GEOTECHNICAL ENGINEERING REPORT

for the proposed

YAKUTAT COMMUNITY HEALTH CLINIC
YAKUTAT, ALASKA

Prepared for:

Yakutat Tlingit Tribe
606 Forest Hwy 10
PO Box 418
Yakutat, AK 99689

Prepared by:

Northern Geotechnical Engineering, Inc. *d.b.a.* Terra Firma Testing

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DECEMBER 2016

NGE-TFT Project # 4562-16

NORTHERN GEOTECHNICAL ENGINEERING, INC. / TERRA FIRMA TESTING

Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

December 13, 2016 NGE-TFT Project #4562-16

Yakutat Tlingit Tribe
606 Forest Hwy 10
PO Box 418
Yakutat, AK 99689

Attn: Rhoda Jensen – Health Director

RE: GEOTECHNICAL ENGINEERING ASSESSMENT OF THE SITE OF THE PROPOSED YAKUTAT COMMUNITY HEALTH CLINIC, YAKUTAT, ALASKA

Rhoda,

We, Northern Geotechnical Engineering, Inc. *d.b.a.* Terra Firma Testing, have completed a geotechnical engineering assessment of the site of the proposed Yakutat Community Health Clinic in Yakutat, Alaska. Our assessment suggests that the project site is suitable for the proposed improvements assuming that the conclusions and recommendations that we present in the following report are considered during the design and construction processes.

The project site is underlain by shallow sand and gravel deposits which will adequately support the proposed improvements with minimal risk of differential movement. We did not identify any geotechnical or geological conditions within the shallow subsurface at the project site that could jeopardize and/or excessively complicate the proposed development, and from a geotechnical viewpoint, the project site has many favorable engineering characteristics that can lead to simplified design approaches and conventional construction practices. In the following report we provide a summary of our subsurface exploration and laboratory testing programs as well as detail our engineering conclusions and recommendations for the proposed health clinic.

We greatly appreciate the opportunity to provide you with our professional service. Please contact us directly with any questions or comments you may have regarding the information that we present in this report, or if you have any other questions, comments, and/or requests.

Sincerely,
Northern Geotechnical Engineering, Inc. *d.b.a.* Terra Firma Testing,

Andrew C. Smith, CPG
Senior Geologist

Keith F. Mobley, P.E.
President

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1.0 INTRODUCTION

In this report, we (Northern Geotechnical Engineering, Inc. *d.b.a.* Terra Firma Testing) present the results of a geotechnical engineering assessment that we conducted at the site of the proposed Yakutat Community Health Clinic (YCHC) located in Yakutat, Alaska; hereafter referred to solely as "the project site". We provided our professional service in accordance with the scope of service that we detail in our response to the YCHC Geotechnical Investigation Request for Proposal (RFP) that the Yakutat Tlingit Tribe (YTT) issued on October 25, 2016. We submitted our RFP response to the YTT on September 1, 2016 and the YTT contracted us to provide our proposed scope of service (by signed contract) on October 13, 2016. YTT subsequently issued us a written Notice to Proceed for our proposed scope of service on October 14, 2016.

YTT contracted us to conduct a geotechnical engineering assessment of the project in an effort to evaluate the suitability of the project site to support the proposed YCHC and to aid in the design and construction of the proposed site improvements.

In this report, we provide a summary of our subsurface exploration and laboratory testing programs as well as provide our geotechnical engineering conclusions and recommendations regarding the suitability of the project site to support the proposed YCHC. We also provide design and construction criteria for the proposed site improvements.

2.0 PROJECT OVERVIEW

The project site is located along the west side of the Yakutat Highway (a.k.a. Airport Road), just south of its intersection with Forest Highway 10 in Yakutat, Alaska (Figure 1). The legal description of the project site is Tract A of the United States Survey (USS) 5630 Subdivision, Yakutat, Alaska.

The project is approximately 2.5 acres in area and is primarily vegetated with mature, second growth Sitka spruce and hemlock trees. The project site has a slightly hummocky surface which generally slopes gradually down to the southeast. A shallow, sub-linear depression is located along the central and southern portions of the project site, which generally trends to the south-southeast. To the best of our knowledge, no current topographic surveys have been completed at the project site (as of our issuance of this report). R&M Engineers, Inc. (R&M), however, completed a boundary survey of the project site in July 2016 during which time R&M set boundary monuments (driven rebar with end caps) at the corners, and along the perimeter, of the project site.

The project site was reportedly logged for timber around the beginning of the 20th century, but no significant ground disturbances and/or other site developments (e.g., fill placement, borrow activities, etc.) are known to have occurred at the project site.

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Proposed improvements to the project site include construction of an approximately 14,000 ft^2 two-story, steel-framed medical clinic building and associated paved vehicle parking areas, driveways, and utilities. We have included a conceptual drawing of the proposed YCHC in Figure 2 of this report. From information we gathered from the RFP, and from conversations we have had with persons familiar with the project, it is our understanding that:

- the exact location/configuration/layout of the proposed YCHC detailed in Figure 2 is subject to revision, however, the proposed YCHC improvements will generally be located along the central portion of the project site;
- approximately 1.2 acres of the project site will be cleared of vegetation in preparation for the construction of the proposed improvements;
- varying amounts of cut/fill will be necessary to level the project site and achieve the final site grade;
- the remaining (undeveloped) portions of the project site will remain relatively undisturbed;
- the proposed clinic will be serviced by the local Yakutat public drinking water utility; and
- the proposed clinic will either be serviced by the local Yakutat sanitary sewer utility or an on-site septic system (location and configuration yet to be determined).

3.0 REGIONAL GEOGRAPHY, CLIMATE, AND GEOLOGY

3.1 Geography

The city and community of Yakutat, Alaska is situated primarily along the shores of Monti Bay, (at the mouth of the larger Yakutat Bay) along the northern coast of The Gulf of Alaska (Figure 1). The regional geography surrounding Yakutat is characterized by the Saint Elias Mountains to the north and northeast, which rise above large glaciers and extensive icefields, by Yakutat Bay and its connecting waterways to the north, and the Gulf of Alaska to the south. The area immediately surrounding (and including) Yakutat can be separated into two major geographic features:

1. the low hills and small lakes of the end moraines that rim the southeast shore of Yakutat Bay; and
2. the nearly flat plain of outwash deposits and shallow-water marine deposits, part of the Yakutat Foreland, extending from Yakutat to the Gulf of Alaska (Yehle, 1979).

3.2 Climate

The Yakutat area experiences a subarctic to subpolar oceanic climate, with monthly daily average temperatures ranging from approximately 22 ^{o}F in January to 54 ^{o}F in July. The Yakutat area receives an annual water equivalent average of approximately 155 inches of precipitation,

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150 inches of which generally falls in the form of snow. Permafrost soils do not generally occur in the Yakutat area, except near the margins of existing glaciers/icefield/moraines.

3.3 Geology

Glacial geology dominates the surficial deposits of the Yakutat area, and radiocarbon dating of organic material contained within recent glacial moraine deposits along the southeastern perimeter of Yakutat Bay suggest that the Yakutat area was covered by glacial ice as recently as 500 to 600 years ago (Yehle, 1979). As we previously mention, the area surrounding Yakutat is dominated by two primary geographic/geologic features:

1. End moraines deposits which form the rolling hills surrounding Monti Bay and along the southeast shore of Yakutat Bay (including the island archipelago just north of Monti Bay); and
2. Glacial outwash deposits which form the relatively flat plain stretching southeast from Yakutat out to the Yakutat Airport.

The end moraine deposits (1) consist generally of unstratified glacial till, which is a mixture of gravel and pebble-laden silt or sand, in varying proportions, and, subordinately, of cobbles, clay, some boulders, and rarely, organic material (Yehle, 1979).

The glacial outwash deposits (2) can be subdivided into two primary subunits: A) coarse-grained; and B) fined-grained deposits. We only provide a description of the coarse-grained outwash deposits as they are directly relevant to the project site. The coarse-grained subunit of the glacial outwash deposits consist primarily of sandy pebble gravel. Close to the end moraines deposits, cobble-rich gravel is a major constituent of the glacial outwash deposits, and some silty, sandy gravel is present, derived from direct melting of the glacier ice to form kame and other types of ice-contact deposits. Outwash deposits are bedded and moderately well sorted within individual beds. The overall thickness of the coarse-grained outwash may average 7m and range from 1 to 17m. The coarse outwash is thought to overlie delta-estuarine sediments and probably some buried morainal deposits. In many places organic deposits cover the coarse outwash deposits (Yehle, 1979).

4.0 PROJECT SITE ACTIVITIES

We conducted an initial reconnaissance of the project site on October 26, 2016 in an effort to locate the proposed test pit explorations, determine excavation equipment access, and gain a general sense of the conceptual layout of the proposed YCHC improvements. We were accompanied on our site reconnaissance by Captain Kelly Leseman; Indian Health Service Project Manager for the proposed YCHC project. Captain Leseman assisted us in determining the location of the six test pit explorations, which generally correspond to the conceptual location of the proposed YCHC improvements (Figure 2). We established the test pit exploration locations by making swing-tie measurements from the existing project site boundary survey monuments using a 300-ft cloth surveyor's tape and the conceptual site drawing detailed in Figure 2 of this report.

4.1 Subsurface Exploration

We coordinated and directed a subsurface exploration program at the project site on October 27, 2016 in an effort to help characterize the subsurface conditions within, and adjacent to, the proposed YCHC improvements. We contracted Pate Construction (PC) of Yakutat, AK who in turn mobilized a Hitachi EX150 tracked excavator and operator to the project site to excavate the six proposed test pit explorations. Under our direction, PC excavated the six test pit explorations to depths ranging from approximately 12 to 15 feet below the existing ground surface. We have detailed the approximate location of each test pit exploration in Figure 2 of this report. A geologist from our firm was present on-site during the entire subsurface exploration program to direct the subsurface exploration activities, log and photograph the geology of each test pit exploration, and collect representative soil samples for laboratory analysis. We sealed each soil sample that we collected during the subsurface exploration program inside of sealed plastic bags (to help preserve the moisture content of each soil sample) and submitted each soil sample to our Anchorage laboratory for further identification and analysis. Once exploration activities were complete, we directed PC to backfill each exploration with its respective spoils. No compactive effort was applied to the backfill. We have provided graphical exploration logs and photographs of each test pit exploration in Appendix A of this report. We also provide the results of our laboratory testing program in Appendix B of this report.

5.0 LABORATORY TESTING

We collected a total of 13 soil samples from the six test pit explorations that PC advanced at the project site and submitted all of the soil samples to our laboratory for further identification and geotechnical analysis. We tested select soil samples in accordance with the respective ASTM standard test methods including:

- moisture content analysis (ASTM D-2216);
- determination of fines content (a.k.a. P200 – ASTM D-1140); and
- grain size sieve and hydrometer analysis (ASTM D-6913 & D-422).

The laboratory test results, along with the observations we made during our subsurface exploration program, aid in our evaluation of the subsurface conditions at the project site and help us to assess the suitability of the subsurface materials located at the project site to support the proposed YCHC improvements. We have provided the results of our geotechnical laboratory analyses on the graphical exploration logs contained in Appendix A of this report and on the laboratory data sheets contained in Appendix B of this report.

6.0 DESCRIPTION OF SUBSURFACE CONDITIONS

We compiled our field observations with the results from our laboratory analyses to produce graphical logs of each subsurface exploration (Appendix A). These graphical exploration logs depict the subsurface conditions that we identified at each exploration location and help us to interpret/extrapolate the subsurface conditions for areas adjacent to, and immediately surrounding, each exploration location across the project site.

6.1 General Subsurface Profile

In general, the project site is overlain by a relatively thin layer of organic material consisting primarily of varying amounts of mosses, fungi, decaying organic matter (leaf litter, woody debris, etc.), and root masses. The organic layer averages approximately 0.50 to 0.75 feet in thickness, with some locally thicker sections of decaying organic material where fallen tree trunks and/or tree stumps occur at the ground surface.

The surficial organic layer is directly underlain by a relatively thick deposit of poorly-graded to well-graded sand and gravel that extends to depths of at least 15 feet below the existing ground surface (bgs), and which likely extends much deeper. The sand/gravel deposits contain few cobble-sized particles ranging from 6 to 12 inches in diameter, and trace boulder-sized particles up to approximately 1 to 3 feet in diameter. The sand/gravel material has very low silt content (generally less than five percent by mass) and classifies as non-frost susceptible (NFS) to potentially frost susceptible (PFS) on the US Army Corps of Engineers Frost Design Soil Classification. Larger soil particles exhibit sub-rounded to rounded angularity and the deposit is massive, with some thinner interbeds of coarse sand (ranging from thinly to thickly bedded) and trace interbeds of silt (generally less than 2 to 3 inches in thickness). The consistency of the sand/gravel material appears to be relatively compact/dense, however, we did observe slight to moderate sloughing of excavation walls cut into the more sand-rich portions of the deposit. The sand/gravel soils were likely deposited during the most recent glacial retreat and are consistent with coarse-grained glacial outwash deposits found elsewhere in the Yakutat area (see Section 3.0 of this report for a more detailed geologic description of the coarse-grained glacial outwash deposits common to the Yakutat area).

6.2 Groundwater

We did not observe any indications of groundwater during our subsurface exploration program and we do not expect groundwater to occur (in any significant volumes) above a depth of 15 feet bgs anywhere across the project site.

6.3 Frozen Soils

We did not observe any indications of frozen soils (seasonal ground frost or permafrost) during our exploration program and we do not expect permafrost conditions to occur anywhere across the project site.

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7.0 ENGINEERING CONCLUSIONS

7.1 General Project Site Conclusions

Based on the findings of our subsurface exploration and laboratory testing programs, it is our conclusion that the sand/gravel soils (i.e., coarse-grained glacial outwash deposits – see Section 6.1 of this report for a more detailed description) which we observed across the project site are generally suitable to support the proposed improvements; provided that our concerns and recommendations that we present in this report are addressed by the design and construction processes.

In general, the project site has many desirable geotechnical/geological characteristics which can accommodate relatively uncomplicated designs and standard construction practices. Minimal excavation (i.e., surface grubbing) will be needed to expose the foundation bearing soils (i.e., sand/gravel soils), and the sand/gravel soils extend far below the bottom of any planned improvements. Varying amounts of mass grading, however, will be required to level the project site and bring it to the planned finished grade.

The sand/gravel soils that we identified across the project site are relatively dense and laboratory testing indicates that they have little to no frost susceptibility. Additionally, there is no readily available groundwater to be drawn towards the freeze front and build soil ice. Therefore, there is very little potential for ice lens development (and associated frost heaving forces and/or thaw-related settlements) at the project site. As a result, shallow foundations and pavement sections can both be constructed directly above the existing sand/gravel soils (or NFS structural fill) with minimal design and/or construction considerations to account for potential ice lens development.

Groundwater should generally not be encountered during the construction efforts. Furthermore, the project site is relatively well-drained, and should lend itself to relatively uncomplicated drainfield design. We detail our conclusions regarding the different geotechnical aspects of the design and construction of the proposed YCHC at the project site in the following subsections of this report.

7.2 Earthworks

As we detail in Section 6.1 of this report, the project site is overlain by a relatively thin layer of surficial organic material which is generally less than 0.50 to 0.75 feet in thickness. This organic material is unsuitable for supporting any of the proposed YCHC improvements and will need to be completely removed from the footprint of any improvements prior to construction. The organic material/soils are immediately underlain by sand/gravel deposits which are suitable for direct support of the proposed YCHC improvements; either in their native (i.e., undisturbed) state or placed as structural fill.

As we briefly discuss in Section 2.0 of this report, the project site has a slightly uneven, sloping surface, and as such, varying amounts of mass grading will be required to level the project site and bring it to the planned finished grade. The existing sand/gravel soils which occur across the project site are suitable for use as structural fill at the project site assuming that they are placed using proper placement and compaction techniques. Depending upon the planned finished grade for the project site, the site grading activities may consist entirely of cut/fill of on-site materials and/or structural fill may need to be imported to the project site from other sources.

The recommendations that we detail in this report assume that any structural fill (re-worked native soils or imported fill) used to bring the project site to grade will be NFS. NFS structural fill (similar to the native sand/gravel soils which occur on-site) should be readily available in the Yakutat area, and at a reasonable cost. However, we should be given sufficient notice if silt-rich (i.e., frost-susceptible) fill is to be used at the project site for any reason, as its usage will affect the recommendations that we present in this report.

7.3 Foundations

Conventional shallow foundations, such as poured-concrete footings, etc., can be constructed directly onto the existing (i.e., undisturbed) sand/gravel soils or properly placed structural fill located directly above the undisturbed sand/gravel soils. As we previously mention in Section 7.1 of this report, the sand/gravel soils that we identified at the project site have a very low potential for ice lens development. Therefore, foundations constructed directly onto the existing (i.e., undisturbed) sand/gravel soils or properly placed NFS structural fill (located directly above the undisturbed sand/gravel soils) will require relatively minimal burial and/or insulation to help protect them from frost damage.

7.4 Underground Utilities

Underground utilities can be founded directly onto the undisturbed sand/gravel soils (or properly placed structural fill) with little risk of differential settlement. While there is little risk of ice lens development at the project site, there is the potential for seasonal frost penetration (i.e., freezing ground temperatures) at the project site, especially in areas where there is a lack of insulating snow cover (e.g., plowed parking lots, exterior porticos, etc.). Utilities which are susceptible to freezing temperatures (i.e., water/sewer) should be buried sufficiently deep to protect them from freezing temperatures. Otherwise, they should be protected from freezing temperatures by incorporating appropriate amounts of artificial insulation into the utility trench backfill and/or by using some form of active freeze protection (i.e., thaw wires, active fluid circulation, etc.).

As we briefly mention in Section 7.1 of this report, we estimate that the sand/gravel soils which we identified across the project site will have relatively high permeability/infiltration rates. As such, the sand/gravel soils can likely dissipate large volumes of sewer discharge in relatively short time intervals and can likely support relatively simple septic and/or stormwater drain field designs. Percolation/infiltration testing will need to be conducted in the area of any proposed drain fields prior to any design efforts to characterize the hydraulic properties of the sand/gravel soils and properly size any drain fields, etc.

7.5 Pavement

Pavement sections can be constructed directly onto the existing sand/gravel soils (either in their native state or placed as structural fill), or imported NFS structural fill, with minimal risk of differential movements due to ice lens development and/or thaw-related weakening of subgrade soils.

7.6 Settlements

Settlements for shallow foundations should be within tolerable limits, provided that they are placed directly onto the undisturbed sand/gravel soils (or properly placed structural fill located directly above the undisturbed sand/gravel soils). We anticipate a total settlement for shallow concrete foundations placed onto the undisturbed sand/gravel soils (or properly placed structural fill located above the undisturbed sand/gravel soils - as we discuss in Section 8.2 of this report) to be less than three-quarters (3/4) of an inch, with differential settlements comprising about one-half (1/2) of the total anticipated settlement. Settlement amounts could increase substantially if the structural fill material used to bring any foundation pads to grade is not properly compacted. Most of the settlements should occur as the building loads are applied, such that additional long-term settlements should be relatively small and within tolerable limits.

Settlements under driveways, parking areas, and street sections are expected to be vary more than under any buildings, especially where utility trenches are located. Proper earthwork is necessary to help reduce the settlement potential. The settlement potential can be reduced by performing all utility excavation and backfill efforts as early in the construction schedule as possible and placing any pavement as last in the construction schedule as possible.

7.7 Seismic Design Parameters

We have assumed that the International Building Code (IBC) 2012 will be used for the design of the proposed structure. The seismic site classification for the project site is D based on the relatively dense sand/gravel soil that we observed at the project site. We utilized the United States Geological Survey (USGS) Seismic Design Maps tool (http://earthquake.usgs.gov/designmaps/us/application.php) to calculate the seismic design parameters for the project site, which are F_a = 1.000 (S_s = 1.630) and F_v = 1.5000 (S_1 = 0.760). A copy of the USGS Design Maps report for the project site is contained in Appendix C of this report.

Based on our findings, we expect there to be no potential for soil liquefaction at the project site given the relatively coarse-grained nature of the sand/gravel deposits which occur across the project site and a relatively deep groundwater table.

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8.0 DESIGN RECOMMENDATIONS

We have presented our design recommendations in the general order that the project site will most likely be developed. Our design recommendations can be used in parts (as needed) for the final design of the proposed YCHC.

8.1 Earthworks

Our recommendations assume that any shallow foundations (i.e., poured-concrete footings) will be founded either directly onto the undisturbed sand/gravel soils or compacted NFS structural fill pads constructed directly above the undisturbed sand/gravel soils. Any structural fill materials used on-site should be compacted to a minimum of 95 percent of the modified Proctor density.

Any NFS sand/gravel material removed during the initial site grading and excavation activities, which does not contain any organic/deleterious material, can be re-used anywhere on-site as structural fill. Proper placement and compaction techniques need to be applied during the backfill process (see Section 9.1 of this report for more details). Additional laboratory testing may be required to verify the silt content and frost susceptibility of any excavated (i.e., on-site) soil for use in structural fill applications. Furthermore, the frost susceptibility of any imported structural fill material should be determined prior to import to the project site. As we mention in Section 7.1 of this report, our recommendations assume that any structural fill (re-worked native soils or imported fill) used to bring the project site to grade will be NFS. Use of silt-rich (i.e., frost susceptible) structural fill will require a re-evaluation of the recommendations that we preset in this report.

All earthworks should be completed with quality control inspection, including: bottom-of-hole inspections; fill gradation classification; and in-situ compacting testing. A bottom-of-hole inspection should be conducted by a qualified geotechnical engineer, geologist, or special inspector following site excavation activities (and before any foundation construction begins) in order to visually confirm the findings of this report and provide recommendations for any non-conforming conditions encountered during the excavation activities.

8.2 Shallow Foundations

For the purposes of this report, a shallow foundation can be considered any foundation which will require over-excavation of the existing surficial organic materials prior to structural fill placement and/or foundation construction.

8.2.1 Soil Bearing Capacity

Concrete foundations placed on either the undisturbed sand/gravel soils or on structural fill pads (constructed directly above the undisturbed sand/gravel soils) may be designed for an allowable soil bearing capacity of 3,000 pounds per square foot (psf). The soil bearing capacity may be increased by one-third (1/3) to accommodate short-term wind and/or seismic loads. Larger

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footings (smallest dimension greater than two feet in plan dimension) may be designed for greater bearing capacities at a rate of 300 psf for every additional horizontal linear foot of footing up to a maximum value of 5,300 psf.

8.2.2 Continuous Strip Footings and Spread Footings

Continuous strip footings and/or spread footings can be founded directly onto either: 1) the undisturbed sand/gravel soils, or 2) properly placed structural fill (located directly above the undisturbed sand/gravel soils). The minimum horizontal dimension for continuous strip footings should be 16 inches. The minimum horizontal dimension for spread footings should be 24 inches. Interior footings should extend a minimum of 12 inches below the finished floor grade (assuming a continuously heated building is maintained during winter months) to achieve the recommended allowable soil bearing capacity and help resist any lateral forces. Shallow foundation footings should extend laterally a minimum of one-eighth (1/8) of the footing width beyond any foundation walls to help resist any anticipated uplift/overturning forces (Figure 3). We discuss the effects of various uplift and lateral forces on foundations in more detail in Sections 8.2.4 and 8.2.5 of this report.

8.2.3 Thickened Edge Slab Foundations and Floor Slabs

Thickened edge slab foundations and/or floor slabs can also be founded directly onto the undisturbed sand/gravel soils or properly placed structural fill located directly above the undisturbed sand/gravel soils. The thickened edge (i.e., perimeter footing) of any thickened edge slab foundation should extend a minimum of 16 inches below the exterior finished grade to achieve the recommended allowable soil bearing capacity and help resist any lateral forces.

The top four to six inches of the structural pad located beneath the slabs should be free draining, with less than 3% passing the #200 sieve. This “blanket” will serve as a capillary break to help maintain a dry slab. Concrete floor slabs constructed directly on the undisturbed sand/gravel soils or on properly constructed granular fill pads (located directly above the undisturbed sand/gravel soils), as we described above, may be designed using a modulus of subgrade reaction of k_1=60 pci (k_1 is the value for a 1-ft × 1-ft rigid plate). For this project, the following equations can be used (with standard English units) to calculate the appropriate modulus of subgrade reaction for slabs bearing on the undisturbed sand/gravel soils or on properly placed granular structural fill located directly above the undisturbed sand/gravel soils:

$$k_{(B\ x\ B)} = k_1 \left(\frac{B+1}{2B}\right)^2 \qquad (1)$$

Where:

B = the slab width of a square slab in feet
k_1 = the modulus of subgrade reaction for a 1-ft × 1-ft rigid plate in pci
$k_{(B\ x\ B)}$ = the modulus of subgrade reaction for a square slab of width B in pci

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The following equation (2) can be used for a rectangular slab having the dimensions $B \times L$ (in feet) with similar bearing soils as the slab loading equation above (1).

$$k_{(B\ x\ L)} = \frac{k_{(B\ x\ B)}\left(1+0.5\frac{B}{L}\right)}{1.5} \tag{2}$$

Where:

$k_{(B\ x\ B)}$ = the modulus of subgrade reaction for a $B \times B$ square slab
$k_{(B\ x\ L)}$ = the modulus of subgrade reaction for $B \times L$ rectangular slab
B = the least horizontal dimension of a rectangular slab
L = the larger horizontal dimension of a rectangular slab

8.2.4 Footing Uplift

Shallow foundations should be buried sufficiently deep so as to resist any anticipated uplift/overturning forces (e.g. wind, seismic, frost jacking, etc.). The uplift capacity of a foundation is a function of its weight, configuration, and depth. The ultimate uplift capacity can be calculated by using 80 percent of the weight of the foundation plus 80 percent of the weight of the effective soil mass located above the footing. Figure 3 of this report illustrates the impact that effective soil mass has on the uplift capacity of a shallow foundation footing. An effective unit weight of 130 pcf can be used for granular structural backfill material. The ultimate uplift load includes any short-term load factors, so no increase in uplift capacity should be added for short-term loading.

8.2.4.1 Frost Heaving and Frost Protection

Frost heaving forces can generate significant footing uplift loads and it is difficult to predict the depth of frost penetration and extent of ice lens formation at any given site. As such, footings need to be buried sufficiently deep so as to resist any anticipated frost heaving uplift forces. As we previously mentioned in Section 7.1 of this report, there is little to no potential for ice lens formation at the project site (assuming that any structural fill used is NFS). As such, uplift forces resulting from frost heave will be negligible.

For the project site, the minimum burial depth for any uninsulated shallow foundation footings (heated or unheated) constructed directly onto the NFS sand/gravel soil (or NFS structural fill) should be 24 inches. Foundation burial requirements will increase if frost susceptible fill is used to bring any foundation pads to grade.

Insulation may be placed directly beneath of any floor slabs. However, no insulation should be placed directly beneath of any perimeter footings, as this can promote freezing of the foundation soils by preventing adequate heat transfer from the interior of a heated building to the foundation bearing soils. Alternatively, insulation can be placed along the exterior of any perimeter footings/stem walls and/or thickened edge slab foundations to help reduce the minimum burial

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depths required to help protect the foundation bearing soils from freezing. For this project, however, no foundation should be buried less than 16 inches below finished grade, even with the application of insulation (unless it is contained entirely within the footprint of a continuously heated structure – see Section 8.2.2. of this report for more details). We have provided our recommended insulation configurations for conventional strip/spread footings in Figure 4 of this report (configurations B and C). We have also provided our recommended insulation configurations for heated thickened edge slab floundations in Figure 4 of this report (configurations E and F).

8.2.5 Lateral Loads for Foundations and Retaining Walls

Retaining walls (such as perimeter foundation stem walls for buildings with basements or crawl spaces) must be designed to resist lateral earth pressures. The magnitude of the pressure exerted on a retaining wall is dependent upon several factors, including:

1) whether the wall is allowed to deflect after placement of backfill;
2) the type of backfill used;
3) compaction effort; and
4) wall drainage provisions.

Any foundation stem walls that are not designed to carry lateral loads should be backfilled on both sides simultaneously to prevent differential lateral loading of the foundation stem wall. We developed the unit weights provided in Table 1 of this report assuming that structural fill (containing less than ten percent fines) is used as backfill, and that the fill is compacted to at least 90 percent of the modified Proctor density.

An active-earth pressure condition will prevail (under static loading) if a retaining wall is allowed to deflect or rotate a minimum of 0.001 times by the wall height. An at-rest pressure condition will prevail if a retaining wall is restrained at the top and cannot move at least 0.001 times the wall height. Lateral forces exerted by wind or seismic activity may be resisted by passive-earth pressures against the sides of the foundation footings, exterior walls (below grade), and grade beams. Therefore, interior footings should extend a minimum of 12 inches below the finished floor grade (assuming a continuously heated building is maintained during winter months) to help resist any lateral forces.

In order to prevent water accumulation against the outside of any foundation or retaining wall, the wall must have a perimeter drainage system connected to an outlet that will not freeze closed at any time of the year. The top of the drainage piping must be located below the top of the footing for the foundation and/or retaining wall. Backfill used against the wall (and extending a minimum of one foot beyond the wall) must be free-draining with less than three percent fines. The top one-foot of backfill against the outside of a foundation and/or retaining wall should consist of relatively impermeable (fine-grained) material and be tightly compacted such that

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surface water is directed away from the foundation and/or retaining wall. A permeable geotextile fabric may be useful to prevent mixing of the impermeable (fine-grained) overburden and underlying free-draining (coarse-grained) backfill. Furthermore, the finished surface should slope away from any foundation and/or retaining wall with a grade between 1 to 2 percent, such that surface water is directed away from the foundation and/or retaining wall.

Seismic loading on foundation and/or retaining walls generally increases the lateral pressures on the wall and decreases the passive resistance. For foundation systems where the building foundation is continuous, the differential lateral movement between the soil and foundation is very small, and as such, essentially no excess lateral loading on the foundation wall is experienced. Foundation walls with a differential in backfill heights of over six feet (basements, crawl spaces, etc.) will experience seismic lateral loading from the inertial effects of seismic waves passing through the foundation.

The lateral soil pressures can be represented by equivalent fluid pressures. The pressure distribution is a function of wall restraint, seismic loading, and drainage conditions. Figure 5 presents the distribution diagrams for various loading conditions. Table 1 presents the unit weights to be used with Figure 5 for this project.

Table 1: Equivalent Fluid Specific Weight for Lateral Loading Design

LOADING CONDITION	DRAINED EQUIVALENT FLUID SPECIFIC WEIGHT		UN-DRAINED EQUIVALENT FLUID SPECIFIC WEIGHT	
	SPECIFIC WEIGHT (pcf)	**SYMBOL**	**SPECIFIC WEIGHT (pcf)**	**SYMBOL**
ACTIVE	35	t_1	24	t_2
AT-REST	55	t_3	38	t_4
PASSIVE	400	t_5	280	t_6
SEISMIC	16	t_7	9	t_8

Lateral forces may also be resisted by friction between the concrete foundations and the underlying soil. The frictional resistance may be calculated using a coefficient of friction of 0.4 between the concrete and soil.

8.3 Underground Utilities

In general, the soils in which deep utility trenches (6 to10 feet bgs) are to be constructed are composed of relatively dense/compact sand and gravel. Any gravity-fed utility trenches extending into the sand/gravel soils should be a minimum of three feet wide at the bottom of the trench with the utility piping located in the center of any trenches. Properly placed structural fill should be used to bring the gravity-fed utilities to the proper installation grade.

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Underground utilities which are susceptible to damage from freezing need to be frost-protected by sufficient amounts of backfill, insulation, and/or active freeze protection systems (e.g., heat tape, thaw wire, etc.); or some combination of the above. Any utilities which are susceptible to damage from freezing that are planned to be constructed less than eight feet below the planned finished grade should contain some level of additional frost-protection (e.g., insulation, active freeze protection systems, or a combination of both).

Any insulation used should conform to the specifications that we detail in Section 9.4 of this report and should extend a minimum of two feet (and a maximum of four feet) perpendicular to either side of the proposed utility alignment. The thickness of the insulation used will be a function of the burial depth. In general one inch of insulation is equal to approximately 12 inches of compacted NFS backfill. Underground utilities which are susceptible to damage from freezing should not be constructed within four feet of the planned finished grade (regardless of insulation measures or active freeze-protection systems).

8.4 Pavement Section

Pavement section thickness will be a function of the amount of cut/fill needed to achieve final grade. In general, the existing sand/gravel soils which occur across the project site have little to no frost susceptibility and there is little to no potential for ice lens development at the project site. As such, minimal engineered pavement sections will be required and the pavement sections can be constructed directly onto the existing NFS sand/gravels soils (in their native state or placed as structural fill) or NFS fill structural fill. We have provided a suitable pavement section for the project site in Table 2 of this report.

Table 2: Suitable Pavement Section Construction above the Existing NFS Material

SECTION THICKNESS	MATERIAL
2 INCHES MIN.	ASPHALT (CONC. PAVEMENT THICKNESS A FUNCTION OF REINFORCEMENT)
2 INCHES MAX.	NFS LEVELING COURSE (A.K.A. “D-1”)
N/A	EXISTING NON-FROST SUSCEPTIBLE SOILS OR NFS STRUCTURAL FILL

Any leveling course used should be NFS in order to maintain a low potential for ice lens development within the leveling course. It is our experience that the “D1” leveling course material currently available in many portions of coastal Alaska (where highly fractured meta-sedimentary flysh-style deposits occur) may not be NFS following compaction, because the compaction with a vibratory compactor further increases the frost susceptibility of the leveling course by increasing the percentage of fine-grained material (due to degradation of the soil particles from the impact of the compaction equipment). As such, the leveling course thickness should be kept to two inches or less to reduce the potential for ice lens formation in the leveling

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course. All of these materials should be placed in thin lifts and each lift should be compacted to a minimum of 95 % of the modified Proctor density. As an alternative to "D1", recycled asphalt pavement (RAP) can be used. The residual oil in the RAP greatly reduces the frost susceptibility.

A geotextile fabric may be useful for the placement of fill material above any fine-grained subgrade soils, but it is not necessary for use within our recommended pavement section. Any geotextile fabric used for this project should conform to the specifications which we present in Table 3 of this report.

Table 3: Type B, Class 2 Geotextile Fabric Strengths

FABRIC PROPERTY	ASTM STANDARD USED TO DETERMINE STRENGTH	WOVEN FABRIC STRENGTH	NON-WOVEN FABRIC STRENGTH
GRAB STRENGTH	D4632	250	160
SEWN SEAM STRENGTH	D4632	225	140
TEAR STRENGTH	D4533	90	56
PUNCTURE STRENGTH	D6241	495	310

Note: Units in lbs per foot.

8.5 Surface Drainage

After the property is brought to grade it should be relatively flat, such that storm water will tend to accumulate and flow off the project site slowly. Water accumulation will have a detrimental effect on foundations, retaining structures, and pavement sections. Provisions should be included in the design to collect runoff and divert it away from any foundations, retaining structures, and pavement sections. The ground surface surrounding the proposed developments should be graded such that surface runoff is channeled away from foundations, retaining walls, and pavement sections. The soils on the surface should be tightly compacted to help reduce surface runoff infiltration. Roof, parking lot, and driveway drainage should be directed away from foundations. If storm sewer is available, tight-line connections from roof drain collectors should be made.

8.6 Insulation

Any subsurface insulation should consist of extruded polystyrene such as DOW Styrofoam™ Highload or UC Industries Foamular. Any subsurface insulation used under pavement sections or structural slabs should be closed cell, board stock with a minimum compressive strength of 60 psi at five percent deflection. Subsurface insulation around foundations should have a minimum compressive strength of 25 psi at five percent deflection. The insulation should not absorb more than two percent water per ASTM Test Method C-272. The thermal conductivity (*k*) of the insulation should not exceed 0.25 BTU-in/hr-ft^2-°F when tested at 75°F.

9.0 CONSTRUCTION RECOMMENDATIONS

We have presented our construction recommendations in the general order that the project site will most likely be developed. Our construction recommendations are intended to aid the construction contractor(s) during the construction process.

9.1 Earthworks

Any and all fill material used should be placed at 95 percent of the modified Proctor density as determined by ASTM D-1557, unless we specifically state otherwise in other sections of this report. The thickness of individual lifts will be determined based on the equipment used, the soil type, and existing soil moisture content. Typically, fill material will need to be placed in lifts of less than one-foot in thickness. All earthworks should be completed with quality control inspection.

Any excavated native sand/gravel soils (which are free of organic material and have relatively low silt contents) which are stockpiled on-site (for later use as structural backfill) should be protected from additional moisture inputs (precipitation, etc.) through the use of plastic tarps, etc. Additional moisture inputs can have detrimental effects on the effort needed to achieve proper compaction rates.

9.2 Shallow Foundations

Care should be taken during foundation excavation activities to limit the disturbance of the bottom of any foundation excavations. The bottom of any foundation excavation should be moisture conditioned and proof-rolled as necessary to return the exposed soils to their original in-situ density.

In general, the soils in which the proposed foundation pads are to be constructed consist primarily of relatively permeable sand and gravel material. As such, any surface water (*e.g.*, from precipitation, snowmelt, etc.) that enters into foundation excavations will tend to dissipate relatively quickly. Excess water can, however, have a negative impact on any backfill and compaction efforts. Therefore, if surface water does accumulate in any open foundation excavations it can be controlled by excavating a shallow drainage trench around the perimeter of the excavation. The drainage trench will collect surface water and direct it to a sump area, which should be located outside of the foundation footprint. The excess water can then be pumped from the sump area and be discharged at an appropriate location away from the excavation and any other existing foundations.

It is imperative that shallow building foundations for heated structures remain in a thawed state for the entire construction period; even when dealing with soils that have little to no frost susceptibility. Foundation soils that are allowed to freeze during the initial construction (before the building is enclosed and heated) may be compromised by the development of ice lenses. Upon thawing, which may take several weeks or months, potential differential settlements could distort the structure resulting in damaged foundations, cracked sheetrock, skewed door frames, and broken windows. If construction extends into the winter months, temporary enclosures should be constructed which completely enclose warm foundations and heat should be applied to the enclosure to prevent freezing of the soils located beneath any warm foundation and/or floor slab.

9.3 Underground Utilities

We expect that utility trench wall stability in the moderately compact/dense sand/gravel to be moderate to poor, especially if utility trenches extend below the groundwater table. The contractor should be responsible for trench safety and regulation compliance. If groundwater is encountered during utility trench excavation then dewatering efforts may be required to facilitate proper utility installation and trench backfill.

All piping should be bedded per the manufacturer's recommendations, with the bedding material compacted to provide pipe support. Above the bedding materials, the backfill should be similar to, and compacted to the approximate density of, the surrounding soils.

9.4 Pavement

All of the earthwork within any areas to be paved should be completed as early in the construction schedule as possible, and the pavement placed as late in the construction schedule as possible. This will give the subgrade soils time to settle, compress, and stabilize prior to placement of the pavement. Any structural fill used should be placed in thin lifts (less than one foot in thickness) and each lift should be compacted to a minimum of 95 percent of the modified Proctor density. Prior to paving, any surface fill material should be re-leveled and re-compacted. All backfill and paving materials should be inspected and tested for material specification compliance and compaction.

Underground utility piping should be installed prior to construction of any pavement sections such that trenching is done through the subgrade soils only. This will help ensure that a uniform pavement section is maintained, which will reduce the potential for differential settlements along underground utility trench alignments.

The minimum thickness for any asphalt pavement surfaces is two inches. The minimum thickness of any concrete pavement surfaces will be a function of the reinforcement required. All applicable ACI and IBC standards should be followed.

9.5 Insulation

The satisfactory performance of any subsurface insulation is in part controlled by the details of construction including: 1) the care taken to ensure that the board stock lies flat on a smooth, level surface; and 2) the adjoining ends of the insulation are closely butted together. Any vertical joints should be staggered where more than one layer of insulation is used.

9.6 Winter Construction

Proper placement and compaction of structural fill is not possible when fill material is frozen, and as such, frozen fill material should never be used for structural support unless it has been subsequently thawed and compacted to 95 percent of the modified Proctor density (throughout its vertical extent). Furthermore, subgrade soils (fill or native) need to be completely thawed prior to the placement and compaction of additional lifts of thawed fill material. In our professional experience, ambient soil temperatures need to be above 37 °F in order to achieve efficient compaction. It is extremely difficult to achieve compaction levels equal to 95 percent of the modified Proctor density in fill material that is between 32 °F to 37 °F. We discuss the risks associated with winter foundation construction in more detail in Sections 9.2 of this report

10.0 THE OBSERVATIONAL METHOD

A comprehensive geoprofessional service (e.g., geotechnical, geological, civil, and/or environmental engineering, etc.) should consist of an interdependent, two-part process comprised of:

Part I - pre-construction site assessment, engineering, and design; and

Part II - continuous construction oversight and design support.

This process, commonly referred to in the geoprofessional industry as "The Observational Method", was developed to reduce the costs required to complete a construction project, while simultaneously reducing the overall risk associated with the design and construction of the project.

In geotechnical engineering, Part I of the Observational Method (OM) begins with a geotechnical assessment of the site, which typically consists of some combination of literature research, site reconnaissance, subsurface exploration, laboratory testing, and geotechnical engineering. These efforts are usually documented in a formal report (e.g., such as this report) that summarizes the findings of the geotechnical assessment, and presents provisional geotechnical engineering recommendations for design and construction. Geotechnical assessment reports (and the findings and recommendations contained within) are considered provisional due to the fact that their contents are typically based primarily on limited subsurface information for a site. Most conventional geotechnical exploration programs only physically characterize a very small percentage of a given site, as it is typically cost prohibitive to conduct extensive (i.e. high density/frequency) exploration programs. As an alternative, geoprofessionals use the subsurface information available for a site to extrapolate subsurface conditions between exploration locations and develop appropriate provisional recommendations based on the inferred site conditions. As a result, the geoprofessional of record cannot be certain that the provisional recommendations will be wholly applicable to the site, as subsurface conditions other than those

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identified during the geotechnical assessment may exist at the site which could present obstacles and/or increased risk to the proposed design and construction.

Part II of the OM is employed by geoprofessionals to help reduce the risk associated with unidentified and/or unexpected subsurface conditions. Geoprofessionals accomplish Part II of the OM by providing construction oversight (e.g., construction observation, inspection, and testing). Part II of the OM is a valuable service, as the geoprofessional of record is available if unexpected conditions are encountered during the construction process (e.g., during excavation, fill placement, etc.) to make timely assessments of the unexpected conditions and modify their design and construction recommendations accordingly; thus reducing considerable cost resulting from potential construction delays and reducing the risk of future problems resulting from inappropriate design and construction practices.

Oftentimes, a client may be persuaded to use an alternative geoprofessional firm to conduct Part II of the OM for a given project; as some geoprofessional firms offer the same services at discounted prices in order to help them obtain the overall construction materials engineering and testing (CoMET) commission. The geoprofessional industry as a whole recommends against this practice. An alternative geoprofessional firm cannot provide the same level of service as the geoprofessional of record. The geoprofessional of record has (amongst other things) a unique familiarity with the project including; an intimate understanding of the subsurface conditions, the proposed design, and the client's unique concerns and needs, as well as other factors that could impact the successful completion of a construction project. An alternative geoprofessional firm is not aware of the inferences made and the judgment applied by the geoprofessional of record in developing the provisional recommendations, and may overlook opportunities to provide extra value during Part II of the geoprofessional service.

Clients that prevent the geoprofessional of record from performing a complete service can be held solely liable for any complications stemming from engineering omissions as a result of unidentified conditions. The geoprofessional of record may not be liable for any resulting complications that occur, as the geoprofessional of record was not able to complete their services. Furthermore, the replacement geoprofessional firm may also be found to have no liability for the same reasons.

We are available at any time to discuss the OM in more detail, or to provide you with an estimate for any additional construction observation and testing services required.

11.0 CLOSURE

We (Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing) prepared this report exclusively for the use of the Yakutat Tlingit Tribe and their consultants/contractors/etc. for use in the design and construction of the proposed YCHC improvements. We should be notified if significant changes are to occur in the nature, design, or location of the proposed improvements

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in order that we may review our conclusions and recommendations that we present in this report and, if necessary, modify them to satisfy the proposed changes.

This report should always be read and/or distributed in its entirety (including all figures, exploration logs, appendices, etc.) to ensure that all of the pertinent information has been adequately disseminated. Otherwise, an incomplete or misinterpreted understanding of the site conditions and/or our engineering recommendations may occur. Our recommended best practice is to make this report accessible, in its entirety, to any design professional and/or contractor working on the project. Any part of this report (e.g., exploration logs, calculations, material values, etc.) which is presented in the design/construction plans and/or specifications for the project should have an adequate reference which clearly identifies where the report can be obtained for further review.

Due to the natural variability of earth materials, variations in the subsurface conditions across the project site may exist other than those we identified during the course of our geotechnical assessment. Therefore, a qualified geotechnical engineer, geologist, and/or special inspector be on-site during construction activities to provide corrective recommendations for any unexpected conditions revealed during construction (see our discussion of the Observational Method in Section 10.0 of this report for more detail). Furthermore, the construction budget should allow for any unanticipated conditions that may be encountered during construction activities.

We conducted this evaluation following the standard of care expected of professionals undertaking similar work in the State of Alaska under similar conditions. No warranty, expressed or implied, is made.

12.0 REFERENCES CITED

Yehle, L. A., 1979, Reconnaissance Engineering Geology of the Yakutat Area, Alaska, with Emphasis on Evaluation of Earthquake and Other Geologic Hazards: United States Geological Survey Professional Paper 1074, 51 p.

NORTHERN GEOTECHNICAL ENGINEERING, INC.
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REPORT
FIGURES

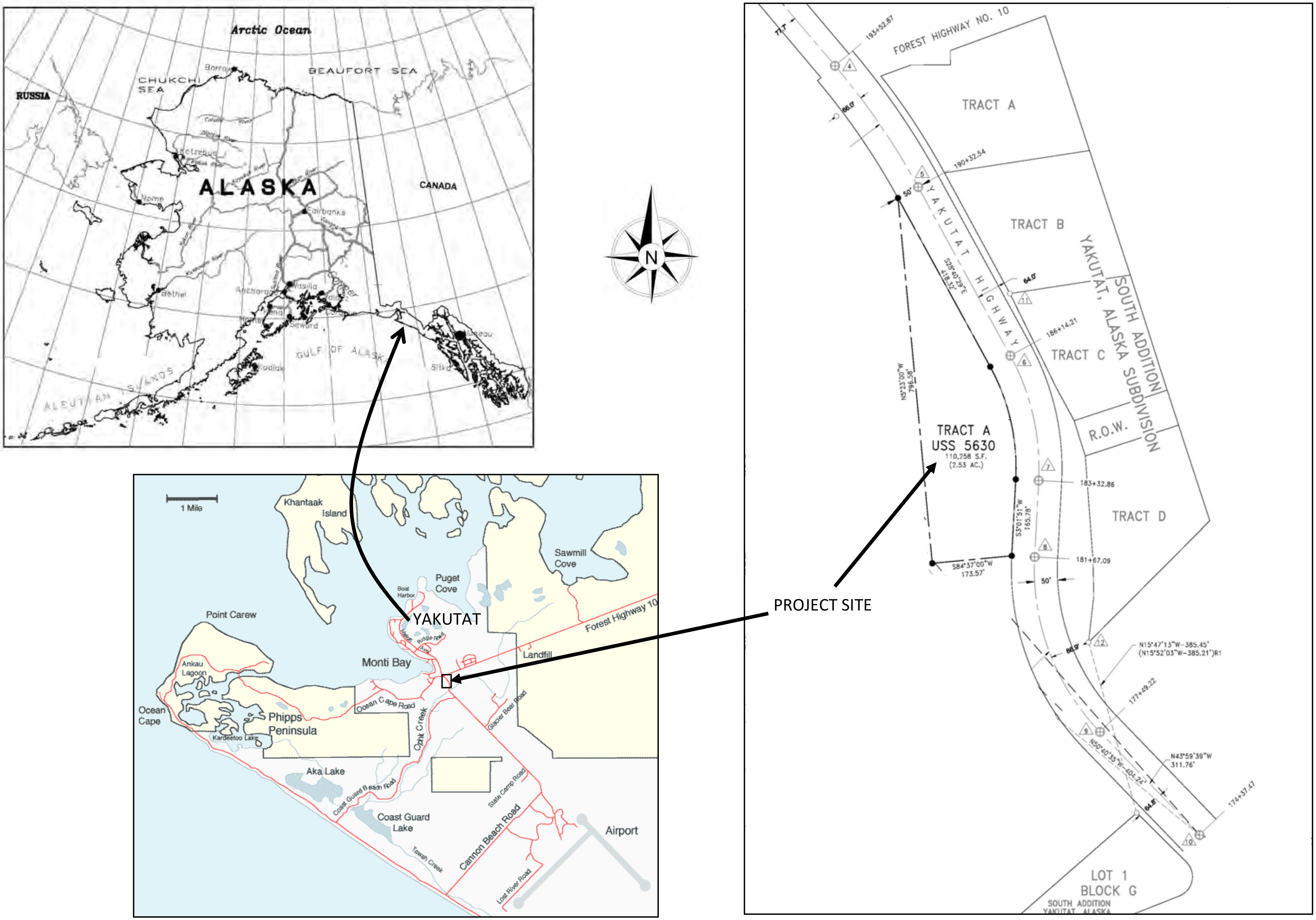

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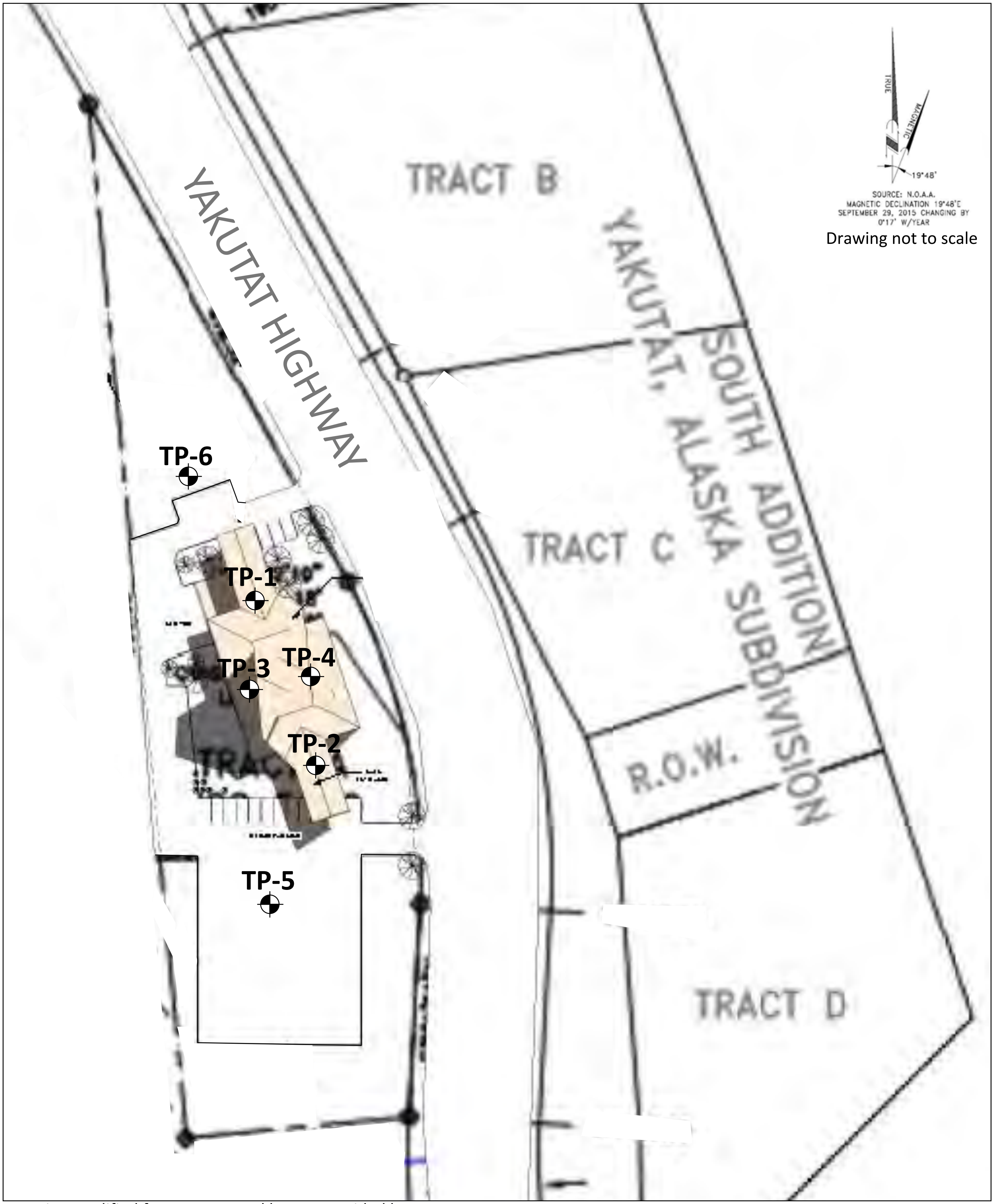
FIGURE TITLE: PROJECT SITE LOCATION	
PROJECT NAME: YAKUTAT COMMUNITY HEALTH CLINIC	PROJECT ID: 4562-16
PROJECT LOCATION: YAKUTAT, ALASKA	FIGURE NUMBER: 1



Drawing modified from conceptual layout provided by YTT

= Approx. location of test pit exploration

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FIGURE TITLE: CONCEPT SITE LAYOUT AND EXPLORATION LOCATIONS	
PROJECT NAME: YAKUTAT COMMUNITY HEALTH CLINIC	PROJECT ID: 4562-16
PROJECT LOCATION: YAKUTAT, ALASKA	FIGURE NUMBER: 2

UPLIFT CAPACITY = 0.8 x (EFFECTIVE SOIL WEIGHT + WEIGHT OF FOUNDATION)

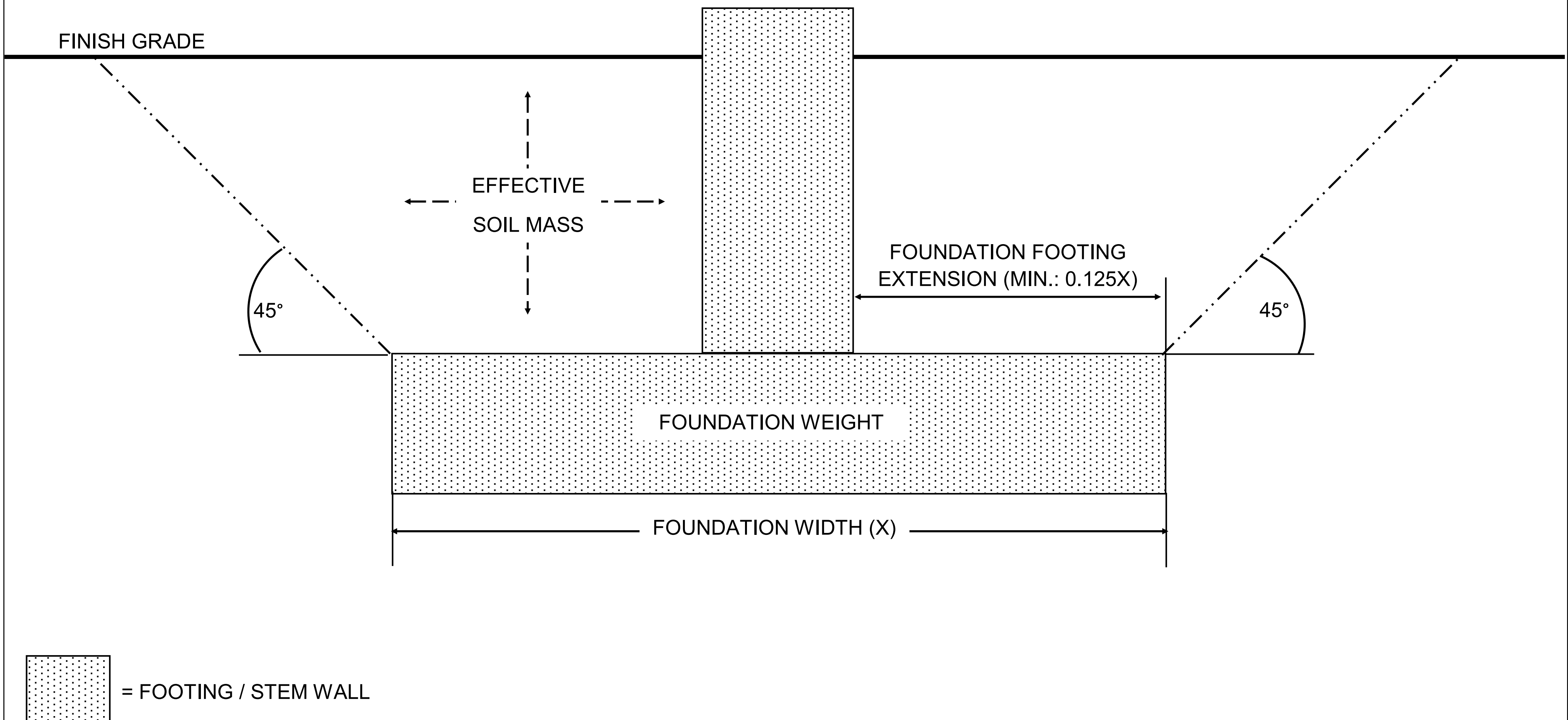

DIAGRAM NOT TO SCALE

NORTHERN GEOTECHNICAL ENGINEERING, INC.
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FIGURE TITLE: UPLIFT CAPACITY DIAGRAM	
PROJECT NAME: YAKUTAT COMMUNITY HEALTH CLINIC	PROJECT ID: 4562-16
PROJECT LOCATION: YAKUTAT, ALASKA	FIGURE NUMBER: 3

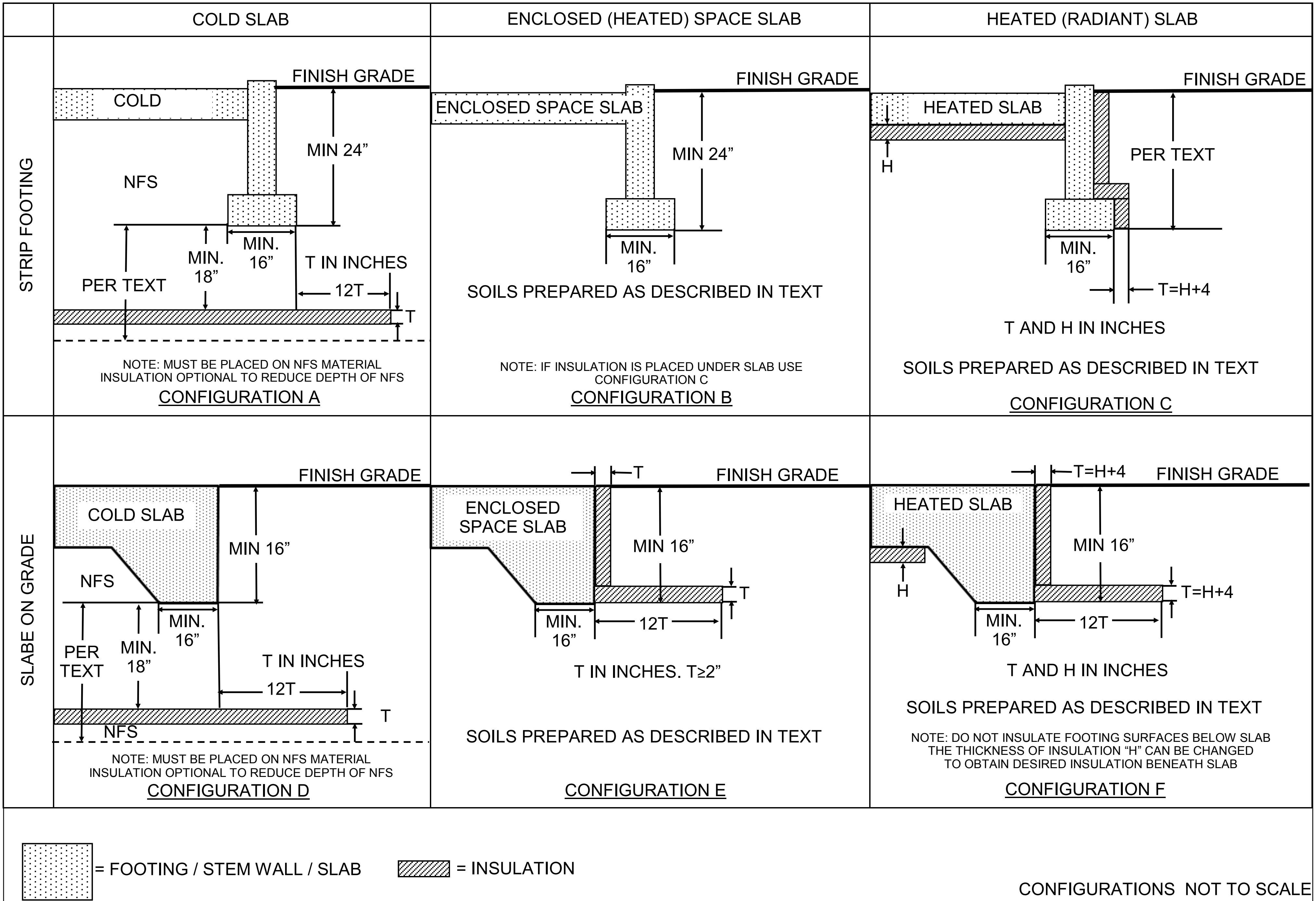

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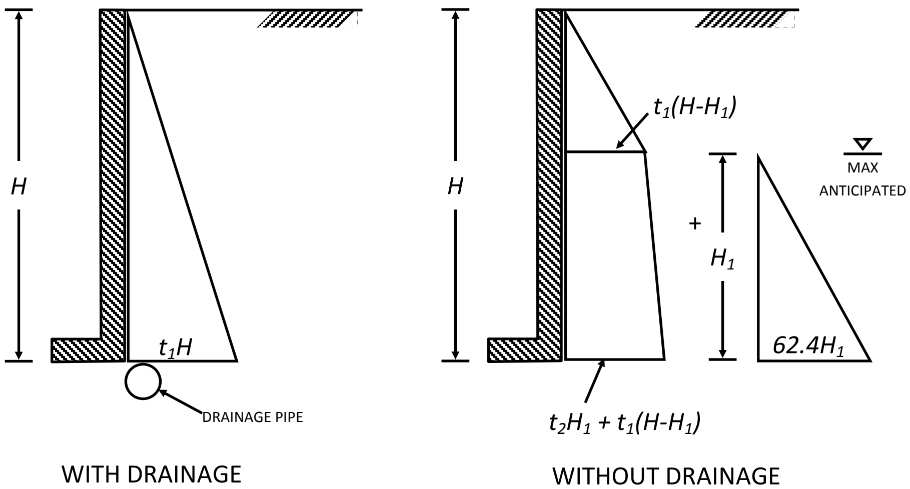
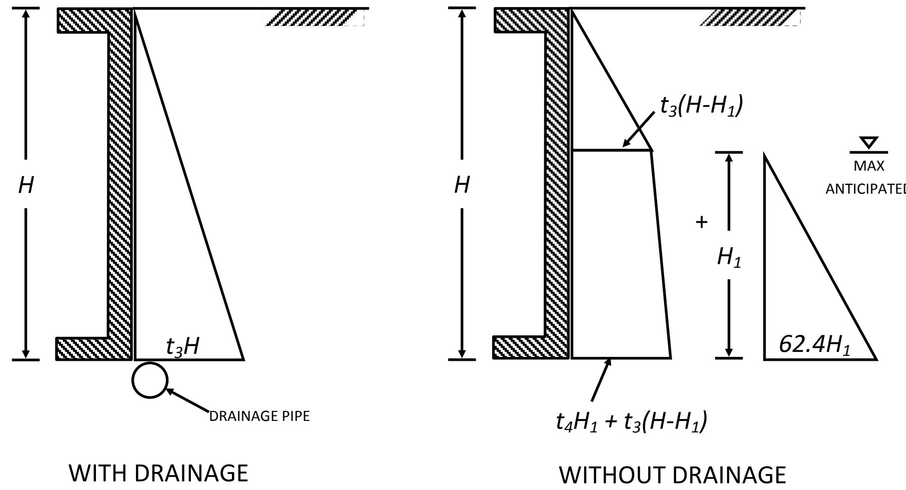
FIGURE TITLE: FOUNDATION INSULATION CONFIGURATIONS	
PROJECT NAME: PROPOSED YAKUTAT COMMUNITY HEALTH CLINIC	PROJECT ID: 4562-16
PROJECT LOCATION: YAKUTAT, ALASKA	FIGURE NUMBER: 4

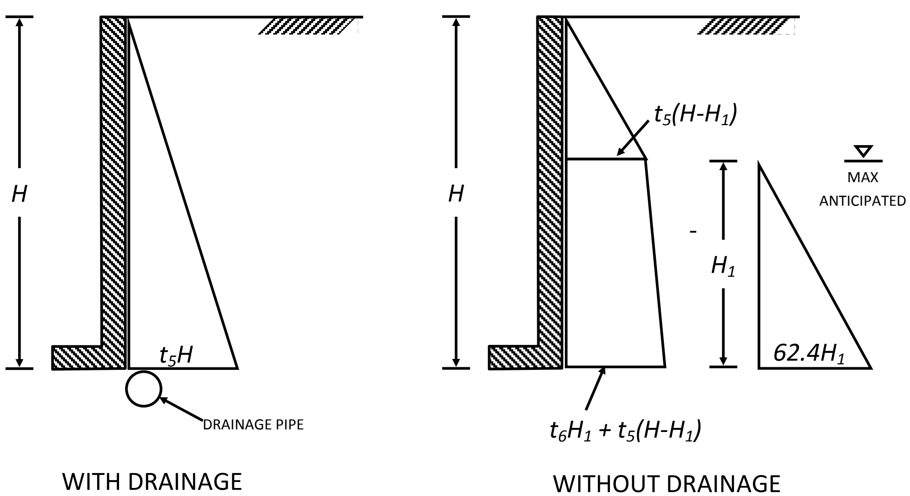
ACTIVE PRESSURE CONDITION



AT-REST PRESSURE CONDITION

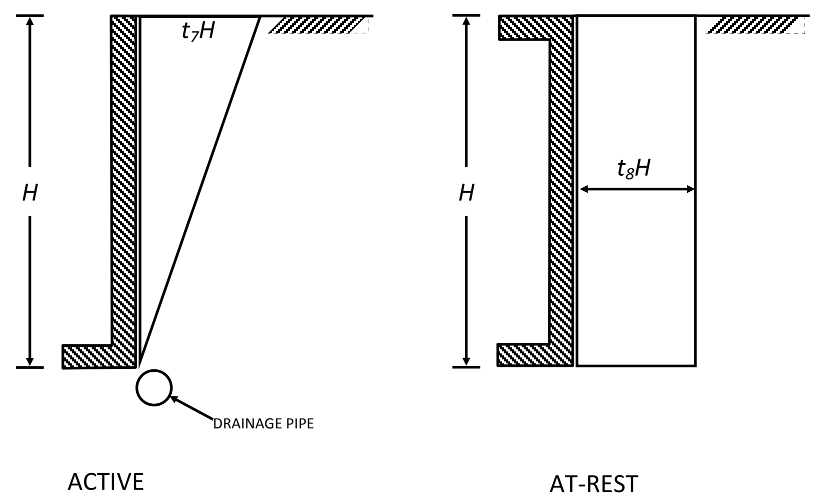


PASSIVE PRESSURE CONDITION



NOTE: WALLS CAN BE EITHER FREE OR RESTRAINED AT THE TOP FOR THE PASSIVE PRESSURE CONDITION. EQUATIONS ARE ONLY VALID FOR UNITS OF t_{1-8} (PCF) AND H-H_1(FT).

SEISMIC



NOTE: SEISMIC LOADS ARE VALID FOR WALLS RETAINING LESS THAN 8 FEET VERTICAL OF EARTH. THE SEISMIC LOAD IS ADDED TO ACTIVE & AT-REST CONDITIONS AND IS SUBTRACTED FROM PASSIVE CONDITIONS.

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FIGURE TITLE: LATERAL RETAINING WALL PRESSURES	
PROJECT NAME: YAKUTAT COMMUNITY HEALTH CLINIC	PROJECT ID: 4562-16
PROJECT LOCATION: YAKUTAT, ALASKA	FIGURE NUMBER: 5

APPENDIX A

GRAPHICAL SUBSURFACE EXPLORATION LOGS AND PHOTOGRAPHS

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EXPLORATION TP-1

NGE-TFT PROJECT NAME: Yakutat Community Health Clinic
NGE-TFT PROJECT NUMBER: 4562-16
PROJECT LOCATION: Yakutat, AK
EXPLORATION CONTRACTOR: Pate Co.
EXPLORATION EQUIPMENT: Hitachi EX 150
EXPLORATION METHOD: Test Pit Excavation
SAMPLING METHOD: Grab Sample
LOGGED BY: A. Smith
DATE/TIME STARTED: 10/27/2016 @ 10:05:00 AM
DATE/TIME COMPLETED: 10/27/2016 @ 10:30:00 AM
EXPLORATION LOCATION: See report Figure 2
GROUND ELEVATION: Not Known
GROUNDWATER (ATD): N/E
GROUNDWATER (): N/A
EXPLORATION COMPLETION: Backfilled with spoils.
WEATHER CONDITIONS: Overcast, calm, 36°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	LAB RESULTS
0.0			Surface organics and root masses			
			WELL GRADED GRAVEL WITH SAND (GW), olive brown to olive gray, damp, subrounded to rounded gravel, gravel up to 3" in diameter, few cobbles and trace boulders 1-2 ft in diameter, coarse sand, massive, GLACIAL OUTWASH			
2.5						
				Grab	S1	S1 MC = 4.4% 57.0% gravel, 38.8% sand, 4.2% silt P0.02 = 2.1% FC = PFS
5.0						
7.5						
10.0						
				Grab	S2	S2 MC = 2.7% P200 = 1.5%

Bottom of test pit at 12.0 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

(Continued Next Page)

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PHOTO APPENDIX

CLIENT Yakutat Tlingit Tribe

PROJECT NAME Yakutat Community Health Clinic

PROJECT NUMBER 4562-16

PROJECT LOCATION Yakutat, AK

Exploration TP-1
Soil Profile

Exploration TP-1
Bottom of Hole

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PHOTO APPENDIX

CLIENT Yakutat Tlingit Tribe

PROJECT NAME Yakutat Community Health Clinic

PROJECT NUMBER 4562-16

PROJECT LOCATION Yakutat, AK

Exploration TP-1
Spoils

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EXPLORATION TP-2

NGE-TFT PROJECT NAME: Yakutat Community Health Clinic
NGE-TFT PROJECT NUMBER: 4562-16
PROJECT LOCATION: Yakutat, AK
EXPLORATION CONTRACTOR: Pate Co.
EXPLORATION EQUIPMENT: Hitachi EX 150
EXPLORATION METHOD: Test Pit Excavation
SAMPLING METHOD: Grab Sample
LOGGED BY: A. Smith
DATE/TIME STARTED: 10/27/2016 @ 2:15:00 PM
DATE/TIME COMPLETED: 10/27/2016 @ 2:40:00 PM
EXPLORATION LOCATION: See report Figure 2
GROUND ELEVATION: Not Known
▽ **GROUNDWATER (ATD):** N/E
▼ **GROUNDWATER ():** N/A
EXPLORATION COMPLETION: Backfilled with spoils.
WEATHER CONDITIONS: Overcast, calm, 36°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	LAB RESULTS
0.0			Surface organics and root masses			
			POORLY GRADED GRAVEL WITH SAND (GP), olive brown to olive gray, damp, subrounded to rounded gravel, gravel up to 3" in diameter, few cobbles and trace boulders 1-2 ft in diameter, interbedded with sand layers 1-4" thick, coarse sand, massive, GLACIAL OUTWASH	Grab	S1	S1 MC = 4.5% 51.0% gravel, 45.4% sand, 3.5% silt P0.02 = 1.5% FC = NFS
2.5						
5.0						
7.5						
10.0						
12.5				Grab	S2	S2 MC = 6.5% P200 = 1.9%

Bottom of test pit at 14.0 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

(Continued Next Page)

PHOTO APPENDIX

Exploration TP-2
Soil Profile

Exploration TP-2
Bottom of Hole

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Fax: 907-344-5993

PHOTO APPENDIX

CLIENT Yakutat Tlingit Tribe **PROJECT NAME** Yakutat Community Health Clinic

PROJECT NUMBER 4562-16 **PROJECT LOCATION** Yakutat, AK

Exploration TP-2
Spoils

Northern Geotechnical Engineering Inc.
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Fax: 907-344-5993

EXPLORATION TP-3

NGE-TFT PROJECT NAME: Yakutat Community Health Clinic
NGE-TFT PROJECT NUMBER: 4562-16
PROJECT LOCATION: Yakutat, AK
EXPLORATION CONTRACTOR: Pate Co.
EXPLORATION EQUIPMENT: Hitachi EX 150
EXPLORATION METHOD: Test Pit Excavation
SAMPLING METHOD: Grab Sample
LOGGED BY: A. Smith
DATE/TIME STARTED: 10/27/2016 @ 1:30:00 PM
DATE/TIME COMPLETED: 10/27/2016 @ 2:05:00 PM
EXPLORATION LOCATION: See report Figure 2
GROUND ELEVATION: Not Known
▽ **GROUNDWATER (ATD):** N/E
▼ **GROUNDWATER ():** N/A
EXPLORATION COMPLETION: Backfilled with spoils.
WEATHER CONDITIONS: Overcast, calm, 36°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	LAB RESULTS
0.0			Surface organics and root masses			
			POORLY GRADED SAND WITH GRAVEL (SP), olive brown to olive gray, damp, subrounded to rounded gravel, gravel up to 3" in diameter, few cobbles and trace boulders 1-3 ft in diameter, coarse sand, massive, GLACIAL OUTWASH			
2.5						
				Grab	S1	S1 MC = 4.5% 47.7% gravel, 50.8% sand, 1.5% silt
5.0						
7.5						
10.0						
12.5						
				Grab	S2	S2 MC = 4.1% P200 = 1.3%

Bottom of test pit at 14.0 ft bgs.

Always refer to our complete geotechnical report for this project for a more detailed explanation of the subsurface conditions at the project site and how they may affect any existing and/or prospective project site development.

(Continued Next Page)

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PHOTO APPENDIX

CLIENT Yakutat Tlingit Tribe **PROJECT NAME** Yakutat Community Health Clinic

PROJECT NUMBER 4562-16 **PROJECT LOCATION** Yakutat, AK

Exploration TP-3
Soil Profile

Exploration TP-3
Bottom of Hole

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PHOTO APPENDIX

CLIENT Yakutat Tlingit Tribe
PROJECT NAME Yakutat Community Health Clinic
PROJECT NUMBER 4562-16
PROJECT LOCATION Yakutat, AK

Exploration TP-3
Spoils

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EXPLORATION TP-4

NGE-TFT PROJECT NAME: Yakutat Community Health Clinic
NGE-TFT PROJECT NUMBER: 4562-16
PROJECT LOCATION: Yakutat, AK
EXPLORATION CONTRACTOR: Pate Co.
EXPLORATION EQUIPMENT: Hitachi EX 150
EXPLORATION METHOD: Test Pit Excavation
SAMPLING METHOD: Grab Sample
LOGGED BY: A. Smith
DATE/TIME STARTED: 10/27/2016 @ 11:45:00 AM
DATE/TIME COMPLETED: 10/27/2016 @ 12:15:00 PM
EXPLORATION LOCATION: See report Figure 2
GROUND ELEVATION: Not Known
▽ **GROUNDWATER (ATD):** N/E
▼ **GROUNDWATER ():** N/A
EXPLORATION COMPLETION: Backfilled with spoils.
WEATHER CONDITIONS: Overcast, calm, 36°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	LAB RESULTS
0.0			Surface organics and root masses			
			POORLY GRADED SAND WITH GRAVEL (SP), loose, olive brown olive gray, damp, subrounded to rounded gravel, gravel up to 3" in diameter, few cobbles and trace boulders 1-2 ft in diameter, coarse sand, massive, GLACIAL OUTWASH	Grab	S1	S1 MC = 13.2% P200 = 2.0%
2.5						
5.0				Grab	S2	S2 MC = 5.3% 47.5% gravel, 48.2% sand, 4.3% silt
7.5						
10.0						
12.5				Grab	S3	S3 MC = 3.6% P200 = 3.9%

Bottom of test pit at 13.0 ft bgs.

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(Continued Next Page)

PHOTO APPENDIX

CLIENT Yakutat Tlingit Tribe **PROJECT NAME** Yakutat Community Health Clinic

PROJECT NUMBER 4562-16 **PROJECT LOCATION** Yakutat, AK

Exploration TP-4
Soil Profile

Exploration TP-4
Bottom of Hole

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PHOTO APPENDIX

CLIENT Yakutat Tlingit Tribe **PROJECT NAME** Yakutat Community Health Clinic

PROJECT NUMBER 4562-16 **PROJECT LOCATION** Yakutat, AK

Exploration TP-4
Spoils

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EXPLORATION TP-5

NGE-TFT PROJECT NAME: Yakutat Community Health Clinic
NGE-TFT PROJECT NUMBER: 4562-16
PROJECT LOCATION: Yakutat, AK
EXPLORATION CONTRACTOR: Pate Co.
EXPLORATION EQUIPMENT: Hitachi EX 150
EXPLORATION METHOD: Test Pit Excavation
SAMPLING METHOD: Grab Sample
LOGGED BY: A. Smith
DATE/TIME STARTED: 10/27/2016 @ 3:20:00 PM
DATE/TIME COMPLETED: 10/27/2016 @ 4:08:00 PM
EXPLORATION LOCATION: See report Figure 2
GROUND ELEVATION: Not Known
▽ **GROUNDWATER (ATD):** N/E
▼ **GROUNDWATER ():** N/A
EXPLORATION COMPLETION: Backfilled with spoils.
WEATHER CONDITIONS: Overcast, calm, 36°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	LAB RESULTS
0			Surface organics and root masses			
			POORLY GRADED GRAVEL WITH SAND (GP), olive brown to olive gray, damp, subrounded to rounded gravel, gravel up to 3" in diameter, few cobbles and trace boulders 1-3 ft in diameter, coarse sand, massive, GLACIAL OUTWASH			
5				Grab	S1	S1 MC = 4.0% 50.6% gravel, 46.7% sand, 2.7% silt P0.02 = 1.5% FC = NFS
10						
15				Grab	S2	S2 MC = 3.8% P0.02 = 2.1%

Bottom of test pit at 15.0 ft bgs.

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(Continued Next Page)

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PHOTO APPENDIX

CLIENT Yakutat Tlingit Tribe

PROJECT NAME Yakutat Community Health Clinic

PROJECT NUMBER 4562-16

PROJECT LOCATION Yakutat, AK

Exploration TP-5
Soil Profile

Exploration TP-5
Bottom of Hole

PHOTO APPENDIX

CLIENT Yakutat Tlingit Tribe **PROJECT NAME** Yakutat Community Health Clinic

PROJECT NUMBER 4562-16 **PROJECT LOCATION** Yakutat, AK

Exploration TP-5
Spoils

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EXPLORATION TP-6

NGE-TFT PROJECT NAME: Yakutat Community Health Clinic
NGE-TFT PROJECT NUMBER: 4562-16
PROJECT LOCATION: Yakutat, AK
EXPLORATION CONTRACTOR: Pate Co.
EXPLORATION EQUIPMENT: Hitachi EX 150
EXPLORATION METHOD: Test Pit Excavation
SAMPLING METHOD: Grab Sample
LOGGED BY: A. Smith
DATE/TIME STARTED: 10/27/2016 @ 10:50:00 AM
DATE/TIME COMPLETED: 10/27/2016 @ 11:15:00 AM
EXPLORATION LOCATION: See report Figure 2
GROUND ELEVATION: Not Known
GROUNDWATER (ATD): N/E
GROUNDWATER (): N/A
EXPLORATION COMPLETION: Backfilled with spoils.
WEATHER CONDITIONS: Overcast, calm, 36°F

DEPTH (ft)	GRAPHIC LOG	FROZEN SOILS	MATERIAL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	LAB RESULTS
0.0			Surface organics and root masses			
			SANDY GRAVEL (GP), olive brown to olive gray, damp, subrounded to rounded gravel, gravel up to 3" in diameter, few cobbles with trace boulders up to 1-2 ft in diameter, coarse sand, massive, GLACIAL OUTWASH			
2.5				Grab	S1	S1 MC = 8.1% P200 = 0.9%
			Approx. 2 in thick silt layer			
5.0						
7.5						
10.0						
12.5				Grab	S2	S2 MC = 3.2% 58.8% gravel, 39.6% sand, 1.6% silt

Bottom of test pit at 13.0 ft bgs.

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(Continued Next Page)

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PHOTO APPENDIX

CLIENT Yakutat Tlingit Tribe
PROJECT NAME Yakutat Community Health Clinic
PROJECT NUMBER 4562-16
PROJECT LOCATION Yakutat, AK

Exploration TP-6
Soil Profile

Exploration TP-6
Bottom of Hole

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PHOTO APPENDIX

CLIENT Yakutat Tlingit Tribe

PROJECT NAME Yakutat Community Health Clinic

PROJECT NUMBER 4562-16

PROJECT LOCATION Yakutat, AK

Exploration TP-6
Spoils

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EXPLORATION LEGEND

CLIENT Yakutat Tlingit Tribe

NGE-TFT PROJECT NAME Yakutat Community Health Center

NGE-TFT PROJECT NUMBER 4562-16

PROJECT LOCATION Yakutat, AK

LITHOLOGIC SYMBOLS
(Unified Soil Classification System)

GPS: Sandy Gravel

GW: USCS Well-graded Gravel

ML: USCS Silt

SPG: Gravelly Sand

TOPSOIL: Topsoil

SAMPLER SYMBOLS

Grab Sample

WELL CONSTRUCTION SYMBOLS

ABBREVIATIONS

LL - LIQUID LIMIT (%)
PI - PLASTIC INDEX (%)
MC - MOISTURE CONTENT (%)
DD - DRY DENSITY (PCF)
NP - NON PLASTIC
P200 - PERCENT PASSING NO. 200 SIEVE
P0.02- PERCENT PASSING 0.02mm SIEVE
PP - POCKET PENETROMETER (TSF)
S/U - CASING STICK-UP

TV - TORVANE
PID - PHOTOIONIZATION DETECTOR
UC - UNCONFINED COMPRESSION
ppm - PARTS PER MILLION
▽ Water Level at Time Drilling, or as Shown
▼ Water Level After 24 Hours, or as Shown

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SOIL CLASSIFICATION CHART

CLIENT Yakutat Tlingit Tribe

PROJECT NAME Yakutat Community Health Center

NGE-TFT PROJECT NUMBER 4562-16

PROJECT LOCATION Yakutat, AK

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS.
DIAGONAL LINES INDICATE UNKNOWN DEPTH OF SOIL TRANSITION.

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EXPLORATION LOG KEY

CLIENT Yakutat Tlingit Tribe
PROJECT NAME Yakutat Community Health Center
NGE-TFT PROJECT NUMBER 4562-16
PROJECT LOCATION Yakutat, AK

SAMPLER SYMBOLS

SPT w/ 140# Hammer
30" Drop and 2.0" O.D. Sampler

Modified SPT w/ 340# Hammer
30" Drop and 3.0 O.D. Sampler

Grab Sample

Shelby Tube Sample

Rock Core Sample

Direct Push Sample

No Recovery

N/E Not Encountered

WELL SYMBOLS

1" Slotted Pipe
Backfilled with Silica Sand

1" PVC Pipe
Backfilled with Auger Cuttings

1" PVC Pipe
with Bentonite Seal

Capped Riser

COMPONENT DEFINITIONS

COMPONENT	SIZE RANGE
Boulders	Larger than 12 in
Cobbles	3 in to 12 in
Gravel	3 in to No. 4 (4.5mm)
Coarse gravel	3 in to 3/4 in
Fine gravel	3/4 in to No. 4 (4.5 mm)
Sand	No. 4 (4.5 mm) to No. 200
Coarse sand	No. 4 (4.5 mm) to No. 10 (2.0 mm)
Medium sand	No. 10 (2.0 mm) to No. 40 (0.42 mm)
Fine sand	No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt and Clay	Smaller than No. 200 (0.074 mm)

COMPONENT PROPORTIONS

DESCRIPTIVE TERMS	RANGE OF PROPORTION
Trace	1-5%
Few	5-10%
Little	10-20%
Some	20-35%
And	35-50%

MOISTURE CONTENT

DRY	Absence of moisture, dusty, dry to the touch
DAMP	Some perceptible moisture; below optimum
MOIST	No visible water; near optimum moisture content
WET	Visible free water, usually soil is below water table

RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N-VALUE

COHESIONLESS SOILS			COHESIVE SOILS		
DENSITY	N (BLOWS/FT)	APPROXIMATE RELATIVE DENSITY (%)	CONSISTENCY	N (BLOWS/FT)	APPROXIMATE UNDRAINED SHEAR STRENGTH (PSF)
VERY LOOSE	0-4	0-15	VERY SOFT	0-1	< 250
LOOSE	5-10	15-35	SOFT	2-4	250-500
MEDIUM DENSE	11-25	35-65	MEDIUM STIFF	5-8	500-1000
DENSE	26-50	65-85	STIFF	9-15	1000-2000
VERY DENSE	> 50	85-100	VERY STIFF	16-30	2000-4000
			HARD	> 30	> 4000

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EXPLORATION LOG KEY

CLIENT Yakutat Tlingit Tribe

PROJECT NAME Yakutat Community Health Center

NGE-TFT PROJECT NUMBER 4562-16

PROJECT LOCATION Yakutat, AK

FROST DESIGN SOIL CLASSIFICATION

FROST GROUP (USACOE)	FROST GROUP (M.O.A.)	SOIL TYPE	% FINER THAN 0.02mm BY MASS	TYPICAL SOIL TYPES UNDER UNIFIED SOIL CLASSIFICATION SYSTEM
NFS*	NFS*	(A) GRAVELS CRUSHED STONE CRUSHED ROCK (B) SANDS	0 - 1.5 0 - 3	GW, GP SW, SP
PFS[+]	NFS*	(A) GRAVELS CRUSHED STONE CRUSHED ROCK	1.5 - 3	GW, GP
	F2	(B) SANDS	3 - 10	SW, SP
S1	F1	GRAVELLY SOILS	3 - 6	GW, GP, GW-GM, GP-GM
S2	F2	SANDY SOILS	3 - 6	SW, SP, SW-SM, SP-SM
F1	F1	GRAVELLY SOILS	6 - 10	GM, GW-GM, GP-GM
F2	F2	(A) GRAVELLY SOILS (B) SANDS	10 - 20 6 - 15	GM, GW-GM, GP-GM SM, SW-SM, SP-SM
F3	F3	(A) GRAVELLY SOILS (B) SANDS, EXCEPT VERY FINE SILTY SANDS (C) CLAYS, PI>12	Over 20 Over 15 - - - - - -	GM, GC SM, SC CL, CH
F4	F4	(A) ALL SILTS (B) VERY FINE SILTY SANDS (C) CLAYS, PI<12 (D) VARVED CLAYS AND OTHER FINE GRAINED, BANDED SEDIMENTS	- - - - - - Over 15 - - - - - - - - - - - -	ML, MH SM CL, CL-ML CL & ML; CL, ML, & SM; CL, CH, & ML; CL, CH, ML, & SM

*Non-frost susceptible
[+]Possibly frost susceptible, but requires lab testing to determine frost design soils classification.

ICE CLASSIFICATION SYSTEM

GROUP	ICE VISIBILITY	DESCRIPTION		SYMBOL	
N	SEGREGATED ICE NOT VISIBLE BY EYE	POORLY BONDED OR FRIABLE		Nf	
		WELL BONDED	NO EXCESS ICE	Nb	Nbn
			EXCESS MICROSCOPIC ICE		Nbe
V	SEGREGATED ICE IS VISIBLE BY EYE AND IS ONE INCH OR LESS IN THICKNESS	INDIVIDUAL ICE CRYSTALS OR INCLUSIONS		Vx	
		ICE COATINGS ON PARTICLES		Vc	
		RANDOM OR IRREGULARY ORIENTED ICE		Vr	
		STRATIFIED OR DISTINCTLY ORIENTED ICE		Vs	
		UNIFORMLY DISTRIBUTED ICE		Vu	
ICE	ICE IS GREATER THAN ONE INCH IN THICKNESS	ICE WITH SOILS INCLUSIONS		ICE + Soil Type	
		ICE WITHOUT SOILS INCLUSIONS		ICE	

APPENDIX B

LABORATORY TEST RESULTS

Summary of Laboratory Test Results

Yakutat Community Health Clinic

Yakutat, AK

NGE-TFT Project #:4562-16

Exploration ID	Sample Number	Depth Interval (ft) Top	(ft) Bottom	Moisture Content ASTM D2216 (% By Dry Mass)	Particle Size Analysis ASTM C136/D422/D6913 (% By Mass) Gravel	Sand	Silt/Clay	Passing #200 ASTM D1140 (% By Mass)	Passing 0.02mm ASTM D422 (% By Mass)	Frost Class.	Unified Soil Classification ASTM D2487
TP1	S1	3.00	4.00	4.4	57	38.8	4.2		2.1	PFS	(GW) Well-graded gravel w/ sand
TP1	S2	11.00	12.00	2.7				1.5			
TP2	S1	1.00	2.00	4.5	51.1	45.4	3.5		1.5	NFS	(GP) Poorly-graded gravel w/ sand
TP2	S2	13.00	14.00	6.5				1.9			
TP3	S1	3.00	4.00	4.5	47.7	50.8	1.5		N/A	N/A	(SP) Poorly-graded sand w/ gravel
TP3	S2	13.00	14.00	4.1				1.3			
TP4	S1	0.50	0.75	13.2				2.0			
TP4	S2	4.00	5.00	5.3	47.5	48.2	4.3		N/A	N/A	(SP) Poorly-graded sand w/ gravel
TP4	S3	12.00	13.00	3.6				3.9			
TP5	S1	3.00	4.00	4.0	50.6	46.7	2.7		1.5	NFS	(GP) Poorly-graded gravel w/ sand
TP5	S2	14.00	15.00	3.8				2.1			
TP6	S1	2.00	3.00	8.1				0.9			
TP6	S2	12.00	13.00	3.2	58.8	39.6	1.6		N/A	N/A	(GP) Poorly-graded gravel w/ sand

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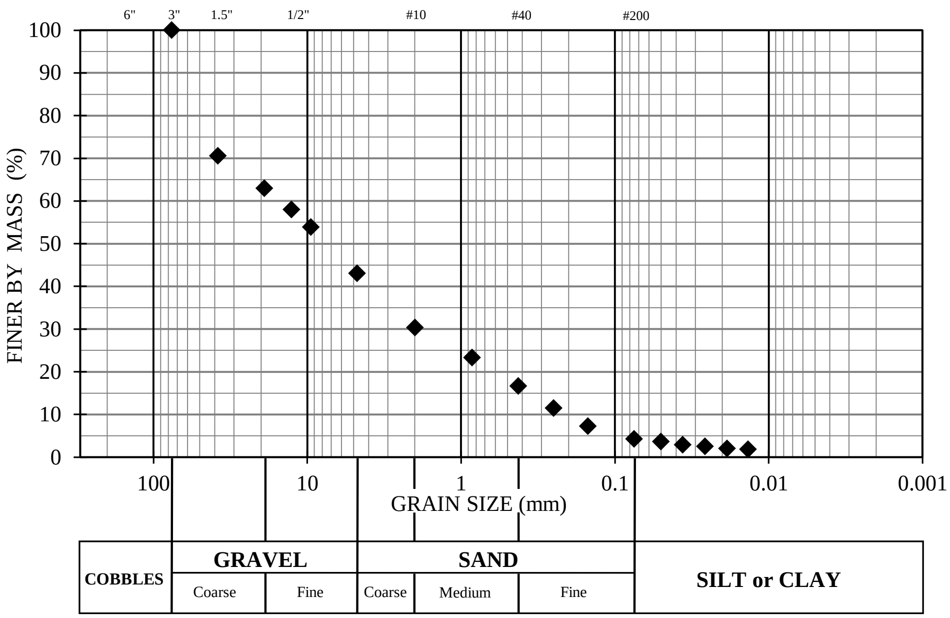
Laboratory Testing · Geotechnical Engineering · Instrumentation · Construction Monitoring Services · Thermal Analysis

PROJECT CLIENT:	**YTT**
PROJECT NAME:	**Yakutat CHC**
PROJECT NO.:	**4562-16**
SAMPLE LOC.:	**TP1**
NUMBER/ DEPTH:	**S1 / 3 '- 4'**
DESCRIPTION:	**Well-graded gravel w/ sand**
DATE RECEIVED:	**10/31/2016**
TESTED BY:	**JA**
REVIEWED BY:	**ACS**

% GRAVEL	**57.0**	USCS	**GW**
% SAND	**38.8**	USACOE FC	**PFS**
% SILT/CLAY	**4.2**	% PASS. 0.02 mm	**2.1**
% MOIST. CONTENT	**4.4**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)		**70.8**	
COEFFICIENT OF GRADATION (C_c)		**1.2**	
ASTM D1557 (uncorrected)		**N/A**	
ASTM D4718 (corrected)		**N/A**	
OPTIMUM MOIST. CONTENT. (corrected)		**N/A**	

PARTICLE SIZE ANALYSIS ASTM D422 / C136



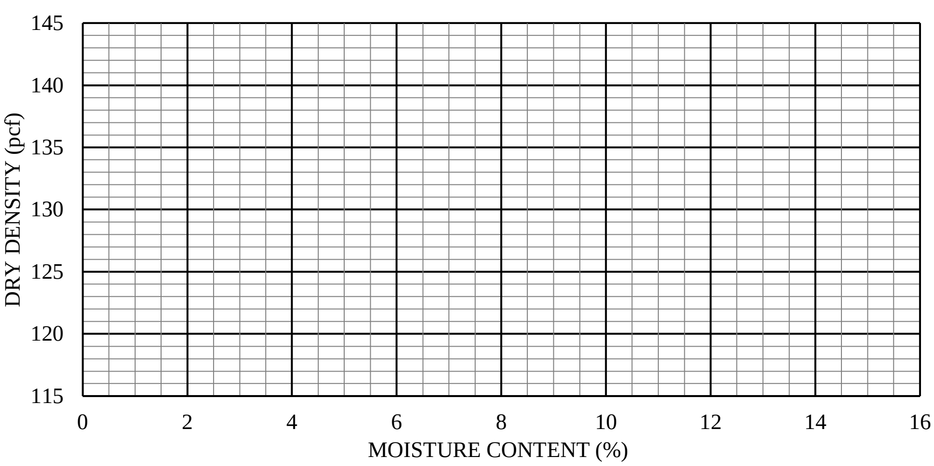
SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
76.20	3"	**100**	
38.10	1.5"	**71**	
19.00	3/4"	**63**	
12.70	1/2"	**58**	
9.50	3/8"	**54**	
4.75	#4	**43**	
2.00	#10	**30**	
0.85	#20	**23**	
0.43	#40	**17**	
0.25	#60	**11**	
0.15	#100	**7**	
0.075	#200	**4.2**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
0.5		
1	0.0503	3.7
2	0.0363	2.9
4	0.0259	2.5
8	0.0187	2.0
15	0.0136	1.8
30		
60		
250		
1440		

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

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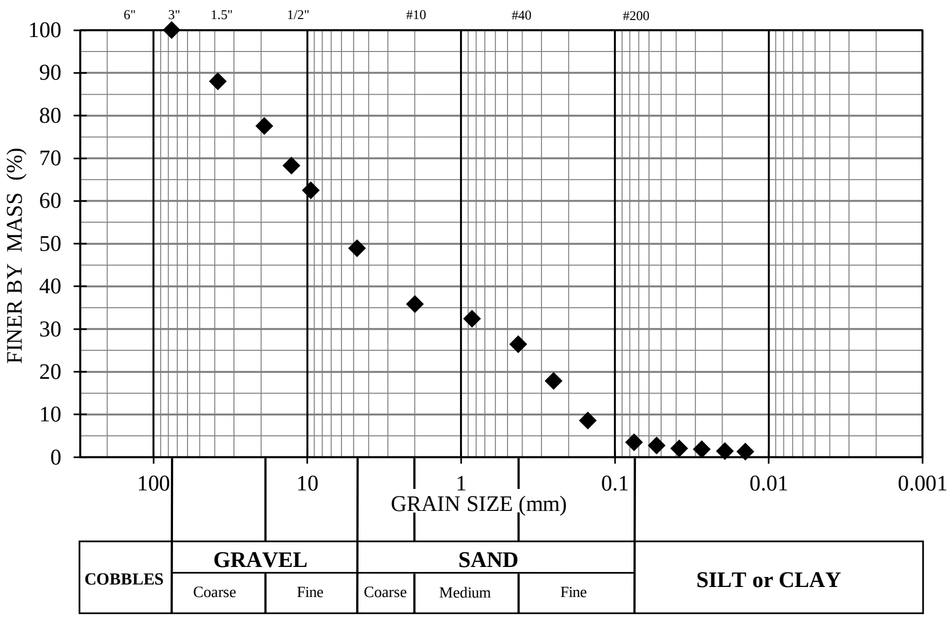
PROJECT CLIENT:	**YTT**
PROJECT NAME:	**Yakutat CHC**
PROJECT NO.:	**4562-16**
SAMPLE LOC.:	**TP2**
NUMBER/ DEPTH:	**S1 / 1' - 2'**
DESCRIPTION:	**Poorly-graded gravel w/ sand**
DATE RECEIVED:	**10/31/2016**
TESTED BY:	**JA**
REVIEWED BY:	**ACS**

% GRAVEL	**51.1**	USCS	**GP**
% SAND	**45.4**	USACOE FC	**NFS**
% SILT/CLAY	**3.5**	% PASS. 0.02 mm	**1.5**
% MOIST. CONTENT	**4.5**	% PASS. 0.002 mm	**N/A**

UNIFORMITY COEFFICIENT (C_u)	**52.2**
COEFFICIENT OF GRADATION (C_c)	**0.3**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

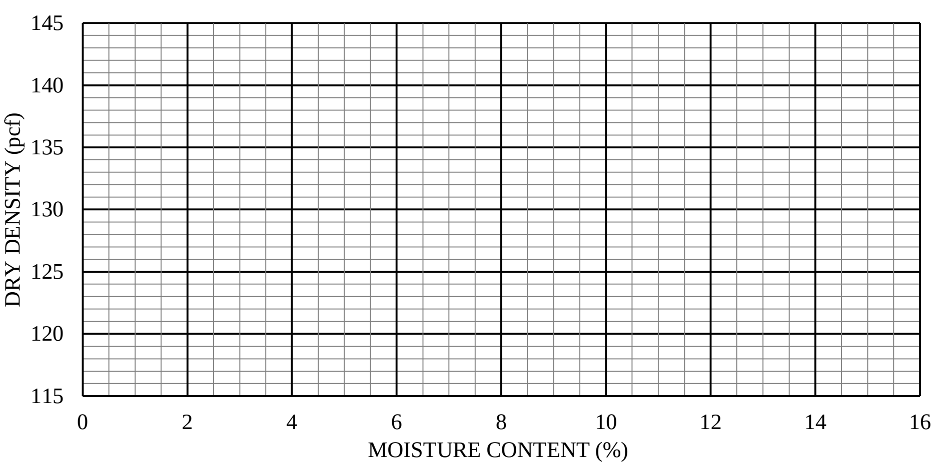
PARTICLE SIZE ANALYSIS ASTM D422 / C136



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
76.20	3"	**100**	
38.10	1.5"	**88**	
19.00	3/4"	**78**	
12.70	1/2"	**68**	
9.50	3/8"	**62**	
4.75	#4	**49**	
2.00	#10	**36**	
0.85	#20	**32**	
0.43	#40	**26**	
0.25	#60	**18**	
0.15	#100	**9**	
0.075	#200	**3.5**	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
0.5		
1	0.0535	2.7
2	0.0382	2.0
4	0.0272	1.9
8	0.0193	1.4
15	0.0142	1.3
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

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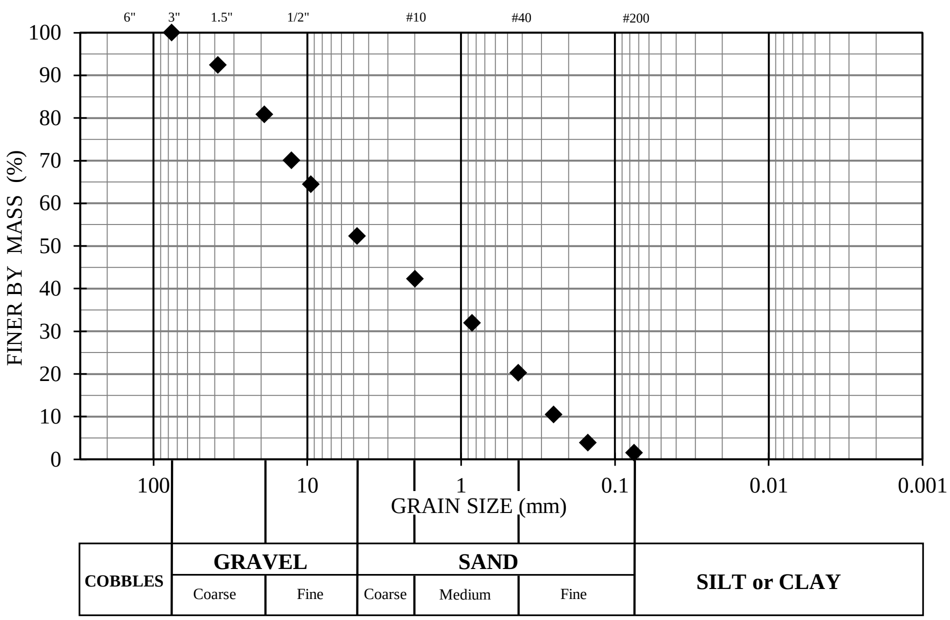
PROJECT CLIENT:	**YTT**
PROJECT NAME:	**Yakutat CHC**
PROJECT NO.:	**4562-16**
SAMPLE LOC.:	**TP3**
NUMBER/ DEPTH:	**S1 / 3 '- 4'**
DESCRIPTION:	**Poorly-graded sand w/ gravel**
DATE RECEIVED:	**10/31/2016**
TESTED BY:	**JA**
REVIEWED BY:	**ACS**

% GRAVEL	**47.7**	USCS	**SP**
% SAND	**50.8**	USACOE FC	**N/A**
% SILT/CLAY	**1.5**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**4.5**	% PASS. 0.002 mm	**N/A**

UNIFORMITY COEFFICIENT (C_u)	**32.0**
COEFFICIENT OF GRADATION (C_c)	**0.3**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

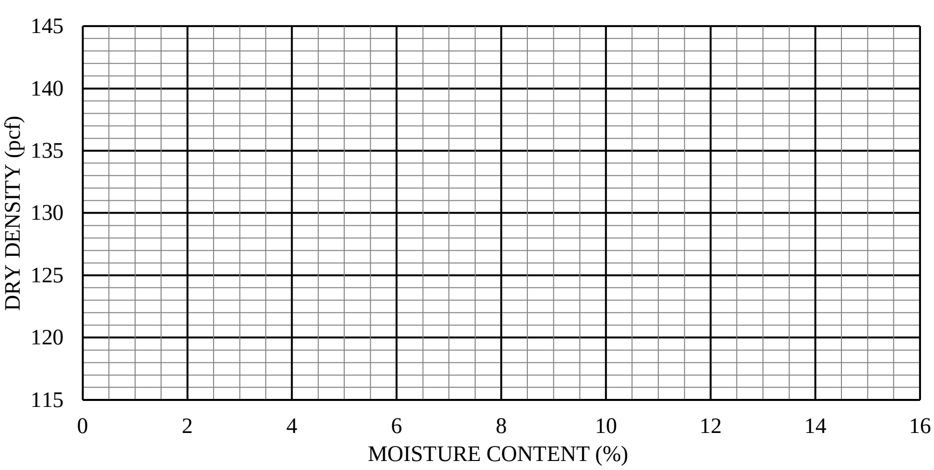
PARTICLE SIZE ANALYSIS ASTM D422 / C136



SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
76.20	3"	**100**	
38.10	1.5"	**92**	
19.00	3/4"	**81**	
12.70	1/2"	**70**	
9.50	3/8"	**64**	
4.75	#4	**52**	
2.00	#10	**42**	
0.85	#20	**32**	
0.43	#40	**20**	
0.25	#60	**10**	
0.15	#100	**4**	
0.075	#200	**1.5**	

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
0.5		
1		
2		
4		
8		
15		
30		
60		
250		
1440		

HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

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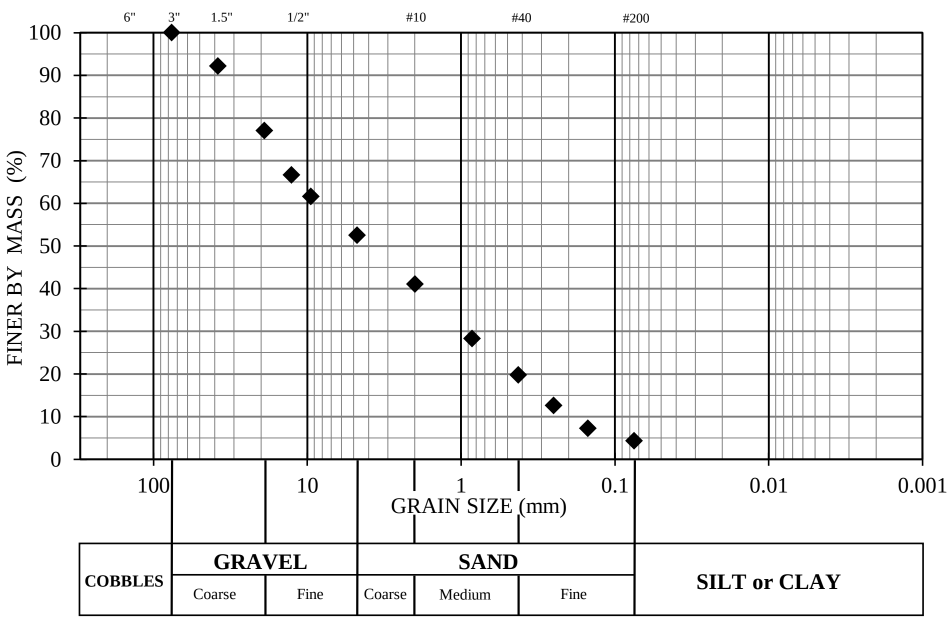
PROJECT CLIENT:	**YTT**
PROJECT NAME:	**Yakutat CHC**
PROJECT NO.:	**4562-16**
SAMPLE LOC.:	**TP4**
NUMBER/ DEPTH:	**S2 / 4' - 5'**
DESCRIPTION:	**Poorly-graded sand w/ gravel**
DATE RECEIVED:	**10/31/2016**
TESTED BY:	**JA**
REVIEWED BY:	**ACS**

% GRAVEL	**47.5**	USCS	**SP**
% SAND	**48.2**	USACOE FC	**N/A**
% SILT/CLAY	**4.3**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**5.3**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)	**43.0**		
COEFFICIENT OF GRADATION (C_c)	**0.6**		
ASTM D1557 (uncorrected)	**N/A**		
ASTM D4718 (corrected)	**N/A**		
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**		

PARTICLE SIZE ANALYSIS ASTM D422 / C136



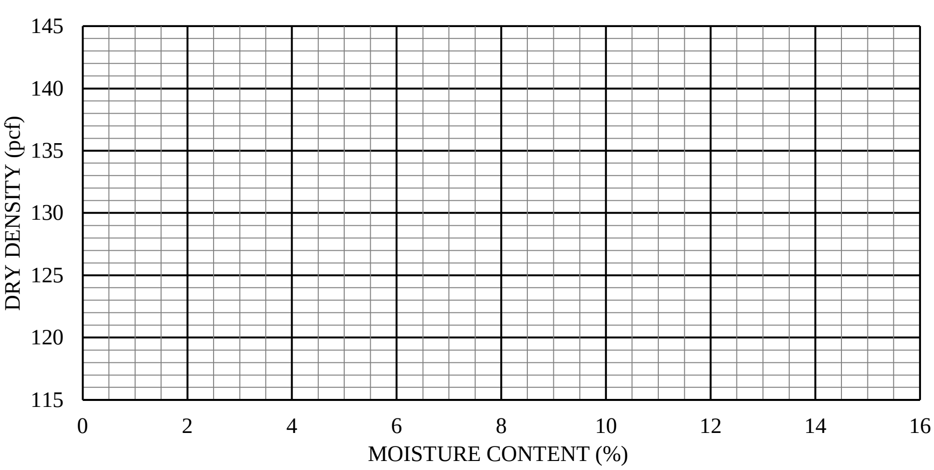
SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
76.20	3"	**100**	
38.10	1.5"	**92**	
19.00	3/4"	**77**	
12.70	1/2"	**67**	
9.50	3/8"	**62**	
4.75	#4	**53**	
2.00	#10	**41**	
0.85	#20	**28**	
0.43	#40	**20**	
0.25	#60	**13**	
0.15	#100	**7**	
0.075	#200	**4.3**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
0.5		
1		
2		
4		
8		
15		
30		
60		
250		
1440		

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

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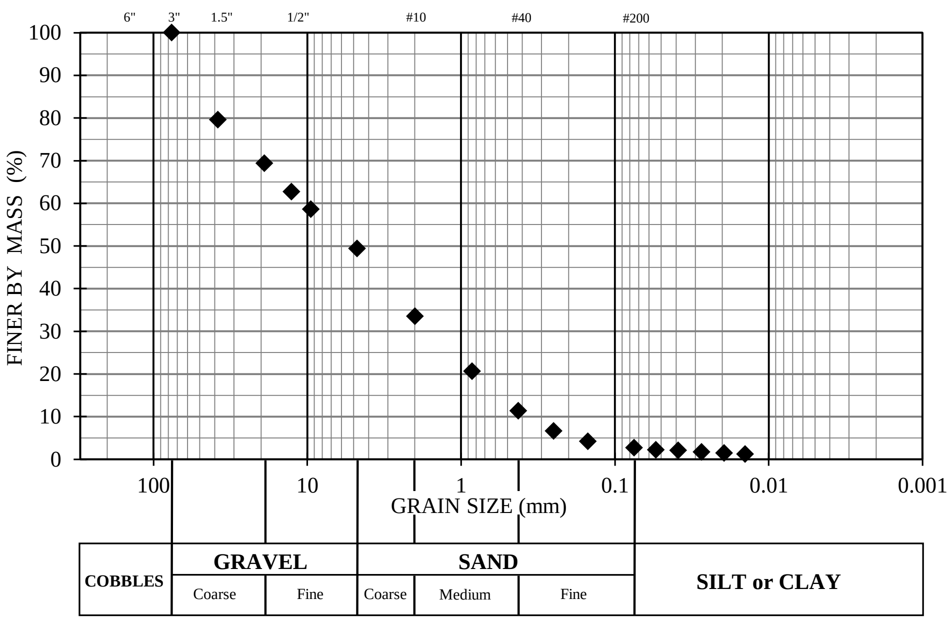
PROJECT CLIENT:	**YTT**
PROJECT NAME:	**Yakutat CHC**
PROJECT NO.:	**4562-16**
SAMPLE LOC.:	**TP5**
NUMBER/ DEPTH:	**S1 / 3' - 4'**
DESCRIPTION:	**Poorly-graded gravel w/ sand**
DATE RECEIVED:	**10/31/2016**
TESTED BY:	**JA**
REVIEWED BY:	**ACS**

% GRAVEL	**50.6**	USCS	**GP**
% SAND	**46.7**	USACOE FC	**NFS**
% SILT/CLAY	**2.7**	% PASS. 0.02 mm	**1.5**
% MOIST. CONTENT	**4.0**	% PASS. 0.002 mm	**N/A**

UNIFORMITY COEFFICIENT (C_u)	**28.3**
COEFFICIENT OF GRADATION (C_c)	**0.7**
ASTM D1557 (uncorrected)	**N/A**
ASTM D4718 (corrected)	**N/A**
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**

PARTICLE SIZE ANALYSIS ASTM D422 / C136



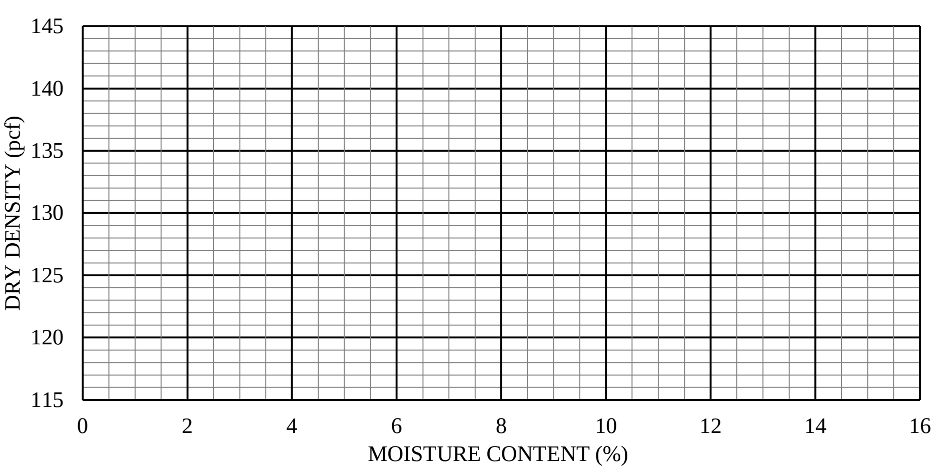
SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
76.20	3"	**100**	
38.10	1.5"	**80**	
19.00	3/4"	**69**	
12.70	1/2"	**63**	
9.50	3/8"	**59**	
4.75	#4	**49**	
2.00	#10	**33**	
0.85	#20	**21**	
0.43	#40	**11**	
0.25	#60	**7**	
0.15	#100	**4**	
0.075	#200	**2.7**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
0.5		
1	0.0542	2.2
2	0.0387	2.1
4	0.0274	1.7
8	0.0195	1.4
15	0.0142	1.2
30		
60		
250		
1440		

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

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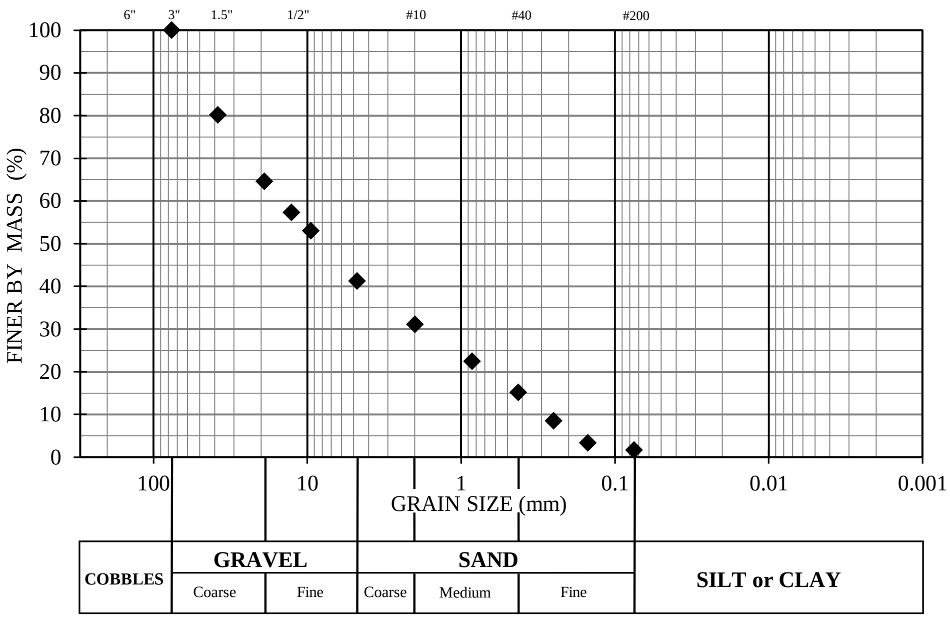
PROJECT CLIENT:	**YTT**
PROJECT NAME:	**Yakutat CHC**
PROJECT NO.:	**4562-16**
SAMPLE LOC.:	**TP6**
NUMBER/ DEPTH:	**S2 / 12' - 13'**
DESCRIPTION:	**Poorly-graded gravel w/ sand**
DATE RECEIVED:	**10/31/2016**
TESTED BY:	**JA**
REVIEWED BY:	**ACS**

% GRAVEL	**58.8**	USCS	**GP**
% SAND	**39.6**	USACOE FC	**N/A**
% SILT/CLAY	**1.6**	% PASS. 0.02 mm	**N/A**
% MOIST. CONTENT	**3.2**	% PASS. 0.002 mm	**N/A**
UNIFORMITY COEFFICIENT (C_u)	**51.8**		
COEFFICIENT OF GRADATION (C_c)	**0.8**		
ASTM D1557 (uncorrected)	**N/A**		
ASTM D4718 (corrected)	**N/A**		
OPTIMUM MOIST. CONTENT. (corrected)	**N/A**		

PARTICLE SIZE ANALYSIS ASTM D422 / C136



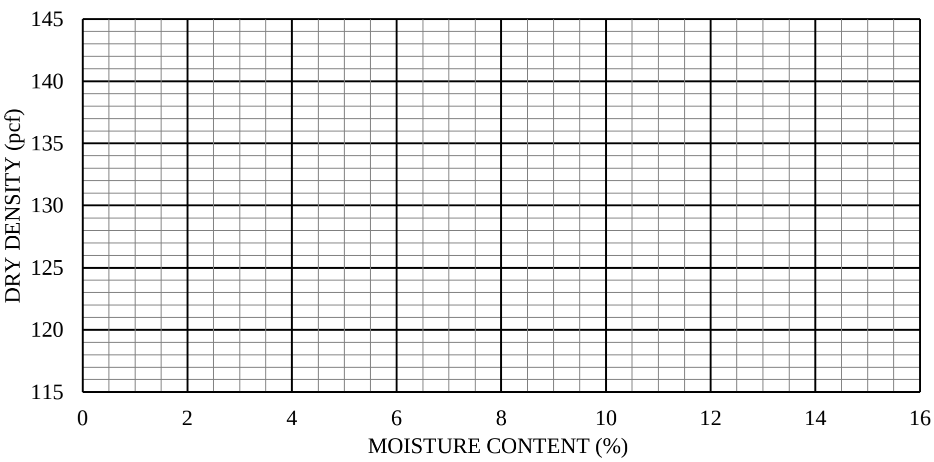
SIEVE ANALYSIS RESULT

SIEVE SIZE (mm)	SIEVE SIZE (U.S.)	TOTAL % PASSING	SPECIFICATION (% PASSING)
76.20	3"	**100**	
38.10	1.5"	**80**	
19.00	3/4"	**65**	
12.70	1/2"	**57**	
9.50	3/8"	**53**	
4.75	#4	**41**	
2.00	#10	**31**	
0.85	#20	**22**	
0.43	#40	**15**	
0.25	#60	**8**	
0.15	#100	**3**	
0.075	#200	**1.6**	

HYDROMETER RESULT

ELAPSED TIME (MIN)	DIAMETER (mm)	TOTAL % PASSING
0		
0.5		
1		
2		
4		
8		
15		
30		
60		
250		
1440		

MOISTURE-DENSITY RELATIONSHIP ASTM D1557



HYDRAULIC COND. (ASTM D2434)	**N/A**
DEGRADATION (ATM T-313)	**N/A**
PLASTICITY INDEX ASTM 4318	**N/A**

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APPENDIX C

USGS SEISMIC SITE CLASSIFICATION REPORTS

USGS Design Maps Summary Report

User–Specified Input

Report Title Yakutat Community Health Clinic
Tue November 22, 2016 17:07:50 UTC

Building Code Reference Document 2012/2015 International Building Code
(which utilizes USGS hazard data available in 2008)

Site Coordinates 59.54535°N, 139.72716°W

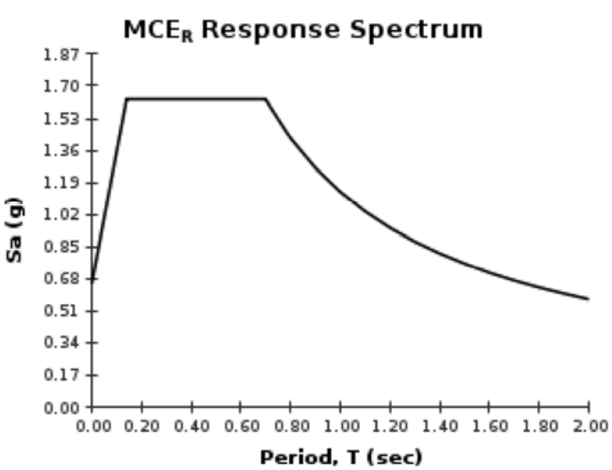
Site Soil Classification Site Class D – "Stiff Soil"

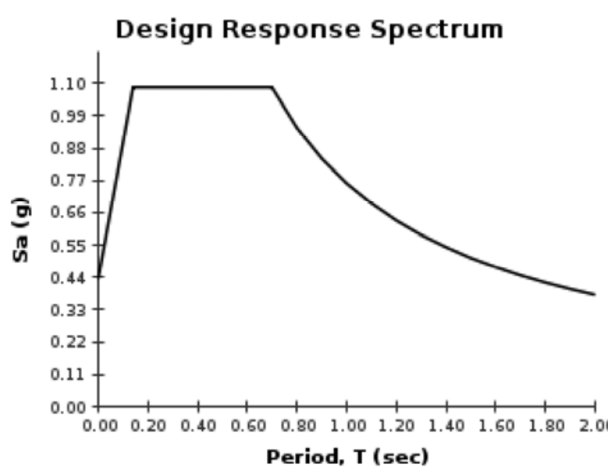
Risk Category I/II/III

USGS–Provided Output

S_S =	1.630 g	S_{MS} =	1.630 g	S_{DS} =	1.086 g
S_1 =	0.760 g	S_{M1} =	1.139 g	S_{D1} =	0.760 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.





Design Maps Detailed Report

2012/2015 International Building Code (59.54535°N, 139.72716°W)

Site Class D – "Stiff Soil", Risk Category I/II/III

Section 1613.3.1 — Mapped acceleration parameters

Note: Ground motion values provided below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_S) and 1.3 (to obtain S_1). Maps in the 2012/2015 International Building Code are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 1613.3.3.

From Figure 1613.3.1(4) [1] S_S = 1.630 g

From Figure 1613.3.1(5) [2] S_1 = 0.760 g

Section 1613.3.2 — Site class definitions

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Section 1613.

2010 ASCE-7 Standard – Table 20.3-1
SITE CLASS DEFINITIONS

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index *PI* > 20, • Moisture content *w* ≥ 40%, and • Undrained shear strength $\bar{s}_u$ < 500 psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 1613.3.3 — Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters

TABLE 1613.3.3(1)
VALUES OF SITE COEFFICIENT F_a

Site Class	Mapped Spectral Response Acceleration at Short Period				
	$S_S \leq 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = D and S_S = 1.630 g, F_a = 1.000

TABLE 1613.3.3(2)
VALUES OF SITE COEFFICIENT F_v

Site Class	Mapped Spectral Response Acceleration at 1–s Period				
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \geq 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = D and S_1 = 0.760 g, F_v = 1.500

Equation (16-37):	$S_{MS} = F_aS_S$ = 1.000 x 1.630 = 1.630 g
Equation (16-38):	$S_{M1} = F_vS_1$ = 1.500 x 0.760 = 1.139 g

Section 1613.3.4 — Design spectral response acceleration parameters

Equation (16-39):	$S_{DS} = ⅔ S_{MS}$ = ⅔ x 1.630 = 1.086 g
Equation (16-40):	$S_{D1} = ⅔ S_{M1}$ = ⅔ x 1.139 = 0.760 g

Section 1613.3.5 — Determination of seismic design category

TABLE 1613.3.5(1)
SEISMIC DESIGN CATEGORY BASED ON SHORT-PERIOD (0.2 second) RESPONSE ACCELERATION

VALUE OF S_{DS}	RISK CATEGORY		
	I or II	III	IV
$S_{DS} < 0.167g$	A	A	A
$0.167g \le S_{DS} < 0.33g$	B	B	C
$0.33g \le S_{DS} < 0.50g$	C	C	D
$0.50g \le S_{DS}$	D	D	D

For Risk Category = I and S_{DS} = 1.086 g, Seismic Design Category = D

TABLE 1613.3.5(2)
SEISMIC DESIGN CATEGORY BASED ON 1-SECOND PERIOD RESPONSE ACCELERATION

VALUE OF S_{D1}	RISK CATEGORY		
	I or II	III	IV
$S_{D1} < 0.067g$	A	A	A
$0.067g \le S_{D1} < 0.133g$	B	B	C
$0.133g \le S_{D1} < 0.20g$	C	C	D
$0.20g \le S_{D1}$	D	D	D

For Risk Category = I and S_{D1} = 0.760 g, Seismic Design Category = D

Note: When S_1 is greater than or equal to 0.75g, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

Seismic Design Category ≡ "the more severe design category in accordance with Table 1613.3.5(1) or 1613.3.5(2)" = E

Note: See Section 1613.3.5.1 for alternative approaches to calculating Seismic Design Category.

References

1. *Figure 1613.3.1(4)*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(4).pdf
2. *Figure 1613.3.1(5)*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(5).pdf