Appendix C

Geotechnical Investigation September 2003

A report prepared for

CE2 Engineers
8221 Dimond Hook
P.O. Box 232946
Anchorage, Alaska 99523

GEOTECHNICAL INVESTIGATION
Heavy Duty Boardwalk Improvements
Tuntutuliak, Alaska

by

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DM&A Job No. 4149.019

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September 30, 2003

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INTRODUCTION

This letter presents the results of the geotechnical investigation along the heavy duty boardwalk in Tuntutuliak, Alaska. The boardwalk was constructed in 1995 to accommodate a low flow haul system for sewage disposal and drinking water distribution, and currently provides the primary means of transportation throughout the village. Since construction, the boardwalk has experienced considerable displacement and deformation due to adverse soil conditions and surface water fluctuations. In places, the boardwalk has been removed entirely from the underlying supports and cribbing has been added at irregular intervals to support failing sections.

The purpose of this geotechnical investigation was to help determine the specific conditions contributing to damage along selected sections of boardwalk, and to provide conclusions regarding repair of the boardwalk foundation. During this work we consulted with Mr. Paul Weisner, P.E., of CE2 Engineers, who identified the problem areas included in this investigation. Mr. Robert Enoch, General Manager of the Tuntatuliak Community Services Association, provided his observations of the boardwalk since it was built. A general site map and photographs of the damaged boardwalk sections were also provided by CE2 Engineers prior to field investigation. The project area and problem locations are shown on Plate 1.

EXISTING DATA

Geotechnical conditions encountered during previous investigations in Tuntutuliak are described in the following reports. Borings drilled near the boardwalk alignment during previous work are shown on Plate 2, Borehole Locations, and copies of the relevant logs are in the appendix of this report.

- In 1979, R&M Consultants, Inc., explored subsurface conditions and made foundation recommendations for the new high school and four fuel tanks. Three test holes were drilled: two to depths of 29 feet and one to 11.5 feet. Their investigation revealed a site underlain by permafrost. The 1-foot thick organic material at the surface was underlain by dark gray silt to the total depth drilled. Significant amounts of ice were found within the soil profile. Moisture contents in the silts ranged from 168% near the surface to 66.2% below 22 feet.

- In 1982, Howard Gray and Associates, Inc., conducted a soils/foundation exploration for AVCP's community housing project. At the time, 27 housing units located throughout the community were proposed. The fieldwork, 7 borings to depths of 5.5 feet to 14 feet, revealed organic material overlying silts and organic silts. In November when the holes were drilled, the permafrost was encountered at 2.5 to 3 feet below the surface with moisture contents ranging from 45 to 68 percent. The report expresses concern for foundation stability due to seasonal freeze-thaw cycles within the wet, organic-silty active zone soils.

- On Apr. 29, 1992, Duane Miller & Associates inspected the condition of AVCP houses in Tuntutuliak. Many of the houses were experiencing large differential movements from the annual freeze-thaw cycles, and at some locations, the surface post and pad footings were losing support because of down-slope creep of the organic surface layer. Some pads were being shimmed with layers of shipping pallets. DM&A recommended that the houses be retrofitted with new post and pad footings constructed to bear on the permafrost below the active layer. We understand that work was accomplished during the winter.

- In 1994, Lambe Engineers and DOWL Engineers prepared a subsurface investigation and geotechnical evaluation for a Village Safe Water project in the community. The project elements in the investigation included the dock at the sewage lagoon, the control work at the lagoon outlet, boardwalks connecting the lagoon to the health clinic, sewage force main, pump station, water main, watering points, and bridges supporting boardwalks over open water. Twenty-nine borings were drilled. The report documents warm permafrost and degraded permafrost in soils with organic material overlying organic silt and silt with ice lenses.

- In 1996, DM&A conducted a geotechnical investigation for the site selection and foundation design for the new fuel tank farm being built by Qinarmiut Corporation. Two borings were drilled to depths of 31 and 27 feet. Both borings showed a thin organic mat at the surface that is underlain by brown organic silt and peat interspersed with medium dense gray silt that grades to denser gray silt to the depths explored. Permafrost was present at the boring near the boardwalk from the airport. High moisture contents suggest that the soil is not thaw stable.

INVESTIGATION

For this investigation, nine boreholes were drilled along the existing boardwalk alignment on January 28 through 30, 2003. The borings were advanced to depths of 8.5 to 31.5 feet, depending on soil conditions, using an SSD2 mobile drill rig owned and operated by Salzbrun Services and Drilling of Bethel. The rig was equipped with standard soil sampling tools, including hollow-stem augers, a 140-pound manual hammer, and a 1.4-inch I.D. split barrel sampler. The locations of the borings drilled for this and previous investigations are shown on Plate 2, Borehole Locations.

The subsurface soils were logged and sampled as the borings were drilled by Ms. J.J. Brown, field geologist with DM&A. Soil samples were obtained by grabbing loosened cuttings from the augers and by advancing the split-barrel sampler ahead of the augers with the manual hammer, according to the Standard Penetration Test procedure. Samples were sealed to prevent the loss of moisture and returned to our laboratory in Anchorage.

In the laboratory the samples were reexamined to confirm field classifications. Select samples were tested for moisture content and organic content, as appropriate. Logs of the borings are presented on Plates 3 through 8. The soils have been classified according to the Unified Soils Classification System described on Plate 9. Laboratory test results are shown graphically on the boring logs, and are tabulated on Plates 10 and 11, the Summary of Samples.

SITE AND SUBSURFACE CONDITIONS

Climate

The climate at Tuntutuliak is characterized by long, cold winters and cool summers. The following data are from the Environmental Atlas of Alaska by Hartmann and Johnson (H&J), 1978, and a 1999 Climatic Conditions Study conducted by DM&A. The evaluation DM&A performed of daily temperatures for Bethel shows that the average air temperature is significantly warmer from 1977 through 1997. In Bethel the average air temperature increased from 28.6° F for 1950 through 1977 to 30.7° F for 1978 through 1997. We expect this warmer weather has been similar in Tuntutuliak.

	H&J, 1978	DM&A, 1999
Average Air Temperature	28.5° F	31° F
Average Freezing Index	3000° F-days	2840° F-days
Design Freezing Index	4000° F-days	4000° F-days
Average Thawing Index	2200° F-days	2580° F-days
Design Thawing Index	3100° F-days	3210° F-days

At the time of drilling, the ground surface was obscured by 2 to 12 inches of ice-crusted snow. Recent freezing rains had left a thick layer of glare ice on the boardwalk surface, making foot travel perilous and limiting the movement of the drill rig to the surrounding natural ground.

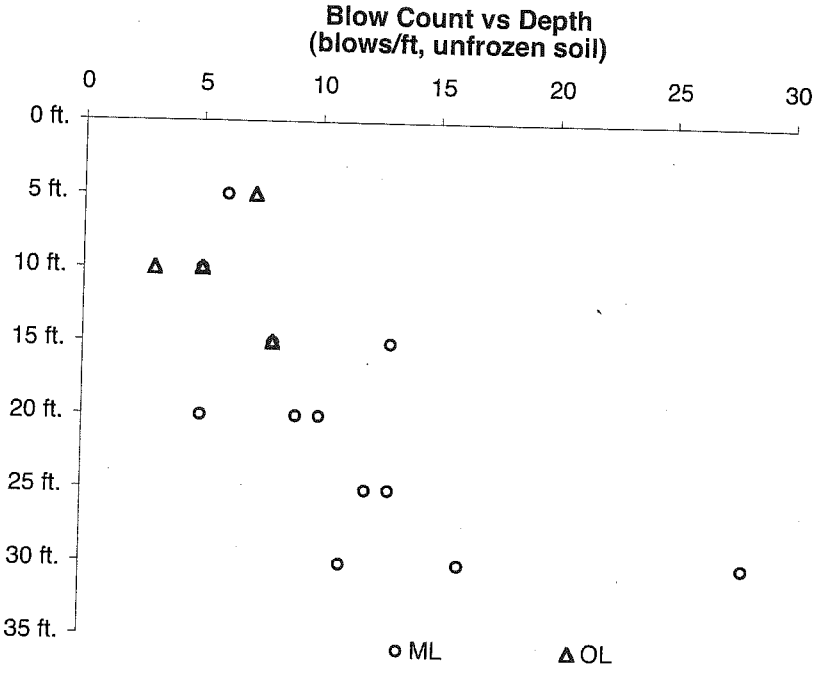
Site Geology and Soil Conditions

The village of Tuntutuliak is located 40 miles southwest of Bethel, Alaska, on the northwest bank of the Kinak River near its confluence with the Kuskokwim River. The regional terrain is flat and poorly drained, with grade changes of less than 15 feet and numerous ponds and small lakes. Vegetation consists primarily of mixed tundra and grass with occasional alder groves along the river banks. Much of the area is subject to flooding from storm surges that push water up the Kinak.

Past boring and test pit holes consistently show a surface layer of peat and organic silt over thick silt deposits throughout the village, and discontinuous permafrost throughout the region. The borings drilled for this investigation reveal subsurface conditions similar to those found during previous work. The

natural soils encountered during drilling include a 2- to 5-foot surface layer of mixed peat and organic silt. The surficial organic soils are underlain by relatively firm inorganic silt interspersed with organic silt and finely divided organic material. Density of the unfrozen silt increases moderately with depth, while moisture and organic content generally decrease.

Figure 1

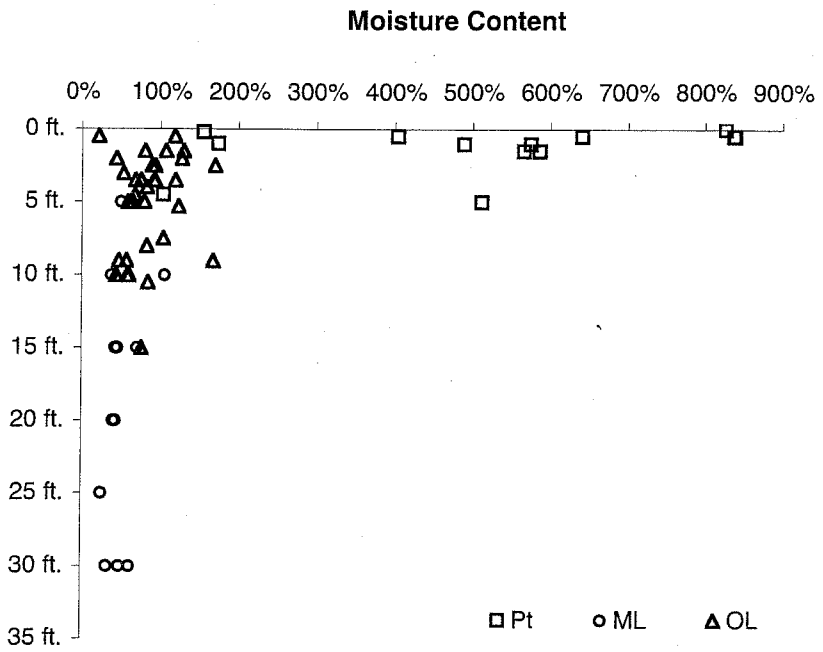


Permafrost was present in five of the nine boreholes. The permafrost is generally warm or degraded and commonly contains visible excess ice with some segregated, massive ice formations. Ice lenses up to 2 inches thick were observed in otherwise marginally frozen soil. Past boring and ground temperature measurements show the permafrost to be discontinuous at or near thawing temperatures near bodies of water and commonly absent beneath drainages.

High moisture contents of the peat, silt, and organic silt indicate that the frozen, natural soils are thaw unstable. Figure 2, Moisture Content vs Depth, shows a significant decrease in moisture content at a depth of about 3 feet, from

well above 300% in the surficial peat and organic silt to an average range of 40% to 60% in the underlying silt and organic silt.

Figure 2



DISCUSSION and CONCLUSIONS

The boardwalk surface is constructed of 3- by 12-inch timbers and is designed to support trailer-mounted sewage and water tanks. The design load was based on a 300 gallon trailer-mounted tank pulled by an all terrain vehicle (4-wheeler). The original foundation design included two systems of support for the surface timbers: 1) 6x6 cross-pieces bearing directly on the tundra, and 2) helical anchors to raise the driving surface above soft, wet areas. During construction, 1- by 4- by 10-foot polystyrene floats were added at transition points between high ground and bridges. As-built drawings of the boardwalk are currently unavailable. The boardwalk was presumably constructed as level as natural terrain would allow, based on a desired elevation within 18 to 24 inches of natural grade.

Where the ground conditions are dry and firm enough so that normal foot traffic can cross without wading through water or sinking into the mud, the boardwalk is generally supported on 6- by 6-inch timber sills with mats and/or blocking bearing directly on the ground surface. Where the soil is less firm and commonly wet, polystyrene floats have been added below the sills, and cribbing placed as needed to maintain a level boardwalk. Helical Chance® anchors support the boardwalk in areas where the soils are too soft to allow support with mudsills or floats within a practical depth. These areas are generally low lying drainages and areas near large ponds or bridge crossings.

According to Mr. Enoch, the boardwalk will float in approximately 8 inches of water where floats are present and the boardwalk has not been properly anchored. He estimates that overall, the boardwalk experiences 6 to 8 inches of vertical movement seasonally. After conditions stabilized in the fall, Mr. Enoch has observed that the floats placed on soft, wet tundra tilt badly, and that lateral movement has separated the boardwalk surface from the underlying supports. Floats placed on transitional ground near bridge sections have pulled the boardwalk out of alignment, in places forcing the boardwalk off of the Chance® anchors beneath the bridge.

The primary factors driving displacement of the boardwalk include weak and/or compressible material, thaw settlement, ponding, and flooding. Recommendations for modifying the existing foundation, repairs, and long-term

maintenance depend on the local conditions specific to each boardwalk section. The problem sections selected for this investigation are discussed in detail below, and photographs of each area are provided on Plates 12 through 22.

Section A

This area is located near new housing along the northwest edge of the village, where the boardwalk crosses a broad, well-defined drainage. Displacement has occurred at either end of the bridge section over the transition between the drainage and surrounding higher ground. Two borings were drilled in this area in April 1994, near each of the transition zones. The borings revealed 4 feet of ice and snow over unfrozen peat and organic silt to depths of 7.5 and 9.5 feet. Below the organic soils, relatively firm inorganic silt with organic lenses and some organic silt was observed to 30 feet. Marginally frozen ground was found below a depth of about 25 feet at each location.

Chance® anchors provide support for the bridge across the drainage. The bridge section appears to be in good shape, with no obvious displacement of the plank surface or underlying anchors. Within the transition zones, the boardwalk rests on cribs placed directly on the natural ground surface which is sloping towards the drainage. Compression of the surface organics and downslope movement of the organic soil has caused much of the cribbing to move down toward the drainage. The loss of support has caused the boardwalk to sag. Over the adjacent, higher ground the boardwalk rests on mudsills and planks which appear to be providing relatively stable support.

Helical anchors should be used to support the boardwalk through the transition zone where the natural ground is steeply sloping, and the cribbing should be removed from that area.

Sections B and C

This section of boardwalk is located on the southeast side of the village near the airport on a terrace of the Kinak River. The local terrain is generally flat and grass-covered with scattered, shallow ponds. The boardwalk here is within the active flood plain of the river, and is commonly inundated by seasonal flood waters. At the time of our field investigation, this portion of the boardwalk was almost entirely obscured by snow and ice. According to Robert Enoch, the

boardwalk is supported on mudsills bearing directly on the ground surface, and Duckbill anchors were installed to prevent excessive movement during floods. Mr. Enoch also noted that the boardwalk will float in approximately 8 inches of water where anchors are absent.

During a 1996 DM&A investigation, a borehole was drilled in this area to a depth of 31 feet. The boring showed a thin organic mat and brown organic silt near the surface, underlain by medium dense to dense gray silt with occasional organics. The soils were frozen below a 3-foot, thawed active layer, with interstitial ice crystals up to 3/8 inch diameter from 5 to 9 feet. The material below 9 feet appeared marginally frozen with no visible excess ice, and measured ground temperatures were very close to the freezing point. High moisture contents in the upper portion of the boring indicate potential for significant thaw settlement.

Photographs taken during previous visits to the village reveal that some settlement has occurred along this section of boardwalk. In places, stress due to differential settlement has caused the individual surface planks to pull free of the support sills at one or both ends. In low areas prone to collecting surface water, earlier photographs suggest that more severe damage has occurred as a result of flooding. Based on conversations with local residents, polystyrene floats may have been added over areas of soft, wet tundra. Residents note that the anchors are either too slack or too few in number to adequately limit movement of the boardwalk during a flood. The boardwalk foundation was concealed by ice and snow at the time of our visit, and the presence of Duckbill anchors and/or polystyrene floats could not be verified.

Where releveling of the boardwalk surface is required, lift the boardwalk using a hydraulic jack and add shims above the mudsills as needed. Remove any floats and replace them with timber sills. Install a sufficient number of Duckbill anchors to resist buoyant uplift forces that occur during high water. The Duckbill anchor must have sufficient slack to allow for a seasonal frost heave movement of about 4 inches.

Section D

South of the armory building, two bridge sections intersect to allow travel over wet ground between a nearby residential area and the school. One bridge

extends west toward the housing development and is supported on floats across a wide drainage. The boardwalk sags dramatically where it crosses the drainage, and portions of the railing are damaged. Near the intersection, a displaced float that appeared in a 2000 photograph was missing in January 2003.

The second bridge runs south from the intersection over a neck of a large pond. The bridge over the pond is supported on Chance anchors. Between the intersection and the pond, the boardwalk rests on cribbing bearing directly on the ground surface. At the northern edge of the pond, at least one polystyrene float was observed beneath the boardwalk. Additional floats may have been obscured by snow at the time of this investigation. Over the Chance anchors, the boardwalk shows no obvious displacement and appears to be in good shape. Near the intersection, however, displacement of the underlying cribbing has caused the boardwalk to drop.

Three borings drilled in 1994 provide soils data for this area. Near the northern bridge intersection, a boring drilled to a depth of 32 feet revealed frozen peat and interlayered silt and organic silt to a depth of 9.5 feet. Below 9.5 feet, unfrozen, interlayered silt and organic silt were encountered to the base of the boring. The depth of frozen soils is greater than that typically expected for seasonal frost penetration. Near the center of the middle bridge, another boring was drilled to a depth of 35 feet. The soil conditions were similar to those described above except only seasonal frost was found in the peat. In the boring drilled at the south end of the center bridge, frost was encountered to 4 feet, and otherwise, similar soil conditions were logged to a depth of 32 feet.

Remove the floats and cribbing that are located within the areas that flood or where the ground is steeply sloping, and replace them with a helical anchor foundation.

Section E

Located to the east of the Moravian church, this section consists of a bridge supported on chance anchors over a perennially wet drainage area. The bridge has experienced minor lateral displacement at the east end, as well as some settlement centered over the terminal chance anchors and transitional cribbing at the west end.

Two borings drilled in 1994 encountered 2.5 feet of mixed peat and silt over silt and organic silt with occasional layers of peat to 32 feet. The soils were unfrozen below 2.5 feet of seasonal frost.

Helical anchors should be used to support the boardwalk through the transition zone where the natural ground is steeply sloping, and the cribbing should be removed from that area. If settlement is obvious at an existing helical pier, additional helical piers could be added to provide more support.

Section F

This boardwalk section is located off the southeast corner of the community hall, along the edge of a large pond. The boardwalk runs north-south on sills with lateral supports. Irregular cribbing suggests that some differential settlement has occurred or that cribbing has been displaced by flotation during flood events.

Boring F encountered 3 feet of peat and organic silt over mixed silt and organic silt with occasional layers of firm organics to the base of the borehole at a depth of 16.5 feet. Seasonal frost was present to 2.5 feet, and icy permafrost was encountered below a depth of 10.5 feet.

The soil above the permafrost is highly compressible and settlement of the timber cribbing will continue to occur with time. A positive, long-term solution would be to replace the timber cribbing with helical anchors. Alternatively, the boardwalk could be releveled periodically and shims placed on the settling cribs. Any floats that might be present should be removed and be replaced with either cribbing or helical anchors to be consistent with the rest of the support.

Section G

This section crosses a low, wet area between two ponds and is subject to intermittent flooding. The boardwalk is supported on floats and is anchored in at least two places by Duckbill cable anchors. Many of the floats are obviously out of place, and cribbing of various sizes and shapes has been added where the boardwalk has been pulled away from the underlying supports. The position of the floats indicates either settlement or displacement during flooding and has resulted in excessive lateral movement of the boardwalk.

Boring G was drilled to a depth of 31.5 feet near the center of this section, where displacement was most severe. The soils encountered include 2.5 feet of peat over organic silt to a depth of 18.5 feet. Beneath the organic silt, gray silt was present to the base of the boring. The soils were unfrozen below 3 feet of seasonal frost.

The soils are highly compressible to a depth of 18.5 feet. Surface support using either cribbing or floats is subject to movement during flooding and settlement from compression of the organic soil. Positive support can be developed using helical anchors gaining support in the silt below 18.5 feet.

Section H

Section H includes a bridge crossing a neck of the lake and the transitions at each end. The bridge section is supported on Chance anchors. The transitions at each end are on floats with Duckbill anchors. Movement has been considerable as evident from the excessive cribbing and displacement of floats. The floats have lifted the bridge almost completely off the Chance anchor at the southeast end. The movement has caused the side planks to break off and has resulted in a slight dip in bridge near west end.

Boring H shows peat and organic silt to 10.5 feet and then medium stiff silt to the depth explored, 31.5 feet. The only frozen soil was a thin layer of seasonal frost.

The soils are highly compressible to a depth of 10.5 feet. The major distress to the transitions appears to be caused by fuplift of the floats during flooding. The cribbing and floats should be removed and replaced with helical anchors gaining support in the silt below 10.5 feet.

Section I

The boardwalk runs north to the armory and crosses local terrain that includes low ridges and shallow swales. The ridges have some mediumhigh brush and the lower ground is grass covered. The boardwalk is supported on cribbing. Differential movement is severe.

Boring I was drilled at a higher location and found a surface layer of peat to 3 feet overlying silt and organic silt to the bottom of the hole, 8.5 feet. Permafrost was found at a depth of 5 feet. Boring II was drilled in a swale and found 5 feet

of peat over organic silt and silt. No permafrost was found to the depth explored, 11.5 feet.

Reportedly this section of boardwalk was constructed when the ground was frozen. The differential movement is probably due to a combination of initial thaw settlement when the ground first thawed and continued compression of the organic soils with repeated traffic loadings.

The boardwalk surface should be releveled by jacking up the 6x6 cross pieces and then adding shims over the existing mudsills. Mudsills should be added if the 6x6 is bearing directly on the tundra. Final leveling should be made after the mudsills have been subjected to the full design load for two hours.

Section J

This section of boardwalk is west of school on the sidehill above a pond. The boardwalk is supported on mudsills and cribbing. The cribbing is up to 2 feet high. The cribbing has pushed into the into the surface organics in places. At some locations, the cribbing appears to have moved laterally. The lateral movement could be due to downslope movement of the active layer or a bearing failure of the cribbing.

A boring at this location was not possible because of the cross slope and the very icy conditions in January.

The boardwalk surface could be releveled by jacking up the 6x6 cross pieces and then adding additional shims. To reduce the risk of downslope soil movements affecting the mudsills, the tundra could be dug out at each support point so that the mudsills are bottomed at a depth of about 3 feet below ground surface. If a post is used to provide support between the timber pad and the 6x6 cross pieces, the connection between the post and pad should be adequate to resist the frost heaving forces that will develop each winter. A 6x6 timber post could experience a frost heave force of about 20 kips. The post would have to be laterally braced to resist the downslope soil load.

Alternatively, the boardwalk could be supported on helical piers in the sloping area. Cross bracing should be used to to provide lateral regidity between the two piers on each side of the boardwalk.

Section K

This section of boardwalk is east of the store and runs northeast to southwest along the north boundary of a lake. The boardwalk appears to be supported primarily on floats through this section, though much of the foundation was obscured by snow and ice in January. In the low areas the floats appear to have settled and cribbing has been added between floats and sills. In places, the foundation is only in partial contact with the boardwalk above. Over higher ground, cribbing exists between as well as in place of the floats.

Boring K was drilled to 10.5 feet at a higher location. The hole showed organic silt with peat to the depth explored and permafrost was present below a depth of 5.5 feet. Boring KK was drilled to 10.5 feet at the lower area and showed organic silt mixed with peat to the full depth. Permafrost is present below below 5 feet and contains stratified ice.

The floats do not appear to affected by floodwaters. If this is confirmed, the floats could be left in place and the boardwalk surface could be releveled by jacking up the 6x6 cross pieces and then adding shims over the blocking. Final leveling should be made after the mudsills have been subjected to the full design load for two hours.

Section L

Section L crosses a drainage. The bridge is supported on helical anchors but the transitions at each end appear to be settling and might have some lateral offset. The cribbing and/or floats were obscured by snow and ice in January. Previously drilled holes show seasonal frost and then unfrozen soils to the depths explored, 32 feet. Peat was at the ground surface and silt was encountered at depths of 1 to 2 feet.

Helical anchors should be used to support the boardwalk through the transition zone where the natural ground is steeply sloping. The cribbing or floats should be removed from that area.

Section M

Section M is a bridge crossing the same drainage as Section E. The bridge is supported on Chance anchors and the transition sections are on cribs or floats. Some movement of the piers appears to have occurred on the west end of the

bridge where the deck has a slight dip on the north side. Settlement of the transitions has damaged the boardwalk.

Boring M was drilled to 31.5 feet and found peat and organic silt 11 feet over silt. The soil was frozen to 1.5 feet at the surface and the between 5 feet and 13 feet and then unfrozen to the bottom of the hole.

Helical anchors should be used to support the boardwalk through the transition zone where the natural ground is steeply sloping. The cribbing or floats should be removed from that area. The bridge section that has settled should be releveled on the existing helical pier.

ILLUSTRATIONS

Plate 1	Project Area
Plate 2	Borehole Locations
Plates 3 through 8	Logs of Borings
Plate 9	Soil Classification Chart
Plates 10 and 11	Summary of Samples
Plates 12 through 22	Photographs
Appendix	Boring Logs from 1994

Note: Air photo ©1996; AeroMap U.S., Inc.

LEGEND:

HEAVY DUTY BOARDWALK

A SELECTED BOARDWALK SECTION

N

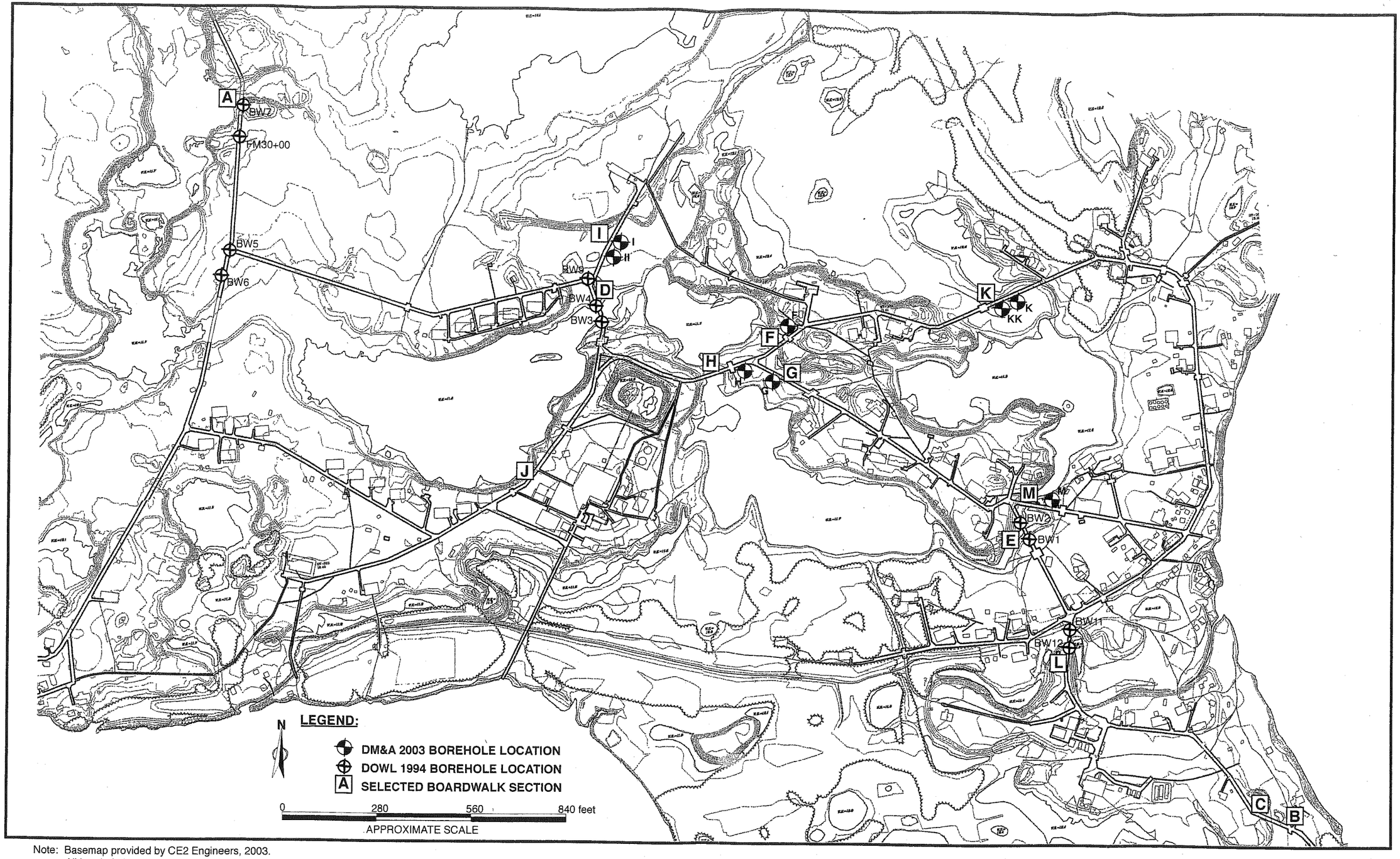
0 480 960 1440

APPROXIMATE SCALE (ft)

Duane Miller & Associates
Arctic & Geotechnical Engineering
Job No.: 4149.19
Date: July 2003

PROJECT AREA
Boardwalk Alignment
Tuntutuliak, Alaska

Plate
1



Note: Basemap provided by CE2 Engineers, 2003.
All borehole locations are approximate.

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Job No.: 4149.19
Date: July 2003

BOREHOLE LOCATIONS
Boardwalk Alignment
Tuntutuliak, Alaska

Plate
2

DUANE MILLER & ASSOCIATES

Project: **Tuntutuliak Boardwalk**

DM&A Job No. :4149.19

Logged By: JJ Brown

Log of HOLE : F

Date Drilled: 1/29/03

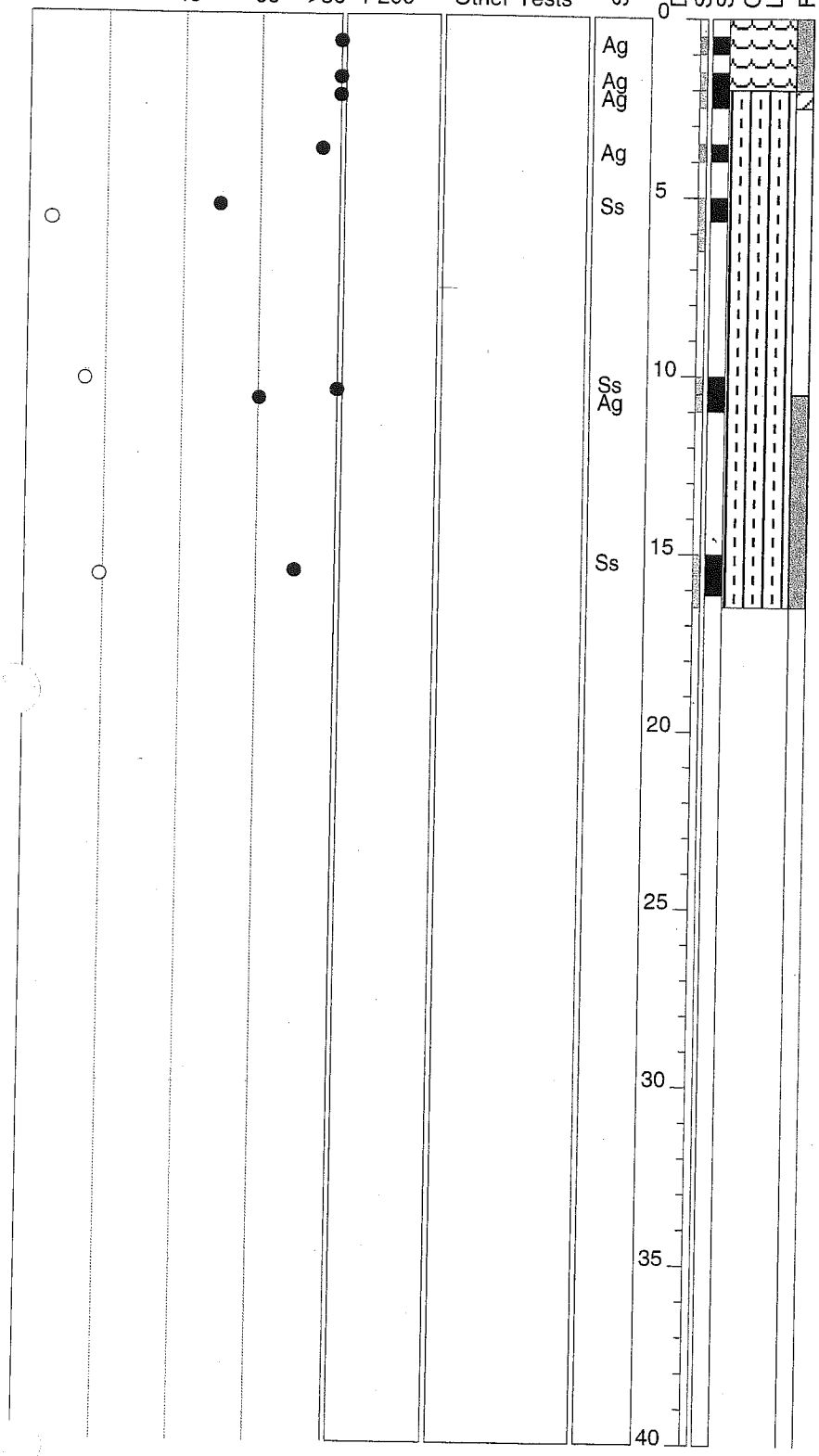
Contractor: Salzbrun Services

Equipment: SSD2

GPS Coord: N 60°20.680' W 162°40.230'

Elevation: Unknown

Boardwalk Section 'F'



Description

PEAT: (Pt) (Vx) Orange to brown, w/ some dark brown organic silt, poorly bonded w/ 15% visible ice

ORGANIC SILT: (OL) Brown to gray, moist, firm, w/ interlayered gray Silt (ML) and occasional dense organics

Frozen below 10.5' w/ 20% visible excess ice (Vx-Vs), horizontal lenses up to 1/2" thick

>30% visible excess ice (Vx-Vr) at 15', random veins up to 1" thick

DUANE MILLER & ASSOCIATES

Project: **Tuntutuliak Boardwalk**

DM&A Job No. :4149.19

Logged By: JJ Brown

Log of HOLE : G

Date Drilled: 1/29/03

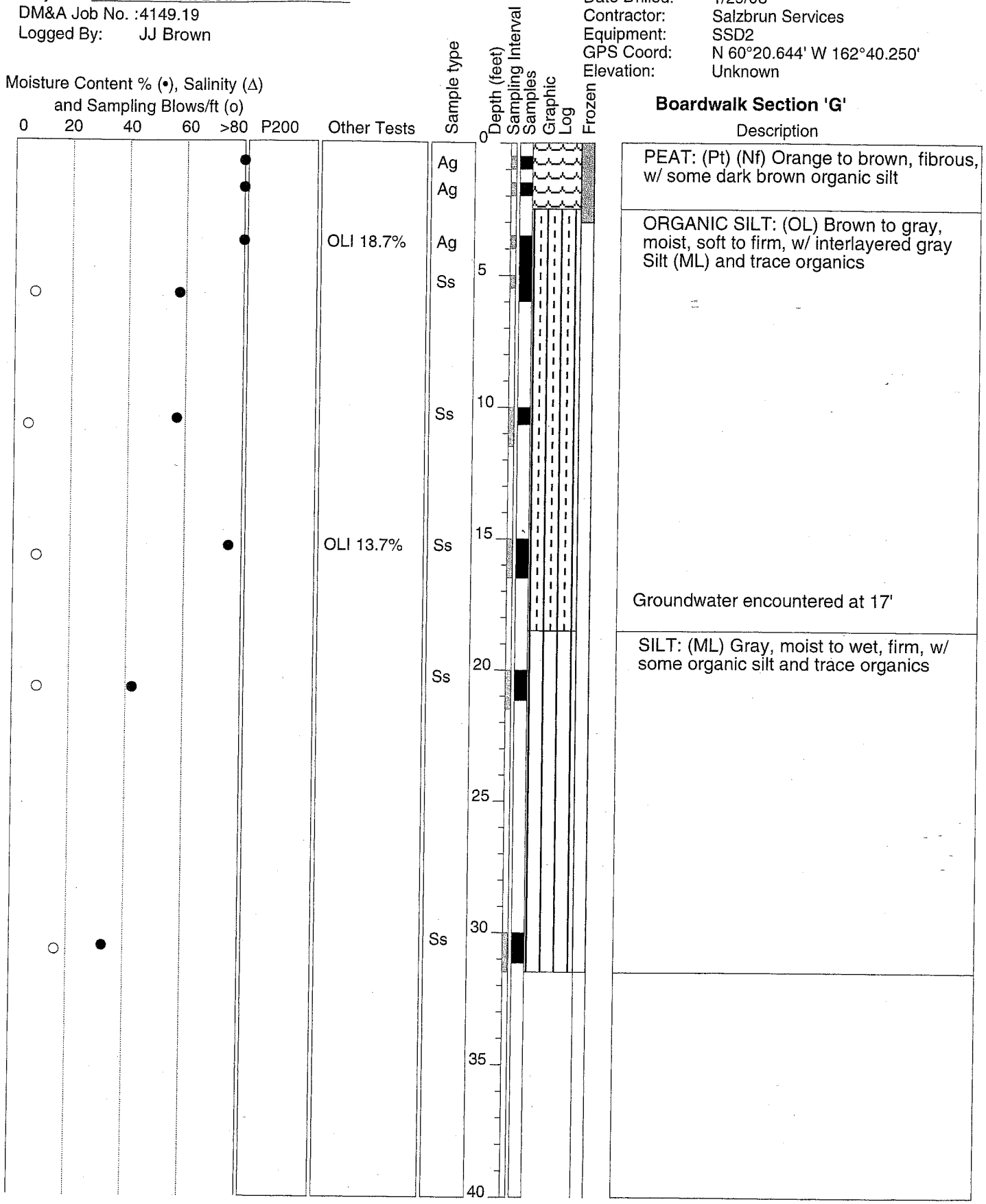
Contractor: Salzbrun Services

Equipment: SSD2

GPS Coord: N 60°20.644' W 162°40.250'

Elevation: Unknown

Boardwalk Section 'G'



Duane Miller & Associates
Arctic & Geotechnical Engineering
Job No.: 4149.019
Date: September 2003

LOG of BORING G
Boardwalk Alignment
Tuntutuliak, Alaska

Plate
4

DUANE MILLER & ASSOCIATES

Project: **Tuntutuliak Boardwalk**

DM&A Job No. :4149.19

Logged By: JJ Brown

Log of HOLE : H

Date Drilled: 1/28/03

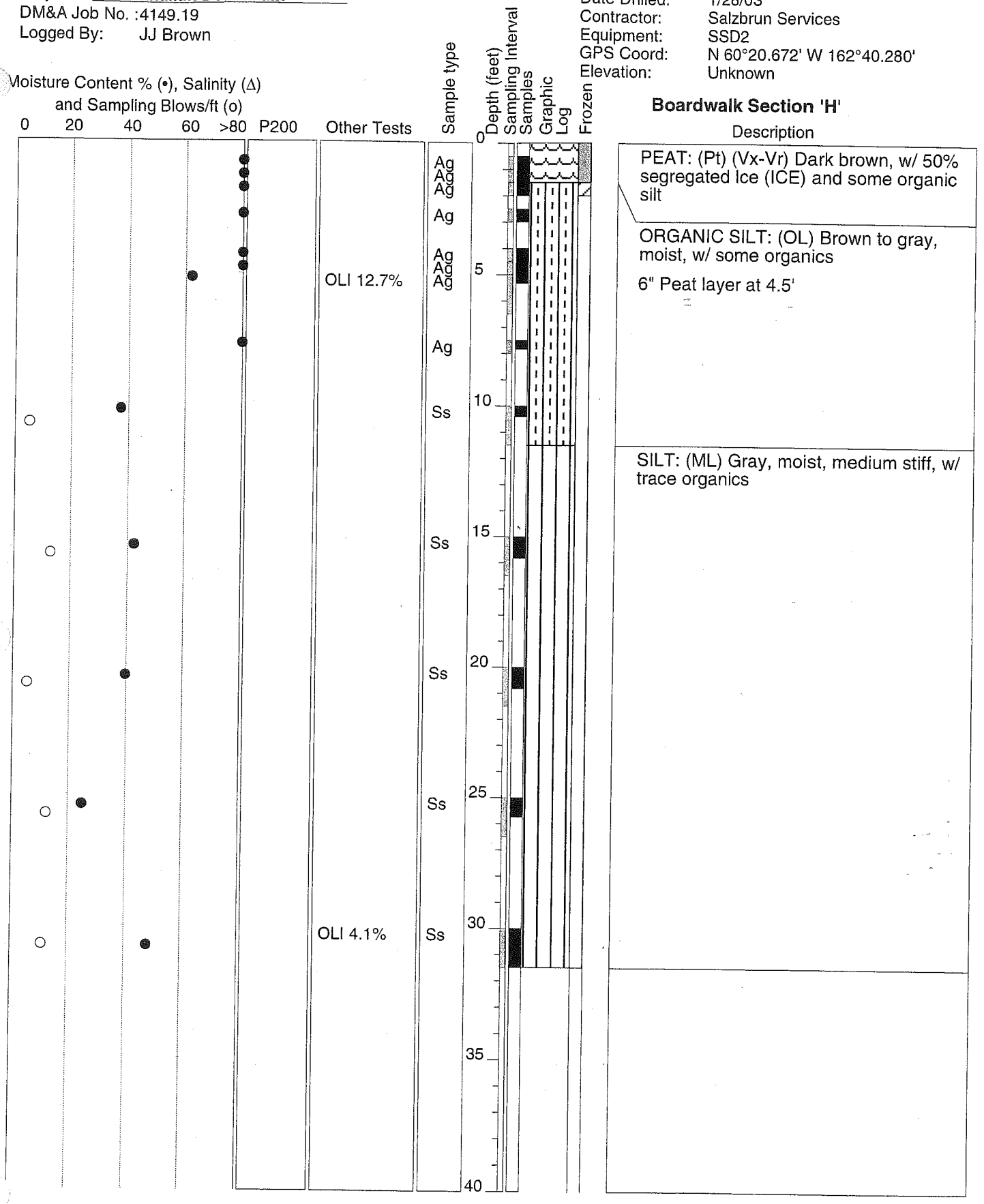
Contractor: Salzbrun Services

Equipment: SSD2

GPS Coord: N 60°20.672' W 162°40.280'

Elevation: Unknown

Boardwalk Section 'H'



Duane Miller & Associates
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Job No.: 4149.019
Date: September 2003

LOG of BORING H
Boardwalk Alignment
Tuntutuliak, Alaska

Plate
5

DUANE MILLER & ASSOCIATES

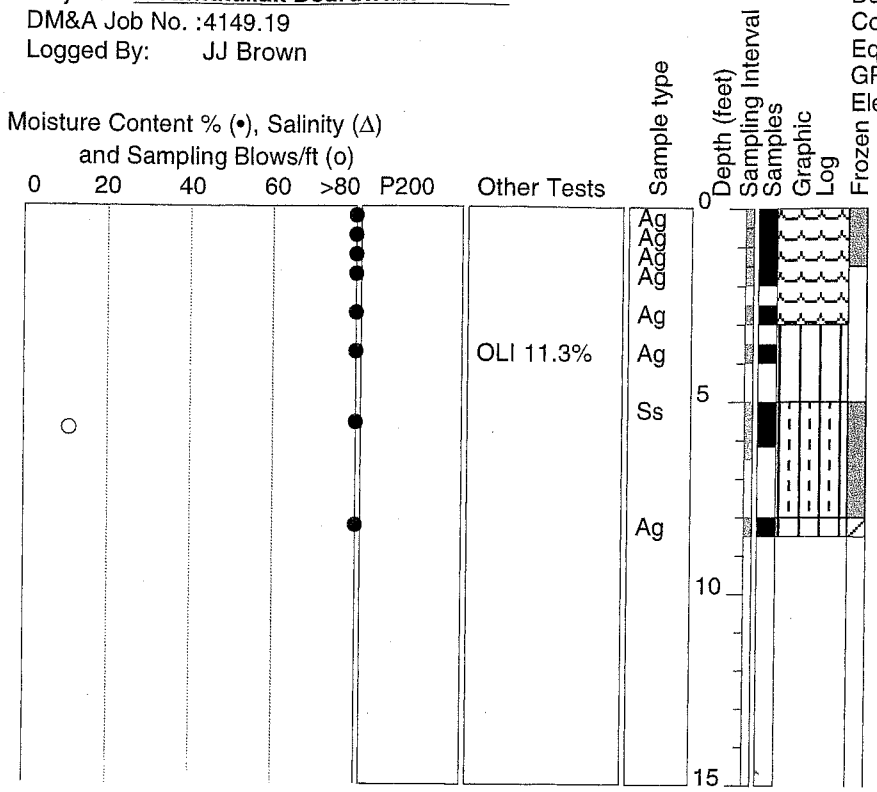
Project: **Tuntutuliak Boardwalk**

DM&A Job No. :4149.19

Logged By: JJ Brown

Log of HOLE : I

Date Drilled: 1/28/03
Contractor: Salzbrun Services
Equipment: SSD2
GPS Coord: N 60°20.725' W 162°40.396'
Elevation: Unknown



Boardwalk Section 'I'

Description

PEAT: (Pt) (Vu) Dark brown, w/ some organic silt, frozen w/ 50% segregated Ice (ICE) above 1.5'

SILT: (ML) Gray, saturated, w/ some organics

ORGANIC SILT: (OL) (Vx-Vs) Brown, w/ 30% visible excess ice

SILT: (ML) Gray to brown, moist to wet, w/ trace organics

DUANE MILLER & ASSOCIATES

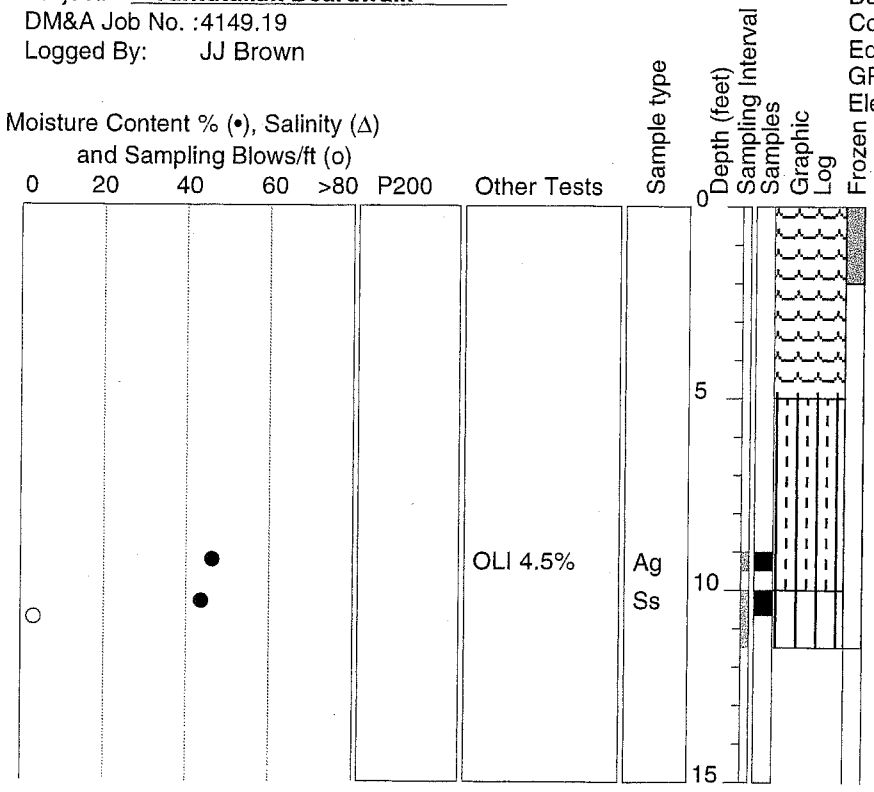
Project: **Tuntutuliak Boardwalk**

DM&A Job No. :4149.19

Logged By: JJ Brown

Log of HOLE : II

Date Drilled: 1/28/03
Contractor: Salzbrun Services
Equipment: SSD2
GPS Coord: N 60°20.727' W 162°40.404'
Elevation: Unknown



Boardwalk Section 'I'

Description

PEAT: (Pt) (Vu) Dark brown, w/ some organic silt, frozen w/ 50% segregated Ice (ICE) above 2'

ORGANIC SILT: (OL) Brown to gray, moist, w/ interlayered dense organics

SILT: (ML) Gray to brown, moist, w/ some organics

Duane Miller & Associates
Arctic & Geotechnical Engineering
Job No.: 4149.019
Date: September 2003

LOG of BORINGS I & II
Boardwalk Alignment
Tuntutuliak, Alaska

Plate
6

DUANE MILLER & ASSOCIATES

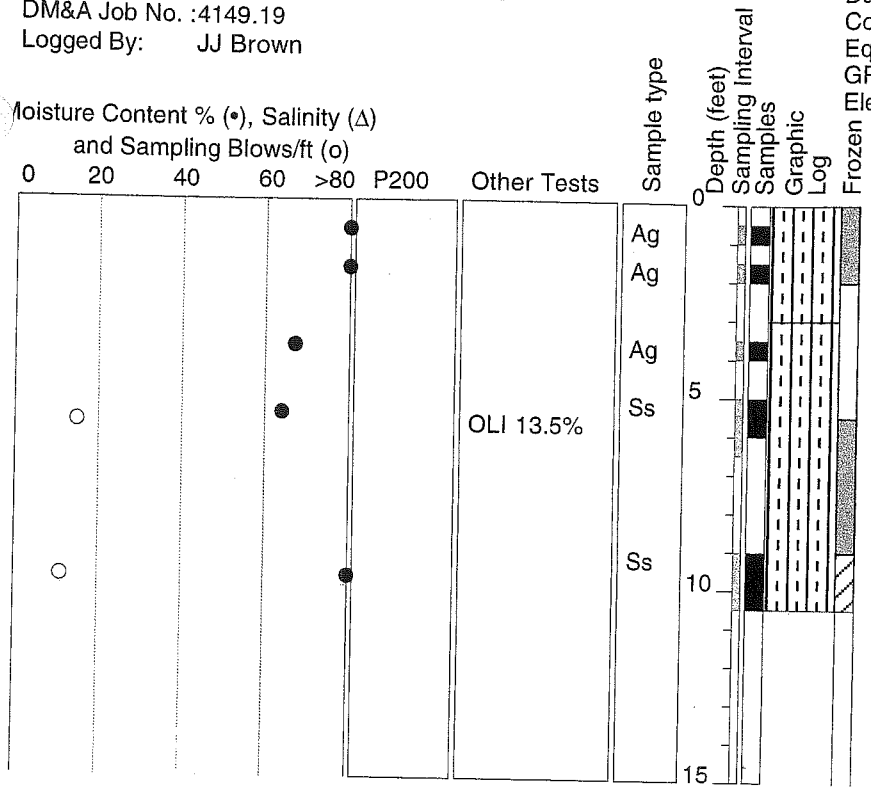
Project: **Tuntutuliak Boardwalk**

DM&A Job No. :4149.19

Logged By: JJ Brown

Log of HOLE : K

Date Drilled: 1/30/03
Contractor: Salzbrun Services
Equipment: SSD2
GPS Coord: N 60°20.691' W 162°40.000'
Elevation: Unkown



Boardwalk Section 'K'

Description
ORGANIC SILT: (OL) Brown, w/ mixed Peat (Pt), frozen to 2' w/ <5% visible ice
ORGANIC SILT: (OL) Brown to gray, moist, w/ some organics Frozen below 5' w/ 5% to 10% visible ice (Vx-Vr)

DUANE MILLER & ASSOCIATES

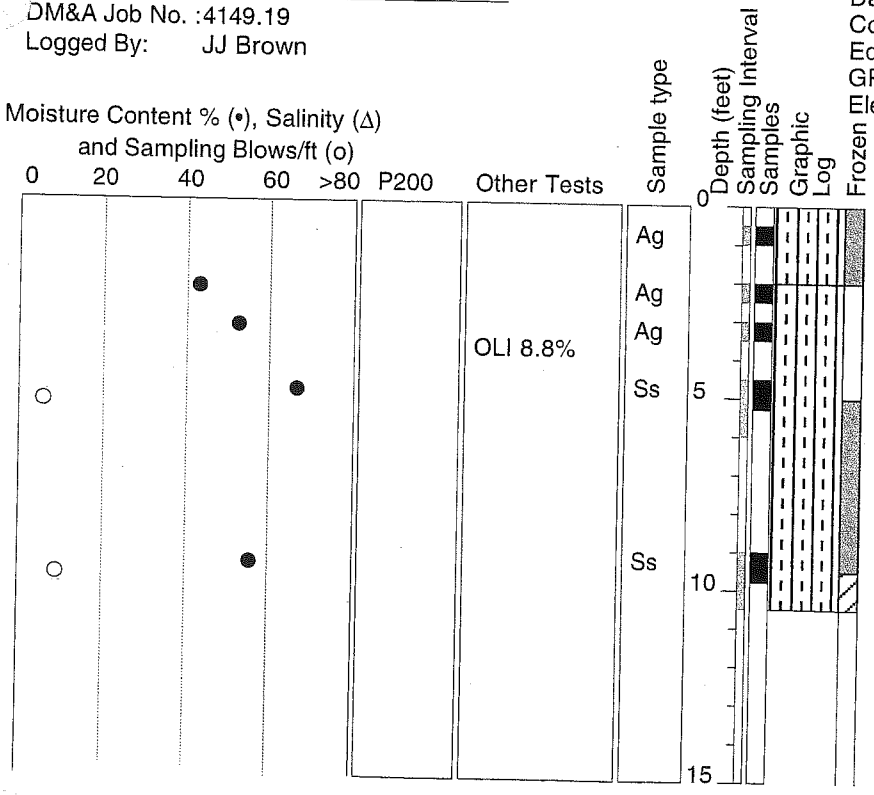
Project: **Tuntutuliak Boardwalk**

DM&A Job No. :4149.19

Logged By: JJ Brown

Log of HOLE : KK

Date Drilled: 1/30/03
Contractor: Salzbrun Services
Equipment: SSD2
GPS Coord: N 60°20.690' W 162°40.008'
Elevation: Unknown



Boardwalk Section 'K'

Description
ORGANIC SILT: (OL) (Nbe) Brown, w/ mixed Peat (Pt), 5% to 10% excess ice
ORGANIC SILT: (OL) Brown to gray, w/ some organics Frozen 5.5' w/ 10% to 20% visible excess ice (Vx-Vr) Stratified ice (Vs) at 9', horizontal lenses up to 1/2" thick

DUANE MILLER & ASSOCIATES

Project: **Tuntutuliak Boardwalk**

DM&A Job No. :4149.19

Logged By: JJ Brown

Log of HOLE : M

Date Drilled: 1/29/03

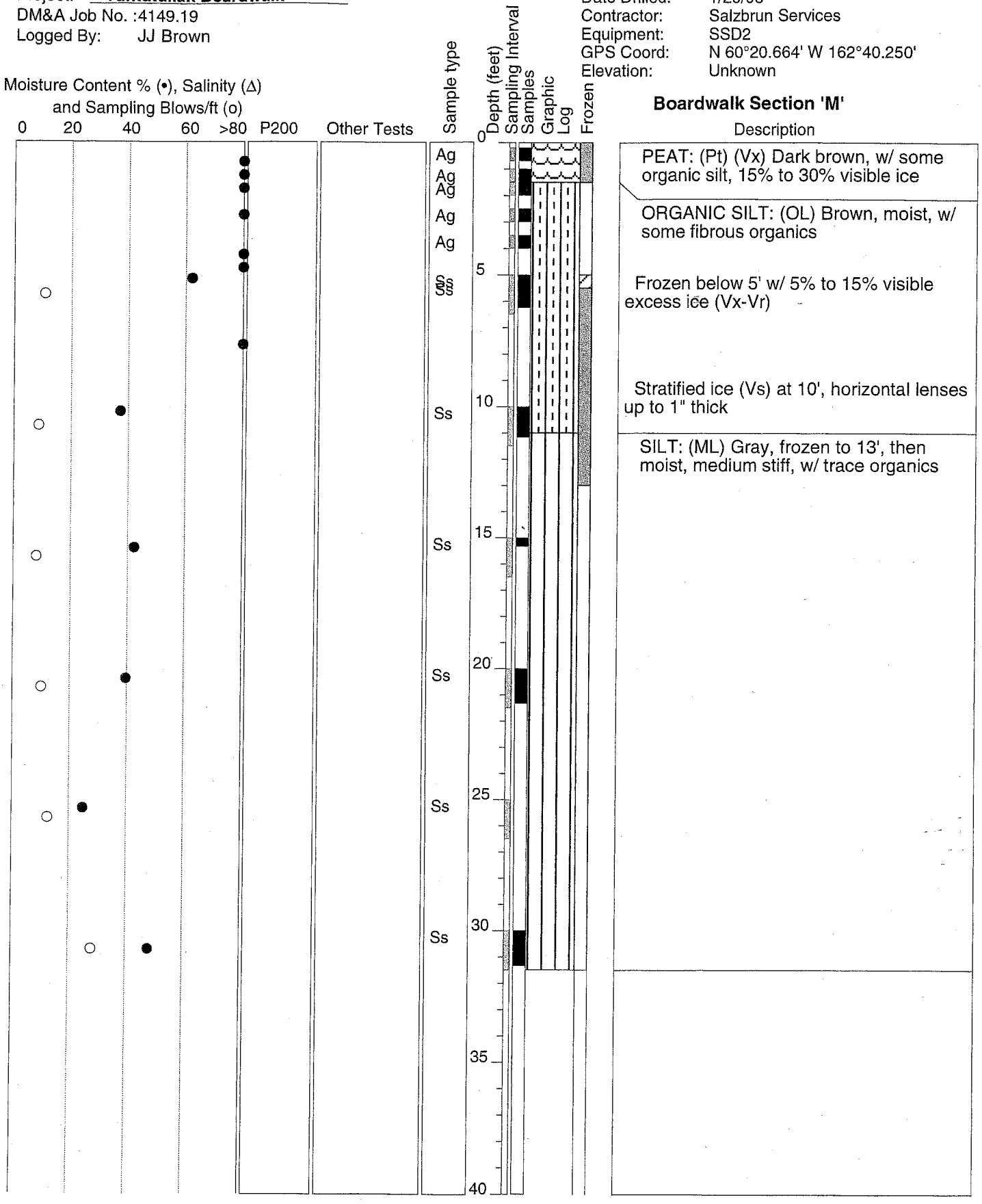
Contractor: Salzbrun Services

Equipment: SSD2

GPS Coord: N 60°20.664' W 162°40.250'

Elevation: Unknown

Boardwalk Section 'M'



Duane Miller & Associates

Arctic & Geotechnical Engineering

Job No.: 4149.019

Date: September 2003

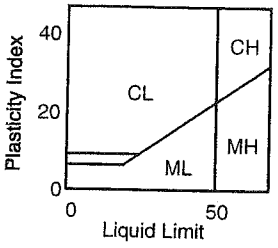
LOG of BORING M

Boardwalk Alignment

Tuntutuliak, Alaska

Plate

8

MAJOR DIVISIONS			SYMBOL		TYPICAL NAMES
COARSE GRAINED SOILS >50% larger than #200 sieve, 75µm	**GRAVELS** More than half of the coarse fraction is larger than #4 sieve size, > 4.75 mm.	Clean gravels with little or no fines (<5%)	GW		Well graded gravels, sandy gravel
			GP		Poorly graded gravels, sandy gravel
		Gravels with more than 12% fines	GM		Silty gravels, silt sand gravel mixtures
			GC		Clayey gravels, clay sand gravel mixtures
	SANDS More than half of the coarse fraction is smaller than #4 sieve size < 4.75 mm.	Clean sands with little or no fines (<5%)	SW		Well graded sand, gravelly sand
			SP		Poorly graded sands, gravelly sand
		Sands with more than 12% fines	SM		Silty sand, silt gravel sand mixtures
			SC		Clayey sand, clay gravel sand mixtures
FINE GRAINED SOILS >50% finer than #200 sieve, 75µm	Plasticity Chart 	**SILTS and CLAYS** Liquid limit less than 50	ML		Inorganic silt and very fine sand, rock flour
			CL		Inorganic clay, gravelly and sandy clay, silty clay
			OL		Organic silts and clay of low plasticity
		SILTS and CLAYS Liquid limit greater than 50	MH		Inorganic silt
			CH		Inorganic clay, fat clay
			OH		Organic silt and clay of high plasticity
HIGHLY ORGANIC SOILS			Pt		Peat and other highly organic soil

UNIFIED SOIL CLASSIFICATION SYSTEM

KEY TO TEST DATA

Dd = Dry Density (pcf)
TC = Thaw Consolidation
TCf = Thaw Consolidation (field)
LL = Liquid Limit
PL = Plastic Limit
PI = Plastic Index
SpG = Specific Gravity
SA = Sieve Analysis
MA = Sieve and Hydrometer Analysis
OLI = Organic Loss
TXUU = Unconsolidated Undrained Triaxial
TXCU = Consolidated Undrained Triaxial
TXCD = Consolidated Drained Triaxial

XXX (YYY)
XXX=$(\sigma 1-\sigma 3)/2$
YYY=$\sigma 3$

KEY TO SAMPLE TYPE

Ag = Auger grab
Ab = Auger bulk
Ac = Air chip
Cc = Continuous Core
Ss = 1.4" ID split barrel w/140 lb. manual hammer
Sh = 2.5" ID split barrel w/340 lb. manual hammer
Sha= 2.5" ID split barrel w/340 lb. automatic hammer
Tw = Shelby tube

GROUP	ICE VISIBILITY	DESCRIPTION		SYMBOL	
N	Segregated ice not visible by eye	Poorly bonded or friable		Nf	
		Well bonded	No excess ice	Nb	Nbn
			Excess microscopic ice		Nbe
V	Segregated ice is visible by eye and is one inch or less in thickness	Individual ice crystals or inclusions		Vx	
		Ice coatings on particles		Vc	
		Random or irregularly oriented ice formations		Vr	
		Stratified or distinctly oriented ice formations		Vs	
		Uniformly distributed ice		Vu	
ICE	Ice greater than one inch in thickness	Ice with soil inclusions		ICE + soil type	
		Ice without soil inclusions		ICE	

ICE CLASSIFICATION SYSTEM

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Job No.: 4149.19
Date: Sept. 2003

SOIL and ICE CLASSIFICATION and KEY TO DATA
Boardwalk Alignment
Tuntutuliak, Alaska

Plate **9**

Test Hole	Sample Depth	Soil Type (USCS)	Thermal State	Sampler Type	Sampling Blows/ ft	Moisture Content	Organic Loss
F	0.5 ft.	Pt	Frozen	Ag		837.7%	
F	1.5 ft.	Pt	Frozen	Ag		565.9%	
F	2.0 ft.	OL	Frozen	Ag		127.4%	
F	3.5 ft.	OL	Unfrozen	Ag		75.3%	
F	5.0 ft.	ML	Unfrozen	Ss	6	49.2%	
F	10.0 ft.	OL	Marginally Frozen	Ss	15	59.9%	
F	10.5 ft.	OL	Frozen	Ag		83.9%	
F	15.0 ft.	ML	Frozen	Ss	19	69.9%	
G	0.5 ft.	Pt	Frozen	Ag		836.6%	
G	1.5 ft.	Pt	Frozen	Ag		585.7%	
G	3.5 ft.	OL	Unfrozen	Ag		119.3%	19%
G	5.0 ft.	OL	Unfrozen	Ss	7	57.9%	
G	10.0 ft.	OL	Unfrozen	Ss	5	57.0%	
G	15.0 ft.	OL	Unfrozen	Ss	8	75.6%	14%
G	20.0 ft.	ML	Unfrozen	Ss	9	42.5%	
G	30.0 ft.	ML	Unfrozen	Ss	16	32.4%	
H	0.5 ft.	Pt	Frozen	Ag		640.4%	
H	1.0 ft.	Pt	Frozen	Ag		488.2%	
H	1.5 ft.	OL	Unfrozen	Ag		129.3%	
H	2.5 ft.	OL	Unfrozen	Ag		92.9%	
H	4.0 ft.	OL	Unfrozen	Ag		82.5%	
H	4.5 ft.	Pt	Unfrozen	Ag		103.6%	
H	5.0 ft.	OL	Unfrozen	Ag		62.3%	13%
H	7.5 ft.	OL	Unfrozen	Ag		103.4%	
H	10.0 ft.	ML	Unfrozen	Ss	5	37.4%	
H	15.0 ft.	ML	Unfrozen	Ss	13	42.2%	
H	20.0 ft.	ML	Unfrozen	Ss	5	39.7%	
H	25.0 ft.	ML	Unfrozen	Ss	12	25.1%	
H	30.0 ft.	ML	Unfrozen	Ss	11	48.0%	4%
I	0.0 ft.	Pt	Frozen	Ag		826.0%	
I	0.5 ft.	Pt	Frozen	Ag		403.5%	
I	1.0 ft.	Pt	Frozen	Ag		574.4%	

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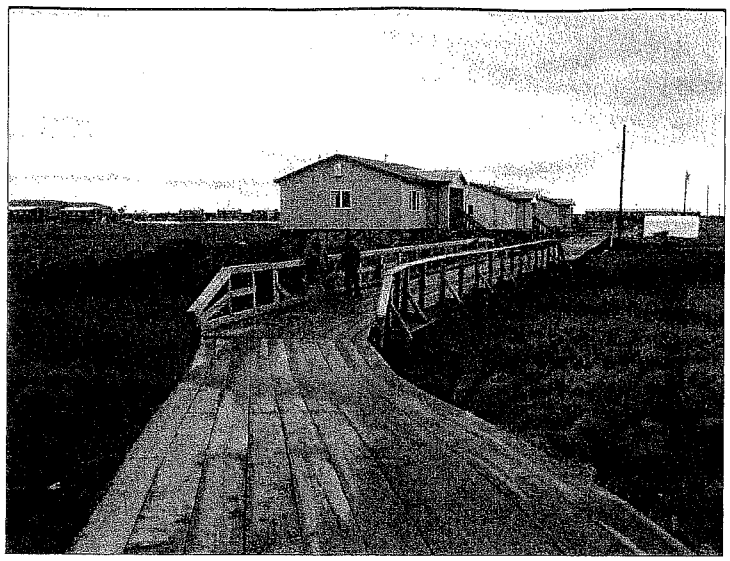
Sept. 2003

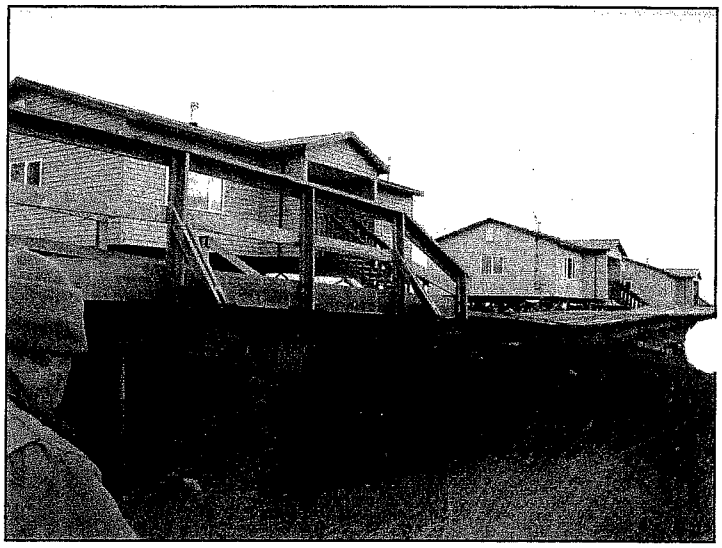
SUMMARY OF SAMPLES

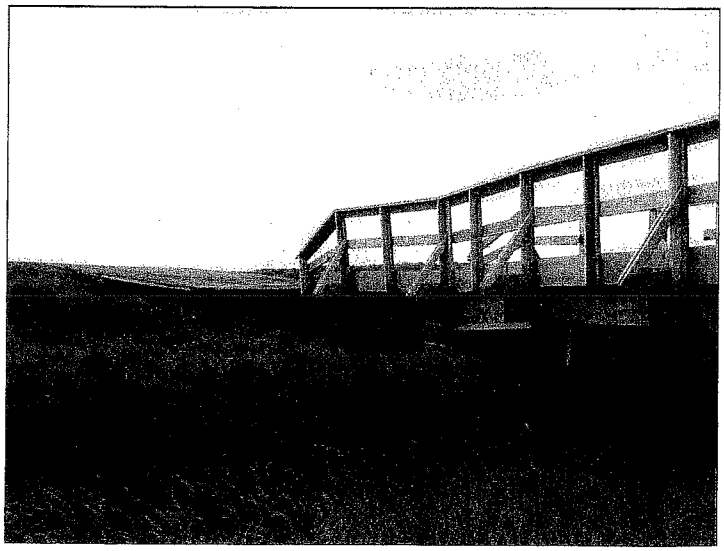
Boardwalk Alignment
Tuntutuliak, Alaska

Plate
10

Test Hole	Sample Depth	Soil Type (USCS)	Thermal State	Sampler Type	Sampling Blows/ ft	Moisture Content	Organic Loss
I	1.5 ft.	Pt	Unfrozen	Ag		1061.1%	
I	2.5 ft.	OL	Unfrozen	Ag		169.9%	
I	3.5 ft.	OL	Unfrozen	Ag		91.6%	11%
I	5.0 ft.	Pt	Frozen	Ss	11	510.8%	
I	8.0 ft.	OL	Marginally Frozen	Ag		82.1%	
II	9.0 ft.	OL	Unfrozen	Ag		46.2%	5%
II	10.0 ft.	OL	Unfrozen	Ss	3	43.4%	
K	0.5 ft.	OL	Frozen	Ag		118.1%	
K	1.5 ft.	OL	Frozen	Ag		79.8%	
K	3.5 ft.	OL	Unfrozen	Ag		67.4%	14%
K	5.0 ft.	OL	Frozen	Ss	15	64.2%	
K	9.0 ft.	OL	Marginally Frozen	Ss	11	167.5%	
KK	0.5 ft.	OL	Frozen	Ag		21.4%	
KK	2.0 ft.	OL	Unfrozen	Ag		43.1%	
KK	3.0 ft.	OL	Unfrozen	Ag		52.2%	
KK	4.5 ft.	OL	Marginally Frozen	Ss	6	66.5%	9%
KK	9.0 ft.	OL	Frozen	Ss	9	55.9%	
M	0.2 ft.	Pt	Frozen	Ag		155.0%	
M	1.0 ft.	Pt	Frozen	Ag		173.9%	
M	1.5 ft.	OL	Unfrozen	Ag		106.7%	
M	2.5 ft.	OL	Unfrozen	Ag		89.1%	
M	3.5 ft.	OL	Unfrozen	Ag		93.0%	
M	5.0 ft.	OL	Marginally Frozen	Ss	11	78.9%	
M	5.3 ft.	OL	Frozen	Ss		123.2%	
M	10.0 ft.	ML	Frozen	Ss	9	105.1%	
M	15.0 ft.	ML	Unfrozen	Ss	8	44.4%	
M	20.0 ft.	ML	Unfrozen	Ss	10	42.1%	
M	25.0 ft.	ML	Unfrozen	Ss	13		
M	30.0 ft.	ML	Unfrozen	Ss	28	60.8%	







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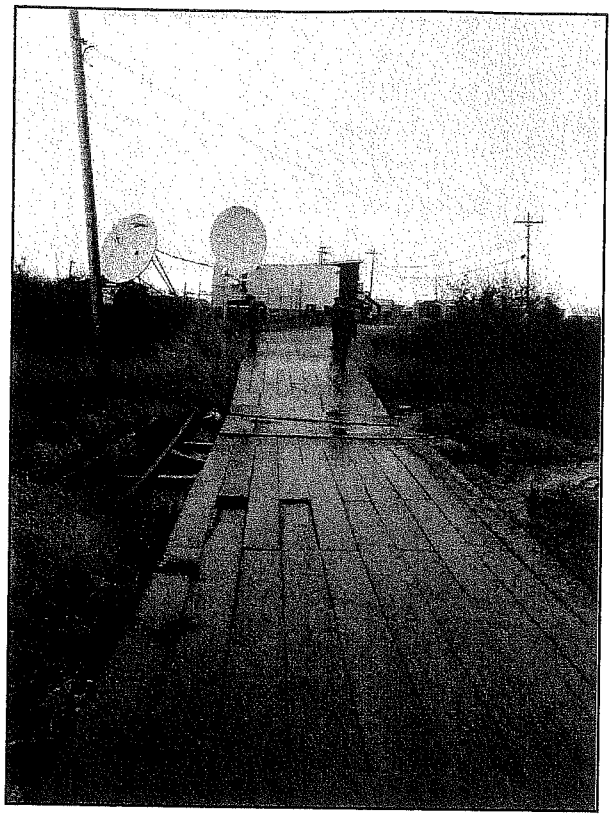
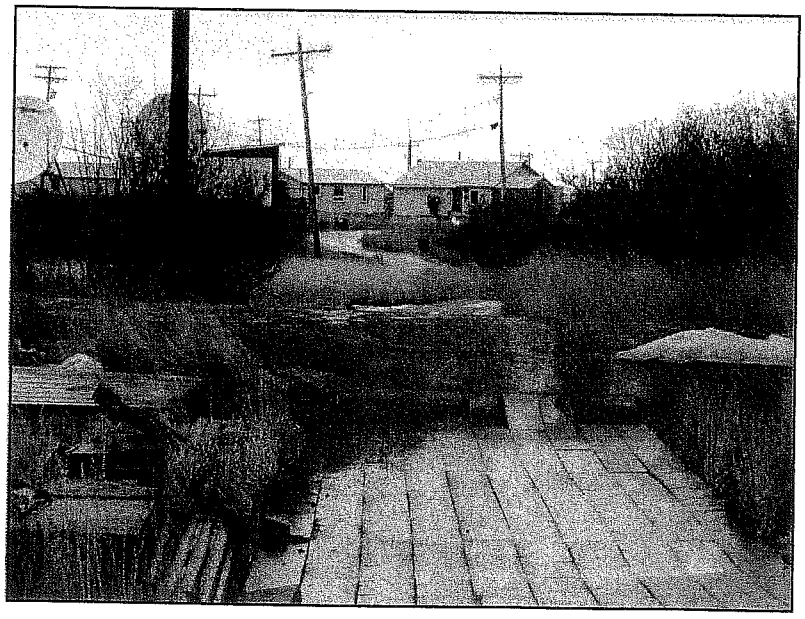
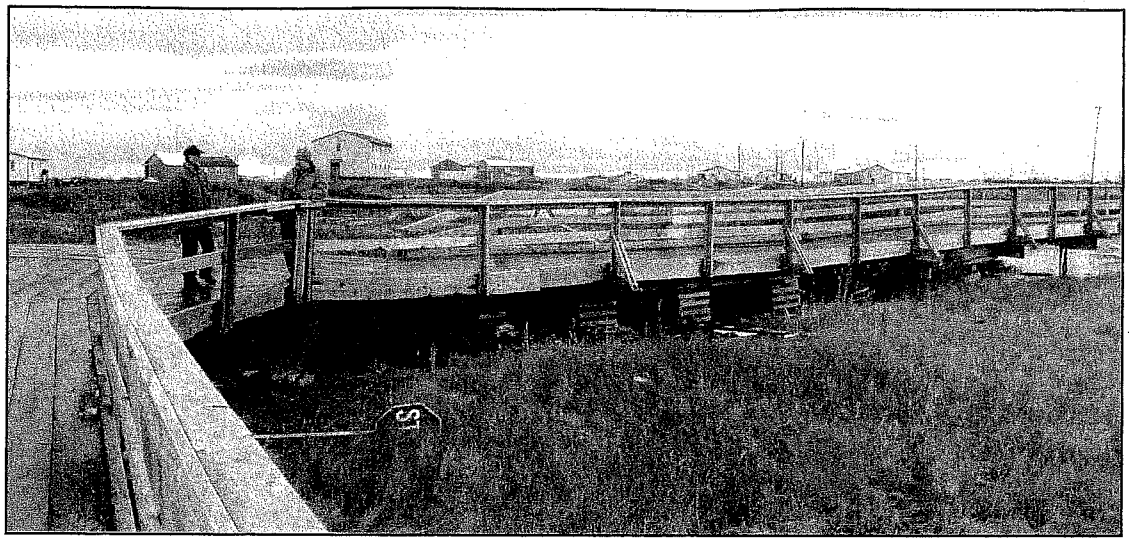
Date: Sept. 2003

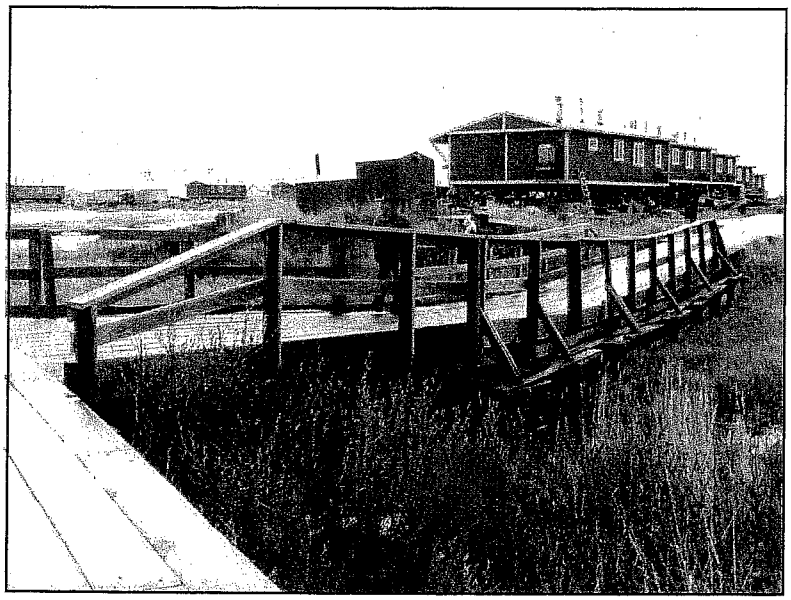
SITE PHOTOGRAPHS
SECTION A
Boardwalk Alignment
Tuntutuliak, Alaska

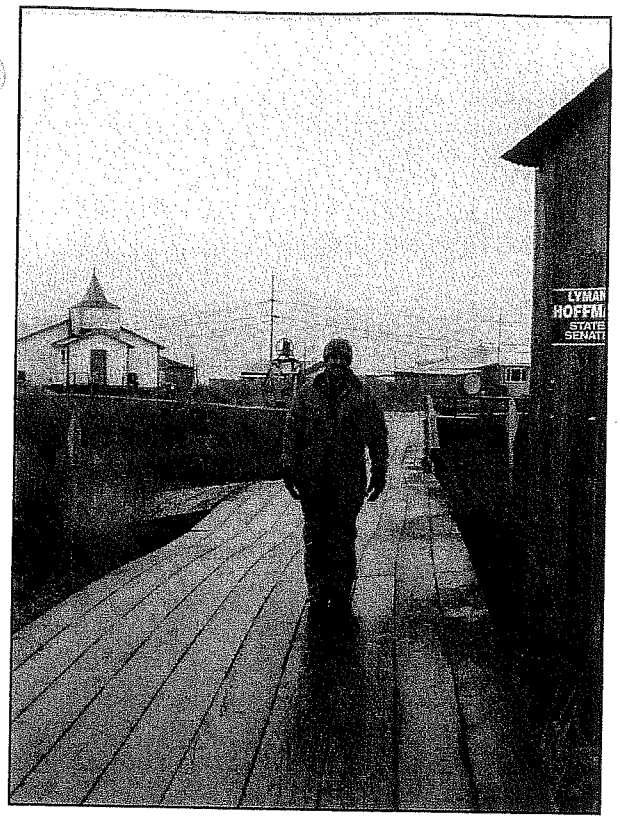
Plate
12

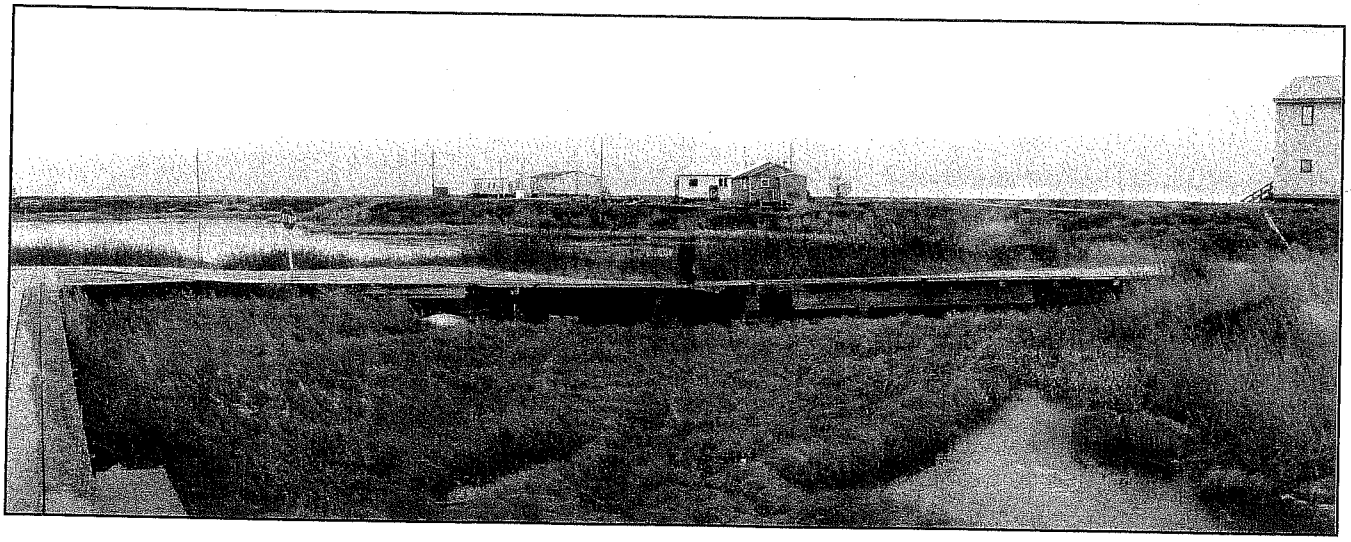


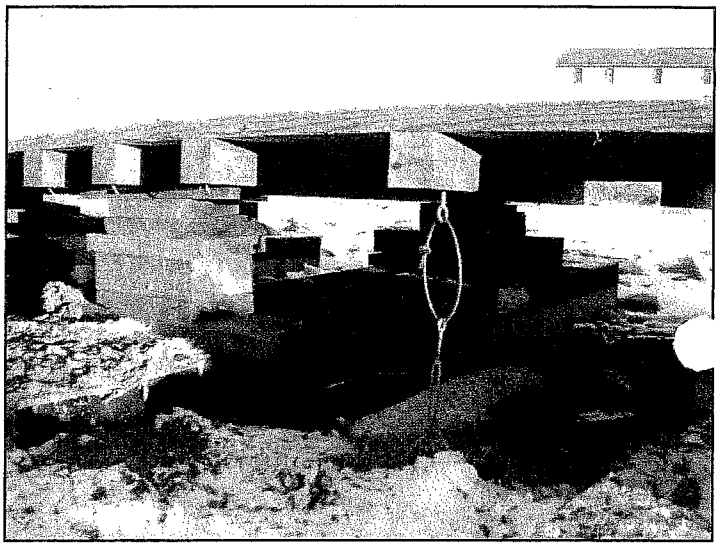


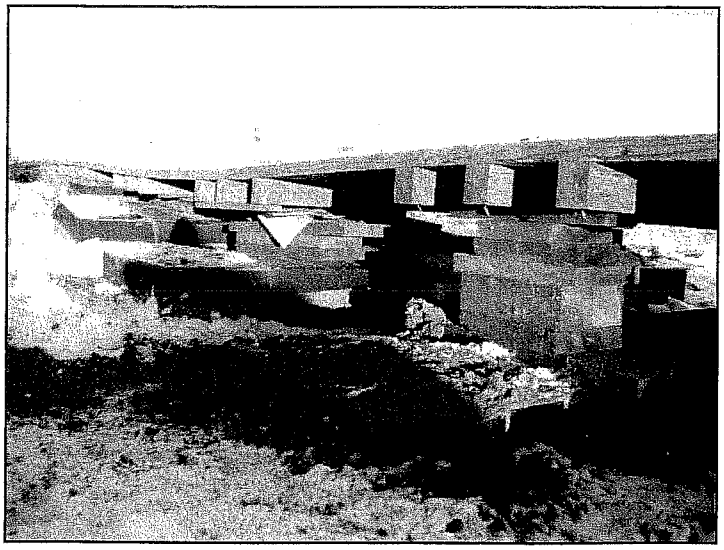


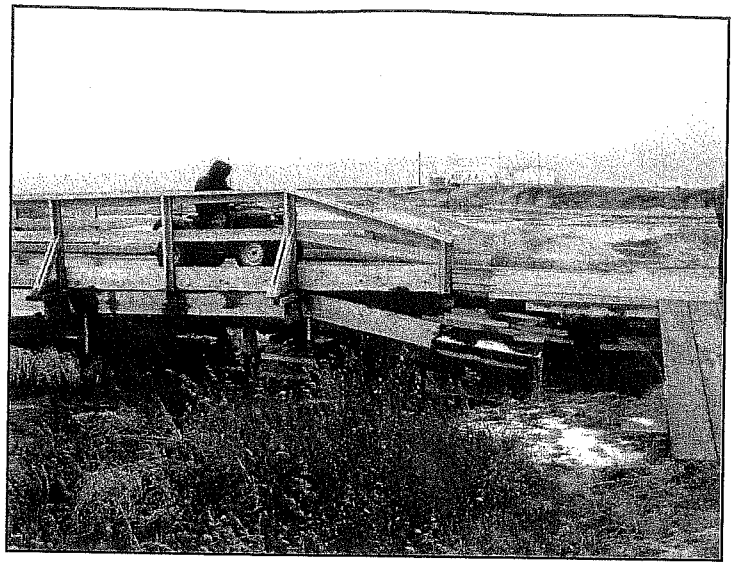


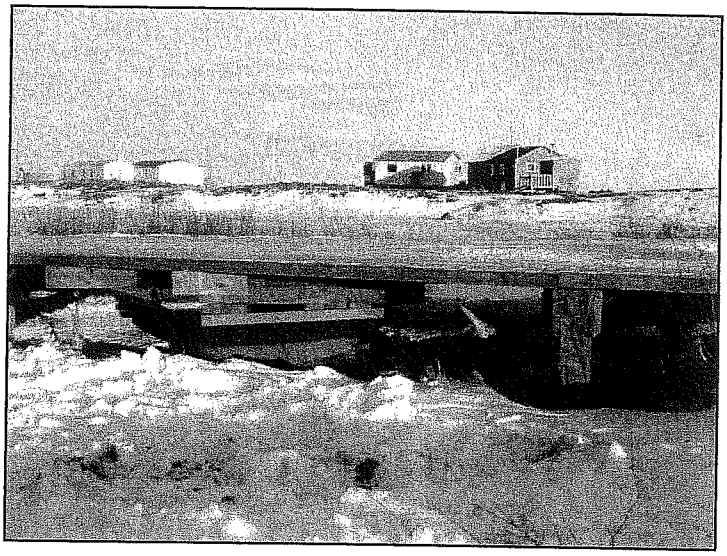

LYMAN
HOFFM
STATE
SENATI

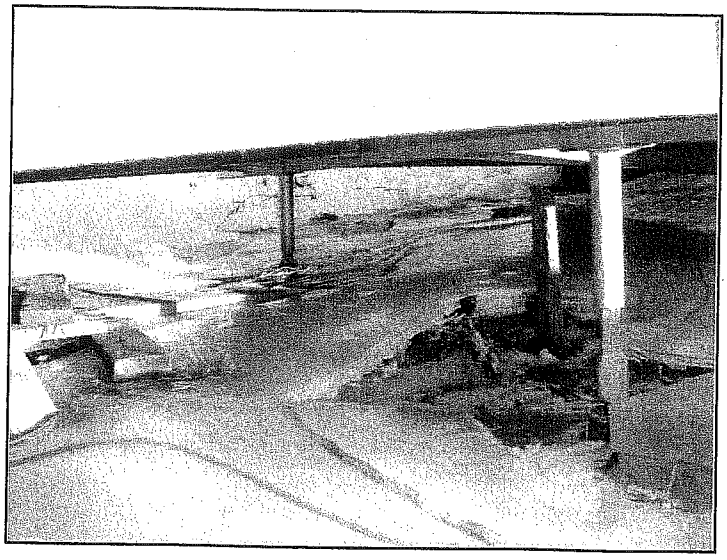


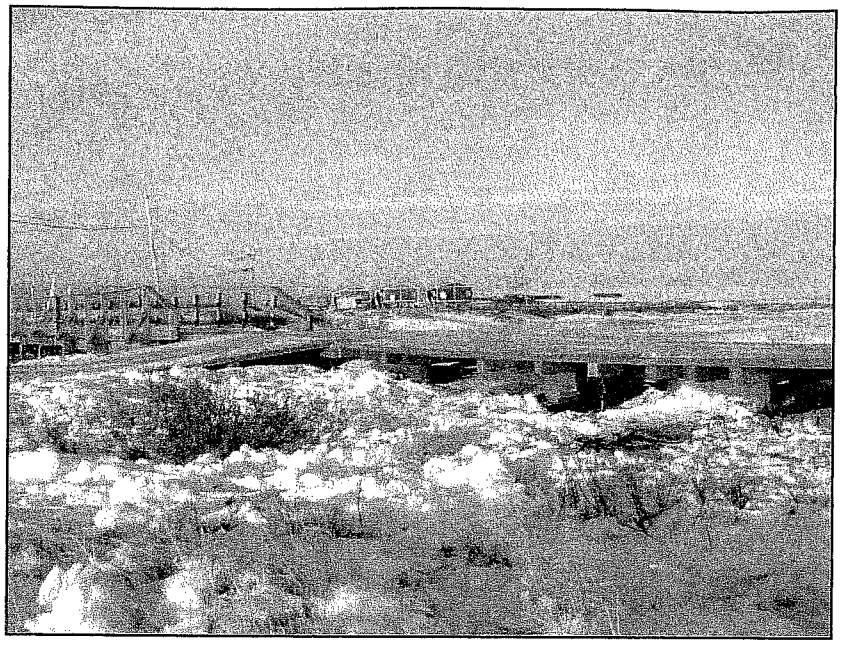


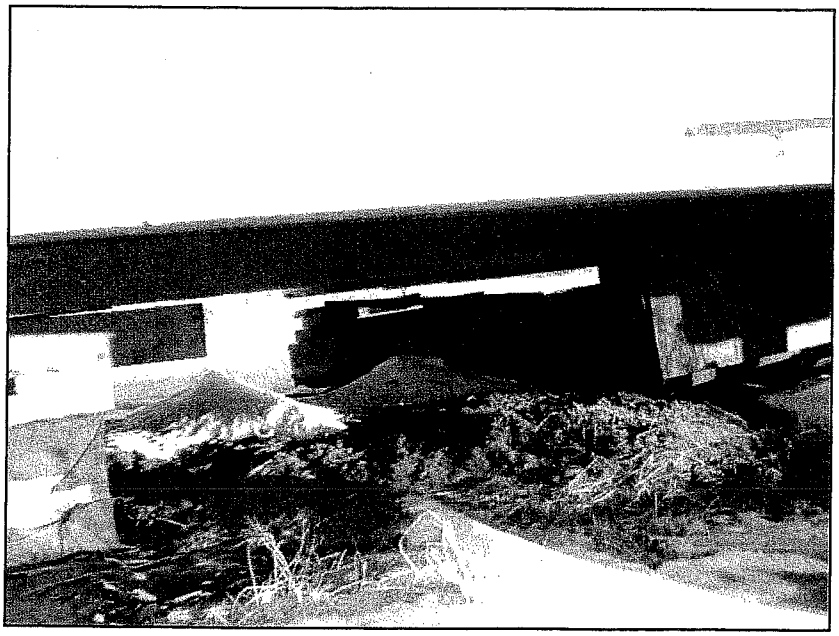


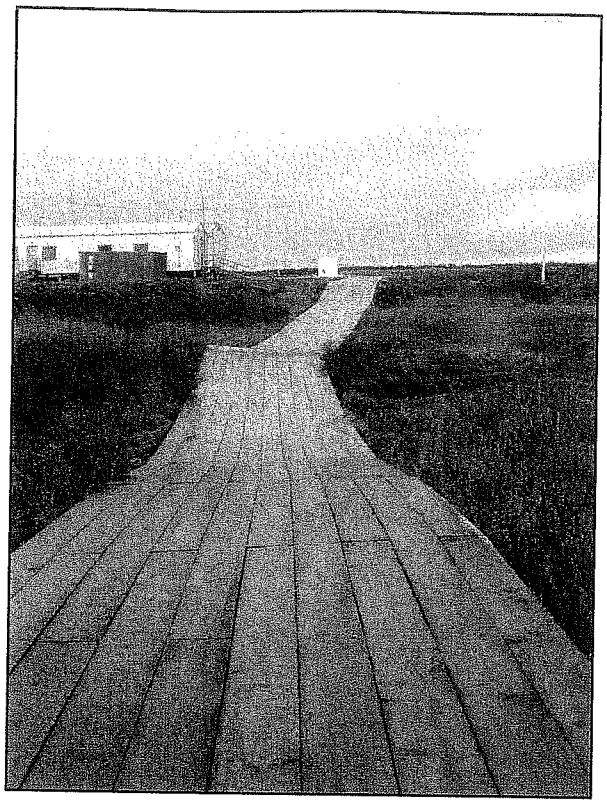


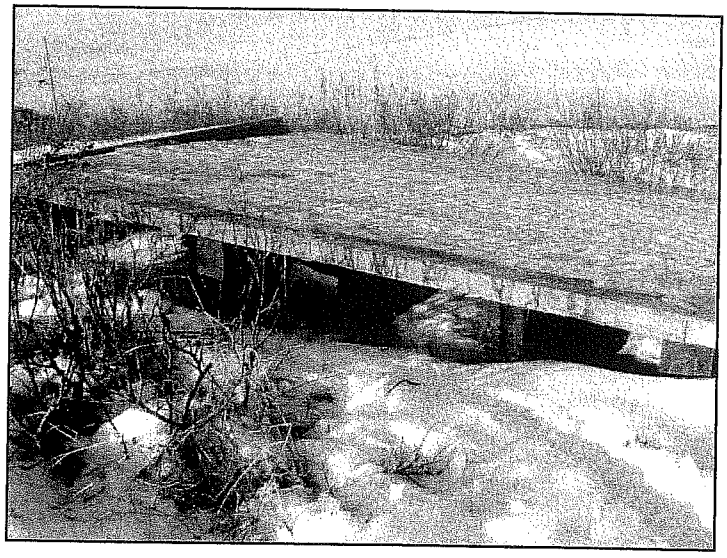


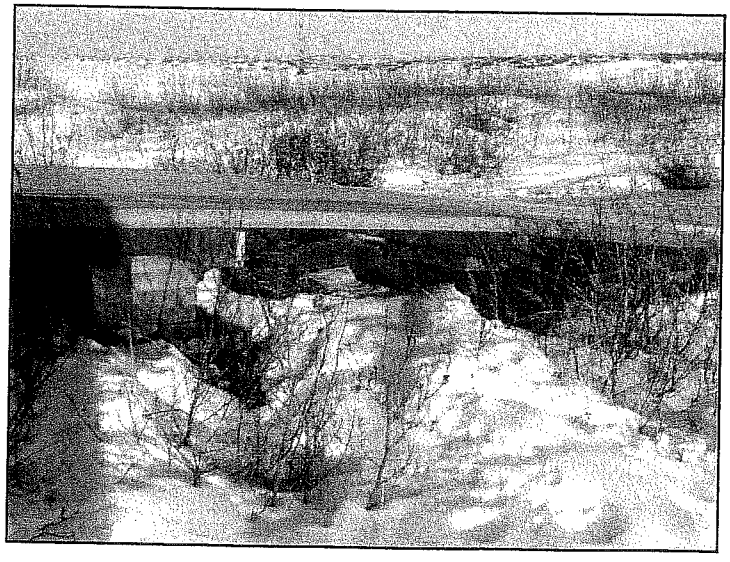


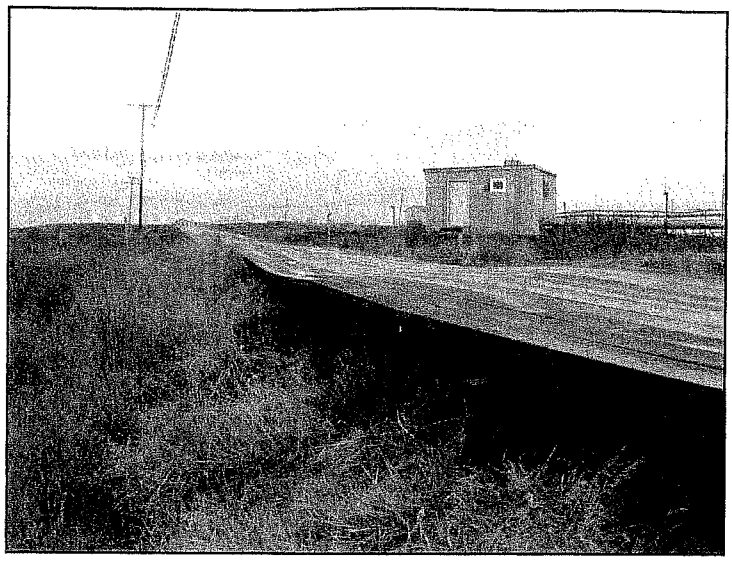


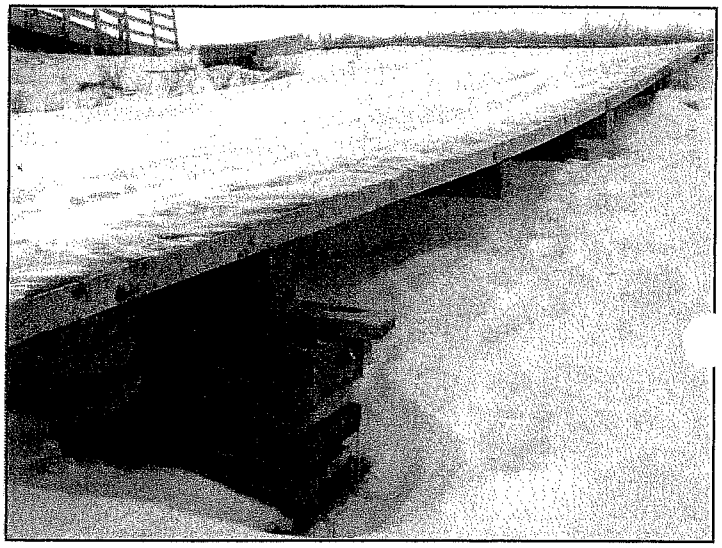


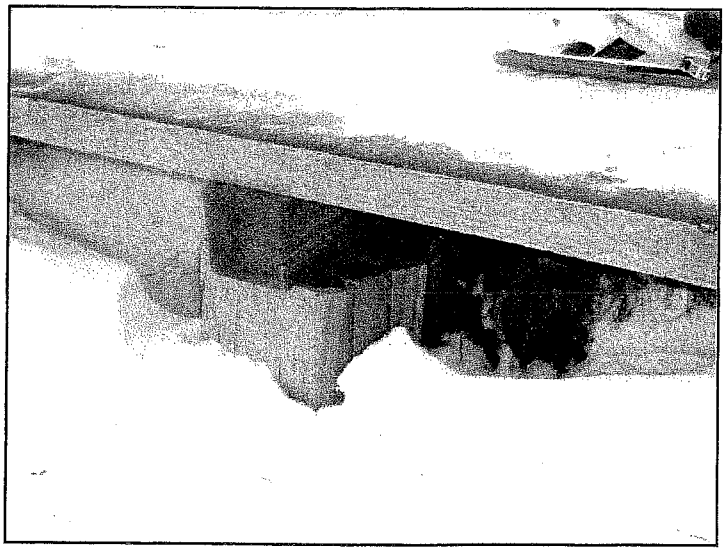


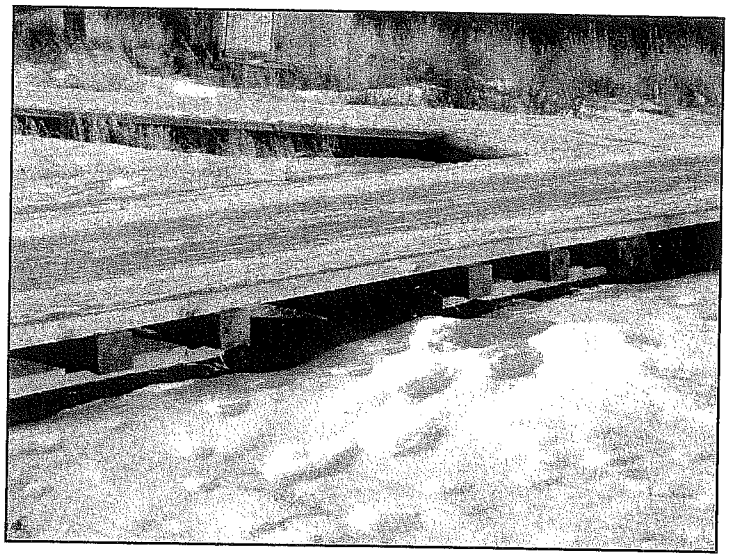


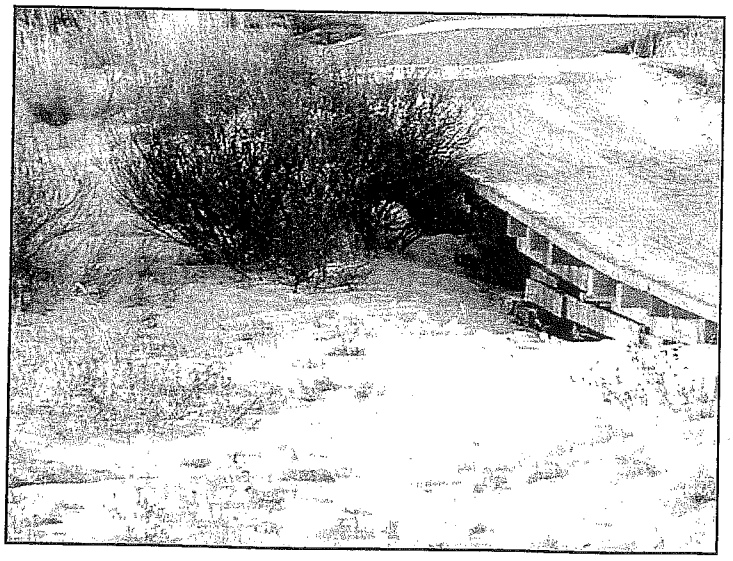


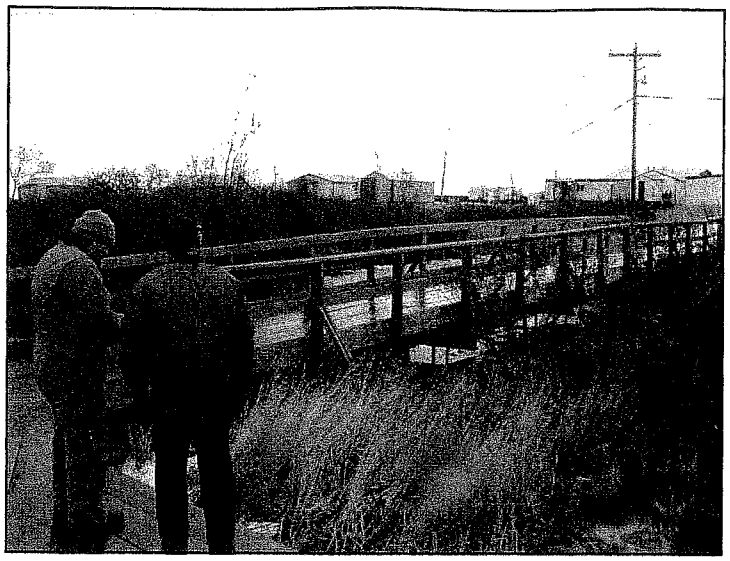


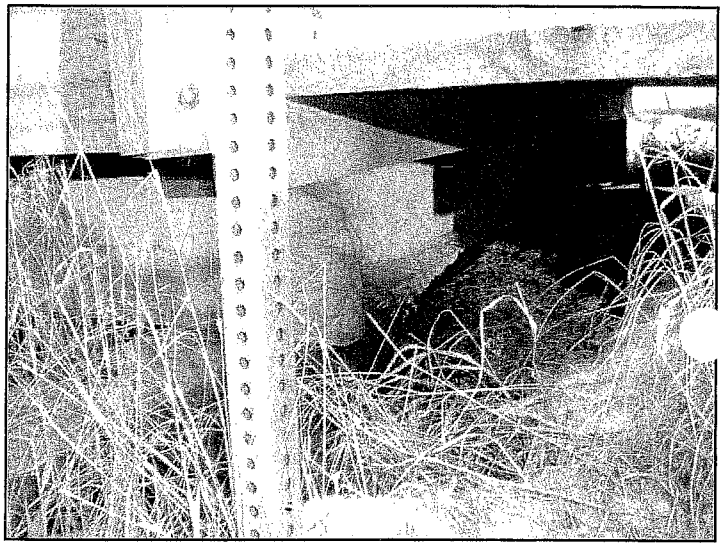


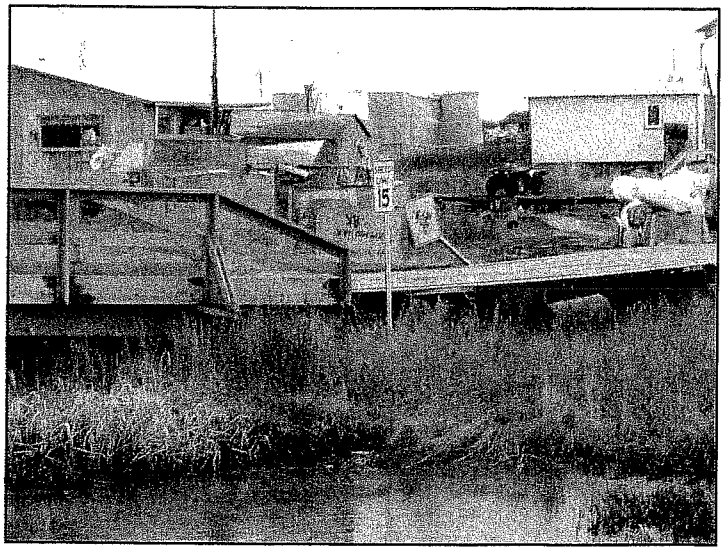












Duane Miller & Associates
Arctic & Geotechnical Engineering
Job No.: 4149.19
Date: Sept. 2003

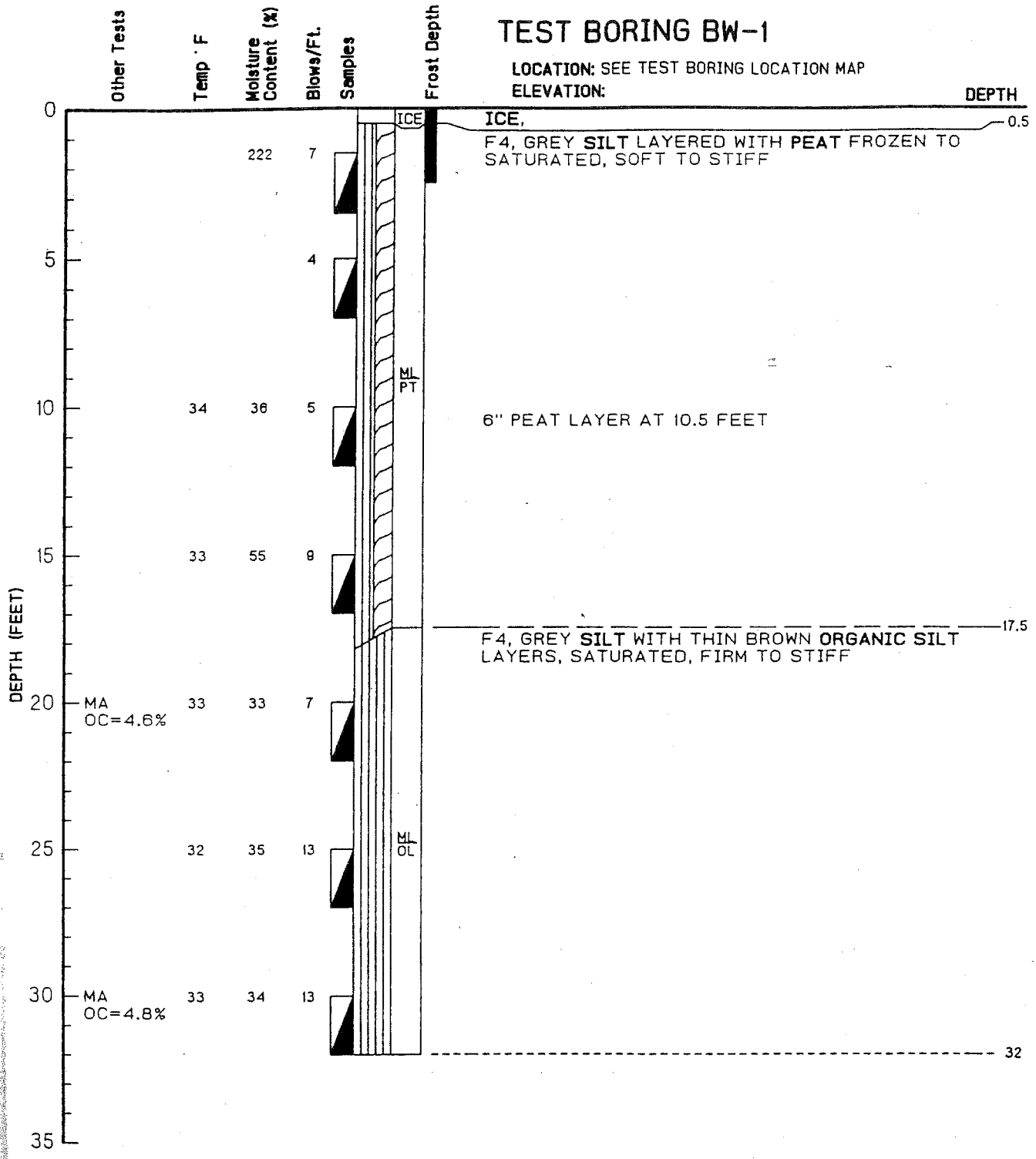
SITE PHOTOGRAPHS
SECTIONS L AND M
Boardwalk Alignment
Tuntutuliak, Alaska

Plate
22

APPENDIX

TEST BORING BW-1

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION:



DEPTH

ICE,
0.5
F4, GREY **SILT** LAYERED WITH **PEAT** FROZEN TO SATURATED, SOFT TO STIFF

6" PEAT LAYER AT 10.5 FEET

17.5
F4, GREY **SILT** WITH THIN BROWN **ORGANIC SILT** LAYERS, SATURATED, FIRM TO STIFF

32

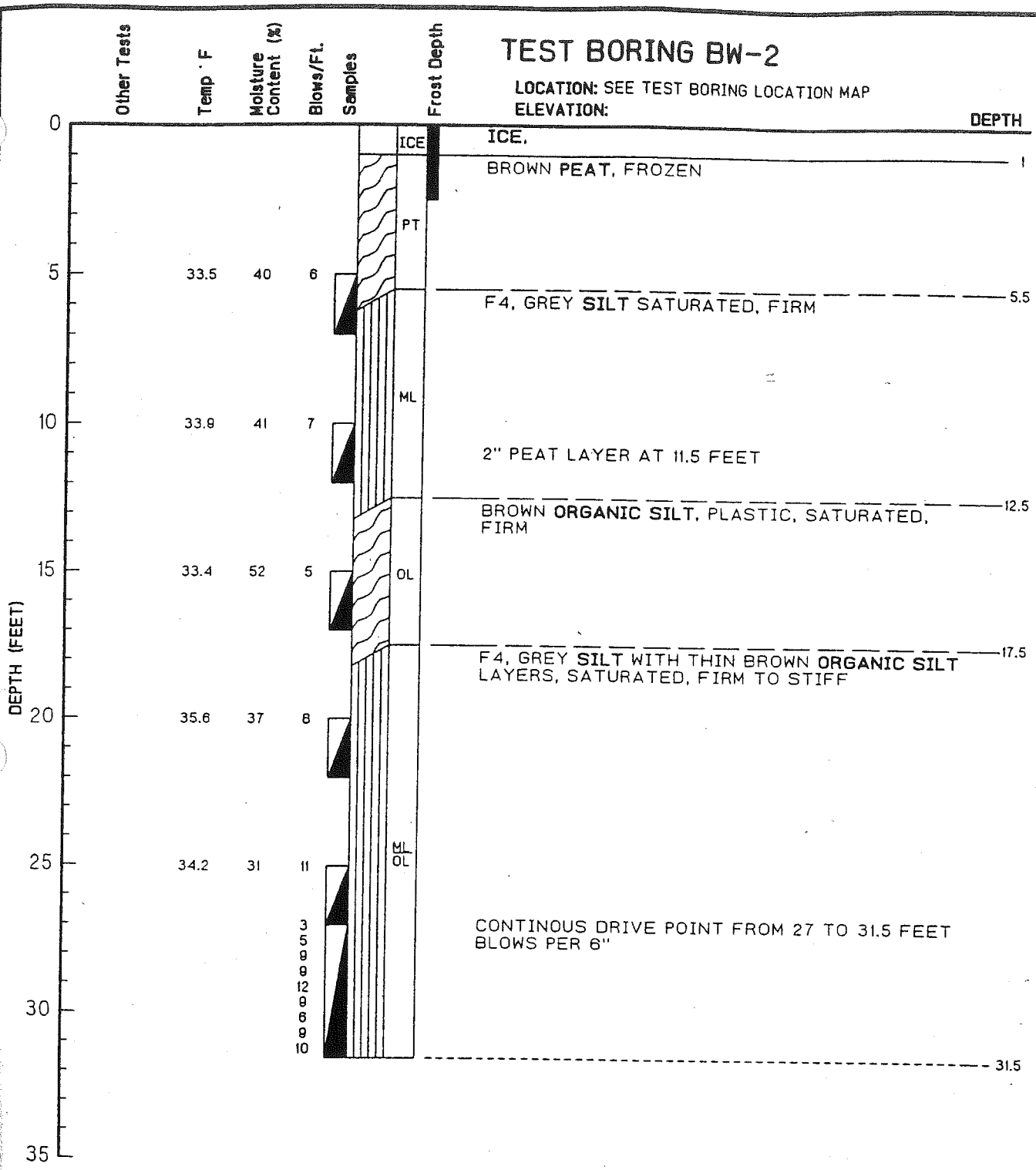
KEY
MA = Mechanical Analysis
LL = Liquid Limit
PI = Plastic Index
PP = Pocket Penetrometer (TSF)
TV = Torvane (TSF)
□ = Grab Sample
◪ = SPT Sample
▨ = Shelby Tube - pushed
▣ = 2.5" I.D. Spoon Sample 340# weight, 30" fall
T = Sample Temperature (° F) probably affected by sampling procedure

CLIENT: ERE
PROJECT: TUNTUTULIAK
LOGGED BY: J. LAMBE
BORING COMPLETED: 4/17/94
W.O. F45006

DOWL ENGINEERS ALASKA TESTLAB	LOG OF BORING	FIGURE 22

TEST BORING BW-2

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION:



DEPTH

ICE.

BROWN **PEAT**, FROZEN — 1

F4, GREY **SILT** SATURATED, FIRM — 5.5

2" PEAT LAYER AT 11.5 FEET

BROWN **ORGANIC SILT**, PLASTIC, SATURATED, FIRM — 12.5

F4, GREY **SILT** WITH THIN BROWN **ORGANIC SILT** LAYERS, SATURATED, FIRM TO STIFF — 17.5

CONTINOUS DRIVE POINT FROM 27 TO 31.5 FEET
BLOWS PER 6"

31.5

KEY
MA = Mechanical Analysis
LL = Liquid Limit
PI = Plastic Index
PP = Pocket Penetrometer (TSF)
TV = Torvane (TSF)
□ = Grab Sample
◪ = SPT Sample
S = Shelby Tube – pushed
⊠ = 2.5" I.D. Spoon Sample 340# weight, 30" fall
T = Sample Temperature (° F) probably affected by sampling procedure

CLIENT: ERE
PROJECT: TUNTUTULIAK
LOGGED BY: J. LAMBE
BORING COMPLETED: 4/17/94
W.O. F45006

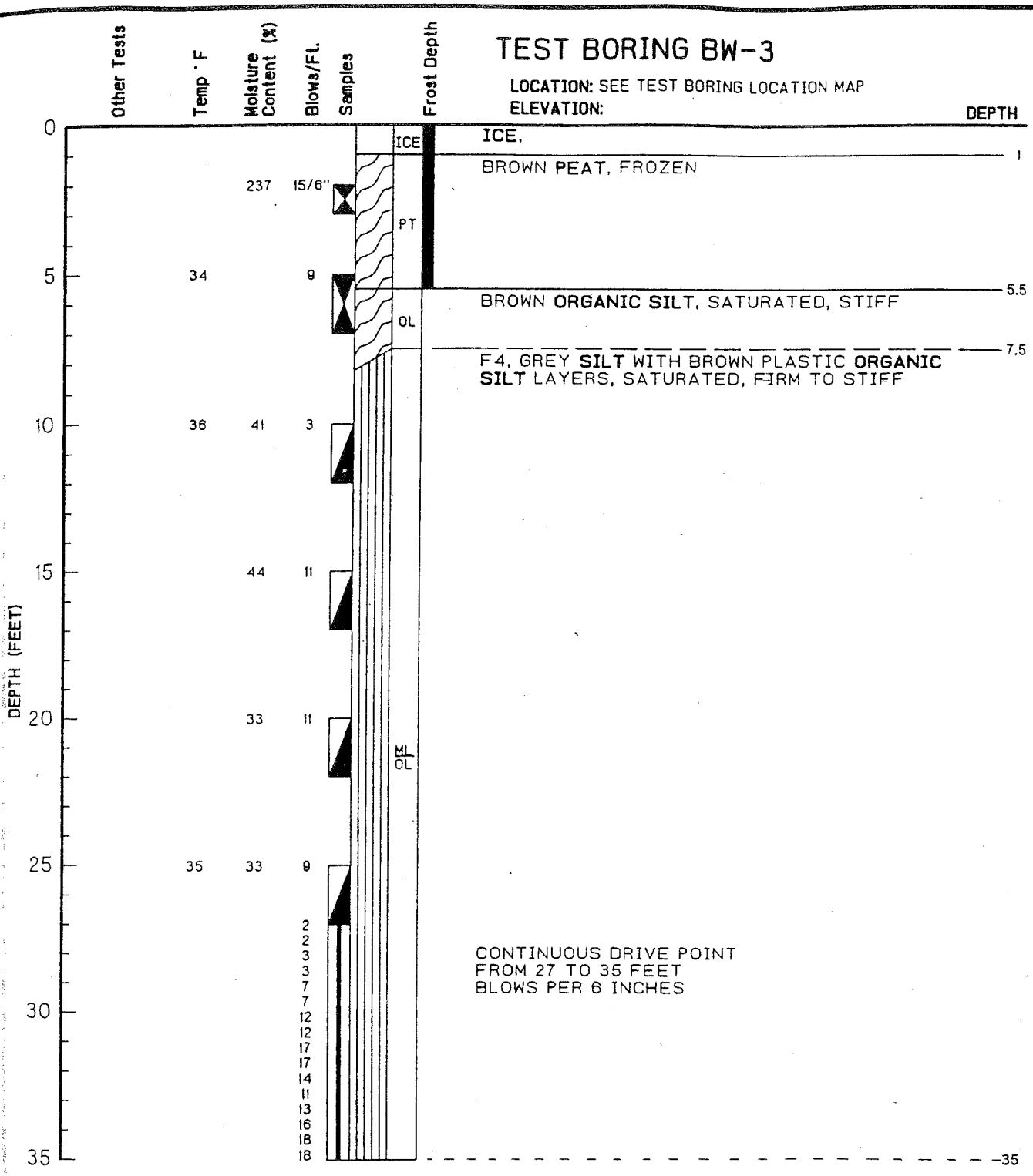
DOWL ENGINEERS
ALASKA TESTLAB

LOG OF BORING

FIGURE 23

TEST BORING BW-3

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION:



KEY
MA = Mechanical Analysis
LL = Liquid Limit
PI = Plastic Index
PP = Pocket Penetrometer (TSF)
TV = Torvane (TSF)
□ = Grab Sample
◪ = SPT Sample
▨ = Shelby Tube - pushed
⊠ = 2.5" I.D. Spoon Sample
340# weight, 30" fall
T = Sample Temperature (° F) probably affected by sampling procedure

CLIENT: ERE
PROJECT: TUNTUTULIAK
LOGGED BY: J. LAMBE
BORING COMPLETED: 4/17/94
W.O. F45006

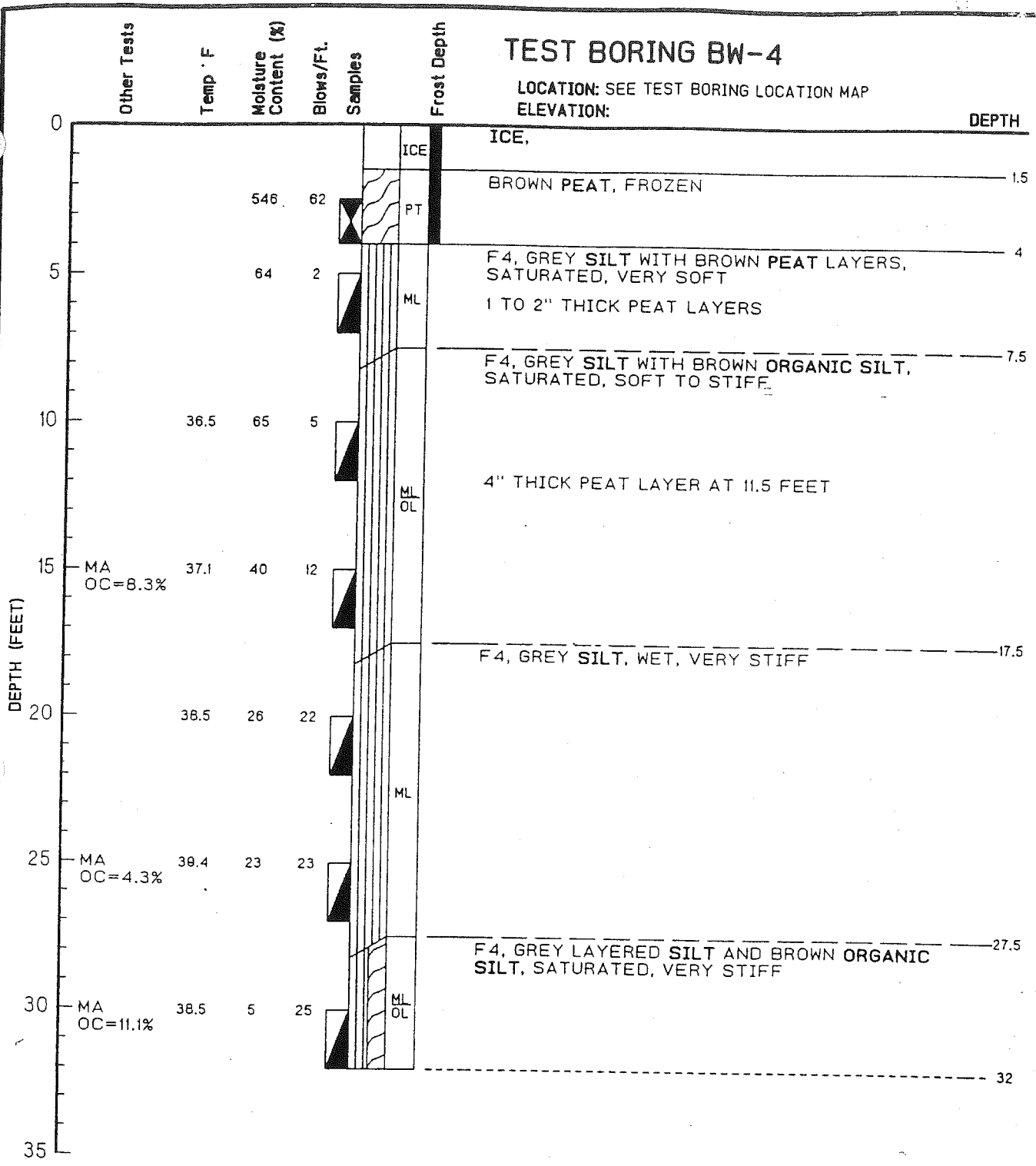
DOWL ENGINEERS
ALASKA TESTLAB

LOG OF BORING

FIGURE 24

TEST BORING BW-4

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION:



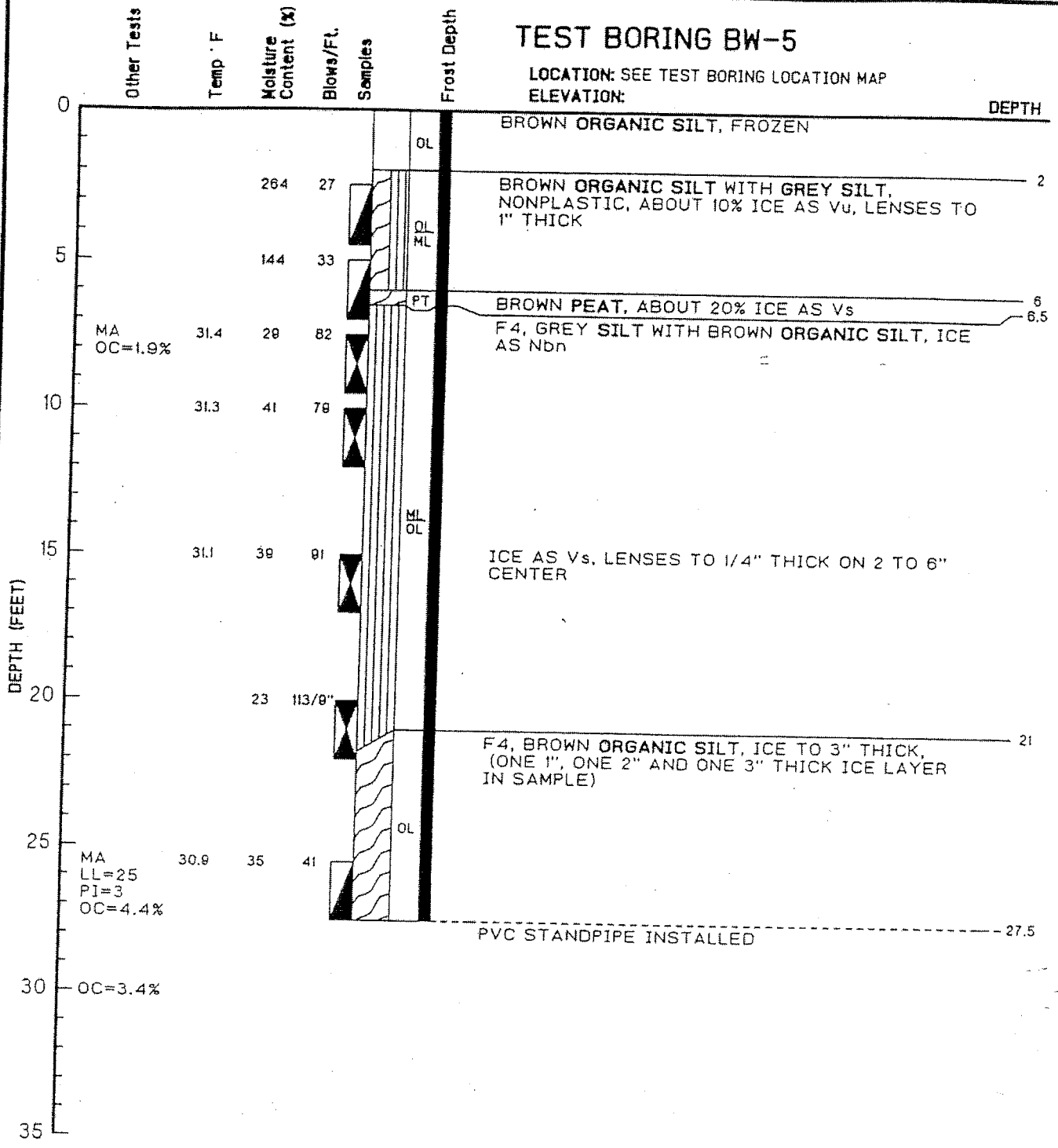
KEY
MA = Mechanical Analysis
LL = Liquid Limit
PI = Plastic Index
PP = Pocket Penetrometer (TSF)
TV = Torvane (TSF)
☐ = Grab Sample
▩ = SPT Sample
▨ = Shelby Tube – pushed
▣ = 2.5" I.D. Spoon Sample 340# weight, 30" fall
T = Sample Temperature (° F) probably affected by sampling procedure

CLIENT: ERE
PROJECT: TUNTUTULIAK
LOGGED BY: J. LAMBE
BORING COMPLETED: 4/18/94
W.O. F45006

DOWL ENGINEERS ALASKA TESTLAB	LOG OF BORING	FIGURE 25

TEST BORING BW-5

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION:



DEPTH

BROWN **ORGANIC SILT**, FROZEN

2

BROWN **ORGANIC SILT** WITH **GREY SILT**, NONPLASTIC, ABOUT 10% ICE AS Vu, LENSES TO 1" THICK

6

BROWN **PEAT**, ABOUT 20% ICE AS Vs

6.5

F4, GREY **SILT** WITH BROWN **ORGANIC SILT**, ICE AS Nbn

ICE AS Vs, LENSES TO 1/4" THICK ON 2 TO 6" CENTER

21

F4, BROWN **ORGANIC SILT**, ICE TO 3" THICK, (ONE 1", ONE 2" AND ONE 3" THICK ICE LAYER IN SAMPLE)

27.5

PVC STANDPIPE INSTALLED

KEY
MA = Mechanical Analysis
LL = Liquid Limit
PI = Plastic Index
PP = Pocket Penetrometer (TSF)
TV = Torvane (TSF)
□ = Grab Sample
■ = SPT Sample
S = Shelby Tube - pushed
■ = 2.5" I.D. Spoon Sample 340# weight, 30" fall
T = Sample Temperature (° F) probably affected by sampling procedure

CLIENT: ERE
PROJECT: TUNTUTULIAK
LOGGED BY: J. LAMBE
BORING COMPLETED: 4/16/94
W.O. F45006

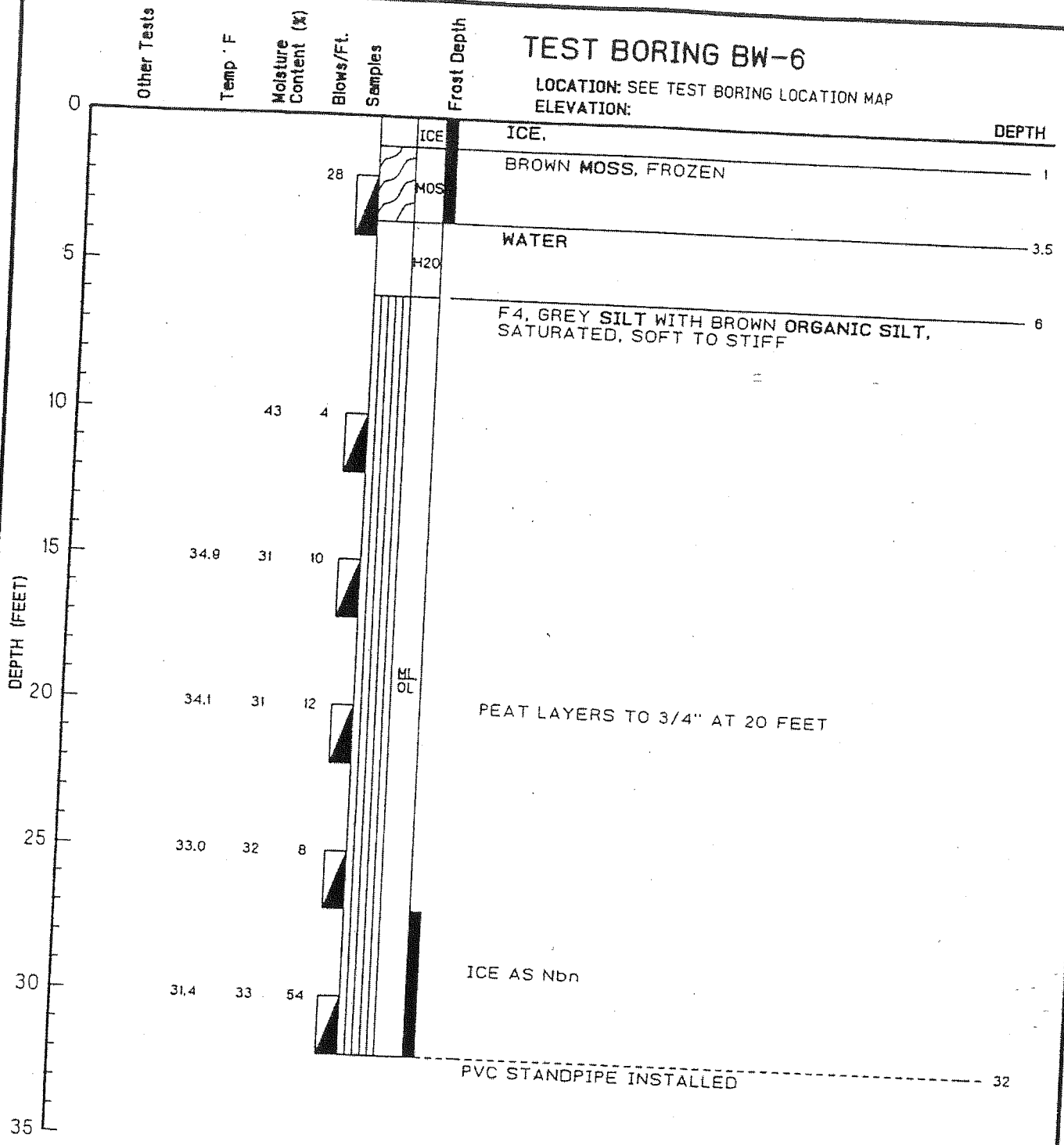
DOWL ENGINEERS
ALASKA TESTLAB

LOG OF BORING

FIGURE 26

TEST BORING BW-6

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION:



KEY
MA = Mechanical Analysis
LL = Liquid Limit
PI = Plastic Index
PP = Pocket Penetrometer (TSF)
TV = Torvane (TSF)
□ = Grab Sample
■ = SPT Sample
▨ = Shelby Tube - pushed
▩ = 2.5" I.D. Spoon Sample 340# weight, 30" fall
T = Sample Temperature (° F) probably affected by sampling procedure

CLIENT: ERE
PROJECT: TUNTUTULIAK
LOGGED BY: J. LAMBE
BORING COMPLETED: 4/16/94
W.O. F45006

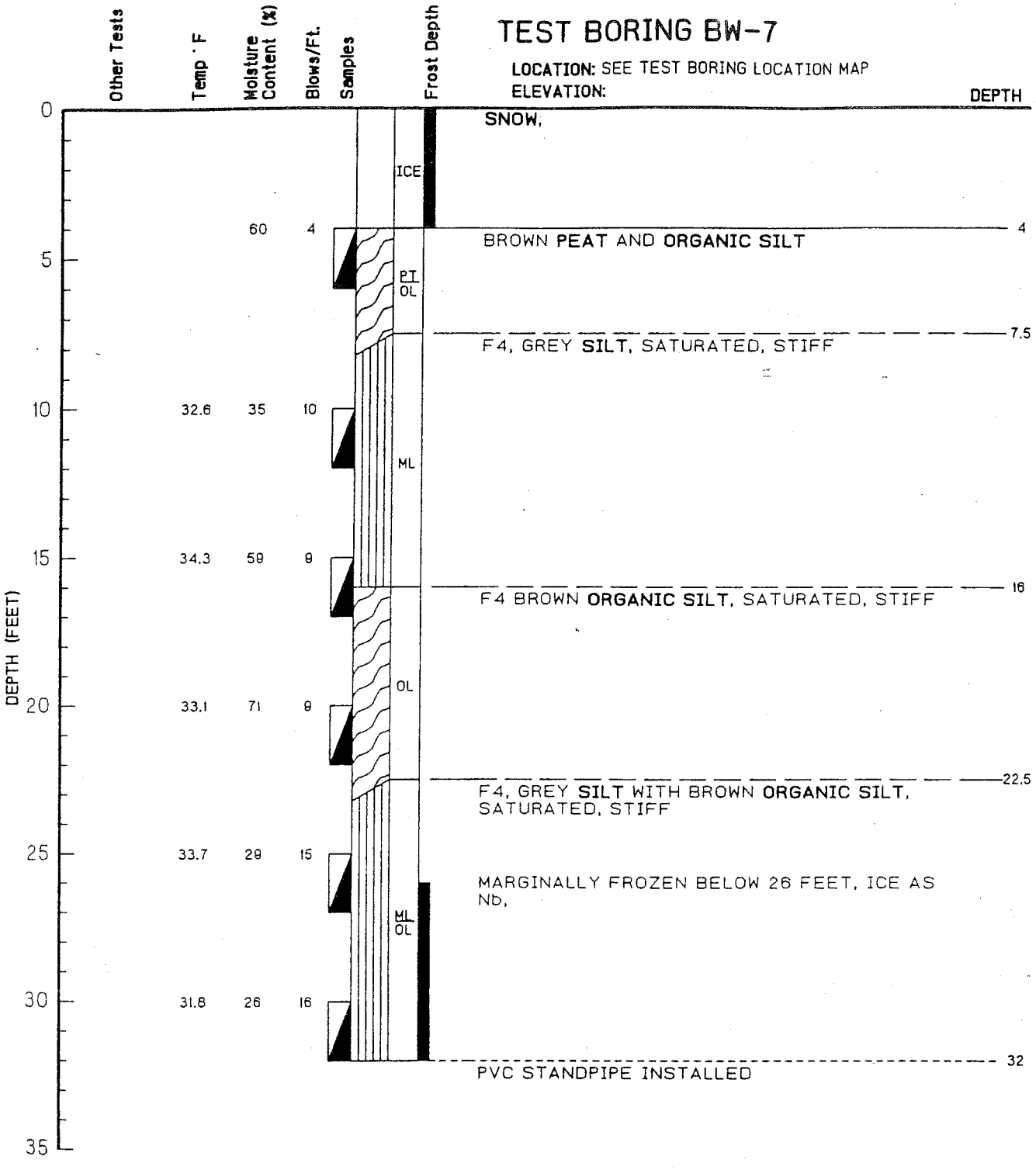
DOWL ENGINEERS
ALASKA TESTLAB

LOG OF BORING

FIGURE 27

TEST BORING BW-7

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION:



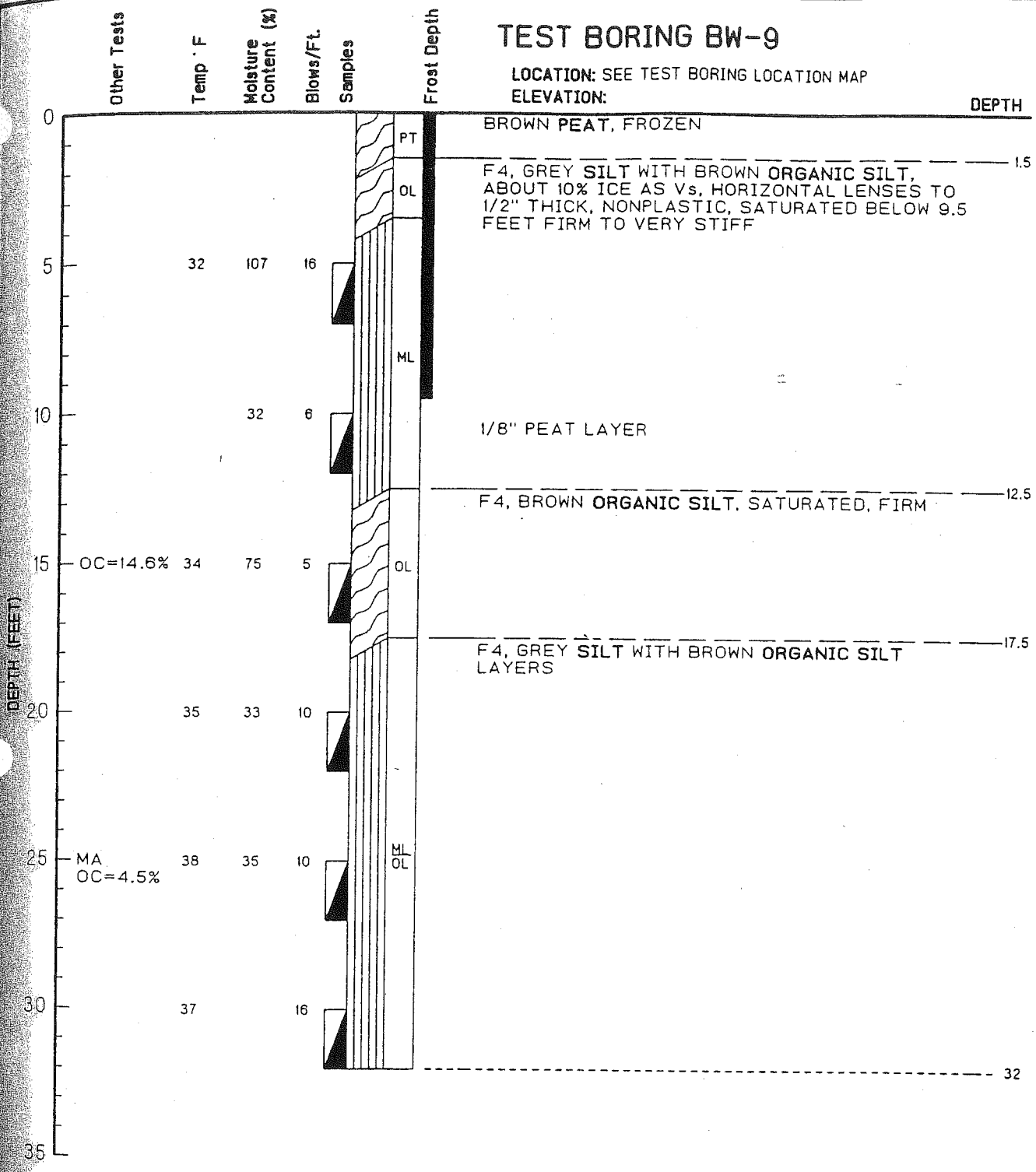
KEY
MA = Mechanical Analysis
LL = Liquid Limit
PI = Plastic Index
PP = Pocket Penetrometer (TSF)
TV = Torvane (TSF)
□ = Grab Sample
◪ = SPT Sample
▨ = Shelby Tube - pushed
■ = 2.5" I.D. Spoon Sample 340# weight, 30" fall
T = Sample Temperature (° F) probably affected by sampling procedure

CLIENT: ERE
PROJECT: TUNTUTULIAK
LOGGED BY: J. LAMBE
BORING COMPLETED: 4/15/94
W.O. F45006

DOWL ENGINEERS ALASKA TESTLAB	LOG OF BORING	FIGURE 28

TEST BORING BW-9

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION:



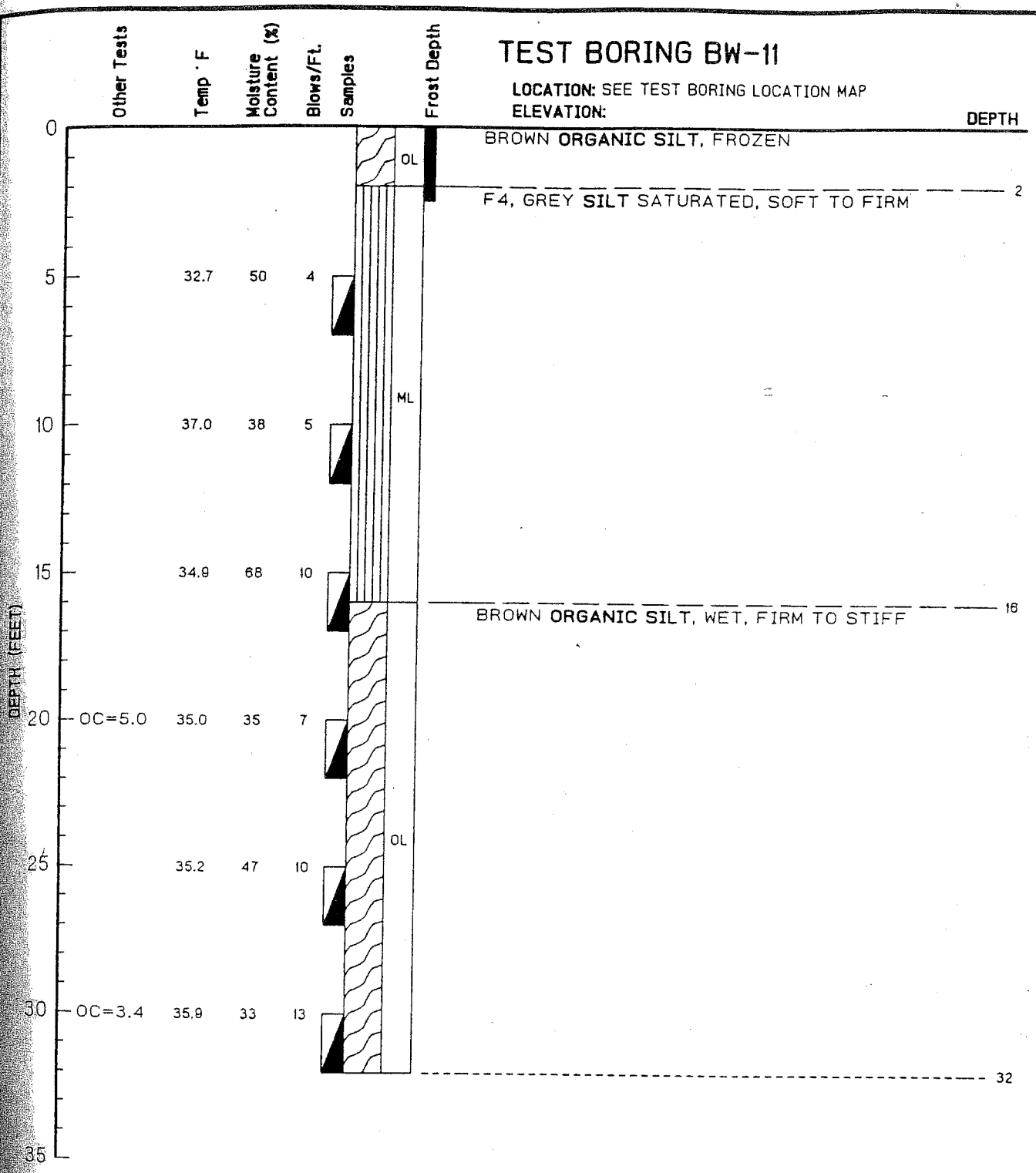
KEY
MA = Mechanical Analysis
LL = Liquid Limit
PI = Plastic Index
PP = Pocket Penetrometer (TSF)
TV = Torvane (TSF)
□ = Grab Sample
◪ = SPT Sample
☒ = Shelby Tube - pushed
▣ = 2.5" I.D. Spoon Sample 340# weight, 30" fall
T = Sample Temperature (° F) probably affected by sampling procedure

CLIENT: ERE
PROJECT: TUNTUTULIAK
LOGGED BY: J. LAMBE
BORING COMPLETED: 4/19/94
W.O. F45006

DOWL ENGINEERS ALASKA TESTLAB	LOG OF BORING	FIGURE 29

TEST BORING BW-11

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION:



KEY
MA = Mechanical Analysis
LL = Liquid Limit
PI = Plastic Index
PP = Pocket Penetrometer (TSF)
TV = Torvane (TSF)
□ = Grab Sample
◪ = SPT Sample
⊠ = Shelby Tube – pushed
■ = 2.5" I.D. Spoon Sample 340# weight, 30" fall
T = Sample Temperature (° F) probably affected by sampling procedure

CLIENT: ERE
PROJECT: TUNTUTULIAK
LOGGED BY: J. LAMBE
BORING COMPLETED: 4/21/94
W.O. F45006

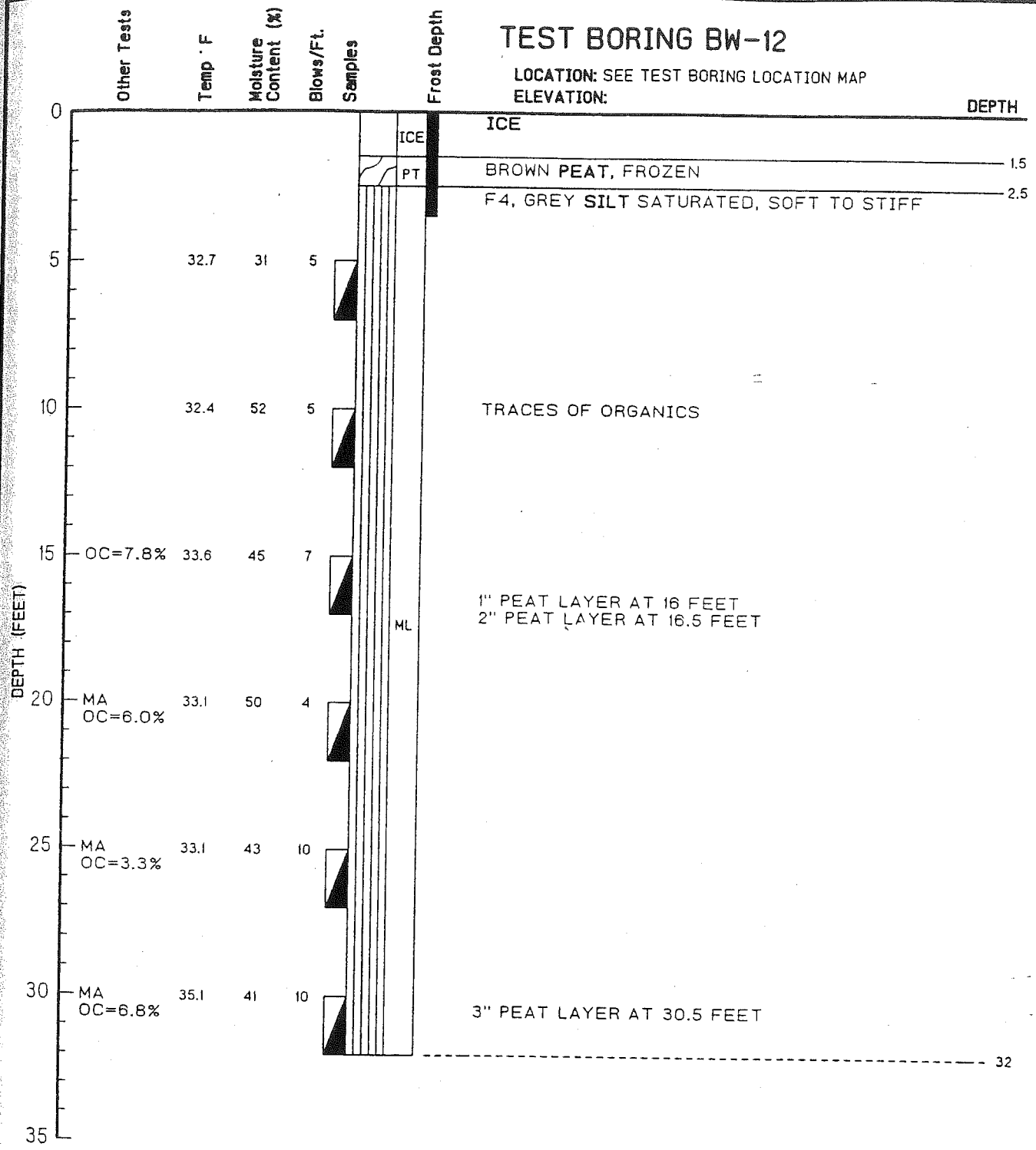
DOWL ENGINEERS
ALASKA TESTLAB

LOG OF BORING

FIGURE 31

TEST BORING BW-12

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION:



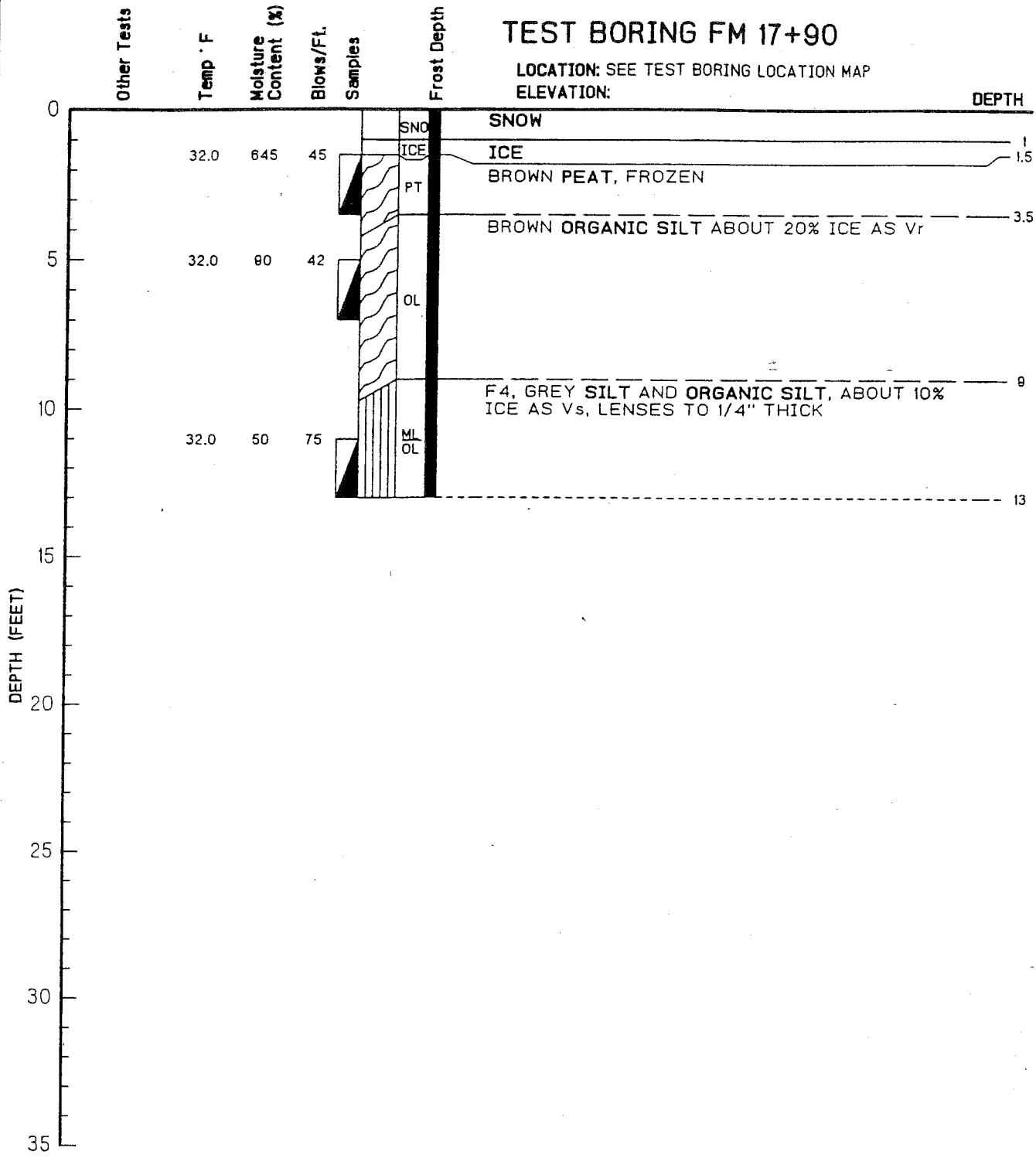
KEY
MA = Mechanical Analysis
LL = Liquid Limit
PI = Plastic Index
PP = Pocket Penetrometer (TSF)
TV = Torvane (TSF)
□ = Grab Sample
■ = SPT Sample
▨ = Shelby Tube - pushed
▩ = 2.5" I.D. Spoon Sample
340# weight, 30" fall
T = Sample Temperature (° F) probably affected by sampling procedure

CLIENT: ERE
PROJECT: TUNTUTULIAK
LOGGED BY: J. LAMBE
BORING COMPLETED: 4/21/94
W.O. F45006

DOWL ENGINEERS ALASKA TESTLAB	LOG OF BORING	FIGURE 32

TEST BORING FM 17+90

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION:



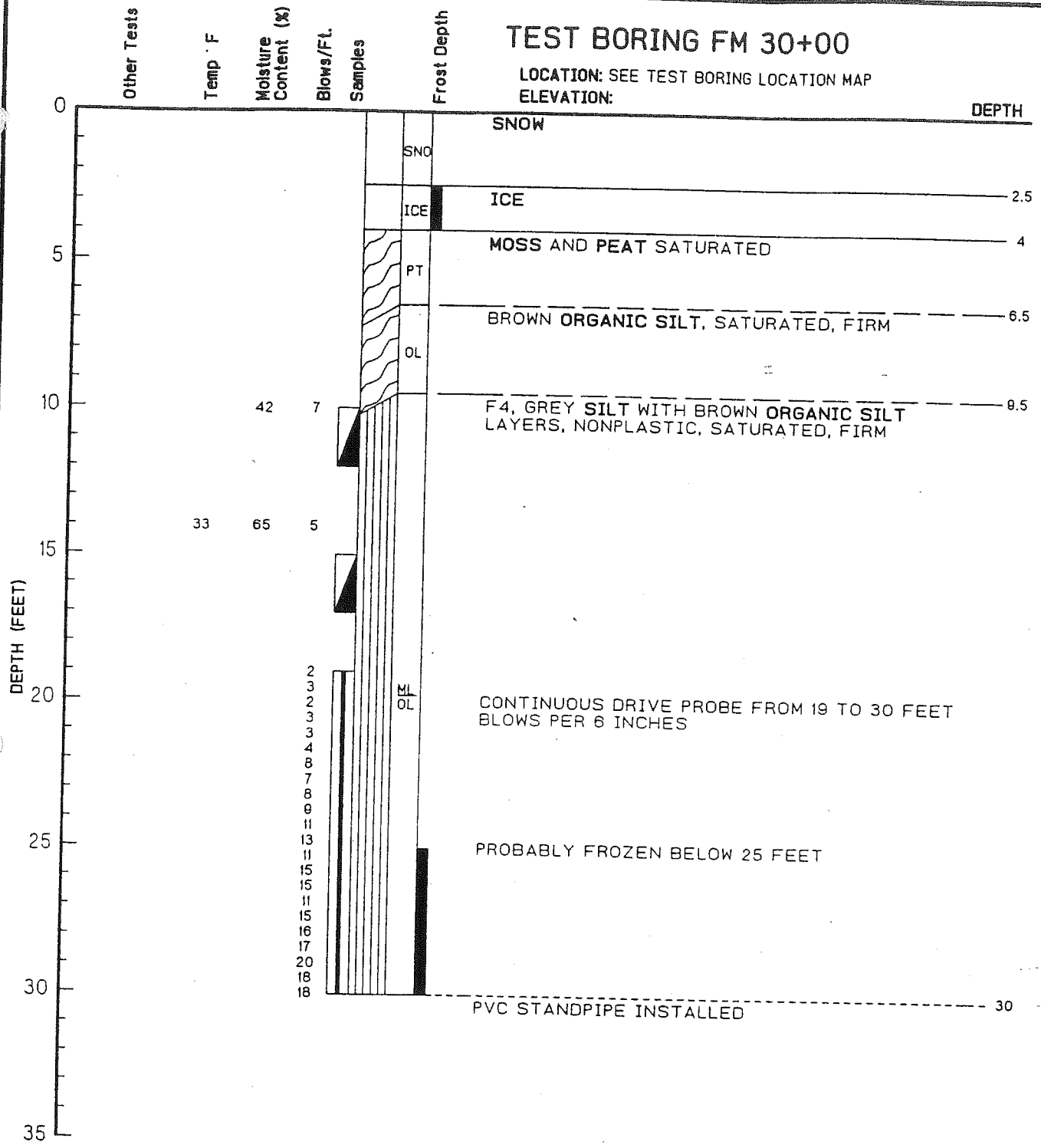
KEY
MA = Mechanical Analysis
LL = Liquid Limit
PI = Plastic Index
PP = Pocket Penetrometer (TSF)
TV = Torvane (TSF)
□ = Grab Sample
◪ = SPT Sample
S = Shelby Tube – pushed
⊠ = 2.5" I.D. Spoon Sample
340# weight, 30" fall
T = Sample Temperature (° F) probably affected by sampling procedure

CLIENT: ERE
PROJECT: TUNTUTULIAK
LOGGED BY: J. LAMBE
BORING COMPLETED: 4/19/94
W.O. F45006

DOWL ENGINEERS ALASKA TESTLAB	LOG OF BORING	FIGURE 10

TEST BORING FM 30+00

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION:



KEY
MA = Mechanical Analysis
LL = Liquid Limit
PI = Plastic Index
PP = Pocket Penetrometer (TSF)
TV = Torvane (TSF)
□ = Grab Sample
◪ = SPT Sample
☑ = Shelby Tube – pushed
☒ = 2.5" I.D. Spoon Sample 340# weight, 30" fall
T = Sample Temperature (° F) probably affected by sampling procedure

CLIENT: ERE
PROJECT: TUNTUTULIAK
LOGGED BY: J. LAMBE
BORING COMPLETED: 4/16/94
W.O. F45006

DOWL ENGINEERS ALASKA TESTLAB	LOG OF BORING	FIGURE 12