	GB				18	Bentonite
5	▼			7	SS	30	15			
		CLAY (TILL), silty, some sand, trace fine to coarse rounded to sub-rounded gravel, medium plasticity, very stiff, brown, moist	1200.5 / 5.2	8	GB			287	11	
6		-occasional cobbles and boulders		9	SS	0	50			Sand
7		-some gravel		10	GB				12	
8		-occasional coal fragments		11	SS	10	19			Screen
				12	GB					
9		CLAY, silty, trace sand, medium plasticity, light brown, occasional oxidation, moist, stiff -grey	1196.5 / 9.1 / 1196.1	13	SS	90	13		27	

Bottom of hole at 9.6m.

EXP GEO CGY-00092055 LOGS.GPJ EXP STD.GDT 21/11/16