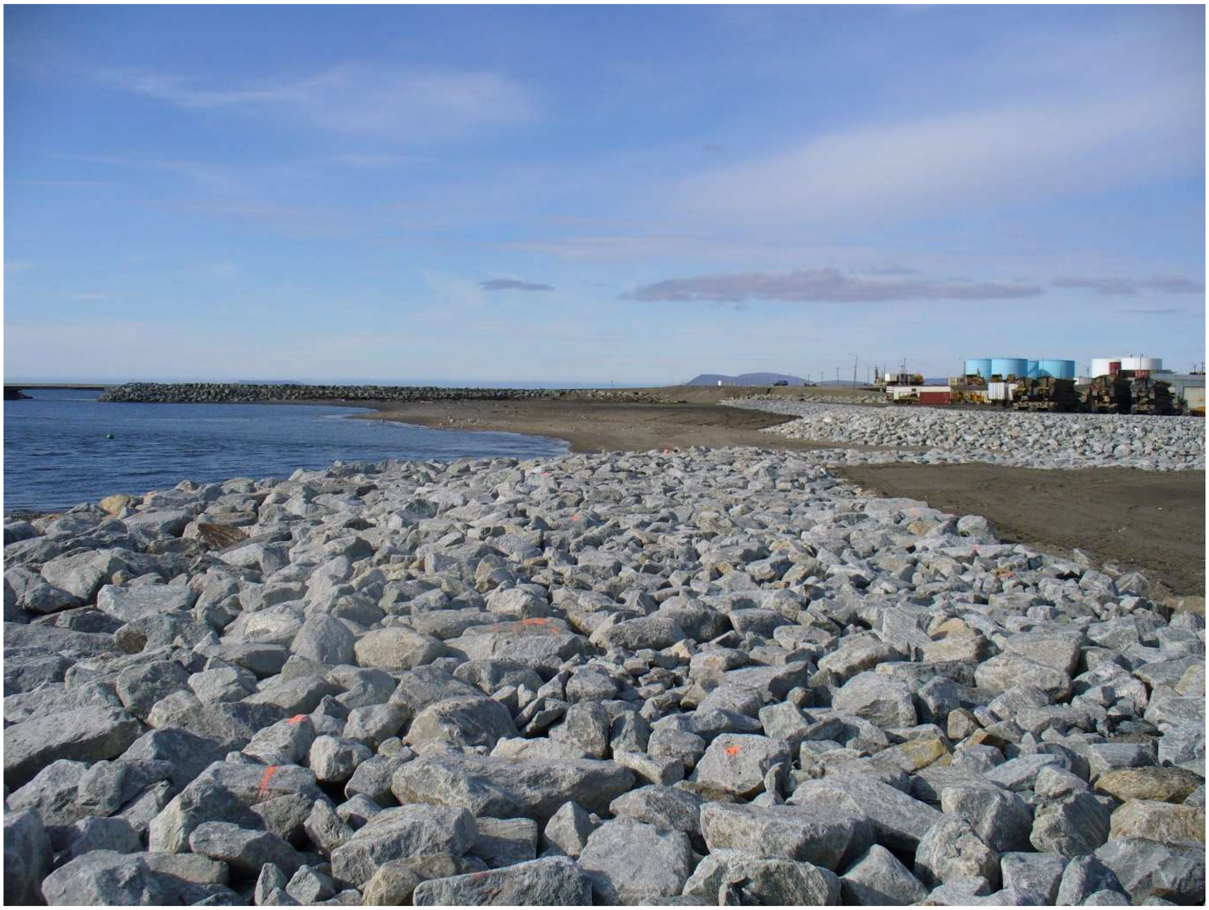
# Appendix B: Geotechnical Engineering

# Port of Nome Modification Feasibility Study

## Appendix B: Geotechnical Feasibility Report



## Nome, Alaska

18 March 2020
P2 Number: 464170
Status: Final

US Army Corps
of Engineers®
Alaska District

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

**Department of the Army**
**Alaska District, U.S. Army Corps of Engineers**
**P.O. Box 6898**
**JBER, AK 99506-0898**

CEPOA-EN-G-GM 18 March 2020

MEMORANDUM FOR CEPOA-PM-C (Attn: Jenipher Cate)

SUBJECT: Final Geotechnical Feasibility Report for the Port of Nome Modification Feasibility Study, Nome, Alaska.

1. Enclosed is the Final Geotechnical Feasibility Report for the Port of Nome Modification Feasibility Study. Included with this report are a discussion of existing geotechnical information pertaining to the project and a previous geotechnical report for the Port of Nome.

2. Questions should be addressed to Matthew Maher at 907-753-2850 or John Rajek at 907-753-5695.

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Chief, Geotechnical and Materials Section
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DOUGLAS A. BLISS, P.E., P.G.
Chief, Geotechnical and Engineering Services
Branch CEPOA-EC-G

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### APPENDIX B.1 – MAPS AND SKETCHES

### APPENDIX B.2 – EXISTING GEOTECHNICAL INFORMATION

## 1. INTRODUCTION

The purpose of this report is to summarize the results of existing geotechnical information at the Port of Nome and document anticipated geotechnical conditions as they pertain to the Recommended Selected Plan (Alternative 8B) for the Port of Nome Modification. This report also provides preliminary geotechnical design criteria for proposed rubble-mound breakwater construction and dredging throughout the harbor. Information and assumptions in this report were developed through a desk study of existing geotechnical information, and it is intended for use by design engineers and planners to evaluate feasibility alternatives for new harbor improvements at the Port of Nome. Information in this report is not intended for use in construction contract documents. A geotechnical site investigation will be performed, and detailed geotechnical design criteria will be developed during the Preconstruction Engineering and Design (PED) phase.

## 2. LOCATION AND PROJECT DESCRIPTION

The Port of Nome is a coastal marine port with a causeway to the west and a breakwater to the east, protecting the existing Outer and Inner Harbors from wind and wave action. The Port of Nome is at the terminus of the Snake River, which flows into the Inner Harbor from the north before flowing into the Outer Harbor and Norton Sound, as illustrated in Sheet B.1-1, located in Appendix B.1.

The proposed Recommended Selected Plan, referenced as Alternative 8B in the Feasibility Report, is illustrated in Sheet B.1-2 along with a preliminary layout of soil borings to be considered for PED that is displayed in Appendix B.1. The Recommended Selected Plan extends an L shape section approximately 3,484 feet (ft) off the existing causeway, with additional docks. The east breakwater is to be removed and replaced with a causeway/breakwater; approximately 3,900 ft long shifted further east to widen the current harbor. The current plan is for dredge depths to be increased to -40 ft mean lower low water (MLLW) within the Deep Water Basin, and deepening to -27 ft MLLW in the Outer Basin.

Alternative 8B shares the same conceptual cross-sectional breakwater design as the current causeway. These breakwaters would be exposed to the open ocean environment and designed as 3-layer rubble mound breakwaters constructed at slopes of 1.5 and 2 horizontal to 1 vertical with 10-ton armor stones to a crest elevation of +28 ft MLLW.

## 3. EXISTING GEOTECHNICAL INFORMATION

The Port of Nome had five historical investigations completed over the years since 1982 for various developments. The first available historical geotechnical investigation report (most applicable for this study) was conducted in 1982 by Harding Lawson Associates (Port of Nome Soil Investigation Report, May 1982), which included the only offshore exploration. The other investigations occurred within the small boat harbor and outside the study footprint. These small boat harbor investigations are still beneficial resources to aid in understanding the overall geotechnical conditions within the general study area.

The summary of relevant subsurface conditions given below will primarily focus on information provided in the 1982 offshore investigation conducted by Harding Lawson.

The Harding Lawson geotechnical investigation included seven test borings along the offshore causeway alignment, as illustrated in the boring location map (Sheet B.1-3). Their report provides information on particle size distribution, triaxial compressive strength, consolidation, and relative density of the soil samples, and associated geotechnical analyses.

Based on the Harding Lawson investigation, subsurface conditions below the causeway consist of four strata consisting of Holocene (recent deposits) sediment underlain by three identifiable Pleistocene deposits (glacial till, older marine deposits, and gravel rubble). Sediment at the mudline was classified as silty sand with a trace amount of gravel (recent deposits) to depths -5 to -37 ft MLLW, followed by gravelly silty sand (glacial till) to depths of approximately -15 ft to -47 ft MLLW, followed by silty fine sand (older marine deposits) to depths of approximately -35 ft to -71 ft MLLW. Sandy gravel underlies the silty fine sand to depths of approximately -45 ft to -72 ft MLLW. Below the sandy gravel, weathered micaceous schist bedrock was encountered to a maximum depth explored (-77 ft MLLW). The recent deposits, glacial till, and older marine deposits were determined to be medium dense to dense, medium dense to very dense, and dense to very dense, respectively, based on the Standard Penetration Test blow count results. The Harding Lawson investigation report with exploration logs is provided in Appendix B.2, with the boring locations provided on Sheet B.1-3.

Boring locations related to the small boat harbor investigations are shown on Sheets B.1-3 and B.1-4. Reports for these investigations, as listed below, can be provided upon request.

- Tippetts-Abbett-McCarthy-Stratton. Port Of Nome, Alaska Design Memorandum. 1982.
- Woodward-Clyde. Nome Harbor Site Investigation Report. 1997.
- USACE. Geotechnical Findings Report-Nome Harbor Sheet Pile Replacement. 2004.
- Shannon & Wilson. Preliminary Geotechnical Report Nome Harbor Sheet Pile Replacement. 2004.
- USACE. Geotechnical Findings Report-Nome Harbor Sheet Pile Replacement. 2006.
- USACE. Alaska Deep-Draft Arctic Port System. 2015.
- USACE. Geotechnical Data Report Nome Harbor Dredging. 2018.

## 4. GEOTECHNICAL ANALYSIS AND RECOMMENDATIONS

Performance of the current causeway and breakwater along with existing geotechnical information suggest favorable foundation conditions for Alternative 8B at the Nome Harbor.

## 4.1 Breakwater Slope Stability and Settlement

The foundation conditions for the proposed breakwater additions/modifications would most likely consist of stratified layers of medium dense to dense, fine to coarse sand with gravel and cobbles. Based on earlier site investigations, bedrock depths below the general study area range from approximately -46 to -72 ft MLLW. Given the existing data, there are no anticipated changes required to the current proposed breakwater cross-section.

Breakwater slope stability, settlement, and seismic hazard analyses were not performed for the Port of Nome alternatives because the expected foundation conditions were assumed to be very similar to the existing causeway and breakwater structures. A brief seismic hazard assessment was conducted using an analysis software developed by the U.S. Geological Survey (USGS) – The Unified Hazard Tool. The primary seismic parameters that are of concern to geotechnical design are the peak ground acceleration (PGA) and the corresponding magnitude ($M_w$), which were determined to be 0.209g and 6.14 in the Unified Hazard Tool for the Port of Nome. Table 1 shows the pertinent data used in the brief seismic hazard assessment and Figure 1 show the deaggregation curve for an estimated magnitude of 6.14. Slope stability, settlement, and seismic hazard analyses will be performed after subsurface soil conditions are investigated in detail during PED.

**Table1. Pertinent Data used in Seismic Evaluation**

| Latitude | Longitude | Design Return Period in Years | Soil Site Classification |
|---|---|---|---|
| 64.499 | -165.429 | 2475 years (2% in 50 years) | 760 m/s (B/C Boundary) |

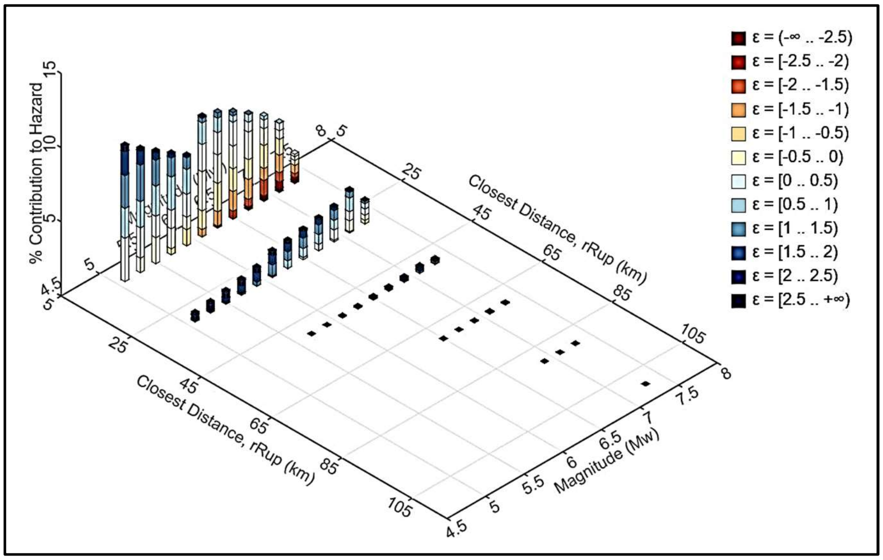


**Figure 1. Deaggregation Curve for Mw=6.14**

## 4.2 Dredging

The proposed harbor sections are to be dredged to depths -40 ft MLLW with 2 ft over dredge for the Deep Water Basin and -27 ft MLLW with 1 ft over dredge for the Outer Basin with. The thickness and character of soil stratum above the bedrock are not completely certain without performing additional field explorations. However, the anticipated dredging methods considered throughout the dredge sections would primarily be mechanical, but hydraulic dredging would be considered in certain areas. Mechanical dredging is considered the primary method due to the in-place denseness of the soil layers and the presence of cobbles. Until further information can be obtained, mechanical dredging is the preferred approach when handling the dense material with an estimated volume of cobbles up to 25 percent. Existing data indicates the soil will allow side slopes and transition slope between the two basin-depths at 1.5 horizontal to 1 vertical, with bedrock not expected to be encountered.

## 4.3 Future Geotechnical Site Investigation Recommendations

Geotechnical investigations need to be performed during PED to properly characterize the proposed dredge material, evaluate and recommend the suitability of breakwater foundation material, and identify any geological conditions that would require special foundation treatment. Geotechnical information will also be used to establish the basis for accurate dredging cost estimates. Preliminary geotechnical exploration costs for both drilling and surveying have been determined and submitted for Alternative 8B, the Tentatively Selected Plan. The following geotechnical investigations are recommended in support of Alternative 8B design:

1. Conduct an offshore geotechnical site investigation consisting of drilling between 50 and 60 test borings below the proposed rubble mound breakwaters and the deep water basin. The preferred drilling method would consist of using standard penetration testing, large penetration testing (SPT/LPT), or sonic drill methods that would be able to penetrate dense, coarse-grained sediments with cobbles and boulders, and thin walled tube sampling. Standard or Large Penetration Testing shall be conducted with regards to the various site conditions and depths such as hammer energy, length of rods, and wave impact on the work platform for accurate field correction.

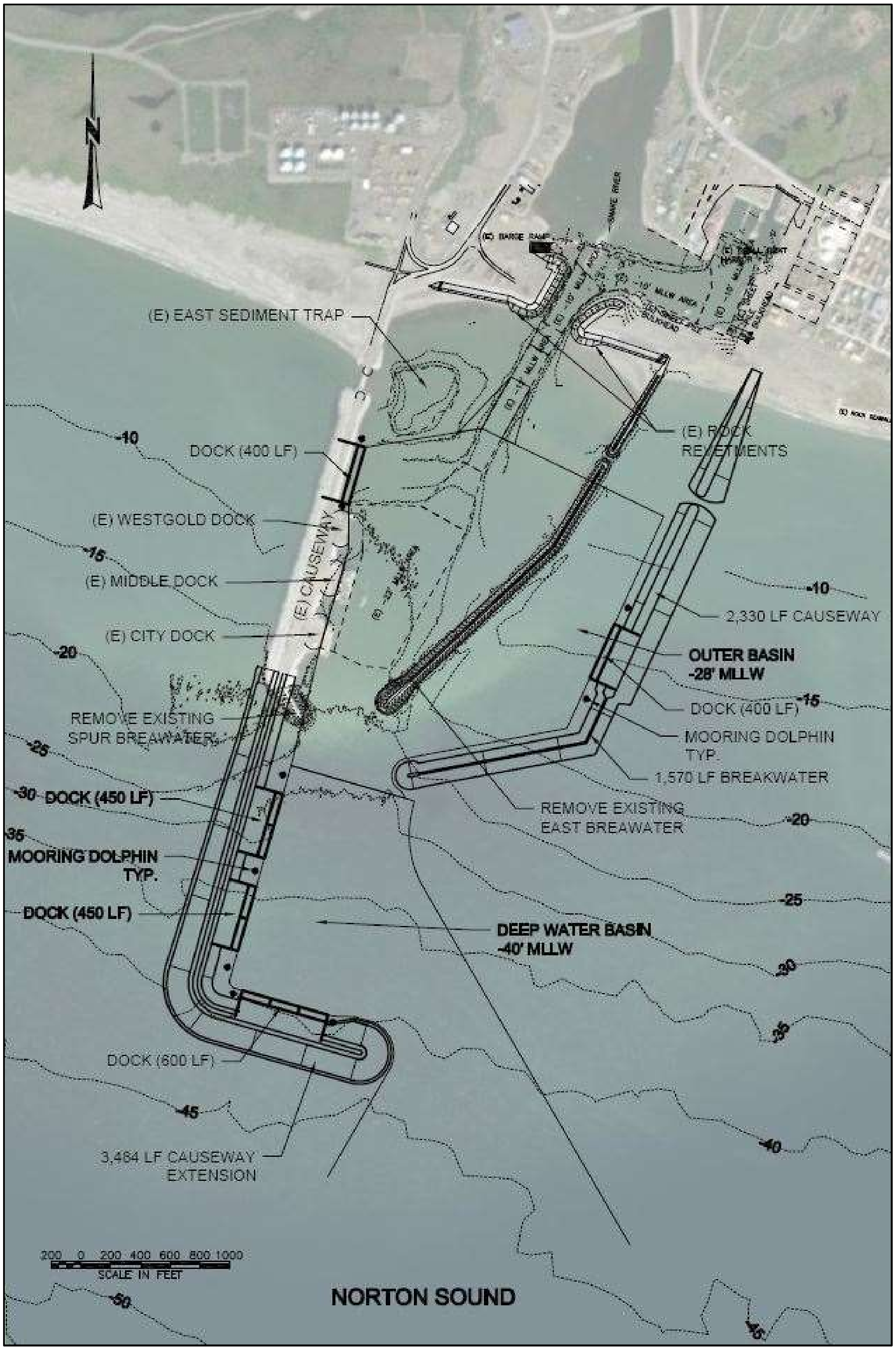
2. Conduct an offshore marine geophysical investigation to define sub-seafloor conditions further and complement the geotechnical drilling by providing a broader understanding of subsurface stratigraphy and the depth to the top of bedrock within the dredging areas. The geophysical investigation should consist of survey track lines collected at a nominal spacing of 25-ft parallel and perpendicular to the proposed breakwater alignments and outer harbor sections.

3. Perform laboratory testing on selected soil samples from the geotechnical site investigation to include but not limited to particle size distribution with and without hydrometer, Atterberg limits, consolidation and triaxial tests.

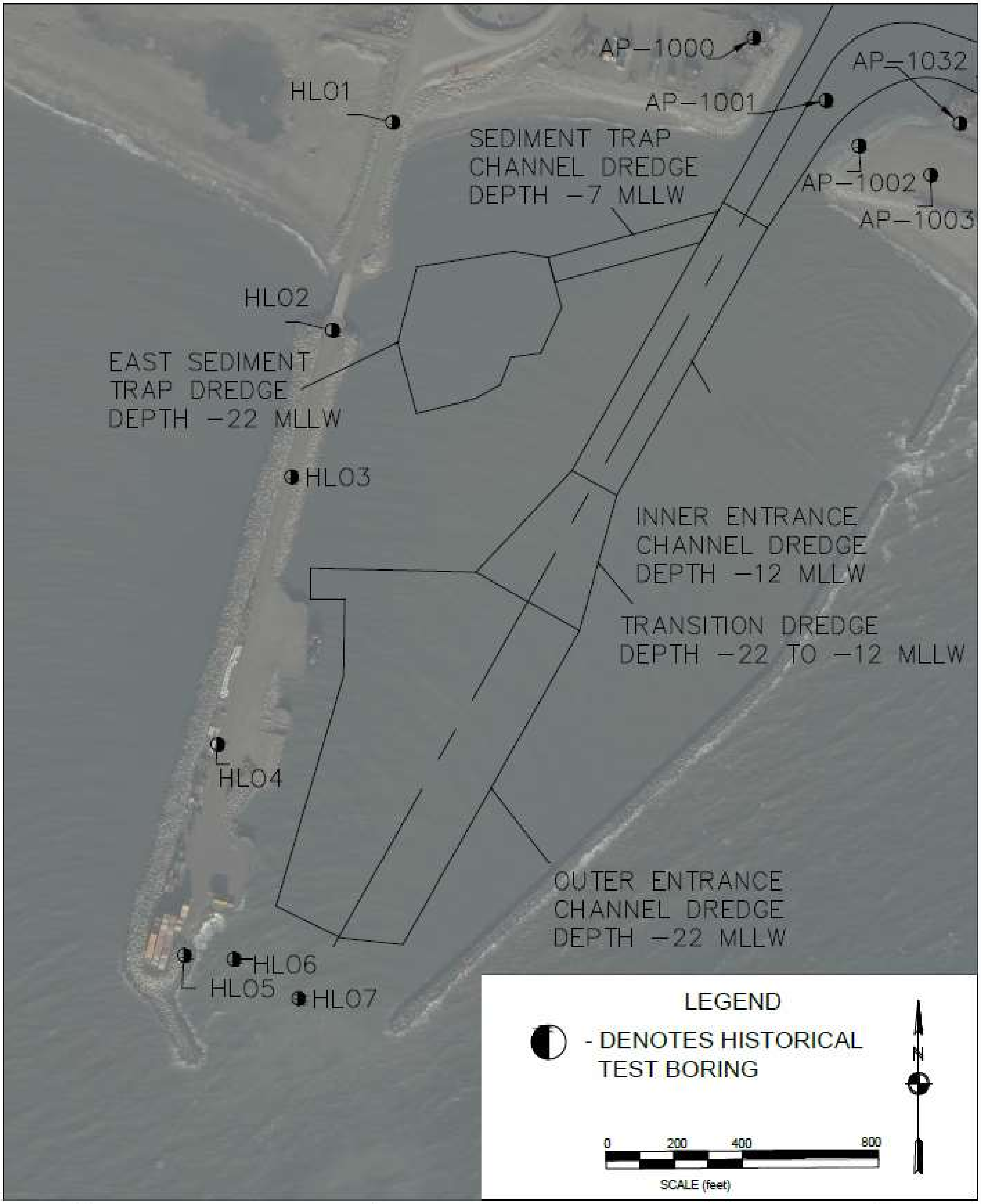
## 5. REFERENCES

"Unified Hazard Tool." *U.S. Geological Survey*, earthquake.usgs.gov/hazards/interactive/

## APPENDIX B.1
## MAPS AND SKETCHES



**Sheet B-1.1 Project Location Map and Alternative 8B**



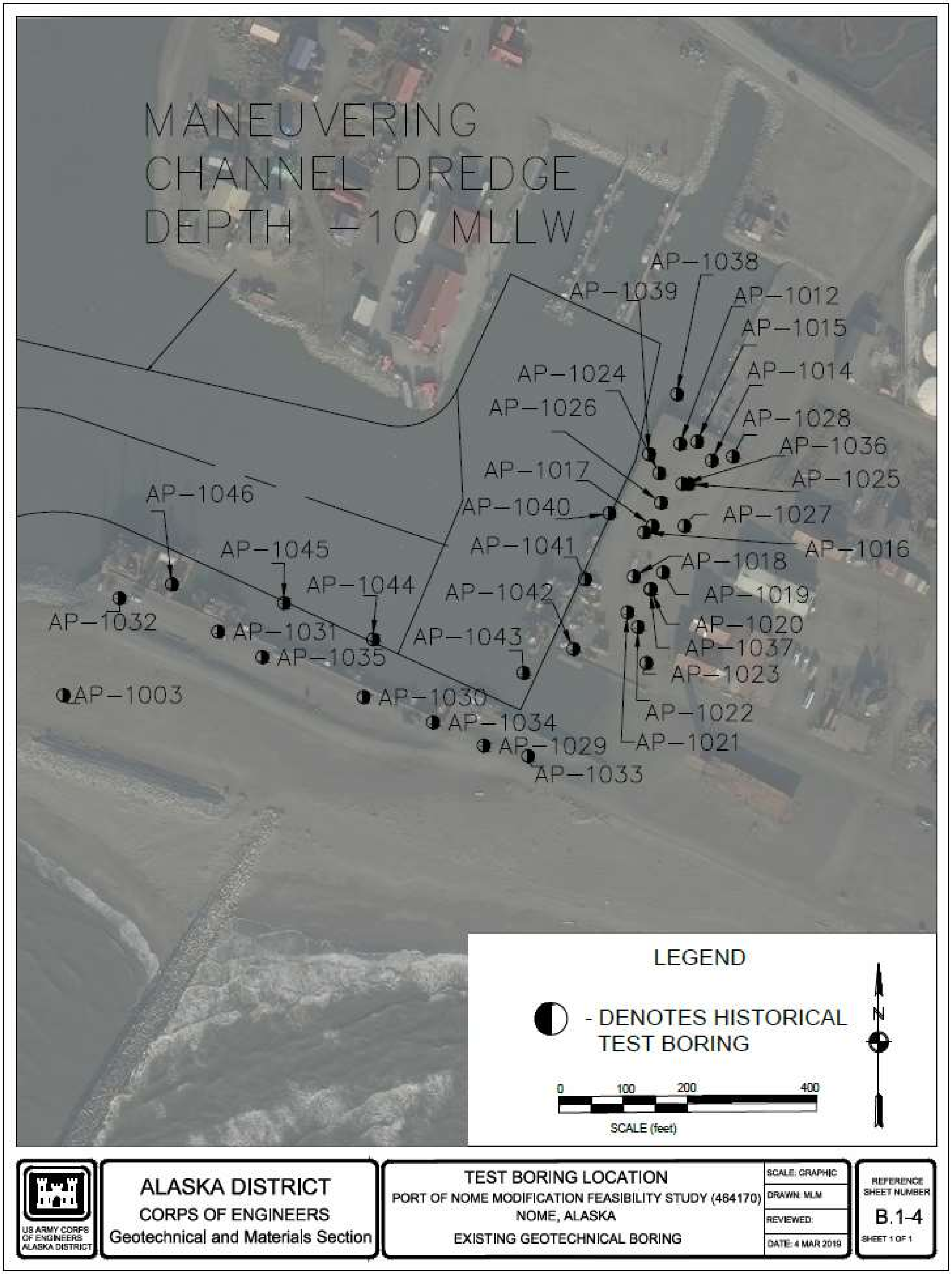
US ARMY CORPS OF ENGINEERS ALASKA DISTRICT

**ALASKA DISTRICT**
CORPS OF ENGINEERS
Geotechnical and Materials Section

TEST BORING LOCATION
PORT OF NOME MODIFICATION FEASIBILITY STUDY (464170)
NOME, ALASKA
EXISTING GEOTECHNICAL BORING

SCALE: GRAPHIC
DRAWN: MLM
REVIEWED:
DATE: 4 MAR 2019

REFERENCE SHEET NUMBER
B.1-3
SHEET 1 OF 1


MANEUVERING
CHANNEL DREDGE
DEPTH -10 MLLW
AP-1038
AP-1039
AP-1012
AP-1015
AP-1014
AP-1024
AP-1026
AP-1028
AP-1036
AP-1025
AP-1017
AP-1040
AP-1027
AP-1016
AP-1046
AP-1045
AP-1041
AP-1018
AP-1044
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AP-1033
AP-1022
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LEGEND
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0
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200
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SCALE (feet)
N
US ARMY CORPS OF ENGINEERS ALASKA DISTRICT
ALASKA DISTRICT
CORPS OF ENGINEERS
Geotechnical and Materials Section
TEST BORING LOCATION
PORT OF NOME MODIFICATION FEASIBILITY STUDY (464170)
NOME, ALASKA
EXISTING GEOTECHNICAL BORING
SCALE: GRAPHIC
DRAWN: MLM
REVIEWED:
DATE: 4 MAR 2019
REFERENCE SHEET NUMBER
B.1-4
SHEET 1 OF 1

## APPENDIX B.2
## EXISTING GEOTECHNICAL INFORMATION

Harding Lawson Associates. Soil Investigation Port of Nome, Alaska. 1982 105 Sheets

BOUND REPORT - DO NOT REMOVE FROM FILE

A Report Prepared for

TAMS Engineers
4791 Business Park Boulevard, Building H
Anchorage, Alaska 99503

# SOIL INVESTIGATION
# PORT OF NOME
# NOME, ALASKA

HLA Job No. 15001,002.08

by

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May, 1982

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## LIST OF ILLUSTRATIONS

## ILLUSTRATIONS
(continued)

# SUMMARY

In February and March 1982, we performed a field and laboratory geotechnical investigation for the proposed Port of Nome in Nome, Alaska. The work consisted of drilling 7 test borings offshore in a causeway area, 13 borings in an onshore facilities area, and 4 borings at the tentative location of a small boat harbor. The offshore borings were drilled from the winter ice canopy using a helicopter-transported rotary wash drill rig. The other borings were drilled onshore with an air-rotary rig. Laboratory tests were performed on select samples to determine pertinent engineering properties of the soils.

Offshore, the soils generally consist of a 5- to 10-foot-thick mantle of medium dense granular Holocene (recent) sediments underlain by 30 to 40 feet of dense, granular glacial till and Pleistocene marine deposits. Bedrock was encountered within 50 feet of mudline and consisted of micaceous shist. The offshore soils are considered fairly competent, and absent of highly compressible organic and fine-grained deposits.

The onshore "upland tundra" (or upland) area is underlain by perenially frozen (permafrost) silt and sand. These soils appear to be thaw-unstable and settlement will occur if the permafrost melts. The "modified" area similarly consisted of sands; permafrost was encountered in only one boring and at a depth of 23 feet.

The small boat harbor area is underlain by loose to medium dense silt, sand and gravel deposited and reworked by the Snake River. Considering the more than 100 years of activity in Nome, it is likely that man-made fill exists in this area.

# I INTRODUCTION

This report presents the result of our investigation for the proposed Port of Nome in Nome, Alaska. The project planning and engineering, including detailed geotechnical analyses, is being performed by Tippetts-Abbet-McCarthy-Stratton, Engineers (TAMS).

The general layout of the port is presented on Plates 1 and 2. As described in our proposal of December 18, 1981 we understand that the facility will consist of a rubble mound causeway/berthing structure extending about 3600 feet offshore into Norton Sound. The top of the causeway will be at approximately Elevation 25(*). It will be topped with a road surface and will support a utilidor containing water, sewage and fuel lines. The causeway will connect to an 800-foot-long short-term general cargo storage and barge berthing area. Dock side depth at this location will be about 30 feet; no dredging is anticipated.

About 500 feet from the shoreline the causeway will be breached to permit salmon migration; the breach will be crossed via a single-span bridge.

Onshore storage and handling facilities will be about 600 feet north of the causeway terminus on a 60-acre parcel between the Snake River and the shoreline of Norton Sound. Two areas have been designated: the "upland tundra" and the "modified" areas, as shown on Plate 1. These areas will be filled to achieve final grade; fills up to nine feet thick, are anticipated. Structures will generally consist of transit sheds having slab-on-grade concrete floors.

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(*) Feet above Mean Lower Low Water (MLLW).

The small boat harbor will be sited on the Snake River about 2000 feet northeast of the modified area (see Plate 2). Facilities will include a boat ramp and lift and about 1000 linear feet of cantilever sheetpile bulkheading. The area will be dredged to produce a minimum water depth of about eight feet at extreme low tide.

## II SCOPE OF SERVICES

The scope of our services was in accordance with our proposal of December 18, 1981 as modified in our letter of January 20, 1982. The objective of our services as discussed in our proposal was to explore the soil, permafrost and bedrock conditions in the project area. Representative soil samples obtained during the exploration program were tested in our Anchorage laboratory to determine their pertinent engineering properties. Selection of geotechnical design parameters was not a part of our scope. The field and laboratory data together with a description of the site conditions are presented herein.

To accomplish this objective:

1. We mobilized a Mobile Drill B-38 rotary wash drill rig from Anchorage to drill seven test borings up to 57 feet below mudline for the causeway structure. The rig operated from the sea-ice canopy; a helicopter was used to move the rig between borings
2. The onshore borings were drilled with a locally contracted rotary-air track-mounted rig. Thirteen test borings ranging from 26 to 73 feet deep were drilled in the storage area. Eight borings were cased with glycol-filled PVC pipe to permit continued ground temperature monitoring. Four borings about 20 feet deep were drilled at the small boat harbor site.
3. The horizontal location and ground or ice surface elevation at each test boring was determined by Silvers Engineering using conventional plane surveying techniques.
4. We completed a laboratory program that was prepared jointly with TAMS

During our field operations, Messrs. Michael G. Horton and Gregory P. Matthews, TAMS' project manager and project geotechnical engineer respectively, were on site to observe the work and assist as necessary. Copies of the field boring logs were submitted at the completion of the test drilling. Results of the laboratory data and copies of the surveyors notes were transmitted on March 30, 1982.

## III SITE CONDITIONS

### A. Geographic Setting

Nome is located in the Norton Sound subregion of the Northwest Region of Alaska(*). This area is comprised of the western three fourths of the Seward Peninsula; Norton Sound (a part of the Bering Sea) is to the south. The city of Nome is on a coastal plain. The Snake River on the western edge of the city is the dominant drainage feature in the area. Landward is an "upland" area consisting of broad, convex hills and flat divides that range from 500 to 2000 feet in elevation. The Kigluaik Mountains are about 30 miles north of Nome and have V-shaped valleys and glaciated mountains.

Nome is located in relatively seismically inactive area. It is a Seismic Zone 1 on the Uniform Building Code (UBC) Seismic Zone Map of the United States.

Climatically Nome is in the transition zone between the moderate maritime and more extreme inland continental climates. Nome receives about 16 inches of precipitation per year, which includes 54 inches of snow. Mean summer temperatures vary from 36°F to 56°F; mean winter temperatures range from -3°F to 36°F. Extreme lows of -46°F and highs of 86°F have been recorded. Nome has feezing and thawing indices of about 4300, and 2000°F days, respectively.

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(*) "Alaska Regional Profiles, Northwest Region," published by University of Alaska, Arctic Environmental Information and Data Center.

## B. Geology

The dominant geologic features at the site are the result of episodes of Pleistocene glaciation and attendent sea level changes. The effects of the Snake River and offshore coastal processes have also contributed to the present geologic condition. The bedrock underlying the site consists of Paleozoic micaceous schists. The rock is overlain by Pleistocene glacial and marine deposits.

The following depositional events could have occurred at the causeway site:

1. During the Pleistocene Epoch (10,000 to 1 million years b.p.(*)), glaciers advanced several times through the mountain ranges of the Seward Peninsula. While the degree of these advances varied, they were greatest during early and middle Pleistocene when ice covered extensive parts of the Northwest Region.

   The upper several feet of material over bedrock consist of a "rubble strata" remaining from one of these advances. The presence of igneous rocks within this strata suggest glacial transport from the Anvil Mountain, Newton Peak and Native Hill areas to the northeast.

2. As the glaciers advanced and retreated, frequent sea level changes occurred. When the area was submerged, well-sorted fine grain marine sands and silts were deposited.

3. During subsequent glacial periods, the sea level was lower and glacial till was subsequently deposited over the marine sediments. The till is a mixture of unsorted gravel, sand, silt and clay transported and deposited by glaciers, usually as moraines. The till has probably been reworked by streams and outwash water from the melting glacier.

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(*) b.p. = before present

4. Overlying the till is Holocene (recent to 10,000 years b.p.) silt and sand deposits derived from both the Snake River and coastal marine sources. Offshore sediments near the shoreline have been deposited and reworked by the Snake River and mining (dredging) operations.

The onshore Upland area is dominated by shallow perenially frozen (permafrost) sand and gravel. Permafrost was observed in only one boring (at a depth of 23 feet) in the Modified area and was not observed in the Small Boat Harbor area. However, permafrost may be present below the depths of our borings.

The permafrost is a remnant feature of the Pleistocene Epoch. The area between the permafrost table is the active layer. When winter freezing does not extend to the permafrost layer a "talik" (unfrozen zone) is created. Taliks are a common feature in the Nome area.

Climate and terrain influence the formation of permafrost. The age of permafrost varies; near Nome, permafrost probably formed 3,000 to 9,000 years ago(*). Due to thawing operations carried out by the mining companies prior to dredging, it is difficult to define the horizontal and vertical contacts between frozen and non-frozen ground in the Nome area. Thaw depths were highly variable, depending on the depth to the "pay streak" to be mined. In many areas thawing was not carried out to bedrock. As a result, a layer of frozen soil often remained above

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(*) Hopkins, D. M., McNeil, F. S., and Leopold, E. B., 1960, "The Coastal Plain of Nome Alaska," in Proceedings of the 21st Geological Congress, Copenhagen, Denmark, pt 4, pp. 46-57.

the bedrock. Due to the difference in freezing and thawing indices (4300 versus 2000$^0$F days) and the insulating effect of the tundra mat, permafrost is probably slowly reforming in those areas that were thawed but not dredged. Dredged areas will probably remain unfrozen below their active zones due to higher heat gain through the mineral soil exposed on their surfaces. Areas of discontinous permafrost and/or areas of extensive taliks exist in undisturbed areas throughout the coastal plain at Nome.

The small boat harbor is within the banks of the Snake River and its tributaries. Recent alluvium is present to depths that will be influenced by development.

## C. Soil Conditions

Engineering properties of the soils are discussed below. Specific geotechnical design parameters should be assigned by the choosing of the designers who will ultimately use them for analyses.

### 1. Causeway Area

The subsurface soil conditions encountered in the causeway area are illustrated on the Cross Section, Plate 3. As discussed, three Pleistocene strata (rubble; marine sand and silt; glacial till) and a Holocene stratum overly bedrock. The soils above the rubble are predominantly silty sands; occasional layers of non-plastic sandy silt was observed in Borings 1 and 5.

The glacial till can be distinguished from the underlying marine sands on the basis of gradation as illustrated on Plate 4. As shown, the marine sand is fine grained, as opposed to the coarser grained and more well-graded till. Similarly, the gradation of the Holocene soils is different from the glacial deposits, as illustrated on Plate 5.

On the basis of blow-counts, the soils are considered medium to very dense. The ranges of blow counts are:

| Strata | Cross Section Symbol | Average Blows/Foot* |
|---|---|---|
| Holocene | QHmn | 15 |
| Till | QPt | 32 |
| Marine | QPm | 42 |
| Rubble | QPr | not obtained |

* Based on a 300-pound hammer falling 30 inches; a 3.0-inch O.D. x 2.4-inch I.D. sampler was used. Equivalent standard penetration or N-values can be approximated by multiplying the above values by 1.4.

Effective strength parameters of the Holocene sediments determined by consolidated-undrained triaxial shear tests indicate effective friction angles of between 35 and 41 degrees and no effective cohesion. These values are comparable to published friction angles for similar soil types and densities(*). Strength tests were not performed in the Pleistocene soils. However, the Pleistocene soils are stronger than the Holocene soils and strength parameters should be obtained using blow counts or other appropriate correlations.

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(*) NAVFAC DM-7, Design Manual - Soil Mechanics, Foundations and Earth Structures, by Department of Navy, 1971.

In general, the Holocene soils are non-plastic silt and sand, and are considered only moderately compressible. Results of two consolidation tests indicate that the soils are overconsolidated by at least 2000 pounds per square foot. Compressible organic material was essentially absent. The underlying Pleistocene soils are judged to be dense and only slightly compressible under the anticipated loads.

2. Onshore Storage Area

The onshore storage area is comprised of the upland area and the modified area. The upland area is at Elevation 33 to 45 while the modified area is considerably lower, at Elevation 6 to 11.

The upland area is blanketed by up to 16 feet of silt and organic silt; the average thickness is 7 feet. This layer tends to be of low density and high moisture content. When unfrozen, it is generally very compressible. Underlying this silt and also at the modified area, the soil consists of sands and silty sands to the depth explored. Geologically, these sands are of the same origin as the offshore glacial till(*); this conclusion is supported by the similarities in soil classifications and particle size distribution.

Permafrost was present in all of the upland test borings. It was present in one boring drilled in the modified area. It is generally accepted that the permafrost was destroyed when gold was mined -- a process which required that the permafrost be thawed prior to dredging.

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(*) Green, H. G. 1970, "Morphology, Sedimentation and Seismic Characteristics of an Arctic Beach, Nome Alaska -- with Economic Significances," U.S. Department of the Interior, Geologial Survey, Open-file Report.

Eight of the upland borings were cased with plastic pipe to permit continued ground temperature measurements. Results of these readings including details of the well installation and thermistor instrumentation are presented in Appendix A. The freezing points (or freezing point depressions) are shown on the plots of temperature versus depth.

A primary geotechnical consideration of development in the upland area will be the effects on the permafrost and possible thaw-strain settlements. Based on the moisture content and silt/clay contents, the soils appear thaw unstable and will settle if thawed. For instance, typical, thaw-stable soils have moisture contents less than about 8 percent and less than about 5 percent "fines".

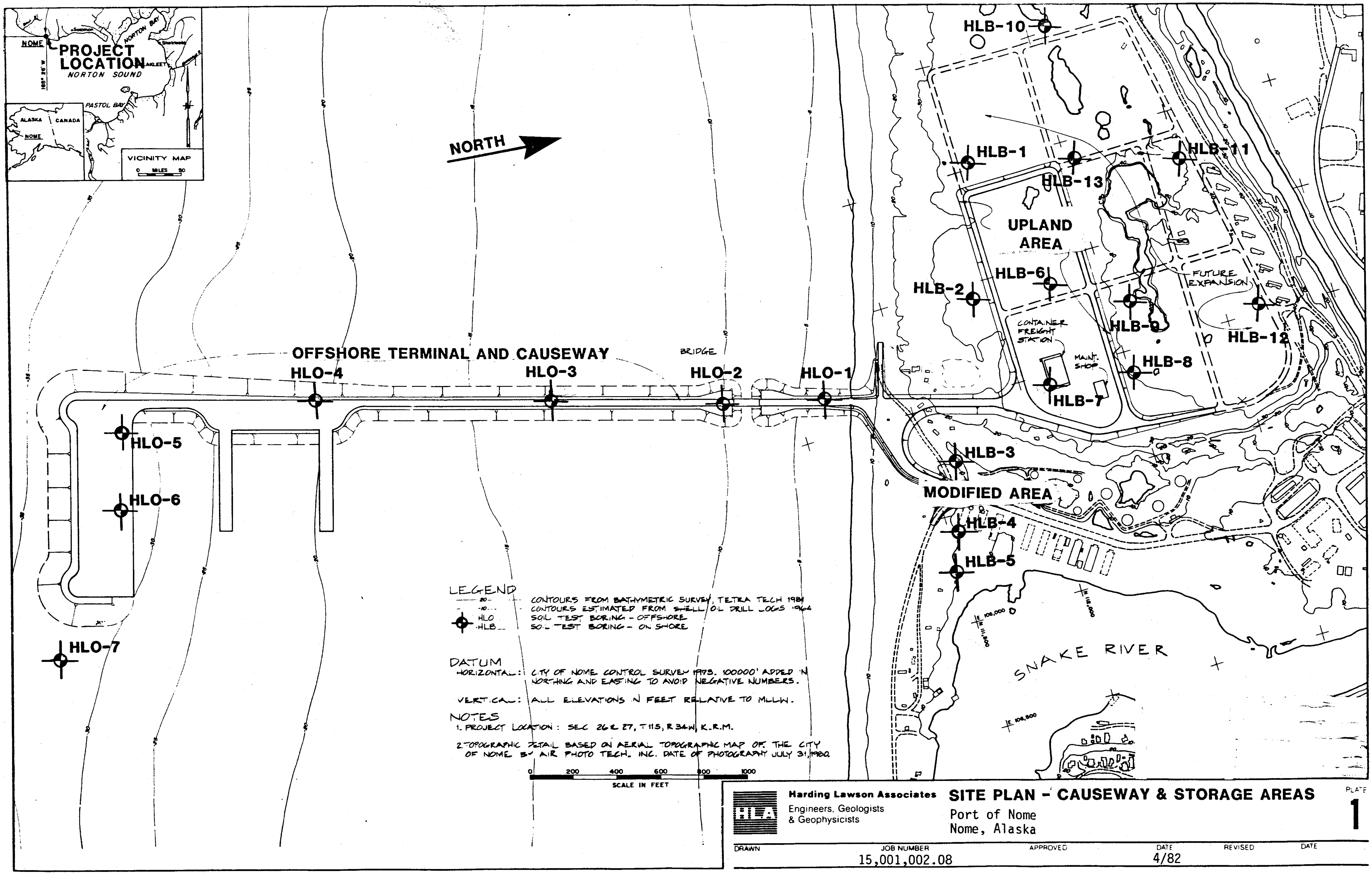
### 3. Small Boat Harbor

Soil conditions in the small boat harbor area consist of gravelly silt, silty sand and clean sand. Although silty, the sand tends to be well-graded, as indicated by the gradation test results.

Considering the proximity of the site to the Snake River and continous activity in the area, it is likely that the area contains fill and/or has been reworked by river flows.

Design parameters should be developed using published correlations relating soil type, gradation and moisture content-dry density to strength and settlement parameters.

# IV ILLUSTRATIONS



LEGEND

- 20 — CONTOURS FROM BATHYMETRIC SURVEY, TETRA TECH 1981
- -10- — CONTOURS ESTIMATED FROM SHELL OIL DRILL LOGS 1964
- HLO — SOIL TEST BORING - OFFSHORE
- HLB — SOIL TEST BORING - ON SHORE

DATUM

HORIZONTAL: CITY OF NOME CONTROL SURVEY 1973. 100000' ADDED IN NORTHING AND EASTING TO AVOID NEGATIVE NUMBERS.

VERTICAL: ALL ELEVATIONS IN FEET RELATIVE TO MLLW.

NOTES

1. PROJECT LOCATION: SEC 26 & 27, T 11S, R 34W, K.R.M.

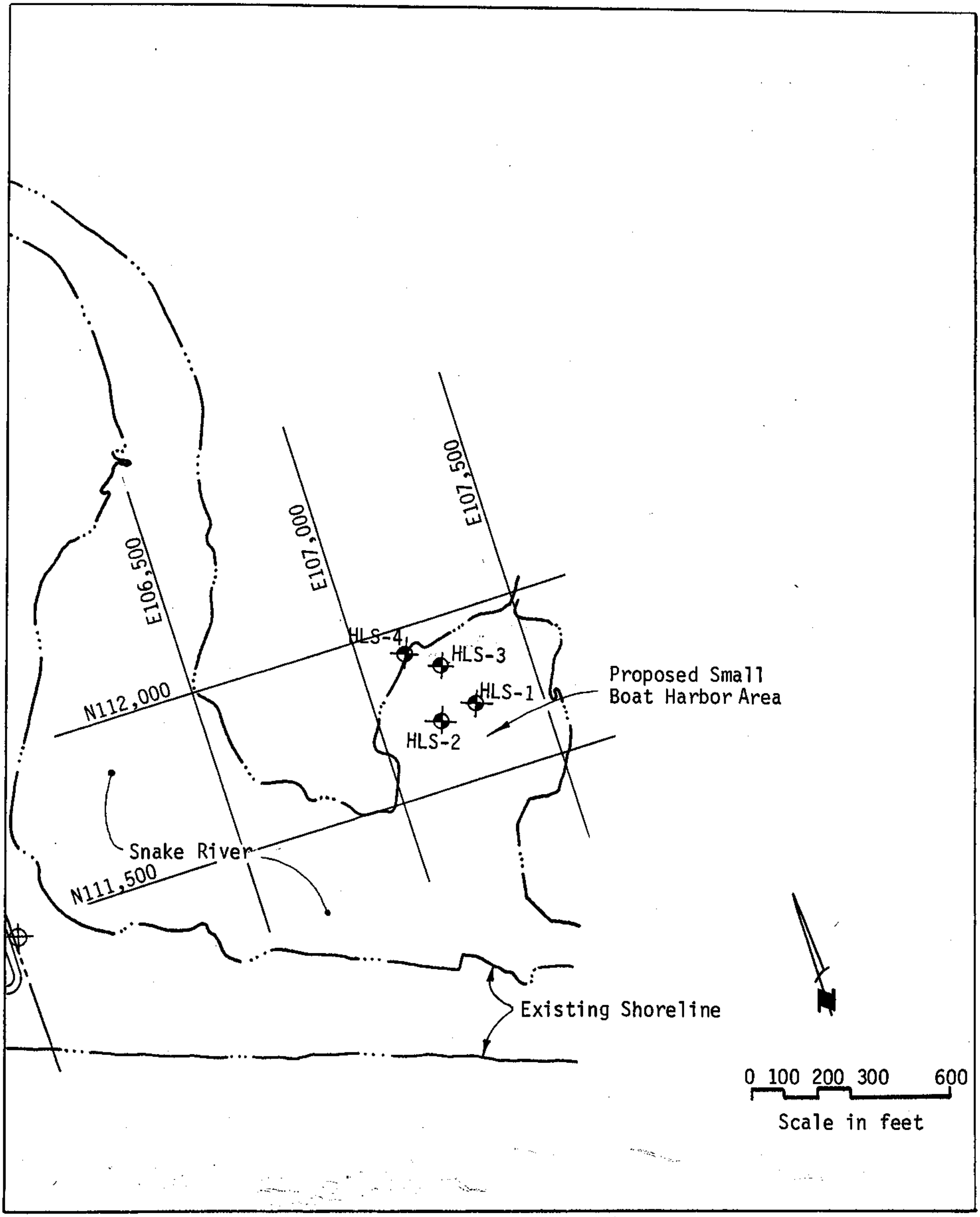
2. TOPOGRAPHIC DETAIL BASED ON AERIAL TOPOGRAPHIC MAP OF THE CITY OF NOME BY AIR PHOTO TECH. INC. DATE OF PHOTOGRAPHY JULY 31, 1980

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

**SITE PLAN - CAUSEWAY & STORAGE AREAS**
Port of Nome
Nome, Alaska

PLATE
**1**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15,001,002.08 | | 4/82 | | |



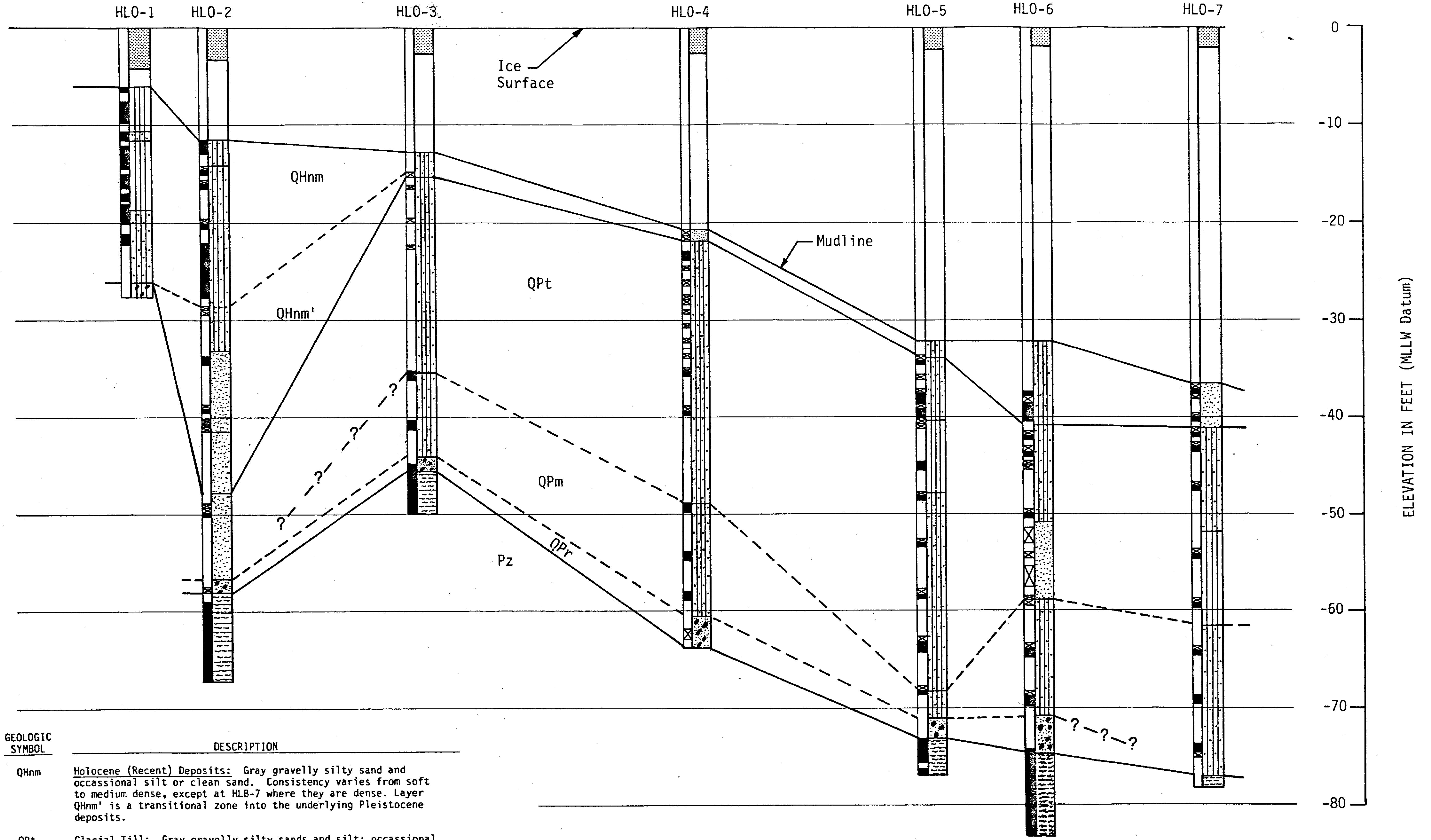
**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

## Site Plan - Small Boat Harbor

Port of Nome
Nome, Alaska

PLATE
2

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15,001,002.08 | TJS | 4/82 | | |



| GEOLOGIC SYMBOL | DESCRIPTION |
|---|---|
| QHnm | Holocene (Recent) Deposits: Gray gravelly silty sand and occassional silt or clean sand. Consistency varies from soft to medium dense, except at HLB-7 where they are dense. Layer QHnm' is a transitional zone into the underlying Pleistocene deposits. |
| QPt | Glacial Till: Gray gravelly silty sands and silt; occassional clean sand and silty gravel. Medium dense to very dense. Contains angular rock fragments (gravels). |
| QPm | Marine: Gray silty sand; fine grain; dense to very dense. |
| QPr | Glacial Rubble: Gray sandy gravel; very dense; silty to clean. |
| Pz | Bedrock: Micaceous shist; highly weathered at surface. |

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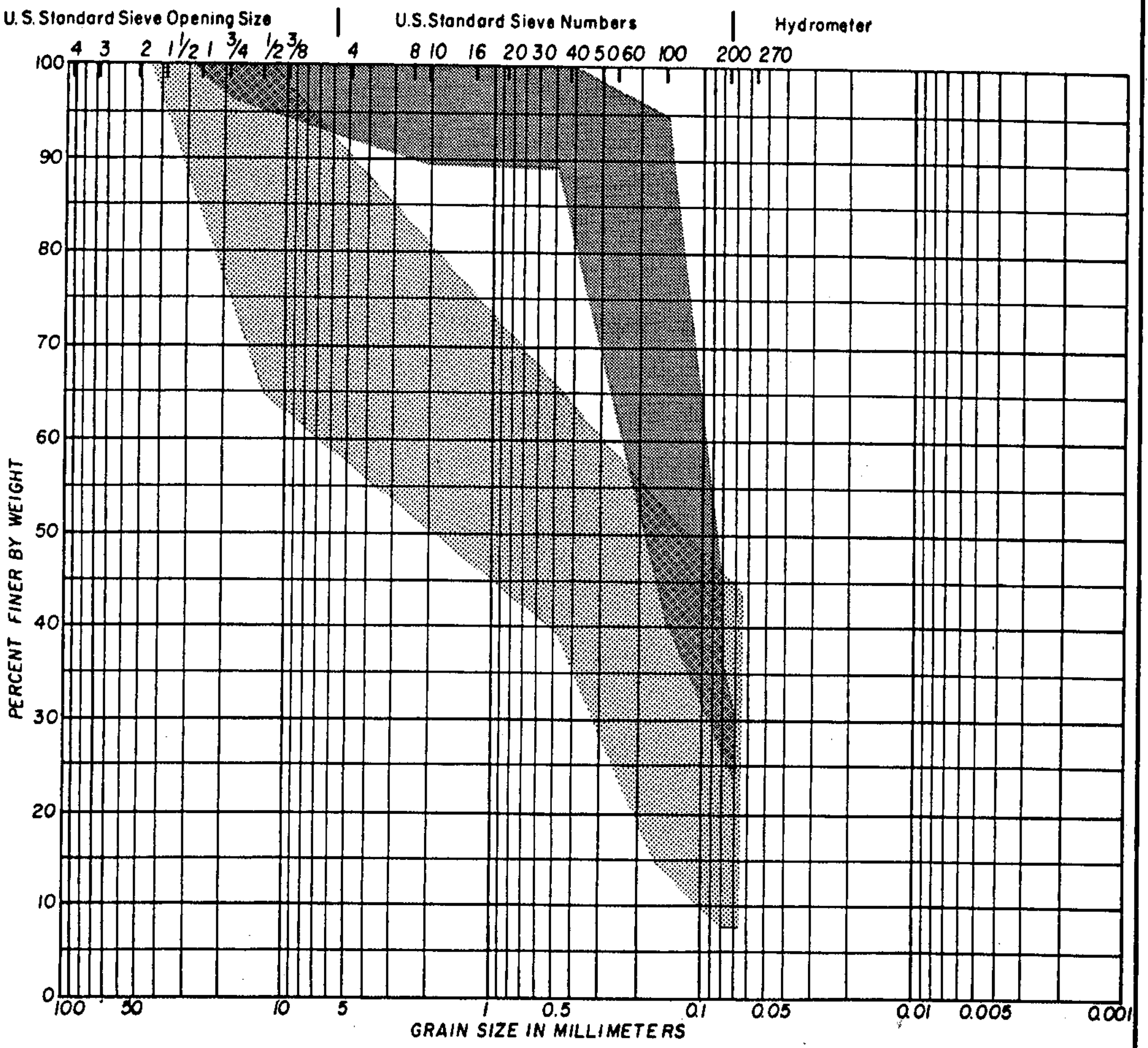
& Geophysicists

## SUBSURFACE CROSS-SECTION

Port of Nome
Nome, Alaska

PLATE
3

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15,001,002.08 | TJS | 4/82 | | |



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | COARSE | FINE | COARSE | MEDIUM | FINE | |

| Symbol | Sample Source | Classification |
|---|---|---|
| ▓ | Offshore Boring | Marine- SILTY SAND (SM) |
| ░ | Offshore Boring | Glacial Till - GRAVELLY SILTY SAND (SM) |

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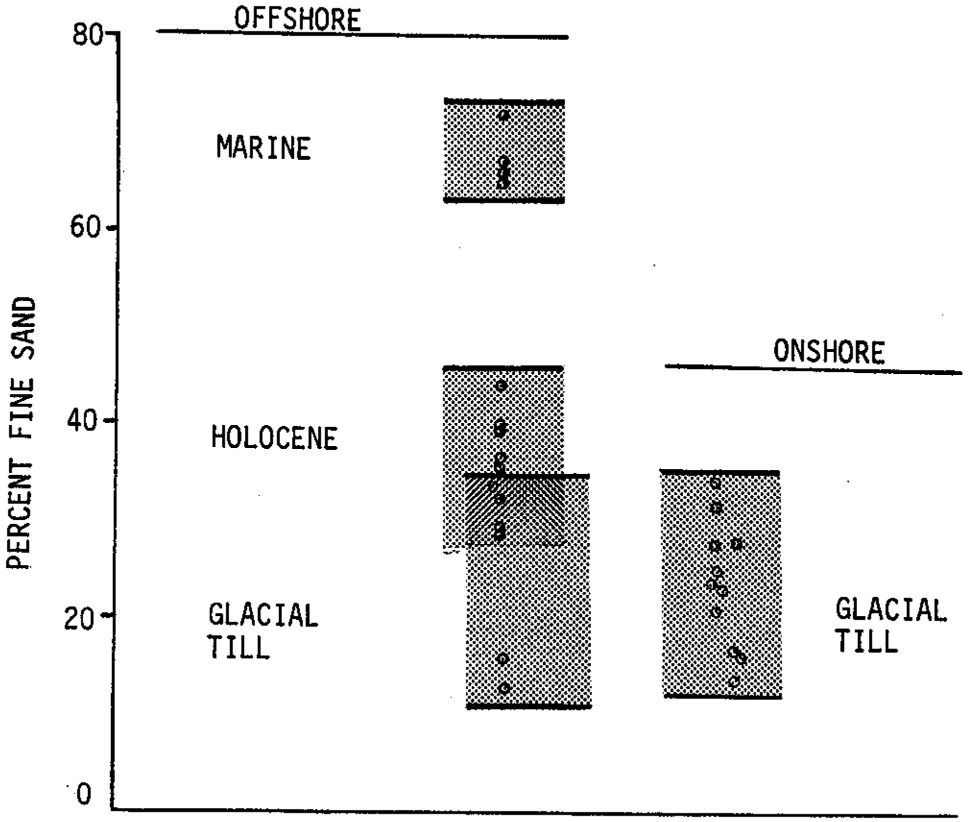
& Geophysicists

## Particle Size Analysis Summary - Causeway

Port of Nome
Nome, Alaska

PLATE
4

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | | 3/82 | | |



Geologic Interpretation Based on
Percent Fine Sand

**Harding Lawson Associates**
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& Geophysicists

## Gradation Interpretation

Port of Nome
Nome, Alaska

PLATE
5

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15,001,002.08 | TJJ | 4/82 | | |

# APPENDIX A - FIELD EXPLORATION

The field exploration was performed between February 1 and 17, 1982 (excluding equipment mobilization and demobilization periods). Onshore and offshore drilling operations were conducted concurrently with separate drill rigs. All field work was coordinated by a senior engineer or geologist.

## A. Offshore Test Borings

### 1. Drilling

The soil conditions were explored by drilling seven test borings ranging from 22 to 57 feet deep (measured from the mudline) along the causeway centerline at the locations shown on Plate 1. The borings penetrated bedrock or suitable, dense bearing strata. Prior to moving the rig onsite, the boring locations were staked by our surveyors, Silvers Engineering. A summary of the test borings is presented on the following table.

Table A-1. Offshore Test Boring Summary

| Boring No. | Coordinates (feet) | Ice Surface Elevation (feet) | Depth to Mudline (feet) | Depth Drilled (feet) |
|---|---|---|---|---|
| *HLO-1 | N 111,137<br>E 104,812 | 0.0 | 6.0 | 22 |
| HLO-2 | N 110,684<br>E 104,712 | -0.1 | 11.3 | 56 |
| HLO-3 | N 109,934<br>E 104,478 | 0.0 | 12.5 | 37 |
| HLO-4 | N 108,898<br>E 104,172 | 0.0 | 20.5 | 43 |
| HLO-5 | N 107,987<br>E 104,061 | 0.0 | 32.5 | 45 |
| HLO-6 | N 107,883<br>E 104,400 | 0.0 | 32.0 | 57 |
| HLO-7 | N 107,417<br>E 105,012 | -0.2 | 36.5 | 42 |

* Adjusted by HLA to as-drilled location.

The test borings were drilled with a helicopter-supported Mobile Drill B-38 rotary wash rig. The rig was flown to Nome by Alaska International Air (AIA) cargo C-130 Hercules aircraft. Accompanying the rig was ancillary equipment, most of which was necessary to complete the work under arctic winter conditions: drill tools and samplers; portable work shed with heaters; mud pump and shed; wind screens; and miscellaneous cold weather equipment. A Bell 205 helicopter supplied by ERA Helicopters Inc., Anchorage was used to transport the crew, rig and equipment to each boring site.

The operation was staffed full time by a geologist, a driller/superintendent and two drill helpers. In addition, TAMS' geotechnical engineer was present during most of the drilling. In general, a 12-hour per day schedule was maintained. The geologist directed the drilling operation, logged the soil and rock encountered and obtained representative samples for laboratory testing. Logs of the test borings are presented on Plates A1 through A12. Soils are classified in accordance with the Unified Soil Classification System shown on Plate A32.

The borings were drilled using the rotary wash method. Sea water was used as the drilling fluid; drilling mud or other additives were not used. Initially, casing was placed from the ice surface to the sea floor at which time sampling began. In general, the casing continued for the full depth of the boring to prevent caving of the sands. The casing was advanced and removed with a 300-pound drive hammer.

## 2. Sampling

Sampling was performed throughout the depth of the borings. Generally, the upper 15 feet were sampled continuously; samples were obtained at five-foot intervals thereafter until bedrock was encountered or suitable depth was obtained. Typically, the boring extended several feet into bedrock. Sample locations are shown on the boring logs.

### a. Shelby Samples

Undisturbed samples were taken using Shelby tubes. The Shelby sampler used was a 2.87-inch I.D. by 36-inch-long steel tube. The tube was placed at the bottom of the boring and, using the drill rig to advance the sampler, pushed into the soil approximately 34 inches or to refusal. This method was used on the fine-grain silts and the loose to medium dense silty sands.

b. Drive Samples

Most of the samples were obtained by drive sampling whereby a 2.4-inch I.D. by 3.0-inch O.D. split-spoon sampler is driven into the soil 18 inches or to practical refusal. The split-spoon sampler contained three, 6.0-inch-long brass liners to retain the sample. This sampler was used primarily in coarse-grain soils.

The split spoon was advanced using a 300-pound hammer falling 30 inches. The number of blow required to drive each six-inch increment was recorded. The number of blows required to drive the sampler the last 12 inches, or fraction thereof, is presented on the boring logs.

c. Standard Penetration Test Sampling (SPT)

On occasion, a standard penetration test was performed. A standard 2.0-inch O.D. by 1.5-inch I.D. sampler was advanced 18 inches by a 140-pound hammer free-falling 30 inches. The number of blows to advance the sampler the last 12 inches is recorded as the N-value in blows per foot.

d. NX Coring

Bedrock samples were obtained using a five-foot-long double-wall diamond-bit NX core barrel.

## B. Onshore Test Borings

### 1. Drilling

The onshore test borings were drilled with a Mayhew 1000, 10-inch-diameter rotary-air drill subcontracted from Thrasher and Associates in Nome. Thirteen borings were drilled in the storage area. Of these, 10 borings were in the Upland and 3 in the Modified areas, respectively. The rig was mounted on an all-terrain track vehicle. As-drilled locations of the test borings were determined by Silvers Engineers and are presented on Plate 1 and listed below.

Table A-2. Storage Area Test Boring Summary

| Boring No. | Coordinates (feet) | Ground Surface Elevation (feet) | Boring Depth (feet) |
|---|---|---|---|
| HLB-1 | N 112,070<br>E 103,967 | 33.8 | 43 |
| HLB-2 | N 111,909<br>E 104,570 | 33.1 | 44 |
| HLB-3 | N 111,619<br>E 105,270 | 10.7 | 26 |
| HLB-4 | N 111,539<br>E 105,570 | 10.5 | 54 |
| HLB-5 | N 111,489<br>E 105,759 | 6.1 | 30 |
| HLB-6 | N 112,278<br>E 104,596 | 38.9 | 30 |
| HLB-7 | N 112,134<br>E 105,040 | 36.6 | 73 |

Table A-2. (continued)

| Boring No. | Coordinates (feet) | Ground Surface Elevation (feet) | Boring Depth (feet) |
|---|---|---|---|
| HLB-8 | N 112,509<br>E 105,100 | 40.2 | 32 |
| HLB-9 | N 112,590<br>E 140,790 | 41.0 | 31 |
| HLB-10 | N 112,583<br>E 103,498 | 36.8 | 43 |
| HLB-11 | N 112,991<br>E 104,238 | 41.1 | 30 |
| HLB-12 | N 113,150<br>E 104,969 | 44.5 | 31 |
| HLB-13 | N 112,535<br>E 104,084 | 38.4 | 44 |

HLB 3, HLB 4 and HLB 5 were not surveyed after drilling but were drilled in their original surveyed positions.

An additional four borings were drilled at the site of the small boat harbor with the Thrasher Rig. Locations of these borings are shown on Plate 2 and presented below.

Table A-3. Small Boat Harbor Test Boring Summary

| Boring No. | Coordinates (feet) | Ice Ground Surface Elevation (feet) | Boring Depth (feet) |
|---|---|---|---|
| HLS-1 | N 111,694<br>E 107,184 | 2.6 | 19 |
| HLS-2 | N 111,708<br>E 107,290 | 2.4 | 19 |
| HLS-3 | N 111,918<br>E 107,139 | 3.3 | 19 |
| HLS-4 | N 111,850<br>E 107,235 | 2.9 | 25 |

The onshore borings were drilled concurrent with the offshore borings. The operation was staffed by our engineer, driller and helper. A minimum 10 hours per day operation was maintained. The engineer directed the operation, logged the soil encountered and obtained samples for visual observation and laboratory testing. Logs of the test borings are presented on Plates A13 through A27. Detailed logs of four samples are shown on Plate A33.

## 2. Sampling

Predominantly grab (or disturbed) samples were obtained from the storage facility borings. These were obtained by trapping cuttings as they discharged out of the borehole. The samples were placed in moisture-proof plastic bags. In the small boat harbor and on occassion the storage area, 2.4-inch I.D. split-spoon samples were obtained using non-standard driving energy.

## C. Sample Handling

The soil samples were visually examined, classified, and logged in the field by our engineer and geologist. Whenever possible, sample temperatures as well as torvane and/or pocket penetrometer readings were taken. Shelby tubes and split spoon liners were sealed with electrical tape to prevent moisture loss and then tagged. Bulk and grab samples were placed in heavy-duty plastic bags, sealed, and tagged. In the field, unbonded samples were protected against freezing, and bonded (frozen) samples were kept frozen by storing them at either low temperatures or in cooler chests.

Periodically, samples were placed in foam-lined carriers and shipped via air freight to our laboratory in Anchorage. Bonded samples were shipped in insulated containers to prevent thawing; they were stored in our laboratory cold room at -4°C until tested.

## D. Onshore Ground Temperatures

Thermistor wells consisting of 1-1/4-inch I.D. PVC pipe filled with propylene glycol were installed in eight of the onshore borings. A probe containing a precisely calibrated thermistor and a standard bead-in-glass thermistor was used to measure the glycol temperatures. The two thermistors were used to verify one another's performance.

### 1. Equipment

The thermistors used were a standard YSI Model 44007 and a Victory Serial No. 50. The YSI thermistor has an interchangeability of 0.2°C from 0°C to 80°C and a resistance of 5000 ohms at 25°C and exhibits a resistance change of approximately 860 ohms per degree centigrade. The precision calibrated Victory thermistor has an interchangeability of 0.05°C and a resistance of 4560 ohms at 0°C and exhibits a resistance change of approximately 220 ohms per degree centigrade.

The thermistors were installed side by side at the bottom of a probe approximately six inches long. A four-conductor cable manufactured by Berk-Teck Company (Model BTONX-734-2F-Q) was used for leadout wire. One conductor was used for a common ground, one for measuring lead wire resistance, and the remaining two for measuring the termistors.

### 2. Thermistor Readings and Data Reduction

The thermistor wells were read twice during the 10 days after installation. A third set of readings was made on April 14 and 15, 1982. Results of these readings are tabulated on Plates A34 through A37 and illustrated on temperature versus depth plots on Plates A38 through A41. Also shown are the freezing points, which can be considerably lower than that of fresh water, depending on the porewater salinity. However, results of laboratory tests indicate that the freezing point is very near that of fresh water.

The resistance readings were made using a Data Precision Model 248 multi-meter. When combined, the calibrated bead-in-glass thermistors and the Model 248 multi-meter have a precision of 0.05°C and an accuracy of 0.1°C.

Resistance readings were made at 3-foot intervals from the ground surface to a depth of 15 feet and then at 5-foot intervals to the bottom of the thermistor well. Depths were referenced to the ground surface surrounding the thermistor well. The thermistors were monitored at each depth until a stabilized reading was obtained. To avoid inducing heat into the thermistors, the multi-meter was turned off between readings. Once a stablized value was obtained, the leadwire resistance was read and then the probe was lowered to the next depth.

The resistance values obtained in the field at given depths were corrected for leadwire resistance by subtracting the measured leadwire resistance from the total resistance. The resistance values were reduced to ground temperatures using the following relationship

$$\frac{1}{T} = A + B\ (\ln R) + C\ (\ln R)^3$$

where: $T$ = temperature in degrees Kelvin

$A, B, C$ = constants for the thermistors

$R$ = measured resistance in ohms

## E. Drilling Operations Diary

The following is a brief daily description of our field operations.

| Date | Activity |
|---|---|
| 2/01/82 | Mobilize personnel from Anchorage to Nome. (Equipment was shipped earlier) Sling Heli-rig to boring HLO-2. |
| 2/02/82 | Drill HLO-2 to 46 feet. Mobilize Thrasher air drill. Complete HLB-5 and begin HLB-4. |
| 2/03/82 | Complete HLO-2 and sling rig to HLO-7. Complete HLB-4; set PVC casing. |

| Date | Activity |
|---|---|
| 2/04/82 | Complete HLO-7 to 42 feet; sling rig to HLO-6. Complete HLB-3, 7, 8 and 6; set PVC in HLB-7 and 8. |
| 2/05/82 | Drill HLO-6 to 25 feet. Install PVC in HLB-6. Drill HLB-9, 12, 11. Install PVC in HLB-9 and 12. |
| 2/06/82 | Complete HLO-6 to 51 feet. Drill HLB-10, 1 and 2. Install PVC in HLB-10 and 2. |
| 2/07/82 | Standby in a.m. due to inclement weather. Drill HLB-5 to 12 feet. |
| 2/08/82 | Complete HLO-5 to 44 feet. Move Thrasher rig to small boat harbor and drill HLS-1 and 2. |
| 2/09/82 | Sling to HLO-4 and drill to 18 feet. Redrill HLS-2 and drill HLS-3 and 4. |
| 2/10/82 | Complete HLO-4 to 42 feet. Demobilize Thrasher rig. |
| 2/11/82 | Begin HLO-3; drill to 11 feet. Reconn Cape Nome area for possible quarry development. |
| 2/12/82 | Complete HLO-3 to 37 feet. Begin ground temperature monitoring in Upland Tundra area. |
| 2/13/82 | Sling to HLO-1 and drill to 12 feet. Continue temperature monitoring. |
| 2/14/82 | Standby during inclement weather. Complete HLO-1 to 22 feet. Continue temperature monitoring. |
| 2/15/82 | Demobilize equipment. Personnel return to Anchorage. One engineer remains to continue ground temperature monitoring. |
| 2/16/82 | Complete initial ground temperature monitoring. |
| 2/17/82 | Complete demobilizing; remaining engineer returns to Anchorage. |

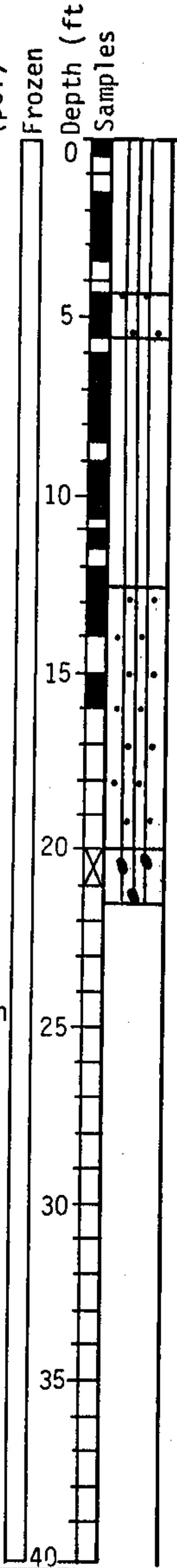
## LOG OF BORING HLO-1

Equipment 4-inch Rotary Wash

Elevation -2.8 ft. MLLW · Date Drilled 02/13/82

N111, 137
E104, 812

| Laboratory Tests | Sample Temp (°F) | Moisture Content (%) | Blows/Foot | Dry Density (pcf) |
|---|---|---|---|---|
| | 34° | | 5 | |
| | 33° | | Push (Shelby) | |
| -#200 Sieve | | 37.6 | | 79 |
| TXCU, Consol | | | | |
| LL=PL=NP | 33° | | 10 | |
| | | | Push (Shelby) | |
| | 33° | | Push (Shelby) | |
| SA,3TXCU, Consol | | 39.6 | | 80 |
| -#200 Sieve | | 41.4 | | 78 |
| LL=PL=NP | 33° | | Push (Shelby) | |
| SA | | 20.2 | | 108 |
| SA | 33° | 17.4 | 10 | 116 |
| | 33° | | 15 | |



BLACK SANDY SILT (ML)
saturated, soft-medium stiff, with organic materials

GRAY SILTY SAND (SM)
saturated, medium dense

GRAY BLACK SANDY SILT (ML)
saturated, medium stiff with organic matters, strong organic odor

GRAY BLACK SILTY SAND (SM)
saturated, medium dense, trace of fibrous organic material

GRAY SILTY GRAVEL (GM)
saturated, dense (Till)

NOTES:

1. Blow counts are based on a 3-inch O.D. 2.43-inch I.D. split-spoon sampler with a 300-lb. hammer and 30-inch drops, unless otherwise specified.
2. Relative density test performed on combined samples from depths 1.5 to 3.5 feet and 9.0 to 14.0 feet.
3. Sample Temperatures were obtained immediately after sample was recovered.
4. Coordinates referenced to City of Nome Datum.

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

**Log of Boring HLO-1**
PORT OF NOME
Nome, Alaska

PLATE
**A1**

DRAWN
JOB NUMBER 15001,002.08
APPROVED TJS
DATE 03/82
REVISED
DATE

N110,684
E104,712

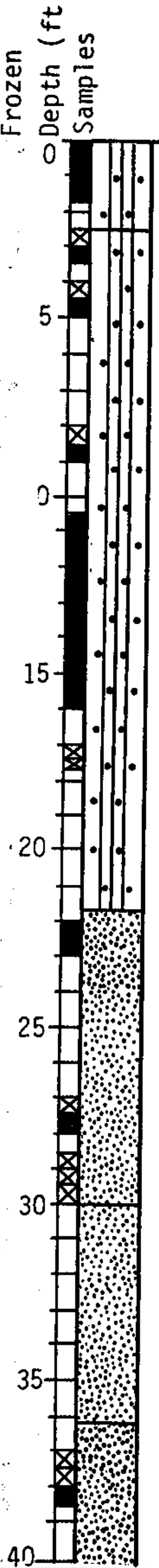
## LOG OF BORING HLO-2

Equipment 4-inch Rotary Wash

Elevation -11.4 ft. MLLW Date Drilled 02/02/82

| Laboratory Tests | Sample Temp (°F) | Moisture Content(%) | Blows/ Foot | Dry Density (pcf) | Frozen |
|---|---|---|---|---|---|
| -#200 Sieve<br>SA | 33° | 20.1 | Push (Shelby) | 104 | |
| SA<br>LL=PL=NP | 33° | 22.1 | 11 | 104 | |
| | 32° | | 12 | | |
| SA TXCU | 32° | 36.2 | 7 | 85 | |
| -#200 Sieve<br>TXCU | 34° | 35.2 | Push (Shelby) | 85 | |
| | 33° | | Push (Shelby) | | |
| | | | Push (Shelby) | | |
| SA | 33° | 22.1 | 14 | 103 | |
| | 31° | | 40 (SPT)* | | |

*SPT = Standard Penetration Test



GRAY SILTY SAND (SP-SM)
saturated, medium dense with occasional black organic material

GRAY SILTY SAND (SM)
saturated, medium dense with traces of fibrous organics

BLACK-BROWN SILTY SAND (SP-SM)
saturated, loose to medium dense

GRAY GRAVELLY SAND (SP)
saturated, medium dense to dense

GRAY GRAVELLY SAND (SP)
saturated, medium dense to dense (Till)

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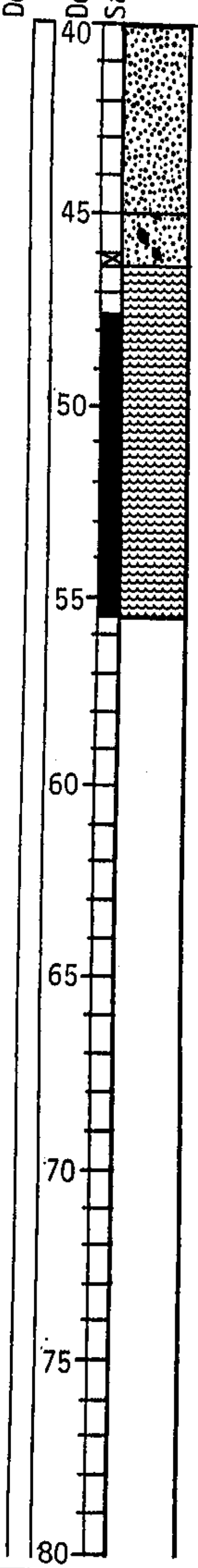
**Log of Boring HLO-2**
PORT OF NOME
Nome, Alaska

**A2**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | TJS | 03/82 | | |

## LOG OF BORING HLO-2

| Laboratory Tests | Sample Temp. (°F) | Blows/Foot (N-Value) | Moisture Content (%) | Dry Density (pcf) |
|---|---|---|---|---|
| | | 40 | | |
| | | NX* | | |



GRAY SANDY GRAVEL (GP)
saturated, very dense (rubble)

BLACK MICACEOUS SCHIST
moderately weathered and fractured. Fractures occur frequently along foliation perpendicular to core, RDQ approximately 70%**

* NX Rock Core
** RQD = Rock Quality Designation

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**Log of Boring HLO-2 (CONT.)**
PORT OF NOME
Nome, Alaska

PLATE
**A3**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001.002.08 | RJ | 3/82 | | |

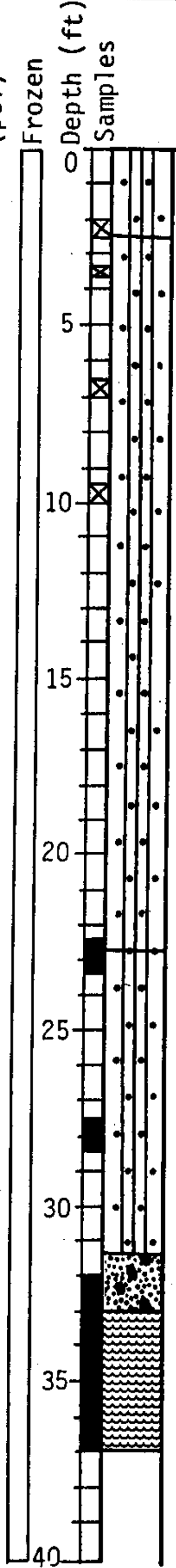
## LOG OF BORING HLO-3

Equipment 4-inch Rotary Wash

Elevation -12.5ft. MLLW Date Drilled 02/11/82

N 109, 934
E 104, 478

| Laboratory Tests | Sample Temp (°F) | Moisture Content(%) | Blows/Foot Push (Shelby) | Dry Density (pcf) |
|---|---|---|---|---|
| SA | 34° | | 17 | |
| | | | 24 | |
| | | | 17 | |
| | 33° | | 25 | |
| | | | 28 | |
| | 33° | | 23 | |
| | 33° | | 18 | |
| | 33° | | 17 | |
| | 33° | | | |
| | 33° | | 23 | |
| SA | 33° | 19.0 | 21 | 115 |
| | | | 50 | |
| | 32° | | NX | |



GRAY SILTY SAND (SM)
saturated, medium dense with occasional shells

GRAY GRAVELLY SILTY SAND (SM)
saturated, medium dense to dense (Till)

GRAY SILTY SAND (SM)
saturated, dense

GRAY BLACK GRAVEL (GP)
saturated, very dense (rubble)

GRAY BLACK MICACEOUS SCHIST
RQD approximately 75% to 80%, inclusions of pyrite and quartz foliation perpendicular to core

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**Log of Boring HLO-3**
PORT OF NOME
Nome, Alaska

PLATE
A4

DRAWN
JOB NUMBER 15001.002.08
APPROVED RJ
DATE 03/82
REVISED
DATE

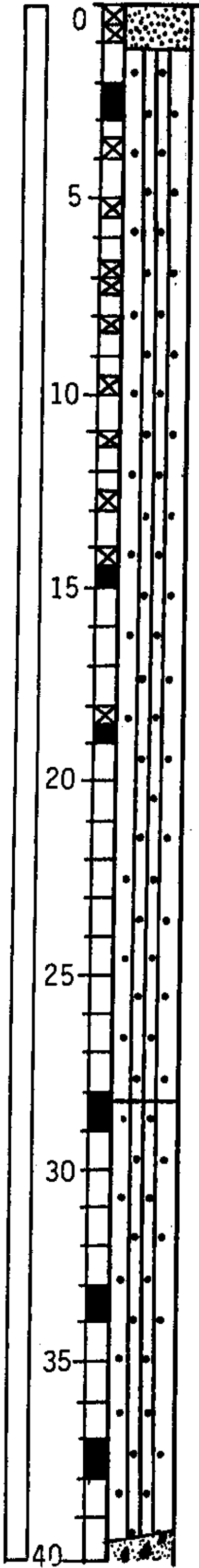
N108,898
E104,172

LOG OF BORING HLO-4

Equipment 4-inch Rotary Wash

Elevation -20.5ft. MLLW . Date Drilled 02/09/82

| Laboratory Tests | Sample Temp (°F) | Moisture Content (%) | Blows/ Foot | Dry Density (pcf) |
|---|---|---|---|---|
| SA | | | 23 | |
| | | | 26 | |
| | | | 36 | |
| | | | 33 | |
| | | | 20 | |
| | | | 34 | |
| SA<br>LL=PL=NP | | | 17 | |
| | | | 18 | |
| | | | 20 | |
| | | | 39 | |
| | | | 74 | |
| | | | 50 | |
| | | | 28 | |
| SA | | 23.8 | 56 | 105 |
| | | | 73 | |



GRAY SILTY SAND (SP)
saturated, medium dense

GRAY GRAVELLY SILTY SAND (SM)
saturated, medium dense to very dense (Till)

GRAY SILTY SAND (SM)
saturated, dense

GRAY GRAVEL (GP)
saturated, very dense (rubble)

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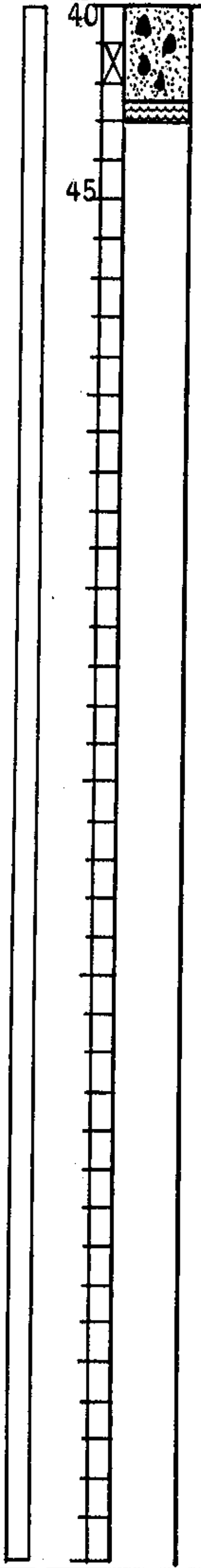
**Log of Boring HLO-4**
PORT OF NOME
Nome, Alaska

PLATE
**A5**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001.002.08 | RJ | 03/82 | | |

## LOG OF BORING HLO-4

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



BEDROCK at 42'

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## Log of Boring HLO-4 (CONT.)

PORT OF NOME
Nome, Alaska

PLATE
**A6**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
|  | 15001,002.08 | RJS | 3/82 |  |  |

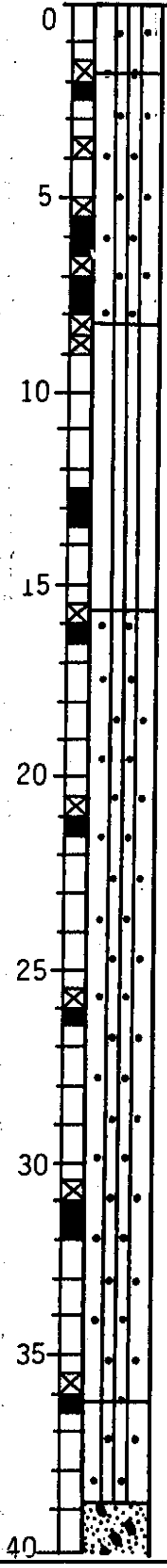
N107,987
E104,061

LOG OF BORING HLO-5

Equipment 4-inch Rotary Wash

Elevation -32.5ft MLLW Date Drilled 02/07/82

| Laboratory Tests | Sample Temp (°F) | Moisture Content (%) | Blows/ Foot | Dry Density (pcf) | Frozen |
|---|---|---|---|---|---|
| | | | 25 | | |
| | | | 24 | | |
| | | 24.7 | 23 | 109 | |
| | | | 20 | | |
| SA<br>LL=PL=NP | | 29.3 | 17 | 101 | |
| | | | 36 | | |
| | | | 51 | | |
| | | | 64 | | |
| | | | 103 | | |
| | | | 34 | | |



GRAY SILTY SAND (SM)
saturated, medium dense

GRAY SILTY SAND (SM)
saturated, medium dense (Till)

GRAY SANDY SILT (ML)
saturated, medium stiff (Till)

GRAY SILTY SAND (SM)
saturated, dense to very dense (Till)

GRAY SILTY SAND (SM)
saturated, very dense

GRAY GRAVEL (GP)
saturated, very dense (rubble)

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

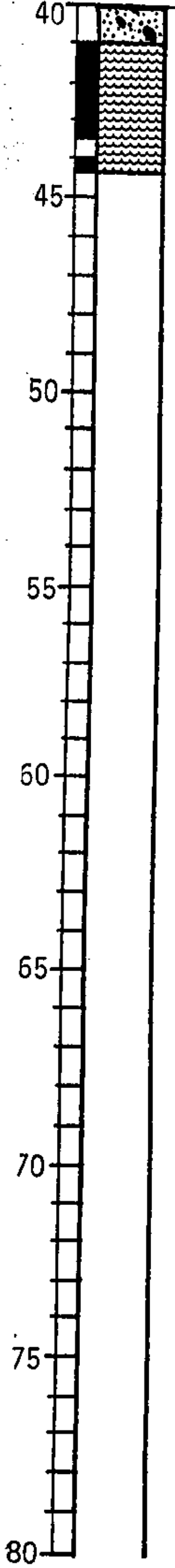
**Log of Boring HLO-5**
PORT OF NOME
Nome, Alaska

PLATE
**A7**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | RJS | 03/82 | | |

LOG OF BORING HLO-5

| Laboratory Tests | Sample Temp. ($^{0}$F) | Blows/Foot (N-Value) | Moisture Content (%) | Dry Density (pcf) | Depth (ft) | Samples |
|---|---|---|---|---|---|---|



GRAY MICACEOUS SCHIST
highly weathered and fractured
RDQ approximately 15%

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

**Log of Boring HLO-5 (CONT.)**
PORT OF NOME
Nome, Alaska

PLATE
**A8**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | TJS | 3/82 | | |

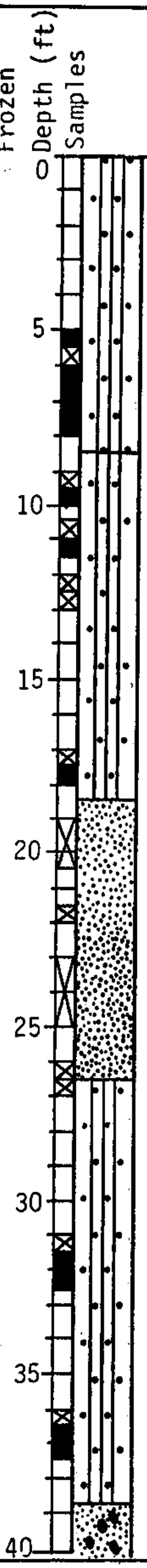
N107,883
E107,417

LOG OF BORING HLO-6

Equipment 4-inch Rotary Wash

Elevation -32 ft. MLLW Date Drilled 02/05/82

| Laboratory Tests | Sample Temp (°F) | Moisture Content (%) | Blows/ Foot | Dry Density (pcf) | Frozen |
|---|---|---|---|---|---|
|  | 32° |  | Push (Shelby) |  |  |
| SA | 32° | 20.0 | 12 | 112 |  |
|  |  |  | Push (Shelby) |  |  |
|  | 32° |  | 26 |  |  |
| SA, Gs | 33° | 10.9 | 21 | 135 |  |
|  | 32° |  | 20 |  |  |
|  | 31° |  | 58 |  |  |
|  |  |  | NX |  |  |
|  |  |  | 45 |  |  |
|  |  |  | NX |  |  |
|  | 32° |  | 30 |  |  |
| SA, Gs | 31° | 25.0 | 50 | 102 |  |
|  |  |  | 39 |  |  |



GRAY SILTY SAND (SM)
saturated, medium dense

GRAY GRAVELLY SILTY SAND (SM)
saturated, medium dense (Till)

GRAY GRAVELLY SILTY SAND (SP)
saturated, very dense (Till)
rock fragments to 2 inches diameter

GRAY SILTY SAND (SM)
saturated, very dense

GRAY SILTY GRAVEL (GP)
saturated, very dense (rubble)

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

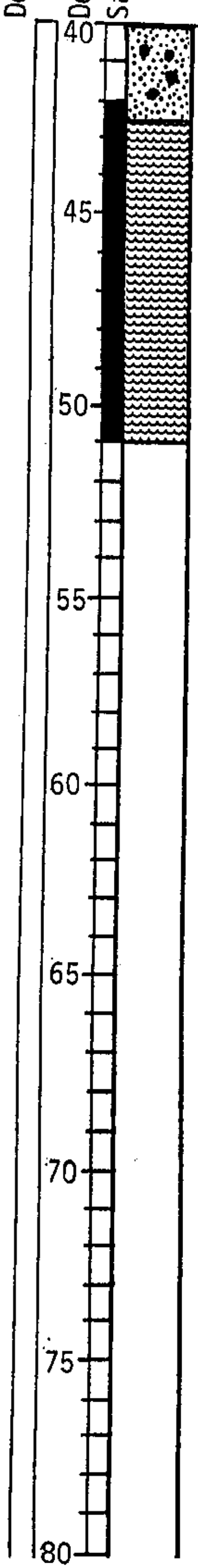
## Log of Boring HLO-6
PORT OF NOME
Nome, Alaska

PLATE
**A9**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
|  | 15001,002.08 | RS | 03/82 |  |  |

## LOG OF BORING HLO-6

| Laboratory Tests | Sample Temp. ($^{o}$F) | Blows/Foot (N-Value) | Moisture Content (%) | Dry Density (pcf) |
|---|---|---|---|---|
| | | NX | | |
| | | NX | | |



BLACK GRAY SCHIST
foliated approximately 30° from vertical; with inclusions of pyrite and quartz RQD approximately 35%

RQD approximately 65% with foliation perpendicular to core at 46.5 feet

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

### Log of Boring HLO-6 (CONT.)

PORT OF NOME
Nome, Alaska

PLATE
A10

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001.002.08 | RJS | 3/82 | | |

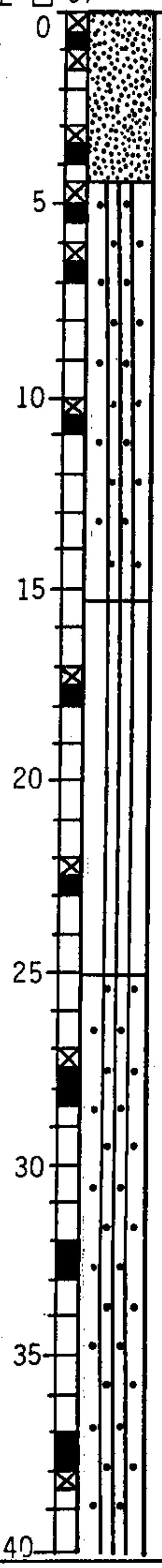
N 107,417
E 105,012

## LOG OF BORING HLO-7

Equipment 4-inch Rotary Wash

Elevation 36.7 ft MLLW Date Drilled 02/03/82

| Laboratory Tests | Sample Temp ($^oF$) | Moisture Content(%) | Blows/ Foot | Dry Density (pcf) | Frozen |
|---|---|---|---|---|---|
| | | | 37 | | |
| SA, Gs | | 15.8 | 20 | 123 | |
| | | | 48 | | |
| | | | 32 | | |
| | | | 30 | | |
| | | | 31 | | |
| | | | 28 | | |
| | | | 28 | | |
| | | | 36 | | |
| SA, Gs | | 27.0 | 53 | 98 | |



BROWN GRAVELLY SILTY SAND (SM)
saturated, dense to very dense

GRAY BLACK GRAVELLY SILTY SAND (SM)
saturated, dense to very dense
(Till)

GRAY GRAVELLY SILT (ML)
saturated, very stiff (Till)

GRAY SILTY SAND (SM)
saturated, very dense

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

## Log of Boring HLO-7

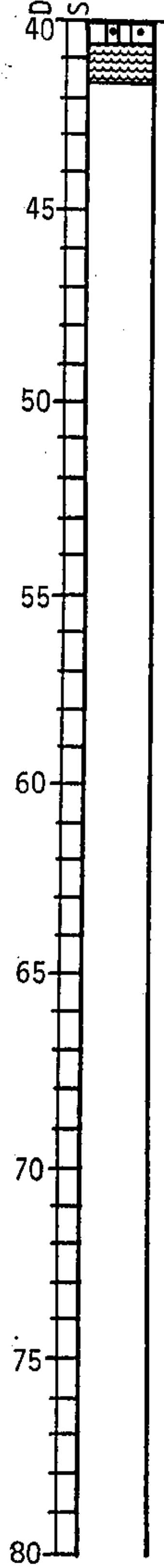
PORT OF NOME
Nome, Alaska

PLATE
A11

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | | 03/82 | | |

LOG OF BORING HLO-7

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



GRAY MICACEOUS SCHIST

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

## Log of Boring HLO-7 (CONT.)

PORT OF NOME
Nome, Alaska

PLATE
**A12**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
|  | 15001,002.08 | TJS | 3/82 |  |  |

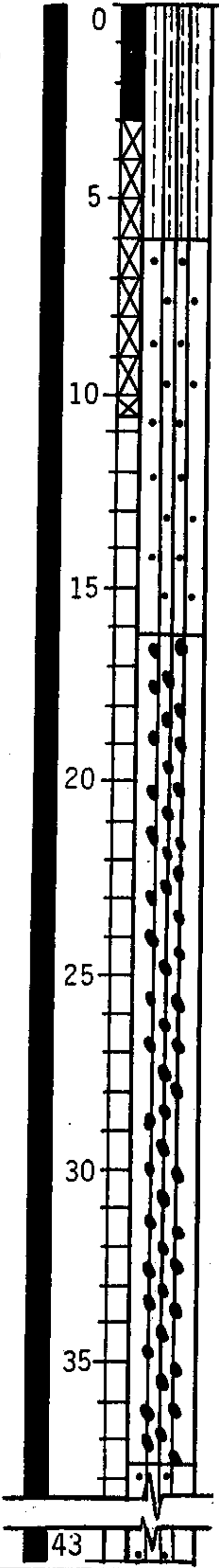
N112,070
E103,967

## LOG OF BORING HLB-1

Equipment 10-inch Air Drill

Elevation 33.8 ft. MLLW Date Drilled 02/06/82

| Laboratory Tests | Moisture Content (%) | Blows/Foot | Dry Density (pcf) |
|---|---|---|---|
| Org. Loss=47% | 600.7 | | 8 |
| | 36.6 | | |
| -#200 Sieve | 27.1 | | |
| | 24.0 | | |



BROWN ORGANIC SILT (OL,$N_{be}$) with occasional fibrous organics, top 1 foot very peaty

BROWN SILTY SAND (SM,$N_{be}$)

DARK GRAY SILTY SANDY GRAVEL (GM, $N_{be}$)

GRAY GRAVELLY SILTY SAND (SM,$N_{bn}$) with occasional subrounded gravel cuttings to 2 inch diameter

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

## Log of Boring HLB-1
PORT OF NOME
Nome, Alaska

PLATE
A13

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | TJS | 03/82 | | |

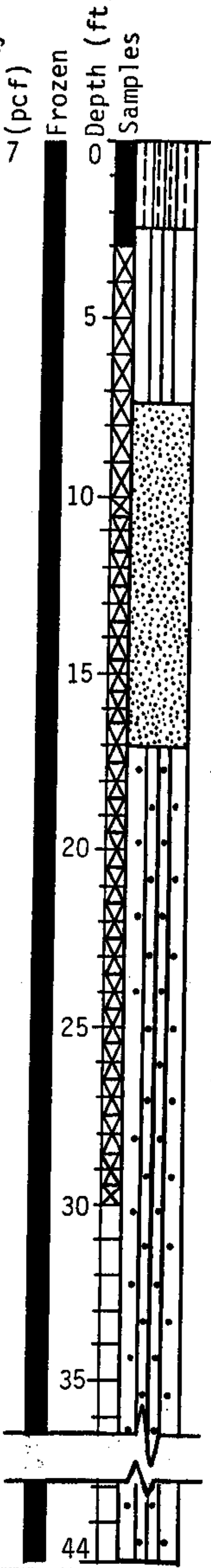
N111,909
E104,570

## LOG OF BORING HLB-2

Equipment 10-inch Air Drill

Elevation +33.1 ft MLLW Date Drilled 02/06/82

| Laboratory Tests | Moisture Content (%) | Blows/ Foot | Dry Density (pcf) |
|---|---|---|---|
| Org. Loss=87% | 795.6 | | 7 |
| Elec. Cond.<br>FPD | 27.4 | | |
| -#200 Sieve | 22.7 | | |
| SA | 19.7 | | |



BROWN ORGANIC SILT (OL, $N_{be}$) with occasional $V_r$ and fibrous organics, top 1 foot very peaty

BROWN SANDY SILT (ML, $N_{be}$)

BROWN SILTY SAND (SP-SM, $N_{be}$)

GRAY GRAVELLY SILTY SAND (SM, $N_{bn}$)

Decreasing gravel content

Encounter gravel greater than 4 inches diameter

NOTE:
1. Installed PVC pipe to 44 feet.

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

**Log of Boring HLB-2**
PORT OF NOME
Nome, Alaska

PLATE
**A14**

DRAWN
JOB NUMBER 15001,002.08
APPROVED TJS
DATE 03/82
REVISED
DATE

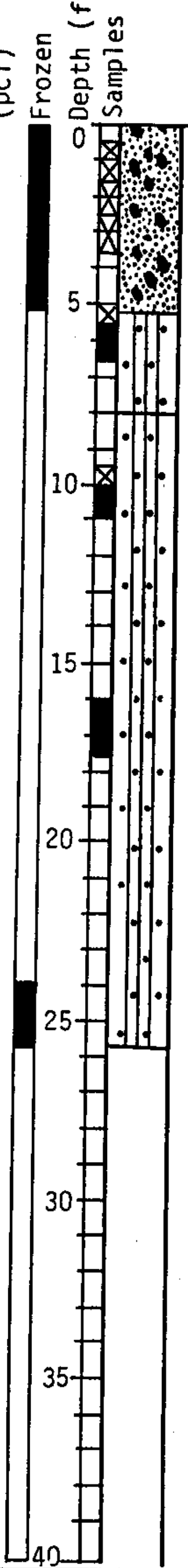
N111,619
E105,270

## LOG OF BORING HLB-3

Equipment 10-inch Air Drill

Elevation 10.7 ft. MLLW Date Drilled 02/04/82

| Laboratory Tests | Moisture Content(%) | Blows/ Foot | Dry Density (pcf) |
|---|---|---|---|
|  | 66.0 |  |  |
| SA | 2.2 |  |  |
| SA |  |  |  |
| SA | 12.5 |  |  |
| SA |  |  |  |



BROWN SANDY GRAVEL (GP, NF)
gravel to 2 inch diameter

BROWN GRAVELLY SAND (SM)
medium dense dry, occasional gravel to 2 inch diameter
Becoming moist at 7.5 feet

BROWN SILTY GRAVELLY SAND (SM)
saturated, dense

Frozen at 24'

NOTE:
1. Installed PVC pipe to 25 feet.

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

**Log of Boring HLB-3**
PORT OF NOME
Nome, Alaska

PLATE
**A15**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
|  | 15001,002.08 | TJS | 03/82 |  |  |

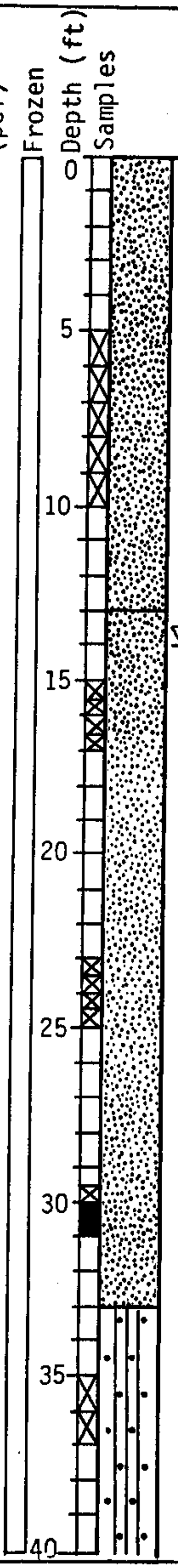
N111,539
E105,570

LOG OF BORING HLB-4

Equipment 10-inch Air Drill

Elevation 10.5 ft. MLLW Date Drilled 02/03/82

| Laboratory Tests | Moisture Content (%) | Blows/ Foot | Dry Density (pcf) |
|---|---|---|---|
|  | 66.0 |  |  |
| SA | 3.6 |  | 99 |
| SA | 19.7 |  |  |



BROWN SAND (SP)
Moist, medium dense

▽ Water Level 2/03/82

DARK GRAY SAND (SP-SM)
saturated, medium dense to dense, with trace gravel to 1 inch diameter

Increasing gravel content

DARK GRAY SILTY SAND (SM)
saturated, medium dense to dense

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

**Log of Boring HLB-4**
PORT OF NOME
Nome, Alaska

PLATE
**A16**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
|  | 15001,002.08 | DS | 03/82 |  |  |

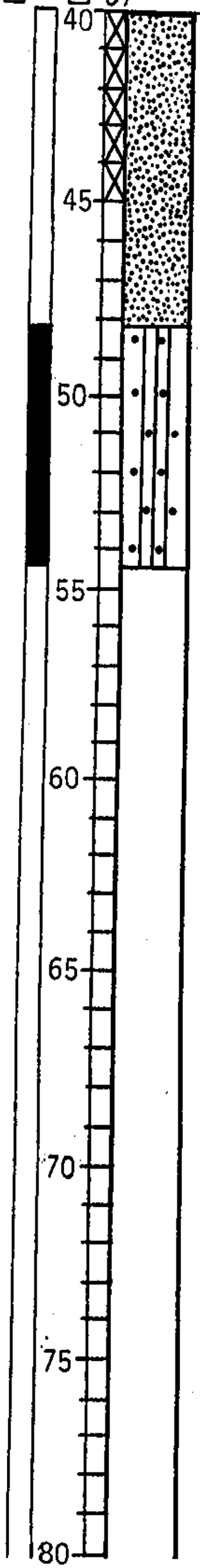
N111,539
E105,570

LOG OF BORING HLB-4

Laboratory Tests

SA

| Laboratory Tests | Blows/Foot (N-Value) | Moisture Content (%) | Dry Density (pcf) | Depth (ft) | Samples |
|---|---|---|---|---|---|
| SA |  | 19.3 |  | 40 |  |



DARK GRAY SILTY SAND (SM)
frozen

NOTE:

1. Installed PVC casing to 45 feet.

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& Geophysicists

**Log of Boring HLB-4 (CONT.)**
PORT OF NOME
Nome, Alaska

PLATE
**A17**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
|  | 15001,002.08 | TJS | 03/82 |  |  |

N111,489
E105,759

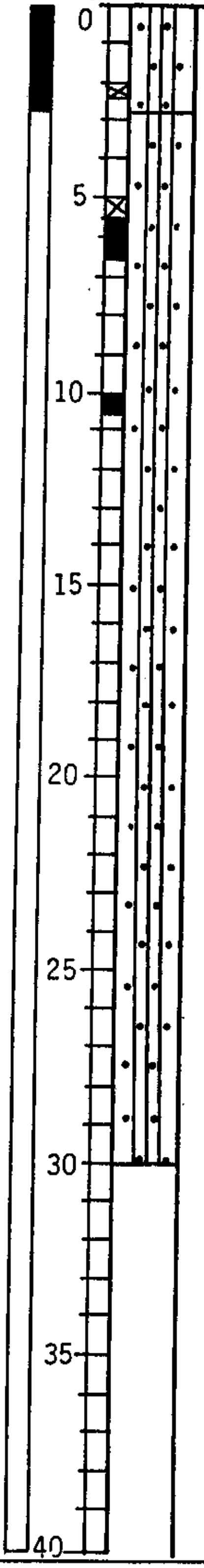
## LOG OF BORING HLB-5

Equipment 10-inch Air Drill

Elevation 6.1 ft. MLLW Date Drilled 02/02/82

| Laboratory Tests | Moisture Content(%) | Blows/ Foot | Dry Density (pcf) |
|---|---|---|---|
| | 40.8 | | |

Frozen Depth (ft) Samples



BLACK SILTY SAND (SM,$N_b$)

BLACK SILTY SAND (SM),
saturated, loose to medium dense

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

## Log of Boring HLB-5

PORT OF NOME
Nome, Alaska

PLATE
A18

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | | 03/82 | | |

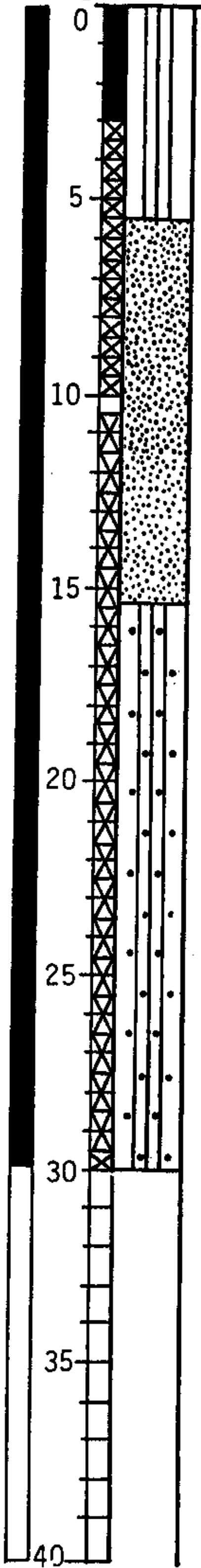
N112,278
E104,596

## LOG OF BORING HLB-6

Equipment 10-inch Air Drill

Elevation +38.9 ft MLLW Date Drilled 02/04/82

| Laboratory Tests | Moisture Content(%) | Blows/ Foot | Dry Density (pcf) |
|---|---|---|---|
| -#200 Sieve<br>Org. Loss | 99.2 | | 40 |
| Elec. Cond.<br>FPD | 21.5 | | |
| -#200 Sieve | 19.9 | | |
| SA | 13.0 | | |
| | 12.0 | | |



LIGHT BROWN ORGANIC SILT(ML,$V_s$) with 6 inches fibrous organics at surface

BROWN SILTY SAND (SP-SM , $N_{be}$)

Becomes gravelly at 10.0 feet

DARK GRAY GRAVELLY SILTY SAND(SM,$N_{bn}$) with interbedded gravel and sand layers

NOTE:

1. Installed PVC casing to 30 feet

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

**Log of Boring HLB-6**
PORT OF NOME
Nome, Alaska

PLATE
A19

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | BS | 03/82 | | |

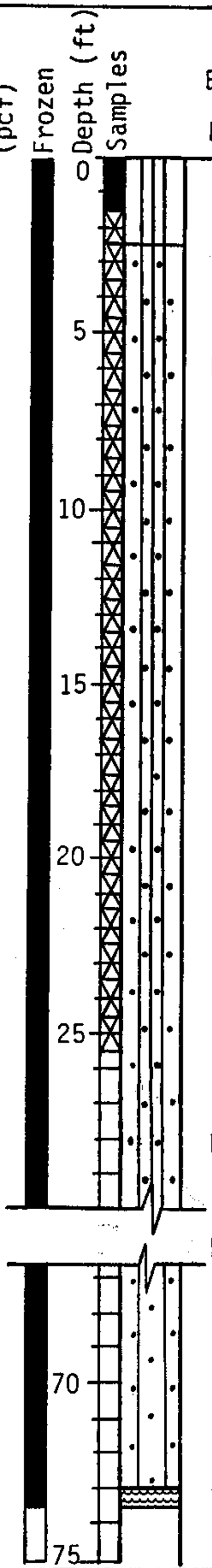
N112,134
E105,040

LOG OF BORING HLB-7

Equipment 10-inch Air Drill

Elevation 36.6 ft. MLLW Date Drilled 02/04/82

| Laboratory Tests | Moisture Content (%) | Blows/ Foot | Dry Density (pcf) |
|---|---|---|---|
| SA | 26.4 | | |
| Elec. Cond.<br>FPD | 17.9 | | |
| SA | 22.1 | | |
| | 12.5 | | |



BROWN ORGANIC SANDY SILT (ML, $N_{be}$)
with 6 inch fibrous organic
material at surface

BROWN GRAY SILTY SAND (SM, $N_{be}$)
with occasional gravel

BROWN GRAY SILTY SAND (SM, $N_{bn}$)
with occasional gravel

Probed to top of rock

TOP OF ROCK at 73'

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

**Log of Boring HLB-7**
PORT OF NOME
Nome, Alaska

PLATE
**A20**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | | 03/82 | | |

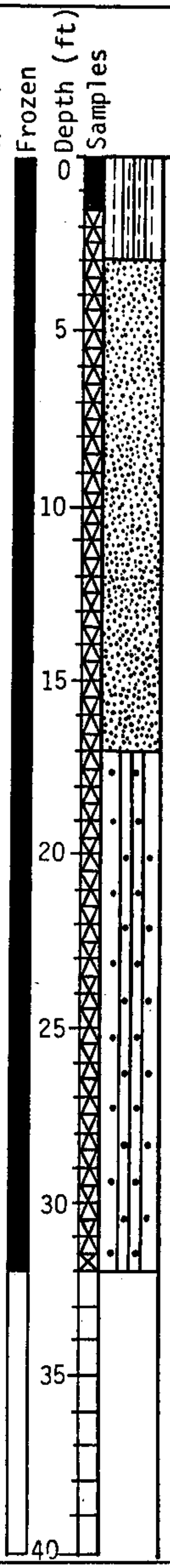
N112,509
E105,100

## LOG OF BORING HLB-8

Equipment 10-inch Air Drill

Elevation 40.2 ft MLLW Date Drilled 02/04/82

| Laboratory Tests | Moisture Content (%) | Blows/ Foot | Dry Density (pcf) |
|---|---|---|---|
| Elec. Cond.<br>FPD | 20.2 | | |
| -#200 Sieve | 17.6 | | |
| | 17.0 | | |
| | 15.7 | | |



DARK BROWN ORGANIC SILT (OL, $N_{be}$) with occasional fibrous organics

BROWN SILTY SAND (SP-SM, $N_{be}$)

Encountered gravel seams

BROWN GRAY GRAVELLY SILTY SAND (SM, $N_{bn}$)

NOTE:

Installed PVC casing to 32 feet.

**Harding Lawson Associates**
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& Geophysicists

**Log of Boring HLB-8**
PORT OF NOME
Nome, Alaska

PLATE
**A21**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001.002.08 | | 03/82 | | |

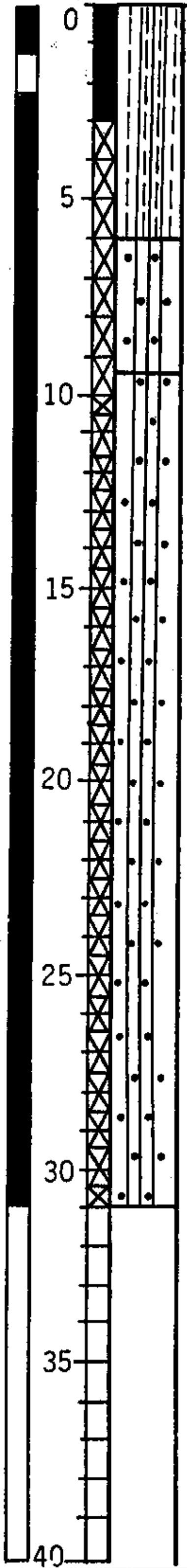
N112,590
E140,790

## LOG OF BORING HLB-9

Equipment 10-inch Air Drill

Elevation 41.0 ft MLLW Date Drilled 02/05/82

| Laboratory Tests | Moisture Content (%) | Blows/Foot | Dry Density (pcf) |
|---|---|---|---|
|  | 492.4 |  |  |
| SA | 17.6 |  |  |
| SA<br>Elec. Cond.<br>FPD |  |  |  |
| SA | 15.4 |  |  |



LIGHT BROWN ORGANIC SILT (OL,$N_{be}$) with occasional fibrous organics, top 1 foot very peaty

BROWN GRAY SILTY SAND (SM, $V_x$)

NOTE:
1. Installed PVC casing to 31 feet.

**Harding Lawson Associates**
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& Geophysicists

**Log of Boring HLB-9**
PORT OF NOME
Nome, Alaska

PLATE
A22

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
|  | 15001,002.08 |  | 03/82 |  |  |

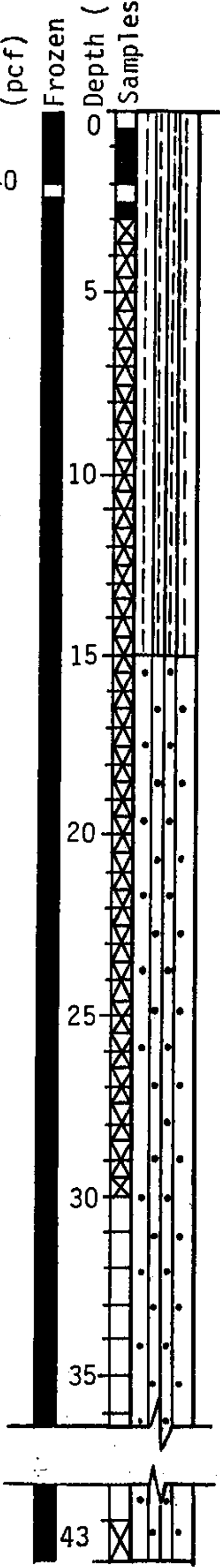
N 112,583
E 103,498

## LOG OF BORING HLB-10

Equipment 10-inch Air Drill

Elevation 36.8 ft. MLLW Date Drilled 02/06/82

| Laboratory Tests | Moisture Content (%) | Blows/ Foot | Dry Density (pcf) |
|---|---|---|---|
| Org. Loss = 33% | 101.0 | | 40 |
| | 76.4 | | |
| | 20.1 | | |
| -#200 Sieve | 27.3 | | |
| SA | 12.3 | | |



BROWN ORGANIC SILT (OL,$N_{be}$)
with occasional fibrous organics
and individual ice inclusions

Thawed zone from 1.5 to 2.0 feet

BROWN SILTY SAND (SM, $N_{bn}$)
with occasional gravel

Gravel greater than 4 inches
at 23 feet

Decreasing gravel content

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

## Log of Boring HLB-10

PORT OF NOME
Nome, Alaska

PLATE
**A23**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | | 03/82 | | |

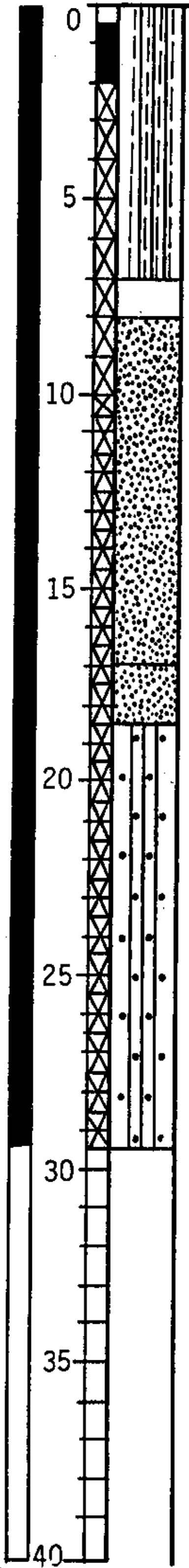
N 112,991
E 104,238

LOG OF BORING HLB-11

Equipment 10-inch Air Drill

Elevation +41.1ft MLLW Date Drilled 02/05/82

| Laboratory Tests | Moisture Content(%) | Blows/ Foot | Dry Density (pcf) |
|---|---|---|---|
| -#200 Sieve<br>Elec. Cond.<br>FPD | 13.2 | | |
| | 9.2 | | |
| | 8.4 | | |



DARK BROWN ORGANIC SILT (OL,$N_{be}$) with occasional fibrous organics

1 foot layer of ice at 7 to 8 feet

BROWN SILTY SAND (SP-SM,$N_{be}$) with occasional gravel to 1 inch diameter

$N_{bn}$ at 15.0 feet

LIGHT GRAY SAND (SP,$N_{bn}$)

GRAY BROWN GRAVELLY SILTY SAND (SM, $N_{bn}$)

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

**Log of Boring HLB-11**
PORT OF NOME
Nome, Alaska

PLATE
**A24**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | | 03/82 | | |

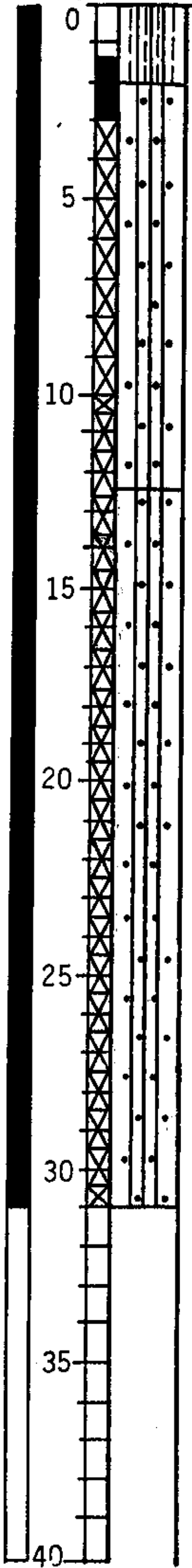
N 113,150
E 104,969

## LOG OF BORING HLB-12

Equipment 10-inch Air Drill

Elevation +44.5ft. MLLW Date Drilled 02/05/82

| Laboratory Tests | Moisture Content(%) | Blows/Foot | Dry Density (pcf) |
|---|---|---|---|
|  | 22.8 |  |  |
| -#200 Sieve | 9.8 |  |  |



BROWN ORGANIC SILT (OL,$N_{be}$)
with occasional fibrous organics

BROWN SILTY SAND (SM,$N_{be}$)
trace gravel to 1 inch diameter

Increasing gravel content

BROWN GRAVELLY SILTY SAND
(SM, $N_{bn}$)

NOTE:
1. Installed PVC casing to 31.0 feet

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

## Log of Boring HLB-12

PORT OF NOME
Nome, Alaska

PLATE
**A25**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
|  | 15001,002,08 |  | 03/82 |  |  |

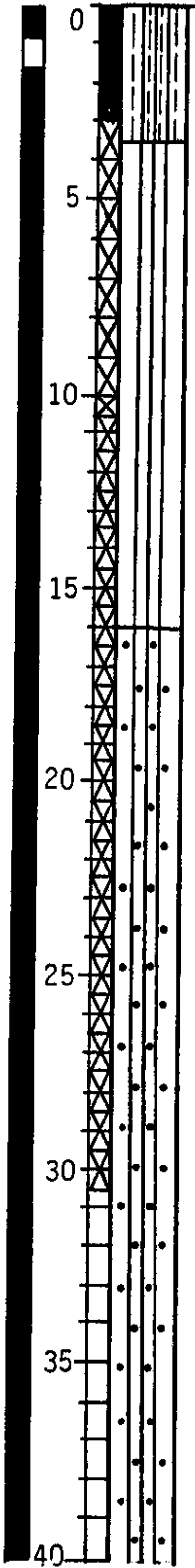
N 112,535
E 104,084

## LOG OF BORING HLB-13

Equipment 10-inch Air Drill

Elevation +38.4 ft Date Drilled 02/06/82

| Laboratory Tests | Moisture Content (%) | Blows/Foot | Dry Density (pcf) |
|---|---|---|---|
| Org. Loss | 277.2 | | 17 |
| | 185.2 | | |
| | 50.6 | | |
| SA | 11.3 | | |
| | 12.1 | | |



BROWN ORGANIC SILT (OL,$N_{be}$)
with occasional fibrous
organics, top 1 foot very peaty

GRAY SILT (ML,$N_{be}$)

Increasing sand content

DARK GRAY GRAVELLY SILTY SAND
(SM, $N_{be}$)

Decreasing gravel content

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

## Log of Boring HLB-12
PORT OF NOME
Nome, Alaska

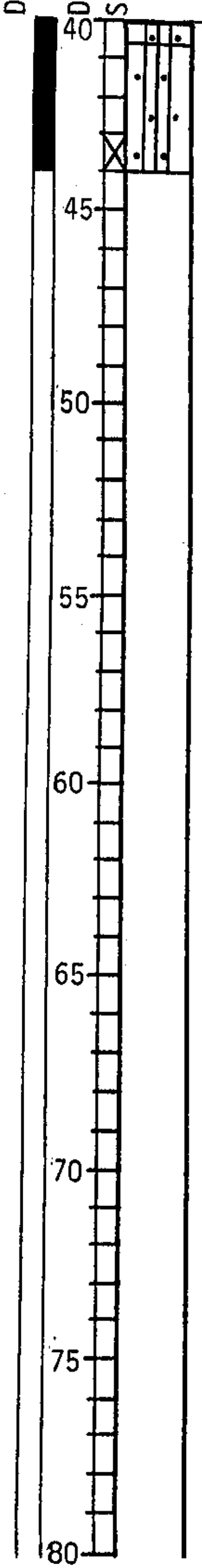
PLATE
**A26**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | | 03/82 | | |

N 112,535
E 104,084

## LOG OF BORING HLB-13

| Laboratory Tests | Blows/Foot (N-Value) | Moisture Content (%) | Dry Density (pcf) | Depth (ft) | Samples |
|---|---|---|---|---|---|
| -#200 Sieve | | | | | |



DARK GRAY SILTY GRAVELLY SAND
(SM, $N_{bn}$)

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Engineers, Geologists
& Geophysicists

## Log of Boring HLB-13 (CONT.)

PORT OF NOME
Nome, Alaska

PLATE
A27

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | BS | 03/82 | | |

N111,694

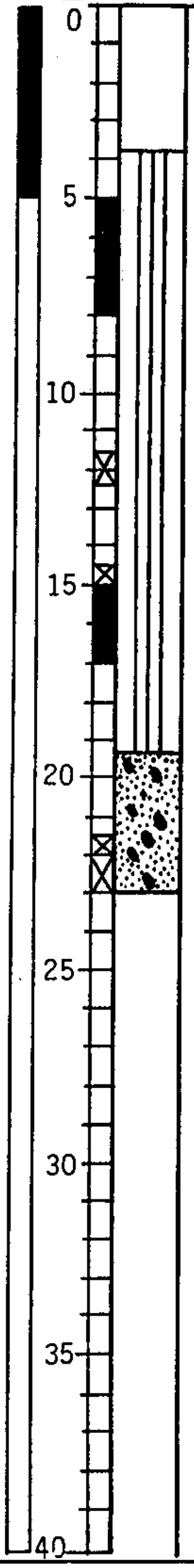
E107,184

## LOG OF BORING HLS-1

Equipment 10-inch Air Drill

Elevation +2.6 ft MLLW · Date Drilled 02/08/82

| Laboratory Tests | Moisture Content (%) | Blows/ Foot | Dry Density (pcf) |
|---|---|---|---|
| SA | 53.2 | | 69 |
| SA | 34.9 | | 80 |



ICE

BLACK GRAVELLY SANDY SILT (ML)
saturated, loose to medium dense,
top 1-foot is frozen

DARK GRAY SANDY GRAVEL (GP)
saturated, medium dense, with
gravel to 2 inch diameter

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

**Log of Boring HLS-1**
PORT OF NOME
Nome, Alaska

PLATE
**A28**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | | 03/82 | | |

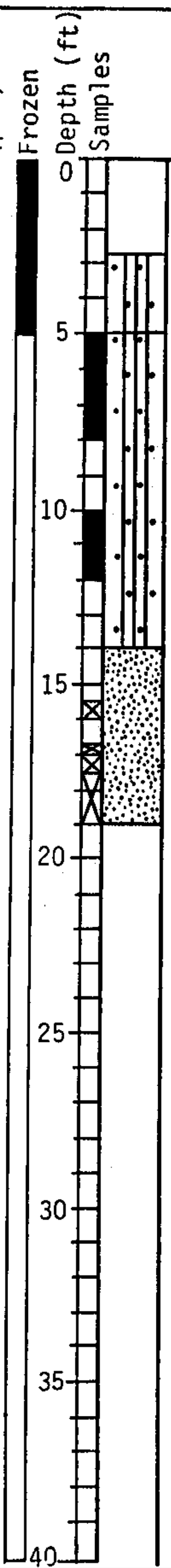
N111,708
E107,290

## LOG OF BORING HLS-2

Equipment 10-inch Air Drill

Elevation +2.4 ft. MLLW Date Drilled 02/09/82

| Laboratory Tests | Moisture Content (%) | Blows/ Foot | Dry Density (pcf) |
|---|---|---|---|
| SA | 18.8 | | 108 |
| SA | | | |



ICE

BLACK SILTY SAND (SM,Nbe)
with considerable fibrous
organic materials

BLACK SILTY SAND (SM)
saturated, loose

BROWN GRAVELLY SAND
saturated medium dense with
occasional gravel to 3 inches
diameter

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

**Log of Boring HLS-2**
PORT OF NOME
Nome, Alaska

PLATE
**A29**

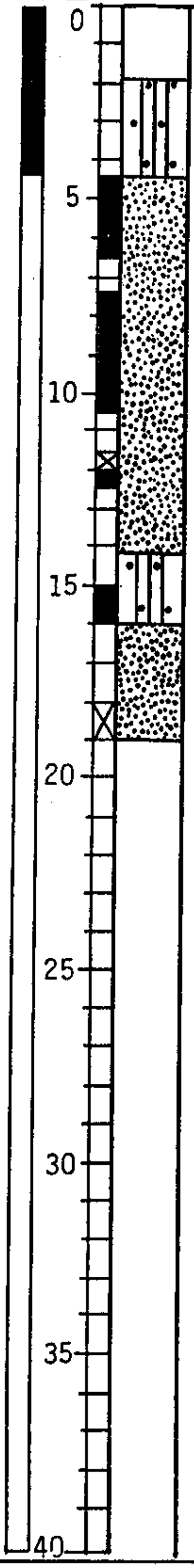
| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | | 03/82 | | |

N111,918
E107,139

## LOG OF BORING HLS-3

Equipment 10-inch Air Drill
Elevation +3.3 ft. MLLW Date Drilled 02/09/82

| Laboratory Tests | Moisture Content (%) | Blows/ Foot | Dry Density (pcf) |
|---|---|---|---|
| SA | 17.7 | | 107 |
| | 17.2 | | 110 |
| SA | 10.7 | | 132 |
| SA | | | |



ICE

BLACK SILTY SAND (SM, $N_{be}$)

BLACK SILTY SAND (SP-SM)
saturated, loose with occasional fibrous organic material

BROWN GRAVELLY SILTY SAND (SM)
saturated, loose to medium dense

BROWN GRAVELLY SILTY SAND (SP-SM)
saturated loose to medium dense with occasional gravel to 4 inches diameter

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

**Log of Boring HLS-3**
PORT OF NOME
Nome, Alaska

PLATE
**A30**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | | 03/82 | | |

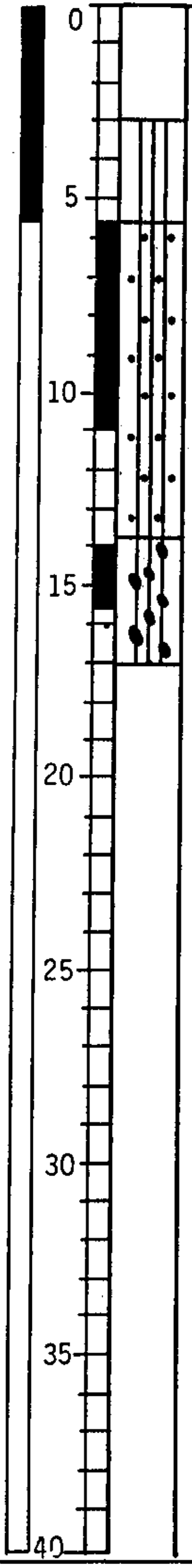
N111,850
E107,235

## LOG OF BORING HLS-4

Equipment 10-inch Air Drill

Elevation +2.9 ft. MLLW Date Drilled 02/09/82

| Laboratory Tests | Moisture Content (%) | Blows/ Foot | Dry Density (pcf) |
|---|---|---|---|
| -#200 Sieve | 25.2 | | 103 |
| SA | 19.8 | | 106 |
| | 41.0 | | 79 |



ICE

BLACK SILTY SAND (SM,$N_{be}$)
with fibrous organic material throughout

BLACK SILTY SAND (SM)
saturated, loose

BROWN SANDY, SILTY GRAVEL (GM)
saturated, medium dense

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

**Log of Boring HLS-4**
PORT OF NOME
Nome, Alaska

PLATE
**A31**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | | 03/82 | | |

## UNIFIED SOIL CLASSIFICATION SYSTEM

| MAJOR DIVISIONS | | | | TYPICAL NAMES |
|---|---|---|---|---|
| COARSE GRAINED SOILS<br>more than half is larger than no. 200 sieve | GRAVELS<br>more than half coarse fraction is larger than No. 4 sieve size | clean gravels with little or no fines | GW | well graded gravels, gravel-sand mixtures |
| | | | GP | poorly graded gravels, gravel-sand mixtures |
| | | gravels with over 12% fines | GM | silty gravels, poorly graded gravel-sand-silt mixtures |
| | | | GC | clayey gravels, poorly graded gravel-sand- clay mixtures |
| | SANDS<br>more than half coarse fraction is smaller than No. 4 sieve size | clean sands with little or no fines | SW | well graded sands, gravelly sands |
| | | | SP | poorly graded sands, gravelly sands |
| | | sands with over 12% fines | SM | silty sands, poorly graded sand-silt mixtures |
| | | | SC | clayey sands, poorly graded sand-clay mixtures |
| FINE GRAINED SOILS<br>more than half is smaller than no. 200 sieve | SILTS AND CLAYS<br>liquid limit less than 50 | | ML | inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity |
| | | | CL | inorganic clays of low to medium plasticity, gravelly clays, sandy clays, |
| | | | OL | organic clays and organic silty clays of low plasticity |
| | SILTS AND CLAYS<br>liquid limit greater than 50 | | MH | inorganic silts, micaceous or diatomacious fine sandy or silty soils, elastic silts |
| | | | CH | inorganic clays of high plasticity, fat clays |
| | | | OH | organic clays of medium to high plasticity, organic silts |
| HIGHLY ORGANIC SOILS | | | Pt | peat and other highly organic soils |

## KEY TO TEST DATA

Consol - Consolidation
LL -Liquid Limit (in %)
PL -Plastic Limit (in %)
SpG -Specific Gravity
PSA -Particle Size Analysis
OLI -Organic Loss by Ignition
■ "Undisturbed" Sample
☒ Bulk Sample
—#200 Minus No.200 Sieve

| | Shear Strength, psf | Confining Pressure, psf | |
|---|---|---|---|
| Tx | 320 | (2600) | Unconsolidated Undrained Triaxial |
| TxCU | 320 | (2600) | Consolidated Undrained Triaxial |
| DS | 2750 | (2000) | Consolidated Drained Direct Shear |
| TxCD | 320 | (2600) | Consolidated Drained Triaxial |
| UC | 2000 | | Unconfined Compression |

## ICE DESCRIPTIONS

| GROUP SYMBOL | ICE VISIBILITY AND CONTENT | SUBGROUP | | | |
|---|---|---|---|---|---|
| | | DESCRIPTION | | SYMBOL | |
| N | Segregated ice not visible by eye | Poorly bonded or friable | | $N_f$ | |
| | | Well bonded | No Excess ice | $N_b$ | $N_{bn}$ |
| | | | Excess ice microscopic | | $N_{be}$ |
| N | Segregated ice is visible by eye, ice one inch or less in thickness | Individual ice crystals or inclusions | | $V_x$ | |
| | | Ice coatings on particles | | $V_c$ | |
| | | Random or irregularly oriented ice formations | | $V_r$ | |
| | | Stratified or distinctly oriented ice formations | | $V_s$ | |
| ICE | Ice greater than one inch in thickness | Ice with soil inclusions | | ICE + soil type | |
| | | Ice without soil inclusions | | ICE | |

## FROST DESIGN SOIL CLASSIFICATION

| FROST GROUP | KIND OF SOIL | PERCENTAGE FINER THAN 0.02 MM BY WEIGHT | TYPICAL SOIL TYPES UNDER UNIFIED SOIL CLASSIFICATION SYSTEM |
|---|---|---|---|
| F1 | Gravelly soils | 3 to 10 | GW, GP, GW-GM, GP-GM |
| F2 | (a) Gravelly soils<br>(b) Sands | 10 to 20<br>3 to 15 | GM, GW-GM, GP-GM<br>SW, SP, SM, SW-SM, SP-SM |
| F3 | (a) Gravelly soils<br>(b) Sands, except very fine silty sands<br>(c) Clays, PI 12 | Over 20<br>Over 15<br>- | GM, GC<br>SM, SC<br>CL, CH |
| F4 | (a) All silts<br>(b) Very fine silty sands<br>(c) Clays, PI 12<br>(d) Varved clays and other fine-grained, banded sediments | -<br>Over 15<br>-<br>- | ML, MH<br>SM<br>CL, CL-ML<br>CL and ML;<br>CL, ML, and SM;<br>CL, CH, and ML;<br>CL, CH, ML, and SM |

Reference: Corps of Engineers, U.S. Army
TM 5-818-2, 13 July 1965

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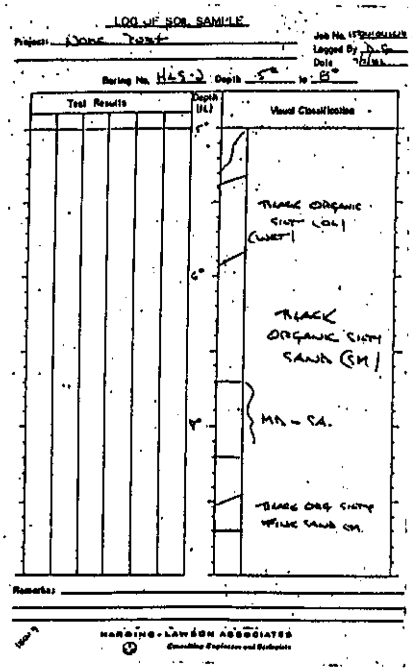
& Geophysicists

**Soil & Ice Classification
and Key to Test Data**
Port of Nome
Nome, Alaska

PLAT
A32

JOB NUMBER
APPROVED
DATE
REVISED
DATE



LOG OF SOIL SAMPLE

Project: Nome Port

Job No. 15[illegible]

Logged By D.G.

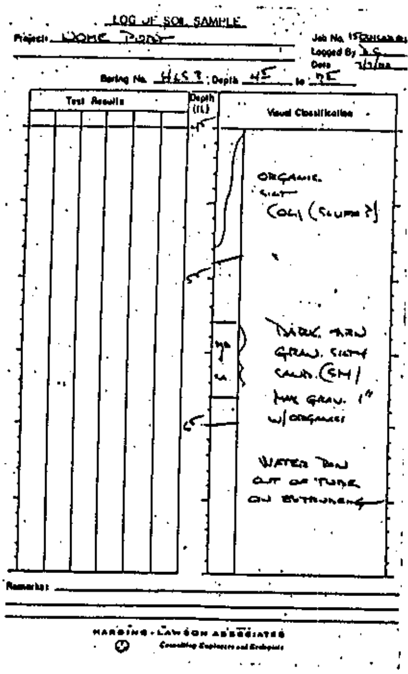
Date 7/[illegible]

Boring No. HLS-2 Depth 5 to 8

| Test Results | Depth (ft.) | Visual Classification |
|---|---|---|
| | 5 | |
| | | BLACK ORGANIC SILT (OL) (WET) |
| | 6 | BLACK ORGANIC SILTY SAND (SM) |
| | 7 | MA ~ SA. |
| | | BLACK ORG SILTY FINE SAND (SM) |

Remarks:

HARDING-LAWSON ASSOCIATES
Consulting Engineers and Geologists



LOG OF SOIL SAMPLE

Project: NOME PORT

Job No. 15[illegible]

Logged By D.G.

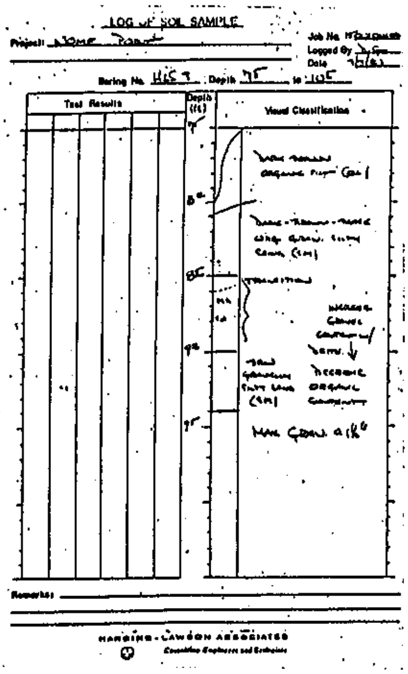
Date 7/[illegible]

Boring No. HLS 3 Depth 45 to 75

| Test Results | Depth (ft.) | Visual Classification |
|---|---|---|
| | 45 | ORGANIC SILT (OL) (SLUMP?) |
| | 55 | |
| | MA<br>SA | DARK BRN GRAV. SILTY SAND (SM)<br>MAX GRAV. 1"<br>w/ORGANICS |
| | 65 | |
| | | WATER RAN OUT OF TUBE ON EXTRUDING |

Remarks:

HARDING-LAWSON ASSOCIATES
Consulting Engineers and Geologists



LOG OF SOIL SAMPLE

Project: NOME Port

Job No. 15[illegible]

Logged By D.G.

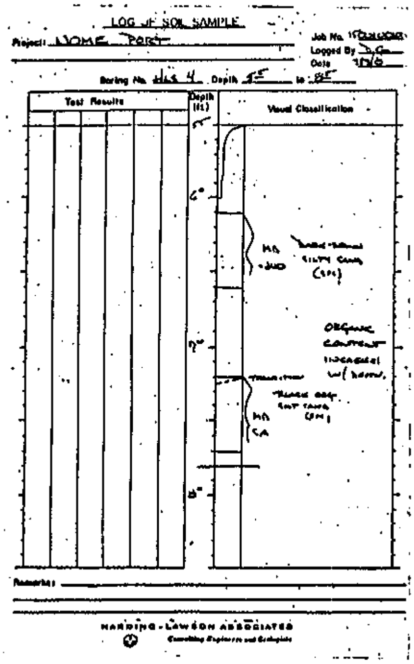
Date 7/[illegible]

Boring No. HLS 3 Depth 75 to 105

| Test Results | Depth (ft.) | Visual Classification |
|---|---|---|
| | 75 | DARK BROWN ORGANIC SILT (OL) |
| | 8 | DARK-BROWN-BLACK ORG. GRAV. SILTY SAND (SM) |
| | 85 | TRANSITION |
| | MA<br>SA | INCREASE GRAVEL CONTENT w/ DEPTH ↓ |
| | 9 | GRAY GRAVELLY SILTY SAND (SM)<br>DECREASE ORGANIC CONTENT |
| | 95 | MAX GRAV. ≈ 1/2" |

Remarks:

HARDING-LAWSON ASSOCIATES
Consulting Engineers and Geologists



LOG OF SOIL SAMPLE

Project: NOME PORT

Job No. 15[illegible]

Logged By D.G.

Date 7/[illegible]

Boring No. HLS 4 Depth 55 to 85

| Test Results | Depth (ft.) | Visual Classification |
|---|---|---|
| | 55 | |
| | 6 | MA ~ 3UD DARK-BROWN SILTY SAND (SM) |
| | 7 | ORGANIC CONTENT INCREASES w/ DEPTH. |
| | | TRANSITION |
| | | MA SA BLACK ORG. SILT SAND (SM) |
| | 8 | |

Remarks:

HARDING-LAWSON ASSOCIATES
Consulting Engineers and Geologists

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Engineers, Geologists
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## Detailed Logs of Samples

Port of Nome
Nome, Alaska

PLATE
**A33**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15,001,002.08 | RS | 4/82 | | |

BORING HLB-2:

| Depth | 15 Feb. 82 | 16 Feb. 82 | 14 April 82 |
|---|---|---|---|
| | Date of Readings | | |
| 0.0 | --- | --- | --- |
| 3.0 | -1.3 | -1.4 | -5.2 |
| 6.0 | -1.2 | -1.0 | -3.2 |
| 9.0 | -0.9 | -1.0 | -2.9 |
| 12.0 | -0.7 | -0.8 | -2.7 |
| 15.0 | -0.6 | -0.7 | -2.4 |
| 20.0 | -0.7 | -0.7 | -2.0 |
| 25.0 | -0.8 | -0.8 | -1.9 |
| 30.0 | -0.9 | -0.9 | -1.8 |
| 35.0 | -0.9 | -0.9 | -1.2 |
| 40.0 | -1.0 | -1.0 | -1.2 |
| 44.5 | -1.0 | -1.0 | -1.3 |

BORING HLB-4:

| Depth | 15 Feb. 82 | 16 Feb. 82 | 14, 15 April 82 |
|---|---|---|---|
| | Date of Readings | | |
| 0.0 | -3.7 | -3.8 | -4.7 |
| 3.0 | -0.6 | -2.1 | -3.7 |
| 6.0 | -0.6 | -0.9 | -2.5 |
| 9.0 | 0.4 | -0.3 | -0.6 |
| 12.0 | 0.8 | 0.6 | -0.2 |
| 15.0 | 1.3 | 1.0 | 0.4 |
| 20.0 | 2.1 | 1.9 | 1.1 |
| 25.0 | 2.2 | 2.2 | 1.6 |
| 30.0 | 2.0 | 2.1 | 1.6 |
| 35.0 | 1.9 | 1.9 | 1.6 |
| 40.0 | 1.8 | 1.8 | 1.5 |
| 45.0 | 1.6 | 1.6 | 1.4 |
| 50.0 | 1.5 | 1.5 | 1.3 |
| 55.0 | 1.5 | 1.5 | 1.2 |

Notes:

1. All temperatures are in degrees Celsius ($^{o}C$).
2. Two thermistors were read at each depth; the highest of the two temperatures are presented.

**Harding Lawson Associates**
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& Geophysicists

**Ground Temperature Observations**
Port of Nome
Nome, Alaska

PLATE
**A34**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15,001,002.08 | | 4/82 | | |

BORING HLB-6:

| | Date of Readings | | |
|---|---|---|---|
| Depth | 13, 14 Feb. 82 | 16 Feb. 82 | 14 April 82 |
| 0.0 | -5.2 | -8.2 | -5.7 |
| 3.0 | -5.5 | -7.0 | -5.1 |
| 6.0 | -5.9 | -6.5 | -5.2 |
| 9.0 | -4.5 | -6.4 | -4.9 |
| 12.0 | -5.5 | -6.4 | -4.5 |
| 15.0 | -0.9 | -1.0 | -4.3 |
| 20.0 | -0.7 | -0.7 | -1.8 |
| 25.0 | -0.8 | -0.8 | -1.2 |
| 30.0 | -0.9 | -0.9 | -1.2 |
| 34.5 | -0.9 | --- | 1.2 |

BORING HLB-7:

| | Date of Readings | | |
|---|---|---|---|
| Depth | 12 Feb. 82 | 15 Feb. 82 | 14 April 82 |
| 0.0 | -6.8 | -12.0 | -10.7 |
| 3.0 | -1.7 | 3.4 | -5.0 |
| 6.0 | -1.4 | -1.5 | -4.3 |
| 9.0 | -1.1 | -1.2 | -3.9 |
| 12.0 | -1.0 | -1.0 | -3.25 |
| 15.0 | -0.9 | -0.9 | -3.0 |
| 20.0 | -1.0 | -0.9 | -3.0 |
| 25.0 | -1.1 | -1.0 | -2.4 |
| 30.0 | -1.2 | -1.1 | -1.7 |

Notes:

1. All temperatures are in degrees Celsius (°C).
2. Two thermistors were read at each depth; the highest of the two temperatures are presented.

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

**Ground Temperature Observations**
Port of Nome
Nome, Alaska

PLATE
**A35**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15,001,002.08 | TCS | 4/82 | | |

BORING HLB-8:

|  | Date of Readings |  |  |  |
|---|---|---|---|---|
| Depth | 13 Feb. 82 | 15 Feb. 82 | 16 Feb. 82 | 15 April 82 |
| 0.0 | -2.3 | -3.4 | -3.1 | -9.7 |
| 3.0 | -1.7 | -4.1 | -4.0 | -4.3 |
| 6.0 | -1.3 | -2.1 | -3.6 | -3.5 |
| 9.0 | -1.2 | -2.0 | -1.6 | -3.3 |
| 12.0 | -1.1 | -1.7 | -1.5 | -2.8 |
| 15.0 | -0.7 | -1.8 | -1.5 | -2.6 |
| 20.0 | -0.9 | -1.4 | -1.6 | -2.4 |
| 25.0 | -1.0 | -1.0 | --- | -2.3 |
| 30.0 | -1.1 | -1.1 | --- | -1.6 |

BORING HLB-9:

|  | Date of Readings |  |  |
|---|---|---|---|
| Depth | 14 Feb. 82 | 16 Feb. 82 | 15 April 82 |
| 0.0 | -1.0 | -12.3 | (1 ft) -3.1 |
| 3.0 | -0.4 | -1.1 | -2.8 |
| 6.0 | -0.1 | -1.0 | -2.6 |
| 9.0 | -0.2 | -0.3 | -2.2 |
| 12.0 | -0.4 | -0.4 | -1.8 |
| 15.0 | -0.5 | -0.4 | -1.8 |
| 20.0 | -0.5 | -0.5 | -1.7. |
| 25.0 | -0.6 | -0.6 | -1.4 |
| 30.0 | -0.7 | -0.7 | -1.0 |

Notes:

1. All temperatures are in degrees Celsius (°C).
2. Two thermistors were read at each depth; the highest of the two temperatures are presented.

HLA

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

**Ground Temperature Observations**
Port of Nome
Nome, Alaska

PLATE
**A36**

DRAWN
JOB NUMBER 15,001,002.08
APPROVED
DATE 4/82
REVISED
DATE

BORING HLB-10:

| Depth | Date of Readings<br>15 Feb. 82 | 16 Feb. 82 |
|---|---|---|
| 0.0 | --- | --- |
| 3.0 | -1.6 | -1.8 |
| 6.0 | -1.1 | -1.2 |
| 9.0 | -0.3 | -0.3 |
| 12.0 | -0.3 | -0.3 |
| 15.0 | -0.3 | -0.3 |
| 20.0 | -0.3 | -0.3 |
| 25.0 | -0.4 | -0.4 |
| 30.0 | -0.4 | -0.4 |
| 35.0 | -0.4 | -0.4 |
| 40.0 | -0.5 | -0.5 |
| 44.5 | -0.5 | -0.5 |

BORING HLB-12:

| Depth | Date of Readings<br>14 Feb. 82 | 16 Feb. 82 | 15 April 82 |
|---|---|---|---|
| 0.0 | --- | --- | --- |
| 3.0 | -0.8 | -0.7 | -2.4 |
| 6.0 | 0.0 | 0.0 | -2.0 |
| 9.0 | 0.0 | -0.0 | 1.0 |
| 12.0 | -0.0 | -0.0 | -0.6 |
| 15.0 | -0.1 | -0.1 | -0.5 |
| 20.0 | -0.1 | -0.2 | -0.5 |
| 25.0 | -0.2 | -0.2 | -0.5 |
| 30.0 | -0.2 | -0.2 | -0.5 |

Notes:

1. All temperatures are in degrees Celsius (°C).
2. Two thermistors were read at each depth; the highest of the two temperatures are presented.

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

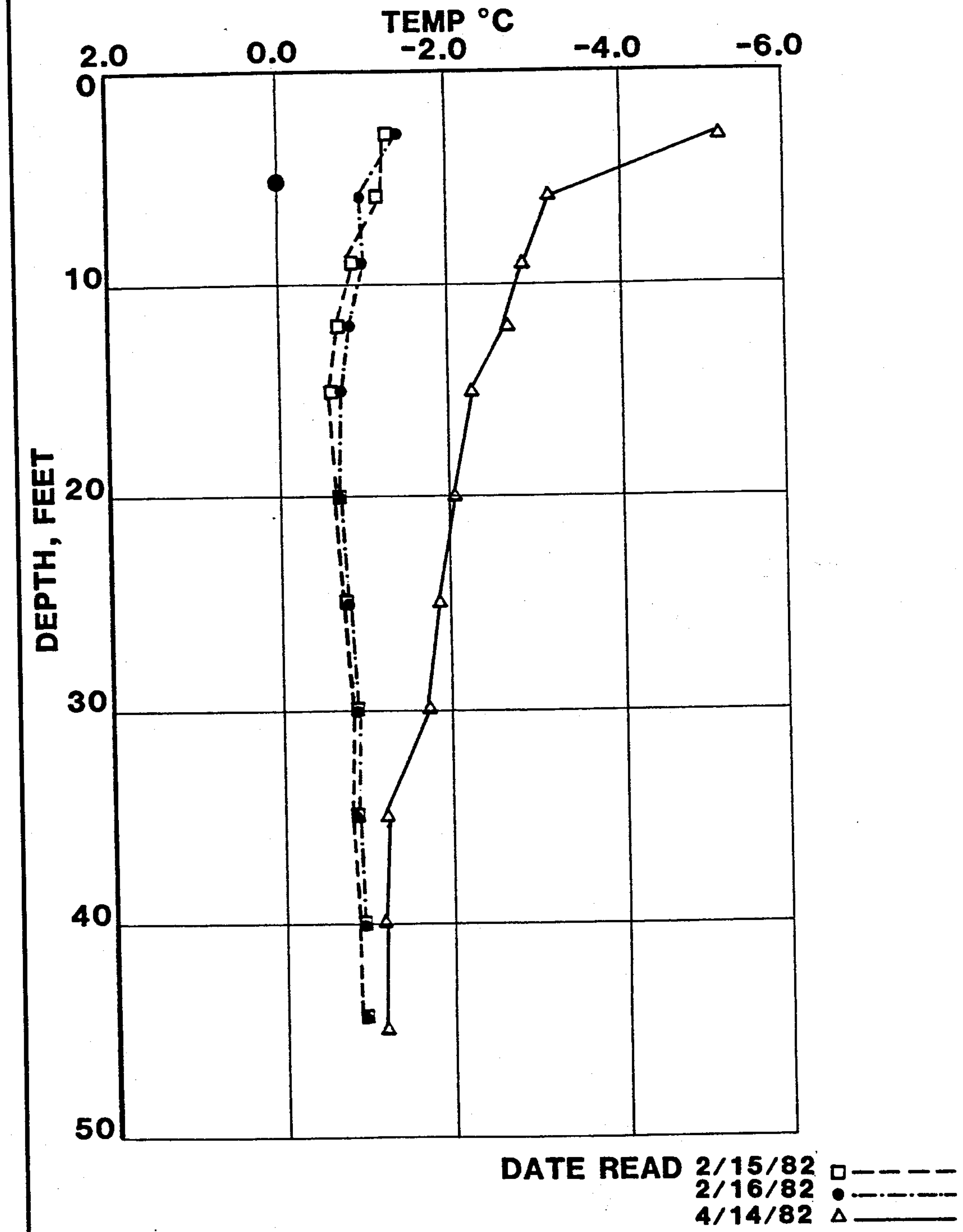
## Ground Temperature Observations

Port of Nome
Nome, Alaska

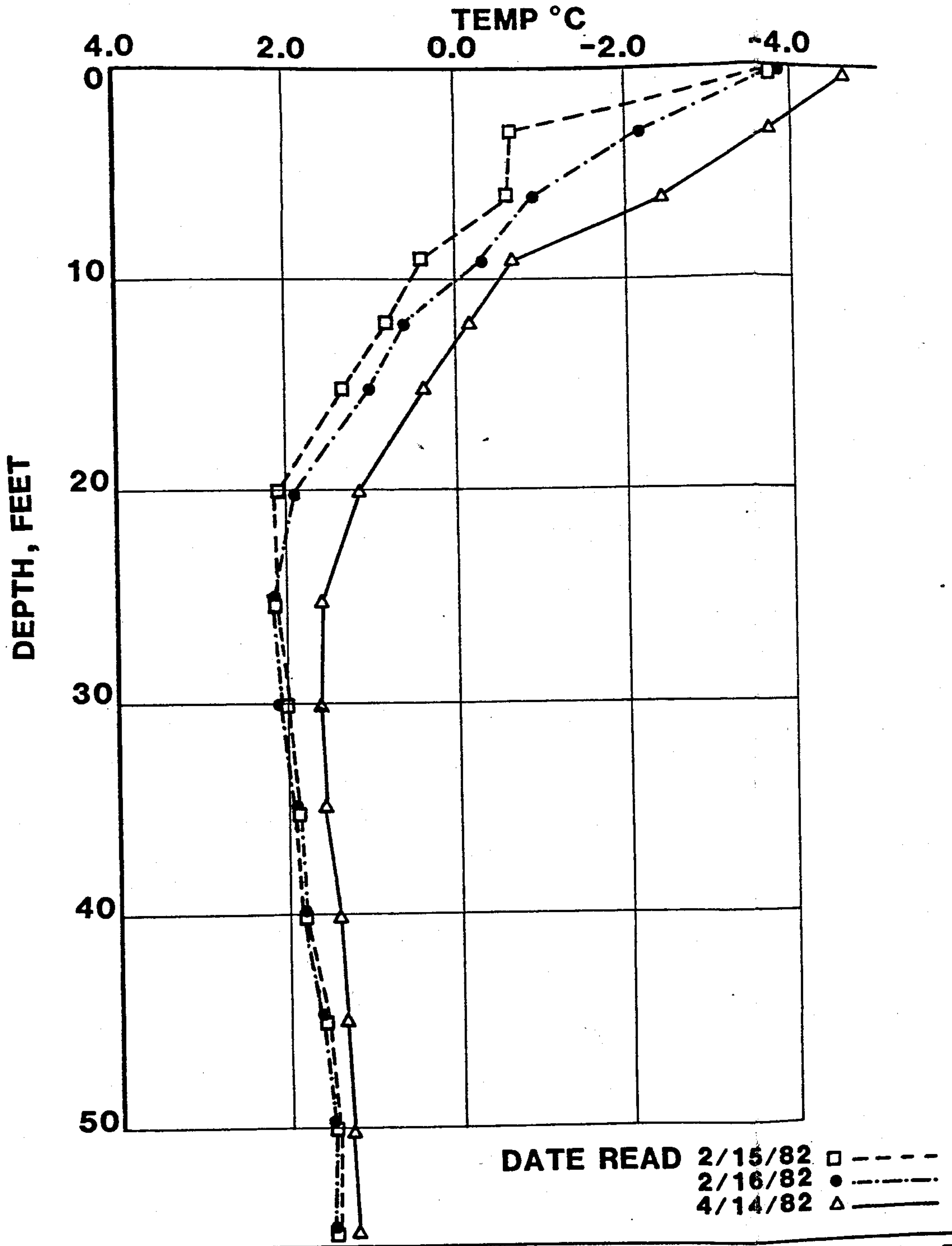
PLATE
**A37**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
|  | 15,001,002.08 |  | 4/82 |  |  |

**BORING**
**HLB-2**



**BORING**
**HLB-4**



● FREEZING POINT, BASED ON LABORATORY TESTING

**Harding Lawson Associates**
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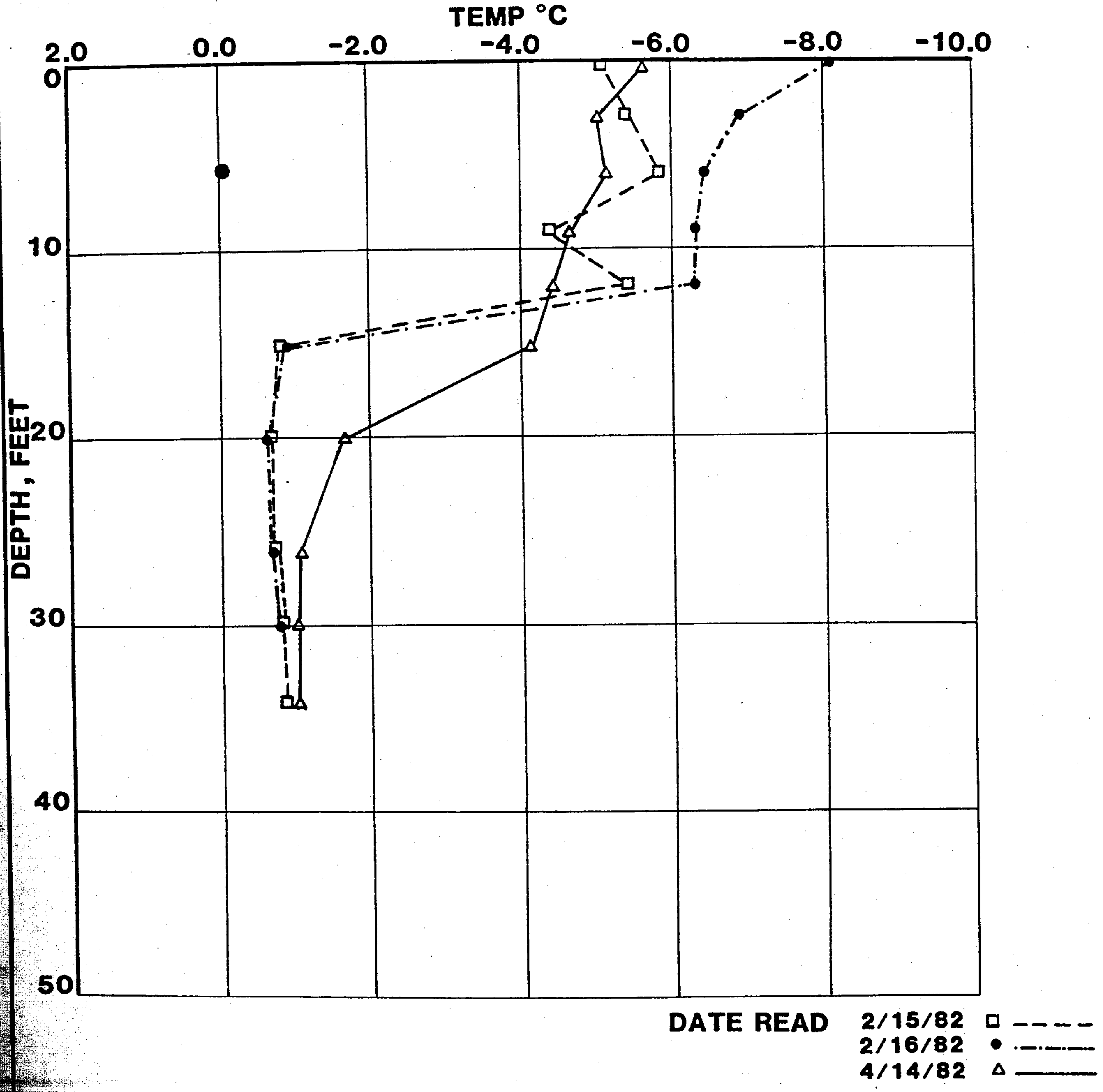
& Geophysicists

**Temperature Vs. Depth**
Port of Nome
Nome, Alaska

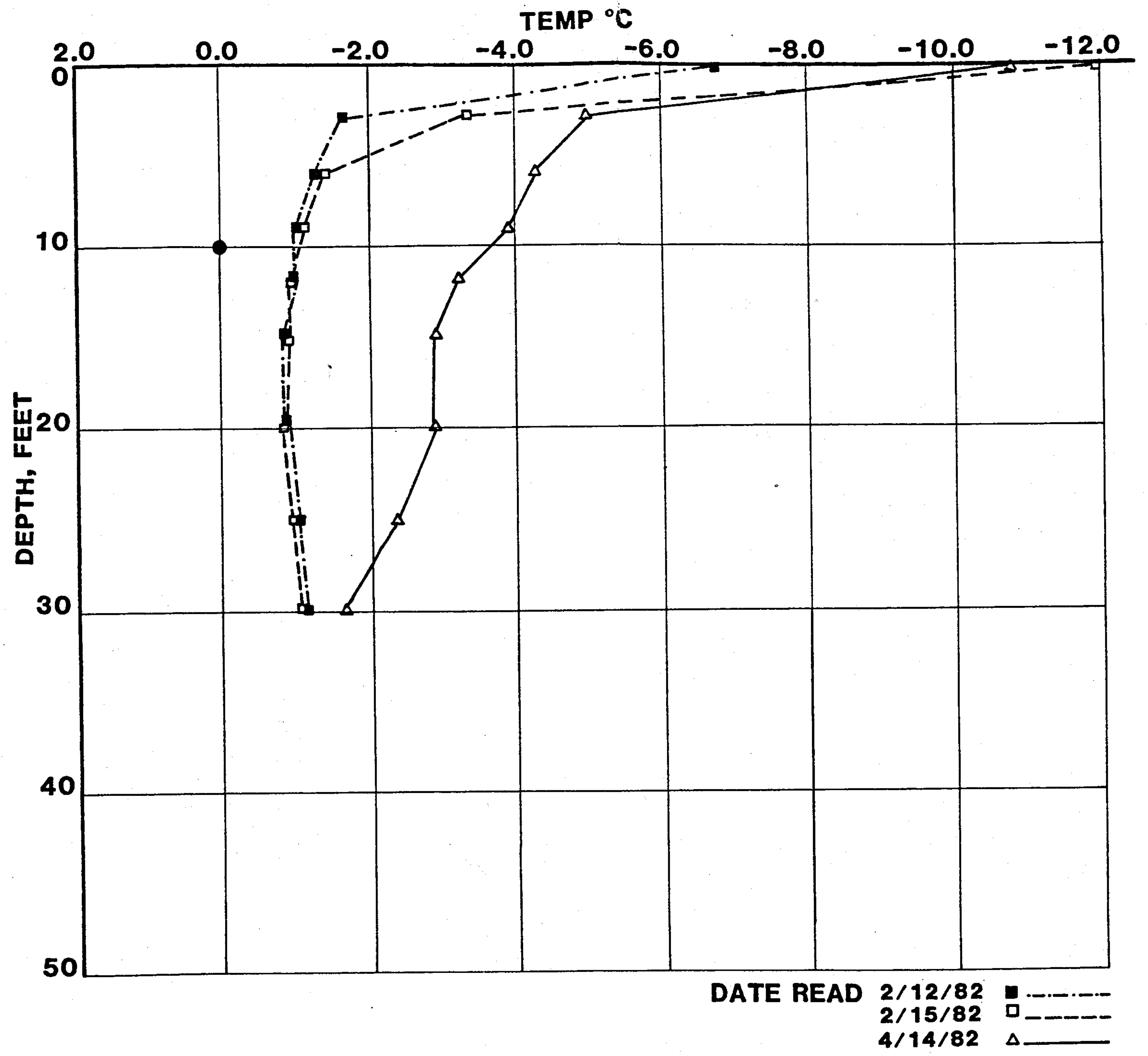
PLATE
**A38**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15,001,002.08 | DS | 4/82 | | |

**BORING HLB-6**



**BORING HLB-7**



● FREEZING POINT, BASED ON LABORATORY TESTING

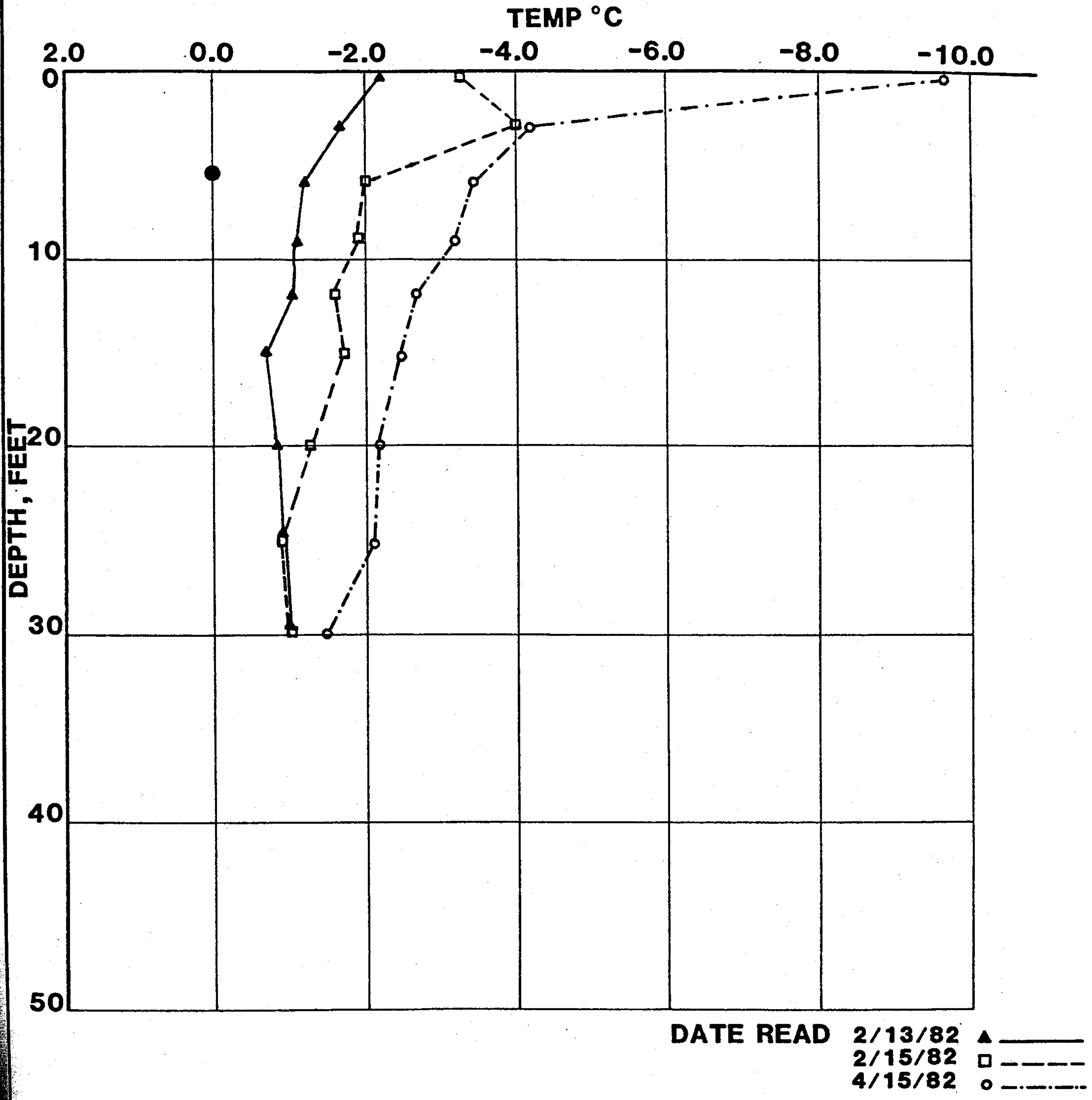
**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

**Temperature Vs. Depth**
Port of Nome
Nome, Alaska

PLATE
A3

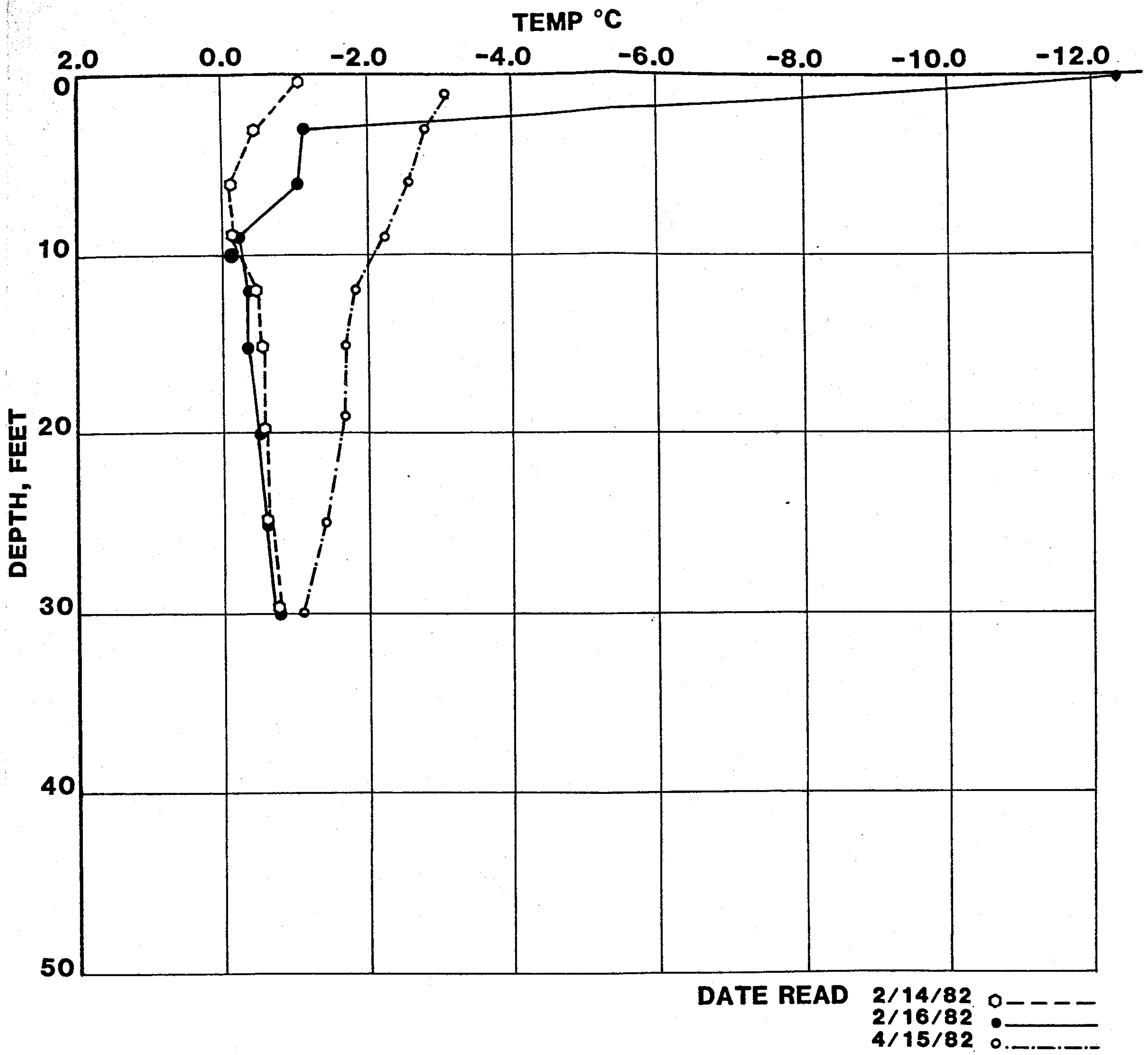
| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15,001,002.08 | RJ | 4/82 | | |

**BORING HLB-8**



● FREEZING POINT, BASED ON LABORATORY TESTING

**BORING HLB-9**



**Harding Lawson Associates**
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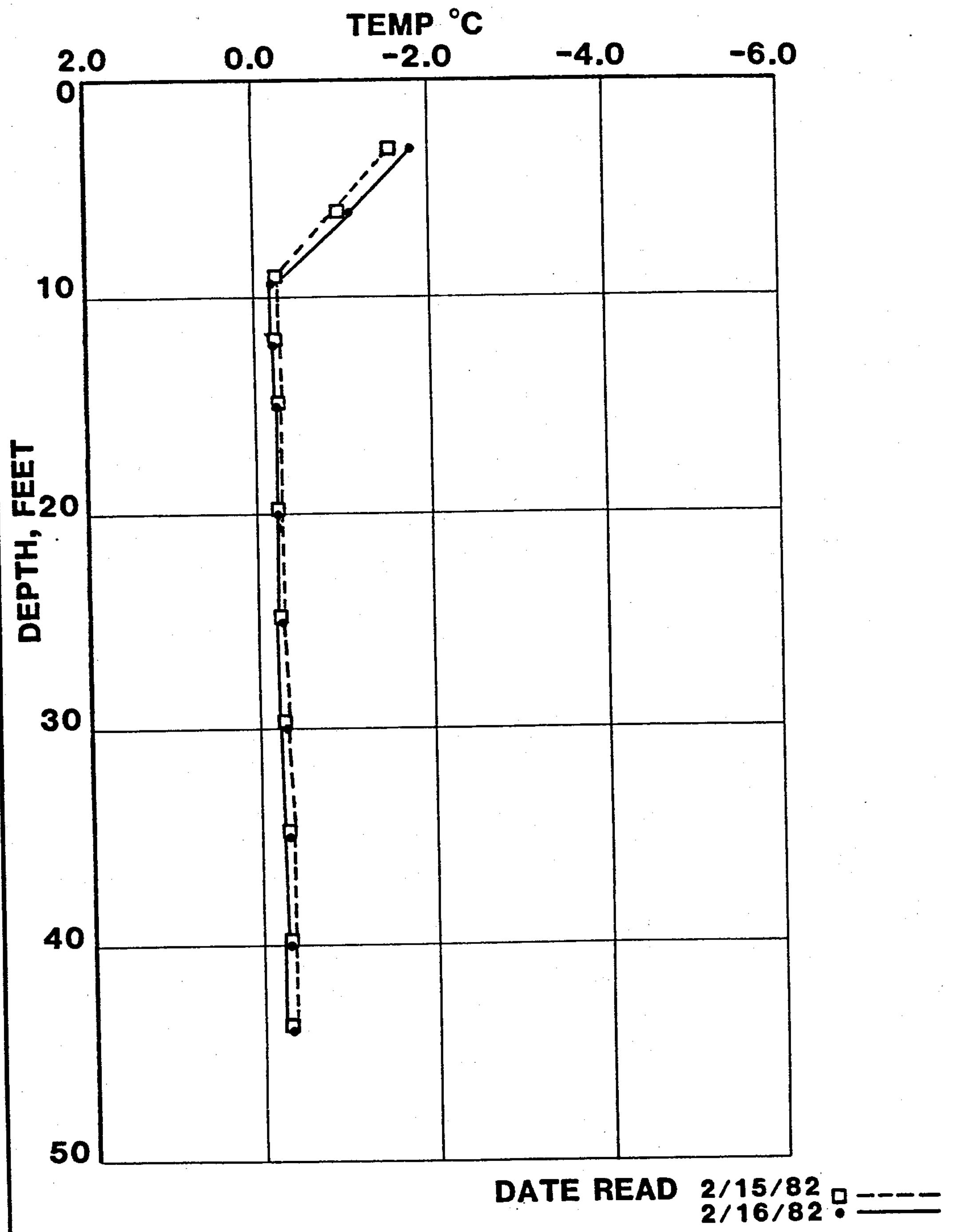
**Temperature Vs. Depth**
Port of Nome
Nome, Alaska

PLATE
**A40**

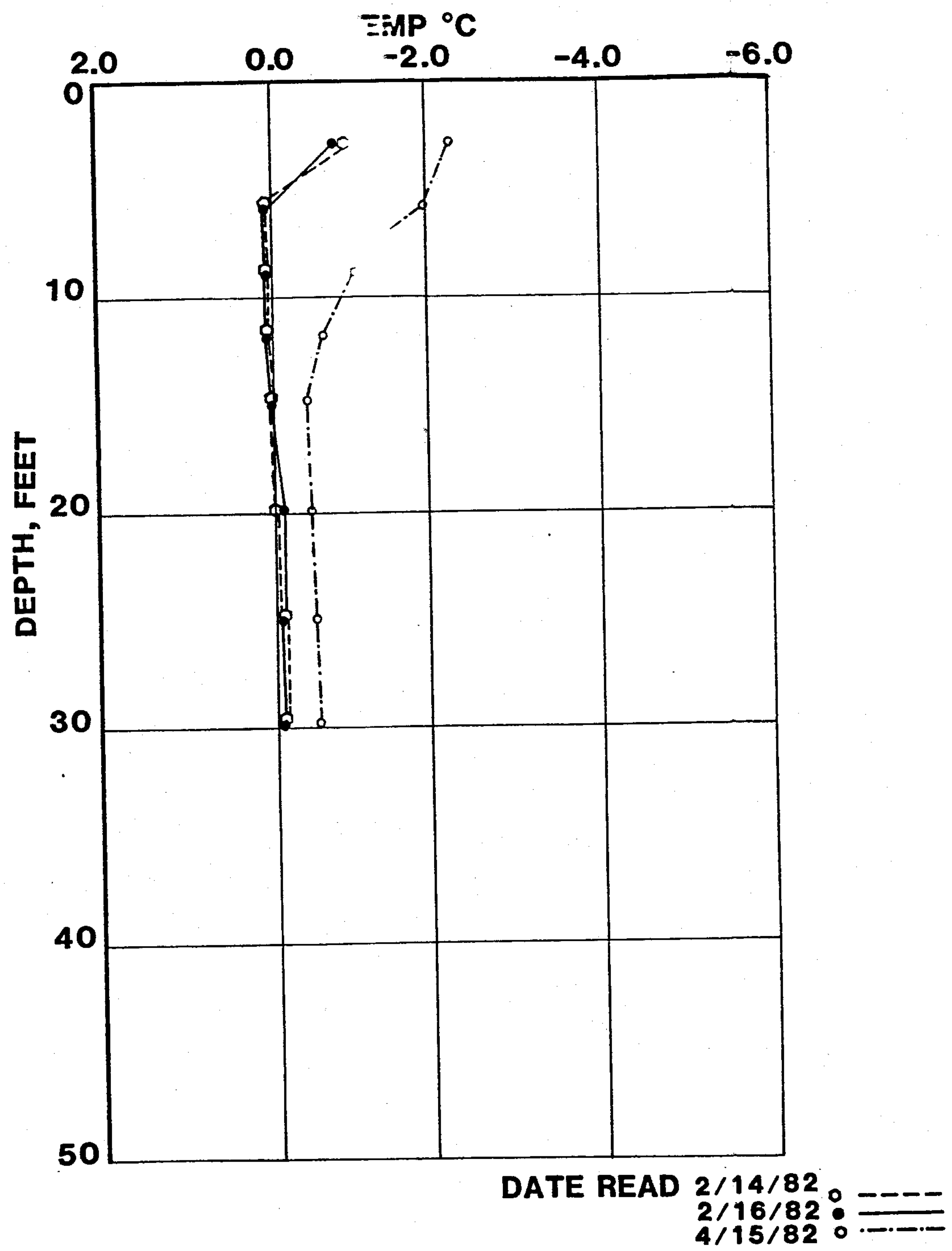
| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15,001,002.08 | RJ | 4/82 | | |

**BORING**
**HLB-10**



**CASING AND**
**WELL DESTROYED**

**BORING**
**HLB-12**



**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

**Temperature Vs. Depth**
Port of Nome
Nome, Alaska

PLATE
**A41**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15,001,002.08 | TJS | 4/82 | | |

# APPENDIX B - LABORATORY TESTING

A laboratory testing program was performed on representative samples from the borings to measure pertinent physical properties of the soils. The program was developed jointly by HLA and TAMS. The testing program, as described below, was oriented to establish typical soil classification, strength, compressibility and thermal characteristics. A summary of the test results is presented on Plates B1 through B4.

## 1. Moisture Content / Dry Density (ASTM D-2216)

Moisture content and dry density determinations were performed to evaluate the natural water content and dry density of typical soil types encountered. These also serve as a basis for correlating soil engineering characteristics determined by other laboratory tests. Where possible, the wet density of the particular specimen was determined on the basis of the entire specimen volume, and the loss of weight upon drying was used for determining the moisture content. The moisture content was obtained by oven drying the wet soil to a constant weight. The results of the moisture content and dry density determinations are shown on the boring logs.

## 2. Organic Content (ASTM D2974)

The organic content of selected specimens was determined by loss of weight by ignition. The specimen to be tested was oven dried for 24 hours at 105$^{o}$C and the dry weight recorded. The specimen was then saturated with alcohol, ignited, and an afterburn weight was observed.

The organic content was then determined as a percent of weight loss upon ignition. The results of these tests are presented on the boring logs.

## 3. Particle Size Analysis (ASTM D422 and D1140)

The quantitative distribution of particle sizes was determined from representative samples by performing sieve and hydrometer analyses. The results of the particle size analysis are presented on Plates B5 through B16.

## 4. Atterberg Limits (ASTM D423 and D424)

The liquid limit and plastic limit of selected representative samples of fine-grained soils were determined. The liquid limit was obtained in accordance with the ASTM standard three-point method D-423. The plastic limit and the plasticity index calculation were performed in accordance with ASTM standard method D-424. The results of these tests are listed on the boring logs. All the samples tested are non-plastic.

## 5. Specific Gravity (ASTM D-854)

The specific gravity of selected specimens was determined in accordance with ASTM specification D-854. The results of the specific gravity tests are presented on the Laboratory Test Summary.

## 6. Strength Tests - ASTM Procedures as Supplemented by the Procedures Presented in "Soil Testing for Engineers" by T. William Lambe, 1951

Soil strength parameters under static loading conditions were determined by Consolidated-Undrained Triaxial Shear Tests (TXCU) - ASTM D2850 (as modified for consolidation).

For the tests, a cylindrical specimen of soil encased in a rubber membrane was placed in a triaxial compression chamber, subjected to a chamber pressure, and then loaded axially to failure. Connections at the ends of the specimen permitted controlled drainage of pore water from the specimen.

In the TXCU test, drainage of the sample occurred during application of the chamber pressure. The sample was allowed to consolidate and saturate by seepage/backpressure. Once the sample had completed consolidation, the drain valve was closed and the axial load applied at a constant strain rate. The tests were performed at a strain rate of about one percent per minute. Two series of tests were performed on the sandy silt (ML) and silty sand (SM) samples from the offshore borings. Results of the tests are presented on Plates B17, B18 and B19.

## 7. Consolidation Tests (ASTM D2435)

One-dimensional consolidation tests were performed on representative specimens of fine-grained soil 0.8 inch in height. Each load increment of the test was double the previous load and was applied for a period of approximately 24 hours unless all significant consolidation occurred within a shorter time span. Time-rate of compression readings were taken at every compression load increment after and a seating load was applied. Consolidation test results are shown on Plates B20 through B23.

## 8. Relative Density Tests (ASTM D2049-69)

One relative density test was performed on samples combined from the upper ten feet of Boring 1. The tests were performed in accordance with ASTM Test Designation D2049-69. The results of these tests are presented on Plate B24. The corresponding particle size analysis is shown on Plate B25.

## 9. Chemical Tests

Chemical testing of the pore fluids was performed by Chemical and Geological Laboratories of Alaska, Inc., Anchorage. The chemistry tests included determining pore water conductivity and total soluble salt concentration and calculating the freezing point (FP). The chemical tests were performed on samples from the borings drilled at onshore storage area. Interpretation of the test results was not within the scope of our services.

## 10. Electrical Conductivity Tests

The electrical conductivity of selected specimens was measured to determine the freezing point of the interstitial fluids from samples obtained from the onshore storage area. The results are summarized on the Laboratory Test Summary.

Electrical conductivities were measured using a YSI Model Conductivity Bridge. The procedure for determining conductivity is as follows. First, the wet weight of a sample, approximately 100 grams, is determined. A solution is created by mixing approximately 100 grams of distilled water with the sample. The mixture is then placed in a bath having a constant temperature of 24°C. The probe from the YSI Conductivity Bridge is inserted into the prepared solution, and a reading is recorded. The solution is weighted and oven dried to determine the moisture content. The conductivity is converted to salinity using the seawater equivalent salinity content, paraconductivity relationship presented in the Handbook of Chemistry and physics, 57th Edition (1976). This value is then corrected to represent the salinity of the natural moisture content by applying Equation 1. The freezing point depression value is then calculated by applying the relationship presented in Equation 2

Equation 1

$$C_1V_1 = C_2V_2$$

where:

$C_1$ = Salinity concentration before dilution (ppt)
$V_1$ = Volume before dilution (gm)
$C_2$ = Salinity concentration after dilution (ppt)
$V_2$ = Volume after dilution (gm)

Equation 2

$$\text{FPD} = 0.00249 - 0.0533\,(C_1) - 0.0000764\,(C_1)^2 + 0.00000187\,(C_1)^3$$

where: FPD = freezing point depression (in degrees Centigrade)

| SAMPLE DESIGNATION | | PARTICLE SIZE ANALYSIS (% Passing) | | | | | | | | | | | | | | | CLASSIFICATION TESTS | | | | | | | | SECONDARY TESTS | | | SOIL CLASSIFICATION | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BORING NO. | DEPTH (ft) | 3" | 2" | 1-1/2" | 1" | 3/4" | 1/2" | No. 4 | No. 10 | No. 20 | No. 30 | No. 40 | No. 100 | No. 200 | .02 mm | .005 mm | Moist. Cont. (%) | Org. Loss by Ignition (%) | Atterberg Limits | | | Dry Density (PCF) | Spec. Grav. | Other | Shear Strength | Elec. Cond. | FPD | USCS | Ice Class | Frost Group | AASHTO Class |
| | | | | | | | | | | | | | | | | | | | L.L. | P.L. | P.I. | | | | | | | | | | |
| HLO-1 | 2.8 | | | | | | | | | | | | | 59 | | | 37.6 | | | | NP | 79 | 2.68 | | | | | ML | | | |
| | 9.5 | | | | | | | 100 | 100 | 99 | 97 | 94 | 71 | 51 | | | 39.6 | | | | | 80 | 2.67 | | | | | ML-SM | | | |
| | 10.5 | | | | | | | | | | | | | 54 | | | 41.4 | | | | NP | 78 | 2.61 | | | | | ML | | | |
| | 13.0 | | | 100 | 87 | 82 | 80 | 74 | 69 | 63 | 60 | 56 | 37 | 24 | | | 20.2 | | | | | 108 | | | | | | SM | | | |
| | 15.0 | | | | 100 | 98 | 97 | 92 | 85 | 77 | 73 | 68 | 48 | 35 | | | 17.4 | | | | | 116 | | | | | | SM | | | |
| HLO-2 | 0.5 | | | | | | | | | | | | | 7 | | | 20.1 | | | | | 104 | | | | | | SP-SM | | | |
| | 1.0 | | | 100 | 98 | 96 | 96 | 92 | 82 | 61 | 49 | 37 | 12 | 8 | | | | | | | | | | | | | | SP-SM | | | |
| | 3.0 | | | | | | 100 | 98 | 94 | 80 | 69 | 53 | 20 | 13 | | | 22.1 | | | | NP | 104 | | | | | | SM | | | |
| | 8.5 | | | | | | | 100 | 100 | 99 | 98 | 96 | 62 | 33 | | | 36.2 | | | | | 85 | 2.66 | | | | | SM | | | |
| | 11.2 | | | | | | | | | | | | | 14 | | | 35.2 | | | | | 85 | 2.66 | | | | | SM | | | |
| | 22.0 | | | | | 100 | 100 | 90 | 78 | 63 | 55 | 45 | 15 | 9 | | | 22.1 | | | | | 103 | | | | | | SP-SM | | | |
| HLO-3 | 2.0 | | | 100 | 81 | 81 | 79 | 75 | 71 | 66 | 63 | 58 | 45 | 29 | | | | | | | | | | | | | | SM | | | |
| | 27.5 | | | | | | 100 | 99 | 98 | 96 | 94 | 91 | 40 | 25 | | | 19.0 | | | | | 115 | | | | | | SM | | | |
| HLO-4 | 0.0 | | | | | | | | 100 | 100 | 100 | 99 | 32 | 4 | | | | | | | | | | | | | | SP | | | |
| | 9.5 | | | 100 | 90 | 77 | 68 | 57 | 51 | 46 | 44 | 42 | 36 | 29 | | | | | | | NP | | | | | | | SM | | | |
| | 33.0 | | | | | | 100 | 100 | 100 | 99 | 99 | 98 | 93 | 32 | | | 23.8 | | | | | 105 | | | | | | SM | | | |
| HLO-5 | 5.0 | | | | | | | | | | | | | | | | 24.7 | | | | | 109 | | | | | | SM | | | |
| | 12.5 | | | | | | | 100 | 100 | 100 | 100 | 100 | 100 | 99 | | | 29.3 | | | | NP | 101 | | | | | | ML | | | |
| HLO-6 | 4.5 | | | | 100 | 94 | 93 | 84 | 78 | 77 | 77 | 77 | 65 | 39 | | | 20.0 | | | | | 112 | | | | | | SM | | | |
| | 11.0 | | | 100 | 96 | 90 | 86 | 76 | 70 | 64 | 62 | 60 | 51 | 43 | | | 10.9 | | | | | 135 | 2.68 | | | | | SM | | | |
| | 32.0 | | | | | | | | 100 | 100 | 100 | 100 | 95 | 27 | | | 25.0 | | | | | 102 | 2.72 | | | | | SM | | | |
| HLO-7 | 3.5 | | | | 100 | 96 | 96 | 90 | 86 | 81 | 78 | 75 | 52 | 36 | | | 15.8 | | | | | 123 | 2.72 | | | | | SM | | | |
| | 37.0 | | | | 100 | 97 | 97 | 92 | 91 | 90 | 90 | 89 | 81 | 22 | | | 27.0 | | | | | 98 | 2.67 | | | | | SM | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

NP = Non - Plastic

FPD = Freezing Point Depression, °C

Elec. Cond. = Electrical Conductivity in $\mu$MHOS / cm

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

## Laboratory Test Summary

Port of Nome
Nome, Alaska

PLATE
**B1**

DRAWN

JOB NUMBER
15001.02.08

APPROVED
PS

DATE

REVISED

DATE

| SAMPLE DESIGNATION | | PARTICLE SIZE ANALYSIS (% Passing) | | | | | | | | | | | | | | | CLASSIFICATION TESTS | | | | | | | | SECONDARY TESTS | | | SOIL CLASSIFICATION | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BORING NO. | DEPTH (ft) | 3" | 2" | 1-1/2" | 1" | 3/4" | 1/2" | No. 4 | No. 10 | No. 20 | No. 30 | No. 40 | No. 100 | No. 200 | .02 mm | .005 mm | Moist. Cont. (%) | Org. Loss by Ignition (%) | Atterberg Limits L.L. | P.L. | P.I. | Dry Density (PCF) | Spec. Grav. | Other | Shear Strength | Elec. Cond. | FPD | USCS | Ice Class | Frost Group | AASHTO Class |
| HLB-1 | 0.0 | | | | | | | | | | | | | | | | 600.7 | 47 | | | | 8 | | | | | | Pt | | | |
| | 5.0 | | | | | | | | | | | | | | | | 36.6 | | | | | | | | | | | OL | | | |
| | 10.0 | | | | | | | | | | | | | 14 | | | 27.1 | | | | | | | | | | | SM | | | |
| | 15.0 | | | | | | | | | | | | | | | | 24.0 | | | | | | | | | | | SM | | | |
| HLB-2 | 0.0 | | | | | | | | | | | | | | | | 795.6 | 87 | | | | 7 | | | | | | Pt | | | |
| | 5.0 | | | | | | | | | | | | | | | | 27.4 | | | | | | | | | 107 | -0.014 | ML | | | |
| | 10.0 | | | | | | | | | | | | | 10 | | | 22.7 | | | | | | | | | | | SP-SM | | | |
| | 20.0 | | | | | 100 | 99 | 93 | 85 | 77 | 73 | 69 | 45 | 35 | | | 19.7 | | | | | | | | | | | SM | | | |
| HLB-3 | 0.5 | | | | | | | | | | | | | | | | 66.0 | | | | | | | | | | | GP | | | |
| | 3.0 | | | 100 | 86 | 77 | 68 | 50 | 39 | 29 | 24 | 18 | 6 | 4 | | | 2.2 | | | | | | | | | | | GP | | | |
| | 5.5 | | 100 | 87 | 87 | 87 | 84 | 77 | 69 | 58 | 52 | 46 | 27 | 18 | | | | | | | | | | | | | | SM | | | |
| | 16.0 | | 100 | 83 | 78 | 69 | 66 | 58 | 53 | 46 | 43 | 41 | 31 | 24 | | | 12.5 | | | | | | | | | | | SM | | | |
| | 16.5 | | | | 100 | 96 | 95 | 85 | 78 | 66 | 60 | 54 | 38 | 26 | | | | | | | | | | | | | | SM | | | |
| HLB-4 | 2.0 | | | | | | | | | | | | | | | | 66.0 | | | | | | | | | | | SM | | | |
| | 5.0 | | | 100 | 94 | 94 | 90 | 75 | 58 | 37 | 29 | 20 | 5 | 3 | | | 3.6 | | | | | 99 | | | | | | SP | | | |
| | 15.0 | | | | 100 | 99 | 98 | 93 | 83 | 64 | 54 | 41 | 10 | 6 | | | 19.7 | | | | | | | | | | | SP-SM | | | |
| | 40.0 | | | | 100 | 99 | 98 | 95 | 83 | 57 | 44 | 32 | 13 | 8 | | | 19.3 | | | | | | | | | | | SP-SM | | | |
| HLB-5 | 2.0 | | | | | | | | | | | | | | | | 40.8 | | | | | | | | | | | SM | | | |
| HLB-6 | 1.5 | | | | | | | | | | | | | 63 | | | 99.2 | 29 | | | | 40 | | | | | | ML | | | |
| | 5.0 | | | | | | | | | | | | | | | | 21.5 | | | | | | | | | 333 | -0.046 | ML | | | |
| | 10.0 | | | | | | | | | | | | | 10 | | | 19.9 | | | | | | | | | | | SP-SM | | | |
| | 20.0 | | | | | 100 | 99 | 90 | 79 | 69 | 66 | 62 | 51 | 41 | | | 13.0 | | | | | | | | | | | SM | | | |
| | 25.0 | | | | | | | | | | | | | | | | 12.0 | | | | | | | | | | | SM | | | |
| HLB-7 | 5.0 | | | | | 100 | 100 | 99 | 99 | 94 | 87 | 77 | 43 | 34 | | | 26.4 | | | | | | | | | | | SM | | | |
| | 10.0 | | | | | | | | | | | | | | | | 17.9 | | | | | | | | | 230 | -0.039 | SM | | | |
| | 20.0 | | | | | 100 | 100 | 96 | 93 | 90 | 89 | 87 | 45 | 20 | | | 22.1 | | | | | | | | | | | SM | | | |
| | 25.0 | | | | | | | | | | | | | | | | 12.5 | | | | | | | | | | | SM | | | |

NP = Non - Plastic

FPD = Freezing Point Depression, °C

Elec. Cond. = Electrical Conductivity in $\mu$MHOS / cm

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

## Laboratory Test Summary

Port of Nome
Nome, Alaska

PLATE
B2

DRAWN
JOB NUMBER 15001.02.08
APPROVED
DATE
REVISED
DATE

| SAMPLE DESIGNATION | | PARTICLE SIZE ANALYSIS (% Passing) | | | | | | | | | | | | | | | CLASSIFICATION TESTS | | | | | | | | SECONDARY TESTS | | | SOIL CLASSIFICATION | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | Atterberg Limits | | | | | | | | | | | | |
| BORING NO. | DEPTH (ft) | 3" | 2" | 1-1/2" | 1" | 3/4" | 1/2" | No. 4 | No. 10 | No. 20 | No. 30 | No. 40 | No. 100 | No. 200 | .02 mm | .005 mm | Moist. Cont. (%) | Org. Loss by Ignition (%) | L.L. | P.L. | P.I. | Dry Density (PCF) | Spec. Grav. | Other | Shear Strength | Elec. Cond. | FPD | USCS | Ice Class | Frost Group | AASHTO Class |
| HLB-8 | 5.0 | | | | | | | | | | | | | | | | 20.2 | | | | | | | | | 71 | -0.012 | SP-SM | | | |
| | 10.0 | | | | | | | | | | | | | 11 | | | 17.6 | | | | | | | | | | | SP-SM | | | |
| | 15.0 | | | | | | | | | | | | | | | | 17.0 | | | | | | | | | | | SP-SM | | | |
| | 20.0 | | | | | | | | | | | | | | | | 15.7 | | | | | | | | | | | SM | | | |
| HLB-9 | 0.0 | | | | | | | | | | | | | | | | 492.4 | | | | | | | | | | | OL | | | |
| | 10.0 | | | | | 100 | 99 | 83 | 67 | 52 | 45 | 39 | 22 | 16 | | | 17.6 | | | | | | | | | | | SM | | | |
| | 20.0 | | | | 100 | 99 | 98 | 83 | 67 | 44 | 53 | 50 | 43 | 37 | | | | | | | | | | | | 560 | -0.158 | SM | | | |
| | 25.0 | | | | 100 | 100 | 94 | 93 | 85 | 79 | 76 | 74 | 61 | 42 | | | 15.4 | | | | | | | | | | | SM | | | |
| HLB-10 | 2.0 | | | | | | | | | | | | | | | | 101.0 | 33 | | | | 40 | | | | | | OL | | | |
| | 5.0 | | | | | | | | | | | | | | | | 76.4 | | | | | | | | | | | OL | | | |
| | 20.0 | | | | | | | | | | | | | | | | 20.1 | | | | | | | | | | | SM | | | |
| | 25.0 | | | | | | | | | | | | | 30 | | | 27.3 | | | | | | | | | | | SM | | | |
| | 43.0 | | | | | 100 | 99 | 90 | 83 | 76 | 72 | 68 | 54 | 43 | | | 12.3 | | | | | | | | | | | SM | | | |
| HLB-11 | 10.0 | | | | | | | | | | | | | 7 | | | 13.2 | | | | | | | | | 815 | -0.168 | SP-SM | | | |
| | 20.0 | | | | | | | | | | | | | | | | 9.2 | | | | | | | | | | | SM | | | |
| | 25.0 | | | | | | | | | | | | | | | | 8.4 | | | | | | | | | | | SM | | | |
| HLB-12 | 10.0 | | | | | | | | | | | | | | | | 22.8 | | | | | | | | | | | SM | | | |
| | 25.0 | | | | | | | | | | | | | 33 | | | 9.8 | | | | | | | | | | | SM | | | |
| HLB-13 | 0.0 | | | | | | | | | | | | | | | | 277.2 | 65 | | | | 17 | | | | | | OL | | | |
| | 5.0 | | | | | | | | | | | | | | | | 185.2 | | | | | | | | | | | ML | | | |
| | 10.0 | | | | | | | | | | | | | | | | 50.6 | | | | | | | | | | | ML | | | |
| | 20.0 | | | | 100 | 98 | 96 | 79 | 61 | 50 | 46 | 43 | 33 | 27 | | | 11.3 | | | | | | | | | | | SM | | | |
| | 25.0 | | | | | | | | | | | | | | | | 12.1 | | | | | | | | | | | SM | | | |
| | 43.0 | | | | | | | | | | | | | 45 | | | | | | | | | | | | | | SM | | | |
| HLS-1 | 1.0 | | | | | | | 100 | 99 | 97 | 95 | 93 | 83 | 63 | | | 53.2 | | | | | 69 | | | | | | ML | | | |
| | 11.5 | | | | | 100 | 99 | 98 | 95 | 89 | 86 | 81 | 68 | 52 | | | 34.9 | | | | | 80 | | | | | | ML | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

NP = Non - Plastic

FPD = Freezing Point Depression, °C

Elec. Cond. = Electrical Conductivity in µMHOS / cm

**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

## Laboratory Test Summary
Port of Nome
Nome, Alaska

PLATE
**B3**

DRAWN
JOB NUMBER 15001.02.08
APPROVED
DATE
REVISED
DATE

| SAMPLE DESIGNATION | | PARTICLE SIZE ANALYSIS (% Passing) | | | | | | | | | | | | | | | CLASSIFICATION TESTS | | | | | | | | SECONDARY TESTS | | | SOIL CLASSIFICATION | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | Atterberg Limits | | | | | | | | | | | | |
| BORING NO. | DEPTH (ft) | 3" | 2" | 1-1/2" | 1" | 3/4" | 1/2" | No. 4 | No. 10 | No. 20 | No. 30 | No. 40 | No. 100 | No. 200 | .02 mm | .005 mm | Moist. Cont. (%) | Org. Loss by Ignition (%) | L.L. | P.L. | P.I. | Dry Density (PCF) | Spec. Grav. | Other | Shear Strength | Elec. Cond. | FPD | USCS | Ice Class | Frost Group | AASHTO Class |
| HLS-2 | 6.7 | | | | | 100 | 99 | 89 | 73 | 57 | 50 | 42 | 21 | 14 | | | 18.8 | | | | | 108 | | | | | | SM | | | |
| | 17.5 | | | 100 | 93 | 88 | 78 | 52 | 38 | 24 | 17 | 11 | 3 | 1 | | | | | | | | | | | | | | SP | | | |
| HLS-3 | 5.8 | | | 100 | 92 | 90 | 85 | 71 | 60 | 45 | 38 | 31 | 10 | 7 | | | 17.7 | | | | | 107 | | | | | | SP-SM | | | |
| | 8.5 | | | 100 | 98 | 95 | 87 | 68 | 53 | 40 | 34 | 29 | 12 | 9 | | | 17.2 | | | | | 110 | | | | | | SP-SM | | | |
| | 15.0 | | 100 | 87 | 78 | 73 | 67 | 58 | 52 | 44 | 41 | 37 | 27 | 19 | | | 10.7 | | | | | 132 | | | | | | SM | | | |
| | 18.0 | 100 | 85 | 85 | 78 | 74 | 69 | 55 | 43 | 32 | 28 | 24 | 15 | 10 | | | | | | | | | | | | | | SP-SM | | | |
| HLS-4 | 6.0 | | | | | | | | | | | | | 13 | | | 25.2 | | | | | 103 | | | | | | SM | | | |
| | 7.2 | | | | | 100 | 100 | 95 | 86 | 68 | 58 | 48 | 28 | 18 | | | 19.8 | | | | | 106 | | | | | | SM | | | |
| | 14.0 | | | | | | | | | | | | | | | | 41.0 | | | | | 79 | | | | | | | | | |

NP = Non - Plastic

FPD = Freezing Point Depression, °C

Elec. Cond. = Electrical Conductivity in μMHOS / cm

HLA

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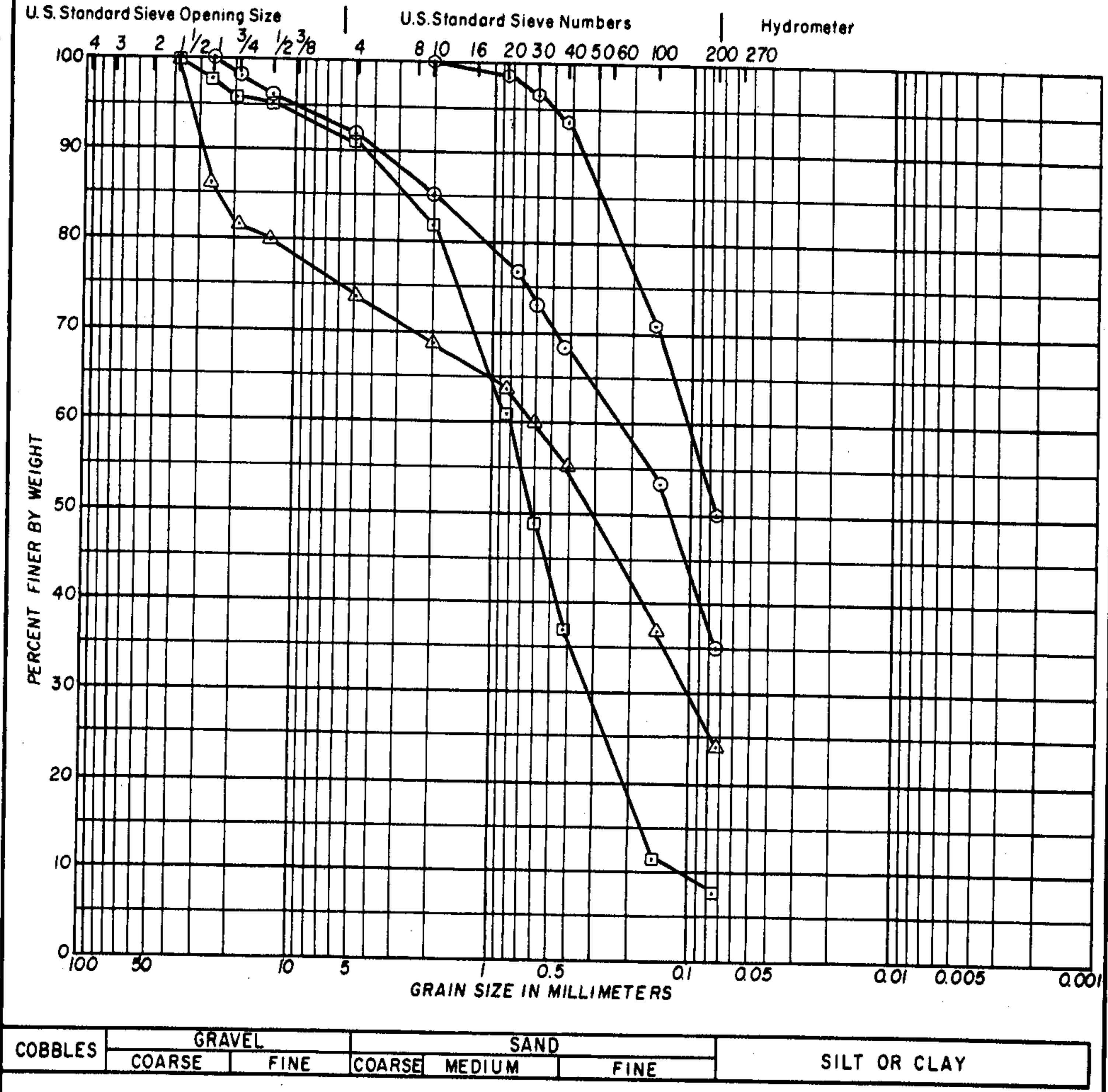
## Laboratory Test Summary

Port of Nome
Nome, Alaska

PLATE
**B4**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001.02.08 | | | | |



| Symbol | Sample Source | Classification |
|---|---|---|
| ⊙ | HLO-1 at 10.0' | GRAY SANDY SILT (ML) |
| △ | HLO-1 at 13.0' | GRAY SILTY GRAVELLY SAND (SM) |
| ⊙ | HLO-1 at 15.0' | GRAY GRAVELLY SILTY SAND (SM) |
| ⊡ | HLO-2 at 1.0' | GRAY SILTY GRAVELLY SAND (SP-SM) |

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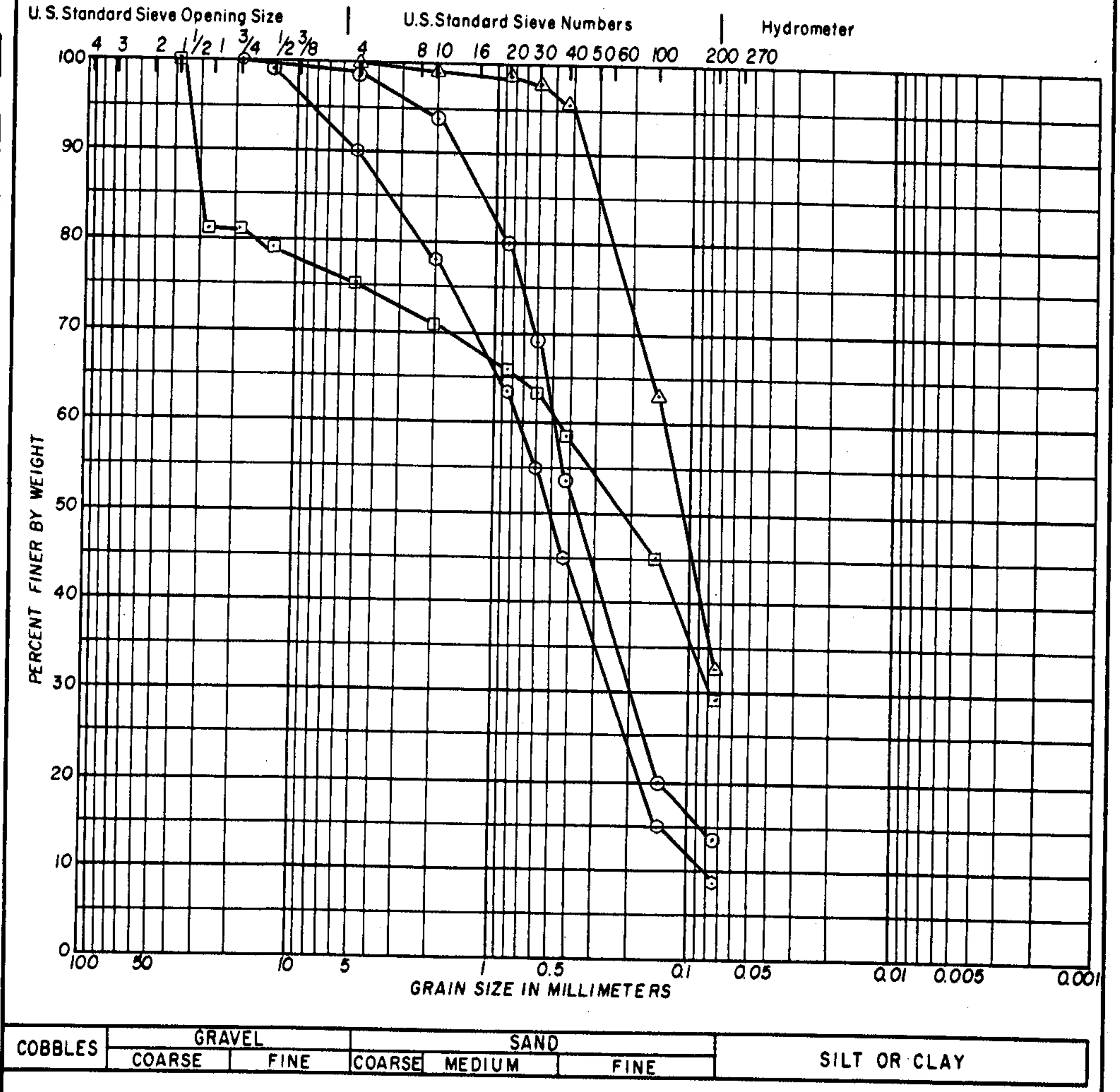
## Particle Size Analysis

Port of Nome
Nome, Alaska

PLATE
**B5**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | | 3/82 | | |



| Symbol | Sample Source | Classification |
|---|---|---|
| ⊙ | HLO-2 at 3.0' | GRAY SILTY SAND (SM) |
| △ | HLO-2 at 8.5' | GRAY SILTY SAND (SM) |
| ⊙ | HLO-2 at 22.0' | GRAY SILTY GRAVELLY SAND (SP-SM) |
| ⊡ | HLO-3 at 2.0' | GRAY GRAVELLY SILTY SAND (SM) |

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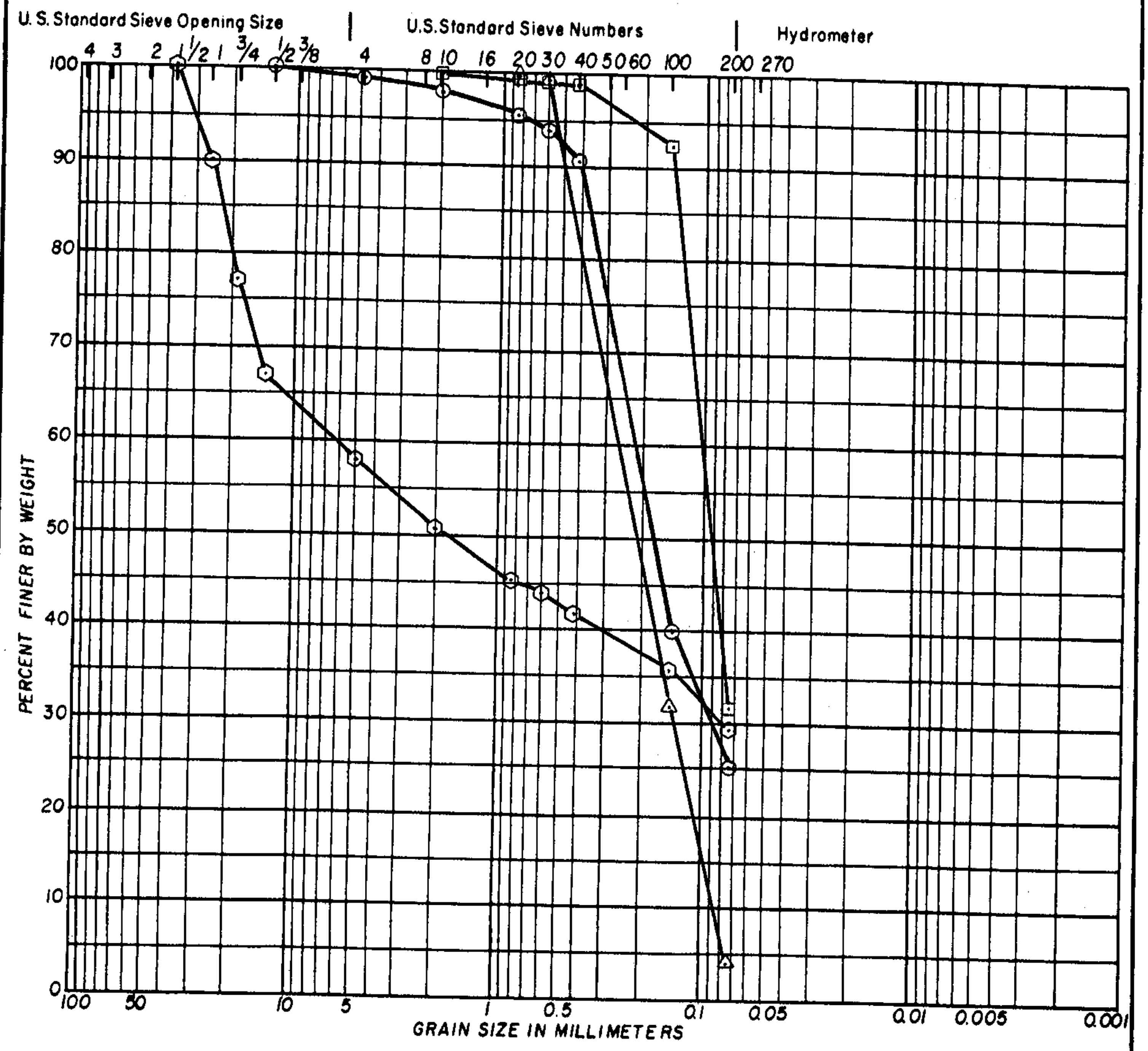
## Particle Size Analysis

Port of Nome
Nome, Alaska

PLATE
**B6**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | TJ | 3/82 | | |



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | COARSE | FINE | COARSE | MEDIUM | FINE | |

| Symbol | Sample Source | Classification |
|---|---|---|
| ⊙ | HLO-3 at 27.5' | GRAY SILTY SAND (SM) |
| △ | HLO-4 at 0.0' | GRAY SAND (SP) |
| ⬡ | HLO-4 at 9.5' | GRAY SILTY GRAVELLY SAND (SM) |
| ⊡ | HLO-4 at 33.0' | GRAY SILTY SAND (SM) |

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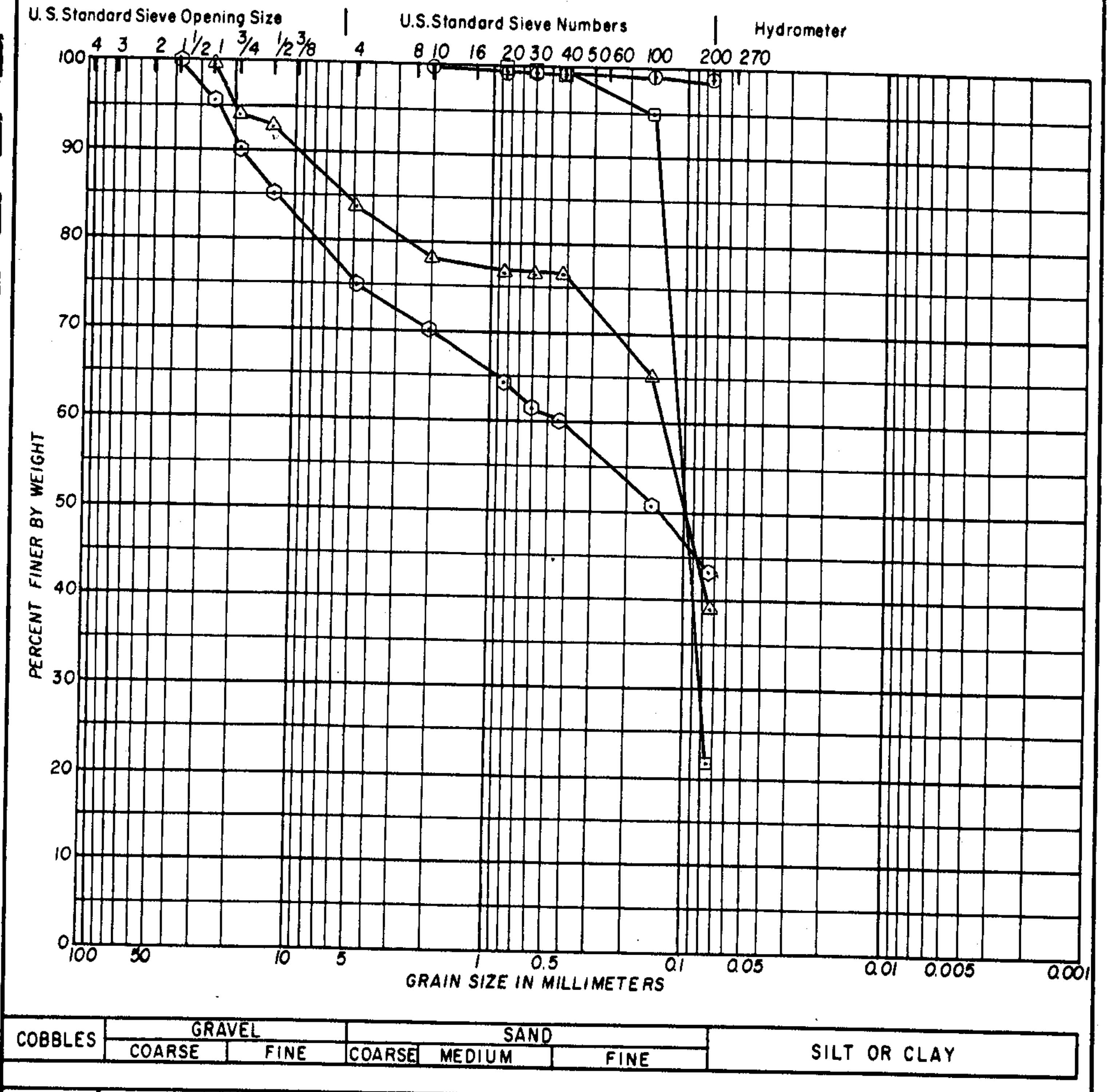
## Particle Size Analysis

Port of Nome
Nome, Alaska

PLATE
**B7**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001.002.08 | | 3/82 | | |



| Symbol | Sample Source | Classification |
|---|---|---|
| ⊙ | HLO-5 at 12.5' | DARK GRAY FINE SILT (ML) |
| △ | HLO-6 at 4.5' | GRAY GRAVELLY SILTY SAND (SM) |
| ⬡ | HLO-6 at 10.5' | GRAY GRAVELLY SILTY SAND (SM) |
| ⊡ | HLO-6 at 31.0' | GRAY SILTY SAND (SM) |

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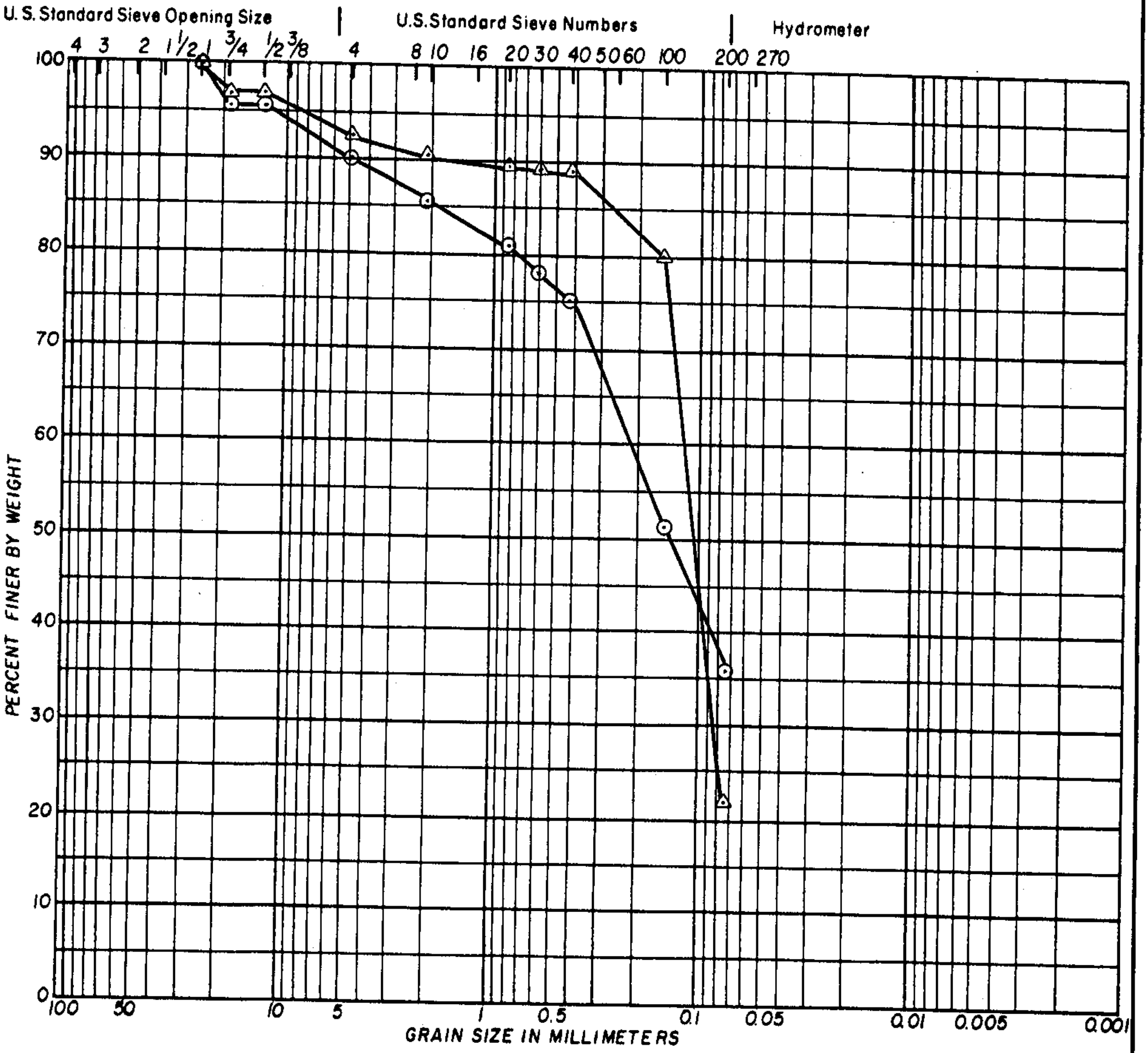
**Particle Size Analysis**

Port of Nome
Nome, Alaska

PLATE
**B8**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | RS | 3/82 | | |



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | COARSE | FINE | COARSE | MEDIUM | FINE | |

| Symbol | Sample Source | Classification |
|---|---|---|
| ⊙ | HLO-7 at 3.5' | GRAY GRAVELLY SILTY FINE SAND (SM) |
| △ | HLO-7 at 37.0' | GRAY GRAVELLY SILTY FINE SAND (SM) |

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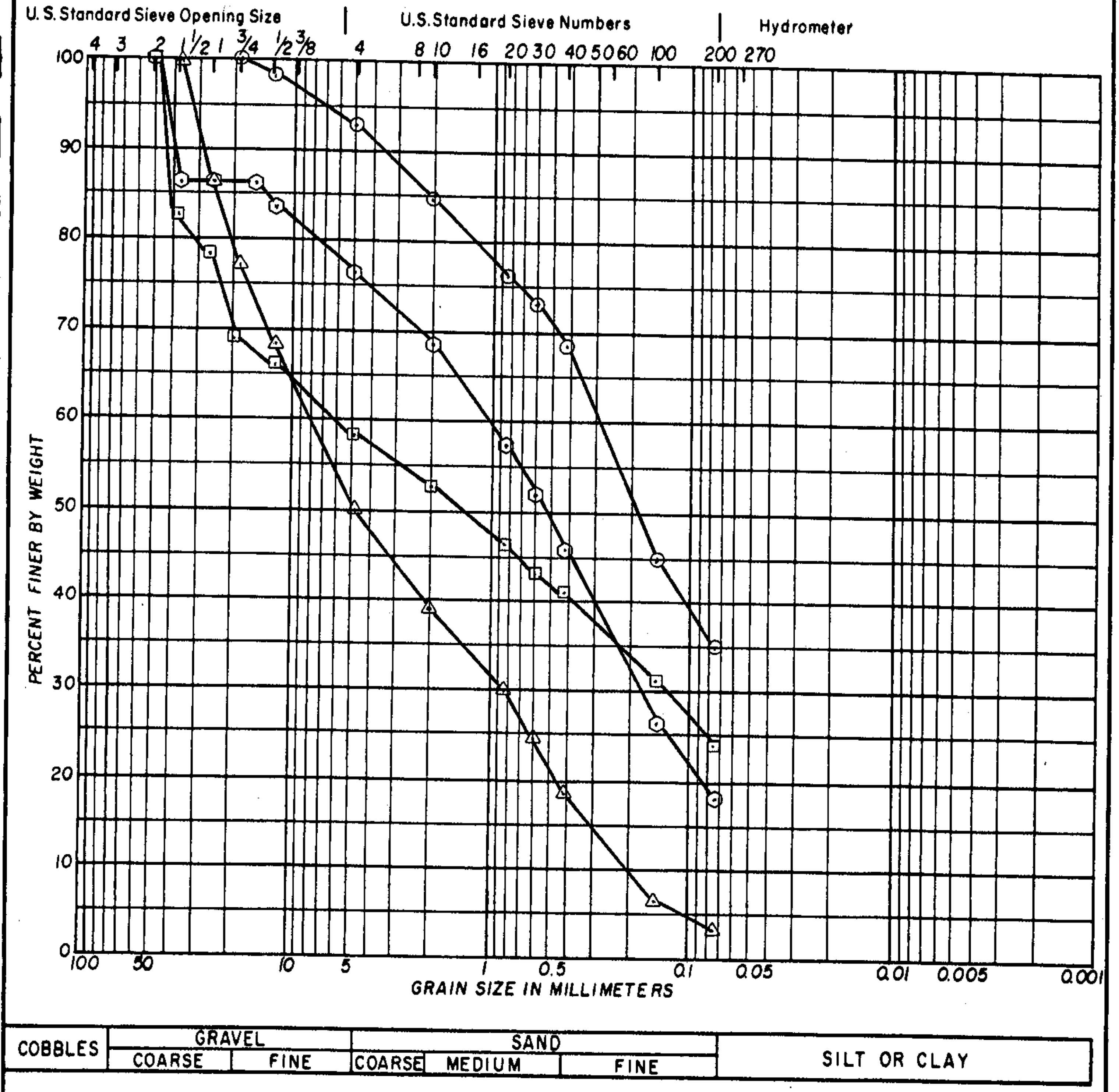
## Particle Size Analysis

Port of Nome
Nome, Alaska

PLATE
**B9**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | RD | 3/82 | | |



| Symbol | Sample Source | Classification |
|---|---|---|
| ⊙ | HLB-2 at 20.0' | GRAY GRAVELLY SILTY SAND (SM) |
| △ | HLB-3 at 3.0' | BROWN SANDY GRAVEL (GP) |
| ⬡ | HLB-3 at 5.5' | BROWN ORGANIC SILTY SAND (SM) |
| ⊡ | HLB-3 at 16.0' | BROWN SILTY GRAVELLY SAND (SM) |

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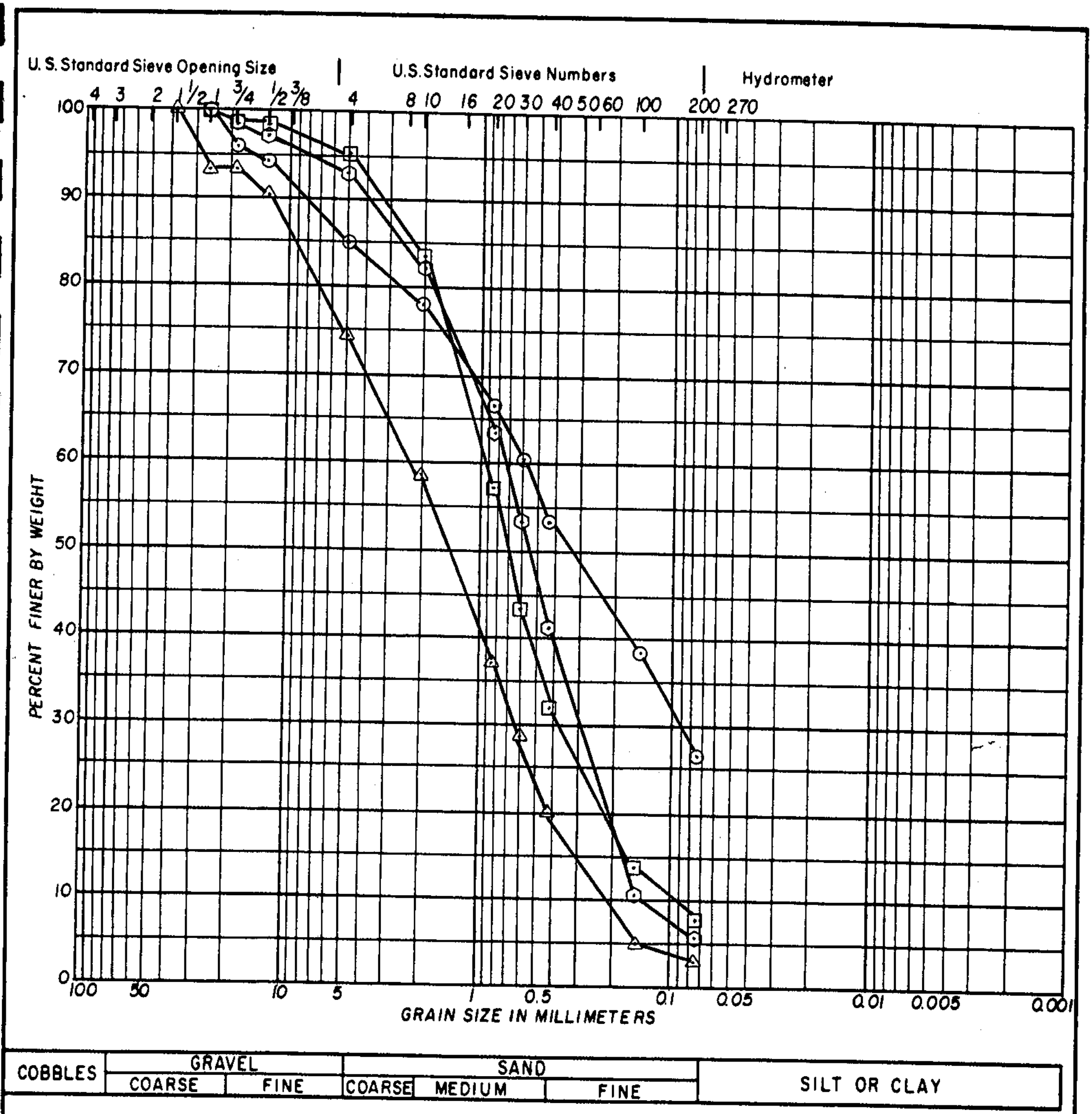
## Particle Size Analysis

Port of Nome
Nome, Alaska

PLATE
**B10**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | | 3/82 | | |



| Symbol | Sample Source | Classification |
|---|---|---|
| ⊙ | HLB-3 at 16.5' | BROWN GRAVELLY SILTY SAND (SM) |
| △ | HLB-4 at 5.0' | BROWN GRAVELLY SAND (SP) |
| ⬡ | HLB-4 at 15.0' | GRAY GRAVELLY SAND (SP-SM) |
| ⊡ | HLB-4 at 40.0' | GRAY SAND (SP-SM) |

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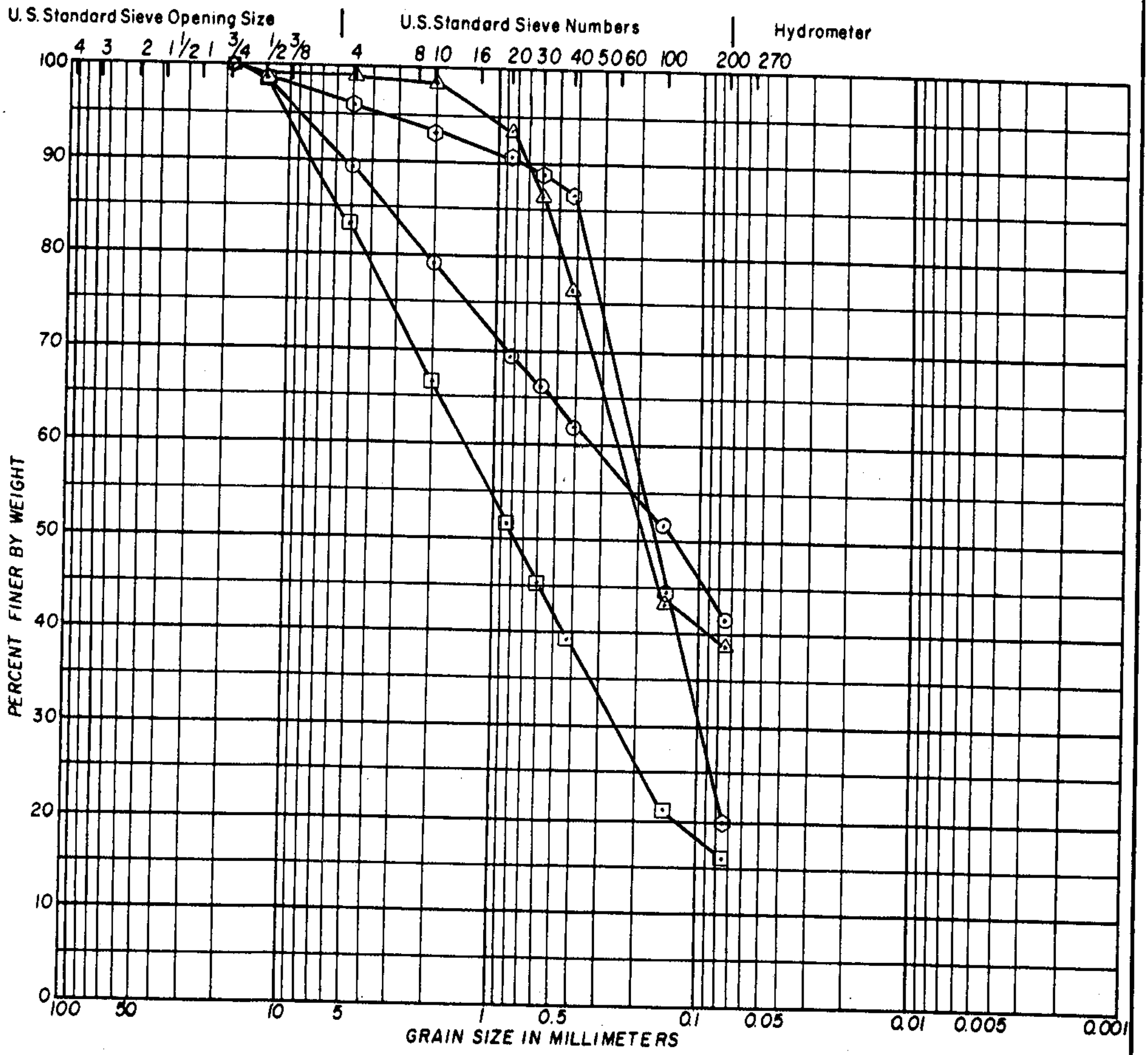
## Particle Size Analysis

Port of Nome
Nome, Alaska

PLATE
**B11**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | | 3/82 | | |



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | COARSE | FINE | COARSE | MEDIUM | FINE | |

| Symbol | Sample Source | Classification |
|---|---|---|
| ⊙ | HLB-6 at 20.0' | DARK GRAY SILTY SAND (SM) |
| △ | HLB-7 at 5.0' | BROWN-GRAY SILTY SAND (SM) |
| ⬡ | HLB-7 at 20.0' | BROWN-GRAY SILTY SAND (SM) |
| ⊡ | HLB-9 at 10.0' | BROWN SILTY GRAVELLY SAND (SM) |

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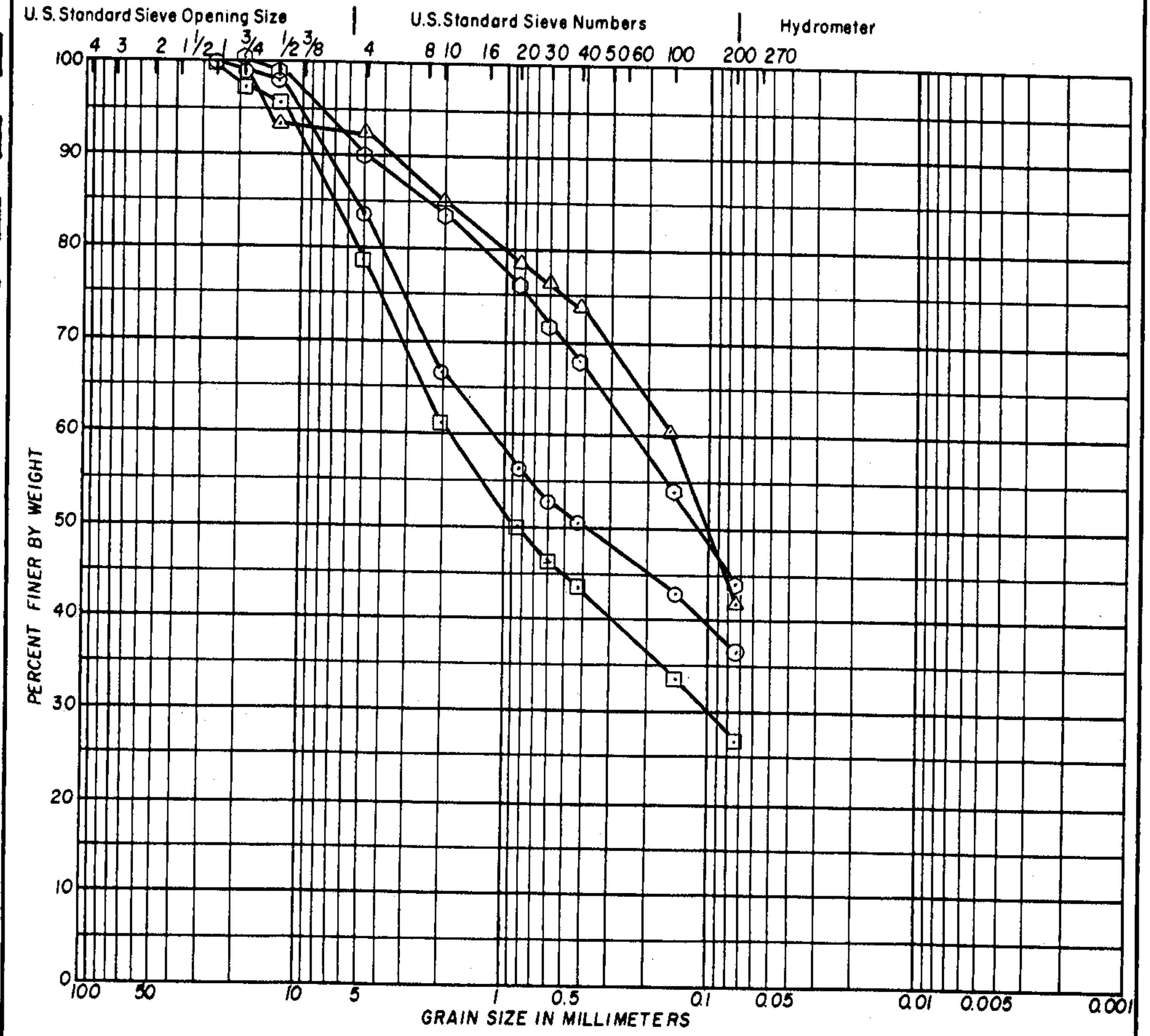
## Particle Size Analysis

Port of Nome
Nome, Alaska

PLATE
**B12**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | TJ | 3/82 | | |



| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | COARSE | FINE | COARSE | MEDIUM | FINE | |

| Symbol | Sample Source | Classification |
|---|---|---|
| ⊙ | HLB-9 at 20.0' | BROWN GRAVELLY SILTY SAND (SM) |
| △ | HLB-9 at 25.0' | BROWN SILTY SAND (SM) |
| ⬡ | HLB-10 at 43.0' | BROWN GRAVELLY SILTY SAND (SM) |
| ⊡ | HLB-13 at 20.0' | BROWN/GRAY GRAVELLY SILTY SAND (SM) |

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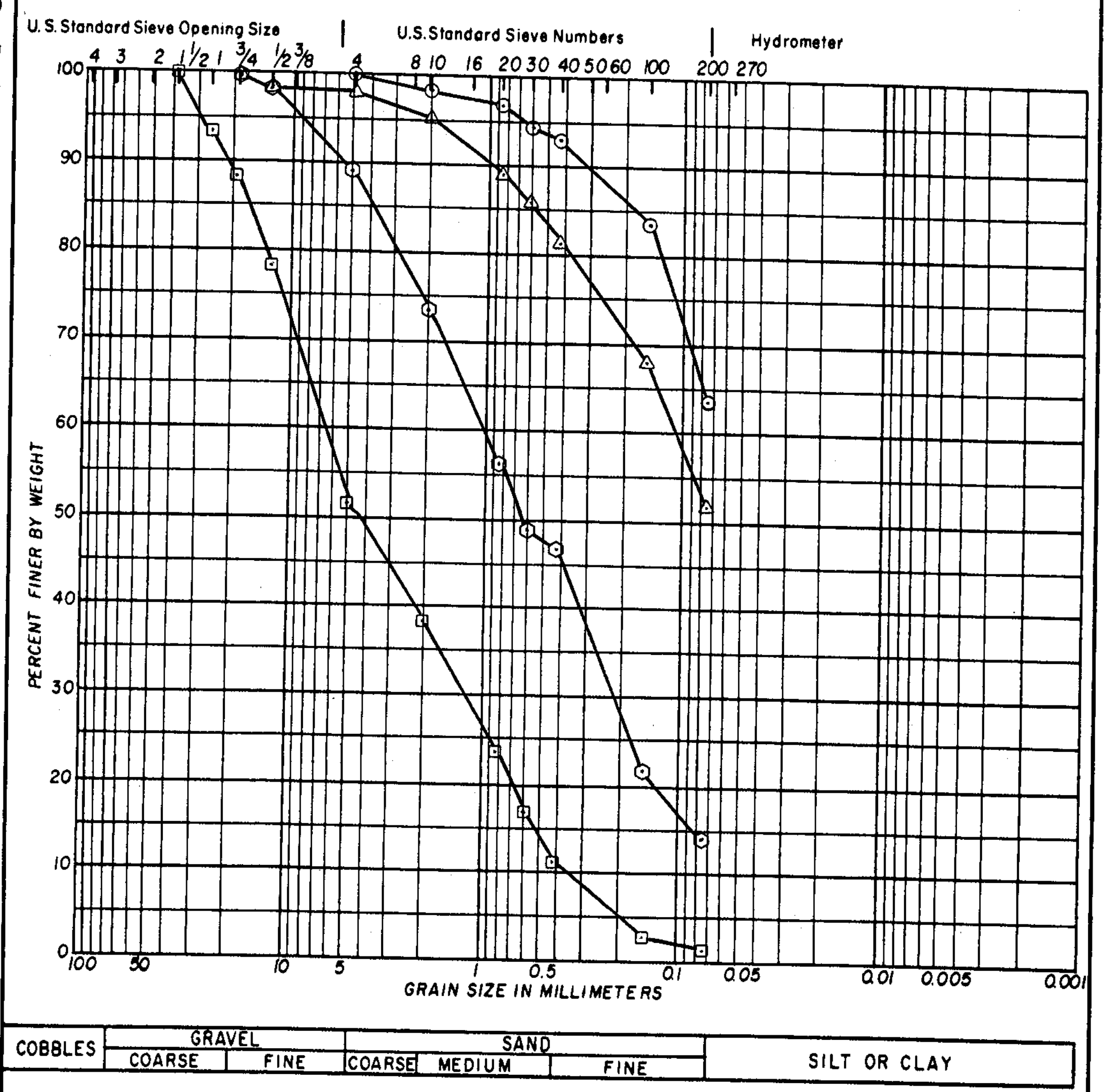
**Particle Size Analysis**

Port of Nome
Nome, Alaska

PLATE
**B13**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | | 3/82 | | |



| Symbol | Sample Source | Classification |
|---|---|---|
| ⊙ | HLS-1 at 1.0' | BROWN SANDY SILT (ML) |
| △ | HLS-1 at 11.5' | BROWN SANDY SILT (ML) |
| ⬡ | HLS-2 at 6.7' | BLACK GRAVELLY SILTY SAND (SM) |
| ⊡ | HLS-2 at 17.5' | BROWN GRAVELLY SAND (SP) |

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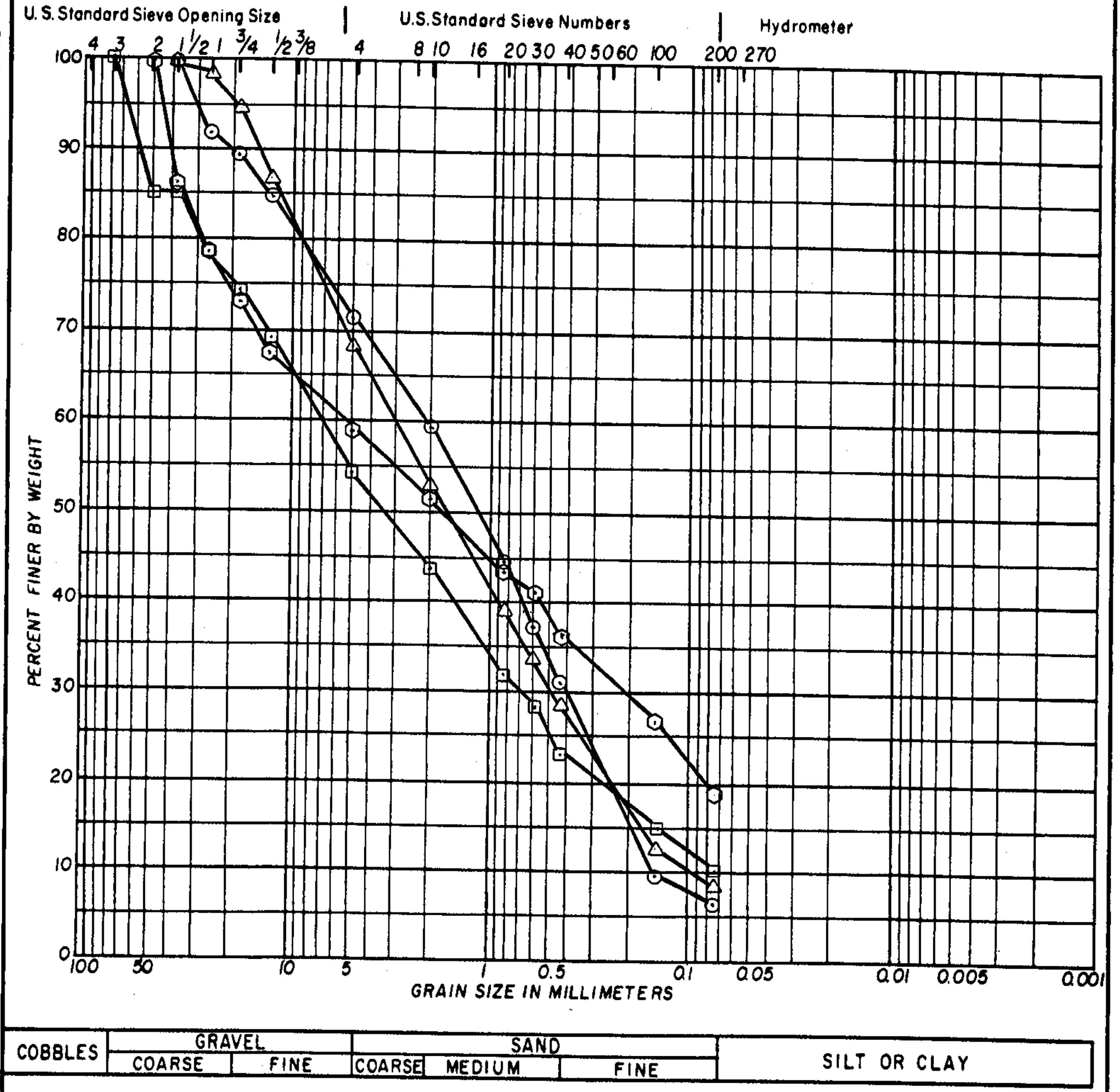
## Particle Size Analysis

Port of Nome
Nome, Alaska

PLATE
**B14**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | | 3/82 | | |



| Symbol | Sample Source | Classification |
|---|---|---|
| ⊙ | HLS-3 at 5.8' | BROWN SILTY GRAVELLY SAND (SP-SM) |
| △ | HLS-3 at 8.5' | DARK BROWN SILTY GRAVELLY SAND (SP-SM) |
| ⬡ | HLS-3 at 15.0' | BROWN SILTY GRAVELLY SAND (SM) |
| ⊡ | HLS-3 at 18.0' | BROWN SILTY GRAVELLY SAND (SP-SM) |

HLA

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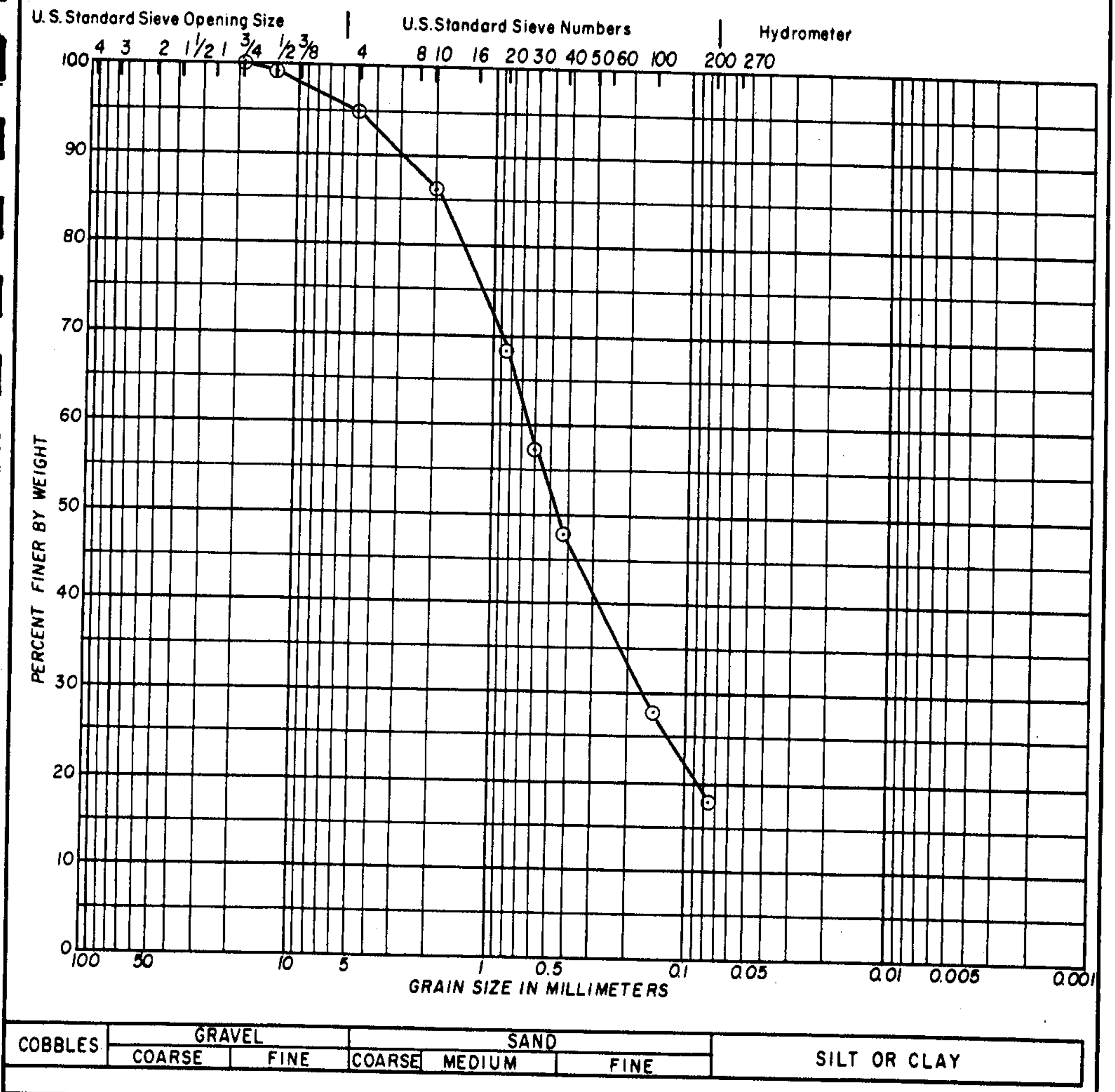
**Particle Size Analysis**
Port of Nome
Nome, Alaska

PLATE
**B15**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
|  | 15001,002.08 |  | 3/82 |  |  |



| Symbol | Sample Source | Classification |
|---|---|---|
| ⊙ | HLS-4 at 7.2' | BLACK ORGANIC SILTY SAND (SM) |

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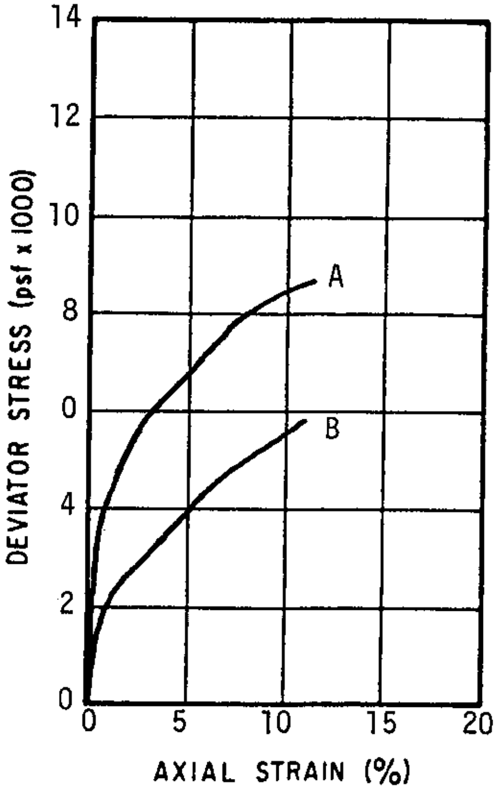
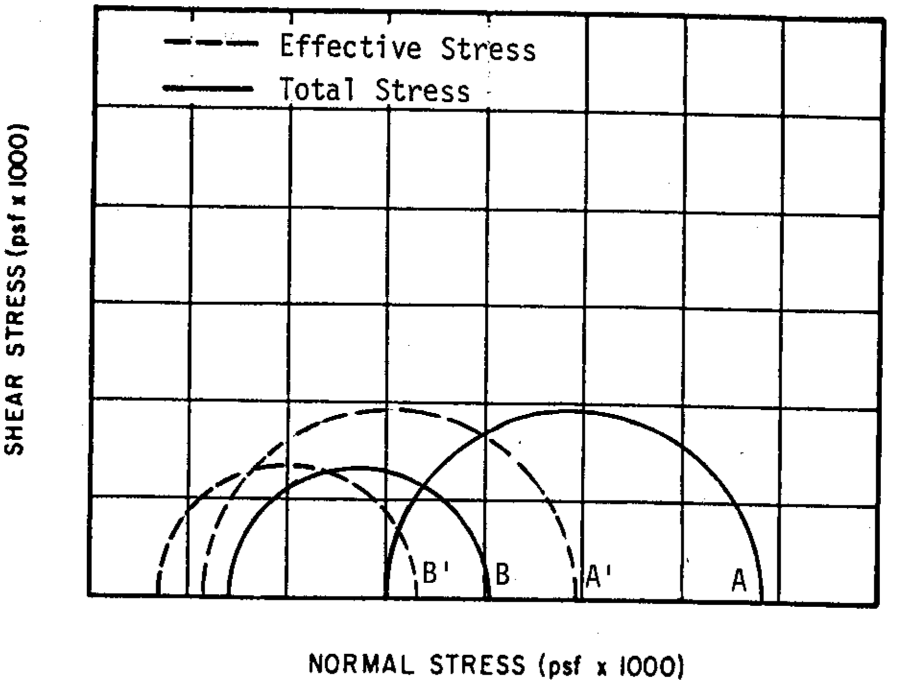
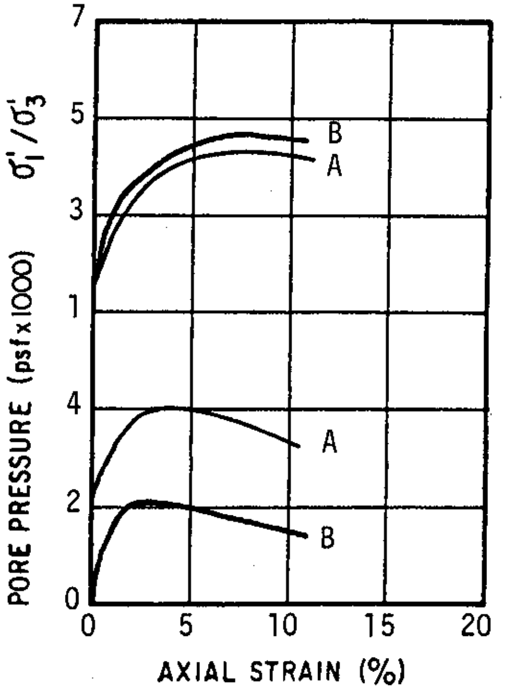
## Particle Size Analysis
Port of Nome
Nome, Alaska

PLATE
**B16**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | | 3/82 | | |







Test Type: Consolidated Undrained Controlled: Strain

Saturation Method: Back Pressure $G_s$ 2.66

| Test No. | | A | B | C |
|---|---|---|---|---|
| Initial | Diameter (in.) | 2.43 | 2.43 | |
| | Height (in.) | 5.10 | 5.20 | |
| | Moisture Content | 35.2 % | 36.2 % | % |
| | Void Ratio | 0.949 | 0.956 | |
| | Saturation | 98.8 % | 100 % | % |
| | Dry Density (pcf) | 85 | 85 | |
| Before Test | Moisture Content | 31.9 % | 31.4 % | % |
| | Void Ratio | 0.840 | 0.827 | |
| | Saturation | 100 % | 100 % | % |
| | Pressure (psf) | 6010 | 3000 | |
| Final | Moisture Content | 31.9 % | 31.4% | % |
| | Void Ratio | 0.840 | 0.827 | |
| $\sigma_1$ Major Prin. Stress (psf) | | 13650 | 8280 | |
| $\sigma_3$ Minor Prin. Stress (psf) | | 6010 | 3020 | |
| Time to Failure (min.) | | 63 | 83 | |

Sample Source: Boring HLO-2 at 11.2' (A) & 8.5' (B)

Classification: GRAY SILTY MICACEOUS SAND (SM)

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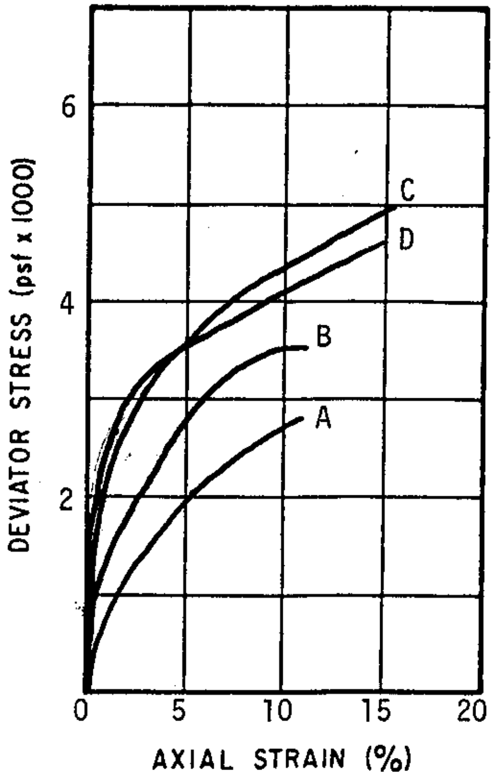
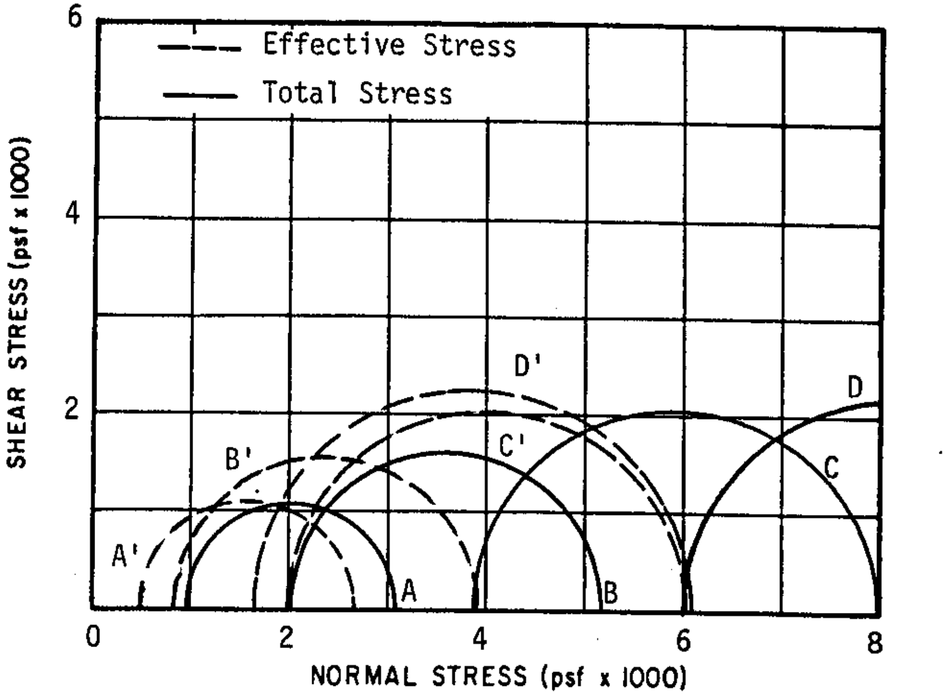
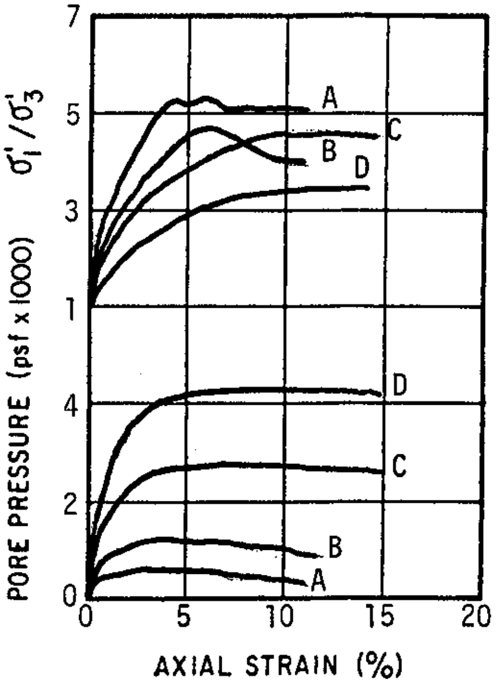
**Triaxial Compression**
**Test Report**
Port of Nome
Nome, Alaska

PLATE
**B17**

DRAWN
JOB NUMBER 15001,002.08
APPROVED
DATE 3/82
REVISED
DATE







Test Type: Consolidated Undrained Controlled: Strain

Saturation Method: Back Pressure $G_s$ 2.64 Average

| Test No. | | A | B | C |
|---|---|---|---|---|
| Initial | Diameter (in.) | 2.43 | 2.43 | 2.43 |
| | Height (in.) | 5.85 | 6.00 | 5.65 |
| | Moisture Content | 39.6 % | 37.6 % | 41.4 % |
| | Void Ratio | 1.081 | 1.132 | 1.078 |
| | Saturation | 98 % | 89 % | 100 % |
| | Dry Density (pcf) | 80 | 79 | 78 |
| Before Test | Moisture Content | 39.1 % | 37.8 % | 36.6 % |
| | Void Ratio | 1.047 | 1.016 | 0.948 |
| | Saturation | 100 % | 100 % | 100 % |
| | Pressure (psf) | 1010 | 2050 | 4000 |
| Final | Moisture Content | 39.1 % | 37.8 % | 36.6 % |
| | Void Ratio | 1.047 | 1.016 | 0.948 |
| $\sigma_1$ Major Prin. Stress (psf) | | 3170 | 5170 | 8140 |
| $\sigma_3$ Minor Prin. Stress (psf) | | 1010 | 2045 | 3960 |
| Time to Failure (min.) | | 60 | 59 | 85 |

Sample Source: Boring HLO-1 at 9.5' (A), 2.8' (B), 10.5' (C)

Classification: GRAY MICACEOUS SANDY SILT (ML)

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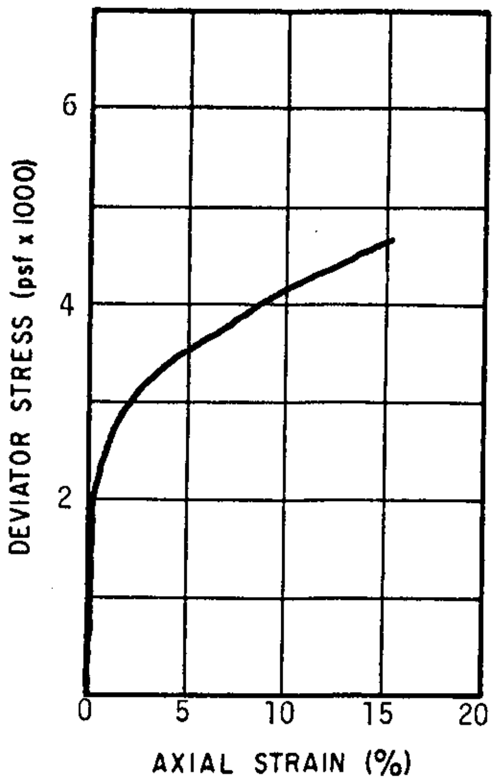
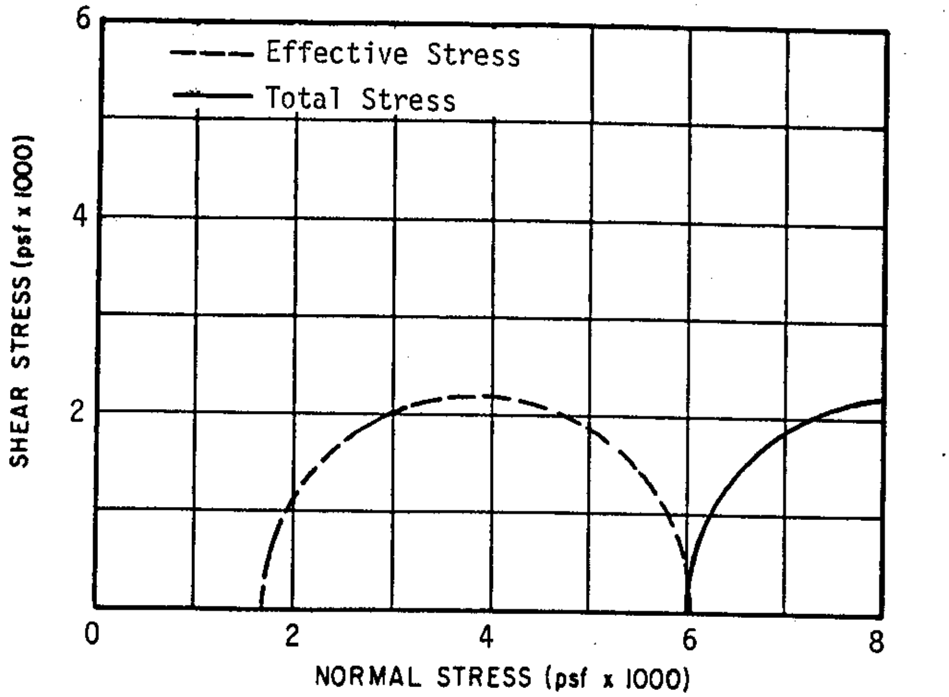
## Triaxial Compression Test Report

Port of Nome
Nome, Alaska

PLATE
**B18**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | | 3/82 | | |





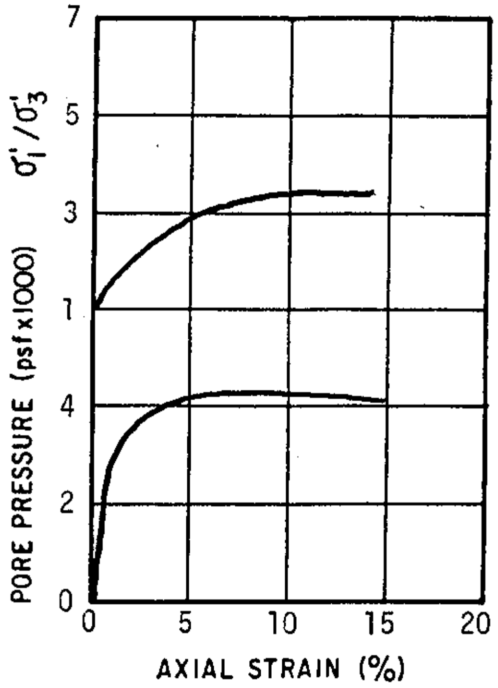
Test Type: Consolidated Undrained Controlled: Strain

Saturation Method: Back Pressure $G_s$ 2.64 Average

| | Test No. | D | E | F |
|---|---|---|---|---|
| Initial | Diameter (in.) | 2.43 | | |
| | Height (in.) | 6.00 | | |
| | Moisture Content | 41.0 % | % | % |
| | Void Ratio | 1.043 | | |
| | Saturation | 100 % | % | % |
| | Dry Density (pcf) | 79 | | |
| Before Test | Moisture Content | 33.8 % | % | % |
| | Void Ratio | 0.866 | | |
| | Saturation | 100 % | % | % |
| | Pressure (psf) | 6000 | | |
| Final | Moisture Content | 33.8 % | % | % |
| | Void Ratio | 0.866 | | |
| $\sigma_1$ Major Prin. Stress (psf) | | 10290 | | |
| $\sigma_3$ Minor Prin. Stress (psf) | | 5950 | | |
| Time to Failure (min.) | | 105 | | |

Sample Source: Boring HLO-1 at 10.0' (D)

Classification: GRAY MICACEOUS SANDY SILT (ML)



Ø =

C =

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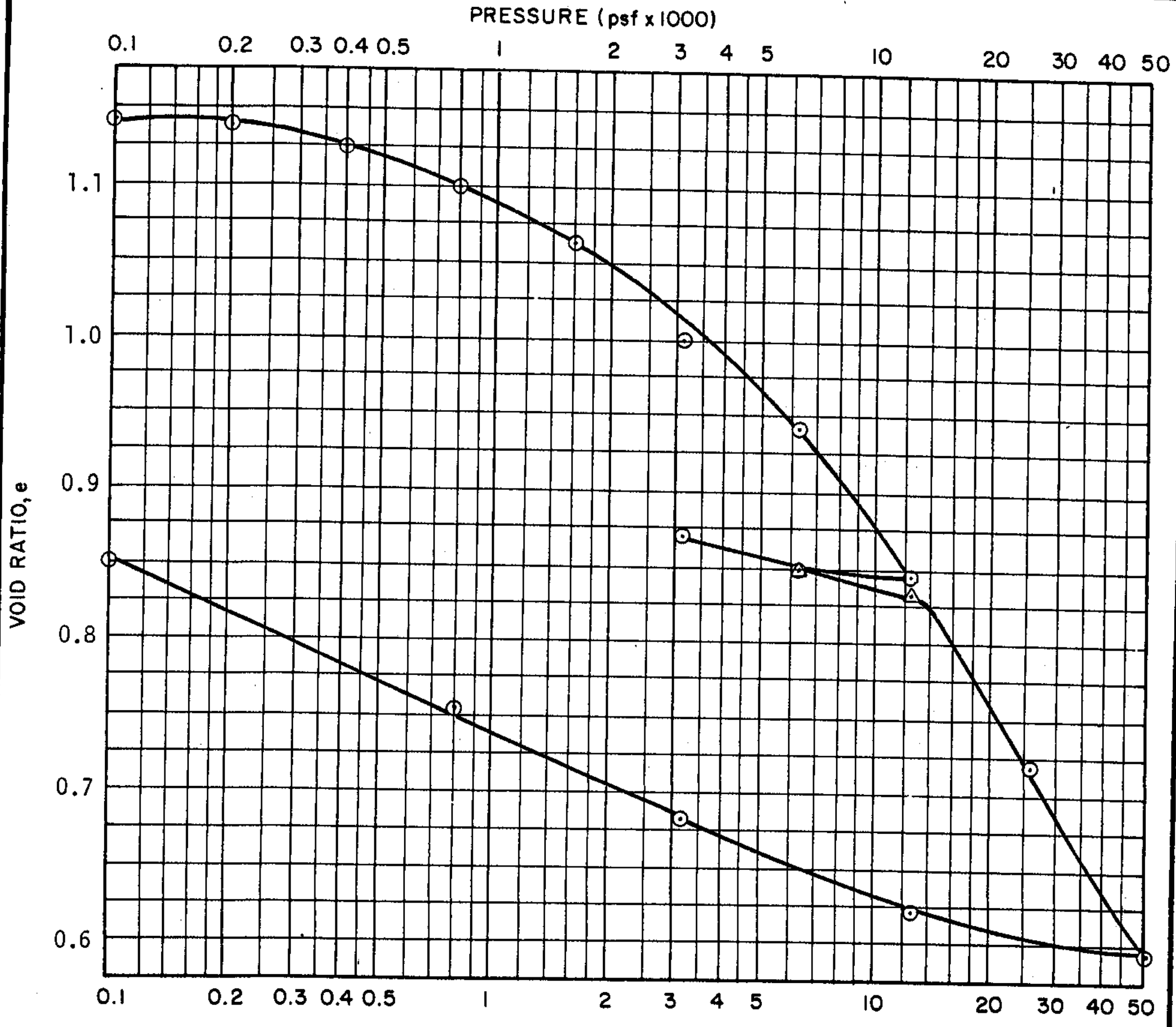
## Triaxial Compression Test Report

Port of Nome
Nome, Alaska

PLATE
**B19**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | | 3/82 | | |



| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TYPE OF SPECIMEN | Undisturbed | | | BEFORE TEST | | | AFTER TEST | |
| DIAMETER (in.) | 2.43 | HEIGHT(in.) | 0.80 | MOISTURE CONTENT | $w_o$ | 44.0 % | $w_f$ | 34.8 % |
| OVERBURDEN PRESS., $P_o$ | 90 psf | | | VOID RATIO | $e_o$ | 1.152 | $e_f$ | 0.853 |
| PRECONSOL. PRESS., $P_c$ | - psf | | | SATURATION | $S_o$ | 96 % | $S_f$ | 100 % |
| COMPRESSION INDEX, $C_c$ | 0.42 | | | DRY DENSITY | $\gamma_d$ | 73 pcf | $\gamma_d$ | 85 pcf |
| LL | NP | PL | NP | PI | NP | | $G_s$ | 2.52 |
| CLASSIFICATION | GRAY BLACK SANDY SILT (ML) | | | SOURCE | Boring HLO-1 at 2.5' | | | |

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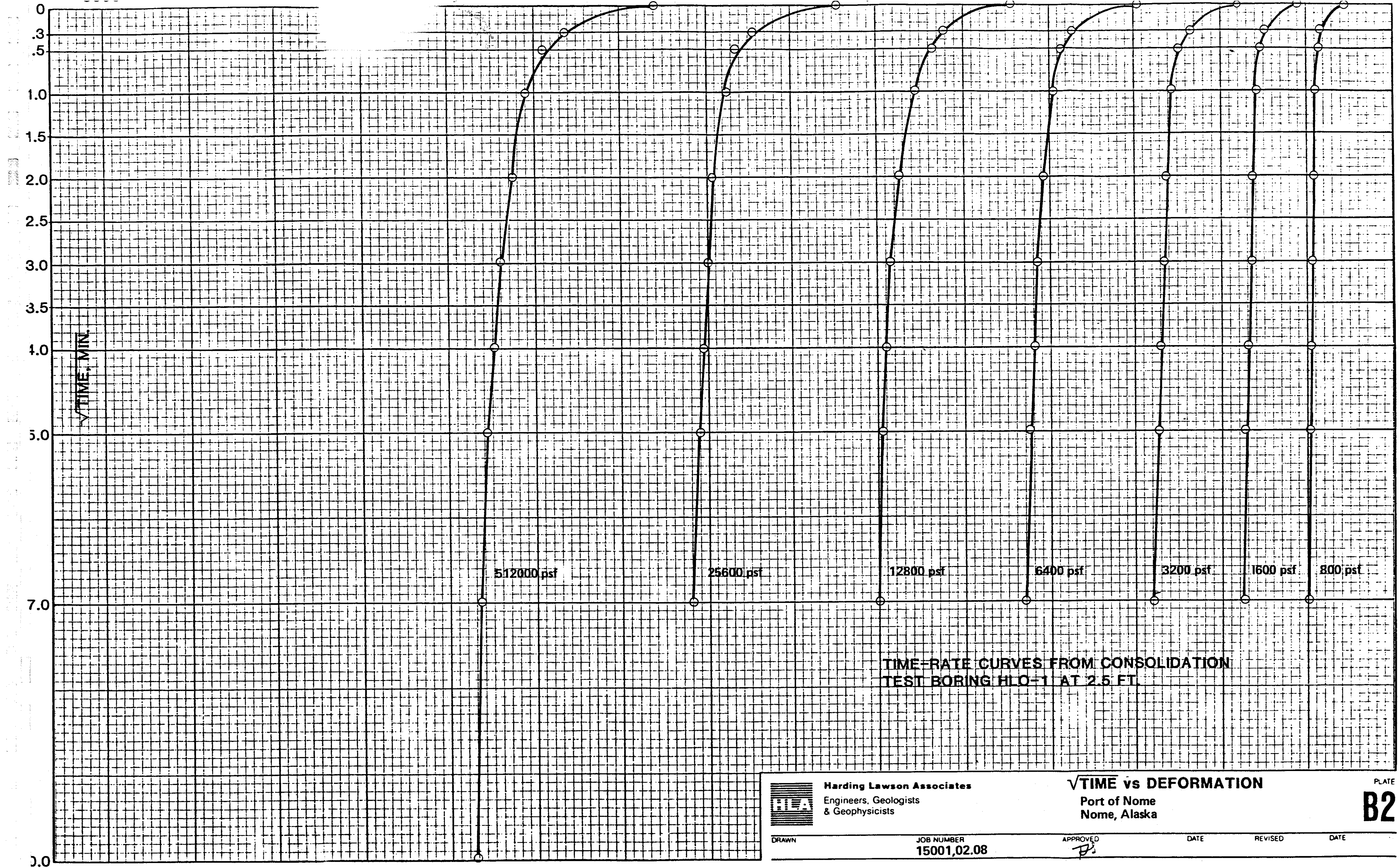
## Consolidation Test Report

Port of Nome
Nome, Alaska

PLATE
**B20**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | TB | 3/82 | | |



TIME-RATE CURVES FROM CONSOLIDATION
TEST BORING HLO-1 AT 2.5 FT.

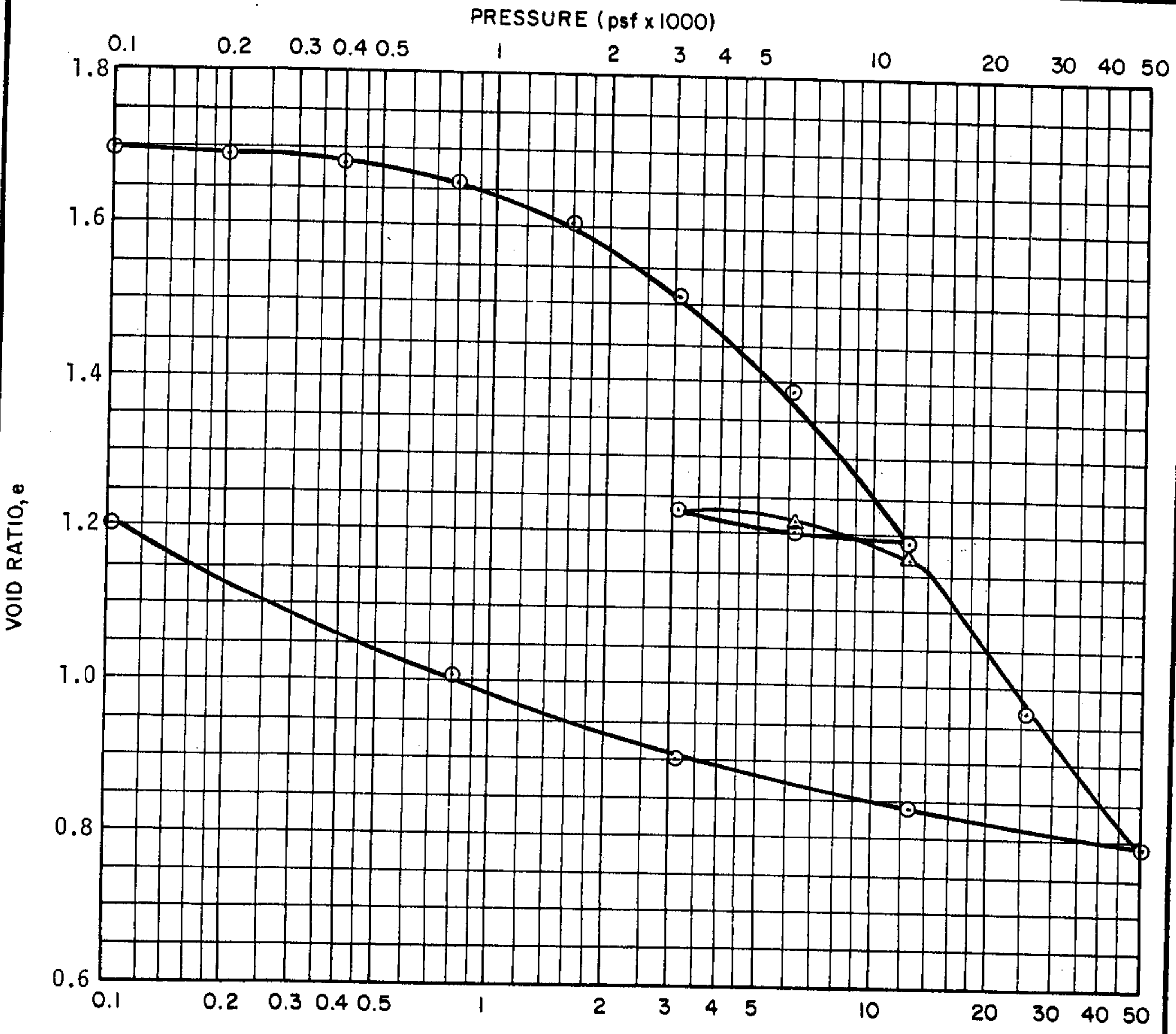
**Harding Lawson Associates**
Engineers, Geologists
& Geophysicists

## √TIME vs DEFORMATION

Port of Nome
Nome, Alaska

PLATE
**B21**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,02.08 | | | | |



| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TYPE OF SPECIMEN | Undisturbed | | | BEFORE TEST | | | AFTER TEST | |
| DIAMETER (in.) | 2.43 | HEIGHT(in.) | 0.80 | MOISTURE CONTENT | $w_o$ | 65.4 % | $w_f$ | 49.1 % |
| OVERBURDEN PRESS., $P_o$ | 400 psf | | | VOID RATIO | $e_o$ | 1.706 | $e_f$ | 1.202 |
| PRECONSOL. PRESS., $P_c$ | - psf | | | SATURATION | $S_o$ | 95 % | $S_f$ | 100 % |
| COMPRESSION INDEX, $C_c$ | 0.08 | | | DRY DENSITY | $\gamma_d$ | 57 pcf | $\gamma_d$ | 70 pcf |
| LL | NP | PL | NP | PI | NP | $G_s$ | 2.47 | |
| CLASSIFICATION | GRAY SANDY SILT (ML) | | | SOURCE | Boring HLO-1 at 11.2' | | | |

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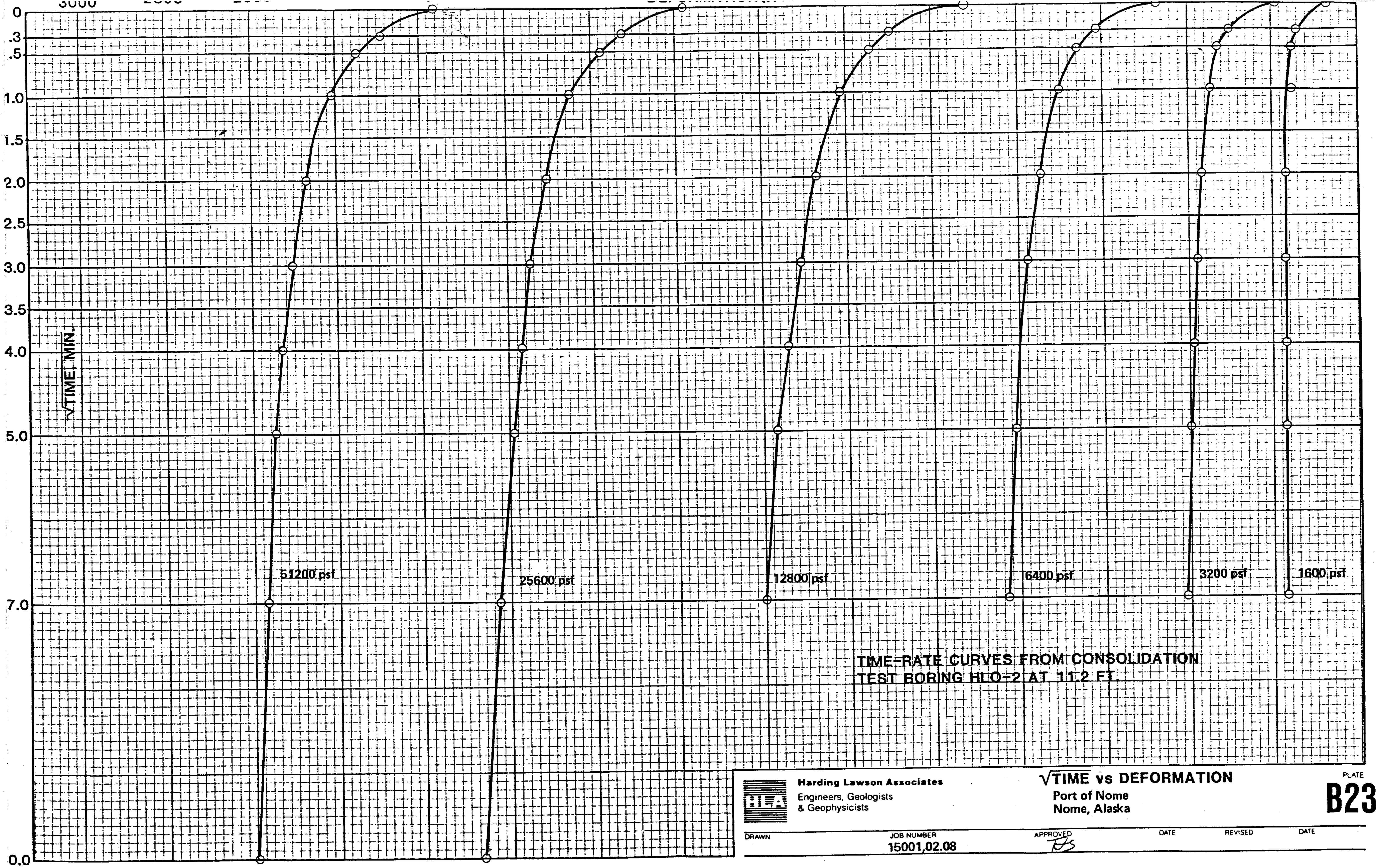
## Consolidation Test Report

Port of Nome
Nome, Alaska

PLATE
B22

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | TJS | 3/82 | | |



TIME-RATE CURVES FROM CONSOLIDATION
TEST BORING HLO-2 AT 11.2 FT.

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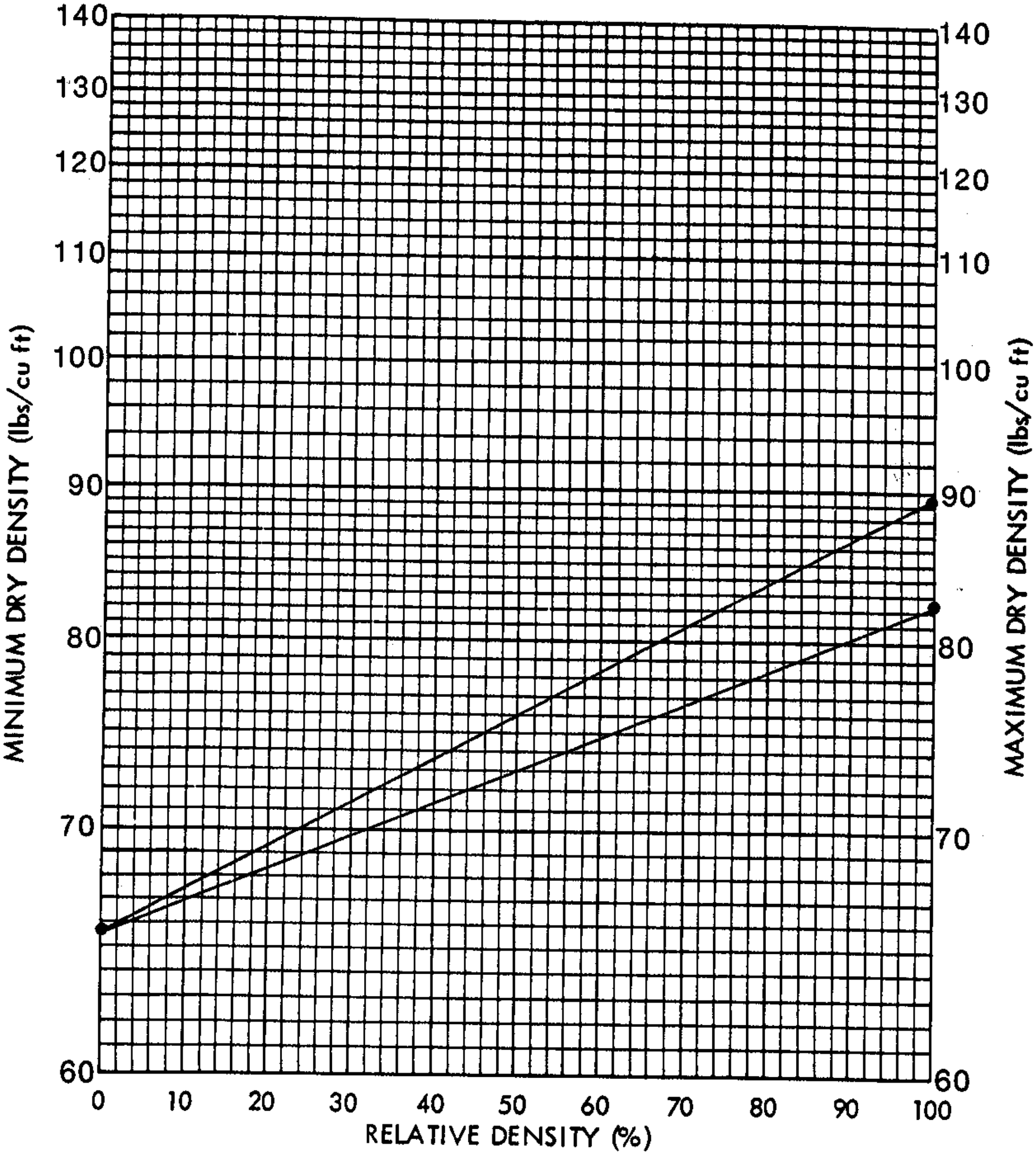
**√TIME vs DEFORMATION**
Port of Nome
Nome, Alaska

PLATE
**B23**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
|  | 15001,02.08 | RS |  |  |  |



| Symbol | Sample Source | Classification | Dry Density (pcf) | | |
|---|---|---|---|---|---|
| | | | Minimum | Max. Wet | Max. Dry |
| | HLO-1 Combined<br>Samples:<br>1.5 - 3.5'<br>9.0 - 11.5'<br>12.0 - 14.0' | GRAY GRAVELLY SILTY SAND (SM) | 65.7 | 82.4 | 89.5 |

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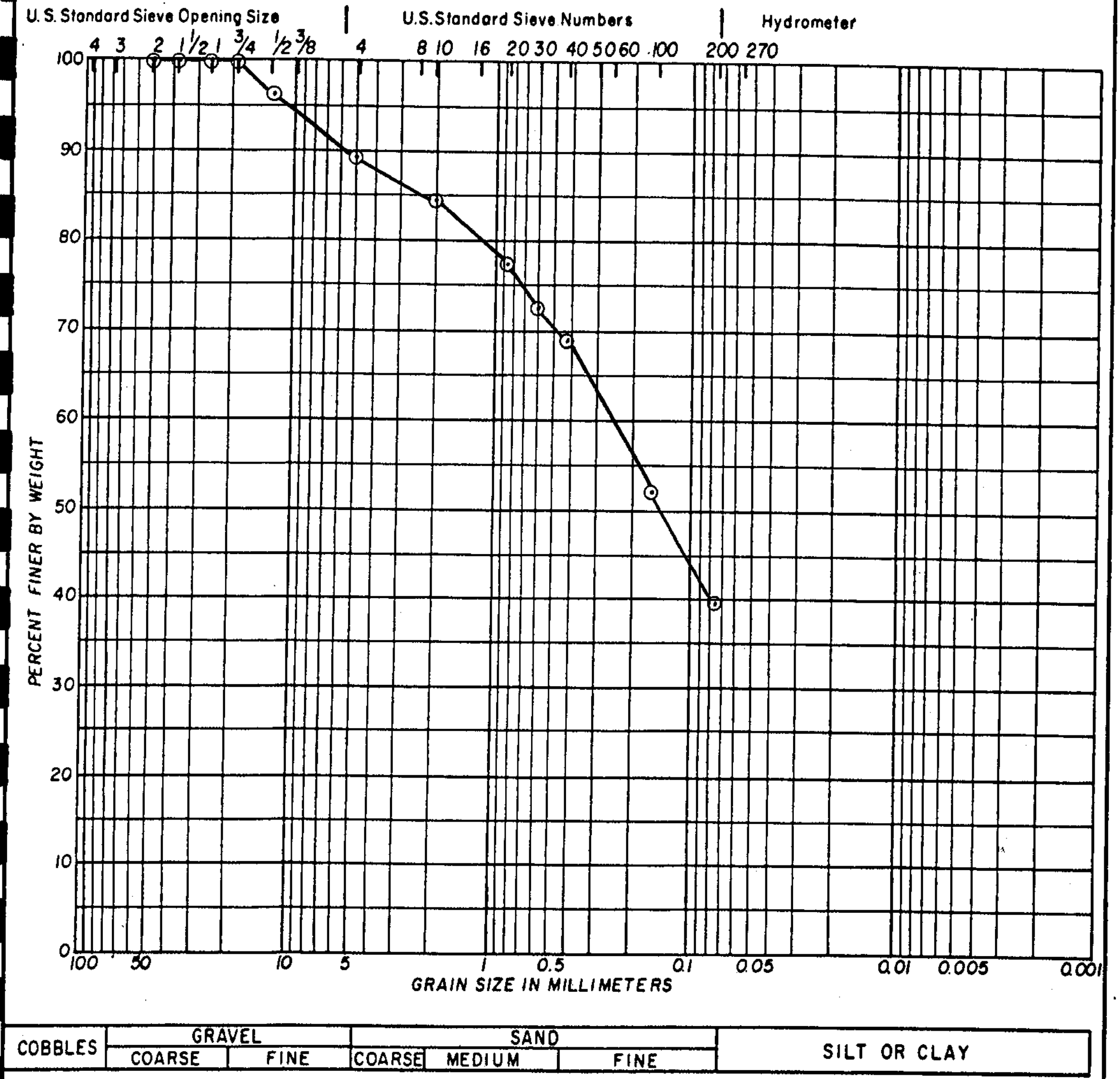
## Relative Density Test Data

Port of Nome
Nome, Alaska

PLATE
**B24**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | TDS | 3/82 | | |



| Symbol | Sample Source | Classification |
|---|---|---|
| ⊙ | HLO-1 Combined Samples:<br>1.5 - 3.5 feet<br>9.0 - 11.5 feet<br>12.0 - 14.0 feet | GRAY GRAVELLY SILTY SAND (SM) |

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## Particle Size Analysis

PORT OF NOME
Nome, Alaska

PLATE
**B25**

| DRAWN | JOB NUMBER | APPROVED | DATE | REVISED | DATE |
|---|---|---|---|---|---|
| | 15001,002.08 | | 3/82 | | |

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