

April 11, 2024

Government of Yukon
Community Services
Land Development Branch
PO Box 2703
Whitehorse, YT Y1A 2N1

ISSUED FOR USE
FILE: 704-ENG.WARC04532-01
Via Email: Eamonn.Pinto@yukon.ca

Attention: Eamonn Pinto – Project Manager

Subject: Lot Development and Foundation Design Bulletin
Phase 7 Whistle Bend Subdivision, Whitehorse, Yukon

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by the Government of Yukon, Department of Community Services Land Development Branch (YG) to provide geotechnical recommendations pertaining to residential lot development and foundation design for Phase 7 of the Whistle Bend Subdivision, Whitehorse, YT.

This bulletin was prepared to be used by builders and developers and its contents incorporated into design and construction plans for single detached structures, cottage cluster homes, and residential townhouses.

2.0 SCOPE OF SERVICES

Tetra Tech's scope of services included the following:

- Describing the site and soil conditions that will be anticipated throughout Phase 7.
- Discussing the site and soil conditions that may affect lot grading and site drainage, along with presenting appropriate methods of controlling surface water flow and disposal.
- Summary of considerations for foundation design and construction including descriptions of foundation systems considered most appropriate for Phase 7.
- Discussion of seasonal frost considerations and providing perimeter insulation recommendations for use during foundation construction of single detached and multi-family structures to minimize potential for damage caused by seasonal frost heave.

3.0 SITE CONDITIONS

3.1 Location and Surficial Features

Phase 7 in the Whistle Bend Subdivision is located directly west of Phase 6. The northern portion of Phase 7 along Witch Hazel Drive is situated between Phase 9B, Phase 10 and Phase 11. The main corridors allowing access into the area are Leota Street, Wyvern Avenue, Flora Avenue, Quick Street, Omega Street, and Witch Hazel Drive.

We understand the proposed zone designations selected for Phase 7 include Cottage Cluster Homes (RCM3), Comprehensive Residential Single Family 3 (RSC3) and Comprehensive Residential Townhouses (RCT).

The site has been cleared of tree cover and graded to promote surface water management, directing the majority of the storm runoff to the retention pond located west of Flora Avenue. Phase 7 is nominally flat and contains some micro terrace features. Prior to grading there was a sand deposit along the west side of Wyvern Avenue in Phase 6, but the sand deposit was used during Phase 6 Construction.

3.2 Soil Conditions

Prior to site grading and deep utility installation, a thin surficial organic root mat was observed at the surface. On the western perimeter of Phase 7, sand containing trace to some silt (0 – 20%), was observed at depths ranging from 0.2 to 1.9 m below the ground surface. It is likely that the thickness of the sand has been reduced in most areas, and the organics have been removed now that site grading, deep utility installation and surface work construction has been completed.

Underlying the surficial organic root mat and sand veneer is glaciolacustrine silt. The silt encountered during the geotechnical evaluation and construction, was found to be clayey and to increase in plasticity at a depth between 4.0 to 4.5 m indicating a possible increase in the content of clay. The moisture content of the silt soils was also found to increase with depth and ranged from approximately 17% to 30%.

3.3 Groundwater

Groundwater was not noted in any of the test pits and boreholes advanced within Phase 7. During development of previous phases, water was encountered when connecting residential services to water and sanitary mains. Presently it is anticipated that this water flowing through the deep utility pipe bedding is not naturally occurring and may be a result of municipal water leaks. We understand that investigation into this is on-going.

During Phase 7 construction and installation of deep utility infrastructure, mitigative measures (trench plugs) were constructed to reduce the potential for water conveyance. The presence of water in Phase 7 deep utility bedding zones has not been observed to date; however, there is potential it may be encountered during water and sanitary service connection work, or foundation and basement excavation. Developers should be prepared to mitigate if required.

4.0 LOT GRADING AND DRAINAGE CONSIDERATIONS

Grading plans for all residential developments should ensure positive drainage of surface water onto paved roadways and/or into the storm sewer system. Rock pits constructed on individual lots for stormwater management are not considered suitable or feasible for Phase 7. Functional eavestroughs and downspouts are critical for diverting surface water runoff away from foundations. Downspouts should be discharged a minimum of 1.0 m from foundation walls. Splash pads are recommended.

5.0 FOUNDATION CONSIDERATIONS

The design and construction of residential housing typically falls under Section 9 of Division B in the National Building Code of Canada (current version NBCC 2020). This includes Group C residential structures that are three

stories or less in building height and having a building footprint area not exceeding 600 m². As new versions of the NBCC are released is the builder's responsibility to ensure they are following the current edition.

This section of the building code provides general guidelines for the design and construction of residential housing, often without the requirement of additional geotechnical input. Typical foundation systems, as described below are expected to perform suitably in Phase 7, provided the guidelines in Section 9 of NBCC, including Section 9.4.4.4 – Soil Movement (which discusses seasonal frost movement), and the recommendations included in this bulletin, are followed.

Tetra Tech understands that there have been some occurrences of ground movement impacting residential foundations in the Whistle Bend subdivision. It is our understanding that these occurrences have been predominately caused by frost-related ground movement, which can be mitigated as discussed below in Section 6, as well as in the referenced NBCC sections.

Foundation systems that are considered appropriate for Phase 7 include:

- Thickened edge monolithic slab-on-grade;
- Shallow strip footings foundation systems;
- Strip footings supporting a partial or full basement if the soils at depth are not excessively wet and soft; and
- Helical piles are also considered acceptable.

For the foundation systems listed, the requirements for damp proofing and seasonal frost protection measures should be reviewed for each development.

If the development falls under Section 4 of Division B of NBCC additional geotechnical evaluation of the site may be required. This may include a geotechnical drilling program, seismic cone penetration, and laboratory testing to assess foundation soil conditions, determine an appropriate Seismic Designation, and assess liquefaction risk. A geotechnical engineering firm should be contacted to provide pricing to complete a site-specific geotechnical evaluation if required.

5.1 Foundation Drainage Considerations

According to the City of Whitehorse Building Advisory October 25, 2010, *Drainage Standards for Building Foundations* (City of Whitehorse, 2010), any new building constructed in Whitehorse with below-grade foundations must adhere to prescribed standards for drainage. The relevant standards referenced in the City of Whitehorse document include the following:

- Permanent Wood Foundations, as outlined in CAN/CSA S-406-92, *Construction of Preserved Wood Foundations* and identified in the 2005 edition of the National Building Code of Canada (NBCC 2005).
- Concrete Foundations, as described in NBCC 2015, Section 9.14, which identifies minimum requirements for foundation drainage, drainage tile and associated piping, granular drainage layers, drainage disposal, and control of surface runoff.

The prescriptive measures are based on CSA and NBCC specifications as summarized in the following sections, as understood from the current edition of the NBCC.

5.1.1 Permanent (Preserved) Wood Foundation Drainage

If the use of permanent (preserved) wood foundations (PWF) is desired, a granular drainage layer should be installed beneath all footings and basement slabs, in accordance with CAN-CSA S406, because of the low permeability of the underlying glaciolacustrine material. Adequate thicknesses of free draining soil (sand and/or gravel) is generally not expected throughout Phase 7, therefore this requirement will not likely be waived for new developments; however, this can be reviewed on a case-by-case basis by a geotechnical engineer if required.

Existing site soils can be used as backfill around foundations and in service trenches. All backfill materials should be moisture conditioned and compacted to at least 95% of Standard Proctor Maximum Dry Density (SPMDD).

The design life of a preserved wood foundation system relies on keeping water away from the preserved wood foundation elements, so damp proofing of the foundation wall and the proper construction of the granular drainage layer is critical. All backfill material placed within 600 mm of the foundation walls should be free of deleterious debris, frozen materials, and large, angular rocks larger than 150 mm in diameter.

When considering the use of potentially frost susceptible fine-grained soil for backfill along the perimeter of the PWF foundation walls, season frost protection may be required to avoid frost related movement.

5.1.2 Concrete Foundation Drainage

If the use of concrete foundations (including ICF Block Wall foundations) is desired, the drainage tile and pipe, granular drainage layers, drainage disposal, and surface drainage specifications outlined in NBCC, Section 9.14 “Drainage” must be followed. As mentioned above, soil throughout Phase 7 is not generally expected to be free draining; however, this can be reviewed on a case-by-case basis by a geotechnical engineer if required.

Concrete footing and foundation wall systems are required to have perimeter drainage tile which terminates in a sump pit. A sump pit shall be installed to assist in the removal of water from the foundation area (should water accumulation in the sump pit warrant it).

All backfill material placed within 600 mm of the foundation walls shall be free of deleterious debris, frozen materials, and boulders larger than 150 mm in diameter.

Existing site soils can be used as backfill around foundations and in service trenches. All backfill materials should be moisture conditioned and compacted to at least 95% of SPMDD.

When considering the use of potentially frost susceptible fine-grained soil for backfill along the perimeter of the concrete foundation walls, season frost protection may be required to avoid frost related movement.

6.0 SEASONAL FROST CONSIDERATIONS

6.1 Seasonal Frost Related Movement

Seasonal frost-related movement is common in cold climates when three conditions exist, including:

- Ground temperatures are below freezing for a period of time that allows ice lens growth;
- Frost susceptible soils (i.e., fine grained soils susceptible to the formation of ice lenses) are present; and
- Soil pore space is near 100% saturation.

Throughout the Whistle Bend area there is the potential that all three of these conditions exist. We understand that this potential for frost related soil movement is required to be addressed per Section 4 in NBCC.

Based on Tetra Tech's experience, seasonal frost penetration in the Whitehorse area can typically range up to 3.5 m. This depth is dependent on soil type, surface type, topography and aspect, and snow cover. For residential foundations Tetra Tech typically recommends protecting foundations from at least 2.4 m of frost penetration.

6.2 Foundation Insulation Recommendations

Current local codes dictate the use of insulation around all foundations as under Section 86 of City of Whitehorse's Building and Plumbing Bylaw 99-50 (City of Whitehorse, 2016). **However, this insulation specification is intended for energy efficiency and may not meet the minimum requirements for preventing frost related movement in frost-susceptible soils.**

Depending on the foundation type and depth additional frost protection measures maybe required. This may consist of installing additional moisture resistant, backfillable, perimeter insulation near the surface or at depth around foundations constructed on frost susceptible soils.

Tetra Tech recommends that builders follow the general specifications listed in Table 1 when selecting perimeter insulation for frost protection around foundations. The cases described are based on four different thickness ranges of soil cover above the horizontal perimeter insulation. Typical details for the cases listed can be found in the attached drawing package.

Table 1: Summary of Recommended Perimeter Insulation Specifications

Case	Thickness of Ground Cover Above Insulation	Horizontal Width of Perimeter Insulation	Thickness of Horizontal Perimeter Insulation ¹
1 – Shallow Footing / Slab-on-Grade	$D < 0.6 \text{ m}$	2.4 m	200 mm
2 – Crawl Space	$0.6 \text{ m} \leq D < 1.2 \text{ m}$	1.8 m	150 mm
3 – Partial Basement	$1.2 \text{ m} \leq D < 1.8 \text{ m}$	1.2 m	100 mm
4 – Full Basement	$1.8 \text{ m} \leq D < 2.4 \text{ m}$	0.6 m	50 mm
	$D \geq 2.4 \text{ m}$	No additional frost protection required	

Note 1: Rigid Insulation Assumed to Have a R Value of 4.0 Per 25.4 mm.

Note the scenarios above allow for placement of frost-protection insulation at varying depths, possibly shallower than the footing depth. In these cases, energy efficiency insulation requirements under Section 86 of Bylaw 99-50 may require separate insulation installed per City of Whitehorse details (i.e., 50 mm thick extending 600 mm, immediately above or at footing level). Builders should confirm requirements with the City.

It is Tetra Tech’s experience that protecting external pads and pedestals from frost related ground movement is often forgotten or neglected. For external pads and pedestals the recommendations above apply, however the insulation must be installed around the entire perimeter of the pedestal or beneath the pad while still maintaining the prescribed specified widths and thicknesses above.

Builders should be aware that the recommended widths for perimeter insulation extending horizontally outward from the building’s perimeter foundations may conflict with required setback distances from the foundation to property lines. **Property lines, setbacks, foundation design, and foundation insulation requirements should be reviewed in unison.**

The above recommendations are solely for protecting the foundations and footings from frost movement. If the ground surface is hardscaped or has elements that can be affected by seasonal frost movements (i.e., paved driveway, concrete sidewalks, etc.), additional frost protection measures may be required, such as additional insulation and/or removal of frost susceptible soils and replacement with granular fill.

6.3 Frost Heave and Lot Drainage Considerations

Drainage is crucial to minimizing the potential of frost heave. Lot drainage requirements are presented in the City of Whitehorse Servicing Standards Manual.

Along with drainage control, it is important that the structure has functioning rain gutters and downspouts installed to minimize potential for water to impact soil along the foundation wall and under the footings.

It is important to limit the infiltration of surface water into foundation soils to minimize seasonal frost-related ground movement. Surface water infiltration should be minimized through site grading, functioning eavestroughs, and snow management. Proper installation of perimeter insulation at a positive slope will also aid in directing water that has infiltrated into the soil away from foundation elements.

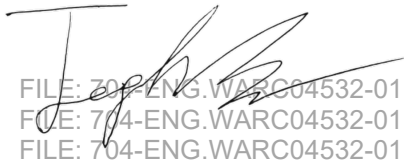
7.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Government of Yukon, Department of Community Services Land Development Branch (YG) and their agents. Tetra Tech Canada Inc. (operating as Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Government of Yukon, Department of Community Services Land Development Branch (YG), or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on the Use of this Document attached in the Appendix or Contractual Terms and Conditions executed by both parties.

8.0 CLOSURE

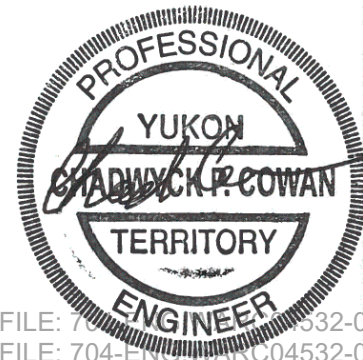
We trust this document meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.



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Prepared by:
Kyle Jephson, E.I.T.
Geotechnical Engineer-in-Training, Arctic Group
Engineering Practice
Direct Line: 250.641.4149
Kyle.Jephson@tetrattech.com



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FILE: 704-ENG.WARC04532-01
FILE: 704-ENG.WARC04532-01
2024-04-11

Reviewed by:
Chad Cowan, P.Eng.
Geotechnical Manager – Yukon, Arctic Group
Engineering Practice
Direct Line: 867.668.9214
Chad.Cowan@tetrattech.com



FILE: 704-ENG.WARC04532-01
FILE: 704-ENG.WARC04532-01
FILE: 704-ENG.WARC04532-01

Reviewed by:
Ian MacIntyre, P.Eng.
Geotechnical Engineer – Team Lead, Arctic Group
Engineering Practice
Direct Line: 867.668.9240
Ian.MacIntyre@tetrattech.com

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Enclosure: References
 Figures
 Appendix A: Tetra Tech and Yukon Government's Limitations on the Use of this Document

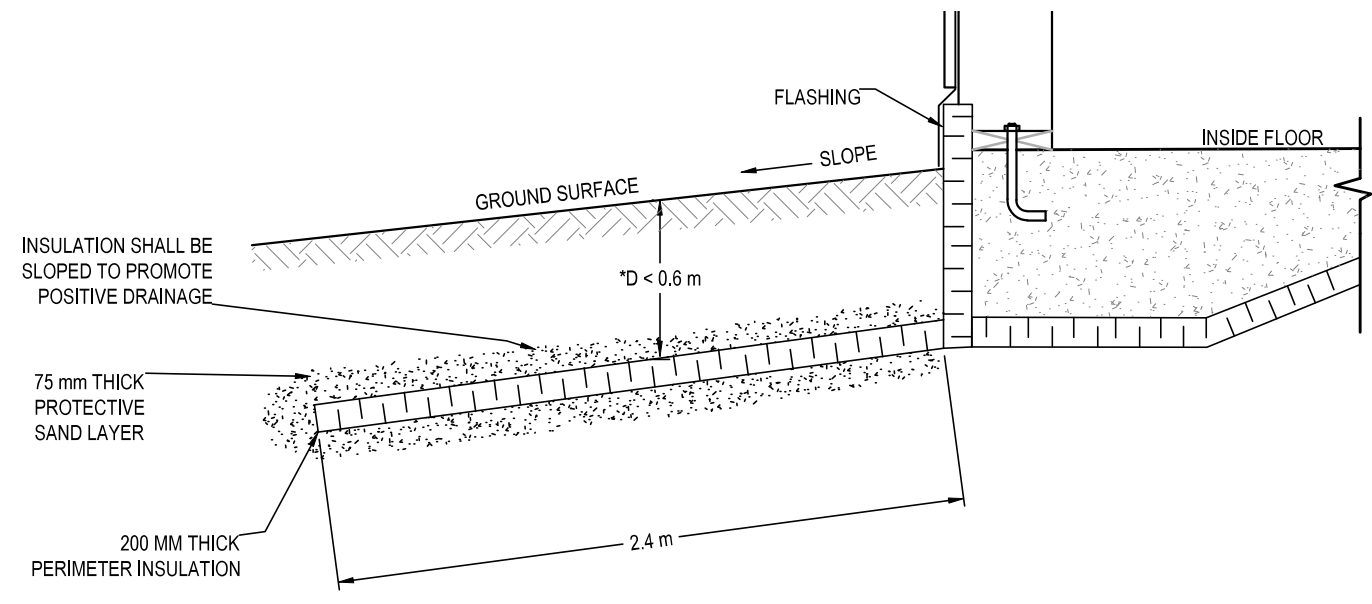
REFERENCES

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- National Research Council of Canada (NBCC). (2005). *National Building Code of Canada 2005*.
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FIGURES

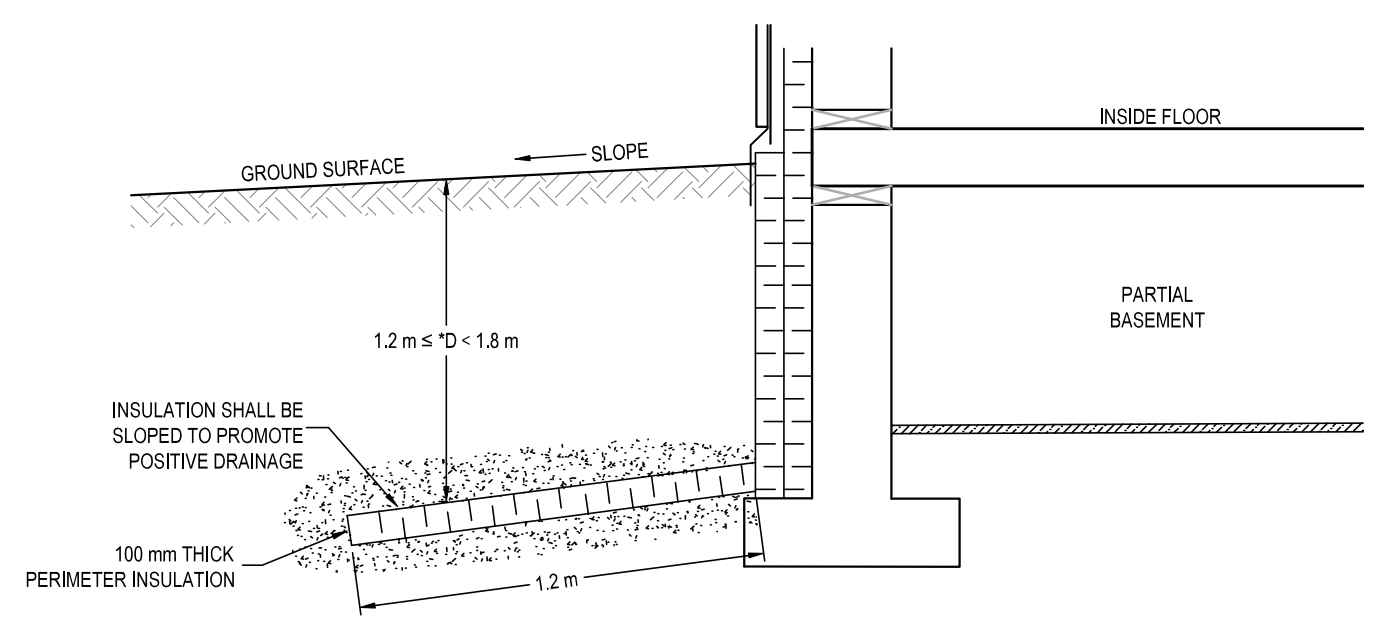
- Figure 1 Residential Foundation Insulation Details (1 of 2)
- Figure 2 Residential Foundation Insulation Details (2 of 2)

Q:\Whitehorse\Drawings\Whitehorse\ENG-WARCO4532-01 Whistle Bend Phase 7 Lot Development and Foundation Design\ENG-WARCO4532-01 Fig.1-R1 - dwg [FIGURE 1] April 02, 2024 - 10:22:19 am (BY: JEPHSON, KYLE)



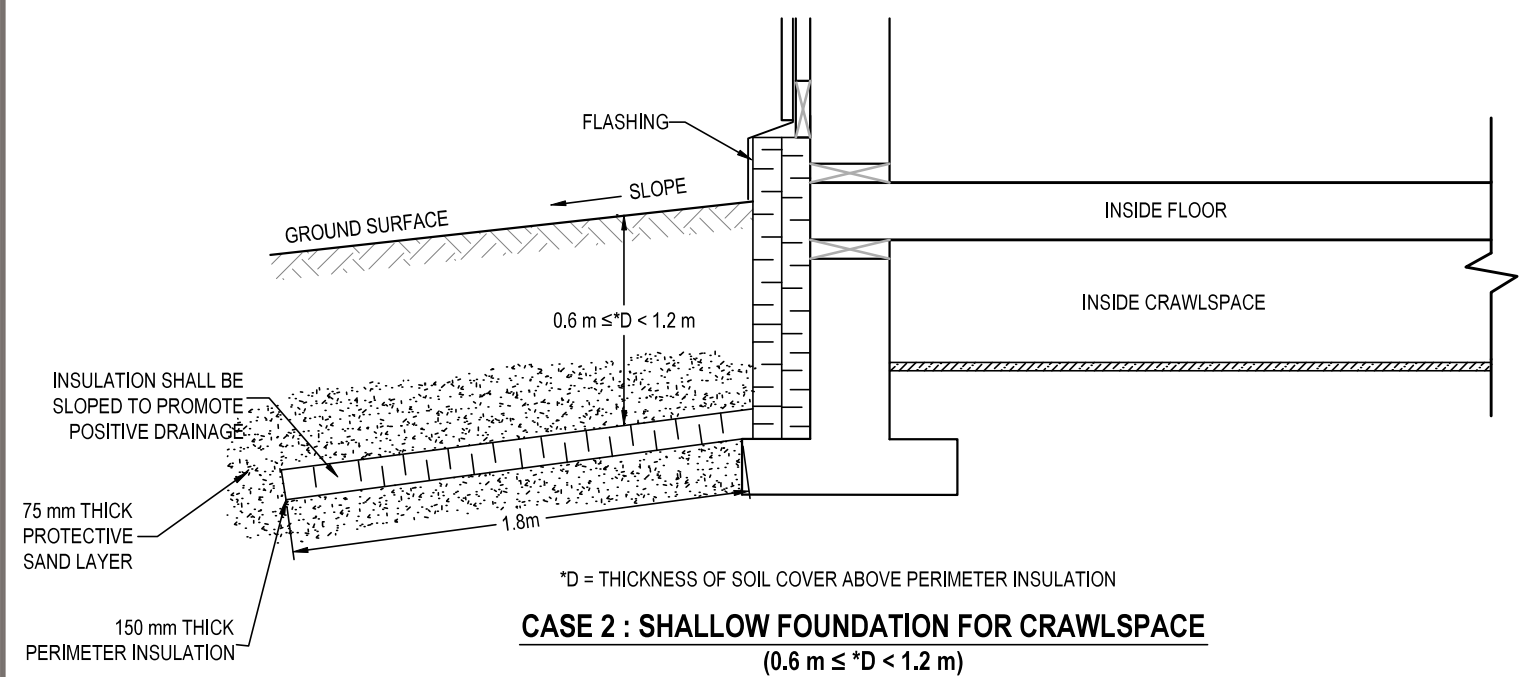
*D = THICKNESS OF SOIL COVER ABOVE PERIMETER INSULATION

CASE 1 : SHALLOW FOOTING / SLAB ON GRADE
(*D < 0.6 m)



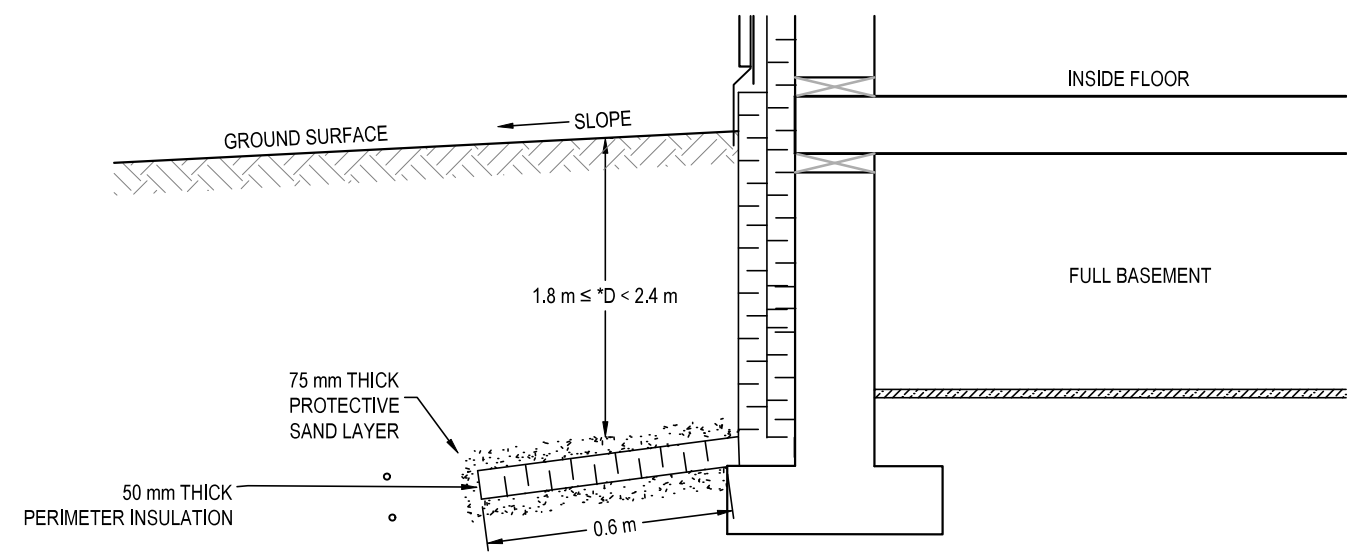
*D = THICKNESS OF SOIL COVER ABOVE PERIMETER INSULATION

CASE 3 : PARTIAL BASEMENT
(1.2 m ≤ *D < 1.8 m)



*D = THICKNESS OF SOIL COVER ABOVE PERIMETER INSULATION

CASE 2 : SHALLOW FOUNDATION FOR CRAWLSPACE
(0.6 m ≤ *D < 1.2 m)



*D = THICKNESS OF SOIL COVER ABOVE PERIMETER INSULATION

CASE 4 : FULL BASEMENT
(1.8 m ≤ *D < 2.4 m)

NOTES :

- INSULATION THICKNESS IS SITE SPECIFIC AND BASED ON SOIL CONDITIONS AND AMOUNT OF SOIL COVER ABOVE FOOTINGS.
- THE INSULATION (DOW CHEMICAL HI SERIES STYROFOAM OR POLYURETHANE OR APPROVED EQUIVALENT) SHOULD BE MOISTURE RESISTANT AND SUITABLE FOR BURIAL
- A MINIMUM BEDDING THICKNESS OF 75 mm OF FINE TO MEDIUM GRAINED SAND SHOULD BE PLACED ABOVE AND BELOW THE INSULATION FOR PROTECTION.
- ALL DIMENSIONS IN TABLE 1 ARE BASED ON RIGID INSULATION ASSUMED TO HAVE A R VALUE OF 4.0 PER 25.4 mm
- THIS PLAN IS NOT TO SCALE

TABLE 1 : SUMMARY OF RECOMMENDED PERIMETER INSULATION SPECIFICATION			
CASE	THICKNESS OF GROUND COVER ABOVE PERIMETER INSULATION	HORIZONTAL WIDTH OF PERIMETER INSULATION	THICKNESS OF PERIMETER INSULATION
1 - SHALLOW FOOTING / SLAB-ON-GRADE	D < 0.6 m	2.4 m	200 mm
2 - CRAWL SPACE	0.6 m ≤ D < 1.2 m	1.8 m	150 mm
3 - PARTIAL BASEMENT	1.2 m ≤ D < 1.8 m	1.2 m	100 mm
4 - FULL BASEMENT	1.8 m ≤ D < 2.4 m	0.6 m	50 mm
	D ≥ 2.4 m	NO ADDITIONAL FROST PROTECTION REQUIRED	

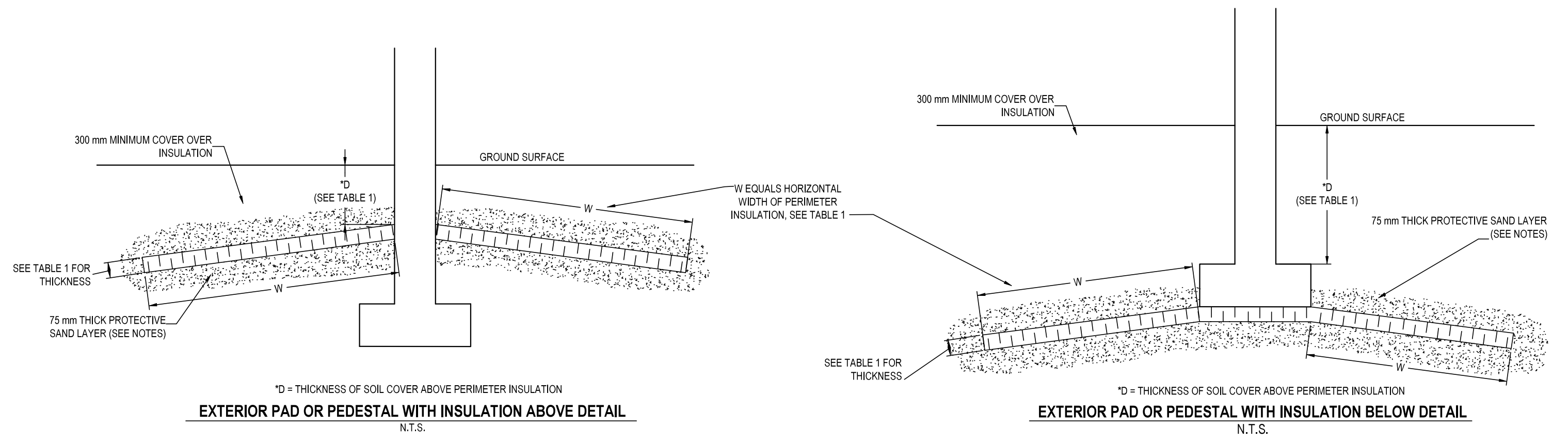
CLIENT

LOT DEVELOPMENT AND FOUNDATION DESIGN BULLETIN
WHISTLE BEND PHASE 7 - WHITEHORSE, YUKON

RESIDENTIAL FOUNDATION INSULATION DETAILS
(1 OF 2)

PROJECT NO. ENG.WARCO4532-01	DWN CB	CKD KJ	REV 0
OFFICE EBA-WHSE	DATE March 27, 2024	Figure 1	

Q:\Whitehorse\Drawings\Whitehorse\ENG-WARC\ENG-WARC04532-01 Whistle Bend Phase 7 Lot Development and Foundation Design\ENG-WARC04532-01 Fig. 1-R1 - dwg [FIGURE 2] April 02, 2024 - 10:22:41 am (BY: JEPHSON, KYLE)



- NOTES :**
- INSULATION THICKNESS IS SITE SPECIFIC AND BASED ON SOIL CONDITIONS AND AMOUNT OF SOIL COVER ABOVE FOOTINGS.
 - THE INSULATION (DOW CHEMICAL HI SERIES STYROFOAM OR POLYURETHANE OR APPROVED EQUIVALENT) SHOULD BE MOISTURE RESISTANT AND SUITABLE FOR BURIAL
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TABLE 1 : SUMMARY OF RECOMMENDED PERIMETER INSULATION SPECIFICATION			
CASE	THICKNESS OF GROUND COVER ABOVE PERIMETER INSULATION	HORIZONTAL WIDTH OF PERIMETER INSULATION	THICKNESS OF PERIMETER INSULATION
1 - SHALLOW FOOTING / SLAB-ON-GRADE	$D < 0.6 \text{ m}$	2.4 m	200 mm
2 - CRAWL SPACE	$0.6 \text{ m} \leq D < 1.2 \text{ m}$	1.8 m	150 mm
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4 - FULL BASEMENT	$1.8 \text{ m} \leq D < 2.4 \text{ m}$	0.6 m	50 mm
	$D \geq 2.4 \text{ m}$	NO ADDITIONAL FROST PROTECTION REQUIRED	

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LOT DEVELOPMENT AND FOUNDATION DESIGN BULLETIN
WHISTLE BEND PHASE 7 - WHITEHORSE, YUKON

**RESIDENTIAL FOUNDATION INSULATION DETAILS
(2 OF 2)**

PROJECT NO. ENG.WARC04532-01	DWN CB	CKD KJ	REV 0
OFFICE EBA-WHSE	DATE March 27, 2024		

Figure 2

APPENDIX A

TETRA TECH AND YUKON GOVERNMENT’S LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL – YUKON GOVERNMENT

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

The Professional Document is intended for the use of TETRA TECH's Client, its officers, employees, agents, representatives, successors and assigns (the "Client") as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the "Contract" herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH. Any changes to the conclusions, opinions, and recommendations presented in TETRA TECH's Professional Document must be authorized by TETRA TECH.

1.2 ALTERNATIVE DOCUMENT FORMAT

Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems, as per agreed project deliverable formats. TETRA TECH makes no representation about the compatibility of these files with the Client's future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be brought to the attention of TETRA TECH within a reasonable time.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by third parties other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, and subject to the standard of care herein, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage, except where TETRA TECH has subcontracted for such information.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

TETRA TECH is neither qualified to make, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 NOTIFICATION OF AUTHORITIES

In certain instances, the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the Client agrees that notification to such bodies or persons as required may be done by TETRA TECH in its reasonably exercised discretion.

1.8 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH has not been retained to explore, address or consider and has not explored, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.9 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems, methods and standards employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.10 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.11 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historical environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional exploration and review may be necessary.

1.12 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.13 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.14 INFLUENCE OF CONSTRUCTION ACTIVITY

Construction activity can impact structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques, and construction sequence are known.

1.15 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, and the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.16 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued satisfactory performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

1.17 DESIGN PARAMETERS

Bearing capacities for Limit States or Allowable Stress Design, strength/stiffness properties and similar geotechnical design parameters quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition used in this report. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions considered in this report in fact exist at the site.

1.18 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

1.19 APPLICABLE CODES, STANDARDS, GUIDELINES & BEST PRACTICE

This document has been prepared based on the applicable codes, standards, guidelines or best practice as identified in the report. Some mandated codes, standards and guidelines (such as ASTM, AASHTO Bridge Design/Construction Codes, Canadian Highway Bridge Design Code, National/Provincial Building Codes) are routinely updated and corrections made. TETRA TECH cannot predict nor be held liable for any such future changes, amendments, errors or omissions in these documents that may have a bearing on the assessment, design or analyses included in this report.