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Transmittal

To: Bear Ketzler, Manager **City of Tanana** **POB 77249** **Tanana, AK 99777**	**From: Susan Randlett** **Phone: (907) 269-7614** **Fax: (907) 269-7509** **Date: 10/25/07**

Hi Bear,

I am returning some soils information I borrowed last June when Mr. Englishoe and I were looking at records on the first floor of the City building.

Susan

Susan

Attached:
Soils Engineering Services, Episcopal Church Rehabilitation, Tanana, Alaska October 1980

11-11-80

Jay
Pls review as soon as you can
Thanks John.

Reroughed 11-17-80
RRoss

Soil Engineering Services
Episcopal Church Rehabilitation
Tanana, Alaska

HLA Job No. 9661,001.08

Prepared for

The City of Tanana
Box 181
Tanana, Alaska 99777

By

John R. Chambers
Project Engineer
337-7835

Jay M. England
Civil Engineer 1943-E

Harding-Lawson Associates
624 West International Airport Road
Anchorage, Alaska 99502
(907) 276-8102

October, 1980

PRELIMINARY

INTRODUCTION

This report presents the results of our soil engineering services for the proposed rehabilitation of the existing Episcopal Church near Tanana, Alaska. The project consists of installing a new foundation beneath the church to replace the present rotted timber footings. The building will remain at its present site.

The building is a one and one-half story log and wood frame structure having approximately 2800 square feet of floor area. Present plans call for use on Sundays and intermittent days during the week, with the building unheated during non-use periods. We understand that total design column loads are 8 to 20 kips, with up to five kips of dead load.

Our scope of services, as outlined in our proposal dated September 29, 1980, was to drill, log and sample five to seven test borings, perform ground temperature measurements in selected borings, and perform laboratory tests on the samples obtained. On the basis of our field investigation and laboratory tests we were to develop conclusions and recommendations regarding the following:

1. Appropriate pile embedment requirements, allowable load capacities, and frost jacking restraints;
2. Pile installation procedures, including criteria for slurry material, placement and densification, and effect of massive ice or unbonded permafrost encountered during construction, if any;
3. Site preparation to maintain a permafrost condition;
4. Examine and sample local sources of fill and backfill.

During the work we have consulted with Messrs. Frank Brown of Charles Bettisworth & Company, Project Architect, Art Whitmer, Structural Engineer, Steve Schwabb, Tanana City Manager, and Sandy and Bruce Jamieson, Project Construction Managers.

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INVESTIGATION

We explored the site September 29 through October 3, 1980 by drilling five test borings inside the church building and one outside as shown on the Boring Location Plan (Plate 1). The borings were advanced to depths of 3.5 to 23 feet using portable equipment mobilized from Anchorage. The equipment included a Mobile Minuteman drill rig and a 17-foot tripod and cathead motor assembly equipped with a 70-pound drop hammer. The drill rig utilized a 2 5/8-inch diameter solid flight auger and standard and modified Shelby tubes for sampling. The standard Shelby tubes were 3.0-inch diameter and the modified tubes were 2.5-inch diameter fitted with hardened tungsten carbide cutting teeth for coring permafrost.

During the field work our engineer selected the boring locations, logged the soil and permafrost conditions encountered, and obtained samples of representative soils types, ~~By~~ coring and driving the Shelby tubes ~~soils were obtained~~ and by retrieving auger returns. The logs of the borings are presented on Plates 2 through 6. The soil and permafrost have been classified in accordance with the Unified Soil Classification System and U.S. Army Corps of Engineers Explanation of Ice Symbols described on Plates 7 and 8, respectively.

The samples were sealed to preserve their physical characteristics and moisture (ice) contents and shipped to our Anchorage laboratory. In the laboratory they were reexamined to verify the field classifications. Selected samples were tested to measure their moisture content, dry density, particle size distribution, Atterberg limits, organic content, freezing point depression, and percent passing the No. 200 sieve size. The test results are shown on the boring logs opposite the samples tested as

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explained on the Key to Test Data, Plate 7. The Particle Size Analysis is presented on Plate 9.

Upon completion of drilling Borings 1 through 4, temperature monitoring wells consisting of one and one-half-inch-diameter plastic pipes were placed in the holes, filled with glycol and the annulus backfilled with cuttings. Twenty-four hours later the ground temperatures were read by lowering a YSI Series 401 thermistor down the conduit and reading the temperatures at depth intervals with a Data Precision Model 248 multimeter. The temperatures are presented on the boring logs. Because of thermal disturbance caused by the drilling, the ground temperatures had probably not stabilized and were probably lower than indicated on the logs.

SITE HISTORY

A Condition Survey Report by Charles Bettisworth & Company, and verbal accounts by others indicate that the existing church was constructed about 1900. The structure was originally founded at grade upon short posts placed in hand-excavated pits and backfilled with the excavation cuttings. Subsequently, the structure settled probably due to thaw consolidation. As the building continued to settle, efforts to maintain the foundation system included placement of isolated and continuous timber footings at grade. These foundations also settled and rotted. During the period of active use, about 1900 to 1940, a thaw bulb apparently developed beneath the structure. After its abandonment during the 1940's, the building was not heated and the permafrost apparently aggraded.

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SITE AND SOIL CONDITIONS

At the time of our investigation the building had been elevated and supported on temporary wood cribbing and the soil beneath the building had been excavated approximately 2-1/2 to 3-1/2 feet below natural grade.

The surrounding terrain to the north, east and west for several hundred feet is relatively flat. However, to the south the ground gradually slopes down at about seven percent to the Yukon River about 500 feet away. The Yukon River elevation is approximately 60 feet below the church site. The surrounding area supports a mixed growth of alder, birch and spruce 4 to 20 inches in diameter. The immediate building vicinity contains numerous graves and is reportedly the site of an old settlement surrounding the church building. We understand that this area is being considered for historical designation and future preservation.

The soil strata is typical of river terraced deposits. The site is covered with a surface mat approximately 2 to 12 inches thick consisting of forest litter and decomposed fibrous particles. However because the building subgrade had been overexcavated the organic soils were absent in Borings 1 through 5. In Borings 1 through 3 buried timber cribbing was encountered which caused refusal drilling for the equipment at 3-1/2 to 4-1/2 feet. The soils encountered consisted of 1 to 3-1/2 feet of peat underlain by silt. The silt contained layers of organic silt and peat to depths of up to 13 feet. In Borings 4 through 6, underlying the interbedded silt and organics, we encountered silt with a trace of fine sand to the depths explored. The sandy silt has a moderate frozen strength and a relatively medium to high dry density. The peat, organic silt, and silt have high moisture contents and are highly frost susceptible and very compressible when thawed. In Boring 6, outside the church, unfrozen soil was encountered to a depth of about eight feet which was underlain by frozen soil to the depth explored (10.5 feet).

Temperature readings taken during our field investigation indicated the soil temperatures to be between 29^{o} to 31^{o}F. However, as previously discussed, these temperatures are only indicators of frozen soil and may not necessarily represent ~~of~~ the ground temperatures typical in Tanana or at the site.

DISCUSSION

We understand that the city does not want the church to appear as an elevated structure for aesthetic reasons. This concept presents problems from a soil engineering standpoint since the underlying permafrost must be maintained to assure a long term foundation integrity and unavoidable heat loss from the building will melt the permafrost. The permafrost may be maintained by providing a clear breezeway or duct system to expose the ground surface to the cold ambient winter temperatures, or by installing insulation and a refrigeration system. The breezeway system is the most common method utilized in permafrost regions of Alaska. Additionally, refrigerating the site would be prohibiti~~ng,~~vely expensive, and unreliable ~~susceptible to mechanical breakdown.~~ Insulation under an at-grade structure without refrigeration would not prevent formation of a thaw bulb but would only slow the advancing thermal front. Settling of the structure would result.

For these reasons we have limited our recommendations to a pile supported structure with open breezeway beneath. The two most practical methods of pile installation that are available are (1) conventional pre-drilled slurry backfilled timber piles, and (2) minimum displacement

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steel piles driven into pre-drilled pilot holes. Either method could involve moving the structure, removing the roof, or utilizing equipment small enough to fit through the doors and be erected inside the structure. Equipment meeting these requirements is available in Alaska and mobilizing such equipment to Tanana would be relatiavely easy because of the small size.

Adequate ventilation beneath the building is necessary regardless of which pile system is used. Because this could be most economically accomplished by founding the building above grade, Mr. Schwabb recommended a light temporary skirting with a log appearance be left in place during the summer and removed during winter months. The temporary skirting would provide the desired appearance during high frequency use periods and this would be part of the formal maintenance program in Tanana.

To prevent ponding of water beneath the building which would aid degradation of the permafrost, the site grade beneath the building should be restored to about six inches above surrounding grade and should be well compacted. Recommendations for foundation design and installation are presented below.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our investigation we conclude that the site can be satisfactorily developed from a geotechnical engineering standpoint for the planned rehabilitation of the structure. Furthermore, we conclude that a pile foundation will provide the most positive support if properly maintained.

Preaugered - Slurried Adfreeze Piles

Wood piles may be installed in predrilled holes in the permafrost and backfilled with sand and water slurry which subsequently freezes and bonds to the pile. Pile support will be derived from the adfreeze bond that develops between the slurry and the pile. The adfreeze strength used to design the pile foundation should not exceed 600 pounds per square foot (psf) for dead loads, 1000 psf for total design loads, and 2000 psf for resisting the uplift force from frost jacking. The upper six feet should be considered the active layer and should be ignored in computing pile capacity. In addition, the piles should be installed butt down and should be embedded at least 20 feet below ~~existing ground surface~~ the active zone to resist frost jacking. (Piles should not be spliced, and they will therefore probably necessitate the removal of the root to install.) Piles should not be installed closer than three diameters center to center.

Pile installation is best scheduled for the winter months when the active layer and ground surface are frozen and ground temperatures are colder. Freezeback of ~~a~~ pile slurry in the warmer months may require several weeks and can delay construction.

Additional recommendations for site preparation and conventional adfreeze piles are as follows:

1. Timber piles should be Douglas Fir conforming to ASTM D25 standards for friction piles and should have eight inch minimum tip diameters. To prevent decay in the active layer, piles should be pressure treated with pentachlorophenol or water-born salts. Creosote treatment should not be allowed.

Pentachlorophenol treatment should be accomplished in accordance with American Wood Preservers Association (AWPA) specifications P-8 and P-9 or Federal Specification Pt-W-570. Treatment with water-born salts should be accomplished in accordance with AWPA specification P-5 or Federal Specifications PT-W-549 and 550.

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2. The piles should be placed in holes dry augered to a diameter at least six inches greater than the pile butt diameter. The holes should be temporarily cased when necessary to seal off surface and groundwater inflow and soil sloughing. Piles should not deviate from ~~a~~ the planned location by more than one inch in any direction or from vertical plumbness by more than 1/4-inch per foot. ~~after taper has been compensated for.~~

3. To provide a contingency for future installation of thermal tubes should the permafrost warm, two-inch I.D., Schedule 40 galvanized steel pipe should be attached to each pile. The pipe should extend from about one-foot above the bottom of the pile to about one-foot above finish grade and should be filled with diesel oil and capped top and bottom. Any buried joints must be sealed and adequately tightened to positively prevent leakage of the diesel oil.

4. The piles should be wrapped in the active layer with a bond break consisting of at least two layers of accordion-folded five mil visqueen. The wrap should extend six feet below the ground surface and should be sealed around the pile with duct tape top and bottom.

5. The cuttings from the pile holes will contain organics and silt and should not be used for pile backfill. Sand from local sources may be used for slurry backfill and should conform approximately to the gradation below:

Sand Gradation

Sieve Size	Percent Passing
3/4	100
No. 4	90 to 100
No. 10	70 to 100
No. 40	40 to 100
No.200	0 to 20

The sand should be free of salt and should not be fozen or contain frozen lumps or ice at the time of placement into the pile annulus. The sample of sand furnished us by Mr. Schwab as proposed slurry material adequately satisfies the above gradation (see Plate 9).

6. Piling should be placed and slurried as soon as possible after drilling the hole. The sand to be used as backfill should be mixed with clean, fresh water to perform a semi-liquid slurry and should be densified in-place with concrete vibrators for the full depth of the pile hole to insure high density and eliminate trapped air. The mixing water used in the slurry should be added to saturate the backfill material and achieve about a six-inch slump as determined by standard concrete slump tests. The pile should be restrained from moving during backfilling and freezeback and should not be free to "float". Backfill material should be mounded around the piles at the ground surface to direct surface water away from the piles and prevent ponding. Piles may be loaded only after freezeback as verified by thermistor readings of 31.0^{O}F or less. If massive ice is encountered it must be compensated for by increasing the depth of embedment on a foot for foot basis.

Driven Piles

Piles driven into the permafrost will gain support from the adfreeze bond developed from the in-situ soils and the steel pile wall. Allowable Adfreeze strengths ~~used to design this~~ for pipe pile foundations should not exceed 350 psf for deadloads, 500 psf for total design loads, and 1000 psf for resisting the uplifting force of frost jacking. (These values may be increased by 10% for steel H piles provided the included perimeter is used in calculating pile capacities and not the actual surface. The [illegible]) Additional recommendations are as follows:

1. To facilitate driving, pilot holes should be predrilled at the pile locations. The pilot hole should be advanced with an auger type drill or an air rotary system. Steam thawing should not be permitted. Casing may be require in the active zone to prevent intrustion of ground water and soil sloughing.

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2. Pilot holes for pipe piles should be at least 1/2-inch smaller than the pile diameter and pilot holes for H piles should not be larger than the web dimension. If driving shoes are required their outside dimension must not be larger than the pile. In addition, pile caps for driving should be used to prevent excessive deformation during driving.

3. The piles should be free of rust, petroleum films, or other deleterious materials prior to installation. Pile material welds and capacities should be checked by a structural engineer.

4. The piles should be driven continuously to design embedment without stopping and restarting the pile driving hammer.

4. The four interior column support piles should be driven at least 30 feet below finished grade to mitigate frost jacking effect. The remainder of the piles should be embedded at least 35 feet.

5. The portion of pile remaining above ground surface should be painted with glossy white paint after pile installation. The paint should be installed in successive coats and have a minimum total thickness of five mils.

6. Driving equipment should be capable of advancing the design pile at a rate of at least one foot per minute. If refusal driving conditions or damage to a pile occurs at less than the required embedment depth, the piles should be pulled or abandoned and additional piles installed as directed by the architect.

7. Final position of the pile should be within one inch of planned location and one-quarter inch per foot of plumb.

8. As a contingency for refreezing the site in the future should the permafrost warm, access for installation of heat tubes should be provided either by welding an access channel on the webs of H piles or by cleaning out pipe piles after they are driven.

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Instrumentation and Site Preparation

1. To monitor freezeback, Yellow Springs Instrument Series 401 or equivalent thermistor probes should be installed on one south facing perimeter and two interior piles at depths of six feet below ground surface, mid-point and bottom of piles. Lead wires of sufficient length with standard plugs should extend above final grade for connection to a common junction box installed within the building. The contractor should provide suitable read-out equipment (Data Precision Corporation Multimeter Model 248 or equivalent) which should become the property of the City of Tanana after project completion. Temperatures should be read every three months for the first year, and annually thereafter.

2. The surrounding ground surface adjacent to the building should remain in an undistrubed condition during and after construction. Adequate drainage should be maintained around the site. An average clearance of at least 1.5 feet between floor girders and the ground surface should be provided to allow free circulation of ambient air. In no instance should the clearance be less than one-foot. Permanent skirting should only be attached to the front side; temporary skirting will be installed on the remaining ~~three sides~~ two side. Back fill against the back wall and should be removed each fall. A breezeway should be left open beneath the building during freezing months to allow free circulation of cold ambient air. Excessive snow accumulation should not be allowed to occur beneath the building, and a regular maintenance program should be implemented if necessary to remove drifted snow.

call John about this one

3. Good foundation performance is very dependent upon the procedures and techniques used during construction. For this reason it is recommended that Harding-Lawson Associates be present during pile installation to verify that the work is performed in accordance with the intent of our

PRELIMINARY

recommendations and that the subsurface conditions are similar to those encountered during exploration. We should also review the plans and specifications to be sure that they conform with the intent of our recommendations.

PRELIMINARY

LIST OF ILLUSTRATIONS

Plate 1 - Boring Location Plan

Plates 2 through 6 - Logs of Borings

Plate 7 - Unified Soil Classification System and Key to Test Data

Plate 8 - Ice Classification System

Plate 9 - Particle Size Analysis

DISTRIBUTION

2 copies: City of Tanana
Box 181
Tanana, Alaska 99777

Attention: Mr. Steve Schwabb

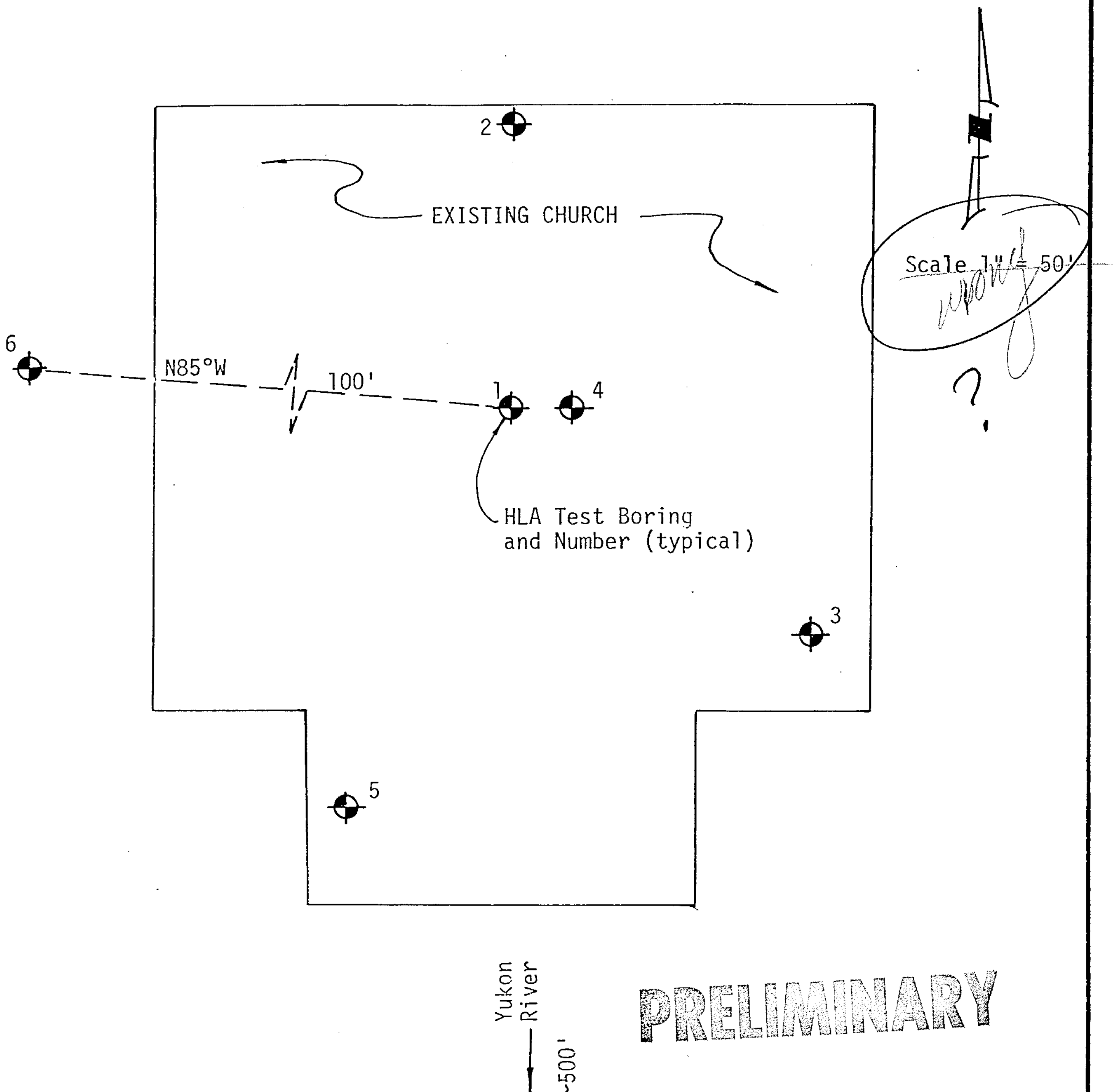
1 copy: Charles Bettisworth & Company
801 Pioneer Road, P.O. Box 73209
Fairbanks, Alaska 99707

Attention: Mr. Frank Brown

1 copy: Arthur H. Whitmer & Associates
1709 S. Bragaw Street
Anchorage, Alaska 99504

Attention: Mr. Art Whitmer

PRELIMINARY



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HARDING - LAWSON ASSOCIATES

Consulting Engineers and Geologists

Job No. 9661,001.08 Appr: Date 10/80

BORING LOCATION PLAN

EPISCOPAL CHURCH REHABILITATION

Tanana, Alaska

PLATE

1

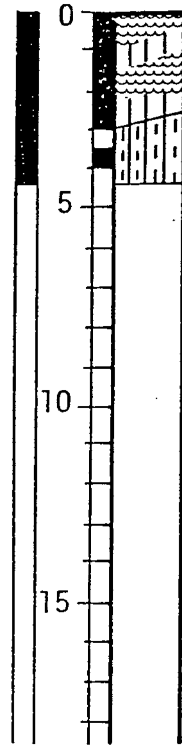
RF1

LOG OF BORING 1

Equipment 2.5" OD Steel Shelby Tube

Elevation — Date Drilled 9/29/80

Laboratory Tests: Ground Temp (°F)	Blows/Foot (N-Value)	Moisture Content (%)	Dry Density (pcf)
46.3(Air)*		90.7	
33.8(1.0')		34.7	
32.4(2.0')		215	25
30.8(3.0')			
30.0(3.8')			



BROWN FIBROUS PEAT (P_t, N_{bn}) with occasional thin lenses of brown silt (ML)

BROWN ORGANIC SILT (OL, Nbn)

No Free Water Encountered

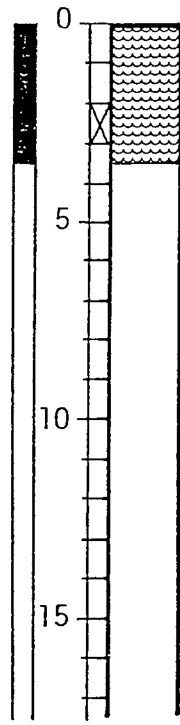
No Unbonded Permafrost Encountered

LOG OF BORING 2

Equipment 2.5" OD Steel Shelby Tube

Elevation — Date Drilled 9/30/80

Ground Temp (°F)
33.0(0.0')
32.1(1.0')
31.9(2.0')



BROWN FIBROUS PEAT (P_t, N_{bn}) fibrous

No Free Water Encountered

No Unbonded Permafrost Encountered

PRELIMINARY

* Temperatures taken 10-3-80

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Consulting Engineers and Geologists

Job No. 9661,001.08 Appr: Date 10/80

LOG OF BORINGS 1 & 2

EPISCOPAL CHURCH REHABILITATION
Tanana, Alaska

PLATE 2

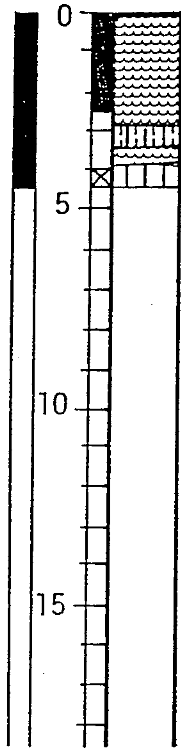
RF1

LOG OF BORING 3

Equipment: 2.5" OD Steel Shelby Tube

Elevation: — Date Drilled: 9/30/80

Laboratory Tests	Ground Temp (°F)	Blows/Foot (N-Value)	Moisture Content (%)	Dry Density (pcf)	Frozen	Depth (ft)	Samples
	33.0(0.0')		86.4				
	32.1(1.0')						
	31.9(2.0')						
			53.1				



BROWN FIBROUS PEAT (P_t, N_{bn})

BROWN ORGANIC SILT (OL, N_{bn})

BROWN PEAT (P_t, N_{bn})

GRAY SANDY SILT (ML, N_{bn}) with trace of fine sand

No Free Water Encountered

No Unbonded Permafrost Encountered

PRELIMINARY

HARDING - LAWSON ASSOCIATES

Consulting Engineers and Geologists

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LOG OF BORING 3

EPISCOPAL CHURCH REHABILITATION
Tanana, Alaska

PLATE 3

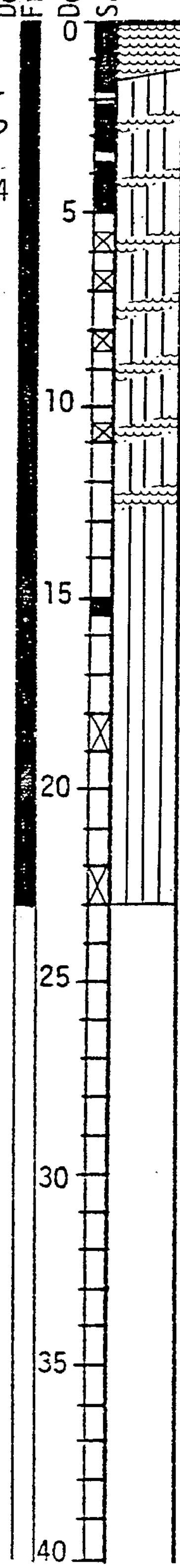
RF1

LOG OF BORING 4

Equipment 2.5" OD Steel Shelby Tube

Elevation — Date Drilled 9/30/80

Laboratory Tests	Ground Temp. (°F)	Blows/Foot (N-Value)	Moisture Content (%)	Dry Density (pcf)
	46.2(Air)			
	31.4(1.0')		44.3	71
			~~56.2~~	~~60~~
			56.2	60
			61.1	54
	30.8(5.0')		70.4	
			60.0	
			96.2	
Atterberg Limits Test = Nonplastic	29.9(10.0')		53.3	
-#200 sieve = 92.9%	29.3(15.0')		46.1	
F.P.D.* < 0.1°C	29.4(18.0')		44.7	
			40.0	



BROWN FIBROUS PEAT (P_t, N_{bn})
with occasional ice particles (V_x)

GRAY SILT (ML, N_{bn})
with trace of fine sand
with fibrous peat lenses of approximately 1' intervals

at 6' becomes V_x

at 13.0' peat lenses decreasing in thickness and frequency

at 13.5' becomes V_x-V_s

at 20.5' increasing sand content

at 21.5' V_x-N_{bn}

No Free Water Encountered

No Unbonded Permafrost Encountered

*F.P.D. = Freezing Point Depression estimated from measured pore water conductivity

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Consulting Engineers and Geologists

Job No. 9661,001.08 Appr: Date 10/80

LOG OF BORING 4
EPISCOPAL CHURCH REHABILITATION
Tanana, Alaska

PLATE 4

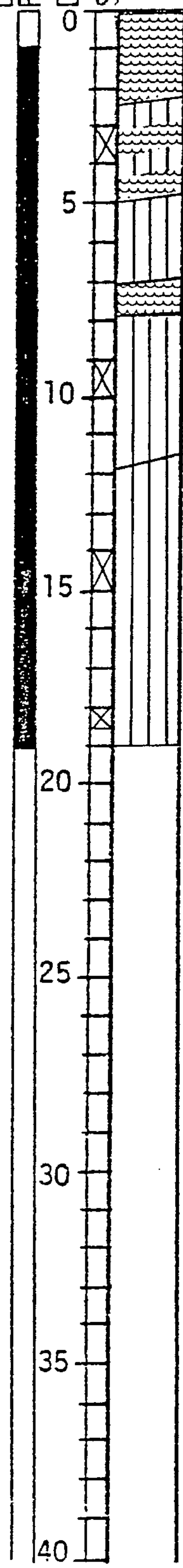
RF1

LOG OF BORING 5

Equipment 2.5" OD Steel Shelby Tube

Elevation — Date Drilled 10/2/80

Laboratory Tests	Ground Temp. (°F)	Blows/Foot (N-Value)	Moisture Content (%)	Dry Density (pcf)
			61.9	
O.L.I.* = 14.0%			42.6	
F.P.D. < 0.1°C			43.7	



BROWN FIBROUS PEAT (Pt, Vx-Vs)
with interbedded organic silt (OL N_{bn})

at 4.0' with interbedded lenses of gray silt (ML, N_{bn})
with trace of fine sand

GRAY SILT (ML, V_x-V_s)
with interbedded lenses of organic silt and fibrous peat

GRAY SILT (ML, V_x-N_{bn})
with trace of fine sand

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*O.L.I. = Organic Loss by Ignition based on oven dry sample weight.

HARDING - LAWSON ASSOCIATES
Consulting Engineers and Geologists

Job No. 9661,001.08 Appr: ____ Date 10/80

LOG OF BORING 5

EPISCOPAL CHURCH REHABILITATION
Tanana, Alaska

PLATE 5

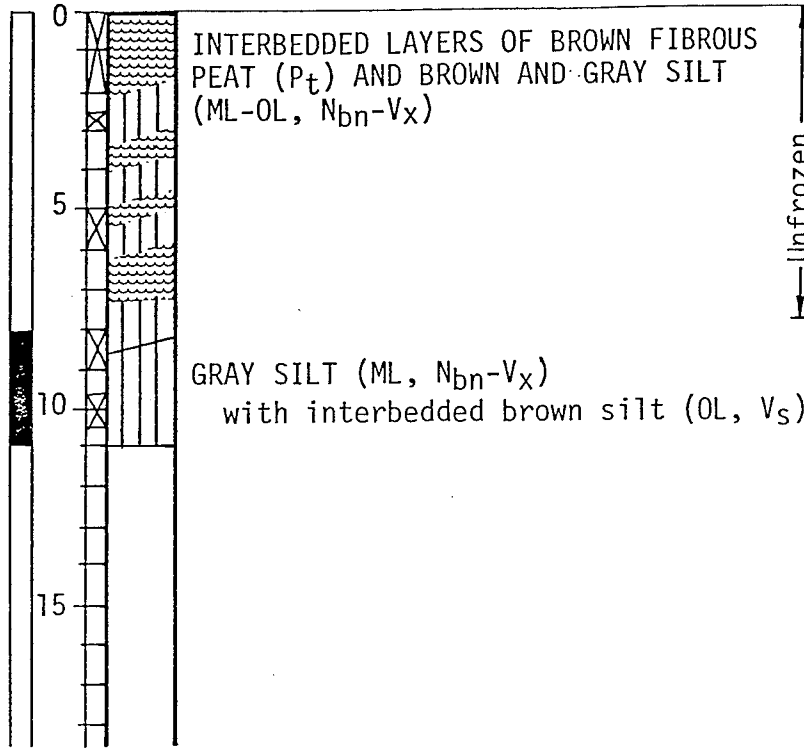
RF1

LOG OF BORING 6

Equipment 2.5" OD Steel Shelby Tube

Elevation — Date Drilled 10/3/80

Laboratory Tests | Ground Temp (°F) | Blows/Foot (N-Value) | Moisture Content (%) | Dry Density (pcf) | Frozen | Depth (ft) | Samples



INTERBEDDED LAYERS OF BROWN FIBROUS PEAT (P_t) AND BROWN AND GRAY SILT (ML-OL, N_{bn}-V_x)

GRAY SILT (ML, N_{bn}-V_x) with interbedded brown silt (OL, V_s)

PRELIMINARY

HARDING - LAWSON ASSOCIATES

Consulting Engineers and Geologists

Job No. 9661,001.08 Appr: Date 10/80

LOG OF BORING 6

EPISCOPAL CHURCH REHABILITATION
Tanana, Alaska

PLATE 6

RF3A

MAJOR DIVISIONS				TYPICAL NAMES
COARSE GRAINED SOILS MORE THAN HALF IS LARGER THAN #200 SIEVE	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL GRADED GRAVELS, GRAVEL - SAND MIXTURES
			GP	POORLY GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH OVER 12% FINES	GM	SILTY GRAVELS, POORLY GRADED GRAVEL - SAND - SILT MIXTURES
			GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL - SAND - CLAY MIXTURES
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL GRADED SANDS, GRAVELLY SANDS
			SP	POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 12% FINES	SM	SILTY SANDS, POORLY GRADED SAND - SILT MIXTURES
			SC	CLAYEY SANDS, POORLY GRADED SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN HALF IS SMALLER THAN #200 SIEVE	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 CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS

UNIFIED SOIL CLASSIFICATION SYSTEM

Shear Strength, psf
Confining Pressure, psf

Consol	— Consolidation	*Tx	320	(2600)	Unconsolidated Undrained Triaxial
LL	— Liquid Limit (in %)	TxCU	320	(2600)	Consolidated Undrained Triaxial
PL	— Plastic Limit (in %)	DS	2750	(2000)	Consolidated Drained Direct Shear
G_s	— Specific Gravity	FVS	470		Field Vane Shear
SA	— Sieve Analysis	*UC	2000		Unconfined Compression
▩	"Undisturbed" Sample	LVS	700		Laboratory Vane Shear
⊠	Bulk Sample				

Notes: (1) All strength tests on 2.8" or 2.4" diameter samples unless otherwise indicated.

(2) * Indicates 1.4" diameter sample.

KEY TO TEST DATA

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SOIL CLASSIFICATION CHART AND KEY TO TEST DATA
EPISCOPAL CHURCH REHABILITATION
Tanana, Alaska

PLATE 7

RF1

ICE DESCRIPTIONS

<table>
<tr><th rowspan="2">GROUP SYMBOL</th><th rowspan="2">ICE VISIBILITY AND CONTENT</th><th colspan="4">SUBGROUP</th></tr>
<tr><th colspan="2">DESCRIPTION</th><th colspan="2">SYMBOL</th></tr>
<tr><td rowspan="3">N</td><td rowspan="3">Segregated
Ice not visible by eye</td><td colspan="2">Poorly bonded or friable</td><td colspan="2">N_f</td></tr>
<tr><td rowspan="2">Well-bonded</td><td>No excess ice</td><td rowspan="2">N_b</td><td>N_{bn}</td></tr>
<tr><td>Excess ice microscopic</td><td>N_{be}</td></tr>
<tr><td rowspan="4">V</td><td rowspan="4">Segregated ice is visible by eye, ice one inch or less in thickness</td><td colspan="2">Individual ice crystals or inclusions</td><td colspan="2">V_x</td></tr>
<tr><td colspan="2">Ice coatings on particles</td><td colspan="2">V_c</td></tr>
<tr><td colspan="2">Random or irregularly oriented ice formations</td><td colspan="2">V_r</td></tr>
<tr><td colspan="2">Stratified or distinctly oriented ice formations</td><td colspan="2">V_s</td></tr>
<tr><td rowspan="2">ICE</td><td rowspan="2">Ice greater than one inch in thickness</td><td colspan="2">Ice with soil inclusions</td><td colspan="2">ICE + soil type</td></tr>
<tr><td colspan="2">Ice without soil inclusions</td><td colspan="2">ICE</td></tr>
</table>

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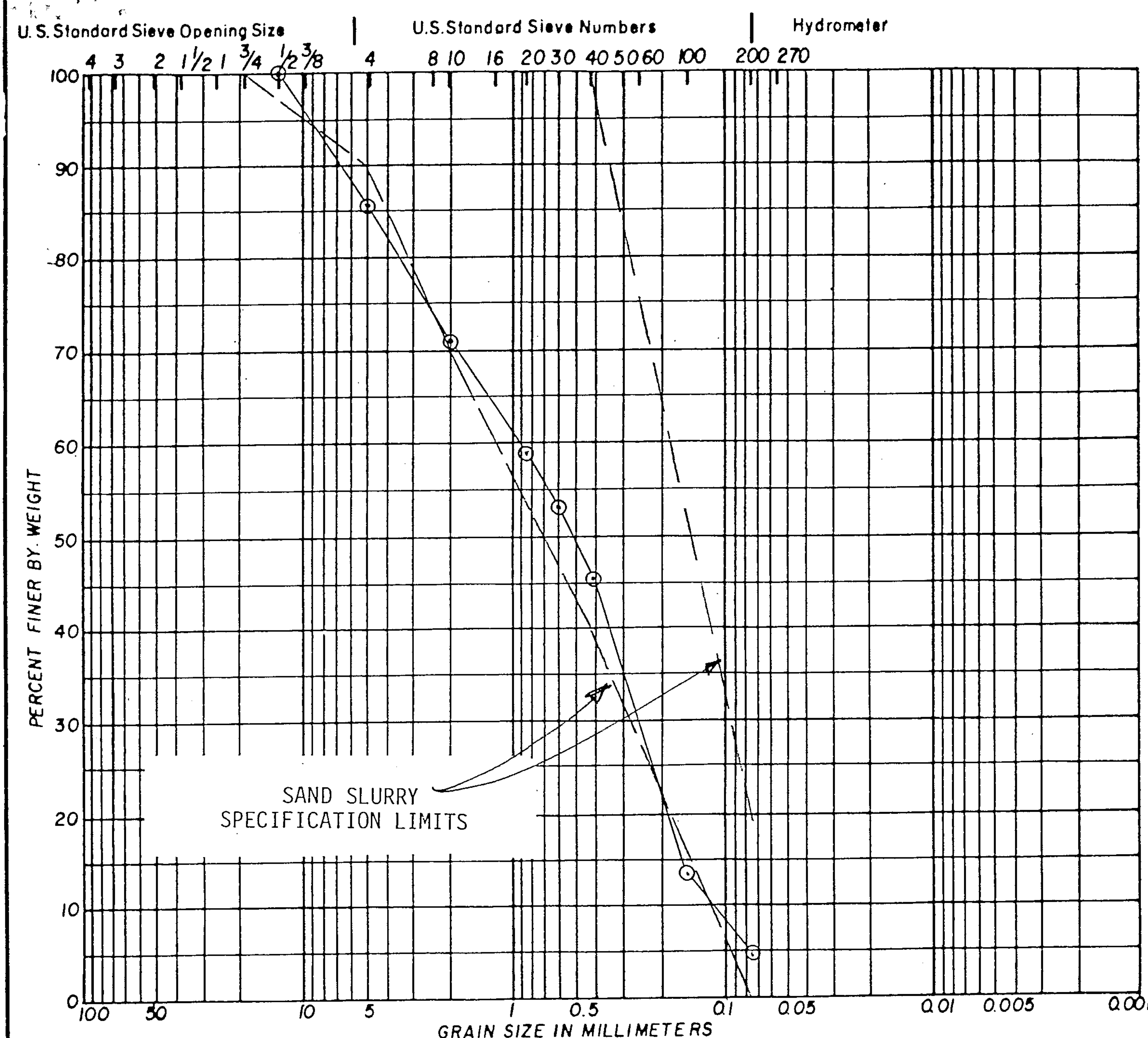
EXPLANATION OF ICE SYMBOLS
UNIFIED SOIL CLASSIFICATION SYSTEM

EPISCOPAL CHURCH REHABILITATION
Tanana, Alaska

PLATE 8

RF24



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
⊙	Stockpile (City of Tanana) Sampled By Others	GRAY GRAVELLY SAND (SP)

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PARTICLE SIZE ANALYSIS

EPISCOPAL CHURCH
REHABILITATION
Tanana, Alaska

PLATE 9

N35080