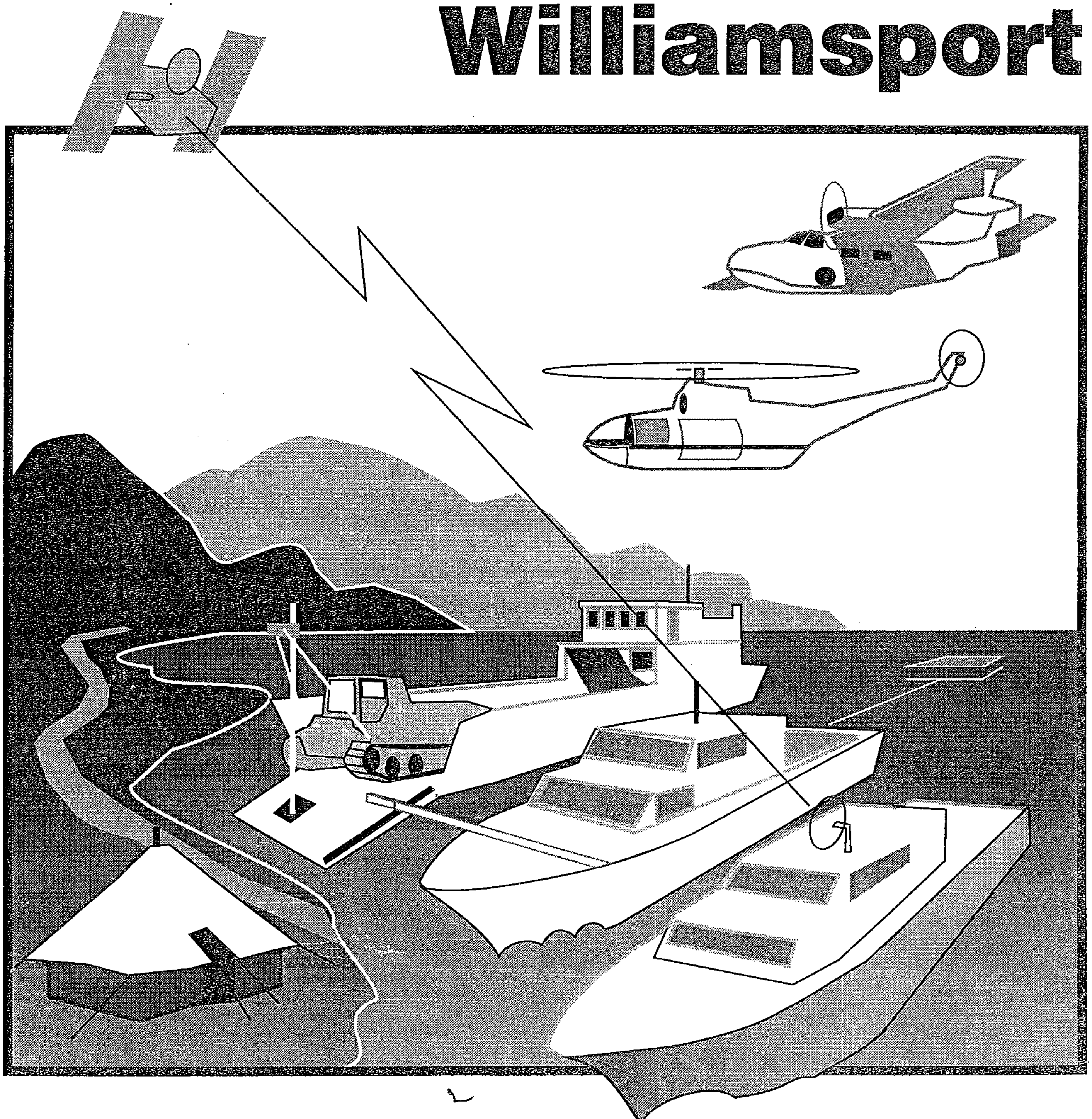
US Army Corps of Engineers
Alaska District

FINAL

Navigation Channel Feasibility Report and Environmental Assessment

Williamsport



December 1995

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, ALASKA
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NAVIGATION CHANNEL FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT:

WILLIAMSPORT

December 1995

Cover design by Monty Henninger.

Summary

The Williamsport-Pile Bay Road has served for hundreds of years as part of an overland route from Cook Inlet to the Iliamna Lake region of southwestern Alaska and on to Bristol Bay and the Bering Sea. Williamsport is the name of the undeveloped terminus of the dirt road, owned and maintained by the State, which leads from Pile Bay on the southeastern shore of Iliamna Lake over the Chigmit Mountains to the western shore of Cook Inlet. Williamsport is inaccessible by sea except for brief periods at the peak of extreme high tides which occur a few days each month. In spite of this extraordinary limitation, landing craft approach Williamsport regularly to offload cargo bound for the communities of Iliamna Lake. The road is also used for truck transport of commercial fishing vessels from Cook Inlet to Iliamna Lake, where the vessels can sail to Bristol Bay via the lake and the Kvichak River. The owners of these vessels prefer to take advantage of more affordable maintenance, repair, and storage services on the Kenai Peninsula (eastern Cook Inlet), versus using much more expensive arrangements in Bristol Bay. A navigation improvement to increase access to Williamsport and enhance the transfer of cargo would significantly reduce transportation cost for cargo and fishing vessels.

This report documents a detailed study of these problems and alternative solutions. The report recommends excavation of a channel 2,700 meters (m) long in Iliamna Bay. The channel bottom would be 30 m wide at 0.5 m below Mean Lower Low Water (MLLW). The channel would end at Williamsport with a turning basin, 55 m long and 55 m wide. The turning basin would provide access to a recommended sheet-pile bulkhead dock, 30 m long, and an adjacent paved launch ramp 8 m wide. These features would save an average $1,525,300 each year in transportation and related costs. The recommended plan would cost $3,822,000 to construct and an average $185,000 per year to maintain. This maintenance cost includes annual grading of the dock, ramp, and staging area; annual surveys the first 4 years, then every 5 years; maintenance dredging every 5 years; replacement of fender piles, ramp concrete, and sheet-pile cathodic protection every 10 years; and replacement of the sheet pile after 30 years. Average annual benefits exceed average annual costs by a ratio of 3.1 to 1.

Pertinent Data

Navigation Improvements in Iliamna Bay at Williamsport, Alaska

Geometric Characteristics of the Recommended Plan

Channel length	2,700 m
Channel width	30 m
Channel bottom elevation	-0.5 m MLLW
Channel excavation quantity	129,825 m^3
Turning basin length	55 m
Turning basin width	55 m
Turning basin bottom elevation	-0.5 m MLLW
Basin excavation quantity	11,875 m^3
Dock face length	30 m
Dock wing wall length at ramp	44 m
Dock surface elevation	7.0 m MLLW
Launch ramp width	12 m (8 m paved)
Launch ramp paved length (on 15% slope)	40 m
Staging area adjacent to dock and ramp	0.4 hectares

Construction Costs of the Recommended Plan

Features	Federal	Non-federal	Total
Channel and turning basin	$1,651,400	$406,600	$2,058,000
Dock, ramp, and staging area	0	1,724,000	1,724,000
Aids to navigation[1]	40,000	0	40,000
Total NED costs[2]	$1,691,400	$2,130,600	$3,822,000

NED investment cost (including interest during design and construction)	$3,920,600
Equivalent annual NED investment cost (7.625 %/year, 50 years)	$306,700
Average annual NED maintenance cost	185,000
Total average annual cost	$491,700
Average annual NED benefits	$1,525,300
Net annual NED benefits	$1,033,600

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[1] Designed, constructed, and maintained by the U.S. Coast Guard.

[2] National Economic Development costs (must be offset by NED benefits for feasibility).

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Conversion Factors

SI (METRIC) TO ENGLISH (INCH-POUND) UNITS OF MEASUREMENT

SI (metric) units of measurement are used in this report. These can be converted to English units as follows:

Multiply	By	To obtain
Celsius degrees	9/5	Fahrenheit degrees*
centimeters	0.3937	inches
cubic meters	1.30794	cubic yards
kilograms	2.2046	pounds
kilometers	0.5399	miles (nautical)
kilometers	0.6214	miles (U.S. statute)
meters	3.281	feet
meters	1.0936	yards

* To obtain Fahrenheit (F) temperature readings from Celsius (C) readings, use the following formula: $F = (9/5)(C + 32)$.

Glossary

ABBREVIATIONS, ACRONYMS, AND TECHNICAL TERMS

ADF&G = Alaska Department of Fish and Game
ADOT&PF = Alaska Department of Transportation and Public Facilities, a State agency
cm = centimeter(s)
ER = Engineering Regulation
ha = hectare(s)
km = kilometer(s)
L = liter(s)
m = meter(s)
mm = millimeter(s)
NED = National Economic Development; a measure of change in the economic value of the national output of goods and services resulting from a project
NEPA = National Environmental Policy Act (of 1969)
NOAA = National Oceanic and Atmospheric Administration
P.L. = Public Law
s = second(s)
USFWS = U.S. Fish and Wildlife Service

Acknowledgments

The investigations summarized in this report were conducted by the staff of the Alaska District, U. S. Army Corps of Engineers, Anchorage, Alaska; contractors of the Alaska District; and the staff of the Alaska Department of Transportation and Public Facilities (ADOT&PF), Coastal and Harbor Engineering Section in Anchorage. The U.S. Fish and Wildlife Service analyzed the potential environmental effects of proposed works at Williamsport, as required by law. The Principal Investigator was Dr. Orson P. Smith of the Project Formulation Section in the Alaska District's Civil Works Branch, Engineering Division.

The study began with an intensive effort to take advantage of extreme high tides predicted for May 19-29, 1994. Access to the site by landing craft from the sea is limited to the highest portions of spring tides, after ice has left Iliamna Bay in early May. The first spring tides of the ice-free season offered a unique opportunity to accomplish surveys and other field measurements before commercial uses of the site interfered. Round-the-clock work was necessary, which required field personnel to stay in tent accommodations operated by the 23d Engineer Company of Fort Richardson, Alaska. This unusual mission, which became known as the Williamsport Field Measurement Expedition, was successfully accomplished by the extraordinary cooperation and hard work of many people representing a wide range of agencies and technical disciplines. An account is provided in Appendix D, Journal of the Williamsport Field Measurement Expedition.

Contributions to the Williamsport feasibility study were provided through contracts with LCMF, Ltd. (hydrographic surveys, tide measurements, and mapping); Golder Associates, Inc. (geophysical measurements and analysis); and Dr. Bruce Finney, University of Alaska Fairbanks, Institute of Marine Science (radioisotope dating of sediments and sedimentation rate analysis).

Primary contributors to this report from the Alaska District's Civil Works Branch, besides Orson Smith, were Carolyn Rinehart, writer/editor, Project Formulation Section; Janis Kara, economist, Economics Section; Lizette Boyer and Deborah McCormick, biologists, Environmental Resources Section; and James Fuhrer, engineering technician, and David Mierzejewski, civil engineer, Hydraulics and Hydrology Section. Other Alaska District primary contributors were Charles Wilson, civil engineer, and Barbara Reilly, chemist, Geotechnical Branch; Melvin Zimmermann, engineering technician, Cost Engineering Branch; and Linda Arrington, realty specialist, Real Estate Division.

Pat Beckley, Central Region Harbors Planner for the ADOT&PF, coordinated the execution of the Feasibility Cost Sharing Agreement through which this study was accomplished and provided funds management assistance throughout the project. Harvey Smith, Statewide Coastal Engineer and Chief of the Coastal and Harbors Engineering Section of the ADOT&PF, participated in field measurements and analyses and designed shore facilities associated with the channel improvements proposed in this report. Both

Mr. Beckley and Mr. Smith reviewed the complete report in its draft form and provided useful comments.

These investigations were conducted under the direction of Claude Vining, Chief of Engineering Division; Kenneth Hitch, Chief of Civil Works Branch; Carl Stormer, Chief of Project Formulation Section; Carl Borash, Chief of Hydraulics and Hydrology Section; Andrew Miller, Chief of Economics Section; and Guy McConnell, Chief of Environmental Resources Section. Colonel Peter A. Topp was Commander and District Engineer of the Alaska District during this study.

NAVIGATION CHANNEL FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT: WILLIAMSPORT

1. Introduction

1.1 Study Authority

The investigations summarized in this report were undertaken through the authority of Section 107 of the River and Harbor Act of 1960 (Public Law [P.L.] 86-645), as amended. This law gives the Corps of Engineers continuing authority to undertake planning, design, and construction of navigation projects where Federal costs do not exceed $4,000,000. The requirements for review and funding are less stringent than for projects specifically authorized by Congress. The law allows Federal expenditures up to $4,500,000 for post-construction maintenance, or 2.25 times the Federal cost for planning, design, and construction, whichever is greater. Other legal requirements still apply, such as those in the National Environmental Policy Act of 1969 (P.L. 91-190), as amended, and various other laws and associated Federal regulations concerning environmental quality.

1.2 Federal Interest

The Federal interest in public works for navigation is derived from the commerce clause of the U.S. Constitution and is limited to the navigable waters of the United States. Federal navigation improvements on those waters must be justified as being in the general public interest and must be open to the use of all on equal terms. Improvements such as channels, jetties, breakwaters, locks, dams, maneuvering basins, and ice control measures may be eligible for Federal participation as general navigation features of waterway projects. Special navigation works may also be in the Federal interest, such as removal of wrecks or obstructions, snagging and clearing for navigation, or drift and debris removal. Facilities to accommodate vessels or load and unload cargo and passengers, such as docks, ramps, or floats, are the responsibility of non-Federal interests. This is so even though these facilities may be necessary to achieve the benefits of the Federal project.

Design and construction of aids to navigation, such as buoys, ranges, lights, or channel markers, are the responsibility of the U.S. Coast Guard.

1.3 Federal Policies and Procedures

The Corps of Engineers must follow administrative policies expressed in various Engineering Regulations (ER's) and other Department of the Army memoranda. The most pertinent of these regulations is ER 1105-2-100, "Guidance for Conducting Civil Works Planning Studies." This regulation summarizes and interprets relevant statutes, congressional resolutions, executive directives, and other regulations regarding studies of this type and the criteria that must be applied in them.

Prospective projects must be evaluated for their economic feasibility and environmental acceptability as well as for their engineering soundness. The Water Resource Council's publication *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* is used in these evaluations. Economic feasibility is determined by evaluating the National Economic Development (NED) benefits of the project alternatives. Chapter II of the Principles and Guidelines, "National Economic Development Benefit Evaluation Procedures," is used for this purpose. Economic feasibility is established if, within these guidelines, the NED benefits achieved by a solution fully offset the long-term costs of its implementation.

Environmental evaluation of proposed navigation improvements must follow Chapter III of the Principles and Guidelines, "Environmental Quality (EQ) Evaluation Procedures," as well as other Federal, State, and local statutes and regulations. Requirements of the National Environmental Policy Act of 1969 (NEPA), as amended, prevail in these considerations. This report includes an Environmental Assessment, which cites the full range of other laws, regulations, and policies which apply.

1.4 Reconnaissance Study Findings and Conclusions

A federally funded preliminary reconnaissance study was initiated in January 1992 in response to a letter dated October 9, 1991, from Mr. John S. Tolley, Chief of Planning and Administrative Services for the Alaska Department of Transportation and Public Facilities (ADOT&PF), Central Region. The "Preliminary Reconnaissance Report for

Navigation Improvements, Williamsport, Alaska," was completed in December 1992. This report was refined following review by the Corps' North Pacific Division (Portland, Oregon), and a "Reconnaissance Report for Navigation Improvements, Williamsport, Alaska," was published in July 1993.

This reconnaissance study found a Federal interest in navigation improvements at Williamsport and concluded that their feasibility should be investigated further. The Kenai Peninsula Borough, with financial assistance from the State of Alaska, was shown to be a qualified and willing non-Federal sponsor. A cost-shared feasibility study was recommended based on the apparent economic feasibility and environmental acceptability of dredging a shallow-draft channel, 8 feet deep and 100 feet wide, with a steel sheet-pile barge landing at its shoreward end. The reconnaissance estimated that this alternative would cost about $2.4 million to construct and have a benefit-to-cost ratio of 1.3.

1.5 Sponsorship

The Water Resources Development Act of 1986 (P.L. 99-662), as amended, specifies that a non-Federal sponsor must agree to the scope and schedule of feasibility studies for navigation projects undertaken by the Corps. The act further specifies that the sponsor must pay half the study cost. A maximum of half the sponsor's cost share may be in-kind contributions to the study. An "Agreement between the United States of America and the Kenai Peninsula Borough for Navigation Improvements at Williamsport on Iliamna Bay, Alaska - Feasibility Study" was executed on April 4, 1994. The ADOT&PF provided funds to the Kenai Peninsula Borough for the non-Federal share of the study cost. The ADOT&PF also provided significant in-kind contributions to the field data collection, data analyses, and design of project features.

1.6 Coordination With Public and Private Interests

This coordination was continuous throughout the feasibility study in the form of correspondence and personal communications between the principal investigator, other study participants, the non-Federal sponsor, the ADOT&PF, and various public and private interests. Appendix E includes correspondence related to coordination with public and private interests. The Environmental Assessment (appendix 2) includes correspondence related to protecting the environment.

Section 2. Physical Setting

2.1 Geography

Williamsport is located in southwestern Alaska, 265 kilometers (km) southwest of Anchorage, on the western shore of Iliamna Bay in Cook Inlet, as indicated in figure 1. Iliamna Bay is approximately 120 km west of the town of Homer at the mouth of Kachemak Bay. Iliamna Bay is approximately 11.3 km long from its northern extreme to its mouth on the larger Kamishak Bay off western Cook Inlet (figure 2). Williamsport is situated at the mouth of Williams Creek at the western head of an arm of upper Iliamna Bay, herein named "Williamsport Bay." Williamsport Bay and Iliamna Bay are surrounded by cliffs and rocky buttresses of the Chigmit Mountains of the Aleutian Range, which rise 600 to 1,000 m within a kilometer of the shore.

Williamsport has no permanent occupants, residences, or other buildings at present, though these have existed in years past. (See section 3.) The site can be reached by sea only with significant difficulty by shallow-draft vessels, due to the shallow approaches in upper Iliamna Bay. Williamsport is located at the eastern terminus of the 25-km-long, one-lane, unpaved Williamsport-Pile Bay Road (figure 2), owned and maintained by the State. This road connects Cook Inlet at Williamsport to Iliamna Lake at the small settlement of Pile Bay. Pile Bay lies on the eastern shore of Iliamna Lake near the abandoned village site of Old Iliamna. The road is used for transshipment of cargo bound for Iliamna Lake and its tributaries, or through Iliamna Lake and the Kvichak River to Bristol Bay communities. Pile Bay is occupied seasonally by employees and guests of the Pile Bay Lodge, which has a dock and ramp suitable for barges, boats, and float planes that navigate Iliamna Lake.

Iliamna Lake is a natural lake, approximately 120 km long and 32 km wide, on the Alaska Peninsula between Cook Inlet and Bristol Bay (figure 1). Iliamna Lake is the largest lake in Alaska. The lake is of glacial origin, with glacial moraines at its boundaries. The lake empties into the Kvichak River, which flows into eastern Bristol Bay near Naknek and King Salmon.

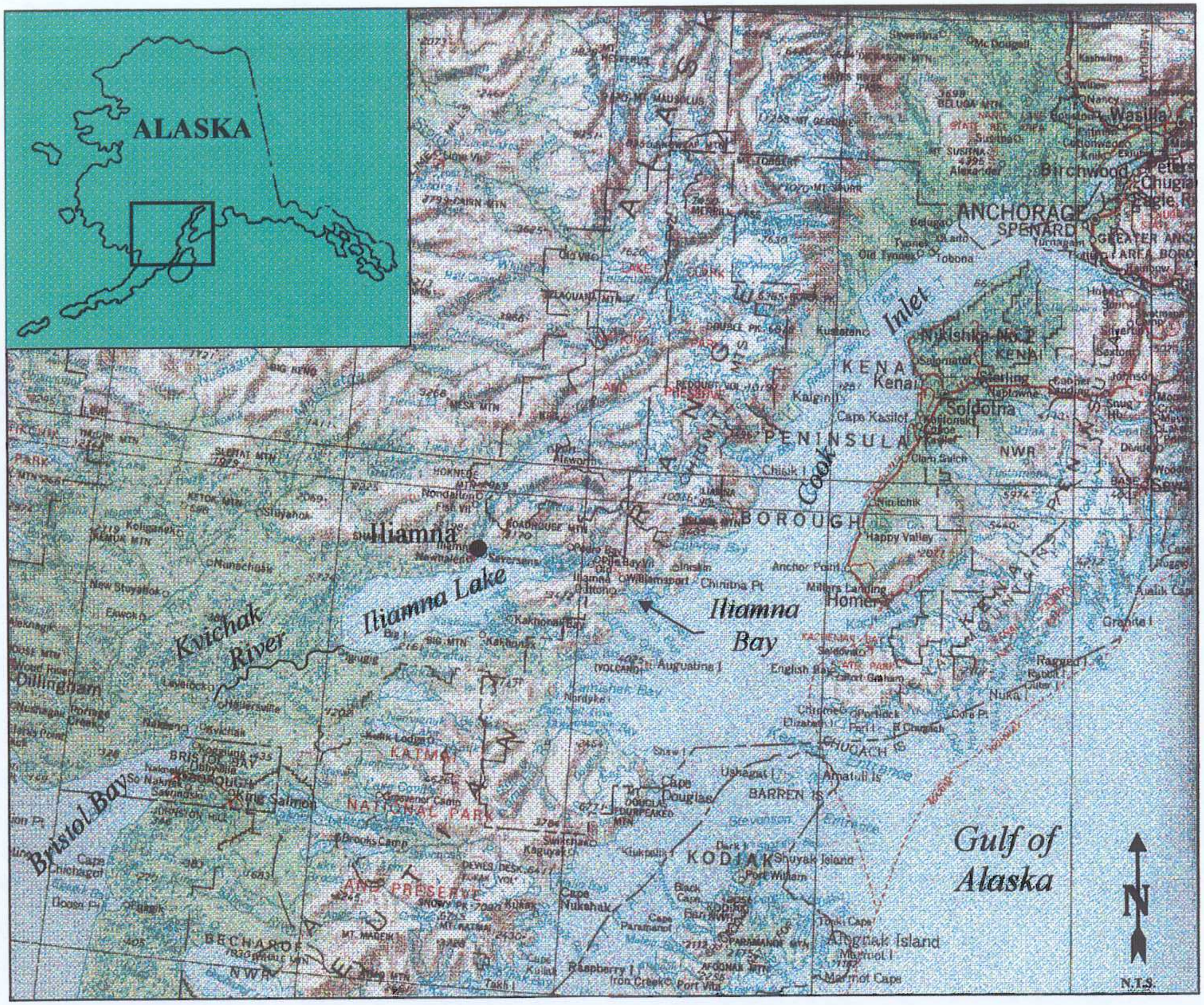


FIGURE 1.--Southcentral and southwestern Alaska.

FIGURE 2.--Iliamna Bay and vicinity.

The villages of Iliamna, Newhalen, Pedro Bay, Kakhanok, and Igiugig lie along the shore of Iliamna Lake. Iliamna, on the north shore of the lake, is the air freight transshipment center for Iliamna Lake communities, both by air and by water. The village of Nondalton is 24 km north of Iliamna on the Newhalen River. A gravel road traverses the 15 km to Nondalton, and freight is transshipped by water from the road terminus to Nondalton. An 8-km gravel road leads west from Iliamna to Newhalen at the mouth of the Newhalen River. Igiugig is located at the lake outlet on the Kvichak River. Kakhonak is located on the south shore of the lake. These villages are all accessible by small float-planes and wheel-planes, but have no roads to major economic centers. Freight is also distributed to communities around Iliamna Lake by Moody's Barge Service, which brings Seattle freight up from Bristol Bay via the Kvichak River.

2.2 Climate

Iliamna Bay has a maritime climate, while the weather on Iliamna Lake is tempered by interior conditions. The Chigmit Mountains over which the Williamsport-Pile Bay Road passes separate Iliamna Lake from the precipitation extremes of Williamsport Bay and Iliamna Bay. During visits to the site in 1993 and 1994, it was common to find sunshine on Iliamna Lake and low clouds and rain at Williamsport. This pronounced orographic effect is indicated by the average annual precipitation trends in figure 3. Annual precipitation on the western side of lower Cook Inlet is greater and more consistent than on the east side. Moist southerly winds are directed up the inlet between the bordering eastern and western mountains. These winds cool as they rise on striking the mountains north of Kamishak Bay and release their moisture as precipitation.

A meteorological station operated intermittently from 1955 to 1961 just beyond the mouth of Iliamna Bay, approximately 24 km from Williamsport on the north shore of Kamishak Bay. This station, known as the Iniskin station, recorded an average annual precipitation of 186 centimeters (cm) of water, including an average annual snowfall of 478 cm. The first snowfall was usually in October. The average snowfall in Homer, on the eastern shore of Cook Inlet opposite Iliamna Bay, is 135 cm.

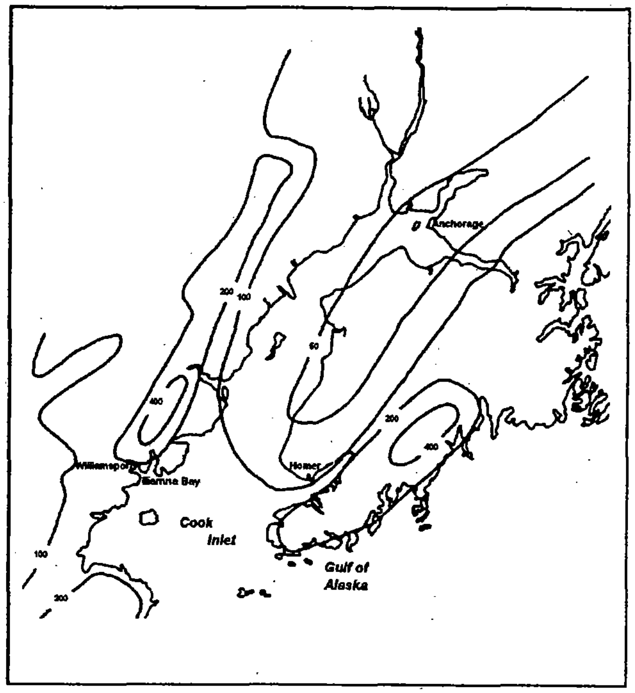


FIGURE 3.--Average annual precipitation in the Cook Inlet region in cm of water (Gatto 1976).

Weather records at the village of Iliamna on Iliamna Lake indicate average summer temperatures from 6° to 17 °C and winter temperatures from -14° to -1 °C. The record high temperature is 33 °C, and the record low is -44 °C. Average annual precipitation at Iliamna is 67 cm of water, including an average annual snowfall of 163 cm.

A meteorological station was operated from 1960 to 1975 at Intricate Bay on Iliamna Lake at an elevation of 40 m above sea level about 16 km southwest of Pile Bay. Records from this station indicate an average November depth of snow on the ground of 25 cm and a maximum of 61 cm. The highest point on the Williamsport-Pile Bay Road is about 370 m above sea level and will have more severe snowfall, both because of its elevation and because it is nearer Williamsport. The road is usually judged to be impassable by about mid-November, based on accounts of knowledgeable local residents and the range of conditions measured at surrounding geographical points.

2.3 Geology

Williamsport and Iliamna Bay are located at the southern end of the Chigmit Mountains at the northern extreme of the Aleutian Range, near its confluence with the southern extreme of the Alaska Range. The terrain surrounding Williamsport is underlain by granitic and metamorphic rocks of the Mesozoic Age (70 to 220 million years ago), with localized occurrences of igneous (volcanic) rock. Faults and fractures are prominent structural features in the vicinity of Iliamna Bay. The Bruin Bay fault system, including the Bruin Bay Fault and related parallel faults, runs diagonally along the east coast of the Alaska Peninsula (*i.e.*, the west shore of Cook Inlet). The region is tectonically active, although the portion of the Bruin Bay Fault in the Iliamna Bay area is not known to have been active during the Quaternary Period (last 1 million years; see appendix C, part 2).

Reports following the 1964 earthquake (Wilson and Tørum 1968) indicate suspicion of uplift on the western shore of Cook Inlet, but no measurements have yet confirmed this.

The region was heavily glaciated during the late Pleistocene Epoch (10,000 years to 1 million years ago), when large glaciers from the Chigmit Mountains flowed eastward across the present day Cook Inlet. Subsequently, these ice masses thinned, separated, and eventually receded into their upland source areas. Marine waters invaded this part of Cook Inlet as early as 16,500 years ago. Surface deposits are primarily the result of glaciation, with subsequent modification by glacio-fluvial, lacustrine, and marine processes. Elevated marine beach deposits and wave-cut bedrock platforms along the west coast of Cook Inlet indicate that the coast is rebounding from the weight of the glaciers at a rate of about 0.6 meters per century.

Geophysical measurements and samples of surface and subsurface materials at Williamsport and in Iliamna Bay, taken as a part of this study in May 1994 (see appendixes C and D), reveal Iliamna Bay to have silt and clay marine deposits overlying glacio-fluvial deposits of mixed sand and gravel. The gravelly subgrade is exposed along natural tidal drainage channels in Williamsport Bay. Away from tidal drainage channels, the silt overburden is 2 to 4 meters thick. The glacio-fluvial subgrade appears continuous in Williamsport Bay to depths of 40 to 70 meters, where geophysical measurements indicate a sharp change which may be interpreted as bedrock. Figure 4 illustrates the geophysical findings from the existing roadhead at Williamsport for the first 500 meters offshore along the center of Williamsport Bay. The upland area in the immediate vicinity of the roadhead is grass-covered sand, gravel, and silt, with bedrock 30 to 40 meters below.

Radioisotope dates of organic material taken from cores of the silt overburden on the tidelands of Williamsport Bay (see appendix C, part 4) indicate a long-term rate of silt accumulation on the order of 0.2 cm per year. Water samples taken at high tide at the shore of Williamsport Bay at Williamsport have suspended sediment concentrations of 20 to 70 mg/L. Median grain sizes of the suspended sediments were consistently on the order of 0.06 millimeters (mm), which is classified as silt. These samples were taken after a severe storm, which had delayed the start of field measurements by 2 days, and during extreme spring tides. These suspended sediment concentrations probably represent an extreme condition.

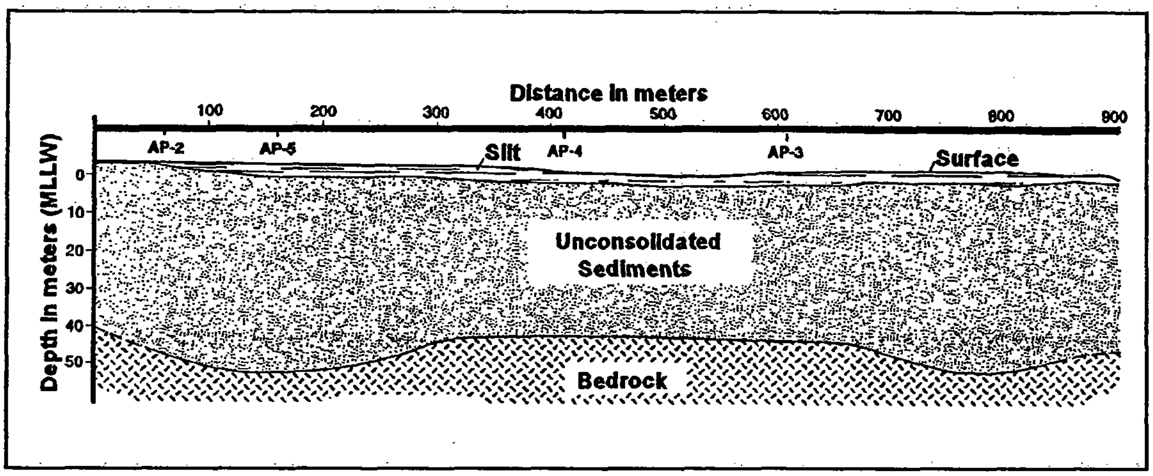


FIGURE 4.--Geophysical measurement results along the center of Williamsport Bay. Distance is measured seaward from the existing dock at Williamsport.

Surface sediment samples were tested for concentrations of potential chemical contaminants with a view toward dredging and open-water disposal of the dredged material. No contaminants were detected consistently or in concentrations not attributable to contamination of the samples during handling in the field or laboratory. All of these 15 samples were 62 to 75 percent solids and were classified as silt with some sand content. The sediment was found to satisfy all criteria for disposal in open water as defined by the Tier II Criteria (USEPA 1991).

The exposed tidelands have scattered large boulders protruding from the silty flats. These boulders have either rolled down from the surrounding mountain slopes or have been rafted there by winter ice. Cobbles and boulders may also be buried at scattered locations through these same processes. Most boulders are located near the margins of the bay, supporting the idea that they rolled there from the adjacent mountain slope. A few larger boulders are farther out in the bay, but none were detected within 50 m of the primary natural tidal drainage channel. The chance that buried boulders exist in the central area of the bay is small, but not negligible. Figure 5 is a panoramic mosaic of low tide photographs taken in May 1994, which shows the meandering tidal drainage channel from Williams Creek, the silty surface of the tidelands, and the valley with Williamsport and the road in the distance.

FIGURE 5.--Panoramic view of Williamsport Harbor. (Photos by Charles Wilson)

2.4 Oceanography

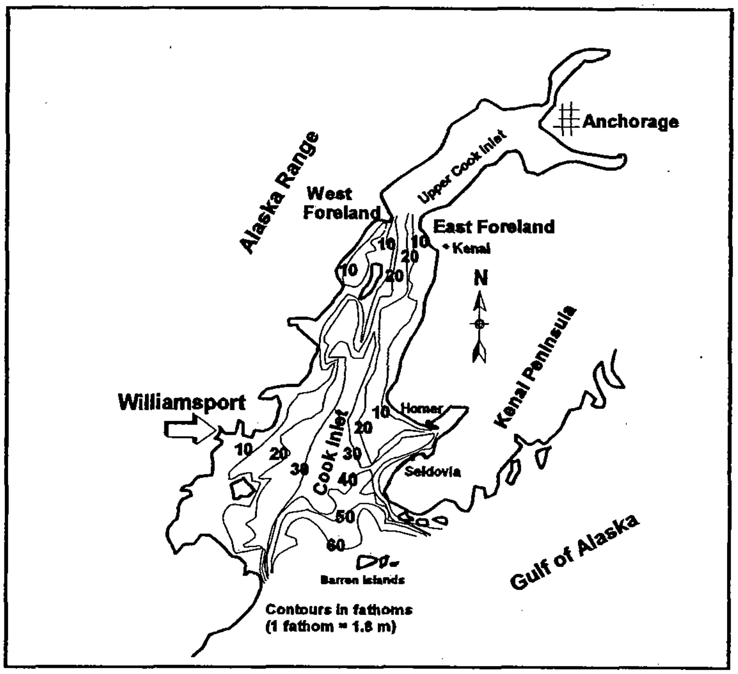


FIGURE 6.--Bathymetry of lower Cook Inlet.

Cook Inlet is a 320-km-long estuary which generally lies on a northeast-southwest axis and opens on the northcentral margin of the Gulf of Alaska (figure 6). The inlet narrows from more than 90 km wide at its mouth at latitude 59 °N., longitude 152 °W., to 22 km at its division into Turnagain and Knik Arms at Anchorage (latitude 61° 10' N., longitude 150° 20' W.). Cook Inlet is divided into upper and lower portions by the 16-km wide constriction at the Forelands (latitude 60° 43' N).

Upper Cook Inlet is heavily influenced by the discharge of major rivers, including the McArthur, Beluga, Susitna, Little Susitna, Matanuska, and Knik, and a number of smaller streams on Turnagain Arm. Average central depths in Upper Cook Inlet steadily decrease from about 40 m near the Forelands to 20 m near the divergence of Knik and Turnagain Arms. Upper Cook Inlet is renowned for its high tidal ranges, which can exceed 13 m at Anchorage. Reversing 4-knot tidal currents erode glacial deposits of beaches and bluffs along Upper Cook Inlet shores and resuspend fine material from complex systems of shoals, adding to sediment influx from rivers to create suspended sediment concentrations regularly in excess of 1,000 mg/L.

Lower Cook Inlet widens north of the Barren Islands at Kachemak Bay on the east and Kamishak Bay on the west (figure 1). Kamishak Bay is roughly triangular, extending approximately 75 km across its mouth on Cook Inlet and 55 km westward at its widest point at the south. The active volcano on Augustine Island is located at the center of Kamishak Bay. Iliamna Bay, where Williamsport is located, opens onto the northern margin of Kamishak Bay. Average depths in central Cook Inlet near the Barren Islands range from 130 m to 160 m from east to west. Central depths decrease to 90 m, on average, just south of the mouths of Kachemak and Kamishak Bays. Central depths then diminish to an average of about 50 m just south of the Forelands. The northern half of Lower Cook Inlet is split by a major shoal system extending north and south from 21-km-long Kalgin Island.

Permanent circulation patterns have a counterclockwise trend in Lower Cook Inlet (figure 7), which is typical of estuaries in the Northern Hemisphere. Influx of ocean water from the Gulf of Alaska is dominated by flow through the Kennedy Entrance east of the Barren Islands at the mouth of the inlet. The relatively rapid decrease of depth past the entrance causes upwelling of nutrient- and plankton-rich Gulf of Alaska water opposite the mouth of Kachemak Bay, which accounts in part for the exceptional biological productivity of that area. The general trend of entering water concentrated on the east and exiting water concentrated on the west continues north to the Forelands. Tidal ranges in lower Cook Inlet vary from 4 to 6 m, increasing northward. Rotary tidal currents with maximum speeds of 2 to 3 knots are typical. A consequence of the net circulation pattern, which is in effect superimposed on the tidal flows, is that suspended sediment from Upper Cook Inlet and sediments eroded from the western shore are concentrated in suspension along the western side of the Inlet. These concentrations steadily diminish from the Forelands south, but are still significantly higher on the west side of Cook Inlet at Kamishak Bay than on the east side at Kachemak Bay.

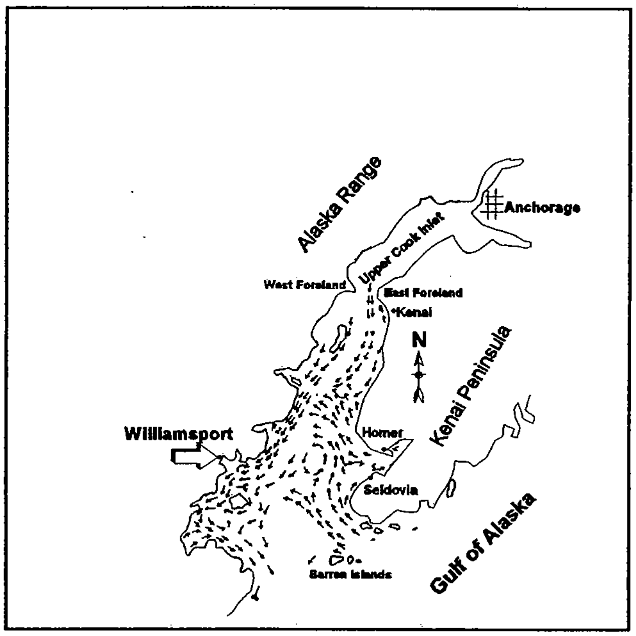


FIGURE 7.--Trends of net circulation in lower Cook Inlet.

Salinity is the mass of dissolved solids per unit mass of seawater, which can be measured in parts per thousand (ppt, or grams of dissolved solids per kilogram of seawater). Salinity at the mouth of Cook Inlet varies from 27 to 32 ppt (WAPORA 1979). Salinities near Anchorage in Upper Cook Inlet vary from 6 to 12 ppt and significantly vary with season and freshwater streamflow. The salinities in lower Cook Inlet range between these values, generally decreasing along the inlet northward, across the inlet westward, and downward from the surface to the bottom. Salinities measured in Iliamna Bay in May 1994 (figure 8) were on the order of 19 ppt for most of the water column. Freshening in the upper meter to about 12 ppt was the stratification effect of recent heavy rain. Water temperatures measured at the same time were uniform with depth at 5 °C. These measurements indicate Iliamna Bay water is fairly typical of lower Cook Inlet water on the western side, with intermittent shallow stratification from recent rainfall and associated rapid runoff from the rocky, mountainous slopes surrounding the bay.

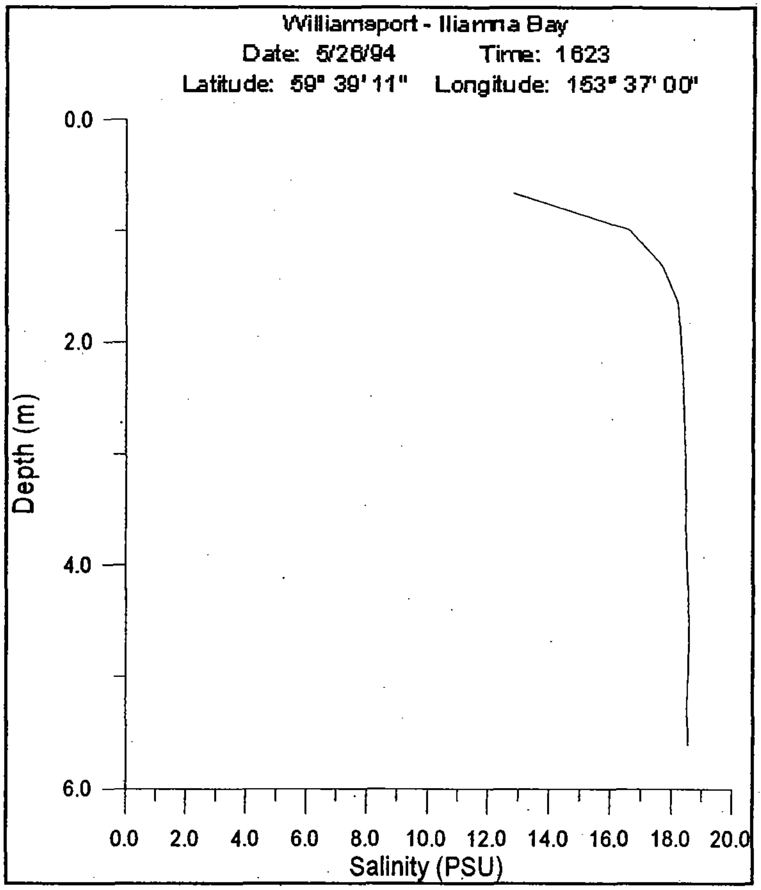


FIGURE 8.--Salinity profile in upper Iliamna Bay 1 hour after high tide. (Note: PSU or practical salinity units are equivalent to parts per thousand.)

Tidal ranges in Iliamna Bay have a mean range of 3.8 m and a diurnal range of 4.4 m, with extremes exceeding 5.0 m. The amplitude, phase, and datum of predicted tides for Seldovia were modified so predictions matched observations at Iliamna Bay as closely as possible. Figure 9 shows tides predicted for May 15 to November 15, 1994. This is the practical navigation season in Iliamna Bay, as constrained by snow on the Williamsport-Pile Bay Road and ice conditions in Iliamna Bay. These predicted tides have a mean water level of 1.9 m above mean lower low water (MLLW). The figure demonstrates the dramatic diurnal inequality and exceptional variability of the tides in Iliamna Bay.

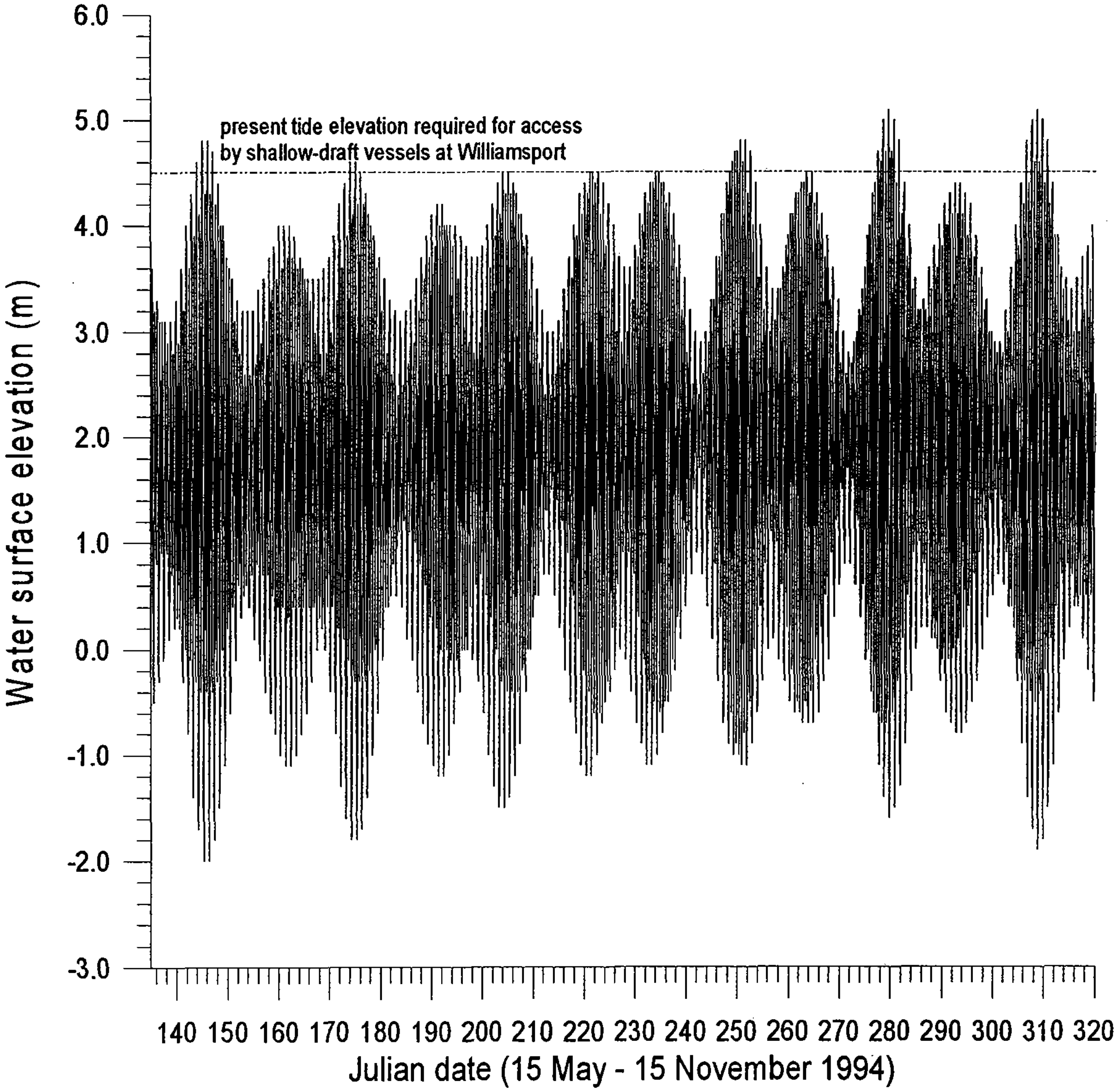


FIGURE 9.--Predicted tides in Iliamna Bay near Williamsport.

Figure 10 shows the exceedance of various water levels in Iliamna Bay. Predicted hourly tides for Iliamna Bay were compared with water levels measured in outer Iliamna Bay from July 13 to August 20, 1994. An estimate of shallow water currents driven by the slope of the tidal wave (Manning's equation) indicates average maximum tidal currents are about 1 knot, which is consistent with May 1994 observations.

2.5 Living Resources

The purpose of this subsection is to provide a general picture of the study area and to suggest how its unique and pristine wildlife, human communities, and spectacular natural environment could contribute to future economic activity. Such background information is important when considering the area's potential ability to support the proposed project. The subsection is not intended to present detailed facts about the environment of the project site. This material is in the Environmental Assessment.

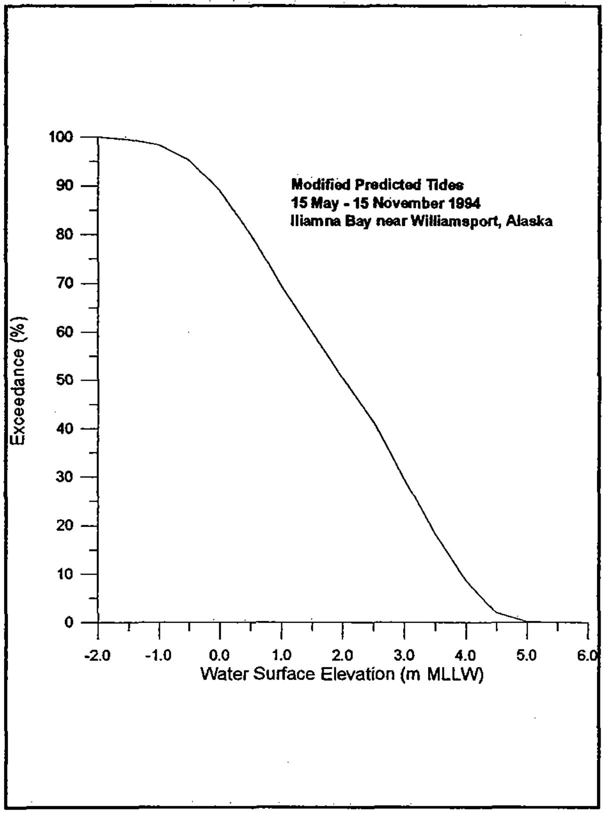


FIGURE 10.--Exceedance of hourly water levels during 1994 in Iliamna Bay near Williamsport.

Williamsport, with no permanent occupants or residences, is situated at the mouth of Williams Creek and is surrounded by cliffs and rocky buttresses of the Chigmit Mountains. The Williamsport-Pile Bay Road connects Cook Inlet to Iliamna Lake, which has six mostly Native villages on its shores or nearby. These six settlements are otherwise isolated from any road system. The area has several long-established lodges for fishermen, hunters, and sightseers. Iliamna Lake empties into the Kvichak River, which in turn flows into the Bering Sea at Bristol Bay. The Kvichak drainage is the most important spawning and rearing habitat for sockeye salmon in the world.

Eastern Iliamna Lake supports one of the world's few freshwater colonies of harbor seals. Seals swim between the lake and Bristol Bay, though some remain in the lake year-round. Beluga whales are also seen in Iliamna Lake. Sport fishing in the lake and the surrounding rivers is first-class for five salmon species, Dolly Varden, and huge rainbow trout. The Alaska Board of Fisheries has designated the Kvichak-Alagnak watershed (including the lake) as a Wild Trout Area, where catch-and-release regulations are the general rule.

Hundreds of thousands of waterfowl, on their way to and from northern nesting areas, stop on the tundra, lakes, and intertidal areas of Bristol Bay and Lake Iliamna in both spring and fall. The Kvichak River is a major migration corridor for sandhill cranes and whistling swans. Loons and Canadian geese also rest, nest, and molt in the area. Shore birds are attracted to the same aquatic habitats as the waterfowl.

During spring and summer, brown bears concentrate along salmon streams near Iliamna Lake. Bears move to coastal and subalpine areas after emerging from their dens in April or May and return to higher altitudes for berries in late summer. The bears enter their dens on the upper slopes in early winter.

Moose concentrate year-round in the area. The Mulchatna caribou herd ranges over an area generally north of Iliamna Lake and west of the Alaska Range. The herd disperses in late summer and early winter; in late winter and early spring the animals begin to gather, moving toward the calving grounds near Lake Clark and the Mulchatna River.

The country surrounding Lake Iliamna supports a number of fur-bearing and small game animals. Mink, beaver, muskrat, and land otter are found in or near water. Lynx and red squirrels live in upland forests. Wolverine are distributed throughout the area. Wolves roam the region in packs of 2 to 30.

3. Human History, Demography, and Government

3.1 Early History

The Williamson-Pile Bay Road, once known as the Iliamna portage, was pioneered by Native Americans traveling between Cook Inlet and the Bristol Bay region. People probably have been using the portage for thousands of years. The historical synopsis that follows was condensed from an article by John Branson, a ranger and historian at the nearby Lake Clark National Park and Preserve (Branson 1993).

According to an 86-year-old Iliamna Native elder, the portage was originally a brown bear trail. Bears harvested spawning salmon until mid-August on the Cook Inlet coast and then walked over into the Iliamna River drainage to fatten up on red salmon before seeking denning sites in late October and early November.

Archeologists believe the Dena'ina Athabascan people have used the portage since they came into the region, about 200-300 years ago. A Russian, Filipp Kashevarov, wrote in a journal of his trip over the passage in 1797 that they used it "ceaselessly, going in both directions." How long other Natives used the portage before that is not certain, because the region has had little archeological investigation. Aleut or Dena'ina guides introduced the Russians to the portage, probably in the late 1780's.

Russian missionaries and explorers brought the Orthodox faith and goods like tea, sugar, axes, needles, beads and cooking pots into the upper Bristol Bay region via the Iliamna Portage during the late 18th century and well into the 19th. The western end of the portage was then located at the village of Old Iliamna, on the Iliamna River near where the river flows into Iliamna Lake. Some historians believe this was the site of a small Russian trading fort, or odinochka, built around 1790 by the Lebedev-Lastochkin Company. About 10 years later the Dena'ina destroyed the fort because of the many crimes of murder, hostage-taking, and cheating they had suffered at the hands of the Lebedev-Lastochkin men. By 1820 the Russians had reestablished themselves in the area, this time apparently with a more benign policy toward the Dena'ina.

The first American reference to the portage occurred in 1869, two years after the United States purchased Alaska from Russia. George Davidson of the U.S. Coast Survey wrote: "At the head of this bay (Iliamna, on Cook Inlet) is a factory of the Russian American Company from which a trail leads about seven miles through a gap in the mountains, to a series of mountain lakes (Summit Lake), discharging within a distance of 15 miles into the great lake of Iliamna."

Soon after that, the Alaska Commercial Company built a post on Cook Inlet about 5 miles south of the head of Iliamna Bay. The place became known as A.C. Point. In the late 1800's and early 1900's, Dena'ina people from the Iliamna region would hike over the portage to trade for manufactured goods at A.C. Point. Once at the head of the bay (now Williamsport), they would take their canoes, or *baidarkas,* the few miles to the point. The baidarkas could be carried across the Iliamna portage. Later, Euroamericans used commercial fishing vessels to haul people and freight from A.C. Point to the start of the portage.

As the 20th century progressed, more and more Euroamericans entered the Iliamna-Lake Clark area seeking valuable minerals, furs, and access to the rich Bristol Bay salmon fishery. In 1902, Wilfred Osgood of the U.S. Biological Survey wrote that pack horses could easily traverse the portage. U.S. Geological Survey crews mapped the trail in 1909 (Brown 1994). Horses and dogsleds were the preferred means of hauling freight over the trail until the World War I era.

During World War I, local interest grew in improving the portage so that wagons and trucks could haul cargo across it. John Zug of the Federal Board of Road Commissioners investigated the portage in 1916 and recommended that a road be built along the trail. The first work was done in 1917, when a crew of eight men improved 9-1/2 miles of trail from the Cook Inlet end. More work was done in 1921, but inspectors reported in 1924 that the route still was not suitable for wagons. The Alaska Road Commission improved the road in 1927 so that horse-drawn wagons could use it. By 1932, small trucks began running over the portage. In 1937 the western terminus was moved from the Iliamna River to Pile Bay on Lake Iliamna, allowing bigger boats direct access to the lake.

3.2 Recent History

Carl Williams came to Alaska from upstate New York in 1934 and took over maintenance and freighting on the Iliamna portage in 1935 for the Alaska Road Commission. He bought property for his home at Williamsport in 1935. He and his brother Lyle started a freighting business, with Carl at Williamsport and Lyle at Pile Bay. Carl brought his bride, Wilma, up 2 years later; they raised five children. Lyle Williams was crushed by heavy equipment in 1944 while grading the road (Brown 1994). Carl moved cargo over the road and maintained it for 40 years, eventually working for two successors of the road commission, the Bureau of Public Roads and, after statehood, the Alaska State Highway Department (Branson 1993).

In 1946 the Williams family moved to Pile Bay, where there was an elementary school. By the mid-1950's, they decided to spend their winters at Anchor Point so the oldest children could attend high school. In 1966 the Williams home at Williamsport, then vacant, was destroyed by an explosion of dynamite stored in an adjacent building (Brown 1994). Carl Williams retired in 1975.

That same year his youngest son, Ray, took over for him. Ray Williams has been working as a private contractor hauling freight and maintaining the road since 1979. He, his wife Linda, and their two children spend summers at their Pile Bay lodge and winters in Anchor Point. His busiest time is in mid-June, when he trucks from 25 to more than 40 commercial fishing vessels over the mountains from Cook Inlet to Lake Iliamna. From there, the boats go 80 miles south across the lake under their own power and enter the 60-mile Kvichak River, which empties into Bristol Bay and the salmon fishing grounds. For the rest of the summer, he trucks whatever freight needs moving, primarily boats, heavy equipment, building materials, propane, aviation gas, and diesel fuel (Brown 1994).

3.3 Regional Demography

Six villages are situated near Iliamna Lake -- Iliamna, Newhalen, Pedro Bay, Kokhanok, and Igiugig on its shores, and Nondalton 15 miles north of the lake on the Newhalen River. (See figure 11.) The recent population history for these communities is shown in table 1.

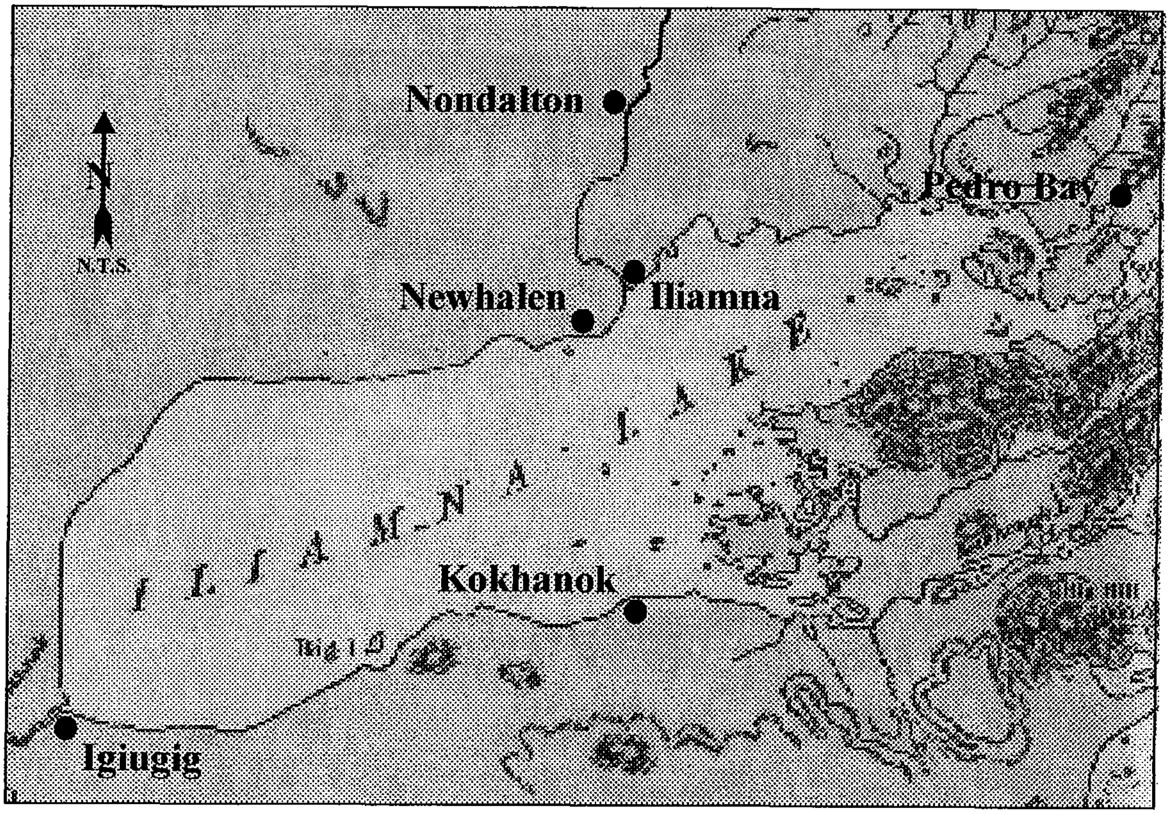


FIGURE 11.--Iliamna Lake and surrounding communities.

TABLE 1.--*Population data for Iliamna Lake villages*

Village	1960	1970	1980	1990	1993
Iliamna	47	58	94	94	92
Newhalen	63	88	87	160	185
Pedro Bay	53	65	33	43	50
Kokhanok	57	88	83	152	139
Igiugig	36	36	33	33	40
Nondalton	205	184	173	178	178

The economies of these predominantly Native communities are based on subsistence hunting and fishing, together with commercial salmon fishing in Bristol Bay. Tourism is also beginning to play a role. Subsistence is an integral part of the village residents' lifestyle and cultural heritage, as well as a vital source of food. The commercial fishing season takes place during the Bristol Bay sockeye salmon run in June and July.

Hunters take rabbit and porcupine year-round, while moose, caribou, bear, ptarmigan, duck, and goose are hunted in season.

Tourism attracts between 35,000 and 40,000 people each summer to the Iliamna Lake area. Privately owned fishing and hunting lodges along the lake and feeder streams are seasonally occupied by employees and guests, greatly boosting the regional population and commerce. Iliamna Lake and its tributaries are known for some of the world's best trout fishing. Articles on the area appear frequently in sport fishing magazines.

Following is a brief description of each of the lake villages.

3.3.1 Iliamna

Iliamna is on the northwest side of Iliamna Lake, near the Lake Clark Park and Preserve. It is accessible by air and water. An 8-mile gravel road connects Iliamna to Newhalen. Iliamna's current size and character can be attributed to the development of fishing and hunting lodges. The mixed population is 66 percent Native.

Iliamna residents get their water from individual wells. The sewer system is a combination of honeybuckets, outhouses, and individual septic tanks, the latter being the most popular. Electrical power is provided by the Iliamna Newhalen Nondalton Electric Co-op. Fuel oil and kerosene heat homes. Health care is provided locally by the Iliamna Health Clinic. Approximately half of Iliamna's households have telephones. The local post office, health clinic, and school provide some employment opportunities for village residents. The median household income is $41,250.

3.3.2 Newhalen

Newhalen, on the north shore of Iliamna Lake at the mouth of the Newhalen River, was established there because of the bountiful fish and game. Salmon fishing is the mainstay of Newhalen's economy. During the commercial salmon season, most residents leave Newhalen to fish in Bristol Bay. Subsistence hunting and fishing are also important.

Traditionally an Eskimo village, Newhalen now also includes Aleuts and Indians. Most people travel by air, using the Iliamna airport 5 miles away.

A public water system provides water for most Newhalen residents. Homes are heated with fuel oil, kerosene or wood. Telephones are in 62 percent of the homes. Employment is available for some professional and construction workers, and there are some jobs at the school and in State, local, and Federal government offices. Subsistence, however, is the predominant way of life for most residents. The median household income is $26,250.

3.3.3 Pedro Bay

Pedro Bay is located at the northeast end of Iliamna Lake. Dena'ina Indians occupied this area historically, warring with Russian fur traders over trade practices in the early 19th century.

Pedro Bay is accessible by air and water. Water sources include individual wells, springs, creeks, or rivers. Heating sources are fuel oil, kerosene and wood. Half of the households have telephones.

Employment conditions are similar to those of other lake villages. Short-term summer employment in the fishing industry or in tourism services is available, and a few relatively steady jobs exist with the government. Most residents, however, depend on subsistence hunting and fishing and/or commercial salmon fishing in Bristol Bay. The median household income is $38,125.

3.3.4 Kokhanok

Kokhanok is on the south shore of Iliamna Lake. Subsistence activities are the focal point of the culture and lifestyle. The village has a mixed Native population, primarily Aleuts with some Eskimos and Indians.

Kokhanok is accessible by air and water. Skiffs, all-terrain vehicles, and trucks are the common forms of transportation. Water is hauled from a central watering point. Heating fuel consists mainly of fuel oil, kerosene, and wood. Approximately 57 percent of the households have telephones. The median household income is $14,286.

3.3.5 Igiugig

Igiugig is on the south shore of the Kvichak River, which flows from Iliamna Lake. Eskimos originally lived on the right bank of the river, in the village of Kaskanak, and used Igiugig as a fish camp. At the turn of the century, these people moved upriver to the present site. The population of Igiugig, now 80 percent Aleut, depends on commercial fishing and a subsistence lifestyle. Sport fishing and tourism attract many visitors in summer.

The village is accessible by water and air. Water supplies are hauled from a central watering point. Heating fuel consists of fuel oil and kerosene. Approximately 75 percent of the local households have telephones. The median household income is $41,250.

3.3.6 Nondalton

Nondalton is on the west shore of Six Mile Lake, between Lakes Clark and Iliamna. It is 15 miles up the Newhalen River from Lake Iliamna. The village was originally located on the north shore of the lake, but in 1940 wood depletion and growing mudflats caused the village to move to its present site. It is a Dena'ina Indian village with a fishing and subsistence lifestyle. Commercial fishing is an important source of income. Most fishermen leave the village in summer to fish in Bristol Bay.

Some gold and copper are mined in the area. Government employs several people to work for the school district and the postal service. Unemployment is high, however, and the community in general relies on subsistence hunting and fishing. Median household income is $21,750.

3.4 Local and Regional Governments

The Williamsport-Pile Bay Road crosses the line between two of Alaska's boroughs -- the Kenai Peninsula Borough on the Cook Inlet side and the Lake and Peninsula Borough on the Lake Iliamna side. Boroughs in Alaska are similar to counties; they are formed to provide services to people in a large geographic area that includes two or more communities.

The Kenai Peninsula Borough includes the project site at Williamsport. With offices in Soldotna, the borough is seated in the populated Kenai Peninsula, which is on the main road system and has an economy based on tourism (including weekend recreation from Anchorage), commercial fishing, seafood processing, and Cook Inlet oil. The borough's population in 1994 was just over 44,000 (*1994 Alaska Municipal Officials Directory*). Incorporated in 1964, it has an elected mayor, a nine-member assembly, a school board and a planning and zoning commission. As a second class borough, it must assume three duties: education, planning/zoning, and tax assessment and collection. Other powers of the borough include solid waste disposal, emergency management, and limited economic development. The borough imposes a general sales tax of 2 percent.

The Lake and Peninsula Borough includes Lake Iliamna and its surrounding communities. It encompasses the vast, sparsely populated region stretching from Lake Iliamna on the north down the Alaska Peninsula to Chignik and Ivanof Bay on the south. Relatively new, the borough, with offices in King Salmon, was incorporated in 1989. The population in 1994 was 1,789. The home rule borough has an elected mayor, a six-member assembly, a school board, and a planning and zoning commission. The only tax is a 2-percent tax on raw fish.

Of the six Lake Iliamna-area villages, two -- Newhalen and Nondalton -- are incorporated second-class cities within the Lake and Peninsula Borough. The others are unincorporated. Newhalen has a seven-member elected assembly that selects one of its members to be mayor. The city employs a city clerk, a fire chief, and a public safety officer. Nondalton has the same assembly-mayor system and employs a city clerk/treasurer, a fire chief, and a health aide. Nondalton collects a 3-percent city sales tax.

4. Present Transportation Activities

4.1 Conditions at Williamsport

A makeshift wood pile and plank retaining wall dock now stands at Williamsport, the Cook Inlet end of the Williamsport-Pile Bay Road. The dock is the only structure there. Its offshore toe is about 4.3 m above mean lower low water (MLLW). The top of the dock is at about +6.7 m MLLW. The dock is made of remnants of a more substantial structure that was built in the 1940's and heavily damaged by the 1964 earthquake. The earthquake caused a tectonic rise in the region which reduced tidal access to the dock and roadhead.

Shallow approaches to Williamsport along the north arm of Iliamna Bay prevent barges and other vessels from reaching the dock during all but a few hours at the peak of extreme high tides. This severely limits the time available to land a loaded barge with a 1.5-meter draft. Barges entering the bay are routinely forced to go dry between high tides. It is rare that a loaded barge can dock at Williamsport, unload, and get back out on a single tide.

4.2 Commodity Shipments

Goods are delivered to Iliamna-area communities by two means: truck from the dock at Williamsport, and airplane (mail or commercial air freight). Approximately 16 percent of the dollars spent on shipped-in goods are spent on barged freight and 84 percent on goods sent by air. Barged freight, however, makes up 60 percent of the total weight shipped. A wide variety of goods, including propane, building materials, boats, general household supplies, complete households, telephone and electric company supplies, and food are barged each year. Residents order as much as possible of the barged supplies, stocking up for winter when commodities must be flown in at a higher cost.

Barge services based in Homer, Alaska, call at Williamsport about 40 times each year and charge an average of $2,000 per 12-hour day. Approximately 80 percent of the time it takes two tide cycles to complete a delivery, doubling the standard fee to $4,000. Iliamna-area village residents spend a total of $144,000 on barged freight annually.

Among the many supplies barged to Williamsport and hauled over the Williamsport-Pile Bay Road, propane and construction materials are especially important.

Ray Williams, son of the original developer of the Williamsport landing and owner of a lodge at Pile Bay on Iliamna Lake, operates Iliamna Transportation Company which offers trucking services over the road. From the lodge Williams supplies 70 to 80 percent of the propane used by residents and businesses in Iliamna Lake communities. His company typically hauls 14,000 to 15,000 gallons of liquid propane each year. The only present alternative to obtain propane is to fly empty cylinders from Iliamna to Anchorage, have them filled, then have them flown back to Iliamna, for a total expense of more than $100 for one 100-pound cylinder. A family in the Alaska bush typically uses from 5 to 10 of these 100-pound bottles of propane each year. Non-propane fuels totaling 4,000 to 5,000 gallons are transported to Iliamna Lake each year, also for sale by the Williams' lodge.

The tourist industry in the Iliamna area has grown rapidly in recent years. Construction firms from the Kenai Peninsula are hired frequently by Iliamna Lake residents to work on projects ranging from building or remodeling homes to completing lodges, restaurants, gift shops, and airports. More than 35,000 people visit the area each year to enjoy the exceptional hunting and sport fishing. The Alaska Department of Commerce predicts that this tourism will continue to increase in the foreseeable future, with construction continuing steadily each year.

Barges loaded with construction equipment and building materials arrive at Williamsport from the Kenai Peninsula. About 100,000 to 150,000 pounds (50 to 75 tons) of these supplies are hauled across the road each year. Difficulties at the Williamsport landing cause significant delays. Severely limited tidal access makes delivery difficult, and groundings are common. Small barges must be used, requiring more trips to get all the necessary equipment and materials to a construction site. Based on available historical data, a cumulative average of $21,300 is incurred annually in additional costs to construction projects due to delivery delays at Williamsport. These extra costs include increased barge operation and maintenance expenses, higher labor fees, and schedule setbacks.

Freight not barged and trucked to the Iliamna area must be flown in. Mail and air freight arrives at Iliamna, the distribution center for the other lake villages. Anchorage retailers charge 15 percent above cost, plus postage, to prepare and send village mail orders. Perishable food and other urgently needed commodities are put directly on a commercial plane by an Anchorage vendor and flown to Iliamna. Residents pay the cost of the goods, a 15-percent handling fee, and air freight charges of $.32 per pound. A single air carrier offers freight service from Iliamna to the other lake villages, charging $.15 per pound. Each Iliamna-area household spends an average of $3,220 on commodities transported by air.

4.3 Fishing Vessel Transport

Williamsport and the road to Iliamna Lake offer Bristol Bay gill-net fishermen a significant shortcut in transporting their vessels between Cook Inlet and Bristol Bay. Of the 1,886 gill-net permit holders registered in Bristol Bay in 1994, roughly three-fourths, or 1,415, store their vessels in Naknek or King Salmon, near the fishing grounds. The remaining 471 winter their boats in Cook Inlet. Although most of the vessels remain in Bristol Bay throughout the year, they are brought to Cook Inlet an average of every 4 years for repairs and maintenance. The average annual gill-net traffic going from Cook Inlet to Bristol Bay and back, then, is 825 vessels each year.

Most of the 825 vessels making this trip do so by traveling around the Alaska Peninsula. This 1,100-mile route takes approximately 3 days each way and exposes the vessel and crew to the dangerous open waters of the Gulf of Alaska, the Bering Sea, and western Bristol Bay. An average of 40 vessel operators each year opt to dock at Williamsport and pay Williams' company $800 to haul their boat over the road to Iliamna Lake and the same amount to haul it back again in the fall. The limitations of the road, including the width and height of a critical metal bridge, make this option available for only the smaller Bristol Bay vessels. Also, the extremely limited time available to dock at Williamsport, combined with the danger of running into large boulders jutting from the floor of the bay, makes getting in and out of Williamsport a hazardous venture. Once in Lake Iliamna, the boats travel from the lake down the Kvichak River, which flows into Bristol Bay. Those making the passage have shortened their trip by 1,000 miles, saving on fuel, wear and tear on the vessel and equipment, and time for the captain and crew.

4.4 Other Present and Potential Activities

Lodges on Iliamna Lake transport guests to Cook Inlet for halibut fishing via the Williamsport-Pile Bay Road, loading charter fishing vessels at Williamsport. Moose hunters cross Cook Inlet each fall in small boats to land at Williamsport and hunt from the Williamsport-Pile Bay Road.

Metallic mineral potential in the Bristol Bay and Lake Iliamna region is relatively unknown. Exploration has been slight; however, mineralized zones containing iron, copper, titanium, lead, magnetite, molybdenum, gold, silver, and zinc have been identified. High-potential mining areas and some mining claims are located near Iliamna Lake.

5. Plan Formulation

5.1 Present Concerns

The Williamsport-Pile Bay Road is a significant transportation link to Cook Inlet and the supply centers of Southcentral Alaska for Iliamna Lake communities. The road has been used for decades to deliver bulk goods such as fuel, construction materials, and heavy equipment to these communities, whose only other transportation links are an annual shipment by barge from Seattle via Bristol Bay and the Kvichak River and expensive air cargo. The road has also been used by commercial fishing vessel owners to transport their vessels from Cook Inlet to the lucrative fisheries of Bristol Bay and back. These vessels are limited to 10 m length by State regulation. The alternative route by sea is 1,800 km longer and involves extended exposure to the open ocean of the Gulf of Alaska and the Bering Sea. Expenses and risks to equipment and crews are clearly much greater via the Gulf of Alaska route.

Broad, shallow tidal flats in upper Iliamna Bay preclude landing at Williamsport except at the very peak of extreme spring high tides. Only shallow-draft vessels whose hulls and propulsion systems are not damaged by going aground can now land at Williamsport (figure 12). Periods of accessibility last an average of 2 hours and repeat about every 25 hours for several days each month. Vessels are sometimes delayed in landing when foul weather or other adversities cause them to miss one of these narrow windows. Cargoes delivered to Williamsport must be carefully scheduled to meet high tide during periods of extreme highs. All other considerations must be secondary for deliveries to be reasonably certain of success.

The unmarked, meandering tidal drainage channel which leads from Williams Creek into Iliamna Bay is difficult to follow in the murky water of Williamsport Bay, even for experienced local pilots. The presence of boulders on adjacent tidal flats adds risk of catastrophic collisions (figure 13). These hazards result in inefficiency and added cost for transportation via Williamsport to Iliamna Lake or beyond to Bristol Bay.

The difficulties of using the Williamsport barge landing in its present condition and of transporting vessels and cargo via the Williamsport-Pile Bay Road have prompted a number of letters and resolutions from concerned citizens to the State and the Corps of Engineers. Most of these are included in appendix E.

The Alaska Department of Transportation and Public Facilities (ADOT&PF) requested the Corps to investigate navigation problems at Williamsport in a letter dated October 9, 1991 (appendix E). In this letter, John F. Tolley, Chief of Planning and Administrative Services, emphasized the importance of the road, owned and maintained by the State, to commercial fishermen, Iliamna Lake communities and lodges, and construction contractors who ship materials to the region. However, he wrote, barge landing improvements are necessary:

> *The landing at Williamsport can not be considered completely accessible, as it can only be used at high tide. We feel that the road would be used more often if the Williamsport landing were an improved site. The Lake Iliamna area is rich in copper and other mineral reserves and an improved landing site has the potential to accelerate resource development.*

The Lake and Peninsula Borough, the regional government with jurisdiction over Iliamna Lake communities, transmitted a paper titled "State Transportation Improvement Program, Remote Roads and Trails Priorities" to the ADOT&PF in July 1993. In this paper, the borough stated in part:

> *Improving the Bristol Bay [Williamsport-Pile Bay] Haul Road would have profound effects for the Iliamna-Bristol Bay region. For the first time, freight, consumer goods, and passenger tariff would enter the region by road. Freight costs could be significantly and permanently lowered. The world-class scenic beauty and outdoor opportunities of the region would be opened to thousands of tourists who now reluctantly turn back to the lower 48 at Lands End in Homer.*

The Kenai Peninsula Borough, the regional government with jurisdiction over Iliamna Bay, passed Resolution 93-103 (appendix E) on September 7, 1993, in support of this cost-shared feasibility study. This resolution stated that there is a demonstrated need to improve the transportation system linking Cook Inlet with Iliamna Lake, that a vital part of that transportation system is the tidewater approach for barges and landing craft at Williamsport, and that the makeshift wooden dock at Williamsport is inadequate.

FIGURE 12.--A barge in Williamsport Bay carries fuel and construction equipment and materials.

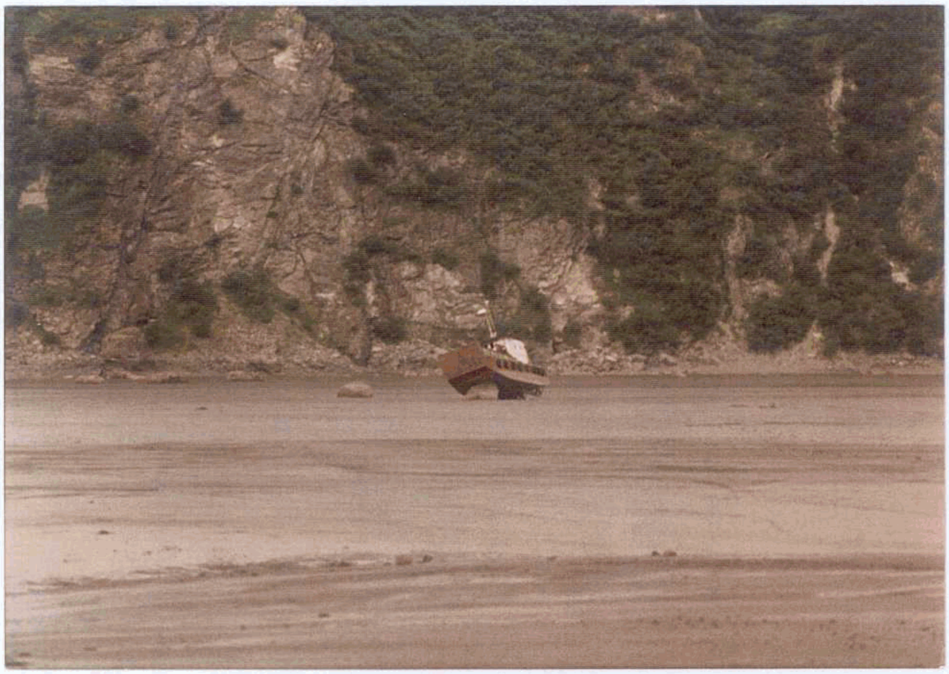


FIGURE 13.--A landing craft is aground on a boulder near Williamsport.

The Kenai Peninsula Borough Economic Development District, Inc., a private organization that promotes development in the Kenai Peninsula region, passed Resolution 93-11, dated July 29, 1993, supporting improvement or replacement of the Williamsport-Pile Bay Road. This resolution is in appendix E. Improvement of this transportation system, the resolution stated, would "lead to employment opportunities in vessel storage and repairs, in development of natural resources, and in improved access to residents in the region."

The demand for use of the road by commercial fishing vessels was emphasized in an independent survey of boat owners conducted by Northern Enterprises, a boat storage and service business in Homer, Alaska. The firm's June 10, 1993, letter to the ADOT&PF requesting upgrade of the Williamsport-Pile Bay Road and responses of 90 fishermen to the survey are in appendix E. The letter reads in part:

> *Our boat yard and vessel repair businesses on the Kenai Peninsula, do considerable repair work and retail sales for vessel owners that are Bristol Bay fishermen, because it is so difficult and expensive to get anything done in Bristol Bay. Some vessels are shipped or run to Seattle to refurbish and repair. Most of the boat storage and repair businesses in the bay are owned and operated by people who live in Seattle. Few if any of the businesses are open to do repairs until spring. When workers return from Seattle in the spring, hourly rates are $80.00 to $120.00 an hour and parts cost twice what they do here. No wonder, people are willing to run 1,000 miles, at great risk, to find a place and time to get repair work done. . .*
>
> *In an attempt to see how much interest there is among Bristol Bay fishermen to bring their boats to Cook Inlet for repair, storage and use, we sent 350 cards to Bristol Bay Permit holders. We only sent them to Bristol Bay Drift Permit Holders that live from Kodiak to Fairbanks.*
>
> *However, we are also finding interest from fishermen who live outside and have received phone calls from two Cordova people who would rather put their boats in Cook Inlet for the winter than Bristol Bay. Of the 350 cards sent out we received 90 back. Enclosed are copies of the cards we received back.*
>
> *Other possible areas of use would be: set netters, fishing lodges and guides, local residents, returning herring seiners, just anybody that wants to repair their vessel for less than $100.00 per hour charges.*

Analysis of the 90 responses to the Northern Enterprises survey shows 54 percent would use the road every year if improvements were accomplished, as indicated in figure 14. Notes with the responses of those who said they would never use the road indicate most were judging present rather than improved conditions. The survey verifies that improved access to Iliamna Lake via the Williamsport-Pile Bay Road would result in increased traffic of commercial fishing vessels traveling to and from Bristol Bay.

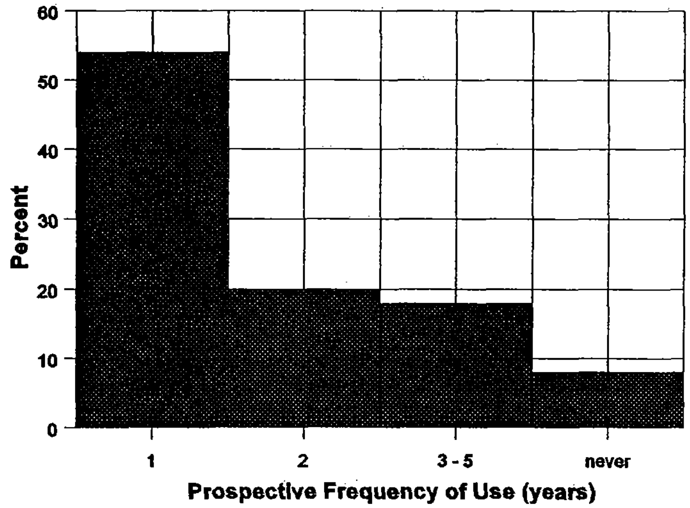


FIGURE 14.--Results of Northern Enterprises, Inc., survey of Bristol Bay drift-net permit holders on their future use of the Williamsport-Pile Bay Road if improvements are accomplished.

An area of large reserves of minerals, including copper and gold ores, in the region north of Williamsport between Iliamna Lake and Lake Clark is known as the Pebble Beach Prospect. The mineral rights for the Pebble Beach Prospect are owned by Cominco Alaska, Inc. These reserves have been explored to a limited extent, but will not be mined until the market value of the ore is high enough to warrant expensive startup costs. When this occurs, Williamsport may not be the best choice for a deep-draft ore export terminal. Ore carriers can have drafts in excess of 13 m, which would require a large dredging or causeway construction project in Iliamna Bay. The materials and equipment for intensified exploration, startup mine construction, and road construction to an ore terminal site on Cook Inlet probably would arrive at Williamsport.

5.2 Opportunities for Improvements

Basic objectives for improvements at Williamsport that respond to the above concerns are:

a. Improve the Williamsport-Pile Bay Road for safer and more efficient passage of heavy trucks, including those towing fishing vessels;

b. Improve the seaward approach to Williamsport for safer, more frequent, and longer-lasting navigation; and

c. Improve the cargo transfer facilities at Williamsport for safer and more efficient loading and unloading of trucks and vessels.

Achievement of any of these objectives through construction of public works would result in reduced transportation costs between Cook Inlet and Iliamna Lake, as well as reduced risk of injury to people and damage to equipment. No purely institutional measures are perceived to be effective toward these objectives. No action at all would allow the present risks and inefficiencies to continue indefinitely.

5.3 Alternative Concepts

5.3.1 Road Improvements

The Williamsport-Pile Bay road needs improvement in the form of grading and bridge repairs for safer and more efficient overland transportation of various types of cargo. These needs formed the incentive for the ADOT&PF to request a Corps study of access to the roadhead at Williamsport. The ADOT&PF is committed to improving the bridges and grading along the road. These improvements will reduce the primary constraints on cargo capacity of the road to heavy winter snowfall (mid-November to mid-May) and tidal access and cargo transfer restrictions at Williamsport.

5.3.2 Iliamna Bay Channel Alternatives

Physical obstruction of vessels approaching Williamsport begins well out into Iliamna Bay at low tide. The obstruction by the naturally shoaling sea floor increases toward Williamsport. Vessels can now float at the unimproved roadhead only for an average of 2 hours at the peak of spring high tides, a few days each month.

Two basic opportunities come to mind for improving access to the roadhead: (1) excavate a deeper channel to the present roadhead, where the ruins of an old dock exist, or (2) extend the roadhead toward deeper natural depths. Figure 15 illustrates the application of these two concepts in Iliamna Bay. The road extension was conceived to reach near the end of the mountain buttress along the south side of Williamsport Bay. This buttress protects Williamsport Bay from wind and waves, which can be severe during storms in outer Iliamna Bay. Artificial protection of the cargo transfer area would be required beyond this point.

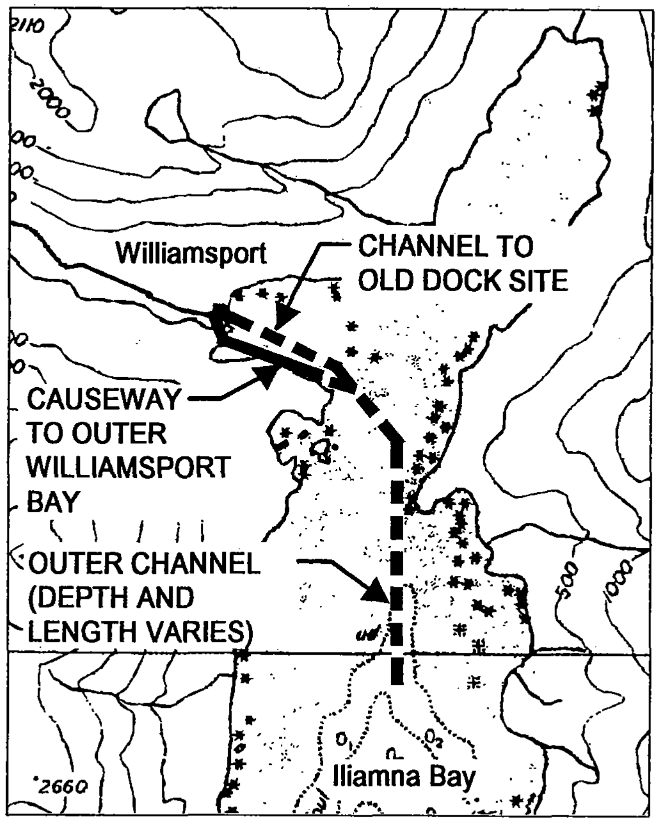


FIGURE 15.--Conceptual view of channel alternatives.

Channel Geometry Alternatives. The amount of time during which a vessel could approach or leave Williamsport would increase with the depth of channel excavation. The length of the channel would also increase with the depth of excavation. A channel dredged to 0.0 m MLLW would extend well out into Iliamna Bay and allow access most of the time, while a channel dredged to +2.0 m MLLW would not extend far beyond the existing roadhead and would improve access only slightly. The depth of the channel greatly affects the cost of excavation; therefore, the optimum depth of a channel must be decided on the basis of economic efficiency, *i.e.*, the depth at which maximum net benefits (annual benefits less average annual life cycle costs) are possible. The channel bottom must be wide enough for pilots to guide their vessels safely along the channel at the minimum practical water depth. Geotechnical findings indicate channel side slopes of 1V:4H (1 part vertical rise to 4 parts horizontal distance) would remain stable in ambient conditions.

Vessels that have historically visited Williamsport include landing craft, private and commercial fishing vessels, and tugs towing barges (figure 16). Fishing vessels of the type used in Bristol Bay and landing craft of the size now serving Williamsport have similar loaded drafts of about 1 m. One custom-built landing craft based in Homer with length-overall (LOA) of 35.4 m, beam of 10 m, and draft of 1.4 m also occasionally lands at Williamsport. Allowances for maneuvering keel clearance and channel depth uncertainties (1.2 m) call for a total water depth of 2.6 m for safe navigation of the larger landing craft. A tug with a minimum 2.4-m draft requires a total water depth of 3.6 m for safe navigation. Landing craft require a 30-m channel width, while a tug towing a barge requires a minimum 40-m channel width.

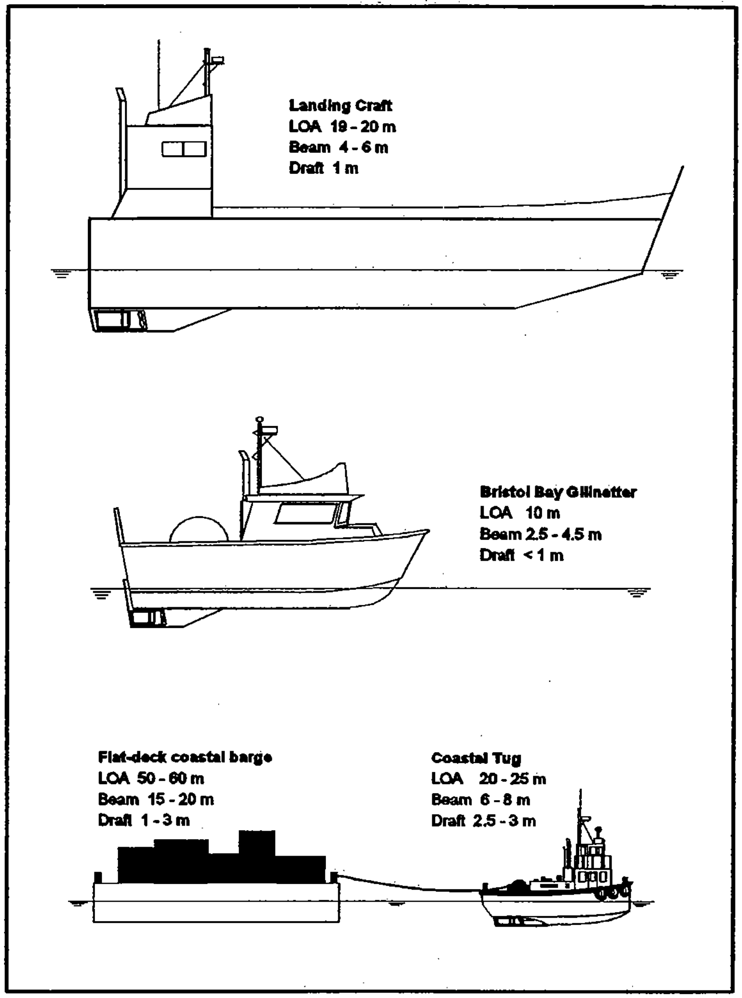


FIGURE 16.--Characteristics of vessels visiting Williamsport.

Commercial fishing vessels and landing craft are typically not harmed by gentle grounding on a smooth bottom. Tugs with rounded hull cross sections may not be able to go aground without damages. A turning basin at the end of the channel by the landing, as shown in figure 17, is required for all vessels. For vessels unharmed by gentle grounding, the basin need not be deeper than the channel.

Tugs require a deeper basin so they remain afloat and upright, even when the channel becomes too shallow for passage at low tide. A turning basin 55 meters square would serve landing craft and fishing boats, but a 90-m-square basin, 3.6 m deeper than the channel, is required for a tug and barge. Combinations of these criteria lead to the range of alternative geometries described in tables 2 and 3, which distinguish between the old dock site option and the option of an earthfill causeway to extend the road along the south margin of Williamsport Bay. Design type "1" (second from left column in the tables) would serve all vessels, while design type "2" would serve only landing craft and fishing vessels.

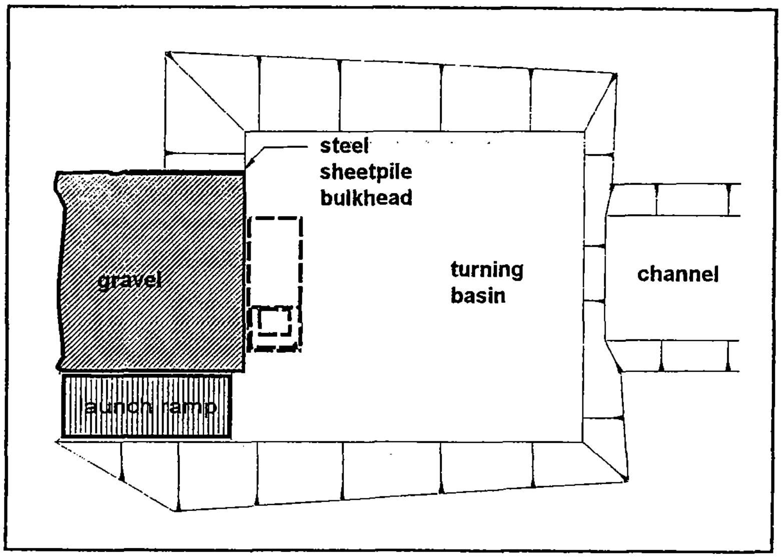


FIGURE 17.--Conceptual plan view of turning basin at end of channel at Williamsport (not to scale).

Dredging and Dredged Material Disposal. The means of excavation and disposal of excavated material must be carefully considered, both in the interest of minimizing cost and to minimize adverse impacts on the living resources and other uses of the surrounding area. The shallow tidal flats of upper Iliamna Bay make disposal of dredged material by barge impractical. Dump scows of all designs will draw too much water to be able to float in their loaded condition except during brief periods at the peak of spring tides. A cutterhead pipeline dredge can operate in shallow water without difficulty and continuously discharge dredged material as a slurry pumped through a pipeline. This slurry can be loaded on barges, but the high water content makes this an inefficient use of the pipeline. The conventional approach is for the dredge to pump its discharge directly to the disposal site. The disposal site can be contained by dikes or can be diffused onto tidelands or open water. The preferred option at Williamsport, for the sake of cost, is to diffuse the pipeline discharge directly onto the tidelands in two locations chosen to minimize migration of the material back into the excavation. Open-water disposal sites are too distant for direct discharge, and double handling with barges would be required

TABLE 2.--*Old dock site alternatives: dimensions and excavation quantities*								
Alt. No.	Design type	Channel width (m)	Channel bottom (m)	Channel length (m)	Channel qty. (m^3)	Basin width (m)	Basin depth (m)	Basin qty. (m^3)
1	1	40	-1.5	4,350	354,700	90	-4.5	64,325
2	1	40	-1.0	3,950	244,800	90	-4.0	60,225
3	1	40	-0.5	2,700	158,150	90	-3.5	56,125
4	1	40	0.0	1,950	101,450	90	-3.0	52,050
5	1	40	0.5	1,200	66,775	90	-2.5	47,975
6	1	40	1.0	1,050	41,800	90	-2.0	43,875
7	1	40	1.5	900	22,150	90	-1.5	39,800
8	1	40	2.0	450	10,025	90	-1.0	35,725
9	2	30	-1.5	4,350	290,050	55	-1.5	14,950
10	2	30	-1.0	3,950	200,250	55	-1.0	13,401
11	2	30	-0.5	2,700	129,825	55	-0.5	11,875
12	2	30	0.0	1,950	83,475	55	0.0	10,325
13	2	30	0.5	1,200	55,075	55	0.5	8,800
14	2	30	1.0	1,050	34,600	55	1.0	7,275
15	2	30	1.5	900	18,600	55	1.5	5,750
16	2	30	2.0	450	8,350	55	2.0	4,250

to place the material beyond the tidelands. The low biological production of the tidelands and the similarity of the dredged material to that found on the tidelands indicates the tidelands disposal option should have no significant impact on the local ecology. Options for dredged material disposal sites investigated during this study are designated in figure 18.

5.3.3 Cargo Transfer Facilities

The existing cargo transfer facilities consist of a roughly graded dirt ramp, 6 m wide, whose toe is at elevation 4.4 m MLLW. The ramp is just wide enough for the ramp of a single landing craft. The ruins of an old dock beside the ramp are no longer usable.

TABLE 3.--*Causeway alternatives: dimensions and excavation quantities*								
Alt. No.	Design type	Channel width (m)	Channel bottom (m)	Channel length (m)	Channel qty. (m^3)	Basin width (m)	Basin depth (m)	Basin qty. (m^3)
17	1	40	-1.5	3,850	262,225	90	-4.5	73,025
18	1	40	-1.0	3,450	168,875	90	-4.0	67,800
19	1	40	-0.5	2,200	97,484	90	-3.5	62,650
20	1	40	0.0	1,450	54,875	90	-3.0	57,600
21	1	40	0.5	700	33,050	90	-2.5	47,625
22	1	40	1.0	550	18,750	90	-2.0	42,625
23	1	40	1.5	400	7,550	90	-1.5	38,125
24	1	40	2.0	150	2,420	90	-1.0	32,900
25	2	30	-1.5	3,850	210,750	55	-1.5	18,425
26	2	30	-1.0	3,450	135,275	55	-1.0	13,550
27	2	30	-0.5	2,200	78,075	55	-0.5	11,525
28	2	30	0.0	1,450	43,850	55	0.0	9,550
29	2	30	0.5	700	26,425	55	0.5	7,350
30	2	30	1.0	550	14,825	55	1.0	5,300
31	2	30	1.5	400	5,825	55	1.5	2,825
32	2	30	2.0	150	1,850	55	2.0	1,300

This old dock, makeshift in its original construction, was destroyed at least 10 years ago by winter snow and ice. The pioneer facilities available at the Williamsport end of the road are not adequate or safe for transfer of substantial amounts of cargo. A more efficient cargo transfer facility would result in quicker turnaround of vessels with much less risk to the people and equipment involved in cargo transfer operations.

A steel sheet-pile bulkhead and adjacent concrete ramp are conceived as a cost-effective combination for the anticipated service at Williamsport, typical of other shallow-draft cargo facilities in Alaska. The conceptual cross section is shown in figure 19. The bulkhead could be used for lifting break-bulk goods from the deck of landing craft or barges and placing them on the bed of a truck. Conventional track- or wheel-mounted

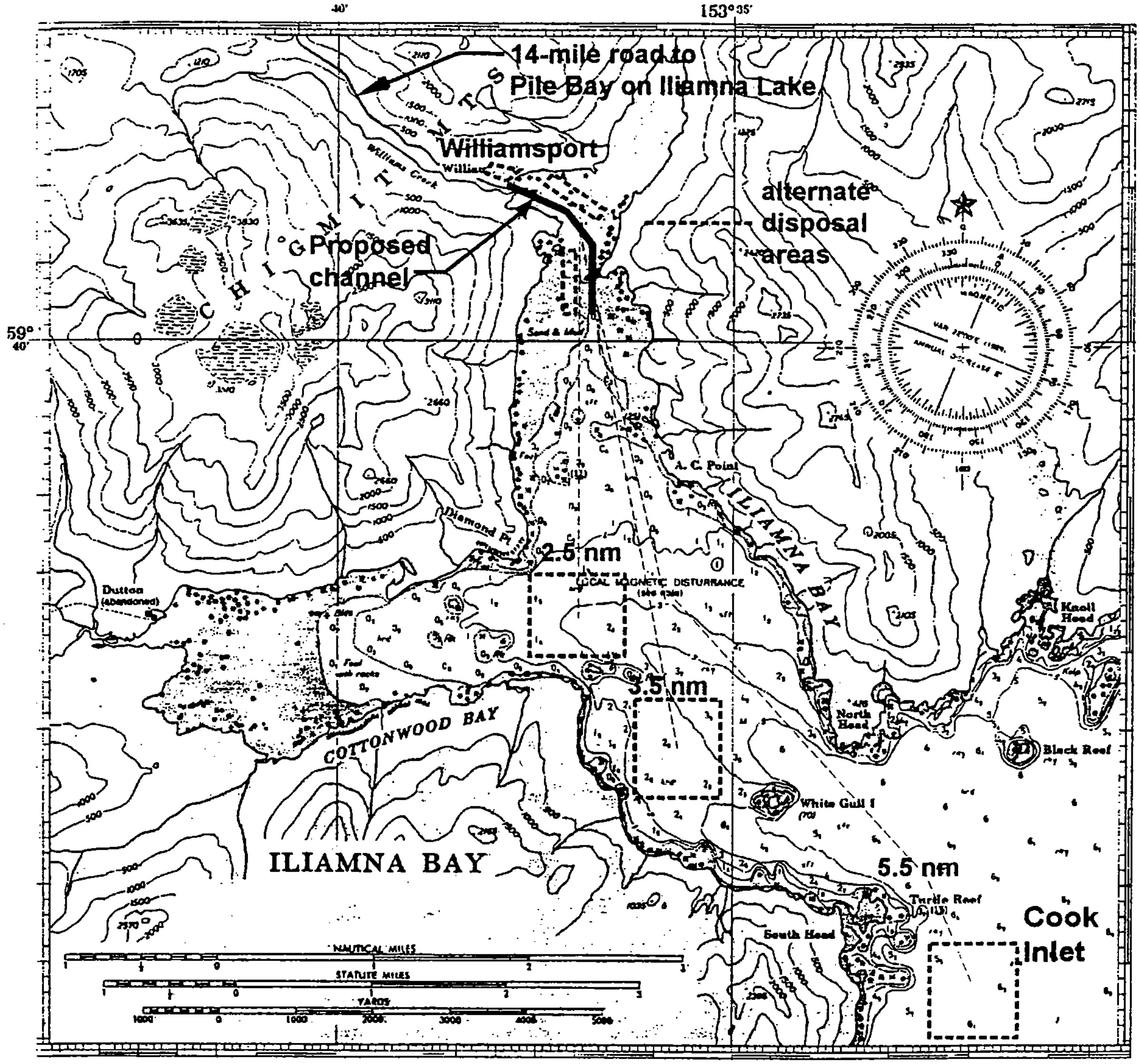


FIGURE 18.--Prospective dredged material disposal sites.

loading equipment (light cranes, front-end loaders, backhoes, boom-trucks) could be used for the transfer. The ramp could be used for loading fishing boats on trailers or for rolling equipment directly off landing craft or ramp-equipped barges.

Figures 21 and 22, in section 7, illustrate the configurations conceived for the site of the old dock and for the end of the earthfill causeway.

5.3.4 Aids to Navigation

No buoys, range markers, lights, or aids to navigation of any kind exist at present in Iliamna Bay. Placement of aids to navigation in coastal waters is the responsibility of the U.S. Coast Guard. A system of aids to navigation in upper Iliamna Bay and Williamsport Bay would reduce the risk of unintentional groundings and collisions with boulders. The U.S. Coast Guard has been informed of the situation and is considering the feasibility of installing aids to navigation in Iliamna Bay.

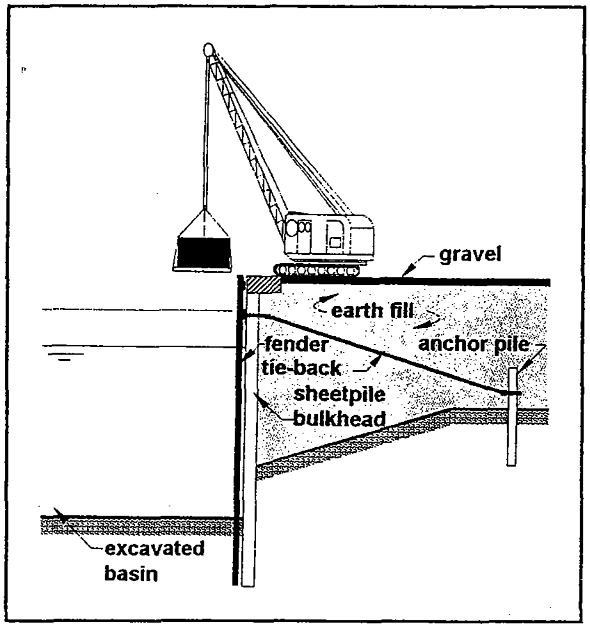


FIGURE 19.--Conceptual cross section of bulkhead-type dock at Williamsport (not to scale).

5.3.5 Boulder Removal

Only three to five boulders are near enough to the natural tidal drainage channel of Williams Creek to be considered risks to prudent navigators experienced in Cook Inlet coastal waters. These boulders now appear on the nautical chart for Iliamna Bay. These and other boulders more distant from the natural channel were precisely located as a part of this investigation, and these locations have been reported to the National Oceanic and Atmospheric Administration (NOAA). The placement of permanent or seasonal navigation aids in upper Iliamna Bay and Williamsport Bay by the U.S. Coast Guard will reduce the risk of accidental groundings or collisions with these boulders. Physical removal of the boulders or their destruction by blasting would eliminate these risks completely.

5.3.6 Iniskin Bay Site

The concerns of the Lake and Peninsula Borough include the eventual need for an deep-draft ore terminal for export of minerals from the Pebble Beach prospect. The Alaska Department of Commerce and Economic Development completed a comprehensive review of Cook Inlet port needs in January 1993 in its Southcentral Ports

Development Study. The study report suggested a new port on Iniskin Bay, the fiord just north of Iliamna Bay on Cook Inlet. This project would involve construction of a new 100-km road from the port site to Iliamna and Nondalton, including a new bridge between Iliamna and Nondalton across the Newhalen River. The cost of an Iniskin Bay road and deep-draft ore terminal was estimated as:

	($ million)
100 km road construction	40
Newhalen River Bridge	4
Iniskin Bay bulk terminal	8
Total	52

This plan is worthy of further consideration for ore exports, but it is too expensive to be justified by present needs alone. Other options may also exist for export of ore. A comprehensive survey of prospective port sites for that purpose should be undertaken when mine startup appears imminent.

6. Evaluation of Alternatives

6.1 Overview

Alternative navigation improvements conceived for Williamsport include two channel alignments, each with variable channel depths and widths, approaching a new dock at the roadhead. Boulders could be removed from the tidal flats near the proposed channel in conjunction with channel improvements or independently. Aids to navigation could also be installed with or without a channel improvement. A proposed port facility on Iniskin Bay was discussed briefly in the previous section, but since its scale and objectives would be so different from those of the improvements proposed in Iliamna Bay, an Iniskin Bay alternative is not evaluated further in this report.

This section evaluates alternatives with regard to navigation-related impacts. Each major alternative is assessed in terms of its operational efficiency and safety, potential environmental impacts, cost, and economic benefits. The relative effect of variations in channel width and depth is also assessed. The section ends with a comparison of the alternatives. The effects of alternative improvements are compared to the present condition and to the future condition without any improvement.

Costs reported in this section and in Appendix A, Channel and Shore Facilities Design, are based on detailed estimates prepared for comparison of alternatives. Some refinements were applied to the recommended plan after it was identified as the economic optimum.

6.2 Road Improvements Without Navigation Improvements

6.2.1 Operational Efficiency and Safety

The ADOT&PF is committed to road improvements which would draw additional traffic into Iliamna Bay by boat, landing craft, and occasionally by tug and barge. These road improvements, by themselves, would reduce the risk of damage to cargo and to fishing vessels during the road passage. Travel time for heavy cargo on the road would be reduced, such that two or three round trips might be possible in a 24-hour period.

There will be little need to accommodate this much road traffic if cargo cannot be more efficiently transferred to the road from the sea at Williamsport. Without navigation improvements in Iliamna Bay, vessels approaching and departing from Williamsport will continue to suffer delays and occasionally run aground and suffer damages (see figure 13). Tidal restriction of access to the roadhead will continue to constrain deliveries of cargo to several hours once a day during a few days of peak spring high tides each month (see figure 9).

Road improvements would draw more owners to use the road to transport their commercial fishing vessels between Cook Inlet and Bristol Bay via the road, Iliamna Lake, and the Kvichak River. These vessels would not be able to travel at the most convenient times, but would be restricted to the same few access windows available for other cargo deliveries. Congestion at the roadhead would result, and some vessels would be left aground in Williamsport Bay to wait at least 12 hours for the next spring high tide. The haul-out and trucking services would be hard-pressed to transfer cargo and haul out vessels during the same few hours of extreme high water. Heavy use of the dirt ramp at the roadhead and the unimproved surrounding land area would result in erosion and extraordinary wear and tear on equipment and cargo. Risks to operating personnel would be high, especially during times of low visibility, inclement weather, and wet ground. Though road improvements would increase the traffic of commercial fishing vessels at Williamsport, most owners would continue to avoid the attendant risks there by paying high storage and service prices in Bristol Bay or by sailing around the Alaska Peninsula.

6.2.2 Environmental Impacts

The increased risk of vessel groundings and related damages would mean an associated risk of fuel spills into Iliamna Bay. The tidelands at the head of Williamsport Bay would continue to be disturbed by groundings and by prop wash from vessels maneuvering in extreme shallow water. The ground at the end of the road would be disturbed and ultimately eroded by periodic intense heavy vehicle use during spring high tides.

6.2.3 Cost

No direct cost for navigation improvements is associated with this alternative.

6.2.4 Economic Benefits

No navigation-related economic benefits would result from this alternative.

6.3 Improved Channel to New Cargo Transfer Facility at Old Dock Site

6.3.1 Operational Efficiency and Safety

A dredged channel would increase the time during which vessels could approach and leave Williamsport. The efficiency of cargo transfer at Williamsport and of the overall transportation system, from sea to land and across the road to Iliamna Lake, would be improved in proportion to the increase in access. The risk of vessel groundings and associated damages would be reduced in proportion to the increase in channel depth. Improved access would allow more economical scheduling of vessel arrivals and departures, which would reduce storage costs and delays in Homer or at any other port of origin on Cook Inlet. Inclement weather encountered while crossing Cook Inlet would be less likely to result in major delays or waiting for high tide in the exposed water of lower Iliamna Bay.

A channel 40 m wide would allow safe navigation of a tug towing a barge. Self-powered landing craft are more maneuverable and require only a 30-m channel width. A 56-m flat-deck barge can generally carry 1,500 tons of cargo with less than 2 m draft, while the largest landing craft now visiting Williamsport can carry 175 tons of cargo at 1.4 m draft. Tugs suitable for this service draw 2.5 to 3 m; therefore, a channel for a tug and barge must be 1 to 2 m deeper than a channel allowing the same access by 1-m-draft landing craft or small commercial fishing vessels. Most of the tugs in year-round service in Cook Inlet can go aground on a smooth bottom without damage. Some have rounded hulls which cause them to list dramatically when aground. Structural damage may not occur, but fluid aboard may overflow and objects stored on shelves may fall. Crew accommodations become unusable. The vessel is completely vulnerable to adverse effects of wind and shallow-water waves until it is again fully afloat. For these reasons, a flotation basin at the end of the channel in Williamsport Bay, deeper than the channel bottom, is necessary for tugs. This basin would be more prone to sedimentation, since it would trap suspended sediments in still water at each low tide.

The availability of a dock (figure 19) and adjacent staging area would dramatically improve the safety and efficiency of cargo transfer operations. A 60-m-wide dock would accommodate larger barges, while a 30-m-wide dock would suffice for landing craft. A 12-m-wide paved launch ramp beside the dock would accommodate safe and efficient loading and launching of commercial fishing vessels with trailers, as well as use by landing craft for rolling cargo. A variety of operating equipment, such as cranes, boom-trucks, loaders, and forklifts, could be used to offload or load cargo vessels from such a dock and ramp combination. Faster cargo transfer would reduce the moorage time of vessels at Williamsport and allow them to leave sooner for other money-earning activities. Risks of damage to cargoes, equipment, and operating personnel would be greatly reduced. The operations of vessel loading and unloading could be performed independently of truck loading and unloading with a graded storage area adjacent to the dock. Erosion of the ground surrounding the roadhead would be prevented. Operational risks and difficulties when the ground is wet, when visibility is reduced, or when winds are high would be reduced or eliminated. The adjacent locations of the dock, staging area, and roadhead would result in minimum equipment and operator time to move cargo between its journey across Cook Inlet and its journey along the road.

6.3.2 Environmental Impacts

The environmental impacts of this alternative are discussed in detail in the Environmental Assessment which follows this main report. Channel excavation and maintenance would alter a portion of the tidelands habitat in Iliamna Bay. Field investigations revealed the bottom of the bay to be unproductive because of the turbid water and the silty surface of the tidelands. Benthic productivity would be minimally impacted by the excavation and its subsequent maintenance.

Dredged material would be pumped as a slurry and dispersed onto the tidelands at two sites near the excavation, as indicated in figure 18. This arrangement would allow efficient use of a hydraulic cutterhead pipeline dredge and thus minimize the time and cost of the excavation and dredged material disposal. Mechanical dredging (*e.g.*, by clamshell or dragline bucket) and barging of dredged material to open-water sites would be too restricted by tides to be practical. Pumping the dredged material ashore to a contained disposal area would be more costly and would involve adverse impacts on the upland ecology.

All but the coarsest fraction of the dredged material pumped to the tidelands disposal sites would disperse quickly into outer Iliamna Bay during subsequent high tides. The dredged material disposal sites are in places where tidal flows tend to carry suspended dredged material away from the excavation and out into the more open waters of Iliamna Bay. The dredged material would have the same physical characteristics as the natural material at the disposal sites and elsewhere in Iliamna Bay. Tests of the material to be excavated (see appendix C) indicate it contains no contaminants or undesirable substances. The adverse impact of the placement of the material at the disposal sites and its dispersion into the waters of Iliamna Bay would not be significant.

An excavated channel would attract more vessel traffic, and consequently the risk of accidental fuel spills would increase. The channel is designed for safe navigation by competent mariners operating vessels in working order. Abuses of laws and regulations regarding waste disposal, use of marine sanitation devices, or human disregard of other institutional environmental protection measures cannot be prevented by channel or port design features. Enforcement of these laws and regulations is the responsibility of the U.S. Coast Guard and other agencies, who would give more attention to marine operations in Iliamna Bay. Nevertheless, increased use of the waterway would probably result in incidents of illegal overboard waste disposal and accidental fuel spills. The impact of these abuses probably would be small, since the tidal range is large and tidal currents exceeding 1 knot tend to rapidly disperse small quantities of undesirable substances and dilute them to harmless concentrations.

Gasoline and other fuels and lubricants are delivered in bulk by sea to Williamsport under present conditions. The presence of an excavated channel could result in increased quantities of these materials delivered at Williamsport, but would at the same time result in dramatically improved safety and efficiency of these deliveries. The overall impact of proposed improvements at Williamsport would be to significantly reduce the present risk of a substantial spill in Iliamna Bay.

Pink and chum salmon fry departing Williams Creek could encounter the dredging operation during the peak migration periods of April to June in the year of initial excavation. The dredging project, as proposed, is expected to involve 6 to 12 weeks of operation for the cutterhead pipeline dredge, depending on the quantity of material excavated. The spring tides during the ice-free period of mid-May to mid-November would be the premium times for efficient operation. The months of September to November are undesirable for demobilization of equipment from the site because of increased frequency of severe storms at sea and associated increases in insurance rates. The best tides for quick and efficient dredging of the channel occur in May through August. The adverse impacts of the dredging operation are not anticipated to be significant. The construction of the dock and staging area at Williamsport would not significantly affect fish migration. The discharge of dredged material onto the tidelands would cause a temporary increase of suspended sediment concentrations, but in waters already turbid from natural concentrations.

The prospect of greatest concern is the small but definite risk of encountering a boulder along the alignment of the dredged channel. No boulders were detected by the geophysical survey of the area, but this is not a fully reliable means to determine none exist there. The chance of encountering a large buried boulder in the proposed channel alignment is estimated to be less than 5 percent, based on the sparsity of boulders exposed on the adjacent tidelands. The cutterhead pipeline dredge proposed for the excavation would not be able to remove large boulders, though it would be able to remove rocks as big as 0.2 to 0.3 m in largest dimension. Several options exist for dealing with boulders encountered along the channel. It may be possible to dredge a hole for the boulder to fall into, but later natural scour may expose the boulder above the surrounding seabed. The boulder may be encountered at the channel margin, where it could be avoided by a minor realignment of the channel. A large boulder encountered in the central portion of the channel would have to be removed. The boulder possibly could be grasped and lifted by equipment on hand for tending the dredge, or by a makeshift adaptation of the dredge ladder.

A large boulder may require blasting with the objective of scattering pieces of harmless size outside the channel limits. Blasting, if necessary, would be performed at low tide to avoid transmitting a shock through the water. The surrounding silt layer, which lies over a sand and gravel substrate, would reduce the shock in the sediment to harmless intensity within a radius of 50 m or less. An instantaneous acoustic shock would be felt by birds and animals in Iliamna Bay, but would cause them no physical harm if they are at least 100 m away. Debris from a blast may scatter as far as 100 m. Blasting would not be allowed when any birds or animals are within 500 m of the charges. Human safety measures would be strictly governed by Corps regulations.

6.3.3 Cost

An excavation quantity of 93,800 cubic meters (m^3) is estimated for a channel 1,950 m long and 30 m wide with a bottom elevation of 0.0 m MLLW and a 55-m-square turning basin at 0.0 m MLLW. A unit price for dredging is estimated to be $6.86/$m^3$, but an additional 25 percent is included as a contingency for encountering boulders in the channel. Mobilization and demobilization are estimated to cost $336,000, which is increased to $403,000 with a 20-percent contingency. Contractor surveys are estimated to cost an additional $72,200, which is increased to $90,200 with a 25-percent contingency. The total dredging contract cost for this alternative is thus estimated to be $1,297,500. The estimated contract cost of a 30-m-wide dock, adjacent launch ramp, and staging area, including a 33-percent contingency, is $1,365,000. The total project construction contract cost for this combination of features is $2,662,500. Real estate costs are estimated at $38,000, including a 27-percent contingency. Design analyses and preparation of dredging contract documents are estimated to cost $201,000, including aerial photography, surveys, and mapping. Dredging contract administration is estimated to be $124,000. Non-federal design and construction contract administration costs for the dock, ramp, and staging area are estimated to be $340,000. The total initial project cost is therefore estimated as $3,405,600. A similar breakdown for the recommended plan (same plan dredged to -0.5 m MLLW) is presented in table 7 (in section 7).

Maintenance dredging is estimated to be 25 percent of the initial quantity every 5 years, with the same mobilization and demobilization, contractor survey, and dredging unit cost as for the initial dredging. Government surveys for monitoring are estimated to cost $40,000 every 5th year preceding dredging episodes, and annually for the first 4 years. The cost of maintaining the dock, ramp, and staging area averages $32,600 per year, as itemized in table 9 (in section 7). The equivalent annual cost of initial construction and maintenance for 50 years, discounted at an annual interest rate of 7.75 percent, is $343,500. In summary, for a channel at 0.0 m MLLW to a new dock at the old dock site --

Total first cost: $3,405,600.

Equivalent annual cost of construction plus 50 years' maintenance: $343,500.

6.3.4 Economic Benefits

The tangible economic benefits of a channel, dock, launch ramp, and staging area at Williamsport have been quantified in four categories: vessel damages prevented, reduced costs to transport commodities, prevented delays of construction projects, and cost savings to owners of commercial fishing vessels. These categories are defined in more detail in appendix B. The alternative discussed above is associated with $5,000 per year in vessel damages prevented, $330,800 per year in reduced transportation costs, $17,800 per year in construction-related savings, and $462,000 per year in fishing vessel-related savings. The total annual benefits for this alternative are $815,600 per year, which exceed its average annual costs.

First cost and maintenance costs vary directly with the channel depth. The time during which vessels can travel to Williamsport also increases with depth, which has a direct effect on the last three categories of benefits. The optimum plan is identified at the end of this section by comparison of net annual benefits for a range of alternatives.

6.4 Improved Channel to New Cargo Transfer Facility at End of New Causeway

6.4.1 Operational Efficiency and Safety

This alternative was conceived to reduce the channel length for the same basic level of access and cargo transfer capability at Williamsport. The causeway would be constructed along the south shore of Williamsport Bay (see figure 15). A 550-m earthfill causeway would extend the cargo transfer facility farther offshore into lower natural elevations in Iliamna Bay, thus reducing the quantity of dredged material. Future maintenance dredging requirements would be less, since there would be less channel length to maintain, and the cut depth would be less than that for a channel into the head of Williamsport Bay. A wide area at the offshore end of the causeway would be adequate for turning trucks with boat trailers, loaders, or other cargo handling equipment. Little temporary storage space for cargo would be provided at the offshore end of the causeway.

The single-lane causeway would have to be traversed by trucks or other cargo handling equipment to reach level land at the roadhead for staging vessel and truck loads. Additional fill and associated construction cost would be required to create cargo storage space adjacent to a dock at the end of the causeway. Cargo handling would be somewhat less efficient than it would be with ample level staging area next to the dock.

6.4.2 Environmental Impacts

The earthfill causeway would extend along the base of steep mountain slopes on the south shore of Williamsport Bay and permanently cover the upper portion of the tidelands along 450 m of that shore. Connection of the causeway to the road would require a crossing of Williams Creek, where a 2.3-m corrugated metal pipe culvert would be placed for creek flow under the causeway. This culvert could have a minor adverse impact on fish migration from Williams Creek by locally increasing velocities. Vessel traffic would increase as a result of the improved access to a cargo transfer facility. Increased risk of accidental spills or abuses of waste disposal and marine sanitation laws and regulations in Iliamna Bay would be equivalent to those associated with a channel to the head of Williamsport Bay. Vessels in this case, however, would travel only to just inside the mouth of Williamsport Bay; they would no longer need to approach the head of the bay. The shorter channel excavation would reduce the risk of encountering boulders along the channel alignment; thus the need for blasting or other means of boulder removal would be less likely. Otherwise, the potential adverse environmental impacts of this alternative are much the same as for a channel excavated to the site of the existing dock.

6.4.3 Cost

The construction cost of a 550-m causeway, dock, launch ramp, and 30-m-wide, 1,450-m-long channel at 0.0 m MLLW is estimated as $5,745,000, which includes $2,685,800 for causeway construction, $1,365,000 for dock construction, and $951,400 for an initial channel and basin excavation of 53,400 m^3, with associated Federal and non-federal design and administration costs. The basin would be 55 square meters in area. Channel and basin maintenance, involving removal of 14,000 m^3 every 15 years, is estimated to cost $215,900. The first cost of this causeway alternative ($5,745,000) is substantially higher than that ($3,405,600) for a longer channel at the same depth leading to a dock at the existing dock site.

Maintenance dredging for this causeway alternative is estimated to be 25 percent of the initial dredging quantity every 5 years, with the same mobilization and demobilization, contractor survey, and dredging unit cost as for the initial dredging. Government surveys for monitoring are estimated to cost $40,000 every 5 years between dredging episodes, the same as for the preceding alternative, since survey costs are dominated by mobilization and setup rather than the actual data collection. The equivalent annual cost of initial construction and maintenance for 50 years, discounted at an annual interest rate of 7.75 percent, is $509,400. This average annual cost is substantially higher than that ($343,500) for a longer channel at the same depth leading to a dock at the existing dock site. In summary--

Total first cost: $5,745,000.
Equivalent annual cost of construction plus 50 years' maintenance: $509,400.

6.4.4 Economic Benefits

The benefits related to transportation of goods and commercial fishing boats via the road to Iliamna Lake are equivalent to those for a channel at the same depth to the old dock site ($815,600 per year), except that cargo handling is somewhat less efficient. Traversing the causeway and turning trucks at its end would not be as fast as cargo transfer operations at the old dock site with an immediately adjacent staging area. This would tend to increase transportation costs by a small percentage, which corresponds to reducing benefits by a small percentage.

6.5 Boulder Removal

6.5.1 Operational Efficiency and Safety

The visible portions of boulders protruding from the tidal flats are 2 to 4 m in diameter and may not be removable by mechanical means. The most dangerous boulders were precisely located as a part of this study and were found to be at least 150 m distant from the natural tidal drainage channel. The location of these boulders has been provided to the National Oceanic and Atmospheric Administration (NOAA) for addition to future nautical chart publications. The boulders are quite stable and show no indication of migrating from their present locations. The surest way to remove the risk of collision with these obstructions is to shatter the larger rocks with explosives. The small pieces remaining would be scattered across and ultimately buried in the silty surface of Williamsport Bay, or they could be mechanically picked up and moved to shore or to deep water. The removal of boulders from the upper tidal flats would reduce or eliminate the risks of vessels colliding with or grounding on these boulders (see figure 13).

6.5.2 Environmental Impacts

Blasting would be performed in September and October, thus minimizing disruption of feeding, breeding, or migrating birds which may be in Iliamna Bay during summer months, as well as impacts to migrating fish. Blasting would be done at low tide so the acoustic shock would not be transmitted by water.

6.5.3 Cost

Boulder removal is estimated to cost $100,000 for the contract, $50,000 for associated surveys, design, and preparation of contract documents, and $50,000 to supervise and administer the work, for a total first cost of $200,000. The equivalent average annual cost of this work at 7.75 percent interest over 50 years is approximately $15,800.

6.5.4 Economic Benefits

Accidental groundings on boulders now present near the natural tidal drainage channel would be prevented, which would save an estimated $570 per year. The average annual cost far exceeds these benefits, so this alternative is clearly not economically justified by itself.

6.6 Improved Aids to Navigation and Nautical Charts

6.6.1 Operational Efficiency and Safety

These nonstructural alternatives would be most efficient if combined. The U.S. Coast Guard has indicated its capability to provide aids to navigation for channel improvements in Iliamna Bay. The Coast Guard would maintain this system on at least an annual basis. These aids to navigation could be installed without a channel improvement to achieve some tangible economic benefits. The safety of navigation in Iliamna Bay would be significantly improved with a system of fixed ranges on shore marking the best route across the tidelands into Williamsport. These aids could mark the alignment of the natural channel as a stand-alone measure. The meandering nature of the natural channel would make channel markers slightly less effective than aids marking an artificially maintained channel of linear increments. A well-designed arrangement of navigation aids would reduce the risk of groundings and collisions, allowing a smoother and more efficient approach and departure from Williamsport. Dangerous boulders now protruding from the tidal flats would be more easily avoided. No boulders are exposed and none were detected by geophysics within 150 m of the natural channel.

A comprehensive tidelands survey from outer Iliamna Bay into Williamsport and publication of an associated detailed nautical chart by NOAA would have a positive effect on marine safety. The maximum positive effect would occur if the new chart also includes the positions and characteristics of a new system of aids to navigation. Risks of unintentional groundings or collisions with boulders would be significantly reduced.

6.6.2 Environmental Impacts

Minor disturbance of tidelands during placement of navigation aids is the extent of anticipated environmental impacts. The increased safety would have a net positive effect by reducing the risk of groundings, collisions, and other accidents which might result in spill of fuel or other undesirable substances into Iliamna Bay. The range markers, as with most aids to navigation, are certain to become a preferred resting place for birds.

No adverse environmental impacts are associated with surveying and charting of Iliamna Bay. The risk of accidents which might result in spill of fuel or other undesirable substances into Iliamna Bay would be reduced, so the net effect on the environment would be positive.

6.6.3 Cost

The cost of navigation aids without a channel improvement is roughly the same as with a channel, though the position of range markers may vary. The Coast Guard estimates the cost of navigation aids for Iliamna Bay as $40,000 for installation, $2,500 per year for maintenance, and $40,000 for replacement in year 20 and year 40. The equivalent annual cost for aids to navigation in Iliamna Bay at 7.75 percent per year interest is $5,700.

The cost of surveys for publication of charts by NOAA is associated with the authorized mission of that agency and is not associated with the cost of engineering works at Williamsport.

6.6.4 Economic Benefits

The risk of groundings and collisions would be reduced, nearly as effectively as with boulder removal. A small risk of grounding would remain, since mechanical or electrical failure or extremely low visibility conditions may infrequently render the navigation aids ineffective. The navigation aids would prevent mariners visiting Williamsport for the first time from making wrong turns and becoming grounded where their vessels may be exposed to waves from outer Iliamna Bay. The damage prevention benefits of aids to navigation are subjectively estimated to be approximately 5 percent less than the boulder removal alternative, or about $2,850 per year. The added intangible justification of potential savings of life and limb may lead the Coast Guard to implement a system of navigation aids in Iliamna Bay, even though this analysis indicates the costs may not be fully offset by tangible economic benefits.

Improved nautical charts would enable more precise location of boulders exposed on the tidelands of Iliamna Bay and increase the effectiveness of a system of aids to navigation. The combination of these two measures would eliminate all but a small risk of boulder-related damages and as much as 20 percent of damages from other inopportune groundings, based on conversations with mariners at Williamsport. The benefits of improved nautical charts with a system of aids to navigation are estimated to be $1,600 per year.

6.7 Comparison

The establishment of a system of aids to navigation would occur with essentially no adverse environmental impacts. These aids would make it easy to avoid the dangerous boulders protruding from the upper tidal flats. Surveys by NOAA for publication of improved nautical charts would improve navigation safety in Iliamna Bay, also without adverse environmental impacts. The adverse impacts associated with boulder removal, though apparently slight, do not appear to be warranted if aids to navigation and chart refinements are accomplished. None of these three alternatives would substantially reduce the delays or transportation costs stemming from the present extremely limited tidal access to Williamsport.

The first cost of the earthfill causeway alternative is much higher than the cost of dredging a longer channel into Williamsport Bay to the site of the existing dock. Environmental impacts to the lower tidelands would be slightly greater with the longer channel, but impacts of the causeway to the upper tidelands would be avoided. The causeway must cross Williams Creek, while the old dock site alternative would avoid impacts at the creek mouth. Neither alternative would have major environmental impacts, but the old dock site alternative would confine its minor impacts to areas of the uplands and tidelands already impacted by present human uses. The old dock site alternative is therefore preferable on the grounds of costs, benefits, and environmental impacts.

6.8 Optimization of Channel Width and Depth

The alternative identified as the National Economic Development (NED) plan must, by Federal policy, have the greatest net benefits, i.e., the greatest positive difference between annual costs and benefits. The long-term benefits of the NED plan must exceed its long-term cost by a margin greater than any other alternative. Costs and benefits of an excavated channel vary with its width and depth, so increases in cost for added channel width and depth must be incrementally compared to the corresponding increases in benefits. This section describes the analyses undertaken to identify the NED plan.

6.8.1 Channel Width

This section approaches the incremental analysis of costs and benefits in two steps. The first deals with channel width, specifically with the added width and other features required to accommodate a coastal tugboat towing a cargo barge. A 40-m channel width is required and, for the same level of access, 1 meter additional depth. Furthermore, the barges are longer than landing craft and require a 60-m dock and a 90-m-square turning basin. These features increase the cost. A single barge can haul 5 to 10 times as much cargo tonnage as any of the Cook Inlet landing craft now available to serve Williamsport. Any improvement which would accommodate a tug and barge would also accommodate landing craft with essentially double the percentage of access to Williamsport.

The annual throughput at Williamsport, assuming some sort of channel improvement is accomplished, is projected to be on the order of 2,000 tons (see appendix B). A 56-m by 16-m flat-deck barge can transport 1,000 to 1,500 tons in one load, so deliveries need be much less frequent by this mode. Deliveries of 500 tons each by tug and barge would require only 4 visits, say one in each month of June to September. For the sake of comparison, a tug-and-barge channel design is considered which is deep enough to allow at least two windows of access each month, which occur during the spring tides on full and new moons. This calls for a water surface elevation of 3.5 m or higher over a channel excavated down to 0.5 m. This is equivalent to about 20 percent access for tugs which require 3 m total depth and to about 40 percent access for landing craft which require 2 m total depth for safe passage. A channel 40 m wide at an elevation of 0.5 m MLLW would allow tugs and barges to call at Williamsport twice a month, but would also allow landing craft to call at least once a week. A schedule of weekly visits by landing craft is sufficient for them to deliver 2,000 tons or more of cargo to Williamsport. This regularity of cargo deliveries would be convenient for the residents and businesses of Iliamna Lake communities, whose individual orders would be small and difficult to organize a month or more in advance.

The life-cycle costs of two configurations are compared in table 4. The first includes a channel 40 m wide at 0.5 m MLLW elevation; its costs are combined with those for a 90-m x 90-m turning basin, a 60-m dock, and an adjacent launch ramp. The second includes a channel 30 m wide at 0.5 m MLLW elevation; its costs are combined with those for a 55-m x 55-m turning basin, a 30-m dock, and an adjacent launch ramp. This second configuration would not absolutely exclude tug and barge service, but would render it much more difficult. Special deliveries of exceptionally large cargoes, perhaps for a major construction project, still would be possible with the second narrower configuration. Both

TABLE 4.--*Comparison of project costs for tug and barge v. landing craft service*

Channel width (m)	First cost	Equivalent annual cost [1]
40 m (tug and barge)	$3,346,000	$692,500
30 m (landing craft)	$3,149,000	$321,000

[1] Including associated maintenance dredging.

configurations allow the full projected Williamsport cargo throughput to be delivered, the first primarily by tug and barge and the second primarily by landing craft.

A coastal tug and barge may charter for $20,000 to $24,000 per 24-hour day. Landing craft charter for about $4,000 per 24-hour day. Assuming for the sake of comparison that at least 48 hours' charter fees are required for each delivery, tugs and barges delivering 500 tons of cargo per visit would make 4 visits involving 192 hours and $192,000. Landing craft delivering 100 tons per delivery would make 20 visits involving 960 hours and $160,000. The channel designs compared above would allow either of these scenarios to be equally likely. The design for landing craft is more affordable and accomplishes the seasonal throughput with more schedule flexibility and less charter cost. The wider channel, wider dock, and deeper turning basin to accommodate tug-and-barge service are not incrementally justified.

6.8.2 Channel Depth

The channel depth is optimized by comparison of the life-cycle costs for 0.5-m increments of increasing depth, from 1.5 m to -1.5 m MLLW, for a 30-m-wide channel leading to a 55-m x 55-m turning basin, a 30-m dock, and an adjacent launch ramp and staging area. This comparison is seen in table 5, based on detailed cost estimates prepared for comparison of alternataives. These costs are subtracted from corresponding total average annual benefits for each level of access to Williamsport by landing craft and commercial fishing vessels. Alternatives shallower than 1.0 m MLLW achieve no net benefits. Alternatives -0.5 m MLLW and deeper achieve the maximum access-related benefits, due primarily to the limited total cargo throughput projected for Williamsport. Deeper channels would cost more but achieve no more benefits; therefore, net benefits continuously decrease for channels deeper than -0.5 m.

The net benefits presented in table 5 demonstrate the optimum channel depth as -0.5 m MLLW, in terms of maximum net benefits. As discussed in appendix A, this conclusion is not sensitive to the frequency of maintenance dredging. This configuration is designated as the NED plan for navigation improvements at Williamsport. It is interesting to note that deeper channels are also economically feasible by a significant margin of net benefits. Channels deeper than -1.5 m MLLW were not addressed in this study, but it is conceivable, based on the apparent trend, that channels achieving full-tide access are economically feasible, though not optimum in terms of maximum net benefits. Major increases in cargo throughput at Williamsport beyond that projected, which would probably cause a shift to deeper-draft vessels, may call for future enhancement of a channel in Iliamna Bay. A future deepening and widening of the proposed channel could be considered under such circumstances with a serious prospect for economic feasibility.

TABLE 5.--*Comparison of costs and benefits for various channel depths*

Channel depth (m)	**First cost ($)**	**Average annual cost ($)**	**Average annual benefits ($)**	**Net benefits ($)**	**Benefit-to-cost ratio**
1.5	2,810,000	291,100	63,800	0	0.2
1.0	2,960,300	304,400	201,500	0	0.7
0.5	3,149,000	321,000	524,600	203,600	1.6
0.0	3,405,600	343,500	815,600	472,100	2.4
-0.5	3,816,000	379,600	1,011,500	631,900	2.7
-1.0	4,433,200	433,600	1,011,500	577,900	2.3
-1.5	5,216,600	502,400	1,011,500	509,100	2.0

7. The Recommended Plan

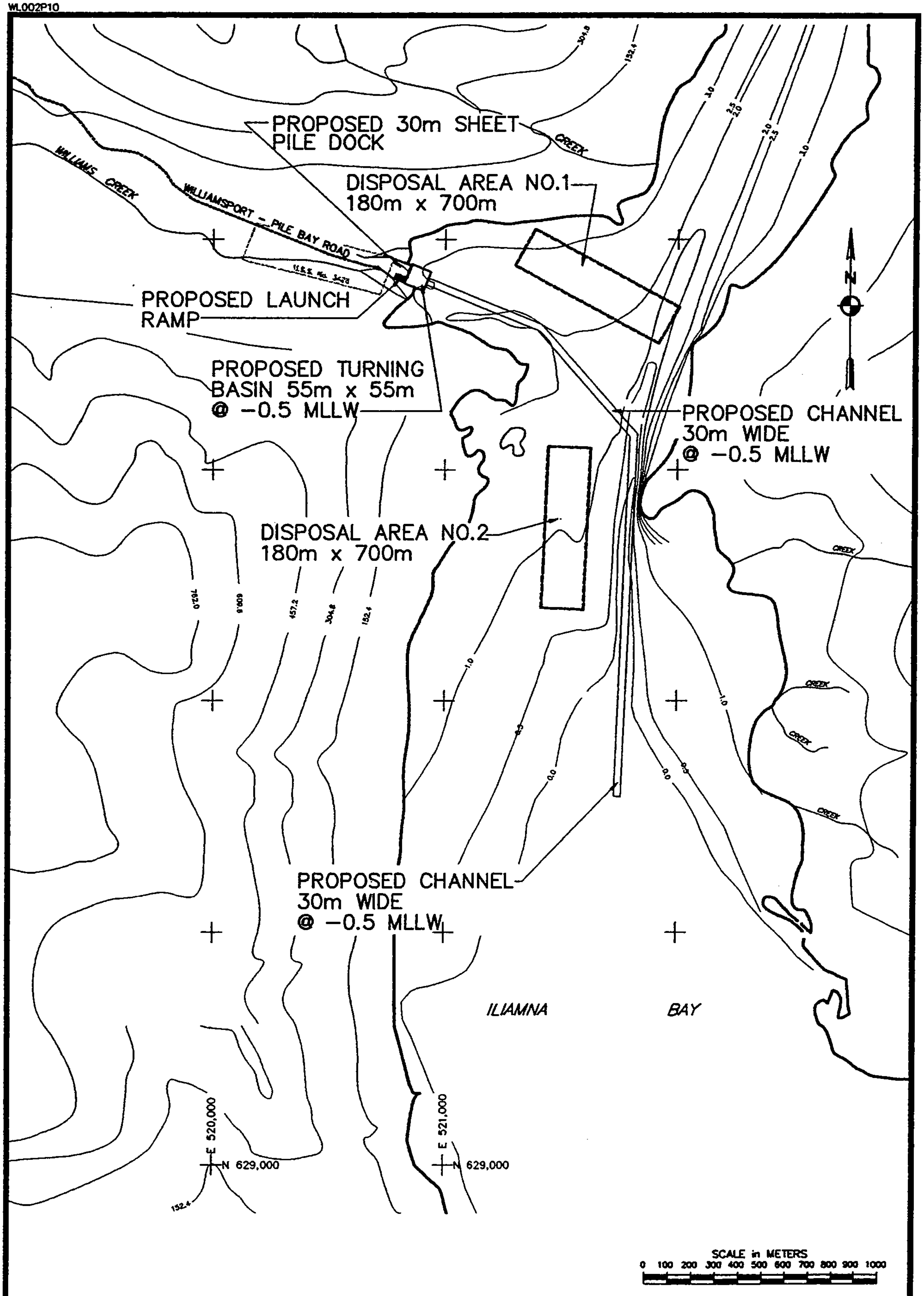
7.1 Description

The navigation improvement plan with the optimum characteristics, based on present knowledge of conditions at Williamsport and the surrounding region, is illustrated in figure 20. A plan view of the turning basin, dock, and launch ramp is shown in figure 21. Cross sections of the dock and ramp are shown in figure 22. This plan has the following characteristics:

Channel length	2,700 m
Channel width	30 m
Channel bottom elevation	-0.5 m MLLW
Channel excavation quantity	129,825 m^3
Turning basin length	55 m
Turning basin width	55 m
Turning basin bottom elevation	-0.5 m MLLW
Basin excavation quantity	11,875 m^3
Dock face length	30 m
Dock wing wall length at ramp	44 m
Dock surface elevation	7.0 m MLLW
Launch ramp width	12 m (8 m paved)
Launch ramp paved length (on 15% slope)	40 m
Staging area adjacent to dock and ramp	0.4 hectares

The excavation would be accomplished by cutterhead pipeline dredge. Excavated material would be pumped as a slurry to be diffused onto two 700-m by 180-m tidelands disposal areas shown in figure 20. The dock and launch ramp would be constructed by conventional means during the same May-to-November period when the dredging would take place. The most efficient arrangement would be for a single contract to be awarded for both increments of work, so the dredgers and dock constructors could share transportation arrangements, camp facilities, staging area, and operational support. An Environmental Assessment of this plan follows this main report.

WL002P10



ALASKA DISTRICT
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CIVIL WORKS BRANCH

RECOMMENDED PLAN

WILLIAMSPORT NAVIGATION IMPROVEMENTS

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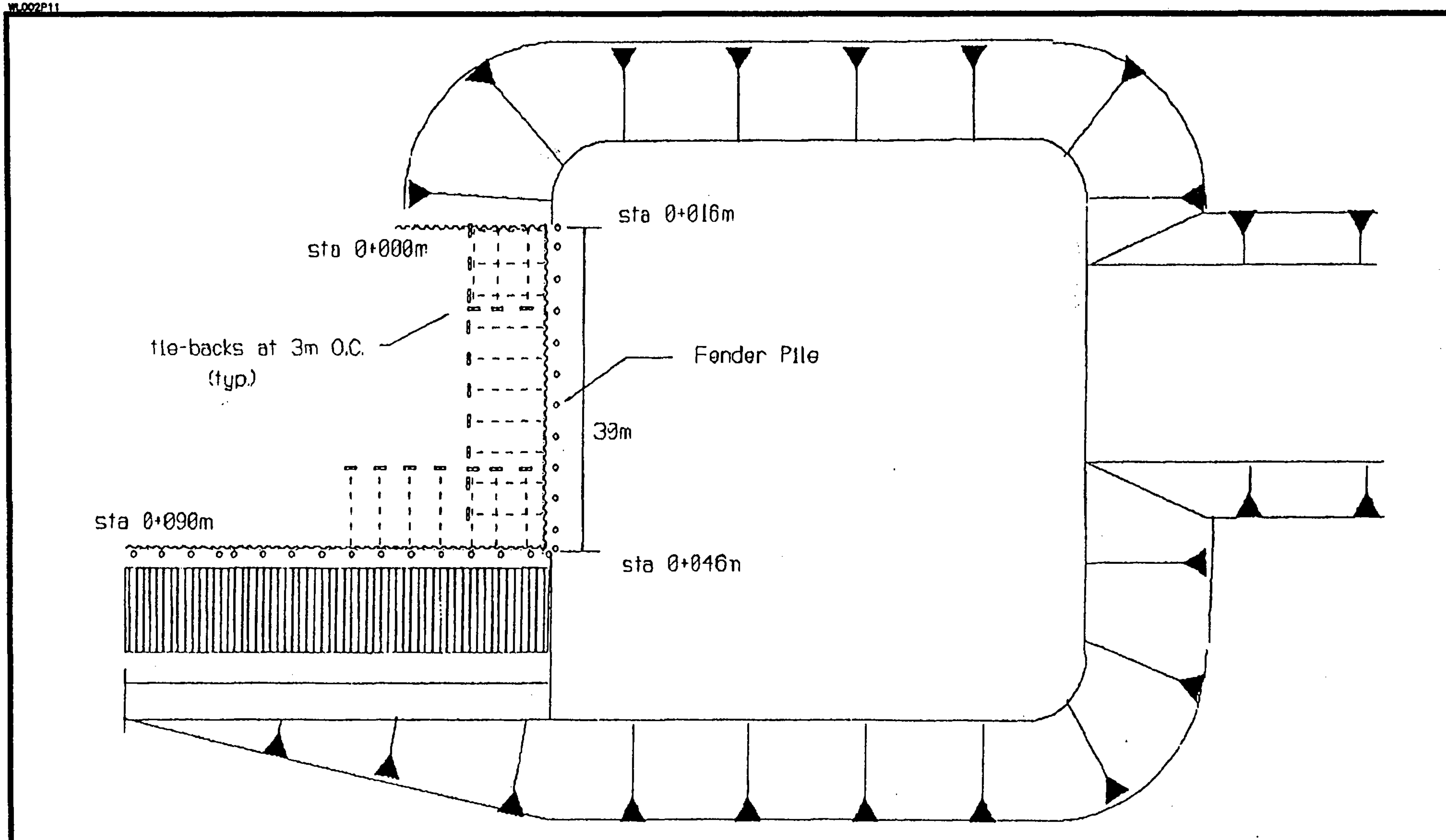
WL002P11



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PLAN VIEW OF BASIN, DOCK, AND LAUNCH RAMP

WILLIAMSPORT NAVIGATION IMPROVEMENTS

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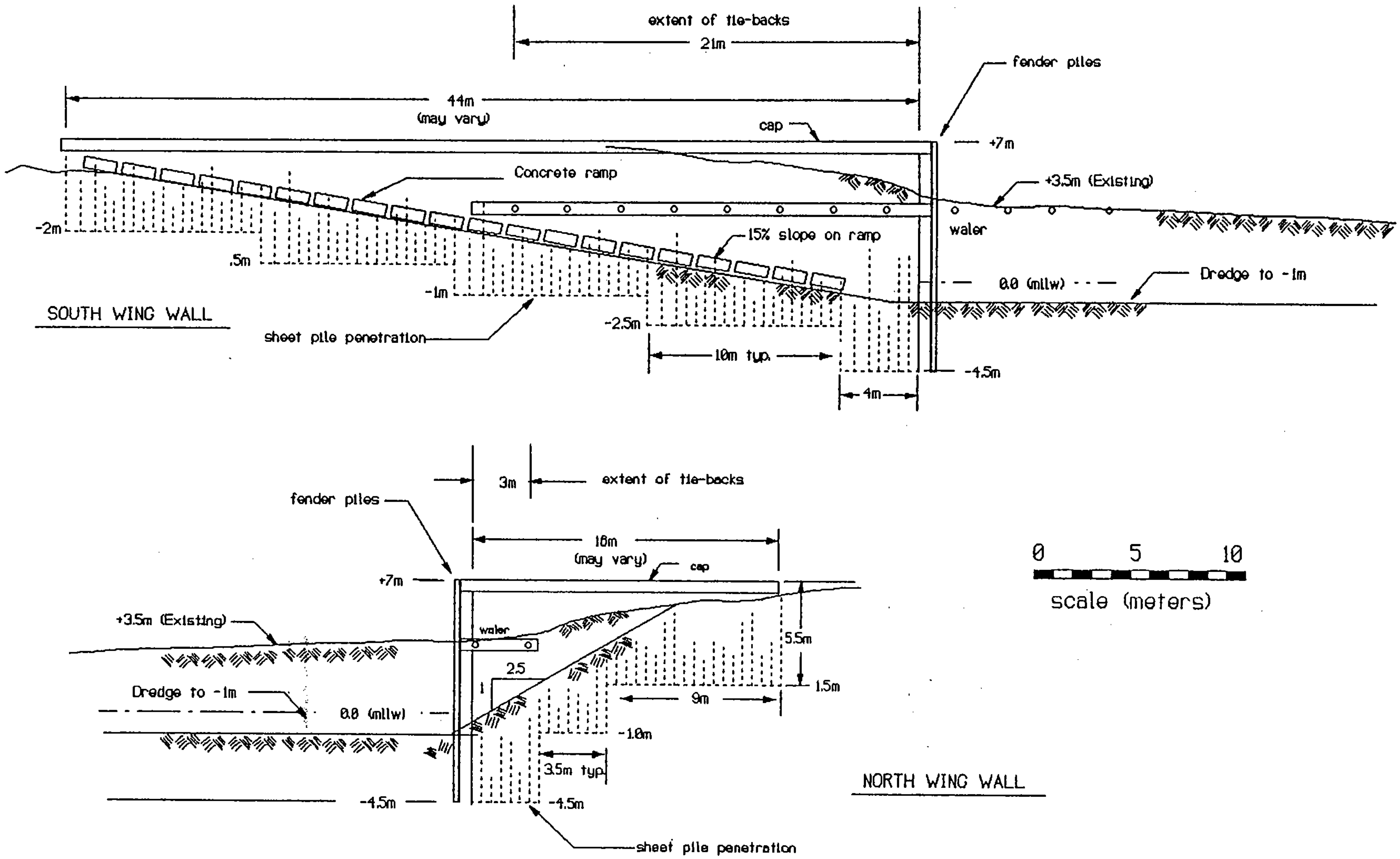
WL002P12



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CROSS SECTION OF DOCK AND LAUNCH RAMP

WILLIAMSPORT NAVIGATION IMPROVEMENTS

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7.2 Real Estate Requirements

The non-federal sponsor of the project will be responsible for providing all lands, easements, rights-of-way, relocations, and dredged material disposal areas (LERRD) necessary for construction, operation, and maintenance of the project in compliance with Public Law 91-646, as amended. The LERRD needed for the project include 36.7 hectares (ha) as itemized in table 6. One hectare equals about 2.5 acres. The National Economic Development (NED) features of the project include a dock, a ramp, a dredged turning basin, and a dredged channel. The real estate affected by the project includes the Williamsport-Pile Bay road, adjacent upland, and tidal lands. The road and tidal lands are owned by the State of Alaska. Adjacent uplands are privately owned.

No real estate interest is required where construction or dredging will occur in tidal lands (below Mean High Water) as these areas are subject to the Federal Government's right of navigational servitude. Two disposal areas of 13 ha each, located in tidal lands subject to navigational servitude (see figure 20), will be used for the placement of dredged material. The existing dock will be removed as a part of the initial construction work. No relocations of utilities or public facilities are required. A temporary staging area will be needed during construction. Public access is available to the project area. The real estate requirements, itemized in table 6, are estimated to cost $44,000, including a 25-percent contingency.

TABLE 6.--*Real estate requirements*

Feature	Area (hectares)	Landowner	Interest required
Entrance channel	9.6	State of Alaska tidelands	Navigational servitude
Turning basin	0.4	State of Alaska tidelands	Navigational servitude
	0.1	Private	Permanent easement
Dredged material disposal areas	(2 @ 13 ha each) 26	State of Alaska tidelands	Navigational servitude
Dock and launch ramp	0.2	State of Alaska tidelands; private	Permanent easement
Upland staging area adjacent to dock	0.4	Private	Temporary easement
TOTAL	36.7		

7.3 Cost Estimate

Incremental costs for the recommended plan are presented in table 7, itemized as Federal and non-federal costs according to relevant statutes and regulations as summarized in section 1 of this report. The National Economic Development (NED) costs are summarized in table 8. These are the costs used to evaluate economic feasibility by Federal standards; they include refinements incorporated after the optimum plan was identified in this study.

Interest during construction (IDC) is added to the first cost to account for the opportunity cost incurred during the time after the funds have been spent and before the benefits begin to accrue. IDC is calculated by matching the construction expenditure flow with interest forgone had the funds been deposited in an interest-bearing account. The actual construction schedule is not known at this time; however, the construction period is assumed to be 9 months. For this analysis level monthly expenditures are assumed.

Preconstruction engineering and design (PED) cost of $371,000 plus 1 year of interest at 7.625 percent is included in the first cost. The IDC for a first cost of $3,843,000 is $77,600.

7.4 Channel and Turning Basin Maintenance

Maintenance dredging of the channel and turning basin is estimated to be necessary at a frequency of 5 years to excavate volumes no more than 25 percent of the initial excavation quantity. Hydrographic surveys to monitor the condition of the channel and basin would be conducted by the Federal Government at 5-year intervals. Annual surveys would be accomplished in the first 4 years following the initial excavation. The U.S. Coast Guard has indicated its proposed system of three shore-based visual ranges for marking the channel at Williamsport would require replacement at 20-year intervals. The Coast Guard would inspect these navigational aids annually and perform routine maintenance. The staging area and upper surface of the dock would be maintained annually in conjunction with the road. The sacrificial anodes and fender piles on the dock would require replacement every 10 years. The sheet-pile and tieback system, with this regular maintenance, is conservatively estimated to last 30 years, at which time a complete replacement of the steel components would be required. The incremental cost and

TABLE 7.--*Cost estimate for the recommended plan, Williamsport, Alaska (October 1995 price levels)*

Item	Quantity	Unit	Unit Price ($)	Cost ($)	Contingency (%)	Contingency ($)	Total ($)	NED Costs ($) Federal	NED Costs ($) Non-federal
CHANNEL EXCAVATION									
Mobilization and demobilization	job	each	336,000	336,000	20	67,000	403,000	322,400	80,600
Dredging (channel & turning basin)	141,700	m^3	6.86	972,100	25	242,700	1,214,800	771,900	242,900
Associated surveys	job	each	72,200	72,200	25	18,000	90,200	72,200	18,000
Subtotal				1,380,300		327,700	1,708,000	1,366,400	341,600
PORT FACILITIES									
Mobilization and demobilization	job	each	100,000	100,000	33	33,000	133,000	0	133,000
Remove existing dock ruins	job	each	20,000	20,000	33	6,600	26,600	0	26,600
Sheet-pile bulkhead (new dock)	job	each	679,800	679,800	33	234,000	903,200	0	903,200
Launch ramp (40 m x 8 m)	job	each	165,200	165,200	33	54,500	219,700	0	219,700
Staging area adjacent to dock	4,000	m^2	15.50	62,000	33	20,500	82,500	0	82,500
Subtotal				1,026,400		338,600	1,365,000	0	1,365,000
TOTAL CONSTRUCTION CONTRACTS				2,406,700		666,300	3,073,000	1,366,400	1,706,600
LERRD	job	each	35,200	35,200	25	8,800	44,000	25,000	19,000
ENGINEERING AND DESIGN									
Federal	job	each	167,000	167,000	20	34,000	201000	160,800	40,200
Non-federal	job	each	142,000	142,000	20	28,000	170,000	0	170,000
Subtotal				309,000		62,000	371,000	160,800	210,200
CONSTRUCTION MANAGEMENT									
Federal	job	each	108,000	108,000	15	16,000	124,000	99,200	24,800
Non-federal	job	each	142,000	142,000	20	28,000	170,000	0	170,000
Subtotal				250,000		44,000	294,000	99,200	194,800
AIDS TO NAVIGATION (3 ranges, U. S. Coast Guard)	lighted ranges	3	11,100	33,300	20	6,700	40,000	40,000	0
TOTAL PROJECT COST				**3,034,200**		**787,800**	**3,822,000**	**1,691,400**	**2,130,600**

frequency of these maintenance requirements are presented in table 9, along with their equivalent annual cost at 7.625 percent per year interest for 50 years.

TABLE 8.--*Summary of project costs (October 1995 price level)*

Item	Cost ($)
Total NED construction cost	3,822,000
NED interest during engineering & design	21,000
NED interest during construction	77,600
NED investment cost	3,920,600
Annual value of NED investment (50 years @7.625%)	306,700
Annual NED maintenance cost	185,000
TOTAL ANNUAL NED COST	**491,700**

TABLE 9.--*Maintenance costs*

Maintenance increment	Cost ($)	Frequency (years)	Equivalent annual cost ($)
Navigation aids (U.S. Coast Guard)	2,500	1	2,500
Grade staging area (non-federal)	3,700	1	3,700
Surveys (Federal)	40,000	5	17,100
Dredging (Federal)	792,900	5	132,400
Replace fenders, ramp concrete, and anodes (non-federal)	317,000	10	18,600
Replace navigation aids (U.S. Coast Guard)	40,000	20	900
Replace sheet-pile dock (non-federal)	1,177,300	30	9,800
Total equivalent annual maintenance cost			**185,000**

7.5 Project Benefits

The benefits for the recommended plan are summarized in table 10 and are discussed in detail in appendix B. The net annual benefits (total annual benefits less total annual costs) for the recommended plan are $1,033,600. The recommended plan had the greatest net benefits of any of the alternatives studied. The ratio of total annual benefits to average annual costs is 3.1.

TABLE 10.--*Average annual benefits for the recommended plan*

Benefit category	**Amount ($)**
Vessel damages prevented	5,700
Savings in transportation of commodities	415,800
Reduction of construction delays	21,300
Savings in transportation, maintenance, and storage of commercial fishing vessels	1,082,500
Total annual benefits	**1,525,300**

7.6 Non-federal Sponsorship

The Kenai Peninsula Borough government has jurisdiction over land at Williamsport and has sponsored this feasibility study with the financial support of the Alaska Department of Transportation and Public Facilities. The Lake and Peninsula Borough has jurisdiction over lands along most of the Williamsport-Pile Bay Road and over the Iliamna Lake region. The State of Alaska is responsible for the road itself and has indicated its intent to maintain the road and improve it as traffic increases. All three non-federal governments have an economic interest in the transportation improvements recommended for Williamsport and have indicated support for the recommended plan. The final division of responsibilities between these non-federal governments will be determined as the Project Cooperation Agreement for project implementation is developed.

An important consideration for non-federal sponsorship is the limitation of the Federal authority, under Section 107 of the 1960 Rivers and Harbors Act (as amended), to maintain the recommended channel in Iliamna Bay. The Corps' authority to maintain the project is limited to a total expenditure of 2.25 times the Federal first cost or $4,500,000, whichever is more. The applicable limit is $4,500,000 for Federal maintenance (not including aids to navigation), plus the initial Federal project cost, which exceeds the estimated life-cycle cost for maintaining the channel. The Federal Government by this estimate has the authority to maintain the proposed channel for approximately 30 years.

The non-federal sponsor for construction of the project must enter into a Project Cooperation Agreement with the Federal Government to share the cost of construction as itemized in table 7. The non-federal sponsor will maintain the dock and launch ramp and operate these facilities so they remain available to all segments of the public on equal terms. The agreement will specify continuous conformance to all applicable Federal, State, and local laws and administrative regulations with special regard to protection of human safety and the environment. The Federal Government will be held harmless for liability associated with use of the project by the public. These terms will be included in the agreement. This agreement must be signed and funds made available before preparations for project construction can begin.

The non-federal sponsor will be required to submit a tideland permit application to the Alaska Department of Natural Resources for construction of the dock and ramp. The sponsor will need to provide the Corps with a copy of this application. The Corps will include the application with a Coastal Zone Management Program review request to the State Division of Governmental Coordination. These requirements are necessary to comply with the State's coastal management program.

8. Conclusions and Recommendations

8.1 Conclusions

Investigations of physical conditions and economic needs show that Federal participation in navigation improvements in Iliamna Bay at Williamsport is justified. Improvements consisting of a 30-m-wide channel dredged at -0.5 m MLLW, a 55-m x 55-m turning basin at the same elevation located at the head of the basin, a 30-m sheet-pile bulkhead at the head of the basin, and a 12-m-wide launch ramp adjacent to the bulkhead are predicted to achieve maximum net economic benefits. The initial cost of implementation for this plan is estimated to be \$3,822,000. Average annual benefits for the plan are estimated to exceed its average annual costs by \$1,033,600, for a benefit/cost ratio of 3.1. Environmental effects of implementation appear to be acceptable. Federal costs are estimated to be \$1,691,400 for design and construction, which is within the authority granted by Section 107 of the 1960 Rivers and Harbors Act, as amended. A non-federal sponsor is available to share the cost and responsibility for the completed project. These conditions satisfy essential requirements for Federal participation in design, construction, and maintenance of the proposed navigation improvements.

8.2 Recommendations

I recommend that the plan proposed in this report for navigation improvements at Williamsport be implemented with the participation of the Federal Government at an estimated initial Federal cost of \$1,691,400. This recommendation is contingent on the non-federal sponsor's satisfying the following requirements prior to construction:

a. The non-federal sponsor must contribute in cash the initial non-federal share of project design and construction cost for the general navigation features of the project;

b. The non-federal sponsor must provide, without cost to the United States, all lands, easements, and rights-of-way necessary for the construction, operation, and maintenance of the project, including disposal areas for dredged material;

c. The non-federal sponsor must accomplish, without cost to the United States, all relocations of structures and related alterations required for construction, operation, and maintenance of the project;

d. The non-federal sponsor must agree to hold and save the United States free from damages due to the construction and maintenance of the project, except damages due to the fault or negligence of the United States or its contractors;

e. The non-federal sponsor must assume responsibility for construction of all non-federal project features, including the dock, launch ramp, and adjacent staging area, and for operation and maintenance of these features in accordance with regulations prescribed by the Secretary of the Army;

f. The non-federal sponsor must assume financial responsibility for the cleanup of hazardous materials located on project lands and covered under the Comprehensive Environmental Response, Compensation, and Liability Act without cost-sharing credit;

g. The non-federal sponsor must agree to operate and maintain the project so that liability will not arise under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act; and

h. The non-federal sponsor must agree to operate and maintain the dock, launch ramp, and adjacent staging area open and available to all on equal terms.

i. The non-federal sponsor must agree to assume responsibility for operation and maintenance of all project features, including both Federal and non-federal features, in the event that Federal expenditures for construction and maintenance exceed $4,500,000.

I also recommend that the U.S. Coast Guard review the present navigation practices and problems that occur along the approaches to Williamsport and design a system of navigational aids to help mariners safely find their way past natural hazards which now exist in Iliamna Bay.

I further recommend that the National Oceanic and Atmospheric Administration conduct surveys of the approaches to Williamsport in Iliamna Bay and revise nautical charts to reflect the findings of these surveys, including, if possible, any new aids to navigation to be installed by the U.S. Coast Guard.

These recommendations are based on the information available at the time this report was published and on current administrative policies. Recommendations for Corps of Engineers efforts may be modified to conform to program and budget priorities inherent in the formulation of the national Civil Works construction program, upon review by Federal officials outside Alaska. Recommendations to the U.S. Coast Guard and the National Oceanic and Atmospheric Administration are advisory in nature and are made with the understanding that administrators of these agencies will make independent decisions regarding needs and actions in Iliamna Bay.

Date: ______________

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PETER A. TOPP
Colonel, Corps of Engineers
District Engineer

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Environmental Section

Finding of No Significant Impact
Environmental Assessment (EA)

EA Appendix 1: Clean Water Act Evaluation, Section 404(b)(1)
EA Appendix 2: Fish and Wildlife Coordination Act Report
EA Appendix 3: Correspondence

FINDING OF NO SIGNIFICANT IMPACT
AND
ENVIRONMENTAL ASSESSMENT

WILLIAMSPORT NAVIGATION IMPROVEMENTS
WILLIAMSPORT, ALASKA

FINDING OF NO SIGNIFICANT IMPACT

In accordance with the National Environmental Policy Act of 1969, as amended, the U.S. Army Engineer District, Alaska, has assessed the environmental effects of the following action:

Williamsport Navigation Improvements
Williamsport, Alaska

Under Section 107 of the Rivers and Harbors Act of 1960, as amended, the Army Corps of Engineers has found a Federal interest in navigation improvements at Williamsport. The project will involve construction of a new dock, dredging a shallow-draft channel, and dredging a turning basin adjacent to the dock. Dredged material from the channel will be disposed of in the tidal flats close to the project. This project will facilitate the transshipment of fishing vessels and cargo bound for Iliamna Lake and its tributaries, or through Iliamna Lake and the Kvichak River to Bristol Bay communities.

The project is not expected to have significant environmental effects. To mitigate effects to migrating herring and salmon, the Corps of Engineers will not conduct any dredging activities from April 1 through mid-June. The project will not have adverse effects on threatened and endangered species because none are known to exist in the area during the summer construction season. To mitigate potential impacts on Steller's eiders (a proposed threatened species), which are known to occur in the area during winter, the Corps of Engineers or the U.S. Fish and Wildlife Service will conduct a preconstruction survey to confirm that no eiders remain in the area. To minimize impacts to Williams Creek, all equipment staging and fuel storage will be set back from the creek a minimum of 75 feet where possible. To avoid destruction of active migratory bird nests, no brush clearing will occur from May 1 through July 15. If blasting is required to remove large boulders from the channel, State blasting standards will be adhered to in order to minimize impacts to fish, birds, and mammals.

The accompanying environmental assessment supports the conclusion that the proposed project will not constitute a major Federal action significantly affecting the quality of the human environment. The proposed action is also consistent with the State coastal zone management plans to the maximum extent practicable. Therefore, an environmental impact statement is not necessary for navigational improvements at Williamsport.

Peter A. Topp Colonel, Corps of Engineers District Engineer	Date

ENVIRONMENTAL ASSESSMENT

WILLIAMSPORT NAVIGATION IMPROVEMENTS
WILLIAMSPORT, ALASKA

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June 6, 1995

ENVIRONMENTAL ASSESSMENT

WILLIAMSPORT NAVIGATION IMPROVEMENTS
WILLIAMSPORT, ALASKA

1. Purpose and Need of the Proposed Action

The purpose of the proposed action is to construct navigation improvements at Williamsport, Alaska. This would include dredging a channel and constructing a new dock to replace the existing one. The dilapidated, makeshift wooden dock at Williamsport is used intermittently in the shipment of cargo and transport of fishing vessels from Cook Inlet to the communities on Iliamna Lake or to Bristol Bay. Shallow water prevents access by barges and landing craft except for an hour or two at the peak of extreme high tides, which occur only two or three times per month. Incoming barges must be towed the last quarter-mile or more by a motorboat to reach the dock, often running aground in the process. Several boulders protruding from the tidal flats have caused extensive damage to approaching vessels. A new dredged channel and barge landing facility would permit cargo transport during normal high tides and would reduce damage to vessels. The project is authorized under the continuing authority provided by Section 107 of the River and Harbor Act of 1960, as amended.

2. Description of the Proposed Action

Williamsport is in southwestern Alaska, about 320 kilometers (km) southwest of Anchorage, on the western shore of Iliamna Bay in Cook Inlet (figure 1). Iliamna Bay opens onto Kamishak Bay on the southwestern margin of the inlet. Williamsport, at the mouth of Williams Creek, is surrounded by the Chigmit Mountains of the Aleutian Range (figure 2). It is the eastern terminus of the 25-km Williamsport-Pile Bay Road, which is owned and maintained by the State of Alaska. The road connects Cook Inlet at Williamsport to Iliamna Lake at the settlement of Pile Bay on its eastern shore. The Williamsport-Pile Bay Road is used for transshipment of cargo and fishing vessels bound for Iliamna Lake and its tributaries, or through Iliamna Lake and the Kvichak River to Bristol Bay communities. This road reduces vessels' travel time between Cook Inlet and Bristol Bay by several days and more than 1,600 km of hazardous Gulf of Alaska waters.

The proposed project would involve dredging a shallow-draft channel in addition to constructing a new dock. These navigation improvements would reduce damage to cargo vessels that run aground during periods of inadequate tides. Gill-net fishing boat traffic from Cook Inlet to Bristol Bay via Williamsport, Iliamna Lake, and the Kvichak River could be increased if access to the Williamsport-Pile Bay Road were improved. A well-marked channel would eliminate the chance of vessels running into large boulders

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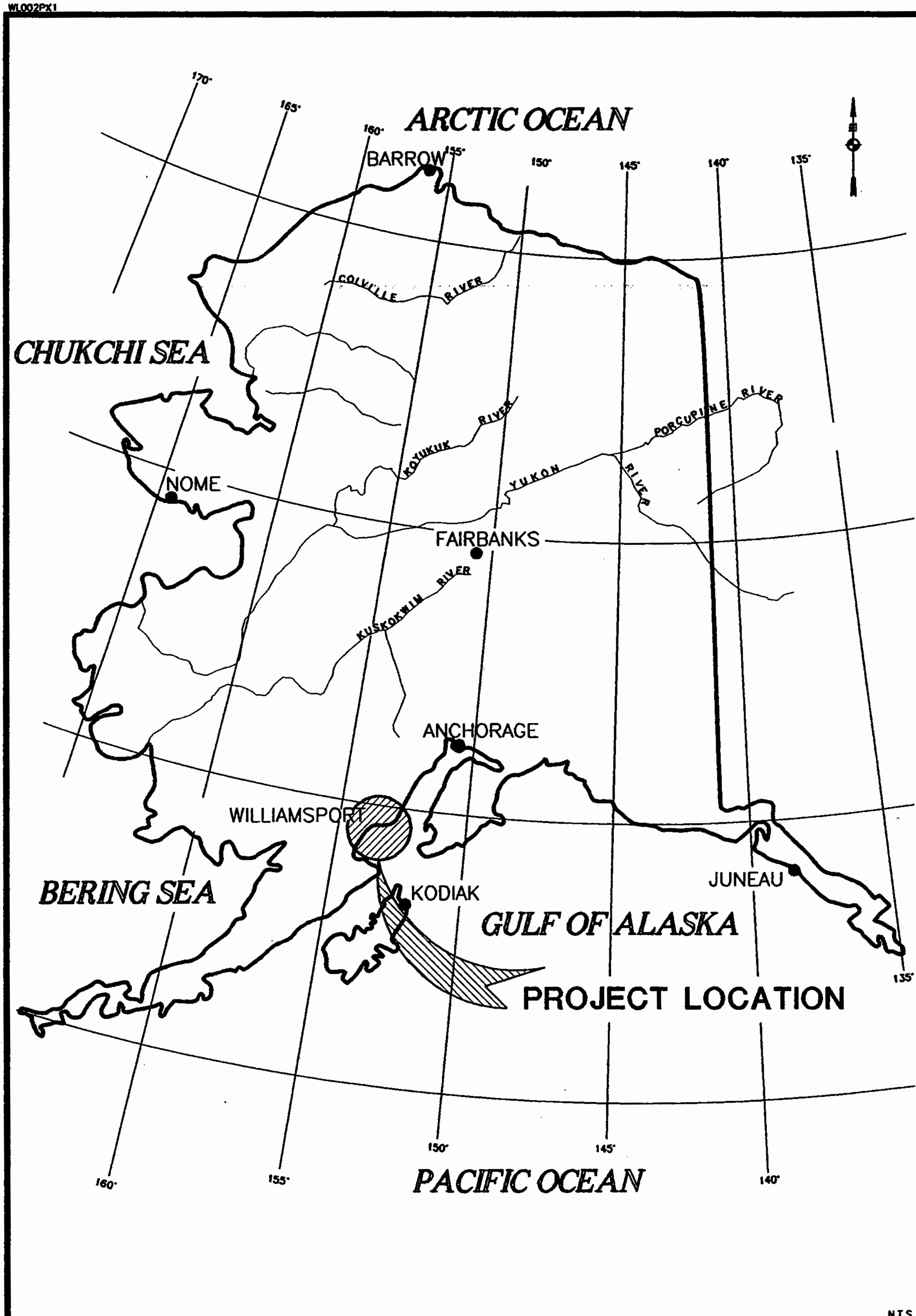

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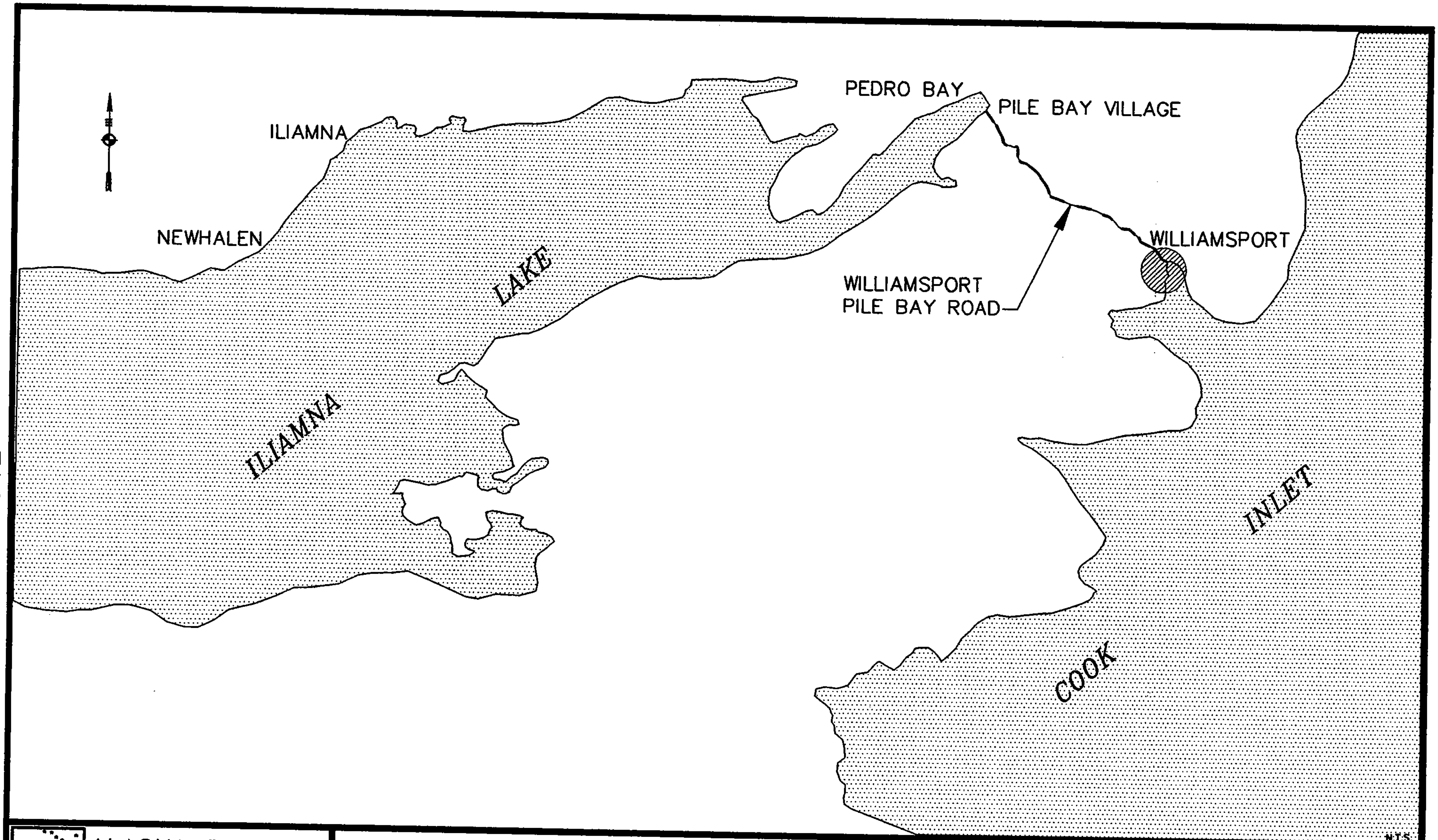

ALASKA DISTRICT
CORPS OF ENGINEERS
CIVIL WORKS BRANCH

PROJECT SITE
WILLIAMSPORT NAVIGATION IMPROVEMENTS

EA-2

that are scattered throughout the bay. It would also reduce cargo vessel delays that have occurred in the past due to the extremely short favorable tide windows.

3. Alternatives Considered

3.1 No-Action Alternative

The no-action alternative would leave the site in its present condition. Incoming barges would have to continue being towed the last quarter-mile or more by motorboat to reach the dock, potentially running aground in the process. Boulders protruding from the tidal flats could continue to cause extensive damage to approaching vessels. When barges do reach the dock, problems would continue to occur in transferring heavy cargo to the dilapidated dock, potentially resulting in damaged equipment, expensive repairs, and delays in construction schedules. Without an overland route between Cook Inlet and Bristol Bay, most owners of gill-net commercial fishing vessels would continue to make the 1,600-km trip through False Pass and the Gulf of Alaska, an expensive, time-consuming, and often unsafe route.

3.2 Proposed Alternative: New Dock, Turning Basin, and Channel

This alternative involves dredging a 2,700-meter-long shallow-draft channel and constructing a new dock. A turning basin, 55 square meters (m^2) in area, would be dredged adjacent to the dock. Construction of a turning basin would require removal of an estimated 11,875 cubic meters (m^3). The dock, designed by the State of Alaska, would be a rectangular steel sheet pile retaining wall, filled with gravelly dredged material and capped with uniform coarse gravel. The dredged channel would be about 30 meters wide and would be dredged to -0.5 meter. The alignment of the channel would take maximum advantage of natural depths and minimize dredging quantities. It would also maximize natural flushing of the channel improvements and thus minimize sedimentation in the excavation. An estimated 129,825 m^3 of material would be dredged from the channel. Maintenance dredging of the channel would be required following the initial excavation.

Dredged material from Williamsport and Iliamna Bay would consist of gravelly sand interspersed with coarse gravel. One proposed disposal site for this material is at the mouth of Iliamna Bay in Cook Inlet. This site is in 11 meters of water with a mud/silt substrate bottom. Another disposal site would be closer to the project area on the tidal flats of Williamsport. Sediments would be side-cast immediately adjacent to the dredged channel. This alternative would be less expensive than using the deep water site, and it is not expected to result in refilling of channel sediments due to low sedimentation rates (about 10 centimeters [cm] per year) in Iliamna Bay.

Sediments in Iliamna Bay and at the proposed deep-water disposal site were tested in 1994 and were found to have similar compositions of silt, sand, and mud in the upper layer of the samples. In the channel, the layer of fine material is underlain with coarser sediments (gravel). Surface sediments at the deep-water disposal site are similar in grain size to surface sediments in the proposed channel.

The sediments were also tested for potential contaminants, including volatile and semivolatile organic compounds, pesticides/polychlorinated biphenyl (PCB) compounds, metals, and total recoverable petroleum hydrocarbons. All of the samples collected either had no detectable contaminant levels or had levels below sediment management standards.

Blasting is being considered to remove large boulders from the dredged channel. These boulders would be too large to remove with the dredging equipment. It is the policy of the Alaska Department of Fish and Game (ADF&G) not to allow blasting within one-fourth mile of any anadromous fish stream or within any of the waters of the State of Alaska. This authority is derived from the Anadromous Fish Act (A.S. 16.05.870). However, the ADF&G may allow the boulders to be blasted out of place provided that State blasting standards are met. These standards may include:

- timing restrictions to avoid impacting migrating salmon;
- restrictions on the frequency and force of the explosions;
- restricted areas near salmon streams; and
- use of scare devices to scare away birds or marine mammals within the project area.

4. Affected Environment

4.1 Physical Environment

Williamsport is near the head of Iliamna Bay, which opens onto Kamishak Bay on the southwest side of Cook Inlet. It is part of the Kenai Peninsula Borough Coastal Zone. The landward limit of the interim coastal zone boundary is the 305-meter elevation contour. The seaward boundary of this zone is the 3-mile limit of State jurisdiction. On the west side of Cook Inlet, the 305-meter elevation contour approximates the vegetation break between coastal forests and alpine tundra, the upper limit of anadromous fish spawning, and the upper limit of areas used for intensive feeding by bears, small mammals, gulls, bald eagles, and Dolly Varden.

This area is a transition zone from interior to maritime climate with mild winters, cool summers, high precipitation, and frequent storms. Precipitation on the west side of

Cook Inlet is estimated to be about 50 percent higher than on the east side. The mean annual precipitation for Homer, directly east of Williamsport across Cook Inlet, is 62 cm.

Soils in the Iliamna Bay area are well-drained, sandy soil, and silty volcanic ash with some peat. The intertidal/subtidal substrate of Iliamna Bay consists of silt and mud underlain with gravelly sand and coarse gravel. Numerous large boulders are scattered throughout the bay. Sedimentation of Iliamna Bay probably comes from Cook Inlet, where long-term circulation brings silty water down the west side of the inlet and the quiet waters of Iliamna Bay allow settlement of fine materials. Sedimentation occurs at the rate of about 10 cm/yr.

4.2 Biological Environment

Vegetation

Vegetation in Iliamna Bay differs considerably from the west side to the east side. On the west side is a coastal western hemlock-Sitka spruce forest, with some birch and poplar. The east side of the bay is a high brush system, with open deciduous vegetation. The upland vegetation is dominated by alder with some willow. Wet meadows occur along the flats adjacent to the bay. *Elymus arenarius* (a ryegrass) is the dominant wetland species, along with *Carex* species (sedges) and seabeach sandwort. This vegetation gives way to tideflats and shallow waters at the head of Iliamna Bay. Typical riparian vegetation borders Williams Creek.

Marine Infauna

The diversity and abundance of the marine sediment infauna was found to be low during a 1994 field investigation. The species assemblage, usually dominated by clams, is characteristic of mud beaches of lower Cook Inlet in general. The dominant invertebrate species found was *Macoma balthica*, a small pink clam. Shells of several other species were seen which included: *Fusitriton oregonensis*, a snail; *Mya arenaria*, a soft shell clam; *Clinocardium nuttalli*, a cockle; *Saxidomus giganteus*, a clam; and *Mytilus edulis*, a blue mussel. Other organisms found in the sediments included unidentified polychaetes and sipunculid worms.

Fish

The ADF&G has not conducted fish inventories for Williams Creek, which drains into Williamsport at the project site. Anecdotal information indicates chum and pink salmon likely use the creek. Dolly Varden char are distributed throughout the project area and adjacent waters. Although ADF&G has not conducted area-specific studies on pink and chum salmon fry emigration in Cottonwood or Iliamna Bays, the agency believes that fry emigrate through these bays from early April through mid-June. Herring spawning migration usually occurs in Iliamna Bay from mid-April through early June.

Birds

No data has been published regarding bird species in the Williamsport area. Species that can be expected in the project area include marine birds, shore birds, waterfowl, raptors, and passerines. Birds observed during the 1994 survey include warblers, winter wren, golden-crowned sparrow, pelagic cormorant, common murre, greater scaup, horned puffin, black-legged kittiwake, and magpie. One bald eagle was observed during the site visit. The greater Iliamna Bay area is a wintering ground for waterfowl and sea birds. Several sea bird colonies are in the area, including White Gull Island and Turtle Reef, both located at the mouth of Iliamna Bay.

Mammals

Little information has been published on the mammals of the Williamsport area. Residents of Pile Bay, however, have reported seeing the following animals in the area: brown bear, moose, red fox, beaver, snowshoe hare, arctic ground squirrel, red squirrel, marten, ermine, shrew, and red-backed vole. Mammals observed during the 1994 site visit included harbor porpoise, red fox, brown bear, and beaver. In the Iliamna Lake region, brown bears concentrate along salmon streams, moving to coastal and subalpine areas after emerging from hibernation in April and May. Moose concentrate year-round in the region, preferring well-drained areas of willow and alder and streambanks. The Mulchatna caribou herd ranges north of Iliamna Lake and west of the Alaska Range, and would not likely occur in the project area.

Marine mammals that may inhabit the waters in or near Iliamna Bay are minke whale, humpback whale, beluga whale, orca, Dall's porpoise, harbor porpoise, Steller's sea lion, harbor seal, and sea otter.

Wetlands

The U.S. Fish and Wildlife Service's (USFWS) National Wetland Inventory maps show that the head of Williamsport Bay is an irregularly flooded tidal area with estuarine intertidal emergent persistent vegetation. During a site visit, the dominant species noted were ryegrass and sedges, which give way to the wide expanse of tidal flats in the bay. Along Williams Creek, wetlands are characterized as palustrine scrub/shrub broad-leaved deciduous vegetation that is temporarily flooded nontidally.

4.3 Endangered, Threatened, and Candidate Species

The project site is within Steller's eider (*Polysticta stelleri*) wintering territory. The Steller's eider is proposed for listing as threatened under the Endangered Species Act of 1973, as amended. Harlequin ducks (*Histrionicus histrionicus*) are present in the Williamsport area in summer and most likely use the area in winter as well. The ducks probably feed on clams and mussels in the bay and use the protected port as a staging area. Harlequin ducks are a Category 2 Candidate species. A candidate species is one the USFWS is reviewing for possible inclusion on the threatened or the endangered list. The agency has concerns over the decreasing population of these species but requires further information to determine their status.

The project area is also within the range of the following Category 2 Candidate species: marbled murrelet, Kittlitz's murrelet, olive-sided flycatcher, and North American lynx.

The National Marine Fisheries Service has indicated that Iliamna Bay is within the range of two threatened or endangered marine mammal species: Steller's sea lion (threatened), and humpback whale (endangered). Due to the shallow conditions in the Williamsport area, it is unlikely that these species would occur at or near the project site. The agency has no specific information on the presence of threatened or endangered species in the waters of the project area.

4.4 Cultural Resources

The State Historic Preservation Officer was consulted regarding cultural sites in the Williamsport area. The officer indicated that no known sites are within the project vicinity. The probability of archeological sites here is only moderate, because Williams Creek does not support a major anadromous fish run, and the bay, with its extensive mudflats, probably would not have attracted prehistoric people.

5. Environmental Consequences and Mitigation Measures

5.1 No-Action Alternative

Williamsport has been used for transshipment of cargo and fishing vessels bound for Lake Iliamna and Bristol Bay. Continued use of the channel in its current hazardous condition could result in ships running aground and spilling oil. This would harm the wildlife resources, particularly waterfowl and sea birds, as well as aquatic resources of the area. This threat would be equal to or greater than the establishment of a new dock and dredged channel. With the navigational improvements, the marine resources would continue to be minimally impacted by the movement of ships in and out of Williamsport, assuming no traffic accidents occurred..

5.2 Preferred Alternative

The project is not expected to have major impacts on fish, birds, or mammals. Temporary disturbances from noise could occur, although the affected species can easily avoid the area during the construction period. Most construction would take place below the high water line or in previously disturbed uplands. The following paragraphs address environmental effects of the proposed action and include measures to mitigate these impacts.

Impacts to Biological Resources

Iliamna Bay is not known to provide critical habitat for any of the wildlife occurring there, although the area may contain potential bear denning and raptor habitat. Construction of the dock and placement of fill material would require the use of heavy equipment. The equipment and noise would deter animals at the site during construction but would not result in long-term impacts. The effects on specific resources are discussed below.

Aquatic Resources

Dredging of a channel or basin or placement of fill would destroy most or all of the organisms living in the affected substrate. This would be a minor effect because past surveys have shown that the area is biologically unproductive, having a low density and diversity of infauna. During a 1994 field survey, few to no live invertebrates were found in substrate samples collected from the proposed dredged channel area or from a sampling site in deeper water at the mouth of Iliamna Bay.

Fish

There are no ADF&G-documented streams flowing into Iliamna Bay that are important for spawning, rearing, or migration of anadromous fish. However, ADF&G has indicated that herring and pink and chum salmon migrate through the Kamishak Bay region from early April through mid-June. The dredging activity proposed in this project would cause localized turbidity that could be detrimental to finfish. To minimize these effects, the ADF&G recommends that the Corps of Engineers conduct no dredging between April 1 and mid-June.

Birds

Brush removal is not anticipated for the project because equipment staging occurs now in the cleared areas. If any additional clearing is required for staging, it would be done to avoid passerine nesting periods, May 1 through July 15. Disturbance to Steller's eiders would be avoided, and disturbance to harlequin ducks would be minimized, by not constructing during winter (October - April). A preconstruction bird survey would be done to determine whether Steller's eiders are using the project area during the construction season. If Steller's eiders are present, the Corps of Engineers would coordinate with USFWS to monitor the project so that construction activities do not disturb the birds.

Mammals

Marine mammals may avoid the area during construction, but this impact would be temporary. Brown bear feeding on salmon in Williams Creek would not be significantly affected by the construction activity because the creek does not represent a major food supply for bears. Any disturbances to them would be temporary.

Blasting

Blasting, if permitted by the ADF&G, could cause significant negative effects if certain guidelines are not followed. Certain hazards are inherent with pressure changes induced by blasting overpressure waves. Blasting affects mammals and birds, if they are close enough to the blast, mainly in the gas exchange organs such as the lungs, hollow viscera, and ears. Marine mammals are adapted to changes in hydrostatic pressure and thus have a greater tolerance for pressure changes induced by shock waves. The pressures resulting from any explosion depend on the type of explosive and on conditions of the blast, such as water depth, bottom type, and depth of detonation. The impulse of the shock wave largely determines the extent of injury. Seals can tolerate pressure up to a 10-pound force per square inch (lbf/in^2).

Salmon are more abundant near shore in summer than at other times of the year. Blasting may injure fish that contact pressure waves and may result in any of the following: tearing of muscle tissue; rupture of the abdominal cavity, blood vessels and internal organs; disruption of the nervous system; loss of scales; or minor blood vessel rupture. The internal organs are affected, especially the kidney, liver, heart, spleen, gonads, and swim bladder. Pressures of 40 to 50 lbf/in^2 usually kill fish with swim bladders. Pressures more than 2.7 lbf/in^2 kill juvenile fish with swim bladders.

The effects of blasting could be reduced by restricting blasting during periods of the year when transient fish populations (primarily salmon and herring) are moving through or near the blasting area. The sensitive period is generally the spring and summer (April through August). Other mitigative measures that could be used include restriction on the frequency and force of the explosions; no blasting within one-fourth mile of anadromous fish streams such as Williams Creek; and use of scare devices to scare birds or mammals away from the project area.

Impacts to Water Quality

A temporary increase in turbidity is expected with dredge and fill activities. Fill materials are not associated with any contamination; thus no decrease in water quality is expected. Sediments in the channel were tested for potential contaminants and were found to have no detectable levels of pesticides/PCB's, metals, volatile and semivolatile organic compounds, or total recoverable petroleum hydrocarbons. Rock placement for the dock would not introduce contaminants or additional sediments into the bay. No water intake sources would be affected by the project. During maintenance dredging sediments would be tested for contaminants prior to disposal.

The unnamed creek north of the Williamsport-Pile Bay Road would have to be rerouted to the north. This creek, which empties into the bay where the new dock would be located, would have to be moved about 100 meters north of the site.

Socioeconomic Impacts

The proposed project alternative would provide the most effective means of solving the navigation problems at Williamsport. Positive impacts from the project include the increased availability of the port to barges and other vessels, decreased risk of damage from shallow conditions to vessels entering the bay, and potentially lowered transportation costs of goods to the Iliamna Lake region.

With increased accessibility to Williamsport, barges could bring more fuel and supplies to the region. Barge traffic would still be limited to summer months and is not likely to displace air cargo. While the project would benefit Bristol Bay fishermen and the residents of the Iliamna Lake Region, the remoteness of the area precludes significant development of the communities in the area.

The navigation improvements at Williamsport are not expected to result in significantly increased use of the Williamsport area by hunters and recreational fishermen. The project does not call for a harbor with slips for securing boats. Therefore, boat owners would have to beach their vessels on the flats at the head of the bay that go completely dry at low tides. These conditions would make it unlikely that Williamsport would become a popular destination for recreational hunters and fishermen.

Mining interests in the area are also not likely to be greatly affected by the navigation improvements at Williamsport. The project could facilitate the movement of people and supplies to and from Williamsport if mine development were to occur. However, this impact is not considered to be economically significant to the current project.

Impacts to Cultural Resources

There are no known or suspected cultural resources in the Williamsport area. Therefore, project activities are not restricted as long as the proposed work is limited to existing disturbed areas.

Impacts to Wetlands

The entire project would take place in subtidal or intertidal areas. No brush removal is expected on shore because existing cleared areas could be used for staging.

Placement of fill would be required along the road west of the dock. Fill would be placed in intertidal zones to an elevation of 7 meters to support dock construction or road construction. The unnamed stream immediately north of the site would have to be redirected to the north to avoid emptying into the bay at the dock location.

The construction activities would impact waters of the United States and would be unavoidable. Impacts from all the fill activities associated with the project are discussed in the Section 404(b)(1) evaluation following this report.

Noise/Air Quality

During construction, large equipment would be used. Noise levels would exceed background for short periods. Temporarily increased fossil fuel emissions are anticipated; however, no adverse effects are expected because the exhaust would dissipate rapidly.

6. Required Permits

The Corps has identified the following permits that would be required before work begins:

- Temporary camp permits would be required of the contractor to generate waste water and to set up camp at the construction site.
- Right-of-entry permits may be required from the landowner(s) to work on or gain access to the project area.
- The Corps would obtain a State water quality certification, pursuant to Section 401(a) of the Clean Water Act, from the Alaska Department of Environmental Conservation.

The local sponsor would be required to obtain a tideland permit from the Alaska Department of Natural Resources for construction of the dock and ramp. The Corps would not obtain a tideland permit for dredging because the Federal navigational servitude includes the right to use the bed of the water for all purposes that aid navigation.

The Alaska Department of Fish and Game (ADF&G) would not require a Fish Habitat Permit for this project. However, ADF&G has made two stipulations regarding the dock construction: (1) For the new barge landing dock, no portion of the wooden structure may be treated with preservatives containing pentachlorophenol. If the structure is treated with creosote, the creosote must be applied using pressure treatment, rather than painted on or allowed to soak into the wood. (2) No dredging may be done from April 1 to mid-June, to mitigate potential impacts to salmon and herring from increased turbidity.

EA Appendix 1
Clean Water Act Evaluation, Section 404(b)(1)

EA APPENDIX 1:
CLEAN WATER ACT EVALUATION, SECTION 404(b)(1)

I. Project Description

The proposed project would involve several navigation improvements at Williamsport, Alaska. These improvements would include a new dock, a turning basin, and dredging a 2,700-meter-long shallow-draft channel one-half meter deep and 30 meters wide. A new dock would replace the dilapidated dock currently in place, and the channel would provide adequate flotation at low tide for small tugs, barges, and landing craft.

An estimated 129,825 cubic meters (m^3) of sediment would be dredged and disposed of for the channel. Rock fill would be placed below the mean high water line to construct a dock. Excavation of a turning basin would require the removal of 11,875 m^3 of material. Another area that would be filled is west of the dock construction area; this area would be filled to bring the dock elevation up to that of the road (elev. = 7 m).

Dredged material from the channel would be disposed of at one of two alternative sites: in deep (11 m) water at the mouth of Iliamna Bay, or in the mudflats close to the project site.

II. Factual Determinations

A. Physical Substrate Determinations

During a 1994 field investigation, sediment samples were collected for soils classification at several proposed disposal sites: the Williamsport channel, Iliamna and Cottonwood Bays, and the open water of Cook Inlet. Sediment samples collected from the proposed main channel and the open-water disposal site showed that sediments consist primarily of fines (more than 70 percent), with the remainder composed of sand and gravel. Sediments collected from Iliamna Bay and Cottonwood Bay are composed of silt, silt with sand, and, at one location, poorly graded gravel.

B. Water Circulation, Fluctuations, and Salinity Determinations

Rock placement below the mean high water line for a dock would not affect the movement of water in and out of the bay. The bottom contour would be altered with the placement of rock fill. Placement of dredged material in the mudflats at the project site or in the deeper waters of Iliamna Bay or Cook Inlet is not likely to affect water circulation and fluctuation. Placement of rock for structures or dredged fine materials in Williamsport Bay would not affect salinity values.

C. Suspended Particulate/Turbidity Determinations

Sediment accumulates in the proposed channel area at a rate of about 10 cm per year. Suspended particulates in Cook Inlet range between 1,000 - 2,000 milligrams to the liter (mg/L), while in Iliamna Bay the particulates range from 10 to 100 mg/L. Placement of gravel and rock riprap placement along the shorelines at the head of Williamsport Bay probably would cause a temporary increase in suspended particulates. Placement of dredged material in Williamsport Bay would also cause a localized temporary increase in turbidity.

D. Contaminant Determinations

Sediment samples were collected from the proposed disposal site and from the area of Iliamna Bay where the dredged channel would be. Chemical analyses showed that none of the samples taken from these areas contained any of the analytes tested for, including metals, volatile and semivolatile organic compounds, total recoverable petroleum hydrocarbons, and pesticides/PCB's.

E. Aquatic Ecosystems and Organism Determinations

During a 1994 field investigation ,the diversity and abundance of the marine sediment infauna was determined to be very low. The dominant invertebrate species found was the clam *Macoma balthica*. Shells of several other species of snails and bivalves were also found during the field sampling, but no live animals were seen. Low densities of unidentified polychaetes and sipunculid worms were also present in the sediments. Disposal of dredged material in Cook Inlet is not expected to significantly affect the scarce sediment infauna.

Williams Creek reportedly supports a small run of pink and chum salmon, Dolly Varden, and smelt. Iliamna Bay is used for rearing habitat primarily by juvenile chum salmon during June and July. Most of these fish probably originate from the Cottonwood Bay system. Herring and pink and chum salmon migrate throughout the Kamishak Bay area between early April and mid-June. The ADF&G believes that a window of no dredging activity from April 1 through mid-June would reduce detrimental impacts to the majority of finfish in the project area.

F. Proposed Disposal Site Determinations

The proposed action would comply with applicable water quality standards and would have no detrimental effects on any of the following:

- Municipal and private water supplies
- Recreational and commercial fisheries
- Water-related recreation
- Esthetics

The proposed fill would have only a temporary effect on the water column. The structures proposed for construction would create stable banks that would not be likely to erode.

G. Determination of Cumulative Effects on the Aquatic Ecosystem

A limited area of relatively unproductive habitat would be affected by the placement of fill. Increased boat traffic would occur as a result of navigation improvements but this activity is not expected to have detrimental effects on the aquatic ecosystem.

H. Determination of Secondary Effects on the Aquatic Ecosystem

There would be no secondary effects from the project.

III. Findings of Compliance or Non-Compliance with the Restrictions on Discharge

A. Adaptation of the Section 404 (b)(1) Guidelines to This Evaluation

The proposed project complies with the requirements set forth in the Environmental Protection Agency's guidelines for specification of discharge sites for dredged or fill material.

B. Evaluation of Availability of Practicable Alternatives to the Proposed Discharge Site Which Would Have Less Adverse Impact on the Aquatic Ecosystem

An environmental assessment was prepared in conjunction with this evaluation. A discussion of the alternatives is contained in the report. The no-action alternative would not meet project objectives because it would continue to severely limit the accessibility of barges and other vessels to Williamsport. The alternative discussed in the environmental assessment is the most practical alternative for navigation improvements at Williamsport.

C. Compliance with Applicable State Water Quality Standards

The proposed project is not expected to affect water supplies, recreation, growth and propagation of fish, shellfish, and other aquatic life, or wildlife. It is not expected to introduce petroleum hydrocarbons, radioactive materials, residues, or other pollutants into the waters of Iliamna Bay and Cook Inlet. The project would not affect water quality parameters such as pH, dissolved oxygen, temperature, color, etc. A temporary increase in turbidity would result from dredging activities. The project complies with State water quality standards.

D. Compliance with Applicable Toxic Effluent Standards or Prohibition Under Section 307 of the Clean Water Act

No toxic effluents are associated with the proposed project that would affect water quality parameters. Therefore the project complies with toxic effluent standards of Section 307 of the Clean Water Act.

E. Compliance with Endangered Species Act of 1973

The proposed project complies with the Endangered Species Act. The Corps of Engineers has coordinated with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, agencies responsible for management of protected species.

F. Evaluation of Extent of Degradation of the Waters of the United States

There are no municipal or private water supplies in the area that could be affected by the project. Commercial and recreational interests would benefit with navigation improvements at Williamsport. There would be no significant adverse impacts to plankton, fish, shellfish, wildlife, and/or special aquatic sites from this project.

EA Appendix 2
Fish and Wildlife Coordination Act Report

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services Anchorage
605 West 4th Avenue, Room 62
Anchorage, Alaska 99501

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

WAES

FEB 16 1995

Colonel Peter A. Topp
District Engineer
Alaska District, Army Corps of Engineers
Attn: Deborah McCormick
Post Office Box 898
Anchorage, Alaska 99506-0898

FEB 16 1995

Dear Colonel Topp:

The enclosed Fish and Wildlife Coordination Act (FWCA) Report constitutes the U.S. Fish and Wildlife Service's (Service) final report on the U.S. Army Corps of Engineers' (Corps) proposed dock and channel dredging project in Williamsport, at the head of Iliamna Bay, Alaska. We appreciate the comments submitted by your staff on the draft report and incorporated them where appropriate.

We recommend Alternative 2 as having the least potential for adverse impacts to fish and wildlife resources due to project construction. Based upon the site-specific information gathered thus far, we do not believe the project will significantly impact any species of concern. However, we were not able to conduct surveys year-round to assess seasonal wildlife use of the project site, and continue to recommend further wildlife surveys, if feasible given project timing and funding constraints. Construction should not occur during winter (October - April). Preconstruction surveys are recommended to confirm that Steller's eiders are not concentrated in the Williamsport area during summer construction (May - September), or in the area of the selected disposal site.

If you have any questions regarding our final report, please contact our project biologist, Laurie Fairchild, at 271-2788.

Sincerely,

Ann G. Rappoport

Ann G. Rappoport
Field Supervisor

7. Agencies and Persons Consulted

- Ann Rappoport, Ecological Services and Endangered Species, U.S. Fish and Wildlife Service

- Judith Bittner, State Historic Preservation Officer, Alaska Department of Natural Resources

- Ronald Morris, National Marine Fisheries Service

- Dennis Gnath and Wayne Dolezal, Habitat and Restoration Division, Alaska Department of Fish and Game

- Harriet Wegner, Kenai Peninsula Borough

8. Preparer of This Document

This Environmental Assessment was prepared by Deborah McCormick, Environmental Resources Section, Alaska District, Corps of Engineers. The study manager is Dr. Orson Smith, Project Formulation Section, Alaska District, Corps of Engineers.

9. Conclusion

Navigation improvements at Williamsport, as discussed in this document, would not cause significant impacts to the environment. The proposed action is also consistent with State coastal zone management plans to the maximum extent practicable. This assessment supports the conclusion that the proposed project does not constitute a major Federal action significantly affecting the quality of the human environment; therefore a Finding of No Significant Impact will be prepared.

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Williamsport Navigation Improvements
Williamsport, Alaska

Final Fish and Wildlife Coordination Act Report

Submitted to:

Alaska District
U.S. Army Corps of Engineers
Anchorage, Alaska

Prepared by:

Laurie A. Fairchild
Anchorage Field Office
Anchorage, Alaska

Department of the Interior
U.S. Fish and Wildlife Service
Alaska Region
Anchorage, Alaska

February 1995

PREFACE

This Fish and Wildlife Coordination Act (FWCA) Report constitutes the U.S. Fish and Wildlife Service's (Service) report on the U.S. Army Corps of Engineer's (Corps) proposed navigation improvements and dock construction at Williamsport, Alaska. It has been prepared under the authority of the Fish and Wildlife Coordination Act, P.L. 85-624 Section 2(b), and in keeping with the spirit and intent of the National Environmental Policy Act. This report will accompany the Corps' Feasibility Stage Detailed Project Report and environmental assessment to the Commander of the U.S. Army Engineer - Civil Works Planning Office.

Williamsport is used sporadically by fishermen trying to reach Bristol Bay and at least bi-annually by barges which supply local rural communities. The Chief of Planning and Administrative Services for the Alaska Department of Transportation and Public Facilities (ADOT) requested assistance from the Corps in evaluating the feasibility of improving access to Williamsport and upgrading the existing dock.

The purposes of the Service in study involvement are to 1) evaluate the principal alternative's potential impacts on fish and wildlife resources and their habitats; and 2) recommend methods for mitigating adverse impacts and/or enhancing these resources. The Service's findings are based on a literature review and coordination with the Corps' Environmental Resources Section. A field investigation was completed May 24-25, 1994.

All previous Service documents are superseded by this document.

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STUDY AREA

Williamsport is located in southwestern Alaska on the western shore of Iliamna Bay in Cook Inlet near the head of the bay (Figures 1 and 2). Cottonwood Bay extends to the east from Iliamna Bay, and both open into Cook Inlet via Kamishak Bay. Williamsport is situated at the head of Iliamna Bay near the mouth of Williams Creek and is bordered by cliffs of the Chigmit Mountains. Barges off-load supplies at Williamsport which are then transported to Iliamna Lake and the surrounding area via Pile Bay Road. Equipment and supplies to be loaded aboard outbound barges are stockpiled on the site. There are no residential or storage buildings at Williamsport. The tidelands involved in this project as well as the entire Pile Bay Road are owned by the State of Alaska.

The proposed project site is at the eastern end of Pile Bay Road, which runs west to end at Pile Bay Lodge on Iliamna Lake. Villages on Iliamna Lake (Iliamna, Newhalen, Pedro Bay, Kakhanok, and Igiugig) receive supplies shipped by barge via this road and by aircraft services. The few residents and seasonal employees at Pile Bay Lodge are likewise served. Fishermen with permits for Bristol Bay occasionally utilize the Williamsport-Pile Bay connection to shorten their transport time, traveling across Iliamna Lake and down the Kvichak River to its outlet in eastern Bristol Bay (near Naknek and King Salmon).

Boulders and extensive mudflats pose navigation hazards to vessels attempting to access Williamsport on a regular basis. The dock is in severe disrepair and virtually useless to marine traffic. The Corps is investigating the feasibility of improving vessel access to Williamsport.

ALTERNATIVE PLAN DESCRIPTIONS

Alternative 1. No Action. Under this alternative, the dock would continue to disintegrate and the barge ramp would erode. Vessel access and transshipment of supplies would continue to be limited to extreme tides and the current level of activity.

Alternative 2. New dock, dredged basin, and channel. Under this alternative, the existing dock, currently in severe disrepair, would be dismantled and a new dock would replace it. The dock is conceptually described in the Corps Preliminary Reconnaissance Report as a rectangular steel sheet pile retaining wall, backfilled with dredge material and capped with gravel. A basin would be dredged at the new dock to allow adequate floatation for vessels at low tide. A dredge channel (to +8 feet MLLW) would provide access to the dock for all vessels during normal high tides.

Alternative 3. Causeway, dock, and dredged basin and channel. Under this alternative an 800-foot causeway would extend the road to deeper water, requiring less dredging (initial and maintenance) for the boat basin and channel. A structure similar to the dock described in Alternative 2 would be constructed at the end of the causeway. An access channel approximately 150 feet wide would also be dredged.

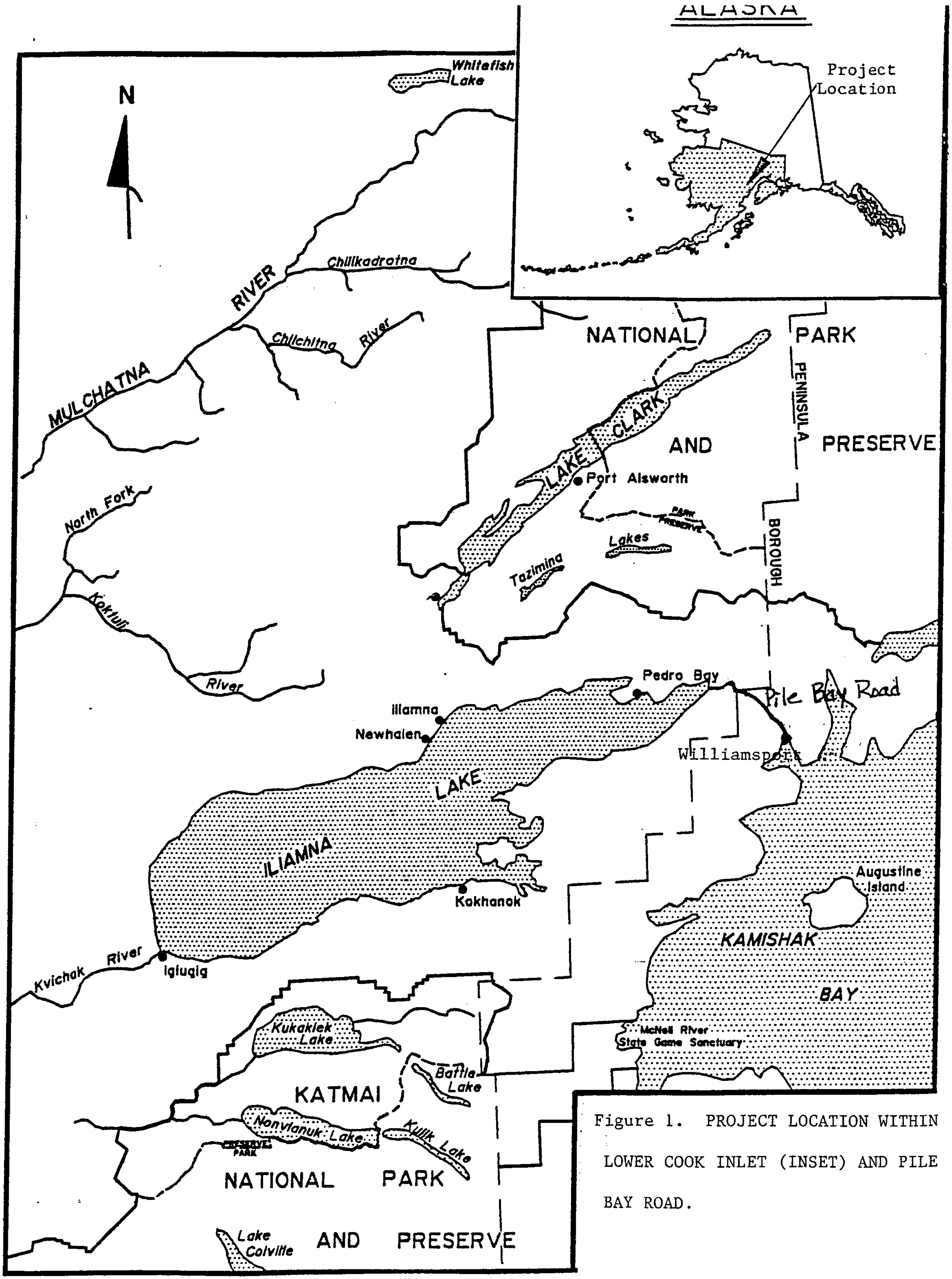

Figure 1. PROJECT LOCATION WITHIN LOWER COOK INLET (INSET) AND PILE BAY ROAD.

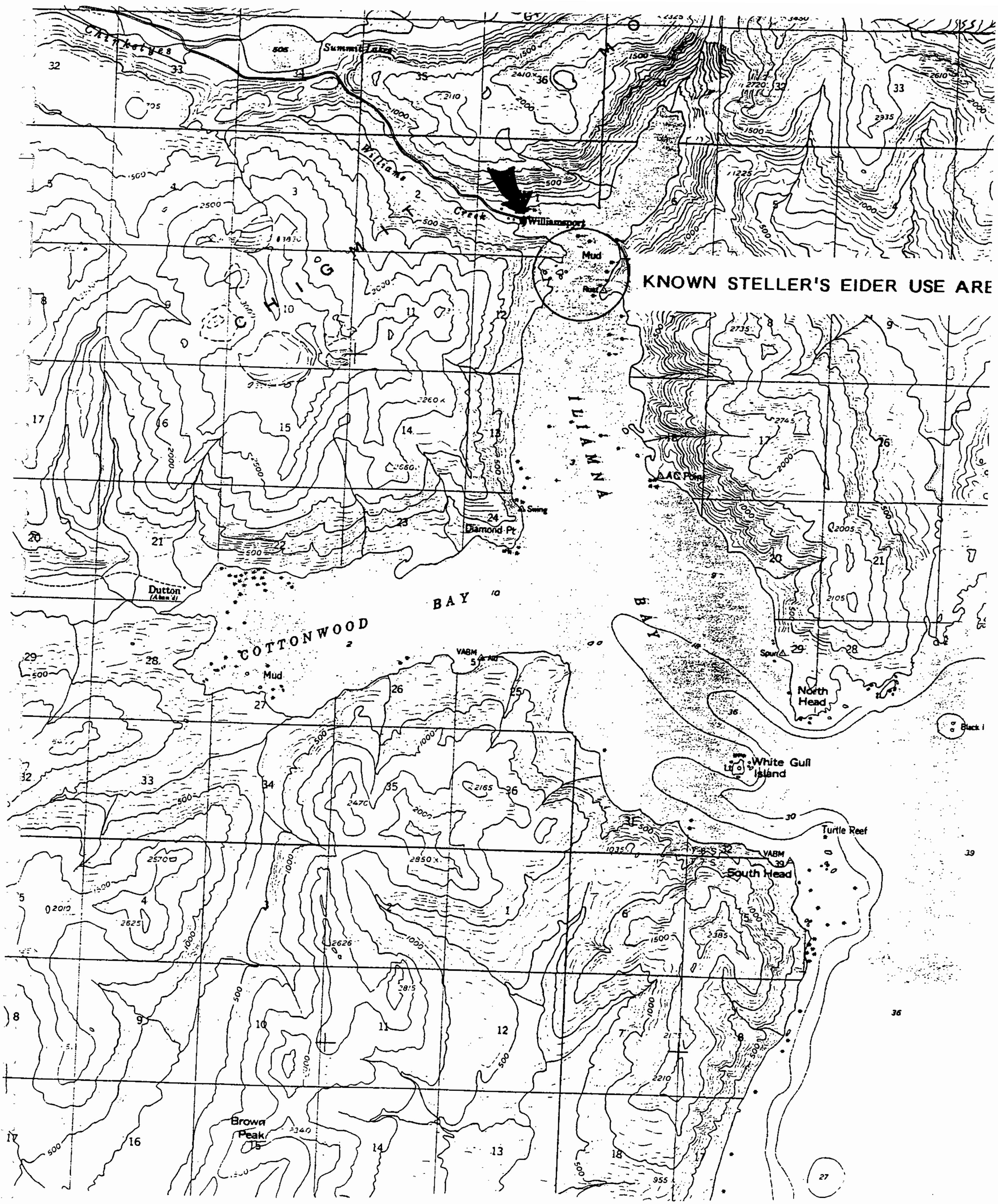

Figure 2. WILLIAMSPORT PROJECT LOCATION, ILIAMNA BAY, ALASKA.

Alternative 4. Dock and concrete ramp combination at existing dock site. Under this alternative, the existing dock would be replaced and a concrete ramp installed to accommodate ramp-equipped barges, landing craft, and boats on trailers. Dredging to allow access to the facilities at ordinary high tide would be similar to that in Alternative 2.

Alternative 5. Dock and concrete ramp combination at end of causeway. Under this alternative, the causeway may terminate with a concrete ramp only, or with a dock and concrete ramp combination. Channel dredging and fill required for the causeway would be similar to Alternative 3.

Alternative 6. Boulder removal. Under this alternative, six large boulders which currently pose a navigation threat to vessels would be removed by blasting. The disrepair of the existing dock and dirt ramp would not be addressed.

BIOLOGICAL RESOURCES

Vegetation/Habitat.

The coastal area surrounding Williamsport has been only minimally impacted by transshipment of supplies via barge and fishing vessel transport. A devegetated area immediately adjacent to and in front of the existing dock and ramp also serves as temporary stockpile for any equipment or supplies being loaded onto barges. The rest of the surrounding valley is characterized by tall cliffs sloping into a narrow valley. The valley is bisected by Pile Bay Road and the meandering Williams Creek. Alder (*Alnus crispa*) and willow (*Salix spp.*) brush is abundant everywhere. The coastal area consists of brush very gradually sloping into tidal flats. Beach rye grass (*Elymus arenarius*), sedges (*Carex spp.*), rockweed (*Fucus distichus*), and other transitional vegetation give way to a wide expanse of tideflats and shallow waters at the head of Iliamna Bay. Typical riparian vegetation is thick around Williams Creek.

Tidal fluctuations did not appear to be a major influence in sediment deposition during the site visit. Site investigators were able to walk out at low tide 100 feet or more from shore to take samples on the relatively stable mudflats. Very little sediment comes from Williams Creek. More silt is eroded from bluffs along the west shore of Cook Inlet.

Benthic organisms were present in a limited variety. A sipunculid worm, polychaete species, were taken in bottom samples and a tree sponge was found washed up on shore. Blue mussels (*Mytilis edulis*) and four types of clams were found washed up in the intertidal area. Samples taken at the outer end of the proposed channel produced the most numerous live samples. The dominant bivalve present was *Macoma balthica*. Less numerous were another soft-shelled clam (*Macoma* spp.) and unidentified polychaetes.

Birds.

Although a fair amount of bird observations have been made for the Iliamna Lake region, very little published data exist regarding avian species occurring in the immediate Williamsport area. Consequently, a list of species occurring in adjacent areas with similar habitats (Table 1) has been compiled to illustrate those species which would likely occur in the project area. No bald eagles (*Haliaeetus leucophalus*) or eagle nests were observed during the site visit although it is likely that a few birds feed off salmon streams near the project site, including Williams Creek. Some of the seabird species listed in Table 1 are present at colonies established on White Gull Island and near the mouth of Iliamna Bay.

Mammals.

A data gap exists for mammals, similar to that for birds, specific to Williamsport. However, residents of Pile Bay (Linda Williams, Pile Bay Lodge, pers. comm.) have reported the following animals present at Williamsport or in the adjacent area:

brown bear	*Ursus arctos*
moose	*Alces alces*
red fox	*Vulpes vulpes*
beaver	*Castor canadensis*
snowshoe hare	*Lepus americanus*
arctic ground squirrel	*Spermophilus parryi*
red squirrel	*Tamiasciurus hudsonicus*
marten	*Martes americana*
ermine	*Mustela erminea*
shrew	*Sorex* spp.
red-backed vole	*Clethrionomys rutilus*

According to range maps in Hood and Zimmerman (1986) and Wynne (1992), the following marine mammals may occur in Kamishak Bay and Iliamna Bay:

minke whale	*Balaenoptera acutorostrata*
humpback whale	*Megaptera novaeangliae*
beluga whale	*Delphinapterus leucas*
orca	*Orcinus orca*
Dall's porpoise	*Phocoenoides dalli*
harbor porpoise	*Phocoena phocoena*
Steller sea lion	*Eumetopias jubatus*
harbor seal	*Phoca vitulina*
sea otter	*Enhydra lutris*

Except for the sea otter, these marine mammals are unlikely to occur beyond the mudflats at the head of Iliamna Bay, where the project is located.

Table 1. Birds species potentially occurring on a regular basis at the Williamsport project site.

Species	Scientific Name
Red-throated loon	*Gavia stellata*
Pacific loon	*G. pacifica*
Common loon	*G. immer*
Horned grebe	*Podiceps auritus*
Red-necked grebe	*P. grisegena*
Northern fulmar	*Fulmarus glacialis*
Short-tailed shearwater	*Puffinus tenuirostris*
Pelagic cormorant[1]	*Phalacrocorax pelagicus*
Double-crested cormorant	*P. auritus*
Canada goose	*Branta canadensis*
Green-winged teal	*Anas crecca*
Mallard	*A. platyrhynchos*
Northern pintail	*A. acuta*
Northern shoveler	*A. clypeata*
American wigeon	*A. americana*
Greater scaup[1]	*Aythya marila*
Common eider	*Somateria mollissima*
Steller's eider	*Polysticta stelleri*
Harlequin duck[1]	*Histrionicus histrionicus*
Oldsquaw	*Clangula hyemalis*
Black scoter	*Melanitta nigra*
Surf scoter[2]	*M. perspicillata*
White-winged scoter[2]	*M. fusca*
Common goldeneye	*Bucephala clangula*
Barrow's goldeneye	*B. icelandica*
Bufflehead	*B. albeola*
Common merganser	*Mergus merganser*
Red-breasted merganser[2]	*M. serrator*
Bald eagle	*Haliaeetus leucophalus*
Sharp-shinned hawk	*Accipiter striatus*
Northern goshawk	*A. gentilis*
Spruce grouse	*Canachites canadensis atratus*
Ptarmigan	*Lagopus spp.*
Sandhill crane	*Grus canadensis*
Black-bellied plover	*Squatarola squatorala*
Golden plover	*Pluvialis dominica*
Semipalmated plover	*Charadrius semipalmatus*
Greater yellowlegs[2]	*Totanus melanoleucus*
Wandering tattler	*Heteroscelus incanus*
Spotted sandpiper	*Actitis macularia*
Whimbrel	*Numenius phaeopus*
Ruddy turnstone	*Arenaria interpres*
Black turnstone	*Arenaria melanocephala*
Surfbird	*Aphriza virgata*
Semipalmated sandpiper	*Charadrius semipalmatus*

Table 1. Continued

Species	Scientific Name
Western sandpiper	*Calidris pusilla*
Least sandpiper	*C. minutilla*
Pectoral sandpiper	*C. melanotos*
Rock sandpiper	*C. ptilocnemis*
Dunlin	*C. alpina*
Short-billed dowitcher	*Limnodromus griseus*
Long-billed dowitcher	*L. scolopaceus*
Common snipe[2]	*Gillinago gallinago*
Red-necked phalarope	*Lobipes lobatus*
Bonaparte's gull	*Larus philadelphia*
Mew gull	*L. canus*
Herring gull	*L. argentatus*
Glaucous-winged gull[2]	*L. glaucescens*
Glaucous gull	*L. hyperboreus*
Black-legged kittiwake[1]	*Rissa tridactyla*
Arctic tern	*Sterna paradisaea*
Aleutian tern	*S. aleutica*
Common murre[1]	*Uria aalge*
Pigeon guillemot	*Cepphus columba*
Marbled murrelet	*Brachyramphus marmoratus*
Kittlitz's murrelet	*B. brevirostris*
Tufted puffin[1]	*Fratercula cirrhata*
Horned puffin[1]	*F. corniculata*
Great horned owl	*Bubo virginianus*
Short-eared owl	*Asio flammeus*
Boreal owl	*Aegolius acadicus*
Belted kingfisher[2]	*Megaceryle alcyon*
Olive-sided flycatcher	*Contopus borealis*
Alder flycatcher	*Empidonax alnorum*
Tree swallow	*Tachycineta bicolor*
Violet-green swallow	*T. thalassina*
Bank swallow	*Riparia riparia*
Cliff swallow	*Hirundo pyrrhonota*
Gray jay	*Perisoreus canadensis*
Steller's jay	*Cyanocitta stelleri*
Black-billed magpie[1]	*Pica pica*
Northwestern crow	*Corvus caurinus*
Common raven[2]	*C. corax*
Black-capped chickadee[2]	*Parus atricapillus*
Boreal chickadee	*P. hudsonicus*
Red-breasted nuthatch	*Sitta canadensis*
Brown creeper	*Certhia americana*
Winter wren[1]	*Troglodytes troglodytes*
American dipper[2]	*Cinclus mexicanus*
Golden-crowned kinglet	*Regulus satrapa*
Ruby-crowned kinglet	*R. calendula*

Table 1. Continued

Species	Scientific Name
Swainson's thrush	*Catharus ustulatus*
Hermit thrush	*Catharus guttatus*
American robin[2]	*Turdus migratorius*
Varied thrush[2]	*Ixoreus naevius*
American pipit	*Anthus rubescens*
Bohemian waxwing	*Bombycilla garullus*
Northern shrike[2]	*Lanius excubitor*
Orange-crowned warbler	*Vermivora celata*
Yellow warbler	*Dendroica petechia*
Yellow-rumped warbler[1]	*D. coronata*
Wilsons warbler[1]	*Wilsonia pusilla*
Savannah sparrow	*Passerculus sandwichensis*
Fox sparrow	*Passerella iliaca*
Song sparrow	*Melospiza melodia*
Lincoln's sparrow	*M. lincolnii*
Golden-crowned sparrow[1]	*Zonotrichia atricapilla*
White-crowned sparrow	*Z. leucophrys*
Dark-eyed junco[2]	*Junco hyemalis*
Lapland longspur	*Calcarius lapponicus*
Rusty blackbird[2]	*Euphagus carolinus*
Pine grosbeak[2]	*Pinicola enucleator*
White-winged crossbill	*Loxia leucoptera*
Common redpoll	*Carduelis flammea*
Pine siskin	*C. pinus*

[1] Observed during May, 1994 site visit.
[2] Birds reported in area by Linda Williams, Pile Bay Lodge.

Fish.

Dolly Varden are generally distributed throughout the project area and adjacent waters. Kamishak Bay is an important commercial bottom and salmon fishing area. Pink (*Oncorhynchus gorbuscha*), coho (*O. kisutch*), and chum (*O. keta*) salmon spawn in Cottonwood Bay near the mouth of Iliamna Bay. The Alaska Department of Fish and Game (ADFG) has not conducted fish inventories for Williams Creek, which drains into Williamsport. Anecdotal information gathered by ADFG biologists indicates chum and pink salmon likely use the creek. The head of Iliamna Bay is too shallow to allow commercial fishing and the area is not thought to provide extensive habitat for spawning or juvenile salmon.

Endangered, Threatened and Candidate Species.

The project site is within the wintering range of Steller's eiders (*Polysticta stelleri*). Illiamna Bay is on the edge of the Steller's winter range (Kertell 1991, as cited in Quakenbush and Cochrane 1993; Larned et. al 1994; Metzner 1993). The Steller's eider is proposed for listing as threatened under the Endangered Species Act (ESA) of 1973, as amended.

An estimated one hundred birds were observed on Iliamna Bay approximately 5 km (3.1 miles) south of Williamsport (see Figure 2) during an aerial survey in February 1994, which included the Williamsport area (W. W. Larned and S. Kendall, Migratory Bird Management, Anchorage, pers. comm.). Steller's eiders migrate north in the summer and no birds are expected to be in the project area at this time.

In cases where any agency action is likely to jeopardize continued existence of any species proposed to be listed under the ESA, conference procedures are to be implemented with the Service (Sec 7 (a) 4 ESA, as amended). "Jeopardize the continued existence" means to engage in an action that reasonably could be expected, directly or indirectly, to appreciably reduce the likelihood of both the survival and recovery of a listed species in the wild by reducing the production, members, or distribution of that species (50 CFR 402.02).

Populations occuring at the <u>edges</u> of a species range are significant in that edges are the critical limits where the population can maintain or expand it's current range. Regularly disturbing or eliminating populations that define the edge of a species range can cause the overall range of a species to contract.

Harlequin ducks (*Histrionicus histrionicus*) are present in the Williamsport area in summer (observed during the May 1994 site visit) and most likely use the area in winter as well. The ducks probably feed on clams and mussels in the area and use the protected port as a staging area. Harlequin ducks are a Category 2 candidate species. A candidate species is one the Service is reviewing for possible inclusion on the threatened and endangered list. Category 2 candidates are those species for which the Service has concerns over decreasing population but requires further information to determine its status.

The project area is also within the range of the following Category 2 candidate species: marbled murrelet, Kittlitz's murrelet, olive-sided flycatcher, and North American lynx.

Iliamna Bay is within the range of two species for which the National Marine Fisheries Service has management responsibility: 1) the Steller sea lion (listed as threatened), and 2) the humpback whale (endangered). It is unlikely these species occur at or near the project site.

PROJECT IMPACTS

Alternative 1, No Action. There would be no direct impact on fish and wildlife resources from this alternative. However, continued use of the channel in its current hazardous condition could result in ships running aground and spilling oil. This would have an adverse impact on wildlife and aquatic invertebrates of the area, but the degree of severity would depend on size of the spill.

Alternative 2, New dock, dredged basin, and channel. Construction activities would cause temporary disruption of near and onshore wildlife use of the area and increase sediment suspension in the water. Timing restrictions could be placed on construction to avoid noise and human disturbance to brown bear feeding on salmon in Williams Creek to mitigate project impacts.

Alternative 3, Causeway, dock, and dredged basin and channel. This alternative would cause the most impact to fish and wildlife resources. An undetermined amount of quarry rock would be placed for the causeway and stabilization of the dock. Basin and channel dredging would disrupt habitat further away from the shore, which is potentially more valuable to invertebrates.

Alternative 4, Dock and concrete ramp combinations at existing dock. Impacts would be similar to those of Alternative 2 but smaller in scope due to decreased dredging needs.

Alternative 5, Dock and concrete ramp combinations at end of causeway. Impacts would be similar to those of Alternative 3 but smaller in scope due to decreased dredging needs.

Alternative 6, Boulder removal. There would be minimal impact to aquatic resources except for temporary suspension of sediments in the water column associated with disruption of bottom sediments during boulder removal.

Disposal Sites

Several disposal sites are being considered for dredged material resulting from project construction and maintenance. One of the sites is at the mouth of Iliamna Bay in approximately 6 fathoms of water with a mud/silt substrate bottom. Samples taken during the site visit did not contain invertebrates. There would be minimal impact to aquatic resources at this site.

Disposal of dredged material closer to the project site has been discussed due to low sedimentation rates and the low productivity rate in the mudflats. This alternative should not present significant adverse impacts as long as it is not placed in such a manner as to become a barrier to fish passage at or adjacent to Williams Creek.

Disposal of the dredged material in uplands may be acceptable on a short-term basis; however, such potential disposal areas should be identified and drainage concerns addressed. Disposal of dredged material in wetlands for lack of a suitable upland site would not be acceptable given the viable and less environmentally damaging alternatives discussed above.

Effects on Endangered, Threatened, and Candidate Species.

Harlequin ducks are usually observed nearshore or along rocky outcroppings and reefs. Williamsport is within the wintering range for Steller's eider. Nearshore activities and human disturbance will likely cause these birds to avoid the construction area. Disturbance to Steller's eiders can be avoided, and disturbance to harlequin ducks can be minimized, by not constructing during winter (October - April). Preconstruction surveys are recommended to ensure there are no Steller's eiders in the area prior to summer construction (May - September).

Because of the shallow waters and relative lack of prey abundance at the head of Iliamna Bay, it is unlikely that Steller sea lions or any other listed marine mammals frequent the Williamsport area. However, the Corps should consult with NMFS to ensure adverse impacts to marine mammals under their jurisdiction are avoided.

DISCUSSION

Based on information about the fish and wildlife resources of the project area, the Service has selected the following species to assess the environmental impacts of the project: 1) brown bear, 2) harbor porpoise, 3) pink salmon, 4) harlequin duck, 5) and golden-crowned sparrow. For the project area, the Service has determined that the habitat for all of these species is of medium to high value and relatively abundant on a national basis. The mitigation goal for all evaluation species is no net loss of habitat value while minimizing loss of in-kind habitat value.

Dock construction is not discussed in detail in the Corps' Preliminary Reconnaissance Report (Report), although a steel sheet pile bulkhead is mentioned in the Conclusions and Recommendation section. A pile-supported structure would be less environmentally damaging and could be constructed to provide the stability needed for transport of supplies and fishing vessels. The piles would provide stable substrate for colonizing mussels and barnacles which would be displaced if the boulders in the channel were removed (Alternative 6) in conjunction with channel dredging. A fill bulkhead could interfere with fish passage, sediment movement and water exchange at the mouth of Williams Creek. A pile-supported structure would not change water patterns to a great degree and would provide cover for any juvenile fish in the immediate area.

A preferred alternative has not been identified by the Corps. However, assuming the Corps will choose from construction alternatives presented in the report, Alternatives 2 and 4 would accomplish project goals for a safe shipping channel and have the least impact to fish and wildlife resources. Alternatives 3 and 5 would require additional fill and quarry work and may result in accelerated erosion. This would necessitate additional maintenance. Alternative 6 would be a temporary fix and would not adequately address safety issues.

Project impacts could be minimized by placing timing restrictions on building the dock to avoid disturbance of salmon migration and brown bear feeding. However, to accurately address the scope of potential impacts, the Corps should conduct winter surveys for Steller's eiders and harlequin ducks.

The proposed project would likely have minimal adverse impacts on golden-crowned sparrows and other nesting birds in the area except for disturbance during the breeding season. The destruction of active bird nests can best be avoided by not clearing brush when birds are nesting. If construction activities (e.g., temporary campsites and equipment staging) were confined to the previously disturbed area adjacent to the existing dock, adverse impacts would be minimized.

SUMMARY/RECOMMENDATIONS

Continued use of the Williamsport facility for barge transshipment and fishing vessel transport to Bristol Bay will result in additional ships going aground. The threat to fish and wildlife resources from resultant oil spills is potentially equal to or greater than impacts from establishment of a new dock and dredged channel. Except for the quarry site, the majority of construction activities would be carried out in a previously disturbed upland area or in water. The aquatic habitat would not be permanently affected, with the exception of periodic maintenance dredging. Wildlife and aquatic species in the immediate project area appear to be relatively sparse and identified impacts could be mitigated by using best management practices, and observing timing restrictions in relation to presence of wildlife.

It is the Service's recommendation that Williamsport be improved so it is no longer a navigation hazard. A preferred alternative was not identified in the Corps planning document. However, Alternative 2 appears to have the least potential for adverse impacts to fish and wildlife resources.

The following recommendations should be adopted regardless of the construction alternative selected:

1. The Corps shall request that ADFG conduct a fish inventory of Williams Creek to ensure maximum protection of fish in the system (e.g., adequate timing restrictions on construction).

2. Equipment staging and fuel storage shall be limited to previously disturbed sites, and be set back from Williams Creek a minimum of 75 feet where possible.

3. No brush clearing shall occur May 1 through July 15 to avoid destruction of active migratory bird nests.

4. Construction should not occur during winter (October - April). Preconstruction surveys are recommended to confirm that Steller's eiders are not concentrated in the Williamsport area during summer construction (May - September), or in the area of the selected disposal site.

We also recommend that informal Section 7 consultation be initiated with the National Marine Fisheries Service regarding potential impacts to threatened or endangered marine mammals under their jurisdiction.

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APPENDIX A. Fish and Wildlife Service Mitigation Policy Synopsis.

Under the Fish and Wildlife Coordination Act and the National Environmental Policy Act, the Fish and Wildlife Service (Service) has responsibilities to ensure that project-related losses to fish and wildlife resources are identified and mitigated. As part of our participation in project planning, a mitigation plan should be developed in accordance with the Service Mitigation Policy (FR Vol. 46, No. 15, January 23, 1981) and in consultation with the Environmental Protection Agency and alaska Department of Environmental Conservation. The plan would provide guidance for evaluating and mitigating impacts of the proposed project to fish and wildlife.

A mitigation plan is developed by first selecting fish and wildlife habitats from among the full range of habitats occurring within the area to be impacted by both direct as well as indirect impacts. These are chosen either because they represent resources which are most characteristic of the area or because the Fish and Wildlife Service has mandated responsibilities for them. By narrowing the scope in this way, the analysis can focus on areas where significant changes are most likely to occur and not be unduly burdened by inclusion of areas with low wildlife value.

After identifying important habitats, evaluation species, which function as indicators of habitat quality and quantity, are chosen, Selection of evaluation species has an important role in determining the extent and type of mitigation achieved. A combination of two sets of criteria is typically used to choose species for this purpose. The first is to pick species with high pubic interest, subsistence, or economic values while the second is to select species which utilize habitats having significant ecological values.

Fish and wildlife habitats are then assigned to one of the four Resource Categories delineated in the Service Mitigation Policy (Table A-1). Designation of habitat into Resource Categories ensures that the level of mitigation recommended is consistent with the value of the habitat and its relative abundance on an ecoregion or national basis.

The determination of the relative scarcity or abundance of the evaluation species' habitat from the national perspective is based on 1) the historic range and habitat quality, and 2) the current status of that habitat. A significant reduction in either the extent or quality of habitat for an evaluation species indicates that it is scarce or becoming scarce, while maintenance of historical quantity and quality is the basis for considering it abundant.

For all Resource Category 1 habitat, the Service will recommend that all losses of existing habitat be prevented, as these one-of-a-kind areas cannot be replaced. Insignificant changes that do not result in adverse impacts on habitat value may be acceptable provided they will have no significant cumulative impact.

Specific ways to achieve the mitigation goal for Resource Category 2 when loss of habitat value is unavoidable include 1) physical modification of replacement habitat to convert it to the same type which was lost, 2) restoration of rehabilitation of previously altered habitat, 3) increased management of similar replacement habitat so that in-kind value of lost habitat is replaced, or 4) a combination of these measures. By replacing habitat value losses with similar habitat values, populations of species associated with that habitat may remain relatively stable in the area over time.

The mitigation goal of in-kind replacement of lost habitat, however, cannot always be achieved. When opposition to a project on this basis alone is not warranted, deviation from this goal may be appropriate. Two such instances occur when either different habitats and species available for replacement are determined to be of greater value than those lost, or when in-kind replacement is not physically or biologically attainable in the ecoregion. In either case, replacement involving different habitat kinds may be recommended, provided that the total value of lost habitat is compensated.

For Resource Category 3, in-kind replacement of lost habitat is preferred though not always possible. substituting different habitats, or increasing management of different habitats so that the value of the lost habitat is replaced,1 may be ways of achieving the planning goal of no net loss of habitat value.

For Resource Category 4, the Service will recommend ways to avoid impacts or to immediately rectify them or to reduce or eliminate them over time. If losses remain likely to occur, then the Service may make a recommendation for compensation, depending on the significance of the potential loss. However, because these areas possess relatively low habitat values, they will likely exhibit the greatest potential for significant habitat value improvements. Service personnel will fully investigate these areas' potential for improvement, since they could be used to mitigate Resource Category 2 and 3 losses.

EA Appendix 3
Correspondence

OFFICE OF THE GOVERNOR

OFFICE OF MANAGEMENT AND BUDGET
DIVISION OF GOVERNMENTAL COORDINATION

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July 26, 1995

U.S. Army Engineer District, Alaska
ATTN: CENPA-EN-CW-ER
(Deborah McCormick)
PO Box 898
Anchorage, AK 99506-0898

RECEIVED
JUL 28 1995
REGULATORY FUNCTIONS BRANCH
Alaska District, Corps of Engineers

Dear Ms. McCormick:

SUBJECT: **NEPA REVIEW**
WILLIAMSPORT NAVIGATION IMPROVEMENTS
ENVIRONMENTAL ASSESSMENT
STATE I.D. NUMBER AK 9504-41AP

The Division of Governmental Coordination has completed the review of the Draft Navigation Channel Feasibility Report and Environmental Assessment (EA) dated June, 1995. This document and public notice have been prepared to satisfy the requirements of the National Environmental Policy Act (NEPA). Therefore, we have reviewed this document in accordance with NEPA and are providing comments and suggestions on the information presented.

The report recommends excavation of a channel 2,700 meters (m) long in Iliamna Bay. The channel bottom would be 30 m wide at 0.5 m below mean Lower Low Water (MLLW). The channel would end at Williamsport with a turning basin, 55 m long and 55 m wide. The turning basin would provide access to a recommended sheet-pile bulkhead dock, 30 m long, and an adjacent paved launch ramp 8 m wide.

These are the comments received by our office on your proposed project:

The Alaska Department of Fish and Game (ADFG) is unable to review the EA at this time. The ADFG conducted a preliminary project review of this proposal on February 6, 1995 (see enclosure). ADFG has no additional comments regarding this proposal.

The Alaska Department of Natural Resources, Division of Land (ADNR/DOL) had these comments:

1) At this time, ADNR/DOL does not have potential Alaska Coastal Management Plan consistency issues regarding the project.

2) ADNR/DOL disagrees with the Corps that no state tideland use permits would be needed for the project. On page 7 of the Coastal Project Questionnaire and Certification Statement (CPQ) that was submitted, as well as page EA-12 of the EA, it is stated that no tideland use permits would be required from the State of Alaska because the navigational improvements proposed in the project are covered under navigational servitude. The EA also states on page EA-12 that no permits would be required for dredging because the Federal navigational servitude includes the right to use the bed of the water for all purposes that aid navigation. The dredging is a moot point in this case since a material sale application will not be required by the ADNR/DOL for the dredged material because it would be utilized on the tidelands and not taken to another location for use. However, it is the position of ADNR/DOL that a state tideland lease application would need to be submitted for the proposed harbor facilities, i.e., the dock, bulkhead, and ramp.

   If you wish to pursue the issue of state permits for the project, the main contact person with ADNR/DOL regarding required state tideland permitting is Kim Kruse. She can be contacted at 762-2270.

Our office will complete a consistency review when the final EA (or Environmental Impact Statement) is completed and sent to us for review. Please refer to this state I.D. Number when sending further correspondence on this particular project.

If you have any questions, please contact me at 269-7474.

Sincerely,

Faye E. Heitz

Faye E. Heitz
Project Review Coordinator

Enclosure

cc: Chris Titus, DNR, DPOR, Soldotna
Dennis Gnath, DFG
Michele Jesperson, DNR, SHPO
Harriet Wegner, KPB
Walt Wrede, LPB
Larry Bullis, DNR, DOL
Kim Kruse, DNR, DOL
Gary Saupe, DEC
Linda Freed, KIB

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES

TONY KNOWLES, GOVERNOR

DIVISION OF LAND
SOUTHCENTRAL REGION

3601 C STREET, SUITE 1080
ANCHORAGE, ALASKA 99503-5937

July 19, 1995

U.S. Army Engineer District, Alaska
Attn: CENPA-EN-CW-ER (McCormick)
P.O. Box 898
Anchorage, Alaska 99506-0898

Dear Ms. McCormick:

The following are comments from the Department of Natural Resources, Division of Land regarding the proposal by the U. S. Army Corps of Engineers (COE) to construct navigation improvements at Williamsport, Alaska. Besides conducting channel dredging, the proposed facilities project would include constructing a new dock to replace the existing damaged one, constructing a steel sheet-pile bulkhead, and an adjacent concrete ramp. We have perused the Draft Navigation Channel Feasibility Report and Environment Assessment (DNCFR/EA) and have the following comments:

1. At this time, we do not have potential ACMP consistency issues regarding the project.

2. The Division of Land (DOL) disagrees with the COE that no state tideland use permits would be needed for the project. On page 7 of the Coastal Project Questionnaire & Certification Statement (CPQ) that you completed for the project and on page EA-12 of the DNCFR/EA, it is stated that no tideland use permits would be required from the State of Alaska because the navigational improvements proposed in the project are covered under navigational servitude. The DNCFR/EA also states on page EA-12 that no permits would be required for dredging because the Federal navigational servitude includes the right to use the bed of the water for all purposes that aid navigation. The latter (dredging) is a moot point in this case since a material sale application will not be required by the DOL for the dredged material because it would be utilized on the tidelands and not taken to another location for use. However, it is the position of the DOL that a state tideland lease application would need to be submitted for the proposed harbor facilities, i.e., the dock, bulkhead, and ramp.

If you wish to pursue the issue of state permits for the project, the main contact person with the Division of Land regarding required state tideland permitting is Kim Kruse. She can be contacted at 762-2270.

Cordially,

Larry Bullis

Larry Bullis
ACMP Liaison

cc: Kim Kruse, DNR/Division of Land
Faye Heitz, DGC (AK9504-41AA)

DEPARTMENT OF FISH AND GAME

HABITAT AND RESTORATION DIVISION

333 RASPBERRY ROAD
ANCHORAGE, ALASKA 99518-1599
PHONE: (907) 344-0541

February 6, 1995

Mr. Guy R. McConnell, Chief
Environmental Resources Section
U.S. Army Corps of Engineers
Post Office Box 898
Anchorage, Alaska 99506-0898

Dear Mr. McConnell:

Re: Proposed Channel Dredging - Iliamna Bay

The Alaska Department of Fish and Game (ADF&G) has reviewed the proposal to dredge a channel through the mud flats in Iliamna Bay, ending at Williamsport. The proposed project would include dredging an 8-foot deep by 100-foot wide shallow-draft channel, disposing of dredged material in a deep-water site at the head of Iliamna Bay, constructing a barge landing dock, and demolishing the old dock. You have requested preliminary comments on the probable biological effects of this proposed project. We offer the following comments for consideration during the planning phase.

The dredging activity described in your letter (received January 11, 1995) can cause localized turbidity due to the disruption of sediment. Such turbidity can prove detrimental to finfish exposed to it. In the Kamishak Bay District, the herring spawning migration usually occurs from mid-April through early June. The presence of herring larvae in Kamishak Bay would be slightly later than the spawning migration, roughly early May through mid-June.

Pink and chum salmon fry emigrate into these waters. Although no area-specific studies on fry emigration has been conducted in the fresh or salt waters of Cottonwood or Iliamna Bays, it is believed that pink and chum salmon fry emigration is slightly later than their cohorts in the outer Kenai Peninsula coastal areas on the Gulf of Alaska. This time differential is attributable to the harsher weather and prolonged winter conditions found in Kamishak Bay. The estimated time period for salmon fry emigration from fresh waters, and their presence in the salt water of Iliamna Bay is estimated between early April through mid-June.

In short, based on these criteria, the ADF&G believes that a window of **no dredging activity from April 1 through mid-June** would effectively reduce detrimental impacts to the majority of finfish in the area of the proposed project.

mouth, not head

The letter indicated that dredged material would be disposed at a deep-water site at the head of Iliamna Bay. We have consulted with ADF&G staff that conduct numerous low- and mid-level aerial surveys in this area. They are not aware of any "deep-water" sites at the head of Iliamna Bay. A review of marine nautical charts has confirmed this. The ADF&G suggests that beneficial uses for the material be considered. We understand that the Alaska Department of Transportation and Public Facilities (DOT&PF) maintains the road between Williamsport and Pile Bay Village. It is conceivable that the DOT&PF may have a need for this material after evaluating its physical suitability for proposed uses.

The project site is located in the coastal zone and would likely be reviewed for consistency with the Alaska Coastal Management Program (ACMP). The ADF&G does not anticipate requiring a Fish Habitat Permit for this proposal, however, there may be stipulations necessary to ensure consistency with the ACMP. For the new barge landing dock, no portion of the wooden structure should be treated with any preservative containing pentachlorophenol. If treated with creosote, the creosote must be applied using pressure treatment, rather than painted on or allowed to soak into the wood. As project plans develop, the ADF&G may be able to provide more detailed information.

Thank you for the opportunity to comment on this proposal. If you should have any further questions please contact me at 267-2284.

Sincerely,

Dennis G. Gnath

Dennis G. Gnath
Habitat Biologist
Habitat and Restoration Division
(907) 267-2284

cc: L. Hammarstrom, ADF&G
J. Westlund, ADF&G
W. Bucher, ADF&G
N. Dudiak, ADF&G
A. Kimker, ADF&G

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
222 West 7th Avenue, Box 43
Anchorage, Alaska 99513-7577

September 27, 1994

Guy McConnell
Chief, Environmental Resources Section
U.S. Army Engineer District, Alaska
P.O. Box 898
Anchorage, Alaska 99506-0898

ATTN: L. Boyer

Dear Mr. McConnell:

Thank you for your letter concerning the proposed dredging of a channel through mud flats at Iliamna Bay near Williamsport, Alaska. You request comments on the probable biological effects of this work and information on the presence of Threatened or Endangered species listed under the Endangered Species Act of 1972, as amended.

Present staffing and workloads do not allow us to undertake a thorough analysis of the potential environmental effects of the proposed dredging. We have no specific information on the presence of Threatened or Endangered species for which our agency is responsible which might occur within the waters of the project area. The Threatened Steller (northern) sea lion is likely to occur nearshore, especially during anadromous fish migrations.

Please contact Brad Smith at 271-5006 concerning any questions you might have, or to discuss future project planning.

Sincerely,

Ronald J. Morris
Western Alaska Office Supervisor
Protected Resources
Management Division

STATE OF ALASKA

WALTER J. HICKEL, GOVERNOR

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF PARKS AND OUTDOOR RECREATION
Office of History and Archaeology

3601 C STREET, Suite 1278
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P.O. Box 107001
ANCHORAGE, ALASKA 99510-7001

April 18, 1994

File No.: 3130-1R COE

Subject: Anchor Point Small Boat Harbor Feasibility
Williamsport Dock Feasibility Study

Lizette Boyer
Environmental Resources Section
U.S. Army Engineer District, Alaska
P.O. Box 898
Anchorage, AK 99506-0898

Dear Ms. Boyer;

Thank you for your letters on the referenced projects. We have no specific information on the "old Russian village remains" near Anchor Point. There are 2 sites on the AHRS in the vicinity (information enclosed) but the locations are only approximate. Neither seem to relate to a Russian occupation. An archaeological survey is recommended.

There are no known sites in the vicinity of Williamsport. It is difficult to assess the potential for cultural resources because no archaeological survey has been done in the area. Williams Creek does not appear to support a major anadromous fish run and the bay with its extensive mud flats may not have been very attractive to prehistoric people. The potential appears to be moderate. An archaeological survey may not be necessary if the proposed work is limited to existing disturbed areas.

Please contact Tim Smith at 762-2625 if there are any questions or if we can be of further assistance.

Sincerely,

Judith E. Bittner

Judith E. Bittner
State Historic Preservation Officer

JEB:tas

Enclosures

Appendix A
Channel and Shore Facilities Design

APPENDIX A
CHANNEL AND SHORE FACILITIES DESIGN
WILLIAMSPORT

Contents

Figures

Tables

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November 7, 1995

APPENDIX A
CHANNEL AND SHORE FACILITIES DESIGN
WILLIAMSPORT

1. Design Criteria

Navigation improvements proposed for Williamsport are conceived to meet the following basic objectives:

a. Reduce transportation costs between the Kenai Peninsula and Iliamna Lake; and

b. Improve marine safety in Iliamna Bay on Cook Inlet.

These objectives relate to the extreme difficulty and danger which is the present situation for mariners in Iliamna Bay at Williamsport. Prospects for transportation savings extend to deliveries of commercial fishing vessels from Cook Inlet to Bristol Bay and back.

Broad tidelands in Iliamna Bay, intermittently broken by narrow, meandering tidal drainage channels, make the approach to Williamsport a challenge for experienced local pilots at the peak of extreme spring high tides. The approach is impossible at any other time. Groundings are inevitable, and some cause serious delays and damages. Boulders scattered across the tide flats are invisible when submerged in the turbid water of Iliamna Bay. Collisions with submerged boulders have severely damaged several vessels which strayed from the meandering course of the main tidal drainage channel. This report investigates the feasibility of navigation improvements which reduce or eliminate these hazards and delays.

2. Physical Constraints

2.1 Tides and Tidal Currents

According to the National Oceanic and Atmospheric Administration's *Tide Tables* (NOAA 1995), the mean tide level in Iliamna Bay is 2.3 m MLLW, the mean range is 3.7 m, and the diurnal range is 4.4 m.

Tidal observations at Iliamna Bay were recorded for this study. Recording tide gauges were used to collect data from May 27 to June 8, 1994, and from July 13 through August 19, 1994. These data and a modification of the tide prediction computer program

NTP4 (Zetler 1982) were applied to predict hourly tides for the entire year of 1994. This year is assumed to represent the tidal variations of any full year. Figure 9 in the main report shows the modified predicted tides for Iliamna Bay. Figure 10 in the main report shows the corresponding hourly exceedance of water levels.

Tidal currents in an excavated channel were estimated by the same tidal prediction program through the use of an added subroutine which superimposed a sinusoidal variation of water level between predicted high and low tide levels. The subroutine further assumed a friction-constrained slope current using Manning's equation. Figure A-1 illustrates currents predicted by this method for a period of spring tides.

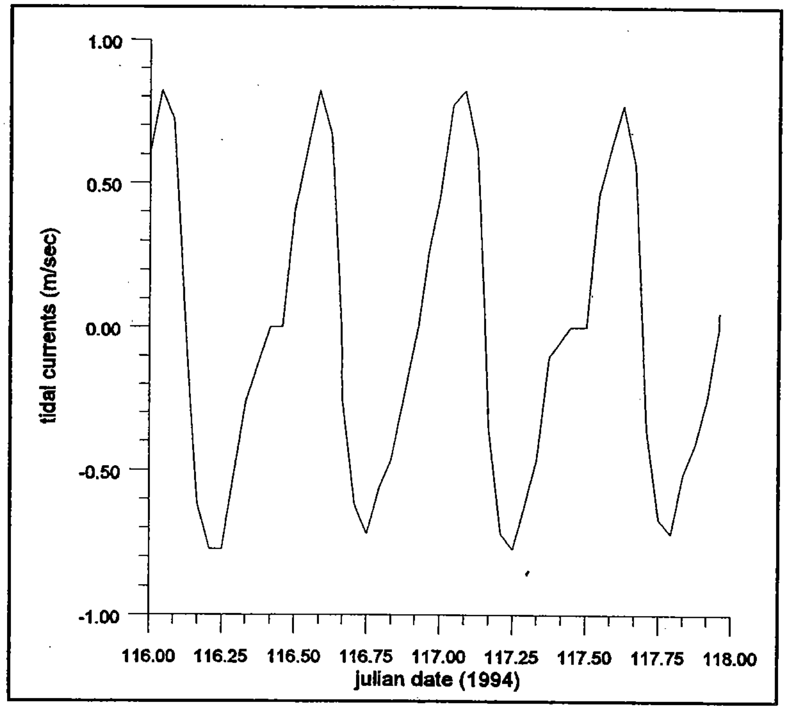

FIGURE A-1.--Predicted tidal currents in upper Iliamna Bay during 1994 spring tides, with a 30-m-wide channel at -0.5 m MLLW excavated in tidelands at 2.5 m MLLW.

Figure A-1 shows two days of spring tides when low tide was lower than the -0.5-m-MLLW channel assumed in this example application of the tidal current subroutine. The subroutine assumed in this example that a trapezoidal channel 30 m wide, with side slopes of 1:4 (1 step vertical to 4 horizontal) extends across tidelands at 2.5 m MLLW.

The bank height of the excavated channel is thus 3 m high. The hydraulic radius is computed for the trapezoidal channel until the water rises above the banks, when the hydraulic radius is assumed to equal the water depth. The average maximum flood and ebb currents were computed to be about 60 centimeters per second (cm/s).

2.2 Winds and Waves

Winds in the Iliamna area are strongly influenced by the steep, mountainous shoreline topography. Airplane pilots report strong westerly winds flowing through the Kamishak Gap between the Aleutian and Chigmit Mountains, especially in autumn. This flow is known to cause water spout formation on Iliamna Lake and at Iniskin Bay, 32 km east of Williamsport. Mr. Ray Williams reports that 2 to 4 times a year, usually in the fall, very strong winds flow from the mountains behind Williamsport down into Iliamna Bay. This situation was encountered at the start of the Williamsport Field Measurement Expedition (see appendix D). These offshore winds at Williamsport have hampered boat traffic into Williamsport, but do not generate large waves in the short fetch and shallow water of Williamsport Bay.

Mr. Williams reports that the southeast winds generate a lot of wave action in the lower portion of Iliamna Bay but very little at Williamsport. This condition was also experienced during the Williamsport Field Measurement Expedition as a low pressure system passed across lower Cook Inlet. Williamsport Bay is protected from southeast winds and waves by the steep mountain buttress that defines the south side of the bay. The wave climate at Williamsport is almost always calm, due to its protection from onshore winds, its short fetch for offshore winds, and its shallow water.

The nearest long-term wind records are at Homer (120 km east of Williamsport), Kenai (160 km northeast), and Kodiak (225 km south). Annual maximum windspeeds from these sites were averaged for estimates at Williamsport. A 50-year return interval windspeed of 28 meters per second (55 knots) and a 6-km local fetch in lower Iliamna Bay can produce a 1.1-meter significant wave height. An estimate of wave diffraction at extreme high tide indicates that Williamsport is not significantly affected by waves generated in Iliamna Bay, nor would it be with any narrow channel improvement. A full-tide channel for shallow-draft vessels approaching Williamsport would not extend into areas of Iliamna Bay which are exposed to the conditions of lower Cook Inlet. The diffraction analysis indicates a wave height of 0.6 m is a conservative estimate of extreme conditions in the upper half of Iliamna Bay.

2.3 Suspended Sediment and Sedimentation

The surface of the tidelands in upper Iliamna Bay is covered with 1 to 3 m of sedimentary silt and clay, as described in more detail in appendix C, parts 1 and 2. This fine material lies above a coarser glaciofluvial deposit. The fine surface material is consolidated 10 cm or less below the surface to the consistency of modeling clay. Walking across the tideflats is not difficult, except in areas where the silt layer has recently been disturbed. Footprints made during the Williamsport Field Measurement Expedition were typically 2 to 3 cm deep.

Suspended sediment concentrations of 16 to 70 mg/L were measured in waters collected in Williamsport Bay in May of 1994. Higher concentrations were measured on incoming tides 0.3 to 0.6 meters from the bottom. The source of this material does not appear to be the surrounding drainages of Iliamna Bay, which are mainly clear streams draining steep, rocky mountain slopes. Section 2 of the main report describes the general circulation of Cook Inlet, which tends to bring sediment-laden inlet water past the mouth of Iliamna Bay. Plumes of sediment-laden water were observed moving into Iliamna Bay during flights associated with the Williamsport Field Measurement Expedition.

Measurements of the median grain size (D_{50}) of the sediment suspended in nine water samples from Iliamna Bay averaged 0.047 mm. The D_{50} of 13 seabed-surface grab samples in upper Iliamna Bay averaged 0.036 mm. These grain sizes classify this material as silt. The bed samples had small fractions of sand and occasionally included pieces of small gravel. An assessment of sediment transport parameters indicates that settlement and deposition of the dominant silt particles are possible when current speeds are below about 20 cm/s. The sediment will tend to erode at higher velocities. This assessment is based on a critical shear stress of 0.01 newtons per square meter for weakly cohesive silt (Partheniades 1984).

The analysis demonstrated in figure A-1 shows that for a 30-m-wide channel at -0.5 m MLLW, tidal currents are less than 20 cm/s for less than 2 hours at low tide and for less than 1 hour at high tide. Otherwise, the suspended particles tend to remain in suspension, and particles of the bed tend to experience scour. The time when the most suspended sediment is present (high tide) is the time when current speeds drop below 20 cm/s for the shortest duration. At low tide, when slower currents last longer, less sediment is present to settle in an excavated channel.

The tidelands appear to be near equilibrium in terms of sedimentation, based on radioisotope dating of sediment core samples collected in Williamsport Bay (see appendix C, part 4). These tests indicate a very slow, long-term accumulation of sediment averaging less than 1 cm/year. Mr. Williams and other mariners with years of experience sailing into Williamsport indicate the alignment of the tidal drainage channel leading from Williams Creek has not discernibly changed since their first observations. An artificial entrapment of the water may give the fine suspended material more time to settle and adhere to the bottom. This hypothesis is based on Corps experience maintaining Dillingham Harbor on upper Bristol Bay, where the mooring basin is excavated below the entrance channel depth. Improvements which do not disrupt tidal currents in this way will probably not experience high unnatural sedimentation rates.

2.4 Snow on the Williamsport-Pile Bay Road

There have been two meteorological measurement sites in the Williamsport area. The Iniskin site was located on the Iniskin Peninsula approximately 24 km east of Williamsport on Cook Inlet. The site was at the 90-m elevation level and had six partial years of data, from 1955 to 1961. This site gives a fair idea of what the climatic conditions at Williamsport are. The second site was located at Intricate Bay on Iliamna Lake, approximately 10 miles southwest of Pile Bay. Intricate Bay was at 40 m elevation and had about 15 years of record from 1960 to 1975. Data from this site represent the climatic conditions at the Pile Bay end of the Williamsport-Pile Bay Road (NOAA 1970). Iniskin data indicates that first snowfall in the area occurs in October. November appears to be the first month in which snowfall and avalanche risks shut down the road. The recorded maximum snow on the ground in November was 61 cm, and the average snow depth was 25 cm. Intricate Bay indicates similar conditions for November, an average of 28 cm of snow with a maximum of 71 cm.

The high point of the road is approximately 370 m in elevation. The depth of snowfall is expected to be greater there than at either of the two meteorological observation sites. This is the vicinity of the steepest slopes along the road and the greatest avalanche risk. Mid-November is assumed to be the latest the road would be safely passable. The climatic data indicate that mid-May, on average, would be the earliest the road could open. Some avalanche danger remains even in May. Mr. Ray Williams of Pile Bay Lodge indicated that mid-May would be the earliest practical date for the road to be assumed open, and that in some years the road is not passable until June.

2.5 Iliamna Bay Ice

Climatic data and ice observations on Cook Inlet (LaBelle *et al.* 1983) indicate that Iliamna Bay starts freezing in December. The bay is typically covered with fast ice during January and February and usually becomes ice-free in March. The ice effectively precludes navigation in upper Iliamna Bay into Williamsport. The navigation season, with regard to the presence of ice, therefore extends, on average, from April to November. The road opens in mid-May when high-elevation snows diminish. These constraints define a 6-month practical navigation season, mid-May through mid-November.

3. Channel and Basin Design

3.1 Vessels

The variety of vessels that call on Williamsport is discussed in the main report. The vessel classes critical to design of channels and maneuvering areas are the commercial fishing vessels (gill-netters), landing craft, and coastal tugs and barges. All vessels that currently access Williamsport except some of the tugs can go aground on a smooth bottom without damage. The landing craft and commercial fishing vessels have similar drafts, but coastal tugs are about 1 m deeper in the water. The depths of water needed in the channel for safe passage are based on the draft and clearance parameters of table A-1.

TABLE A-1.--*Channel depth design parameters*

Parameter	Coastal tug	Landing craft
Vessel draft (m)	2.4	1.4
Squat allowance (m)	0.3	0.3
Response to waves (m)	0.3	0.3
Keel clearance (m)	0.3	0.3
Bottom irregularities (m)	0.3	0.3
Total channel depth (m)	3.6	2.6

3.2 Channel and Basin Geometry

Two channel and basin sizes were considered in detail for Williamsport. A 40-m-wide channel and a 90-m-square basin were designed to handle all vessels, including a tug and barge. A 30-m-wide channel and a 55-m-square basin were designed to handle the landing craft as the maximum size vessel. The navigation channels and basins considered for Williamsport were designed based on guidance presented in EM 1110-2-1613, "Hydraulic Design of Deep-Draft Navigation Projects." The channels were designed for one-way traffic. The landing craft and the tug and barge combination are considered to have good controllability. Each channel would have two bends requiring 25- to 30-degree turns. The channel widths for the straight reaches are based on 180 percent of beam for the maneuvering lane and 60 percent of beam for bank clearance on both sides of the maneuvering lane. Alignment of the straight segments and angles of the turns were arranged to accommodate marking each straight segment with visual range markers on shore. The apex or cutoff method was used to widen the channels approximately 25 meters at the inside of each turn. Analysis of slope stability, which considered rapid drawdown in the high tidal ranges of Iliamna Bay, found side slopes of 1 vertical to 4 horizontal had a practical maximum steepness.

3.3 Causeway Option

Two major alternatives for layout of the channel and basin were considered. One alternative layout aligns the channel with the deepest areas of Iliamna Bay, following the natural tidal drainage channel of Williams Creek well into Williamsport Bay. The channel leads to a new basin and dock at the site of existing ruins of an old dock at the terminus of the Pile Bay Road. The main report discusses this as the "old dock site" alternative. The second alternative layout follows the same channel alignment past the first turn, but its second turn diverts its center line toward a basin and dock on the outer south margin of Williamsport Bay. An earthfill causeway connects the dock to the existing Pile Bay roadhead. The incentive for this option was to shorten the excavation across the upper tidelands.

3.4 Channel and Turning Basin Maintenance

A depression was observed in the upper tidelands at the existing roadhead at Williamsport. This shallow pit was created by repeated groundings and propeller wash of landing craft and other vessels that have landed there. A layer of sand was spread over the silt surface in this small basin at the start of the Williamsport Field Measurement Expedition, in an area slightly below the elevation of the natural channel leading seaward from the basin. Small holes with vertical sides were periodically dug with a shovel through the sand to observe any apparent sedimentation. About 0.3 to 0.6 cm deposition of silt on top of the sand was measured 3½ days after the first observation. The natural tidal drainage channel did not appear to change. Though the intense activities of the

Williamsport Field Measurement Expedition resuspended unnatural amounts of bed material, only a small amount of sedimentation was observed in a low area.

The natural sedimentation rate is low in Williamsport Bay. An excavated channel as proposed will focus tidal energy along its alignment, which will encourage scour, rather than sedimentation, for most of each tidal cycle. Scour by tidal currents may cause an excavated channel to lose its straight alignment over a period of years until meanders develop which diminish its effectiveness. A basin excavated to an elevation below the channel bottom may require annual maintenance, since suspended sediment below the level of the channel would have ample time to settle. For this reason, the basin is proposed at the same elevation as the channel. Vessels will go dry at low tide, but will have ample space to turn at intermediate and high stages of the tide.

Ice movements in Iliamna Bay are expected to move some material into the channel. The streams that flow into Williamsport Bay would be captured by the channel and are expected to erode the channel side slopes, depositing material on the insides of bends. Some scour by the streamflow in the area where the streams first enter the channel is expected. Increased turbulence from vessel traffic may cause scour of channel side slopes to deposit material along the margins of the channel. Maintenance dredging of the channel is estimated on the basis of these factors to be necessary at a frequency of 5 years to excavate volumes no more than 25 percent of the initial excavation quantity.

Hydrographic surveys, each costing an estimated $40,000, would be required at 5-year intervals to monitor the condition of the channel in the years preceding maintenance dredging episodes. Annual surveys would be accomplished during the first 4 years following the initial excavation..

3.5 Aids to Navigation

The U.S. Coast Guard has tentatively proposed a system of three shore-based visual ranges for marking the channel at Williamsport, pending final design of the channel and a detailed investigation of the site by Coast Guard specialists. These ranges are estimated to cost $40,000 to construct. Annual inspection and routine maintenance by the Coast Guard is estimated to cost $2,500.

3.6 Cargo Transfer Facilities

The Alaska Department of Transportation and Public Facilities provided a design for a steel sheet-pile bulkhead and adjacent launch ramp at Williamsport. This design included two alternative dock designs: a 60-m-long dock for the 90-m basin design intended for tugs and barges, and a 30-m-long dock for the 55-m basin design intended for landing craft. The top elevation of the dock is 7 m above MLLW. The sheet-pile bulkhead is filled behind with gravel, which covers and holds deadweight anchors for the tiebacks of the sheet pile. The steel sheet pile is protected from corrosion by epoxy coating and a passive cathodic protection system (*i.e.*, zinc sacrificial anodes). The bulkhead is protected from physical damage by an interconnected array of timber fender piles. A wooden pile cap protects the upper edge of the sheet pile. Each of the two dock geometries includes a 12-m-wide ramp, graded at a 15-percent slope to the basin bottom elevation, 8 m of which is paved with precast concrete panels. A 0.4-hectare (4,000-m^2) graded gravel staging area would be prepared immediately adjacent to the dock and ramp.

The staging area and upper surface of the dock would be maintained annually in conjunction with road maintenance at an estimated incremental cost of $3,100. The sacrificial anodes and fender piles would require replacement every 10 years at an estimated cost of $317,000. The sheet-pile and tieback system, with this regular maintenance, is conservatively estimated to last 30 years, at which time a complete replacement of the steel components will be required at an estimated cost of $1,254,000.

3.7 Optimization

The optimum combination of features is identified by its maximum net benefits, *i.e.*, the maximum positive difference of annual economic benefits and equivalent annual life-cycle costs. The optimization of proposed Williamsport navigation improvements was accomplished in three steps: (1) Comparison of causeway and old dock site alternatives, (2) comparison of channel and basin designs for tugs and barges with those designed only for landing craft and commercial fishing vessels, and (3) comparison of a range of channel and basin depths. The features and maintenance assumptions discussed above were applied in this process. The final step of channel depth comparison was accomplished by computing excavation quantities for channels of the same alignment ranging in elevation from -1.5 m to 1.5 m MLLW in 0.5-m increments.

All causeway options were eliminated in the first step, because the cost of causeway construction proved to significantly exceed that of dredging a channel to the head of Williamsport Bay, including the long-term cost of maintenance dredging. The wider channel and the wider and deeper basin required for tug and barge service proved to be less economically efficient than a design for landing craft service, basically due to the limited amount of cargo throughput projected for Williamsport. The optimum geometry was computed to be a 2,700-m-long, 30-m-wide channel at -0.5 m MLLW, which leads to a 55-m-square basin at the same elevation. The basin would serve a 30-m-long dock with an adjacent launch ramp and staging area. The detailed features and costs of this recommended plan are itemized in the main report.

A sensitivity analysis of the effect of dredging frequency was accomplished using preliminary estimates of net benefits for the various channel bottom elevation alternatives at varying maintenance dredging intervals. Table A-2 illustrates that dredging intervals of 15, 10, 5, and 2 years are all feasible and result in an optimum channel bottom elevation of -0.5 m MLLW. Later adjustments to the benefit analysis for the recommended plan do not affect this trend.

TABLE A-2.--*Net benefits ($) of alternative channel bottom elevations at various dredging frequencies*							
Dredging frequency	**Channel elevation (m MLLW)**						
	-1.5	**-1.0**	**-0.5**	**0.0**	**0.5**	**1.0**	**1.5**
every 15 yr	509,115	577,870	***632,022***	472,125	203,639	-102,888	-227,309
10 yr	464,693	537,886	***595,521***	437,935	170,897	-134,551	-258,047
5 yr	358,166	445,968	***515,067***	365,090	102,821	-199,076	-319,529
2 yr	49,979	174,661	***272,700***	141,932	-108,300	-401,234	-514,003
yr	-496,602	-289,194	-126,239	-213,921	-437,152	-709,979	-805,514

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Appendix B
Economics

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APPENDIX B
ECONOMICS
WILLIAMSPORT

1. General Information

The purpose of this section is to provide general background information on the socioeconomic composition of the study area. This discussion is necessary to enable planners and report reviewers to gain an understanding of the community infrastructure, the level of economic activity generated from this rural area, and the area's potential ability to support the project under consideration.

General information about Williamsport and the surrounding area, especially the area around Iliamna Lake, is provided in section 2 of the main report. Subsection 2.1, Geography, and Subsection 2.5, Living Resources, are of particular interest.

1.1 Iliamna Lake Communities

The six communities surrounding Iliamna Lake, which receive commodities through Williamsport, are briefly described in section 3 of the main report. A map in the main report, figure 11, shows their locations, and table 1 in the main report lists their populations by decade since 1960. More information about these communities is presented in this subsection. The Alaska Department of Community and Regional Affairs is the source of most of the data.

The villages of Iliamna, Newhalen, Pedro Bay, Kokhanok, and Igiugig are situated on the shores of Iliamna Lake. Nondalton, 15 miles north of the lake on the Newhalen River, is connected by road to the village of Iliamna. The economies of these predominantly Native communities are based in large part on subsistence hunting and fishing. Subsistence is an integral part of the village residents' lifestyle and cultural heritage, as well as a vital source of food. The economic well-being of the communities depends in large part on the fishermen's success during the red salmon run in Bristol Bay during June and July. Hunters take rabbit and porcupine year-round, while moose, caribou, bear, ptarmigan, duck, and goose are hunted in season.

The following paragraphs describe each of the lake villages.

1.1.1 Iliamna

Iliamna is an unincorporated village within the Lake and Peninsula Borough. Its 1993 population was 92. The village is located on the northwest side of Iliamna Lake, near the Lake Clark Park and Preserve. Prior to 1935, "Old Iliamna," a traditional Athabascan village, was located near the mouth of the Iliamna River. Iliamna has become a recreational and tourist attraction due to the excellent fishing at Iliamna Lake. The population is mixed, with 66 percent Native, including Tanaina Athabascans, Aleuts, and Eskimos.

Iliamna is accessible by air and water. An 8-mile gravel road connects Iliamna to Newhalen. Regular and charter flights are available from King Salmon.

The Iliamna community water system consists of individual wells. The sewer system is a combination of honeybuckets, outhouses, and individual septic tanks, the latter being the most popular. Electrical power is provided by the Iliamna Newhalen Nondalton Electric Co-op. Fuel oil and kerosene heat homes. Health care is provided locally by the Iliamna Health Clinic. Approximately 50 percent of Iliamna's households have telephones.

Local, State and Federal government provide some employment opportunities for village residents at the local post office, health clinic, and school. The median household income is $41,250.

1.1.2 Newhalen

Newhalen is a second-class incorporated city within the Lake and Peninsula Borough. The community, with a 1994 population of 185, is on the north shore of Iliamna Lake at the mouth of the Newhalen River. It was established at this location because of the bountiful fish and game in the immediate area. Salmon fishing is the mainstay of Newhalen's economy. During the red salmon season, most village residents leave Newhalen to fish in Bristol Bay. As with other lake villages, Newhalen's people depend heavily on subsistence hunting and fishing.

Traditionally an Eskimo village, Newhalen now also includes Aleuts and Indians. Most people travel by air, using the Iliamna airport located 5 miles away. Air charter services are available from King Salmon.

A public water system provides water for the majority of Newhalen's residents. Homes are heated with fuel oil, kerosene, or wood. Sixty-two percent of the residents have telephone service.

Newhalen's median household income is $26,250. Although some jobs are provided by local, State, or Federal government, and employment is available for some professional and construction workers, subsistence is the predominant way of life for most residents.

1.1.3 Pedro Bay

Pedro Bay, with a 1993 population of 50, is located at the northeast end of Iliamna Lake, 176 air miles southwest of Anchorage. It is an unincorporated village within the Lake and Peninsula Borough. Dena'ina Indians occupied this area historically, warring with Russian fur traders over trade practices in the early 20th century.

Employment conditions are similar to that of other lake villages. Short-term summer employment in the fishing industry or in tourism services is available, and a few relatively steady jobs exist with the government. Most residents, however, depend on subsistence hunting and fishing. The median household income is $38,125.

Pedro Bay is accessible by air and water. There is regular flight service from Iliamna, and charter services are available from King Salmon. Barge service is available to Naknek, and goods are lightered to the shore of Iliamna Lake. Water sources include individual wells, springs, creeks, rivers, etc. Heating sources are fuel oil, kerosene and wood. Fifty percent of Pedro Bay's households have telephones.

1.1.4 Kokhanok

Kokhanok, with a 1993 population of 139, is on the south shore of Iliamna Lake. It is an unincorporated village within the Lake and Peninsula Borough. Subsistence activities are the focal point of the culture and lifestyle. The village has a mixed Native population, primarily Aleuts, with some Eskimos and Indians. The median household income is $14,286.

Kokhanok is accessible by air and water. Skiffs, all-terrain vehicles, and trucks are the common forms of transportation. Regular air service is available from Iliamna, and charter services depart from King Salmon.

Water is hauled from a central watering point. Heating fuel consists mainly of fuel oil, kerosene, and wood. Approximately 57 percent of Kokhanok's households have telephones.

1.1.5 Igiugig

Igiugig, with a 1993 population of 40, is on the south shore of the Kvichak River, which flows from Iliamna Lake. It is an unincorporated village within the Lake and Peninsula Borough. Eskimos originally lived on the right bank of the Kvichak River and used Igiugig as a fish camp. At the turn of the century, these people moved upriver to the present site. Historically an Eskimo village, the population of Igiugig is now 80 percent Aleut. The residents depend on commercial fishing and a subsistence lifestyle. Sport fishing and tourism attract a large number of visitors in summer. The median household income is $41,250.

Igiugig is accessible by water and air. Scheduled and charter flights are available from Kodiak and King Salmon.

Igiugig residents haul water from a central watering point. Heating fuel consists of fuel oil and kerosene. Approximately 75 percent of the local households have telephones.

1.1.6 Nondalton

The community of Nondalton, with a 1994 population of 231, is on the west shore of Six Mile Lake, between Lakes Clark and Iliamna. It is a second-class incorporated city within the Lake and Peninsula Borough. Nondalton was originally located on the north shore of the lake, but in 1940 wood depletion in the surrounding area and growing mudflats caused the village to move to its present site. It is a Tanaina Indian (Athabascan and Iliamna) village with a fishing and subsistence lifestyle.

As with the other lake villages, commercial fishing is an important source of income in Nondalton. Most fishermen leave the village in summer to fish in Bristol Bay.

Some gold and copper are mined in the area. Unemployment is high, and the community in general relies on subsistence hunting and fishing for its survival. Median household income is $21,750.

1.2 Tourism and Mining Potential

Tourism attracts between 35,000 and 40,000 people to the Iliamna Lake area each summer. Privately owned fishing and hunting lodges along the lake and feeder streams are seasonally occupied by employees and guests, greatly boosting the regional population and commerce. Iliamna Lake and its tributaries are known for some of the world's best trout fishing. Articles on the area appear frequently in issues of sport fishing magazines.

The potential for metallic minerals in the Bristol Bay and Lake Iliamna region is relatively unknown. Exploration has been slight. However, mineralized zones containing iron, copper, titanium, lead, magnetite, molybdenum, gold, silver, and zinc have been identified. High-potential mining areas and some mining claims are located near Iliamna Lake.

2. Existing Conditions

The dock at the end of the Williamsport-Pile Bay Road is composed of a makeshift wood pile and plank retaining wall. The offshore toe of the dock is about 4.3 m above mean lower low water (MLLW). The top of the dock is at about 6.7 m above MLLW. The dock is constructed of remnants of a more substantial structure that was built in the 1940's and heavily damaged by the 1964 earthquake.

Commodities are carried to the region by two primary routes: air cargo from Anchorage, and vessel cargo from the Kenai Peninsula. No systematic commodity flow data directly applicable to this study are known to exist. These estimates of historical commodity movements by type, volume, and route into the Iliamna Lake region have been compiled from conversations with shippers and local consumers and from available historical records.

Shallow approaches to Williamsport along the north arm of Iliamna Bay prevent access by barges and landing craft for all but several hours at the peak of extreme high tides. Cargo delivery vessels entering the bay are routinely grounded or forced to go dry between high tides. It is rare that a loaded vessel can dock at Williamsport, unload, and get back out on a single tide. Vessels requiring less than the standard 4- to 5-foot draft of a barge or landing craft, such as commercial gill-net fishing vessels, are able to access Williamsport somewhat more frequently, but not enough to meet demand.

2.1 Vessel Damage

Damage to vessels attempting to dock at Williamsport occurs routinely. Frequent groundings leave hulls scraped and dented. Several large boulders protrude from the sand and gravel of the tidal flats approaching Williamsport. A 1982 incident resulted in $20,000 in damages when a vessel ran aground on a boulder. Another grounding not involving a boulder crumpled a portion of a vessel's steel hull, requiring $5,500 in repairs. Major structural damage to vessels as a result of groundings and/or exposed boulders occurs an average of two times yearly. Minor damages are sustained 10 times per year. Based on data gathered from conversations with owners of vessels damaged by boulders and/or groundings in the last 12 years, average annual damage to all types of vessels equals $5,700.

2.2 Commodity Flows

Commodities for Lake Iliamna residents are delivered via water or air. Freight shipped to Williamsport by barge or landing craft from the Kenai Peninsula is hauled over the Williamsport-Pile Bay Road and circulated to the various villages around the lake. Air freight is sent to the village of Iliamna, distribution center for lake residents, via mail or commercial plane. Barge and landing craft freight account for 60 percent of the total weight shipped. A wide variety of goods, including propane, boats, general household supplies, telephone and electric company supplies, and food are delivered each year. Residents order as much as possible of the barged supplies, stocking up for winter when commodities must be flown in at a cost approximately four times as high.

Marine freight delivery vessels (barges and landing craft) make calls to Williamsport an average of 40 times per year, (exclusive of construction-related freight barges) carrying roughly 20 tons per call. Barge and landing craft companies charge an average of $2,000 per 12-hour day to deliver to Williamsport. Delays requiring a freight vessel to go dry between high tides occur with 80-percent frequency, or 32 times yearly. Each delay doubles the consumer's delivery fee to $4,000. This increase encompasses additional vessel owner expenses incurred because of the delay including fuel, labor fees, insurance, and general operating and maintenance costs. This translates into expenses associated with barges and landing craft deliveries of $144,000, as shown below:

8 trips	x	$2,000	=	$ 16,000
32 delays	x	$4,000	=	$128,000
				$144,000

Vessels servicing Williamsport require approximately 2 meters of water depth to manage the channel safely. An average of 4 hours is needed for barges and landing craft to complete a full delivery to Williamsport. Barge owners report they use tugs to aid navigation into and out of Williamsport less than 5 percent of the time. The incremental benefits for regular tug-and-barge service do not offset the incremental costs for a tug-and-barge channel design. All tug-and-barge channel variations are therefore eliminated from further consideration.

Air freight to Lake Iliamna communities arrives by mail or commercial plane twice weekly. Anchorage retailers charge 15 percent above cost, plus postage, to prepare and send village orders. A single air carrier offers freight service from Iliamna to the other lake villages, charging an additional $.15 per pound.

Commodities needed urgently or goods such as perishable foods are put directly on a commercial plane by an Anchorage vendor and flown to the village of Iliamna, distribution center for the other lake villages. In these cases residents pay for the cost of the goods, a 15-percent handling fee, air freight charges from Anchorage to Iliamna village, and again from Iliamna village to any of the other villages. On average, village residents relate they spend $.49 per pound on air freight. Telephone interviews with village residents show an average of $3,223 is spent annually per household on commodities transported by air. Approximately 228 households exist in the villages around Lake Iliamna. Multiplying 228 by $3,223 results in a total spent on air freight by Iliamna Lake residents of $734,800 per year.

The annual weight and value of freight currently being transported by water and by air to the Lake Iliamna area is shown in table B-1.

TABLE B-1.--*Existing annual commodity flows to Iliamna Lake villages*

Shipping method	Dollars	Pounds
Surface (sea and road)	$144,000	1,600,000
Air	734,800	1,500,000
TOTAL	$878,800	3,100,000

2.3 Construction

Construction firms located on the Kenai Peninsula are frequently hired by Iliamna Lake villages to work on projects ranging from building or remodeling homes to completing lodges, restaurants, gift shops, and airports. Lake Iliamna's tourist industry has grown by leaps and bounds in recent years. According to the Alaska Division of Tourism, more than 35,000 people visit the lake area yearly to enjoy the exceptional hunting and fishing. This expansion has led to frequent building and/or remodeling projects. According to village residents and businesses, and Kenai Peninsula construction firms, construction companies are hired to work in the Iliamna Lake area an average of three times per year.

Freight vessels loaded with construction equipment and building materials arrive at Williamsport from the Kenai Peninsula. Building supplies are then hauled over the Williamsport-Pile Bay Road and delivered to the appropriate construction site. Severely limited tidal windows for access make delays a frequent occurrence. Construction personnel relate that groundings are common. Small barges must be used, requiring more trips to get all the necessary equipment and materials to the site. Based on available historical data provided by construction personnel, a cumulative average expense of $21,300 is incurred annually due to delivery delays at Williamsport. These extra project costs include increased vessel operation and maintenance expenses, higher labor fees, and costly schedule setbacks. Construction expenses incurred are in addition to normal commodity flow costs.

2.4 Bristol Bay Gill-net Fleet

Williamsport offers Bristol Bay gill-net fishermen a significant shortcut in transporting their vessels from Cook Inlet to Bristol Bay. Of the 1,886 gill-net permit holders registered in Bristol Bay in 1994, roughly three-fourths, or 1,415, store their vessels in Naknek or King Salmon, on the bay. The remaining 471 winter their boats in Cook Inlet. Although most of the gill-net vessels remain in Bristol Bay throughout the year, boats are brought to Cook Inlet an average of once every 4 years for repairs and/or overhauls and maintenance. This brings the average annual gill-net traffic going from Cook Inlet to Bristol Bay and back to 825 vessels (471 + 1,415/4) each way.

Each spring the Williamsport-Pile Bay road is used as an alternative route for transporting vessels from Cook Inlet to Bristol Bay. In fall, the road is again used to haul the vessels back from Bristol Bay to Cook Inlet. Williamsport allows fishermen to avoid the long journey around the Alaska Peninsula, reducing travel time by several days and shortening the trip by almost 1,000 miles, saving on fuel, wear and tear of the vessel and equipment, and opportunity cost of time for the crew. However, the extremely limited time available for docking at Williamsport, combined with the danger of running into large boulders jutting from the floor of the bay, make Williamsport a hazardous alternative. An average of 40 gill-net boats have risked docking at Williamsport in each of the last several years. Once vessels dock at Williamsport, they are trailered across the Williamsport-Pile Bay road to the tip of Iliamna Lake at a cost of $800 per vessel. From the head of Iliamna Lake, boats travel down Lake Iliamna and into the Kvichak River, which flows into Bristol Bay.

A breakdown of expenses incurred making this trip is shown below. Opportunity costs of time were calculated according to Engineering Regulation (ER) 1105-2-100. In lieu of a project-specific estimate of the opportunity cost of leisure time, a value equal to one-third the wage rate is used. The Alaska Department of Labor has determined the 1994 average Alaska hourly wage for fishermen in this category to be $15.35. Opportunity cost of time is therefore $5.12 per hour. Two crewmembers per vessel is standard. Gill-net drift vessels run on diesel fuel, burning about 14 gallons per hour. The average per-gallon price for this type of fuel was $1.09 in 1994, making the total cost of fuel per hour $15.26. The journey from the head of Lake Iliamna to Bristol Bay is about 160 miles and takes approximately 17 hours.

The fuel used per trip per vessel is estimated as:

$15.26/fuel per hour x 17 hours = $259

The opportunity cost of time (OCT) per trip per vessel is estimated as:

$5.12/OCT hour x 2 crew x 17 hours = $174

Fuel and OCT expenditures total $433. Add to that the $800 per vessel charge for transporting the vessel from Williamsport to Lake Iliamna, for a total cost of $1,233.

The vast majority of vessels, 785, (825 less the 40 currently using Williamsport) going from Cook Inlet to Bristol Bay and back each spring and fall do so by traveling around the Alaska Peninsula. This 1,000-mile route takes approximately 3 days and exposes the vessel and crew to the dangerous open waters of the Gulf of Alaska, the Bering Sea, and western Bristol Bay. The journey takes an average of 72 hours. The crew normally rotate sleeping so someone is always piloting the boat.

The fuel used per trip per vessel is estimated as:

\$15.26/fuel per hour x 72 hours	=	\$1,099

The opportunity cost of time (OCT) per trip per vessel is estimated as:

\$5.12/OCT hour x 2 crew x 54 hours (6 hours/day for rest)	=	\$553

Fuel and opportunity cost of time expenditures total \$1,652. Vessel owners relate they spend an additional \$120 to \$150 on miscellaneous expenses, including insurance, oil, and general maintenance, each trip. Adding the mean of these figures (\$135) to fuel and OCT expenses brings the total cost per journey to approximately \$1,800. Multiplying \$1,800 by 1,570 (the total number of vessels making the journey in spring and fall) and adding the cost for those traveling over the Williamsport-Pile Bay Road (\$1,233 x 80 vessels) gives the total cost incurred by the Bristol Bay gill-net fleet.

The total cost to the Bristol Bay gill-net fleet is estimated as:

\$1,800 x 1,570	=	\$2,826,000
\$1,233 x 80	=	98,600
		\$2,924,600

Northern Enterprises, a boat vessel and repair company located in Homer, Alaska, sent a survey to 350 randomly selected Bristol Bay gill-net permit holders to determine how many would use the Williamsport route were it a viable alternative to going around the Alaska Peninsula. Of the 90 fishermen that responded to the survey, 90 percent indicated they would use Williamsport if it were a safe, accessible alternative.

3. Conditions Without a Project

If no improvements are made to allow safer and more dependable access to Williamsport, conditions will remain as described above and most likely worsen with time. Vessels will continue to sustain major and minor damages due to groundings and jutting boulders. Barge and landing craft deliveries will require two tide cycles at least 80 percent of the time, resulting in higher costs to Iliamna Lake residents and freight companies.

The Alaska Department of Commerce projects that Iliamna Lake tourism will increase steadily in the foreseeable future. Construction will likewise increase each year. If access to Williamsport is not improved, construction firms will experience increasing delay costs.

The vast majority of gill-net fishermen moving their vessels from Cook Inlet to Bristol Bay will continue to journey around the Alaska Peninsula. Using Williamsport to reach Bristol Bay saves time and expense, but the limited tidal timeframe, combined with the danger of going aground and/or hitting one of several large boulders, is a significant deterrent.

4. Conditions With a Project

This section presents a detailed description of the benefits for the National Economic Development (NED) plan, which is the recommended plan. This plan is the Old Dock Site alternative with a 2,700-m channel and a turning basin, both excavated to -0.5 m MLLW. The benefits can be grouped into the following categories: (1) vessel damages; (2) commodity flows; (3) construction delays; and (4) Bristol Bay gill-net fleet.

4.1 Vessel Damages

The NED plan provides a dredged channel to -0.5m MLLW. Dredging and marking a channel would allow vessel operators deeper water and more time to safely dock at Williamsport. Freight and fishing vessels would be able to complete standard deliveries within a single tide. Vessel damage currently caused by groundings and boulders would be eliminated. As seen in calculations in the Existing Conditions section, an annual benefit of $5,700 would be realized.

4.2 Commodity Flows

Barges and landing craft deliver to Williamsport an average of 40 times per year. Two tide cycles are required to complete deliveries 80 percent of the time. As stated in the Existing Conditions section, village residents spend $144,000 annually on water-associated freight costs.

Eliminating costly barge delays would make overwater freight a less expensive and more dependable alternative for transporting goods. Village residents interviewed indicate they would prefer to order a greater percentage of supplies via barge and landing craft, as opposed to more costly air freight. Barge and landing craft companies relate they would increase the number of trips made to meet demand if safe and dependable access were available. Although some freight, *i.e.*, perishable foods, would continue to be shipped via air, a large part of the total commodity flow could be transported over water, at a lower cost. Interviews with village residents and businesses show that if a project were constructed, demand would support barge and landing craft traffic of at least twice weekly and probably three times weekly. This averages to 10 times per month, or 60 times per season. Consistent and dependable overwater freight service would allow Iliamna Lake residents and businesses to order a greater percentage of their total freight via this transportation mode, thereby saving significantly on freight charges.

According to Lake Iliamna residents, with the recommended project, annual barge and landing craft freight expenses would be as shown below:

60 trips x $2,000 = $120,000

The existing condition ratio of dollars spent on overwater freight to those spent on air freight is approximately 1:4. The with-project ratio would be 7:13. A with-project breakdown of freight going by barge and air is shown in table B-2.

TABLE B-2.--*Estimated annual commodity flows to Iliamna Lake villages with recommended navigation improvement at Williamsport*

Shipping method	Dollars	Pounds
Surface (sea and road)	$120,000	2,400,000
Air	343,000	700,000
TOTAL	$463,000	3,100,000

Iliamna Lake residents spend an estimated $878,800 annually (see table B-1) on incoming freight under existing conditions. With the selected project, total dollars spent would decrease to $463,000, for an annual efficiency gain of $415,800.

4.3 Construction

With the selected plan, savings to construction companies working on projects around Iliamna Lake would be in the form of eliminated delays. Construction firms now cumulatively average $21,300 yearly in costs associated with delays getting in and out of Williamsport. With the project, ample access would be guaranteed so that these delays would be eliminated. This would result in total annual construction savings of $21,300.

4.4 Bristol Bay Gill-net Fishermen

Bristol Bay gill-net fishermen would save if a much shorter and less expensive route to Bristol Bay were available. A survey of Bristol Bay gill-netters showed that improved road and harbor conditions would suffice to make this route preferable to going around the Alaska Peninsula. Currently 40 gill-net boats use Williamsport to access Bristol Bay and make the return trip each fall; the remaining 785 go around the Alaska Peninsula twice yearly.

80 vessels	x	$1,233/vessel	=	$98,600
1,570 vessels	x	$1,800/vessel	=	$2,826,000
				$2,924,600

This navigation improvement would increase vessel traffic to 1,494 each year (the 80 which currently use this route plus 90 percent of the 1,570 which presently go around the Alaska Peninsula). With the project, the vast majority of vessels traveling from Cook Inlet to Bristol Bay and back each year would use the Williamsport route.

1,494 vessels	x	$1,233/vessel	=	$1,842,100

With the project, Bristol Bay gill-net fishermen would realize an annual efficiency gain of $1,082,500 ($2,924,600 - $1,842,100).

5. Benefit Summary

Table B-3 presents a summary of benefits for the recommended plan. The total annual benefit would be $1,525,300.

TABLE B-3.--*Benefit summary*

Category	Without project	With project	Benefits
Vessel damage	$5,700	0	$5,700
Commodity flows	$878,800	$463,000	$415,800
Construction delay costs	$21,300	0	$21,300
Gill-net fishery	$2,924,600	$1,842,100	$1,082,500
TOTAL			$1,525,300

Appendix C
Geotechnical Studies

Part 1: Geotechnical Investigation for Williamsport Harbor Improvements
(Alaska District, Corps of Engineers)

Part 2: Marine and Terrestrial Geophysical Investigation of Iliamna Bay
(Golder Associates)

Part 3: Final Chemical Report, Williamsport, Alaska
(Alaska District, Corps of Engineers)

Part 4: Sedimentation Analysis
(University of Alaska-Fairbanks)

Geotechnical Studies

Part 1:
Geotechnical Investigation for
Williamsport Harbor Improvements
(Alaska District, Corps of Engineers)

GEOTECHNICAL INVESTIGATION
for
WILLIAMSPORT HARBOR IMPROVEMENTS
WILLIAMSPORT, ALASKA

1. Scope and Purpose of Investigation

The investigation was initiated at the request of the Corps of Engineers Civil Works (CENPA-EN-CW-PF). The purpose is to evaluate subsurface conditions at the site of the proposed harbor facilities.

The scope of the investigation was:

1. Conduct subsurface explorations along the proposed channel alignment and in the dock and basin area;

2. perform laboratory tests to determine engineering and physical properties of the soils encountered;

3. evaluate these properties and their effect on the proposed improvements; and

4. provide geotechnical recommendations concerning channel, basin and dock design.

2. Site Location and Description

Williamsport is located in southwestern Alaska, about 300 kilometers southwest of Anchorage, on the western shore of Cook Inlet at the head of Iliamna Bay. It is situated at the mouth of Williams Creek. The only structure at Williamsport is a makeshift, dilapidated, wood pile and plank retaining wall dock. There are no permanent inhabitants or residences. The location is shown on the enlosed Vicinity Map, Figure 1.

3. Project Description

The proposed harbor improvements consist of dredging the entrance channel and turning basin and constructing a new dock. Two options have been proposed and primarily involve the location of the dock. Option A conceives the new dock at the location of the existing dock while Option B includes a causeway to a dock about 180 meters offshore. Alternative conceptions for the entrance channel include widths varying from about 30 to 45 meters and channel bottom elevations varying from about 2.5 to 0.0 MLLW. The proposed turning basin is to be about 60 by 60 meters with a bottom elevation of about 0.0 MLLW. The dock is conceived to be a rectangular, steel sheet pile, retaining wall structure backfilled with native borrow material.

4. Field Exploration

The subsurface exploration for the project was conducted 25 to 27 May 1994. Five test borings were drilled to depths of about 3.5 to 7.5 meters. The borings were drilled with a Mobile B-47 drill rig fitted with continuous flight, 0.2-meter diameter, hollow stem auger. The drilling was performed by the Corps of Engineers, Alaska District's drill crew. The drilling was conducted through a moon pool in the bow gate of the barge Rama Lee. Offshore drilling was performed by grounding the barge at times of low tides. Drilling and test borings were logged by an engineer with the Corps, in accordance with ASTM D-2488, "Description and Identification of Soils (Visual - Manual Procedure)." The test boring locations were surveyed horizontally and are shown on the enclosed Test Boring Location Map, Figure 2. Additionally, a geophysical survey of the project area was conducted by Golder Associates. The results of that survey are presented in a report dated January 1995.

Soil samples were procured at frequent intervals in the test borings, generally 1.5 meters of less. Drive samples were taken with 3.56 and 6.35 centimeter I.D. split spoon samplers driven with a 64 kilogram hammer falling 0.75 meter. The samplers were driven 46 or 61 centimeters ahead of the auger. The number of blows required to drive each 15-centimeter increment is recorded on the boring logs. This blowcount is an indication of the relative density or consistency of the soil. Shelby samples were obtained in AP-4 and AP-5, preserved, and transported in general accordance to ASTM D-1587, "Thin-Walled tube Sampling of Soils, and ASTM D-4220, "Preserving and Transporting Soil Samples." A grab sample was taken near the surface in AP-1.

5. Laboratory Testing and Soil Classification

A testing program was established to determine pertinent physical and engineering properties of the soils encountered. Sieve and hydrometer analyses were conducted and the grain size distributions were determined in accordance with ASTM D-422, "Particle Size Analysis of Soils." Atterberg Limits Tests were also performed on samples of the fine-grain soils in conformance with ASTM D-4318, "Liquid Limit, Plastic Limit, and Plasticity Index of Soils." The soils were classified in conformance to ASTM D-2487, "Classification of Soils for Engineering Purposes." Moisture contents were determined in accordance with ASTM D-2216, "Laboratory Determination of Water (Moisture) Content of Soil, Rock and Soil - Aggregate Mixtures." The organic content was determined in conformance to ASTM D-2974, "Moisture, Ash and Organic Matter of Peat Materials." The soil specific gravity was determined in accordance with ASTM D-854, "Specific Gravity of Soils." The triaxial strength was determined in accordance with ASTM D-2850, "Unconsolidated, Undrained Compressive Strength of Cohesive Soils in Triaxial Compression" and ASTM D-4767, "Consolidated, Undrained Triaxial Compression of Cohesive Soils."

Frost classification is in accordance with TM 5-818-2, "Pavement Design for Seasonal Frost Conditions."

The soil descriptions and classifications contained in this report and presented on the final test boring logs are the project geotechnical engineer's interpretation of the field logs and results of the laboratory testing program. The stratification lines represent approximate boundaries between soil types; the transitions are often gradual. Gradation curves for samples can be acquired at the Geotechnical Branch office of the Alaska District Corps of Engineers.

6. Site Conditions

Geographical Setting and Regional Geology: Of the physiographic regions of Alaska, Williamsport is in the Alaska Range section (southern part) of the Alaska-Aleutian province of the Pacific Mountain System division. Williamsport is situated at the mouth of Williams Creek at the head of the Williams Creek Arm of Iliamna Bay. It is surrounded by cliffs and rocky buttresses of the Chigmit Mountains (Aleutian Range), which rise to about 1,000 meters within a kilometer of the shore. The Williams Creek arm generally is greater than elevation 2 meters MLLW and therefore typically exposed as tidal flats. Maximum high and low tides can range from about 7 to -2 MLLW at Iliamna Bay.

Williams Creek has the U-shape signature of a glacier cut valley with typical over-steepened sides which are developing basal talus slopes. The valley and lower slope deposits consist typically of alluvium from Williams Creek and talus colluvium. Estuarine deposits, chiefly clay and silt, form the tidal flats of Williams Creek Arm and extend to the base of the surrounding cliffs and talus slopes. Colluvial boulders having diameters to about 3 meters and originating from the cliffs surrounding the arm are common on the tidal flats, but are more prevalent near the shore. Boulders also are expected within the estuarine deposits.

Seismic Zoning: Williamsport is located in seismic probability zone 4, which has been assigned a seismic coefficient "Z" value of 0.4 according to Department of the Army TM 5-809-10 (October 1992), "Seismic Design for Buildings."

Subsurface Conditions: The subsurface exploration indicates that the area of the existing dilapidated dock to be underlain primarily by sand to boulder size particles of Williams Creek alluvium and talus colluvium origin. The estuarine clay and silt deposits of the tidal flats abut the dock area and appear to become thicker at greater distances offshore. These subsurface conditions encountered within the existing dock area and within the tidal flat area abutting the dock and along the proposed channel alignment are described below.

Existing Dock Area

Test boring AP-1 indicates the dock area to be underlain by coarse-grain soils classifying primarily as Silty GRAVEL w/ Sand, Cobbles and Boulders (GM) to a depth of about 2 meters. These soils are grey with moisture contents of about 10 percent and consist of subangular to angular gravel, fine to coarse sand, and nonplastic fines. An N-value of 24 was recorded for these soils.

A mottled grey and brown, Clayey GRAVEL w/ Sand (GC) was encountered from about 2 to 3 meters. These clayey soils have a moisture content of about 20 percent and consist of angular gravel, fine to coarse sand, and plastic fines (LL=32 and PI=10).

Brown and grey sandy soils classifying as Silty SAND w/ Gravel (SM), Well-Graded SAND w/ Gravel (SW) and Poorly Graded SAND w/ Gravel (SP) were encountered below the clayey layer to the limit of the test boring (8.6 meters). These soils consist of subangular to angular gravel and fine to coarse sands. Random cobbles were encountered within the sands and drilling refusal occurred at 8.6 meters. N-values of 24 and 48 were recorded at about 4.5 and 6 meters, respectively. Additionally, artesian water flowed from the top of auger when sample 7 was retrieved. The geophysical survey in the vicinity of the dock indicated that unconsolidated sediments of 20 to 40 meters overlie the bedrock.

Tidal Flat Area

The tidal deposits classify primarily as clays, silts, and fine sands (CL, ML, and SM) and are composed of various combinations thereof. They are typically blackish grey and become grey or brown with depth. The blackish color indicates the presence of organics. Organic contents of these blackish soils ranged from about 3 to 5 percent. These tidal deposits also contain angular gravel and occasional cobbles and boulders. The water contents were measured to range from about 20 to 50 percent. The soils range from non-plastic to plastic with liquid limits and plastic indices to about 50 and 20, respectively. N-values were recorded from 2 to 10 to a depth of about 3 meters. The largest N-value recorded below 3 meters was about 30. The results of the geophysical survey indicate bedrock at depths from 40 to 60 meters.

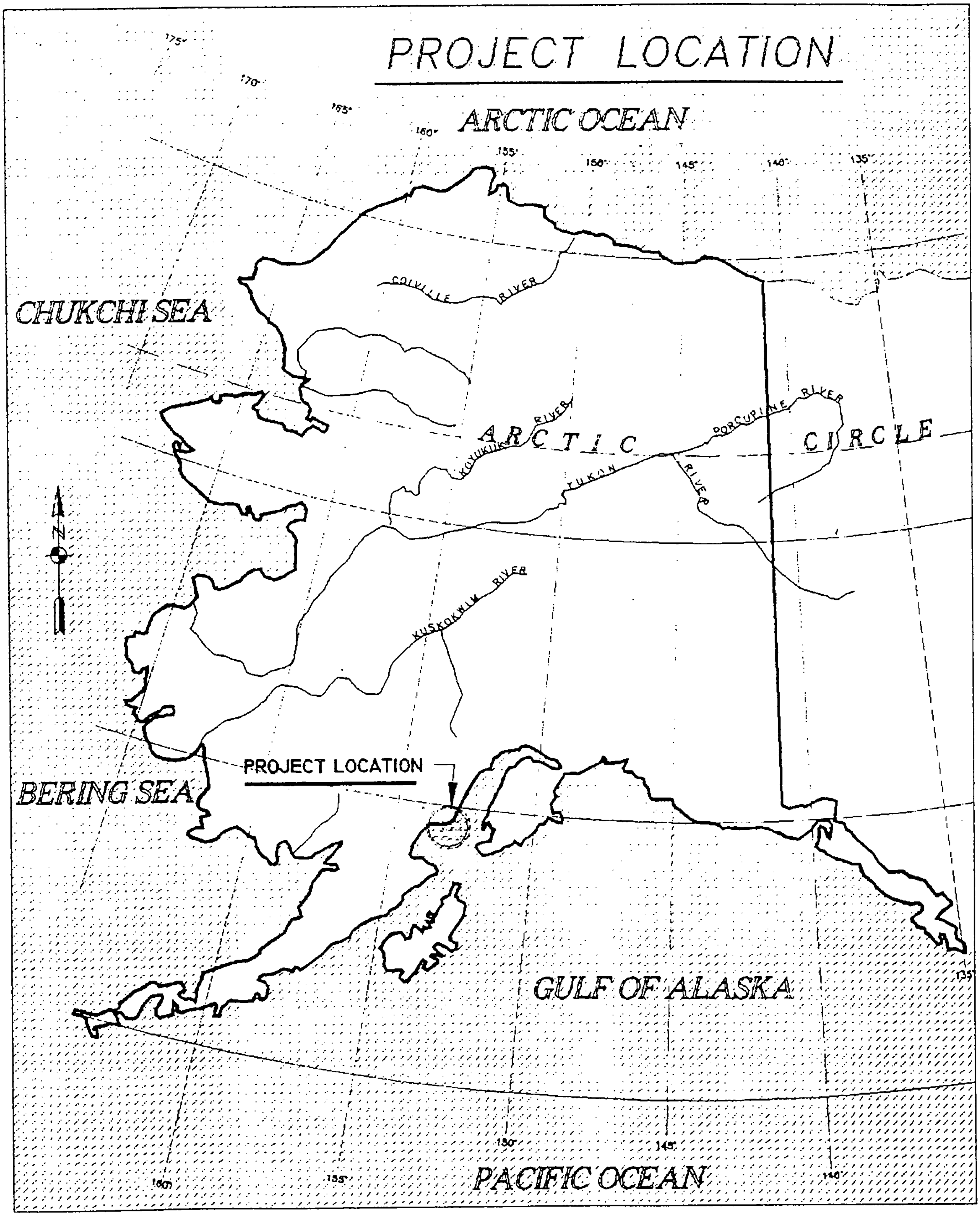
7. __Slope Stability Analysis__

The slope stability of the embankments for the entrance channel and turning basin is of major concern to the project. A slope failure could block normal channel access or impede barge maneuverability within the turning basin. The most critical case for slope failure is considered to occur at low tide with the embankments in a saturated undrained condition. Also, the probability of failure within the estuarine deposits increases as the height of the slopes increase.

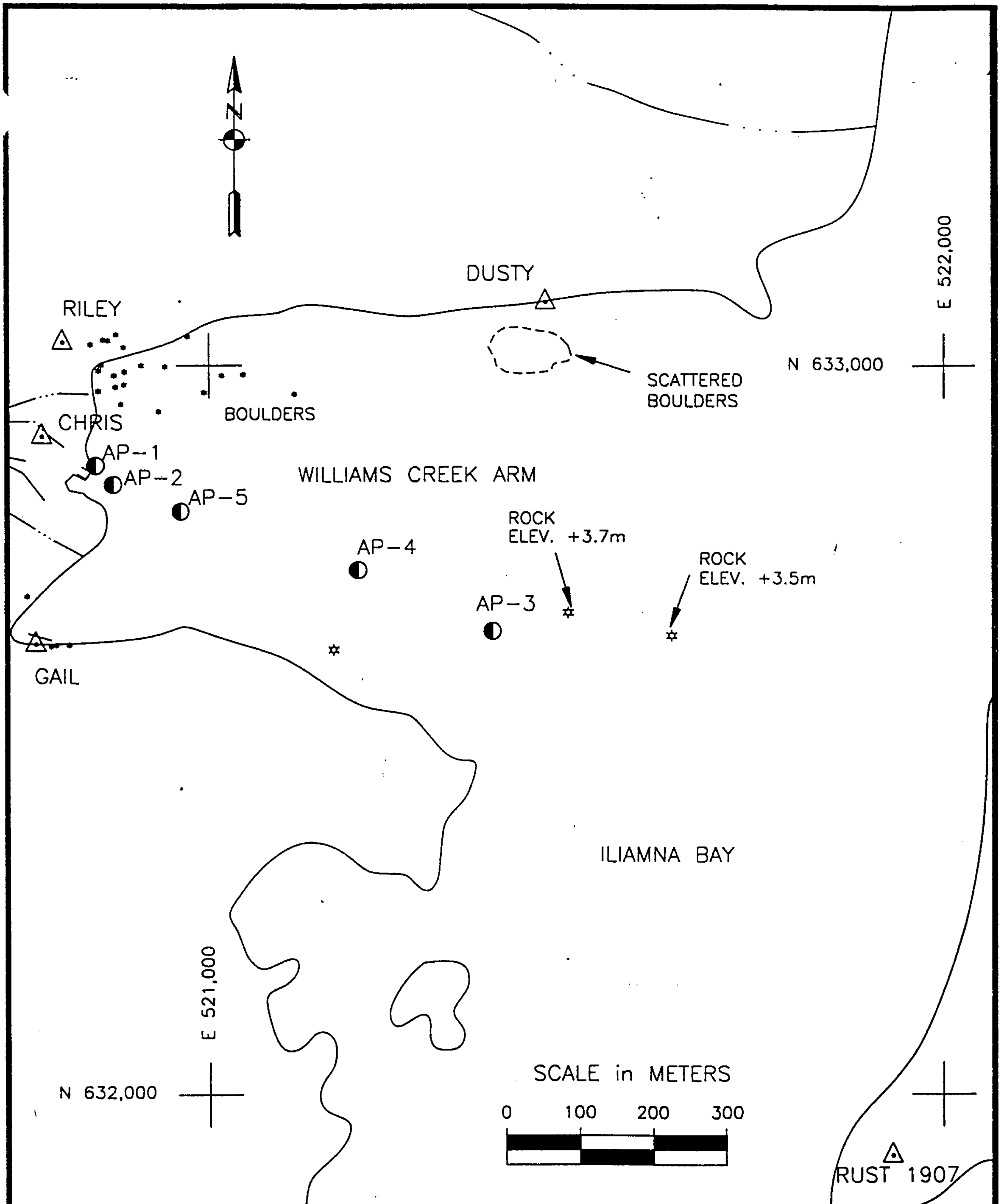
A stability analysis was performed for the most critical case described above having an embankment height of 3 meters. The analysis indicated that a slope of 3 horizontal to 1 vertical to have a factor of safety on the order of 3. Also, observing the natural cut banks of the tidal tributaries, a 3 to 1 slope would appear to be appropriate for design. Tidal erosion however, will ultimately govern the slope of the embankments.

Enclosures

1. Vicinity Map
2. Test Boring Location Map
3. Test Boring Logs
4. Grain-Size Distribution Curves
5. Panoramic Photograph of Project Area (in main report)



ALASKA DISTRICT CORPS OF ENGINEERS SURVEY SECTION	Figure 1 Project Vicinity Map Williamsport Harbor Improvements Williamsport, Alaska	SCALE: N.T.S. DATE: MARCH, 1995 DWG. NO.



ALASKA DISTRICT
CORPS OF ENGINEERS
GEOTECHNICAL BRANCH

Figure 2
Test Boring Location Map
Williamsport Harbor Improvements
Williamsport, Alaska

SCALE:
DATE: March 1995
DWG/RVW:
C:\ACAD12C2\DWGLIB\

DEPARTMENT OF THE ARMY

North Pacific Division
U.S. Army Engineer District Alaska

EXPLORATION LOG

Project: WILLIAMSPORT, ALASKA HARBOR IMPROVEMENTS

Location Coordinates	Northing 632,863 Easting 520,846
Drilling Agency	XXX Corps of Engineers; Other: Alaska District
Hole Number	Field AP-1 Permanent AP-1
Name of Driller	D. Ackerman
Weather	Ptly Cldy, 5°K
Type of Hole	Test Pit; XXX Auger Hole
Depth To	0.0
Depth Drilled	8.6
Total Depth	8.6
Size and Type of Bit	0.2 m Hollow Stem
Elevation Datum	XXX MSL
Type of Equipment	Mobile B-47
Number of Samples	7
Type of Samples	Grab and Drive
Depth to Groundwater	0.0
Date	25 May 1994
Top of Hole Elevation	4.00
Inspector	C. Wilson
Chief, Soils Section	J. Raychel
Chief, Geotechnical Branch	D. Thomas

Depth in Meters	% Water	Sample	Soil Legend	Classification	Max Size cm	Description and Remarks
	10	1	GM	Silty GRAVEL w/ Sand, Cobbles and Boulders	35	54%Gr 34%Sa 12%Fines F1 Grey, wet, suba. to angular gravel, fine to coarse sand, NP fines, eroded fill from dock
	9	2	GM	Silty GRAVEL w/ Sand, Cobbles and Boulders	35	54%Gr 29%Sa 17%Fines F1 Grey w/ brown, wet, suba. to angular gravel, fine to coarse sand, NP fines *2/12/12/12
1						
	11	3	SW-SM	Poorly Graded SAND w/ Silt, Gravel and Cobbles	30	26%Gr 63%Sa 11%Fines S2 Grey, wet, suba. to angular gravel, fine to coarse sand, NP fines *(14/16)
2						
	20	4A	GC	Clayey GRAVEL w/ Sand	5	41%Gr 19%Sa 40%Fines F3 Mottled grey w/ brown, wet, angular gravel, fine to coarse sand, LL=32 PI=10
3	12	4B	SM	Silty SAND w/ Gravel	3	21%Gr 59%Sa 20%Fines F2 Brown/grey, wet, angular gravel, fine to coarse sand, NP fines *13/18/20/38 ~0.15 m cobble @ 3.7 m Few random cobbles to BOH
4						
		5	SW	Well-Graded SAND w/ Gravel	1	Brown, wet, suba. to angular gravel, fine to coarse sand *½/½/9
5						
		6	SP	Poorly Graded SAND w/ Gravel	3	0.15 m "heaving sand" Brown, wet, suba. to angular gravel, fine to med. sand *8/16/22
6						

CONTINUED

DEPARTMENT OF THE ARMY North Pacific Division U.S. Army Engineer District Alaska EXPLORATION LOG	Project WILLIAMSPORT, ALASKA HARBOR IMPROVEMENTS	Sheet 2 of 2
	Location Coordinates Northing 632,863 Easting 520,846	
	Drilling Agency [XXX] Corps of Engineers [ ] Other Alaska District	

Hole Number	Name of Driller	Weather
Field AP-1 Permanent AP-1	D. Ackerman	Ptly Cldy, 5°K

Type of Hole	Depth To	Depth Drilled	Total Depth
[ ] Test Pit [XXX] Auger Hole [ ]	0.0	8.6	8.6

Size and Type of Bit	Elevation Datum	Type of Equipment
0.2 m Hollow Stem	[XXX] MSL [ ]	Mobile B-47

Number of Samples	Type of Samples	Depth to Groundwater	Date
7	Grab and Drive	0.0	25 May 1994

Top of Hole Elevation	Inspector	Chief, Soils Section	Chief, Geotechnical Branch
4.00	C. Wilson	J. Raychel	D. Thomas

Depth in Meters	% Water	Sample	Soil Legend	Classification	Max Size cm	Description and Remarks
						Indications are that a confining layer exists between samples 6 and 7. Upon withdrawing sample 7, artesian water flowed from top of auger.
7		7	SW	Well-Graded SAND w/ Gravel	3	Grey, wet, angular gravel, fine to coarse sand *15/28/20
8				Refusal on Obstruction @ 8.6m		1.5 m "heaving sand" No sample effort
9						Bottom of hole 8.6 Elevation -4.6 Groundwater elev. 4.0 Tidal flat *Number of blows to drive a 3.6 cm (6.3 cm) I.D. split spoon sampler each 15 cm increment with a 64 kg hammer falling 0.75 m
10						
11						
12						

DEPARTMENT OF THE ARMY North Pacific Division U.S. Army Engineer District Alaska **EXPLORATION LOG**	Project WILLIAMSPORT, ALASKA HARBOR IMPROVEMENTS Location Coordinates Northing 632,837 Easting 520,869 Drilling Agency [XXX] Corps of Engineers [ ] Other Alaska District	Sheet 1 of 1

Hole Number Field AP-2 Permanent AP-2	Name of Driller D. Ackerman	Weather Ptly Cldy, 13°K

Type of Hole [ ] Test Pit [XXX] Auger Hole	Depth To 0.0	Depth Drilled 5.2	Total Depth 5.2

Size and Type of Bit 0.2 m Hollow Stem	Elevation Datum [XXX] MSL	Type of Equipment Mobile B-47

Number of Samples 4	Type of Samples Drive	Depth to Groundwater 0.0	Date 25 May 1994

Top of Hole Elevation 3.20	Inspector C. Wilson	Chief, Soils Section J. Raychel	Chief, Geotechnical Branch D. Thomas

Depth in Meters	% Water	Sample	Soil Legend	Classification	Max Size cm	Description and Remarks
0–1.2	33	1	CL	Gravelly Lean CLAY w/ Sand	5	21%Gr 21%Sa 58%Fines F3 Blackish grey, wet, suba. to angular gravel, fine to coarse sand, LL=44 PI=19 *(3/10/11)
1.2–2.6	9	2	GP-GM	Poorly Graded GRAVEL w/ Silt, Sand, Cobbles and Boulders	35	0.3 m "slough 50%Gr 42%Sa 8%Fines PFS Brown, moist to wet, suba. to angular gravel, fine to coarse sand, NP fines, cold *(22/28) Cobble @ 2.4 m
2.6–5.2	15	3	SW-SM	Well-Graded SAND w/ Silt and GRAVEL	3	0.15 m "heaving sand" 31%Gr 61%Sa 8%Fines S2 Brown/grey, wet, suba. to angular gravel, med. to coarse sand *4/8 Small cobbles @ 4 m
	17	4	SM	Silty SAND	3	10%Gr 72%Sa 18%Fines F2 Layered brown and rusty brown, wet, angular gravel, fine to coarse sand, NP fines *11/16/19
				*Number of blows to drive a 3.6 cm (6.3 cm) I.D. split spoon sampler each 15 cm increment with a 64 kg hammer falling 0.75 m		Bottom of hole 5.2 Elevation -2.0 Groundwater elev. 3.2 Tidal flat

DEPARTMENT OF THE ARMY	Project WILLIAMSPORT, ALASKA HARBOR IMPROVEMENTS	Sheet 1 of 1

North Pacific Division
U.S. Army Engineer District Alaska

EXPLORATION LOG

Location Coordinates	Northing 632,635 Easting 521,384
Drilling Agency	[XXX] Corps of Engineers [ ] Other Alaska District
Hole Number	Field AP-3 Permanent AP-3
Name of Driller	D. Ackerman
Weather	Clear, 10°K
Type of Hole	[ ] Test Pit [XXX] Auger Hole
Depth To	0.0
Depth Drilled	3.7
Total Depth	3.0
Size and Type of Bit	0.2 m Hollow Stem
Elevation Datum	[XXX] MSL
Type of Equipment	Mobile B-47
Number of Samples	5
Type of Samples	Drive
Depth to Groundwater	-0.3
Date	26 May 1994
Top of Hole Elevation	2.50
Inspector	C. Wilson
Chief, Soils Section	J. Raychel
Chief, Geotechnical Branch	D. Thomas

Depth in Meters	% Water	Sample	Soil Legend	Classification	Max Size cm	Description and Remarks
	26	1	CL	Sandy Lean CLAY w/ Gravel	3	16%Gr 33%Sa 51%Fines F3 Blackish grey, wet, suba. to angular gravel, fine to coarse sand, LL=37 PI=15, contains lense of clayey sand *(1/5/5/6)
1	21	2	SM	Silty SAND	3	11%Gr 56%Sa 33%Fines F4 Blackish grey, wet, fine to coarse sand, NP fines, O.C.=1.6% *(2/4/3)
		3				No recovery - on a rock *22 for 8 cm
2		4	SW-SC	Well-Graded SAND w/ Clay and Cobbles	33	Grey, wet, suba. gravel, fine to coarse sand, plastic fines, contains lenses of clayey sand and sandy clay *1/3/4/5
3	25	5A	SM	Silty SAND		7%Gr 51%Sa 42%Fines F4 Grey, wet, fine to coarse sand, NP fines, many white clam shells
	35	5B	ML	Sandy SILT		5%Gr 35%Sa 60%Fines F4 Grey, wet, fine sand, NP fines, many chips of clam shells *7/7/3/11
4						Bottom of hole 3.7 Elevation -1.2 Groundwater elev. 2.8 In stream channel *Number of blows to drive a 3.6 cm (6.3 cm) I.D. split spoon sampler each 15 cm increment with a 64 kg hammer falling 0.75 m
5						
6						

NPA Form 19-E
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DEPARTMENT OF THE ARMY	Project WILLIAMSPORT, ALASKA HARBOR IMPROVEMENTS	Sheet 1 of 1
North Pacific Division U.S. Army Engineer District Alaska	Location Coordinates Northing 632,719 Easting 521,202	
EXPLORATION LOG	Drilling Agency [XXX] Corps of Engineers [ ] Other Alaska District	

Hole Number		Name of Driller	Weather
Field AP-4	Permanent AP-4	D. Ackerman	Clear, 7°K

Type of Hole	Depth To	Depth Drilled	Total Depth
[ ] Test Pit [XXX] Auger Hole	0.0	5.0	5.0

Size and Type of Bit	Elevation Datum	Type of Equipment
0.2 m Hollow Stem	[XXX] MSL	Mobile B-47

Number of Samples	Type of Samples	Depth to Groundwater	Date
5	Shelby and Drive	0.0	26 May 1994

Top of Hole Elevation	Inspector	Chief, Soils Section	Chief, Geotechnical Branch
2.30	C. Wilson	J. Raychel	D. Thomas

Depth in Meters	% Water	Sample	Soil Legend	Classification	Max Size cm	Description and Remarks

	38	1	OH	Organic SILT		1%Sa 99%Fines F4
						Blackish grey, wet,
						#LL=33 PI=7, G_s=2.73,
						O.C.=1.9, γ_d =13.1kN/m^3,

1	34	2	CL	Lean CLAY		2%Sa 98%Fines F3 Blackish grey, moist, LL=44 PI=19, O.C.=3.5 *1/1/2/3
2	36	3	ML	SILT		5%Sa 95%Fines F4 Blackish grey, moist, LL=42 PI=16, O.C.=5.0, contains 3 cm lense black, coarse SP-SM and ½ cm lense fine SP *1/3/3
3	42	4	CL	Lean CLAY		9%Sa 91%Fines F3 Blackish grey, moist, LL=43 PI=17, 3 cm lense grey, fine to med. SP-SM and 3 cm lense black, coarse SP-SM *(1/1/6)
4						Few random cobbles from 4 m to BOH
5	19	5	ML	Sandy SILT w/ Gravel and Cobbles	15	15%Gr 32%Sa 53%Fines F4 Grey, moist, subr. to suba. gravel, fine to coarse sand, NP fines, 2 pieces gravel *20/17/12
6				*Number of blows to drive a 3.6 cm (6.3 cm) I.D. split spoon sampler each 15 cm increment with a 64 kg hammer		Bottom of hole 5.0 Elevation -2.7 Groundwater elev. 2.3 Tidal flat #Oven dried

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Project WILLIAMSPORT, ALASKA HARBOR IMPROVEMENTS	Hole Number AP-4

DEPARTMENT OF THE ARMY North Pacific Division U.S. Army Engineer District Alaska **EXPLORATION LOG**	Project WILLIAMSPORT, ALASKA HARBOR IMPROVEMENTS Location Coordinates Northing 632,800 Easting 520,961 Drilling Agency [XXX] Corps of Engineers [ ] Other Alaska District	Sheet 1 of 1

Hole Number Field AP-5 Permanent AP-5	Name of Driller D. Ackerman	Weather Clear, 7°K	
Type of Hole [ ] Test Pit [XXX] Auger Hole	Depth To 0.0	Depth Drilled 5.2	Total Depth 5.2
Size and Type of Bit 0.2 m Hollow Stem	Elevation Datum [XXX] MSL [ ]	Type of Equipment Mobile B-47	
Number of Samples 5	Type of Samples Shelby and Drive	Depth to Groundwater 0.0	Date 27 May 1994
Top of Hole Elevation 2.60	Inspector C. Wilson	Chief, Soils Section J. Raychel	Chief, Geotechnical Branch D. Thomas

Depth in Meters	% Water	Sample	Soil Legend	Classification	Max Size cm	Description and Remarks
	48	1	CL	Lean CLAY	1	1%Gr 1%Sa 98%Fines F3 Blackish grey, moist, LL=48 PI=21, 1 piece gravel *½/½/1/2
	51	2	OH	Organic SILT		1%Sa 99%Fines F4 Blackish grey, moist, LL=52 PI=22, G_s=2.75, O.C.=2.6, γ_d =11.2 kN/m^3,
1					4	Angular gravel from 1 to 1½ m
	37	3	CL	Lean CLAY		3%Sa 97%Fines F3 Blackish grey, moist, LL=45 PI=19, O.C.=3.3, 1 cm lense brown, fine sand *2/4/3/3
2						Random gravel and cobbles to BOH
3	42	4	ML	SILT	1	2%Gr 4%Sa 94%Fines F4 Grey, moist, LL=49 PI=21, O.C.=3.4, thin black seams throughout w/ organic fibers and a small twig *(12/12/50 for 10 cm)
4						
	19	5	SM	Silty SAND	3	5%Gr 77%Sa 18%Fines F2 Grey, moist, fine sand, NP fines, 1 piece gravel *2/2/4/16
5						
6				*Number of blows to drive a 3.6 cm (6.3 cm) I.D. split spoon sampler each 15 cm increment with a 64 kg hammer falling 0.75 m		Bottom of hole 5.2 Elevation -2.6 Groundwater elev. 2.6 Tidal flat

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WILLIAMSPORT (94-288)

Boring: **AP-1** Sample: **1** Depth: **0.0-0.5'** Lab No.: 28816

Sieve Analysis

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	315.01	93.0
1 In.	489.13	89.2
3/4 In.	869.10	80.8
1/2 In.	1465.30	67.6
3/8 In.	1836.60	59.3
No. 4	2452.70	45.7
No. 10	3060.80	32.3
Pan	4518.00	0.0
No. 16	9.86	27.9
No. 30	24.47	21.4
No. 50	36.12	16.2
No. 100	41.91	13.6
No. 200	45.18	12.1
Pan	72.39	0.0

Hydrometer Analysis

Sample Weight: 72.39 gr. Start Time: 0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	24.3	0.0470	10.9
3	20.0	21.3	0.0277	9.6
10	20.0	19.8	0.0153	9.0
100	20.0	9.3	0.0066	4.3
200	20.0	9.3	0.0047	4.3

D85: 21.8 D60: 9.75 D50: 6.12 D30: 1.55 D15: 0.23 D10: .033 mm

Cu: 100+ Cc: 7.37

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 54.3% Sand: 33.6% Fines: 12.1%

ASTM D 2487 Classification

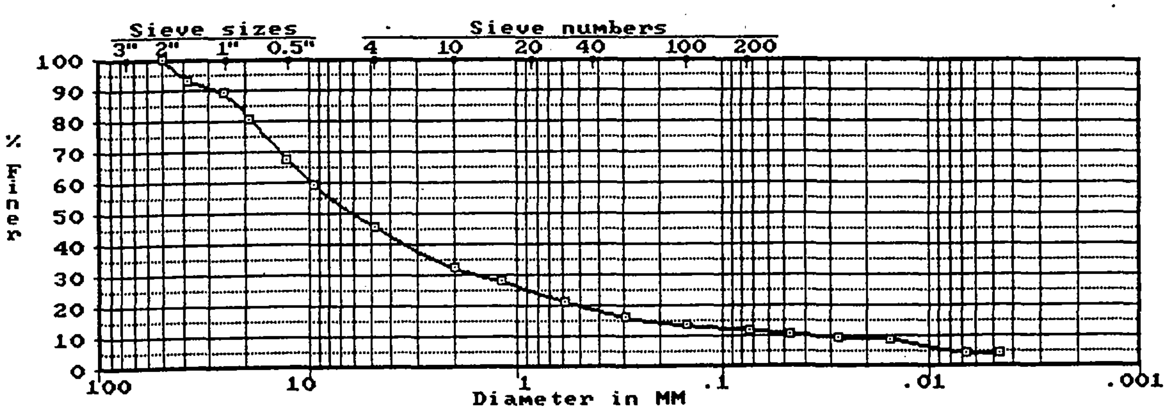
GM Silty GRAVEL with sand

TM 5-818-2 Frost Classification

Percent finer than 0.02 mm: 9.4 Frost Classification: **F1**

Comments

- WATER CONTENT = 9.8%
- GRAB SAMPLE
- 25 MAY 94



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WILLIAMSPORT (94-288)

Boring: **AP-1** Sample: **2** Depth: **2.0-4.0'** Lab No.: 28817

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	38.74	92.7
3/4 In.	81.80	84.5
1/2 In.	157.04	70.3
3/8 In.	197.95	62.5
No. 4	286.44	45.7
No. 10	350.57	33.6
Pan	527.90	0.0
No. 16	10.57	29.5
No. 30	23.17	24.7
No. 50	34.34	20.4
No. 100	42.87	17.1
No. 200	42.94	17.1
Pan	87.54	0.0

----------- Hydrometer Analysis -----------

Sample Weight:87.54 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	31.8	0.0446	12.3
3	20.0	26.3	0.0268	10.2
10	20.0	19.8	0.0153	7.7
100	20.0	11.3	0.0066	4.5
200	20.0	9.3	0.0047	3.7

D85: 19.4 D60: 8.66 D50: 5.79 D30: 1.27 D15: .059 D10: .026 mm

Cu: 100+ Cc: 7.30

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 54.3% Sand: 28.6% Fines: 17.1%

------------------------- ASTM D 2487 Classification -------------------------

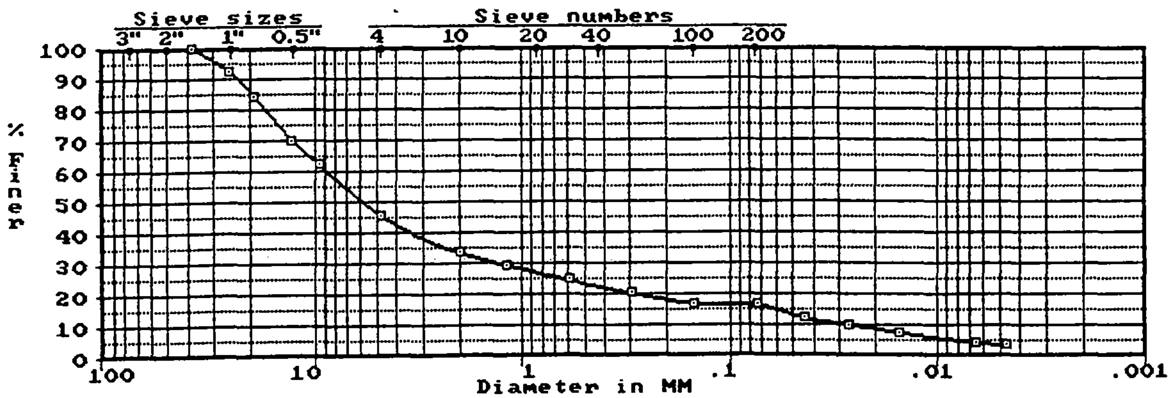
GM Silty GRAVEL with sand

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 8.9 Frost Classification: **F1**

---------------------------------- Comments ----------------------------------

- WATER CONTENT = 9.1%
- DRIVE SAMPLE



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WILLIAMSPORT (94-288)

Boring: **AP-1** Sample: 3 Depth: **3.5-5.0'** Lab No.: 28832

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	33.10	92.6
3/4 In.	42.22	90.6
1/2 In.	76.95	82.9
3/8 In.	107.78	76.0
No. 4	116.28	74.1
No. 10	224.06	50.1
Pan	449.10	0.0
No. 16	17.00	42.3
No. 30	37.34	33.0
No. 50	58.24	23.4
No. 100	72.76	16.7
No. 200	85.41	10.9
Pan	109.24	0.0

----------- Hydrometer Analysis -----------

Sample Weight:109.24 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	16.2	0.0495	7.6
3	20.0	12.2	0.0293	5.8
10	20.0	8.2	0.0164	4.0
100	20.0	3.2	0.0069	1.7
200	20.0	1.7	0.0049	1.0

D85: 13.9 D60: 2.80 D50: 1.99 D30: 0.48 D15: 0.12 D10: .067 mm

Cu: 41.8 Cc: 1.23

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 25.9% Sand: 63.2% Fines: 10.9%

------------------------ ASTM D 2487 Classification ------------------------

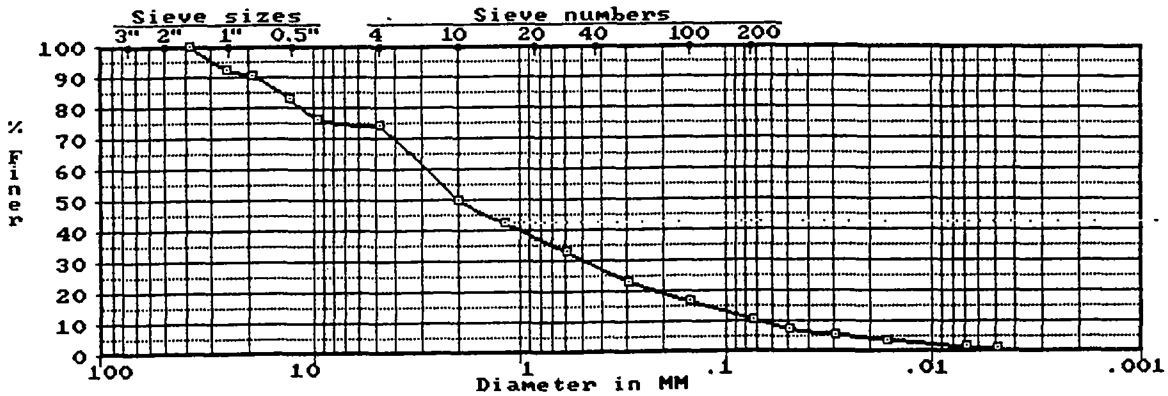
SW-SM Well-graded SAND with silt and gravel

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 4.6 Frost Classification: **S2**

--------------------------------- Comments ---------------------------------

- WATER CONTENT = 10.6%
- DRIVE SAMPLE



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WILLIAMSPORT (94-288)

Boring: **AP-1** Sample: **4A** Depth: **8.5-9.5'** Lab No.: 28818

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	94.27	88.1
1 In.	167.08	78.9
3/4 In.	214.19	73.0
1/2 In.	249.90	68.5
3/8 In.	278.91	64.8
No. 4	325.83	58.9
No. 10	373.09	52.9
Pan	792.87	0.0
No. 16	2.46	51.0
No. 30	6.01	48.3
No. 50	9.97	45.3
No. 100	13.38	42.6
No. 200	16.98	39.9
Pan	68.69	0.0

----------- Hydrometer Analysis -----------

Sample Weight:68.69 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	45.5	0.0399	35.1
3	20.0	41.0	0.0239	31.7
10	20.0	32.5	0.0140	25.2
100	20.0	18.5	0.0063	14.5
200	20.0	16.3	0.0045	12.8

D85: 34.0 D60: 5.56 D50: 0.91 D30: .021 D15: .0066 mm

Liquid Limit: 32 Plasticity Index: 10

Fines Type Used for Classification: CL, Lean CLAY

Gravel: 41.1% Sand: 19.0% Fines: 39.9%

------------------------- ASTM D 2487 Classification -------------------------

GC Clayey GRAVEL with sand

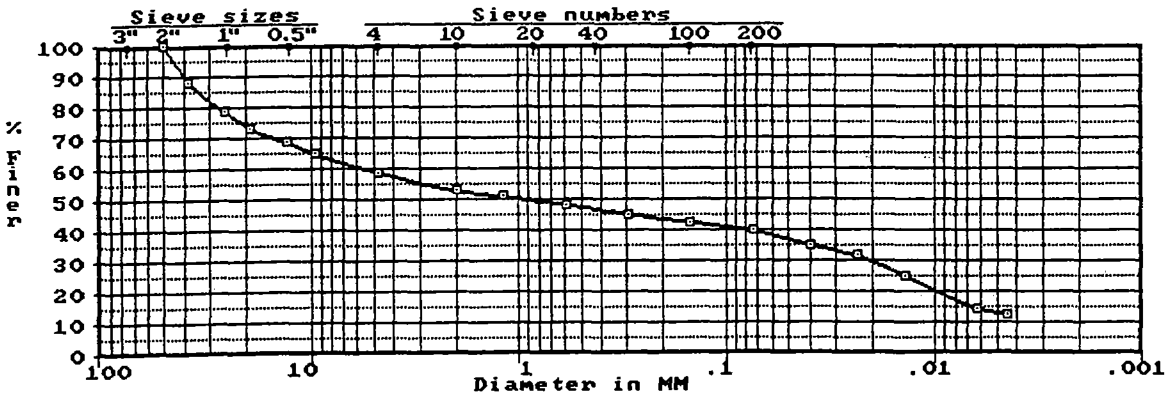
---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 29.7 Frost Classification: **F3**

---------------------------------- Comments ----------------------------------

- WATER COTNENT = 19.7%

DRIVE SAMPLE



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WILLIAMSPORT (94-288)

Boring: **AP-1** Sample: **4B** Depth: **9.5-10.5'** Lab No.: 28833

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	34.92	97.1
1/2 In.	90.59	92.5
3/8 In.	146.42	87.9
No. 4	257.16	78.8
No. 10	405.91	66.5
Pan	1211.90	0.0
No. 16	9.73	59.4
No. 30	22.69	49.9
No. 50	38.84	38.1
No. 100	52.77	28.0
No. 200	63.40	20.2
Pan	91.07	0.0

----------- Hydrometer Analysis -----------

Sample Weight:91.07 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	21.7	0.0478	16.1
3	20.0	16.2	0.0286	12.1
10	20.0	10.7	0.0162	8.1
100	20.0	4.2	0.0068	3.4
200	20.0	2.7	0.0049	2.3

D85: 7.68 D60: 1.23 D50: 0.59 D30: 0.17 D15: .042 D10: .021 mm

Cu: 57.7 Cc: 1.13

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 21.2% Sand: 58.6% Fines: 20.2%

------------------------- ASTM D 2487 Classification -------------------------

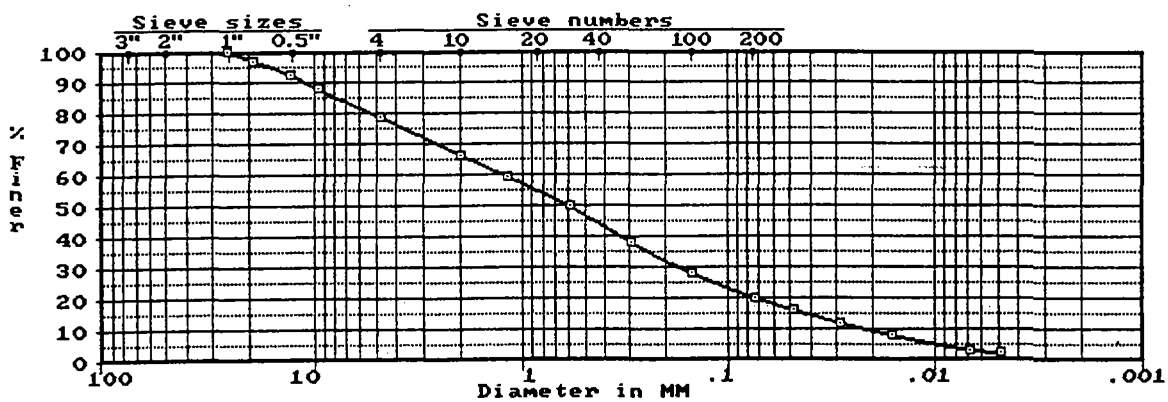
SM Silty SAND with gravel

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 9.5 Frost Classification: **F2**

---------------------------------- Comments ----------------------------------

\- WATER CONTENT = 12.1%



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WILLIAMSPORT (94-288)

Boring: **AP-1** Sample: **6** Depth: **18.5-20.0'** Lab No.: 28819

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	38.57	92.5
1/2 In.	113.12	78.1
3/8 In.	176.98	65.7
No. 4	304.47	40.9
No. 10	454.74	11.8
Pan	515.50	0.0
No. 16	17.37	9.6
No. 30	37.86	7.1
No. 50	54.84	5.0
No. 100	67.65	3.4
No. 200	77.21	2.2
Pan	94.65	0.0

----------- Hydrometer Analysis -----------

Sample Weight:94.65 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	11.8	0.0508	1.5
3	20.0	8.3	0.0299	1.1
10	20.0	5.3	0.0166	0.7
100	20.0	2.3	0.0069	0.3
200	20.0	2.2	0.0049	0.3

D85: 15.2 D60: 8.18 D50: 6.22 D30: 3.63 D15: 2.27 D10: 1.30 mm

Cu: 6.30 Cc: 1.24

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 59.1% Sand: 38.7% Fines: 2.2%

------------------------- ASTM D 2487 Classification -------------------------

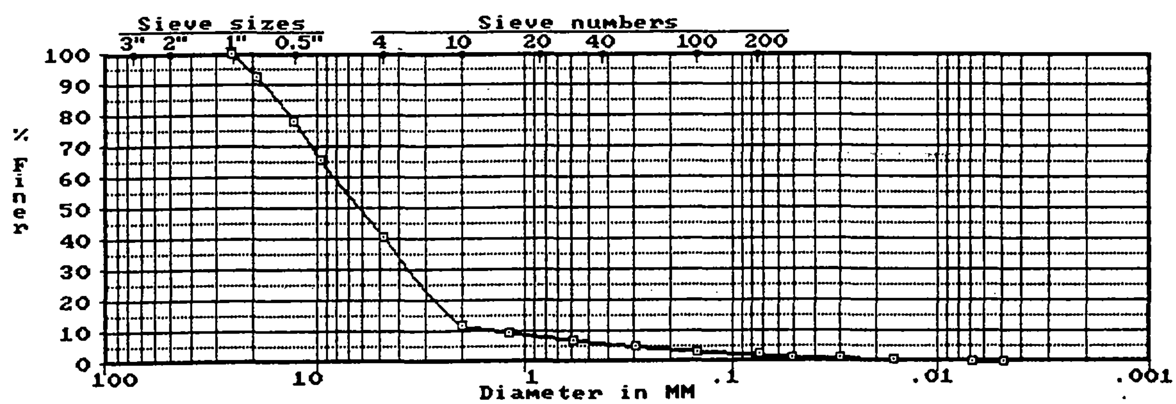
GW Well-graded GRAVEL with sand

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 0.8 Frost Classification: **NFS**

---------------------------------- Comments ----------------------------------

\- WATER CONTENT = 11.5%



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WILLIAMSPORT (94-288)

Boring: **AP-1** Sample: **7** Depth: **23.5-25.0'** Lab No.: 28820

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	27.04	96.8
1/2 In.	49.30	94.1
3/8 In.	61.21	92.7
No. 4	106.14	87.4
No. 10	173.80	79.3
Pan	840.98	0.0
No. 16	0.10	79.2
No. 30	0.31	79.0
No. 50	1.17	78.2
No. 100	2.24	77.2
No. 200	2.26	77.2
Pan	84.95	0.0

----------- Hydrometer Analysis -----------

Sample Weight:84.95 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	55.1	0.0361	51.4
3	20.0	48.1	0.0224	44.9
10	20.0	36.6	0.0136	34.3
100	20.0	22.1	0.0062	20.9
200	20.0	20.3	0.0044	19.2

D85: 3.84 D60: .045 D50: .033 D30: .011 mm

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 12.6% Sand: 10.2% Fines: 77.2%

------------------------- ASTM D 2487 Classification -------------------------

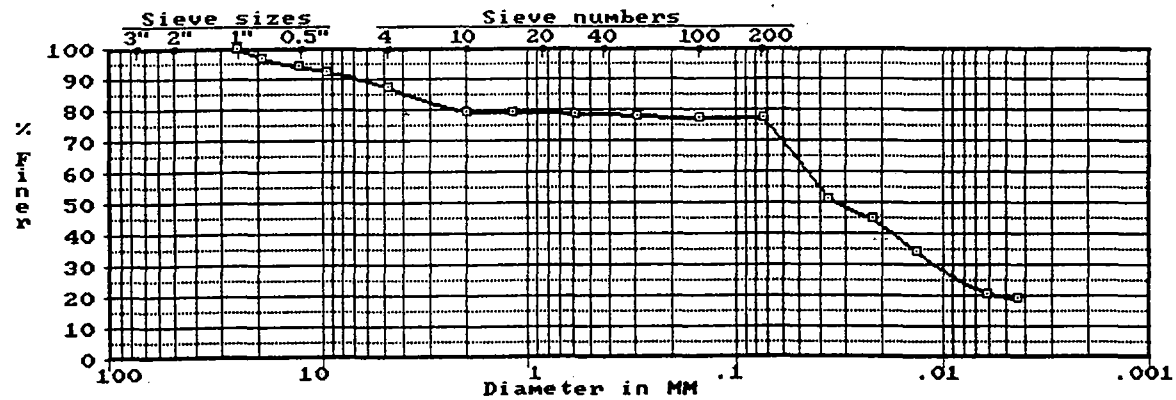
ML SILT with gravel

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 42.6 Frost Classification: **F4**

---------------------------------- Comments ----------------------------------

- WATER CONTENT = 10.6%



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WILLIAMSPORT (94-288)

Boring: **AP-2** Sample: **1** Depth: **0.0-1.5'** Lab No.: 28821

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	71.73	94.7
3/4 In.	114.91	91.6
1/2 In.	166.90	87.8
3/8 In.	214.30	84.3
No. 4	292.44	78.6
No. 10	369.96	72.9
Pan	1365.43	0.0
No. 16	1.80	70.6
No. 30	4.77	66.7
No. 50	7.66	62.9
No. 100	9.94	60.0
No. 200	11.82	57.5
Pan	56.07	0.0

----------- Hydrometer Analysis -----------

Sample Weight:56.07 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	42.3	0.0410	55.1
3	20.0	32.3	0.0257	42.2
10	20.0	32.3	0.0141	42.2
100	20.0	20.3	0.0062	26.8
200	20.0	17.2	0.0045	22.8

D85: 10.1 D60: 0.15 D50: .034 D30: .0072 mm

Liquid Limit: 44 Plasticity Index: 19

Fines Type Used for Classification: CL, Lean CLAY

Gravel: 21.4% Sand: 21.1% Fines: 57.5%

------------------------- ASTM D 2487 Classification -------------------------

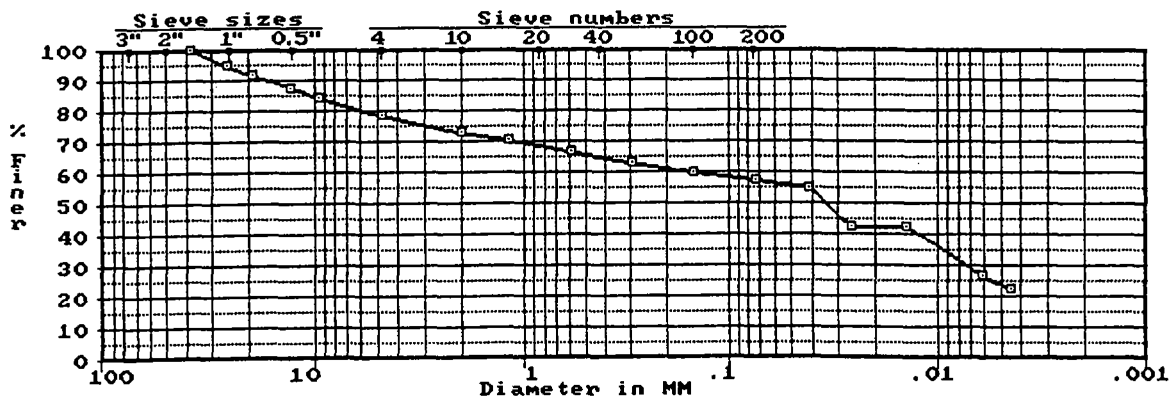
CL Gravelly Lean CLAY with sand

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 42.2 Frost Classification: **F3**

----------------------------------- Comments -----------------------------------

- WATER CONTENT = 33.2%
- DRIVE 2.5"



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WILLIAMSPORT (94-288)

Boring: **AP-2** Sample: **2** Depth: **5.5-6.5'** Lab No.: 28822

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	133.63	84.0
1 In.	184.90	77.9
3/4 In.	213.19	74.5
1/2 In.	290.88	65.2
3/8 In.	323.74	61.3
No. 4	411.88	50.7
No. 10	499.86	40.2
Pan	835.87	0.0
No. 16	10.26	35.4
No. 30	24.42	28.7
No. 50	41.95	20.5
No. 100	56.57	13.6
No. 200	67.64	8.4
Pan	85.50	0.0

----------- Hydrometer Analysis -----------

Sample Weight:85.50 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	11.1	0.0510	5.4
3	20.0	7.6	0.0300	3.8
10	20.0	5.1	0.0167	2.6
100	20.0	1.6	0.0069	1.0
200	20.0	1.1	0.0049	0.7

D85: 38.8 D60: 8.73 D50: 4.53 D30: 0.67 D15: 0.17 D10: .093 mm

Cu: 94.3 Cc: 0.55

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 49.3% Sand: 42.3% Fines: 8.4%

------------------------ ASTM D 2487 Classification ------------------------

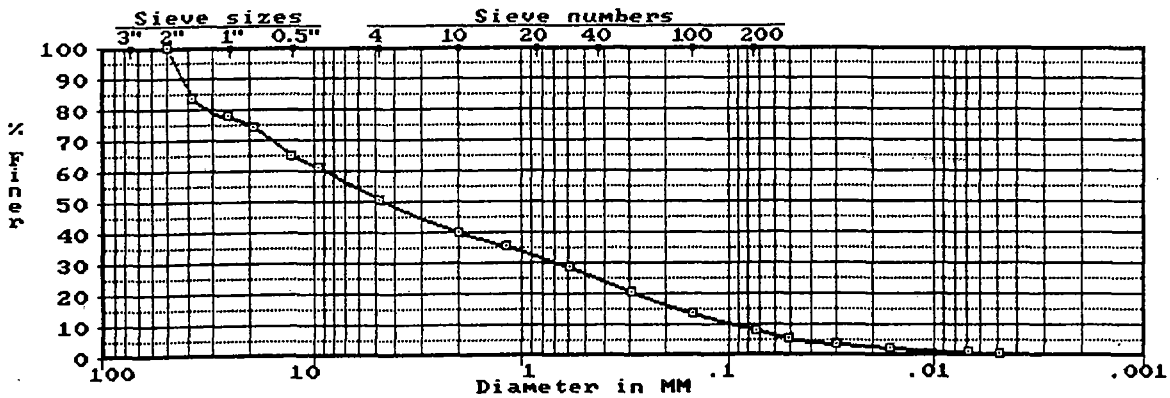
GP-GM Poorly graded GRAVEL with silt and sand

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 2.9 Frost Classification: **PFS**

-------------------------------- Comments --------------------------------

- WATER CONTENT = 8.5%



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WILLIAMSPORT (94-288)

Boring: **AP-2** Sample: 3 Depth: **10.0-11.5'** Lab No.: 28823

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	15.60	91.3
1/2 In.	18.67	89.6
3/8 In.	21.90	87.8
No. 4	55.84	68.9
No. 10	102.27	43.1
Pan	179.73	0.0
No. 16	21.59	31.0
No. 30	43.04	19.0
No. 50	56.14	11.7
No. 100	61.93	8.5
No. 200	61.97	8.4
Pan	77.04	0.0

----------- Hydrometer Analysis -----------

Sample Weight:77.04 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	9.7	0.0514	5.6
3	20.0	7.7	0.0300	4.5
10	20.0	4.7	0.0167	2.9
100	20.0	2.2	0.0069	1.5
200	20.0	1.3	0.0049	1.0

D85: 8.31 D60: 3.56 D50: 2.54 D30: 1.12 D15: 0.43 D10: 0.23 mm

Cu: 15.8 Cc: 1.57

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 31.1% Sand: 60.5% Fines: 8.4%

------------------------ ASTM D 2487 Classification ------------------------

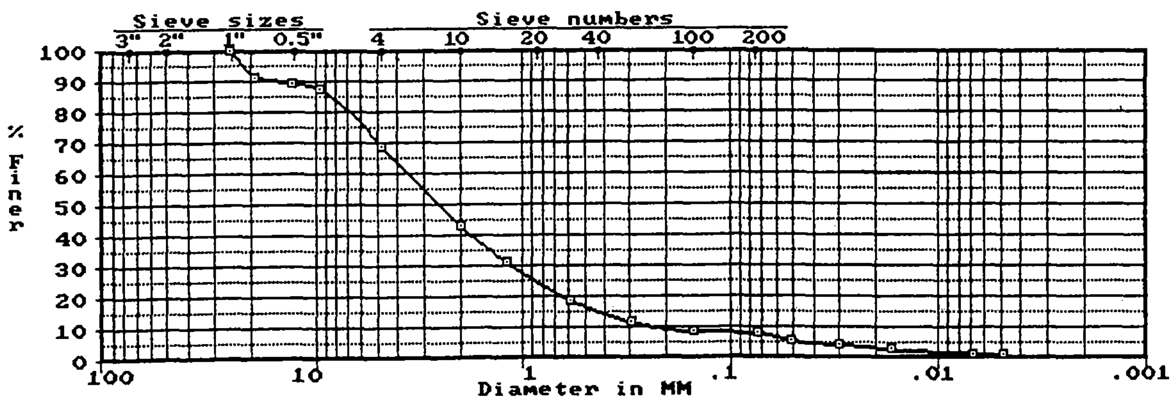
SW-SM Well-graded SAND with silt and gravel

--------------------- TM 5-818-2 Frost Classification ---------------------

Percent finer than 0.02 mm: 3.4 Frost Classification: **S2**

---------------------------------- Comments ----------------------------------

\- WATER CONTENT = 14.9%



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WILLIAMSPORT (94-288)

Boring: **AP-2** Sample: **4** Depth: **15.5-17.0'** Lab No.: 28834

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	0.00	100.0
1/2 In.	22.46	96.5
3/8 In.	30.68	95.2
No. 4	61.62	90.3
No. 10	120.52	81.1
Pan	636.52	0.0
No. 16	4.46	75.4
No. 30	12.85	64.7
No. 50	25.46	48.6
No. 100	38.99	31.3
No. 200	48.98	18.5
Pan	63.51	0.0

----------- Hydrometer Analysis -----------

Sample Weight:63.51 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	8.2	0.0518	11.0
3	20.0	5.7	0.0303	7.8
10	20.0	4.2	0.0167	5.9
100	20.0	1.4	0.0069	2.4
200	20.0	0.7	0.0049	1.5

D85: 2.83 D60: 0.48 D50: 0.31 D30: 0.14 D15: .063 D10: .047 mm

Cu: 10.1 Cc: 0.87

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 9.7% Sand: 71.8% Fines: 18.5%

------------------------- ASTM D 2487 Classification -------------------------

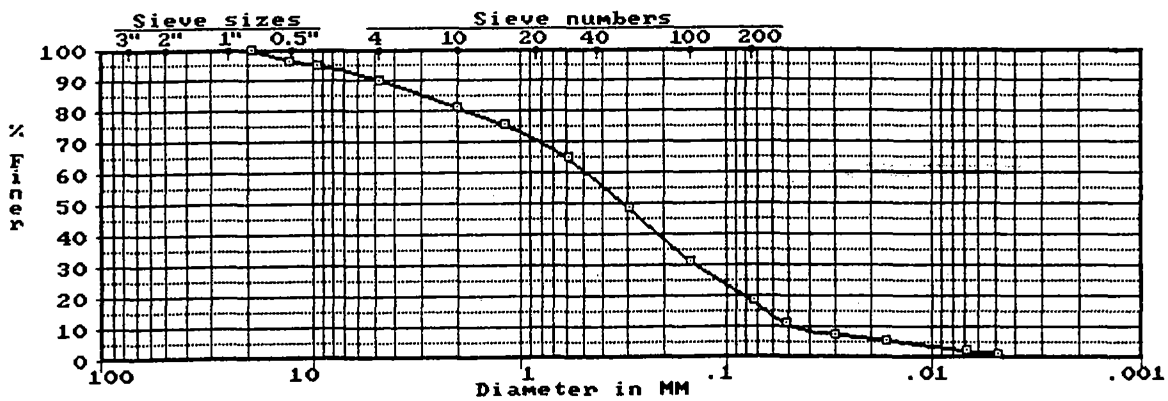
SM Silty SAND

--------------------- TM 5-818-2 Frost Classification ---------------------

Percent finer than 0.02 mm: 6.4 Frost Classification: **F2**

--------------------------------- Comments ---------------------------------

- WATER CONTENT = 16.5%



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WILLIAMSPORT (94-288)

Boring: **AP-3** Sample: 1 Depth: **0.0-2.0'** Lab No.: 28824

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	26.41	98.1
1/2 In.	59.34	95.7
3/8 In.	109.80	92.0
No. 4	216.68	84.2
No. 10	327.49	76.1
Pan	1368.31	0.0
No. 16	2.13	73.3
No. 30	6.50	67.8
No. 50	14.05	58.1
No. 100	19.78	50.8
No. 200	19.82	50.7
Pan	59.49	0.0

----------- Hydrometer Analysis -----------

Sample Weight:59.49 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	35.7	0.0433	45.8
3	20.0	32.2	0.0257	41.4
10	20.0	24.7	0.0148	31.9
100	20.0	15.2	0.0064	19.9
200	20.0	14.2	0.0046	18.6

D85: 5.14 D60: 0.34 D50: .068 D30: .013 mm

Liquid Limit: 37 Plasticity Index: 15

Fines Type Used for Classification: CL, Lean CLAY

Gravel: 15.8% Sand: 33.5% Fines: 50.7%

------------------------- ASTM D 2487 Classification -------------------------

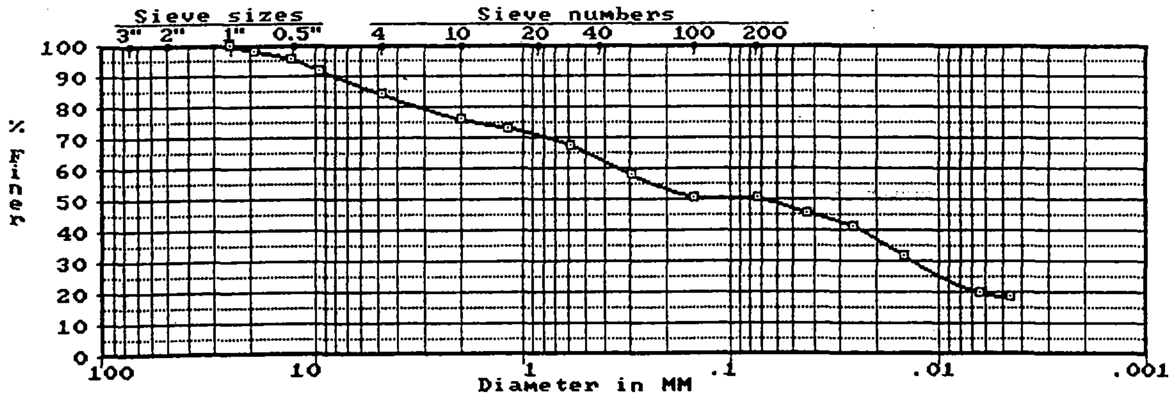
CL Sandy Lean CLAY with gravel

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 37.3 Frost Classification: **F3**

--------------------------------- Comments ---------------------------------

- WATER CONTENT = 26.2%



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WILLIAMSPORT (94-288)

Boring: **AP-3** Sample: **2** Depth: **2.5-4.0'** Lab No.: 28835

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	23.16	97.9
3/4 In.	23.16	97.9
1/2 In.	45.46	95.9
3/8 In.	61.23	94.4
No. 4	121.44	88.9
No. 10	220.72	79.9
Pan	1095.60	0.0
No. 16	5.02	73.3
No. 30	14.33	61.1
No. 50	25.72	46.3
No. 100	31.07	39.3
No. 200	35.99	32.9
Pan	61.17	0.0

----------- Hydrometer Analysis -----------

Sample Weight:61.17 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	22.7	0.0475	30.0
3	20.0	20.2	0.0279	26.8
10	20.0	15.7	0.0157	20.9
100	20.0	9.0	0.0067	12.3
200	20.0	6.7	0.0048	9.3

D85: 3.18 D60: 0.56 D50: 0.36 D30: .048 D15: .0088 D10: .0052 mm

Cu: 100+ Cc: 0.78

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 11.1% Sand: 56.0% Fines: 32.9%

------------------------- ASTM D 2487 Classification -------------------------

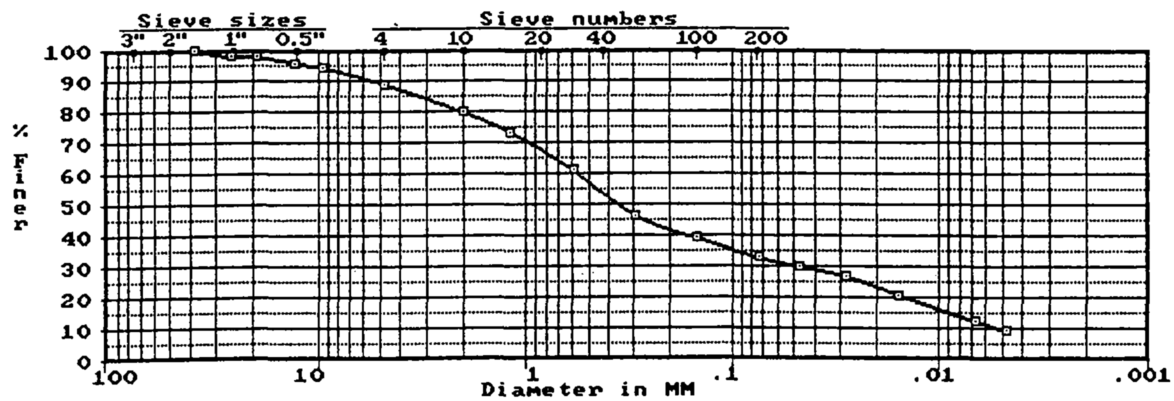
SM Silty SAND

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 23.5 Frost Classification: **F4**

---------------------------------- Comments ----------------------------------

- WATER CONTENT = 21.4%
- VOLATILE SOLIDS = 1.6%



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WILLIAMSPORT (94-288)

Boring: **AP-3** Sample: **5A** Depth: **10.0-11.0'** Lab No.: 28836

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	0.00	100.0
1/2 In.	6.92	97.4
3/8 In.	11.51	95.7
No. 4	19.94	92.6
No. 10	38.59	85.7
Pan	269.60	0.0
No. 16	2.46	81.4
No. 30	6.71	74.1
No. 50	12.84	63.6
No. 100	18.74	53.4
No. 200	25.43	41.9
Pan	49.74	0.0

----------- Hydrometer Analysis -----------

Sample Weight:49.74 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	19.7	0.0484	34.5
3	20.0	16.2	0.0286	28.5
10	20.0	14.2	0.0158	25.1
100	20.0	9.2	0.0067	16.5
200	20.0	7.2	0.0048	13.1

D85: 1.83 D60: 0.23 D50: 0.12 D30: .034 D15: .0057 mm

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 7.4% Sand: 50.7% Fines: 41.9%

------------------------- ASTM D 2487 Classification -------------------------

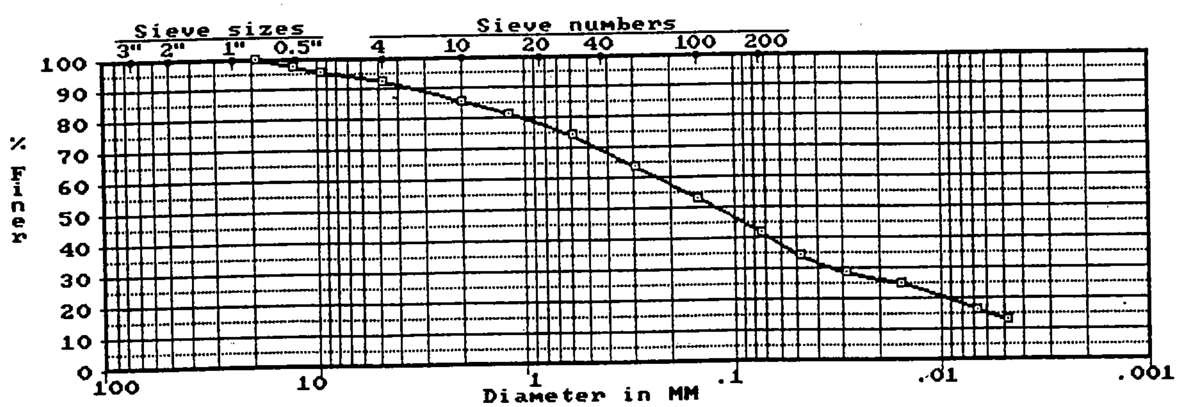
SM Silty SAND

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 26.4 Frost Classification: **F4**

---------------------------------- Comments ----------------------------------

\- WATER CONTENT = 25.1%



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WILLIAMSPORT (94-288)

Boring: **AP-3** Sample: **5B** Depth: **11.0-12.0'** Lab No.: 28837

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	0.00	100.0
1/2 In.	0.00	100.0
3/8 In.	2.35	98.9
No. 4	9.69	95.3
No. 10	20.38	90.1
Pan	205.60	0.0
No. 16	1.65	88.0
No. 30	4.24	84.7
No. 50	8.17	79.7
No. 100	13.85	72.4
No. 200	23.81	59.7
Pan	70.64	0.0

----------- Hydrometer Analysis -----------

Sample Weight:70.64 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	36.2	0.0431	46.3
3	20.0	30.2	0.0261	38.8
10	20.0	24.7	0.0148	31.8
100	20.0	17.2	0.0064	22.3
200	20.0	13.2	0.0046	17.3

D85: 0.62 D60: .075 D50: .050 D30: .012 mm

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 4.7% Sand: 35.6% Fines: 59.7%

------------------------- ASTM D 2487 Classification -------------------------

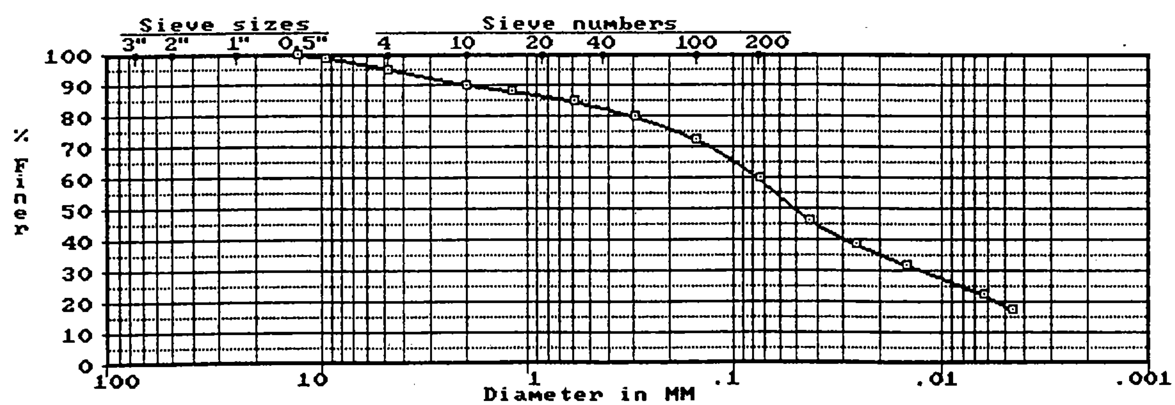
ML Sandy SILT

--------------------- TM 5-818-2 Frost Classification ---------------------

Percent finer than 0.02 mm: 35.4 Frost Classification: **F4**

-------------------------------- Comments --------------------------------

- WATER CONTENT = 35.4%



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WILLIAMSPORT (94-288)

Boring: **AP-4** Sample: **2** Depth: **2.0-4.0'** Lab No.: 28825

Sieve Analysis

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	0.00	100.0
1/2 In.	0.00	100.0
3/8 In.	0.00	100.0
No. 4	0.00	100.0
No. 10	0.58	99.9
Pan	591.75	0.0
No. 16	0.05	99.8
No. 30	0.19	99.6
No. 50	0.55	99.1
No. 100	1.31	97.9
No. 200	1.34	97.9
Pan	65.86	0.0

Hydrometer Analysis

Sample Weight:65.86 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	61.3	0.0335	92.8
3	20.0	52.8	0.0214	80.0
10	20.0	41.3	0.0131	62.8
100	20.0	24.3	0.0061	37.2
200	20.0	19.3	0.0044	29.7

D85: .025 D60: .012 D50: .0091 D30: .0045 mm

Liquid Limit: 44 Plasticity Index: 19

Fines Type Used for Classification: CL, Lean CLAY

Gravel: 0.0% Sand: 2.1% Fines: 97.9%

ASTM D 2487 Classification

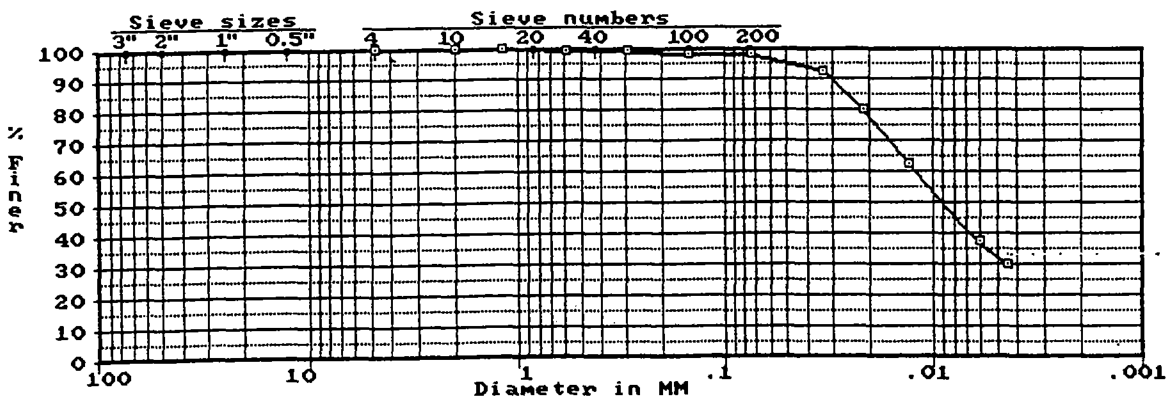
CL Lean CLAY

TM 5-818-2 Frost Classification

Percent finer than 0.02 mm: 77.7 Frost Classification: **F3**

Comments

- WATER CONTENT = 34.2%
- VOLATILE SOLIDS = 3.5%



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WILLIAMSPORT (94-288)

Boring: **AP-4** Sample: **3** Depth: **5.0-6.5'** Lab No.: 28826

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	0.00	100.0
1/2 In.	0.00	100.0
3/8 In.	0.00	100.0
No. 4	0.21	99.9
No. 10	0.87	99.7
Pan	334.87	0.0
No. 16	0.03	99.6
No. 30	0.13	99.2
No. 50	0.54	97.6
No. 100	1.02	95.6
No. 200	1.07	95.4
Pan	24.71	0.0

----------- Hydrometer Analysis -----------

Sample Weight:24.71 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	21.7	0.0478	88.7
3	20.0	20.2	0.0279	82.7
10	20.0	14.7	0.0158	60.7
100	20.0	8.7	0.0067	36.8
200	20.0	6.7	0.0048	28.8

D85: .032 D60: .015 D50: .011 D30: .0050 mm

Liquid Limit: 42 Plasticity Index: 16

Fines Type Used for Classification: ML, SILT

Gravel: 0.0% Sand: 4.5% Fines: 95.4%

------------------------ ASTM D 2487 Classification ------------------------

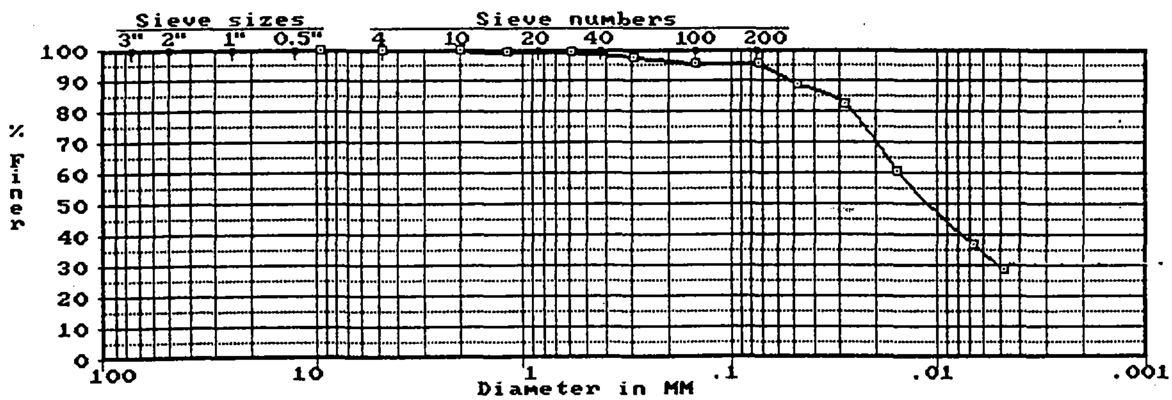
ML SILT

--------------------- TM 5-818-2 Frost Classification ---------------------

Percent finer than 0.02 mm: 70.5 Frost Classification: **F4**

--------------------------------- Comments ---------------------------------

- WATER CONTENT = 35.5%
- VOLATILE SOLIDS = 5.0%



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WILLIAMSPORT (94-288)

Boring: **AP-4** Sample: **4** Depth: **10.0-11.5'** Lab No.: 28827

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	0.00	100.0
1/2 In.	0.00	100.0
3/8 In.	0.00	100.0
No. 4	0.00	100.0
No. 10	1.06	99.8
Pan	673.87	0.0
No. 16	0.14	99.6
No. 30	0.40	99.2
No. 50	1.14	98.0
No. 100	3.22	94.6
No. 200	5.58	90.7
Pan	61.07	0.0

----------- Hydrometer Analysis -----------

Sample Weight:61.07 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	50.8	0.0378	83.0
3	20.0	44.8	0.0232	73.3
10	20.0	35.3	0.0137	57.9
100	20.0	22.3	0.0062	36.9
200	20.0	19.8	0.0044	32.9

D85: .043 D60: .015 D50: .011 mm

Liquid Limit: 43 Plasticity Index: 17

Fines Type Used for Classification: CL, Lean CLAY

Gravel: 0.0% Sand: 9.3% Fines: 90.7%

------------------------ ASTM D 2487 Classification ------------------------

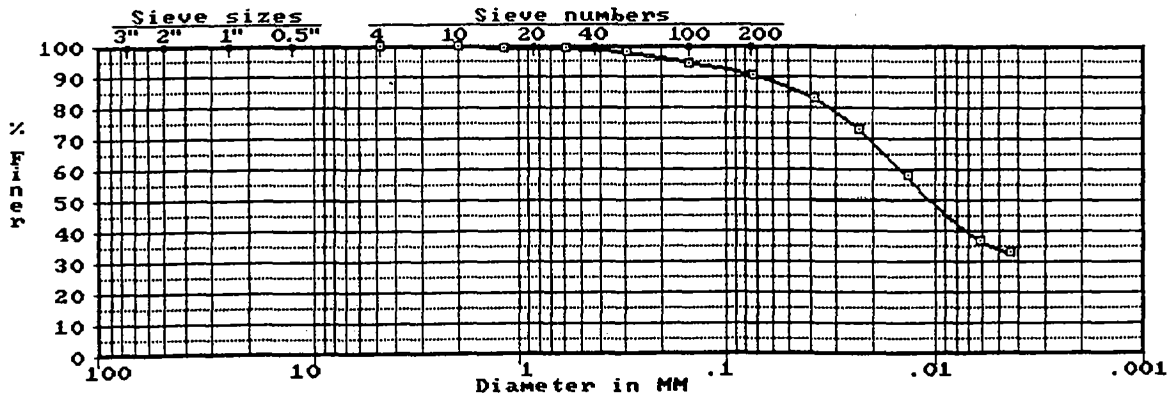
CL Lean CLAY

--------------------- TM 5-818-2 Frost Classification ---------------------

Percent finer than 0.02 mm: 69.2 Frost Classification: **F3**

--------------------------------- Comments ---------------------------------

- WATER CONTENT = 42.0%



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WILLIAMSPORT (94-288)

Boring: **AP-4** Sample: **5** Depth: **15.0-16.5'** Lab No.: 28828

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	41.74	88.5
3/4 In.	41.74	88.5
1/2 In.	41.74	88.5
3/8 In.	46.81	87.1
No. 4	55.27	84.7
No. 10	77.04	78.7
Pan	361.90	0.0
No. 16	1.94	76.4
No. 30	5.70	72.0
No. 50	12.41	64.1
No. 100	21.52	53.4
No. 200	22.15	52.6
Pan	66.87	0.0

----------- Hydrometer Analysis -----------

Sample Weight:66.87 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	23.5	0.0473	28.0
3	20.0	16.5	0.0285	19.8
10	20.0	15.0	0.0158	18.1
100	20.0	6.5	0.0068	8.2
200	20.0	6.3	0.0048	7.9

D85: 5.16 D60: 0.23 D50: .070 D30: .049 D15: .012 D10: .0080 mm

Cu: 29.3 Cc: 1.28

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 15.3% Sand: 32.1% Fines: 52.6%

------------------------ ASTM D 2487 Classification ------------------------

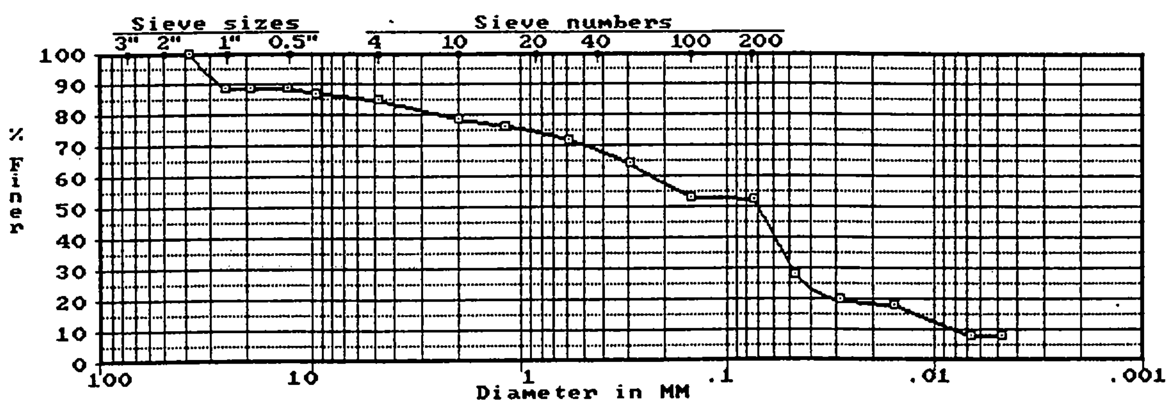
ML Sandy SILT with gravel

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 18.5 Frost Classification: **F4**

---------------------------------- Comments ----------------------------------

- WATER CONTENT = 19.4%
- DRIVE SAMPLE



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WILLIAMSPORT (94-288)

Boring: **AP-5** Sample: 1 Depth: **0.0-2.0'** Lab No.: 28829

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	0.00	100.0
1/2 In.	3.69	98.6
3/8 In.	3.69	98.6
No. 4	3.69	98.6
No. 10	4.17	98.4
Pan	259.52	0.0
No. 16	0.02	98.4
No. 30	0.07	98.3
No. 50	0.14	98.1
No. 100	0.18	98.1
No. 200	0.21	98.0
Pan	55.42	0.0

----------- Hydrometer Analysis -----------

Sample Weight:55.42 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	53.1	0.0369	94.2
3	20.0	48.6	0.0223	86.3
10	20.0	39.1	0.0133	69.6
100	20.0	24.1	0.0061	43.2
200	20.0	21.2	0.0044	38.1

D85: .021 D60: .010 D50: .0077 mm

Liquid Limit: 48 Plasticity Index: 21

Fines Type Used for Classification: CL, Lean CLAY

Gravel: 1.4% Sand: 0.6% Fines: 98.0%

------------------------- ASTM D 2487 Classification -------------------------

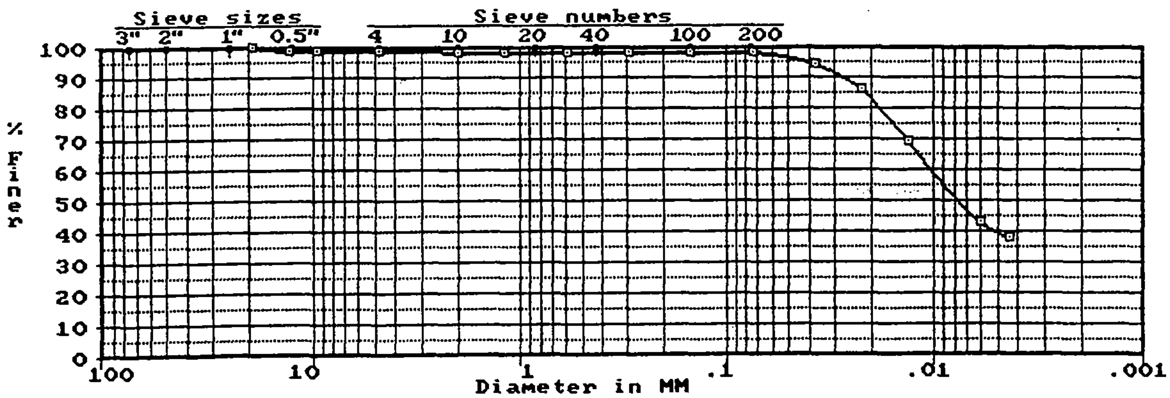
CL Lean CLAY

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 83.1 Frost Classification: **F3**

---------------------------------- Comments ----------------------------------

\- WATER CONTENT = 47.8%



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WILLIAMSPORT (94-288)

Boring: **AP-5** Sample: 3 Depth: **5.0-7.0'** Lab No.: 28830

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	0.00	100.0
1/2 In.	0.00	100.0
3/8 In.	1.35	99.8
No. 4	1.59	99.8
No. 10	2.86	99.6
Pan	657.22	0.0
No. 16	0.09	99.4
No. 30	0.32	99.1
No. 50	0.58	98.7
No. 100	1.06	98.1
No. 200	2.11	96.6
Pan	70.19	0.0

----------- Hydrometer Analysis -----------

Sample Weight:70.19 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	63.1	0.0327	89.3
3	20.0	56.1	0.0206	79.5
10	20.0	45.1	0.0126	64.0
100	20.0	29.1	0.0059	41.6
200	20.0	24.3	0.0043	34.8

D85: .026 D60: .011 D50: .0080 mm

Liquid Limit: 45 Plasticity Index: 19

Fines Type Used for Classification: CL, Lean CLAY

Gravel: 0.2% Sand: 3.2% Fines: 96.6%

------------------------ ASTM D 2487 Classification ------------------------

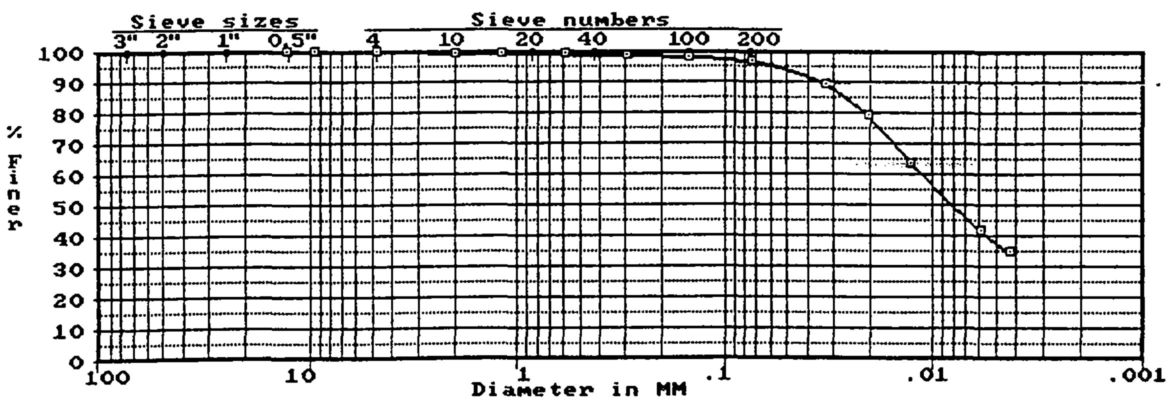
CL Lean CLAY

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 79.5 Frost Classification: **F3**

---------------------------------- Comments ----------------------------------

- WATER CONTENT = 36.7%
- VOLATILE SOLIDS = 3.3%



* * * CORPS OF ENGINEERS - NORTH PACIFIC DIVISION LABORATORY * * *

WILLIAMSPORT (94-288)

Boring: **AP-5** Sample: **4** Depth: **10.0-11.3'** Lab No.: 28831

Sieve Analysis

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	0.00	100.0
1/2 In.	17.68	98.3
3/8 In.	19.53	98.2
No. 4	23.75	97.8
No. 10	33.30	96.9
Pan	1061.90	0.0
No. 16	0.25	96.4
No. 30	0.56	95.8
No. 50	0.99	95.0
No. 100	1.56	94.0
No. 200	1.61	93.9
Pan	52.24	0.0

Hydrometer Analysis

Sample Weight:52.24 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	46.7	0.0394	86.6
3	20.0	42.7	0.0236	79.3
10	20.0	34.2	0.0139	63.7
100	20.0	19.4	0.0063	36.5
200	20.0	19.3	0.0044	36.3

D85: .034 D60: .013 D50: .0098 mm

Liquid Limit: 49 Plasticity Index: 21

Fines Type Used for Classification: ML, SILT

Gravel: 2.2% Sand: 3.9% Fines: 93.9%

ASTM D 2487 Classification

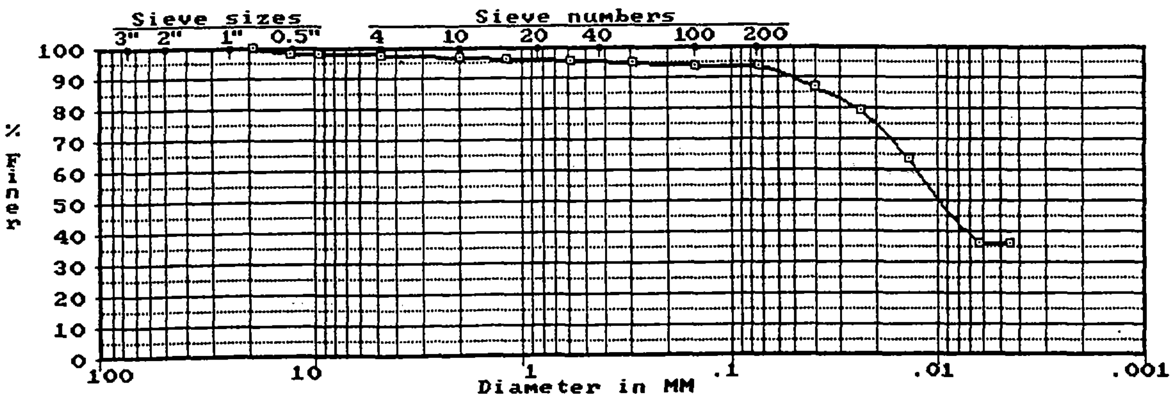
ML SILT

TM 5-818-2 Frost Classification

Percent finer than 0.02 mm: 75.0 Frost Classification: **F4**

Comments

- WATER CONTENT = 41.7%
- VOLATILE SOLIDS = 3.4%



* * * CORPS OF ENGINEERS - NORTH PACIFIC DIVISION LABORATORY * * *

WILLIAMSPORT (94-288)

Boring: **AP-5** Sample: **5** Depth: **15.0-17.0'** Lab No.: 28838

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	16.17	96.8
1/2 In.	21.51	95.8
3/8 In.	21.51	95.8
No. 4	27.54	94.6
No. 10	48.49	90.5
Pan	510.40	0.0
No. 16	2.98	87.4
No. 30	10.26	79.7
No. 50	29.38	59.6
No. 100	51.55	36.3
No. 200	68.68	18.3
Pan	86.10	0.0

----------- Hydrometer Analysis -----------

Sample Weight:86.10 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	12.2	0.0507	13.2
3	20.0	9.2	0.0298	10.1
10	20.0	6.7	0.0165	7.5
100	20.0	2.7	0.0069	3.3
200	20.0	1.7	0.0049	2.3

D85: 0.87 D60: 0.30 D50: 0.22 D30: 0.12 D15: .059 D10: .029 mm

Cu: 10.3 Cc: 1.67

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 5.4% Sand: 76.3% Fines: 18.3%

------------------------- ASTM D 2487 Classification -------------------------

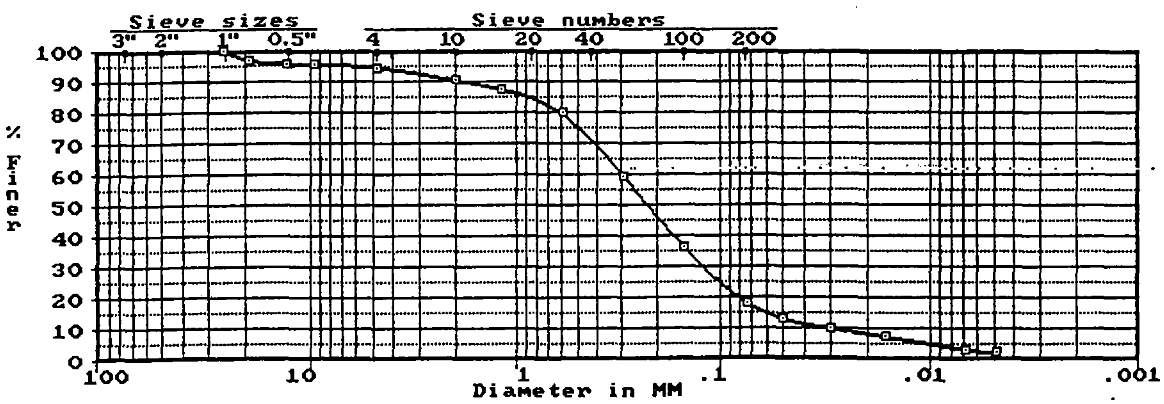
SM Silty SAND

--------------------- TM 5-818-2 Frost Classification ---------------------

Percent finer than 0.02 mm: 8.3 Frost Classification: **F2**

---------------------------------- Comments ----------------------------------

- WATER CONTENT = 19.4%



Geotechnical Studies

Part 2:
Marine and Terrestrial
Geophysical Investigation of Iliamna Bay
(Golder Associates)

Golder Associates Inc.

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Golder Associates

A MARINE AND TERRESTRIAL GEOPHYSICAL INVESTIGATION OF ILIAMNA BAY, NEAR WILLIAMSPORT, ALASKA

Prepared for:

Department of The Army
U.S. Army Engineer District, Alaska

Prepared by:

Golder Associates Inc.
Anchorage, Alaska

Robert G. Dugan, C.P.G.
Associate/Senior Engineering Geologist

Richard E. Sylwester /MRM
Associate/Senior Geophysicist

January 1995

D/F: RGD-95/52180131.RPT

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1. INTRODUCTION

This report presents the results of a marine and terrestrial geophysical survey conducted in Iliamna Bay near Williamsport, Alaska. The survey was conducted from May 24th to May 28th, 1994 by Golder Associates, Anchorage, Alaska, under the direction of Dr. Orson Smith of the U.S. Army Engineer District, Alaska. The project was conducted as Delivery Order No. 3 of contract No. DACA85-94D-0001.

The specific objectives of the investigation were to:

1. Locate and identify interfaces between lithological units (e.g., surface silt, gravel, clays, boulders and bedrock) to a depth of 15 meters below the ground surface or to 10 meters mean lower low water (MLLW) whichever is shallower, within the bounds of a corridor of 300 meters maximum width extending from the existing dock at Williamsport to MLLW in Iliamna Bay.

2. Locate and identify interfaces between lithological units to a depth of 20 meters below the surface within an area extending shoreward 300 meters from the seaward face of the existing dock and 300 meters wide, centered on the existing dock.

3. Provide field interpretation of measurements for location of cores to be extracted from the site, and apply the core log information to interpretation of the geophysical data.

The geophysical methods used for the investigation included precision bathymetry, high-resolution subbottom profiling, continuous seismic reflection profiling and seismic refraction.

2. GEOLOGIC SETTING

The proposed channel excavation at Williamsport is located at the base of the Chigmit Mountains at the head of Iliamna Bay on the west side of middle Cook Inlet. The general region is primarily underlain by granitic and metamorphic rocks of Mesozoic age, with local areas of volcanic rocks. Faults and fractures are prominent structural features in the vicinity of Iliamna Bay. The Bruin Bay fault system, including the Bruin Bay Fault and related parallel faults, runs diagonally along the east coast of the Alaska Peninsula. The region is tectonically active although the portion of the Bruin Bay Fault in the Iliamna Bay area is not known to be active during the Quaternary Period (Detterman and Reed, 1973a).

The region was heavily glaciated during the late Pleistocene epoch when large glaciers from the Chigmit Mountains flowed eastward across the present day Cook Inlet. Subsequently, these ice masses thinned, separated, and eventually receded into their upland source areas. Marine waters invaded middle Cook Inlet as early as 16,500 years ago (Reger and Phinney, 1994). Surficial deposits are primarily the result of glaciation, with subsequent modification by glacio-fluvial, lacustrine, and marine processes. Elevated marine beach deposits and wave-cut bedrock platforms along the west coast of Cook Inlet indicate that the coast is rising at a rate of about two feet per year (Detterman and Reed, 1973b).

3. SURVEY AREAS AND NAVIGATION

3.1 Survey Area

The geophysical investigation included both an onshore area located west of the dock at Williamsport and an offshore area extending east of the dock into Iliamna Bay (Figure 1). The onshore seismic refraction survey investigated an area approximately 300 meters by 300 meters centered on the old Williamsport dock. The primary offshore marine survey covered an area 100 meters by 900 meters centered on the dock. A marine survey was also made over a secondary area consisting of a narrow corridor extending south from the primary area for approximately 1000 meters.

3.2 Horizontal Control and Navigation

Navigation and positioning of the survey vessel was accomplished with differential GPS. Horizontal control and vessel tracking used a Trimble Model 4000SSE Differential GPS System and hydrographic data acquisition was done with an Innerspace Model 488 Precision Echosounder. Horizontal and vertical control was established by LCMF Ltd., Anchorage, Alaska, the navigation contractor for the project.

Prior to conducting the marine geophysical investigation, a GPS receiver and telemetry system were installed at the shore station. The shore-based GPS receiver transmitted real-time corrections to the shipboard GPS receiver at a rate of one correction per second. This information was used to plot the vessel's position as it moved along preselected survey lines. In addition, vertical control was established and water elevations were recorded at a 15-minute interval during data acquisition.

The preplotted survey lines, and the actual survey lines traversed, were displayed in real-time on a monitor during the survey. The navigation data acquisition system acquired position and depth information at a rate of 1 sample per second and provided navigation fix marks to the geophysical instruments and graphic recorders every 20 seconds.

The marine geophysical survey consisted of a series of transects parallel and perpendicular to the Williamsport dock which is oriented east-west. In the primary survey area the spacing between the east-west lines was 20 meters and the north-south lines 150 meters. Two survey lines, space 20 meters apart, were run in the narrow corridor that extended south into Iliamna Bay.

A total of 5 seismic refraction lines, each 150 meters in length, were run for the onshore investigation. One of these refraction lines extended eastward from the dock into the mud flats and the other 4 were oriented east-west adjacent to, and also west of the dock.

4. GEOPHYSICAL INSTRUMENTATION

In addition to obtaining precision bathymetric data, two marine geophysical acoustic methods were employed to determine surficial and subsurface conditions of the marine sediments. These methods were high-resolution continuous seismic reflection profiling (CSRP), and subbottom profiling (SBP). Determination of the thickness of the sediments on land was done with a 24-channel seismic refraction system using electrically discharged shotgun shells.

4.1 Precision Bathymetric System

The precision bathymetric system used a single 200 kHz transducer to transmit an acoustic pulse and receive the reflected pulse from the sea bed. The data, displayed as a profile view of the sea bed, were plotted on a thermal graphic recorder and also logged, as digital depths, on the navigation computer. To calibrate the digital echosounder, an acoustic velocimeter was used to measure the velocity of sound in the water. This calibration velocity, and the water elevation, were logged and used to correct the bathymetric information during data processing. The final bathymetric map was submitted to the Corps in a separate report by LCMF, the navigation and hydrographic contractor.

4.2 Subbottom Profiler System

The subbottom profiler (SBP) is similar to the precision echosounder and uses a single transducer to transmit and receive acoustic signals. However, the SBP operates at a much lower frequency, 3.5kHz, and at a considerably higher energy level. These two operational parameters enable the acoustic signal from the SBP, under the right conditions, to provide a continuous profile of shallow subsurface stratigraphy. The depth of subsurface penetration is a function of the density of sediments and typically ranges from 1 to 20 meters in fine to medium grained sediments such as silt and sand. It is not possible to obtain subsurface penetration in coarse-grained sediments such as gravel and cobbles with these systems.

A Datasonics Model 5000 SBP, with a 3.5kHz transducer and an EPC Model 9800 thermal graphic display recorder were used for the survey. The SBP transducer was mounted adjacent to the bathymetric transducer near the starboard stern of the vessel .

4.3 High-Resolution Continuous Seismic Reflection System

Continuous seismic reflection profiling provides information on the subsurface stratigraphy and geologic features, similar to the SBP, but can achieve considerably more subsurface penetration. The source used for this system emits relatively high energy, and low frequency (400 Hz), acoustic pulses. Under ideal conditions these systems can achieve several hundreds of meters of subsurface penetration through coarse-grained sediments, such as sands and gravels.

A Datasonics Model 1200 Bubble Pulser was used as the source and the data were displayed on the same graphic recorder used for the SBP. The reflection data were received with a 6 meter, 18 element hydrophone, filtered and amplified prior to being displayed. The source and receiver were towed 15 meters astern of the vessel.

4.4 Seismic Refraction System

Seismic refraction is traditionally used on land geophysical surveys to obtain information on the compressional velocity of geology. This velocity information can be used to infer the type of lithology, e.g., rock, weathered rock, sediments, etc., as well as for interpreting the nature of the geologic section. For instance, under the right conditions, it is possible to map the top of bedrock beneath overlying sediments.

A Bison Model 7000 Digital Floating Point Seismograph ,with 24 channels, having a geophone interval of 5 meters, was used to acquire the refraction data. The energy used were shotgun shells that could be discharged electrically. These shells contain no load and were buried approximately 1 meter below the ground surface for each shot and were detonated with an electric blaster. The seismic waves were detected by geophones spaced 5 meters apart and connected to the seismograph. The data were immediately printed in the field and stored digitally.

5. GEOPHYSICAL INTERPRETATION AND RESULTS

This section briefly discusses the results of the interpretation of the geophysical data. These results are summarized in Figures 3 and 4.

5.1 Bathymetric Data

The bathymetry within the survey area varies in elevation from +2 to -4 meters relative to MLLW. Generally the topographic relief is minimal with the exception of several scour channels that meander across the mud flats. A detailed bathymetric map of the offshore area is presented with the LCMF report.

5.2 Subbottom Profiler Data

The SBP obtained subsurface data over most of the primary survey area. However, because of the turbulence generated around the SBP transducer by high tidal currents, no subbottom data could be acquired in the secondary survey area.

In much of the primary survey area subsurface penetration varied from approximately 2 to 4 meters (Figure 2). In boreholes AP-3, AP-4 and AP-5 these acoustically transparent sediments are identified as silts and clays. In borehole AP-2, these fine-grained sediments were quite thin and graded into gravels and cobbles which can not be penetrated by the SBP acoustic signal. Copies of the Corps' borehole logs are provided in Appendix A.

5.3 High-Resolution, Continuous Seismic Reflection Data

In general, the seismic reflection data, in the primary survey area, achieved subsurface information to a depth of 40 to 70 meters (Figure 3). In the secondary area, however, the strong tidal currents created high-noise conditions on the hydrophone streamer and the data were generally poor. Occasionally a subsurface reflector could be detected for a short distance before being masked by acoustic noise due to the turbulence. For this reason only the data from the primary area could be interpreted, mapped and contoured.

An acoustic reflector, interpreted to be the top of bedrock, was identified on most of the reflection data in the primary area (Figures 4 and 5). The sediments above this reflector are interpreted to be sands and gravels, and possibly larger materials such as cobbles, in those areas where penetration was poor. Borings AP-1 and AP-2, located near the old dock, sampled these type of sediments.

In the secondary area the depth to bedrock is believed to be approximately 40 to 70 meters below the seabed, based on sparse reflection information. It is not anticipated that the bedrock occurs at a subsurface depth less than 10 to 20 meters.

5.4 Seismic Refraction Data

The results of the seismic refraction data were excellent in terms of signal to noise levels. However, there was no evidence of bedrock on these data except on the refraction line that was run southeast of the Williamsport Dock (Figure 4 and 5). On this line, bedrock varied from 30 to 40 meters below the mudline. On the remaining refraction lines bedrock was estimated to be at a minimum depth of 30 to 40 meters. This calculation was based on a model that used a bedrock velocity of 12,400 feet/second and a sediment velocity of 6200 feet/second. Both of these compressional velocities were measured on site.

6. SUMMARY AND CONCLUSIONS

A comprehensive marine geophysical survey using precision navigation and echosounding, subbottom profiling, continuous seismic reflection profiling, and land refraction was undertaken to determine the sedimentary conditions at Williamsport, Alaska. A summary of the results of this geophysical investigation are presented on Figures 3 and 4 and discussed below.

1. The offshore survey area is a tidal mud flat having very little relief except for several channels that meander across the site. Onshore, the area of investigation was flat and covered with coarse sand, gravel and cobbles to the west of the dock. North and south of the dock area are grass-covered tidal flats consisting of sand, gravel and mud.

2. The subbottom profiler identified an acoustic transparent sediment layer that varied in thickness from 2 to 4 meters, in the offshore area east of the Williamsport Dock. Based on several boring these sediments were classified as clays and silts which corresponds with their acoustic characteristic. Because of acoustic noise generated by tidal currents, it was not possible to obtain SBP data in the secondary survey area that extended into Iliamna Bay from Williamsport.

3. The seismic reflection data identified a relatively deep subsurface reflector that is interpreted to be the top of bedrock. This reflector is at a subsurface depth of 40 to 60 meters in the Williamsport area and possibly as deep as 70 meters in Iliamna Bay.

4. Onshore seismic refraction data mapped the top of bedrock at a depth of 30 to 40 meters along one line near the Williamsport Dock. This depth agrees closely with the depth to bedrock determined from the seismic reflection data in this area. On the other 5 refraction lines the top of bedrock was too deep for detection based on the length of the geophone spread used. However, based on models that used a velocity of 12,400 feet/second for the bedrock velocity, and 6,400 feet/second for the velocity of the sediments, the minimum depth to top of bedrock was calculated to be 30 meters in the dock area and west of the dock for several hundred meters.

7. REFERENCES

1. Detterman, Robert L., and Bruce L. Reed, 1973, Surficial Geology of the Iliamna Quadrangle, Alaska. Bulletin 1368-A. U.S. Geological Survey, Washington, D.C.

2. Detterman, Robert L., and Bruce L. Reed, 1973, Stratigraphy, Structure, and Economic Geology of the Iliamna Quadrangle, Alaska. Bulletin 1368-B. U.S. Geological Survey, Washington, D.C.

3. Reger, Richard D., and DeAnne S. Phinney, 1994, Late Wisconsin Glaciation of the Cook Inlet Region With Emphasis on Kenai Lowland and Implications for Early Peopling. Unpublished, Alaska Division of Geological and Geophysical Surveys.

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Golder Associates

February 23, 1995 | 943-5218x003

U.S. Army Engineer District, Alaska
P.O. Box 898 (Bldg. 21-700 EAFB, Rm. 71)
Anchorage, Alaska 99506-0898

Attention: Dr. Orson Smith, P.E.

RE: DREDGE SLOPES IN ILIAMNA BAY NEAR WILLIAMSPORT, ALASKA

Dear Orson:

At your request we have evaluated potential dredge slope angles for the proposed dredged channel to the Williamsport dock in Iliamna Bay. The results are presented in this letter as a supplement our report entitled "A Marine and Terrestrial Geophysical Investigation of Iliamna Bay Near Williamsport, Alaska," dated January 1995.

Sensitivity analyses were performed using an infinite slope analysis. The following soil properties were used, based on our evaluation of the boring logs:

Total Unit Weight:	120 pounds per cubic foot (pcf)
Buoyant Unit Weight:	57.6 pcf
Friction Angle:	34 degrees
Cohesion:	0 psf

A seismic acceleration coefficient of 0.45g was used for pseudo-static analyses. This acceleration has a 10 percent chance of exceedance in 50 years based on Algermissen, et. al. (1990)[1]. Significant attenuation of the bedrock acceleration can be expected because of the deep soil deposits in the project area, but was not considered in our analysis. A detailed evaluation of these effects is beyond the scope of this investigation.

Because of the high tidal range which the slopes will be exposed to, the analysis considered rapid drawdown conditions. Under this scenario, pore pressures build up below the

[1] Algermissen, S.T., D.M. Perkins, P.C. Thenhaus, S.L. Hanson, and B.L. Bender (1990), Probabilistic Earthquake Acceleration and Velocity Maps for the United States and Puerto Rico, U.S. Geological Survey Map MF-2120.

mudline during high tide. As the tide goes out, the pore pressures below the mudline drop more slowly than the water level above the mudline. Thus, a condition occurs where there are excess pore pressures below the mudline which is detrimental to the stability of the slopes.

The analyses indicated that the slope angle was very sensitive to the rate of pore pressure dissipation below the mudline and moderately sensitive to the unit weight of the material below the mudline. Neither of these two parameters are well defined at this time, so assumptions must be made which significantly affect the conclusions of the analysis. It will be necessary to better define these parameters before final design slopes can be determined.

For the conditions which we estimated to be representative of the dredged area, dredge slopes of 6H:1V will have a factor of safety generally greater than 2.0 under static and rapid drawdown conditions. A factor of safety less than one is expected during the seismic event described above, but deformations of the slope are expected to be within tolerable values. Dredge slopes of 3H:1V will have a factor of safety close to one under rapid drawdown conditions, and are likely to undergo large deformations during a seismic event of the magnitude described above. Dredge slopes in the range of 4H:1V to 5H:1V may be feasible depending on actual pore pressure distributions and bedrock acceleration attenuation effects.

If you have any questions regarding our analyses or need any additional information, please call us.

Sincerely,

GOLDER ASSOCIATES INC.

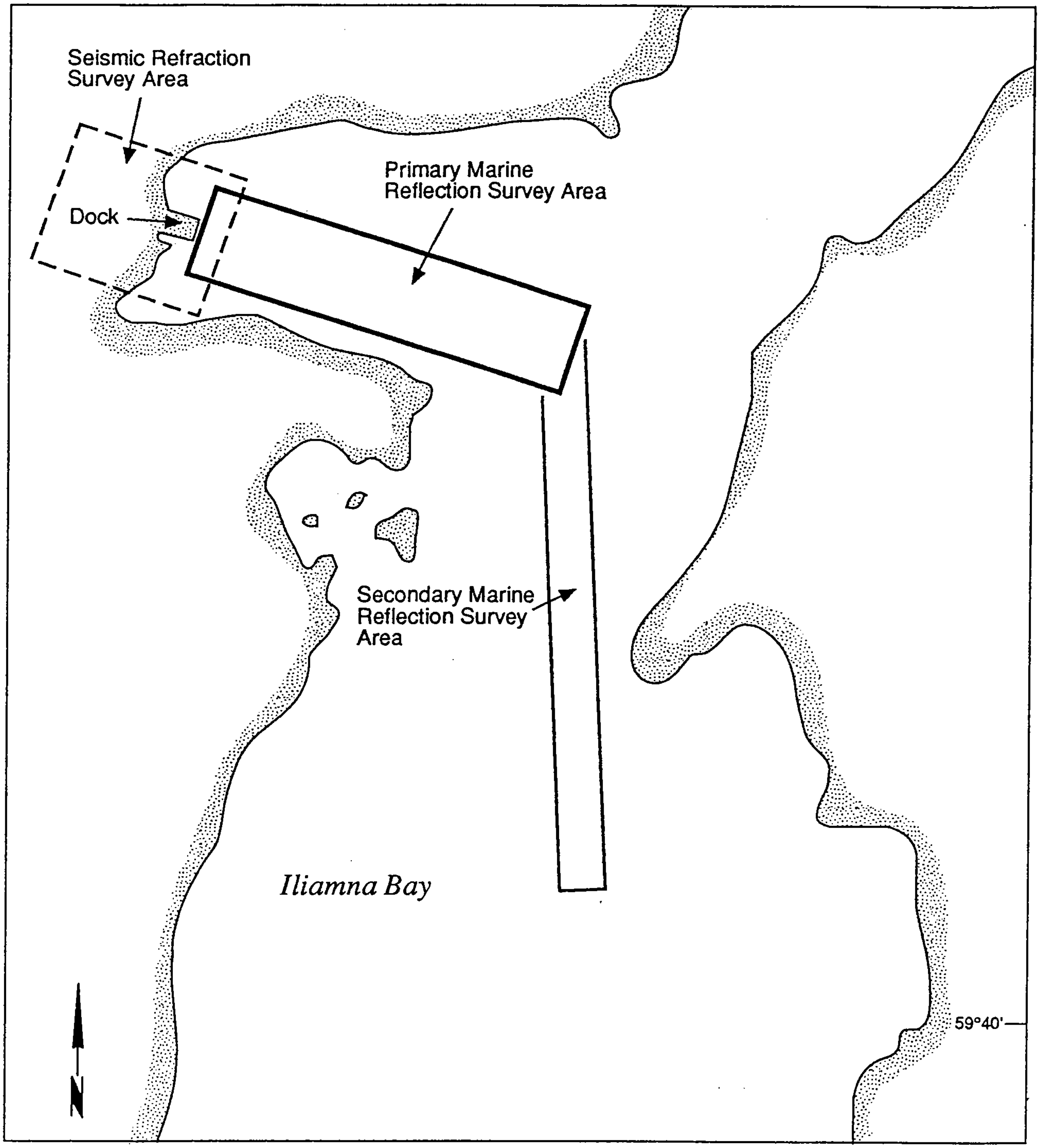
Robert G. Dugan, C.P.G.
Associate/Senior Engineering Geologist

Steven R. Thompson, P.E.
Associate/Senior Geotechnical Engineer

RGD/SRT/plb

D/F: RGD-95/52180223.LTR

Golder Associates



Not to Scale

FIGURE 1

LOCATION MAP FOR LAND REFRACTION AND MARINE REFLECTION SURVEY, WILLIAMSPORT, ALASKA

ACOE/WILLIAMSPORT/AK

PROJECT NO. 943 5218.010 DRAWING NO. 55252 DATE 1/6/95 DRAWN BY CB

Golder Associates

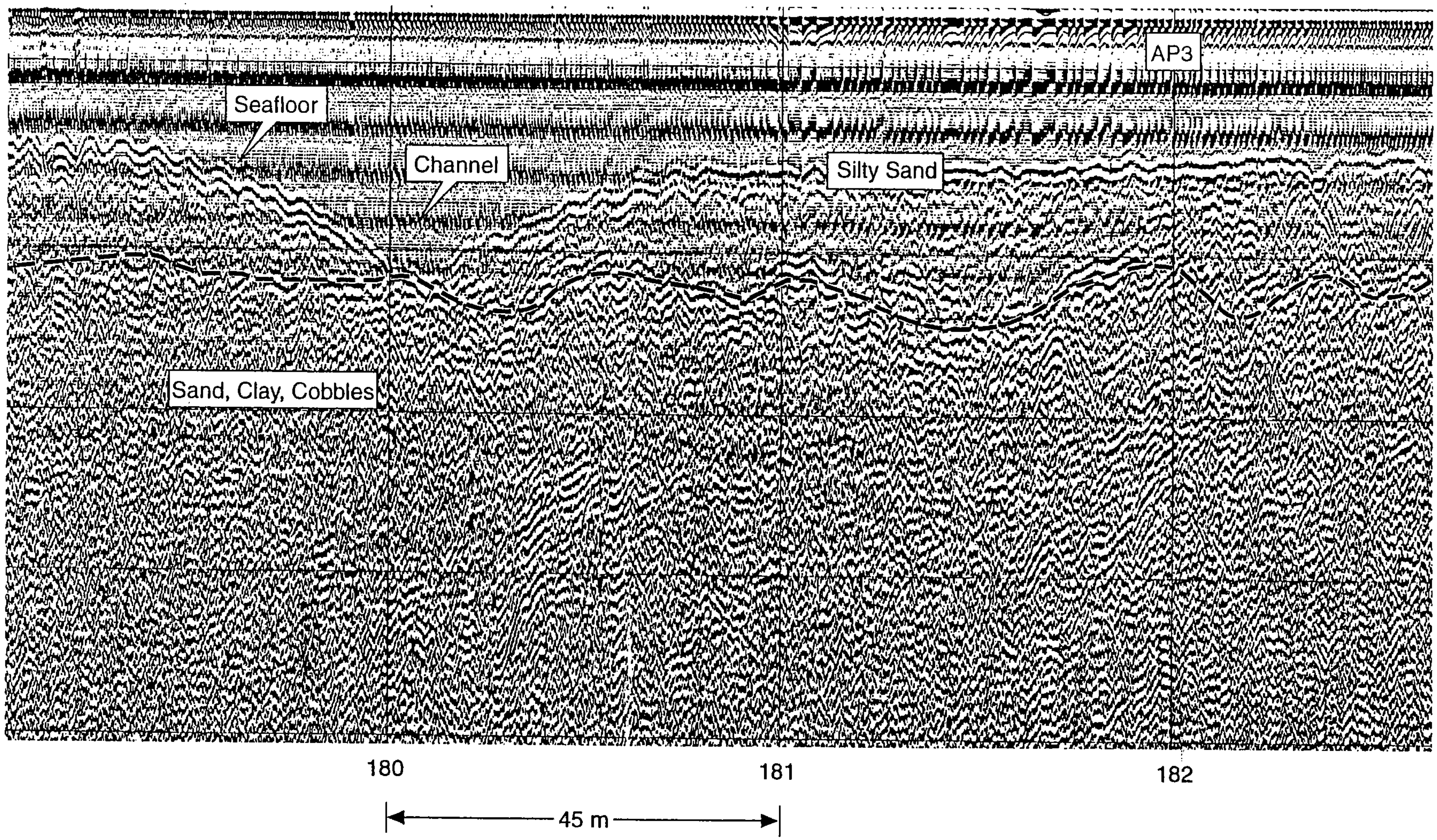


FIGURE **2**
SBP RECORD
WILLIAMSPORT, ALASKA
ACOE/WILLIAMSPORT/AK

PROJECT NO. 943 5218.010 DRAWING NO. 55264 DATE 1/19/95 DRAWN BY CB

Golder Associates

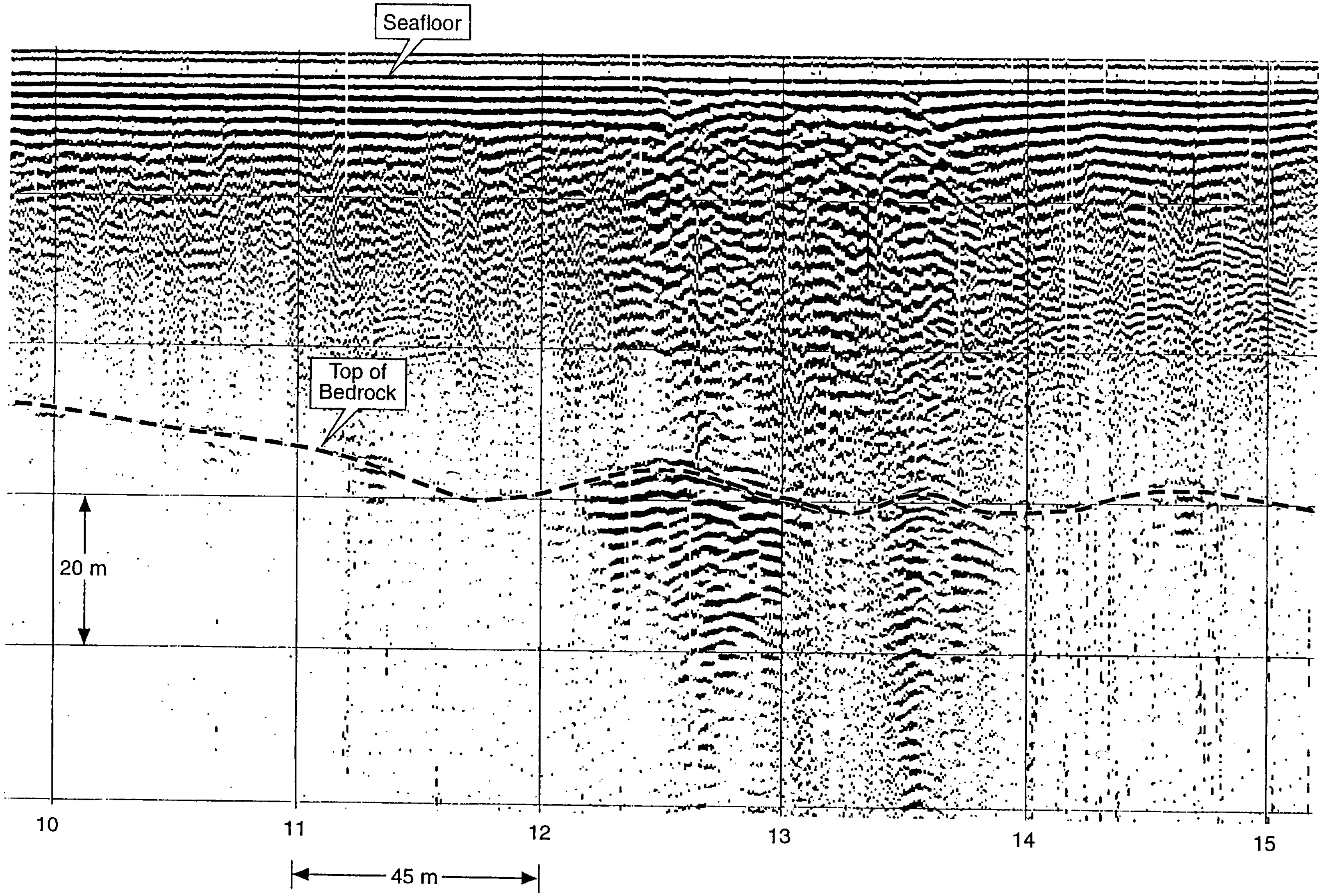


FIGURE 3
CONTINUOUS SEISMIC REFLECTION RECORD
WILLIAMSPORT, ALASKA
ACOE/WILLIAMSPORT/AK

PROJECT NO. 943 5218.010 DRAWING NO. 55265 DATE 1/19/95 DRAWN BY CB

Golder Associates

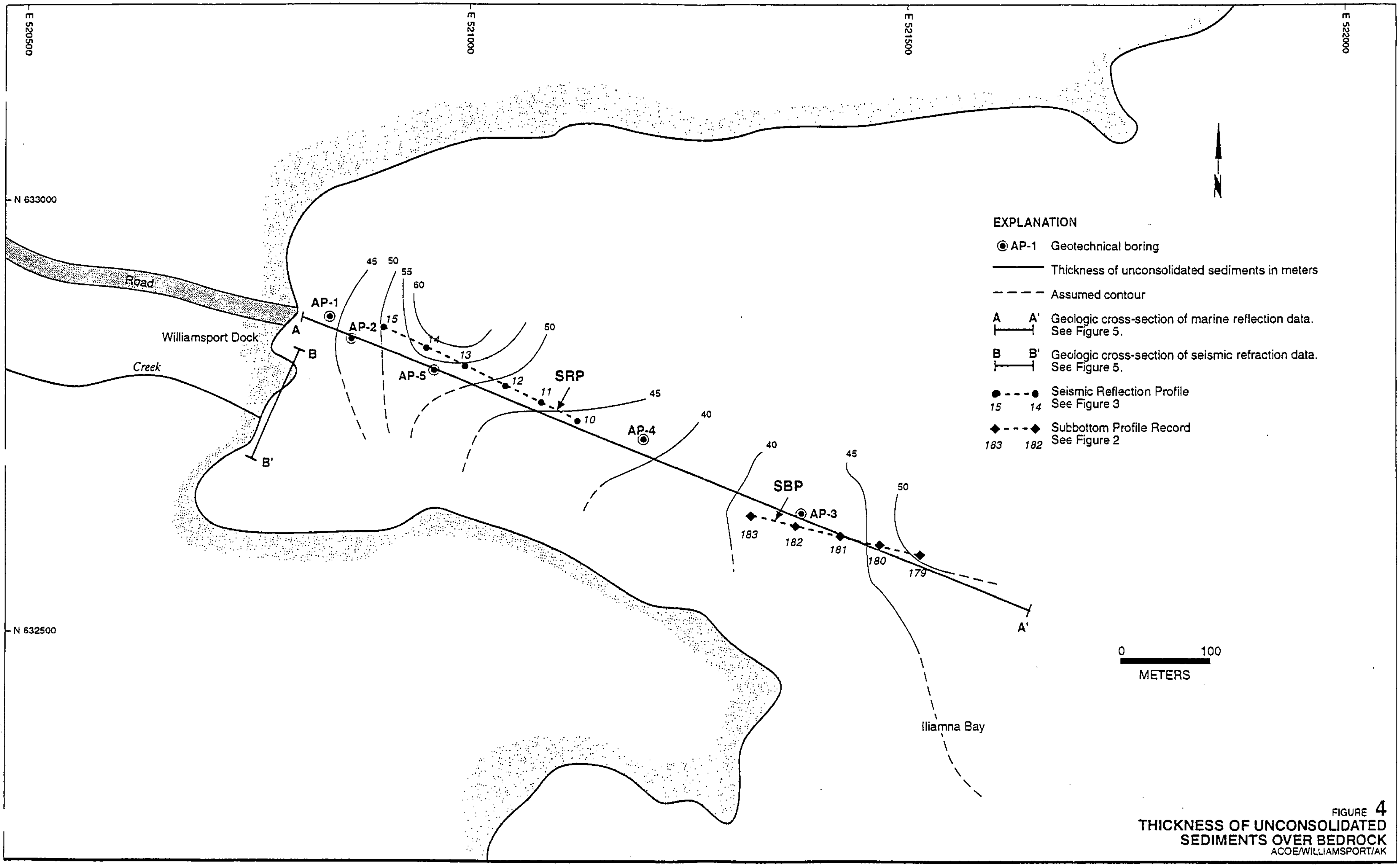
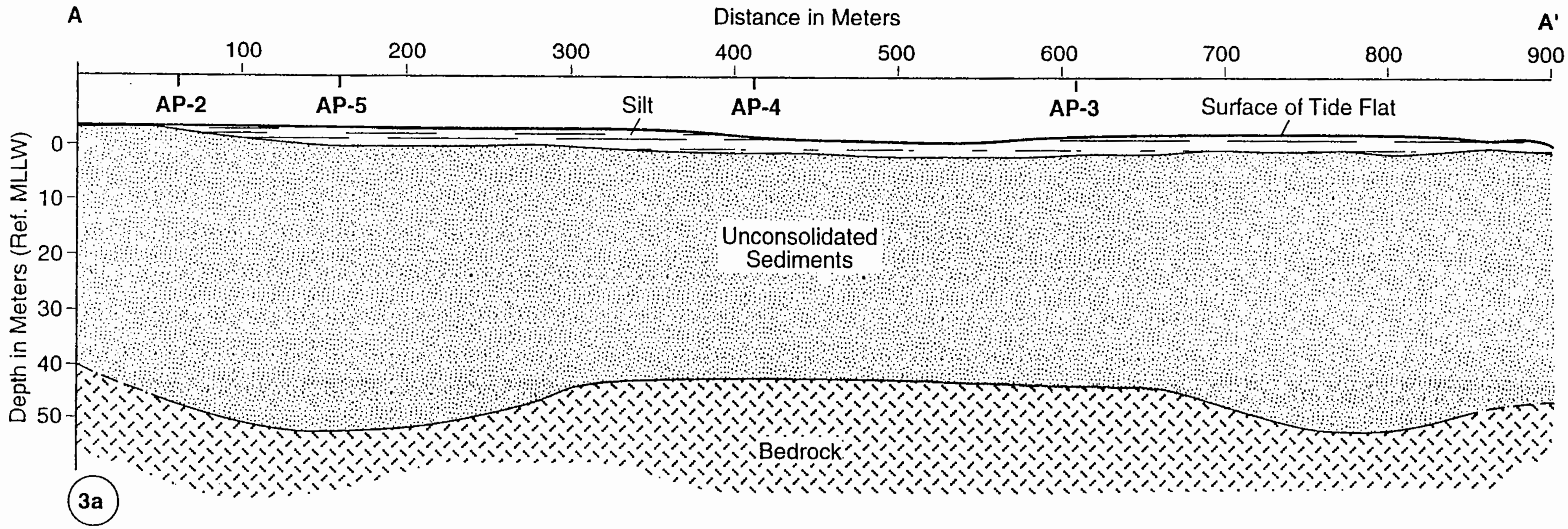
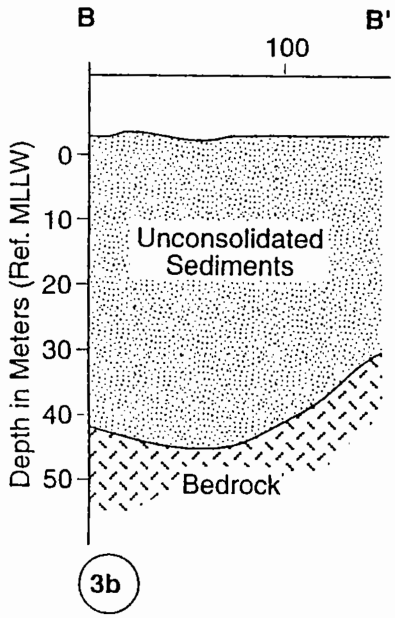


FIGURE 4
THICKNESS OF UNCONSOLIDATED SEDIMENTS OVER BEDROCK
ACOE/WILLIAMSPORT/AK

PROJECT NO. 943 5218.010 DRAWING NO. 50502 DATE 1/20/95 DRAWN BY EA

Golder Associates





LEGEND

AP-5 Geotechnical Borings

Notes:

- See Figure 4 for location of cross sections
- Depth and elevations are referenced to mean lower low water

0 100
METERS

FIGURE 5

INTERPRETED CROSS SECTIONS FROM SEISMIC REFLECTION DATA (3a) AND SEISMIC REFRACTION DATA (3b)

ACOE/WILLIAMSPORT/AK

PROJECT NO. 943 5218.010 DRAWING NO. 55253 DATE 1//95 DRAWN BY CB

Golder Associates

Geotechnical Studies

Part 3:
Final Chemical Report, Williamsport, Alaska
(Alaska District, Corps of Engineers)

FINAL CHEMICAL REPORT

WILLIAMSPORT

ALASKA

PREPARED BY

ALASKA DISTRICT ARMY CORPS OF ENGINEERS

MATERIALS AND INSTRUMENTATION SECTION

GEOTECHNICAL BRANCH

SEPTEMBER 1994

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1.0 EXECUTIVE SUMMARY

This report presents the results of a chemical and geotechnical investigation performed by the Materials and Instrumentation Section, Geotechnical Branch, Engineering Division, Alaska District, U.S. Army Corps of Engineers (CENPA-EN-G-MI). This sampling effort was performed for the Alaska District, Engineering Division, Civil Works Branch, Project Formation Section (CENPA-EN-CW-PF) to investigate the possible chemical contamination of the sediment and secondly, to geotechnically characterize the sediment in the proposed construction project.

Samples were collected from 15 sites and chemical analyses report the following detections. Total Recoverable Petroleum Hydrocarbons (TRPH) were detected in only one sample (94WISP05SD; quality assurance (QA)) and in the laboratory method blank for this sample. The laboratory method blank detection results in this data being unacceptable. Of the sixty-five volatile organic compounds (VOC's) analyzed, only three common laboratory compounds were detected: acetone and 2-butanone (MEK), 68 ppb and 15 ppb respectively. These compounds were found in only one sample (94WISP01SD; Channel A.) The third analyte, methylene chloride (7.8 ppb), was found in sample 94WISP05SD and the laboratory blank. No other volatile organic compounds were detected in any sample. These compounds are common laboratory contaminats. No levels of any semivolatile organic compounds were detected in any samples. No polychlorinated biphenyls (PCB's) are detected in any sediments. Arsenic, barium, chromium and lead were detected in every sample; all at levels below the most stringent chemical criteria of the State of Washington, Department of Ecology, Marine Sediment Quality Standards-Chemical Criteria, Sediment Management Standards, Chapter 173-204 WAC, April, 1991. Washington State Department of Ecology has the only known regionally published sedimentation criteria. Cadmium, mercury, selenium and silver were not detected in any sample. Samples ranged from 61.9% to 75.5% total solids and were almost always classified as sandy silt or silt or silt with sand. Overall, primary data is acceptable. Some data from the quality assurance (QA) laboratory (VOCs and TRPH) are not acceptable due to laboratory cross contamination and high relative percent differences. Barium data from the quality assurance laboratory should be considered an estimate and low levels of selenium may not have been detected.

The sediment collected at the proposed construction project at Williamsport, AK, is acceptable for disposal as defined by the Tier II Criteria listed in the jointly authored, U. S. Army Corps of Engineers and U. S. Environmental Protection Agency document EPA-503/8-91/001, Evaluation Of Dredged Material Proposed For Ocean Disposal, February, 1991. This material is suitable for open water disposal at the designated disposal site.

2.0 INTRODUCTION

2.1 Authority

The U.S. Army Corps of Engineers (USACE), Alaska District, Civil Works Branch, Planning Formation Section (CENPA-EN-CW-PF), requested that an investigation be performed at a proposed construction project by the Alaska District, U.S. Army Corps of Engineers Geotechnical Branch, Materials and Instrumentation Section (CENPA-EN-G-MI). The purpose of the investigation was to analyze the sediment for geotechnical and chemical characterization at the proposed construction site. CENPA-EN-G-MI was responsible for the development of a Sampling and Analysis Plan to include, a Quality Assurance Program Plan (QAPP) and a Site-Specific Health and Safety Plan (SSHSP). The Sampling and Analysis Plan meets the requirements of the Environmental Protection Agency (EPA), the Alaska Department of Environmental Conservation (ADEC), and the United States Army Corps of Engineers (USACE).

The U. S. Army Corps of Engineers has been regulating activities in the nation's waters since 1890. Until the 1960's, the primary purpose of the U.S. Army Corps of Engineers was to protect navigation. Since then, as a result of laws and court decisions, the Corps of Engineer's scope has been broadened so that now the full public interest for both the protection and utilization of water resources is considered. Authority is authorized by the National Environmental Policy Act, the Coastal Zone Management Act, the Fish and Wildlife Coordination Act, the Endangered Species Act, the National Historic Preservation Act, the Deepwater Port Act, the Federal Power Act, the Marine Mammal Protection Act, the Wild and Scenic Rivers Act, and the National Fishing Enhancement Act of 1984.

3.0 BACKGROUND

3.1 Project Location

Williamsport is located on Cook Inlet, in southcentral Alaska, about 200 miles southwest of Anchorage, on the western shore of Iliamna Bay. Williamsport is situated at the mouth of Williams Creek and is surrounded by the cliffs and rock buttresses of the Chigmit Mountains of the Aleutian Range. These mountains rise to heights of 2,000 to 3,000 feet within a mile from the shore. The project site is the eastern terminus of the 15.5 mile Williamsport-Pile Bay Road which is owned and maintained by the State of Alaska. This road connects Cook Inlet at Williamsport to Pile Bay on the eastern shore of Lake Iliamna. Illustrations, Figures 1 and 2, provide a site vicinity and location map.

3.2 Site History

Williamsport is used for the transport of cargo bound for Iliamna Lake, its tributaries or the Bristol Bay communities. Williamsport has no permanent occupants or residences of any kind.

Five villages; Iliamna, Newhalen, Pedro Bay, Kakhanok and Igiugig lie along the shores of 75 miles long, 20 mile wide Lake Iliamna. Nondalton, 15 miles north of Iliamna on the Newhalen River, is connected by road to Iliamna and depends on air and waterborne cargo. These villages are all accessible by wheel and float plane, but have no roads to major economic centers. Iliamna is the air freight center for the Iliamna Lake communities. Freight is distributed to communities around Lake Iliamna by Moody's Barge Service which also navigates Kvichak River and delivers freight arriving in Bristol Bay. Pedro Bay is accessible via the Williamsport-Pile Bay road from Iliamna Bay on Cook Inlet. Iliamna and Newhalen are connected by road and all areas of Iliamna Lake are served by local barge and landing craft services.

The Williamsport-Pile Bay Road is used for trailering salmon gill-netter commercial fishing vessels from Williamsport to Iliamna Lake. The vessels then motor across Lake Iliamna, continue down the Kvichak River and enter into Bristol Bay. This route reduces travel time from Cook Inlet by several days and 1,100 miles of hazardous waters. As a consequence of the Williamsport-Pile Bay Road, Bristol Bay gill netters are provided access to protected mooring sites in Cook Inlet and Lake Iliamna, plus avoid crossing the dangerous open waters of the Gulf of Alaska, the Bering Sea and western Bristol Bay.

Economies of the Lake Iliamna area are based on commercial salmon fishing, sport fishing, hunting and private lodges which guide parties of fishers and hunters. A source for quarry rock exists at Williamsport as well as substantial deposits of copper ore. Copper-gold prospecting is conducted a few miles north of Iliamna by Cominco's Exploration Pebble Beach. In surrounding areas there are other mineral deposits.

4.0 FIELD INVESTIGATION SUMMARY

4.1 Objectives

The objectives of this sampling event were to collect chemical and geotechnical samples thereby providing data that would characterize the channel area sediments and aid in construction operations. The objectives of this investigative activity were the:

-- collection of eighteen sediment samples within the proposed construction limits

-- record physical water quality parameters: pH, temperature, conductivity, salinity, oxidation-reduction potential and dissolved oxygen at the sample collection sites

-- collection of samples and resultant data to be compliant with state and federal agencies

-- produce data of such quality that the chemical and geotechnical analyses can be used to prepare disposal plume models to assist in the determination of disposal options of the dredged material

-- produce chemical and geotechnical characterization of the proposed harbor, channel and disposal site sediments in order to facilitate proposed construction and maintenance dredging operations

Sampling sites were selected to provide an overall evaluation of the sediment quality within the dredging limits. Sampled dredging locations were tested using a Two Tiered approach and analytical methods employed are listed in Appendix A, Table 1-5.

4.2 Summary of Field Work

This sampling event began on 23 May, 1994 and ended on 27 May, 1994. The field crew consisted of Lizette Boyer, CENPA-EN-CW-ER, biologist, Harvey Smith, State of Alaska, Department of Transportation, coastal engineer and Barbara Reilly, CENPA-EN-G-MI, chemist.

Illustrations, Figure 1, provides a project location map; Figure 2 supplies a project site map. Figure 3 shows the sampling locations for sediment classifications and Figure 4 illustrates the locations of the samples collected for chemical and classification purposes. Geotechnical classification and chemical analysis data of this project are on file in CENPA-EN-G-MI and are included with this report in Appendice C.

All samples were collected in accordance with the procedures specified in the work plan (Ref. 6h.) with deviations listed below.

a) The complete battery of planned samples were not collected due to:

-- Logistical difficulties
-- Delays created by inclement weather
-- Engine failure of the sampling vessel
-- Premature termination of the field event

-- Rinsates were not prepared because samples were collected at low tide using only dedicated sampling equipment and for reasons listed above

One quality assurance (QA) and one quality control (QC) sample was collected at site Channel E. This site was selected as the QA/QC site because the material is representative of the area. The QC sample is a blind duplicate of the project sample, as is the QA sample. No proposed upland sites were considered or sampled.

TABLE 1

SAMPLING AT WILLIAMSPORT

Number of Samples Location	Method	Matrix	# QA/QC
Tier I Testing:			
15	Gradations (ASTM D 2487)	Sediment	0/0
15	Particle Size (ASTM D 422)	Sediment	0/0
Tier II:			
3	Total Metals (Method 3050)	Sediment	1/1
3	8 RCRA Metals (Series 6000-7000s)	Sediment	1/1
3	Semivolatile Organics (Method 8270)	Sediment	1/1
3	Volatile Organics (Method 8260)	Sediment	1/1
3	Pesticides and PCBs (Method 8080)	Sediment	1/1

4.3 Sampling Activities

The table above lists the number of samples submitted for chemical analysis and sediment classification, the method of analyses requested, matrix and the number of quality assurance and quality control samples. Appendix A, Table 5, lists the sample number, the water content, the soil classification, and the percentage of gravel, sand and fines in each sample. Appendix C, Report of Soil Analysis, #2 states " Results for remaining 23 samples will be forwarded when available." This is a point of confusion on the part of the laboratory as the 23 remaining samples were collected by the Soils Section of CENPA-EN-G-SG, and are on file in that office. Chemical sediment samples were obtained from each major area of Williamsport significant to the project's design and construction: the northern terminus of the channel (Channel A), the southern end of the channel (Channel E) and the open water disposal site.

Tabulated summary tables of the analytical data are provided in Appendix A, in the following order:

Series 6000-7000s 3050 Extraction	8 Resource Conservation and Recovery Act Metals	Table 1
Method 418.1	Total Recoverable Petroleum Hydrocarbons	Table 1
Method 160.3	Percent Solids	Table 1
Method 8080	Pesticides and Polychlorinated Biphenyls	Table 2
Method 8260	Volatile Organic Compounds	Table 3
Method 8270	Semivolatile Organic Compounds	Table 4
ASTM D 2487	Soils Classification	Table 5

4.4 Summary of Observations

Mud flats stretch for considerable distance throughout the project area and surrounding regions making them characteristic of the entire territory. The shoreline and channel sediments are a dark charcoal grey color and are composed of fine sands, silts and clays. No sheen was visible in the sediments or water and both appeared uncontaminated. Aquatic life in the littorial zone was negligible; even worms were absent. During sample collection, no intertidal life was retrieved with the sediments. This area is battered by fierce storms.

4.5 Laboratory Assignments

Quality assurance (QA) and quality control (QC) duplicates comprised one third of the project samples. The primary and quality assurance laboratories were Columbia Analytical Services Inc., Kelso, WA (CAS) and National Environmental Testing, Santa Rosa, CA (NET) respectively.

The data and associated materials were reviewed by chemists at the Corps of Engineers North Pacific Division Laboratory (CENPD-PE-GE-L) to evaluate the data quality. The resultant Quality Assurance Report (QAR) is provided in Appendix B. All project data are acceptable. Quality assurance data for three volatile organic analytes and TRPH are not acceptable and selenium may not have been detected if it was presence at low levels. Primary laboratory data for selenium is suspect also. Barium data should be considered an estimate. All data agree and are comparable (Ref. 6b). The Soils Classifications Report is enclosed in Appendix C.

4.6 Description of Appendices

This memorandum includes the four appendices listed below:

Illustrations
A. Chemical Results, In Summary Table
B. Quality Assurance Report
C. Soils Classification

Illustrations:	Figure 1	Project Location Map
	Figure 2	Project Site Map
	Figure 3	Sample Locations-Sediment Classification Only
	Figure 4	Sample Locations-Chemical and Sediment Classification

Appendix A: Chemical Results, in Summary Tables
Appendix A presents data collected from chemical analyses.

Appendix B: Quality Assurance Report

Appendix C: Soils Classification

5.0 SUMMARY OF FINDINGS

Data from the chemical analyses are provided in Appendix A Tables 1-4. Each table summarizes the chemical data for one test method. No pesticides or polychlorinated biphenyls were detected in any sample. Three out of 65 volatile organic compounds were detected in the sediments, all at levels below the State of Washington, Department of Ecology, Sediment Management Standards Minimum Clean-Up Levels-Chemical Criteria and all attributable to laboratory contamination. Washington State, Department of Ecology, has the only regionally published sediment criteria. Semivolatiles were not detected in any sample. No cadmium, mercury, selenium or silver was detected in any sample. Detected metals (arsenic, barium, chromium and lead) are all below the State of Washington, Department of Ecology, Sediment Management Standards Minimum Clean-Up Levels-Chemical Criteria. Total recoverable petroleum hydrocarbons (TRPH) were detected in one sample and are attributed to laboratory contamination as the hydrocarbons were found in the laboratory method blank as well. The sediments vary in classification from sandy silt to poorly graded gravel. All primary laboratory data is acceptable and all comparisons agree. Quality assurance data is not acceptable for three volatile organic compound analytes or TRPH.

a. EIGHT RESOURCE AND RECOVERY ACT METALS (8 RCRA), TOTAL RECOVERABLE PETROLEUM HYDROCARBONS (Method 418.1), TABLE 1:

EIGHT RESOURCE AND RECOVERY ACT METALS (8 RCRA), TABLE 1:
No cadmium, mercury, selenium or silver were detected in any sediment sample. The highest levels of arsenic, lead, barium and chromium were detected at 11 ppm, 13 ppm, 158 ppm, and 13 ppm respectively, all well below the Sediment Management Standards, Chapters 173-204 WAC, Washington State, Department of Ecology, Designated Minimum Clean-Up Levels-Chemical Criteria, on a dry weight basis, for the four detected RCRA metals are listed below.

Washington State Department of Ecology Sediment Management Standards (ppm)		Williamsport 1994 Investigation Levels Detected (ppm)	
Arsenic	93 ppm	Arsenic	11 ppm
Barium	Not Listed	Barium	158 ppm
Chromium	270 ppm	Chromium	46 ppm
Lead	530 ppm	Lead	13 ppm

Washington State, Department of Ecology, has the only regionally published sediment criteria.

TOTAL RECOVERABLE PETROLEUM HYDROCARBONS (Method 418.1), TABLE 1:
Total Recoverable Petroleum Hydrocarbons (TRPH) analysis detects the levels of recoverable biogenic and non-biogenic petroleum hydrocarbons in the sediment. No TRPHs were detected in any sample except for the quality assurance sample 94WISP05SD; Channel E (64 ppm). However, the quality assurance datum is unacceptable due to laboratory contamination and high relative percent differences (RPD) (Ref. 6b). The non-detection of recoverable petroleum hydrocarbons demonstrates the absence of organics in the sediment of this area, since this methodology targets both biogenic and non-biogenic petroleum hydrocarbons. This non-detection of TRPH in the sediments is substantiated by visual inspection of the sediment in the field where no supra-littorial, littorial or sub-littorial biota were observed.

TOTAL SOLIDS (METHOD 160.3), TABLE 1:
This procedure is conducted twice on the sample; once for the portion used for volatile organic compounds analysis and once again for the portion of the sample used for other requested

analyses. The highest percentage of total solids for non-volatile organic compounds analyses was 75.5% (Open Water; 94TWISP07SD) while the lowest reported is 61.9% (Channel A; 94WISP01SD).

b. PESTICIDES AND POLYCHLORINATED BIPHENLYS- METHOD 8080, TABLE 2:
No organochlorine pesticides or polychlorinated biphenyls were detected in any sample. The primary laboratory data and the quality assurance data agree with each other and are acceptable.

c. VOLATILE ORGANIC COMPOUNDS-METHOD 8260- TABLE 3:
Only two targeted analytes out of sixty-five were found in the analyses for volatile organic compound by the primary laboratory, Columbia Analytical Services, Kelso, WA (CAS). Acetone and 2-butanone were found in one sediment sample (94WISP01SD; 68 ppb and 15 ppb respectively). Methylene chloride was found in a second sample (94WISP05SD; 7.8 ppb) and the laboratory method blank. The presence of acetone and 2-butanone in the soil samples should be attributed to laboratory contamination as these two compounds are common laboratory compounds. Methylene chloride is also a common extraction agent and its appearance in the laboratory blank supports a conclusion of laboratory contamination. Tentatively identified compounds (TICs) were few in number and low in concentration, ranging from 4 TICs with a concentration of 128 ppb (Channel A-94WISP01SD) to 10 TICS detected at 318 ppb (Open Water-94WISP07SD). TICs, tentatively identified compounds, are compounds which are detected but cannot be unequivocally identified as specifically named compounds.

d. SEMIVOLATILE ORGANIC COMPOUNDS-METHOD 8270, TABLE 4:
Semivolatiles were not detected in any sediment. TICs were few in number and low in concentration, ranging from 3 TICs with a concentration of 1.8 parts per million (Open Water-94WISP07SD) to 15 TICs totaling 14.8 ppm (Channel E-94WISP06SD). The quality assurance sample (94WISP05SD) had the highest concentration of TICS (2.2 ppm).

e. SOILS CLASSIFICATIONS (ASTM D 2487/422), TABLE 5:
Sediment samples for classification were collected throughout the length of the proposed Williamsport channel and Iliamna and Cottonwood Bay (See Figures 3 and 4). Sediment classifications are presented in Appendix A, Table 5. Samples -01 (Channel A), -05(Channel E), -07 (Open Water), -91, -92, -95, -97, -98 were collected from the proposed main channel and consist primarily of silts, clays and clayey gravel with sand. Samples -41, -42, -46, -48, -51, -52 were collected from Iliamna and Cottonwood Bay and are composed of sandy silt, silt, silt with sand and one sample of poorly graded gravel.

6.0 REFERENCES

The following documents were used in writing this report:

a. CC:MAIL, CENPA-EN-CW-PF, 16 Mar 94, Subject: Ocean Water and Sediment Measurements, Williamsport, AK.

b. Memorandum CENPD-PE-GE-L dated 1 Jul 94, Subject: W. O. 94-288, Results of Chemical Analysis, Williamsport, AK.

c. Memorandum CENPA-PE-GE-L dated 16 Jun 94, Subject: W.O. 94-288, Report of Soils Analysis, Williamsport, AK.

d. U.S. Army Corps of Engineers, ER 1110-1-263, Chemical Data Quality Management for Hazardous Waste Remedial Activities, 1 October, 1990.

e. U. S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Test Methods for Evaluating Solid Wastes, SW-846, Third Edition, November 1986.

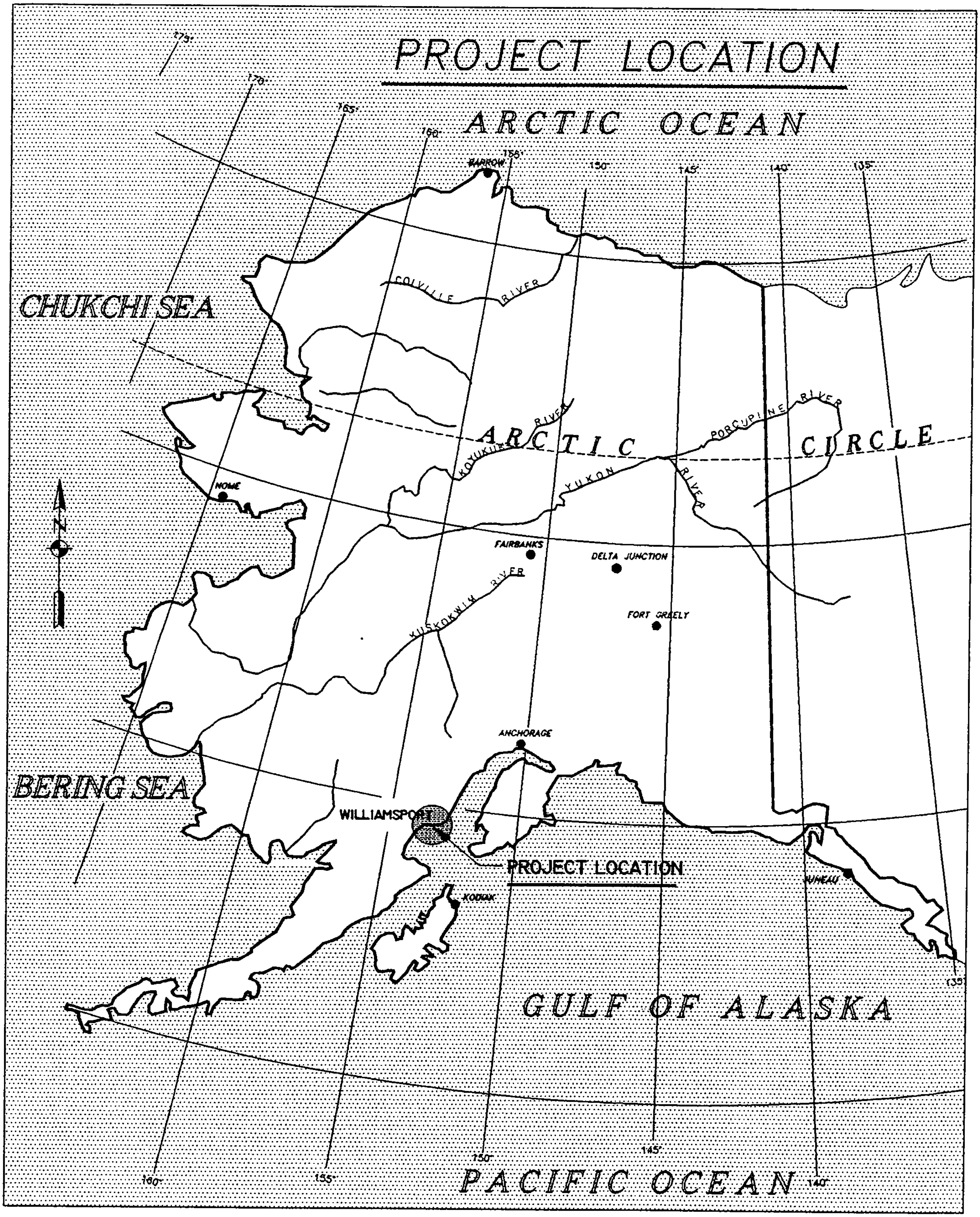
f. U. S. Army Corps of Engineers, Sample Handling Protocol for Low, Medium and High Concentration Samples of Hazardous Waste, October, 1986.

g. Memorandum CENPA-EN-G-MI, dated 18 Mar 94, Subject: Budget, Williamsport, AK.

h. Memorandum CENPA-EN-G-MI dated 12 Apr 94, Subject: Work Plan for Williamsport, AK.

i. Environmental Protection Agency, EPA-823-B-94-002, Evaluation of Dredged Material Proposed For Discharge In Waters of the U.S.-Testing Manual (Draft), June, 1994.

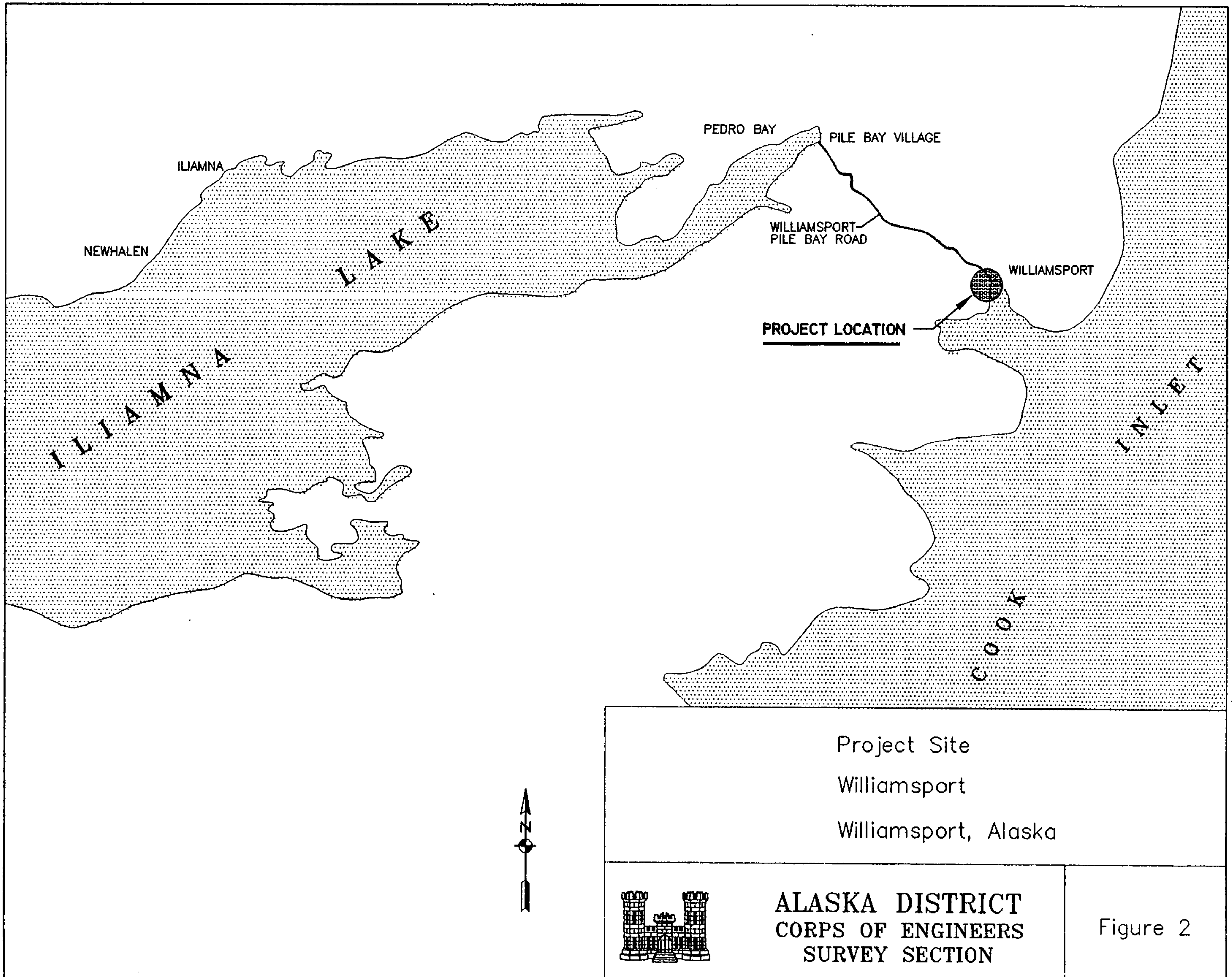
j. Environmental Protection Agency, EPA-503/B-91-001, Evaluation of Dredged Material Proposed For Ocean Disposal, February, 1991.



ALASKA DISTRICT CORPS OF ENGINEERS SURVEY SECTION	Figure 1 Project Location Williamsport Williamsport, Alaska	SCALE: DATE: DWG. NO.

CORPS OF ENGINEERS

U.S. ARMY



Project Site

Williamsport

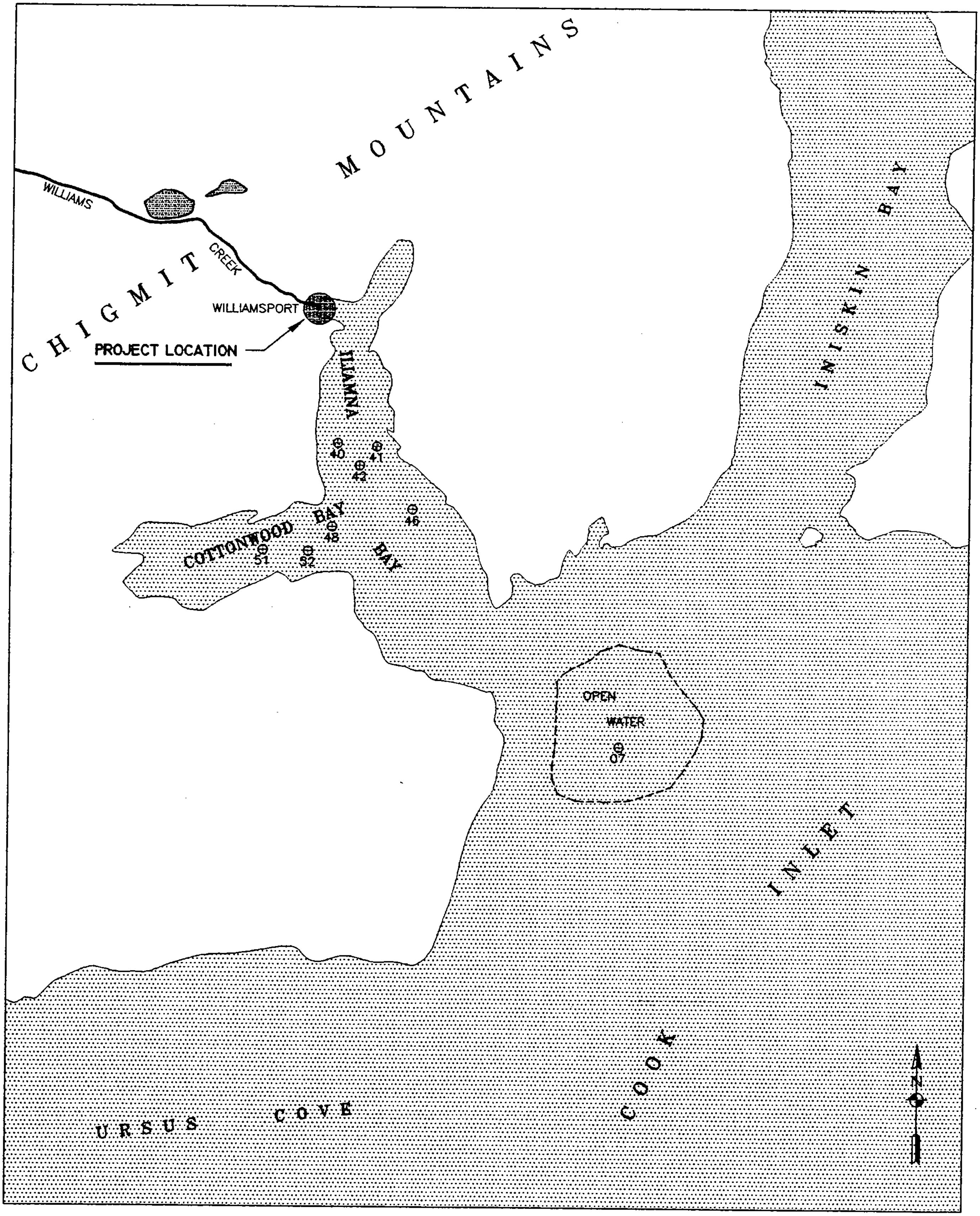
Williamsport, Alaska

ALASKA DISTRICT
CORPS OF ENGINEERS
SURVEY SECTION

Figure 2

CORPS OF ENGINEERS

U.S. ARMY



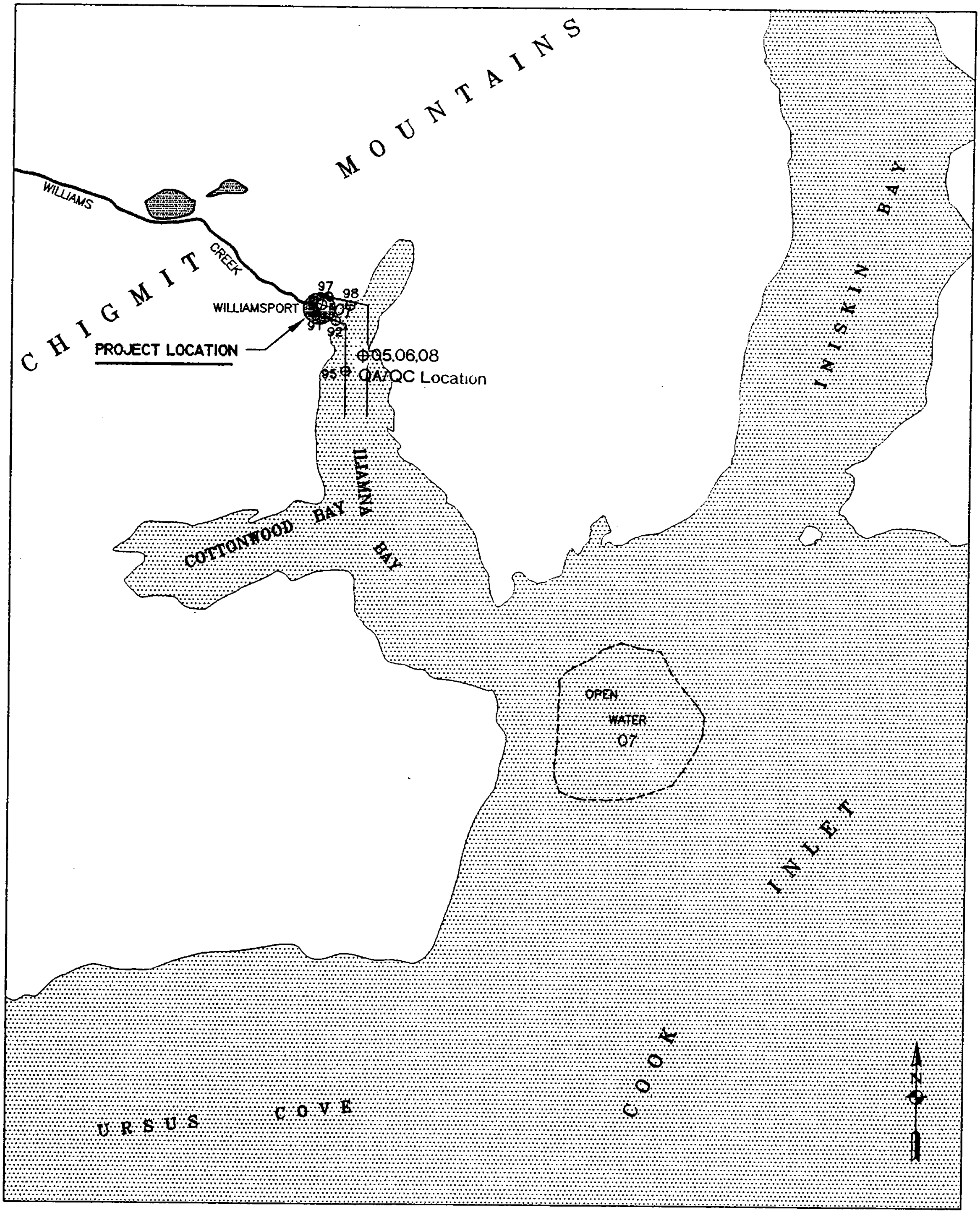
ALASKA DISTRICT
CORPS OF ENGINEERS
SURVEY SECTION

Figure 3
Sample Locations
Williamsport, Alaska

SCALE:	N.T.S.
DATE:	AUG. 1994
DWG. NO.	

CORPS OF ENGINEERS

U.S. ARMY



ALASKA DISTRICT
CORPS OF ENGINEERS
SURVEY SECTION

Figure 4
Soil Sampling Sites
Williamsport, Alaska

SCALE: N.T.S.
DATE: AUG. 1994
DWG. NO.

Table 1

Williamsport
8 RCRA Metals
Total Recoverable Hydrocarbons (TRPH)
Method 418.1
% Total Solids & % Total Solids (VOC)
Method 160.3
June, 1994

				QA DUP	QC DUP
LOCATION:	Channel A	Open Water	Channel E	Channel E	Channel E
DATE OF SAMPLING:	5/25/94	5/25/94	5/25/94	5/25/94	5/25/94
TYPE OF SAMPLE:	sediment	sediment	sediment	sediment	sediment
FIELD SAMPLE #:94WISP-	01SD	07SD	08SD	05SD	06SD
TESTING LABORATORY:	CAS	CAS	CAS	NET	CAS
LABORATORY SAMPLE #:	K328804	K328801	K328803	195885 &4~	K328802
DATE RECEIVED:	6/01/94	6/01/94	6/01/94	6/02/94	6/01/94
DATE TESTED:	NR	NR	NR	6/08-09/94	NR
CONCENTRATION UNITS:	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Arsenic	11	6	10	11	10
Barium	158	78	121	96 *	120
Cadmium	ND (1)	ND (1)	ND (1)	ND (2.9)	ND (1)
Chromium	46	20	34	26	34
Lead	13	5	8	7.2	8
Mercury	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.1)	ND (0.2)
Selenium +	ND (1)	ND (1)	ND (1)	ND (0.7) **	ND (1)
Silver	ND (2)	ND (2)	ND (2)	ND (2.9)	ND (2)
Total Recoverable Petroleum Hydrocarbons (TRPH)	ND (20) a	ND (10)	ND (20) a	64 b	ND (20) a
CONCENTRATION UNITS:	%	%	%	%	%
Total Solids	61.9	75.5	64.4	68.5	64.9
Total Solids (VOC)	62.5	74.2	64.2	70.1~	68.3

CAS: Columbia Analytical Service, Kelso, WA.
NET: National Environmental Testing, Santa Rosa, CA.
The value in the parentheses is the Method Reporting Limit (MRL).
ND: Not Detected
a: MRL is elevated because of the low percent solids in the sample as received.
b: Analyte found in blank and sample.
**: Matrix spikes out of control, post digestion spike in control.
*: RPD between sample duplicates exceeds 20 %.
~: Denotes use of a different sample number by the laboratory.
+: This data is suspect.

Table 2

Williamsport
Method 8080
Pesticides and Polychlorinated Biphenyls (PCB's)
June, 1994

				QA DUP	QC DUP
LOCATION:	Channel A	Open Water	Channel E	Channel E	Channel E
DATE OF SAMPLING:	5/25/94	5/25/94	5/25/94	5/25/94	5/25/94
TYPE OF SAMPLE:	sediment	sediment	sediment	sediment	sediment
FIELD SAMPLE #:94WISP-	01SD	07SD	08SD	05SD	06SD
TESTING LABORATORY:	CAS	CAS	CAS	NET	CAS
LABORATORY SAMPLE #:	K328804	K328801	K328803	195885	K328802
DATE RECEIVED:	6/01/94	6/01/94	6/01/94	6/02/94	6/01/94
DATE TESTED:	6/21/94	6/21/94	6/21/94	6/17/94	6/21/94
CONCENTRATION UNITS:	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
alpha-BHC	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.0004)	ND (0.01)
beta-BHC	ND (0.03)	ND (0.03)	ND (0.03)	ND (0.0004)	ND (0.03)
delta-BHC	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.0004)	ND (0.01)
Heptachlor	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.004)	ND (0.01)
Aldrin	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.0018)	ND (0.01)
gamma-BHC (Lindane)	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.0018)	ND (0.01)
Heptachlor epoxide	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.004)	ND (0.01)
Endosulfan I	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.004)	ND (0.01)
Endrin	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.004)	ND (0.01)
Endosulfan II	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.004)	ND (0.01)
4,4'-DDD	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.004)	ND (0.01)
Endrin aldehyde	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.004)	ND (0.01)
Endosulfan sulfate	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.004)	ND (0.01)
4,4'- DDT	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.004)	ND (0.01)
4,4'-DDE	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.004)	ND (0.01)
Dieldrin	ND (0.01)	ND (0.01)	ND (0.01)	ND (0.004)	ND (0.01)
Methoxychlor	ND (0.02)	ND (0.02)	ND (0.02)	ND (0.007)	ND (0.02)
Toxaphene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.088)	ND (0.3)
Chlordane	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.036)	ND (0.1)
Aroclor 1016	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.117)	ND (0.1)
Aroclor 1221	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.117)	ND (0.1)
Aroclor 1232	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.117)	ND (0.1)
Aroclor 1242	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.063)	ND (0.1)
Aroclor 1248	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.117)	ND (0.1)
Aroclor 1254	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.073)	ND (0.1)
Aroclor 1260	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.073)	ND (0.1)

CAS: Columbia Analytical Service, Kelso, WA.
NET: National Environmental Testing, Santa Rosa, CA.
The value in parentheses is the Method Reporting Limit (MRL).
ND: Not Detected

Table 3
Williamsport
Volatile Organics Compounds (VOC)
Method 8260
June, 1994

				QA DUP	QC DUP
LOCATION:	Channel A	Open Water	Channel E	Channel E	Channel E
DATE OF SAMPLING:	5/25/94	5/25/94	5/25/94	5/25/94	5/25/94
TYPE OF SAMPLE:	sediment	sediment	sediment	sediment	sediment
FIELD SAMPLE #:94WISP-	01SD	07SD	08SD	05SD	06SD
TESTING LABORATORY:	CAS	CAS	CAS	NET	CAS
LABORATORY SAMPLE #:	K328804	K328801	K328803	195884~	K328802
DATE RECEIVED:	6/01/94	6/01/94	6/01/94	6/02/94	6/01/94
DATE TESTED:	6/07/94	6/07/94	6/07/94	6/07/94	6/07/94
CONCENTRATION UNITS:	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
Acetone	68	ND (50)	ND (50)	ND (14)	ND (50)
Benzene	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
Bromobenzene	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
Bromochloromethane	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
Bromodichloromethane	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
Bromoform	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
Bromomethane	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
2-butanone	15	ND (10)	ND (10)	ND (14)	ND (10)
n-Butylbenzene	ND (20)	ND (20)	ND (20)	ND (7.1)	ND (20)
sec-Butylbenzene	ND (20)	ND (20)	ND (20)	ND (7.1)	ND (20)
tert-Butylbenzene	ND (20)	ND (20)	ND (20)	ND (7.1)	ND (20)
Carbon Disulfide	ND (5)	ND (5)	ND (5)	NR	ND (5)
Carbon Tetrachloride	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
Chlorobenzene	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
Chloroethane	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
Chloroform	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
Chloromethane	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
2-Chlorotoluene	ND (20)	ND (20)	ND (20)	ND (7.1)	ND (20)
4-Chlorotoluene	ND (20)	ND (20)	ND (20)	ND (7.1)	ND (20)
1,2-Dibromo-3-chloropropane	ND (20)	ND (20)	ND (20)	ND (7.1)	ND (20)
1,2-Dibromoethane	ND (20)	ND (20)	ND (20)	ND (7.1)	ND (20)
Dibromochloromethane	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
Dibromomethane	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
1,2-Dichlorobenzene	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
1,3-Dichlorobenzene	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
1,4-Dichlorobenzene	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
Dichlorodifluoromethane	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
1,1-Dichloroethane	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
1,2-Dichloroethane	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
1,1-Dichloroethene	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
cis-1,2-Dichloroethene	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
trans-1,2-Dichloroethene	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
1,2-Dichloropropane	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
1,3-Dichloropropane	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
2,2-Dichloropropane	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
cis-1,3-Dichloropropene	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)

Table 3
Williams Port
Volatile Organics Compounds (VOC)
Method 8260
June, 1994

				QA DUP	QC DUP
LOCATION:	Channel A	Open Water	Channel E	Channel E	Channel E
DATE OF SAMPLING:	5/25/94	5/25/94	5/25/94	5/25/94	5/25/94
TYPE OF SAMPLE:	sediment	sediment	sediment	sediment	sediment
FIELD SAMPLE #:94WISP-	01SD	07SD	08SD	05SD	06SD
TESTING LABORATORY:	CAS	CAS	CAS	NET	CAS
LABORATORY SAMPLE #:	K328804	K328801	K328803	195884~	K328802
DATE RECEIVED:	6/01/94	6/01/94	6/01/94	6/02/94	6/01/94
DATE TESTED:	6/07/94	6/07/94	6/07/94	6/07/94	6/07/94
CONCENTRATION UNITS:	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
1,1-Dichloropropene	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
trans-1,3-Dichloropropene	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
Ethylbenzene	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
Hexachlorobutadiene	ND (20)	ND (20)	ND (20)	ND (7.1)	ND (20)
2-Hexanone	ND (10)	ND (10)	ND (10)	NR	ND (10)
Isopropylbenzene	ND (20)	ND (20)	ND (20)	ND (7.1)	ND (20)
p-Isopropyltoluene	ND (20)	ND (20)	ND (20)	ND (7.1)	ND (20)
Methylene Chloride	ND (10)	ND (10)	ND (10)	7.8 B	ND (10)
4-Methyl-2-pentanone	ND (10)	ND (10)	ND (10)	NR	ND (10)
Naphthalene	ND (20)	ND (20)	ND (20)	ND (7.1)	ND (20)
n-Propylbenzene	ND (20)	ND (20)	ND (20)	ND (7.1)	ND (20)
Styrene	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
1,1,1,2-Tetrachloroethane	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
1,1,2,2-Tetrachloroethane	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
Tetrachloroethene	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
1,2,3-Trichlorobenzene	ND (20)	ND (20)	ND (20)	ND (7.1)	ND (20)
1,2,4-Trichlorobenzene	ND (20)	ND (20)	ND (20)	ND (7.1)	ND (20)
1,1,1-Trichloroethane	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
1,1,2-Trichloroethane	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
Trichloroethene	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
Trichlorofluoromethane	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
1,2,3-Trichloropropane	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
1,2,4-Trimethylbenzene	ND (20)	ND (20)	ND (20)	ND (7.1)	ND (20)
1,3,5-Trimethylbenzene	ND (20)	ND (20)	ND (20)	ND (7.1)	ND (20)
Toluene	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
Vinyl Chloride	ND (5)	ND (5)	ND (5)	ND (7.1)	ND (5)
o-Xylene	NR	NR	NR	ND (7.1)	NR
m- & p-Xylene	NR	NR	NR	ND (7.1)	NR
Total Xylenes	ND (5)	ND (5)	ND (5)	NR	ND (5)
Number of TICs	4	10	4	2	5
Total Concentration of TICs	128	318	141	14	144
Total Concentration of TICs	ND	ND	ND	53 B	ND

NET: National Environmental Testing, Santa Rosa, CA.
CAS: Columbia Analytical Service, Kelso, WA.
The value in parentheses is the Method Reporting Limit (MRL).
ND: Not Detected
NR : Not Reported
~: Sample is a (VOC) result, so sample number is not the same.
B: Analyte found in blank and sample.

Table 4
Williamsport
Method 8270
Semivolatile Organic Compounds
June, 1994

				QA DUP	QC DUP
LOCATION:	Channel A	Open Water	Channel E	Channel E	Channel E
DATE OF SAMPLING:	5/25/94	5/25/94	5/25/94	5/25/94	5/25/94
TYPE OF SAMPLE:	sediment	sediment	sediment	sediment	sediment
FIELD SAMPLE #:94WISP-	01SD	07SD	08SD	05SD	06SD
TESTING LABORATORY:	CAS	CAS	CAS	NET	CAS
LABORATORY SAMPLE #:	K328804	K328801	K328803	195885	K328802
DATE RECEIVED:	6/01/94	6/01/94	6/01/94	6/02/94	6/01/94
DATE TESTED:	6/08/94	6/08/94	6/08/94	6/06/94	6/08/94
CONCENTRATION UNITS:	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Acenaphthene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Acenaphthylene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Aldrin	NR	NR	NR	ND (2.340)	NR
Anthracene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Aniline	ND (1)	ND (1)	ND (1)	NR	ND (1)
Benzidine	NR	NR	NR	ND (2.340)	NR
Benzo(a)anthracene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Benzo(b)fluoranthene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Benzo(k)fluoranthene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Benzo(a)pyrene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Benzo(g,h,i)perylene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Benzoic acid	ND (2)	ND (2)	ND (2)	ND (2.340)	ND (2)
Benzyl alcohol	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Butylbenzyl phthalate	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
bis(2-Chloroethyl)ether	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
bis(2-Chloroethoxy)methane	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
bis(2-Chloroisopropyl)ether	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
bis(2-Ethylhexyl)phthalate	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
4-Bromophenyl phenyl ether	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
4-Chloroanaline	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
2-Chloronaphthalene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
4-Chlorophenyl phenyl ether	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Chrysene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Dibenzo(a,h)anthracene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
delta-BHC	NR	NR	NR	ND (2.340)	NR
gamma-BHC	NR	NR	NR	ND (2.340)	NR
Dibenzofuran	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Di-n-butylphthlate	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
4,4'-DDD	NR	NR	NR	ND (2.340)	NR
4,4'-DDE	NR	NR	NR	ND (2.340)	NR
4,4'-DDT	NR	NR	NR	ND (2.340)	NR

Table 4
Williamsport
Method 8270
Semivolatile Organic Compounds
June, 1994

LOCATION:	Channel A	Open Water	Channel 5	QA DUP Channel	QC DUP Channel E
DATE OF SAMPLING:	5/25/94	5/25/94	5/25/94	5/25/94	5/25/94
TYPE OF SAMPLE:	sediment	sediment	sediment	sediment	sediment
FIELD SAMPLE #:94WISP-	01SD	07SD	08SD	05SD	06SD
TESTING LABORATORY:	CAS	CAS	CAS	NET	CAS
LABORATORY SAMPLE #:	K328804	K328801	K328803	195885	K328802
DATE RECEIVED:	6/01/94	6/01/94	6/01/94	6/02/94	6/01/94
DATE TESTED:	6/08/94	6/08/94	6/08/94	6/06/94	6/08/94
CONCENTRATION UNITS:	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
1, 2-Dichlorobenzene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
1, 3-Dichlorobenzene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
1, 4-Dichlorobenzene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
3, 3'-Dichlorobenzidine	ND (2)	ND (2)	ND (2)	ND (0.964)	ND (2)
Dieldrin	NR	NR	NR	ND (2.340)	NR
Diethylphthalate	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Dimethyl phthalate	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
2, 4-Dinitrotoluene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
2, 6-Dinitrotoluene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Di-n-octyl phthalate	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Endrin aldehyde	NR	NR	NR	ND (2.340)	NR
Fluoranthene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Fluorene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Heptachlor	NR	NR	NR	ND (2.340)	NR
Heptachlor epoxide	NR	NR	NR	ND (2.340)	NR
Hexachlorobenzene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Hexachlorobutadiene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Hexachlorocyclopentadiene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Hexachloroethane	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Indeno(1, 2 ,3-cd)pyrene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
Isophorone	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
2-Methylnaphthalene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
3- and 4- Methylphenol *	ND (0.3)	ND (0.3)	ND (0.3)	NR	ND (0.3)
Naphthalene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
2-Nitroaniline	ND (2)	ND (2)	ND (2)	ND (2.340)	ND (2)
3-Nitroaniline	ND (2)	ND (2)	ND (2)	ND (2.340)	ND (2)
4-Nitroaniline	ND (2)	ND (2)	ND (2)	ND (2.340)	ND (2)
Nitrobenzene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
N-Nitroso-Di-N-propylamine	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
N-Nitrosodiphenylamine	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
N-Nitrosodimethylamine	ND (2)	ND (2)	ND (2)	NR	ND (2)
Phenanthrene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)

Table 4
Williams Port
Method 8270
Semivolatile Organic Compounds
June, 1994

				QA DUP	QC DUP
LOCATION:	Channel A	Open Water	Channel E	Channel E	Channel E
DATE OF SAMPLING:	5/25/94	5/25/94	5/25/94	5/25/94	5/25/94
TYPE OF SAMPLE:	sediment	sediment	sediment	sediment	sediment
FIELD SAMPLE #:94WISP-	01SD	07SD	08SD	05SD	06SD
TESTING LABORATORY:	CAS	CAS	CAS	NET	CAS
LABORATORY SAMPLE #:	K328804	K328801	K328803	195885	K328802
DATE RECEIVED:	6/01/94	6/01/94	6/01/94	6/02/94	6/01/94
DATE TESTED:	6/08/94	6/08/94	6/08/94	6/06/94	6/08/94
CONCENTRATION UNITS:	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Pyrene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
1, 2, 4-Trichlorobenzene	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
4-Chloro-3-methylphenol	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
2-Chlorophenol	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
2, 4-Dichlorophenol	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
2, 4-Dimethylphenol	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
2, 4-Dinitrophenol	ND (2)	ND (2)	ND (2)	ND (2.340)	ND (2)
4, 6-Dinitro-2-methylphenol	ND (2)	ND (2)	ND (2)	ND (2.340)	ND (2)
2-Nitrophenol	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
4-Nitrophenol	ND (2)	ND (2)	ND (2)	ND (2.340)	ND (2)
Pentachlorophenol	ND (2)	ND (2)	ND (2)	ND (2.340)	ND (2)
Phenol	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
2, 4, 6-Trichlorophenol	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
2-Methylphenol	ND (0.3)	ND (0.3)	ND (0.3)	ND (0.482)	ND (0.3)
4-Methylphenol	NR	NR	NR	ND (0.482)	NR
2, 4, 5-Trichlorophenol	ND (0.3)	ND (0.3)	ND (0.3)	ND (2.340)	ND (0.3)
Number of TICs:	13	3	13	7	15
Total TIC Concentration:	7.1	1.8	16.5	2.2	14.8

CAS: Columbia Analytical Services, Kelso, Wa.
NET: National Environmental Testing, Santa Rosa, CA.
The value in parentheses is the Method Reporting Limit (MRL).
ND: Not Detected
NR: Not Reported
a: MRL is elevated because of martix interferences.
b: Result is from an analysis performed on February 16, 1994
*: Quantified as 4-methylphenol.

Table 5
Williamsport
Soils Classification
June, 1994

Sample No. 94 WISP-	Water Content	Soil Classification ASTM D-2487	Soil Classification TM5-818-2	Gravel (%)	Sand (%)	Fines (%)
01SD	64.4	MH	F4	0.9	1.0	98.1
05SD	42.2	ML	F4	0.0	5.7	94.2
07SD	29.5	ML	F4	0.0	45.6	54.3
40SD	56.3	ML	F4	2.9	8.2	88.9
41SD	47.1	ML	F4	0.2	11.8	88.0
42SD	53.9	ML	F4	0.4	2.6	97.0
46SD	33.1	SM	F4	10.2	41.7	48.1
48SD	1.7	GP	NFS	99.5	0.4	0.1
51SD	50.2	ML	F4	0.5	11.7	87.8
52SD	62.7	ML	F4	0.0	13.4	86.5
91SD	19.7	GC-GM	F3	37.4	26.8	35.8
92SD	48.2	CL	F3	5.9	2.9	91.2
95SD	37.7	ML	F4	0.2	4.0	95.8
97SD	31.6	ML	F4	7.6	20.5	71.9
98SD	70.5	MH	F4	2.1	12.2	85.7

NPD: North Pacific Division, Troutdale OR.
MH: Elastic Silt
ML: Sandy Silt or Silt or Silt with Sand
GP: Poorly Graded Gravel
NFS: Not Frost Susceptible
SM: Silty Sand
GC-GM: Silty, Clayey Gravel with Sand
CL: Lean Clay

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION LABORATORY
CORPS OF ENGINEERS
1491 N.W. GRAHAM AVENUE
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CENPD-PE-GE-L (1110-1-8100c) 1 Jul 94

MEMORANDUM FOR: Commander, Alaska District, ATTN: CENPA-EN-G (Thomas)

SUBJECT: W.O. 94-288, Report of ~~Soil~~ Chemical Analysis

Project: WILLIAMSPORT
Intended Use: Site Evaluation
Source of Material: Reference Chain of Custody Records
Submitted by: CENPA-EN-G
Date Sampled: 25 May 94 Date Received: 1, 2 Jun 94
Method of Test or Specification: Reference Enclosure 1
Reference: a) DD Form 448, currently being processed
b) Original report number K943288A from Columbia Analytical Services, Inc. (CAS) previously submitted to your office by laboratory

1. Enclosed are Chemical Quality Assurance Report and original report number 94.02288 with diskette from NET Pacific, Inc., original Chain of Custody and original Sample Cooler Receipt form.

2. Project Laboratory's Data: Up to 11, 158, 46 and 13 ppm of arsenic, barium, chromium and lead were found, respectively. 68 and 15 ppb of acetone and 2-butanone were detected, respectively, in sample -01SD and no targeted volatile organics (VOC), pesticides/PCB, semi-volatile organics (BNA) or total recoverable petroleum hydrocarbons (TRPH) were found in these four soil/sediment samples. Up to four tentatively identified compounds of fuel hydrocarbon and cholesterol were found in the ranges of 0.1 through 3 ppm.

3. Evaluation of the Project Laboratory's Data: All holding times, reporting limits and method blanks were within EPA quality control (QC) limits. All matrix spike (MS) and matrix spike duplicate (MSD) and relative percent differences (RPDs) were within EPA QC limits and are acceptable with the exception of MS recovery of selenium, which was 58 percent due to matrix interference. Low levels of selenium, if present, may not have been detected. The RPD of lead was 25, but was considered significant as RPD was calculated within a factor of five to the detection limits. Overall project data are acceptable.

CENPD-PE-GE-L (1110-1-8100c)
SUBJECT: W.O. 94-288, Report of ~~Soil~~ Chemical Analysis

4. Evaluation of the QA (~~CAS~~ NET) Laboratory's Data: All holding times, reporting limits and method blanks were within EPA QC limits except 11 ppm of TRPH, 6 ppb of acetone, 6.3 ppb of methylene chloride and 270 ppb of 1,1,2,2-tetrachloroethane was found in the laboratory blanks. Data of these analytes are not acceptable. MS/MSD, surrogate recoveries and RPDs were within method requirements with the exception of MS and MSD of selenium and RPD of TRPH and barium. Low levels of selenium, if present, may not have been detected. Barium data should be considered estimates. TRPH data are not acceptable due to laboratory cross-contamination and high RPD. Low recoveries of selenium (64 and 52 percent) is due to matrix interference as was also experienced in the project sample. 58 RPD of barium is not acceptable and data should be considered estimates.

5. Project and QA Data Comparisons: The project and QA data comparisons are shown in Table I-1 through I-5. All data agree and are comparable.

6. If you have any questions or comments regarding the Chemical Quality Assurance Report, please contact Dr. Ajmal M. Ilias at (503) 665-4166.

Enclosures

Timothy J. Seeman
TIMOTHY J. SEEMAN
Director

Copy Furnished: CENPD-PE-GE
CEMRD-EP-EC
CEMP-RT

MFR: Self-explanatory. Complete copy in office file.

CENPD-PE-GE-L (94-288)

COMPARISON OF PROJECT AND QA RESULTS

Table I

Project: Williamsport Matrix: Soil Prefix: 94WISP-
Project Laboratory: CAS, Inc. QA Laboratory: NET Pacific, Inc.

1. Method: Volatile Organic Compounds (EPA 8260) Units: ug/Kg (ppm)

Analytes Detected	Project Lab 06SD	Project Lab 08SD	Detection Limits	QA Lab 05SD	Detection Limits
Methylene Chloride	ND	ND	10	7.8 B	7.1

B = Found in method blank
ND = None detected

SUMMARY: The project blind duplicate and QA data agree within a factor of two to each other or their detection limits for all sixty-three targeted analytes and are comparable.

2. Method: Semi-Volatile Organic Compounds (EPA 8270) Units: mg/Kg (ppm)

Analytes Detected	Project Lab 06SD	Project Lab 08SD	Detection Limits	QA Lab 05SD	Detection Limits
	ND	ND	0.3-2	ND	0.48-2.3
Tentatively Identified Compounds:					
Up to four fuel hydrocarbons	0.1-2	0.5-2		--	
Cholestrol	3	1		--	

SUMMARY: The project blind duplicate and QA data agree with each other for all targeted analytes and are comparable.

CENPD-PE-GE-L (94-288)
Table I cont.

3. Method: Organochlorine Pesticides/PCBs (EPA 8080) Units: ug/Kg (ppb)

Analytes Detected	Project Lab 06SD	08SD	Detection Limits	QA Lab 05SD	Detection Limits
	ND	ND	10-300	ND	0.4-117

SUMMARY: The project blind duplicate and QA data agree with each other and are comparable.

4. Method: Total Recoverable Petroleum Hydrocarbons (EPA 418.1) Units: mg/Kg (ppm)

Analytes Detected	Project Lab 06SD	08SD	Detection Limits	QA Lab 05SD	Detection Limits
TRPH	ND	ND	20	64 B	15

SUMMARY: The project blind duplicate and QA data agree within a factor of four to each other or their detection limits and are comparable.

5. Method: Total Metals (EPA 6010,7000 Series) Units: mg/Kg (ppm)

Analytes Detected	Project Lab 06SD	08SD	Detection Limits	QA Lab 05SD	Detection Limits
Arsenic	10	10	1	11	0.7
Barium	120	121	1	96	2.9
Cadmium	ND	ND	1	ND	2.9
Chromium	34	34	2	26	2.9
Lead	8	8	1	7.2	0.3
Mercury	ND	ND	0.2	ND	0.1
Selenium	ND	ND	1	ND	0.7
Silver	ND	ND	2	ND	2.9

SUMMARY: The project blind duplicate and QA data agree within a factor of two to each other and are comparable.

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION LABORATORY
CORPS OF ENGINEERS
1491 N.W. GRAHAM AVENUE
TROUTDALE, OREGON 97060-9503

CENPD-PE-GE-L (1110-1-8100c) June 16, 1994

MEMORANDUM FOR Commander, Alaska District, ATTN: CENPA-EN-G (Thomas)

SUBJECT: W.O. #94-288, Report of Soil Analysis

Project: WILLIAMSPORT
Source of Material: Williamsport, Alaska
Submitted by: CENPA-EN-G (Thomas)
Date Sampled: 24, 25 May 94 Date Received: 31 May 94
Method of Test or Specification: ASTM, EM1110-2-1906
Reference: 1) DD Form 448 currently being processed
2) Chain of Custody dated 31 May 94 outlining required tests

1. Enclosed is report of mechanical analysis for 15 soil samples submitted from the above project.

a) Enclosure 1, Summary of Water Content and Soil Classification

b) Enclosures 2 through 16, Report of Particle Size Analysis and Classification Tests, one for each sample submitted.

2. Results for remaining 23 samples will be forwarded when available.

Timothy J. Seeman

Enclosures

TIMOTHY J. SEEMAN
Director

Copy Furnished: CENPD-PE-GE

CENPD-PE-GT-L (94-288)

WILLIAMSPORT

Summary of Water Content and Soil Classification

Sample			Water	Soil Classification	
Location	No.	Depth, ft.	Content, %	ASTM D-2487	TM5-818-2
94WISP	01SD	--	64.4	MH	F4
	05SD	--	42.2	ML	F4
	07SD	--	29.5	ML	F4
	40SD	--	56.3	ML	F4
	41SD	--	47.1	ML	F4
	42SD	--	53.9	ML	F4
	46SD	--	33.1	SM	F4
	48SD	--	1.7	GP	NFS
	51SD	--	50.2	ML	F4
	52SD	--	62.7	ML	F4
	91SD	--	19.7	GC-GM	F3
	92SD	--	48.2	CL	F3
	95SD	--	37.7	ML	F4
	97SD	--	31.6	ML	F4
	98SD	--	70.5	MH	F4

CENPDL No. 4946, received 31 May 94

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WILLIAMSPORT (94-288)

Boring: **94WISP** Sample: **01SD** Depth: -- Lab No.: 28801

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	0.00	100.0
1/2 In.	0.00	100.0
3/8 In.	1.99	99.7
No. 4	5.64	99.1
No. 10	7.98	98.8
Pan	643.97	0.0
No. 16	0.11	98.6
No. 30	0.22	98.5
No. 50	0.38	98.3
No. 100	0.51	98.1
No. 200	0.53	98.1
Pan	75.92	0.0

----------- Hydrometer Analysis -----------

Sample Weight:75.92 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	66.6	0.0311	86.4
3	20.0	65.1	0.0184	84.5
10	20.0	55.1	0.0114	71.6
100	20.0	36.6	0.0056	47.8
200	20.0	30.6	0.0041	40.1

D85: .021 D60: .0081 D50: .0059 mm

Liquid Limit: 51 Plasticity Index: 22

Fines Type Used for Classification: MH, Elastic SILT

Gravel: 0.9% Sand: 1.0% Fines: 98.1%

------------------------- ASTM D 2487 Classification -------------------------

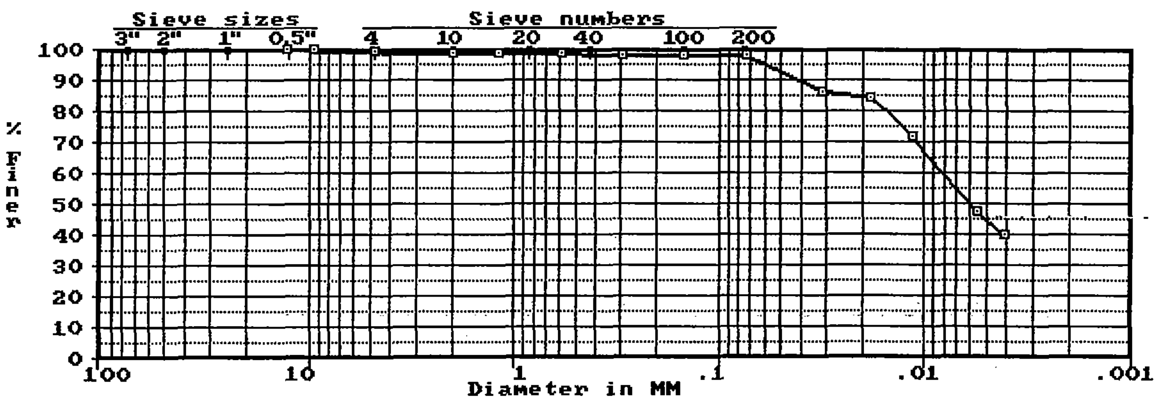
MH Elastic SILT

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 84.8 Frost Classification: **F4**

---------------------------------- Comments ----------------------------------

- WATER CONTENT = 64.4%
- 25 MAY 1994



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WILLIAMSPORT (94-288)

Boring: **94WISP** Sample: **05SD** Depth: -- Lab No.: 28802

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	0.00	100.0
1/2 In.	0.00	100.0
3/8 In.	0.00	100.0
No. 4	1.02	99.9
No. 10	4.75	99.5
Pan	934.45	0.0
No. 16	0.12	99.4
No. 30	0.39	99.1
No. 50	0.66	98.8
No. 100	1.32	98.2
No. 200	5.24	94.2
Pan	99.12	0.0

----------- Hydrometer Analysis -----------

Sample Weight:99.12 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	65.6	0.0316	65.7
3	20.0	51.6	0.0217	51.8
10	20.0	36.6	0.0136	36.9
100	20.0	22.6	0.0061	23.0
200	20.0	18.6	0.0045	19.0

D85: .053 D60: .027 D50: .021 D30: .0098 mm

Liquid Limit: 31 Plasticity Index: 6

Fines Type Used for Classification: ML, SILT

Gravel: 0.0% Sand: 5.7% Fines: 94.2%

------------------------- ASTM D 2487 Classification -------------------------

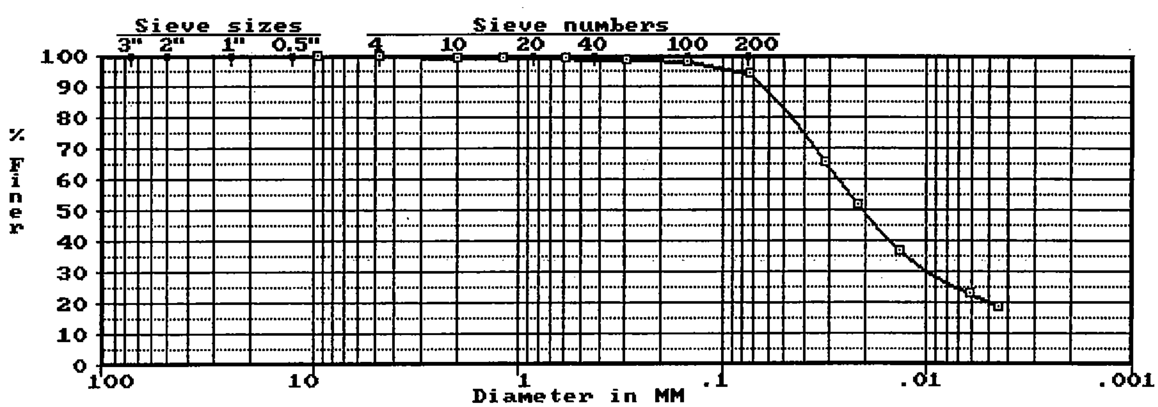
ML SILT

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 49.0 Frost Classification: **F4**

---------------------------------- Comments ----------------------------------

- WATER CONTENT = 42.2%
- 25 MAY 1994
- PLASTIC BAG MARKED 06



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WILLIAMSPORT (94-288)

Boring: **94WISP** Sample: **07SD** Depth: **--** Lab No.: 28803

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	0.00	100.0
1/2 In.	0.00	100.0
3/8 In.	0.00	100.0
No. 4	0.45	99.9
No. 10	0.82	99.8
Pan	431.10	0.0
No. 16	0.01	99.8
No. 30	0.05	99.7
No. 50	0.26	99.5
No. 100	1.30	98.2
No. 200	36.86	54.3
Pan	80.84	0.0

----------- Hydrometer Analysis -----------

Sample Weight:80.84 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	18.6	0.0488	23.3
3	20.0	11.6	0.0294	14.8
10	20.0	8.6	0.0164	11.1
100	20.0	4.6	0.0068	6.2
200	20.0	3.6	0.0048	5.0

D85: 0.11 D60: .079 D50: .070 D30: .054 D15: .030 D10: .014 mm

Cu: 5.78 Cc: 2.66

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 0.0% Sand: 45.6% Fines: 54.3%

------------------------ ASTM D 2487 Classification ------------------------

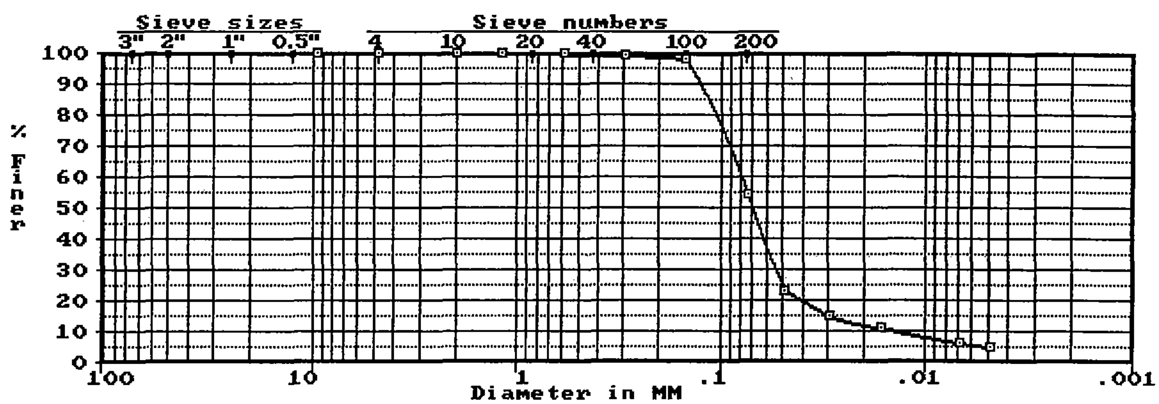
ML Sandy SILT

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 12.0 Frost Classification: **F4**

---------------------------------- Comments ----------------------------------

- WATER CONTENT = 29.5%
- 25 MAY 1994



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WILLIAMSPORT (94-288)

Boring: **94WISP** Sample: **40SD** Depth: **17.0'** Lab No.: 28804

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	0.00	100.0
1/2 In.	17.97	97.2
3/8 In.	17.97	97.2
No. 4	18.74	97.1
No. 10	23.51	96.3
Pan	638.90	0.0
No. 16	0.15	96.1
No. 30	0.44	95.8
No. 50	0.72	95.4
No. 100	1.09	94.9
No. 200	5.79	88.9
Pan	75.26	0.0

----------- Hydrometer Analysis -----------

Sample Weight:75.26 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	51.1	0.0377	65.4
3	20.0	38.6	0.0244	49.5
10	20.0	27.6	0.0145	35.6
100	20.0	17.6	0.0063	22.9
200	20.0	14.6	0.0046	19.1

D85: .065 D60: .033 D50: .025 D30: .011 mm

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 2.9% Sand: 8.2% Fines: 88.9%

------------------------- ASTM D 2487 Classification -------------------------

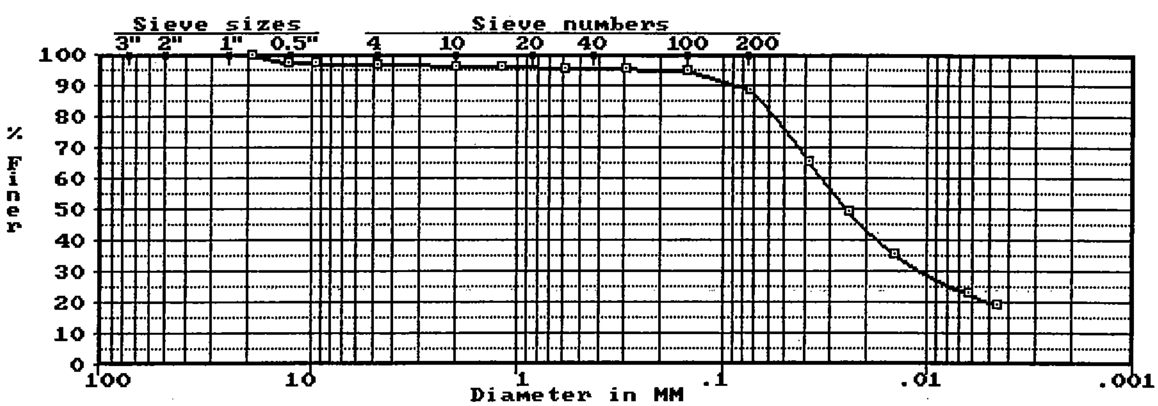
ML SILT

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 43.5 Frost Classification: **F4**

---------------------------------- Comments ----------------------------------

- WATER CONTENT = 56.3%
- 24 MAY 1994



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WILLIAMSPORT (94-288)

Boring: **94WISP** Sample: **41SD** Depth: -- Lab No.: 28805

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	0.00	100.0
1/2 In.	0.00	100.0
3/8 In.	0.00	100.0
No. 4	1.57	99.8
No. 10	5.26	99.3
Pan	762.60	0.0
No. 16	0.13	99.2
No. 30	0.31	98.9
No. 50	0.56	98.6
No. 100	1.55	97.4
No. 200	9.37	88.0
Pan	82.05	0.0

----------- Hydrometer Analysis -----------

Sample Weight:82.05 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	53.6	0.0367	64.8
3	20.0	40.1	0.0241	48.6
10	20.0	28.6	0.0144	34.9
100	20.0	18.6	0.0063	22.9
200	20.0	15.6	0.0045	19.3

D85: .066 D60: .033 D50: .025 D30: .011 mm

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 0.2% Sand: 11.8% Fines: 88.0%

------------------------- ASTM D 2487 Classification -------------------------

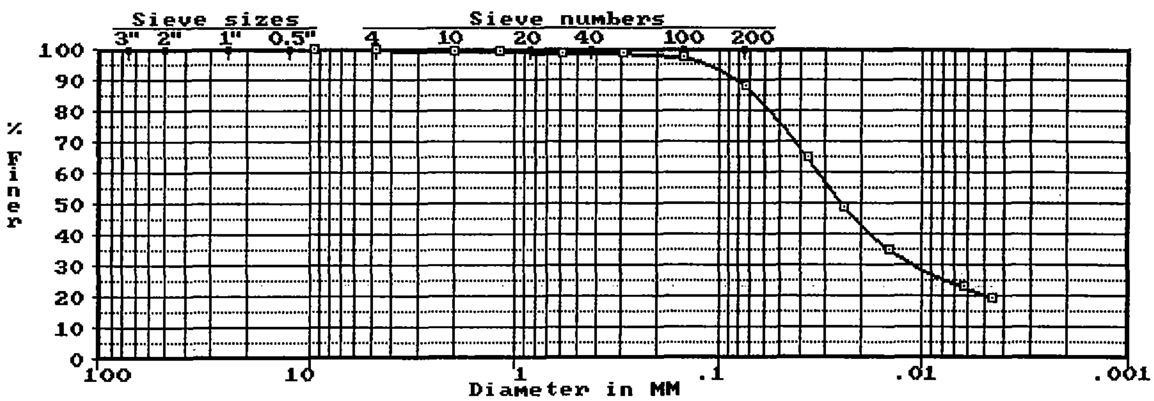
ML SILT

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 42.9 Frost Classification: **F4**

---------------------------------- Comments ----------------------------------

- WATER CONTENT = 47.1%
- 24 MAY 1994



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WILLIAMSPORT (94-288)

Boring: **94WISP** Sample: **42SD** Depth: **20.0'** Lab No.: 28806

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	0.00	100.0
1/2 In.	0.00	100.0
3/8 In.	0.00	100.0
No. 4	5.15	99.6
No. 10	8.96	99.3
Pan	1292.80	0.0
No. 16	0.08	99.2
No. 30	0.18	99.0
No. 50	0.33	98.8
No. 100	0.63	98.4
No. 200	1.53	97.0
Pan	66.46	0.0

----------- Hydrometer Analysis -----------

Sample Weight:66.46 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	45.6	0.0398	68.2
3	20.0	34.6	0.0252	51.9
10	20.0	25.1	0.0148	37.9
100	20.0	15.6	0.0064	23.8
200	20.0	12.6	0.0046	19.4

D85: .056 D60: .032 D50: .024 D30: .0097 mm

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 0.4% Sand: 2.6% Fines: 97.0%

------------------------- ASTM D 2487 Classification -------------------------

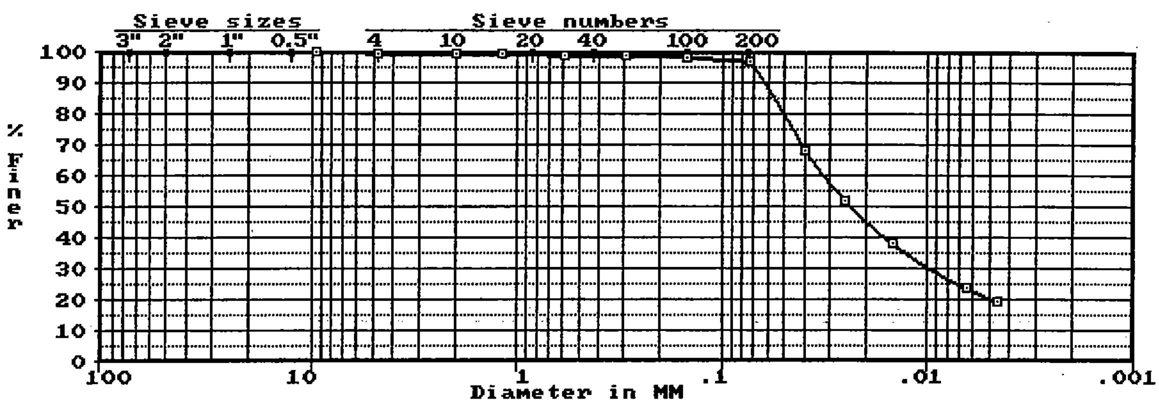
ML SILT

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 45.2 Frost Classification: **F4**

---------------------------------- Comments ----------------------------------

\- WATER CONTENT = 53.9%



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WILLIAMSPORT (94-288)

Boring: **94WISP** Sample: **46SD** Depth: -- Lab No.: 28807

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	28.87	96.2
1/2 In.	65.30	91.5
3/8 In.	68.69	91.0
No. 4	78.09	89.8
No. 10	87.01	88.6
Pan	766.40	0.0
No. 16	0.42	88.2
No. 30	1.27	87.2
No. 50	3.01	85.3
No. 100	17.40	69.3
No. 200	36.58	48.1
Pan	79.90	0.0

----------- Hydrometer Analysis -----------

Sample Weight:79.90 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	32.6	0.0444	36.4
3	20.0	25.6	0.0269	28.7
10	20.0	19.6	0.0153	22.1
100	20.0	12.1	0.0065	13.8
200	20.0	9.6	0.0047	11.1

D85: 0.29 D60: 0.11 D50: .079 D30: .030 D15: .0075 mm

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 10.2% Sand: 41.7% Fines: 48.1%

------------------------ ASTM D 2487 Classification ------------------------

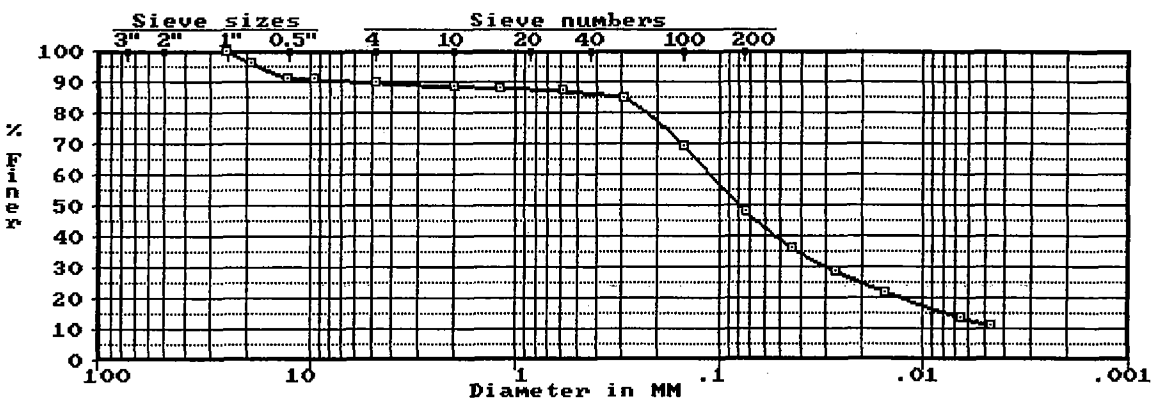
SM Silty SAND

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 25.0 Frost Classification: **F4**

---------------------------------- Comments ----------------------------------

- WATER CONTENT = 33.1%
- 24 MAY 94



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WILLIAMSPORT (94-288)

Boring: **94WISP** Sample: **48SD** Depth: **26.0'** Lab No.: 28808

------ Sieve Analysis ------

No hydrometer analysis.

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	135.86	43.1
1 In.	204.51	14.4
3/4 In.	237.62	0.5
1/2 In.	237.62	0.5
3/8 In.	237.62	0.5
No. 4	237.62	0.5
No. 10	237.77	0.4
Pan	238.80	0.0
No. 16	0.05	0.4
No. 30	0.36	0.3
No. 50	0.75	0.3
No. 100	1.04	0.2
No. 200	1.32	0.1
Pan	1.85	0.0

D85: 47.2 D60: 41.6 D50: 39.5 D30: 33.4 D15: 25.9 D10: 23.6 mm

Cu: 1.77 Cc: 1.14

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 99.5% Sand: 0.4% Fines: 0.1%

------------------------- ASTM D 2487 Classification -------------------------

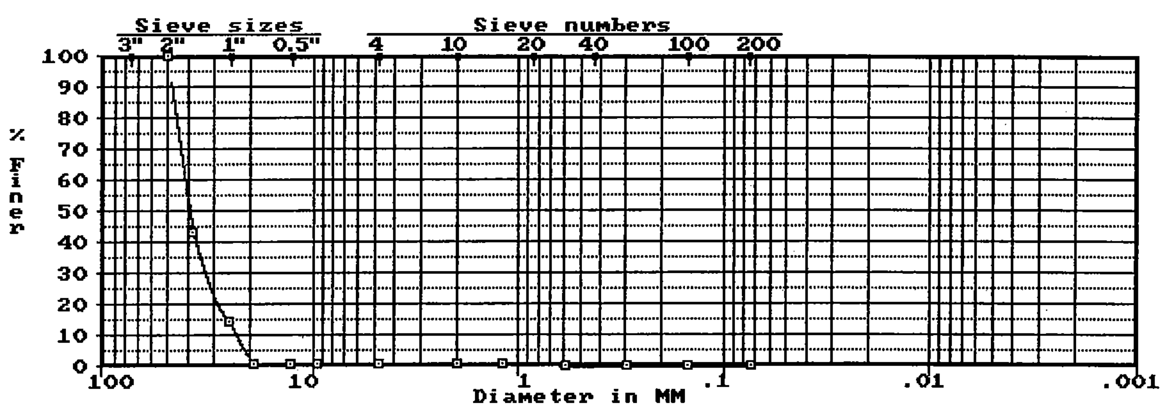
GP Poorly graded GRAVEL

---------------------- TM 5-818-2 Frost Classification ----------------------

Frost Classification: **NFS**

-------------------------------- Comments --------------------------------

- WATER CONTENT = 1.7%



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WILLIAMSPORT (94-288)

Boring: **94WISP** Sample: **51SD** Depth: -- Lab No.: 28809

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	0.00	100.0
1/2 In.	0.00	100.0
3/8 In.	0.00	100.0
No. 4	5.06	99.5
No. 10	7.69	99.3
Pan	1078.10	0.0
No. 16	0.10	99.1
No. 30	0.18	99.0
No. 50	0.51	98.4
No. 100	1.47	96.9
No. 200	6.99	87.8
Pan	60.30	0.0

----------- Hydrometer Analysis -----------

Sample Weight:60.30 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	45.5	0.0399	75.0
3	20.0	36.5	0.0249	60.3
10	20.0	27.5	0.0146	45.6
100	20.0	17.6	0.0063	29.5
200	20.0	14.5	0.0046	24.5

D85: .063 D60: .025 D50: .017 D30: .0065 mm

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 0.5% Sand: 11.7% Fines: 87.8%

------------------------ ASTM D 2487 Classification ------------------------

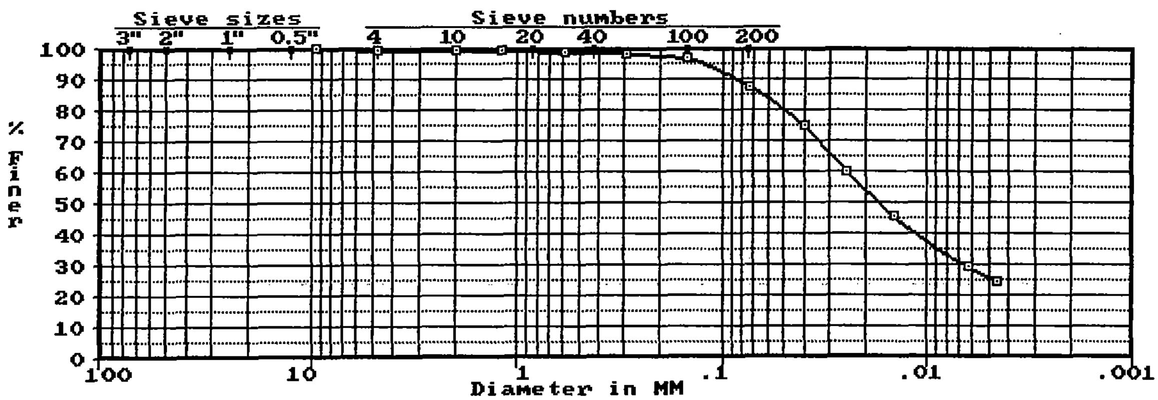
ML SILT

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 54.0 Frost Classification: **F4**

------------------------------ Comments ------------------------------

- WATER CONTENT = 50.2%
- 24 MAY 94



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WILLIAMSPORT (94-288)

Boring: **94WISP** Sample: **52SD** Depth: -- Lab No.: 28810

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	0.00	100.0
1/2 In.	0.00	100.0
3/8 In.	0.00	100.0
No. 4	0.83	99.9
No. 10	1.52	99.9
Pan	1336.77	0.0
No. 16	0.03	99.8
No. 30	0.11	99.7
No. 50	0.33	99.5
No. 100	1.44	98.0
No. 200	10.38	86.5
Pan	77.35	0.0

----------- Hydrometer Analysis -----------

Sample Weight:77.35 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	54.6	0.0363	70.4
3	20.0	44.6	0.0232	57.7
10	20.0	33.6	0.0139	43.6
100	20.0	21.6	0.0062	28.3
200	20.0	17.6	0.0045	23.1

D85: .069 D60: .025 D50: .018 D30: .0069 mm

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 0.0% Sand: 13.4% Fines: 86.5%

------------------------- ASTM D 2487 Classification -------------------------

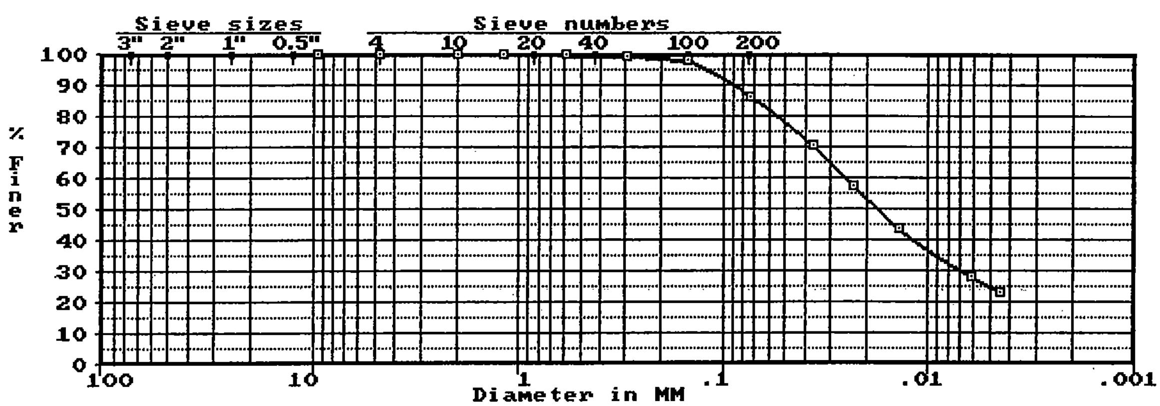
ML SILT

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 53.4 Frost Classification: **F4**

---------------------------------- Comments ----------------------------------

- WATER CONTENT = 62.7%
- 24 MAY 94



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WILLIAMSPORT (94-288)

Boring: **94WISP** Sample: **91SD** Depth: **--** Lab No.: 28811

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	176.17	91.5
3/4 In.	302.92	85.4
1/2 In.	464.89	77.6
3/8 In.	586.29	71.7
No. 4	775.48	62.6
No. 10	924.96	55.4
Pan	2071.91	0.0
No. 16	3.98	51.7
No. 30	9.19	47.0
No. 50	14.63	42.0
No. 100	18.27	38.7
No. 200	21.38	35.8
Pan	60.60	0.0

----------- Hydrometer Analysis -----------

Sample Weight:60.60 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	37.6	0.0427	34.5
3	20.0	34.6	0.0252	31.7
10	20.0	28.1	0.0145	25.9
100	20.0	17.1	0.0064	15.9
200	20.0	14.1	0.0046	13.2

D85: 18.7 D60: 3.62 D50: 0.92 D30: .021 D15: .0057 mm

Liquid Limit: 27 Plasticity Index: 6

Fines Type Used for Classification: CL-ML, Silty CLAY

Gravel: 37.4% Sand: 26.8% Fines: 35.8%

------------------------ ASTM D 2487 Classification ------------------------

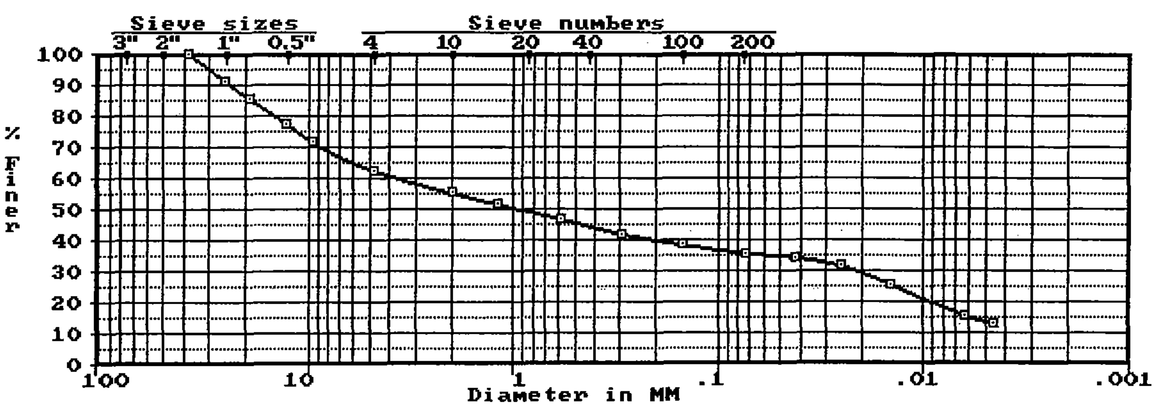
GC-GM Silty, clayey GRAVEL with sand

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 29.5 Frost Classification: **F3**

--------------------------------- Comments ---------------------------------

- WATER CONTENT = 19.7%
- 24 MAY 94



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WILLIAMSPORT (94-288)

Boring: **94WISP** Sample: **92SD** Depth: **--** Lab No.: 28812

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	34.04	98.1
3/4 In.	53.07	97.0
1/2 In.	62.06	96.5
3/8 In.	86.14	95.1
No. 4	103.23	94.1
No. 10	122.69	93.0
Pan	1749.64	0.0
No. 16	0.19	92.7
No. 30	0.43	92.3
No. 50	0.72	91.9
No. 100	1.08	91.3
No. 200	1.14	91.2
Pan	60.45	0.0

----------- Hydrometer Analysis -----------

Sample Weight:60.45 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	55.8	0.0358	85.7
3	20.0	50.3	0.0220	77.4
10	20.0	39.3	0.0133	60.6
100	20.0	22.3	0.0062	34.7
200	20.0	18.2	0.0045	28.5

D85: .034 D60: .013 D50: .0100 D30: .0049 mm

Liquid Limit: 46 Plasticity Index: 20

Fines Type Used for Classification: CL, Lean CLAY

Gravel: 5.9% Sand: 2.9% Fines: 91.2%

------------ ASTM D 2487 Classification ------------

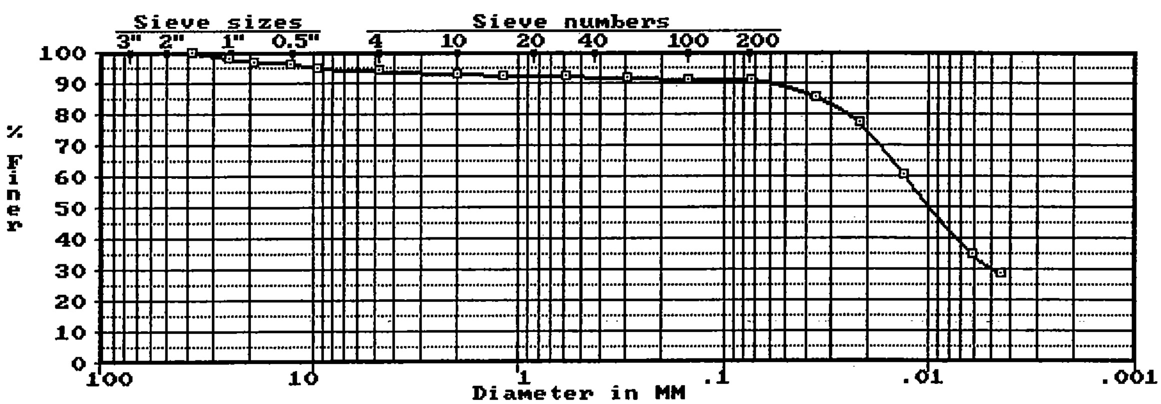
CL Lean CLAY

------------ TM 5-818-2 Frost Classification ------------

Percent finer than 0.02 mm: 74.6 Frost Classification: **F3**

------------ Comments ------------

- WATER CONTENT = 48.2%
- 24 MAY 94



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WILLIAMSPORT (94-288)

Boring: **94WISP** Sample: **95SD** Depth: **--** Lab No.: 28813

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	0.00	100.0
1/2 In.	0.00	100.0
3/8 In.	0.00	100.0
No. 4	1.34	99.8
No. 10	2.34	99.7
Pan	724.86	0.0
No. 16	0.08	99.6
No. 30	0.31	99.3
No. 50	0.56	99.0
No. 100	0.95	98.5
No. 200	3.18	95.8
Pan	82.69	0.0

----------- Hydrometer Analysis -----------

Sample Weight:82.69 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	56.6	0.0355	68.1
3	20.0	41.6	0.0238	50.2
10	20.0	28.6	0.0144	34.7
100	20.0	17.1	0.0064	21.0
200	20.0	14.1	0.0046	17.4

D85: .053 D60: .030 D50: .024 D30: .012 mm

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 0.2% Sand: 4.0% Fines: 95.8%

------------------------- ASTM D 2487 Classification -------------------------

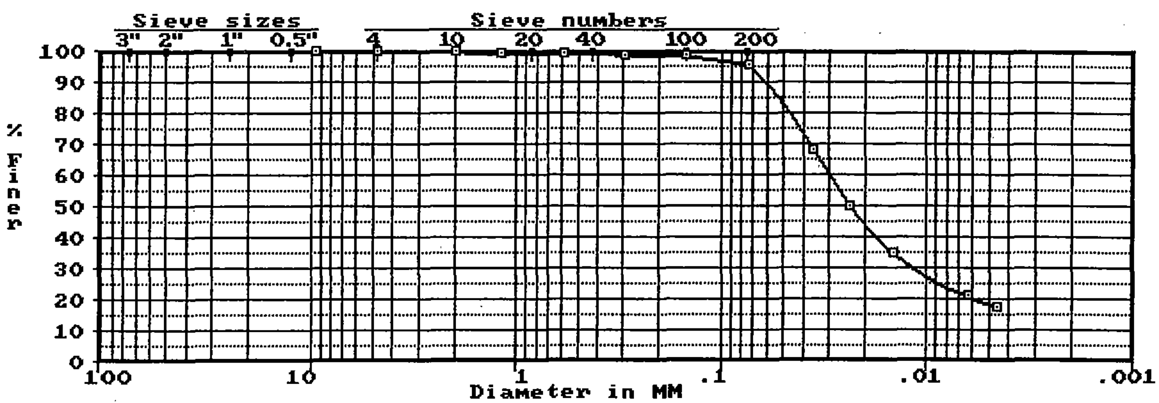
ML SILT

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 44.0 Frost Classification: **F4**

---------------------------------- Comments ----------------------------------

- WATER CONTENT = 37.7%
- 24 MAY 94



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WILLIAMSPORT (94-288)

Boring: **94WISP** Sample: **97SD** Depth: -- Lab No.: 28814

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	35.33	98.2
3/4 In.	35.33	98.2
1/2 In.	73.33	96.3
3/8 In.	93.19	95.3
No. 4	150.17	92.4
No. 10	257.03	87.0
Pan	1972.90	0.0
No. 16	3.15	83.5
No. 30	6.28	80.0
No. 50	9.93	75.9
No. 100	13.41	72.0
No. 200	13.49	71.9
Pan	77.89	0.0

----------- Hydrometer Analysis -----------

Sample Weight:77.89 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	57.6	0.0351	64.2
3	20.0	52.6	0.0214	58.7
10	20.0	43.1	0.0129	48.2
100	20.0	28.1	0.0059	31.6
200	20.0	22.1	0.0044	25.0

D85: 1.49 D60: .024 D50: .014 D30: .0055 mm

Liquid Limit: NP Plasticity Index: NP

Fines Type Used for Classification: ML, SILT

Gravel: 7.6% Sand: 20.5% Fines: 71.9%

------------------------- ASTM D 2487 Classification -------------------------

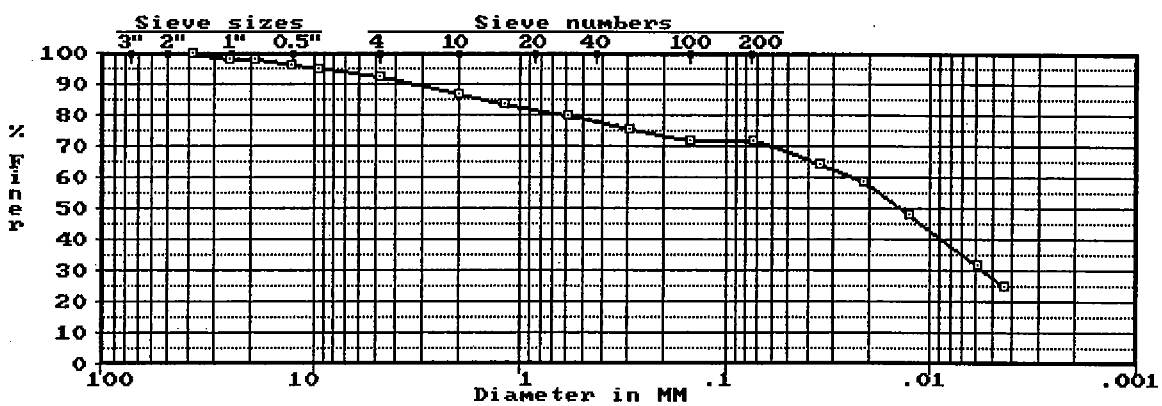
ML SILT with sand

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 57.4 Frost Classification: **F4**

---------------------------------- Comments ----------------------------------

- WATER CONTENT = 31.6%
- 25 MAY 94



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WILLIAMSPORT (94-288)

Boring: **94WISP** Sample: **98SD** Depth: **--** Lab No.: 28815

------ Sieve Analysis ------

Sieve	Cumulative Grams Retained	Percent Passing
3 In.	0.00	100.0
2 In.	0.00	100.0
1.5 In.	0.00	100.0
1 In.	0.00	100.0
3/4 In.	0.00	100.0
1/2 In.	0.00	100.0
3/8 In.	7.48	99.4
No. 4	24.36	97.9
No. 10	38.53	96.7
Pan	1157.13	0.0
No. 16	0.68	95.4
No. 30	1.43	94.1
No. 50	2.83	91.6
No. 100	4.43	88.7
No. 200	6.07	85.7
Pan	53.73	0.0

----------- Hydrometer Analysis -----------

Sample Weight:53.73 gr. Start Time:0000

Time	Temp (C)	Hydrometer Reading	Diameter in mm	Percent Finer
1	20.0	47.6	0.0391	85.7
3	20.0	44.6	0.0232	80.3
10	20.0	38.1	0.0134	68.8
100	20.0	24.6	0.0061	44.7
200	20.0	20.6	0.0044	37.6

D85: .035 D60: .010 D50: .0072 mm

Liquid Limit: 53 Plasticity Index: 22

Fines Type Used for Classification: MH, Elastic SILT

Gravel: 2.1% Sand: 12.2% Fines: 85.7%

------------------------ ASTM D 2487 Classification ------------------------

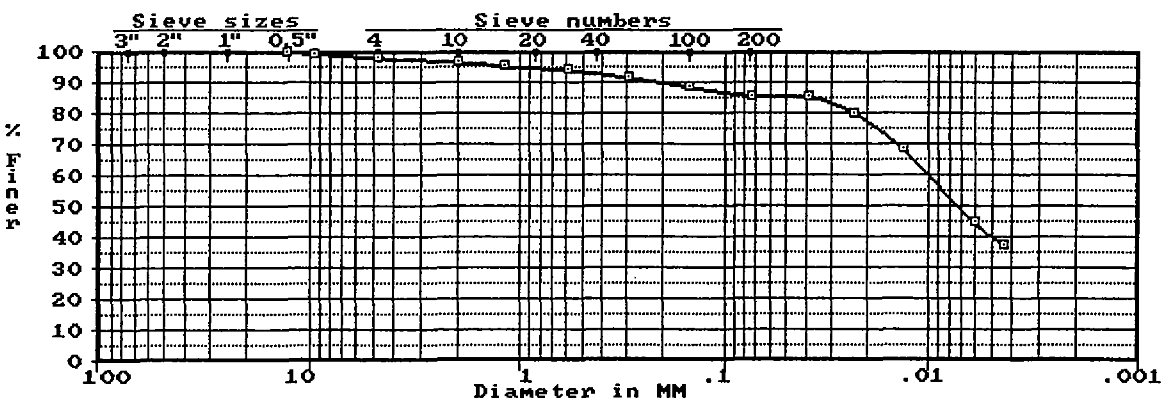
MH Elastic SILT

---------------------- TM 5-818-2 Frost Classification ----------------------

Percent finer than 0.02 mm: 77.7 Frost Classification: **F4**

---------------------------------- Comments ----------------------------------

- WATER CONTENT = 70.5%
- 25 MAY 94



Geotechnical Studies

Part 4:
Sedimentation Analysis
(University of Alaska-Fairbanks)

FINAL REPORT

RADIOISOTOPIC DETERMINATION OF SEDIMENTATION RATES

AND

GRAIN SIZE DISTRIBUTION AND SUSPENDED LOAD OF WATER SAMPLES

WILLIAMSPORT, ALASKA

Bruce Finney

and

Sathy Naidu

Institute of Marine Science
University of Alaska Fairbanks
Fairbanks, AK 99775

April 28, 1995

Reference: SFOS 94-126, SFOS 94-091
Contract/Purchase Order No.: DACW85-94-P-0522

INTRODUCTION

The U.S. Army Corps of Engineers, Alaska District, and the State of Alaska are proposing a feasibility study regarding designs for improved navigational access at Williamsport in Iliamna Bay, Lower Cook Inlet. As part of this study, we have: 1) estimated sedimentation rates in this area by radiocarbon dating of sediment samples, and 2) determined grain size distributions and suspended concentrations of particles in water samples. This information will help to evaluate the effectiveness and costs of dredging and maintaining channels to improve access. Fieldwork was carried out in May 1994, coordinated with Dr. Orson Smith.

SEDIMENTATION RATES

OBJECTIVES AND METHODS

The main objective of this component of the project is to determine sedimentation rates in appropriate areas at Williamsport, Iliamna Bay, Alaska. Sedimentation rates have been determined by appropriate field sampling and radiocarbon dating of materials in these samples. These samples were collected during May 1994 by Bruce Finney. Sediment samples for this study were obtained in two ways. Three piston cores were collected in a transect offshore from the proposed dock using a Livingstone piston core. Locations, lengths, and descriptions of these cores are given in Table 1. These cores were subsampled at intervals of 1 - 2 cm. Subsamples are being stored at UAF for possible future analysis, including ^{210}Pb dating. The second method of field sampling entailed examination of geologic sections of the intertidal sediments exposed by stream cuts in the field area. Four sections were selected after a reconnaissance survey. Each section was described and sediment samples were collected for laboratory analysis (Table 1). Samples have been archived from the cores and sections for future additional analyses.

Radiocarbon (^{14}C) dating

Carbon-14 (^{14}C) is a naturally occurring radioisotope of carbon with a half-live of about 5,730 years (Faure, 1986). It is useful for dating carbon-containing samples from 100 to about 40,000 years old. We used the accelerator mass spectrometric method (AMS) for dating materials in the cores because the samples were of relatively small size (Taylor, 1987). Materials for AMS dating were selected by visually inspecting the cores and sections for carbon-bearing materials such as wood, plant materials and shells. Any such materials were carefully picked from the cores or sections. In some intervals, relatively small organic particles were observed and these were isolated by sieving the samples through a 0.5 mm sieve. The carbon samples were carefully washed with distilled water and placed in clean vials. The samples for ^{14}C determination were sent for processing to the University of Minnesota Radiocarbon Preparation Lab, and from there to Lawrence Livermore National Laboratory for AMS ^{14}C measurements.

Sedimentation Rate Determination

Four cores or sections were dated along an offshore transect from the proposed dock (Table 2). The sites selected encompass a wide range of representative environments within the bay. For each site, the sample considered to be the most reliable candidate was submitted for AMS dating. The reported ^{14}C ages were calibrated to calendar years using the CALIBETH calibration program (e.g., Stuiver and Kra, 1986). Sedimentation rates were calculated from relationships between calibrated ^{14}C age and sub-bottom depth. The sedimentation rate information is summarized in Table 2. The rates are generally similar and average 0.18 cm/year.

Several factors lead to uncertainty in the sedimentation rate estimates. Some uncertainty comes from analytical measurement and uncertainty in calibration due to natural fluctuations in ^{14}C production. The analytical uncertainty is listed in the "^{14}C Age" column of Table 2, and the total uncertainty due to both analytical and calibration uncertainties is found in the "Date-Calibrated" column. Because these samples are young compared to the half-life of ^{14}C, the relative error in terms of the sedimentation rate estimate is generally greatest for the youngest samples. Percent error relative to the sedimentation rate estimate is 4% for CB3, 9% for CB4, 12% for Core 1 and 28% for CB2 (the youngest sample). Another source of uncertainty is due to an unknown amount of time before incorporation of the carbon-bearing material into the sediments. This error would tend to make the sedimentation rate estimates lower limits. As these estimates reflect average sedimentation rates over the time interval dated, any recent change in sedimentation processes could result in different sedimentation rates at the present time. In the following section, factors that could result in changes in sedimentation rate are discussed.

On the intertidal mudflats, sedimentation is relatively slow. Even though the overlying water has extremely high suspended loads (10 - 70 mg/l), tidal currents prohibit rapid sediment accumulation. Seismic reflection data show about 2 to 4 m of mud overlying coarser material, also indicating relatively slow accumulation of mud over the late Quaternary. Such slow sedimentation on intertidal mudflats in not surprising, as the present mud flat elevation is probably at near equilibrium with current sea level. Subsidence, tectonic movement, global sea-level change and variation in sediment load are the main factors that could result in changes in sedimentation rates. Relative sea-level change due to subsidence and tectonic activity would effect sedimentation rates. However, no significant recent changes (e.g., post 1964 earthquake) in relative sea-level at the study site were observed as part of the field expedition or in the regional study of Plafker (1969). Another possible factor that could effect sedimentation rates would be increased local sediment loading due to road building, etc.

Several observations made as part this study point to important processes in this intertidal environment that may be pertinent with regard to possible future dredging. Any depressions in the mudflats would tend to sediment more rapidly than the mudflats, and thus sedimentation rate estimates based on mudflat environments may not apply to dredged channels. The intertidal river channels are erosional features cutting across the mudflats that prohibit mud accumulation. The channels are conduits of higher water velocities due to freshwater discharge and the focusing of water during tidal cycles. The deposits sampled for radiocarbon analysis probably represent former river channel materials overlain by intertidal mudflat sediments that have been subsequently cut by river channels. Although channels are essentially erosional, natural channels tend to be migratory features that wander across the mudflats over time. Nonetheless, if a dredged channel served to focus freshwater discharge and/or tidal currents, sedimentation rates could be lower than the mudflat estimates in areas not acting as deltas.

DELIVERABLES

This letter report includes all the deliverables as described in the original agreement relevant to this analysis. This includes description of the analytical methods employed, sediment core descriptions, tabulation of all laboratory results, and estimates of sedimentation rates for each core.

DETERMINATION OF GRAIN SIZE DISTRIBUTIONS AND SUSPENDED PARTICLE CONCENTRATIONS

OBJECTIVES AND METHODS

The objective of this component of the project is to determine the grain size distribution and suspended particle concentration in water samples collected in the Williamsport study area. Ten samples were collected during the field expedition in May 1994 by personnel employed by the U.S. Army Corps of Engineers and shipped to UAF for analysis.

The method of analysis is modified from Krumbein and Pettijohn (1938) and Folk (1980) as briefly described below. The volume of water in each sample was measured using a graduated cylinder. Each sample was then sieved through a 230-mesh sieve (0.062 mm) to separate the sand (coarse) and mud (fine) fractions. The sand fraction was then dried and weighed. The mud fraction was collected by filtration, dried and weighed. The total suspended load was calculated as the dry weight of the sand and mud fractions, divided by the volume of water. The grain size distribution of the mud fraction was determined by analysis on a Met One laser particle size analyzer. Counts of particles were determined for 15 size classes and converted to mass assuming a particle density of 2.65 g/cm^2. If the sand fraction consisted of more than 5% of the total suspended mass, then further size grading was done using sieving techniques. All weights were determined on a digital Mettler balance. Grain size data for the sand and mud fractions were integrated and a cumulative mass vs. particle size distribution determined. From this distribution, standard grain size parameters were calculated following Folk (1980). The results are summarized in Table 3. Appendix 1 contains detailed grain size information for each individual sample.

DELIVERABLES

This letter report includes all the deliverables as described in the original agreement relevant to this analysis, which include: description of the analytical methods employed, tabulated data of grain size parameters and suspended load concentration, and laboratory sheets detailing analysis of individual samples.

REFERENCES

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Folk, R. L. (1980). Petrology of Sedimentary Rocks. Hemphill Publishing Co., Austin, Texas., 182 pp.

Krumbein, W. C. and Pettijohn, F. J. (1938). Manual of Sedimentary Petrography. Appleton-Century, NY, 549 pp.

Plafker, G. (1969). Tectonics of the March 27, 1964 Alaska Earthquake. U.S. Geological Survey Professional Paper, **543-I**, 74 pp.

Stuiver, M. and Kra, R.S. (1986) Proceedings of the 12th international radiocarbon conference, Trondheim, Norway. *Radiocarbon* **28**.

Taylor, R.E. (1987). Radiocarbon Dating and Archaeological Perspective. Academic Press, NY, 212 pp.

TABLE 1. Site Locations and Geologic Descriptions, Williamsport, Alaska.

SITE ID	LOCATION	DESCRIPTION
CORE SAMPLES		
Core 1	59° 40.96' N, 153°37.71' W	Core length 70 cm. 0-5 cm: homogeneous non-compacted grey mud. 5-66 cm: compacted grey mud with rare gravel. 66-70 cm: Orange Fe-crust overlying sandy gravel with some organic matter present.
Core 2	59° 40.96' N, 153°37.63' W	Core length 25 cm. 0-5 cm: homogeneous non-compacted grey mud. 5-25 cm: compacted grey mud with no gravel or macrofossils observed.
Core 3	59° 40.95' N, 153°37.57' W	Core length 25 cm. 0-10 cm homogeneous non-compacted grey mud. 10-25 cm: compacted grey mud with black silt bands, occasional sand but no macrofossils observed.
GEOLOGICAL SECTIONS		
CB1	59° 41.00' N, 153°37.68' W	Section height 122 cm. Black-grey mud with rare sand and macrofossils.
CB2	59° 40.94' N, 153°37.66' W	Section height 82 cm. 0-48 cm: compacted grey mud. 48-82 cm: coarser with visible bedding planes. Many layers contain organics and shells from 78-82 cm.
CB3	59° 40.94' N, 153°37.38' W	Section height 180 cm. Section is homogeneous grey compacted silt with rare gravel and macrofossils. Lens with molluscs shells-180 cm.
CB4	59° 40.95' N, 153°37.47' W	Section height 160 cm. Homogeneous grey mud with rare gravel. Layer with organics and shells at 160 cm.

TABLE 2. Radiocarbon Analysis and Sedimentation Rates, Williamsport, Alaska.

Sample/Depth	CAMS #	Material Dated	^{14}C Age (yr before 1950)	Date-Calibrated (year)	Sedimentation Rate (cm/year)
Core 1, 67-70 cm	18703	terrestrial organic macrofossils	320±40	1563±52 AD	0.16
CB2, 78 cm	18705	wood	280±60	1614±106 AD	0.20
CB3, 180 cm	19244	shells	2120±60	181±95 BC	0.08
CB4, 160 cm	18704	wood	500±60	1408±55 AD	0.27

TABLE 3.
Summary of Water Particle Analysis - Williamsport, Alaska
Bruce Finney, University of Alaska Fairbanks

Sample ID	Date	Time	Volume (l)	Suspended conc. (mg/l)	Sand (%)	Mud (%)	Mean (Ø)	Median (Ø)	Sorting (Ø)	Skewness (Ø)	Kurtosis (Ø)
D 1	5/24/94	0010	7.012	70.57	3.88	96.12	4.63	4.51	0.58	0.40	1.03
D 2	5/24/94	0100	4.862	49.14	8.83	91.17	4.66	4.58	0.62	0.16	1.19
D 3	5/24/94	0200	7.170	37.55	57.75	42.25	3.90	3.86	0.65	0.18	1.01
D 4	5/25/94	1440	6.421	55.98	16.67	83.34	4.62	4.57	0.74	0.11	1.24
D 5	5/25/94	1520	7.831	23.37	13.88	86.12	4.72	4.63	0.76	0.13	1.18
D 7	5/24/94	1720	5.610	23.15	2.23	97.77	4.78	4.66	0.62	0.38	1.01
C-1 Drill hole #3	5/26/94	1700	9.380	30.31	5.70	94.30	5.68	5.86	0.93	-0.28	1.16
C 2	5/26/94	1710	10.045	16.35	10.23	89.77	5.70	5.84	1.02	-0.25	1.25
15' open water			10.370	8.17	8.67	91.28	4.40	4.33	0.45	0.22	1.61
15' dup			10.370	8.17	8.67	91.28	4.41	4.34	0.46	0.22	1.61
35' open water			10.775	24.75	21.94	78.06	4.36	4.34	0.72	0.09	1.59

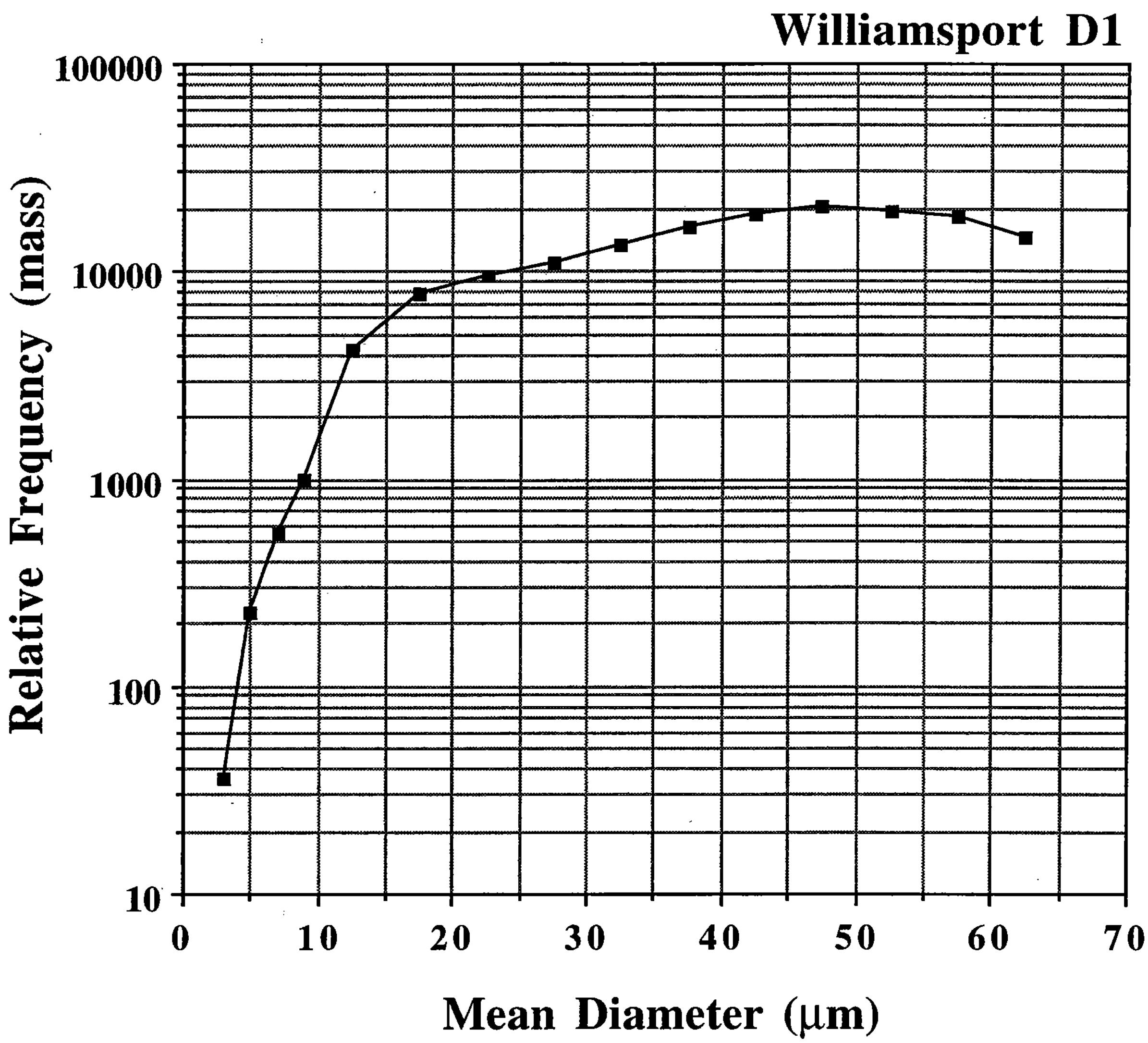
dup = duplicate sample for particle size

APPENDIX 1

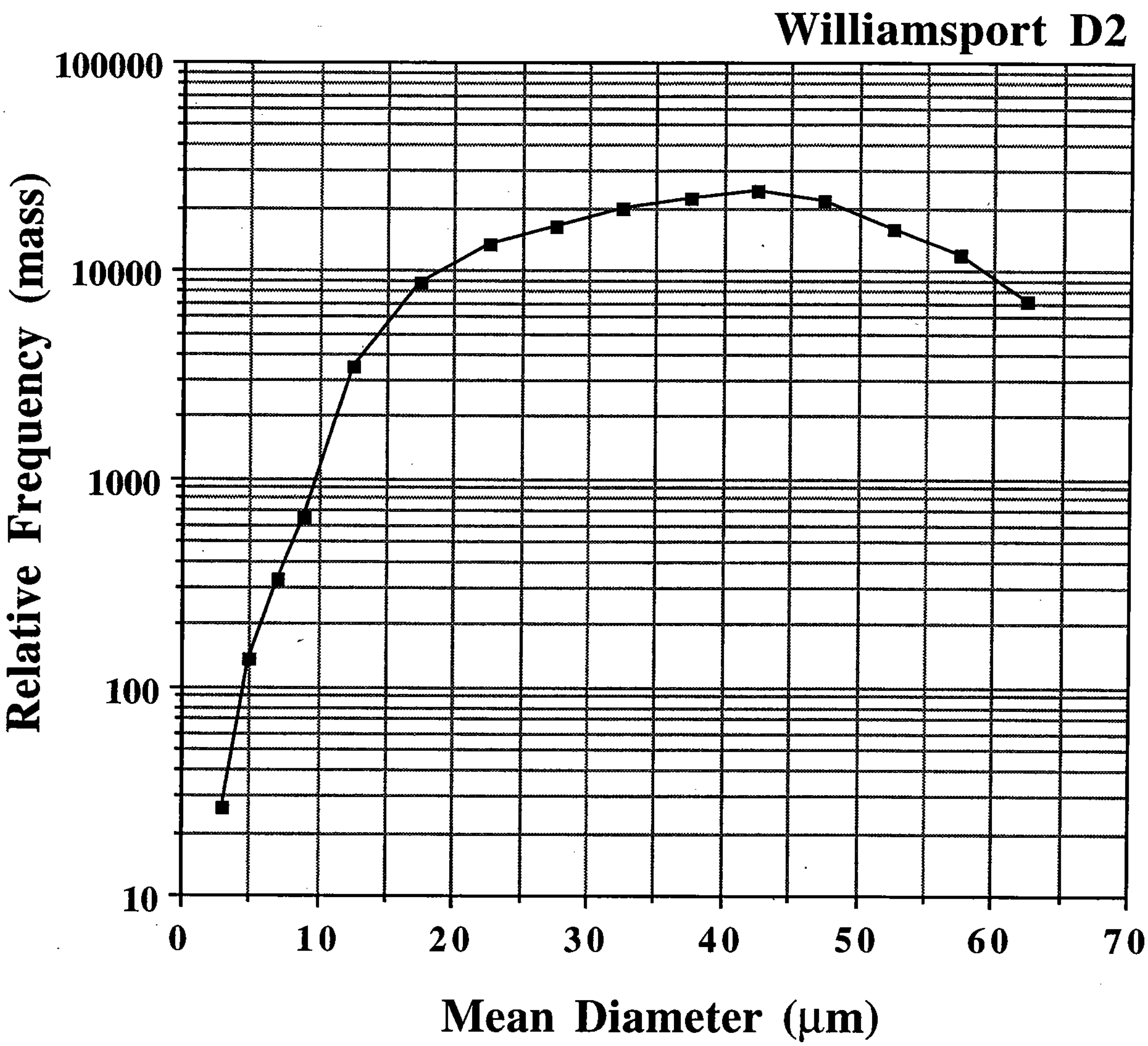
DETAILED DATA ON GRAIN SIZE DISTRIBUTIONS OF SUSPENDED PARTICLES IN WATER SAMPLES, WILLIAMSPORT, ALASKA

(Data summarized in Table 3)

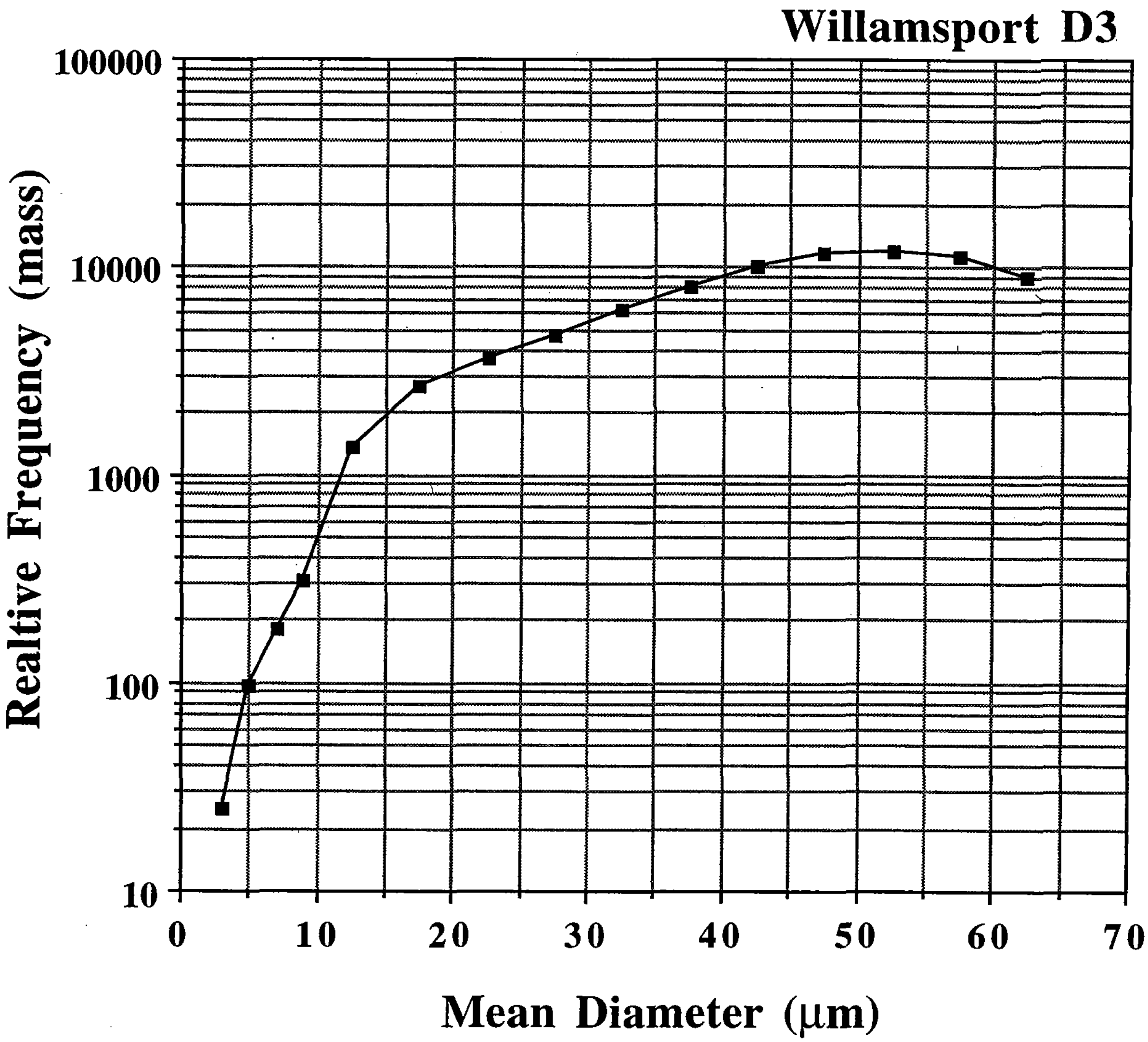
SAMPLE #						sus conc (mg/l)	
D 1						70.57	
Diameter (µm)	Ø	Counts	rel wt. mud	Wt. sand (g)	Wt. mud (g)	rel wt. fr	Cum. wt. %
125	3	-		0	0.4757	0	0
62.5	4	-		0.0192	0.4757	0.0388	3.88
60	4.1	45.18	14401.291	0.0192	0.4757	0.089	12.78
55	4.2	69.82	18412.82	0.0192	0.4757	0.1138	24.16
50	4.3	96.54	19378.588	0.0192	0.4757	0.1197	36.13
45	4.5	137.07	20377.935	0.0192	0.4757	0.1259	48.72
40	4.6	178.02	18957.127	0.0192	0.4757	0.1171	60.44
35	4.8	219.87	16084.098	0.0192	0.4757	0.0994	70.37
30	5.1	281.49	13404.48	0.0192	0.4757	0.0828	78.66
25	5.3	385.38	11117.936	0.0192	0.4757	0.0687	85.53
20	5.6	609.47	9630.233	0.0192	0.4757	0.0595	91.48
15	6.1	1046.49	7780.117	0.0192	0.4757	0.0481	96.29
10	6.6	1558.99	4223.868	0.0192	0.4757	0.0261	98.9
8	7	966.61	977.498	0.0192	0.4757	0.006	99.5
6	7.4	1158.47	551.208	0.0192	0.4757	0.0034	99.84
4	8	1285.73	222.944	0.0192	0.4757	0.0014	99.98
2	9	964.6	36.128	0.0192	0.4757	0.0002	100
						1	
Percentile	Ø		Mean (Ø)	4.6267			
5	4.01		Median (Ø)	4.51			
16	4.12		Sorting (Ø)	0.5764			
25	4.2		Skewness (Ø)	0.3971			
50	4.51		Kurtosis (Ø)	1.0326			
75	4.97		Sand (%)	3.8799			
84	5.25		Mud (%)	96.1201			
95	5.95						


Williamsport D1
Relative Frequency (mass)
100000
10000
1000
100
10
0
10
20
30
40
50
60
70
Mean Diameter (μm)

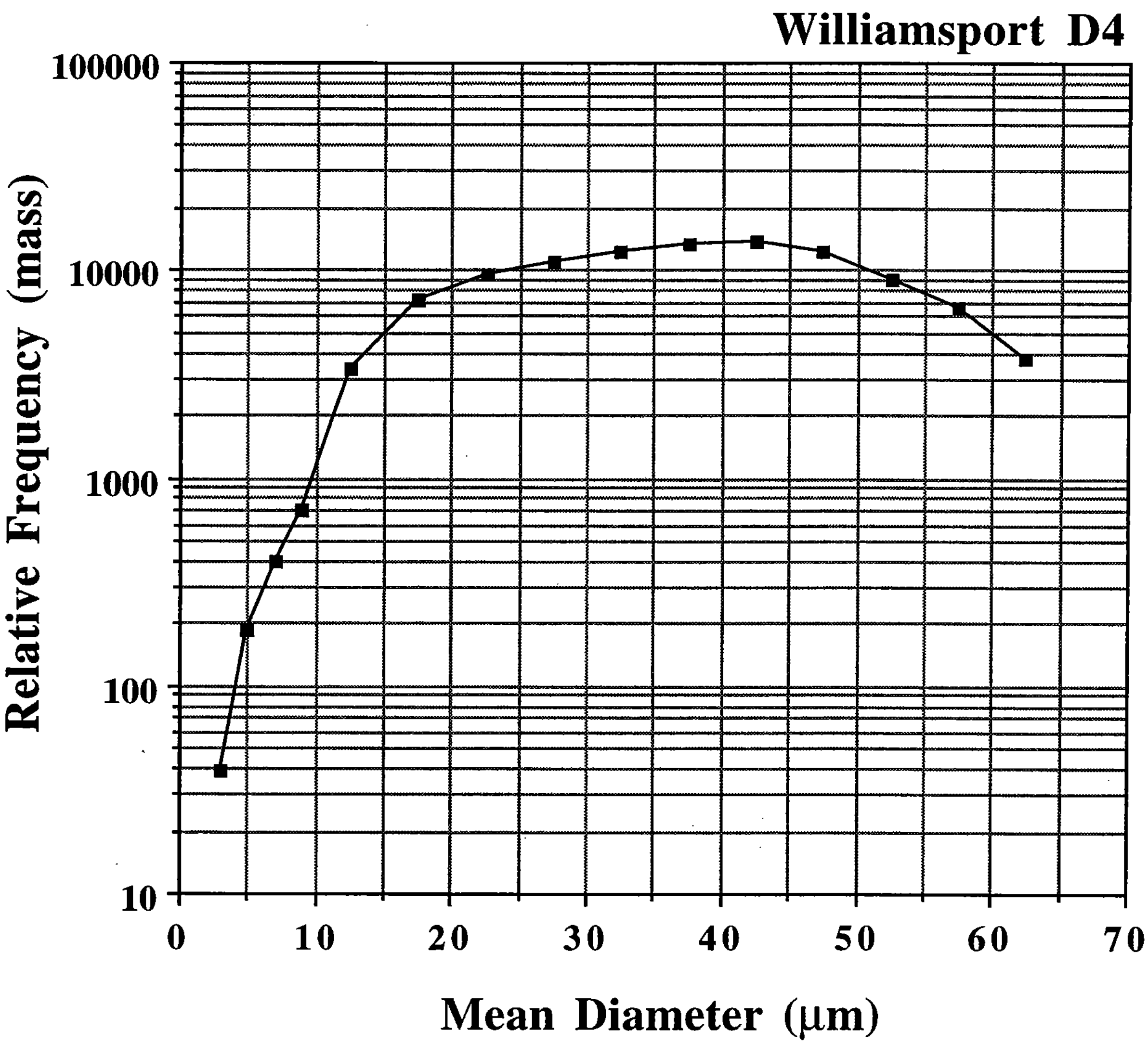
SAMPLE #						sus conc (mg/l)	
D 2						49.14	
Diameter (µm)	Ø	Counts	rel wt. mud	Wt. sand (g)	Wt. mud (g)	rel wt. fr	Cum. wt. %
125	3	-		0	0.2178	0	0
62.5	4	-		0.0211	0.2178	0.0883	8.83
60	4.1	22.55	7187.895	0.0211	0.2178	0.0395	12.78
55	4.2	45.65	12038.746	0.0211	0.2178	0.0661	19.4
50	4.3	79.89	16036.414	0.0211	0.2178	0.0881	28.21
45	4.5	143.64	21354.684	0.0211	0.2178	0.1173	39.94
40	4.6	226.96	24168.686	0.0211	0.2178	0.1328	53.22
35	4.8	307.36	22484.233	0.0211	0.2178	0.1235	65.57
30	5.1	413.95	19712.191	0.0211	0.2178	0.1083	76.4
25	5.3	569.53	16430.531	0.0211	0.2178	0.0903	85.43
20	5.6	836	13209.633	0.0211	0.2178	0.0726	92.69
15	6.1	1172.87	8719.688	0.0211	0.2178	0.0479	97.48
10	6.6	1276.11	3457.443	0.0211	0.2178	0.019	99.38
8	7	641.76	648.989	0.0211	0.2178	0.0036	99.73
6	7.4	685.12	325.985	0.0211	0.2178	0.0018	99.91
4	8	773.45	134.116	0.0211	0.2178	0.0007	99.99
2	9	700.06	26.22	0.0211	0.2178	0.0001	100
						1	
Percentile	Ø		Mean (Ø)	4.6633			
5	3.56		Median (Ø)	4.58			
16	4.15		Sorting (Ø)	0.6214			
25	4.28		Skewness (Ø)	0.1633			
50	4.58		Kurtosis (Ø)	1.1927			
75	5.06		Sand (%)	8.8322			
84	5.26		Mud (%)	91.1678			
95	5.83						


Williamsport D2
Relative Frequency (mass)
100000
10000
1000
100
10
0
10
20
30
40
50
60
70
Mean Diameter (µm)

SAMPLE #						sus conc (mg/l)	
D 3						37.55	
Diameter (µm)	Ø	Counts	rel wt. mud	Wt. sand (g)	Wt. mud (g)	rel wt. fr	Cum. wt. %
125	3	-		0	0.1138	0	0
62.5	4	-		0.1555	0.1138	0.5775	57.75
60	4.1	28.55	9100.417	0.1555	0.1138	0.0474	62.49
55	4.2	42.58	11229.13	0.1555	0.1138	0.0585	68.33
50	4.3	59.67	11977.629	0.1555	0.1138	0.0624	74.57
45	4.5	77.98	11593.137	0.1555	0.1138	0.0604	80.61
40	4.6	95.22	10139.858	0.1555	0.1138	0.0528	85.89
35	4.8	109.53	8012.422	0.1555	0.1138	0.0417	90.06
30	5.1	130.42	6210.566	0.1555	0.1138	0.0323	93.29
25	5.3	161.26	4652.235	0.1555	0.1138	0.0242	95.71
20	5.6	229.95	3633.439	0.1555	0.1138	0.0189	97.6
15	6.1	356.52	2650.544	0.1555	0.1138	0.0138	98.98
10	6.6	494.46	1339.671	0.1555	0.1138	0.007	99.68
8	7	306.56	310.013	0.1555	0.1138	0.0016	99.84
6	7.4	376.83	179.298	0.1555	0.1138	0.0009	99.94
4	8	553.02	95.893	0.1555	0.1138	0.0005	99.99
2	9	657.18	24.614	0.1555	0.1138	0.0001	100
						1	
Percentile	Ø		Mean (Ø)	3.8967			
5	3.08		Median (Ø)	3.86			
16	3.27		Sorting (Ø)	0.6483			
25	3.43		Skewness (Ø)	0.1798			
50	3.86		Kurtosis (Ø)	1.0128			
75	4.3		Sand (%)	57.7494			
84	4.56		Mud (%)	42.2506			
95	5.23						

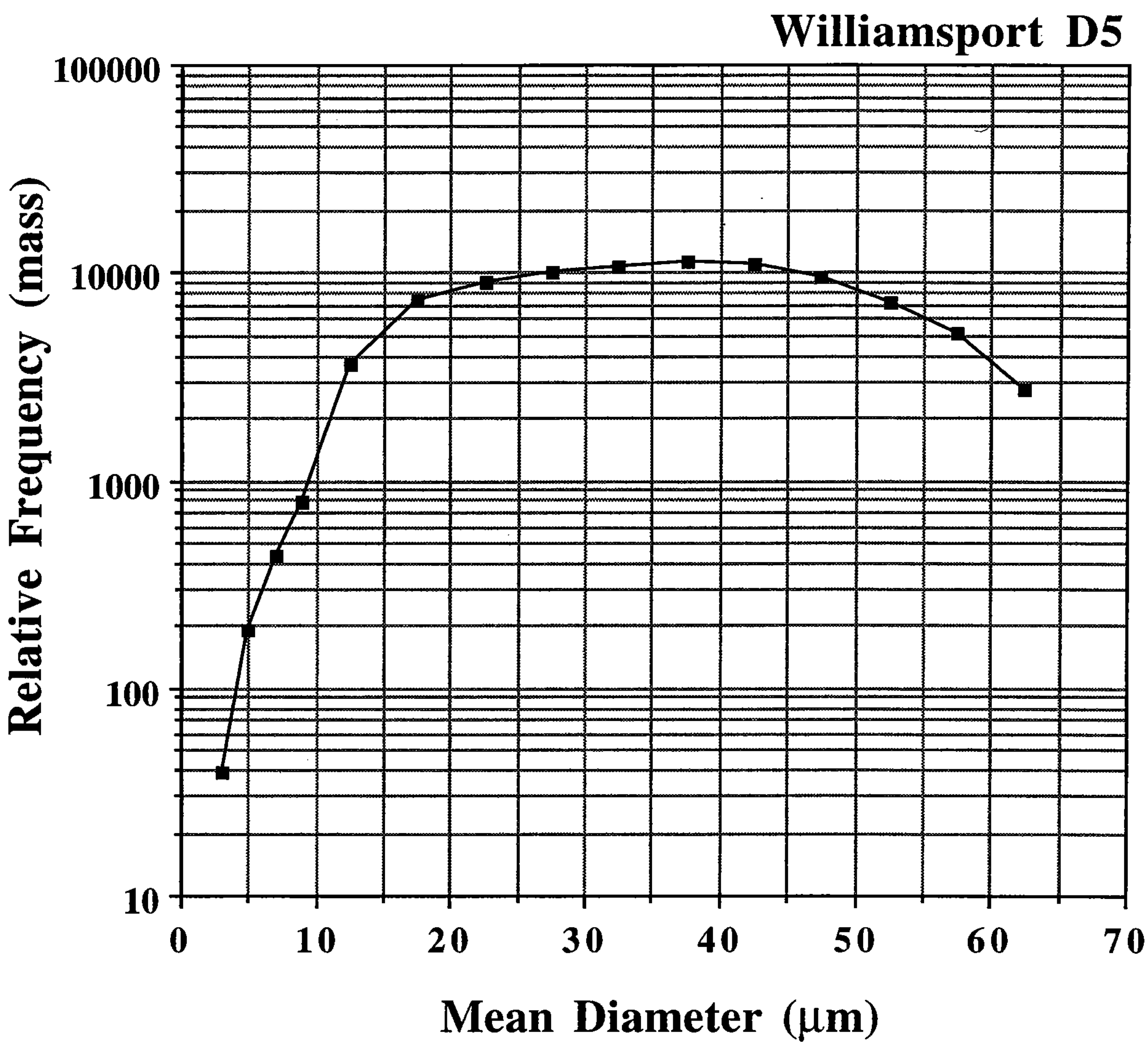

Willamsport D3
100000
10000
1000
100
10
Realtive Frequency (mass)
0
10
20
30
40
50
60
70
Mean Diameter (µm)

SAMPLE #						sus conc (mg/l)	
D 4						55.98	
Diameter (µm)	Ø	Counts	rel wt. mud	Wt. sand (g)	Wt. mud (g)	rel wt. fr	Cum. wt. %
125	3	-		0	0.2996	0	0
62.5	4	-		0.0599	0.2996	0.1666	16.66
60	4.1	11.77	3751.731	0.0599	0.2996	0.0301	19.67
55	4.2	25.16	6635.155	0.0599	0.2996	0.0532	24.99
50	4.3	45.35	9103.159	0.0599	0.2996	0.073	32.29
45	4.5	82.06	12199.703	0.0599	0.2996	0.0978	42.07
40	4.6	130.87	13936.182	0.0599	0.2996	0.1117	53.24
35	4.8	185.18	13546.428	0.0599	0.2996	0.1086	64.1
30	5.1	260.38	12399.228	0.0599	0.2996	0.0994	74.04
25	5.3	379.23	10940.513	0.0599	0.2996	0.0877	82.81
20	5.6	607.67	9601.792	0.0599	0.2996	0.077	90.51
15	6.1	970.27	7213.461	0.0599	0.2996	0.0578	96.29
10	6.6	1218.33	3300.896	0.0599	0.2996	0.0265	98.94
8	7	695.88	703.718	0.0599	0.2996	0.0056	99.5
6	7.4	826.13	393.079	0.0599	0.2996	0.0032	99.82
4	8	1068.64	185.301	0.0599	0.2996	0.0015	99.97
2	9	1055.06	39.516	0.0599	0.2996	0.0003	100
						1	
Percentile	Ø		Mean (Ø)	4.6267			
5	3.39		Median (Ø)	4.57			
16	3.96		Sorting (Ø)	0.7414			
25	4.26		Skewness (Ø)	0.1073			
50	4.57		Kurtosis (Ø)	1.239			
75	5.12		Sand (%)	16.6637			
84	5.35		Mud (%)	83.3363			
95	5.99						

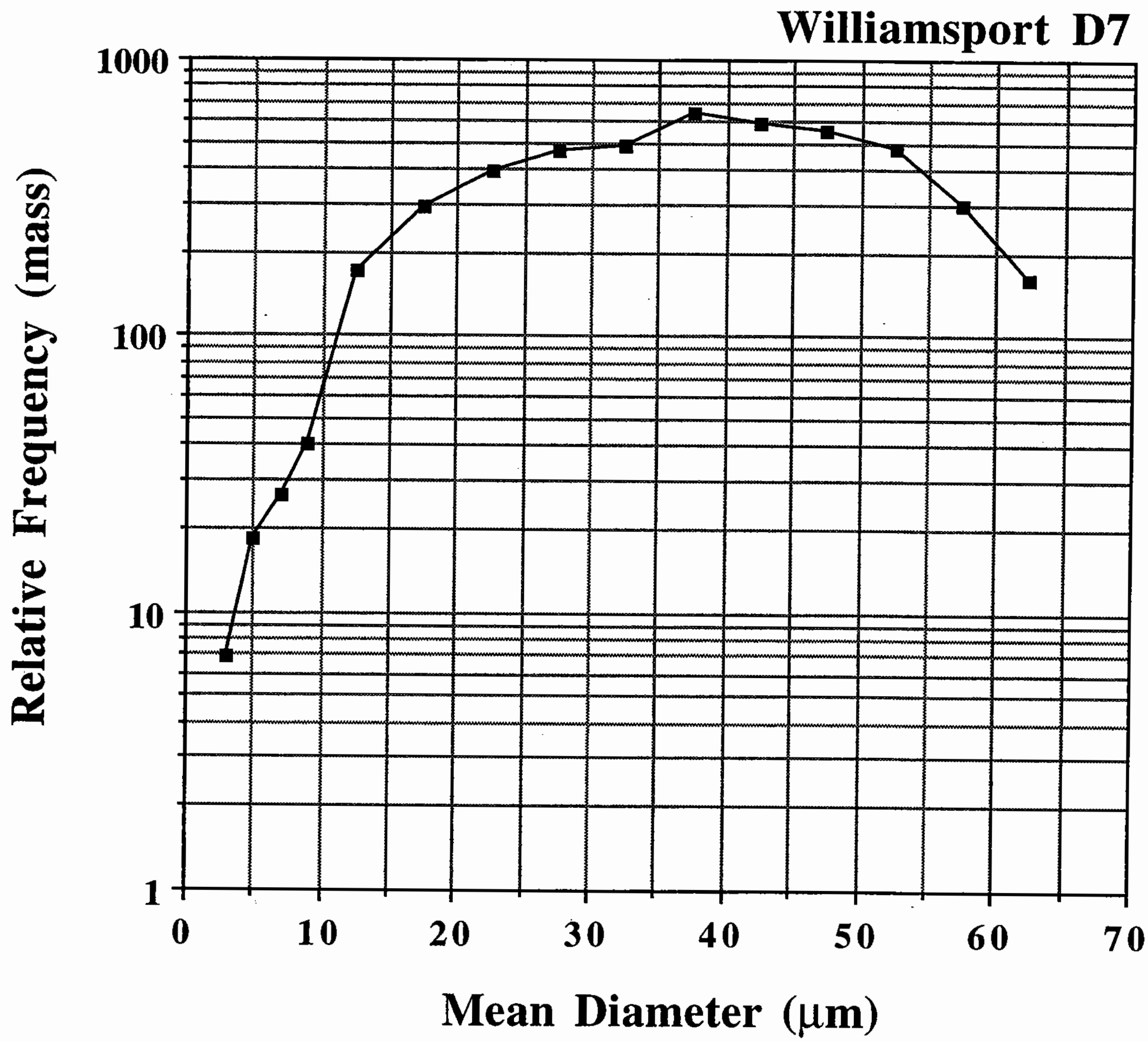


Williamsport D4
Relative Frequency (mass)
100000
10000
1000
100
10
0
10
20
30
40
50
60
70
Mean Diameter (μm)

SAMPLE #						sus conc (mg/l)	
D 5						23.37	
Diameter (µm)	Ø	Counts	rel wt. mud	Wt. sand (g)	Wt. mud (g)	rel wt. fr	Cum. wt. %
125	3	-		0	0.1576	0	0
62.5	4	-		0.0254	0.1576	0.1388	13.88
60	4.1	8.53	2718.969	0.0254	0.1576	0.0264	16.51
55	4.2	19.14	5047.57	0.0254	0.1576	0.049	21.41
50	4.3	35.21	7067.745	0.0254	0.1576	0.0686	28.27
45	4.5	63.54	9446.37	0.0254	0.1576	0.0916	37.43
40	4.6	103.07	10975.795	0.0254	0.1576	0.1065	48.07
35	4.8	156.07	11416.952	0.0254	0.1576	0.1107	59.15
30	5.1	221.48	10546.82	0.0254	0.1576	0.1023	69.38
25	5.3	350.6	10114.558	0.0254	0.1576	0.0981	79.19
20	5.6	573.6	9063.452	0.0254	0.1576	0.0879	87.98
15	6.1	989.06	7353.155	0.0254	0.1576	0.0713	95.11
10	6.6	1327.6	3596.948	0.0254	0.1576	0.0349	98.6
8	7	773.93	782.647	0.0254	0.1576	0.0076	99.36
6	7.4	903.26	429.778	0.0254	0.1576	0.0042	99.78
4	8	1110.2	192.508	0.0254	0.1576	0.0019	99.96
2	9	1044.54	39.122	0.0254	0.1576	0.0004	100
						1	
Percentile	Ø		Mean (Ø)	4.72			
5	3.36		Median (Ø)	4.63			
16	4.07		Sorting (Ø)	0.7611			
25	4.26		Skewness (Ø)	0.1319			
50	4.63		Kurtosis (Ø)	1.1777			
75	5.21		Sand (%)	13.8773			
84	5.46		Mud (%)	86.1227			
95	6.09						


Williamsport D5
Relative Frequency (mass)
100000
10000
1000
100
10
0
10
20
30
40
50
60
70
Mean Diameter (µm)

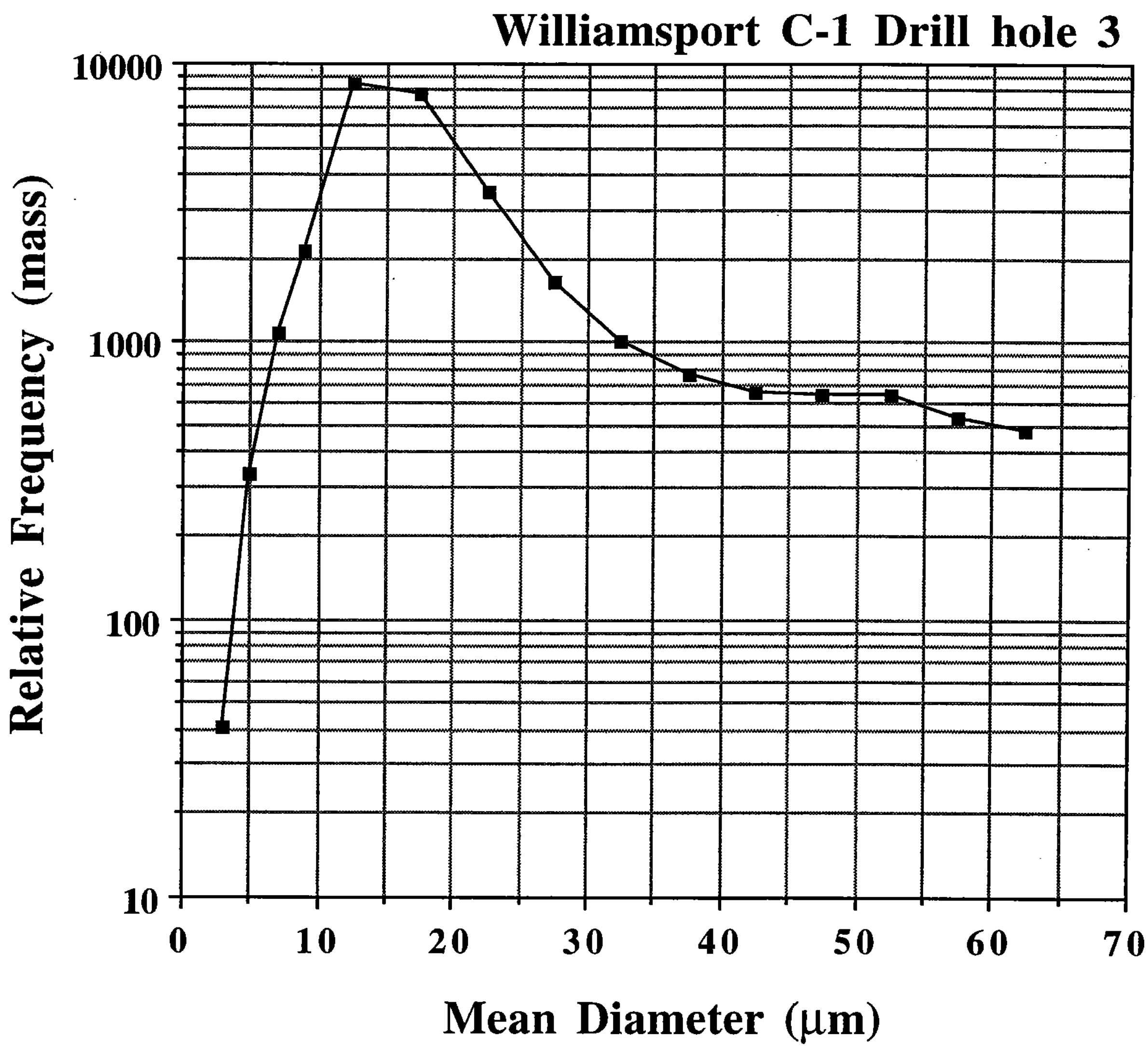
SAMPLE #						sus conc (mg/l)	
D 7						23.15	
Diameter (µm)	Ø	Counts	rel wt. mud	Wt. sand (g)	Wt. mud (g)	rel wt. fr	Cum. wt. %
125	3	-		0	0.127	0	0
62.5	4	-		0.0029	0.127	0.0223	2.23
60	4.1	0.5	159.377	0.0029	0.127	0.0339	5.62
55	4.2	1.12	295.365	0.0029	0.127	0.0628	11.9
50	4.3	2.35	471.718	0.0029	0.127	0.1003	21.92
45	4.5	3.69	548.585	0.0029	0.127	0.1166	33.58
40	4.6	5.52	587.818	0.0029	0.127	0.1249	46.08
35	4.8	8.7	636.429	0.0029	0.127	0.1353	59.6
30	5.1	10.27	489.055	0.0029	0.127	0.1039	70
25	5.3	16.11	464.762	0.0029	0.127	0.0988	79.88
20	5.6	24.89	393.287	0.0029	0.127	0.0836	88.23
15	6.1	39.29	292.101	0.0029	0.127	0.0621	94.44
10	6.6	62.62	169.66	0.0029	0.127	0.0361	98.05
8	7	39.62	40.066	0.0029	0.127	0.0085	98.9
6	7.4	55.29	26.307	0.0029	0.127	0.0056	99.46
4	8	106.95	18.545	0.0029	0.127	0.0039	99.85
2	9	183.53	6.874	0.0029	0.127	0.0015	100
						1	
Percentile	Ø		Mean (Ø)	4.78			
5	4.09		Median (Ø)	4.66			
16	4.24		Sorting (Ø)	0.6167			
25	4.35		Skewness (Ø)	0.3773			
50	4.66		Kurtosis (Ø)	1.0077			
75	5.2		Sand (%)	2.2332			
84	5.44		Mud (%)	97.7668			
95	6.18						



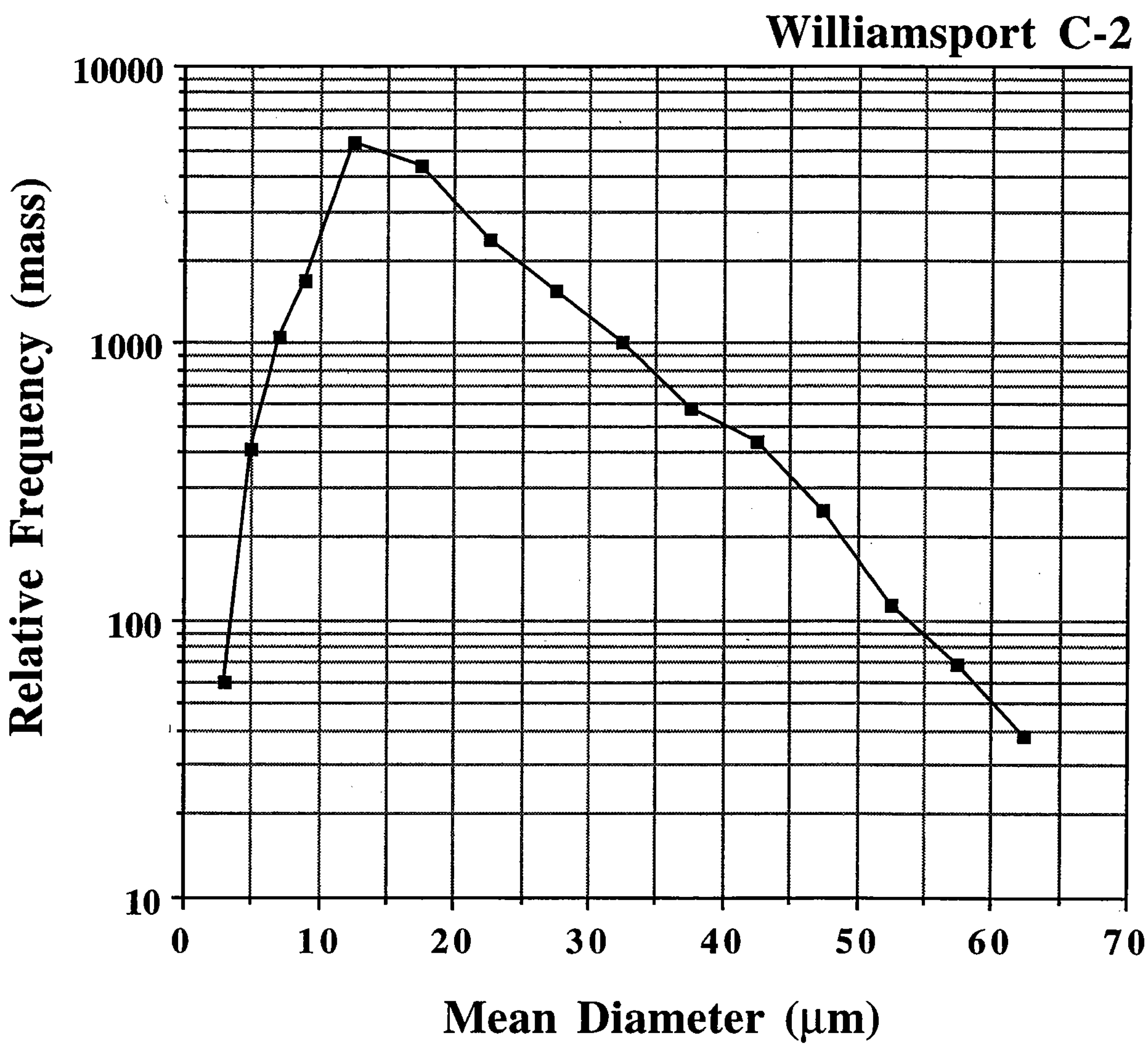
Williamsport D7
1000
100
10
1
Relative Frequency (mass)
0
10
20
30
40
50
60
70
Mean Diameter (µm)

C-1 Drill hole 3

SAMPLE #						sus conc (mg/l)	
C-1 Drill Hole 3						30.31	
Diameter (µm)	Ø	Counts	rel wt. mud	Wt. sand (g)	Wt. mud (g)	rel wt. fr	Cum. wt. %
125	3	-		0	0.2681	0	0
62.5	4	-		0.0162	0.2681	0.057	5.7
60	4.1	1.5	478.131	0.0162	0.2681	0.0153	7.23
55	4.2	2	527.437	0.0162	0.2681	0.0169	8.91
50	4.3	3.19	640.332	0.0162	0.2681	0.0205	10.96
45	4.5	4.3	639.273	0.0162	0.2681	0.0204	13
40	4.6	6.13	652.776	0.0162	0.2681	0.0209	15.09
35	4.8	10.34	756.4	0.0162	0.2681	0.0242	17.5
30	5.1	21.3	1014.3	0.0162	0.2681	0.0324	20.75
25	5.3	57.09	1647.005	0.0162	0.2681	0.0526	26.01
20	5.6	218.58	3453.782	0.0162	0.2681	0.1104	37.05
15	6.1	1031.69	7670.087	0.0162	0.2681	0.2451	61.56
10	6.6	3113.25	8434.92	0.0162	0.2681	0.2696	88.52
8	7	2112.56	2136.355	0.0162	0.2681	0.0683	95.35
6	7.4	2267.51	1078.898	0.0162	0.2681	0.0345	98.8
4	8	1930.53	334.752	0.0162	0.2681	0.0107	99.87
2	9	1089.53	40.807	0.0162	0.2681	0.0013	100
						1	
Percentile	Ø		Mean (Ø)	5.6833			
5	3.89		Median (Ø)	5.86			
16	4.67		Sorting (Ø)	0.9292			
25	5.26		Skewness (Ø)	-0.2829			
50	5.86		Kurtosis (Ø)	1.1581			
75	6.35		Sand (%)	5.6973			
84	6.52		Mud (%)	94.3027			
95	6.97						

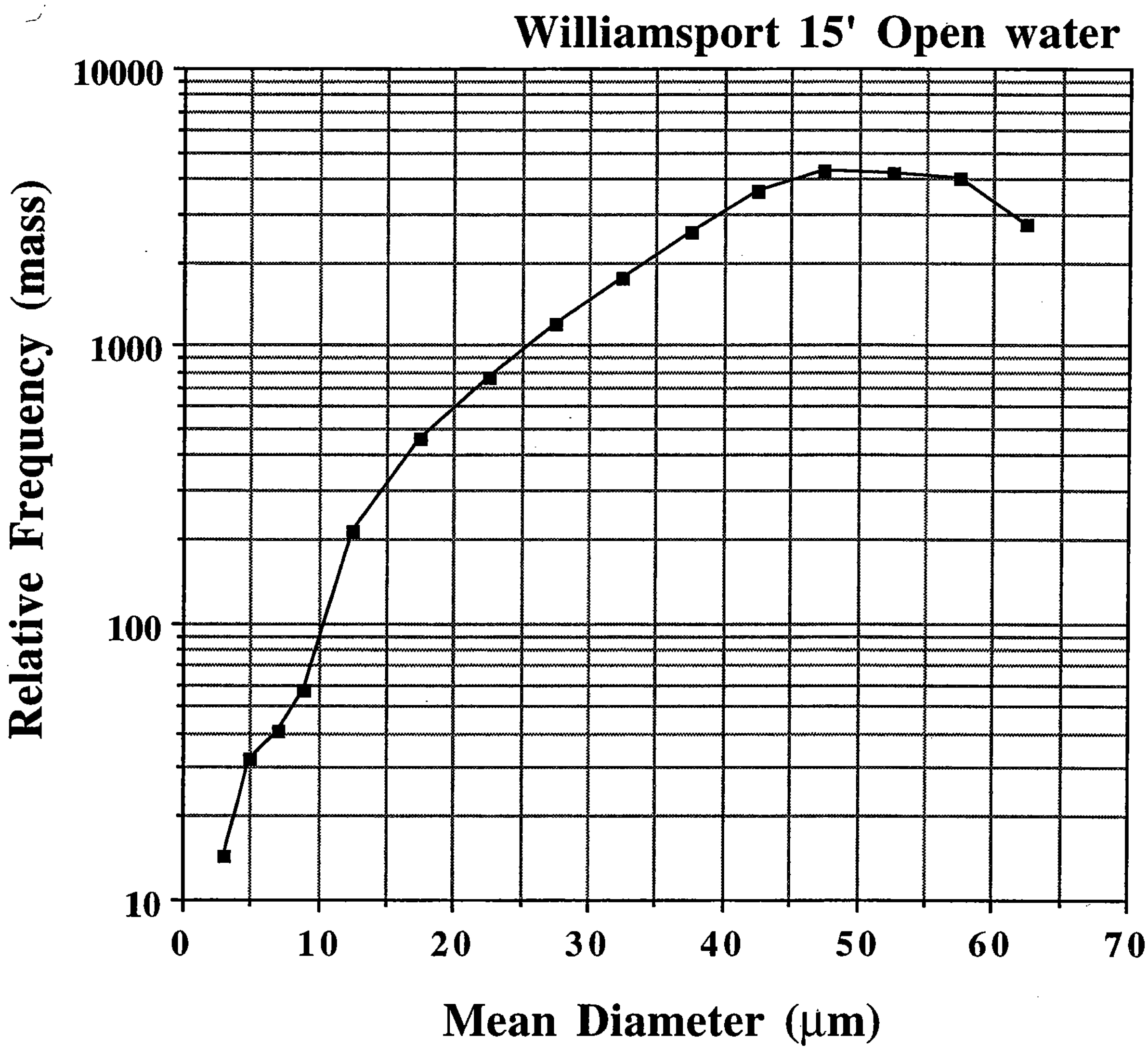

Williamsport C-1 Drill hole 3
Relative Frequency (mass)
10000
1000
100
10
0
10
20
30
40
50
60
70
Mean Diameter (μm)

SAMPLE #						sus conc (mg/l)	
C-2						16.35	
Diameter (µm)	Ø	Counts	rel wt. mud	Wt. sand (g)	Wt. mud (g)	rel wt. fr	Cum. wt. %
125	3	-		0	0.1475	0	0
62.5	4	-		0.0168	0.1475	0.1023	10.23
60	4.1	0.12	38.25	0.0168	0.1475	0.0018	10.41
55	4.2	0.26	68.567	0.0168	0.1475	0.0032	10.72
50	4.3	0.56	112.409	0.0168	0.1475	0.0052	11.25
45	4.5	1.65	245.302	0.0168	0.1475	0.0114	12.39
40	4.6	4.11	437.669	0.0168	0.1475	0.0204	14.43
35	4.8	8	585.222	0.0168	0.1475	0.0273	17.15
30	5.1	21.13	1006.205	0.0168	0.1475	0.0469	21.84
25	5.3	53.1	1531.897	0.0168	0.1475	0.0713	28.97
20	5.6	150.19	2373.152	0.0168	0.1475	0.1105	40.02
15	6.1	592.71	4406.495	0.0168	0.1475	0.2052	60.54
10	6.6	1947.89	5277.538	0.0168	0.1475	0.2458	85.12
8	7	1665.4	1684.159	0.0168	0.1475	0.0784	92.96
6	7.4	2189.4	1041.732	0.0168	0.1475	0.0485	97.81
4	8	2362.56	409.666	0.0168	0.1475	0.0191	99.72
2	9	1590.89	59.586	0.0168	0.1475	0.0028	100
						1	
Percentile	Ø		Mean (Ø)	5.7033			
5	3.49		Median (Ø)	5.84			
16	4.7		Sorting (Ø)	1.0236			
25	5.19		Skewness (Ø)	-0.25			
50	5.84		Kurtosis (Ø)	1.2534			
75	6.39		Sand (%)	10.2271			
84	6.57		Mud (%)	89.7729			
95	7.16						


Williamsport C-2
10000
1000
100
10
Relative Frequency (mass)
0
10
20
30
40
50
60
70
Mean Diameter (µm)

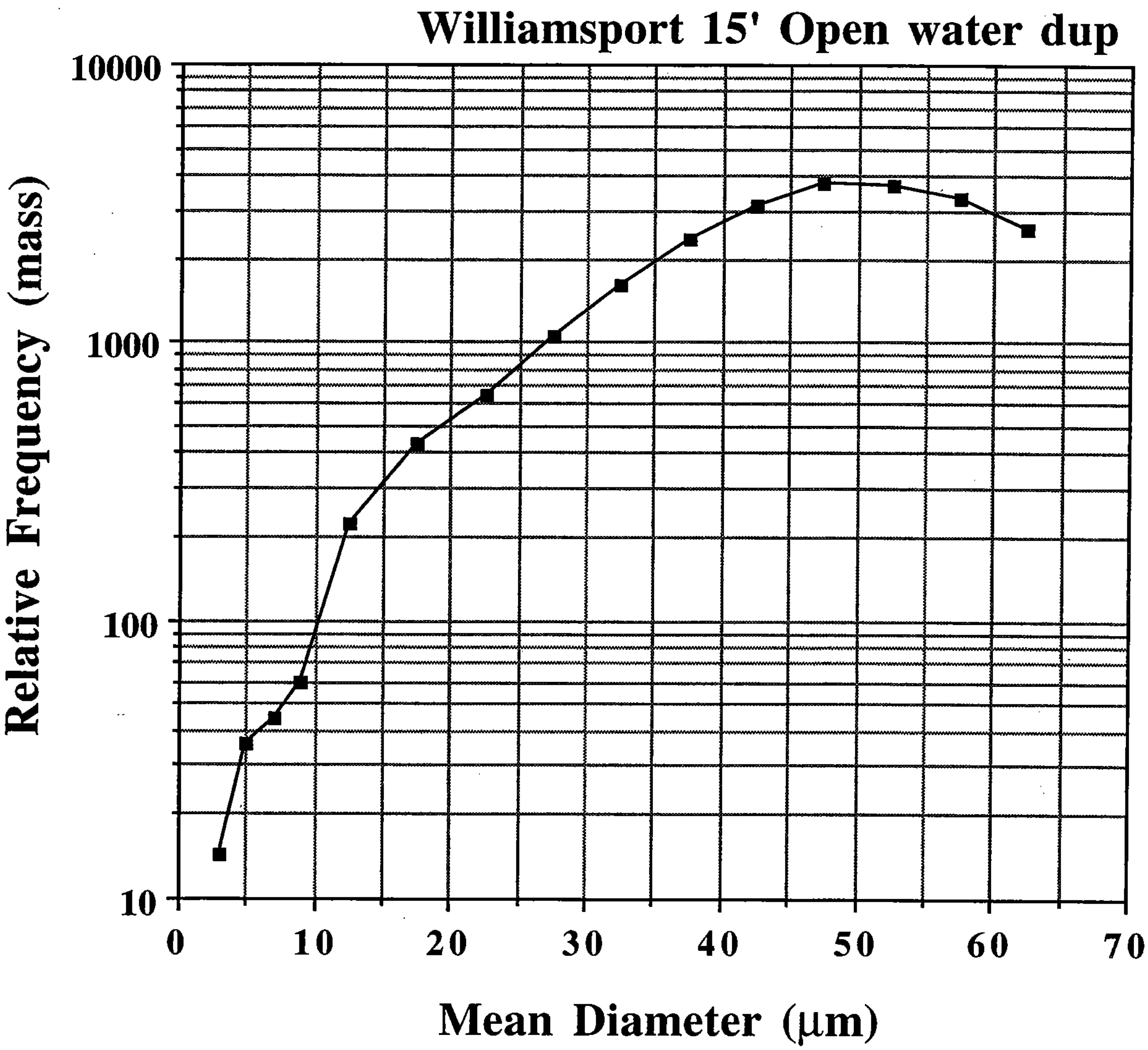
15' Open Water

SAMPLE #						sus conc (mg/l)	
15' Open water						8.17	
Diameter (µm)	Ø	Counts	rel wt. mud	Wt. sand (g)	Wt. mud (g)	rel wt. fr	Cum. wt. %
125	3	-		0	0.0774	0	0
62.5	4	-		0.0073	0.0774	0.0867	8.67
60	4.1	8.62	2747.657	0.0073	0.0774	0.0966	18.32
55	4.2	15.36	4050.715	0.0073	0.0774	0.1424	32.56
50	4.3	20.77	4169.187	0.0073	0.0774	0.1465	47.21
45	4.5	29.05	4318.808	0.0073	0.0774	0.1518	62.39
40	4.6	33.91	3611.033	0.0073	0.0774	0.1269	75.08
35	4.8	34.95	2556.689	0.0073	0.0774	0.0898	84.06
30	5.1	36.97	1760.502	0.0073	0.0774	0.0619	90.25
25	5.3	41.41	1194.649	0.0073	0.0774	0.042	94.45
20	5.6	48.4	764.768	0.0073	0.0774	0.0269	97.13
15	6.1	61.6	457.964	0.0073	0.0774	0.0161	98.74
10	6.6	78.7	213.227	0.0073	0.0774	0.0075	99.49
8	7	57	57.642	0.0073	0.0774	0.002	99.69
6	7.4	84.9	40.396	0.0073	0.0774	0.0014	99.84
4	8	185.2	32.114	0.0073	0.0774	0.0011	99.95
2	9	385.5	14.439	0.0073	0.0774	0.0005	100
						1	
Percentile	Ø		Mean (Ø)	4.4			
5	3.58		Median (Ø)	4.33			
16	4.07		Sorting (Ø)	0.4507			
25	4.15		Skewness (Ø)	0.2201			
50	4.33		Kurtosis (Ø)	1.612			
75	4.6		Sand (%)	8.6654			
84	4.8		Mud (%)	91.3346			
95	5.35						



Williamsport 15' Open water
Relative Frequency (mass)
10000
1000
100
10
0
10
20
30
40
50
60
70
Mean Diameter (µm)

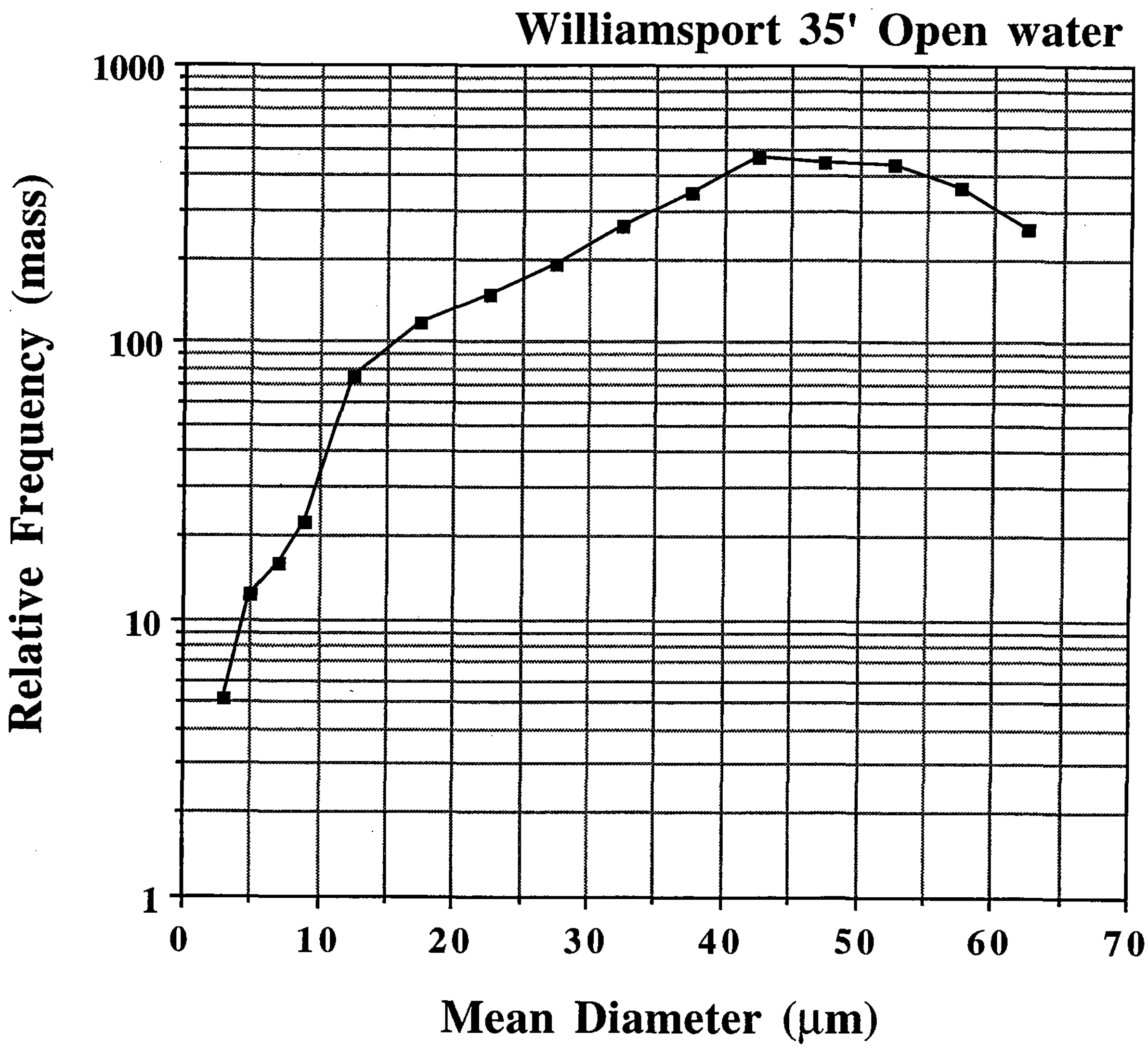
SAMPLE #						sus conc (mg/l)	
15' Open water dup						8.17	
Diameter (µm)	Ø	Counts	rel wt. mud	Wt. sand (g)	Wt. mud (g)	rel wt. fr	Cum. wt. %
125	3	-		0	0.0774	0	0
62.5	4	-		0.0073	0.0774	0.0867	8.67
60	4.1	8.01	2553.217	0.0073	0.0774	0.1019	18.85
55	4.2	12.43	3278.02	0.0073	0.0774	0.1308	31.94
50	4.3	18.38	3689.439	0.0073	0.0774	0.1472	46.66
45	4.5	25.46	3785.089	0.0073	0.0774	0.151	61.76
40	4.6	29.46	3137.158	0.0073	0.0774	0.1252	74.28
35	4.8	32.09	2347.472	0.0073	0.0774	0.0937	83.65
30	5.1	33.73	1606.214	0.0073	0.0774	0.0641	90.06
25	5.3	36.2	1044.344	0.0073	0.0774	0.0417	94.23
20	5.6	40.45	639.15	0.0073	0.0774	0.0255	96.78
15	6.1	58.24	432.985	0.0073	0.0774	0.0173	98.5
10	6.6	81.57	221.003	0.0073	0.0774	0.0088	99.39
8	7	58.52	59.179	0.0073	0.0774	0.0024	99.62
6	7.4	93.71	44.588	0.0073	0.0774	0.0018	99.8
4	8	206.15	35.746	0.0073	0.0774	0.0014	99.94
2	9	379.64	14.219	0.0073	0.0774	0.0006	100
						1	
Percentile	Ø		Mean (Ø)	4.41			
5	3.58		Median (Ø)	4.34			
16	4.08		Sorting (Ø)	0.4567			
25	4.15		Skewness (Ø)	0.2239			
50	4.34		Kurtosis (Ø)	1.6126			
75	4.61		Sand (%)	8.6654			
84	4.81		Mud (%)	91.3346			
95	5.39						



Williamsport 15' Open water dup
Relative Frequency (mass)
10000
1000
100
10
0
10
20
30
40
50
60
70
Mean Diameter (μm)

35' Open water

SAMPLE #						sus conc (mg/l)	
35' Open water						24.75	
Diameter (µm)	Ø	Counts	rel wt. mud	Wt. sand (g)	Wt. mud (g)	rel wt. fr	Cum. wt. %
125	3	-		0	0.2081	0	0
62.5	4	-		0.0585	0.2081	0.2194	21.94
60	4.1	0.8	255.003	0.0585	0.2081	0.0629	28.24
55	4.2	1.37	361.294	0.0585	0.2081	0.0892	37.15
50	4.3	2.16	433.579	0.0585	0.2081	0.107	47.86
45	4.5	3.03	450.464	0.0585	0.2081	0.1112	58.97
40	4.6	4.37	465.356	0.0585	0.2081	0.1149	70.46
35	4.8	4.76	348.207	0.0585	0.2081	0.086	79.06
30	5.1	5.49	261.432	0.0585	0.2081	0.0645	85.51
25	5.3	6.64	191.559	0.0585	0.2081	0.0473	90.24
20	5.6	9.36	147.897	0.0585	0.2081	0.0365	93.89
15	6.1	15.66	116.424	0.0585	0.2081	0.0287	96.76
10	6.6	27.82	75.374	0.0585	0.2081	0.0186	98.62
8	7	22.24	22.491	0.0585	0.2081	0.0056	99.18
6	7.4	33.4	15.892	0.0585	0.2081	0.0039	99.57
4	8	70.98	12.308	0.0585	0.2081	0.003	99.87
2	9	136.34	5.107	0.0585	0.2081	0.0013	100
						1	
Percentile	Ø		Mean (Ø)	4.3633			
5	3.22		Median (Ø)	4.34			
16	3.72		Sorting (Ø)	0.7154			
25	4.05		Skewness (Ø)	0.0892			
50	4.34		Kurtosis (Ø)	1.5897			
75	4.71		Sand (%)	21.9406			
84	5.03		Mud (%)	78.0594			
95	5.78						



Williamsport 35' Open water
1000
100
10
1
0
10
20
30
40
50
60
70
Relative Frequency (mass)
Mean Diameter (μm)

Appendix D
Journal of the Williamsport Field Measurement Expedition

JOURNAL OF THE WILLIAMSPORT FIELD MEASUREMENT EXPEDITION, 19-29 MAY 1994

This journal recounts events in preparation for and during execution of the Williamsport Field Measurement Expedition, which accomplished field measurements for the Feasibility Study of Navigation Improvements, Williamsport, Alaska. The technical findings of the expedition will be reported in subsequent documents and in the Feasibility Report. The study and expedition are conducted through collaboration of the Alaska District, U.S. Army Corps of Engineers; the U. S. Fish and Wildlife Service; the Kenai Peninsula Borough; and the State of Alaska Department of Transportation and Public Facilities (ADOT&PF). The 23d Engineer Company, Fort Richardson, Alaska, provided shelters and meals at Williamsport. Contractors involved and their services were:

LCMF, Ltd.	topographic and hydrographic surveys,
Golder Associates	geophysical surveys,
MicroSpecialties	radio communications and electronics support,
University of Alaska Fairbanks	radioisotope sedimentation analyses,
Iliamna Transport	field support and transportation,
Coastal Freight and Salvage	charter landing craft service,
Maritime Helicopters	charter helicopter service,
Kachemak Air	charter plane service, and
Rust's Flying Service	charter plane service.

Dr. Orson Smith of the Alaska District Civil Works Branch, Project Formulation Section, is manager of the study and was leader of the expedition. A roster of those visiting Williamsport during the expedition is at the end of this account. A number of others were instrumental in the success of the expedition through their participation in preparations in Anchorage. Notable among these was Lavette Buford of the Alaska District Procurement Section, who negotiated and awarded a remarkable number of orders for services and supplies for the expedition in a very short time. Bart Lane of the Civil Works Branch shopped and drafted requisitions for most of the safety equipment and operating supplies used. Terry Gill and Marsha Bright of Civil Works Branch expedited the requisitions and other correspondence through the approval process. Karl Harvey laid much of the ground work for the camp logistics and geotechnical sampling during his assignments to the Civil Works and Geotechnical Branches as an Engineering Intern. LTC Marc Van Dongen, Deputy District Engineer, was personally responsible for securing the assistance of the 23d Engineer Company of the Special Forces Battalion. Carl Borash was Chief of Project Formulation Section at the time of the expedition, and Ken Hitch was Chief of Civil Works Branch. Others in Alaska District and the ADOT&PF made much-appreciated special efforts to support the Williamsport Field Measurement Expedition.

Thursday, 19 May

Final preparations for travel to Homer and Williamsport, Alaska, took place this day. Alaska District personnel marshaled equipment and supplies at the Corps' shop building (bldg. 21-849) and packed a van to travel to Homer the next day. The ADOT&PF personnel finalized mechanical checks of the *R/V Bill Egan* (a 24-foot aluminum jet-powered survey boat) and loaded equipment and supplies aboard. The 23d Engineers purchased provisions and packed equipment and supplies for convoy to Homer and landing craft transport to Williamsport. Richard Brown of MicroSpecialties delivered instruments and equipment and helped pack a Corps van bound for Homer the next day.

Friday, 20 May

The Corps van and the 23d Engineers convoy departed Anchorage and Fort Richardson for Homer, with inter-communication by cellular phone. Orson Smith and Richard Brown were in the Corps van, which departed Anchorage about 0930. SFC Chris Baker and five other Army personnel were in three deuce-and-a-half trucks, one towing a 500-gallon water trailer. SFC Baker and Orson Smith were both equipped with cellular phones issued by the District. SFC Baker called the van about 1330 with notice that an Army truck had broken down between Girdwood and Portage and a replacement had been called. He called back several more times throughout the day and evening to report progress.

The Corps van arrived at Homer about 1600 and proceeded to the harbor area. The first stop was at the Homer harbormaster's office to review upcoming harbor activities and confirm arrangements for temporary parking and loading of vehicles and equipment. The next stop was at North Star Terminal and Stevedoring to confirm rental of a forklift, which was available as previously arranged. The drill rig had already been delivered with two rented portable toilets, and these were standing near the top of the commercial ramp on the offshore side of the harbor.

The *M/V Rama Lee* was located at about 1600, rafted with the *M/V Nanuk* (both of Coastal Freight and Salvage Service) at the transient float by the commercial ramp in Homer Harbor. The *Rama Lee* appeared to be in the midst of modifications to its wooden wheel house and was littered with materials, mechanical parts, and tools. The ship obviously was not ready for sea. The *Nanuk* appeared seaworthy, but its well-deck beam was paced at about 9 feet (ft) to the

Rama Lee's 11 ft. Both vessels had little room and no accommodations for passengers in their small wheel houses. No one was aboard either ship.

Maritime Helicopters was visited at about 1700. The chief pilot, Howard Reed, discussed plans for four passengers to be flown the next day to outer Iliamna Bay, Pile Bay on Iliamna Lake, and points between to deploy a radio repeater. The Bell Long Ranger III helicopter was inspected, and no concerns arose over cargo capacity. An extra stop at Pile Bay appeared necessary to install a base station in order to check the operation of the repeater. During this stop, the helicopter would be released to fly to Iliamna to refuel for the flight back to Homer.

Kachemak Air was visited about 1745, and arrangements were confirmed to transport five passengers to Pile Bay on May 22. The prospect of an additional flight the next day (21 May) was discussed, since carrying passengers aboard either the *Rama Lee* or *Nanuk* appeared unacceptable. Bill and Barbara de Creeft of Kachemak Air indicated that their aircraft, a deHavilland Beaver and a deHavilland Otter, were both available for flights to Pile Bay.

A phone call was placed to Willie Flyum, who was known by the deCreefts to be associated with Coastal Freight and Salvage. Mr. Flyum arranged a call from Bruce Flannigan, the licensed pilot who was to skipper the *Rama Lee*. Captain Flannigan said the *Rama Lee* was not ready and the *Nanuk* would take the first and second loads across Cook Inlet to Williamsport. He indicated that he would pilot the *Nanuk* instead. The *Rama Lee* would be ready for transporting the drill rig and support of drilling operations by Monday (23 May). A 12-inch-diameter hole was to be placed in the bow ramp to accommodate the auger of the Corps drill rig, but work on this had not begun. The delay in preparation of the Rama Lee apparently related both to work on the new wheel house and to complications in a recent Coast Guard inspection. No other practical alternative appeared to exist, so the use of the *Nanuk* for the first two loads with Bruce Flannigan as pilot was authorized by Orson Smith. The weather forecast was marginal for crossing Cook Inlet in either landing craft or aircraft. Before leaving Kachemak Air, Willie Flyum called back to confirm the contact with Bruce Flannigan and commented that another person recently grounded the *Nanuk* through poor piloting.

Orson Smith and Richard Brown checked in at the Heritage Hotel and confirmed rooms for the six Army personnel on their way. Their last call estimated a midnight arrival of the Army group in Homer.

The next stop was at the ADOT&PF highway maintenance yard on the Sterling Highway just north of Homer. The key to the gate padlock was provided by ADOT&PF personnel on duty, and arrangements for parking the Army trucks were confirmed.

The LCMF party was staying at Lands End Hotel. Orson Smith and Richard Brown drove there for supper at about 2000. Larry Whiting, John Oswald, and Bob Kohut of LCMF were met there and plans were discussed over dinner. The LCMF group was told they would all be flown across the Inlet rather than ride the landing craft. After the meal, Orson Smith left Richard Brown at the Heritage Hotel and drove to the maintenance yard to meet the Army convoy, which arrived about 2345. The convoy now consisted of two trucks, a cargo trailer, and the water tank trailer.

Saturday, 21 May

Orson Smith, Richard Brown, and the LCMF group met Bruce Flannigan at the harbor about 0810 in cold, rainy, and windy conditions. The forecast on marine radio was marginal for crossing Cook Inlet that evening. A start for loading operations at 1100 was agreed, in conjunction with high tide.

Orson Smith next visited Kachemak Air to make arrangements for an eight-passenger flight to Pile Bay with substantial cargo beyond personal gear, including radios, survey equipment, and electronics not appropriate for transport on the *Nanuk.*

Orson Smith transported two Army personnel at 1000 to the ADOT&PF compound to retrieve the Army trucks, and remaining personnel were picked up at the Heritage Hotel and transported to the harbor. The *Nanuk* was met by the entire Williamsport group at the public "fish dock" in the harbor at 1100. Weather conditions had worsened. The Army water trailer was lifted into the *Nanuk* by crane; then the *Nanuk* motored over to the ramp at 1130 to load one of the two toilets and the LCMF survey boat and trailer. Three pallets of shrink-wrapped LCMF survey gear were loaded forward of the boat, and tents, cots, and poles were loaded individually beneath the trailers wherever deck space was available. The wind and rain increased in intensity as loading progressed. By 1430 it was clear a crossing that evening would not be possible, and flights with Maritime Helicopters and Kachemak Air were postponed by phone for a day.

All present agreed to meet at the fish dock at 1200 on Sunday (22 May) to reorganize gear already loaded and to load small packages of provisions and supplies in "fish bins" to be rented by the *Nanuk* and lashed to its small fantail deck area aft of the wheel house. The Army trucks were escorted to the ADOT&PF compound at 1530, and all personnel were checked in again at the Heritage Hotel by 1600.

Ron Cothren and Skip Barber arrived in Homer with the *Egan* in tow about 1800, parked the trailer at the ADOT&PF compound, and checked into the Heritage Hotel.

Sunday, 22 May

Two Army personnel were transported to get the trucks at 1100. Skip Barber and Ron Cothren left to get the *Egan* about the same time. The *Nanuk* was met at the fish dock at 1200 and, as reorganizing the cargo proceeded, the prospect of towing the *Egan* was discussed. Though the weather had improved somewhat, it was still quite windy and rough in Cook Inlet. The self-bailing and sealed engine compartment design of the *Egan* appeared to make towing a satisfactory arrangement with only moderate risk to either vessel. Towing the *Egan* would serve to make both survey boats available for use immediately on arrival at Williamsport and, with the reorganized cargo of the *Nanuk*'s first load, save an entire landing craft crossing and more than 24 hours of cargo transshipment time. The *Egan* was launched at the commercial ramp and fixed to the towing cable of the *Nanuk* about 1300. The *Nanuk* departed the harbor with the *Egan* in tow at 1330.

The Army trucks, now with less than half their original cargoes, were parked at the ADOT&PF compound about 1430. It was agreed that SFC Baker, PVT Yambo, and PVT Alvarez would stay in Homer to load the remaining truck cargo with the drill rig on the *Rama Lee* on Monday. The drill rig's crew (Chuck Wilson, Dan Ackerman, and Rich Sorensen) were traveling by road to Homer that day with some additional drilling and sampling-related cargo in two pickup trucks.

The LCMF team met Orson Smith, Ron Cothren, and Richard Brown at Maritime Helicopters in Homer at 1500. Inspection of the survey and radio cargo revealed that taking four passengers (Smith, Brown, Kohut, and Oswald) plus even a thinned version of the cargo was impossible. It was agreed that Richard Brown and the radio equipment would be transported by fixed wing (Kachemak Air) to Pile Bay, while Smith, Kohut, and Oswald proceeded in the helicopter to the tide gauge site with the survey equipment. The surveyors (Kohut and Oswald) would be dropped off, and Richard Brown and the radio repeater would be picked up at Pile Bay to install the repeater on a mountain ridge between Pile Bay and Williamsport. This contingency and other unanticipated cargo for the planned fixed-wing flight resulted in a requirement for two Kachemak Air flights from Homer to Pile Bay this day. Landing a float plane at Williamsport, even at high tide, was considered too hazardous because of submerged rocks and rapidly changing water levels.

The weather on the western side of Cook Inlet was worsening at the helicopter approached outer Iliamna Bay around 1600 with strong winds, heavy rain, and low flying ceilings. An airborne search and several landings were necessary to locate the rocky point which had the NOAA bench marks required for tide-gauge deployment. The monuments were finally located around 1700, and Bob Kohut and John Oswald were dropped off with camping gear to stay the night. They were well prepared, and the time until high tide the next day would allow a more methodical installation of the tide gauge. The helicopter left Iliamna Bay for Pile Bay via Williamsport about 1810 and landed at Pile Bay about 1830. Strong winds over Williamsport and a low ceiling at the pass confirmed the helicopter pilot's earlier suspicion that he would have to stay the night in Pile Bay and that the radio repeater work would have to wait until the next day. The two fixed-wing flights from Homer, one Otter and one Beaver, had arrived at Pile Bay in the interim, also noting extreme turbulence over Iliamna Bay. A total of nine persons were housed at Pile Bay Lodge this night (Smith, Brown, Cothren, Barber, Whiting, Campbell, Stewart, Duckworth, and the helicopter pilot, Gary Brogdon).

Monday, 23 May

The group left at 2200 (22 May) with Ray Williams, owner of Iliamna Transport and Pile Bay Lodge, in two rented trucks (a Ford 2WD pickup and GMC 4WD pickup) on the 1-1/4-hour road trip to Williamsport to meet the *Nanuk* at high tide. The ford over the upper Iliamna River involved whitecaps splashing over the hoods of both pickups. Strong winds and heavy rain worsened on crossing the pass to Williamsport. Both trucks arrived together at Williamsport about 2315.

The *Nanuk* was first sighted about 2330 with the *Egan* lashed alongside. Unloading proceeded in extremely adverse conditions until 0230 (23 May), at which time the *Nanuk* departed. Cargo was stacked at the area graded for the camp site. The *Egan* was grounded at high tide by the loading ramp. The engine compartment of the *Egan* proved to be flooded. Bruce Flannigan, skipper of the *Nanuk*, revealed that 60-knot winds and seas in excess of 20 ft had been encountered during the Cook Inlet crossing and that the *Egan* had twice broken her tow (a 2-inch polypropylene hawser). He thought the *Nanuk* would have to lay to in outer Iliamna Bay until the wind let up before crossing Cook Inlet, which would delay the next load from Homer at least 12 hours. The trucks and all personnel returned to Pile Bay about 0400.

Richard Brown and Orson Smith departed by helicopter for the repeater site at 0955. A suitable place on a mountain ridge at about the 3,500-foot level was quickly located. The battery-powered (and solar-charged) radio repeater was to relay radio messages on Corps frequencies between the camp at Williamsport and Pile Bay Lodge, where messages could be relayed by phone or other radio. Richard Brown had installed a base station at the lodge the previous evening. The repeater was deployed without incident, and the helicopter and passengers departed for Williamsport about 1045.

Richard Brown was left at Williamsport to begin sorting equipment with the forklift. The helicopter and Orson Smith left about 1050 and landed in Iliamna Bay at about 1100 at the site where Bob Kohut and John Oswald had been left the previous evening. Both surveyors were found to be still working at installation of the tide gauge. Orson Smith assisted with the last of the levels and with packing up the tent camp, where the two had stayed the night in reasonable safety. All returned to Williamsport about 1215, and the helicopter was released to return to Homer.

The trucks arrived from Pile Bay about 1300 with the remaining guests from Pile Bay Lodge, plus five passengers from two charter flights which had arrived at Pile Bay from Anchorage about 1030. One flight had been scheduled with Rust's Flying Service, but two (an Otter and a Beaver) were found to be necessary to carry the five passengers, plus about 1,500 pounds of Golder Associates' bulky geophysical equipment. The five new arrivals included Bobbe Reilly and Dave Mierzejewski (Alaska District), Harvey Smith (ADOT&PF), and Dick Sylwester and Roy Retzlaff (Golder Associates). A total of 15 personnel were now at Williamsport.

The LCMF team began unpacking survey equipment and launched their boat at about 1400. The Golder team also began unpacking and walked the upland areas to be tested by seismic refraction. Orson Smith advised both teams to give priority to the hydrographic survey of the nearest half-mile, followed by the middle area (next half-mile), and the half-mile farthest offshore. The Golder team would have to focus on upland measurements and attempt low tide measurements on the tidelands until the LCMF team could accomplish the first priority work.

Meals Ready to Eat (MRE's) were set out and drink dispensers filled as the Army team progressed with unpacking camp equipment. All free hands were called to set up tents, which included two GP mediums (conventional wooden poles, approximately 20 ft by 40 ft), one for men's sleeping and one for mess, and two TOC tents (internal steel pipe frame, approximately 10 ft by 15 ft), one for women's sleeping and one for radios and other electronics. Bobbe Reilly, the only woman in camp this night, eventually moved her sleeping gear into the small trailer nearby, which belonged to Iliamna Transport and had been made available to the camp. Supplies were subsequently moved into the TOC tent.

The afternoon and evening weather was cool, with a light rain and steady breeze. Spells of stronger wind and rain came and went. The recently graded sandy gravel pad at the camp site was saturated and did not hold tent stakes well. The ground was covered with puddles everywhere, even under the tents. A gas-powered generator was started and power supplied to the Operations tent. All other tents were lighted with propane lanterns. Antennas were erected, and radio communications with Pile Bay and meteor-burst telemetry with Anchorage were established. Burners in the mess tent were lighted, giving welcome warmth. Most food remained in Homer awaiting transport, so only MRE's, coffee, and soup were available at this time.

A brief camp meeting was held at 1800. Orson Smith reviewed safety measures and radio call-in conventions to be used by parties leaving camp, with special attention to the prospect of brown bear encounters. Field parties were instructed to immediately report bear sightings. Encounters were to be avoided, even at the cost of property and work progress. Pepper spray, emergency flares, and hand-held radios were issued to all field parties. Field parties reported their position and status at least hourly. Reports were posted on a marker board in the Operations tent. Richard Brown, Ron Cothren, and Orson Smith began alternating duty watches in the Operations tent.

The portable toilet was placed at the corner of the graded area and filled with antiseptic solution. The supplier did not provide either toilet paper or hand towels. An interim supply of toilet paper was provided from Pile Bay Lodge, and a full supply was ordered via Pile Bay to SFC Baker on his cellular phone in Homer. Shrink wrap for repacking the camp was also ordered.

Communications via Pile Bay to Homer later in the day were confused regarding the status of the *Rama Lee* and the prospects for bringing her over with the drill rig, fitted with an opening in her ramp for the drill stem. Word was passed to Chuck Wilson (from Alaska District Geotechnical Branch, who was now in Homer) to return the drill rig to Anchorage if an opening was not to be provided aboard the *Rama Lee*.

The LCMF team made steady progress in establishing shore control at the cost of sleep and comfort. Wind and rain became more severe with the coming of night. The Golder team succeeded in measuring two or three seismic lines ashore. Dave Mierzejewski and Bobbe Reilly began observations of the tidelands.

Tuesday, 24 May

Orson Smith relieved Ron Cothren at 0100 on duty in the Operations tent. The LCMF team returned from the bay at 0130, and their boat was pulled out on its trailer for work on the survey computer and satellite Global Positioning Systems (GPS) radio telemetry systems. The team was cold and wet in spite of their foul-weather clothing. Dave Mierzejewski visited the dock to collect a high-tide water sample at 0200. All parties were in camp by 0220.

The wind and rain increased as the night wore on. Orson Smith went into the mess tent at about 0230 to check on a flapping noise. Side poles of the GP medium tent were being lifted off the ground by gusts and several had fallen out as tent stakes pulled out of the soggy ground. Harvey Smith joined Orson in the mess tent about 0245 and announced that the TOC tent with supplies had blown over and was lying across the house trailer in which Bobbe Reilly was sleeping. Harvey and Orson, joined by SGT Campbell and SPC Duckworth, began tightening tent tie-downs and replacing loose or missing stakes. The Operations TOC tent was tied down with ropes thrown over its top. The frame of the other TOC tent was dismantled for reassembly later in the daylight. The tents were all relatively secure by 0420.

Ron Cothren and Orson Smith left for Pile Bay at 0915 in the GMC truck to meet more passengers arriving from Anchorage. The charter plane flew overhead with Lizette Boyer (Alaska District), Laurie Fairchild (U. S. Fish and Wildlife Service), and Bruce Finney (University of Alaska Fairbanks) aboard. Weather was partly sunny by their arrival at Pile Bay about 1030.

Orson called the Corps office in Anchorage and reported the expedition's progress to date. Orson also called SFC Baker on his cellular phone in Homer and asked about his status. Chuck Wilson was available nearby since loading the *Rama Lee*, and the *Nanuk* was underway at the time of the call. The *Rama Lee* had just recertified with the Coast Guard, and the well in the ramp for the drill was to be completed at Williamsport after the drill rig was delivered for its shore work. Skip Barber passed word for the *Egan*'s trailer and the State truck to be brought. Kachemak Air was scheduled at 1500 to bring the drill crew (Chuck Wilson, Dan Ackerman, and Rich Sorensen) and Army personnel in Homer (SFC Baker, PVT Yambo, and PVT Alvarez). The group departed Pile Bay about 1100 and arrived without incident in Williamsport about 1215. Skip Barber, who had called to have an ADOT&PF mechanic flown to Pile Bay, left in the truck to meet the mechanic and bring him to Williamsport.

Hydrographic and geophysical surveys were well under way during the morning and Army personnel had further strengthened tent riggings. Plastic tarp awnings were strung between tents, though by this time the rain had quit and skies were partly sunny. The supply tent was emptied into the margins of the mess tent. Spare military stoves were lighted in the supply tent and lines rigged for drying clothes.

Lizette and Laurie began investigations of the shoreline and tidelands, walking toward the mountain buttress northeast of the landing, a prospective quarry site. Dave Mierzejewski had also walked to the point and judged the talus slope there to have potential as a quarry for coastal works. Golder Associates continued upland and tideland geophysical surveys, including two lines parallel to the nominal channel alignment to about one-fourth mile offshore of the dock.

About 1500, Orson Smith relayed to SFC Baker in Homer, via Skip Barber in Pile Bay, to bring an evening meal with him on the plane, since many of those at Williamsport had not eaten a full meal for a while and were short of sleep and dry clothes. Skip relayed the message about 1600 that two flights instead of one were scheduled from Homer to Pile Bay, the first to deliver the drill crew, and the second to deliver the three Army personnel with an evening meal.

Bobbe Reilly and Harvey Smith left camp about 1700 in the outboard-powered ADOT&PF inflatable for water and sediment sampling in Iliamna Bay. They returned about 1900, having to pole and walk the boat up the tidal drainage channels and finally drag the boat up to the high tide mark about a half-mile southeast of camp.

Bruce Finney took a series of cores about 190 ft offshore of the old dock. Harvey Smith set up a radar unit on the old dock for drogue tracking on a later high tide.

Two trucks (the rented GMC and Ray Williams' Blazer) arrived about 2030 with three Army, three drillers, Skip Barber, and the ADOT&PF mechanic. A hot meal of steak, corn, and mashed potatoes was served at 2300 to 24 tired, but rallying campers.

Wednesday, 25 May

The LCMF boat was launched at 0030, but mechanical problems delayed its departure. Both landing craft arrived at about 0230. Most of the camp turned out to offload the landing craft; this was completed about 0500. The drill rig was unloaded from the *Rama Lee* and moved to an upland site near the old dock for its first hole. Investigation of the *Egan* revealed that all parts of the engine and the fuel supply had been contaminated with salt water and field repairs were impossible. The *Egan* was lifted with some difficulty on its trailer, which was reloaded aboard the *Nanuk*. The ADOT&PF truck did not fit aboard with the trailer and remained in Williamsport. Since a single toilet had served the camp to date and the *Nanuk* had just delivered a second, the first toilet was loaded aboard the *Nanuk* for shipment back to Homer. The *Nanuk* departed with the tide for Homer. The *Rama Lee* went aground at the ramp and began making modifications to the ramp to accommodate offshore drilling.

Orson Smith and SFC Baker left for Pile Bay in the GMC and ADOT&PF trucks at about 0745. The temperature was cool, but clear skies and mild winds lasted all day. Laurie Fairchild rode along in hopes of returning to Anchorage a day early. The charter plane from Anchorage arrived about 0915 with seven passengers (LTC Van Dongen, John Killoran, Janis Kara, Mel Zimmermann, Pat Galbraith, and Ventis Plume from Alaska District and LTC Haith from the Special Forces Battalion). Laurie Fairchild made arrangements with the pilot to take her to Iliamna, where she could catch a scheduled commercial flight to Anchorage. The plane then returned to Pile Bay to stand by for returning the same seven passengers to Anchorage. While fording the Iliamna River on the road trip to Williamsport, the ADOT&PF truck had water splashed into its air intake and had to be towed ashore. The carburetor was dried, the truck was restarted, and the group proceeded to Williamsport. Two brown bears were spotted by occupants of the rear truck just before crossing the stream. The group arrived in Williamsport about 1030 to find sunshine and blue skies.

Mel Zimmermann and Pat Galbraith left almost immediately for the prospective quarry site northeast of Williamsport. Janis Kara and Lizette Boyer also walked the shoreline in that direction, after lunch was served at 1200. Ventis Plume, the Alaska District real estate appraiser, toured the upland area at Williamsport and viewed the tidelands. All of the Wednesday visitors were briefed by Orson Smith on the project purposes and its tentative physical scope and schedule of implementation. Orson Smith and SFC Baker departed Williamsport about 1345 to deliver the group to Pile Bay for their return flight to Anchorage. At high tide the drill rig was reloaded aboard the *Rama Lee*, which moved to the farthest offshore site, anchored, and went aground on the ebb.

Harvey Smith, Bobbe Reilly, and Lizette Boyer left camp about 1500 in the aluminum outboard-powered skiff provided by the *Rama Lee*, for a reconnaissance of potential dredged material disposal sites in outer Iliamna Bay. High tide was predicted at 1549, giving them about 2 to 2-1/2 hours to return. While in the outer bay the outboard motor stalled, and after some partially successful efforts to restart, it stalled completely as the skiff was making its way back to Williamsport. The skiff finally grounded in the middle of Iliamna Bay and was forced to wait out the extreme low tide. SFC Baker and PVT Stewart climbed the ridge separating Williamsport from outer Iliamna Bay, sighted the skiff, and established communications. Communications directly from camp (via the repeater) were possible by the time the skiff was grounded, and regular radio checks were established. The next high tide was predicted for 0332 the next morning. The team had left with a thermos of coffee, 4 MRE's, and some other snacks. Flooding tidal currents eventually carried the field party past the side channel leading to Williamsport, forcing them to paddle vigorously to reach Williamsport around 0300 (26 May). The three people involved were generally in good health, though Lizette Boyer suffered from back pain and showed some signs of incipient hypothermia since she was less able to help with the paddling. She was warmed under supervision in the cab of the State truck before retiring to her sleeping bag in the Williams' trailer.

The six Army personnel left about 2000 in the State truck, driven by Skip Barber, for an off-duty fishing outing to Summit Lake, about one-third of the way along the road to Pile Bay. Skip and SFC Baker dropped the others off at the lake and went on to Pile Bay Lodge to make phone calls and use the showers. These two returned in the truck to pick up the others about

2330, but the truck became stuck in a deceptively soft area on the side road to the lake. Williamsport camp was called by radio about 2400 for assistance. Orson Smith left camp in the GMC after asking Dave Mierzejewski to watch the radios. The State truck was pulled out and the group returned to Williamsport in both trucks about 0030 (26 May). No fish from the lake were sampled.

Thursday, 26 May

The LCMF boat went out for hydrography at high tide about 0130 and made several hours' uninterrupted progress in the near and middle portions of the survey area. The beached inflatable southeast of the camp was recovered and returned to the camp about 0300. The *Rama Lee* moved from the farthest offshore drilling site to the middle site and commenced drilling after the ship settled on the bottom during the ebb.

Biological reconnaissance of the tidelands and adjacent near-shore area was concluded during the morning by Lizette Boyer, who was much recovered from the previous night's ordeal after a warm dry rest. Likewise, Bobbe Reilly and Harvey Smith were recovered and spent the morning packing equipment and samples for shipment to Anchorage.

Two trucks left Williamsport about 1230 to deliver Lizette Boyer, Bobbe Reilly, Harvey Smith, Skip Barber, Dave Mierzejewski, and Bruce Finney to Pile Bay for a flight to Anchorage. An Otter from Rust's Flying Service arrived about 1400. This schedule was arranged to allow the minimum number of charter flights between Pile Bay and Anchorage, though it required Bobbe, Dave, and Harvey to leave a day earlier than originally planned. Rust's was also requested to pick up the Golder team and their equipment this day, but the separate Otter flight required was not possible until 1000 the following Friday morning.

The *Rama Lee* moved to the farthest inshore site at high tide about 1500. The LCMF boat was outfitted for geophysical surveys during the morning low tide and went out during high water to survey the middle and outer portions of the survey area. Golder deployed the Corps CTD during this outing, measuring two profiles of temperature and conductivity (salinity). The geophysical measurements were successful, and the LCMF boat returned to the ramp and was pulled out on its trailer about 1700. An evening meal was prepared with the Williams family (Ray, Linda, and son) as guests.

Friday, 27 May

No field parties left camp during the night, so a radio watch was not maintained. The *Rama Lee* remained on its last station, and no new drilling was initiated in order that the next low water period could be used to rig the equipment for transport back to Homer. Temperatures were cool with clear skies and light winds in the morning, and these conditions were constant throughout the day and evening.

The Golder team and their equipment were transported about 0745 by truck to Pile Bay and departed Pile Bay about 1000 on a Rust's Flying Service Otter. SGT Campbell and PVT Duckworth also came to Pile Bay with a considerable amount of food, which would not be consumed at the camp at Williamsport. These two were left at Pile Bay with the intent of preparing a meal for all those departing that evening. Some lunch items had been left at Williamsport. Unused dry goods (foam cups, plates, etc.) were left in the hands of Iliamna Transport. Perishable food (bread, fruit, and vegetables) would be delivered to families in the villages surrounding Pile Bay Lodge, according to Ray and Linda Williams.

Two additional landing craft came into sight at about 1600: the *Nanuk* and the *Fox River*, another much larger landing craft from Homer which intended to pick up some heavy equipment from Iliamna Transport at Williamsport. The *Rama Lee* came ashore first, followed by the *Nanuk*. Both lowered their ramps for loading in the graded landing area. The drill rig aboard the *Rama Lee* was rigged for transport and moved aft as far as possible. The LCMF boat on its trailer was loaded on the *Nanuk*. The toilet and remaining camp equipment were loaded with considerable haste into the remaining space aboard the *Rama Lee* and *Nanuk*. Both landing craft departed by 1900. The *Fox River* then came ashore, but was not able to be loaded in time to depart on this high tide. The State truck was loaded on the *Fox River*, which was bound for Anchorage, through arrangements made by the ADOT&PF.

The Maritime Helicopters Bell Long Ranger arrived about 1700 and was sent with Richard Brown and Bob Kohut aboard to retrieve the radio repeater station. The helicopter returned to Williamsport, picked up Orson Smith, and flew on to the tide gauge site. Bob Kohut exchanged solid-state memory modules in the Endeco tide gauge recording canister, after checking that the gauge was functioning. Some water levels were quickly measured and recorded, and the helicopter left the tide gauge site for Homer with the three passengers aboard. The helicopter arrived in Homer about 1930, and the services of Maritime Helicopters were terminated with compliments.

The Corps van and LCMF truck left at Kachemak Air were picked up and the three personnel in Homer checked into hotel rooms, confirming reservations for those yet to arrive that evening.

The remaining personnel at Williamsport left by truck at about 1730 for Pile Bay. A Kachemak Air Otter picked up all but four and flew them to Homer, arriving about 2130. The passengers were picked up at Kachemak Air and delivered to their hotel rooms.

Saturday, 28 May

Army personnel in Homer were delivered to the State compound at about 0545 to drive the Army trucks to the commercial ramp at Homer Harbor. All arrived at the harbor about 0600, so offloading could take place during high tide. High water was predicted for 0508. The *Nanuk* was offloaded first with great haste. The *Rama Lee* was still at sea at 0600, having reported engine over-heating problems by radio. The *Rama Lee* came into the harbor about 0730, just as the *Nanuk* was emptied. The cargoes of both landing craft were piled with minimum order on the ground near the ramp for later sorting and loading into vehicles. The *Rama Lee* offloading was completed about 0830. The services of Coastal Freight and Salvage Service were terminated with sincere compliments on the accommodation of changing conditions and requirements, the risks taken at the start during adverse weather, and the punctuality of arrivals and departures in spite of these difficulties.

The four personnel who stayed over at Pile Bay Lodge arrived at Kachemak Air aboard a Beaver at 0930 and were picked up in the Corps van and taken to the harbor to help with sorting and packing cargo. The services of Kachemak Air were terminated with compliments on their gracious response to last-minute changes in passengers, cargoes, and schedules. The Corps van and LCMF's two trucks were loaded and ready to depart by about 1030. The two Corps pickups driven by the drill crew were loaded about the same time. The State's inflatable skiff, its outboard motor, and accessories were delivered by one of these pickups to the State compound on the way out of Homer. The Army team stayed in Homer to repack the trucks and perform mechanical maintenance before returning to Fort Richardson the next day. The Corps van, with Orson Smith, Ron Cothren, and Richard Brown, left Homer about 1100. The drill crew's pickups left Homer about the same time. The van arrived at building 21-849 (the Corps shop) on Elmendorf Air Force Base at 1730 and was parked inside the security fence for unloading on the next work day.

Concluding Remarks

The expedition to Williamsport was successful, in spite of adverse weather at its start and a series of mechanical difficulties. Virtually every person involved worked extremely hard, some to near exhaustion, to see this success. The congeniality of the group, even when most people were tired, wet, cold, and hungry, was commendable. Very little improvement in the logistical arrangements would have been possible without dramatic increases in the overall cost. Nevertheless, some lessons learned are noted below.

a. **Aircraft charters**: Charter companies make an honest effort to estimate aircraft capacities, using the information they are given about passenger and cargo weights. These arrangements are typically not made with the pilots themselves, however, and certainly not with the passengers, their personal luggage, and their job-related cargo in view. An average weight of 200 pounds per passenger is appropriate, even though it is known that the unencumbered people involved are not above average in weight. Instruments and equipment should be weighed whenever the opportunity arises, and the weights should be recorded. A contingency of 25 to 50 percent should be applied when making charter arrangements, since items are invariably forgotten or added at the last. A more accurate schedule of flights to Pile Bay would have been possible if these rules-of-thumb had been consistently applied. Some changes were and will always be due to completely unforeseeable circumstances. Charter contracts should include funding contingencies and other terms to allow one or more additional flights or an equivalent extension of services under the authority of the person in charge in the field.

b. **Camp mobilization and other preliminaries**: Access to Williamsport was limited to the peak of extreme high tides; therefore, both deliveries of equipment and supplies and the field work itself were scheduled for the 7-day period of spring tides in May. Adverse weather delayed delivery of camp equipment and most food until operations were well underway. Funds availability delayed many contractual arrangements until 2 weeks before the expedition took place. Future field work requiring camp arrangements should allow for camp supplies to be delivered to the site well in advance of operations. Williamsport was not accessible due to ice a month earlier, during the previous spring tide. A startup set of camp equipment could have been delivered by air, along with the first couple of days of food, and set up before operating personnel arrived. This could have prevented much of the discomfort in the first days of the Williamsport expedition. The increase in cost would have been nominal, given carefully managed flights in Otter-sized aircraft or larger.

c. **Cargo packaging**: Some cargo was palletized and secured with heavy-duty plastic shrink wrap. Both pallets and shrink wrap were in short supply when the landing craft were loaded in Homer. Heavy-duty lidded plastic garbage cans were used to pack some instruments and light supplies, also serving as garbage receptacles at camp. Geotechnical Branch made extensive use of large plastic coolers, which helped in efficient packing of the landing craft. The idea of using "fish bins," large bins with heavy-duty lids, approximately 3 by 4 by 4 ft, saved problems in carrying food and other water-sensitive smaller packages. Some type of lockable weather-tight container, designed for forklift movement, would have made loading and unloading operations safer and faster, and would have reduced risk of water damage. These containers would be useful in the field for secure, weatherproof storage. They could be used for transporting instruments and equipment in pickup beds for field work along the road system or transported in larger aircraft as freight. Several such containers for Williamsport would have been superior to shrink-wrapped pallets, coolers, garbage cans, and borrowed fish bins.

d. **Positioning:** Location by map coordinates of samples, drill holes, and miscellaneous observations was accomplished with rented hand-held GPS receivers. These devices were in steady demand, and conflicts occurred over their use during critical periods of high and low tide. Positioning accuracy without differential mode is possible to within 100 meters anytime and anywhere in Alaska. This accuracy exceeds the accuracy of plotted fixes or other features published on U.S. Geological Survey topographic maps or NOAA nautical charts. The District should acquire a set of hand-held GPS receivers to be checked out by any personnel who intend to make measurements, take samples, or record observations in the field. This is now common practice among our counterparts in other agencies and private industry.

e. **Communications**: The hand-held radios, base stations, and repeater were basically in working order, but batteries on hand were discharged for so long that they were not rechargeable and had to be replaced at the last minute. This would have been difficult or perhaps impossible in an emergency response to a major earthquake or other natural disaster. Most of the radios were limited to Army frequencies and could not be adapted to the marine band or aviation bands in normal use by chartered boats and aircraft. A set of synthesized radios, fully adaptable to frequencies commonly used by commercial operators and other agencies, should be acquired.

Some should be held in reserve for emergency operations. Others should be available for checkout to project-related field operations. The two cellular phones issued to those who traveled to Homer by road proved invaluable for coordinating schedule changes. More units, perhaps more compact than those available now and with extra battery capacity, should be acquired and made available for District field operations. All of this equipment should be subject to a rigorous schedule of maintenance and replacement of batteries or other perishable components.

f. **Military support**: The specialized skills and equipment of the Army were responsible in no small measure for the success of the Williamsport expedition. The military personnel involved obviously gained from the experience, since they were forced to improvise cargo transportation arrangements on a variety of commercial vehicles, closely coordinate logistics and field operations with civilian counterparts, and operate in a field situation without full military support on demand. All the Army personnel were easily equal to this, but the experience has improved their abilities to work closely with civilians in a largely commercial setting. These general circumstances are likely to be common in the future for all military services. When other opportunities for collaboration between the District and our active-duty Army colleagues arise, we should consider future joint operations.

g:\en-cw\en-cw-pf\wilmsprt\field94\triprpt.txt

Roster at Williamsport/Pile Bay Williamsport Field Measurement Expedition - 22-28 May 1994				
Name	**representing**	**arrived**	**departed**	**responsibility**
Orson Smith	Alaska District	Sun 22	Fri 27	project manager
Richard Brown	Micro Specialties	Sun 22	Fri 27	radios, electronics
SFC Christopher Baker	23rd Engineer Co.	Tues 24	Sat 28	camp, cooking
SGT Cameron Campbell	23rd Engineer Co.	Sun 22	Sat 28	camp, cooking
PFC Humberto Alvarez	23rd Engineer Co.	Tues 24	Fri 27	camp, cooking
PFC Eric Duckworth	23rd Engineer Co.	Sun 22	Fri 27	camp, cooking
PFC Orlando Yambo	23rd Engineer Co.	Tues 24	Fri 22	camp, cooking
PFC Alexander Stewart	23rd Engineer Co.	Sun 22	Fri 27	camp, cooking
Larry Whiting	LCMF, Inc.	Sun 22	Fri 27	hydro/topo surveys
John Oswald	LCMF, Inc.	Sun 22	Fri 27	hydro/topo surveys
Bob Kohut	LCMF, Inc.	Sun 22	Fri 27	hydro/topo surveys
Dick Sylwester	Golder Associates	Sun 22	Fri 27	geophysical survey
Roy Retzlaff	Golder Associates	Mon 23	Fri 27	geophysical survey
Ron Cothren	UAA	Sun 22	Fri 27	surveys & positioning
Bobbe Reilly	Alaska District	Mon 23	Thurs 26	sediment samples
Dave Mierzejewski	Alaska District	Mon 23	Thurs 26	water samples
Skip Barber	ADOT&PF	Sun 22	Thurs 26	pilot *R/V Bill Egan*
Harvey Smith	ADOT&PF	Mon 23	Thurs 26	bulkhead design
Danny Ackerman	Alaska District	Tues 24	Fri 27	drill rig
Richard Sorensen	Alaska District	Tues 24	Sat 28	drill rig
Chuck Wilson	Alaska District	Tues 24	Sat 28	drilling supervisor
Lizette Boyer	Alaska District	Tues 24	Thurs 26	biological survey
Loraine Fairchild	USFWS	Tues 24	Thurs 26	biological survey
Bruce Finney	UAF	Tues 24	Thurs 26	radioisotope dating
LTC Van Dongen	Alaska District	Wed 25	Wed 25	Deputy District Engineer
LTC Haith	Special Troops Batt.	Wed 25	Wed 25	Battalion Command
John Killoran	Alaska District	Wed 25	Wed 25	District public affairs
Mel Zimmermann	Alaska District	Wed 25	Wed 25	cost estimator
Janis Kara	Alaska District	Wed 25	Wed 25	economics survey
Ventis Plume	Alaska District	Wed 25	Wed 25	real estate appraisal
Pat Galbraith	Alaska District	Wed 25	Wed 25	quarry investigation

Figure 1. Area map

Figure 2. *M/V Nanuk* leaves Homer Harbor on 22 May 1994 with *R/V Bill Egan* in tow.

Figure 3. *M/V Rama Lee* and *M/V Nanuk* at ramp. Old dock ruins are at left.

Figure 4. Drilling for subsurface samples on upper tidelands.

Figure 5. Water tank trailer, Operations tent, and men's sleeping tent behind.

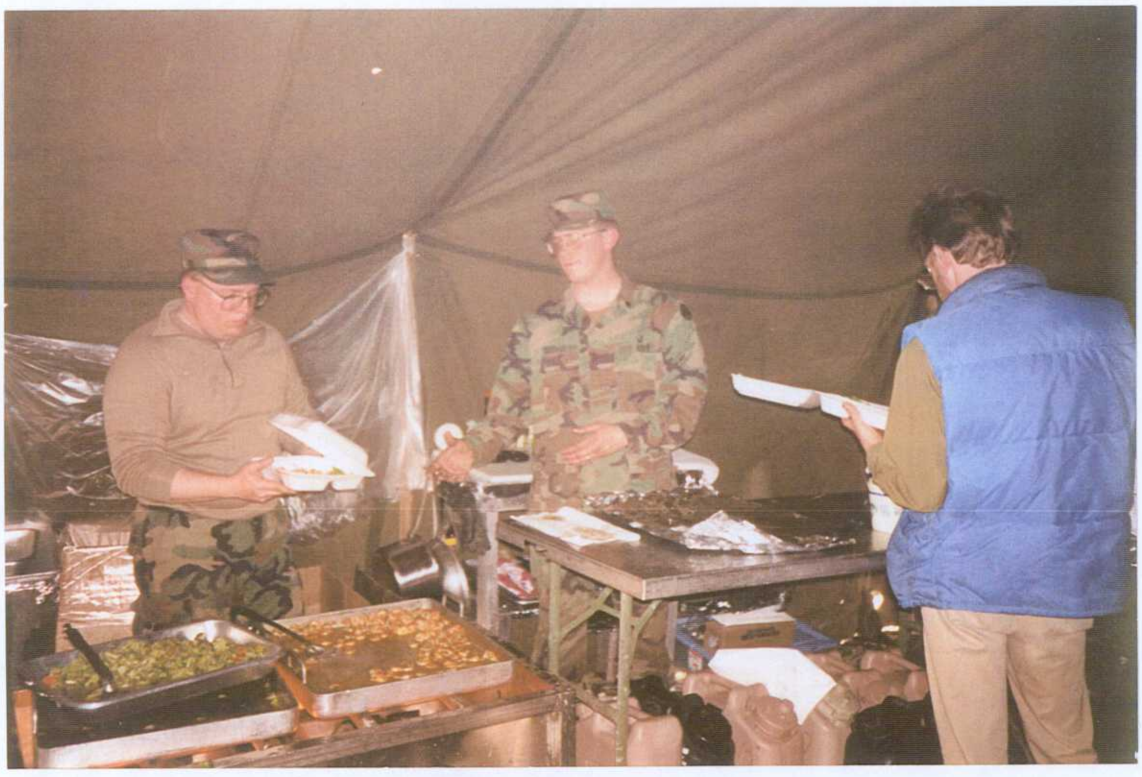


Figure 6. SGT Cameron Campbell and SPC Eric Duckworth provide food service in mess tent.

Figure 7. Visitors arrive at Pile Bay by chartered float plane.

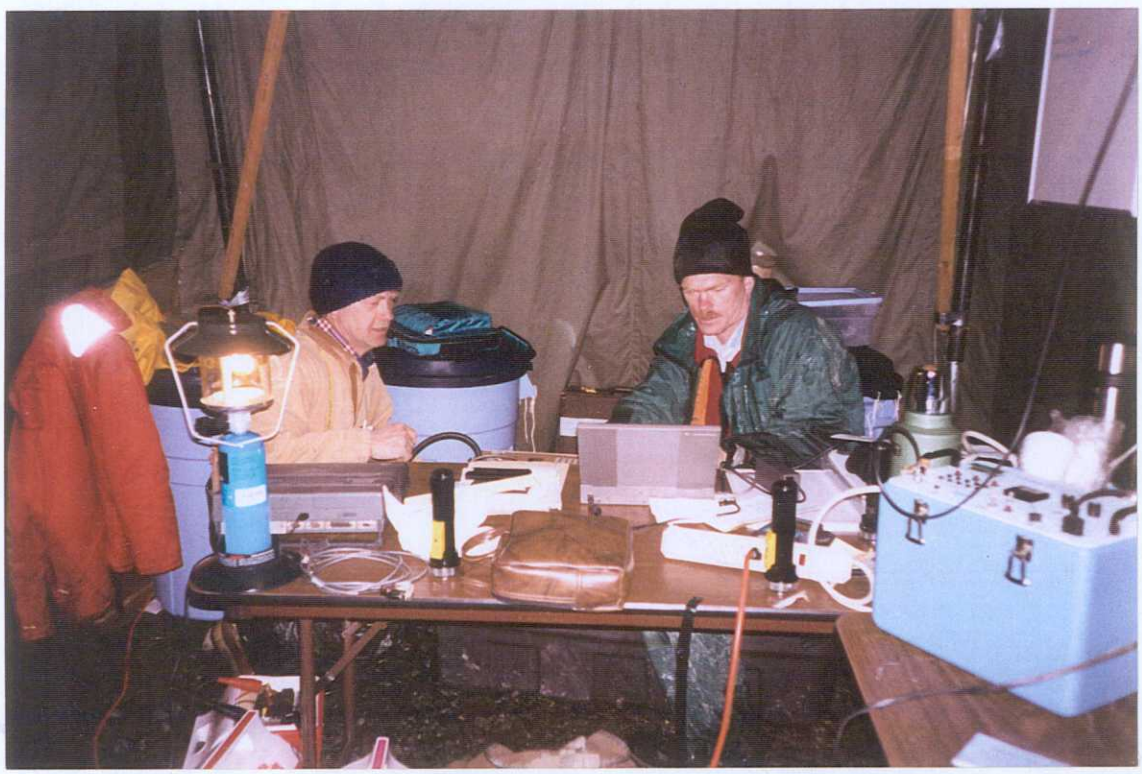


Figure 8. Geophysicists Dick Sylwester and Roy Retzlaff process data in the Operations tent.

Appendix E
Public Comments and Correspondence

TONY KNOWLES, GOVERNOR

DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

OFFICE OF THE COMMISSIONER

3132 CHANNEL DRIVE
JUNEAU, ALASKA 99801-7898

TEXT: (907) 465-3652
FAX: (907) 586-8365
PHONE: (907) 465-3900

March 13, 1995

Mr. and Mrs. Raymond L. Williams
HC 67 Box 1290
Anchor Point, AK 99556

Dear Mr. and Mrs. Williams:

Governor Knowles asked me to respond to your letter regarding the Pile Bay-Williamsport Road. In preparing the department's capital improvement program we ask local governments to assist us in selecting the highest priority needs in their area. The Lake and Peninsula Borough identified improvements to Pile Bay-Williamsport Road as one of their highest priority needs. Based on the Borough's recommendation we included preliminary engineering for the corridor in the current FY 95-97 Statewide Transportation Improvement Program (STIP). The field work for the project is scheduled to begin once the snow has melted this spring. The field work will determine the scope of the improvements needed to improve access along the corridor, as well as analyze all associated environmental impacts. Once preliminary engineering is complete, we will review the cost estimates for the various alternatives and determine best how to proceed.

The department is also participating with the Kenai Peninsula Borough and the U.S. Army Corps of Engineers (COE) in a feasibility study to evaluate the need for navigation improvements at Williamsport. The feasibility study will focus on an analysis of dredging options in Iliamna Bay to improve access to the road at Williamsport. Orson Smith, COE project manager, can be contacted at 753-2632 if you have questions regarding the navigation improvements study. Information from the navigation study may be helpful in identifying long-term improvement needs on the road corridor. It is very timely that work on the two studies is occurring simultaneously.

In your letter, you expressed concern regarding the funds available for maintenance on the road. Present funding for maintenance is less than desirable, but that is not unique to this road. Simply put, the maintenance budget has not kept pace with the cost of doing business and increased responsibilities throughout the state have prompted us to stretch our resources as far as possible to meet our needs.

You expressed concern about the mandatory insurance required as part of the Pile Bay-Williamsport Road contract. I asked John Horn, Central Region

Director, to review the insurance requirement in the maintenance contract. If you would like to discuss this issue, please contact John at 266-1440. Thank you for taking the time to write and let me know of your concerns.

Sincerely,

Joseph L. Perkins

Joseph L. Perkins, P.E.
Commissioner

cc: Don Gilman, Mayor, Kenai Peninsula Borough
John D. Horn, P.E., Regional Director, Central Region, DOT&PF
Representative Gail H. Phillips, Alaska State Legislature
Orson P. Smith, P.E., PhD., Project Manager, COE
Walt Wrede, Manager, Lake and Peninsula Borough

STATE OF ALASKA

WALTER J. HICKEL, GOVERNOR

DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

REGIONAL DIRECTOR, CENTRAL REGION

P.O. BOX 196900
ANCHORAGE, ALASKA 99519-6900
(907) 266-1440 (FAX 248-1573)

January 6, 1994

RE: Williamsport, Channel
Dredging Project

Colonel John W. Pierce
Corps of Engineers
Alaska District
P.O. Box 898
Anchorage, AK 99506-0898

Dear Colonel Pierce:

This memo is to confirm that the State of Alaska will provide the local match funding for the feasibility study phase of the Williamsport Channel Dredging project. It is our understanding that a local match of $260,267 will be needed for this phase of the project. Funds from the department's Corps of Engineers Match Fund will be used to provide the match.

The Kenai Peninsula Borough has agreed to be the local sponsor for the feasibility phase of the project (enclosure). We will need to meet with the Borough and your staff to review the Feasibility Cost Share Agreement. Please have your staff contact Patrick Beckley at 266-1675 for any further information on this project.

Sincerely,

Rowe D. Redick
for John D. Horn, P.E.
Regional Director

PB/mc

Enclosure (1)

cc: B.A. Campbell, Commissioner
Don Gilman, Mayor, Kenai Peninsula Borough

LAKE AND PENINSULA BOROUGH
RESOLUTION NO. 93-41

A RESOLUTION SUPPORTING THE RECOMMENDATION OF THE KENAI PENINSULA BOROUGH THAT THE U.S. ARMY CORPS OF ENGINEERS PROCEED WITH THE FEASIBILITY STUDY OF A CHANNEL DREDGING AND DOCK CONSTRUCTION PROJECT AT WILLAMSPORT, AND FURTHER RECOMMENDING THAT THE CORPS UNDERTAKE A RECONNAISSANCE STUDY FOR THE DEVELOPMENT OF A DEEP-DRAFT PORT FACILITY AT INISKIN BAY.

WHEREAS, the Kenai Peninsula Borough has adopted a resolution recommending that the U.S. Army Corps of Engineers proceed with the feasibility study of a channel dredging and dock construction project at Williamsport; and

WHEREAS, the Lake and Peninsula Borough supports any project that will improve surface transportation between Cook Inlet and Iliamna Lake, but believes that, ultimately, a deep-draft port facility is required, rather than a facility that can only accommodate shallow draft vessels during high tides; and

WHEREAS, the Corps has also acknowledged that the development of a deep-draft port facility will be required to accommodate the eventual exportation of minerals from the Cominco Exploration's Pebble Beach Mine; and

WHEREAS, the Lake and Peninsula Borough believes that the present transportation needs of Bristol Bay region communities justify the immediate development of a deep-draft port facility and an improved road to Iliamna Lake; and

WHEREAS, a reconnaissance study is needed to examine the physical and economic feasibility of developing a deep-draft port facility at Iniskin Bay;

NOW, THEREFORE, BE IT RESOLVED by the Lake and Peninsula Borough Assembly that the Lake and Peninsula Borough supports the recommendation of the Kenai Peninsula Borough that the U.S. Army Corps of Engineers proceed with the feasibility study of a channel dredging and dock construction project at Williamsport; and

BE IT FURTHER RESOLVED that the U.S. Army Corps of Engineers is hereby requested to undertake the preparation of a reconnaissance study to examine the physical and economical feasibility of the development of a deep-draft port facility at Iniskin Bay.

ADOPTED by a duly constituted quorum of the Lake and Peninsula Borough this 21st day of September, 1993.

IN WITNESS THEREOF:

Mayor

ATTEST:

Robin S. Gardner

Borough Clerk

KENAI PENINSULA BOROUGH
144 N. BINKLEY • SOLDOTNA, ALASKA 99669
PHONE (907) 262-4441

DON GILMAN
MAYOR

September 10, 1993

Colonel John W. Pierce
District Engineer
Department of of the Army
U.S. Engineer District, Alaska
P.O. Box 898
Anchorage, AK 99506-0898

Dear Colonel Pierce:

On September 7, 1993, the Kenai Peninsula Borough Assembly unanimously adopted Resolution 93-103: "A Resolution Recommending the U.S. Corps of Engineers Proceed with the Feasibility Study of a Channel Dredging and Dock Construction Project at Williamsport and Agreeing to Act as the Local Sponsor for the Feasibility Study".

The Mayor and Assembly have requested that you receive a copy of this resolution.

Respectfully yours:

Beverley Dove

Beverley Dove, Secretary
KPB Clerk's Office

/bd

Introduced by:	Scalzi
Date:	09/07/93
Action:	Adopted
Vote:	Unanimous

KENAI PENINSULA BOROUGH
RESOLUTION 93-103

A RESOLUTION RECOMMENDING THE U.S. CORPS OF ENGINEERS PROCEED WITH THE FEASIBILITY STUDY OF A CHANNEL DREDGING AND DOCK CONSTRUCTION PROJECT AT WILLIAMSPORT AND AGREEING TO ACT AS THE LOCAL SPONSOR FOR THE FEASIBILITY STUDY

WHEREAS, it has been demonstrated that there is a need to improve the transportation system linking Cook Inlet with Iliamna Lake; and

WHEREAS, a vital part of the transportation system is the tidewater approach for barges and landing craft at Williamsport located near the head of Iliamna Bay which opens into Kamishak Bay; and

WHEREAS, the makeshift wooden dock at Williamsport is inadequate for its intended purpose; and

WHEREAS, the U.S. Corps of Engineers has performed a reconnaissance study under the authority of Section 107 of the Rivers and Harbors Act of 1960, as amended, and finds a Federal interest in navigation improvements at Williamsport; and

WHEREAS, the reconnaissance study has shown that in the interest of saving time and money, a cost-shared feasibility study should be initiated; and

WHEREAS, feasibility studies for projects administered under the Section 107 Continuing Authorities Program requires 50 percent financial participation by a local sponsor; and

WHEREAS, the Alaska Department of Transportation and Public Facilities is ready to provide the local sponsor funding; and

WHEREAS, it is the State's policy that a local government act as the local sponsor and has requested the Kenai Peninsula Borough to act in that capacity because Williamsport is within the Borough's boundary;

NOW, THEREFORE, BE IT RESOLVED BY THE ASSEMBLY OF THE KENAI PENINSULA BOROUGH:

SECTION 1. That the Assembly of the Kenai Peninsula Borough recommends that the feasibility study of navigation improvements at Williamsport, Alaska be initiated by the U.S. Corps of Engineers at the earliest possible date.

SECTION 2. That the Kenai Peninsula Borough agrees to act as the local sponsor of the feasibility study.

SECTION 3. That the Assembly understands that acting as the local sponsor does not obligate the Borough in any way to provide funds for this, or future activities connected with navigational improvements at Williamsport.

SECTION 4. That the Assembly understands that actual funding for the local sponsorship of this activity will be provided by the Alaska Department of Transportation and Public Facilities.

SECTION 5. That the Mayor is authorized to enter into any agreement necessary to effectuate the terms of the Resolution.

SECTION 6. That the Resolution takes effect immediately upon its adoption.

ADOPTED BY THE KENAI PENINSULA BOROUGH ASSEMBLY THIS 7TH DAY OF SEPTEMBER, 1993.

Betty J. Glick

Betty J. Glick, Assembly President

ATTEST:

Gaye J. Vaughan

Gaye J. Vaughan, Borough Clerk

KENAI PENINSULA BOROUGH
ECONOMIC DEVELOPMENT DISTRICT, INC.

RESOLUTION 93-11

REQUESTING ALL APPROPRIATE AGENCIES OF THE STATE AND FEDERAL GOVERNMENTS TO PARTICIPATE IN A FEASIBILITY ANALYSIS OF THE SITING AND DEVELOPMENT APPROACH TO EITHER MAKE IMPROVEMENTS OR REPLACE THE BRISTOL BAY HAUL ROAD ON THE WEST SIDE OF COOK INLET.

WHEREAS, the Bristol Bay Haul Road has served a valuable purpose since the 1930s in the transport of vessels between Bristol Bay and Cook Inlet, with little repairs having been incurred at public cost while substantial private dollars having been expended; and

WHEREAS, there is increasing demand for haul road use and there is the potential for an adequately improved and sited road to open up development of mineral resources on the west side of Cook Inlet; and

WHEREAS, the Kenai Peninsula Borough has placed as priority the improvement of the road and entered into dialogue with other governments in the region and the State to establish a plan for the feasibility study and development of the road; and

WHEREAS, the Kenai Peninsula Borough Economic Development District, Inc. believes road development would lead to employment opportunities in vessel storage and repairs, in development of natural resources, and in improved access to residents in the region.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF THE KENAI PENINSULA BOROUGH ECONOMIC DEVELOPMENT DISTRICT, INC. THAT

Section 1: The District requests all appropriate agencies of the State and Federal Governments to participate in a feasibility analysis of the siting and development approach to either make improvements or replace the Bristol Bay Haul Road.

Section 2: This resolution shall take effect upon adoption.

APPROVED BY THE BOARD OF DIRECTORS OF THE KENAI PENINSULA BOROUGH ECONOMIC DEVELOPMENT DISTRICT, INC., HOMER, ALASKA, THIS 29 DAY OF July, 1993.

James A. Elson, Chairman

Attest: 7-29-9?

Post-It™ brand fax transmittal memo 7671	# of pages ▸ 1
To DR. ORSON SMITH	From MIKE SIMS
Co. CORPS OF ENGINEERS	Co. KPB ECON. DEV. DIST.
Dept. U.S. ARMY	Phone # 283-3335
Fax # 753-2526	Fax # 2833913

NORTHERN ENTERPRISES
(907) 235-8234
FAX 235-7083
41930 KACHEMAK DRIVE HOMER, ALASKA 99603

June 10, 1993

RECEIVED
DOT & P F PLANNING
JUN 11 1993
ANCHORAGE, ALASKA

Jeff Landers
DOT Planning Section
P.O. Box 196900
Anchorage, AK 99519-6900

Dear Mr. Landers:

We own a boat storage and repair yard located at Homer, Alaska on the Kenai Penninsula. We are across Cook Inlet from Williams Port. We store as many as 500 vessels at one time and lease out 60,000 square feet of retail sales and boat repair shop space.

My wife and I have also been involved in commercial fishing over most or the State, for 25 years. We still have a vessel in Bristol Bay and fish there. We have each made many trips around the Alaska Peninsula to Bristol Bay and back. We also have made one trip with a small gillnetter across Iliamna Lake and over the portage. It reduces 1,000 miles of risk, a week or more time, wear and tear, thousands of dollars in expenses, down to a couple hundred miles of mostly covered inland travel. Unfortunately the boats are almost all bigger than the bridge and the road needs repair.

Our boat yard and vessel repair businesses on the Kenai Penninsula, do considerable repair work and retail sales for vessel owners that are Bristol Bay fishermen, because it is so difficult and expensive to get anything done in Bristol Bay. Some vessels are shipped or run to Seattle to refurbish and repair. Most of the boat storage and repair businesses in the bay are owned and operated by people who live in Seattle. Few if any of the businesses are open to do repairs until spring. When workers return from Seattle in the spring, hourly rates are $80,00 to $120.00 an hour and parts cost twice what they do here. No wonder, people are willing to run 1,000 miles, at great risk, to find a place and time to get repair work done.

With road improvements to allow the longer boats over the haul road, we would see an increase in jobs on the Kenai Peninsula and supplies bought through Alaska businesses.

People on the Kenai Peninsula are actively doing boat repair and buying supplies for retail sales all winter long.

We alone, have 8 heated shops up to 60' long and 40' tall. Judging by the amount of bay boats we store now, I believe there would be a surprising amount of boats hauled over the road if it were possible.

In an attempt to see how much interest there is among Bristol Bay Fishermen to bring their boats to Cook Inlet for repair, storage and use, we sent 350 cards to Bristol Bay Permit Holders. We only sent them to Bristol Bay Drift Permit Holders that live from Kodiak to Fairbanks.

However, we are also finding interest from fishermen who live outside and have received phone calls from two Cordova people who would rather put their boats in Cook Inlet for the winter than Bristol Bay. Of the 350 cards sent out we have received 90 back. Enclosed are copies of the cards we received back.

Other possible areas of use would be:

- Set netters
- Fishing lodges and guides
- Local residents
- Returning Herring seiners
- Just anybody that wants to repair their vessel for less than $100.00 per hour charges.

Most of the repair is done by people that live in Seattle and are only in Bristol Bay for a few summer months.

In my opinion we would be looking at several million dollars in vessel repair work and storage that would come to the Kenai Peninsula each year.

I do not really believe in buying jobs, and I have no idea what it would cost to replace bridges and do necessary road work.

With their being over 1800 drift boats and permits in Bristol Bay, I think that the bridge replacement could be of great benefit to the Kenai Peninsula.

Respectfully,

Kenneth D. Moore

(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

_____ Use the road annually to bring my vessel back from Bristol Bay.
X Use the road every other year.
_____ Use the road every 3 to 5 years.
_____ Never use the road.

Comments:

Name: HOWARD KNUTSON Vessel: SEA HUNTER II
Address: P.O. BOX 93930
ANCHORAGE, AK 99509

(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

_____ Use the road annually to bring my vessel back from Bristol Bay.
X Use the road every other year.
_____ Use the road every 3 to 5 years.
_____ Never use the road.

Comments:

Name: DAVID IVY Vessel: F/V Winter Blues
Address: PO Box 15207, FRITZ CREEK, AK. 99603

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

_____ Use the road annually to bring my vessel back from Bristol Bay.
X Use the road every other year.
_____ Use the road every 3 to 5 years.
_____ Never use the road.

Comments: Yes - very good idea. I would use it at least every other year, possibly more.

Name: DAVID IVY Vessel: F/V Winter Blues
Address: PO BOX 15207, FRITZ CREEK AK 99603

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

_____ Use the road annually to bring my vessel back from Bristol Bay.
X Use the road every other year.
_____ Use the road every 3 to 5 years.
_____ Never use the road.

Comments:

Name: Bobby [illegible] Vessel: Sapphire
Address: Box 878573
Wasilla, AK 99687

If improvements were made to road, thus allowing larger vessels, I would:

- ______ Use the road annually to bring my vessel back from Bristol Bay.
- ______ Use the road every other year.
- ✓ Use the road every 3 to 5 years.
- ______ Never use the road.

Comments:

Name: Leonard Herzog Vessel: F/V Mighty Son

Address: 732 "O" St No 2

Anchorage AK 99501

(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ______ Use the road annually to bring my vessel back from Bristol Bay.
- ______ Use the road every other year.
- ______ Use the road every 3 to 5 years.
- ______ Never use the road.

Comments:

Name: Henry Clark Vessel: Silver Tide

Address: P.O Box 2185

Soldotna AK 99669

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ______ Use the road annually to bring my vessel back from Bristol Bay.
- ______ Use the road every other year.
- ______ Use the road every 3 to 5 years.
- ______ Never use the road.

Comments: I would probably use the haul road But I don't know how often, because it wasn't Been available to me before (14.5 wide)

Name: Gary Olson Vessel: Lady Kathleen

Address: 1825 W. 15th Ave.

Anchorage, AK 99501 - 274-2021

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ______ Use the road annually to bring my vessel back from Bristol Bay.
- ______ Use the road every other year.
- X Use the road every 3 to 5 years.
- ______ Never use the road.

Comments: I used the road several times in the last 10 years and feel the safety factor of not going to False Pass was key to my fishing.

Name: BoB Williams Vessel: Sourdough

Address: Box 5555

KENAI AK 99611

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ______ Use the road annually to bring my vessel back from Bristol Bay.
- X Use the road every other year.
- HUX Use the road every 3 to 5 years.
- ______ Never use the road.

Comments: It would Be Nice if The Bridge was wider to get Boats thru that are wider than 12' some can work on Boat

Name: Hal Upton Vessel: Rio-De-ORO

Address: P.O. BOX 877549

Wasilla AK 99687

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ______ Use the road annually to bring my vessel back from Bristol Bay.
- ✓ Use the road every other year.
- ______ Use the road every 3 to 5 years.
- ______ Never use the road.

Comments:

Name: Ernest Demoski Vessel: Jody K

Address: 1816 Cindy lee Lane

Anchorage, AK 99507

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ______ Use the road annually to bring my vessel back from Bristol Bay.
- X Use the road every other year.
- ______ Use the road every 3 to 5 years.
- ______ Never use the road.

Comments:

Name: Vessel:

Address:

F/V Star Trek
Ignaty Basargin
P.O. Box 2355
Homer, AK 99603-2355

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ______ Use the road annually to bring my vessel back from Bristol Bay.
- X Use the road every other year.
- ______ Use the road every 3 to 5 years.
- ______ Never use the road.

Comments:

Name: Vessel:

Address:

F/V Sea Glider
Ignaty Basargin
P.O. Box 2355
Homer, AK 99603-2355

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ____ Use the road annually to bring my vessel back from Bristol Bay.
- ____ Use the road every other year.
- X Use the road every 3 to 5 years.
- ____ Never use the road.

Comments: Unquestionable preference in which I would bring the boat to Homer for maintenance, Repairs.

Name: David C. Strebel Vessel: Reflections

Address: 3605 Arctic Blvd #724
Anchorage AK 99503

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ____ Use the road annually to bring my vessel back from Bristol Bay.
- ✓ Use the road every other year.
- ✓ Use the road every 3 to 5 years.
- ____ Never use the road.

Comments: We sure need that Road. We need access to B. Bay with out going through Dutch Harbor.

Name: Nathan Chesser Vessel: Snug Seas

Address: PO Box 383, Anchor Point, AK 995[illegible]

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ____ Use the road annually to bring my vessel back from Bristol Bay.
- ____ Use the road every other year.
- X Use the road every 3 to 5 years.
- ____ Never use the road.

Comments:

Name: Bob Mielke Vessel: Caprice

Address: Box 870498
Wasilla AK 99687

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ____ Use the road annually to bring my vessel back from Bristol Bay.
- ✓ Use the road every other year.
- ✓ Use the road every 3 to 5 years.
- ____ Never use the road.

Comments: Would also reduce Frt Rates for Bulk Frt.

Name: Reinhold Thiele Vessel: Gloria Dea

Address: 8126 Wisteria
Anchorage AK 99502

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ____ Use the road annually to bring my vessel back from Bristol Bay.
- ____ Use the road every other year.
- X Use the road every 3 to 5 years.
- ____ Never use the road.

Comments: I think it very important transport link not only for Boats But Freight Also

Name: Kevin Hogan Vessel:

Address: Box 2228
Homer AK 99603

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ____ Use the road annually to bring my vessel back from Bristol Bay.
- ____ Use the road every other year.
- ✓ Use the road every 3 to 5 years.
- ____ Never use the road.

Comments: We use the road almost every year for access to the Inlet, but not necessarily for boats. It is a vital link ~~needs~~ improvement!

Name: David Wilder Vessel: Maggie

Address: 3323 Dry Creek
Port Alsworth, AK 99653

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ____ Use the road annually to bring my vessel back from Bristol Bay.
- ✓ Use the road every other year.
- ✓ Use the road every 3 to 5 years.
- ____ Never use the road.

Comments: Badly Needed Improvements Needed, Bridges Needed, Road up Grading Needed for →

Name: Nick Shanigan Vessel: Arctic Maid

Address: Box 1036
[illegible] AK 996[illegible]

(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ______ Use the road annually to bring my vessel back from Bristol Bay.
- ✓ Use the road every other year.
- ______ Use the road every 3 to 5 years.
- ______ Never use the road.

Comments: THIS WOULD BE REAL HELPFUL ON MAJOR REPAIRS/IMPROVEMENTS ON EQUIPMENT.

Name: Jim Tillotson Vessel: St. JOSEPHINE

Address: 1218 W 10th Ave ANC. Ak. 99501

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ______ Use the road annually to bring my vessel back from Bristol Bay.
- X Use the road every other year.
- ______ Use the road every 3 to 5 years.
- ______ Never use the road.

Comments: I have used this Road Before + Like it. I have since gone to a biger Boat + hate the Falspass trip b (not to mention Coast Guard Regs)

Name: John M Lindow Vessel: Red Wing

Address: 6127 Blackberry St Anc Ak 99502

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ______ Use the road annually to bring my vessel back from Bristol Bay.
- ______ Use the road every other year.
- ✓ Use the road every 3 to 5 years.
- ______ Never use the road.

Comments: Many fishermen would bring their boats to the cook Inlet area for up-grading + repairs.

Name: Chester + Isabelle Nillett Vessel: F/V GUERIE MARIE

Address: 6960 VIBURNUM DRIVE ANCHORAGE, ALASKA 99507

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ______ Use the road annually to bring my vessel back from Bristol Bay.
- ______ Use the road every other year.
- X Use the road every 3 to 5 years.
- ______ Never use the road.

Comments:

Name: Vladimir Martushev Vessel: "KAZBEK"

Address: VLADIMIR MARTUSHEV P.O. BOX 5148 NIKOLAEVSK ANCHOR POINT, AK 99556

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ______ Use the road annually to bring my vessel back from Bristol Bay.
- ______ Use the road every other year.
- X Use the road every 3 to 5 years.
- ______ Never use the road.

Comments: I'd be very much in favor of improving the road.

Name: Chuck McMahan Vessels: The Chenann and the Bonanza

Address: P.O. Box 2 GAKONA ALASKA 99586

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ______ Use the road annually to bring my vessel back from Bristol Bay.
- ______ Use the road every other year.
- ✓ Use the road every 3 to 5 years.
- ______ Never use the road.

Comments:

Name: Charlie Williams Vessel: Independence

Address: 2611 E Little Isl. Rd. Cathlamet Wash 98612

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ______ Use the road annually to bring my vessel back from Bristol Bay.
- ______ Use the road every other year.
- ✓ Use the road every 3 to 5 years.
- ______ Never use the road.

Comments: I've used the road once & own property at Pedro Bay & Naknek. Will probably use the road in next 5 years

Name: Fred Walatka Vessel: Byrd

Address: 3107 W. 29th Ave Anchorage, AK 99517

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

- ______ Use the road annually to bring my vessel back from Bristol Bay.
- ______ Use the road every other year.
- ✓ Use the road every 3 to 5 years.
- ______ Never use the road.

Comments: I have used this road to transport my boat once. I have gone around by False Pass twice. There is no comparison as to safety, costs, time etc. Let's get that road portage operating.

Name: Clarence Bokk Vessel: Clare Ann

Address: 4753 W. 80th Ave Anchorage AK 99502

(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

(2) ✓ Use the road annually to bring my vessel back from Bristol Bay.
(1) ✓ Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments: IN 10 YEARS I'VE PORTAGED + RT, - THEN WITH BOAT TOO BIG, HAVE RT, FALSE PASS, 3 TRIPS FOR HALIBUT FISHING - NEW BOAT DELIVERY AND REPAIRS. ESTIMATE USING PORTAGE 2 OF 3 YRS AND WOULD SPEND A WEEK ON RECREATION IN LAKE.

Name: ______ Vessel: F/V JAZZ

Address: John J. Kane
2152 Davis St.
Anchorage, Alaska 99503

If improvements were made to road, thus allowing larger vessels, I would:

______ Use the road annually to bring my vessel back from Bristol Bay.
✓ Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments: This is an excellent idea. I hope it becomes a reality.

Name: Chuck Hughes of Hughes & Sons Vessel: Hat Trick Sea Bird

Address: P.O. Box 110693 Anch. AK 99511

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

______ Use the road annually to bring my vessel back from Bristol Bay.
X Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments: thanks for the Support on this ISSUE.

Name: Michelle Oleary Vessel: Whiskey Creek

Address: P.O. Box 1052
CORDOVA, Alaska 99574

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

______ Use the road annually to bring my vessel back from Bristol Bay.
X Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments: I used the road only one time (1982), but I was sure happy that the haul road was there. We need upgrading.

Name: Keith Sandvik Vessel: "Ingolf"

Address: HC02 7472
Palmer AK 99645

The boat I have now is a little too wide to go through the bridge. Keith Sandvik

---

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

______ Use the road annually to bring my vessel back from Bristol Bay.
✓ Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments: ______

Name: Art Elliott Vessel: F/V Innovator

Address: 1523 Alder Dr.
Anchorage, AK 99508

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

______ Use the road annually to bring my vessel back from Bristol Bay.
X Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments: ______

Name: Loren Kroon Vessel: F/V Tillken

Address: 3400 Balchen Dr.
Anch AK 99517

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

______ Use the road annually to bring my vessel back from Bristol Bay.
X Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments: ______

Name: Dan Hastings Vessel: F/V Grand Marnier

Address: P.O. Box 3324 Soldotna, AK. 99669

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

______ Use the road annually to bring my vessel back from Bristol Bay.
✓ Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments: ______

Name: Keith Langman Vessel: F/V Silverside

Address: 7124 Timothy ST
Anchorage AK 99502

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

YES! Use the road annually to bring my vessel back from Bristol Bay.
______ Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments: Build it now - I would use it tomarrow - Both ways each year

Name: ~~Ega~~ Agaafon Matveev Vessel: Flying Saucer
Address: Box 874
Homer, AK 99603

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

Yes Use the road annually to bring my vessel back from Bristol Bay.
______ Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments:

Name: Konrad Schaaf Vessel: FV Sluice Box
Address: 53198 McNeil ~~Pt~~
~~Homer~~ AK 99603

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
______ Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments:

Name: Lonny Andree Vessel: Howie-W
Address: P.O. Box 2146
Homer AK 99603

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

✓ Use the road annually to bring my vessel back from Bristol Bay.
______ Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments: Widen bridge & improve road

Name: Herbert Streb Vessel: [illegible]
Address: 434 E 24 907 258 6195
Anch AK 99503

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
______ Use the road every other year.
______ Use the road every 3 to 5 years. ?
______ Never use the road.

Comments: Our boat, like many others in the Bay, are "beamy", 13' + up. We'd use the road for access to K Bay off season & possible storage.

Name: Jim Blees Vessel: F/V Soschi
Address: 4330 S. Park Bluff Dr.
Anchorage AK 99516

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
______ Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments: Please make sure it is wide enough for the largest Bay or Peninsula Boat - + 17' without vertical clearance problems.

Name: Michael W. Franks Vessel: FV Kuskokwim Gayle
Address: 4130 Viscount Cir
Anchorage AK 99502
Please indicate storage rate.

If improvements were made to road, thus allowing larger vessels, I would:

______ Use the road annually to bring my vessel back from Bristol Bay.
______ Use the road every other year.
______ Use the road every 3 to 5 years.
__X__ Never use the road.

Comments: We have a 14' wide with trphouse, a total height of about 12'. We can't use the road now Can't get through.

Name: Norm Stadem Vessel: Cassiopeia

Address: 1826 E 26th Ave
Anchorage, AK 99508

If improvements were made to road, thus allowing larger vessels, I would:

______ Use the road annually to bring my vessel back from Bristol Bay.
______ Use the road every other year.
______ Use the road every 3 to 5 years.
__X__ Never use the road.

Comments: I might use it once [illegible] Bay I'd [illegible] on it unless I move out of FAI to a closer place than [illegible]

Name: [illegible] P. [illegible] Vessel: ~~[illegible]~~ [illegible]

Address: 1306 9th Ave
Fairbanks, AK 99701

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

______ Use the road annually to bring my vessel back from Bristol Bay.
______ Use the road every other year.
______ Use the road every 3 to 5 years.
__X__ Never use the road.

Comments: This road is a waste of money & a threat to water quality. Please oppose added funding.

Name: M. Holum Vessel:

Address: 1013 E. Dimond, #184
Anchorage, AK 99515

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

______ Use the road annually to bring my vessel back from Bristol Bay.
______ Use the road every other year.
______ Use the road every 3 to 5 years.
__X__ Never use the road.

Comments: I'm a deckhand - Don't own a boat, but do most of the driving around the chain. Save alot of t

Name: Cheryl Jolly Vessel:

Address: P.O. Box 75
AnchorPoint, AK 99556

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

__X__ Use the road annually to bring my vessel back from Bristol Bay.
______ Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments:

Name: Dave McDonald Vessel: Bristol Breeze

Address: PO Box 15052 Fritz Creek
AK 99603

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

______ Use the road annually to bring my vessel back from Bristol Bay.
______ Use the road every other year.
______ Use the road every 3 to 5 years.
__X__ Never use the road.

Comments: The only people that benefit (Money wise) from this road are the Williams so they should do some repairs.

Name: James Brew Vessel: Wally D

Address: Box 111533
Anchorage Alaska 99511

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

______ Use the road annually to bring my vessel back from Bristol Bay.
______ Use the road every other year.
______ Use the road every 3 to 5 years.
__X__ Never use the road.

Comments: Make Wider Road for My Kind Boat (16'2") (ft) Higher

Name: Steve Fefelov Vessel: F/V Serenity

Address: P.O. Box 304
Homer Alaska 99603

(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

✓ Use the road annually to bring my vessel back from Bristol Bay.
____ Use the road every other year.
____ Use the road every 3 to 5 years.
____ Never use the road.

Comments:

Name: Art Woinowsky Vessel: Lady June

Address: Gen. Del. Ugashik, AK Via King Salmon, AK 99532

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
____ Use the road every other year.
____ Use the road every 3 to 5 years.
____ Never use the road.

Comments: Sure need that road!

Name: Sergey YAkunin Vessel: Alaskan Pride

Address: P.O. Box 5044 Nikolaevsk, AK. 99556

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
____ Use the road every other year.
____ Use the road every 3 to 5 years.
____ Never use the road.

Comments: I would use the road to bring my vessel to Kodiak

Name: S. Olson Vessel: Blind luck

Address: 1213 E 26th Anchorage, AK 99508

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
____ Use the road every other year.
____ Use the road every 3 to 5 years.
____ Never use the road.

Comments: at This Time it is not wide enof

Name: Dorothy Fleenor Vessel: F/v Aaron Kos

Address: 906 Mattox Ct. Homer Ak. 99603

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

✓ Use the road annually to bring my vessel back from Bristol Bay.
____ Use the road every other year.
____ Use the road every 3 to 5 years.
____ Never use the road.

Comments:

Name: Debbie Hushfield Vessel: Gunsmoke

Address: P.O Box 546 Anchor Point, AK 99556

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

✓ Use the road annually to bring my vessel back from Bristol Bay.
____ Use the road every other year.
____ Use the road every 3 to 5 years.
____ Never use the road.

Comments: This year will be my 11 [illegible] over the Road. the Bridge [illegible] Has kept me from purcheing a larger [illegible]

Name: Robert Winningham Vessel: Heidi-Ann

Address: PO Box 2925 Homer AK 99603

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

✓ Use the road annually to bring my vessel back from Bristol Bay. for maintenance.
____ Use the road every other year.
____ Use the road every 3 to 5 years.
____ Never use the road.

Comments: Bridges needs to wider and higher or have no height restrictions How about the hairpin turn at the top?

Name: L. Thompson Vessel: F/V Champ

Address: Bx 747 Homer AK 99603

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
____ Use the road every other year.
____ Use the road every 3 to 5 years.
____ Never use the road.

Comments:

Name: HARRY FORQUER Vessel: michelle

Address: Box 1187 Homer AK 99603 phone 235-8317

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
___ Use the road every other year.
___ Use the road every 3 to 5 years.
___ Never use the road.

Comments: This project is of great importance to recreational boaters who wish to access Iliamna/Bristol Bay

Name: Michael J Ficcero Vessel: Rainy Daum

Address: PO BOX 2187
KODIAK AK 99615
907-486-5942

(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
___ Use the road every other year.
___ Use the road every 3 to 5 years.
___ Never use the road.

Comments: I live in Cordova and would love To bring my boat back from The bay.

Name: Troy Tirrell Vessel: F/V Whitney Ra

Address: Box 1044
Cordova AK. 99574

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
___ Use the road every other year.
___ Use the road every 3 to 5 years.
___ Never use the road.

Comments: Halibut Fishing access

Name: H. Leslie Burtner Jr. Vessel: Jessie Lucile

Address: Box 111041
Anch AK 99511

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
___ Use the road every other year.
___ Use the road every 3 to 5 years.
___ Never use the road.

Comments: My boat is too tall for the present bridge. With a new bridge I would Winter my boat in Soldotna

Name: Bill Severson Vessel: Sky Dancer

Address: P.O. Box 1054, Soldotna Alaska 99664

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

✓ Use the road annually to bring my vessel back from Bristol Bay.
___ Use the road every other year.
___ Use the road every 3 to 5 years.
___ Never use the road.

Comments: Last used road in '79, got a larger boat, It wont fit through the bridge.

Name: James Sandin Vessel: VANESSA

Address: Box 1223
Kodiak AK, 99615

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
___ Use the road every other year.
___ Use the road every 3 to 5 years.
___ Never use the road.

Comments: Make the bridge

Name: Dan Regan Jr Vessel: Selma

Address: 2814 Will Rogers Pl.
Anchorage, Alaska 99517.

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
___ Use the road every other year.
___ Use the road every 3 to 5 years.
___ Never use the road.

Comments: Badly needed for fishermen, good for southcentral economy, creating more jobs for Alaskans

Name: R. K. Mueller Vessel: Sea Eagle

Address: 8335 E 130th Ave
Anchorage, Alaska 99516

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
___ Use the road every other year.
___ Use the road every 3 to 5 years.
___ Never use the road.

Comments: MY BOAT IS 13 FT WIDE SO THE ROAD IS OF NO USE AT THIS TIME.

Name: DAVID THORNTON Vessel: SEA WOLF

Address: BOX 418
KENAI, AK 99611

If improvements were made to road, thus allowing larger vessels, I would:

✓ Use the road annually to bring my vessel back from Bristol Bay.
______ Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments:

Name: LEE HAWKINS Vessel: F/V CATHRYN LEE
Address: P.O. BOX 1039
HOMER, AK 99603

(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

✓ Use the road annually to bring my vessel back from Bristol Bay.
______ Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments: I've used it when I had a smaller boat. My current vessel is too large.

Name: David Whitmire Vessel: Thunder Bay
Address: P.O. Box 2481
Homer, AK 99603 235-7670

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

✓ Use the road annually to bring my vessel back from Bristol Bay.
______ Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments: I WOULD USE THE ROAD AT LEAST TWICE A YEAR AND HAVE HEARD A NUMBER OF KODIAK SPORT FISHERMEN & HUNTERS SAY THEY WOULD USE THE ROAD

F/V DUESPAYER
Name: Peter T. Thompson Vessel:
P.O. Box 3037
Address: Kodiak, AK 99615

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
______ Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments: As mentioned in the letter, it would be much safer also fishing is my livelihood and if anything should happen my family would be in jeopardy

Name: Ivan A. Martushev Vessel: Malachite
Address: Box 1939
Homer, AK 99603

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
______ Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments:

Name: Charles Arens Vessel: 3 Sisters
Address: 1730 Shore Dr.
Anchorage Alaska 99516

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

✓ Use the road annually to bring my vessel back from Bristol Bay.
______ Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments: I WOULD LIKE TO SEE THE ROAD IMPROVED

Name: NIKOLAS KOURIS Vessel: GOLDEN GREEK * 14 FT WIDE *
Address: 2101 W 29 # 25
ANCHORAGE, AK. 99517

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X X Use the road annually to bring my vessel to and back from Bristol Bay.
______ Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments: I TOTALLY AGREE WITH THE LETTER YOU SENT ME. HOPEFULLY WE'LL SEE THIS SHORTCUT WORK FOR MY BIG BOAT IN NEAR FUTURE.

Name: IVAN. F. BASARGIN. Vessel: NIGHTMARE
Address: P.O. BOX 324
HOMER, ALASKA 99603-0324

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

✓ Use the road annually to bring my vessel back from Bristol Bay.
______ Use the road every other year.
______ Use the road every 3 to 5 years.
______ Never use the road.

Comments: I've been waiting for years hoping the bridge would be replaced + the road up-graded

Name: Blanton Fortson Vessel: F/V Glacier Bay
Address: 7731 Anne Circle
Anchorage, Alaska 99504

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
____ Use the road every other year.
____ Use the road every 3 to 5 years.
____ Never use the road.

Comments: This road project would be a real benefit for myself and many other Bristol Bay fishermen.

Name: Jerald Vanfrease Vessel: F/V Chulyen

Address: 2440 E Tudor # 1054
Anchorage, Ak 99507

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
____ Use the road every other year.
____ Use the road every 3 to 5 years.
____ Never use the road.

Comments: Will use road annualy if The price does not much exceed fuel cos running around The Peninsula

Name: George Kirk Vessel: F/V Phantom

Address: box 2796
Kodiak AK 99615

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
____ Use the road every other year.
____ Use the road every 3 to 5 years.
____ Never use the road.

Comments: I used the portage for years until I upgraded my boat - now the bridge is too narrow and too low to go through - please fix the Bridge!

Name: Adrian Dorsee Vessel: Wanda Rose

Address: Box 473, Ninilchik, AK 99639

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
____ Use the road every other year.
____ Use the road every 3 to 5 years.
____ Never use the road.

Comments: I've Been Talking [illegible] Ray Williams about [illegible] My Boat through the [illegible]

Name: Greg Walker Vessel: C [illegible]

Address: 7601 Soldotna
Anch. AK 99516.

PS My Boat Is 12' Wide

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
____ Use the road every other year.
____ Use the road every 3 to 5 years.
____ Never use the road.

Comments: The use of This improved Road would provid Reasonable access to cooking areas and save lives [illegible] to The Falsepass Route

Name: Robert Peikes Vessel:

Address: Box 2250
Homer AK 99603

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

✓ Use the road annually to bring my vessel back from Bristol Bay.
____ Use the road every other year.
____ Use the road every 3 to 5 years.
____ Never use the road.

Comments: It would be great to use my fishing equip year round without the 200+ hour long trip each season.

Name: Donald Bakk Vessel: Alpha

Address: HC 67 Box 920A
Anchor Point, AK. 99556

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
____ Use the road every other year.
____ Use the road every 3 to 5 years.
____ Never use the road.

Comments:

Name: Wayne E. Taylor Vessel: Sea Hawk

Address: P.O. Box 292
Nenana, AK. 99760

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
____ Use the road every other year.
____ Use the road every 3 to 5 years.
____ Never use the road.

Comments:

Name: Peter W Balch Vessel: F/V Rainbow Chaser

Address: 1730 Willow Run
Fairbanks, Alaska 99709

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

✓ Use the road annually to bring my vessel back from Bristol Bay.
_____ Use the road every other year.
_____ Use the road every 3 to 5 years.
_____ Never use the road.

Comments: Dont waste money on DreDging, its not needed AnD never enDing project. Just fix BriDge & RoAD

Name: CRAIG COGGINS Vessel: CHUBasco

Address: P.O. 3427
Homer, AK.

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

✓ Use the road annually to bring my vessel back from Bristol Bay.
_____ Use the road every other year.
_____ Use the road every 3 to 5 years.
_____ Never use the road.

Comments: This is one of the most important projects I have seen in a long time.

Name: NAZARY BASARGIN Vessel: YEN Dulek

Address: P.O. Box 3264
Homer AK 99603

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
_____ Use the road every other year.
_____ Use the road every 3 to 5 years.
_____ Never use the road.

Comments:

Name: Dave Boone Vessel: F/V Beacon Bay

Address: 641 Rangeview Ave
Homer, AK 99603

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would: 14' wide

✓ Use the road annually to bring my vessel back from Bristol Bay.
_____ Use the road every other year.
_____ Use the road every 3 to 5 years.
_____ Never use the road.

Comments: Great idea and real saving - all the Bristol Bay Fisherman living In's Cook. LeRoy Buell

Name: Bill Buell Vessel: "Kanista" "Ghost Trader"

Address: P.O. Box 190825
Anchorage AK 99519

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

✓ Use the road annually to bring my vessel back from Bristol Bay.
_____ Use the road every other year.
_____ Use the road every 3 to 5 years.
_____ Never use the road.

Comments: I would use the boat in Cook Inlet for sport Fishing & Hunting in the entire southcentral Area.

Name: Dennis Albert Vessel: Shirley M

Address: 2201 Banbury
Anch AK 99504

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
_____ Use the road every other year.
_____ Use the road every 3 to 5 years.
_____ Never use the road.

Comments: I have 32 x 13½' Boat Am interested in bringing back annually.

Name: Kim Evers Vessel: Espresso

Address: Box 1324
Cordova AK 99574

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

✓ Use the road annually to bring my vessel back from Bristol Bay.

or ✓ Use the road every other year.

______ Use the road every 3 to 5 years.

______ Never use the road.

Comments: See Attachment (A)

Name: Dan Hennick Vessel: F/V ORACLE

Address: 40345 WATERMAN ROAD HOMER ALASKA

Attachment A

I think improving the Pile Bay - Williamsport road is a very good idea, however I think competition is necessary regards hauling boats to keep costs down. Deep draft boats will be limited due to shallow river conditions. Maybe dredging can help.

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
_____ Use the road every other year.
_____ Use the road every 3 to 5 years.
_____ Never use the road.

Comments: please Hurry im Tian at the False Pass trips

Name: MICHAEL J LOZANO Vessel: F/V TOKINO / A. BB-12 F/V SHADOWFAX

Address: 13682 Sunshine Anch AK 99515.

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

X Use the road annually to bring my vessel back from Bristol Bay.
_____ Use the road every other year.
_____ Use the road every 3 to 5 years.
_____ Never use the road.

Comments: I would also like to use this road to transport both seiners I use in Norton Sound.

Name: Kristi McLean Vessel: Red-Eye

Address: P.O. Box 283, Homer, AK. 99603

PILE BAY / WILLIAMS' PORT HAUL ROAD
(ILIAMNA LAKE TO COOK INLET)

If improvements were made to road, thus allowing larger vessels, I would:

_____ Use the road annually to bring my vessel back from Bristol Bay.
X Use the road every other year.
_____ Use the road every 3 to 5 years.
_____ Never use the road.

Comments: Improvements are long over due

Name: John Regitano Vessel: Esculent

Address: 2826 Totem Dr. Fairbanks AK 99709

WALTER J. HICKEL, GOVERNOR

STATE OF ALASKA

DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES

CENTRAL REGION — PLANNING

4111 AVIATION AVENUE
P.O. BOX 196900
ANCHORAGE, ALASKA 99519-6900
(TELEX 25-185) (907) 266-1462

October 9, 1991

RE: Williamsport
Reconnaissance Study

Alaska District Corps of Engineers
Attn: Ken Hitch, Chief of Planning
P.O. Box 898
Anchorage, Alaska, 99506-0898

Dear Mr. Hitch:

The State of Alaska Department of Transportation and Public Facilities (DOT&PF) requests a Section 207 Project (Continuing Authority for Small Navigation Improvements) of the Williamsport landing site be initiated by the Corps (Attachments). We request this site be analyzed as a preliminary reconnaissance study to determine the feasibility of federal involvement to the improvement of this access from the water. It is our understanding that there is no local sponsor contribution necessary to initiate the reconnaissance level study.

The Williamsport/Pile Bay Road is a state-owned and maintained gravel road that provides the only surface transportation link between Cook Inlet and Lake Iliamna. This road is used primarily to transport fishing boats from Cook Inlet across the peninsula. From the lake, the boats travel down the Kvichak River to Bristol Bay. This overland route reduces travel time by several days and eliminates the need for crossing the open waters of the Gulf of Alaska. The trip represents a difference between 400 miles via the Williamsport/Pile Bay Road, as opposed to 1,500 miles via False Pass and the Gulf of Alaska. The overland/lake trip also provides more protected moorage opportunities for the boats than a trip via the Gulf of Alaska. It is estimated that 35 to 40 boats are hauled over the road in an average season, although as many as 67 boats have been transported over the road in one year.

In addition to the boat haul, this road also accommodates other users. Contractors haul equipment to the Lake Iliamna region for summer construction work. There are two lodges operating adjacent to the road. One lodge is operated by the Pedro Bay Native Corporation and there is seasonal traffic from Pedro Bay, on Lake Iliamna, to the lodge at Williamsport. The second lodge, also on the Williamsport side, is privately-owned and operated.

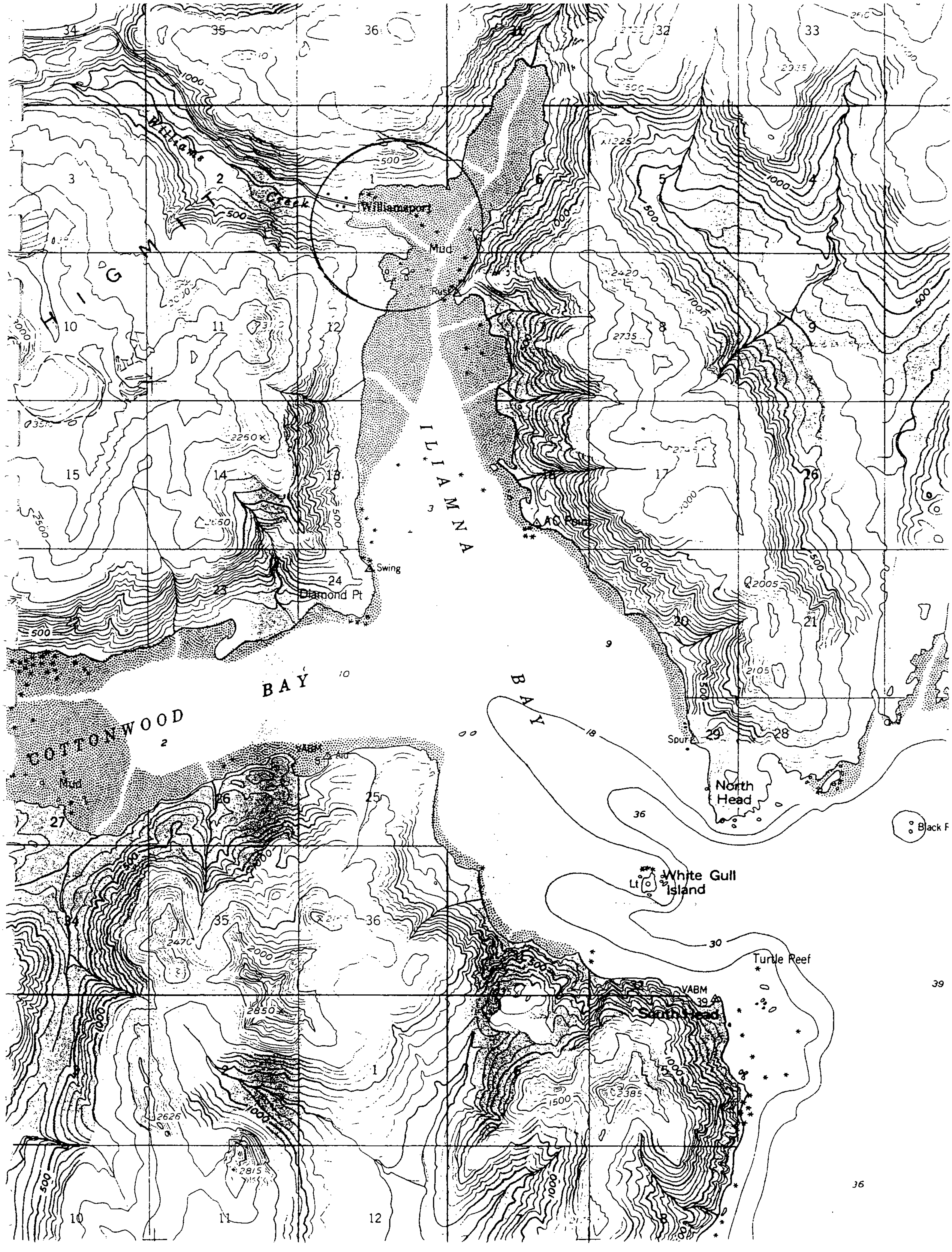
The landing at Williamsport can not be considered completely accessible as it can only be used at high tide. We feel that the road would be used more often if the Williamsport landing were an improved site. The Lake Iliamna area is rich in copper and other mineral reserves and an improved landing site has the potential to accelerate resource development.

We will look forward to hearing from you on the possibilities of improving this transportation facility. If you have any questions, please call Jeff Landes at 266-1672. Thank you for your considerations.

John S. Tolley
Chief, Planning and
Administrative Services

JL/jtf

cc: Representative George Jacko



Williams Creek
Williamsport
Mud
ILIAMNA BAY
COTTONWOOD BAY
Swing
Diamond Pt
Spur
North Head
White Gull Island
Lt
Turtle Reef
VABM
South Head
Aid
Black R

Knutson Bay
Knutson Mtn
Knutson Valley
Pedro Bay
Pedro Mtn
Chekok (Site)
Millets Pt
Flat I
Triangle I
Seal Is
Porcupine I
PILE BAY
Pile Bay Village
Old Iliamna (Site)
Long Lake
KENAI PENINSULA BOROUGH
Sugarloaf Mtn
Williamsport
Iliamna Bay
Cottonwood Bay
Dutton
North Head
White Gull I
South Head
Turtle Reef
Brown Peak
Ursus Head
Ursus Cove
Mt Eleanor
Roscoe Peak
Range Peak
INISKIN BAY
Iniskin Shoal
Scott
Pomeroy
Big Rock
Shark Tooth Hill
Oil Reef
Oil Pt
Copper Lake
Boot Lake
Meadow Lake
Intricate Bay
Kokhanok Bay
Pike Lakes
Fog Lake
Kakhonak R
The Cone
Step Mtn
Fortification Bluff
Rocky Cove
Big Hill
Seven Sisters
Bruin Bay
Contact Point
Amakdedori (Site)
Chenik Mtn
Chenik Head
Juma Reef
Amakdedulia Cove
Nordyke I
Pilot Knob
Middle Mtn
McNeil Cove
McNeil Islet
McNeil Head
Kamishak (Site)
Horseshoe Cove
Kamishak Bay
Augustine Island
Augustine Volcano
South Augustine
Burr Pt
Augustine Rks (Approximate Location)
KAMISHAK BAY
McNEIL RIVER STATE GAME SANCTUARY
Little Kamishak River
KATMAI NATIONAL MONUMENT
BOUNDARY
Shaw I
R. 31 W
R. 30 W.
R. 29 W.
154°
R. 28 W.
R. 27 W
R. 26 W.
30'
R. 25 W.