PERMAFROST
TECHNOLOGY
FOUNDATION

FINAL REPORT

FOUNDATION STABILITY RESEARCH

ON

1664 KIVALINA STREET
FAIRBANKS ALASKA

JUNE 1998

Final Report
on
Foundation Stabilization Research Studies on

1664 Kivalina Street
Fairbanks, Alaska

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Introduction

In 1988 an engineering report prepared by Stutzmann Engineering Inc. (see appendix) designated the foundation of this house as being potentially unstable due to permafrost soil. The house was subsequently deeded to the Permafrost Technology Foundation by Alaska Housing Finance Corporation for the purpose of research to develop economic techniques for stabilizing the foundations of permafrost-sited houses.

Permafrost underlying the foundation was suspected due to cracks found in the wallboard on the exterior wall of one of the bedrooms. Two test holes were drilled and revealed permafrost in sandy gravel soils at depths of 23 and 25 feet. Moisture content of the permafrost was sampled at four depths and was reported to be 5.4%, 8.8%, 13.3% and 21.4%. The 21.4% sample was taken at the top of the permafrost. Saturation of gravels and sands is dependent on the density of the soils but typically occurs at moisture contents of between 20% for loose soils and 9% for highly compacted soils. Soils with moisture contents below saturation are generally considered to be thaw-stable and to not undergo settlement. Since these soils had exhibited loose characteristics during drilling, indicating less dense soils, all the moisture contents could be within saturation limits, and even if they are slightly above saturation, the amount of settlement could be very small. The loose soils might settle during an earthquake or other dynamic event, but the melting of the permafrost would probably not incur any settlement.

In the beginning of the project, the Permafrost Technology Foundation was not aware of the original engineering reports on the house by Stutzman Engineering (they were not transferred to PTF). Therefore, when PTF received the house another permafrost exploration hole was drilled. This hole was located near the northeast corner of the house, and it discovered permafrost at 30.5 feet. The hole was drilled into the permafrost to a depth of 49 feet.

Due to the borderline nature of the permafrost moisture content and because the house showed almost no settlement damage in the wallboard (a few cracks of hairline and slightly larger width on the inside wallboard of the house were the only manifestations of possible settlement) there was a question as to whether or not there was thaw unstable permafrost at the site. In the absence of serious damage that would indicate permafrost settlement, it was decided to monitor the foundation for a period of time to see if any settlement or danger signs of settlement occurred. When no evidence of settlement was found after a year of monitoring the structure, the decision was made to continue the monitoring to determine the ultimate stability of the foundation and to gain data on what can be expected at a site with this type of permafrost at a depth that approximates the mature thaw bulb depth for a house of this size.

Structure Description

This house is a split level design with the garage and an unfinished basement room on the ground-level floor (see Figures 1a and 1b). The front entrance opens to a landing midway between the two floors with stairs leading to the two levels. The garage occupies slightly over one half of the ground level. The basement room that occupies the other half of the ground floor is used as a family room, although it is unfinished and has no covering over the studs and insulation. There are three bedrooms, two baths, living room, dining room, and kitchen on the upper floor. The house has a concrete block foundation with frame construction. The lower floor is concrete slab. Exterior siding is T-111 painted light brown. There is a small deck on the upper level at the rear of the house that is accessible from the dining room. The driveway is dirt with a concrete pad (with numerous cracks) in front of the garage door. The driveway leads to the street which is approximately 25 feet away.

Level Measurements

Level measurement were taken to determine the relative elevation of the floor. The level measurements were made using a small precise telescopic level mounted on a tripod (sometime referred to as a "contractor's level") and a rod calibrated in millimeters. The millimeter rod was used instead of a standard surveyor's rod to give more precision to the measurements. Since the distance from the level to the rod was rarely over 15 feet, the rod could easily be read to the nearest millimeter (0.04 in.).

In should be noted, however, that when level measurement are this precise, that perturbations can and do occur due to the placement of the rod from one measurement set to the next. Often the rod had to be placed behind furniture, and it was impossible to determine if it was sitting on the exact spot as the previous measurement or if it was sitting on an electrical cord or a magazine etc. (even the thickness of several sheets of paper will show up at this precision). There was also the possibility for a gross error in reading the level, since the level had the standard three cross hairs (center, upper, and lower) used for measuring distances in surveying. If the operator was inexperienced (student labor was used for these measurements), a reading could be made using either the upper or lower cross hair instead of the center crosshair. This error would yield an elevation that was in error from several tens of millimeters to as much as a few inches.

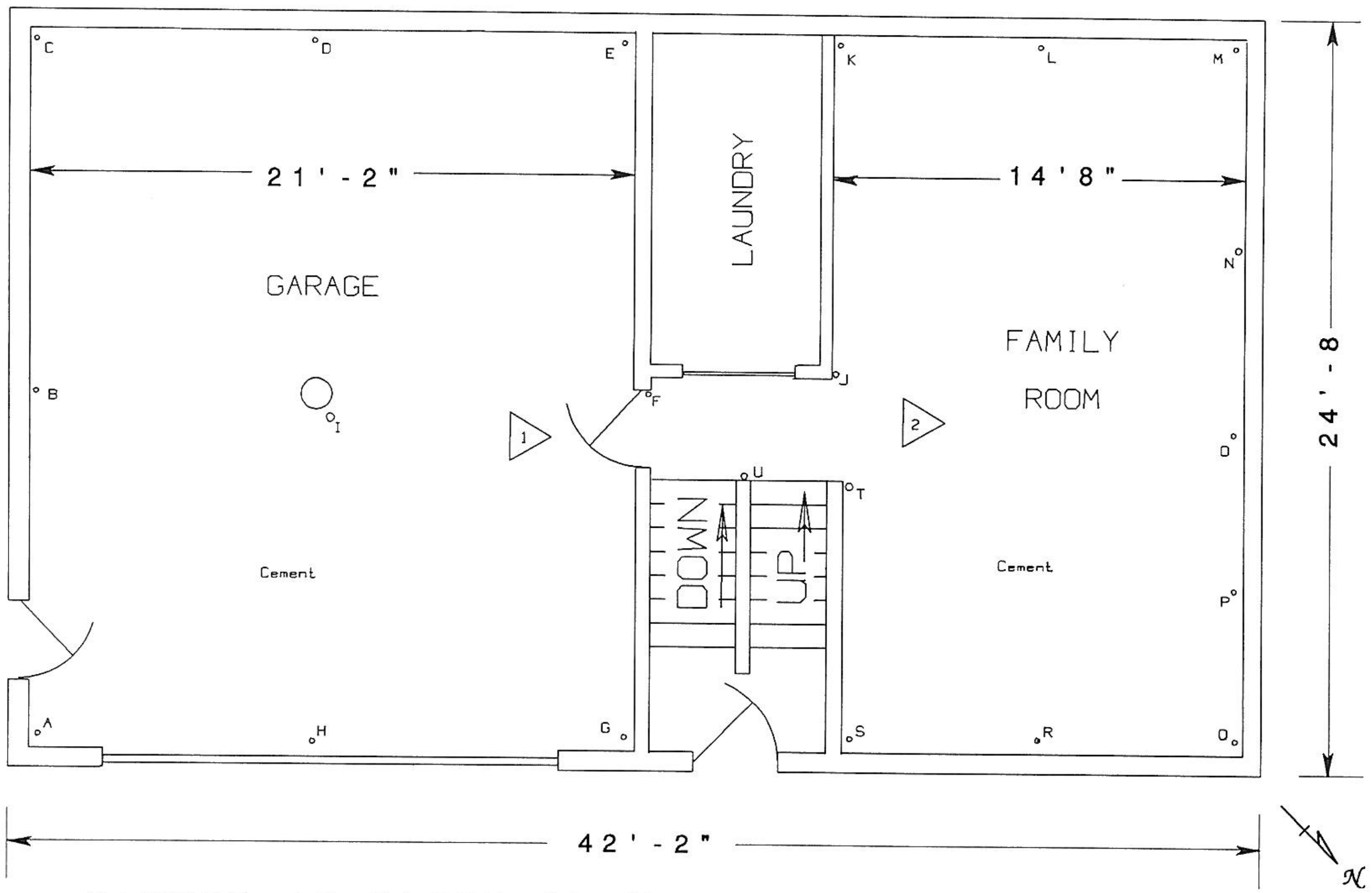

FIGURE 1B-FLOOR PLAN OF DOWNSTAIRS LEVEL
1664 KIVALINA STREET

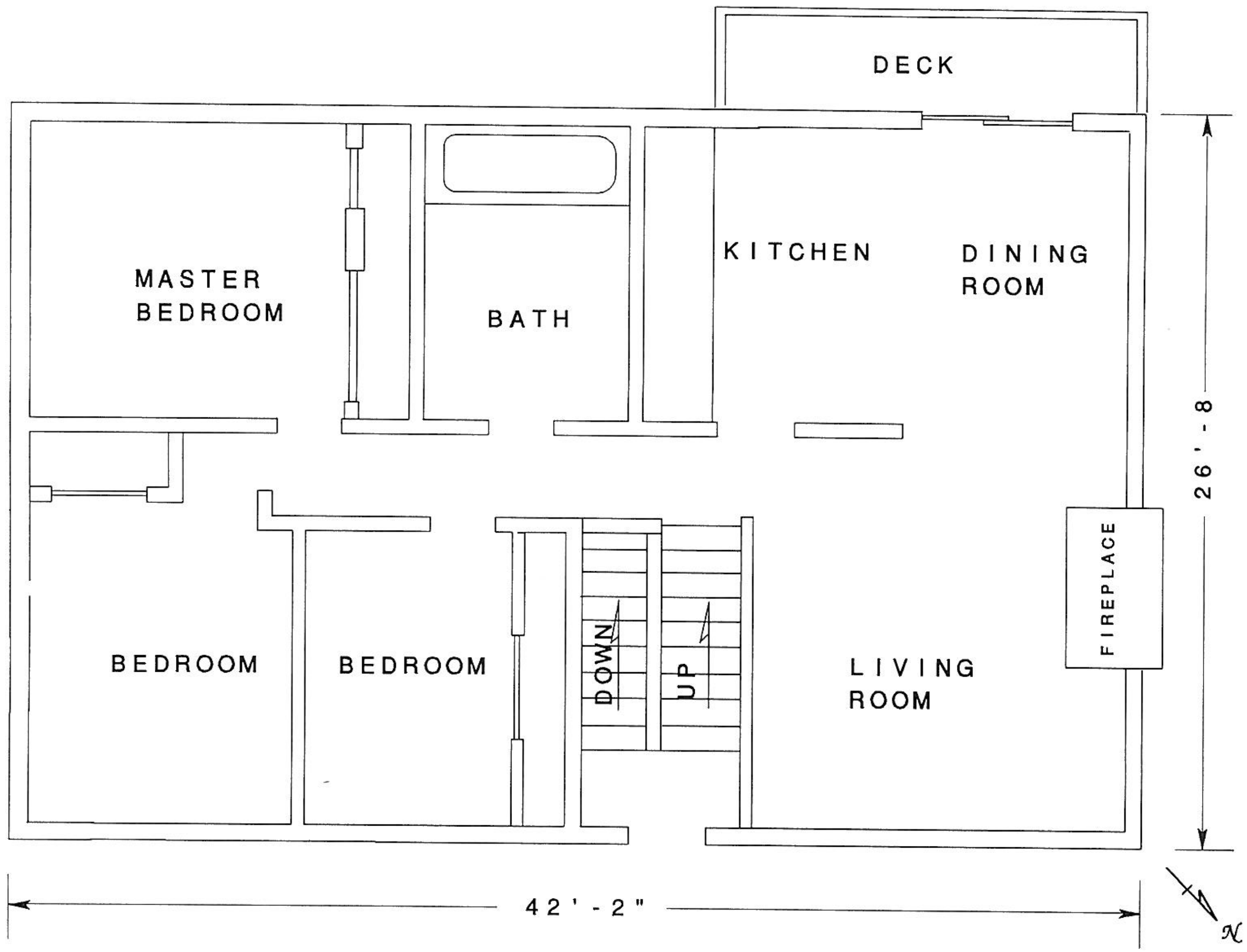

FIGURE 1a-FLOOR PLAN OF UPSTAIRS LEVEL
1664 KIVALINA STREET

These errors however are readily discernible when the data is shown plotted as a function of time (see the level charts in the appendix).

Level data on the concrete slab floor in the lower level was collected several times a year and accumulated for a period of six years. The level data is plotted against time, and the charts are shown in the appendix of this report. Each measurement location is designated on the floor plan by a letter. Different groups of letters were plotted together on the charts to show relevant comparisons such as the south wall or the diagonal across the structure. In each chart, all levels are referenced to a single reference point "A". This allows the elevation of each point to be compared as a relative elevation on the floor plan to point A. From this data, differential elevations between various parts of the floor can be seen easily and can be tracked with time.

This system, however, does not give information as to the absolute elevation of the house with respect to the ground outside, and therefore any elevation variation of point A is also reflected in all other points. Determining absolute elevations requires a stable surveyor's benchmark or other stable reference outside of the structure. At this location there was no such stable reference available, but relative elevations allow differential settlement to be tracked, and that is the most important information for these studies.

For perspective, a differential elevation of one to two inches (25 mm to 50 mm) across the length of an average room is not readily noticeable to the unaided eye. Up to four inches (100 mm) over the distance across a normal room, although noticeable, is not an overly unpleasant condition with which to live.

Temperature Measurement

When the permafrost test boring was drilled, a thermistor string with 12 thermistors was placed in the hole. The thermistor string was positioned to measure temperatures at the surface of the ground and at depths of 5, 10, 15, 20, 21, 21.5, 22, 23, 25, 35 and 45 feet. These temperatures were monitored periodically at the same time the level measurements were taken (and sometimes more often) resulting in a data base of five years of soil temperatures for the site. The temperature data was plotted with respect to time on charts to give a graphic indication of the soil temperature trends over the duration of the study. These charts are included in the appendix of this report.

Thermistors are capable of measuring temperature to the nearest one thousandth of a °C. Thermistors were used because they are more accurate and easier to read than thermocouples; however, they have the disadvantage of being more fragile, and they can drift a few thousands of a degree over time. To obtain the maximum accuracy the strings must be calibrated in a reference bath both before and after their use. These thermistor strings were calibrated before placing them in the hole, but since once installed they are buried, it is impractical to remove them without destroying them, therefore the secondary calibration cannot be made. The temperatures, therefore, are reliable to about a tenth of a degree. However, for the purposes required for these studies, an accuracy of one tenth of a degree Celsius is adequate.

Thermistors located at various depths allow the temperatures at those depths to be tracked to determine if the permafrost is getting deeper, remaining stable, or actually rising. The data also points out any anomalies in temperature that may occur due to outside influences such as new construction nearby, landscaping modifications, or damage or deterioration of protective insulation.

Geotechnical Exploration

In order to determine the condition of the soils below the structure, a borehole was drilled and samples of the soil were taken at regular intervals of depth. Samples were collected by driving a split-spoon sample core barrel through the hollow stem using a 300 pound hammer and a 30 inch drop. The number of hammer blows required to drive the core barrel gives information on the competency of the soil at each sample depth. These samples are considered "disturbed samples." However, since they are retrieved essentially intact in their natural state, they provide useful information about the soil. This method of sampling was continued until frozen ground was encountered. Below this the soils were sampled with a dry core barrel. This brings to the surface a five-foot-long, three-inch-diameter, intact soil sample. Representative soil samples were then sent to the laboratory for analysis of grain size and water content. With this data, a model of the soil conditions and types was constructed for the hole. This does not necessarily apply to the soils under the structure since soil conditions can, and often do, change radically over short distances, but if boreholes on both sides of the structure are similar in nature, then the soils beneath the house can be at least inferred.

Results and Conclusions

Temperature measurements: The trend of the temperature of the soils at depth (15 feet and below) over the five year period was a gradual rise by as much as 0.5 °C (~1 °F). The temperature at the 8 meter (25 foot) depth started just below freezing (approximately -0.05°C, indicating the top of the permafrost in 1992) but rose above freezing sometime during the summer of 1993 and continued to rise to nearly +0.5 °C at the last reading in 1996. This indicates that the top of the permafrost subsided to a greater depth during this period. The temperature at the 35 foot depth remained below freezing for the entire period. The permafrost had not receded to that depth.

This temperature data is interesting for several reasons. First, since the borehole in which the thermistor string is located is over 10 feet away from the house, the effect of heat from the house is only one perturbation in the thermal regime of the soil. This suggests that the permafrost in this area might be receding even if the house were not there. The fact that prior to construction, the area was cleared of its original vegetation of black spruce, willows, and other brush is in itself a large influence on the soil thermal regime and is usually enough to cause the permafrost to subside from several feet to several tens of feet (Johnston 1981, McFadden 1991).

Secondly, and perhaps more importantly to our concerns with the foundation, since the permafrost outside the house has subsided, it can be assumed that the permafrost under the house has subsided even deeper. The outside temperature reference location is subject to over 8 months each year of freezing weather during which time there is reinforcement of the permafrost. Beneath the house, on the other hand, there is a positive heat input for 12 continuous months. This reasoning implies that the permafrost subsidence under the house is probably several feet. A permafrost subsidence under the house of this amount without any detectable settlement of the house further reinforces the possibility that the sandy gravel permafrost at this depth is thaw stable.

If a thaw-unstable layer exists below the depth of the sandy gravel in the borehole (the borehole extended to a depth of 49 feet without finding unstable permafrost) and the permafrost beneath the house subsides into it, then it is possible for settlement to begin. This however will be several decades in the future if at all since the thaw must reach below 49 feet and possibly much deeper if it is to find thaw-unstable soil. This could be explored further with a deeper borehole, but the lifetime of the house is probably less than the time required for the thaw bulb to reach unstable soils (if any do exist at this site) below the 49 foot depth.

Finally, the subsidence of the permafrost outside the boundaries of the structure suggests that the permafrost in the entire subdivision may be receding and will continue to do so until a thermal balance between input from the surface environment and the geothermal input is reestablished. This could mean that the permafrost will melt to a depth several tens of feet deeper than it is presently, or in an area such as Fairbanks where permafrost is very marginal, it could disappear entirely. Total melting of all of the permafrost will take from many decades to over a century. Our exploration borehole was drilled to 49 feet, and at that depth the soil was still frozen when the last temperature reading was taken in October 1996.

With the possibility of thawing of the permafrost over the entire area of the subdivision in mind, an inspection of other structures in the area could provide useful information. Keeping in mind that the homeowner who is willing to allow his house to be inspected for possible permafrost damage is rare, this inspection had to be of the exterior of the houses and somewhat casual. Inspection of the houses in the subdivision as a whole, at this time, does not show any gross damage that might be attributed to thaw-unstable permafrost. At least no obvious settlement-damaged houses such as those seen in other parts of Fairbanks are readily apparent. Of course if an owner was very diligent about upkeep and repair on a structure, this type of damage would be difficult to detect from the street.

Level measurements confirm what the temperature readings have indicated. There was some initial level difference at the time the structure was transferred to the Permafrost Technology Foundation. This was small enough that it could be attributed to initial construction, lack of compaction of the initial fill, poor craftsmanship, or subsidence of shallower layers of permafrost as they melted. However, the subsidence was not enough to cause problems in the livability of the structure and has, for now at least, stopped and has not produced additional settlement for the past 5 years.

The initial differential level in the concrete slab floor from the southeast corner of the garage to the northwest corner of the family room was between 15 mm and 25 mm (3/4 to 1 inch) overall. Across just the family room, the differential was as small as 5 mm (less than ¼ inch). During the six years of monitoring the level of the floor, this variation remained remarkably constant. The diagonal distance from the southeast corner of the garage to the northwest corner of the family room is 48 ft 10 in. (points C to Q on the basement floor plan, see appendix). At the beginning of these studies, the differential elevation between these two corners was 22 mm (7/8 in.); at the end of the studies it was 17 mm (3/4 in.). This change is only 5mm (less than ¼ in.) in 48 feet and indicates good foundation stability. A line lengthwise across the house from the center of the east wall of the garage to the center of the west wall of the family room (points B to O) is 42 ft 2 in. and shows a very similar stability. Initial differential was 24.5 mm, and the end-of-study differential was 24 mm, a 0.5 mm (less than 1/32 in.) difference in 6 years. A similar comparison along the width of the house from the northeast wall to the southeast wall of the family room (points S to K) shows no measurable change in relative elevation over the six year period. Initial level and final level measurements were made at the same time of the year (January/February), thus largely removing the effects of seasonal variations.

Loose soils also raise the concern of settlement during a dynamic event such as an earthquake. During the period over which the level measurements were made on this house there were 15 earthquakes over Richter 4.0 in the Fairbanks vicinity (approximately a 30 mile radius). Of those, one was 5.0 on Nov 1, 1992 and one was 6.2 on October 6, 1995. This last one was the most significant event, since it was not only the largest but also the shallowest at only 9 kilometers below the surface. It was felt very strongly by residents of Fairbanks. However, reviewing the data on level measurements shows that no significant measurable settlement can be identified in our data during any of these events. This suggests that either settlement into the loose soils beneath the structure was not triggered by a dynamic event of this magnitude or that settlement into the loose soils was already complete before the Permafrost Technology Foundation started monitoring the structure. These circumstances and observations do not preclude the possibility of settlement during a more severe earthquake or other type of dynamic event.

If a structure is settling differentially, one of the first manifestations of that settlement can be seen in the concrete block foundation wall. One of the weakest links in the foundation wall is the joint between the concrete block and the grout bonding the blocks together. No cracks of any kind are evident in the exposed portion of the block foundation wall of this structure either inside or outside the building. This suggests that the out-of-level condition found in the first level measurement was more likely built into the structure at the time of its initial construction rather than caused by subsequent settlement (which should have cracked the foundation wall). The absence of cracks in the block wall also provides another independent indication of the apparent stability of this structure at this time.

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Appendicies

Bore Hole Logs

SOIL DESCRIPTION

SURFACE ELEVATION:

BROWN TO GREY SAND w/TRACE OF SILT. MOIST MEDIUM GRAINED.

BROWN SILTY SAND TO SANDY SILT MOIST MED. TO FINE GRAINED.

BROWN TO GRAY SAND, MED. GRAINED VERY MOIST TO WET.

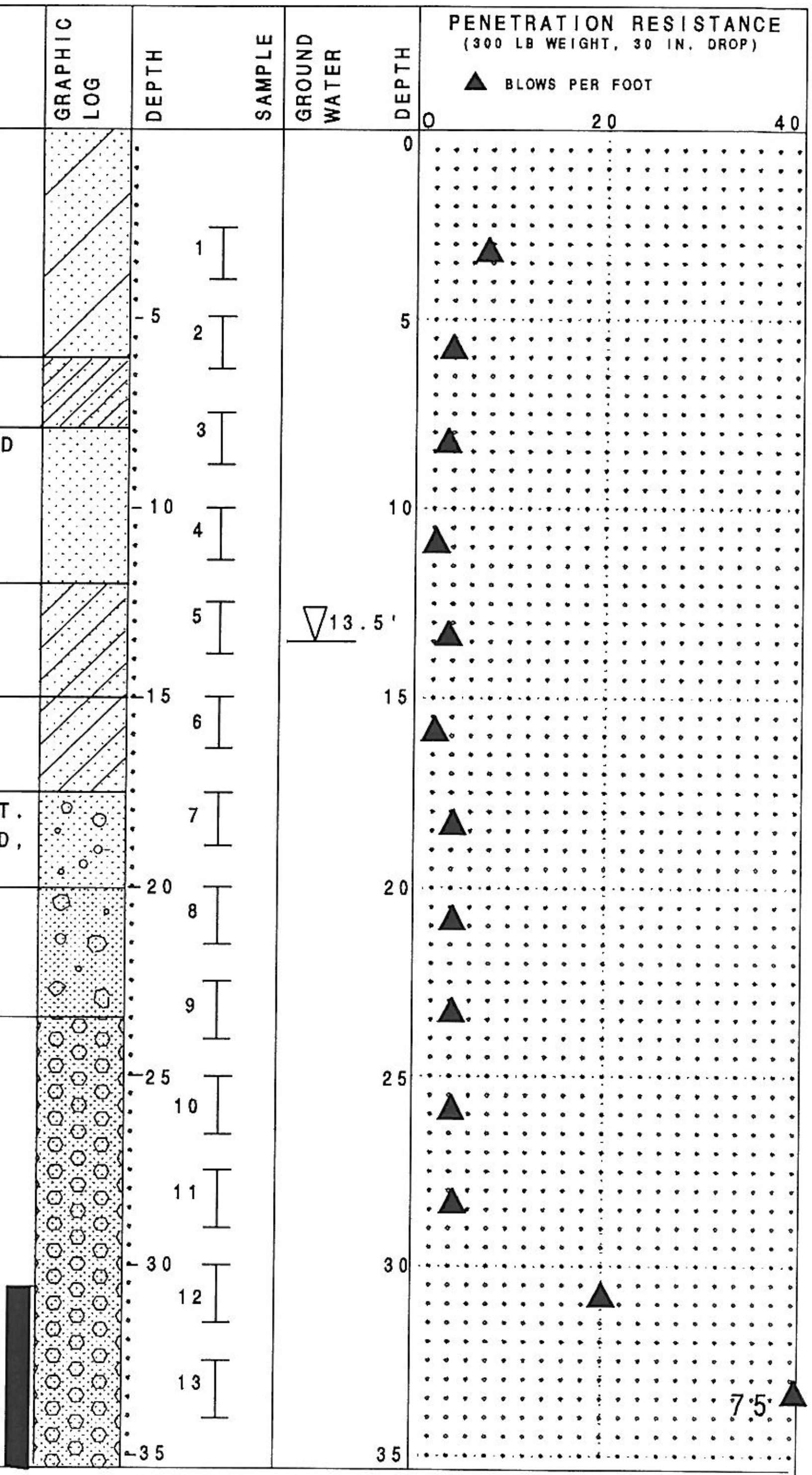
BROWN SLIGHTLY SILTY SAND, WET MEDIUM TO FINE GRAINED.

GRAY SLIGHTLY SILTY SAND, WET MEDIUM TO FINE GRAINED.

GRAY SLIGHTLY GRAVELLY SAND, WET. GRAVEL MED.TO FINE GRAINED, SAND, MED. TO COARSE GRAINED.

GRAY GRAVELLY SAND, WET. GRAVEL MEDIUM TO FINE, SAND MEDIUM TO COARSE.

GRAY SANDY GRAVEL, WET GRAVEL FINE TO COARSE, SAND MED TO COARSE.



LEGEND

FROZEN GROUND

GRAVEL

SAND

CLAY

PEAT

ORGANIC CONTENT

IMPERVIOUS SEAL

WATER LEVEL

SCREENED INTERVAL

THERMISTOR

3 IN O.D. SPLIT SPOON SAMPLE

GRAB SAMPLE

3 IN. O.D. THIN-WALL SAMPLE

3 IN. O.D. DRY CORE RUN

● % WATER CONTENT

BORING LOG

NAME: 1664 KIVALINA ST.

LOCATION: BH1 N.E. CORNER

PAGE: 1 OF 2

DATE: JULY 23, 1992

PERMAFROST TECHNOLOGY FOUNDATION

SOIL DESCRIPTION

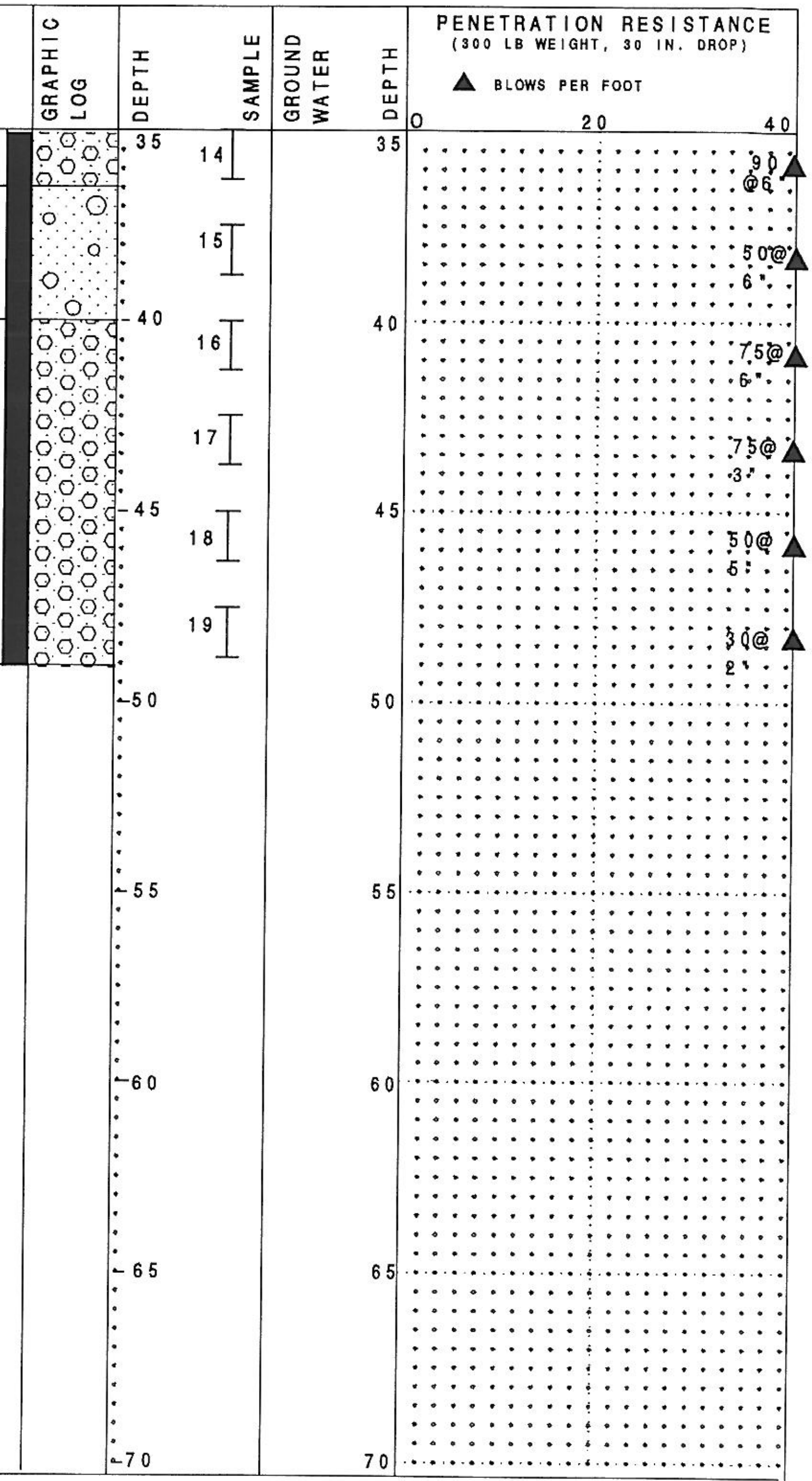
SURFACE ELEVATION:

GRAY SANDY GRAVEL, Nf TO Nbn, WET. GRAVEL COARSE TO FINE

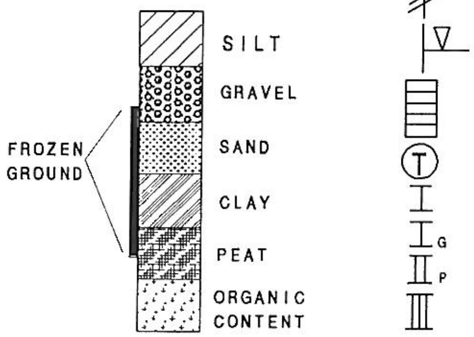
GREY SLIGHTLY GRAVELLY SAND,Nbn, MED GR. SAND, FINE TO COARSE GRAVEL.

GRAY SANDY GRAVEL, Nf, WET GRAVEL COARSE TO FINE,SAND MED.

BOH 49'



LEGEND



IMPERVIOUS SEAL

WATER LEVEL

SCREENED INTERVAL

THERMISTOR

3 IN O.D. SPLIT SPOON SAMPLE

GRAB SAMPLE

3 IN. O.D. THIN-WALL SAMPLE

3 IN. O.D. DRY CORE RUN

● % WATER CONTENT

BORING LOG

NAME: 1664 KIVALINA ST.

LOCATION: BH1-N.E.CORNER (CONT.)

PAGE: TWO OF TWO

DATE: JULY 23, 1992

PERMAFROST TECHNOLOGY FOUNDATION

45X@PJL EOJ NAME = "MSJOB 1"

Level Measurements

kivalina Level Data

Operator : sara/b-o

	Previous Elevation	New Reading	New Elevation	Elevation Difference
Date	10/31/96	1/22/97	1/22/97	(mm)
A (1)*	0	372	0	0
B (1)	-29	334	-38	-9
C (1)	-40	331	-41	-1
D (1)	-34	336	-36	-2
E (1)	-21	342	-30	-9
F (1)	-13	353	-19	-6
G (1)	-2	369	-3	-1
H (1)	11	380	8	-3
I (1)	-34	334	-38	-4
F (2)**	\	367	\	\
J (2)	-11	369	-17	-6
K (2)	-16	362	-24	-8
L (2)	-12	373	-13	-1
M (2)	-7	373	-13	-6
N (2)	-8	372	-14	-6
O (2)	-4	372	-14	-10
P (2)	-13	367	-19	-6
Q (2)	-18	363	-23	-5
R (2)	-34	356	-30	4
S (2)	-35	353	-33	2
T (2)	-11	370	-16	-5
U (2)	-13	368	-18	-5

F(1) - F(2)= -14

* Point "A (1)" should be the first point measured in the house. This point then becomes the datum from which all other points are referenced.

** Point "F" is the common point used to correlate data from all points to point "A (1)".

kivalina Level Data

Operator : fu/michael

	Previous Elevation	New Reading	New Elevation	Elevation Difference
Date	5/20/95	7/16/95	7/16/95	(mm)
A (1)*	0	605	0	0
B (1)	-36	572	-33	3
C (1)	-38	569	-36	2
D (1)	-37	569	-36	1
E (1)	-32	577	-28	4
F (1)	-18	588	-17	1
G (1)	-4	602	-3	1
H (1)	8	615	10	2
I (1)	-19	573	-32	-13
F (2)**	\	582	\	\
J (2)	-16	583	-16	0
K (2)	-14	578	-21	-7
L (2)	-12	586	-13	-1
M (2)	-11	586	-13	-2
N (2)	-13	588	-11	2
O (2)	-16	577	-22	-6
P (2)	-18	581	-18	0
Q (2)	-26	577	-22	4
R (2)	-30	567	-32	-2
S (2)	-32	568	-31	1
T (2)	-16	583	-16	0
U (2)	-18	583	-16	2

F(1) - F(2)= 6

* Point "A (1)" should be the first point measured in the house. This point then becomes the datum from which all other points are referenced.

** Point "F" is the common point used to correlate data from all points to point "A (1)".

kivalina Level Data

Operator : shane/ma

	Previous Elevation	New Reading	New Elevation	Elevation Difference
Date	12/2/93	2/26/94	2/26/94	(mm)
A (1)*	0	419	0	0
B (1)	-30	385	-34	-4
C (1)	-35	382	-37	-2
D (1)	-34	383	-36	-2
E (1)	-27	388	-31	-4
F (1)	-13	402	-17	-4
G (1)	0	416	-3	-3
H (1)	11	429	10	-1
I (1)	-30	383	-36	-6
F (2)**	\	414	\	\
J (2)	-14	419	-12	2
K (2)	-16	411	-20	-4
L (2)	-10	419	-12	-2
M (2)	-9	418	-13	-4
N (2)	-7	422	-9	-2
O (2)	-9	418	-13	-4
P (2)	-15	415	-16	-1
Q (2)	-18	408	-23	-5
R (2)	-25	403	-28	-3
S (2)	-28	400	-31	-3
T (2)	-11	417	-14	-3
U (2)	-12	416	-15	-3

F(1) - F(2)= -12

* Point "A (1)" should be the first point measured in the house. This point then becomes the datum from which all other points are referenced.

** Point "F" is the common point used to correlate data from all points to point "A (1)".

kivalina Level Data

Operator : Yuan, DLB

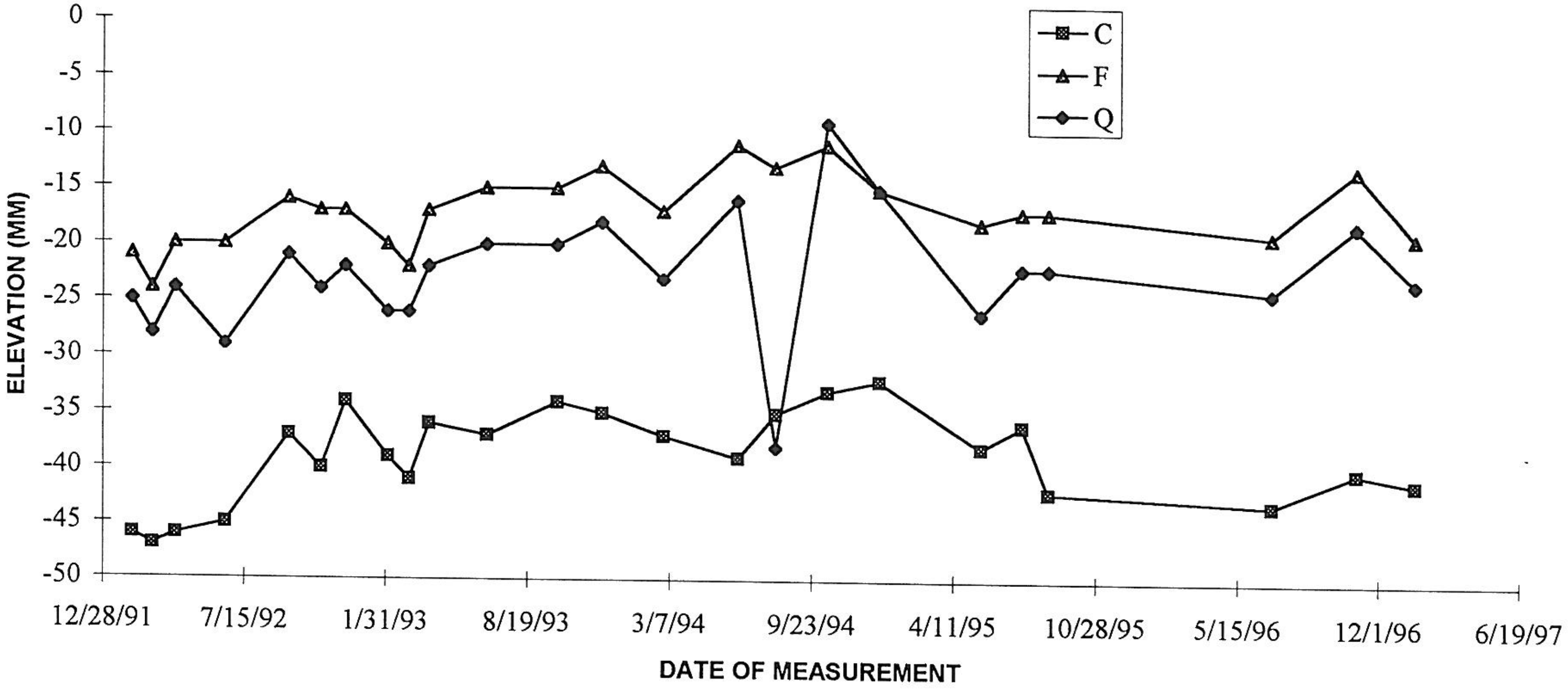
	Previous Elevation	New Reading	New Elevation	Elevation Difference
Date	2/7/92	3/7/92	3/7/92	1 Month
A (1)*	0	499	0	0
B (1)	-40	458	-41	-1
C (1)	-46	452	-47	-1
D (1)	-39	455	-44	-5
E (1)	-32	461	-38	-6
F (1)	-21	475	-24	-3
F (2)**	\	498	\	\
G (1)	-7	491	-8	-1
H (1)	6	499	0	-6
I (1)	-37	459	-40	-3
J (2)	-19	501	-21	-2
K (2)	-24	495	-27	-3
L (2)	-15	504	-18	-3
M (2)	-15	506	-16	-1
N (2)	-13	506	-16	-3
O (2)	-16	505	-17	-1
P (2)	-15	500	-22	-7
Q (2)	-25	494	-28	-3
R (2)	-31	488	-34	-3
S (2)	-35	485	-37	-2
T (2)	-20	501	-21	-1
U (2)	-21	499	-23	-2

F(1) - F(2)= -23

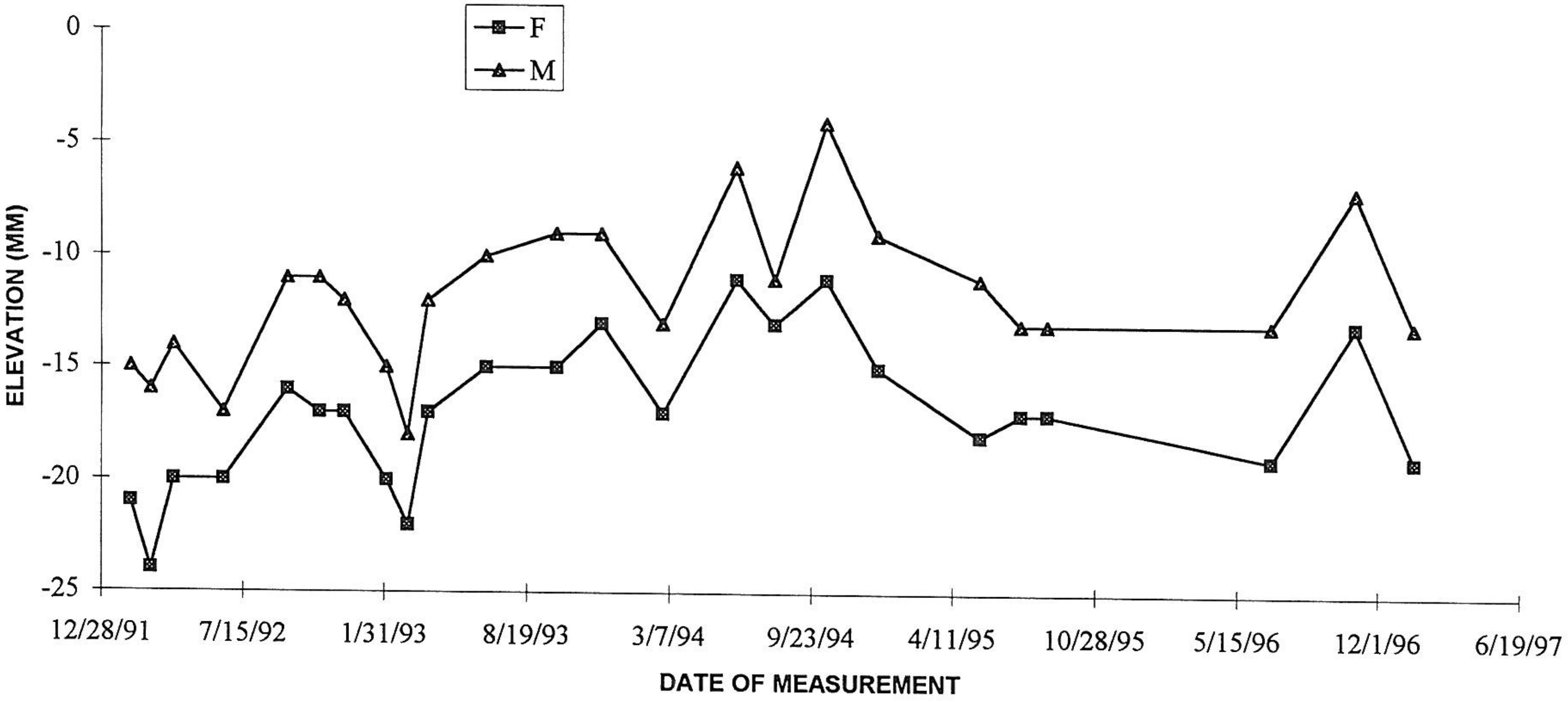
* Point "A (1)" should be the first point measured in the house. This point then becomes the datum from which all other points are referenced.

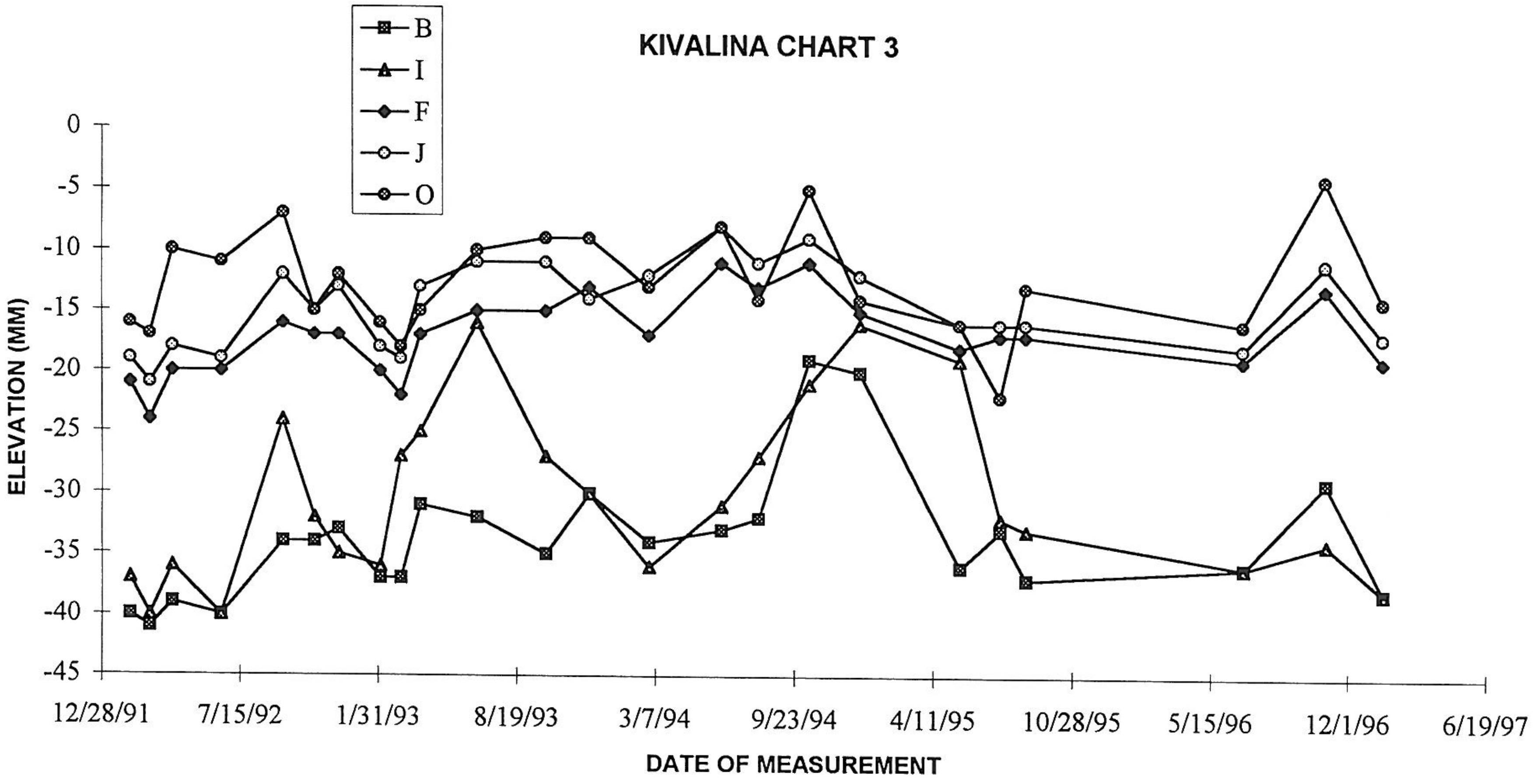
** Point "F" is the common point used to correlate data from all points to point "A (1)".

KIVALINA CHART 1



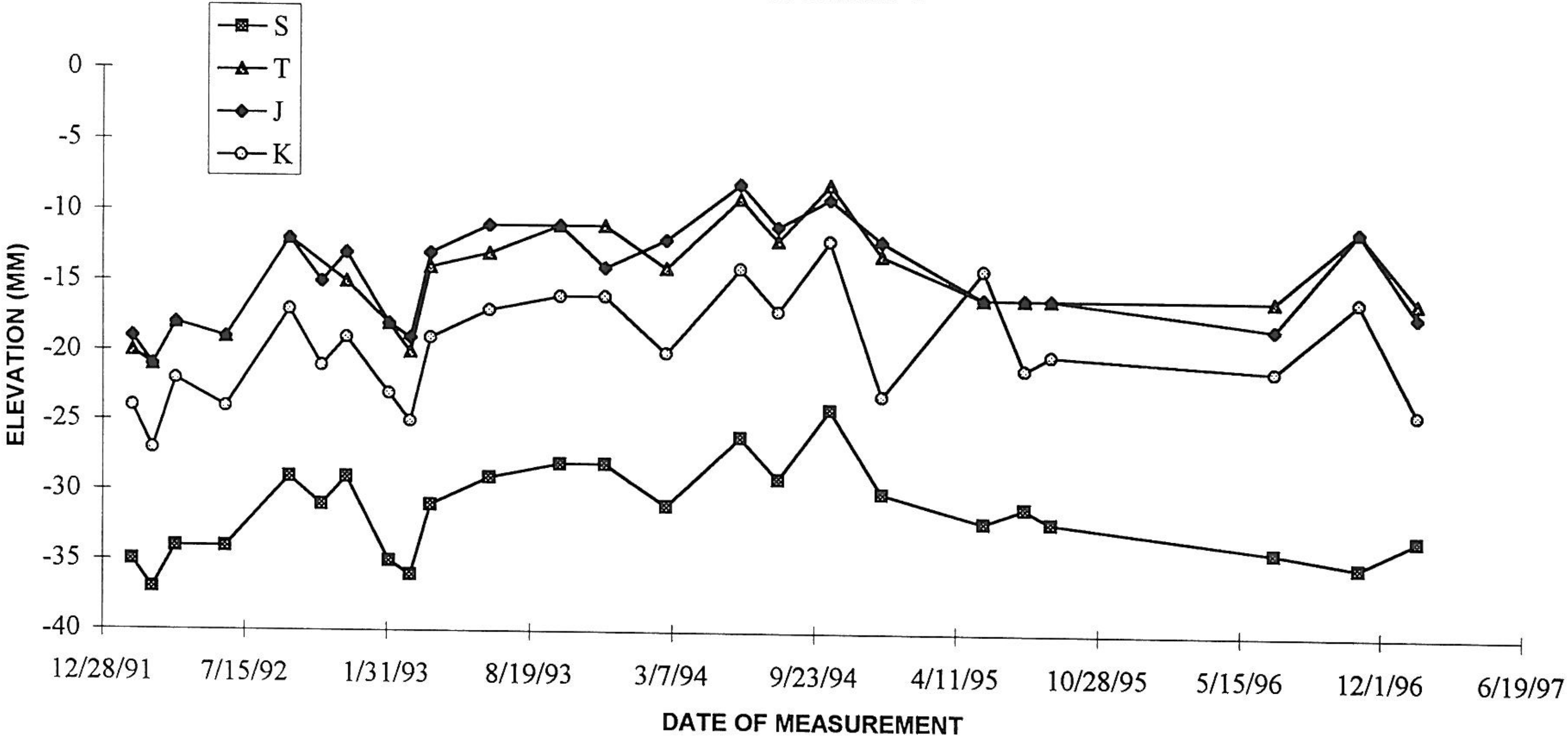
KIVALINA CHART 2



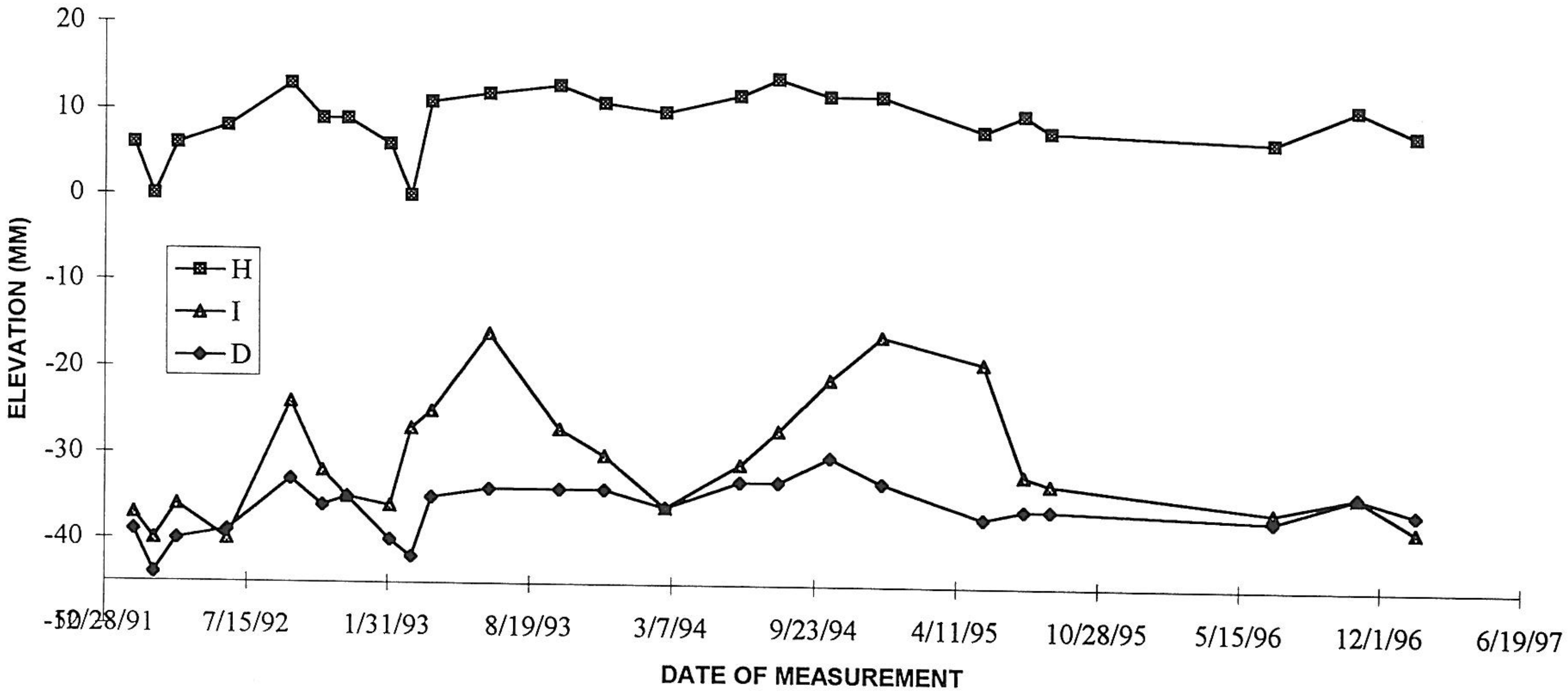


KIVALINA CHART 3
B
I
F
J
O
ELEVATION (MM)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
12/28/91
7/15/92
1/31/93
8/19/93
3/7/94
9/23/94
4/11/95
10/28/95
5/15/96
12/1/96
6/19/97
DATE OF MEASUREMENT

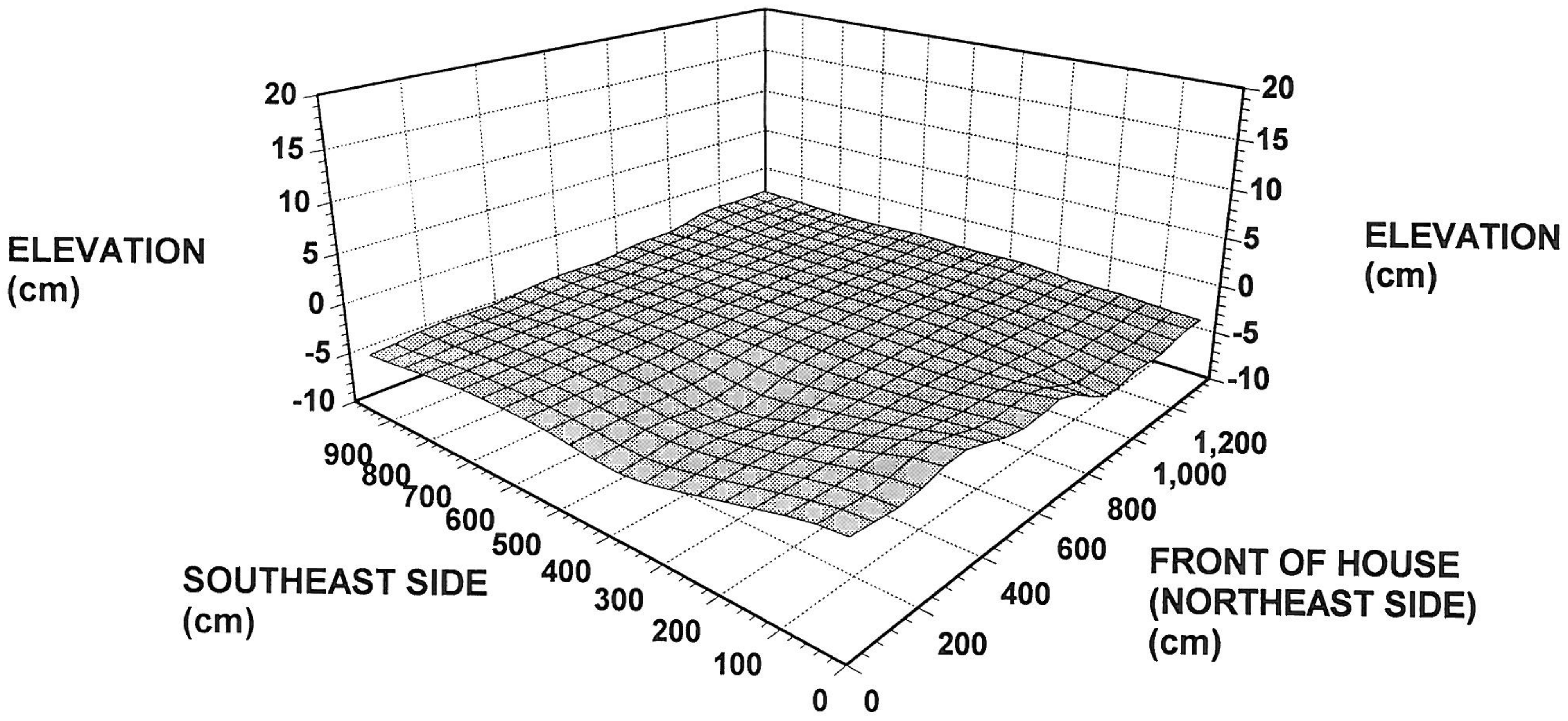
KIVALINA CHART 4



KIVALINA CHART 5

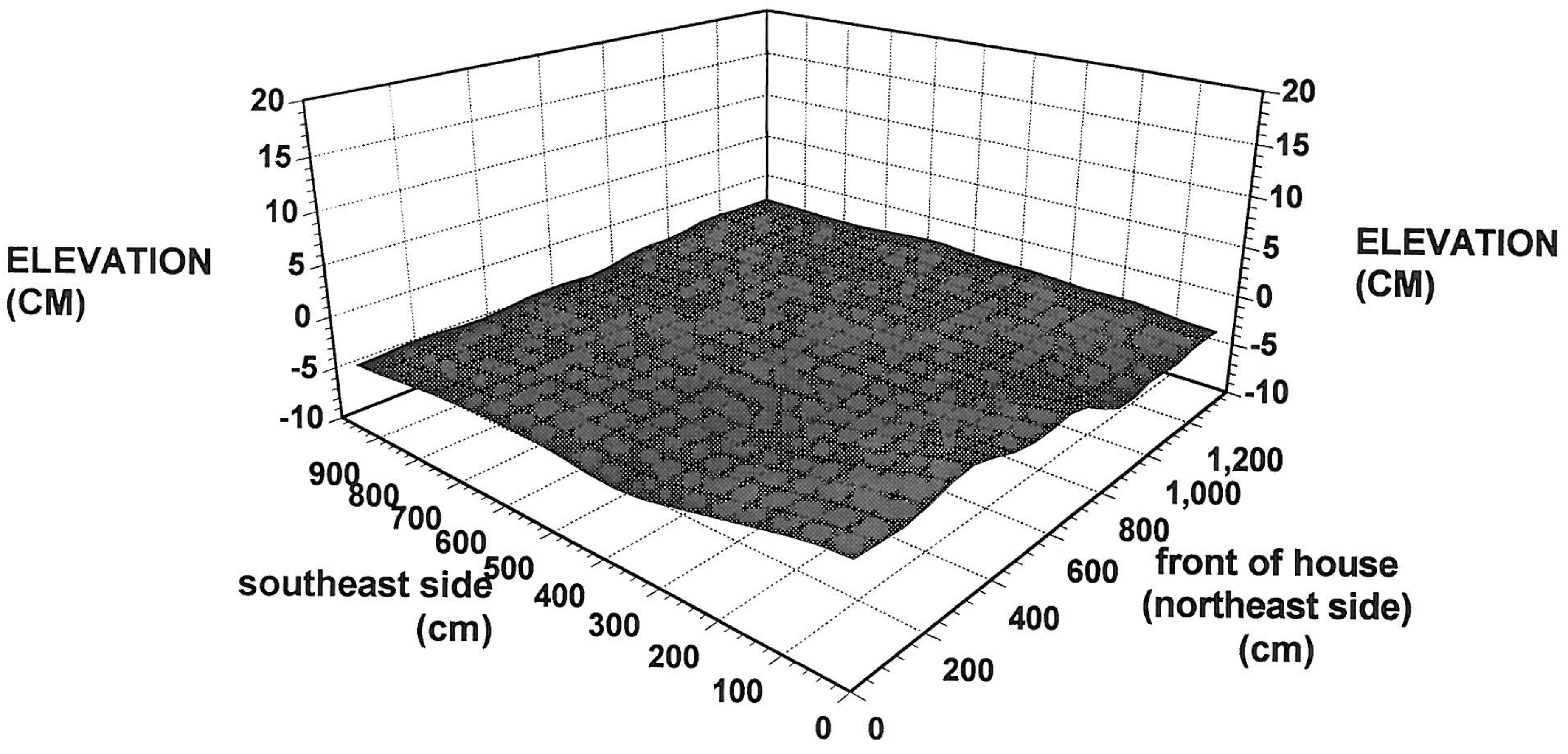


KIVALINA
JANUARY 22, 1997



kivalina basement level

february 26, 1994



Temperature Measurements

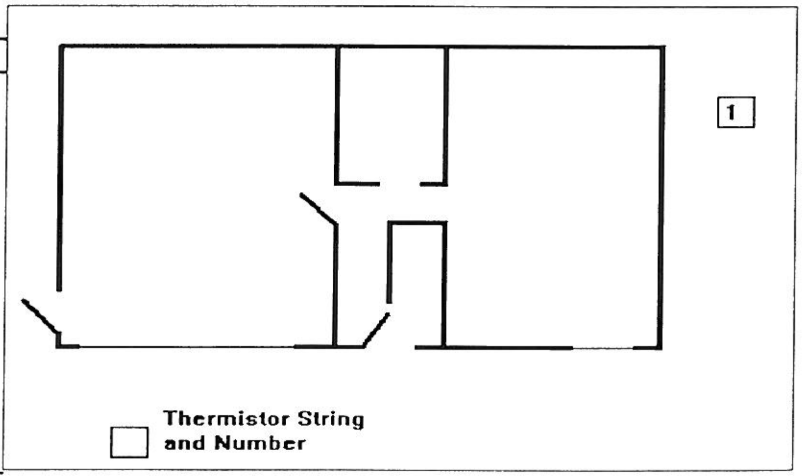
KV Thermistor Temperature Log

Operator : Sara/B-O
Date : 1/17/97

		String #1			String #2			String #3	
Therm #	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)
1	0	13102	4.368		#N/A	#N/A		#N/A	#N/A
2	5	13675	3.508		#N/A	#N/A		#N/A	#N/A
3	10	14356	2.538		#N/A	#N/A		#N/A	#N/A
4	15	15035	1.621		#N/A	#N/A		#N/A	#N/A
5	20	15477	1.049		#N/A	#N/A		#N/A	#N/A
6	21	15568	0.933		#N/A	#N/A		#N/A	#N/A
7	21.5	15575	0.924		#N/A	#N/A		#N/A	#N/A
8	22	15625	0.861		#N/A	#N/A		#N/A	#N/A
9	23	15712	0.752		#N/A	#N/A		#N/A	#N/A
10	25	15892	0.528		#N/A	#N/A		#N/A	#N/A
11	35	#N/A	#N/A		#N/A	#N/A		#N/A	#N/A
12	45	#N/A	#N/A		#N/A	#N/A		#N/A	#N/A

		String #4			String #5			String #6	
Therm #	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)
1		#N/A	#N/A		#N/A	#N/A		#N/A	#N/A
2		#N/A	#N/A		#N/A	#N/A		#N/A	#N/A
3		#N/A	#N/A		#N/A	#N/A		#N/A	#N/A
4		#N/A	#N/A		#N/A	#N/A		#N/A	#N/A
5		#N/A	#N/A		#N/A	#N/A		#N/A	#N/A
6		#N/A	#N/A		#N/A	#N/A		#N/A	#N/A
7		#N/A	#N/A		#N/A	#N/A		#N/A	#N/A
8		#N/A	#N/A		#N/A	#N/A		#N/A	#N/A
9		#N/A	#N/A		#N/A	#N/A		#N/A	#N/A
10		#N/A	#N/A		#N/A	#N/A		#N/A	#N/A
11		#N/A	#N/A		#N/A	#N/A		#N/A	#N/A
12		#N/A	#N/A		#N/A	#N/A		#N/A	#N/A

		String #7	
Therm #	Depth (ft)	R (avg)	Temp (C)
1		#N/A	#N/A
2		#N/A	#N/A
3		#N/A	#N/A
4		#N/A	#N/A
5		#N/A	#N/A
6		#N/A	#N/A
7		#N/A	#N/A
8		#N/A	#N/A
9		#N/A	#N/A
10		#N/A	#N/A
11		#N/A	#N/A
12		#N/A	#N/A



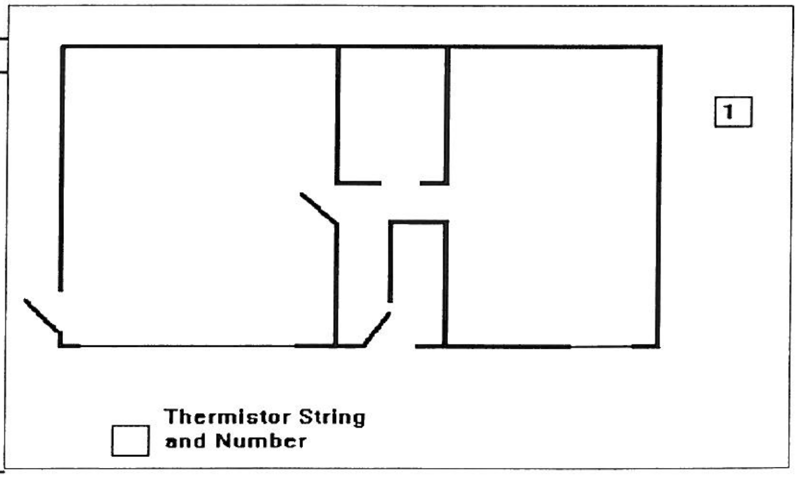
KV Thermistor Temperature Log

Operator : fu
Date : 5/20/95

		String #1				String #2				String #3	
Therm #	Depth (ft)	R (avg)	Temp (C)		Depth (ft)	R (avg)	Temp (C)		Depth (ft)	R (avg)	Temp (C)
1	0	#N/A	#N/A			#N/A	#N/A			#N/A	#N/A
2	5	#N/A	#N/A			#N/A	#N/A			#N/A	#N/A
3	10	14671	2.107			#N/A	#N/A			#N/A	#N/A
4	15	15342	1.222			#N/A	#N/A			#N/A	#N/A
5	20	15744	0.712			#N/A	#N/A			#N/A	#N/A
6	21	15826	0.61			#N/A	#N/A			#N/A	#N/A
7	21.5	15825	0.611			#N/A	#N/A			#N/A	#N/A
8	22	15862	0.565			#N/A	#N/A			#N/A	#N/A
9	23	19646	-3.587			#N/A	#N/A			#N/A	#N/A
10	25	16099	0.274			#N/A	#N/A			#N/A	#N/A
11	35	#N/A	#N/A			#N/A	#N/A			#N/A	#N/A
12	45	#N/A	#N/A			#N/A	#N/A			#N/A	#N/A

		String #4				String #5				String #6	
Therm #	Depth (ft)	R (avg)	Temp (C)		Depth (ft)	R (avg)	Temp (C)		Depth (ft)	R (avg)	Temp (C)
1		#N/A	#N/A			#N/A	#N/A			#N/A	#N/A
2		#N/A	#N/A			#N/A	#N/A			#N/A	#N/A
3		#N/A	#N/A			#N/A	#N/A			#N/A	#N/A
4		#N/A	#N/A			#N/A	#N/A			#N/A	#N/A
5		#N/A	#N/A			#N/A	#N/A			#N/A	#N/A
6		#N/A	#N/A			#N/A	#N/A			#N/A	#N/A
7		#N/A	#N/A			#N/A	#N/A			#N/A	#N/A
8		#N/A	#N/A			#N/A	#N/A			#N/A	#N/A
9		#N/A	#N/A			#N/A	#N/A			#N/A	#N/A
10		#N/A	#N/A			#N/A	#N/A			#N/A	#N/A
11		#N/A	#N/A			#N/A	#N/A			#N/A	#N/A
12		#N/A	#N/A			#N/A	#N/A			#N/A	#N/A

		String #7	
Therm #	Depth (ft)	R (avg)	Temp (C)
1		#N/A	#N/A
2		#N/A	#N/A
3		#N/A	#N/A
4		#N/A	#N/A
5		#N/A	#N/A
6		#N/A	#N/A
7		#N/A	#N/A
8		#N/A	#N/A
9		#N/A	#N/A
10		#N/A	#N/A
11		#N/A	#N/A
12		#N/A	#N/A



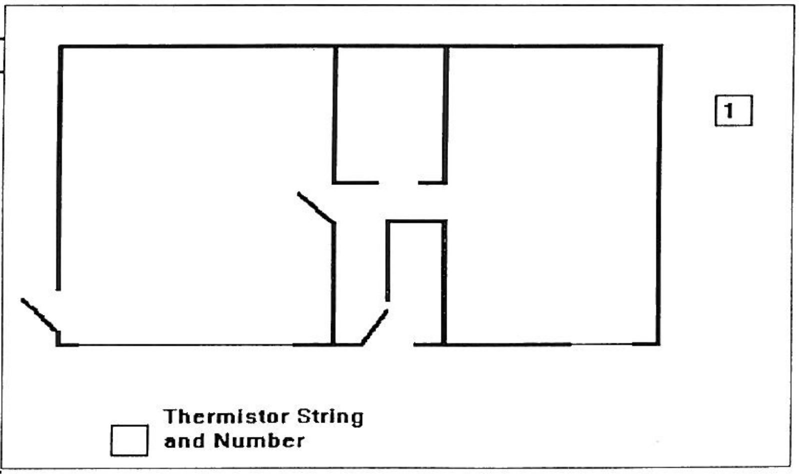
KV Thermistor Temperature Log

Operator : shane
Date : 2/19/94

		String #1			String #2			String #3	
Therm #	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)
1	0	13170	4.264		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
2	5	15280	1.302		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
3	10	14215	2.735		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
4	15	15005	1.661		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
5	20	15565	0.937		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
6	21	15705	0.761		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
7	21.5	15985	0.413		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
8	22	15765	0.686		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
9	23	15880	0.543		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
10	25	16200	0.151		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
11	35	16400	-0.09		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
12	45	16490	-0.197		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!

		String #4			String #5			String #6	
Therm #	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)
1		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
2		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
3		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
4		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
5		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
6		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
7		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
8		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
9		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
10		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
11		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!
12		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!

		String #7	
Therm #	Depth (ft)	R (avg)	Temp (C)
1		#DIV/0!	#DIV/0!
2		#DIV/0!	#DIV/0!
3		#DIV/0!	#DIV/0!
4		#DIV/0!	#DIV/0!
5		#DIV/0!	#DIV/0!
6		#DIV/0!	#DIV/0!
7		#DIV/0!	#DIV/0!
8		#DIV/0!	#DIV/0!
9		#DIV/0!	#DIV/0!
10		#DIV/0!	#DIV/0!
11		#DIV/0!	#DIV/0!
12		#DIV/0!	#DIV/0!

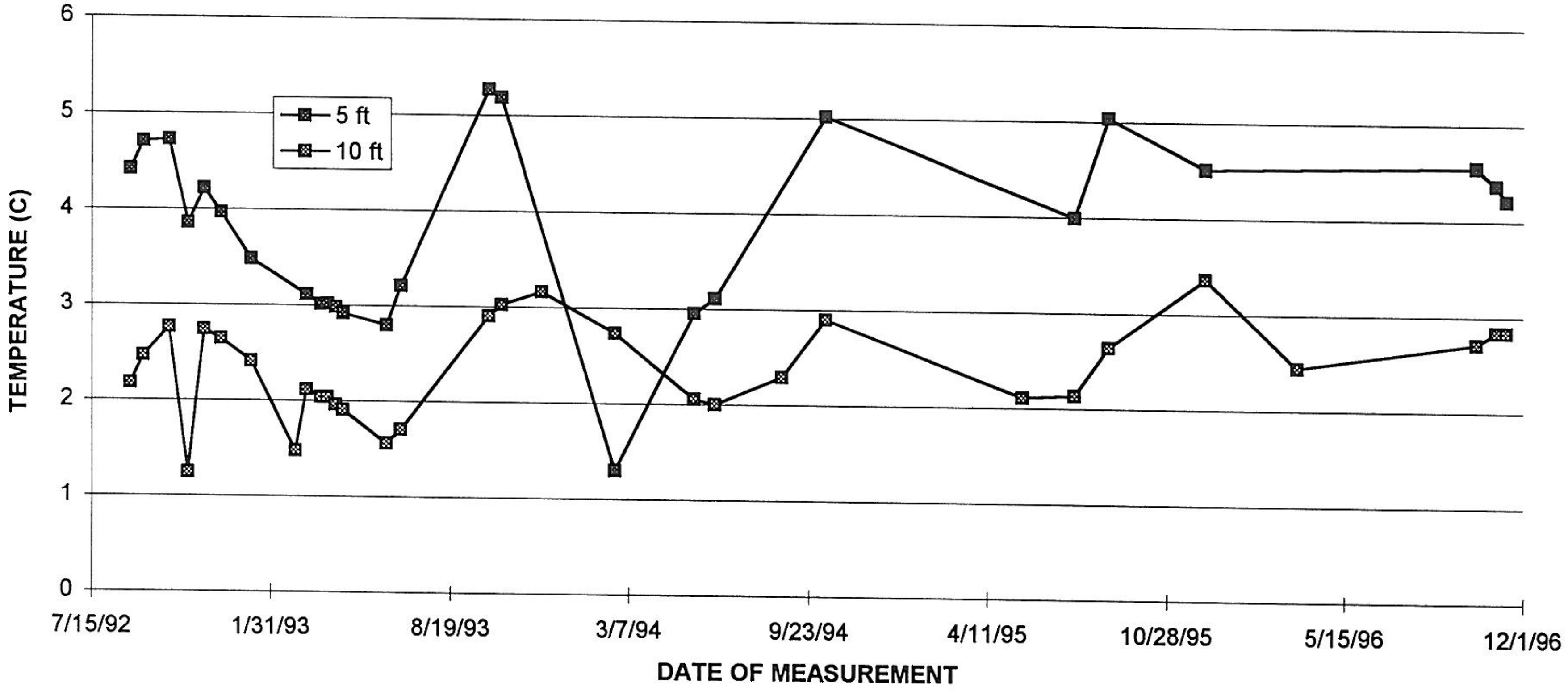


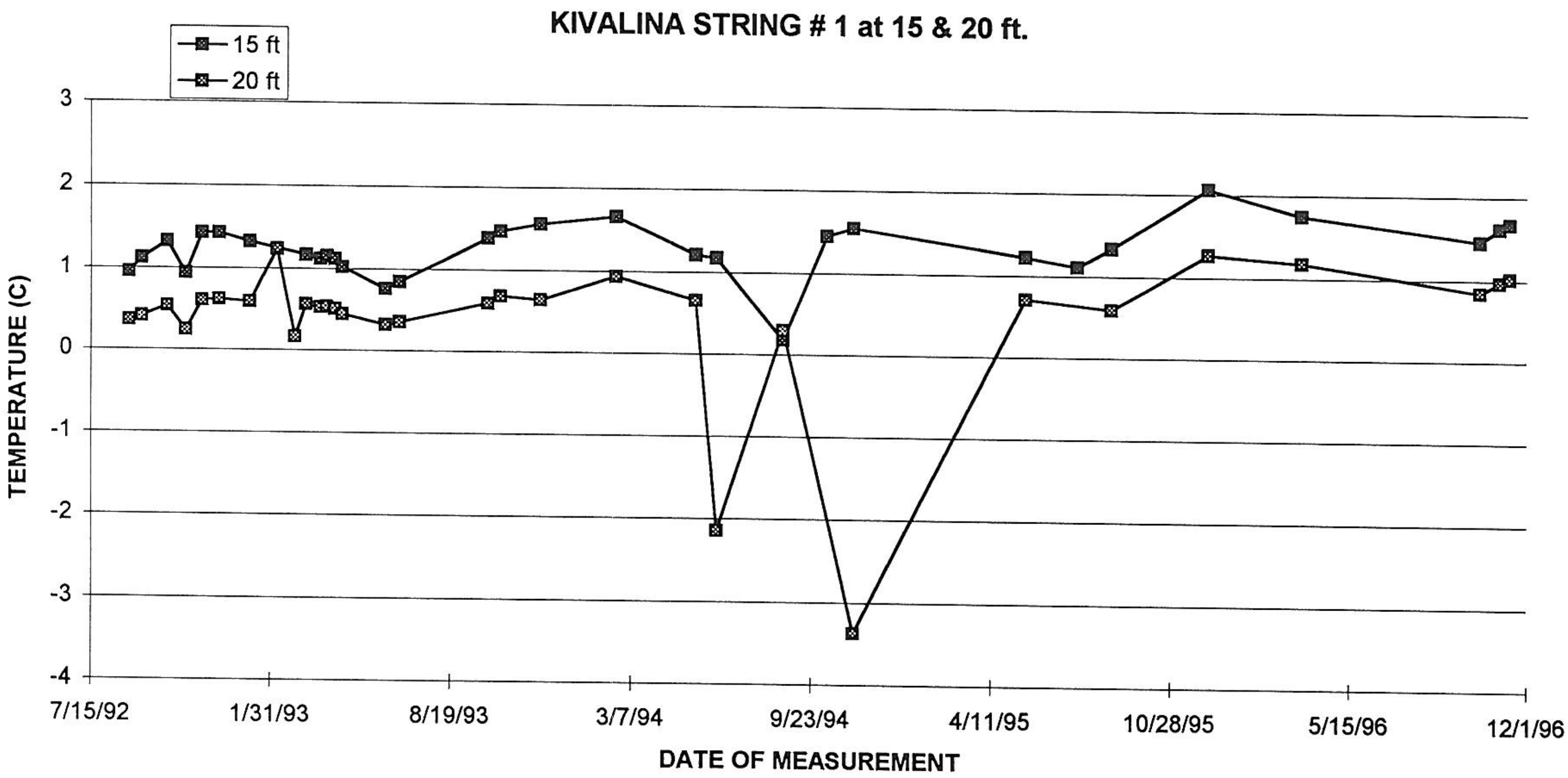
KV Thermistor Temperature Log

Operator : zhang
Date : 8/27/92

		String #1	
Therm #	Depth (ft)	R (avg)	Temp (C)
1	0	10640	8.613
2	5	13070	4.417
3	10	14620	2.176
4	15	15555	0.95
5	20	16030	0.358
6	21	16110	0.26
7	21.5	16120	0.248
8	22	16160	0.199
9	23	16215	0.133
10	25	16350	-0.03
11	35	16340	-0.018
12	45	16455	-0.155

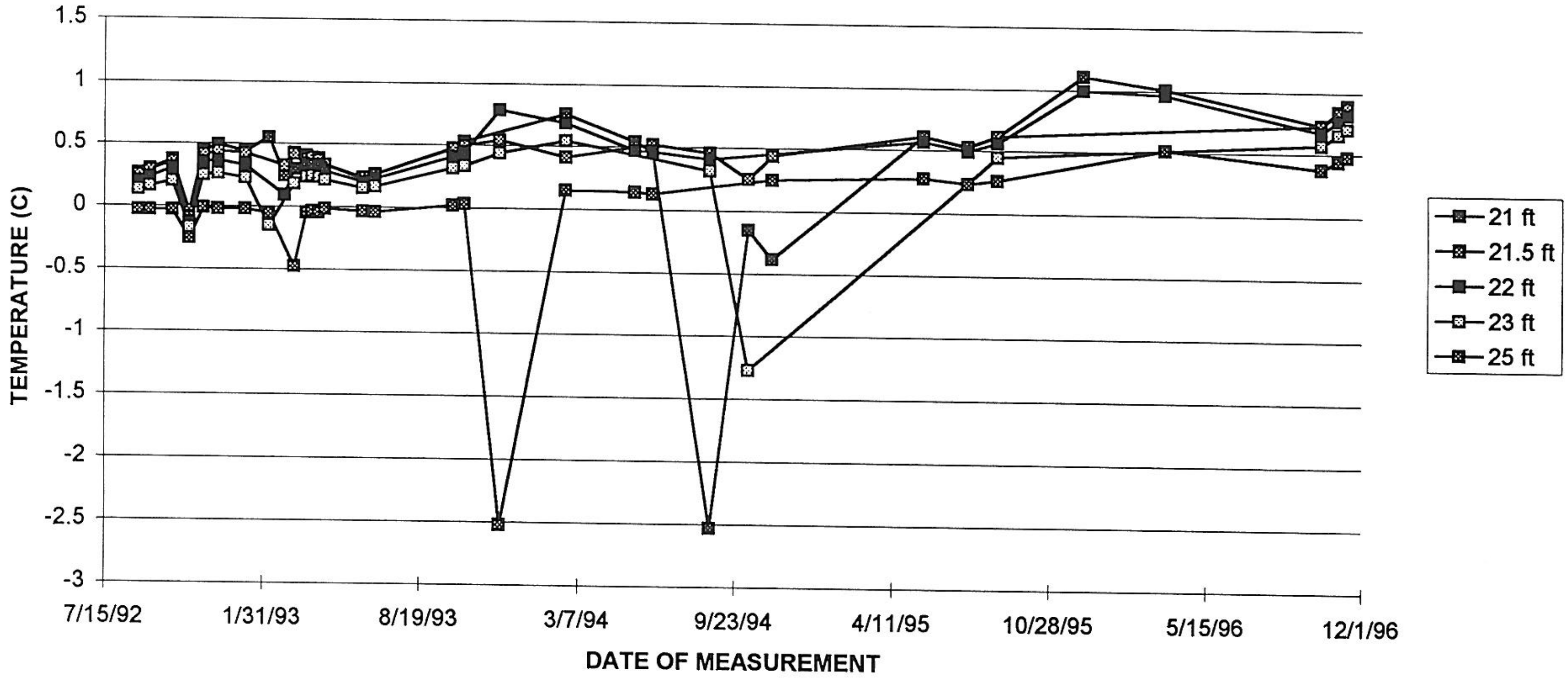
KIVALINA STRING # 1 at 5 & 10 ft.



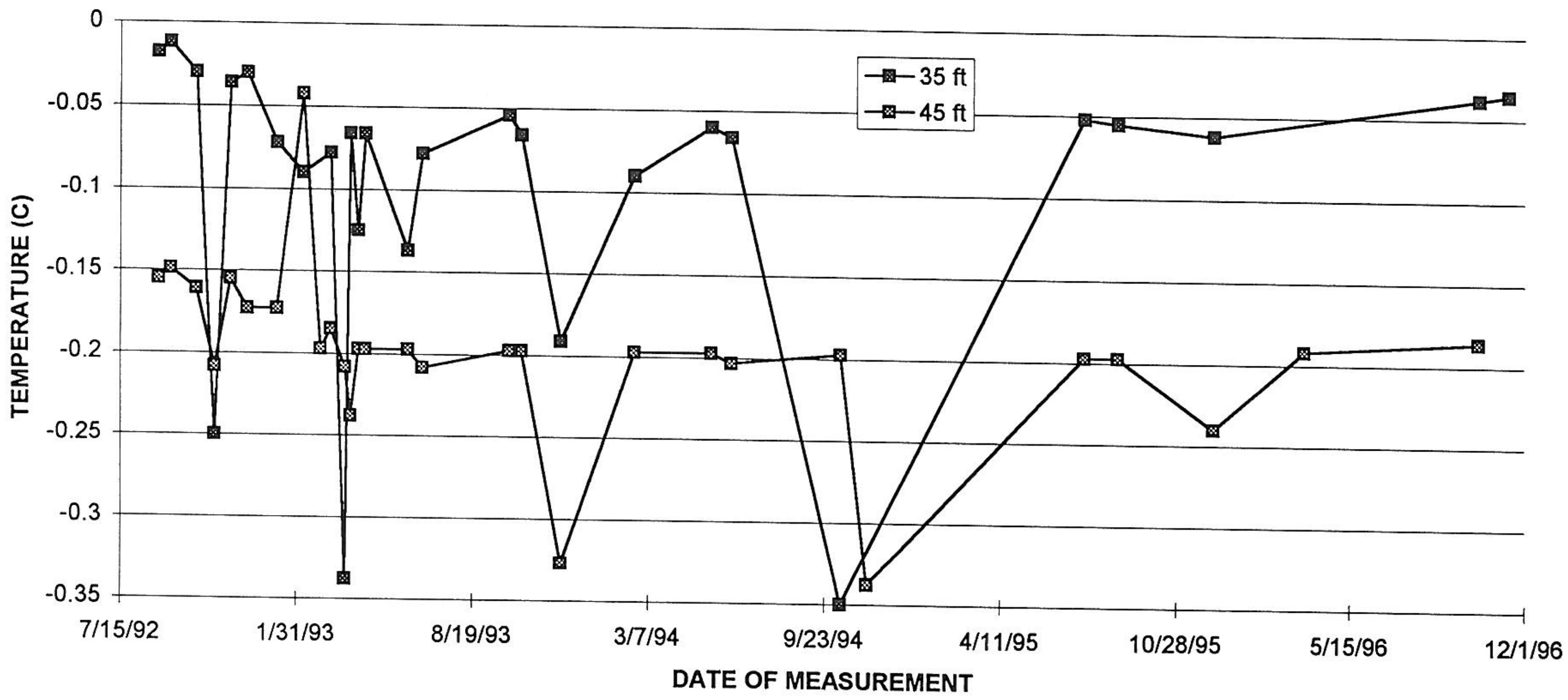


KIVALINA STRING # 1 at 15 & 20 ft.

KIVALINA STRING # 1 at 21, 21.5,22, 23 & 25 ft.



KIVALINA STRING # 1 at 35 & 45 ft.



Engineering Reports

STUTZMANN ENGINEERING ASSOC., INC.
P.O. BOX 71429
FAIRBANKS, ALASKA 99707
PHONE (907) 452-4094
FAX (907) 452-1034

January 20, 1998

Permafrost Technology Foundation
3875 Geist Road, Suite E-275
Fairbanks, Alaska 99709

Attn: Mr. Terry McFadden

Re: Engineering Report
1664 Kivalina Street
Fairbanks, Alaska

Dear Mr. McFadden:

As requested we have conducted an onsite inspection of the above referenced property. This inspection was performed on January 15, 1998.

We have previously inspected this structure on October 26 and 27, 1988, for the Alaska Housing Finance Corporation (A.H.F.C.). The purpose of our recent inspection was to allow for re-evaluation of our original report and subsequent findings.

It is our understanding, and appears to be so, that essentially no maintenance or repairs have been performed on the building during the 9 years following our original inspection.

PERMAFROST TECHNOLOGY FOUNDATION DATA

We are in receipt of data pertinent to this structure recorded by the Permafrost Technology Foundation (P.T.F.) during the period between February 20, 1991 and January 22, 1997. This data consists of three categories of information and is included with this report.

1.) A log of Geotechnical drilling.
2.) Temperature data in the bore hole.
3.) Relative elevations in the building.

The Geotechnical drilling consisted of one boring located at the north side of the structure. This boring was drilled on July 23, 1992 and near the location of a previous soils boring logged by our office on October 27, 1988. The soils data obtained by the P.T.F. indicates the presence of permafrost at a depth of 30.5 feet below the ground surface.

The temperature log of the soils encountered within the P.T.F. boring indicate that at the time of boring the permafrost surface was at a depth of approximately 25 feet. This depth increased to between 30 and 35 feet at the time of last recording July 16, 1995. This indicates that the permafrost level receded between 5 and 10 feet in 3 years.

The elevation data indicates approximately 1 3/4" of elevation differential on the basement concrete floor surface. This data also indicates little if any additional differential settlement occurred during the period of monitoring. No measurements were made from a stable bench mark to determine if the building as a whole is settling.

CURRENT INVESTIGATION

No additional soils boring were drilled during our January 15, 1998 inspection of this structure.

Our investigation did include elevation readings on the concrete basement floor and top of concrete block foundation wall. Comparison of these elevation readings to those which we took on October 26, 1988 indicates little if any additional differential movement has occurred. Our recent measurements indicate approximately 2" of elevation differential on the concrete floor surface and 1/2" of differential on the top of the concrete block foundation wall. Approximately 3/4" of floor differential occurs within the dwelling portion of the basement. These recent findings are similar to those we found in October, 1988.

Our inspection of the remainder of the structure revealed that the repairs recommended to be performed in our November 9, 1988 report have not been accomplished.

A copy of that report is included with this report. The recommended repairs are included therein.

Our recent inspection revealed that the elevation differential of the concrete garage floor is such that proper drainage to the floor drain is inhibited. Snow melt from vehicles should not be allowed to drain to the garage walls so to prevent rotting of the interior walls or seepage to the perimeter foundation walls. Future replacement of this garage slab is expected to be required.

Our inspection revealed that the existing concrete landing at the front entry doorway is sloping towards the building. Any water on this landing will drain towards the building foundation. We recommend that this landing be replaced so to drain away from the building. All yard areas adjacent to the building should be graded to drain away from the structure. Earth should not be placed above the foundation walls.

Inspection within the structure also revealed cracks in the sheetrocked wall and ceiling surfaces of the upper floor level. In most all areas the cracks found are not considered abnormal for wood framed structures. One sheetrock crack located on the east wall of the southeast bedroom and above the corner of the garage is larger than would be expected. This cracking is attributed to the excessive bending of the undersize garage door header beam below. We would expect the proper replacement of the garage door header to minimize this cracking.

CONCLUSION

The single soils boring drilled by the P.T.F. provided data similar to our soil borings on this property. The P.T.F. boring of 7/23/92 indicated the permafrost was encountered at a depth of 30.5 feet. However the temperature sensors installed within this hole indicated that the permafrost was at a depth of approximately 25 feet. Our boring, four years earlier encountered frozen soil at depth of 23 feet. In both cases, the soils encountered above the permafrost are relatively loose.

The data from the last temperature readings taken within the P.T.F. boring hole indicates that the freezing level was between the depths of 30 and 35 feet. This indicates an approximate 10 foot receding of the permafrost surface, since October, 1988.

Over nine years have lapsed since the date of our initial inspection of this dwelling. During this time, the floor and foundation elevation differentials appear to have not changed. The continued monitoring of this structure during this period by the P.T.F. indicates similar findings.

Our initial concerns of additional differential settlement of this structure appear not to have occurred. Some settlement of this structure may still be possible. In our opinion however, any settlement of this structure will not be catastrophic and with proper maintenance, this structure is expected to serve a normal and useful life.

In conjunction with this report, we recommend that those repairs stated in our inspection report dated November 9, 1988 also be performed.

Our recommendations are based on problems which were readily apparent during the inspection. This report is meant to address only those concerns specifically mentioned herein and does not address the adequacy of the structure as a whole. Construction methods identified in one particular area have been assumed to be representative of like portions of the building. Hidden structural defects or deficiencies which may exist, but have not manifested themselves through some movement or failure, were likely to not have been identified with the inspection.

If you have any questions regarding this report, please contact our office.

Sincerely,

STUTZMANN ENGINEERING ASSOC., INC.

STATE OF ALASKA
49TH
James H. Altherr
JAMES H. ALTHERR
NO. 8039
CE
REGISTERED PROFESSIONAL ENGINEER

James H. Altherr, C.E.
97-228c

ORIGINAL REPORTS

BY
STUTZMANN ENGINEERING ASSOC., INC.

STUTZMANN ENGINEERING ASSOC., INC.
P.O. BOX 1429
FAIRBANKS, ALASKA 99707
(907) 452-4094

November 9, 1988

Coldwell Banker
105 Adak
Fairbanks, Alaska 99701

Attn: Dick Moriarty

Re: AHFC #30908 (Tingley)
MBS #70225911
Lot 11, Blk 10, South Westgate Sub.
1664 Kivalina Street, Fairbanks

Gentlemen:

We inspected the above referenced property on October 26-27, 1988. Two soil test borings were also drilled on October 27, 1988.

I have the following comments with regards to these investigations.

EXISTING CONDITIONS

The existing structure is a wood frame, single family dwelling with a daylight basement.

The main floor contains approximately 1200 square feet and is comprised of a kitchen, dining room, living room, bathroom, two bedrooms and a master bedroom with adjoining bathroom.

The daylight basement contains approximately 570 square feet and is currently unfinished. The garage comprises the remaining half of the basement level.

The foundation is comprised of a standard concrete footing with four foot concrete block foundation wall. The bottom of the concrete footing is approximately four feet below grade. The exterior walls of the entire structure are of 2x6s at 16" O.C. construction. The roof is of gable design and constructed or professionally manufactured trusses at 24" O.C. The floor of the basement is concrete slab. The exterior of the structure is T-111 siding. Some of these items can be seen on the enclosed Photos 1 through 10.

Soils encountered during soils testing are noted on the two enclosed soils logs.

PROBLEMS AND RECOMMENDED SOLUTIONS

A list of problem areas found during these inspections are as follows:

1. Soils encountered in soil borings.
2. Main level TJ1 floor joists at two foot overhang.
3. Garage door header.
4. Ceiling beam in basement supporting a section of the main floor.
5. Existing concrete apron in front of garage.

These problems, with recommended solutions, will be discussed in the remainder of this letter.

Item 1: Two soil borings were drilled by Alsinco on October 27, 1988 with a 8" hollow stem auger to depths of 31 and 35 feet. Soil samples were obtained at approximately five foot intervals with the use of a split spoon sampler. The soils encountered during drilling are noted on the enclosed soils log.

Permafrost was encountered in both TH #1 and 2 at depths of 25 and 23 feet respectively. Marginally frozen ground was encountered in TH #1 from a depth of 15½ to 25 feet. This did not contain excess moisture. Excess moisture in the form of ice cdrystals was found in both test holes, as indicated on the soil logs. Fairly loose sand was encountered in both test holes from a depth of approximately five feet down to frozen soils. This is indicated by N values of 10 or less on the soil logs.

With reference to Photo 1, TH #1 was drilled at the Southeast corner of the building, near the garage door and the side entrance door to the garage. TH #2 was drilled on the North side of the building, somewhat behind the chimney. It should be noted the ground surface is approximately 3½ feet lower at TH #1 than at TH #2.

At the present time, we have found no problems with this structure that we can directly relate to the underlying loose sands and permafrost. But we probably would have recommended against building a standard dwelling upon these soils if asked before construction began. A minimum requirement would have been compaction of the underlying loose sands.

We have taken elevations on the existing concrete basement floor and top of foundation wall. These indicate an elevation difference of 2 inches on the concrete floor. One half of this difference occurs near the garage door; this may be due to slight frost jacking at the garage door. The remainder of the difference may be due to construction.

Elevations on top of the concrete block, foundation wall indicate only 5/8" differential. This is quite acceptable for a dwelling this size. No cracks were noticed in the foundation walls.

There is no indication of differential settlement of the structure. This does not mean that none will occur in the future. The underlying loose sands would be expected to remain as is, unless some dynamic event, i.e., earthquake, large construction project nearby, etc., were to happen. Even then, I would expect settlement of these sands to be somewhat constant for the entire area, thus resulting in little differential settlement of the structure. It is also our opinion that little differential settlement will occur from the thawing of the underlying permafrost. The layer of ice rich permafrost is quite deep and at approximately the same relative depth, if differences of ground surface are taken into account.

We feel that any attempts to prevent the permafrost from thawing would be quite expensive and maybe impossible.

Since this house is existing with no problems presently directly attributed to the underlying soils, it is our opinion that the underlying soils should be left as is. We would expect any settlement of this structure to be somewhat even.

Item 2: The floor joists of the main level of the house are 9½" TJ1 at 24" O.C. These are adequate for the existing spans with the exception of the 2 foot overhang at the living room and the bedrooms over the garage door. According to the Trus Joist Corporation Installation Guide, the existing TJ1's with a 2 foot overhang are not adequate to support the required roof loading. The existing floor joists should be modified, as per the enclosed detail for TJ1 floor joists, in order to be adequate for the required design loading. This will require some sheetrock removal from the garage ceiling.

Item 3: The existing garage door header appears to be a 5-1/8" x 15" Glulam beam spanning 16½ feet. This beam is currently indicating approximately 1" of sag and is not adequate to support first floor and roof design loading. We recommend this header be replaced with a 5-1/8"x18" Glulam beam. This may require the height of opening be made 2-3 inches lower, but removal of one of the top wall plates may be possible to lessen this height decrease. This can be determined when the contractor proceeds with the work.

Item 4: There is currently a 3½"x11" solid wood ceiling beam in the daylight basement which is supporting the upper TJ1 floor joists. This beam is not adequate for the existing span of 10½ foot (approximately). This ceiling beam should be replaced with a 3-1/8"x10½" Glulam beam, only in the "open" portion of the basement. This is indicated on the enclosed sketch.

Item 5: The existing 19½'x13½' concrete apron in front of the garage is cracked and portions of it are sloping toward the garage instead of away. This slab also sounds "hollow" for the entire area near the garage. It is assumed that poor compaction around the foundation wall at the time of construction has resulted in some settling. This settling is the probable cause of the cracking of the concrete slab and the resulting poor drainage.

We recommend the removal of the slab and one foot of the underlying soil. This should be replaced with gravel and the entire area below the slab compacted to 95%. A new 4 inch concrete slab, reinforced with 6x6-10/10 wire fabric, sloping away from the building at 2% grade, should be constructed.

The small section of sidewalk to the garage side entry door may also need to be replaced due to the construction activities.

The construction of this slab and recompaction of the underlying soils will provide positive drainage away from the garage. This will hopefully prevent future frost heave problems in the garage entrance area.

A summary of the recommended solutions or repairs is as follows:

1. The underlying soils do have a potential for future settlement; however, it is our opinion that since there are no visible problems which we can attribute to these soils, we recommend leaving existing conditions as is.

2. Modify the existing main level TJ1 floor joists at the two foot overhang portions only, as per the enclosed sketch.

3. Replace the existing garage door header beam with a 5-1/8"x18" Glulam (F = 2400 psi E = 1.8x10 psi min.).

4. Replace the existing 3½"x11" solid wood ceiling beam in the basement "open" portion only (approximately 10½feet) with a 3-1/8"x10½" Glulam (F = 24 psi, E = 1.8x10^{6}psi min.).

5. Remove and replace existing 19½'x13½' concrete slab in front of the garage. Remove one foot of the underlying soils and replace with gravel, compact to 95%. Construct 4 inch concrete slab reinforced with 6x6-10/10 wire fabric sloped a 2% away from the building.

Our recommendations are based on problems which were readily apparent during the inspection. Hidden structural defects or deficiencies which may exist and have not manifested themselves through some movement or failure were likely to not have been identified with the inspection. This report is not meant to address the adequacy of the remainder of the building.

As the contractor proceeds with construction, if further problems are encountered, he should contact us for further recommendations. It is assumed the contractor will be knowledgeable enough to perform his duties in a proper manner and be capable of identifying other possible deficiencies if they are revealed during construction.

It is the responsibility of the contractor to contact us as work progresses, so that we can inspect items being repaired. Repairs should not be covered before inspection.

If you have any questions regarding this matter, please contact us.

Very truly yours,

STUTZMANN ENGINEERING ASSOC., INC.

Gregory E. Wyman, P.E.

Enc.
42/C7

STUTZMANN ENGINEERING ASSOC., INC.

P.O. BOX 1429, FAIRBANKS, ALASKA 99707 — (907) 452-4094

CLIENT: COLDWELL BANKER

JOB No. AHFC # 30908 / TINGLEY

HOLE No.: TH 1

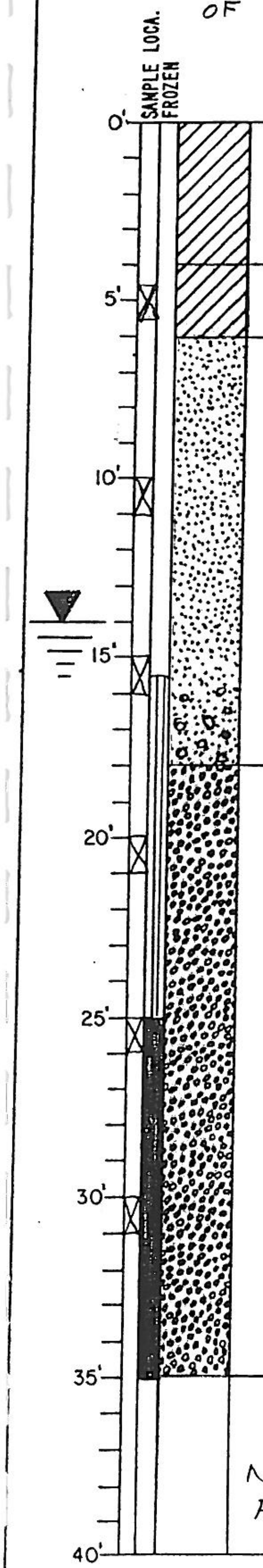
DATE 10/27/88

LOCATION: LOT 11 BLK 10 SOUTH WESTGATE
1664 KIVALINA ST. 4'E. AND 4'S.
OF SE COR. OF GARAGE

DRILLER: ALSINCO

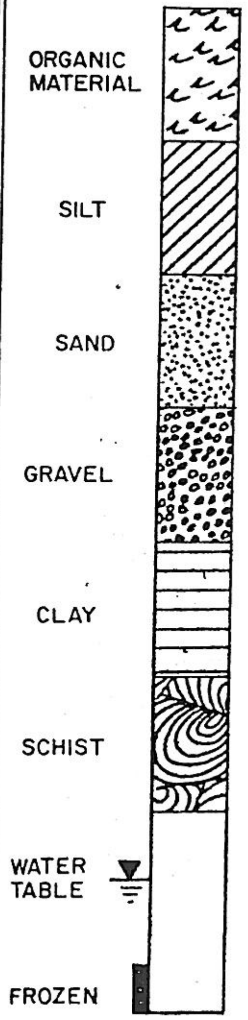
LOGGED BY: J. H. A.

SHEET No. 1 OF 1



SOIL DESCRIPTION	SAMPLE DATA
FINE BROWN SILT DAMP	
FINE BROWN SANDY SILT	N = 6 W = 26.2 %
FINE BROWN SAND	
FINE GREY SAND	N = 4 W = 25.0 %
GROUND WATER TABLE @ 14'±	
GRAVELLY SAND, MOIST	N = 22 SAMPLE NOT FROZEN
INTERMIXED GRAVEL AND SANDY GRAVEL LAYERS MOIST	N = 100+ SAMPLE NOT FROZEN
(FREE ICE IN SAMPLE)	N = 100+ W = 21.4 %
	N = 100+ W = 8.8 %
END OF BORING @ 35' NOTE: MAY HAVE BEEN MARGINALLY FROZEN FROM 15½' TO 25'	

LEGEND



N = SPT blows/ft.
3" O.D. spoon
300 #, 18" drop

W = % Moisture

GSS = % Gravel / Silt / Sand

STUTZMANN ENGINEERING ASSOC., INC.

P.O. BOX 1429, FAIRBANKS, ALASKA 99707 — (907) 452-4094

CLIENT: COLDWELL BANKER

JOB No. AHFC # 30908 / TINGLEY

HOLE No.: TH 2

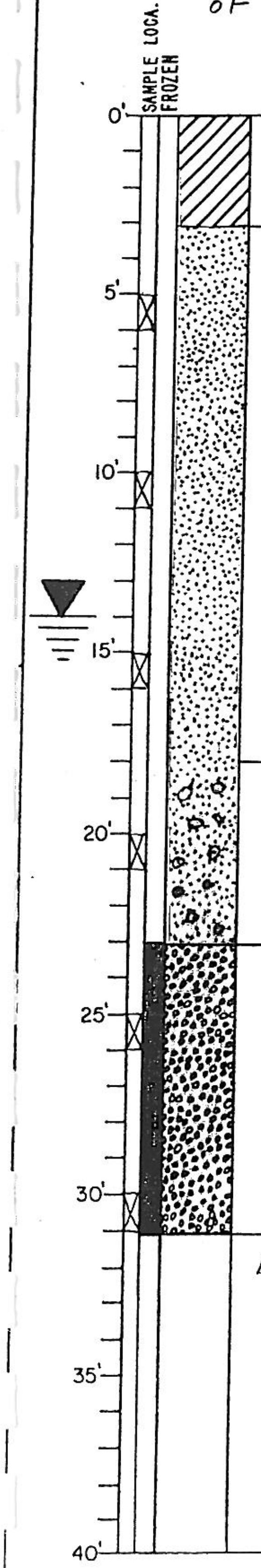
DATE 10/27/88

LOCATION: LOT 11 BLK 10 SOUTH WESTGATE 1664 KIVALINA ST. 7'N. OF NORTH SIDE OF HOUSE

DRILLER: ALSINCO

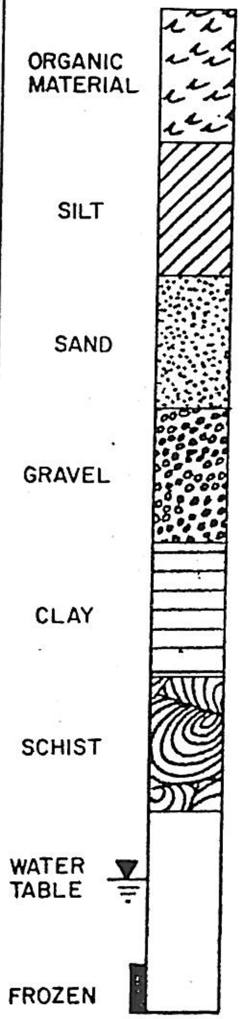
LOGGED BY: J. H. A.

SHEET No. 1 OF 1



SOIL DESCRIPTION	SAMPLE DATA
FINE BROWN SILT DAMP	
FINE BROWN SAND DAMP	N=15
	N=9 W= 6.4 %
GROUND WATER TABLE @ 14'±	
FINE GREY SAND	N=7
FINE GREY SAND SLIGHT GRAVEL	N=12
GRAVEL WITH INTERMIXED SANDY GRAVEL LAYERS	N=100+ W= 5.4 %
LARGER GRAVEL @ 29' (ICE CRYSTALS)	N=100+ W = 13.3 %
END OF BORING @ 31'	

LEGEND



N = SPT blows/ft.
3" O.D. spoon
300#, 18" drop
W = % Moisture
GSS = % Gravel / Silt / Sand

STUTZMANN ENGINEERING ASSOC., INC.
P.O. BOX 1429
FAIRBANKS, ALASKA 99707
(907) 452-4094

June 8, 1989

Coldwell Banker
105 Adak Avenue
Fairbanks, AK 99701

Attn: Rad Carlson

Re: AHFC #30908 (Tingley)
MBS #70225911
Lot 11, Block 10, South Westgate Subdivision
1664 Kivalina Street
Fairbanks, Alaska

Dear Sirs:

As per your request, we have computed predicted settlements of the above referenced property.

As noted in our inspection report dated November 9, 1988, two soils test borings were drilled. These borings encountered permafrost at depths of 23 and 25 feet. The permafrost continued to the end of the boring in both holes, 31 feet and 35 feet respectively. Layers of fairly loose sand were encountered above the permafrost.

Copies of the soil boring logs are included with the report.

Differential settlement of this structure could occur due to one or both of the following reasons.

1. Settlement of the unfrozen loose sand layers.
2. Thawing of the underlying permafrost layer.

Our calculations indicate that settlement due to the loose sand layer could result in a settlement of four inches or more. Calculations also indicate that settlement of approximately 12 inches could result from the thawing of 12 feet of permafrost, to a depth of 35 feet. The current level of permafrost is at approximately 23 feet below the ground surface.

The predicted settlement due to thawing of the underlying permafrost has been calculated using procedures outlined in the published article "Thaw Strain Data And Settlement Predictions For Alaskan Soils", by R.A. Nelson, U. Luscher, J.W. Rooney, and A.A. Stramler.

As mentioned previously in our initial inspection letter, we would expect the majority of the settlement that will occur within this dwelling to be somewhat evenly distributed. Our initial inspection indicated only 5/8 inch differential settlement of the top of the concrete block foundation wall. This does not mean that a greater differential settlement will not occur in the future. A dynamic event, such as an earthquake, large construction project, street improvements, or other similar events could cause further settlement of the underlying loose sands, resulting in settlement of the structure.

In our opinion differential settlement would be most likely to occur in the Southeast corner of the garage. The footing loading is considerably greater in this area because of the support of the large garage door header. It would be possible to construct a larger foundation footing, approximately 4' X 4', below the existing foundation footing in this area. The larger footing would result in more even foundation footing pressures on the underlying soils for the entire perimeter of the dwelling. This may result in less differential settlement, but there is no assurance of it. Any attempts to adequately compact the underlying soils may result in creating problems with other neighboring properties.

It would not be possible for us to guarantee that the existing foundation will remain adequate and useful for the life of a 30 year mortgage.

The most permanent solution to the potential settlement problem would be to move the dwelling to another lot or the installation of deep piles and necessary supports. Both methods of repair will be quite expensive.

At the present time, since little or no differential settlement has occurred, we would recommend using the dwelling as is. The building should be monitored to determine if settlement is occurring. This approach to the problem should not be considered a permanent one.

If a more permanent fix is determined to be necessary, we would be glad to assist you.

The issue of foundation support and underlying soils should be addressed prior to addressing the recommended structural improvements listed in our letter dated November 9, 1988.

If you have any questions regarding this report, please contact our office.

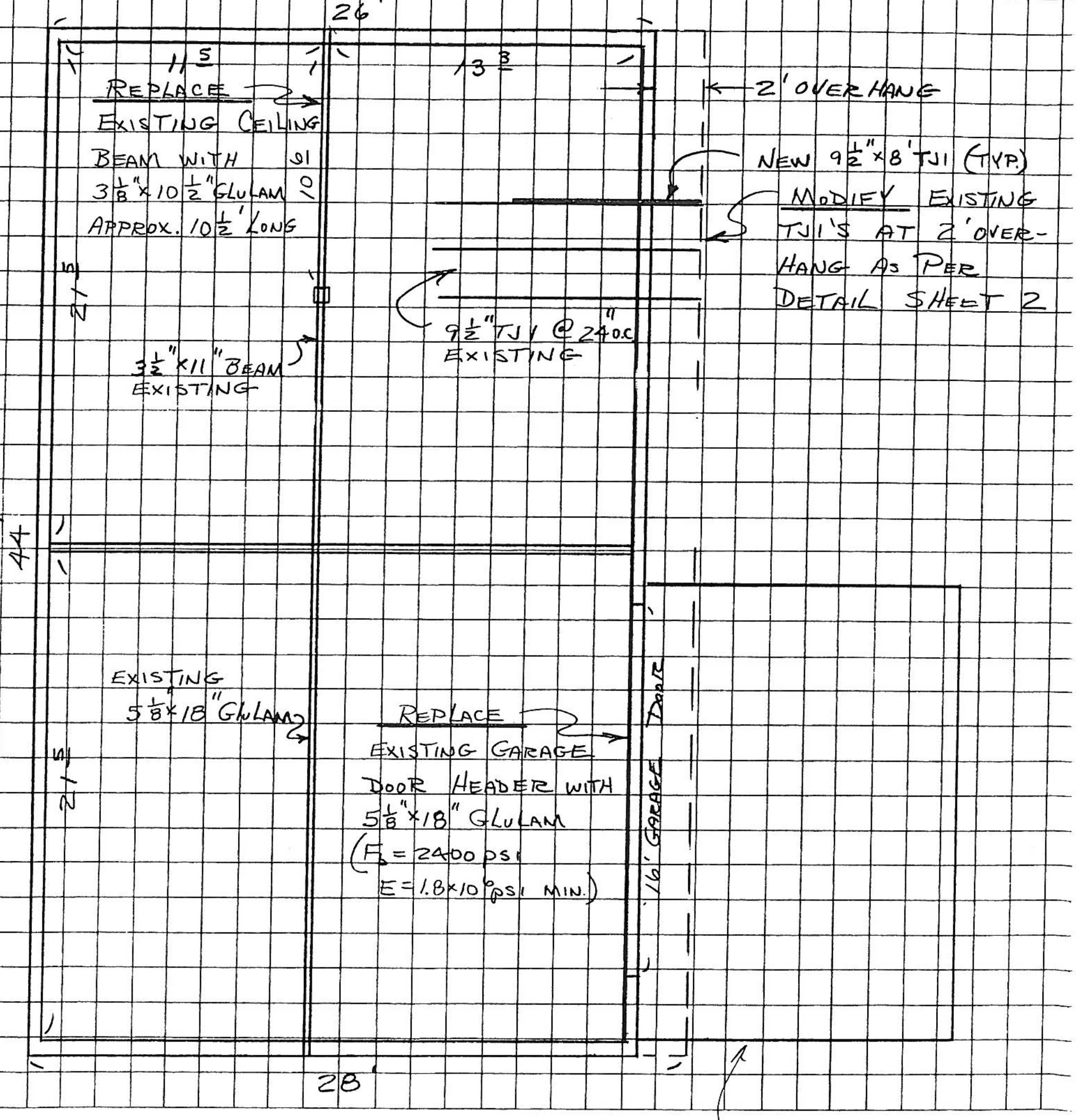
Sincerely,

STUTZMANN ENGINEERING ASSOC., INC.

Scott E. Wortman, P.E.
48-tt

STUTZMANN ENGINEERING ASSOCIATES, INC.
ENGINEERS
SURVEYORS
PLANNERS
P.O. BOX 1429, FAIRBANKS, ALASKA 99707
(907) 452-4094

PROJECT: AHFC # 30908
CLIENT: COLDWELL BANKER
LOCATION: 1664 KIVALINA ST
FIELD BOOK:
CALCULATED BY: JHA
SHEET NO. 1 OF 2
JOB NO.
DATE: 10/27/88
SCALE: 1"=6'
DISC:



REPLACE EXISTING CEILING BEAM WITH $3\frac{1}{8}$" x $10\frac{1}{2}$" GLULAM APPROX. $10\frac{1}{2}$' LONG

$3\frac{1}{2}$" x 11" BEAM EXISTING

$9\frac{1}{2}$" TJI @ 24" o.c. EXISTING

2' OVERHANG

NEW $9\frac{1}{2}$" x 8' TJI (TYP.)

MODIFY EXISTING TJI'S AT 2' OVERHANG AS PER DETAIL SHEET 2

EXISTING $5\frac{1}{8}$" x 18" GLULAM

REPLACE EXISTING GARAGE DOOR HEADER WITH $5\frac{1}{8}$" x 18" GLULAM (F_b = 2400 psi $E = 1.8 \times 10^6$ psi MIN.)

REMOVE AND REPLACE EXISTING CONCRETE SLAB

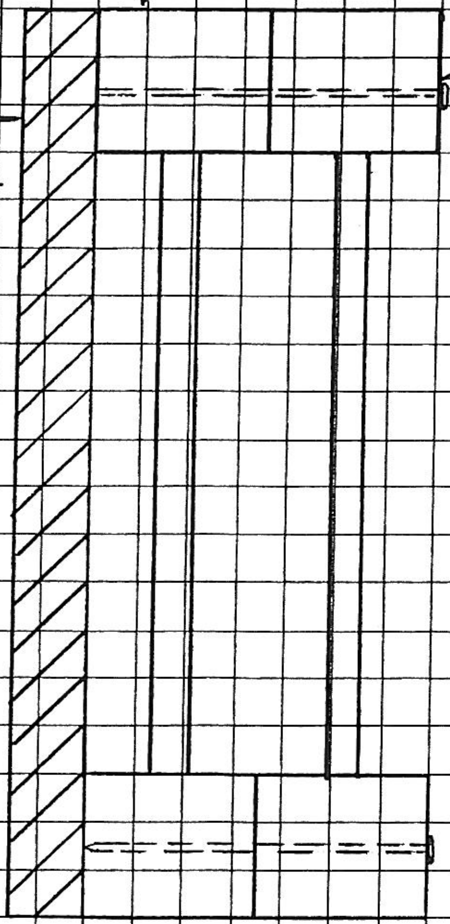
COMMENTS:

STUTZMANN ENGINEERING ASSOCIATES, INC.
ENGINEERS
SURVEYORS
PLANNERS
P.O. BOX 1429, FAIRBANKS, ALASKA 99707
(907) 452-4094

PROJECT: AHFC# 30908
CLIENT: COLDWELL BANKER
LOCATION: 1664 KIVALINA ST.
FIELD BOOK:
CALCULATED BY: J.H.A.

SHEET NO. 2 OF 2
JOB NO.
DATE: 11/3/88
SCALE: 1"=2"
DISC:

EXISTING 9½" TJI FLOOR JOIST



EXISTING 3/4" PLYWOOD APPROX. 4' LONG @ OVERHANG

INSTALL NEW 9½ x 8' TJI @ ALL TJI'S WITH 2' OVERHAN

FASTEN WITH 16d NAILS @ 12" O.C. MIN. TOP AND BOTTOM FLANGES.

NOTE: REINSTALL TJI BLOCKING AT EXTERIOR WALL AND REINSULATE OVERHANG PORTION OF FLOOR.

MMENTS: