Final Report
Foundation Stabilization Research Studies

House at 1600 Cordwood Drive
Fairbanks, Alaska

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Introduction

The house at 1600 Cordwood Drive is a three bedroom rambler with a two car attached garage. It is founded on perimeter footings and has a crawl space.

AHFC took possession of the house and retained Stutzmann Engineering to do two studies. The first was a traditional house inspection that culminated in a report dated September 6, 1989, which recommends a series of modifications. This report did not deal with the foundation soils, but is included in the appendix of this report because it gives a good description of the structure. The second study was a foundation exploration that culminated in a report dated January 2, 1990. The second report states that the house is on permafrost and that it could settle as much as half a foot. The portions of this report which are available, are included in the appendix.

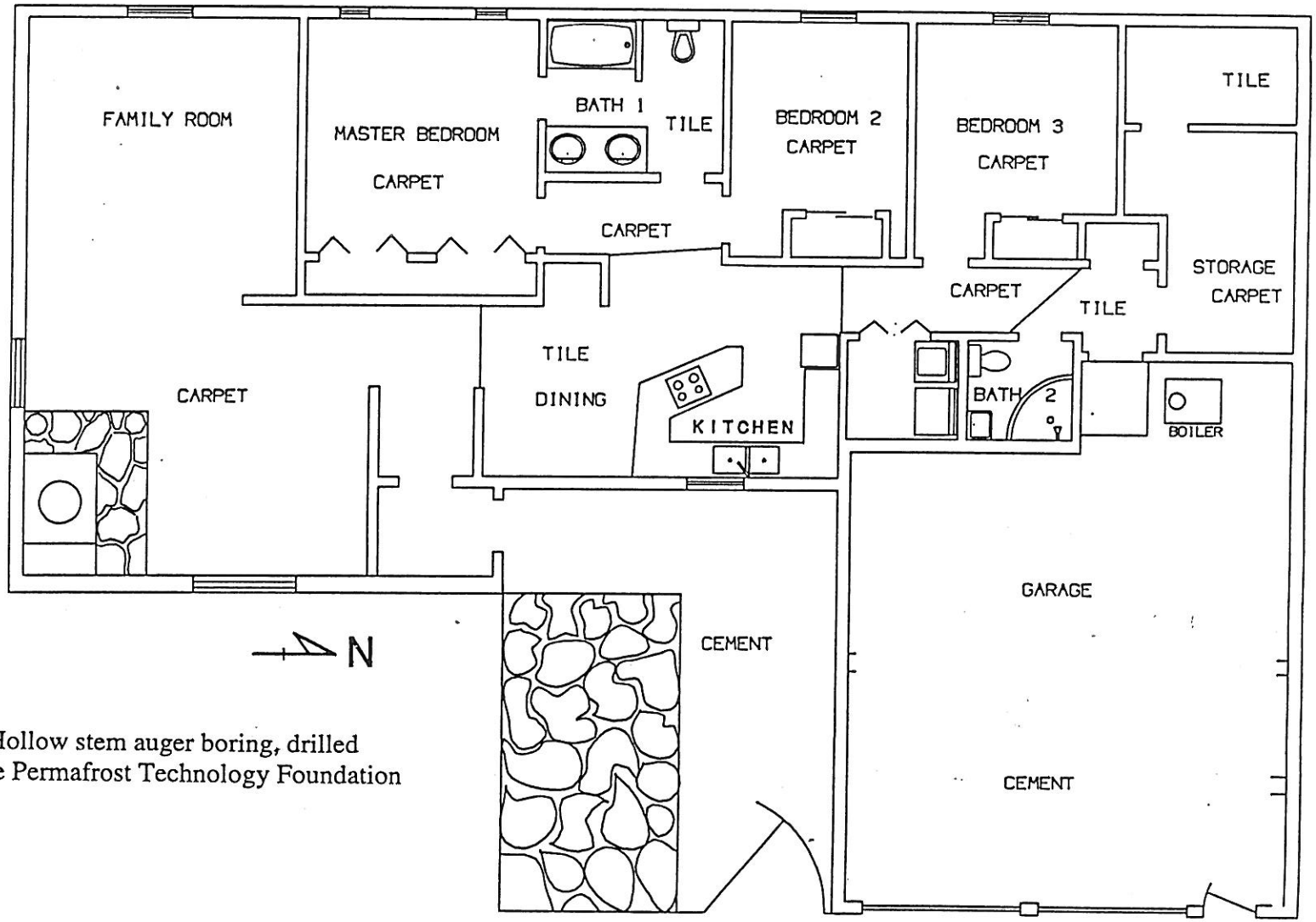
The second Stutzmann Engineering report caused the house to be deeded to the Permafrost Technology Foundation for part of a study concerning house foundations on permafrost. The Permafrost Technology Foundation study included drilling an additional boring, installing temperature measuring devices and survey points, and measuring the temperature and settlement over a six year period. A floor plan of the house showing the location of the boring is presented in Figure 1. This report is the final Permafrost Technology Foundation report on the foundation study on this house.

Geotechnical Exploration

Stutzmann Engineering had six borings drilled as part of their studies in late 1989. Those borings are described in the portion of the Stutzmann Engineering report dated January 2, 1990, which is included in the appendix. Each boring encountered about 5 feet of Silt underlain by fine Sand to depths of 13 to 17 feet. Under the fine Sand all borings encountered intermixed layers of Sand and Gravel. The descriptions indicate that permafrost was encountered at depths of 13 to 21 feet on the north side of the house and at 34 feet to 37 ft on the east and west sides. This report eludes to calculations based on water content measurements indicating that up to ½ foot of settlement could be experienced if the permafrost along the north side of the house were to thaw to the depth that it had already thawed along the east and west sides.

This report also describes shims on the foundation to make the house level. The shims are up to 1-1/2 inches thick along the north wall and grade to nothing along the south wall. It was not known when the shims were installed. They may have been part of the initial construction or they may have been part of a later releveling effort.

B-1
June 1992



Legend: B – Hollow stem auger boring, drilled for the Permafrost Technology Foundation

FIGURE 1 – FLOOR PLAN OF HOUSE AT 1600 CORDWOOD DRIVE SHOWING LOCATIONS OF SUBSURFACE EXPLORATIONS

One boring was drilled and samples of the soil were taken as shown on the Boring Log, Figure B-1 as part of the Permafrost Technology Foundation study. Samples of the soil were collected by driving a split spoon sampler out the bottom of a hollow stem auger 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 unfrozen soil. These samples are considered "disturbed samples." However, since they are retrieved essentially intact in their natural state they provide useful information about the soil.

The boring encountered a surficial layer of sandy Silt about 3 feet thick underlain by gray to brown Sand over gray Sands and Gravels. The water table was encountered at a depth of about 26.5 feet. Permafrost was encountered at a depth of 33.0 feet. Water used to prevent heave during drilling and from the water table was enough to thaw the permafrost in all but the last sample prior to reaching the surface. For that reason, water content tests would have been meaningless in the permafrost. However, the fact that a minimal inflow of water was enough to thaw the sample, indicates the frozen water content was fairly low.

Level Measurements

Background

Level measurements were taken to determine the relative elevation of the floor. The level measurements were made using a small precise telescopic level (sometime referred to as a "contractor's level") mounted on a tripod, and a surveyor's 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 inch).

It should be noted, however, that when level measurements are this precise, perturbations can, and do, occur. These small changes are 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 same spot under the same conditions as the previous measurement. If the location were slightly different or an electrical cord or something else happened to be under the rod, the readings would be different. Even the thickness of a few sheets of paper will show up at this precision. Many of the areas are carpeted, which makes it particularly difficult to get consistent readings.

There was also the possibility for a gross error in reading the rod. The level had the standard three cross hairs (center, upper, and lower) used for measuring distances in surveying. If the operator was careless or 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 one. This would cause an error of tens of millimeters. These errors are readily identifiable when the data is plotted as a function of time. They have been included in the raw data, but have been eliminated in the analyses presented herein.

Level data was collected several times a year and accumulated for a period of five years. Each measurement location is designated by a letter on the Floor Plan, Figure B-1. The settlement data are presented in Table B-1. The data from different groups of letters were plotted together to show relevant comparisons such as along the south wall or along the diagonal across the structure. These charts are shown on Figures B-2 through B-5. Table B-1 and Figures B-2 through B-5 show all the data collected.

All level data discussed thus far are referenced to Point A. The difference between curves representing two points is the relative difference in elevation of those two points but neither curve represents the true elevation or even relative changes in actual elevation.

Determining absolute elevations requires a stable surveyor's benchmark or other stable reference outside the structure. No such reference or benchmark was available at this location. Nevertheless, the relative elevations allow differential settlement to be observed. Relative differential movement between points in the structure is the most important information for this study.

In analysis of the data a number of points were determined to be grossly in error and were eliminated. From the remaining data it was determined that the accuracy of any given data point was on the order of 4 mm. Several individual measurements were made in succession to connect points within the house. The errors in individual measurements are accumulative hence, errors of up to 10 mm should be considered normal. In general the house is quite stable, hence it was necessary to resort to a statistical analysis of the data to determine trends regarding the stability of the house.

A statistical analysis of the data indicates that point D is the high point. Using point D as a reference differential movements between various points in the house are generally less than 2 mm per year with a absolute maximum of about 3 mm per year. Relative movement within any one room is always less than 1 mm per year. In general the north wall is settling the fastest and the central portion of the house is the most stable.

The house is about 20 mm out of level at the present time. If the settlement trend over the past five years continues, it would take on the order of 20 years to get enough differential settlement to be noticeable and more than that before any remedial measures would be contemplated.

Earthquakes and Other Dynamic Events

The presence of loose soils gives raise to the concern for settlement during a dynamic event such, as an earthquake. During the period over which the level measurements were made, there were 15 earthquakes over a Richter Magnitude of 4.0. The two largest were a Magnitude 5.0 on November 1, 1992 and a Richter Magnitude 6.2 on October 6, 1995. The last one was the most significant, not only because it was the largest, but also because it was the shallowest at only 9 km below the surface. It was felt very strongly by residents of Fairbanks, however, reviewing our settlement data we can not see any

settlement that can be attributed to an earthquake. This suggests that significant settlement will not be caused by future earthquakes producing the same intensity. This does not preclude the possibility of settlement during a more severe earthquake or other type of dynamic event. Even the same magnitude earthquake either closer or shallower may produce a higher intensity.

Temperature Measurements

Temperature measurements were made with thermistors, which were read with a datalogger and converted, automatically to temperature.

When the test boring was drilled for this study, a thermistor string with twelve thermistors was placed in the hole prior to backfilling. The depths of the thermistors are shown on the data sheets, Table C-1 and on the boring log, Figure A-1.

The thermistor string was monitored periodically for five years. The raw data is shown in Table C-1. The temperature data was plotted with respect to time on charts to give a graphic indication of the trends over the duration of the study. These charts are shown on Figures C-2 through C-6. All data collected are shown in Table C-1 and on Figures C-2 through C-6.

Thermistors are capable of measuring temperature to the nearest one thousandth of a degree Centigrade. However, the nearest one tenth of a degree is probably satisfactory for our purposes for everything except the location of the actual freezing front. 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 they are buried after installation, it is impractical to remove them without destroying them. Therefore, the secondary calibration cannot be made. Since the calibration could not be completed the temperatures cannot be relied upon to more than about a tenth of a degree.

Figure 2 shows all the data within the range of –0.6 to 1.0 degrees C. Several pieces of data were considered to be in error and were eliminated prior to making the figure shown. The following trends are obvious from this figure:

- Every reading for every thermistor below a depth of 40 feet was below freezing at all times.
- The thermal gradient below the top of the permafrost is about 0.013 degrees per foot.
- The depth to the top of the permafrost was about 32 feet in mid 1992 and about 35 feet in early 1997. This is a rate of thaw of about 7 inches per year.
- Temperatures in the permafrost seem to be increasing very slowly, about 0.006 to 0.01 degrees per year. This can be seen in the figures by drawing a line through the data points in late winter for any thermistor. This translates to a slow, but

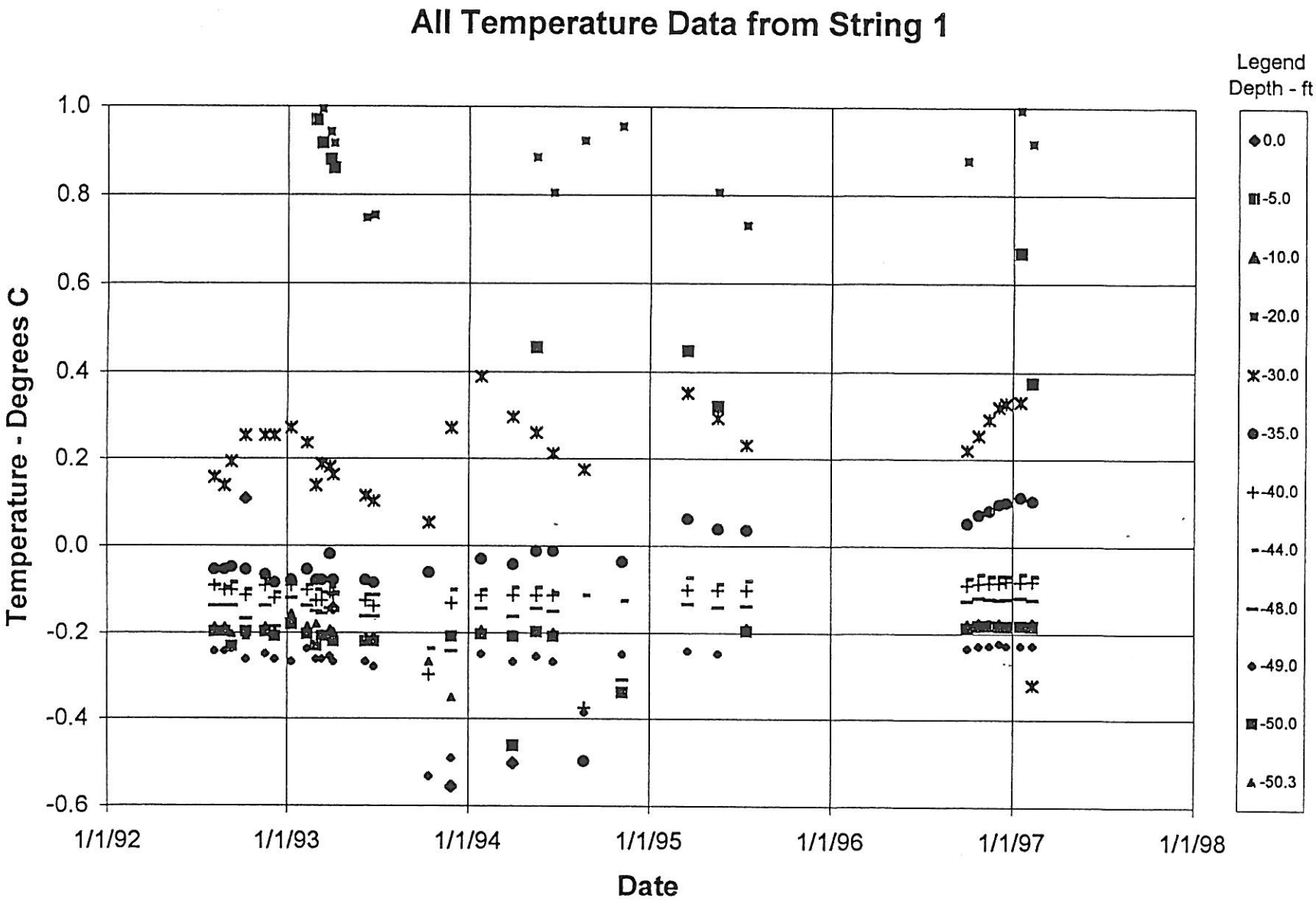

All Temperature Data from String 1
Legend
Depth - ft
0.0
-5.0
-10.0
-20.0
-30.0
-35.0
-40.0
-44.0
-48.0
-49.0
-50.0
-50.3
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
Temperature - Degrees C
1/1/92
1/1/93
1/1/94
1/1/95
1/1/96
1/1/97
1/1/98
Date

FIGURE 2

steady, thawing of the permafrost. Based on this gradient the permafrost would be expected to thaw at the rate of about 5 to 9 inches per year.

Results and Conclusions

The borings encountered 3 to 5 feet of Silt overlying Sand to a depth of 13 to 17 feet over interbedded Sand and Sand and Gravel. The water table was found at a depth of 26 feet in 1992. Permafrost was found at depths of 13 to 21 feet along the north end of the house in 1989 and at depths of 32 to 37 feet on the sides and south end in 1989 and 1992. No ice was mentioned in any soil descriptions.

The 1990 Stutzmann Engineering report mentioned shims on the foundation varying from 0 on the south end to 1-1/2 inches on the north end. That report states that shims resulted in a nearly level floor. It also states that the house was constructed in 1970, hence it had had 20 years to settle since its construction. The report goes on to suggest that up to ½ foot of settlement could be expected along the north wall if the permafrost there were to thaw to the 30 foot depth.

It is likely that the foundation was poured reasonably level. Therefore, it is likely that the 1-1/2 inches of shims noted in the crawl space were installed to compensate for later differential movement. It is entirely possible that thaw settlement occurred during construction. It is likely that there would be more settlement from near surface thawing than deeper thawing, hence there would be more settlement on the north end for equal amounts of thawing. It is also likely that there would be more thawing in the areas of shallower permafrost during construction and the permafrost on the north end was shallower. It is possible that 1-1/2 inches of differential settlement could have occurred in a year or two during construction due to thaw settlement. It is also possible that the shims are a product of differential frost heave and subsequent thaw settlement during construction.

One and a half inches of settlement are not much for a house of this size. It is therefore unlikely that this much settlement would have been enough to cause the owners to take the initiative to relevel the house after construction was complete.

Based on the assumption that the shims were installed during construction, the structure probably did not settle measurably in the 20 years after construction.

Permafrost Technology Foundation measured settlement for about five years. During that time, the permafrost on the south side of the house thawed about 3 feet. The permafrost on the north side of the building was not monitored. However, considering the foundation type and the surrounding conditions, it is likely that it was thawing, but more slowly.

The settlement measurements are conclusive in that they do not show large settlements. In fact, virtually all measurements are within about 20 mm and there is a great deal of randomness to the readings. Based on the randomness of the readings and the known

limits on accuracy of the measurements, it could be concluded that little, if any, differential settlement occurred during this time.

Stretching statistics to the limit, it could be argued that there was a tendency of the center of the house to stay level and for the ends to settle slightly relative to the center. A slight settlement in this case is up to 1 mm per year on the south end and up to 2 or 3 mm per year on the north end. These trends would make sense. The center of the house should be thawing the least and the settlement due to thawing of the higher permafrost along the north end would probably create more settlement along the north end.

Based on a cursory evaluation of the date and the hypothesis that the shims were installed during construction, there has been no significant settlement in the past 30 years. Based on a statistical analysis of the data and an assumption that the shims were installed quite recently, there has been differential settlement on the order of an inch every ten years.

When the frozen sands in the Fairbanks area thaw, there is often a small amount of settlement (up to an inch or two). When the interbedded sands and gravels thaw, there is usually very little, if any, settlement. Calculated amounts of settlement are frequently higher than this because engineers present the worst case scenario. It is difficult to predict how much settlement will occur, so engineers pick upper bound values. There are exceptions, and no amount of exploration will define precisely how much settlement will occur when either formation thaws.

It is heartening that most of Fairbanks is constructed on similar soils. Some settlement is observed, but where settlement is excessive, there are almost always other circumstances such as localized slough channels filled with non-thaw-stable soils or poorly compacted backfill.

It is likely that this house will settle some. It is unlikely that it will settle enough to make releveling necessary or even highly desirable. If it were to settle enough to make the owner want to relevel it, it would be easy to relevel by installing additional shims in a similar manner to the ones already installed.

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Appendices

Appendix A
Bore Hole Logs

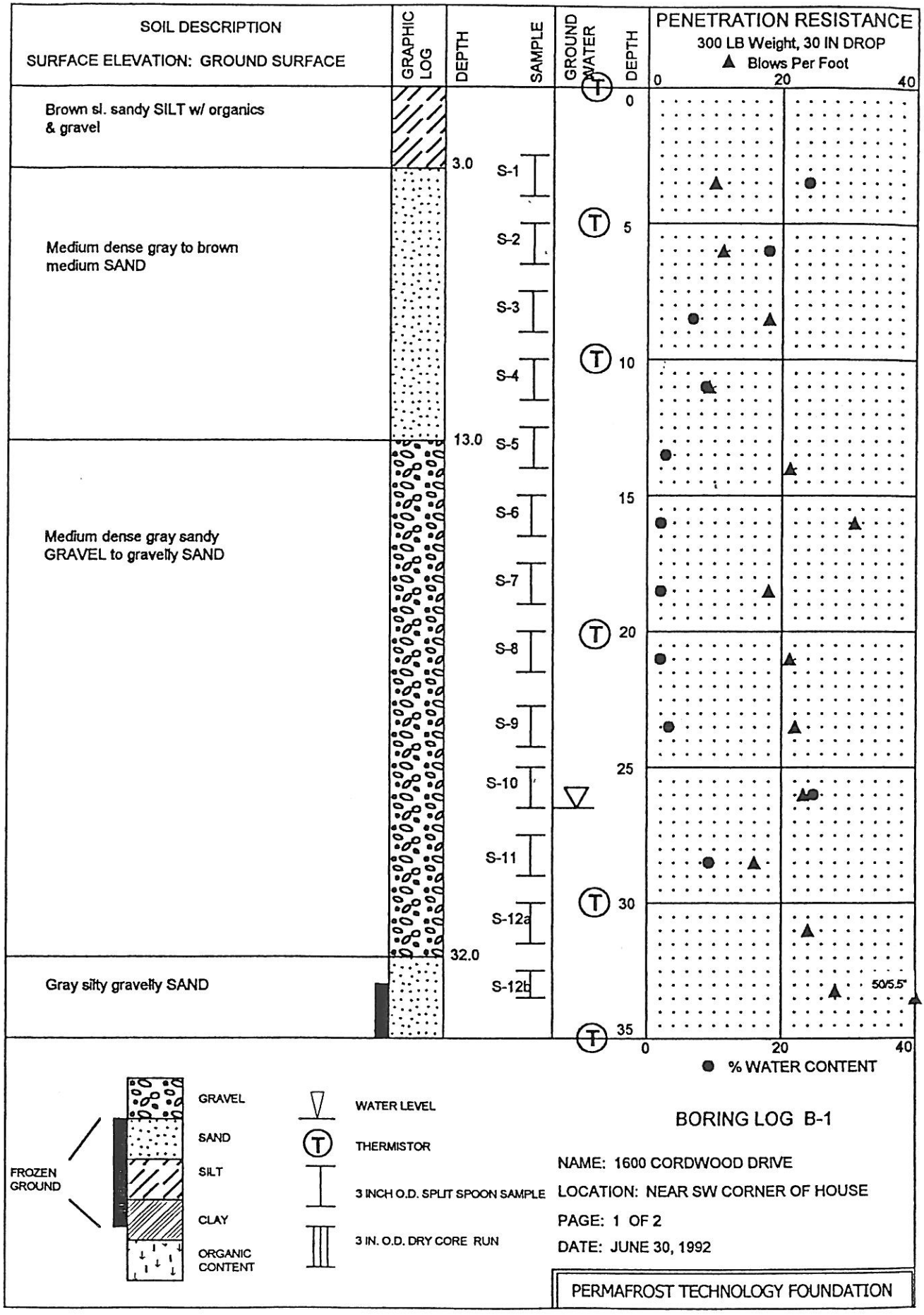
SOIL DESCRIPTION
SURFACE ELEVATION: GROUND SURFACE
GRAPHIC LOG
DEPTH
SAMPLE
GROUND WATER
DEPTH
PENETRATION RESISTANCE
300 LB Weight, 30 IN DROP
Blows Per Foot
Brown sl. sandy SILT w/ organics & gravel
3.0
Medium dense gray to brown medium SAND
13.0
Medium dense gray sandy GRAVEL to gravelly SAND
32.0
Gray silty gravelly SAND
S-1
S-2
S-3
S-4
S-5
S-6
S-7
S-8
S-9
S-10
S-11
S-12a
S-12b
50/5.5"
% WATER CONTENT
GRAVEL
SAND
SILT
CLAY
ORGANIC CONTENT
FROZEN GROUND
WATER LEVEL
THERMISTOR
3 INCH O.D. SPLIT SPOON SAMPLE
3 IN. O.D. DRY CORE RUN
BORING LOG B-1
NAME: 1600 CORDWOOD DRIVE
LOCATION: NEAR SW CORNER OF HOUSE
PAGE: 1 OF 2
DATE: JUNE 30, 1992
PERMAFROST TECHNOLOGY FOUNDATION

FIGURE A-1a

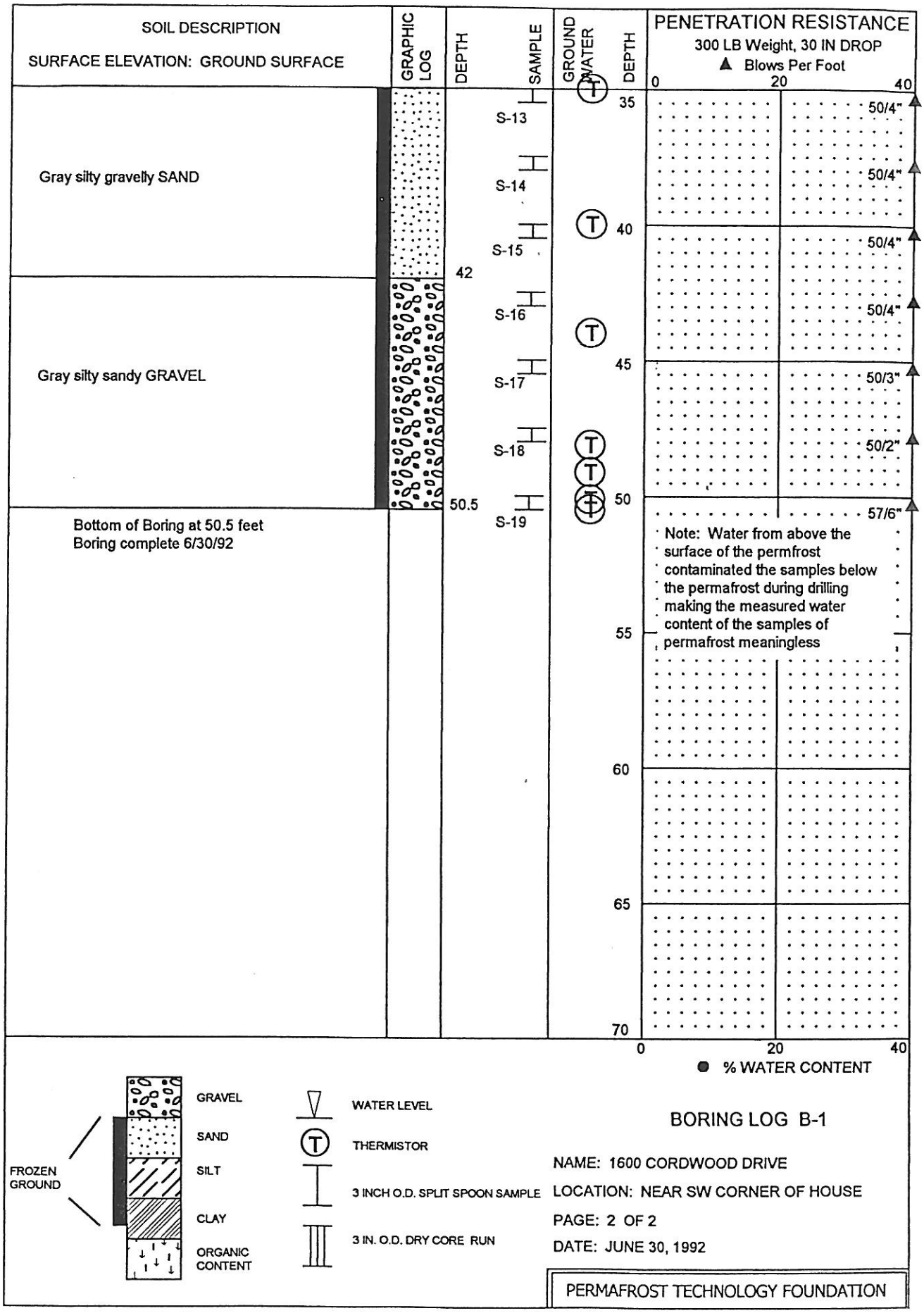
SOIL DESCRIPTION
SURFACE ELEVATION: GROUND SURFACE
GRAPHIC LOG
DEPTH
SAMPLE
GROUND WATER
DEPTH
PENETRATION RESISTANCE
300 LB Weight, 30 IN DROP
▲ Blows Per Foot
0
20
40
Gray silty gravelly SAND
Gray silty sandy GRAVEL
Bottom of Boring at 50.5 feet
Boring complete 6/30/92
S-13
S-14
S-15
S-16
S-17
S-18
S-19
42
50.5
35
40
45
50
55
60
65
70
50/4"
50/4"
50/4"
50/4"
50/3"
50/2"
57/6"
Note: Water from above the surface of the permfrost contaminated the samples below the permafrost during drilling making the measured water content of the samples of permafrost meaningless
0
20
40
% WATER CONTENT
GRAVEL
SAND
SILT
CLAY
ORGANIC CONTENT
FROZEN GROUND
WATER LEVEL
THERMISTOR
3 INCH O.D. SPLIT SPOON SAMPLE
3 IN. O.D. DRY CORE RUN
BORING LOG B-1
NAME: 1600 CORDWOOD DRIVE
LOCATION: NEAR SW CORNER OF HOUSE
PAGE: 2 OF 2
DATE: JUNE 30, 1992
PERMAFROST TECHNOLOGY FOUNDATION

FIGURE A1b

Appendix B
Level Measurements

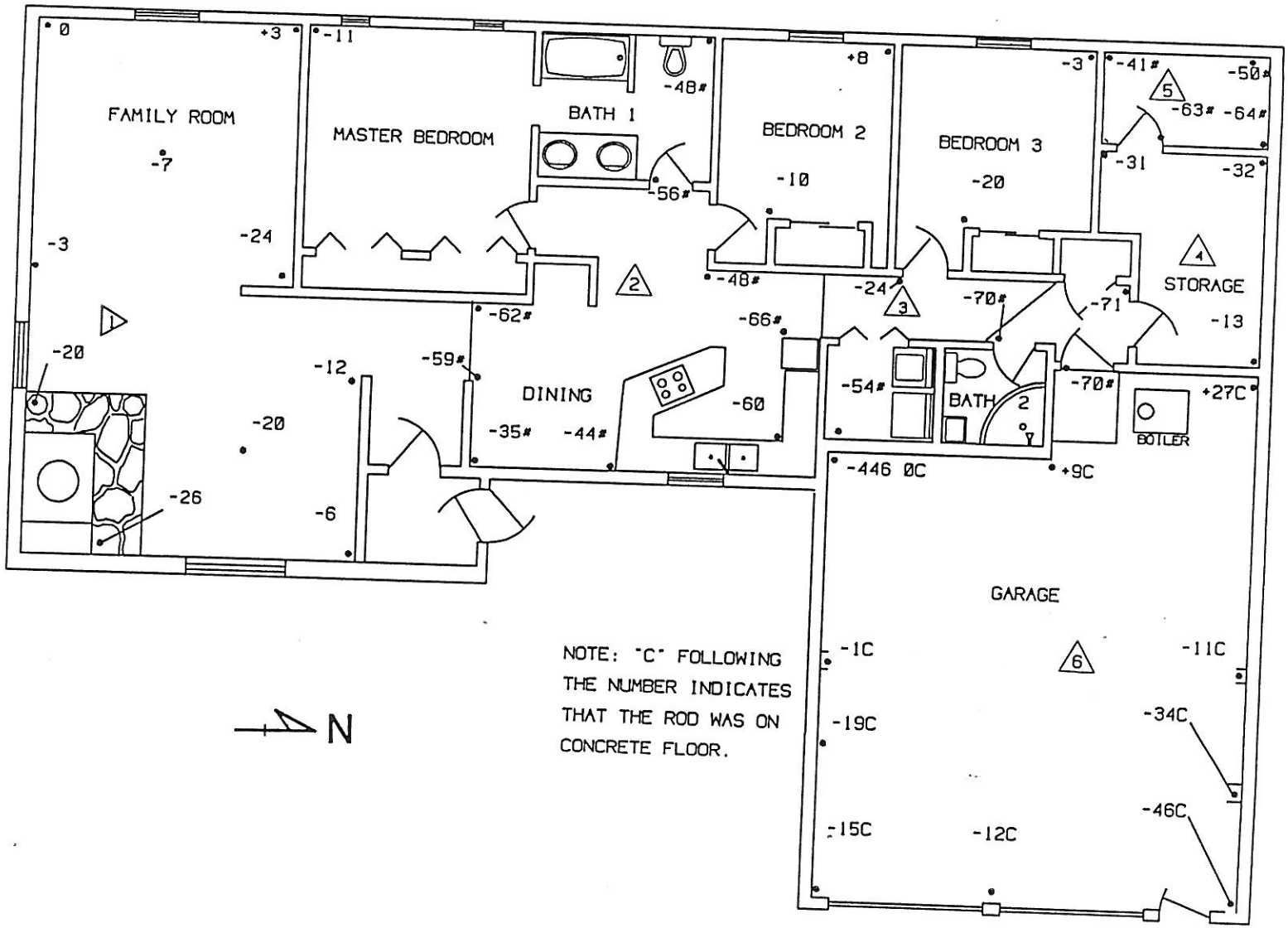

FIGURE B-1 – FLOOR PLAN OF HOUSE ON CORDWOOD DRIVE
SHOWING LOCATIONS OF LEVEL MEASUREMENTS

Elevation Measurements for House on Cordwood

Note: All measurements in mm relative to point A

Point	Date 5/27/91	2/5/92	4/22/92	6/25/92	10/11/92	11/14/92	12/19/92	2/20/93	3/21/93
A	0	0	0	0	0	0	0	0	0
B	3	-4	-3	-1	-3	-5	-1	-1	-3
C	-7	-6	-4	-4	-8	-8	-6	-9	-9
D	-24	-21	-9	-18	-20	17	-24	-26	-25
E	-62	-25	-23	-22	-25	-22	-25	-29	-30
F	-59	-20	-19	-19	-23	-17	-22	-25	-26
G	-12	-11	-9	-8	-10	-8	-10	-9	-11
H	-6	-8	-8	-11	-8	-6	-3	-15	-6
I	-20	-8	-15	-16	-13	-13	-11	-15	-17
J	-26	16	18	17	12	12	12	12	10
K	-20	26	26	-2	21	18	21	20	16
L	-3	-1	-6	9	-5	1	1	-2	-3
M	-11	-13	-10	-10	-13	-16	-13	-16	-14
N	-48	-11	-8	-8	-13	-17	-13	-9	-9
O	-56	-17	-16	-15	-21	-24	-21	-24	-24
P	8	8		9	4	0	3	4	3
Q	-10	-13	-9	-10	-13	-15	-16	-20	-18
R	-48	-17	-17	-17	-22	-26	-24	-28	-27
S	-24	-25	-22	-18	-24	-30	-25	-28	-28
T	-66	-25	-24	-23	-28	-32	-29	-33	-33
U	-60	-21	-21	-19	-25	-29	-25	-29	-29
V	-44	-15	-15	-12	-19	-22	-19	-22	-21
W	-35	-7	-7	-4	-10	-14	-10	-14	-14
X	-20	-25	-19	-20	-24	-25	-22	-24	-26
Y	-3	-9	-3	-3	-4	-5	-7	-18	-9
Z	-71	-34	-34	-33	-37	-40	-37	-40	-40
AA		-26	-24	-27	-23	-33	-24	-34	-35
AB	-70	-34		-32	-36	-41	-36	-38	-39
AC	-54	-16	-17	-16	-18	-21	-17	-21	-22
AD	-70	-20	-19	-21	-15	-26	-17	-26	-29
AE	-31	-33		-33		-40	-26	-39	-41
AF	-63	-35	-38	-40	-38	-49	-35	-34	-49
AG	-32	-33	-33	-34	-27	-39	-31	-40	-41
AH	-13	-30	-31	-33		-631			-23
AI	-41	-6	-4	-3	-2	-12	1	-10	-14
AJ	-50	-19	-18	-15	-19	-34	-15	-26	-28
AK	-64	-29	-29	-27	-29	-38	-26	-35	-40
AL	-446	-407	-406	-409	-403	-412	-406	-414	-415
AM	-437	-398	-398	-405	-399	-404	-397	-409	-410
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AR	-458	-417	-417	-421	-416	-424	-417	-426	-428
AS	-461	-420	-419	-423	-421	-421	-419		-428
AT	-465	-412	-410	-415	-409	-415	-410	-419	-418
AU	-447	-411	-401	-409	-399	-406	-404	-414	-411

TABLE B-1

Elevation Measurements for House on Cordwood

Note: All measurements in mm relative to point A

Point	Date 5/7/93	10/21/93	12/8/93	1/27/94	4/1/94	8/4/94	10/16/94	5/19/95	7/16/95
A	0	0	0	0	0	0	0	0	0
B	-3	-1	-2	-6	-9	-6	-6	-1	-5
C	-7	-4	-9	-13	-8	-10	-12	-5	-9
D	-24	-20	-24	-27	-25	-22	-20	-11	-14
E	-29	-25	-29	-34	-30	-28	-18	-23	-27
F	-26	-24	-26	-30	-26	-26	-18	-22	-25
G	-12	-9	-13	-16	-13	-12	-18	-9	-9
H	-8	-2	-8	-11	-6	-7	-13	-4	-8
I	-13	-13	-20	-21	-14	-15	-18	-11	-14
J	12	13	9	6	10	10	12	16	11
K	19	19	15	13	17	16	12	21	17
L	-4	0	-3	-6	-2	-3	0	5	2
M	-16	-4	-3	-11	-8	-9	-14	-6	-13
N	-10	-16	-17	-22	-18	-18	-19	-12	-14
O	-26	-21	-25	-29	-25	-24	-26	-20	-22
P	0	9	7	-1	1	-3	-4	6	3
Q	-20	-12	-13	-20	-19	-18	-20	-12	-17
R	-27	-24	-26	-32	-27	-26	-29	-20	-23
S	-29	-24	-27	-33	-31	-29	-28	-24	-24
T	-33	-29	-33	-37	-34	-31	-34	-28	-31
U	-29	-26	-30	-34	-31	-28	-34	-24	-27
V	-23	-20	-22	-27	-23	-18	-17	-16	-19
W	-15	-11	-14	-19	-16	-13	-21	-8	-11
X	-27	-22	-25	-31	-30	-29	-31	-22	-29
Y	-14	-8	-7	-13	-10	-14	-13	-7	-5
Z	-40	-38	-41	-45	-40	-37	-43	-38	-41
AA	-34	-28	-29	-34	-34	-31	-34	-29	-33
AB	-38	-37	-41	-45	-41	-40	-43	-35	-40
AC	-21	-19	-24	-26	-22	-21	-26	-16	-23
AD	-29	-23	-23	-26	-25	-24	-32	-22	-26
AE	-41	-34	-36	-41	-38	-37	-46	-29	-33
AF	-50	-44	-31	-50	-46	-41	-51	-40	-45
AG	-42	-36	-25	-39	-31	-41	-37	-34	-38
AH		-20	-19	-23	-19	-21	-34	-26	-28
AI	-10	-11	-6	-21	-9	-18	-19	-7	-12
AJ	-27	-26	-23	-36	-23	-28	-29	-30	-25
AK	-37	-37	-33	-46	-38	-38	-42	-34	-39
AL	-416	-412	-411	-412	-411	-411	-419	-409	-416
AM	-409	-406	-403	-406	-406	-407	-414	-400	-406
AN	-399	-387	-391	-393	-394	-389	-399	-399	-398
AO	-419	-428	-406	-426	-428	-419	-438	-438	-428
AP	-447	-454	-440	-450	-450	-449	-461	-453	-459
AQ	-462	-463	-457	-450	-460	-463	-469	-463	-469
AR	-429	-423	-422	-423	-424	-425	-429	-427	-426
AS	-432	-427	-426	-425	-425	-427	-439	-425	-431
AT	-422	-417	-415	-416	-418	-419	-421	-414	-431
AU	-412	-408	-411	-411		-415	-417	-406	-412

TABLE B-1

Elevation Measurements for House on Cordwood

Note: All measurements in mm relative to point A

Point	Date 2/10/96	7/2/96	10/22/96	12/19/96	2/10/97
A	0	0	0	0	0
B	-4	-3	-6	-9	-8
C	-8	-7	-9	-13	-13
D	-13	-12	-24	-20	-24
E	-26	-25	-27	-29	-30
F	-21	-23	-24	-26	-25
G	-9	-8	-10	-14	-9
H	-4	-3	-7	-11	-7
I	-12	-18	-17	-18	-18
J	11	14	12	11	10
K	19	10	19	15	18
L	-4	-3	-4	-7	-7
M	-6	-15	-8	-14	-10
N		-14	-16	-19	-20
O		-22	-22	-24	-25
P	9	4	7	4	4
Q	-15	-12	-16	-19	-17
R	-22	-20	-19	-23	-26
S	-24	-25	-25	-29	-29
T	-31	-30	-29	-34	-34
U	-28	-26	-25	-30	-32
V	-19	-19	-19	-22	-23
W	-9	-10	-9	-14	-13
X	-24	-28	-26	-27	-27
Y	-4	-9	-5	-5	-6
Z	-38	-39	-39	-41	-42
AA	-30	-31	-31	-34	-33
AB	-37	-38	-38	-41	-41
AC	-20	-20	-20	-22	-23
AD	-25	-24	-24	-28	-27
AE	-32	-31	-37	-41	-39
AF	-33	-43	-46	-47	-47
AG	-27	-34	-30	-37	-35
AH	-25	-19	-25	-27	-26
AI	-11	-7	-22	-18	-14
AJ	-28	-30	-36	-36	-32
AK	-33	-35	-43	-39	-36
AL	-412	-412	-412	-416	-412
AM	-405	-404	-405	-408	-405
AN	-394	-395	-390	-395	-392
AO	-427	-427	-427	-430	-428
AP	-440	-454	-455	-453	-453
AQ	-445	-467	-462	-459	-456
AR	-418	-431	-429	-429	-425
AS	-408	-430	-430	-428	-425
AT	-411	-414	-422	-420	-417
AU	-409	-412	-407	-414	-410

TABLE B-1

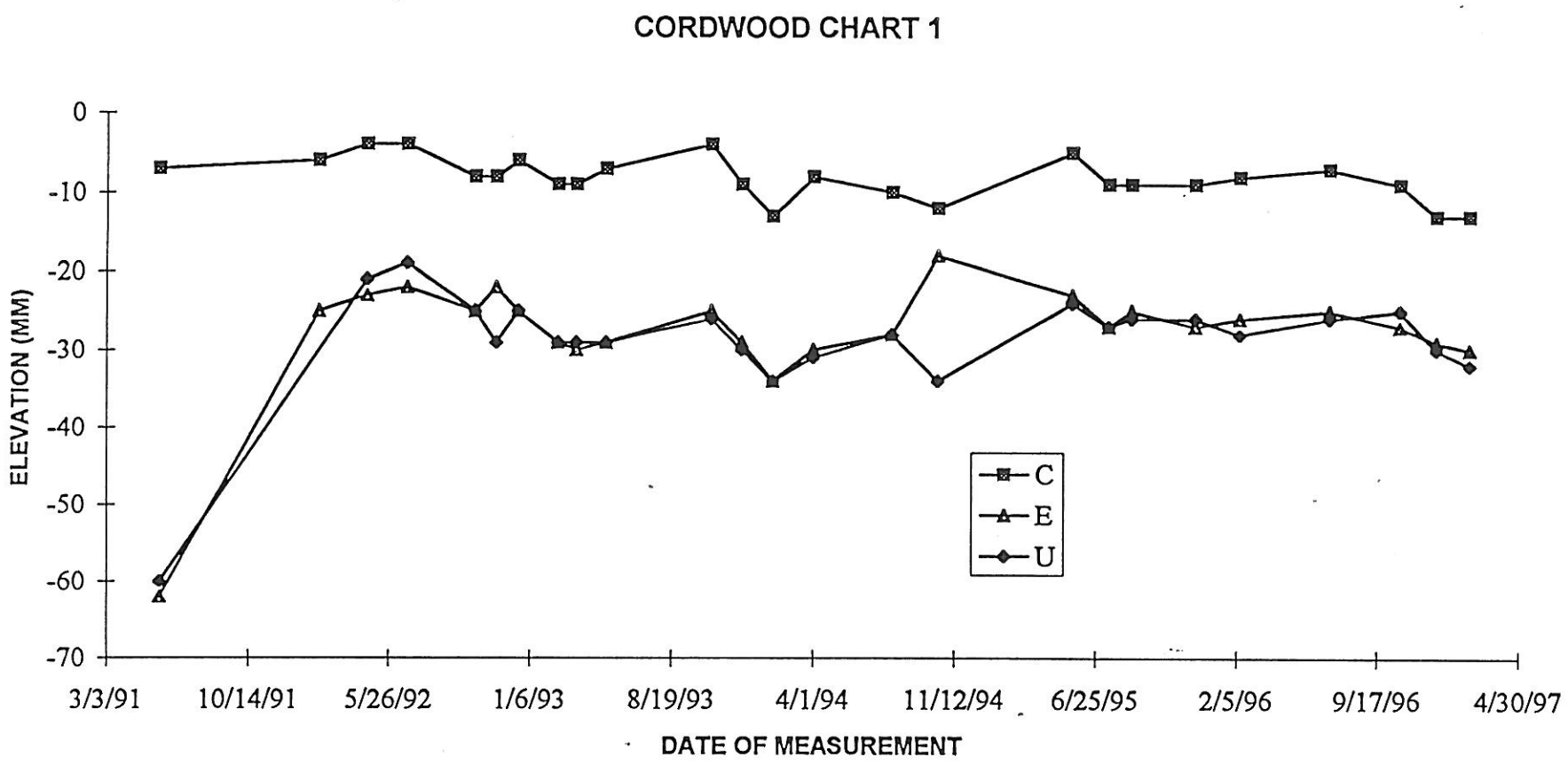

CORDWOOD CHART 1
0
-10
-20
-30
-40
-50
-60
-70
ELEVATION (MM)
3/3/91
10/14/91
5/26/92
1/6/93
8/19/93
4/1/94
11/12/94
6/25/95
2/5/96
9/17/96
4/30/97
DATE OF MEASUREMENT
C
E
U

FIGURE B-2

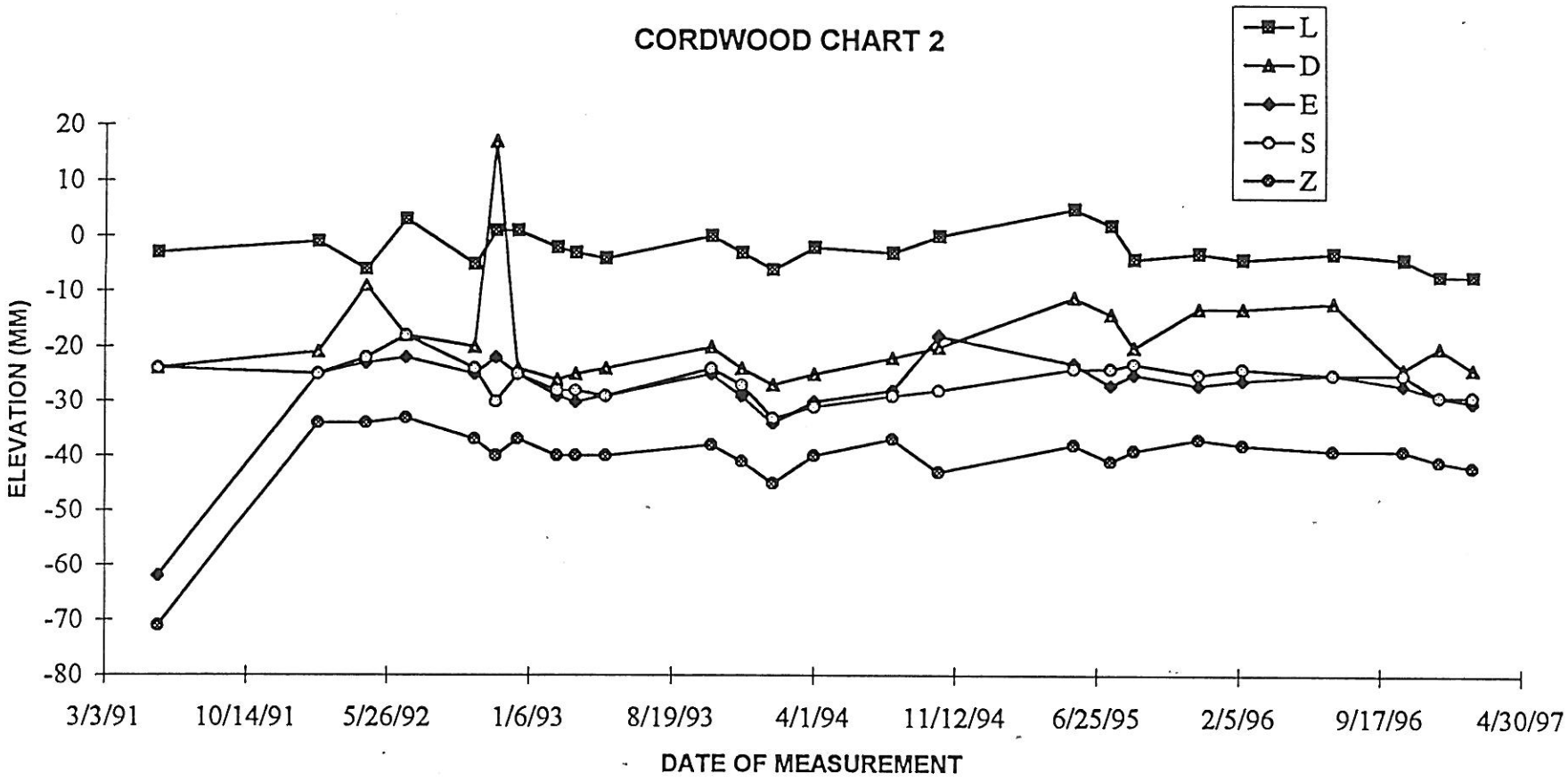

CORDWOOD CHART 2
L
D
E
S
Z
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
ELEVATION (MM)
3/3/91
10/14/91
5/26/92
1/6/93
8/19/93
4/1/94
11/12/94
6/25/95
2/5/96
9/17/96
4/30/97
DATE OF MEASUREMENT

FIGURE B-3

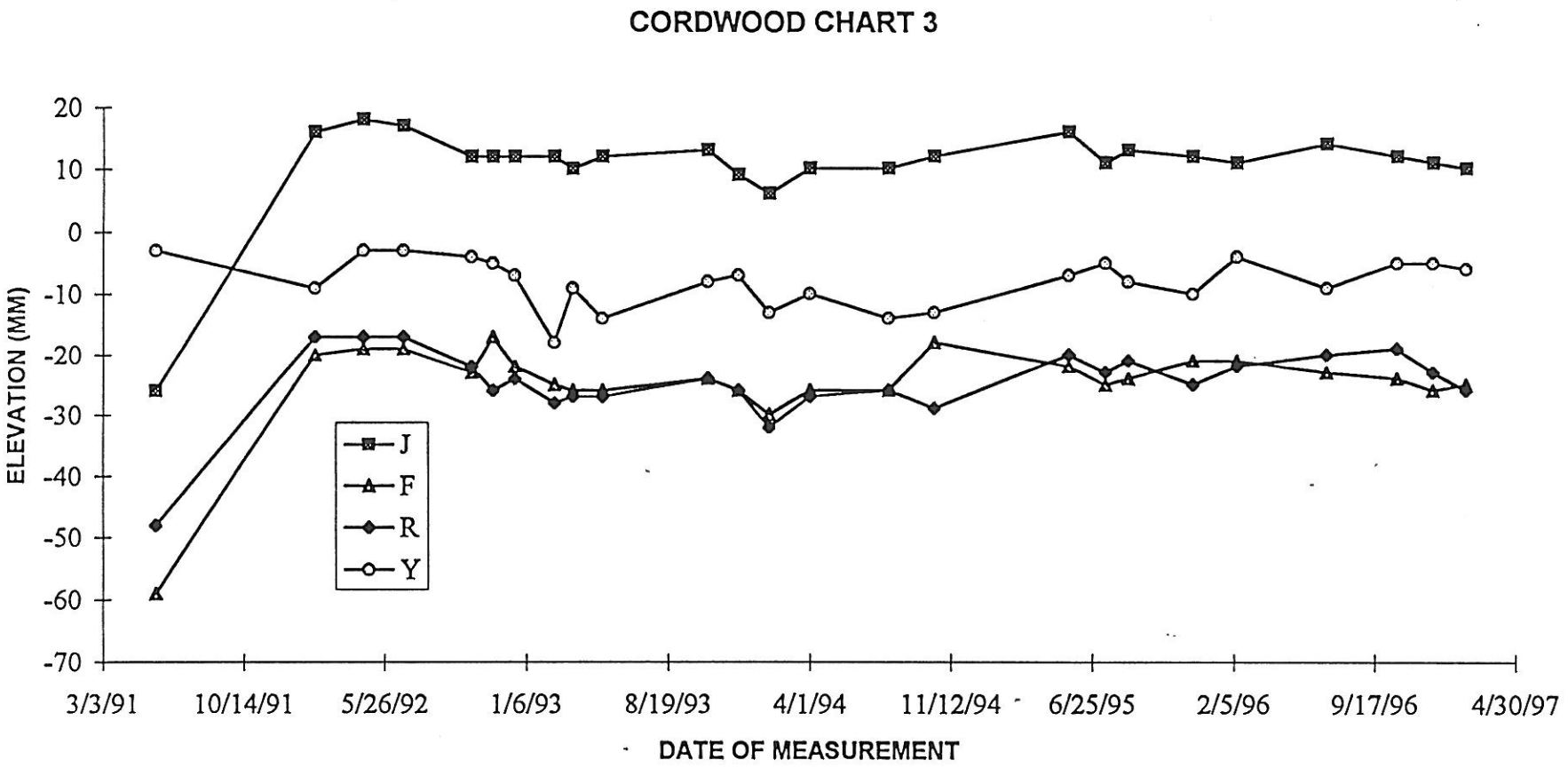

CORDWOOD CHART 3
ELEVATION (MM)
20
10
0
-10
-20
-30
-40
-50
-60
-70
J
F
R
Y
3/3/91
10/14/91
5/26/92
1/6/93
8/19/93
4/1/94
11/12/94
6/25/95
2/5/96
9/17/96
4/30/97
DATE OF MEASUREMENT

FIGURE B-4

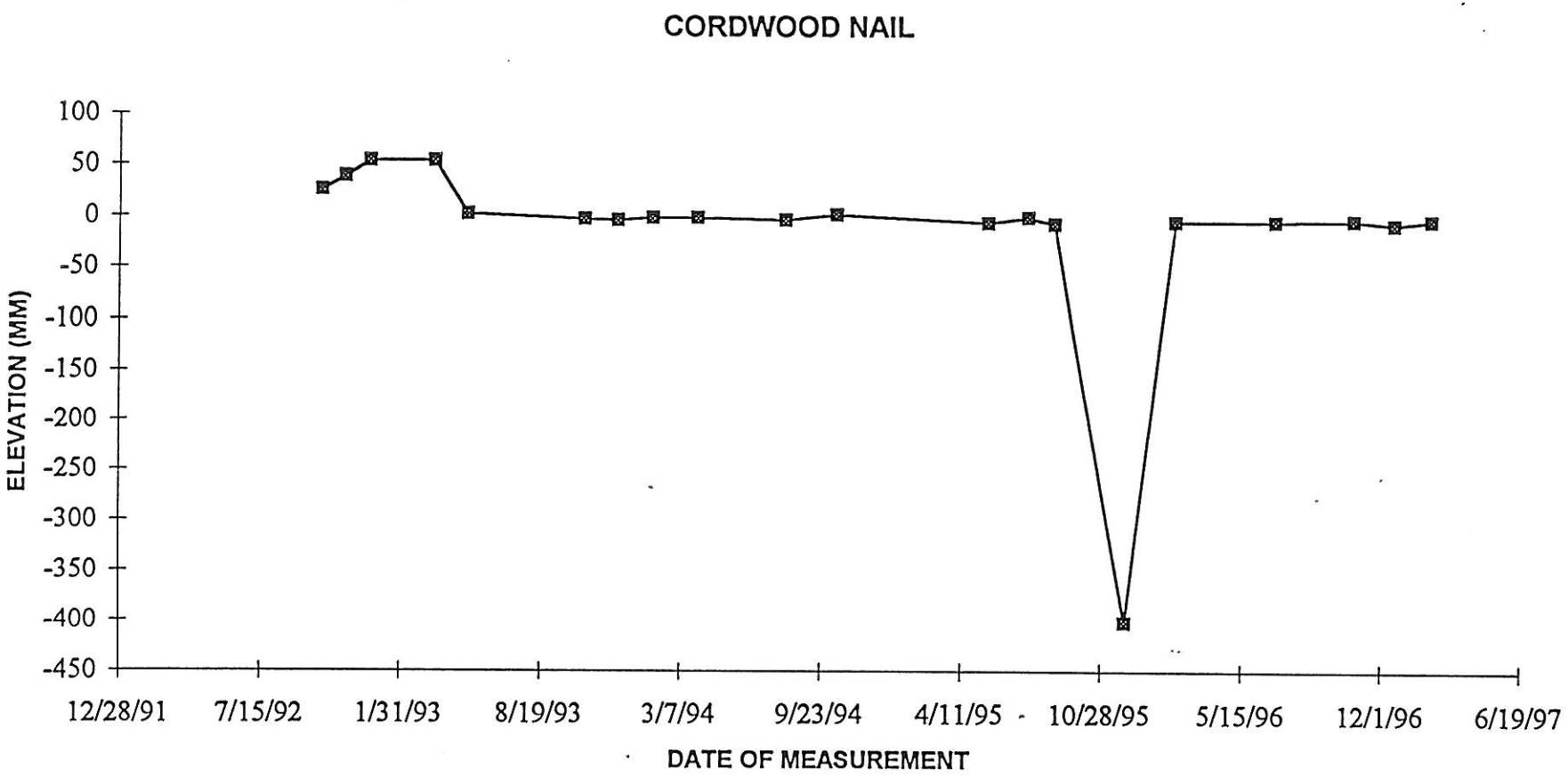

CORDWOOD NAIL
100
50
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
ELEVATION (MM)
12/28/91
7/15/92
1/31/93
8/19/93
3/7/94
9/23/94
4/11/95
10/28/95
5/15/96
12/1/96
6/19/97
DATE OF MEASUREMENT

FIGURE B-5

Appendix C
Temperature Measurements

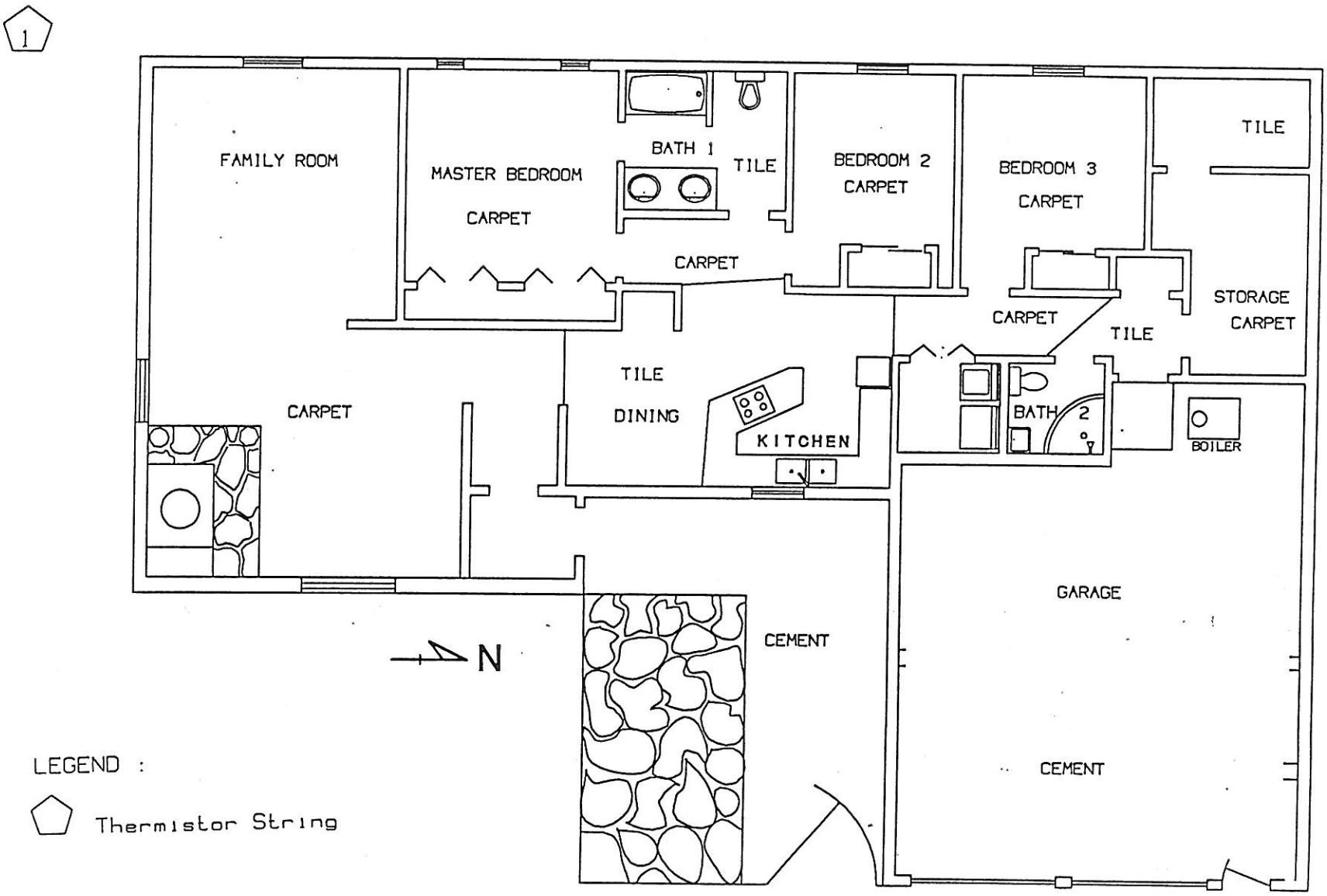


FIGURE C-1 – FLOOR PLAN OF HOUSE ON CORDWOOD DRIVE
SHOWING LOCATIONS OF THERMISTOR STRINGS

Temperature Data from String 1 at the House on Cordwood

	Date															
Depth - ft	Data In Degrees C															
	8/6/92	8/27/92	9/10/92	10/9/92	11/17/92	12/6/92	1/9/93	2/10/93	2/28/93	3/12/93	3/28/93	4/4/93	6/8/93	6/24/93	10/14/93	11/28/93
0.0	20.8	13.2	7.3	0.1	-1.3	-4.2	-1.7	-3.6	-1.7	-1.8	-1.2	-0.1	18.6	20.9	3.0	-0.6
-5.0	9.5	10.1	9.8	6.0	3.2	2.5	1.5	1.1	1.0	0.9	0.9	0.9	3.7	6.4	-3.5	-13.2
-10.0	3.9	5.2	5.7	5.6	4.0	3.3	2.4	1.9	1.7	1.7	1.6	1.5	1.6	2.1	4.9	3.6
-20.0	1.1	1.4	1.6	1.9	1.6	1.5	1.3	1.1	1.0	1.0	0.9	0.9	0.7	0.8	1.5	1.7
-30.0	0.2	0.1	0.2	0.3	0.3	0.3	0.3	0.2	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.3
-35.0	-0.1	-0.1	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	-0.1	-0.1	-0.1	-0.1	
-40.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.3	-0.1
-44.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2	-0.1
-48.0	-0.1	-0.1	-0.1	-0.2	-0.1	-0.2	-0.1	-0.1	-0.1	-0.2	-0.1	-0.1	-0.2	-0.2		-0.2
-49.0	-0.2	-0.2	-0.2	-0.3	-0.3	-0.3	-0.3	-0.2	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.5	-0.5
-50.0	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.7	-0.2
-50.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3	-0.4

	Date															
Depth - ft	1/27/94	4/1/94	5/18/94	6/21/94	8/23/94	11/7/94	3/19/95	5/19/95	7/16/95	10/2/96	10/25/96	11/15/96	12/5/96	12/19/96	1/17/97	2/10/97
0.0	-2.4	-0.5	9.8	13.9	-19.1	-2.9					-1.1	-1.7	-3.7	-3.4	-5.3	-4.9
-5.0	1.2	-0.5	0.5	2.4	10.3	-1.5	0.4	0.3	8.0	5.6	3.4	2.2	1.5	1.1	0.7	0.4
-10.0	2.2	1.5	1.3	1.4	4.3	-8.9	1.5	1.2	2.6	3.4	3.1	2.5	2.1	1.9	1.5	1.3
-20.0	1.5	1.1	0.9	0.8	0.9	1.0	1.1	0.8	0.7	0.9	1.0	1.1	1.1	1.1	1.0	0.9
-30.0	0.4	0.3	0.3	0.2	0.2		0.4	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.3	-0.3
-35.0	0.0	0.0	0.0	0.0	-0.5	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
-40.0	-0.1	-0.1	-0.1	-0.1	-0.4	-1.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
-44.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
-48.0	-0.1	-0.2	-0.1	-0.1		-0.3	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
-49.0	-0.3	-0.3	-0.3	-0.3	-0.4	-0.3	-0.2	-0.2		-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
-50.0	-0.2	-0.2	-0.2	-0.2		-0.3			-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
-50.3	-0.2	-0.2	-0.2	-0.2					-0.2	-0.2	-0.2	-0.2	-0.2			-0.2

TABLE C-1

Cdts1s.xlc

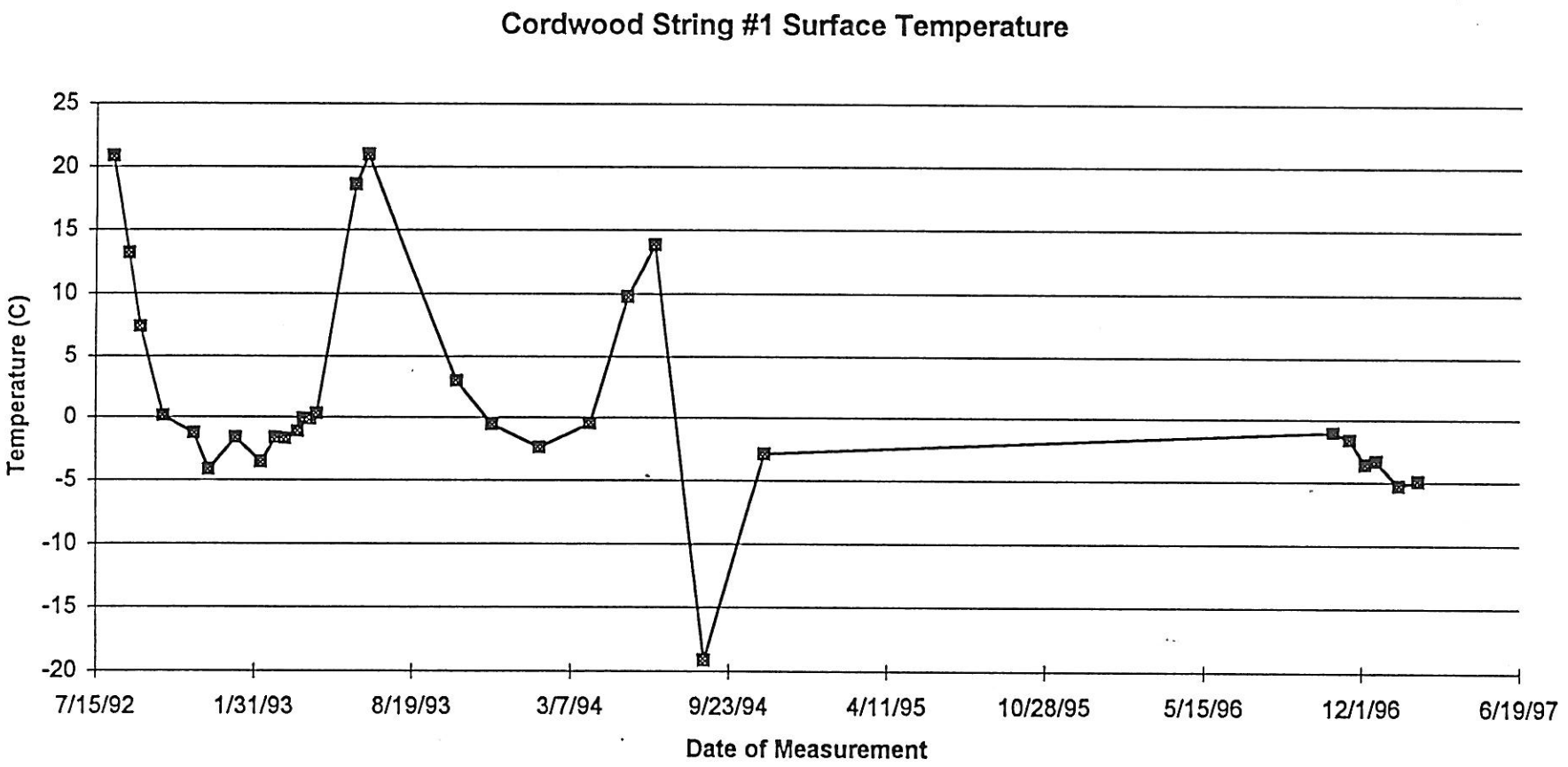


FIGURE C-2

Cdts1a.xlc

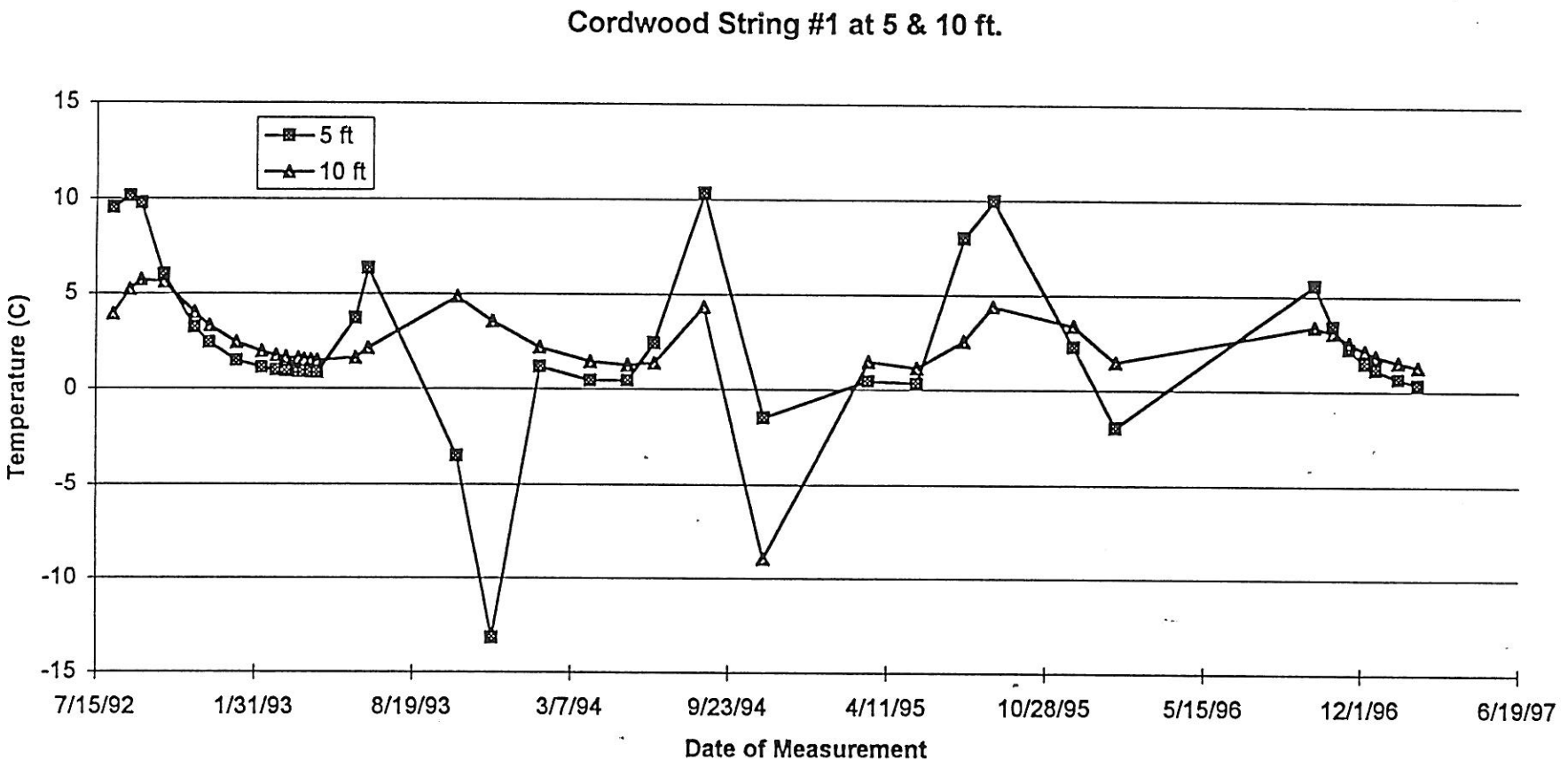


FIGURE C-3

Cdts1b.xlc

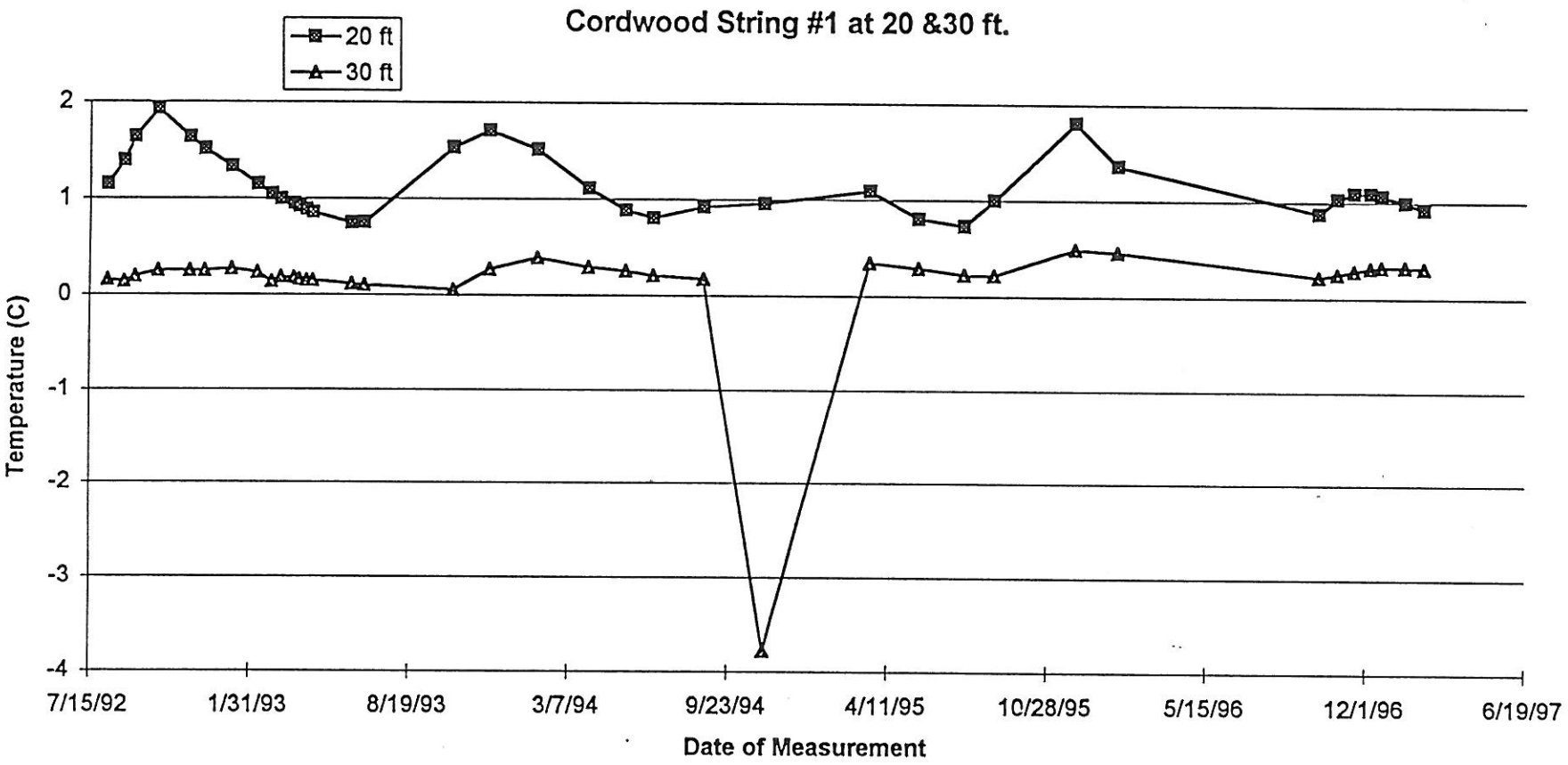


FIGURE C-4

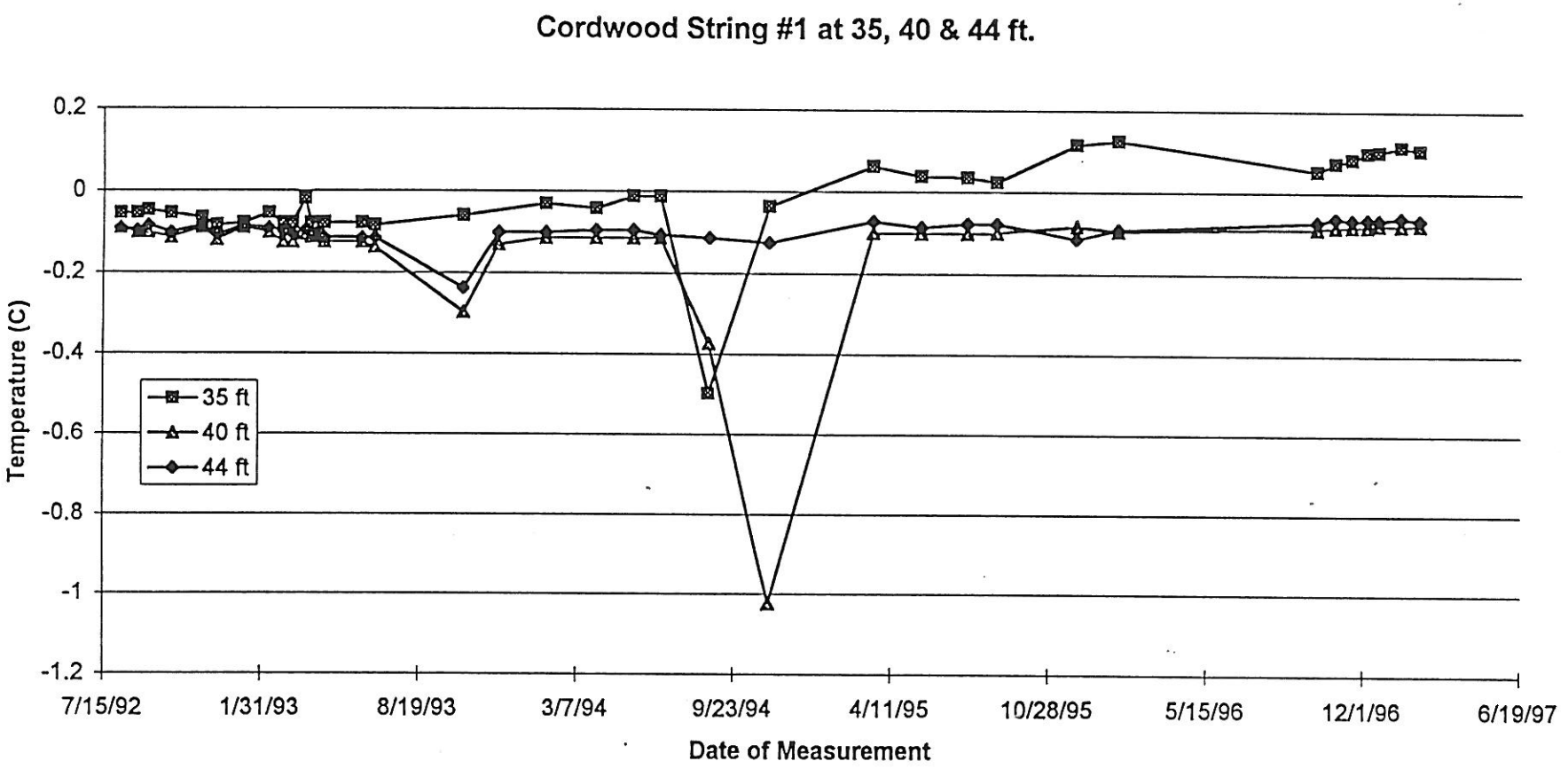

Cordwood String #1 at 35, 40 & 44 ft.
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
Temperature (C)
35 ft
40 ft
44 ft
7/15/92
1/31/93
8/19/93
3/7/94
9/23/94
4/11/95
10/28/95
5/15/96
12/1/96
6/19/97
Date of Measurement

FIGURE C-5

Cdts1d.xlc

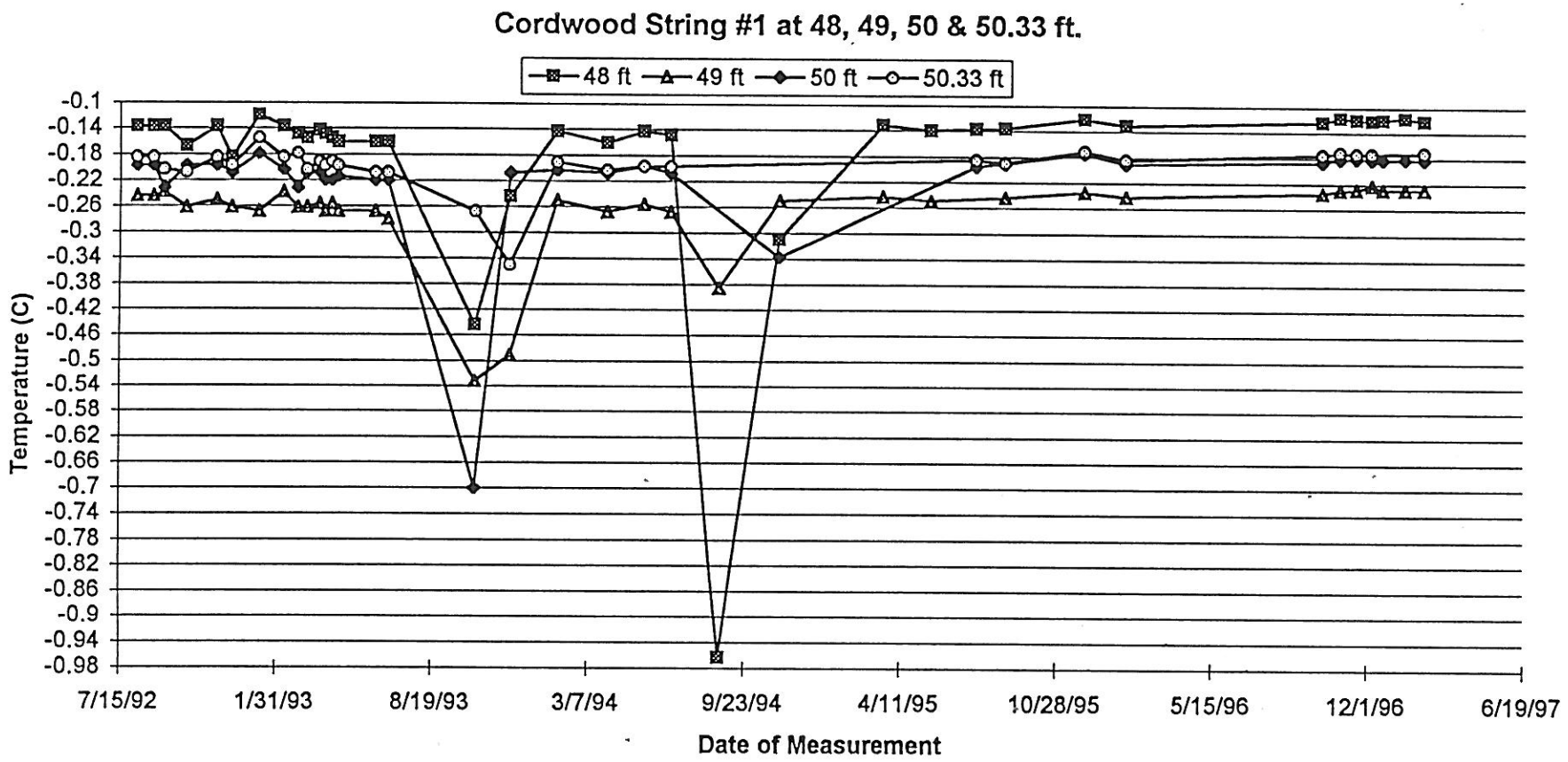


FIGURE C-6

Appendix D
Engineering Reports

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

September 6, 1989

Coldwell Banker
105 Adak Avenue
Fairbanks, Alaska 99701

Attn: Tom Hovenden

Re: AHFC #66149 (Banker)
MBS - No Pool
Lot 7 Block 7; North Shanley
1600 Cordwood Drive
Fairbanks, Alaska

Gentlemen:

As per your request, we inspected the above referenced property on August 31, 1989. We have the following comments with regard to that inspection.

EXISTING CONDITIONS

The existing structure is a single family, one story, wood frame dwelling constructed upon a poured concrete crawlspace foundation wall. The dwelling has an attached two car garage.

The dwelling contains approximately 1890 square feet of living area and is comprised of a large living room area with a rock fireplace, a dining/kitchen area, three bedrooms, two bathrooms, a laundry room, and

two utility rooms. The garage contains approximately 650 square feet of area. The oil forced air furnace is contained within the garage area. The house appears to be heated by a combination of forced air and electric baseboard heat.

The foundation consists of 6" poured concrete foundation walls with standard concrete footings. The bottom of footing is approximately 3 feet below the finished exterior ground surface. The exterior of the foundation wall is insulated with 2" of beadboard insulation for its entire depth.

The crawlspace area has an existing polyethylene moisture barrier on the ground surface, but it is in a state of disrepair.

The exterior walls of the dwelling appear to be of double wall or slightly greater than 2" X 6" construction. They are insulated with fiberglass insulation and have an interior vapor barrier. The windows are of double pane construction. The exterior of the dwelling is finished with wood beveled siding.

The roof is of gable design and finished with three tab composition shingles. The roof is constructed of what appears to be homemade trusses at 16" on center. It is insulated with a combination of fiberglass batt and loose fiber insulation for an approximate total R value of 35.

Some of the items mentioned can be seen on the enclosed photos.

DISCREPANCIES FOUND AND RECOMMENDED SOLUTIONS

Item 1

The existing three member, 2" X 10", floor support beam that is located within the crawlspace area has considerable dry rot at its northernmost end. This can be seen on the enclosed Photo #11. We could find no obvious cause, but the lack of an adequate crawlspace moisture barrier may be a contributing factor.

We recommend that approximately 12 feet of this beam, at its northernmost end, be removed and replaced. This beam should be replaced with a three member 2" X 10", D.F. #2 or better, built-up beam. All solid wood blocking installed to support this beam upon the existing concrete pillars should be treated wood (see Drawing #1).

Item 2

The existing three member 2" X 10" floor beam is currently spanning up to 13 feet in some areas. Those spans are excessive for the existing beam. Calculations using design loading values of 40 pounds per square foot (psi) live loading and 10 psf dead loading also indicate that the existing column footings are placing excessive pressure on the crawlspace ground surface.

We, therefore, recommend that additional column footings and columns be constructed to adequately support the existing floor beam. These new footings should be constructed midway between all existing footing locations. This would require the construction of 6 support footings. The new footings should be 2' X 2' X 8" poured concrete with three #4 rebar each way. The existing ground should be compacted prior to the installation of these footings. Column support posts at the new footing locations should be constructed of three 2" X 6" treated wood members adequately fastened together. This column should be fastened to the built-up floor beam with plywood gussets on both sides.

The entire floor beam should be leveled during this footing installation and all existing wood blocking at the existing concrete pier locations should be replaced with treated wood blocking.

Item 3

The existing crawlspace ground surface does have a partial polyethylene moisture barrier. But, this moisture barrier is in a state of disrepair. The existing crawlspace ground surface is also quite littered with miscellaneous construction debris. Abandoned sewer waste lines are also still remaining within the crawlspace.

We recommend that all debris, abandoned waste lines, and miscellaneous junk be removed from the crawlspace area. The existing polyethylene layer can remain and need not be discarded. The existing larger sheets of beadboard insulation should be adequately fastened to the exterior foundation walls with construction adhesive and should not be discarded.

No additional beadboard insulation needs to be installed. The floor joists end cavities at the rim joist should be insured to be adequately insulated with 6 inches of fiberglass insulation.

We also recommend that the crawlspace ground surface be somewhat leveled, especially at the outer walls and corners to allow for the installation of a moisture barrier.

A new 6 mil polyethylene moisture barrier should be installed on the entire crawlspace ground surface when all other work is completed within this area.

Item 4

The existing roof trusses appear to be homemade and are installed at 16" O.C. Both top and bottom chords are of 2" X 6" lumber. Metal gusset plates have been installed. The garage trusses were not accessible and are assumed to be similar to those over the house portion of the dwelling. Calculations using design loading values of 40 pounds per square foot (psf) and 10 psf dead load indicate that these trusses are, in general, adequate. But, the large overhang portion of the roof covering the front patio area does need some additional support.

We recommend that the trusses at the large roof overhang over the front patio area be modified as per the enclosed Drawing No. 2. The existing roof trusses are cantilevered approximately 8½ feet over the patio in this area. Two 2" X 4" web members should be installed at each existing truss in this area. Approximately 26 trusses should be modified (see attached Drawing #2).

Item 5

The existing ground surface around the perimeter of the dwelling is at the level of the bottom of the exterior wood siding in some areas. In some areas the immediate surrounding ground is also sloping towards the building.

It was noted previously that the existing concrete foundation footing is approximately 36 inches below ground level. The recommended depth is 42 inches to prevent movement due to freezing below the footing. We did not find any problem with the existing foundation, but we do recommend keeping the ground as dry as possible.

We, therefore, recommend grading around the North, West, and South sides of the house to provide adequate drainage away from the structure. The earth should be placed no closer than 3 inches to the bottom of the wood siding and sloped to drain away from the building. A 6 inch clearance below the bottom of untreated wood is desirable, but would be very difficult to attain around this structure.

This regrading will require the removal of trees and debris from the North side of the garage. The regrading should allow for drainage away from the building for a distance of 15 feet or more.

The ground surface on the West side (back) of the house is somewhat irregular. Major regrading is not required, but the irregularities should be filled in with topsoil and smoothed.

All other excavated material can be disposed of within the property limits if it does not hinder site drainage. Otherwise, the excavated material should be removed from the property.

The existing trees in the front yard should remain.

Item 6

During our inspection, we noticed haphazard electrical wiring laying in the crawlspace area. This can be seen on the enclosed Photo #13.

This may or may not be a problem but we would recommend that a qualified electrician inspect and comment on the existing wiring.

CONCLUSION

A summary of our recommended repairs to the referenced dwelling is as follows:

1. Remove and replace approximately 12 feet of the existing floor beam located within the crawlspace area. Replace with a 3 member 2" X 10", D.F. #2 or better built-up beam. All joints to be centered at column locations.

2. Install six (6) 2' X 2' X 8" concrete column footings with three #4 rebar each way. Install a three 2" X 6" member, treated wood, column at new footings to support floor beam. Level the entire floor beam and install treated wood blocking at all existing pier locations.

3. Clean debris from crawlspace area and remove abandoned plumbing lines. Fasten existing beadboard insulation to foundation wall with construction adhesive. No additional insulation need be added. Insure that floor joist end cavities are insulated with six inches of fiberglass insulation. Level the existing crawlspace ground surface and install a new 6 mil polyethylene moisture barrier on the entire ground surface.

4. Install additional web members in the roof trusses at the large overhang above the front patio area, as per Drawing No. 2.

5. Regrade the surrounding ground surface on the North, East and South sides of the structure to provide positive drainage away from the building. Fill in the low areas on the West side of the structure.

6. Have the electrical wiring inspected by a qualified electrician.

All of the above construction shall conform to standard practice and the Uniform Building Code.

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 the contractor encounters more structural problems during construction, he should contact us for our 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.

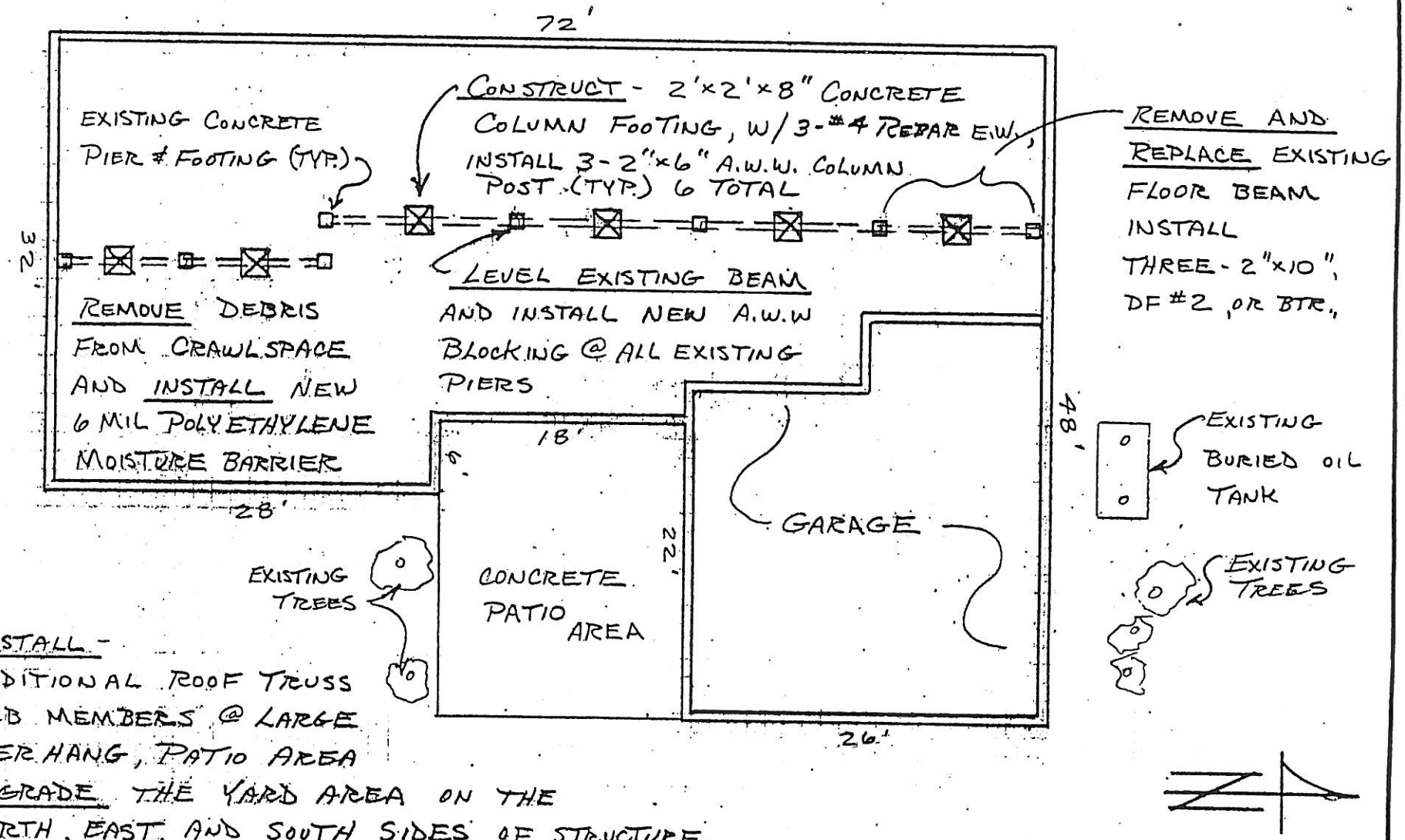
Prior to commencing work, the contractor should contact us to set up an inspection schedule. It is the responsibility of the contractor to contact us as work progresses, so that we can inspect items being repaired. Repairs should not be covered before inspection.

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

Sincerely,

STUTZMANN ENGINEERING ASSOC., INC.

Scott E. Wortman, P.E.
52/b



INSTALL -
ADDITIONAL ROOF TRUSS WEB MEMBERS @ LARGE OVER HANG, PATIO AREA

REGRADE THE YARD AREA ON THE NORTH, EAST AND SOUTH SIDES OF STRUCTURE FILL IN HOLES ON WEST SIDE.

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

A.H.F.C. # 66149 (BANKER)

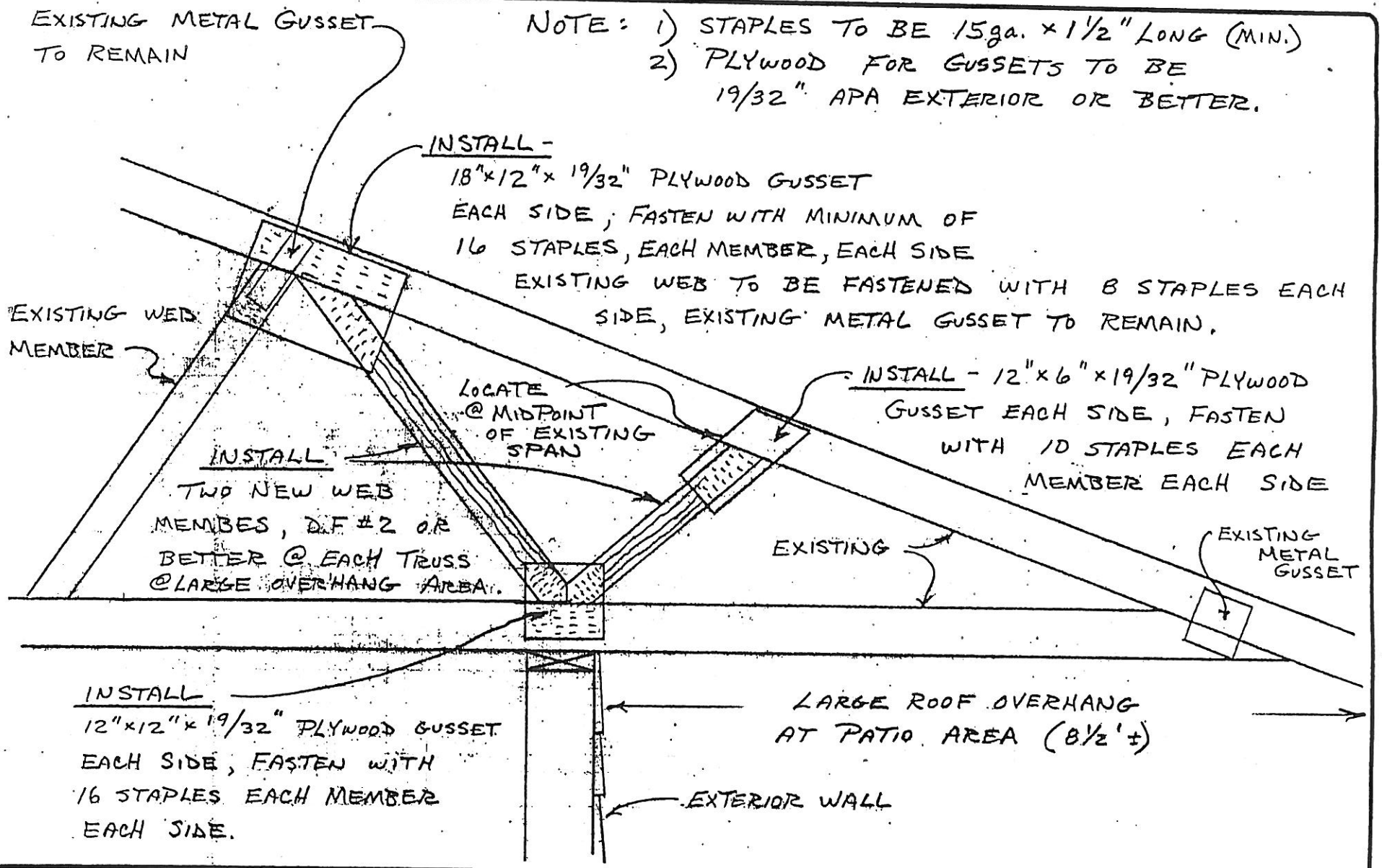
REPAIR OVER VIEW

FOR: COLDWELL BANKER / AHFC.

DRAWN BY: JHA
DATE: 9/5/89
SCALE: 3/32" = 1'
REVISED:

DRAWING NUMBER 1

NOTE: 1) STAPLES TO BE 15ga. x 1½" LONG (MIN.)
2) PLYWOOD FOR GUSSETS TO BE 19/32" APA EXTERIOR OR BETTER.



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

A.H.F.C. # 66149 (BANKER)
ROOF TRUSS MODIFICATION AT LARGE OVERHANG
FOR: COLDWELL BANKER / A.H.F.C.

DRAWN BY: JHA
DATE: 9/7/89
SCALE: ¾"=1'
REVISED:

DRAWING NUMBER 2

PHOTO #1: FRONT OF HOUSE AT 1600 CORDWOOD DRIVE.

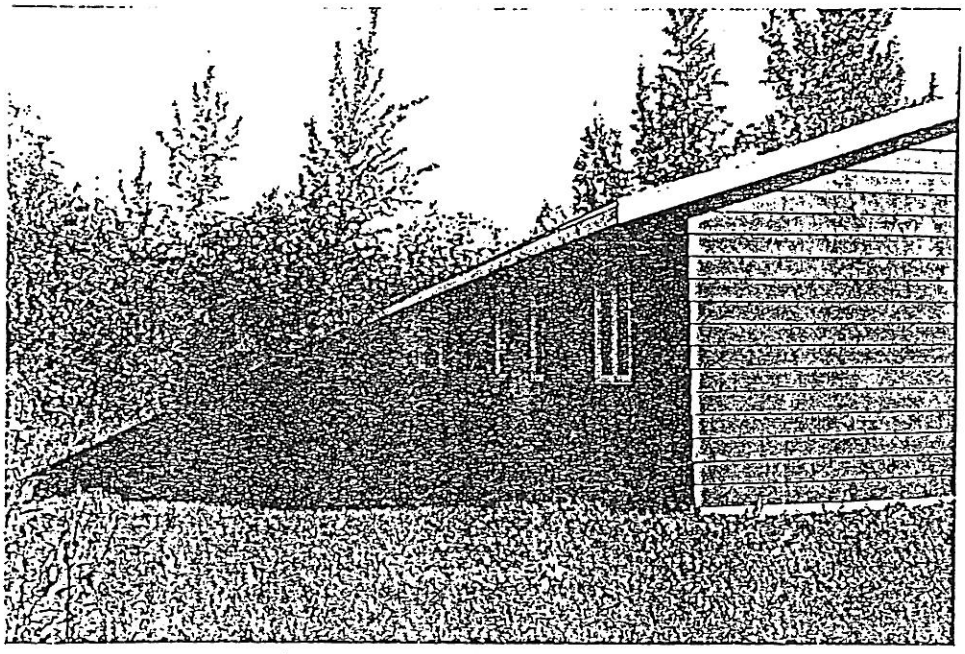


PHOTO #2: BACK OF HOUSE AT 1600 CORDWOOD DRIVE.

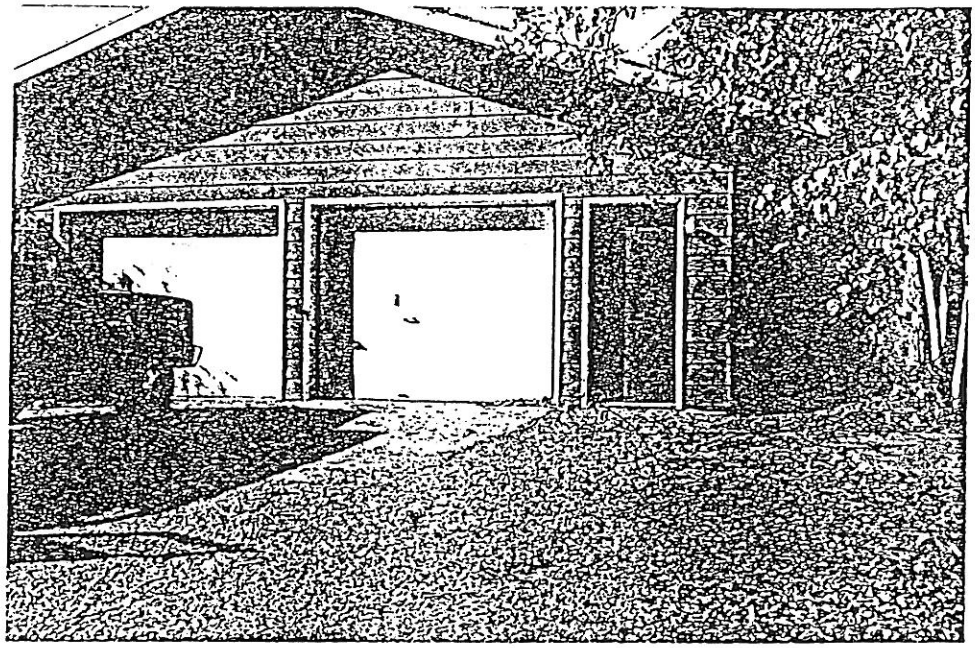


PHOTO #3: GARAGE AND APRON AREA.

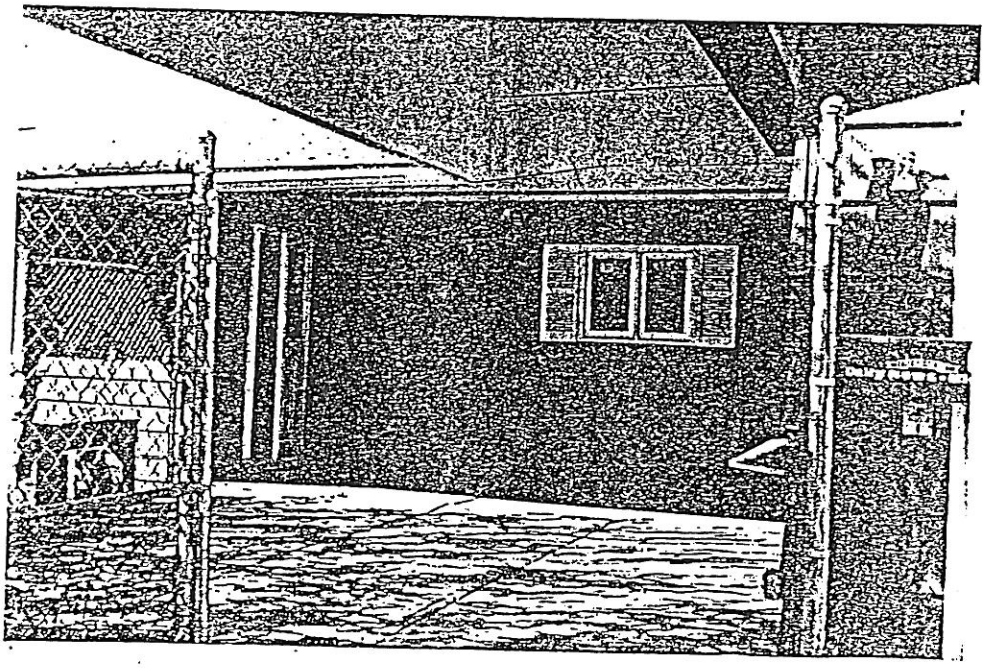


PHOTO #4: FRONT ENTRY DOOR AND PATIO.

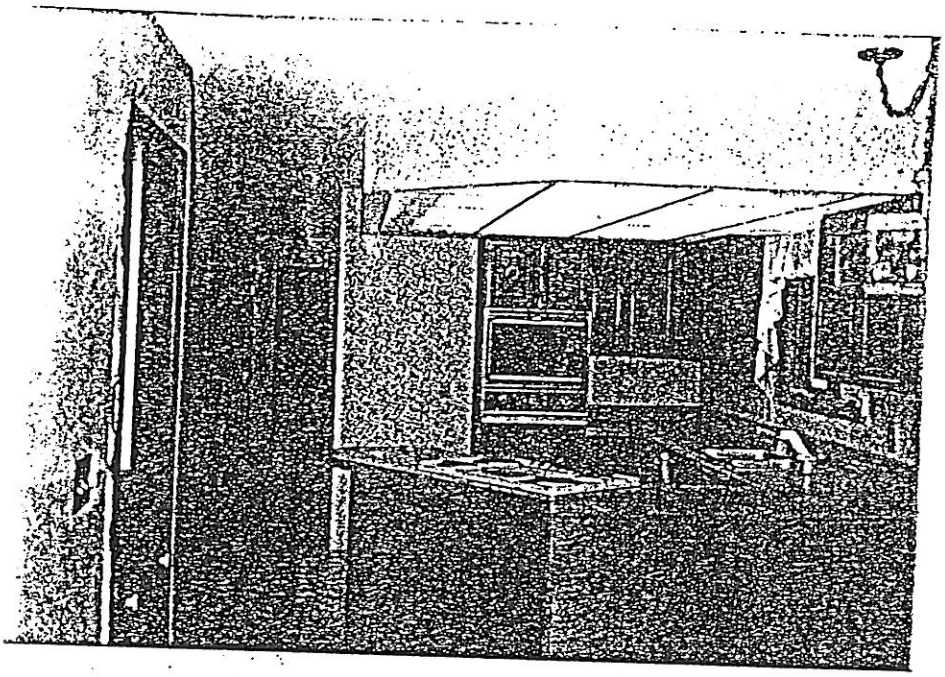


PHOTO #5: KITCHEN AREA, HALLWAY TO BEDROOMS, BATHROOMS AND GARAGE AREA IS AT LEFT. PHOTO TAKEN FROM HALLWAY AT THE ENTRY AREA.

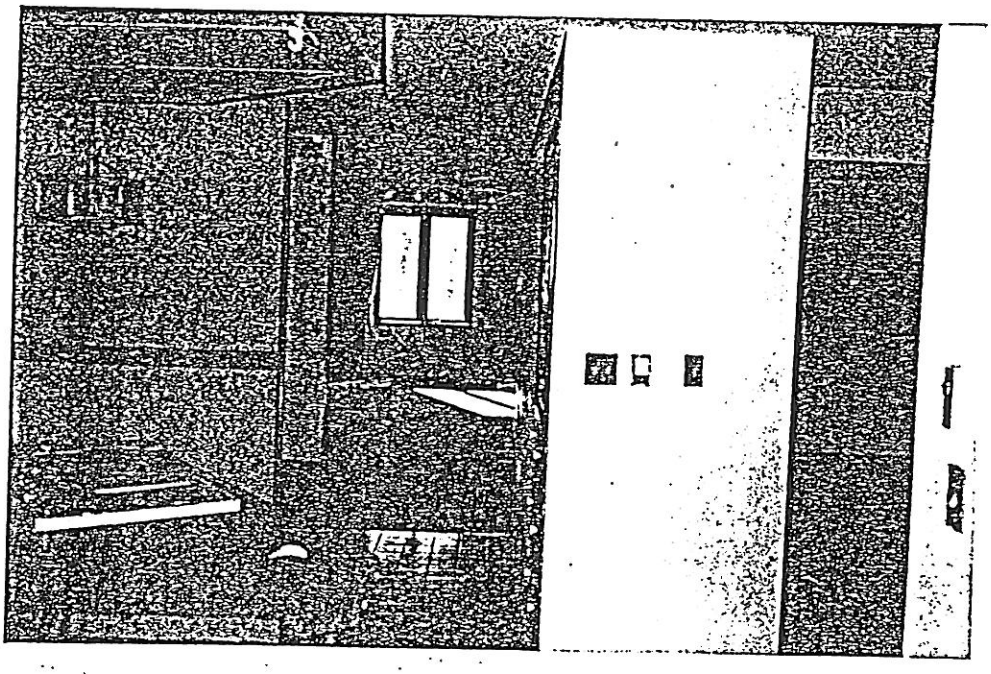


PHOTO #6: PHOTO TAKEN FROM KITCHEN AREA LOOKING TOWARDS LIVING ROOM. MAIN ENTRY IS AT HALL TO LEFT BETWEEN KITCHEN AND LIVING ROOM (JUST BEYOND VINYL FLOOR COVERING). DOOR TO MASTER BEDROOM IS AT RIGHT.

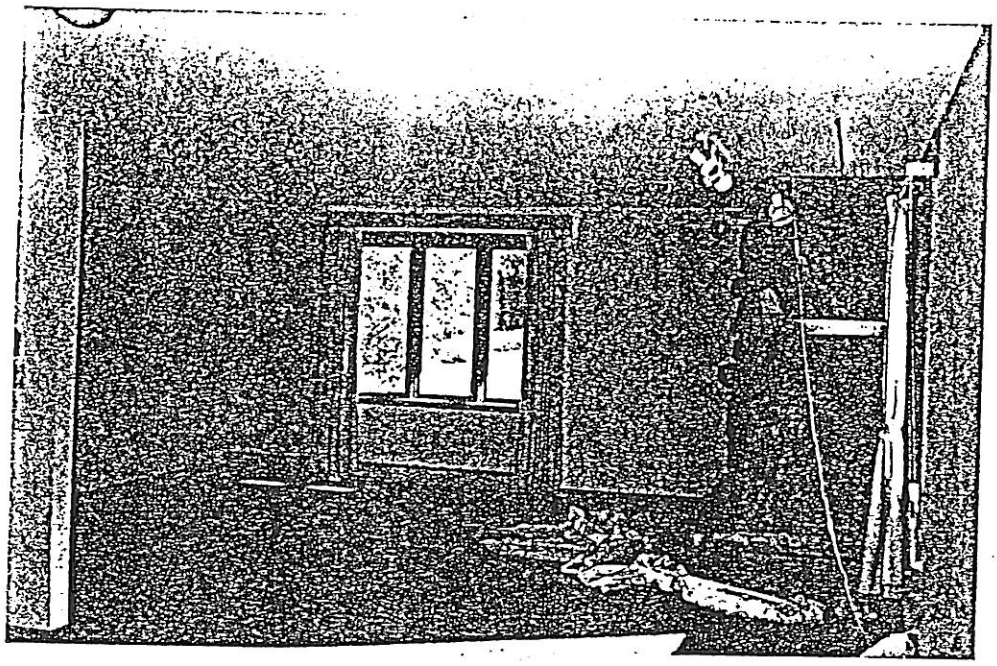


PHOTO #7: LIVING ROOM AREA. ROCK FIREPLACE.

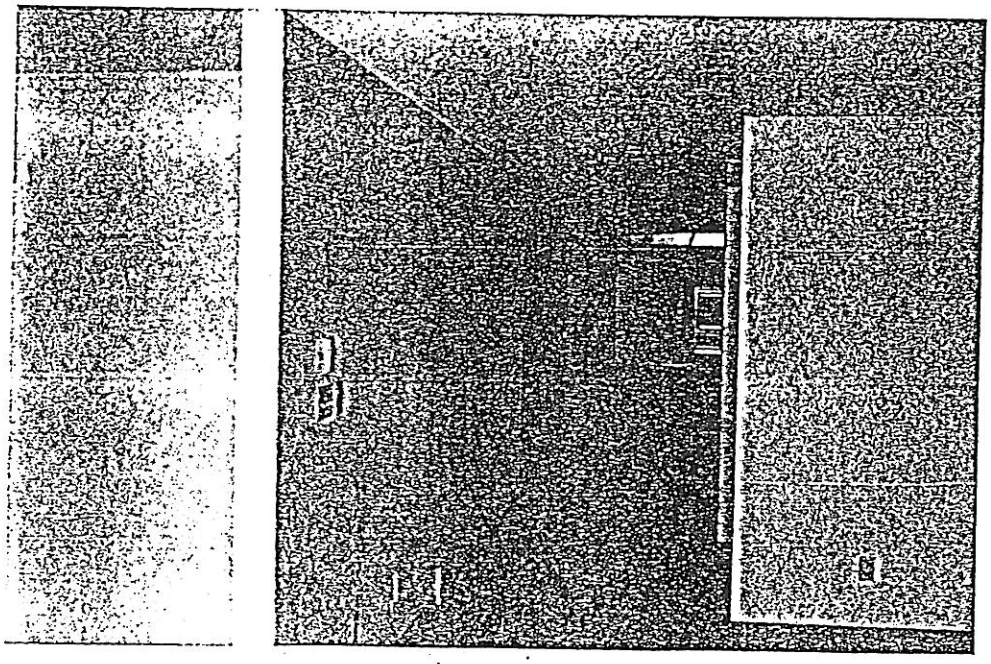


PHOTO #8: PHOTO TAKEN FROM LIVING ROOM AREA, NEAR THE ROCK FIREPLACE, LOOKING AT MAIN HALLWAY TO BEDROOMS AND BATHROOMS. KITCHEN AREA IS BELOW LIGHT AT FAR RIGHT.

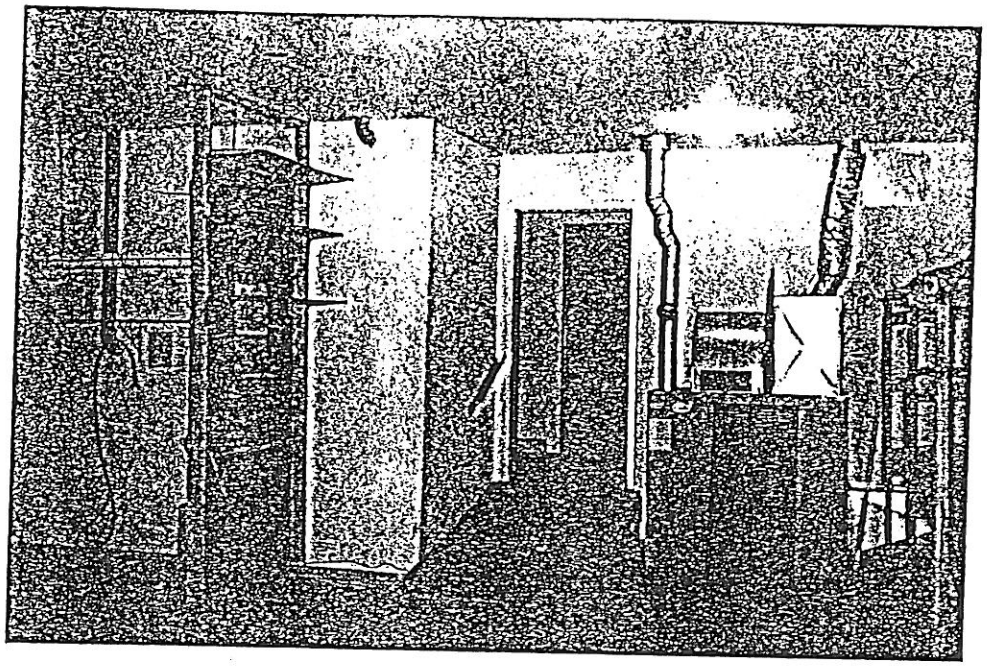


PHOTO #9: GARAGE AREA, OIL FORCED AIR FURNACE, ENTRY DOOR FROM GARAGE INTO HOUSE AT CENTER.

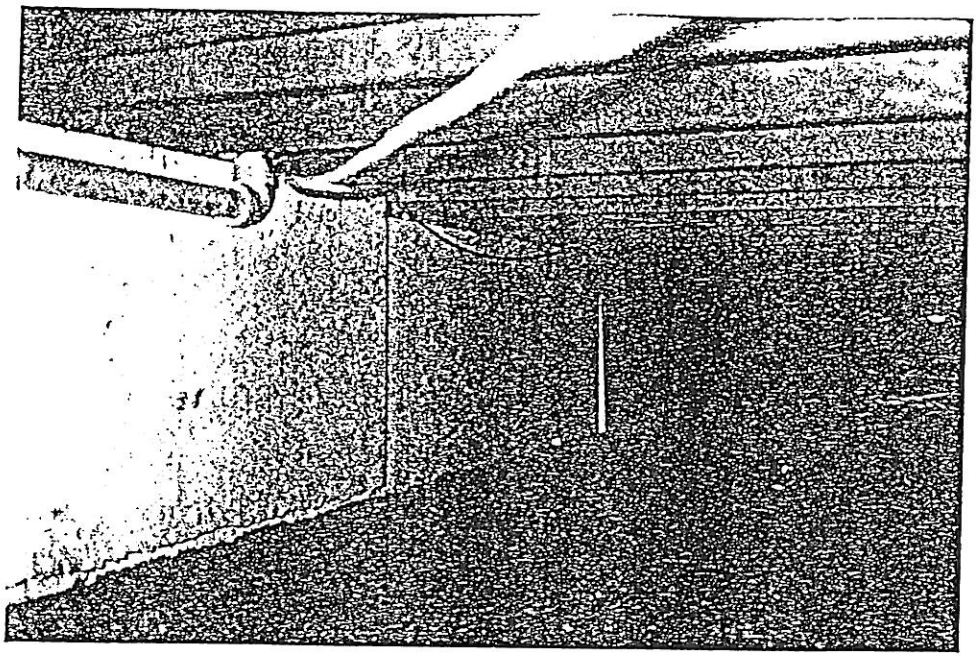


PHOTO #10: CRAWLSPACE AREA, EXISTING 2" OF BEADBOARD INSULATION ON SOME PORTIONS OF WALL. DISCONTINUOUS MOISTURE BARRIER ON GROUND SURFACE.

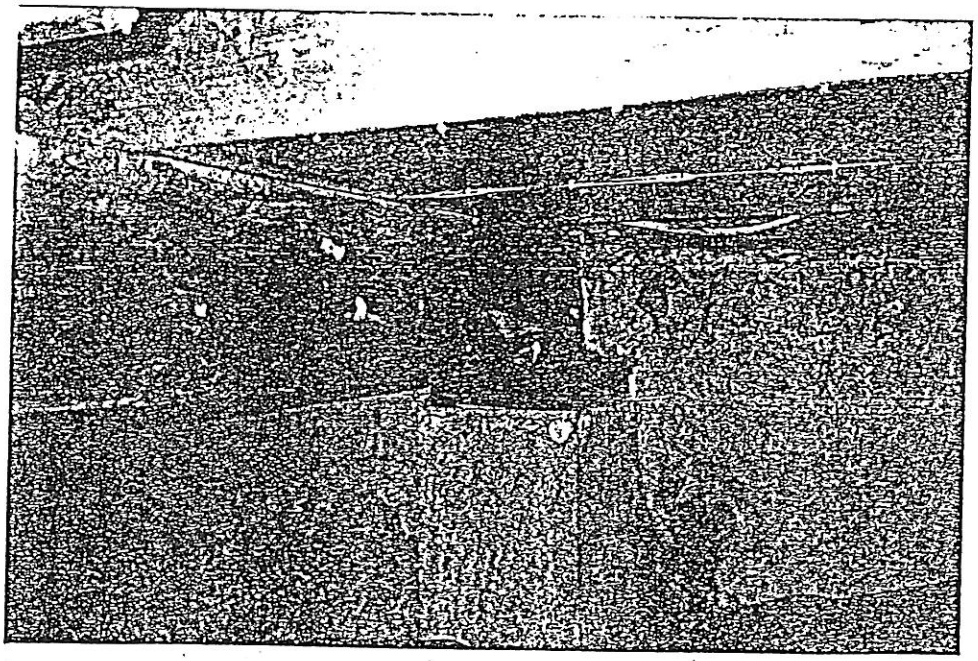


PHOTO #11: CRAWLSPACE AREA, THE EXISTING 3 MEMBER 2" X 10" FLOOR BEAM AT THE NORTH END OF HOUSE IS DRY ROTTED AND NEEDS TO BE REPLACED.

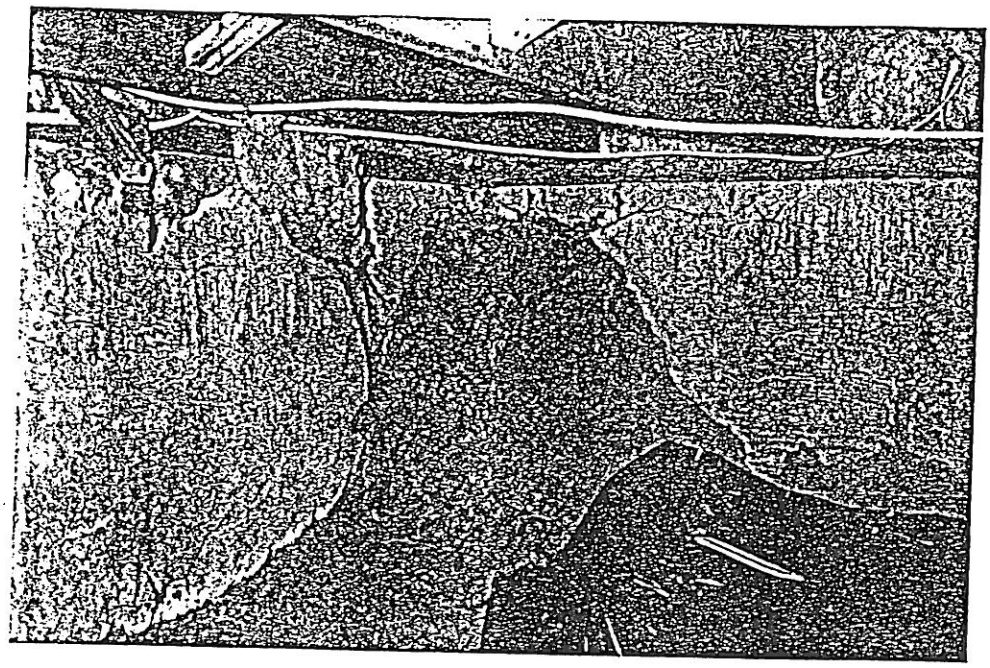


PHOTO #12: CRAWLSPACE AREA, EXISTING EARTH AGAINST INSIDE CORNERS OF FOUNDATION. DISCONTINUOUS MOISTURE BARRIER ON GROUND SURFACE.

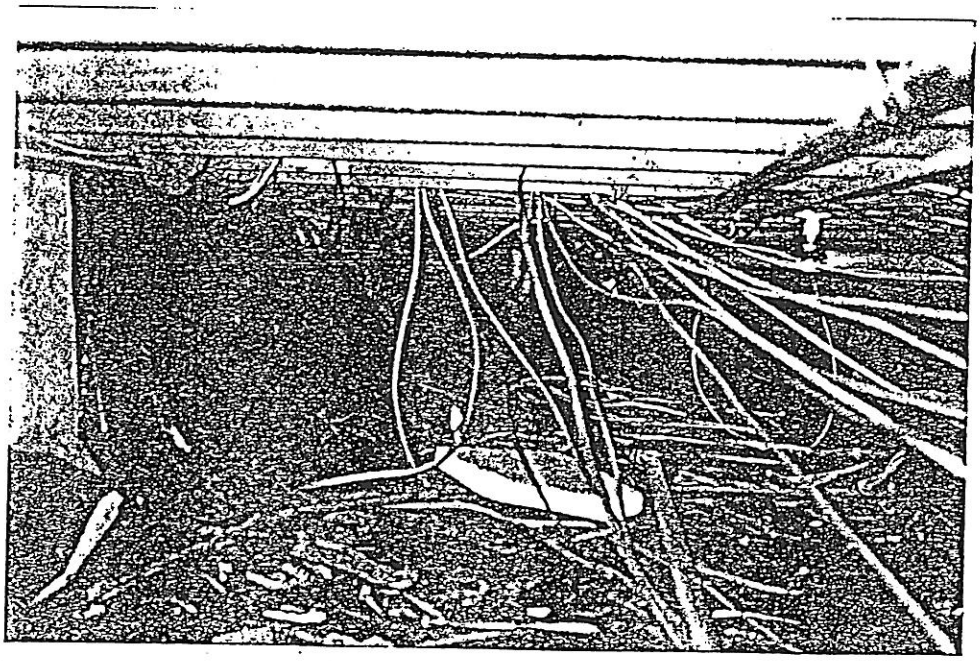


PHOTO #13: CRAWLSPACE AREA, EXISTING WIRING AND DEBRIS.

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

January 2, 1990

Coldwell Banker
105 Adak Avenue
Fairbanks, Alaska 99701

Attn: Tom Hovenden

Re: AHFC #66149 (Banker)
MBS - No Pool; WA #53993
Lot 7, Block 7; North Shanley Subdivision
1600 Cordwood Drive
Fairbanks, Alaska

Gentlemen:

As per your approval, soils borings were performed on the above referenced property. A total of 6 test holes were drilled on three separate occasions. These borings were drilled on December 12 (TH 1), December 28 (TH 2), and December 29 (TH 3, 4, 5, 6), 1989. This report addresses the findings of these investigations.

Test hole #1 and #2 were drilled with an 8 inch, hollow stem auger to depths as indicated on the enclosed soils logs. Test holes #3 through #6 were drilled with a 4 inch, solid stem, flight auger to depths as indicated on the enclosed soils logs. Soil samples and penetration tests were obtained in TH #1 and #2 with the use of a split spoon sampler.

Approximately the top 5 ft. of all test holes encountered silt, below which was fine sand to the approximate depth of 13 ft. to 17 ft. at which point gravel with intermixed layers of sand was encountered. The actual depths and elevations for each boring are noted on the enclosed soils logs.

Frozen gravel was encountered in all test holes with the exception of TH #2. Test holes #1, #3, and #6 encountered frozen gravel at depths of 17 ft., 13 ft., and 21 ft. respectfully. These holes are located at the North end of the dwelling. Test holes #4 and #5 encountered frozen gravel at 37 ft. and 34 ft. respectfully. These test holes were drilled in the front and back yards of the dwelling at the approximate mid-point of the building length. Any frozen ground below a depth of 6 ft. should be considered permafrost.

Soil samples were obtained at depths indicated on the soils logs. Samples obtained within the frozen soils were tested for moisture content to allow for the calculation of settlement upon thawing. These calculations indicate that settlement in excess of 1/2 ft. could result from the thawing of the underlying permafrost, below the North end of the building if the soils were to thaw, to a depth of 30 ft.

Elevation readings were taken on top of the poured concrete foundation within the crawlspace area. These elevations indicate a differential of elevation of approximately 1½ inches. This amount of difference is slightly more than expected, but 1 inch of elevation differential would not be uncommon in a house of this size (approximately 75 ft. long).

We have found that approximately 1½ inch thickness of wood shims have been installed between the concrete foundation and wood sill plate at the North end of the dwelling. These shims taper to zero at the South end of the dwelling and have the tendency to produce a level, finished, first floor. It is not known whether these shims were installed during the construction phase of this dwelling or sometime after.

This house was constructed in 1970, as per the Fairbanks North Star Borough assessment records. Approximately 20 years have passed since that time of construction.

Our findings may indicate that the permafrost below the Northern portion of the dwelling was quite shallow at the time of construction and that some settlement of this portion of the building may have occurred due to the thawing of the permafrost to its present depth. The permafrost level below the South half of the dwelling may have always been quite deep with very little thawing occurring since construction.

In our opinion, the thawing of permafrost below a depth of 30 ft. will not result in settlement of the structure. It is impossible; however, to ensure that no differential settlement of this structure will occur due to the thawing of the permafrost below the Northerly portion of the dwelling.

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

Sincerely,

STUTZMANN ENGINEERING ASSOC., INC.

Scott E. Wortman, P.E.
56/bb