GEOTECHNICAL DESKTOP ASSESSMENT – PARKS CANADA STAFF HOUSING DUPLEX

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Executive Summary

This document presents the results of a desktop geotechnical assessment prepared by Stantec Consulting Ltd. (Stantec) for Parks Canada, relative to the construction of the proposed Staff Housing Duplex, to be located in a lot 36 m wide by 40 m long at 113B McDermot Avenue, in Fort Chipewyan, AB.

A house with a full basement was previously present in the same lot, subsequently demolished and removed. The demolition site is currently covered with fill. As-built records of the backfill material were not available at the time of report preparation, but based on communications with Parks Canada the fill was placed in a compacted condition.

Based on the review of available geotechnical information from two nearby sites and regional geology documents, the subsurface conditions in native, undisturbed areas are expected to consist of silty sand with some gravel, overlying granite gneiss bedrock. Different subsurface conditions may be expected at the demolition site, where the presence of fill (possibly common fill) potentially extending to bedrock may be encountered. The following general findings were noted during Stantec's review of existing geotechnical information:

- Groundwater was not encountered during the excavation of the test pits reviewed, which achieved depths ranging from 1.4 m to 2.3 m.
- An Ultimate Limit States (ULS) factored bearing capacity of 500 kPa was recommended for spread footings bearing on levelling gravel pads over competent granite gneiss bedrock.
- Based on the potential content of water-soluble sulphates in the soil, moderate sulphate resistant (Type MS) hydraulic cement was recommended.
- Additional recommendations in the desktop geotechnical assessment include site preparation, excavations, frost protection, grading and drainage, and site seismic classification.

1 Introduction

Stantec Consulting Ltd. (Stantec) was retained by Parks Canada to undertake a geotechnical desktop assessment to support the detailed design and construction of a proposed new modular duplex housing building located at 113B McDermot Avenue (the Site) in the Hamlet of Fort Chipewyan, AB.

The present report provides the results of the desktop geotechnical assessment, prepared based on the scope of work described in Stantec's proposal to Parks Canada dated October 13, 2023.

Limitations associated with this report and its contents are provided in the statement included in **Appendix A**.

2 Background

The proposed Staff Housing Duplex will consist of a two-story structure constructed on a lot approximately 36 m wide by 40 m long. The building will consist of above-grade modular elements without basements. The type of foundation initially preferred by Parks Canada was a space frame. Subsequently a crawl space and footing foundations were put forward by Parks Canada as the preferred foundation option.

A house with a full basement was previously present in the same lot. Based on communications with Parks Canada, Stantec understands that the house was demolished and removed in March 2023, and that the excavated area was subsequently backfilled and compacted. The backfill depth, the type of material used for backfilling, the compaction level the backfill material was placed with, and the results of materials testing during backfill compaction and placement had not been provided to Stantec at the time of preparation of this report.

A plan view of the area showing the location of the site is included in **Figure 1**.

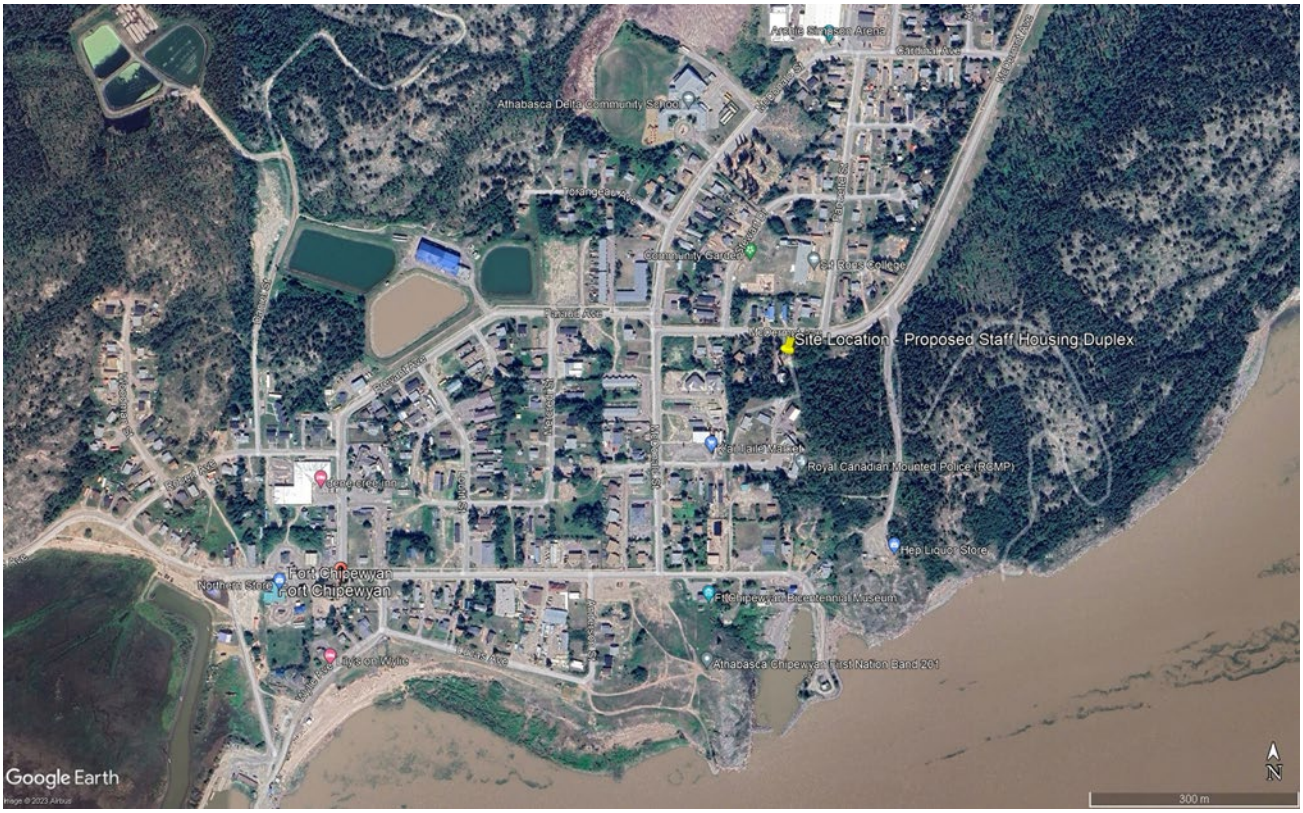

Figure 1 Site Location

3 Methodology

The methodology followed in the preparation of the geotechnical desktop assessment is outlined below:

(a) Review of available geotechnical information and regional geology documents. The sources of information are included in the references.

(b) Assess potential subsurface conditions.

(c) Provide recommendations applying geotechnical engineering judgement and the criteria established in the Canadian Foundation Engineering Manual, 4th Ed. (2006).

4 Regional Geology and Expected Subsurface Conditions

A review of published regional geology (Godfrey, 1980) indicated Fort Chipewyan is situated in an area dominated by alluvial sediments deposited in the delta at the convergence of the Peace and Athabasca Rivers. Deltaic sediments form a continuous complex of sand, silt and clay over much of the lowlands west of Lake Athabasca and are covered by a series of shallow lakes and swamps. The deltaic surficial deposits vary widely in sand, silt and clay contents. In particular, the area where the site is present comprises a surficial sand deposit, overlying biotite granite gneiss bedrock. The bedrock composition is predominantly granite, with minor quartz monzonite, granodiorite, quartz diorite and monzodiorite. The biotite granite gneiss color is typically pink to reddish. Bedrock may be present at shallow depth, which in the vicinity of the site may be about 2 m, based on the references noted below.

The geotechnical investigations carried out by Thurber Engineering Ltd. (Thurber 2018) and Parkland Geotechnical Consulting Ltd. (Parkland Geo 2020) included the excavation of test pits located relatively close to the proposed building site. The test pit logs of both geotechnical investigations above noted are included in **Appendix B** and **Appendix C**. A site plan showing the approximate locations of the test pits excavated by Thurber and Parkland Geo is shown in **Figure 2**.

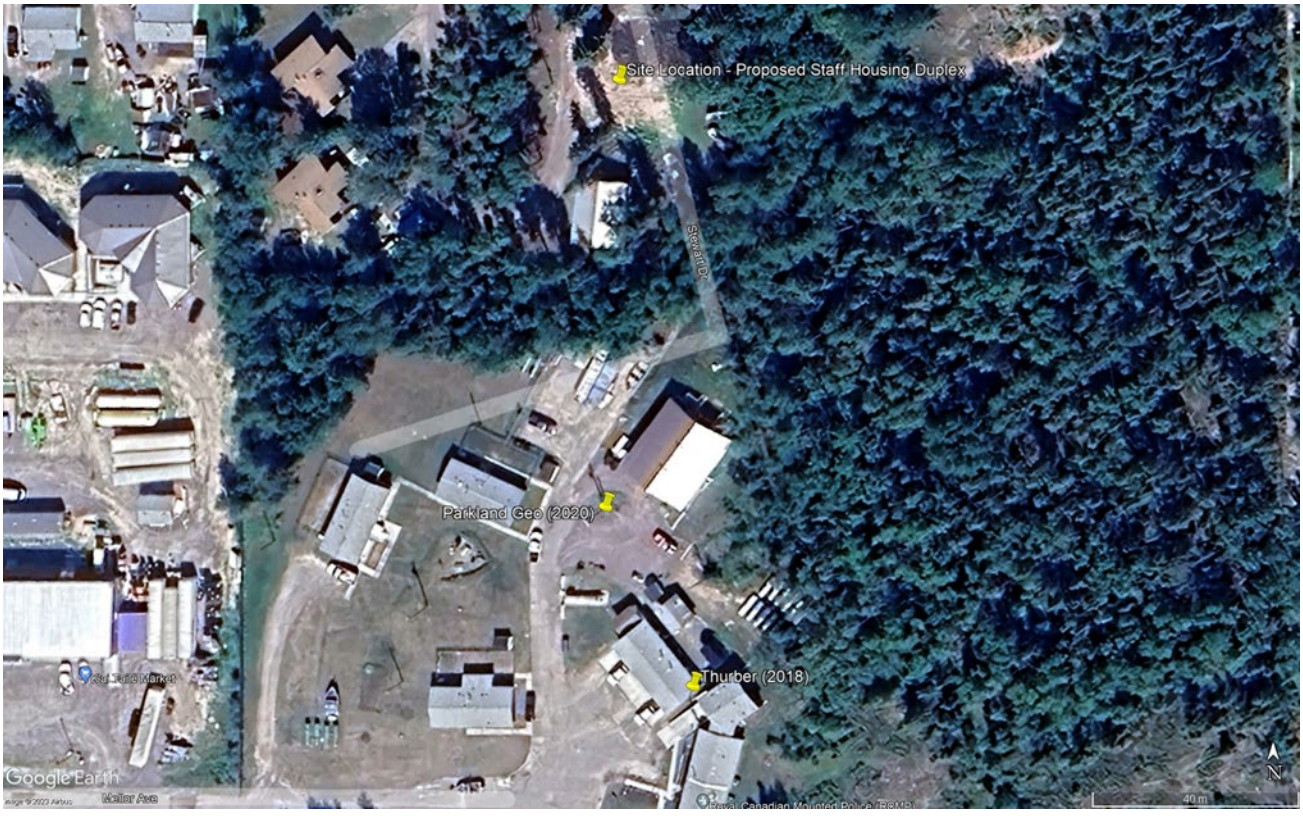

Figure 2 **Plan View Showing the Location of the Proposed Modular Complex and the Test Pits Carried Out by Thurber (2018) and Parkland Geo (2020)**

Based on the findings from the test pit programs carried out by Thurber and Parkland Geo, and the review of regional geology previously noted, the following subsurface conditions are expected in undisturbed native areas around the site, in descending order:

(a) TOPSOIL, potentially up to about 0.4 m thick.

(b) SAND, silty, with some gravel, potentially up to about 2 m thick, with a compact relative density.

(c) BEDROCK, granite gneiss, weathered, moderately hard.

Different subsurface conditions are expected at the demolition site, where a house with full basement was previously present. As noted in **Section 2**, the backfill depth, the type of material used for backfilling, the compaction level the backfill material was placed with and the results of materials testing during backfill compaction and placement had not been provided to Stantec at the time of this report preparation. On this basis but considering Parks Canada indicated the fill had been compacted during placement, it is recommended to consider the material above bedrock as common fill but not consider it for load bearing purposes.

The groundwater level was not encountered during the excavation of the test pits carried out by Thurber and Parkland Geo, which achieved maximum depths of 1.7 m and 2.3 m, respectively. No seepage was observed in the walls of the test pits, which remained stable, showing no signs of sloughing. It should be noted that the test pits excavated by Thurber and Parkland Geo were carried out in February and November, respectively. Groundwater levels fluctuate during the year, typically being higher after spring thaw and in the summer season.

5 Geotechnical Recommendations

5.1 Site Preparation

The following recommendations for site preparation are provided:

(a) Strip topsoil and stockpile it separately from mineral soil materials for potential reuse. Place it over a geotextile to prevent material contamination. Topsoil thickness up to 400 mm was observed in the test pits excavated by Parkland Geo (2020).

(b) The foundations of the modular complex should be founded on bedrock. For this purpose, carry out the excavation to competent bedrock following the recommendations included in **Section 5.2**.

(c) Stock-pile competent excavated material, to be reused as backfill. Refer to excavation recommendations included **Section 5.2**.

(d) Prior to construction foundation, prepare bedrock surface as noted in **Section 5.4**.

(e) Following footing construction, backfill the excavation using competent excavated material, compacted to 95% Standard Proctor Maximum Dry Density (SPMDD), placed in compacted lifts not exceeding 150 mm thickness. The fill should have a water content within ±3% of the Optimum Moisture Content (OMC) to achieve the required degree of compaction. Organics, frozen soil, or otherwise deleterious material should be excluded from the fill.

(f) Follow grading and drainage recommendations included **Section 5.5**.

5.2 Excavation

Excavations for foundations, trenches and potentially other infrastructure will be required. All temporary excavations, (i.e. excavations made for construction purposes, under regular observation and backfilled at the end of the construction activity), including trenches, should be carried out in accordance with the Alberta Occupational Health and Safety (OH&S) Act.

Temporary excavations in fill or native soils up to a depth of 2.5 m should be carried out no steeper than 2H:1V. Alternatively, a shoring system may be used. Excavations should be inspected regularly for signs of instability and flattened as required, particularly after periods of rain or adjacent to surface water ponding or accumulation.

Groundwater and isolated perched water levels may be encountered in excavations. On this basis, the Contractor should consider the possibility of further flattening the cut slope and requiring drainage measures, which are expected to comprise ditches along the perimeter of the excavation, discharging to a sump containing a submersible pump to manage water influx. In case of deep buried utilities, water in the bottom of trenches may be directed to sumps and subsequently pumped out.

Stockpiles of materials and excavated soil should be placed away from the crest by a distance equal to at least the proposed depth of excavation. Similarly, light vehicles should be kept back at least 1 m from the crest of the excavation. Heavy vehicles including hydrovac trucks, should be parked away from the crest by a distance equal to at least the proposed depth of excavation. The excavation slopes should be checked regularly for signs of spalling, cracking, slumping, ravelling, etc., particularly after periods of rain or adjacent to surface water ponding or accumulation.

Surface run-off can potentially saturate and degrade the excavation material if not directed away from excavations promptly. Surface drainage should be directed away from the crest of the excavation. If groundwater seepage occurs through the sides of the excavation, the slopes may tend to undergo sloughing, and maintenance and monitoring of the excavation may be necessary.

5.3 Frost Protection

The soil in undisturbed areas, consisting of silty sand with some gravel, and the fill in the demolition site area, may be considered frost susceptible. The mean annual frost penetration depth estimated for a silty sand granular soil is 2.6 m. The frost penetration depth for a 50-year return period is 3.1 m.

Foundations are expected to be outside heated areas due to the presence of the crawl space. As mentioned in **Section 5.4**, the footings will be founded directed over the bedrock with minimum leveling gravel, the potential of frost heave below the footing is considered negligible. Therefore, no frost protection is needed for footings founded on bedrock.

Buried water/sewer lines subjected to freezing should be installed below the frost penetration depth of 3.1 m or alternatively protected by insulation. The insulation can be assembled to form a four-sided shaped box, or alternatively placed in one horizontal layer above the pipe or in an “inverted U” shape, where insulation is installed vertically along the trench walls, in addition to a horizontal section above the pipe. The total length of insulation required, including any vertical sections, is dependent on the burial depth and can be determined based on the following formula:

$$W = D + 2(F - X) - 0.3$$

Where:

W = width of insulation (m)

D = pipe diameter (m)

X = insulation depth (m)

F = estimated frost penetration depth, 3.1 m for 50-year return period (m)

5.4 Foundations

Based on the subsurface conditions expected at the site, spread footings bearing on competent granite gneiss bedrock are considered adequate to support the proposed Staff Housing Duplex. In order to provide an adequate surface for the concrete footings and avoid stress concentrations, placement of a levelling pad with 150 mm minimum thickness located between the footing underside and the bedrock is recommended. The levelling pad may consist of crushed gravel (with less than 10% passing the 80 µm sieve and a maximum aggregate size of 20 mm). The gravel pad should extend a minimum of 300 mm from the edge of the footings. The gravel should be placed in 150 mm lifts and compacted to 100% of Standard Proctor Maximum Dry Density. Lean concrete may be used as an alternative to create a leveling pad for the footings.

Based on these recommendations, a ULS factored bearing capacity of 500 kPa may be considered for spread footings founded on the above recommended leveling pad overlaying competent granite bedrock. The ULS factored bearing capacity above noted includes a geotechnical resistance factor of 0.5.

Prior to footing construction, the exposed bedrock surface should be inspected by qualified geotechnical personnel.

Based on the results of water-soluble sulphate testing (Parkland Geo, 2020), the use of Moderate Sulphate Resistant (Type MS) hydraulic cement is recommended. The minimum 56-day compressive strength is 30 MPa, with a maximum water / cement ratio of 0.5. All concrete exposed to freezing environment during or after construction should be air entrained.

Imported soil material brought to site to be used as fill should be tested for water-soluble sulphate ion content prior to use.

5.5 Grading and Drainage

The site should be graded during the early stages of construction to provide for positive drainage of surface runoff away from the work areas.

Excessive rutting and subgrade failure caused by construction activities should be prevented. Precautions should include use of light, track mounted equipment and restricting traffic over the subgrade. Gravel covered geotextile placed over unstable, weak subgrades to create working platforms for construction may be required. Scrutiny of construction activities is recommended.

The upper 0.5 m of backfill around the proposed new building should consist of compacted cohesive soil to act as a seal against the ingress of surface runoff. The cohesive soil should extend a minimum distance of 1.5 m beyond the building and should be graded at a minimum gradient of 2%.

Roof leaders at the building location should preferably connect directly into a storm water collection system. Alternatively, down spout extensions should be installed to ensure that the discharge water does not back up against the building nor allowed to collect in depressed areas near the building.

5.6 Site Seismic Classification

The site is in a relatively low seismic activity zone; however, the proposed structures should be designed to resist a minimum earthquake force as per the National Building Code of Canada (NBCC) National Resources Canada (NRC 2015).

Based on the NBCC ground motions for a 2% probability of exceedance in 50 years and a damping ratio of 5%, the following spectral acceleration (Sa) and peak ground acceleration (PGA) parameters expressed as a fraction of gravity acceleration (g) should be used in the analyses:

- Sa (0.2) = 0.052 g
- Sa (0.5) = 0.031 g
- Sa (1.0) = 0.016 g
- Sa (2.0) = 0.006 g
- PGA = 0.030 g.

The site area is considered to be Site Class C, average shear wave velocity 450 m/sec, corresponding to “firm ground”, defined by NBCC.

6 Closure

This report has been prepared for the sole benefit of the Client (Parks Canada) and their agents and may not be used by any third party without the expressed written consent of Stantec Consulting Ltd. (Stantec) and Parks Canada. Any use that a third party makes of this document is the responsibility of such third party. Use of this report is subject to the Statement of General Conditions provided in **Appendix A**.

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- Standard of care
- Interpretation of site conditions
- Varying or unexpected site conditions
- Planning, design or construction

We trust that this report meets your requirements at this time. Should you have any questions, or if we can be of further assistance, please do not hesitate to contact the undersigned at any time. This report was prepared by Gustavo Padros, M.Sc, P.Eng., and Eric Leishman, M.Sc, P.Eng., and reviewed by Xiteng Liu, M.Sc., P.Eng., PMP.

Respectfully Submitted,

Stantec Consulting Ltd.