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Alpine Development Project

Environmental Evaluation Document

Appendices 1 & 2

Prepared for COE

Sep 1997 Revised

APPENDIX X

AGENCY APPROVAL OF VERTICAL PIPELINE LOOPS FOR THE ALPINE PROJECT

U.S. Department of Transportation
Research and Special Programs Administration

400 Seventh Street, S.W
Washington, D.C 20590

JUL 28 1997

Mr. William M. Fowler
Senior Permit Coordinator
Alpine Development Project
PO Box 100360
Anchorage, AK 99510-0360

Dear Mr. Fowler:

This replies to your letter of April 9, 1997, to Cesar De Leon, requesting our review and approval of the use of alternative technology in lieu of valves required under 49 CFR § 192.260(e). Your enclosed report "Alpine Project - Oil Pipeline Spill Technology Strategy" analyzes the use of vertical loops as an alternative to placing valves on either side of large streams being crossed by the proposed Alpine Pipeline from the Colville River Delta to the Kuparuk Pipeline on Alaska's north slope.

As you stated, the report models spills from small pinhole leaks up to catastrophic failure, and the proposed technology reduces spill volumes below what would be anticipated from the same system utilizing valves, under all scenarios. The report shows how the proposed alternative vertical loop system, in addition to providing better protection than valves, also eliminates the potential spills associated with valve leaks or failures.

Based on the information provided in the report, your request is approved and Arco Alaska, Inc., may place a vertical loop system on the proposed Alpine pipeline on each side of large streams in lieu of valves to satisfy the requirements of § 195.260(e). The vertical loop system provides adequate protection in lieu of valves that is required under § 195.260(e).

Sincerely,

for Cesar De Leon

Richard B. Felder
Associate Administrator for Pipeline Safety

STATE OF ALASKA

TONY KNOWLES, GOVERNOR
Phone: (907) 269-7539
Fax: (907) 269-7687
TTY: (907) 269-7511

DEPT. OF ENVIRONMENTAL CONSERVATION
DIVISION OF SPILL PREVENTION AND RESPONSE
Industry Preparedness and Pipeline Program
Exploration, Production and Refineries Section
555 Cordova Street
Anchorage, AK 99501

September 11, 1997

William M. Fowler
Senior Permit Coordinator
Alpine Development
ARCO Alaska, Inc.
P.O. Box 100360
Anchorage, AK 99510-0360

Letter No. 97-15-*RKW*
File No. 305.20

Certified Mail
Return Receipt Requested
 # Z 257 463 148

Dear Mr. Fowler:

Re: Best Available Technology Assessment of Vertical Pipeline Loops for ARCO Alaska's Alpine Pipeline Development

The Alaska Department of Environmental Conservation (ADEC) has completed review of the document entitled Alpine Project Oil Pipeline Spill Isolation Strategy, dated April 1997. This document was submitted by ARCO Alaska for the Department's review of a proposed spill control design for the Alpine Pipeline Project. An oil discharge prevention and contingency plan approved by ADEC must demonstrate that the best available technology (BAT) for source control of a discharge is utilized by the pipeline according to the criteria specified in 18 AAC 75.445(k). The project is still in the design phase, and a contingency plan will be developed and submitted to ADEC at a later date.

ARCO is seeking the Department's determination concerning compliance with the State's BAT Review regulation, 18 AAC 75.425(e)(4), for the use of vertical pipeline loops (risers) for discharge control in lieu of the more conventional isolation block valve design. The risers function by creating artificial drainage breaks in the line that can significantly reduce the size of potential spills.

Based upon the information provided, the riser design appears to provide a higher level of spill control than remotely actuated or manual block valves under most circumstances for this project. Therefore, ADEC accepts the riser design as demonstrating BAT for contingency planning.

purposes. When the contingency plan is submitted to the Department for public review, the aforementioned document would be satisfactory as an appendix to the plan for the required BAT review analysis. However, it is important to note that there may be other design aspects of the pipeline or facility that may require additional BAT analyses during the formal contingency plan review.

If you have comments or questions, please do not hesitate to contact either Ted Moore at 269-7569 or myself at 269-7539.

Sincerely,

Joe Sautner
Manager

RKW/JS/pea: (G:\EQ-CLER\JOES\ALPRISER.WPD)

cc: Bill Britt, ADNR, JPO
Tom Chapple, ADEC, IPP
Carl Lautenburger, USEPA, JPO
Ted Moore, ADEC, IPP
James Taylor, USDOT
Jeff Walker, USMMS

Alpine Development Project: Environmental Evaluation Document

Prepared for:
U.S. Army Corps of Engineers

Submitted by:
ARCO Alaska, Inc., Operator

Anadarko Petroleum Corporation, Co-Owner

Union Texas Petroleum Alaska Corporation, Co-Owner

APPENDICES - VOLUME 1

September 1997
Revised

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APPENDIX A

PRE-APPLICATION INFORMATION PACKAGES

APPENDIX A-1

MARCH 1996 INFORMATION PACKAGE

APPENDIX A-1

MARCH 1996 INFORMATION PACKAGE

ARCO Alaska, Inc.
Post Office Box 100360
Anchorage, Alaska 99510-0360
Telephone 907 276 1215

March 6, 1996

To: Alpine Development Pre-Application Meeting Participant
(See Attached Distribution List)

Re: ALPINE DEVELOPMENT INFORMATION PACKAGE
North Slope, Alaska

Dear Participant:

The purpose of this information package is to present to the state, federal, and local resource agencies, native entities and populations, and other interested parties the key findings (graphics included) of various environmental and technical studies completed to date for the proposed Alpine Development Project. These findings begin to provide a foundation for assessing potential environmental and human impacts of the proposed project.

ARCO Alaska, Inc. will use this information package as the basis of discussion in upcoming pre-application meetings which will be held in accordance with state, federal, and local government regulations. Accordingly, we would appreciate your review of this information package prior to the yet to be scheduled pre-application meetings to be held in Nuiqsut and Anchorage. We anticipate the meetings will be held in late March or early April. These meetings will provide a broader and more detailed description of the proposed project and represent an opportunity for ARCO to receive external input and for meeting participants to interact with our contractors. We hope the enclosed information aids you in formulating your input and interaction.

The proposed project, as presently conceived, is generally the same in scope as described last May/June 1995 in project roll out meetings. However, ARCO has evaluated a suite of reasonable alternatives which will be discussed at the pre-application meetings along with feedback to concerns and issues raised in earlier meetings. Although certain design modes, primarily river crossings, are still being evaluated, ARCO is proceeding with certain preferred alternative designs which include two gravel pads (one drill site pad, and one drill site/production facility pad) connected by a 4-mile road having a 5500-foot spur used for an airstrip. The pads will be located in the Colville River Delta, approximately 8 miles north of the village of Nuiqsut and immediately east of the Nechelik Channel. The sales quality oil will be transported to the Kuparuk River Unit by a 33-mile pipeline elevated on vertical support members throughout the route except at the river crossings. The main channel preferred alternative crossing will be bored beneath the main channel mud line using horizontal directional drilling technology. The preferred alternative for the Miluveach and Kachemach river crossings will also be underground utilizing either bored or trenched technology. A seawater pipeline will parallel the oil pipeline on the same vertical support members. The proposed project does not include a gravel road along the pipeline route, since the project will be accessed by ice roads and aircraft. However, as part of our normal alternatives analysis ARCO has evaluated the siting of a road. We will continue to evaluate all alternatives as new information becomes available and as issues of concern are voiced. Furthermore, the configuration will be refined as ARCO engineers better define the boundaries of the oil reservoir.

The enclosed information package consists of:

1. A chart of ARCO Alaska, Inc.'s permitting-related contractors for the Alpine Development Project.

2. Executive summaries and associated maps of the key environmental and technical findings of studies conducted in the delta and pipeline corridor. Summaries are provided for Human and Cultural Resources, Fish, Wildlife, Geomorphology and Hydrology, Water Quality, and Air Quality. The information was largely developed from multi-year studies funded by ARCO and its co-owners Anadarko and Union Texas Petroleum, a variety of technical reports specific to the North Slope region, and discussions with people knowledgeable about the delta. An emphasis of the information provided in the summaries was to address and identify concerns voiced at planning meetings and other forums held by ARCO.

Depicted on the maps are fish and wildlife habitat use patterns, and landscape features relative to the preferred project configuration including several alternative configurations. These maps represent a sample of site-specific data collected for the project area. Please note that the reference numbers in the map titles are solely for use in the Environmental Evaluation Document that ARCO is currently preparing for submission to the Corps of Engineers in June 1996.

ARCO is currently producing a separate base map depicting preferred and alternative project configurations, 1996 exploratory operations, historical exploration wells, and sites of cultural importance. This map will be distributed as soon as available.

3. A draft of the proposed Colville Region - Alpine Development 1996 Wildlife and Fish Studies Plan.

4. A set of engineering (Michael Baker Jr., Inc.) maps and drawings. The blueline spot imagery maps and drawings depict the project configuration and various alternative routes and designs being evaluated.

We will be contacting each recipient of this information package to verify receipt and answer any questions or comments regarding its proposed use. Thank you again for your continued participation in this planning process.

Sincerely,

Mark J. Schindler
Director, Colville Permits and Compliance

Distribution List
Alpine Development Pre-Application Package

Name	Fax	Phone
State of Alaska		
Jim Haynes / Steve Schmitz State of Alaska Department of Natural Resources Division of Oil and Gas 3601 C Street Anchorage, Alaska 99503-5937	562-3852	762-2592
Al Ott / Carl Heming Regional Supervisor Habitat Division State of Alaska Department of Fish & Game 1300 College Road Fairbanks, AK 99701	456-3091	459-7289
Sverre Pedersen / Terry Haynes ADF&G (Fairbanks)	479-5699	479-6211
Robert Watkins / Scott Bailey State of Alaska Dept. of Environmental Conservation 411 West 4th Avenue, Suite 2-C Anchorage, AK 99501-2343	272-0690	271-3693
Molly Birnbaum State of Alaska Division of Governmental Coordination Pipeline Corridor Regional Office 411 West 4th Avenue Anchorage, AK 99501-2343	272-0690	271-4317
Jerry Brossia SPCO (Anchorage)	272-0690	271-4336
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State of Alaska		
Bill Van Dyke State of Alaska Department of Natural Resources Division of Oil & Gas 3601 C Street, Suite 1380 Anchorage, AK 9903	562-3852	762-2550
Federal		
Bruce Batton Asst. Regional Director-Public Affairs U.S. Fish & Wildlife Service 1011 East Tudor Road Anchorage, AK 99503-6199	786-3640	786-3544
Philip Martin United States Dept. of the Interior Fish and Wildlife Service Northern Alaska Ecological Services 101 - 12 Avenue, Box 19 Fairbanks, AK 99701-6267	456-0208	456-0325
Lloyd Fanter ACOE (Anchorage)	753-5567	753-5567
Ted Rockwell EPA (Anchorage)	271-3424	271-3689
North Slope Borough		
Mayor Ahmaogak /Keith Quinteval / Warren Matumeak P.O. Box 69 Barrow, AK 99723	852-0322	852-2611
Arctic Slope Regional Corporation		
Bill Thomas P.O. Box 129 Barrow, AK 99723-0129	852-8633	

Name	Fax	Phone
Nuiqsut		
Mayor Gordon Brown / Leonard Lampe Nuiqsut Mayor's office P.O. Box 148 Nuiqsut, AK 99789	480-6928	480-6518/ 6727
Joe Nukapigak / Lanston Chinn Kuukpik Corp. P.O. Box 187 Nuiqsut, AK 99789-0187	480-6126	480-6220
Colville Village		
Mark Helmericks Colville Environ Svcs. (Anchorage)	345-9095	345-9095
Contractors		
Jay Brueggeman Parametrix	206 889-8808	882-8880
Bob Griffeth Parametrix	265-1515	265-6952 206 328-0656 (Seattle)
Jack Lobdell Lobdell Assoc.	505 867-5602	867-6602
Steve Murphy / Brian Lawhead ABR (Fairbanks)	455-6781	455-6777
Larry Moulton	206 842-7421	842-8654
Ed Owens OCC	206 842-2861	842-2951
Other Interested Parties		

Alpine Development
Environmental Contractor Organization Chart
ARCO Alaska, Inc. Operator

Operator Representative: Mark Schindler, Director, Colville Permits & Compliance
Phone:(907) 263-4766
Fax: (907) 265-1515 or 263-4966

Contractor	Point Of Contact	Phone #	Work Scope
Parametrix	Jay Brueggeman	(206) 822-8880 Fax (206) 889-8808	EA or EIS Document
*ABR	Brian Lawhead	(907) 455-6777 Fax (907) 455-6781	Enviro. & GeoMorph Studies/ Mapping
*Larry Moulton	Same	(206) 842-8654 Fax (206) 842-7421	Fish & Fisheries Studies
*Bob Griffeth	Same	(907) 265-6952 Fax (907) 265-1515	Socio. & Eco. Impact/ Native Relations
*Ed Owen	Same	(206) 842-2951 Fax (206) 842-2861	Oil Spill Impact/ Planning
*Jack Lobdell	Same	(505) 867-6602 Fax (505) 867-5602	Cultural & Arch. Impact & Site Selection

*These contractors are also subcontractors to Parametrix for creation of the environmental document.

HUMAN AND CULTURAL RESOURCES

As revealed through public meeting comments, recorded testimony drawn from past socio-economic studies, and from individual consultations, Nuiqsut residents have expressed concerns in two areas which may be affected by oil and gas development, production, and transportation in the Colville River delta. The first general area deals with economic benefits or costs likely to be associated with development. The second concerns possible impacts on subsistence.

Key findings include:

ECONOMIC BENEFITS/COSTS

- Strong desire for economic benefits flowing directly to the community (Kuukpik Corporation as major landowner and residents through their civic institutions) as contrasted to economic benefits indirectly received from state, NSB, or ASRC.
- Desire for enhanced employment opportunities (local hire) by project contractors/oil company operators.
- Desire for acquisition of natural gas from any development to be supplied to Nuiqsut for its use.
- Desire (not a uniform community view) by many for enhanced infrastructural improvements (roads, use of community facilities, e.g., airport) for project needs.
- Desire for production facilities to be located west of the Nechelik Channel, outside the delta.
- Costs were regarded mainly as potential adverse impacts on subsistence.

SUBSISTENCE CONCERNS

- Concern that facility construction and operation might adversely impact fish and wildlife populations in the delta (e.g., freshwater withdrawals from fish-bearing lakes, pipelines impeding caribou movements, disturbance from aircraft overflights).
- Concern that oil spills might damage wildlife and fish habitat.
- Concern that user access to traditional subsistence use areas in the delta would be seriously curtailed by restrictions on hunting in the vicinity of facilities.
- Strongly expressed desire for local participation in subsistence oversight boards and committees.
- Desire for reactivation of local oil spill response team.

FISH

A primary concern expressed by the agencies and Nuiqsut residents is the effect of the Alpine Development Project on the fish populations in the delta. At issue is safeguarding against the general effects of oil development activities and oil spill that may enter the rivers, channels, and lakes. To help address these concerns, ARCO has been conducting studies since 1991 to determine where, what, and how fish use the waters in the delta and transportation corridor. These studies build upon a substantial base of fishery information collected since the early 1970's.

Key findings include:

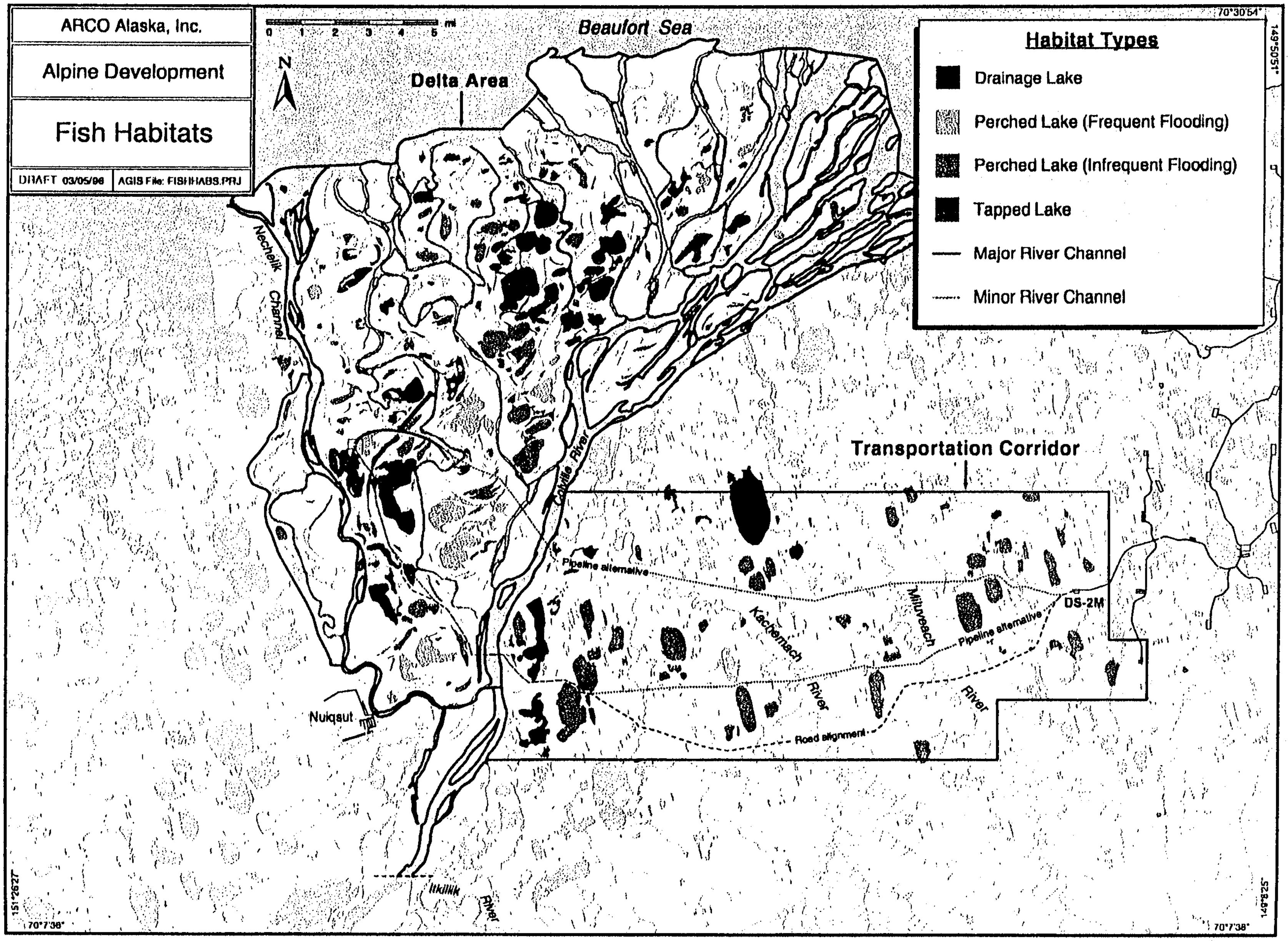
- The delta is heavily used for subsistence and commercial fishing, particularly along the major channels. Subsistence fishing occurs year-round, but is especially concentrated in the summer and fall. Commercial fishing is most active during the fall.

- A variety of aquatic habitats are used by fish, including major and minor river channels, lakes connected to channels, and lakes not connected to channels. Flooding frequency differs among the disconnected lakes, and this feature influences the specific species composition in each lake.

- Within the river channels, dominant species include least cisco, broad whitefish, humpback whitefish year-round, and Arctic cisco and Dolly Varden char seasonally.

- Fish are present in 70 (93%) of 75 lakes sampled since 1991.

- Least cisco were the most common fish, occurring in 68% of the lakes sampled. Other abundant species included ninespine stickleback (53%), broad whitefish (31%), Alaska blackfish (25%), Arctic cisco (19%), and humpback whitefish (12%). (see attached figures)



4.4.2-1. Distribution of fish habitats within the Colville Delta and Transportation corridor.

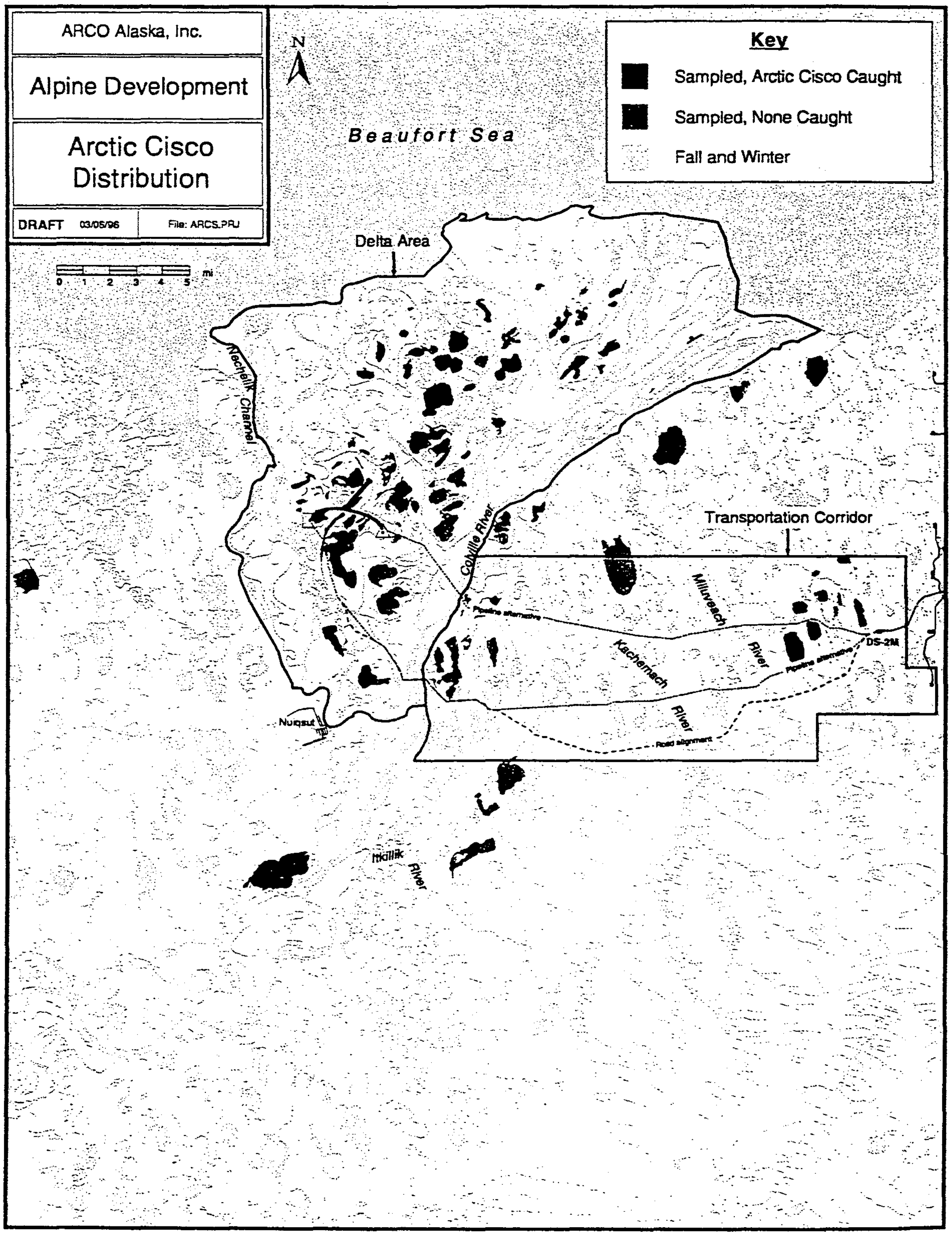


Figure 4.4.2-2. Habitat use by Arctic cisco within the Colville Delta and transportation corridor.

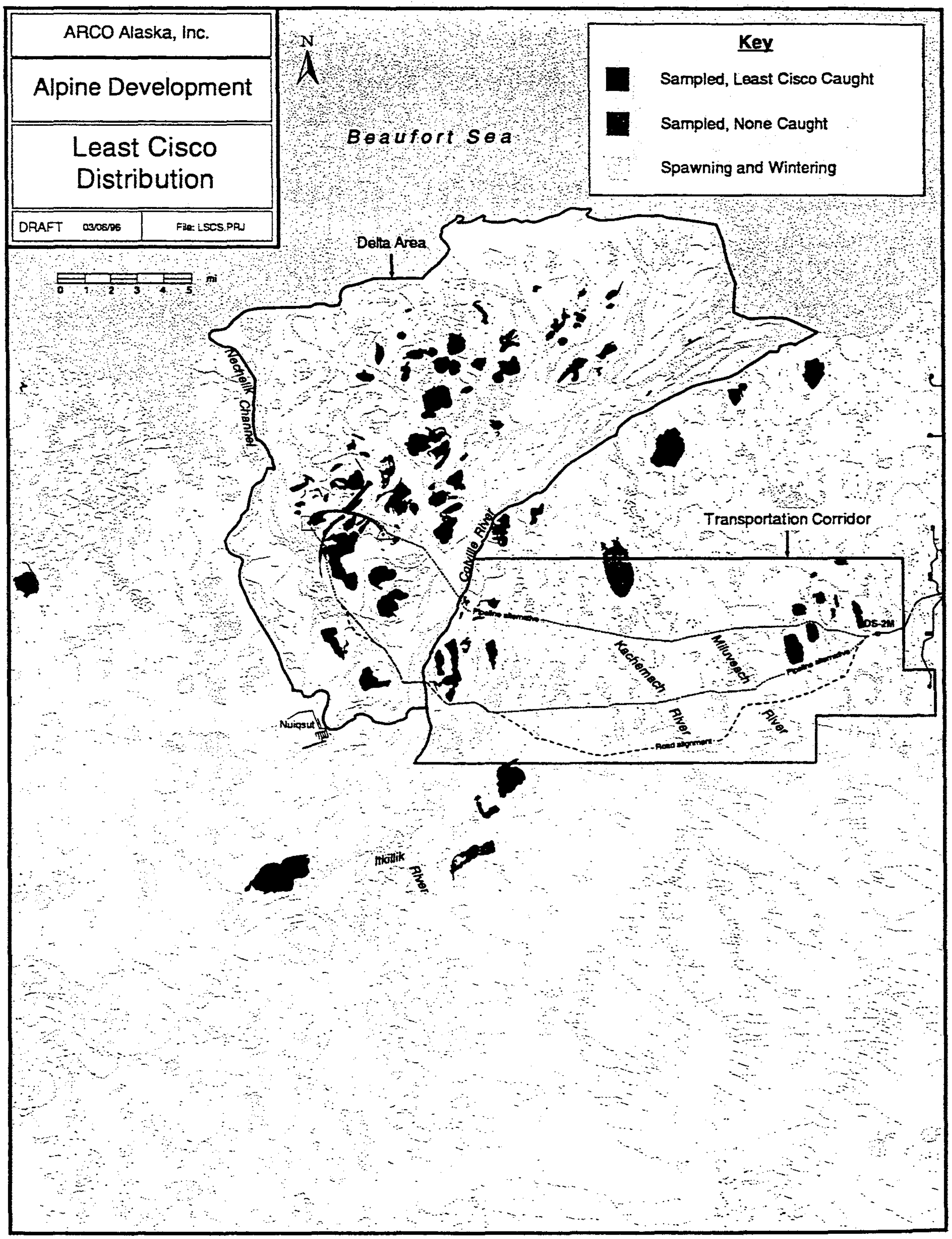


Figure 4.4.2-4. Habitat use by least cisco within the Colville Delta and transportation corridor.

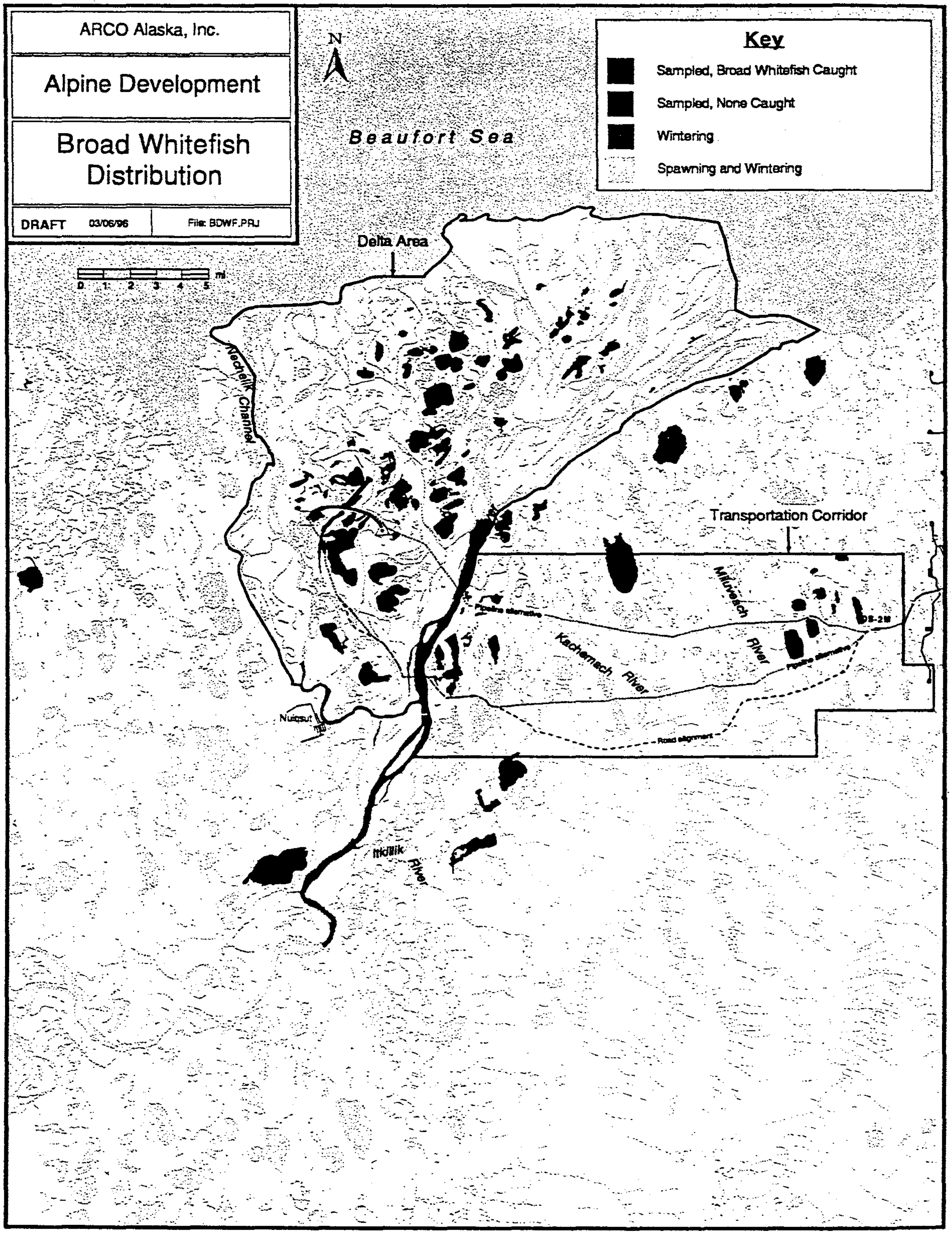


Figure 4.4.2-5. Habitat use by broad whitefish within the Colville Delta and transportation corridor.

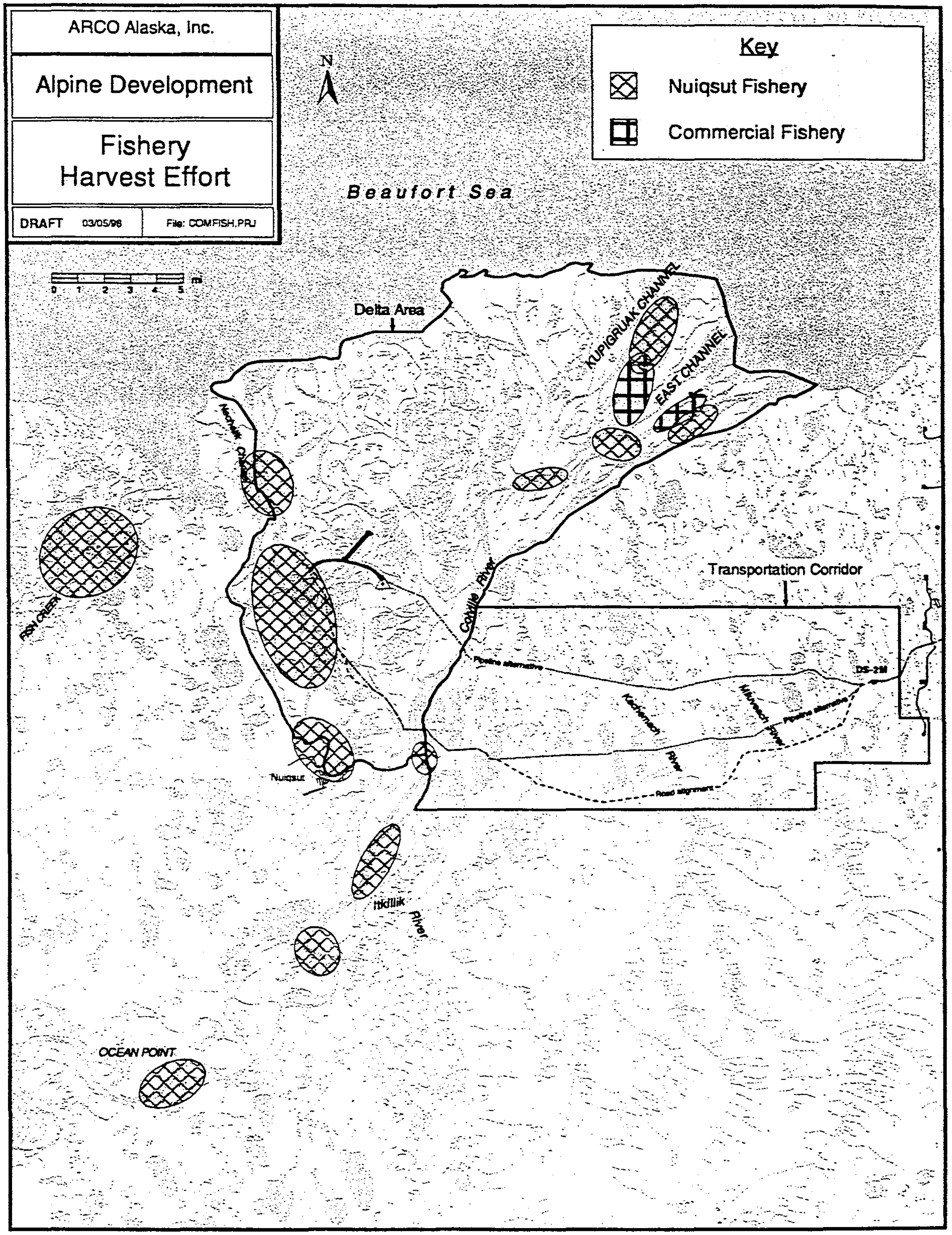


Figure 4.4.2-9. Areas of major fishing activity within the lower Colville River and delta.

WILDLIFE STUDIES (1992–1995)

Concerns have been raised about the potential effects of the Alpine Development on birds and mammals that use the Colville River Delta. Wildlife research has been occurring on the delta for decades, and studies specifically designed to establish a pre-development baseline on the abundance, distribution, and habitat use of key bird and mammal species have been conducted annually in and around the Colville Delta since 1992. For these pre-development studies, Spectacled Eiders, Yellow-billed Loons, Tundra Swans, Brant, caribou, and arctic foxes were identified as key species primarily based on the following criteria: 1) threatened or endangered status, 2) importance of the delta as breeding habitat, and/or 3) special concern of regulatory agencies. These studies have relied on extensive aerial surveys to assess regional distribution, ground-based surveys to locate nests, dens, and young-of-the-year, and remote sensing and ground truthing to delineate wildlife habitats.

Key findings include:

WILDLIFE HABITAT MAP

- Wildlife habitats on the delta (213 mi^2) and proposed transportation corridor (132 mi^2) were mapped in 1995 to facilitate quantitative assessments of habitat use by key wildlife species. Twenty-four habitats were described that comprised a rich diversity of lakes, rivers, wetlands, and tundra habitats. (see attached figure)

BIRDS

- Spectacled Eiders—Spectacled Eiders, a federally-listed threatened species, breed in low densities on the delta and are strongly associated with the coast (e.g., all sightings during pre-nesting have been <10 mi from the coastline). Nesting Spectacled Eiders appear to be attracted to coastal habitats, although only 25 nests have been found during 4 years of nest searches. Permanently flooded polygons, shallow lakes with islands, and saline lakes were the most important habitats used by breeding Spectacled Eiders. No nests or broods were found in the proposed transportation corridor, and overall this area received very little use by Spectacled Eiders. (see attached figures)

- Yellow-billed Loons—The delta is a regionally important breeding area for Yellow-billed Loons, which have a patchy distribution on Alaska's Arctic Coastal Plain. Yellow-billed Loons favor large, deep lakes in the central and northern portions of the delta for nesting and raising young. They breed in relatively low densities on the delta, and numbers of nests appear to be fairly stable from year to year. No nests or broods were found in the proposed transportation corridor.

- Tundra Swans—The delta is used by large numbers (high count = 295) of Tundra Swans during both spring and fall staging. Swans nest throughout the delta (high count = 38 nests) and the proposed transportation corridor (high count = 17 nests), where they use a wide variety of habitats associated with lakes. Brood-rearing swans have a strong affinity for coastal habitats such as salt marsh, saline lakes, and lakes hydrologically connected to the river. The number of swan nests on the delta in 1995 increased almost 3-fold (from 14 to 38 nests) since 1992. (see attached figures)

- Brant—The delta is an important staging area for Brant during spring and fall, and it supports the largest concentration of nesting Brant along the Alaska's Arctic Coastal Plain. Over 900 Brant nests occur within a complex of colonies at the mouth of the East Channel. Brant most frequently use coastal habitats such as salt marsh and saline lakes during the breeding and staging seasons. The proposed transportation corridor received low use by Brant in 1995. (see attached figures)

- In addition to these key species, data have been collected opportunistically for Red-throated Loons, Pacific Loons, Greater White-fronted Geese, and King Eiders, which all breed and raise young on the delta and in the proposed transportation corridor.

MAMMALS

- Caribou. Few caribou use the Colville delta during the calving season (late May–mid-June), although the area east of the delta, including the proposed transportation corridor, has become increasingly important for calving since the late 1980s. Large numbers of Central Arctic Herd caribou can be expected to move through the proposed transportation corridor and onto the delta during periods of mosquito harassment; up to 3,300 caribou were observed using the delta for relief from insect harassment during the summers of 1992–93 and 1995. Caribou from the Teshekpuk Lake Herd also occasionally use the delta for insect relief.

- Arctic Foxes. During 1992–93 and 1995, 36 arctic fox dens and 4 red fox dens were found between the western edge of the Colville delta and the western edge of the Kuparuk Oilfield. The overall density of arctic fox dens in this area was 1 den/37 km^2, which is comparable to the results of den surveys in other undeveloped areas on the Arctic Coastal Plain. (see attached figure)

- Data also have been collected for muskoxen (up to 61 muskoxen have been seen in the uplands east of the Itkillik River), brown bears (which occur throughout the area in summer), polar bears (which den in low densities on the delta), and moose (which occur on the delta in low numbers).

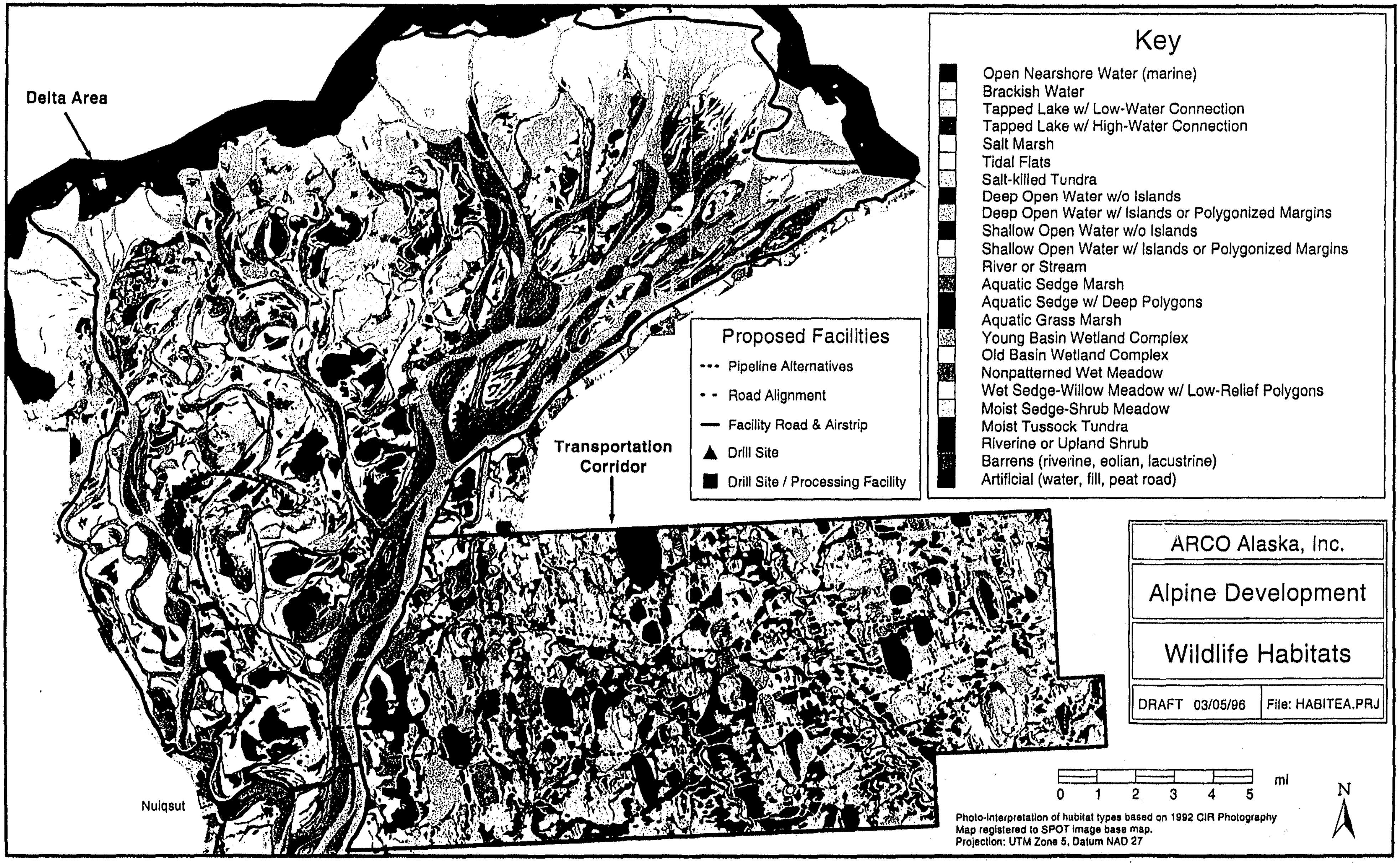


Figure 4.4.1-1. Wildlife habitat map of the Colville River Delta and transportation corridor for the proposed Alpine Development.

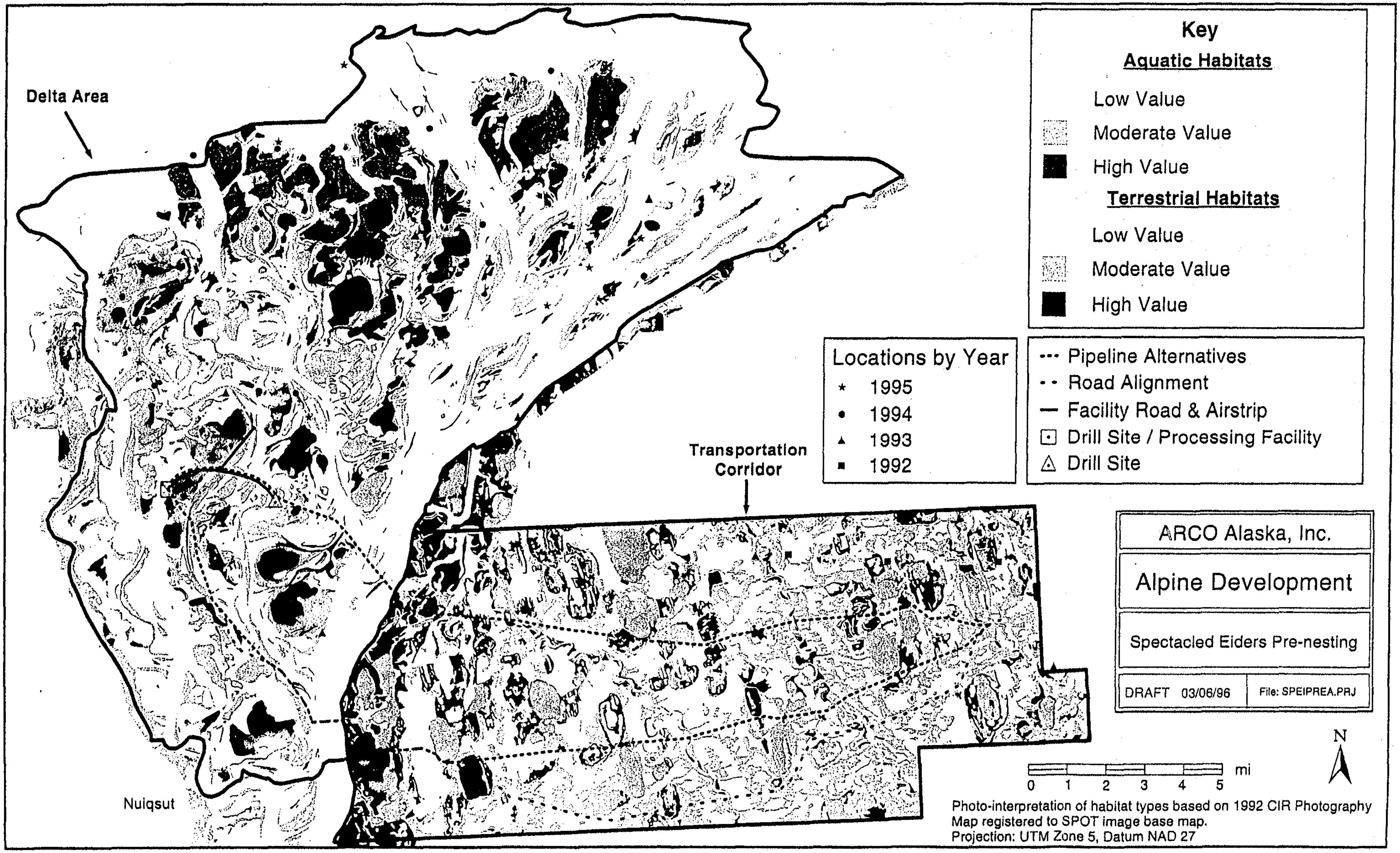


Figure 4.4.4-1. Pre-nesting habitat values and distribution of Spectacled Eiders on the Colville Delta and Alpine Development project area, 1992-95.

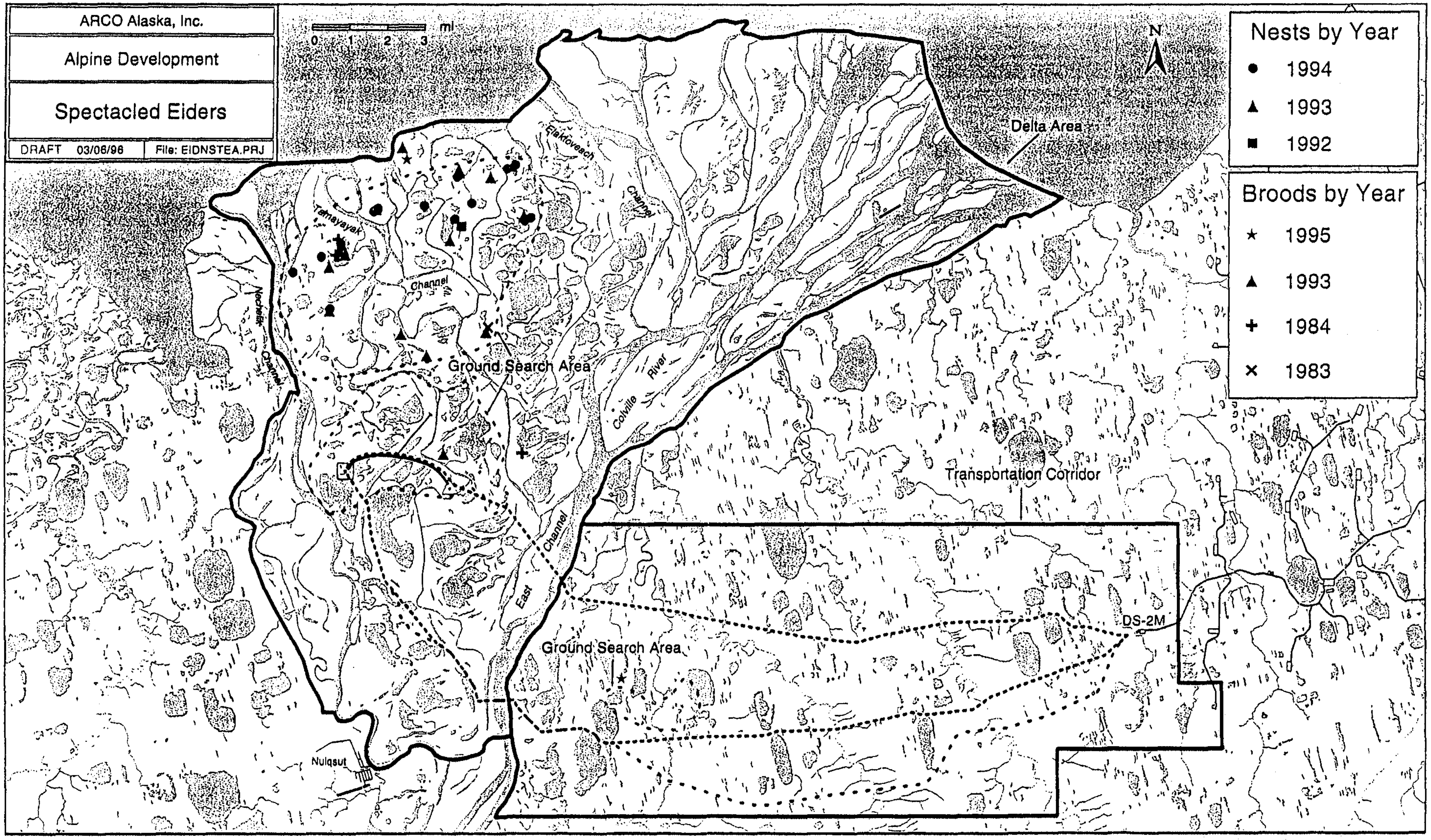


Figure 4.4.4-2. Distribution of Spectacled Eider nests in selected locations (encircled with the red dotted line) and broods in the Colville River Delta and Alpine Development project area.

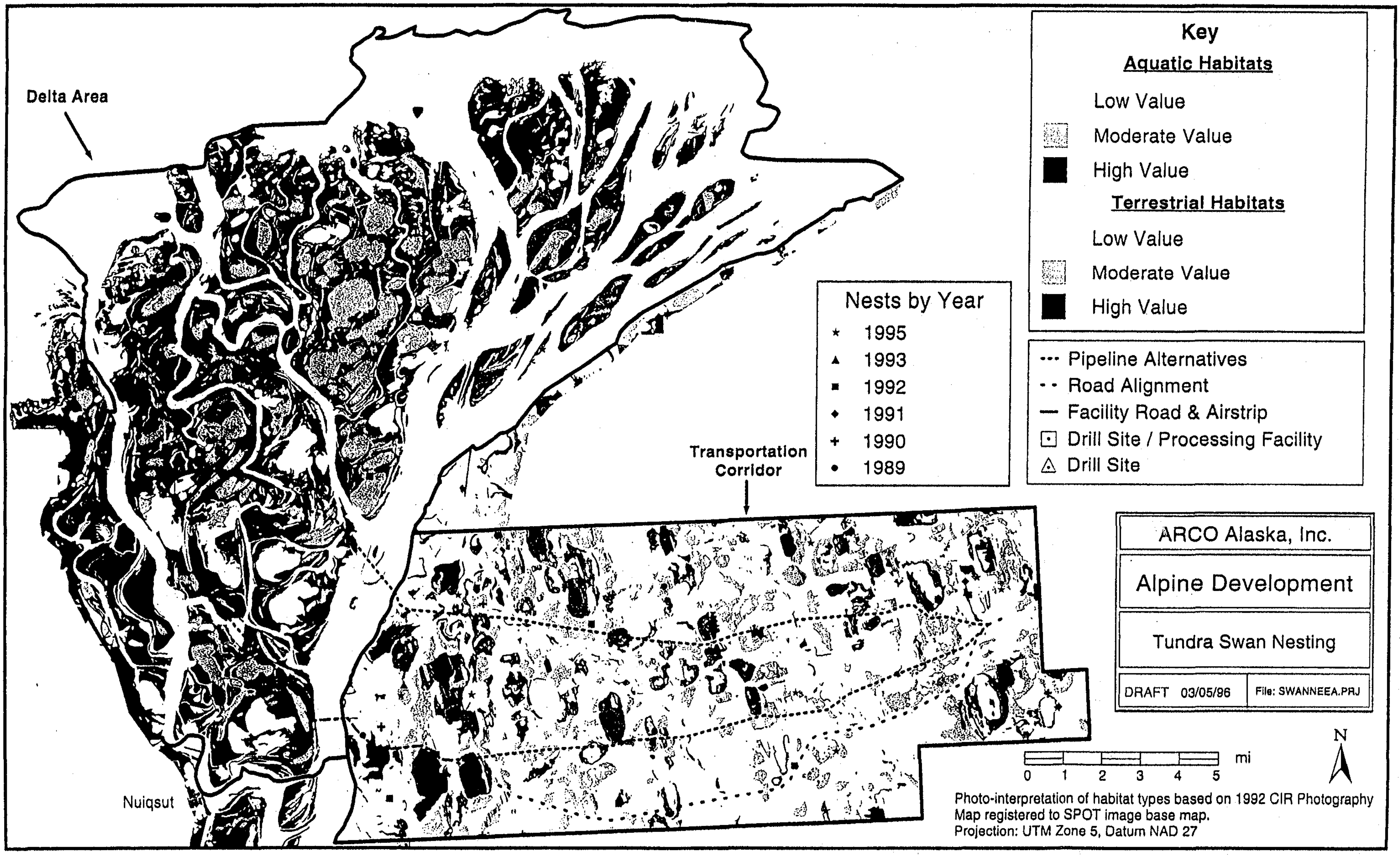


Figure 4.4.3-3. Nesting habitat values and nest distribution of Tundra Swans on the Colville Delta and Alpine Development project area, 1989-93 and 1995.

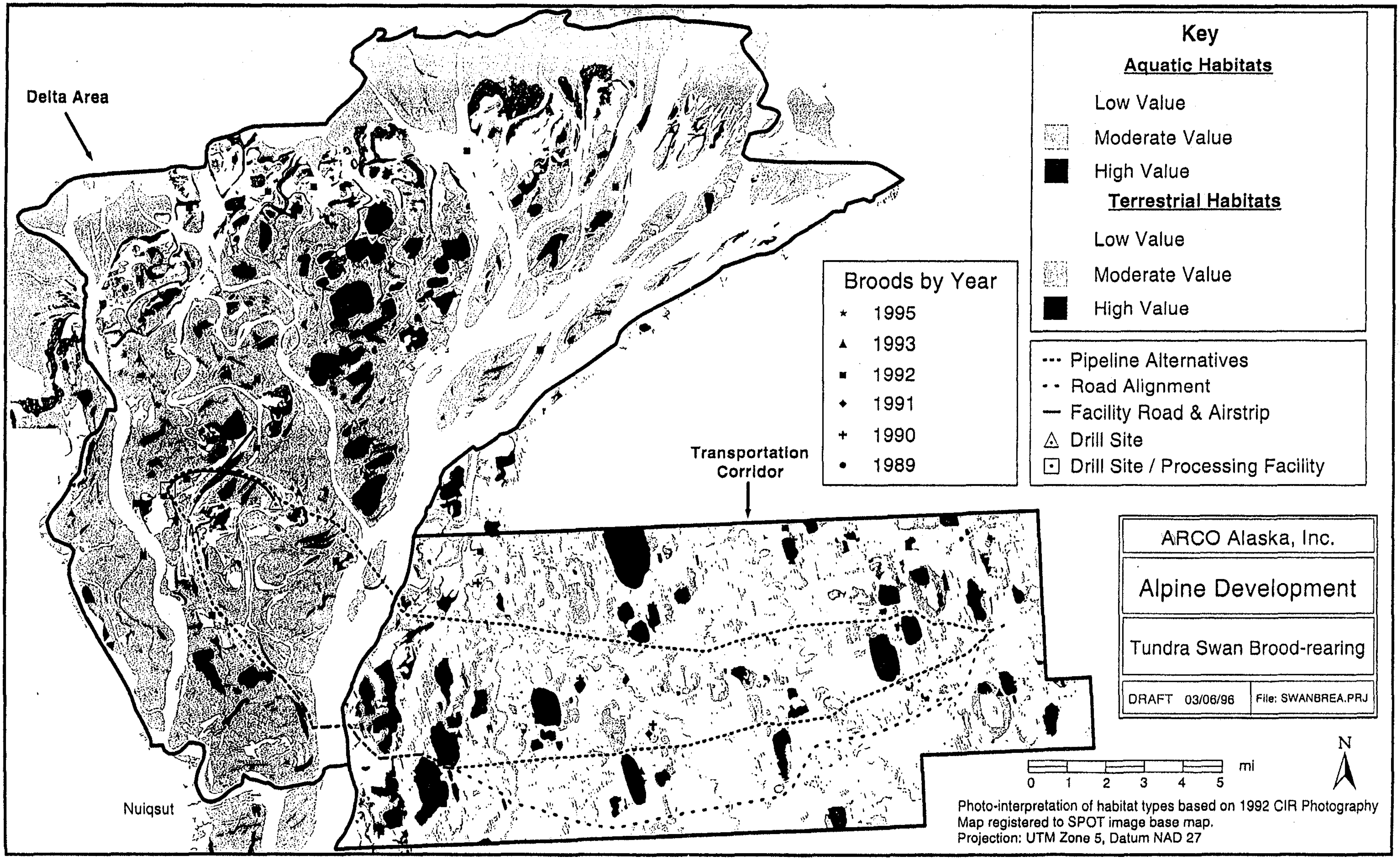


Figure 4.4.3-4. Brood-rearing habitat values and brood distribution of Tundra Swans on the Colville Delta and Alpine Development project area, 1989-93 and 1995.

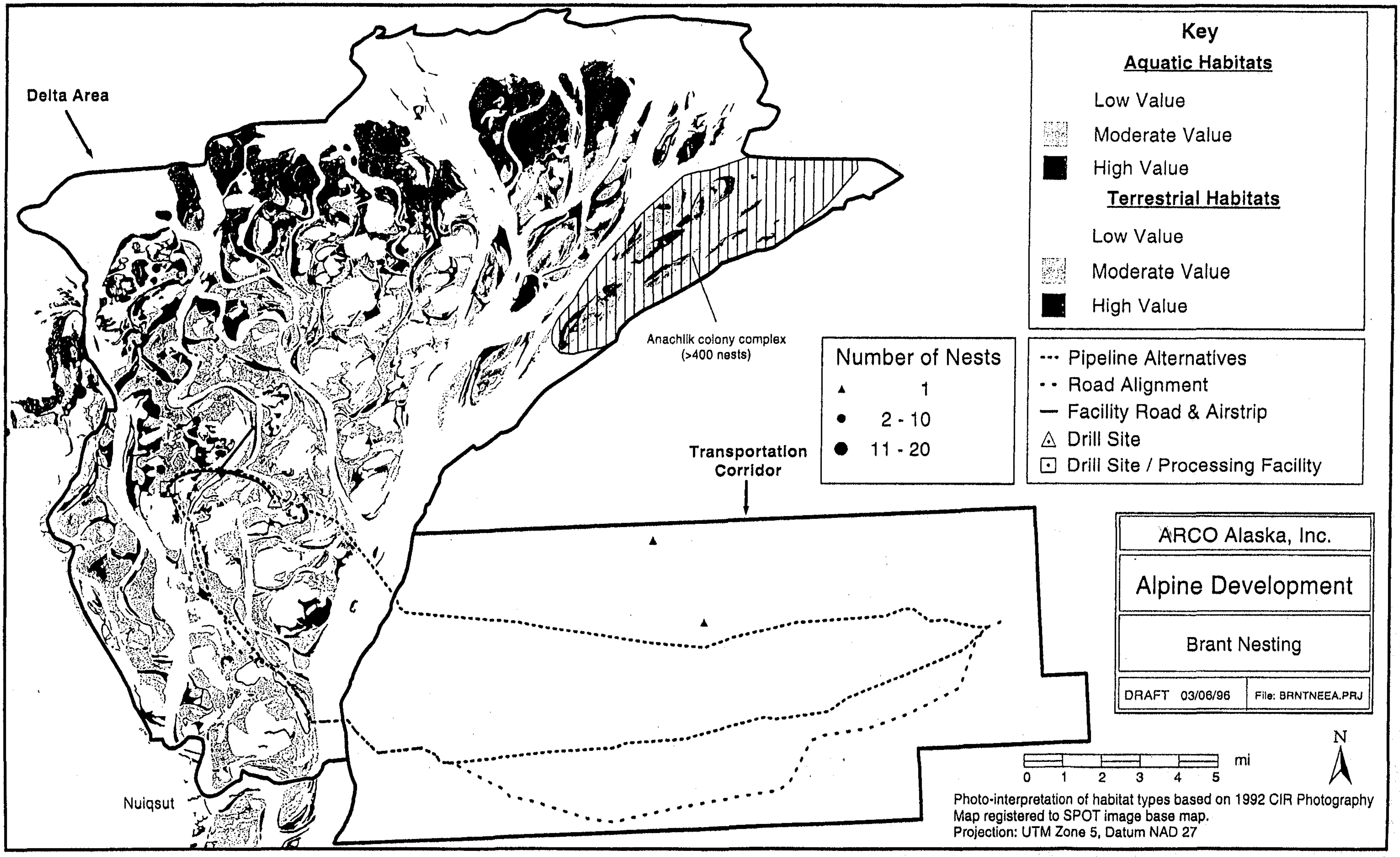


Figure 4.4.3-5. Nesting habitat values and nest distribution of Brant on the Colville Delta and Alpine Development project area, 1989-93 and 1995.

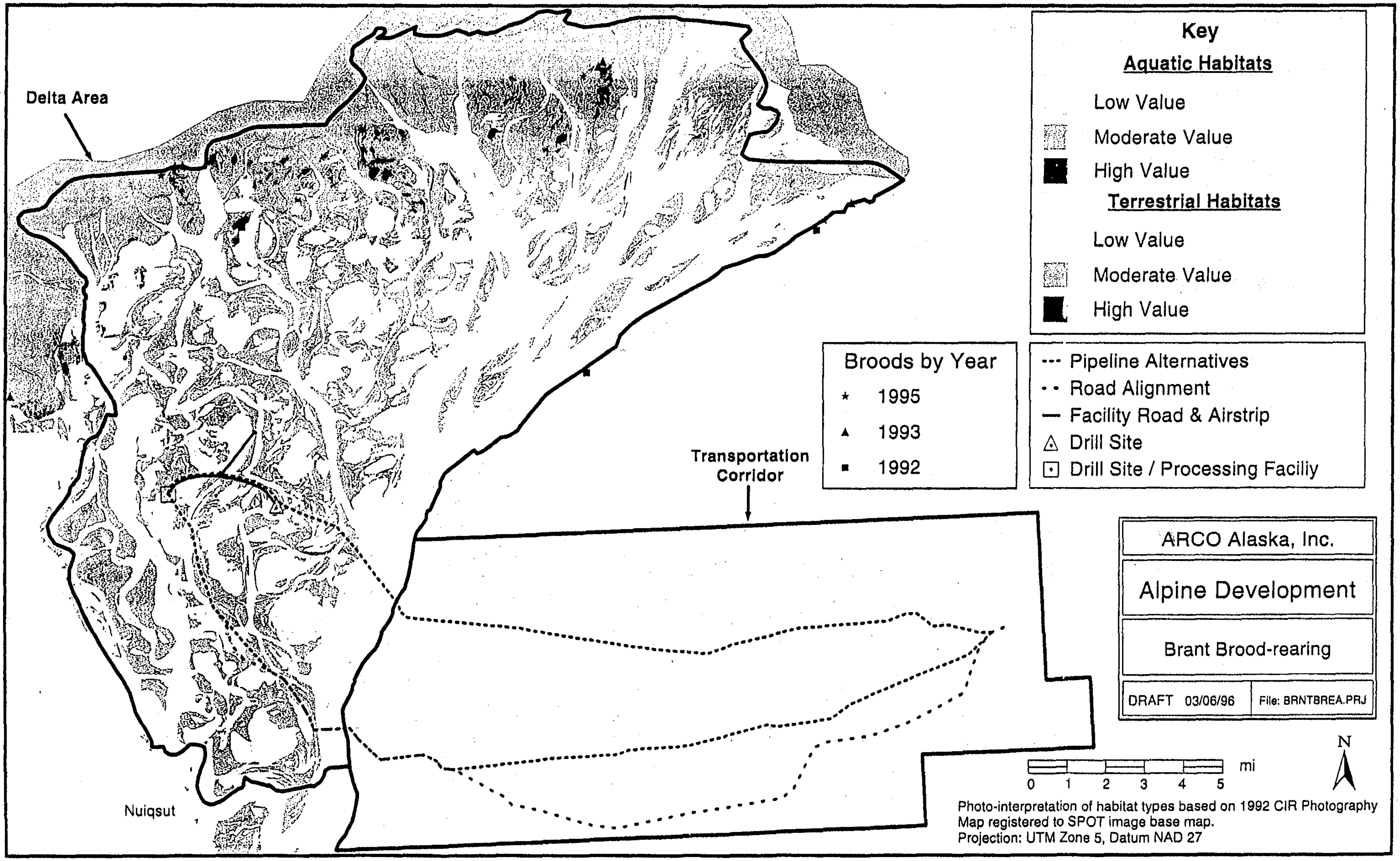
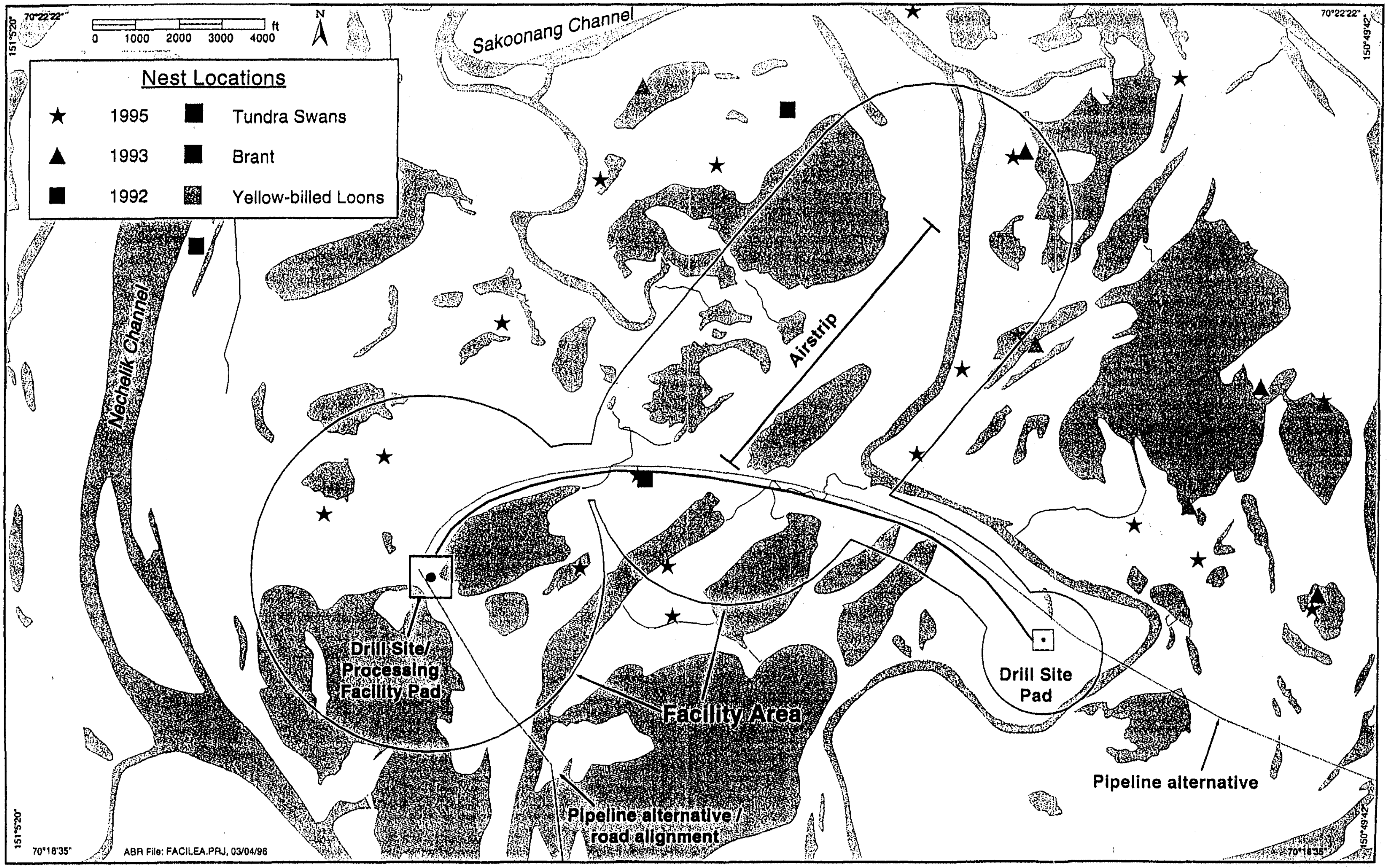


Figure 4.4.3-6. Brood-rearing habitat values and brood distribution of Brant on the Colville Delta and Alpine Development project area, 1989-93 and 1995.


70°22'22"
151°5'20"
0 1000 2000 3000 4000 ft
N
Nest Locations
1995
1993
1992
Tundra Swans
Brant
Yellow-billed Loons
Sakoonang Channel
Nechelik Channel
Airstrip
Drill Site/
Processing
Facility Pad
Facility Area
Drill Site
Pad
Pipeline alternative
Pipeline alternative /
road alignment
150°49'42"
70°18'35"
ABR File: FACILEA.PRJ, 03/04/96

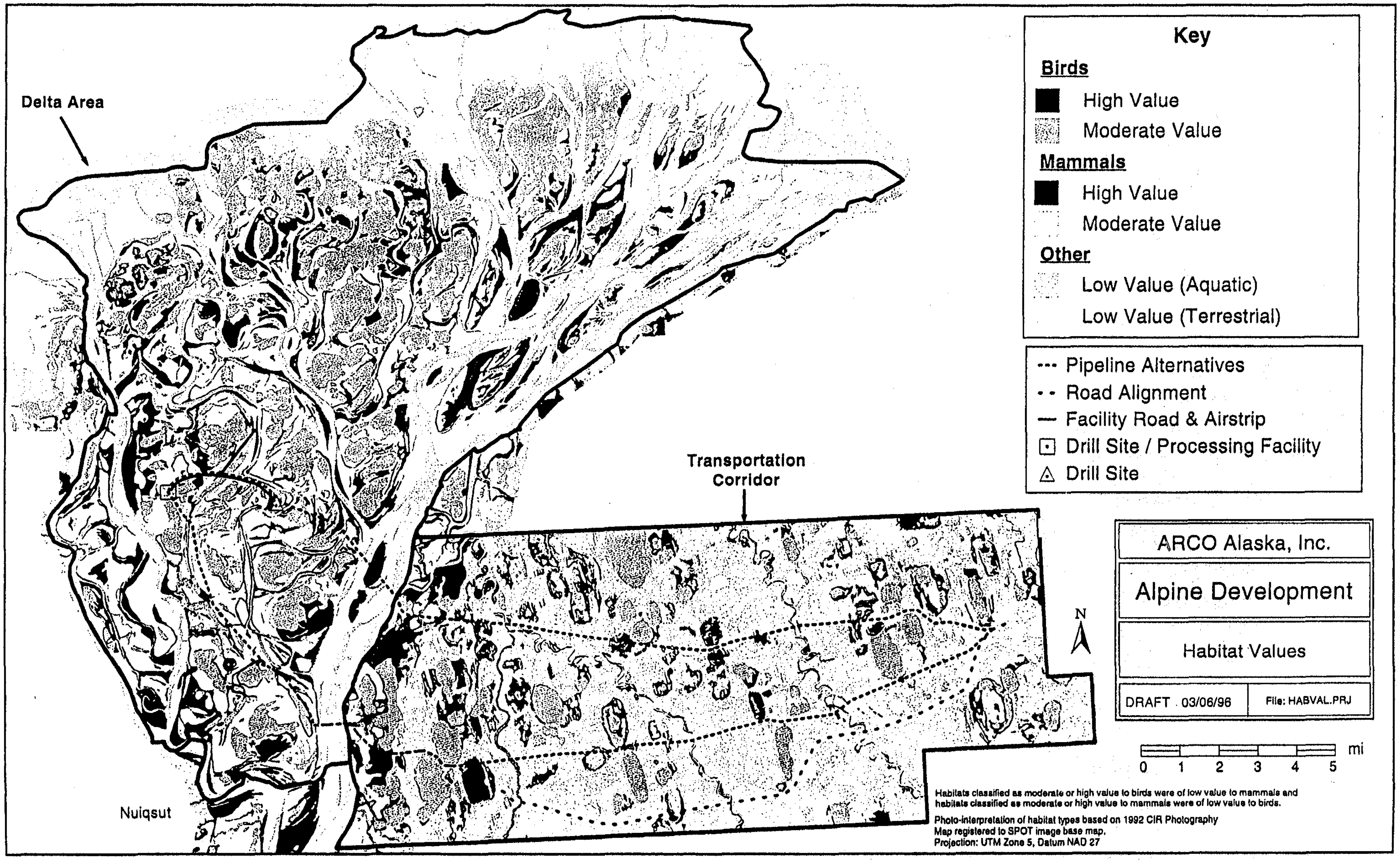


Figure 4.4.3-9. Value of bird and mammal habitats on the Colville Delta and Alpine Development project area.

GEOMORPHOLOGY AND HYDROLOGY STUDIES (1992–1995)

Geomorphology and hydrology studies, which have been conducted annually since 1992, were designed to provide information for the design of pipeline crossings and for siting roads and pads to minimize problems associated with flooding and terrain stability. The studies have focused on the Colville River Delta and to a lesser degree the proposed transportation corridor.

Key findings include:

GEOMRPHOLOGY

- Eighteen terrain units were mapped within the delta and the proposed transportation corridor. These terrain units formed the basis for analyzing differences in soil properties, flood distribution, and rates of erosion and deposition.

- Soil properties differed among terrain units in soil texture, organic matter accumulation, ice structure and volume. The terrain units of most interest for development on the delta are abandoned-floodplain cover deposits and eolian sand deposits because they have the highest elevations and therefore are least prone to flooding. The eolian (wind-blown) sand deposits have the best geotechnical properties for construction because they are well-drained, coarser textured, and have relatively low ice content. The abandoned-floodplain cover deposits have the poorest properties because they are composed of organic and fine-grained material and are extremely ice rich.

- Map analysis of landscape change revealed that 8.2% of the development area has been affected by erosion and deposition over a 37-yr period (1955-1992), due mostly to erosion (1.9%) and deposition (4.0%) of riverbed/sandbar deposits within the main channels (see attached figure). In contrast, erosion of the higher floodplain steps by thaw lakes (0.2%) and rivers (0.7%) was minor, indicating that most of the higher floodplain is stable over a long period.

- A high-resolution base map was created for environmental and engineering studies from SPOT satellite images.

HYDROLOGY

- Peak discharge at the head of the delta has been estimated for six years: 1962 (215,000 cubic feet per second, cfs), 1977 (407,000 cfs), 1992 (188,000 cfs), 1993 (379,000 cfs), 1994 (159,000 cfs), and 1995 (233,000 cfs).

- Stage-velocity and stage-discharge curves have been developed for the head of the delta. At bankfull (approx. elevation of 20.5 ft), estimated velocity is 6.1 (feet per second, fps) and discharge is 385,000 cfs. After breakup, discharge generally is low, ranging between 10,000 and 75,000 cfs.

- A flood-frequency relationship for the Colville River was estimated with 6 years of data for the Colville River and 25 years of data for the Kuparuk River. Preliminary estimates of peak discharge for the 50-, 100-, and 200-year floods are 805,000, 947,000, and 1,110,000 cfs, respectively.

- Between 1992 and 1995 the percentage of area flooded ranged from 33% in 1995, when peak discharge was 233,000 cfs, to 55% in 1993, when peak discharge was 379,000 cfs. In 1993, the area flooded on the two highest floodplain steps was small: 16% on inactive-floodplain and 11% on abandoned-floodplain cover deposits. A simple model of flood distribution was developed based on differences among terrain units in relative height, flood coverage during 1992-1995, and soil stratigraphy. Although frequency of flooding for the low (every 5-25 yr ?) and very low (every 26-150 yr ?) classes are uncertain, the model reliably identifies those areas least prone to flooding. (see attached figure)

- Channel geometry has been measured at 10 intensive cross sections (high-precision data) and at numerous other cross sections (moderate-precision data) for the analysis of stream flow, channel stability, barge access, and ice-road construction.

- In 1995, water depth was measured off the mouth of the Kupigruak and Nechelik channels, and within the Kupigruak, East, and Nechelik channels to determine the feasibility of moving barges through these channels. Water depth off the mouths of the Kupigruak and Nechelik channels was shallow (3-4 ft) and the length of channel that is less than 6 ft deep was ~1.6 and ~4 mi, respectively.

- The drainage network within the proposed transportation corridor was mapped to identify potential paths of oil movement for oil-spill contingency planning. Thaw-lake basins that potentially could serve as oil containment areas also were mapped.

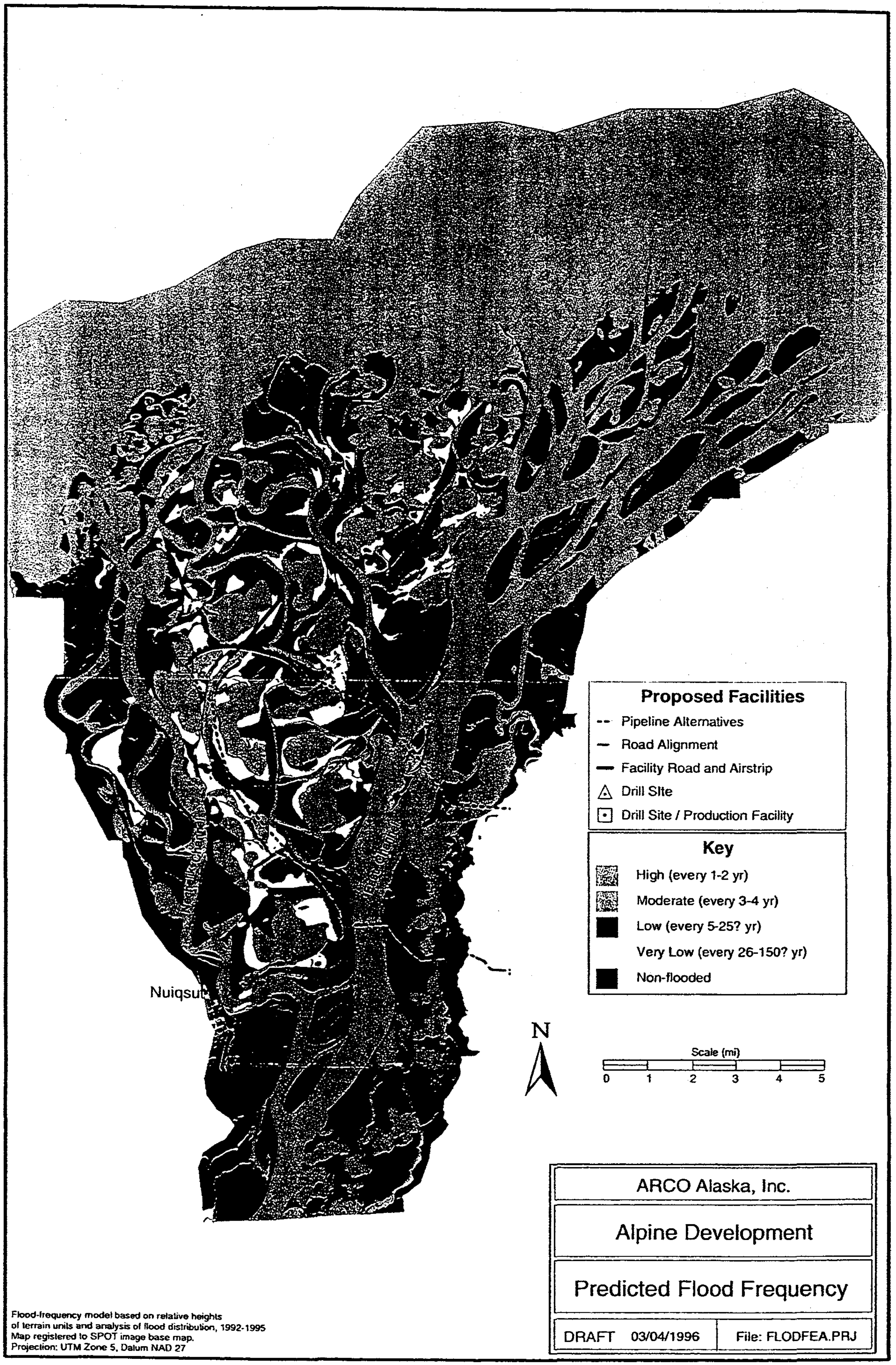


Figure 4.2.1-5. Predicted flood frequency for the Colville River Delta, Alaska.

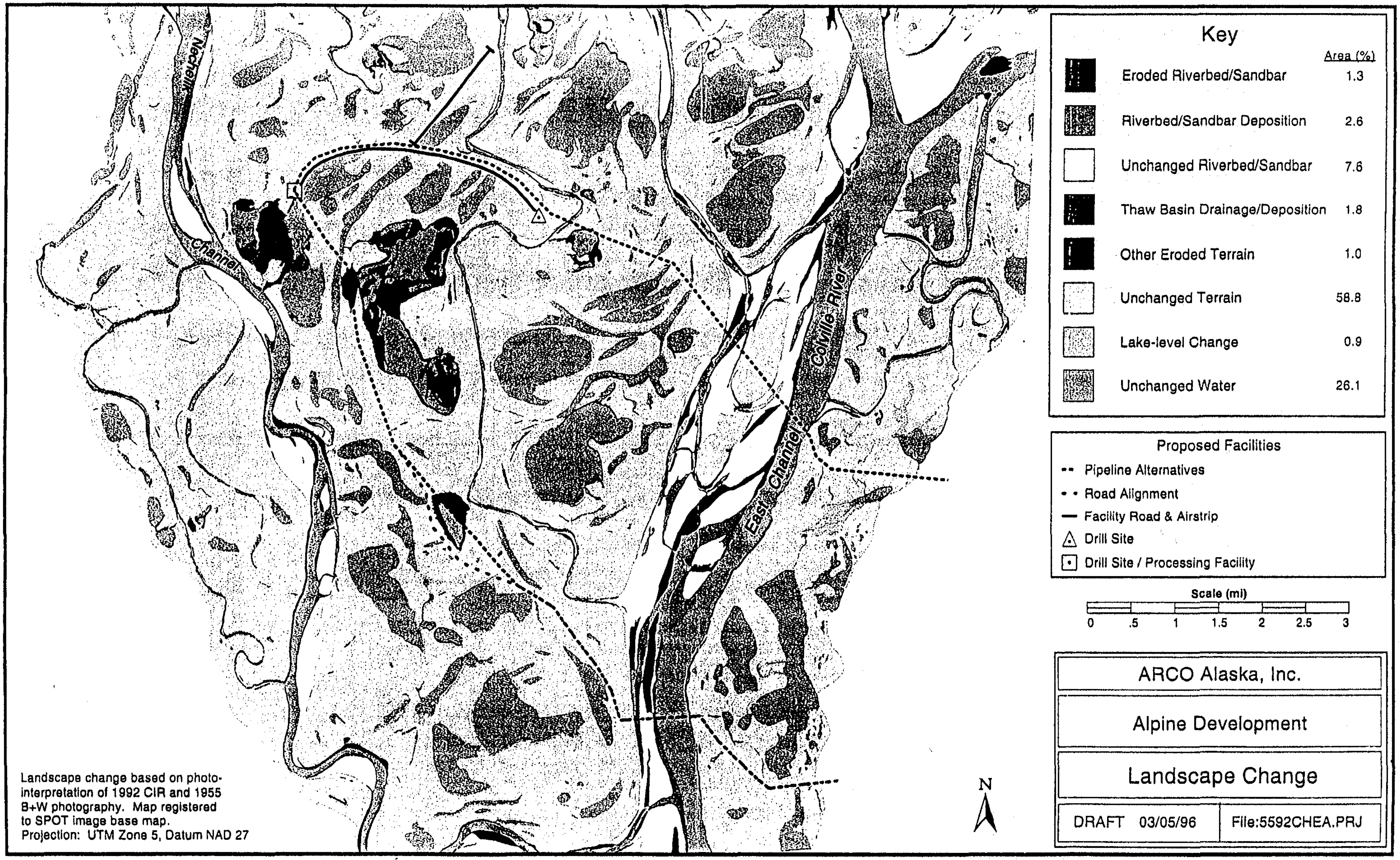


Figure 4.2.2-1. Landscape change from 1955 to 1992 in the Alpine Development project area, Colville River Delta, Alaska.

WATER QUALITY

Water quality in the rivers, lakes, groundwater and Beaufort Sea in and near the project area is essentially pristine, since human activity has been very limited. Productive fisheries in the Colville River delta area show that fish populations have adapted to the seasonal variations in water temperature, dissolved oxygen, turbidity, and other water quality characteristics, such as naturally high levels of heavy metals.

Key finding include:

- Colville River water temperatures increase from breakup to a peak in early August, then the river gradually cools until freeze-up in late September or early October.
- Naturally-occurring oxygen depletion has been documented in Colville River delta channels during winter.
- Salinity increases in the Colville River channels as seawater advances upstream during winter.
- The clarity of the Colville River is lowest after spring breakup when large amounts of sediment are transported by the flooding river. Clarity improves as the flows recede and becomes highest in winter after freeze-up.
- Copper, zinc, cadmium and lead naturally occur in the Colville River.

AIR QUALITY

Air quality has not been a major concern raised by the agencies or Nuiqsut residents. Project effects on air quality will be largely confined to the facilities on the two drilling pads. The EA, however, will address air quality for the entire project infrastructure.

Key findings include:

- Existing air quality is well below ambient air quality standards at the project site based on Kuparuk River Unit monitoring data. Emissions sources are few and dispersion conditions are high in the project area.
- The proposed project will be subject to Prevention of Significant Deterioration (PSD) regulations, since nitrogen oxide emissions will exceed 250 tons per year.
- Construction of the project may temporarily produce fugitive dust and exhaust from heavy construction equipment operations.
- Production facility and drilling equipment operations will generate pollutant emissions including nitrogen oxides, sulfur dioxides, carbon monoxides, particulate matter, and volatile organic compounds.
- While emissions will increase ambient pollutants at the project site, they will contribute little cumulative deterioration of air quality in this region and will not violate ambient air quality conditions.
- Lakes and ponds in the Colville Delta are generally at or slightly above freezing (32 to 38° F); however, shallow clear lakes reach temperatures as high as 68°F during summer. Some lakes become oxygen-depleted during winter.
- Groundwater occurs over the permafrost during summer, and it is generally high in organic content. Groundwater also occurs below the permafrost, and it is extremely brackish from seawater intrusion during the winter.

COLVILLE REGION - ALPINE DEVELOPMENT
1996 WILDLIFE AND FISH STUDIES PLAN

Project specific wildlife and fish studies have been conducted throughout the Colville Delta and Transportation Corridor since 1992. These data were collected to provide baseline information to support project feasibility evaluations, and provide site specific information for adequate project assessment and potential permitting. Annual reports of the results of these studies have been distributed to interested parties. In 1995 these efforts included programs to study birds, mammals, fish and their habitats, and specifically focused on potential development areas at the Alpine location, at alternate river crossings, and along the transportation corridor to the Kuparuk Field.

Additional delineation drilling is occurring in the late winter of 1996. If results from this drilling program warrant development of this prospect, additional wildlife and fish studies will be conducted in summer 1996 to further support the permit application package. Study scopes for these field programs will be finalized by late spring following completion of this year's drilling and further internal and external review of the existing data collected to date.

At this time we anticipate conducting a 1996 program that is very similar to that conducted in 1995. Regional surveys for selected birds and mammals will be conducted across the delta for an annual comparative perspective, while more detailed surveys focusing on all wildlife species studied in previous years will be conducted at potential development zones. Sampling techniques will utilize aerial and ground surveys for wildlife and live capture gear for fish. Survey protocols will match those used in previous years. Probable 1996 study components include the following.

FISH AND WATER QUALITY

- seasonal distribution and relative abundance by waterbody, age class, and species
- basic seasonal water quality conditions at selected locations

BIRDS

- pre-nesting, nesting, and brood rearing habitat use, general distribution, and relative abundance for swans, loons, eiders, and geese
- species specific nest locations and brood rearing locations
- habitat use and overall habitat values

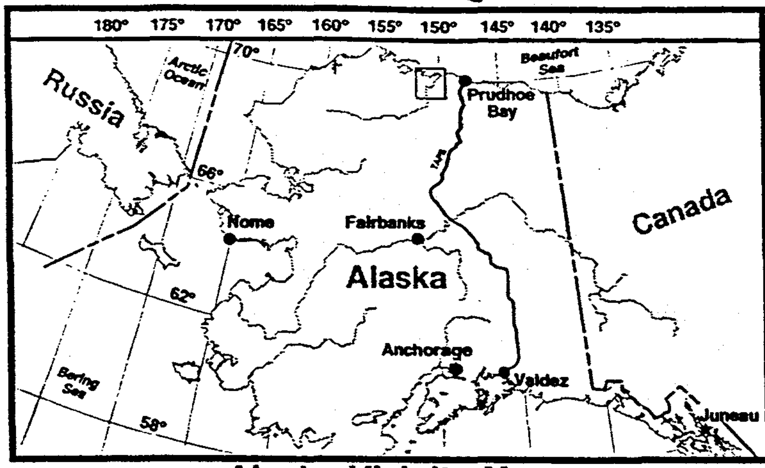
MAMMALS

- caribou calving and insect season surveys for regional distribution and relative abundance
- fox den surveys
- document observations of musk oxen, bear, and moose

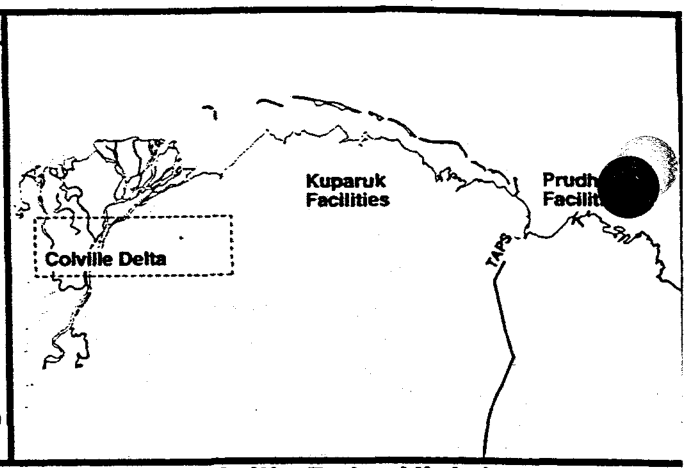
HABITAT MAPPING

- evaluate need to fill in any missing habitat mapping to fully support permit application and assessment

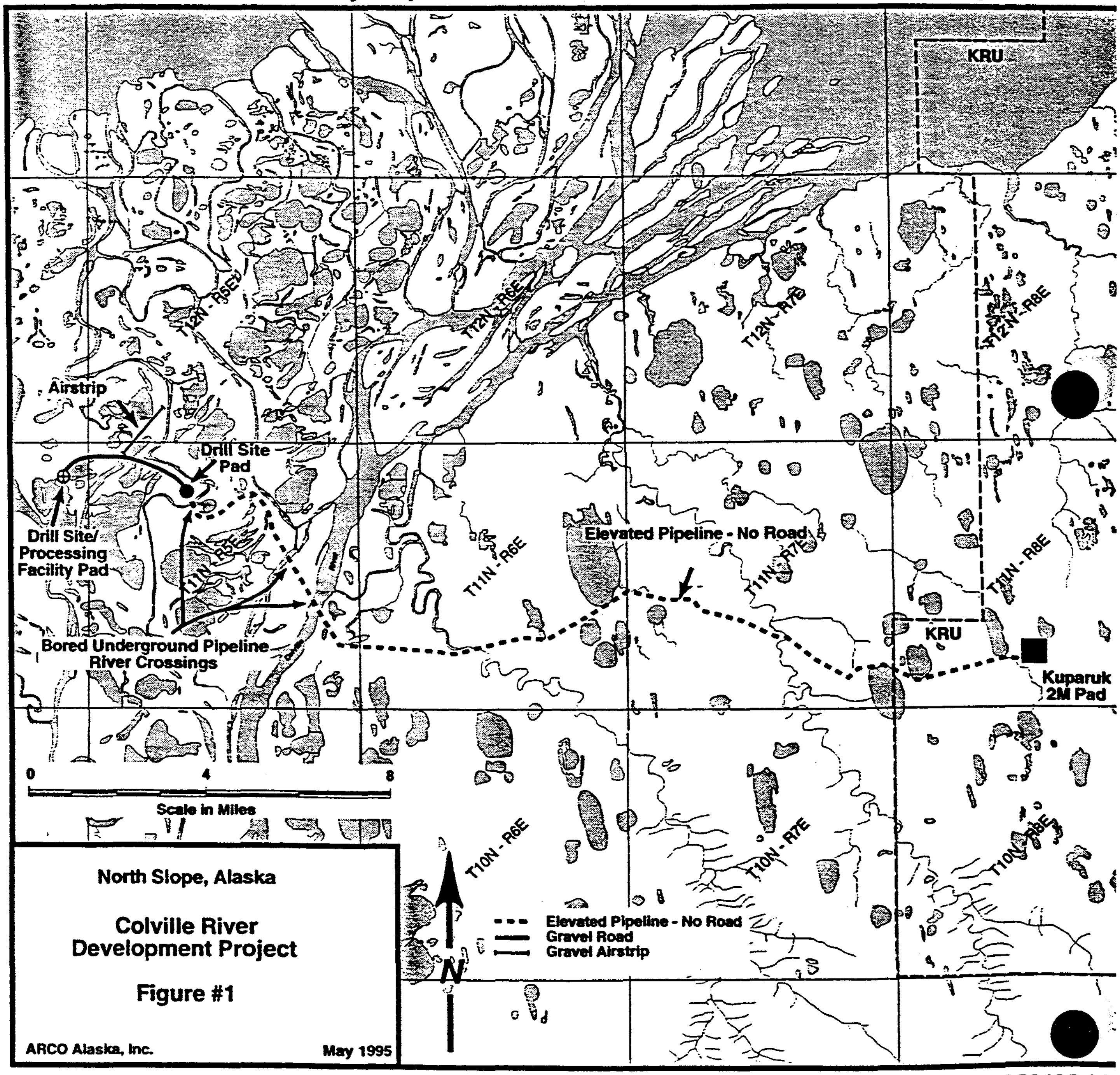
May 95 Project Roll Out Version



Alaska Vicinity Map



Colville Delta Vicinity



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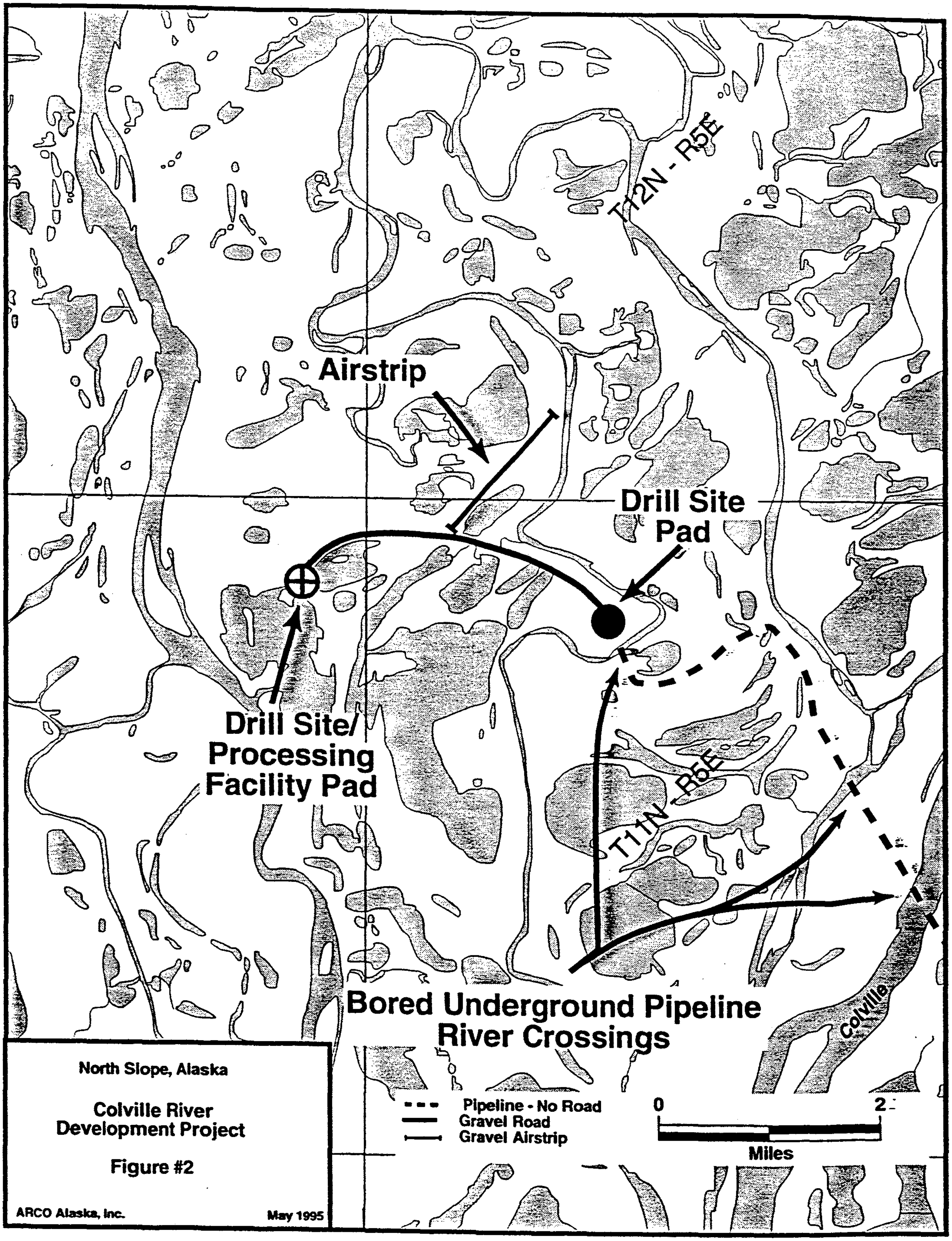

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APPENDIX A-2

APRIL 1996 INFORMATION PACKAGE

ARCO Alaska, Inc.
Post Office Box 100360
Anchorage, Alaska 99510-0360
Telephone 907 276 1215

April 23, 1996

To: Alpine Development Pre-Application Meeting Participant
(See Attached Distribution List)

Re: 2nd ALPINE DEVELOPMENT PRE-APPLICATION INFORMATION PACKAGE
North Slope, Alaska

Dear Participant:

On March 6, 1996, ARCO Alaska, Inc. sent out its first Alpine Development Pre-application Package (see attached cover letter) to potential participants of a pre-application meeting which had only been tentatively scheduled. As you were notified on April 12, 1996 by the State Of Alaska, Division of Governmental Coordination (memorandum attached), this pre-application meeting has now been scheduled for Thursday, May 2, 1996 at 9 AM in Conference Room ANO 1 of ARCO's Anchorage Towers. Your attendance and participation at this meeting would be greatly appreciated.

Enclosed with this transmittal, you will find a second pre-application package which has also been designed to enhance your participation at the upcoming May 2 meeting. This second package contains three summary documents: 1.) Executive summaries of potential impacts of the Alpine Development, 2.) Report of significant comments received since ARCO disclosed its proposed project in May 1995, and 3.) Record of major meetings (excluding phone calls). Summary documents #2 and #3 above do not reflect certain process and political discussions that are too complex or lengthy for a summary document, however, these discussions will be present in ARCO's environmental evaluation document.

The pre-application packages are part of ARCO's effort to engage resource agencies and native entities in the "early consultation process". Please understand that ARCO is providing these pre-application packages as soon as they become available during our process to build and submit an environmental evaluation document along with our permit applications to be submitted June 1996. We have designed these packages in executive summary formats to facilitate their review and use. **The packages do not identify the mitigation that will minimize or eliminate the potential impacts. Mitigation will be developed during additional coordination and consultation efforts, and will be explicitly proposed in ARCO's June 1996 permit application package.**

Thank you again for your continued participation in this planning process. We look forward to seeing or hearing you on May 2nd. If you have questions or comments, please call me at 263-4766.

Sincerely,

Mark J. Schindler
Director, Alpine Development Permits and Compliance

Distribution List
Alpine Development Pre-Application Package

Name	Fax	Phone
State of Alaska		
Jim Haynes / Steve Schmitz State of Alaska Department of Natural Resources Division of Oil and Gas 3601 C Street Anchorage, AK 99503-5937	562-3852	269-8775 269-8777
Bill Van Dyke ADNR-ADOG (Anchorage)	562-3852	269-8786
Al Ott / Carl Heming Regional Supervisor Habitat Division State of Alaska Department of Fish & Game 1300 College Road Fairbanks, AK 99701	456-3091	459-7279
Sverre Pedersen / Terry Haynes ADF&G (Fairbanks)	479-5699	479-6211
Robert Watkins State of Alaska Dept. of Environmental Conservation 555 Cordova Street Anchorage, AK 99501	269-7652	269-7680
Laura Ogar ADEC (Anchorage)	451-2187	451-2360
Scott Bailey ADEC (Anchorage)	269-7508	269-7500
Al Bohn Manager, Air Quality Permits State of Alaska State of Alaska Dept. of Enviornmental Conservation 410 Willoughby Avenue, Suite 105 Juneau, Alaska 99801	465-5129	465-5100

Name	Fax	Phone
Molly Birnbaum State of Alaska Division of Governmental Coordination Joint Pipeline Office (JPO) 411 West 4th Avenue Anchorage, AK 99501-2343	272-0690	271-4317
Jerry Brossia JPO (Anchorage)	272-0690	271-4336
Tony Braden JPO (Anchorage)	272-2901	271-4336
John Strawn USDOT @ JPO (Anchorage)		
Glenn Gray State of Alaska Division of Governmental Coordination P.O. Box 110030 (431 N. Franklin) Juneau, AK 99811-0300	465-3075	465-3562
Gary Schultz State of Alaska Department of Natural Resources Division of Land Northern Region 3700 Airport Way Fairbanks, AK 99709-4699	451-2751	451-2732 (Fbks) 659-2830 (Ddhrse)
Jack Kerin ADNR-ADW (Fairbanks)	451-2751	451-2736
Brad Fristoe Alaska Dept. of Environmental Conservation 410 University Ave. Fairbanks, AK 99709-3643	451-2187	451-2360

Federal

Name	Fax	Phone
Bruce Batton Asst. Regional Director-Public Affairs U.S. Fish & Wildlife Service 1011 East Tudor Road Anchorage, AK 99503-6199	786-3640	786-3544

Name	Fax	Phone
Philip Martin United States Dept. of the Interior Fish and Wildlife Service Northern Alaska Ecological Services 101 - 12 Avenue, Box 19 Fairbanks, AK 99701-6267	456-0208	456-0325
Lloyd Fanter U.S. Army Corp of Engineers Regulatory Branch P.O. Box 898 Anchorage, AK 99506-0898	753-5567	753-2720
Ted Rockwell U.S. Enivornmental Protection Agency 222 W. 7th Avenue #19 Anchorage, AK 99513-7588	271-3424	271-3689
Carl Lautenburger EPA (Anchorage)	272-0690	271-4206
Dee Ritchie, District Manager U.S. Dept. of the Interior Bureau of Land Management 1150 University Avenue Fairbanks, AK 99709-3844	474-2280	474-2302
Joe Dygas U.S. Dept. of Interior Bureau of Land Management 6881 Abbott Loop Road Anchorage, AK 99507-2591	267-1267	267-1246
Jeff Walker U. S. Dept. of Interior Minerals Management Service 949 E. 36th AVenue, Room 603 Anchorage, AK 99508-4302	271-6805	271-6008
Jeanne Hanson National Marine Fisheries Services 222 W. 7th AVenue #43 Anchorage, AK 99513-7577	271-3711	271-3029

North Slope Borough (NSB)

Name	Fax	Phone
Mayor Ahmaogak /Ralph Davis / Warren Matumeak P.O. Box 69 Barrow, AK 99723	(Davis) 852-0322 (Ahmaogak) 852-0337 (Matumeak) 852-0351	852-2611

Name	Fax	Phone
Tom Lohman NSB (Anchorage)	349-2602	349-2602
Arctic Slope Regional Corporation		
Bill Thomas P.O. Box 129 Barrow, AK 99723-0129	852-9460	852-8633
Nuiqsut		
Mayor Gordon Brown / Leonard Lampe Nuiqsut Mayor's office P.O. Box 148 Nuiqsut, AK 99789	480-6928	480-6518/ 6727
Joe Nukapigak / Lanston Chinn Kuukpik Corp. P.O. Box 187 Nuiqsut, AK 99789-0187	480-6126	480-6220
Arctic Slope Native Association		
Michael Peterson P.O. Box 1232 Barrow, AK 99723-1232	852-2763	852-2762 x3015
Colville Village		
Mark Helmericks Colville Environ Svcs. (Anchorage)	345-9095	345-9095
Other Interested Parties To Be Determined		

ARCO Alaska, Inc.
Post Office Box 100360
Anchorage, Alaska 99510-0360
Telephone 907 276 1215

March 6, 1996

To: Alpine Development Pre-Application Meeting Participant
(See Attached Distribution List)

Re: ALPINE DEVELOPMENT INFORMATION PACKAGE
North Slope, Alaska

Dear Participant:

The purpose of this information package is to present to the state, federal, and local resource agencies, native entities and populations, and other interested parties the key findings (graphics included) of various environmental and technical studies completed to date for the proposed Alpine Development Project. These findings begin to provide a foundation for assessing potential environmental and human impacts of the proposed project.

ARCO Alaska, Inc. will use this information package as the basis of discussion in upcoming pre-application meetings which will be held in accordance with state, federal, and local government regulations. Accordingly, we would appreciate your review of this information package prior to the yet to be scheduled pre-application meetings to be held in Nuiqsut and Anchorage. We anticipate the meetings will be held in late March or early April. These meetings will provide a broader and more detailed description of the proposed project and represent an opportunity for ARCO to receive external input and for meeting participants to interact with our contractors. We hope the enclosed information aids you in formulating your input and interaction.

The proposed project, as presently conceived, is generally the same in scope as described last May/June 1995 in project roll out meetings. However, ARCO has evaluated a suite of reasonable alternatives which will be discussed at the pre-application meetings along with feedback to concerns and issues raised in earlier meetings. Although certain design modes, primarily river crossings, are still being evaluated, ARCO is proceeding with certain preferred alternative designs which include two gravel pads (one drill site pad, and one drill site/production facility pad) connected by a 4-mile road having a 5500-foot spur used for an airstrip. The pads will be located in the Colville River Delta, approximately 8 miles north of the village of Nuiqsut and immediately east of the Nechelik Channel. The sales quality oil will be transported to the Kuparuk River Unit by a 33-mile pipeline elevated on vertical support members throughout the route except at the river crossings. The main channel preferred alternative crossing will be bored beneath the main channel mud line using horizontal directional drilling technology. The preferred alternative for the Miluveach and Kachemach river crossings will also be underground utilizing either bored or trenched technology. A seawater pipeline will parallel the oil pipeline on the same vertical support members. The proposed project does not include a gravel road along the pipeline route, since the project will be accessed by ice roads and aircraft. However, as part of our normal alternatives analysis ARCO has evaluated the siting of a road. We will continue to evaluate all alternatives as new information becomes available and as issues of concern are voiced. Furthermore, the configuration will be refined as ARCO engineers better define the boundaries of the oil reservoir.

The enclosed information package consists of:

1. A chart of ARCO Alaska, Inc.'s permitting-related contractors for the Alpine Development Project.

2. Executive summaries and associated maps of the key environmental and technical findings of studies conducted in the delta and pipeline corridor. Summaries are provided for Human and Cultural Resources, Fish, Wildlife, Geomorphology and Hydrology, Water Quality, and Air Quality. The information was largely developed from multi-year studies funded by ARCO and its co-owners Anadarko and Union Texas Petroleum, a variety of technical reports specific to the North Slope region, and discussions with people knowledgeable about the delta. An emphasis of the information provided in the summaries was to address and identify concerns voiced at planning meetings and other forums held by ARCO.

Depicted on the maps are fish and wildlife habitat use patterns, and landscape features relative to the preferred project configuration including several alternative configurations. These maps represent a sample of site-specific data collected for the project area. Please note that the reference numbers in the map titles are solely for use in the Environmental Evaluation Document that ARCO is currently preparing for submission to the Corps of Engineers in June 1996.

ARCO is currently producing a separate base map depicting preferred and alternative project configurations, 1996 exploratory operations, historical exploration wells, and sites of cultural importance. This map will be distributed as soon as available.

3. A draft of the proposed Colville Region - Alpine Development 1996 Wildlife and Fish Studies Plan.

4. A set of engineering (Michael Baker Jr., Inc.) maps and drawings. The blueline spot imagery maps and drawings depict the project configuration and various alternative routes and designs being evaluated.

We will be contacting each recipient of this information package to verify receipt and answer any questions or comments regarding its proposed use. Thank you again for your continued participation in this planning process.

Sincerely,

Mark J. Schindler
Director, Colville Permits and Compliance

MEMORANDUM
STATE OF ALASKA
Division of Governmental Coordination

TO: Distribution

DATE: April 12, 1996
PHONE NO: 271-4317
FAX: 272-0690

BY: Molly Birnbaum, DGC

SUBJECT: ALPINE DEVELOPMENT PRE-APPLICATION MEETING

ARCO Alaska Inc. has requested a pre-application meeting to discuss its Alpine Development Project in the Colville Delta area of the North Slope. The meeting will be conducted on May 2, 1996 at the ARCO Towers, 700 G Street, Anchorage in conference room ANO-1. Participants should register at the front security desk. The meeting will start at 9:00 am and will continue through the afternoon. Lunch service will be available at the meeting site.

Please respond to me to confirm your participation or to advise me who will be representing your agency and division. ARCO does have possible tele-conference capability but requests that the tele-conference be located at one site.

All-day parking is available at the municipal parking garage at 700 West 6th Ave.

Please note that on March 6, 1996 ARCO mailed an Alpine Development Package for agencies to review prior to this meeting. If you have not received a package and need one for preparation of this meeting please call me or Lloyd Fanter, the U.S. Corps of Engineers contact at 753-2712 and one will be immediately sent to you. I can also be reached by E-Mail and SYSM (GCHCMKB).

Distribution:

Jim Haynes/Steve Schmitz, DNR/DOG
Bill Van Dyke, DNR/DOG
Al Ott/Carl Hemming, DFG/Habitat
Sverre Pedersen/Terry Haynes, DFG/Subsistence
Robert Watkins, DEC/SPAR
Kathleen Young, DEC/JPO
Laura Ogar, DEC/Solid Waste
Scott Bailey, DEC/Air
Al Bohn, DEC/Air
Jerry Brossia, DNR/JPO
Tony Braden, DNR/JPO
Glenn Gray, DGC/Juneau
Gary Schultz, DNR/Lands
Jack Kerin, DNR/Water
Brad Fristoe, DEC/Fairbanks
Bruce Batton, USFWS
Phil Martin, USFWS
Lloyd Fanter, USCOE
Ted Rockwell, USEPA
Carl Lautenburger, USEPA
Dee Ritchie, USDOI
John Straun, USDOT/OPS
Joe Dygus, USBLM
Jeff Walker, MMS
Jeanne Hanson, NMFS
Mayor Ahmaogak, NSB
Ralph Davis, NSB
Warren Matumeak, NSB
Tom Lohman, NSB
Bill Thomas, ASRC
Mayor Gordon Brown, Nuiqsut
Leonard Lampe, Nuiqsut
Joe Nukapigak, Kuukpik Corp.
Lanston Chinn, Kuukpik Corp.
Michael Peterson, ASNA
Mark Helmericks, Colville Environmental Services

HUMAN USE IMPACTS

Note: The following impacts are provided at this time without off-setting mitigation since that mitigation will be developed, in part, through subsequent coordination and consultation with State, Federal, and local resources agencies and native entities. ARCO will propose mitigation to minimize or eliminate these impacts on or before June 1996, when permit applications will be submitted.

Socio-cultural and socio-economic impacts are most likely to occur in the areas of economic institutions and Kuukpikmiut subsistence activities and lifestyle.

Potential construction and operation impacts:

- Potential disturbance of archaeological/historical/cultural sites or resources.
- Possible negative impacts on socio-cultural systems from cross-cultural misunderstanding on part of non-Inupiat project personnel.
- Possible extra demands on community resources and facilities.
- Enhanced revenue potential for local and state governments, and for Kuukpik Corp. and ASRC.
- Net increase in locally available jobs in both construction and operations phases of the project.
- Potential for provision of natural gas to Nuiqsut via NSB managed utility.
- Road access to oilfield road system from project winter ice roads.
- Potential adverse impacts on wildlife populations from habitat loss to development, noise disturbance, oil spills.
- Potential adverse impacts on fish and fishery resources from encroachment on traditional fish camps and fishing sites in the Nigliq channel area; from water withdrawals from freshwater lakes; from habitat alteration; from oil spills.

- Potential adverse impacts on user access to subsistence areas and resources (e.g. no hunting buffer zones around facilities).

- Competition for subsistence resources from non-residents based on easier access to traditional hunting and fishing areas.

WATER QUALITY IMPACTS

Note: The following impacts are provided at this time without off-setting mitigation since that mitigation will be developed, in part, through subsequent coordination and consultation with State, Federal, and local resources agencies and native entities. ARCO will propose mitigation to minimize or eliminate these impacts on or before June 1996, when permit applications will be submitted.

Water quality impacts may occur both during construction and operation. Potentially affected water resources include groundwater, the Colville River and its distributary channels, other rivers and streams in the project area, Harrison Bay, and area lakes and ponds.

Potential construction impacts include:

- Horizontal directional drilling for the bored underground pipeline at the Colville River crossing would eliminate disturbance to the channel, however, disposal of drilling muds and cuttings on sand bars may increase turbidity and suspended solids downstream when the river rises and erodes these materials. A non-toxic corn starch product is the only proposed chemical additive to drilling muds, however, additional additives may be required.

- Minor leaks or spills of fuel, oil, or other chemical products may occur during accidents, during refueling, or during routine construction procedures. The ultimate impacts will depend on the types of products, locations, volumes, and durations of spills and leaks, and the effectiveness of containment and cleanup.

- Turbidity and suspended solids increases are likely to occur from several sources: erosion from drainage alterations, pipeline trenching at the Kachemach and Miluveach Rivers, gravel placement in wet areas, gravel mining, and dust fallout. Concomitant effects may include temporary water temperature increases, reduced dissolved oxygen concentrations, and increased nutrients.

- Localized, short-term increases in salinity may occur where treated seawater leaks from pipes during hydrostatic testing.

Potential operation impacts include:

- The major water quality impact that could occur during Alpine Development operations is an oil spill resulting from a break in a pipeline or well blowout. Depending on the location, timing, and volume of the spill, impacts could be contained within a localized area of lakes and wetlands, or spread to distributaries of the Colville River and to Harrison Bay. The most important effects of a major oil spill are impacts to wildlife and fisheries. However, the probability of a spill will be minimized by pipeline and facility design, training, prevention, planning, pre-staged equipment, and massive equipment inventories and response organizations.

- A break in the pipeline carrying treated seawater from KRU to the Alpine Development could impact receiving waters. The seawater is treated to remove suspended solids and dissolved oxygen, and biocides (e.g., glutaraldehyde) are added. Depending on the location and magnitude of the spill, the increased salinity and decreased dissolved oxygen could have a detrimental effect on aquatic life.

- Other potential water quality impacts during operations are similar to construction impacts: minor leaks and spills of petroleum and other chemical products, drilling mud and cuttings disposal, and increased turbidity and sedimentation from erosion and dust fallout.

AIR QUALITY IMPACT

Note: The following impacts are provided at this time without off-setting mitigation since that mitigation will be developed, in part, through subsequent coordination and consultation with State, Federal, and local resources agencies and native entities. ARCO will propose mitigation to minimize or eliminate these impacts on or before June 1996, when permit applications will be submitted.

Construction and operation of the proposed project will generate temporary and long-term impacts on air quality at the project area. However, the air quality impacts will not be significant and will not cause exceedance of the ambient air quality standards.

Potential construction impacts:

- Fugitive dust and exhaust may temporarily be produced from heavy construction equipment operations. Fugitive dust impacts will be greatly reduced because the ground will be frozen and snow-covered during the winter construction period.

- Both fugitive dust and exhaust impacts will be temporary and localized at the project site.

Potential operation impacts:

- Operations of the production facility and drilling equipment will generate air pollutant emissions including nitrogen oxides (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO), particulate matter (PM_{10}), and volatile organic compounds (VOCs).

- Potential NO_x emissions from the gas turbines and the process heater may exceed 250 tons per year.

- While emissions will increase ambient air pollutants at the project site, they will contribute little cumulative deterioration of air quality in this region, and they will not exceed the allowable PSD limits or the ambient air quality standards.

FISHERY IMPACTS

Note: The following impacts are provided at this time without off-setting mitigation since that mitigation will be developed, in part, through subsequent coordination and consultation with State, Federal, and local resources agencies and native entities. ARCO will propose mitigation to minimize or eliminate these impacts on or before June 1996, when permit applications will be submitted.

The Colville Delta contains numerous lakes and channels that provide habitats for a variety of fish species. Critical factors necessary to maintain fish populations include adequate wintering areas, suitable feeding and spawning areas and the ability to access these areas, since they are often in different geographical locations. The primary concern with fish populations within the delta or transportation corridor is to maintain overwintering habitat, which is the most critical habitat to arctic fishes. The next highest priority is to maintain access to the other seasonally used habitats.

Potential construction and operation impacts:

- Water Withdrawal. During both construction and operation, water is needed for building ice roads, drilling, and camp operation. The project does not have a permanent road, thus, ice road construction will be performed annually during construction and development drilling then only during major maintenance years. Since these activities necessarily remove water, the volume of water available for overwintering will be reduced therefore, use of rechargeable resources will be key.

- Alteration of Flow Patterns. Flow patterns may be altered when the road between the two pads is constructed across wetlands and streams, or the stream beds are altered through construction activities. Fish migrate into and out of lakes during breakup when wetlands are flooded. There is rarely a defined channel connecting the perched lakes to the river channel, often the connection is through a low-lying wetland. Changing the flow patterns could prevent fish access to some habitats.

- Chronic Release of Contaminants. Any industrial site has the potential to release contaminants into the environment through low level spills over time. Such releases can create build-ups of contaminants such that the productivity of the receiving environment is impaired. In addition, contaminants can be incorporated into the food web. The proximity of the drill pads, airstrip and road increase the chances of spilled contaminants entering water bodies and, hence, aquatic food chains.

GEOMORPHIC/HYDROLOGIC IMPACTS

Note: The following impacts are provided at this time without off-setting mitigation since that mitigation will be developed, in part, through subsequent coordination and consultation with State, Federal, and local resources agencies and native entities. ARCO will propose mitigation to minimize or eliminate these impacts on or before June 1996, when permit applications will be submitted.

Extensive research in arctic conditions has resulted in better understanding the landscape processes that shape arctic coastal tundra, and this understanding has greatly improved design of development facilities. The design of the Alpine Development Project will incorporate the following knowledge as a basis for minimizing impacts on arctic tundra.

Potential construction impacts:

- Surface organic layer could be compacted under ice roads and work pads, leading to potential interruption of surface drainage patterns through prolonged melting of ice roads and ice pads, and temporary variation of normal drainage patterns soil temperature.
- Existing drainage patterns at the proposed material site could be altered from excavation of gravel pit and placement of overburden.

Potential operation impacts:

- Localized soil temperature regime could be altered by gravel fill.
- Localized soil temperature regime could be altered by fallout of fugitive dust, leading to thermokarst.
- Localized soil temperature regime could be altered by impoundment of water in deep, low-centered polygons on flat delta floodplain.
- Localized soil temperature regime in ice-rich floodplain cover deposits could be altered by hot-oil pipeline, leading to thermokarst.
- Floodwater could be impeded by in-field facilities (gravel roads and pads) during high flood stages, leading to higher sedimentation from erosion of roads and pads.

- Tundra surface could be damaged or compacted by vehicles used for emergency tundra travel, altering drainage patterns and soil temperature regime and leading to thermokarst.

- Tundra surface could be disturbed during cleanup of soil spills, leading to vegetation damage, alteration of soil temperature regime, and thermokarst.

WILDLIFE IMPACTS

Note: The following impacts are provided at this time without off-setting mitigation since that mitigation will be developed, in part, through subsequent coordination and consultation with State, Federal, and local resources agencies and native entities. ARCO will propose mitigation to minimize or eliminate these impacts on or before June 1996, when permit applications will be submitted.

Based on over 20 years of research in the North Slope oilfields and other areas of the Arctic, the types and duration of the potential impacts resulting from the Alpine Development Project on wildlife populations can be predicted with a high degree of certainty. The extent of impacts associated with new development projects has decreased, as industry and regulatory agencies have developed increasingly effective mitigation measures. The key issues for wildlife are habitat loss and alteration, and behavioral response during critical life-cycle stages.

Potential construction impacts:

- Bird nesting habitats could be lost (one season) from ice roads and work pads due to delayed melt of ice and snow and some compaction of standing dead vegetation (nesting cover); effect would persist longer than one season in small mammal habitats on drier sites (where evergreen shrubs are affected).

- Wildlife habitats will be lost from gravel extraction from mine site and placement for pads, roads, and airstrip.

Potential operation impacts:

- Disturbance in "zones of influence" around facilities, roads, and airstrip (including aircraft approach/departure zones) from equipment operations and traffic could potentially affect nesting and brood-rearing birds (within 500-700 ft), caribou during calving (within 1,500-3,300 ft) and insect seasons, bears during winter denning, and spotted seals hauled out on river bars.

- Crossing success of caribou groups along the 4.5 mile gravel road between the two gravel pads (and probably muskoxen) could be reduced in the alternative where pipelines and roads are adjacent ($<$ 300 ft) to each other and traffic rates reach $\geq$ 15 vehicles per hour.

  The preferred alternative of elevating the pipeline to 5-ft-minimum height along the x-country pipeline route from Kuparuk to the Alpine Development facilities is not a concern in the absence of a gravel road, however, portions of this pipeline will be elevated to height, greater than 5 feet due to design and perceived necessity.

- Predators and scavengers (gulls, ravens, foxes, bears) could be attracted to artificial food sources and affect human safety (bears and rabid foxes).

- Herbivores could be attracted to "dust shadows" (early snowmelt caused by fallout of fugitive dust) within 350 ft of roads and airstrip, due to early availability of forage, leading to increased disturbance and some nest failure in poor-quality habitats chosen too early in the season.

- Caribou could be attracted to project facilities for relief from harassment by oestrid flies.

- Wildlife could be injured or die from collisions with vehicles and structures, fouling by spills, and ingestion of contaminants.

- Birds could be attracted to elevated pipeline for perching (raptors, ptarmigan, songbirds, shorebirds) and nesting (Snow Buntings, possibly some raptors).

- Use of nesting habitat could be reduced by birds directly under elevated pipeline.

- Habitats could be reduced, altered, and/or enhanced (depending on species) from dust fallout, snow drifts, impoundments, thermokarst, vegetative changes, water drawdown.

- Disturbance and habitat alteration ("zones of influence") could shift habitat use within 150-350 ft of roads for birds and within 1,500-3,300 ft of roads and pads for female caribou with young calves.

- Some prey populations could be reduced by increased predator populations.

ALPINE DEVELOPMENT PROJECT

MEETINGS SUMMARY - ISSUES OF CONCERN

This report summarizes the issues of concern raised during presentations made by ARCO about the Alpine Development project. Agencies or entities that commented include Nuiqsut residents, the Kuukpik Corporation, the Arctic Slope Regional Corporation (ASRC), the North Slope Borough (NSB), Alaska Departments of Natural Resources (DNR), Fish and Game (ADF&G), Environmental Conservation (DEC) and the Joint Pipeline Office (JPO), U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), U.S. Army Corps of Engineers (COE) and the U.S. Environmental Protection Agency (EPA).

The Nuiqsut residents raised the following issues:

- The socio-cultural impacts of the project, particularly in reference to Native subsistence activities are a concern. It will be important for people working on the project to be familiar with the Nuiqsut Cultural Plan and to meet with the community in Nuiqsut. The City, jointly with the Kuukpik Corporation and the Native Village of Nuiqsut, passed a resolution on June 26, 1995 formally adopting *nuiqsut paisanich* (Nuiqsut Heritage: A Cultural Plan).

- The City of Nuiqsut government is concerned that permits are being issued by the NSB government without adequate local review and input.

- Nuiqsut and the Kuukpik Corporation jointly proposed an alternative development scenario which they named the "Western Initiative". Their view is that production facilities should be located to the west of the Nechelik channel of the Colville River in an environmentally less sensitive location, and have a gravel road connected from there to the village which would permit use of the existing airport.

- Residents feel that if permanent roads are not built along the pipeline, it may not be possible to respond in a timely manner to an oil spill. In any event, the pipeline should be equipped with oil spill alarms and shut-off valves.

- Water that is pumped from lakes for the project (including construction of ice roads) could affect fish by removing habitat and creating air pockets under the ice.

- The caribou migration route may be affected by the elevated pipeline, particularly during winter, when snow drifts may block passage under the pipeline. The pipeline and the production facilities may impact the general migration pattern which is currently from east to west.

The Kuukpik Corporation related these concerns:

- Given the potential impacts of the project on the social and physical environment, an EIS should be the proper NEPA document for the project.

- It is the Kuukpik Corporation's preference that the main production facilities be sited on the west side of the Nechelik Channel with a permanent road connection south to Nuiqsut and beyond to the main channel of the Colville and to the Kuparuk road system. The airstrip at the Village of Nuiqsut could be used as the staging and support area for the project.

- Fish habitat could be impacted by withdrawing too much water from lakes.

- There is a concern over the proposal to place the pipeline under the Colville River. Other alternatives to this option should be explored especially if this type of development has never been tried or tested in the Arctic before. A more common method would be to have the pipeline cross over the river on a bridge. If the underground pipeline were to rupture, fish could be affected.

- The current route for the pipeline crosses environmentally sensitive areas, and therefore, a different route should be considered by federal and state agencies.

- The timing of construction activities may affect the local community.

- There is a concern that local residents may not benefit from the development, particularly since it would be constructed on hunting and fishing grounds. The development may also cause some restrictions on hunting activity in the vicinity of the field.

- The weather in the project area is unpredictable and harsh and could create challenges in a major oil spill. In bad weather, it may not be possible to respond quickly to an oil spill and this could impact waterfowl, caribou, fish, and people in the Colville delta. In addition, during the annual ice breakup, an elevated pipeline could be damaged by moving ice.

- Concerns were raised about the effectiveness of counting nesting sites from an aircraft.

- The elevated pipeline may block travel by snow machines.

- Previous exploratory drilling has taken place to the north of the Delta and there is a concern that the project may expand throughout this area.

- Kuukpik is interested in the opportunity to bid on contract services for the development.

Kuukpik Corporation and ASRC:

- Significant unresolved issues (some of which are being litigated) exist between the Kuukpik Corporation and ASRC concerning the consent to oil and gas activities on Native lands off-setting the proposed Alpine Development project.

The North Slope Borough raised the following questions or concerns:

- Will ARCO negotiate a new surface use agreement with Kuukpik for lands east and west of the Nechelik Channel?

- The entry point for the pipeline traveling under the river should be set back enough to allow caribou to use the river bank, since they walk up and down river looking for places to cross.

- Will natural gas supplies be made available to the NSB for shipment to and use in Nuiqsut?

The Alaska Department of Natural Resources, Division of Oil and Gas, had the following comments:

- The location of the gravel source for the construction of the project is important.

- Will there be an opportunity to provide natural gas for the Village of Nuiqsut?

- More details about the proposed unitization are necessary.

The Alaska Department of Fish and Game had the following concerns:

- The department was primarily concerned over river-crossing impacts to fish. However, they were not concerned over the potential impacts to wildlife from the raised pipeline. Periodic brief "trip reports" from the environmental fieldwork contractors would be helpful. Also, the EA needs to particularly address cumulative impacts.

The Alaska Department of Environmental Conservation expressed the following views:

- The three oil spill scenarios selected for analysis in the environmental documentation will need to be reviewed to see if they are complementary to those in the KRU oil spill plan. DEC is most interested in the worst case (as opposed to the most likely) oil spill. Analysis of winter-oriented scenarios should not be the primary focus since the worst case is an oil spill in the main channel during breakup. Spill trajectories are not necessary.

- The ability to control and clean up a spill of oil in fresh water is a major concern. The impacts and volume of a spill in the most environmentally sensitive areas need to be assessed.

- The responsibilities, logistics, and placement of recovered oil relative to amount of oil spilled must be defined in the spill response plan.

- Plans with poor oil spill response capability due to the lack of permanent roads are not permittable by DEC. Automatic shut-off valves should be used on the pipeline.

The Alaska Joint Pipeline Office had the following concern:

- The JPO was concerned that sustained contacts and agreements with the Native resident subsistence hunters and fishermen have to be maintained. In their view, this may be the single most important issue bearing on the success of the permit issuance process. Particular attention should be given to ANILCA Section A (10) on subsistence issues.

The U.S. Fish and Wildlife Service made the following statements:

- Minimization of helicopter disturbance to waterfowl is important. They would also like to be allowed site visits during field survey work.

  Recent budget cuts will impact their ability to attend meetings and conduct field visits.

The National Marine Fisheries Service expressed the following concerns:

- The gravel source for the development is a concern. The proposed gravel extraction from the Kuukpik/ASRC lands lying to the east of the main channel of the Colville River has been controversial. At the time of the original permit application, no need had been demonstrated for the gravel to be mined.

- The pipeline may alter or adversely affect fish over-wintering habitat at river or stream crossings. (There is uncertainty about whether over-wintering fish habitat or aquatic food resources constitutes the primary limiting factor on fish abundance.)

- The facility footprints should be minimized to the extent possible.

- Construction work should be conducted under freeze-up conditions or during open water. Nuiqsut may want any temporary works to continue after construction is completed.

The U.S. Army Corps of Engineers stated the following:

- The EA must (1) address issues associated with the various environmental acts addressing air, water, wildlife, etc; (2) fulfill the information requirements of the 404 (b)(1) evaluation; (3) evaluate the "reasonable worst case" for a major oil spill in the delta; (4) comply with the NEPA requirements set out in 40 CFR 1500.

- The draft pipeline ROW and facility siting designs must be reviewed by COE.

- The water requirements for the project, both for the waterflood recovery technique and for potable use, must be adequately detailed in the EA.

- The COE's major concerns include the possibility of an oil spill, cumulative impacts of oil exploration, development and production and subsistence/social/cultural impacts.

- The comments, concerns and suggestions raised during informational meetings have not been incorporated into ARCO's information package. There is no record of how these comments have or are going to be addressed.

- Navigational dredging of the Colville River would trigger the need for an EIS.

The U.S. Environmental Protection Agency had the following comments:

- The monitoring proposals provided by ARCO to EPA need to include water quality studies, including water chemistry (for NPDES purposes), and air quality studies.

- Oil spill response planning is critical.

- Detailed habitat mapping should not be done until the actual pipeline corridor is determined. It is important to consider alternative pipeline routes including connections to the 2-M and 2-K Kuparuk drill pads.

- Depth of permafrost during winter or summer is a concern because of the possibility of a hot oil pipeline creating water pools during the summer.

ALPINE DEVELOPMENT PROJECT

Record of meetings with agencies and organizations for the Alpine Development Project:

7 June 1995	Meeting held at Joint Pipeline Coordinator's Office where a presentation was given on the proposed Alpine Development Project to NSB, State of Alaska, Federal, and Kuukpik Corporation representatives.
8 June 1995	Meeting held at COE office to update Lloyd Fanter of the Regulatory Affairs Division on status of the Alpine Development Project and to discuss COE expectations concerning the EA.
9 June 1995	Meeting at Joint Pipeline Coordinator's Office to give staff a presentation on proposed facility and pipeline elements of the Alpine Development Project.
16 June 1995	Meeting at EPA office to update Ted Rockwell and discuss specific EPA questions about the Alpine Development Project.
24 June 1995	Meeting in Nuiqsut to give a presentation on the Alpine Development Project to Kuukpik Corporation shareholders.
26 June 1995	Meeting to give a presentation on the Alpine Development Project to Commissioner John Shively and Alaska Department of Natural Resources staff.
27 June 1995	Meeting in Fairbanks at the Alaska Department of Fish and Game office to discuss socio-cultural, socio-economic, and subsistence components of the Alpine Development Project EA with Sverre Pedersen and Terry Haynes.
5 July 1995	Meeting at COE Office with Lloyd Fanter to obtain examples of EAs deemed satisfactory by the COE.
2 August 1995	Meeting in Nuiqsut to give a presentation on the Alpine

Development Project to local residents and the NSB, ASRC, and State and Federal government representatives.

14 September 1995 Meeting at the National Marine Fisheries Service office in Anchorage with Jeanne Hanson to give a presentation on Alpine Development Project.

28 September 1995 Meeting at the COE office with Lloyd Fanter to discuss the EA outline for the Alpine Development Project.

6 November 1995 Meeting with Nuiqsut City Council regarding potential subsistence impact and mitigation issues.

11 March 1996 Meeting held by ADNR in Nuiqsut to receive public testimony on proposed oil and gas lease sale #86A (certain Kuukpik Corporation lands along the Nechelik channel of the Colville River delta).

19 March 1996 Special pre-application meeting between ARCO, its contractors, Kuukpik Corporation, City of Nuiqsut and Native Village of Nuiqsut representatives in Anchorage to review results of field study programs (wildlife, fish, geomorphology, socio-economics and cultural site surveys).

20 March 1996 Meeting at the Alaska Department of Environmental Conservation's office in Anchorage to give an update on the status of the Alpine Development project and to receive input on oil spill scenarios.

28 March 1996 Pre-application meeting with COE to discuss the EA for the Alpine Development project with Lloyd Fanter.

Appendix B

APPENDIX B

PERFORMANCE AGREEMENT

Performance Agreement

between

The President of the United States

William Jefferson Clinton

and

The Secretary of Energy

Hazel R. O'Leary

Fiscal Year 1996

Overview

The Department of Energy is working to advance the nation's priorities and the Administration's commitments in the areas of energy security, environmental quality, national security, and science and technology. For FY 1996, the Department's commitments advance the goals, priorities, and expectations of Secretary Hazel O'Leary and move us toward our vision of a more efficient and effective government. We have begun the difficult task of downsizing through office consolidations, business process reengineering, and elimination of nonessential activities. We are building on our past successes and improving our management as we move forward.

Building on our success

We have delivered on all of our FY 1995 commitments. In FY 1996 we will continue to build on our progress in strengthening nuclear nonproliferation, replacing underground testing with science, understanding and dealing with risks associated with environmental problems resulting from nuclear weapons production during the Cold War, and promoting clean and efficient supply of energy. We have additional commitments in the areas of global non-proliferation, advancement of science for environmental cleanup, and management practices at DOE's laboratories.

Improving our processes

With experience, we are improving the measures for these commitments. They are more specific, quantified, and meaningful for managers, employees, and the American taxpayers. This Agreement is the commitment by the Department of Energy team to turn resources into results. We will continuously improve the Department of Energy as we create a government that works better and costs less.

Our Vision

The Department of Energy through its leadership in science and technology will advance U.S. economic, energy, environmental, and national security by being:

- A major partner in world class science and technology, research centers and university research.
- A vital contributor to reducing the global nuclear danger through its national security and nonproliferation activities.
- A world leader in environmental restoration, waste management, and pollution prevention.
- A key contributor in developing, applying, and exporting sustainable, clean and economically competitive energy technologies.
- A key contributor in maintaining U.S. global competitiveness through leadership in environmentally-conscious materials, technologies, and industrial processes.
- A safe and rewarding workplace that promotes excellence, nurtures creativity, rewards achievement, and is results-oriented and enjoyable.

DOE's Goals

To realize our Vision, the Department has established the following FIVE KEY GOALS:

- Leverage DOE's Unique Science and Technology Capabilities to Provide Knowledge that Drives the Nation's Future
- Reduce the Global Nuclear Danger
- Restore, Stabilize, Protect, and Enhance the Environment
- Develop and Promote Clean Efficient Energy Technologies and Enhance Energy Security
- Stimulate U.S. Economic Productivity

DOE's Critical Success Factors

To sustain all of our initiatives, the Department has adopted the principles of total quality management to improve customer service and cut costs. Consistent with these principles, DOE will build its reinvention on FOUR FACTORS critical to realizing our vision:

- Improve Communications and trust
- Increase Productivity of DOE's Human Resources for Our New Mission
- Achieve Excellence in the Safety and Health of DOE Workers, the Public, and the Environment
- Become the "Best In Class" in the Use of Management Practices

Under each of our goals and critical success factors, the Department has established commitments that identify our most significant outcomes. Under each commitment, and consistent with our budget for FY 1996 we have established **"measures of success"**. In this FY 96 Agreement, we have set forth a total of 67 commitments and 183 measures of success.

The Department of Energy's Goals

The Department of Energy has a rich heritage of meeting important national goals in the areas of science and technology, national security, environmental quality, energy resources, and economic productivity. The following goals and commitments are our contract with the American taxpayers in FY 1996.

Science & Technology

Unleash the Department's deep reservoir of scientific and technological assets and capabilities 40,000 scientists and engineers, including Nobel prize winners, and a $30 billion laboratory system to perform world class basic and applied research in energy and national security arenas, that will advance U.S.

security and economic productivity. DOE will continue to support a broad national science and technology portfolio, ranging from the supercomputing initiative with its oil and gas exploration applications, to advanced materials research, with its automotive applications.

Our Commitments

ST-1 IMPROVING SERVICE DELIVERY AT DOE SCIENCE FACILITIES

Improve the efficiency of operations and quality of services provided to scientists at the Department's leading-edge basic research facilities. Ensure that facilities are available to users and operated in a reliable and predictable manner that ensures high-quality research products and technology innovations. (ER)

Success will be measured in FY 1996 by:

- *Increasing the availability of DOE scientific facilities consistent with the Science Facilities Initiative to enable a wide array of research that will advance science and produce tomorrow's technologies by increasing the operating time at the:*
  - *Stanford Synchrotron Radiation Laboratory from 4,000 to 5,600 hours, a 40 percent increase,*
  - *Advanced Light Source from 3,000 to 4,200 hours, a 40 percent increase,*
  - *Intense Pulse Neutron Source from 2,000 to 4,000 hours, a 100 percent increase,*
  - *High Flux Beam Reactor from 3,600 to 4,700 hours, a 30 percent increase, and*

  increasing or upgrading user beamlines from 200 to 210 to improve user capabilities at the synchrotron light sources and neutron facilities.

ST-2 INITIATING SCIENCE-BASED PROGRAMS TO FIND NEW METHODS FOR ENVIRONMENTAL CLEANUP

Initiating science-based programs to find new cost-effective methods for environmental clean-up of DOE sites. (ER)

Success will be measured by:

- *Developing a 10-year program plan for bioremediation research and implementing the first phase by March 1996 for clean-up of national laboratory and nuclear weapons production sites.*
- *Initiating a basic research program effort by September 1996 through an ER/EM partnership in order to provide less costly and more effective cleanup technologies.*

ST-3 TRANSFERRING ENVIRONMENTAL TECHNOLOGIES

Demonstrate new environmental technologies and systems and transfer them to private industry and Federal facilities. (EM)

Success will be measured by:

- *Demonstrating over 166 new environmental technologies and systems, to include the:*
  - *Radioactive Plasma Hearth Process,*
  - *Cesium Removal Demonstration at Oak Ridge, and*
  - *Spectral Gamma Probe for Cone Penetrometer.*
- *Making 66 environmental technologies available for transfer and use by private industry and Federal facilities, to include the:*
  - *Light Duty Utility Arm at Hanford,*

- Portable Vitrification Unit at Oak Ridge,
- Mobile Evaporator at Oak Ridge, and
- LASAGNETM in-situ process for waste treatment.

ST-4 EXPLORING THE FRONTIER OF HIGH ENERGY PHYSICS

Pursue opportunities for the U.S. to participate in the Large Hadron Collider (LHC) project at the European Laboratory for Particle Physics (CERN) in Geneva, Switzerland to explore the frontier of experimental high energy physics and promote increased international scientific collaboration. (ER)

Success will be measured in 1996 by negotiating one or more LHC agreements with CERN, in partnership with the National Science Foundation to enable American scientists to explore the fundamental nature of energy and matter.

ST-5 INVESTIGATING THE CAUSES OF GLOBAL CLIMATE CHANGE

Continue to provide strong support to the Interagency effort to investigate the natural and human causes of global climate change phenomena and reduce U.S. greenhouse gas emissions. (ER)

Success will be measured in FY 1996 by collecting and analyzing data on atmospheric conditions to enable better assessments, damage prediction, and mitigation for ecosystems by:
- designing, building, and testing an Atmospheric Radiation and Cloud Station in the Western Pacific by September 1996 to collect critical cloud and radiation data,
- completing atmospheric radiation measurements by June 1996 to verify enhanced absorption of solar radiation by clouds to improve the accuracy and predictive capability of global climate models,
- completing preparations to measure the absorption of CO2 from the atmosphere by March 1996, and
- implementing experiments that quantify effects of changes in weather and air pollution on forests by June 1996.

ST-6 CONTINUING PEACEFUL USES OF THE ATOM

Continue cooperative efforts begun in 1973 for fundamental properties of matter, magnetic confinement fusion, nuclear reactor safety, environmental restoration and nuclear waste management under the Peaceful Uses of Atomic Energy Agreement (PUAE). (PO)

Success will be measured by:

- *Continuing cooperation with Russia under the PUAE, even if the agreement is not formally extended.*
- *Working with the State Department, National Security Council, and the Office of the Vice President to:*

- develop an interagency strategy by December 1995 for renewal of the PUAE agreement,
- extend the PUAE umbrella agreement for one year period beginning January 1996, and
- extend the four cooperative agreements under the PUAE for their full terms.

ST-7 ENSURING THE AVAILABILITY OF ISOTOPES FOR INDUSTRY, RESEARCH AND HEALTH CARE

Ensure the timely, reliable and cost-effective availability of isotopes for use in U.S. industry, research, and health care. Reduce dependence on foreign markets for molybdenum-99, which is used in 15 million diagnostic medical tests per year in the U.S. (NE)

Success will be measured by:

- *Issuing the Environmental Impact Statement and reaching a Record of Decision by March 1996 on establishing a domestic source of molybdenum-99 production.*
- *Demonstrating a domestic source capability for molybdenum-99, through production of at least 30 curies of molybdenum-99 per week by September 1996.*
- *Improving the on-time delivery rate from 91 to 95 percent by January 1996 for all isotopes.*
- *Working with U.S. industry to identify by the end of September 1996 at least five specific activities now conducted by the DOE Isotope Production and Distribution program that can be privatized within one year.*

ST-8 PROVIDING RADIOISOTOPE POWER SYSTEMS FOR U.S. SPACE EXPLORATION

Provide the Radioisotope Thermoelectric Generators (RTGs) and Radioisotope Heater Units (RHUs) for current National Aeronautics and Space Administration (NASA) missions and maintain the infrastructure and capability to produce radioisotope power systems for the future. (NE)

Success will be measured by:

- *Delivering by August 1996, three RHUs for the Mars Pathfinder mission to be launched in December 1996.*
- *Completing fabrication of 157 RHUs for the 1997 Cassini mission to Saturn by September 1996.*
- *Completing, by August 1996, fabrication of two of the three heat sources to be placed in the RTGs for the Cassini mission.*

ST-9 RESTRUCTURING THE FUSION ENERGY RESEARCH PROGRAM

Preserve the fusion energy science base and maintain fusion as a U.S. energy option for the future. (ER)

Success will be measured in FY 1996 by incorporating the Fusion Energy Advisory Committee recommendations and finalizing the strategy by February 1996 to restructure the fusion energy research program to emphasize fusion energy science.

ST-10 ADVANCING THE STATE OF THE ART IN HIGH PERFORMANCE COMPUTING

Advance the state-of-the-art in high performance computing and apply these capabilities to DOE and national priorities, such as national security, environmental cleanup, world leadership in science and technology, and economic productivity. (ER)

Success will be measured in FY 1996 by:

- *Completing a roadmap for development and deployment of advanced communications and computing technologies to create "National Collaboratories," as envisioned in the DOE 2000 initiative to improve research productivity.*
- *Developing computational software, in collaboration with Electric Power Research Institute and others, for the President's National Information Infrastructure initiative, to improve energy supply and demand management for utility companies.*

ST-11 EXPANDING ACCESS TO GLOBAL SCIENCE THROUGH THE

INFORMATION INFRASTRUCTURE

Facilitate open access to the Department's programmatic, scientific, and technical information by providing better communications with U.S. industry, academia, the scientific community, and the public. Capitalize on interagency and international collaborations to benefit the U.S. (ET)

Success will be measured by:

- *Creating the following four new mechanisms for public access to global energy-related information, resulting in a 20 percent increase in service to customers, measured by surveys and programmed feedback for each product through:*
  - *- listing of DOE scientific and technical information resources in a centralized government directory,*
  - *- the Openness Initiative Information, to be available through open systems networks by March 1996,*
  - *- electronic delivery of formerly printed products by June 1996, and*
  - *- 30 percent increase in full text electronic access to R&D information by September 1996.*

ST-12 DIVERSIFYING AMERICA'S SCIENCE WORKFORCE

Work with minority educational institutions to diversify and develop an effective scientific and technical workforce. (ED)

Success will be measured by:

- *Increasing awards to Historically Black Colleges and Universities, Hispanic-serving institutions, Native American, and other minority institutions from over $58 million in FY 1995 to over $100 million.*
- *Showcasing research accomplishments and forging at least three cooperative research and development agreements and partnerships with minority educational institutions.*

ST-13 EDUCATING YOUNG SCIENTISTS

Use the science and technology at the national laboratories to increase knowledge, analytical thinking and research capabilities of faculty and students through hands-on experience. (ET)

Success will be measured by the participation of 5,000 undergraduate, graduate, postdoctoral students and faculty in DOE science education programs at our national laboratories in FY 1996 that results in 40 percent of the participants showing an increase in knowledge and skills as measured by surveys developed in collaboration with other Federal agencies.

National Security

Support and maintain a safe, secure, reliable, and smaller nuclear weapons stockpile without underground nuclear testing; dismantle excess weapons; and provide technical leadership for national and global nonproliferation to reduce the continuing and new nuclear dangers in the world.

Our Commitments

NS-1 REDUCING THE WEAPONS STOCKPILE

Safely reduce the U.S. nuclear weapons stockpile in order to reduce the nuclear danger and enhance international accord. (DP)

Success will be measured by dismantling 1,164 weapons in FY 1996 without adversely impacting the environment, public safety and health.

NS-2 REPLACING UNDERGROUND TESTING WITH SCIENCE

Redirect the DOE weapons programs to maintain confidence in the enduring stockpile through the science-based Stockpile Stewardship Program. (DP) Success will be measured by :

- Developing the Accelerated Strategic Computing Initiative Implementation Plan by April 1996 to improve simulation capabilities.
- Demonstrating the Los Alamos Neutron Scattering Center's (LANSCE) concept of fast neutron radiography of weapons systems to detect small scale (2-3 mm) defects by September 1996.
- Developing a new annual certification process with the National Security Council.
- Completing an integrated program plan for stockpile stewardship and management by March 1996.
- Conducting enhanced nonnuclear experiments on existing stockpile weapons and improving predictive techniques to repair or replace aging weapons.

NS-3 MAINTAINING RELIABILITY OF THE FUTURE STOCKPILE

Develop a replacement source for tritium to ensure the U.S. nuclear weapons stockpile remains reliable. (DP)

Success will be measured by:

- *Publishing the final Programmatic Environmental Impact Statement in November 1995 and the Record of Decision in December 1995 in support of a new tritium production source.*
- *Selecting a prime contractor for the accelerator design by September 1996.*
- *Issuing a request for proposal for supplying tritium through commercial reactors or irradiation services.*

NS-4 DETERMINING THE FUTURE SIZE AND SCOPE OF THE NUCLEAR WEAPONS COMPLEX

Decide on the appropriate size and scope of the nuclear weapons complex. (DP)

Success will be measured by:

- *Issuing the draft Programmatic Environmental Impact Statement (PEIS) for stockpile stewardship and management in February 1996.*
- *Issuing the final PEIS for stockpile stewardship and management in June 1996, and*
- *Issuing the Record of Decision on stockpile stewardship and management in August 1996.*

NS-5 DESIGNING AND CHOOSING A POTENTIAL SITE FOR THE NATIONAL IGNITION FACILITY

Design and select a site for an above-ground experimental physics facility to simulate on a small scale the conditions during a nuclear weapons detonation in order to maintain confidence in the enduring nuclear weapons stockpile. Decide whether to request funding to proceed with the construction of the facility. (DP)

Success will be measured by:

- *Completing the nonproliferation assessment by December 1995.*

- *Finishing the preliminary design by September 1996.*
- *Deciding on the specific site for construction of the National Ignition Facility as part of the Record of Decision for stockpile stewardship and management.*

NS-6 MANAGING SURPLUS WEAPONS-USABLE FISSILE MATERIALS

Define and implement a path forward for verifiable storage and disposition of U.S. weapons-usable fissile materials and support efforts to attain reciprocal actions for disposition of surplus Russian plutonium. (MD)

Success will be measured by:

- *Publishing by February 1996 a draft and by September 1996 the final Programmatic Environmental Impact Statement for storage and disposition of weapons-usable fissile materials.*
- *Completing by May 1996 a final Environmental Impact Statement for down-blending surplus weapons-usable uranium into low enriched uranium for potential use in commercial reactor fuel.*
- *Completing by September 1996 a United States/Russian joint study to develop a set of consistently evaluated plutonium disposition alternatives.*

NS-7 ASSISTING RUSSIA AND NIS IN IMPROVING THE SECURITY OF NUCLEAR MATERIALS

Work with Russia and the Newly Independent States (NIS) to improve material protection, control and accounting (MPC&A) activities at nuclear facilities that contain weapons-usable nuclear material. Develop with their scientists MPC&A equipment suitable for mass production and use in their nuclear complexes. Work with national authorities in instituting and standardizing MPC&A activities (civilian and military). (NN)

Success will be measured by:

- *Expanding MPC&A upgrades at the 26 facilities currently underway, adding additional facilities to be upgraded, and including Russian-manufactured personnel security equipment in these upgrades.*
- *Initiating MPC&A training for Russian national regulatory authorities from each region and beginning procurement of equipment for the Russian nuclear regulatory authority inspections by May 1996.*
- *Developing a preliminary design for a national Russian nuclear materials accounting system by July 1996.*

NS-8 LIMITING WEAPONS-USABLE FISSILE MATERIALS WORLDWIDE

Promote alternatives to the civilian use of plutonium (Pu). Eliminate the civilian use of highly enriched uranium (HEU). Reduce stockpiles of HEU and Pu. Initiate regional fissile material control activities. Assist the shutdown of Russian Pu production reactors. Negotiate an international convention to end the production of fissile material for weapons purposes. (NN)

Success will be measured by:

- *Recommending a preferred alternative regarding the acceptance of spent fuel from foreign research reactors by October 1995, issuing the Environmental Impact Statement in November 1995, and issuing the Record of Decision in January 1996.*
- *Working with the German government to redesign the planned FRM-II research reactor to use low enriched uranium.*
- *Supporting the June 1994 Gore-Chernomydrin Commission agreement to shutdown the Russian plutonium production reactors in Tomsk-7 and Krasnoyarsk-26 by the year 2000. Complete*

technical analyses on nuclear replacement power options by December 1995 and an analysis of fossil fuel replacement power options by July 1996. (NE)

NS-9 ESTABLISHING TRANSPARENT AND IRREVERSIBLE NUCLEAR REDUCTIONS WORLDWIDE

Exchange and confirm data on weapons materials inventories. Monitor nuclear warhead production and expedite dismantlement of excess weapons under bilateral agreements. Conduct reciprocal bilateral inspections of nuclear components and materials. Implement the purchase agreement of the 500 metric tons of HEU from dismantled former Soviet Union warheads. Work to reduce weapons inventories. (NN)

Success will be measured in FY 1996 by:

- *Implementing the draft agreement with Russia initialed in November 1995, implementing transparency measures for the Ural Electrochemical Integrated Enterprise (UEIE) and the Portsmouth Gaseous Diffusion Plant.*
- *Finalizing annexes to the agreement with Russia.*
- *Before the 6th Gore/Chernomyrdin Commission meeting, resolving issues of timely payment to Russia for the natural uranium used to convert the HEU into low enriched uranium.*
- *Supporting White House efforts to obtain Congressional approvals for Presidential authority to waive anti-dumping duties against uranium imported into the U.S. under the HEU Purchase Agreement.*
- *Obtaining the low enriched equivalent of 12 metric tons of HEU.*

NS-10 STRENGTHENING THE NUCLEAR NONPROLIFERATION REGIME

Promote adherence to the Nuclear Non-Proliferation Treaty. Increase the effectiveness and efficiency of the International Atomic Energy Agency (IAEA). Conclude successful negotiation of a Comprehensive Nuclear Test Ban Treaty. Facilitate IAEA inspections of excess fissile materials. Promote regional nonproliferation measures. (NN)

Success will be measured by:

- *Providing direct technical assistance for IAEA inspections in North Korea and Iraq.*
- *Implementing 11 agreements for safeguards cooperation between DOE and foreign governments or organizations (Argentina, Australia, Brazil, EURATOM, France, Germany, Japan, South Korea, United Kingdom, IAEA, and ABACC).*
- *Beginning IAEA inspections of excess plutonium at Rocky Flats by December 1995, bringing the amount of excess fissile material under IAEA safeguards to approximately 12 metric tons.*
- *Placing 13 metric tons of U.S. highly enriched uranium hexafluoride (part of the 200 metric tons of U.S. weapons-grade material declared excess by the President) under IAEA safeguards by the second quarter of FY 1996.*
- *Blending at least four metric tons of weapons-grade uranium down to commercial levels by September 1996. (NE)*

NS-11 CONTROLLING NUCLEAR EXPORTS

Assist the international community in effectively controlling exports and establishing responsible supplier policies. Implement U.S. statutory licensing requirements for nuclear export controls. Encourage adherence to the Nuclear Suppliers Guidelines. Strengthen multilateral supplier initiatives. Foster transparency through automated information sharing and analysis. Advance nonproliferation objectives through technology security. (NN)

Success will be measured by:

- *Adopting the Nuclear Suppliers Group Information Sharing System at the April 1996 Nuclear Suppliers Group Plenary Meeting in Buenos Aires.*
- *Enlisting new signatories to the Nuclear Suppliers Guidelines: China, Brazil, Ukraine, and Turkey by April 1996.*
- *Completing technical reviews of three non-sensitive fuel cycle technologies which trigger multilateral nuclear export controls and seeking formal adoption of a revised list at the May 1996 meeting of the Nonproliferation Treaty Exporters Committee.*
- *Expanding to four additional countries during FY 1996, training in strategic material identification and illicit trafficking prevention, in order to improve export control systems in Russia, the other Newly Independent States, and Eastern Europe.*

NS-12 ENHANCING THE SAFETY OF SOVIET-DESIGNED REACTORS

Increase the safety of Soviet-era nuclear powerplants in countries of Central and Eastern Europe and the Newly Independent States. (NE)

Success will be measured in FY 1996 by the Department continuing to increase the operational safety of Soviet-designed nuclear power plants and enhancing the safety cultures in the countries that operate them, by:

- *Completing draft emergency procedures for all four types of Soviet-era nuclear plants.*
- *Improving training of power plant operators by providing training simulators for five nuclear power plants and training 150 plant staff through seven operator exchange visits by the end of FY 1996.*
- *Assisting the nuclear regulator in Ukraine by completing the training on licensing dry casks for spent fuel storage by June 1996, and in Russia by providing key U.S. DOE safety documentation for large research reactors and fuel cycle facilities, and completing several technical workshops by October 1996.*
- *Improving performance of safety systems at four nuclear power plants by installing fire detection systems and removing fire hazards by installing DC power supplies and by providing an emergency water supply system by September 1996.*

NS-13 ASSISTING IN THE SHUTDOWN OF THE CHORNOBYL NUCLEAR POWER PLANT

Facilitate the closure of the Chornobyl nuclear power plant in Ukraine and reduce safety risks during the plant's remaining operating period. (NE)

Success will be measured by:

- *Providing improved fire safety and other safety equipment; completing a joint U.S./Ukrainian risk assessment of operating Chornobyl Unit 3; and preparing a preliminary decommissioning plan for Units 1 through 3.*
- *Establishing the International Nuclear Safety and Environmental Research Center at Slavutich, Ukraine near Chornobyl by April 1996 to coordinate nuclear safety research.*
- *Transferring dry cask spent fuel storage technology, including three casks and a transporter, to Ukraine and evaluating Ukraine's spent fuel management and disposal requirements and options by September 1996.*

NS-14 MANAGING WORKFORCE RESTRUCTURING

Assure fair treatment of workers and communities affected by changing DOE missions through a cost-effective workforce restructuring process that allows an average cost per separation of $25,000. The workforce restructuring since 1994 will result in a total savings of $3 billion per year. (WT)

Success will be measured by:

- *Limiting the involuntary separation of prime contractor employees due to workforce restructuring to 20-33 percent by sponsoring voluntary separation, transfers and retraining.*
- *Ensuring reemployment of at least 60 percent of separated workers seeking new jobs by sponsoring community-based businesses, career assistance programs, further education and retraining programs.*
- *Ensuring that at least 66 percent of the affected workers are satisfied with DOE's workforce restructuring process.*
- *Establishing a workforce planning system with a database on workers' abilities by September 1996.*
- *Establishing a departmental policy for the treatment of contractor employees affected by organizational changes such as contract reform, privatization and outsourcing.*

Environmental Quality

Protect public health and the environment by understanding and reducing the environmental, safety, and health risks and threats from DOE facilities and develop the technologies and institutions required for solving domestic and global environmental problems.

Our Commitments

EQ-1 UNDERSTANDING AND DEALING WITH THE RISKS

Utilize newly developed information to maximize risk reduction and risk prevention associated with environmental problems resulting from nuclear weapons production during the Cold War. (EM)

Success will be measured by:

- *Completing the sampling, analysis and characterization of 25 high-level radioactive waste tanks at Hanford.*
- *Finishing an analysis of DOE "materials in inventory," including a path forward for at least 10 material types, including lithium, chemicals and weapons components.*
- *Submitting to Congress in May 1996 an updated Baseline Environmental Management Report that will improve the accuracy of cost data over the 1995 report. This report will analyze the long-term cost impact of delaying or accelerating funding rates.*

EQ-2 MAKING PROGRESS ON MIXED WASTE TREATMENT

Continue working with state and EPA regulators to reach agreements and implement plans to treat sites with low level mixed waste.(EM)

Success will be measured by:

- *Reaching agreements at seven remaining sites by December 1995.*
- *Meeting the 130 milestones for FY 1996 for waste characterization and treatment activities, including:*
  - *awarding a contract for privatized treatment of certain waste streams at the Oak Ridge Reservation and the Hanford site,*

- requesting proposals for an advanced mixed waste treatment facility at the Idaho National Engineering Laboratory,
- starting operations of the Consolidated Incineration Facility at the Savannah River Site, and

- treating more than 180,000 cubic meters of mixed waste.

EQ-3 REDUCING THE RISKS; CLEANING UP NUCLEAR WEAPONS SITES

Reduce environmental, safety and health risks by cleaning up DOE sites. (EM)

Success will be measured by:
- *Completing 120 environmental cleanup actions.*
- *Stabilizing 250 kg of plutonium residues and solutions at the Hanford and Savannah River sites.*
- *Finishing 12 decommissioning projects and 154 Uranium Mill Tailings Remedial Action (UMTRA) property clean-ups.*
- *Treating and/or disposing of more than 3 million cubic meters of DOE waste, including starting up vitrification of high-level radioactive waste at the Defense Waste Processing Facility in Savannah River by December 1995 and at the West Valley Demonstration Project by March 1996.*

EQ-4 FINDING SOLUTIONS TO SPENT NUCLEAR FUEL STORAGE AND FUNDING ISSUES

Refocus the Civilian Radioactive Waste Management Program to provide meaningful deliverables, that are consistent with reduced funding and revised policies. (RW)

Success will be measured by:
- *Issuing by March 1996 a revised program plan to determine the suitability of the Yucca Mountain site.*
- *Preparing a plan by September 1996 that identifies the steps to ensure an aggressive start on interim storage of spent fuel, should enabling legislation be enacted.*
- *Completing by March 1996 2.5 miles of the exploratory tunnel and beginning two test alcoves in the potential repository formation at Yucca Mountain.*

EQ-5 SHUTTING DOWN AND CLEANING UP SURPLUS NON-WEAPONS NUCLEAR REACTOR SITES

Safely deactivate surplus nuclear facilities, including the Fast Flux Test Facility (FFTF) reactor in Washington and the Experimental Breeder Reactor-II (EBR-II) in Idaho, and prepare wastes for interim storage and ultimate disposition. (NE)

Success will be measured by:
- *Completing critical steps to deactivate the FFTF by:*
  - washing and packaging 56 of 382 FFTF spent fuel assemblies into interim storage casks and placing the casks in secure storage by September 1996,
  - removing fresh fuel and eliminating unneeded security at the FFTF by September 1996, thus saving $500,000 annually, and
  - completing construction of the Sodium Processing Facility by September 1996 to stabilize coolant drained from the FFTF.
- *Completing 86 percent of the EBR-II fuel removal by September 1996. All fuel will be removed from the reactor by December 1996.*

EQ-6 ENSURING ENVIRONMENTAL JUSTICE

Implement the Department's plan to reduce disproportionate negative impacts of our operations and facilities on low-income and minority communities by accelerating waste management, pollution prevention, and environmental remediation activities. (ED)

Success will be measured by:

- *Increasing the removal of organic solvents from soil and groundwater within the "A/M" area of the Savannah River Site by 74 percent by September 1996.*
- *Initiating construction of an interim cap to prevent the migration of contaminants from the Old Burial Ground at the Savannah River Site by September 1996.*
- *Initiating clean up activities near the East Fork Poplar Creek community at the Oak Ridge Site by April 1996.*
- *Implementing an environmental justice communications strategy plan for affected communities.*

EQ-7 PREVENTING FUTURE POLLUTION

Implement pollution prevention programs that pay for themselves through productivity gains and the avoidance of future waste management costs. (EM)

Success will be measured by:

- *Issuing pollution prevention performance measures and waste reduction goals by March 1996 to be achieved by the year 2000.*
- *Ensuring that half of DOE's purchases of EPA-designated products contain recycled or recovered materials.*
- *Initiating 20 additional projects in FY 1996 that will yield net savings of at least $30 million over a three year period.*
- *Completing analysis and issuing a report by March 1996 concerning the contamination resulting from each step of nuclear weapons production to prevent future generation of waste.*

Energy Resources

Develop and promote energy efficient and renewable energy technologies; advance the efficient and environmentally responsible production, transportation, and use of domestic fossil fuels and other conventional energy sources; promote development of sustainable energy technologies with high export potential; promote an equitable system of energy supply and end use; and reduce U.S. vulnerability to energy supply disruptions.

Our Commitments

ER-1 TRANSFERRING PROVEN ENERGY EFFICIENCY MEASURES

Apply energy efficiency measures to buildings and operations to reduce government energy consumption by 30 percent by 2005, save low-income residents over $10 million in annual energy costs and reduce energy consumption by one quad by the turn of the century. (EE)

Success will be measured by:

- *Adding six new major Energy Savings Performance Contracts, including an innovative government-wide contract to make it simpler, cheaper and faster for government agencies to save energy.*

- *Applying the 15 energy and money saving technologies used in the "Greening of the White House" to three additional showcase buildings and existing Federal facilities. Adopting these technologies will save taxpayers and their Federal agencies $50 million in energy costs in 1996, 10% from DOE facilities and, attract double the current private investment for new Federal facility energy projects, accumulating $60 million by year's end.*
- *Weatherizing 83,300 more low income homes, for a total of 4.4 million homes, which will save those residents a total of $450 million in energy costs every year.*

ER-2 DESIGNING AND DELIVERING CARS OF THE FUTURE

Lead the design team, of the multi-agency and industry Partnership for a New Generation Vehicle, with the goal of developing an 80 mile-per-gallon family car. Deliver the individual technologies in new car models as they are proven effective and demonstrate a prototype car of the future by 2004. (EE)

Success will be measured by:
- *Delivering fuel cell, battery, turbocharger, generator and diesel prototype technologies for demonstration, testing and pilot production.*
- *Adding the final "engine" project partnership, completing the planned R&D team and portfolio needed to design and build the prototype family car.*
- *Adding 15,000 alternative fuel vehicles to the existing 27,000 car fleet in 50 Clean Cities, including 15 new cities this year. The new vehicles will reduce annual oil imports by an additional 4 million gallons, increasing the program savings to eleven million gallons a year.*

ER-3 DEVELOPING RENEWABLE DOMESTIC ENERGY

Advance renewable energy development through cost-shared industry, laboratory and DOE partnerships. By the year 2000, add 15 gigawatts (GW) of renewable based capacity, increase annual production and sales of renewable technology by the equivalent of 5 GW of new capacity every year, and create 30,000 industry-driven high-technology jobs. (EE)

Success will be measured by:
- *Developing the U.S. renewable industry through $400 million of foreign and domestic sales.*
- *Showcasing 25 energy efficiency and renewable energy technologies at the 1996 Summer Olympic Games in Atlanta to over 2 million visitors and 3 billion viewers.*
- *Attracting $100 million of private sector investment to cost share our R&D in renewable technologies.*

ER-4 BOOSTING THE NATION'S PRODUCTION OF NATURAL GAS AND OIL

Improve the capability of the nation's petroleum industry to produce additional supplies of secure, domestic natural gas and oil, increasing U.S. gas and oil production by an average of 1 million barrels per day (oil equivalent) during the 2001-2010 period. (FE)

Success will be measured by:
- *Demonstrating and/or transferring to industry using national laboratory expertise, at least six new geophysical imaging technologies that will improve exploratory well success rates from a current average of 40 percent to 50 percent.*
- *Demonstrating at least five new data processing and simulation methods for applying advanced computing technology developed by national laboratories for other government programs to*

improve domestic prospects for producing natural gas and oil.

ER-5 PROVIDING A NEW OPTION TO SUPPLEMENT THE NATION'S LIQUID FUELS

Provide the nation by 2005 with an alternative source of liquid fuels, costing $25 per barrel or less, that can be produced from coal and solid wastes. (FE)

Success will be measured by:

- *Completing an initial series of laboratory-scale baseline tests that verify the potential for significantly reducing the cost of producing liquid fuels by processing coal with plastics, rubber or other solid wastes.*

ER-6 REDUCING U.S. VULNERABILITY TO ENERGY SUPPLY DISRUPTIONS

Ensure by the year 2000 the readiness of the Strategic Petroleum Reserve (SPR) to drawdown 585 million barrels (MMB) of crude oil at a sustainable rate of 3.9 MMB/day within 15 days of direction from the President. (See Commitment EP-4.) (FE)

Success will be measured by:

- *Degasifying an additional 61 million barrels of inventory to increase drawdown capability from 3.2 to 3.4 MMB/day and inventory availability to 510 MMB.*
- *Implementing an additional 22 percent of the infrastructure life extension program thereby completing nearly half of the program.*
- *Completing transfer or sale of 80 percent of 72 million barrels of oil from the Weeks Island storage site to a more geologically stable site ensuring the availability of this oil.*

ER-7 DEVELOPING THE CLEAN, HIGH EFFICIENCY POWER PLANT OF THE 21ST CENTURY

Provide the nation's electric power industry from 2,000 to 2,010 with a new generation of natural gas and coal power technologies that progressively reduce CO_2 emissions by 30 to 50 percent, lower SO_2 and NO_x emissions to as little as 1/10th of the levels mandated by current Federal standards, and produce electricity at costs 10 to 20 percent below today's conventional plants. (FE)

Success will be measured by:

- *Continuing accomplishments in the Clean Coal Technology Demonstration Program, including:*
  - *starting up the nation's first two full commercial-scale coal gasification-combined cycle facilities, both achieving 96 percent or greater SO_2 removal and NO_x reductions of at least 90 percent and*
  - *demonstrating the market readiness of two more advanced pollution control retrofit technologies that can remove up to 70 percent of NO_x and SO_2 pollutants.*
- *Demonstrating a low-cost combustion gas additive that increases SO_2 emissions removal from 92 percent to 98 percent in wet scrubbers, and reduces cost from about $300 to $50 to $100 per additional ton of SO_2 removed.*
- *Beginning the test runs of the first two complete natural gas molten carbonate fuel cell plants one for utility power generation, the other for onsite cogeneration that will lead to a 60 percent-efficient market-ready fuel cell system by the year 2000.*
- *Moving two U.S. natural gas turbine technologies into the large-scale component development stage, leading by 2000 to a full-scale prototype of a 60 percent-efficient, ultra-low NO_x advanced gas turbine system.*

ER-8 CERTIFYING THE NEXT GENERATION OF NUCLEAR POWER PLANTS

Establish standardized designs and complete the testing and other activities necessary to receive NRC certification of the next generation of light water reactors that will be simpler, safer and less expensive to build and operate than existing plants. (NE)

Success will be measured by:

- *Supporting design certification by the NRC for the Advanced Boiling Water Reactor by the end of FY 1996.*
- *Supporting design certification by the NRC for the System 80+ by the end of FY 1996.*
- *By April 1996, completing testing and test analysis reports for the AP-600 nuclear plant design that are needed to support issuance by NRC of the Supplemental Draft Safety Evaluation Report.*

ER-9 IMPLEMENTING INTERNATIONAL CLIMATE CHANGE INITIATIVES

Monitor and mitigate greenhouse gas emissions and achieve U.S. goals under the Climate Change Treaty. (PO)

Success will be measured in FY 1996 by:

- *Conducting an interagency evaluation of the second round of the U.S. Initiative on Joint Implementation proposals and awarding the winning proposals by December 1995. These actions are estimated to reduce carbon emissions by more than 5 million metric tons in the developing countries by the year 2000.*
- *Completing the first round of 56 climate change country studies, which will produce each country's greenhouse gas emission inventories, risks associated with climate change, and mitigation plans to reduce or capture greenhouse gas emissions.*

ER-10 IMPLEMENTING THE CLIMATE CHANGE ACTION PLAN

Support the President's Climate Change Action Plan to reduce carbon emissions by over 23 million metric tons, produce $15 billion in energy savings, and stimulate $20 billion in industrial investment, by the year 2000. (EE)

Success will be measured by:

- *Increasing sales of the most energy efficient appliance and building equipment by $50 million this year through eight industry collaboratives and four of the biggest national appliance retailers. This program,* ***Energy Saver****, will save enough energy to eliminate 8 million metric tons of carbon by 2000.*
- *Tripling industry* ***Climate Wise*** *commitments to voluntarily reduce carbon emissions by adding 100 additional industrial companies and two new Climate Wise Trade Associations. Our industrial partners are improving their competitive position by recycling, eliminating waste and saving energy, enough to reduce carbon emissions by 4 million metric tons by 2000.*
- *Awarding 16 new NICE3 grants to industry and government cost-shared projects that will demonstrate new cost-effective clean energy technologies, attracting five investor dollars for every Federal dollar and reducing our year 2000 carbon emissions by nearly 2 million metric tons.*
- *Implementing our 21 new Showcase national partner demonstration projects for electric motor drives and systems in our* ***Motor Challenge*** *program, saving businesses $4 million this year and taking more than 5 million metric tons of carbon out of the air by the year 2000.*
- *Nearly doubling the community and regional partnerships to improve commercial building energy efficiency. The 90* ***Rebuild America*** *partnerships - 40 are new this year - attract an average of $30*

of private investment for every public dollar. By the year 2000 the buildings adopting the ***Rebuild energy*** *savings practices will save their communities over $2 billion and take over 1 million tons of carbon out of the air.*

- *Adding 40 new utilities to our 108* ***Climate Challenge*** *agreements to voluntarily reduce emissions. By the end of the year we will have 600 partner utilities, that account for two-thirds of utility carbon emissions. We expect our utility partners to increase their ongoing energy saving programs enough to take an additional 7 million metric tons of carbon out of their service areas by the year 2000.*

ER-11 MAXIMIZING THE VALUE OF FEDERAL OIL FIELDS

Maximize the value to the taxpayer of the Naval Petroleum and Oil Shale Reserves by divesting them to the private sector, subject to Congressional authorization, before the end of FY 1997. (FE)

Success will be measured by:

- *Offering the government-owned and operated commercial oil field at Elk Hills for sale to the private sector.*
- *Prior to the sale, operating the Reserves in FY 1996 so as to achieve net revenues in the range of $217 to 256 million to the Treasury.*

Economic Productivity

Promote sustained U.S. economic growth that stimulates creation of high-wage jobs, diversity in research and development collaborations, efficiency and pollution prevention, and global DOE technology usage and exports.

Our Commitments

EP-1 INCREASING U.S. ENERGY TECHNOLOGY EXPORTS AND INVESTMENTS

Stimulate sales of U.S. energy technology and capital investments in countries with large, emerging markets. Diversify world wide supply through targeted support for U.S. industry efforts to invest in new oil and gas supplies and energy efficiency and renewable technologies. (EE/FE)

Success will be measured by:

- *Promoting the U.S. renewable industry in fostering foreign and domestic sales of $400 million, and foreign sales agreements representing $1.5 billion in sales. (EE)*
- *Removing barriers to U.S. companies in coal technology export and efficiency and renewables markets, including those in China, Brazil and other developing countries that will use coal, by:*
  - *establishing U.S. and foreign partnerships and*
  - *providing technical expertise to mulilaterial and regional financing institutions in evaluation of finance applications. (FE)*
- *Initiating a forum, similar to that done for the Western Hemisphere, for Arctic oil and gas practices with the Russian producing associations. (FE)*
- *Opening of oil, gas, energy efficiency and renewable technology opportunities for U.S. companies by Ukraine. (EE/FE)*

EP-2 IMPROVING EFFICIENCY IN ENERGY INTENSIVE INDUSTRIES

Work with the most energy-intensive industries to focus cooperative research, increase energy and resource efficiency and improve U.S. competitiveness resulting in over $20 billion of industry energy cost saving by the year 2000. (EE)

Success will be measured by:

- *Signing partnership agreements with the metal castings industry in October, chemical industry by June, glass industry by September, and aluminum industry by September to achieve "Industrial Visions of the Future", which include economic, energy efficient, and environmentally superior technologies.*
- *Beginning four new technology roadmaps with industry representatives teaming and cost-sharing with DOE programs, researchers and laboratories.*

EP-3 ACCELERATING FEDERAL AND PRIVATE SECTOR TECHNOLOGY DEVELOPMENT THROUGH PARTNERSHIPS

Enhance the Department's research impact through partnerships with industry and increase the amount of research performed for and with other government agencies and the private sector. (DS)

Success will be measured in FY 1996 by:

- *Increasing the program-supported DOE laboratory R&D funding that is leveraged with the private sector from $108 million in FY 1995 to $158 million in FY 1996.*
- *Demonstrating the value of the laboratories and facilities to the nation by increasing private sector funded R&D at the labs by at least 10 percent over 1995.*
- *Developing by June 1996 a measurement process that documents mission benefits derived through partnerships, such as the improved productivity of laboratory research.*

DOE's Critical Success Factors

The Department has adopted Total Quality Management principles to drive our National Performance Review initiatives to improve overall effectiveness and reduce costs. We will meet or exceed customer requirements and make DOE a professional and personally rewarding place to work. DOE has focused on FOUR FACTORS critical to successfully realizing the Department's mission:

Communication and Trust

Communicate our new post-Cold War missions in an environment of openness, communication, and trust.

Our Commitments

CT-1 MAKING MORE INFORMATION AVAILABLE TO THE PUBLIC

Declassify information under the Atomic Energy Act and Executive Order 12958, reduce the volume of new information classified and make information more accessible. (NN)

Success will be measured by:

- *Reviewing 440,000 documents for possible declassification.*
- *Completing a survey of classified DOE records for declassification and making public a list of records reviewed.*
- *Completing declassification and release of 15 percent of historically significant national security information records 25 years old and older.*

- *Issuing the final report on Fundamental Classification Policy Review and implementing its recommendations for declassifications.*
- *Making available on the Internet a list of unclassified documents on Human Radiation Studies.*

CT-2 IMPROVING SERVICES TO CUSTOMERS AND STAKEHOLDERS

Develop techniques to improve delivery of services and products to customers and stakeholders. (HR)

Success will be measured by:
- *Eliminating the 1993 to 1994 backlog of 208 Freedom of Information Act (FOIA) cases.*
- *Centralizing FOIA/Privacy Act headquarters operations to ensure compliance with the 10-day statutory response time.*

CT-3 INVOLVING STAKEHOLDERS IN THE POLICY MAKING PROCESS

Assure that the business of DOE will be open to the full view and input of those whom it serves, consistent with applicable laws, regulations and contracts. (EM)

Success will be measured by:
- *Ensuring that Environmental Management decisions consider the input of site specific groups.*
- *Completing a third national survey of DOE stakeholders' attitudes, needs and expectations of DOE by July 1996 to assess the Department's progress against the FY 1993 baseline.*

Human Resources

Create an environment where teamwork, trust, openness, pride and respect are standard practices, and excellent performance is rewarded. Provide meaningful work opportunities and implement innovative compensation and personnel initiatives to attract and retain a diverse and well-trained workforce, capable of carrying out DOE's new mission.

Our Commitments

HR-1 STREAMLINING MANAGEMENT STRUCTURE

Reduce management layers and encourage employee empowerment. (HR)

Success will be measured by:
- *Increasing the worker to supervisor ratio to 11:1 from a ratio of 8:1 in September 1995.*
- *Decreasing the number of employees in senior level positions (SESs, GS 15s and 14s) by 194 from 5,568 at the end of FY 1995.*

HR-2 ENSURING WORKFORCE DIVERSITY

Recruit, hire and retain a diverse workforce and assure that DOE contractors achieve diversity. (ED)

Success will be measured by:
- *Maintaining diversity achievements during downsizing in FY 1996.*
- *Developing and implementing diversity strategies at all DOE field sites.*
- *Implementing the DOE strategic diversity plan at five additional reactor sites.*

HR-3 RECRUITING, REWARDING AND RETAINING TECHNICAL EXCELLENCE

Use personnel tools to attract and retain technical excellence. (HR)

Success will be measured by:

- *Fully implementing the Technical Qualifications Program by December 1995 to cover all 2,800 technical employees involved in managing defense nuclear facilities.*
- *Updating all Individual Development Plans for the technical employees of defense nuclear facilities to incorporate the Technical Qualifications Program competencies.*
- *Increasing the technical to non-technical ratio for defense nuclear related positions to 1:0.8 by December 1996, from a ratio of 1:.85 in December 1995.*

HR-4 IMPROVING HUMAN RESOURCE PRACTICES

Develop techniques for ensuring management success in achieving performance goals critical to realizing the Department's mission. (HR)

Success will be measured in FY 1996 by:

- *Implementing "360 Degree" performance feedback for all SES employees by collecting input from supervisors, peers, subordinates and customers and by obtaining input for all career SES employees during FY 1996.*
- *Beginning to implement the "360 Degree" process for non-SES supervisors and managers by March 1996.*
- *All managers receiving appropriate quality training by June 1996 and promoting training for their staffs. (QM)*
- *Establishing pilot partnership programs to reengineer how personnel services are delivered to customers, with a goal of reducing processing times of typical personnel services by 25 percent.*

HR-5 PROVIDING TRANSITION ASSISTANCE TO EMPLOYEES

Offer career transition assistance to minimize impacts of downsizing on Department employees. (HR)

Success will be measured by:

- *Expanding services of the Career Management Resource Centers to provide transition assistance to headquarters employees by:*
  - *increasing the number of employees served by 20 percent, from 3,235 in FY 1995 to 3,880 in FY 1996,*
  - *increasing customer satisfaction (via users meeting specified personal objectives) from 75 percent in FY 1995 to 80 percent in FY 1996, and*
  - *increasing the number of workshops to aid employees in actions related to career transition by over 40 percent; from 22 workshops in FY 1995 to 36 in FY 1996.*
- *Increasing Departmental field sites with transition assistance services from four in FY 1995 to thirteen in FY 1996 as needed.*

Environment, Safety, and Health

Continue to shift from a reactive approach to an emphasis on prevention and excellence in protecting worker and public safety and health and in achieving environmental standards. Open the Department's records related to environment, safety and health and provide stakeholders easy access to this information.

Our Commitments

EH-1 INCORPORATING THE EXISTING RISK-BASED PLANNING AND BUDGETING PROCESS INTO ALL MAJOR MANAGEMENT AND OPERATION CONTRACTS

By September 1996, incorporate the risk-based environment, safety, and health planning and budgeting process into all new major Management and Operation contracts and those that are scheduled for renewal. (EH)

Success will be measured by inclusion of strong and effective environment, safety, and health provisions in six Management and Operation contracts.

EH-2 ELIMINATING SERIOUS VULNERABILITIES

By September 1996, complete Highly Enriched Uranium Vulnerability Study to identify environment, safety and health vulnerabilities. (EH)

Success will be measured by reducing the number of unaddressed serious highly enriched uranium vulnerabilities at DOE facilities to zero.

EH-3 IMPLEMENT THE "NECESSARY AND SUFFICIENT CLOSURE PROCESS" TO ENSURE SAFE OPERATIONS IN A STREAMLINED ENVIRONMENT

Identify and implement appropriate standards for work being done that will provide for the health and safety of workers, the public and the environment. (EH)

Success will be measured by completing nine pilot projects initiated in FY 1995 and beginning the full implementation of this process into the Department's operations by February 1996.

EH-4 INSTITUTIONALIZE A MULTI-DISCIPLINARY OVERSIGHT PROCESS

By September 1996, institutionalize a multi-disciplinary, fully integrated oversight process for evaluating environment, safety, health, and safeguards and security programs.

Success will be measured by completing value-added, comprehensive oversight evaluations, focusing on environment, safety, and health-management systems at eight DOE sites.

Management Practices

Adopt "Best in Class" management practices in conjunction with the Department's mission by meeting or exceeding customer expectations by empowering and enabling people to be results-oriented and cost-effective, and by contributing to the Administration's deficit reduction objectives. Take an integrated approach to managing headquarters, field and contractor operations that focuses on performance.

Our Commitments

MP-1 ALIGNING THE DEPARTMENT TO SAVE MONEY AND ENHANCE PERFORMANCE

Implement the Strategic Alignment Initiative through office consolidations, business process re-engineering, and elimination of non-essential activities. (FM)

Success will be measured by:

- *Closing eight field offices and four headquarters locations and reducing 1,380 Federal staff positions.*
- *Through process improvements saving $49 million in information resource management, $35 million in Federal and contractor travel and $5 million in National Environmental Policy Act compliance activities.*
- *Return $15 million to the Treasury from the sale of surplus assets.*

MP-2 BECOMING A WORLD CLASS QUALITY ORGANIZATION

Implement improvement action plans based on the results of the 1995 self-assessment. Conduct a 1996 self-assessment of DOE quality management practices using the President's Quality Award or Malcolm Baldridge National Quality Award Criteria. (QM)

Success will be measured by:

- *Implementing quality improvement action plans by January 1996 at all Headquarters and Field Organizations;*
- *All headquarters and field organizations completing their annual quality self-assessment by September 1996;*
- *By demonstrating continuous performance improvement at all headquarters and field organizations in 1996 as compared with the results of their 1995 quality baseline self-assessment.*
- *By January 1996, completing the development of a system which aligns strategic and operational planning with strategic intent, ensures this planning drives resource allocation, involves regular evaluation of results, and provides feedback. (PO)*

MP-3 SETTING A NEW HIGH STANDARD IN CONTRACT MANAGEMENT

Establish a new legacy of improved contracting through the Department's solicitations and negotiations, facilitating privatization activities, and ensuring translation of contract reform into Department policies, procedures, and guidance. (FM)

Success will be measured by:

- *Selecting contractors and incorporating contract reforms into contracts for four sites and for the 15 DOE facilities whose contracts are to be extended in FY 1996.*
- *Developing Departmental policy on privatization by April 1996.*
- *Issuing a solicitation to privatize the treatment of tank waste at Hanford by February 1996.*
- *Publishing a proposed rulemaking by April 1996 which reflects Departmental policies on competition, contractor accountability, contractor fees, and make-or-buy decisions.*
- *Reducing support service contracts to $610 million by September 1996 from an FY 1994 baseline of $700 million.*

MP-4 REDUCING FEDERAL REGULATIONS

Eliminate unnecessary prescriptive requirements as well as nonessential processes, reports, forms, and directives. (HR)

Success will be measured by:

- *Reducing the number of DOE operations offices' field directives from 856 in FY 1995 to 290 in FY 1996, a 66 percent decrease. Overall, the number of directives will have been reduced by 80 percent since this effort began in FY 1993.*
- *Achieving an additional 10 percent reduction in the number of headquarters directives from of 156 in FY 1995 to 140 in FY 1996.*
- *Reporting operational improvements realized as a result of the directives reduction efforts.*

MP-5 REDUCING THE OVERSIGHT BURDEN ON FIELD ACTIVITIES

Improve the efficiency of DOE oversight of field offices, laboratories and major contractors by consolidating oversight visits and simplifying technical reviews. (DS)

Success will be measured by:

- *Improving the business management review process for field activities, reducing the number of oversight visits by 80 percent and associated costs by $10 million. (FM)*
- *Improving the technical review oversight process for the national laboratories, reducing the number of reviews and overall cost of oversight. (ER)*
- *Improving the program supported Environment, Safety and Health oversight process at six pilot laboratories and reducing associated costs by 30 percent. (DP)*

MP-6 EXTENDING USE OF DOE LANDS AND FACILITIES

Initiate comprehensive planning to integrate life cycle asset management goals of stakeholders and the Department and to determine ways to broaden the use of DOE lands and facilities. (FM)

Success will be measured in FY 1996 by:

- *Initiating comprehensive land use planning processes at 40 of the Department's 50 major sites to set the context for future use decisions and to reduce duplicative planning efforts.*
- *Completing at least ten major actions to make land and facilities available for broader public use.*

MP-7 IMPROVING MANAGEMENT PRACTICES AT THE DEPARTMENT OF ENERGY'S LABORATORIES

Focus and clarify the missions of DOE laboratories, to simplify oversight practices and adopt "best business practices" to ensure efficient operations. (DS)

Success will be measured by:

- *Reducing laboratory operating cost by $264 million in FY 1996 towards the goal of reducing these costs by $1.6 billion over the next five years.*
- *Establishing with the Laboratory Operations Board by February 1996:*
  - *a process to define the missions of each multi-program laboratory, and*
  - *a process to validate missions and privatization options for each single program and special mission laboratory.*

Measurement and Monitoring of Performance

To maintain focus, a sense of urgency, and to have a real impact on performance, there will be periodic reviews of progress, discussion of difficulties encountered, and agreement on appropriate actions. These reviews will be held between the President and/or his designees and Department officials and, with greater frequency within the Department. Any specific reporting requirements will be developed jointly with the Department.

Administration Support

In order to accomplish the goals herein described, it is the Administration's objective to: *Provide visible, high profile support for:*

- The Department's National Security programs, including the science-based stockpile stewardship program and the Department's leadership in reducing the global nuclear danger.
- Maintaining the fusion energy option for the U.S.
- International collaboration in major science facilities.
- The Department meeting its environmental cleanup and compliance commitments.
- Departmental efforts to expand international trade in energy technology for U.S. companies.
- The Department's efforts to promote economic growth and protect environmental quality through advancing energy efficiency and renewable energy.

Terms of Agreement

This agreement is intended only to improve the internal management of the Executive Branch and is not intended to and does not create any right, benefit, trust or responsibility, substantive or procedural, enforceable by law or equity by any party against the United States, its agencies, its officers, or any person. This agreement will remain in effect until modified. It is expected that it will be updated at least annually to reflect significant changes in budget, policy, personnel, or other factors that may affect the accomplishment of objectives. This agreement represents our joint commitment to a Department of Energy that works better, costs less, and fulfills our sacred trust to the American People.

Appendix C

APPENDIX C

SCOPE OF ARCO ANNUAL ENVIRONMENTAL STUDIES

APPENDIX C-1

COLVILLE ENVIRONMENTAL STUDIES 1992, 1993, 1994

1

Colville Environmental Studies

1992 • 1993 • 1994

Biological & Physical

2

Wildlife

Birds

- Swans
- Loons - Y-B
- Geese - Brant
- Eiders - Specs

Mammals

- Caribou
- Arctic Fox
- Grizzly Bear
- Musk Oxen

Habitat

Physical Environment

Geomorphology & Hydrology

Flooding Regime

Channel Morphology

Terrain Unit Mapping

Landscape Stability

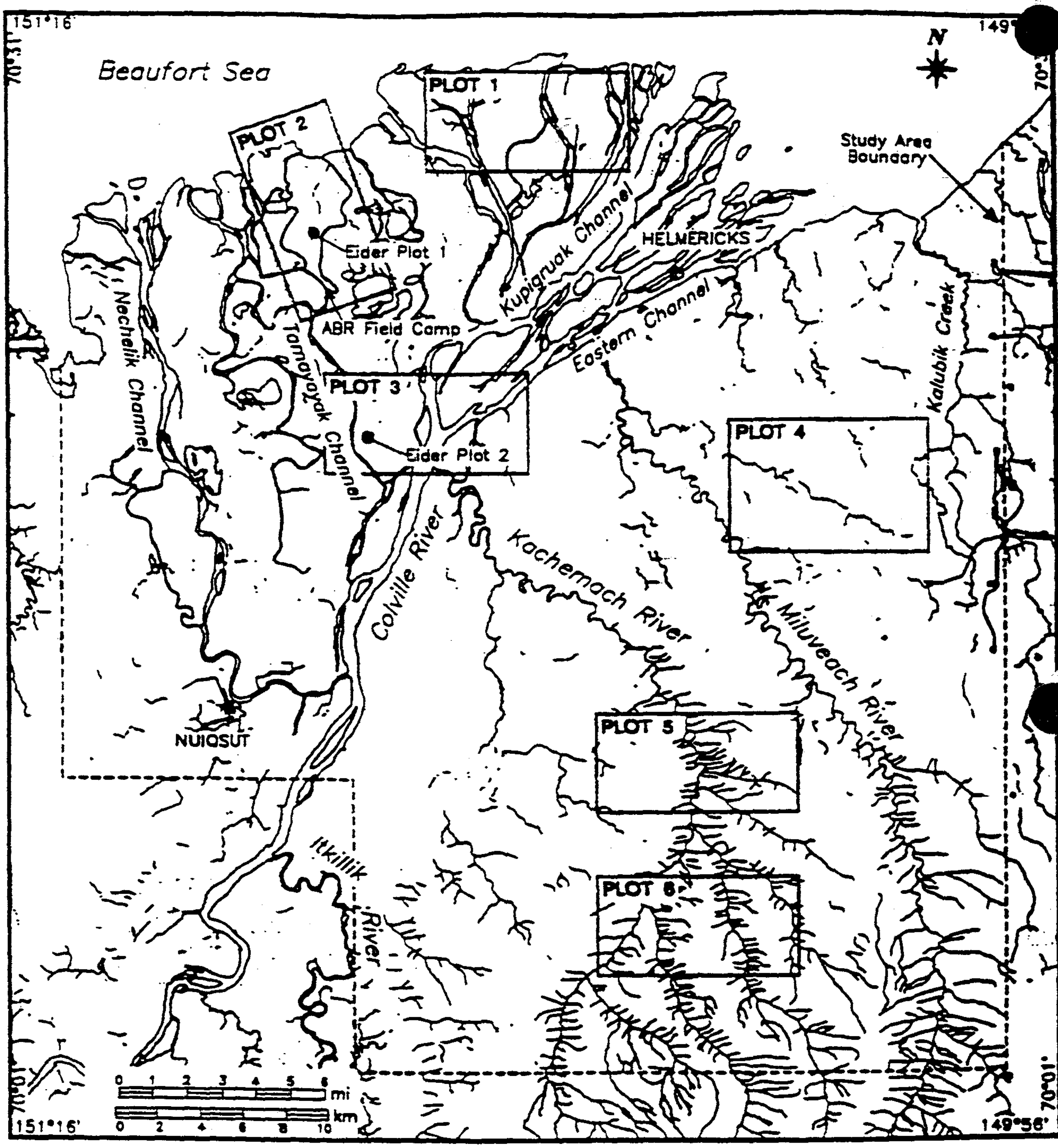

Figure 1. Study area, and locations of Study Plots 1-6 and Eider Plots 1 and 2 for the Colville River Delta Wildlife Study, June-September 1992. The facilities at the eastern edge of the map are the westernmost drill sites of the Kuparuk Oilfield.

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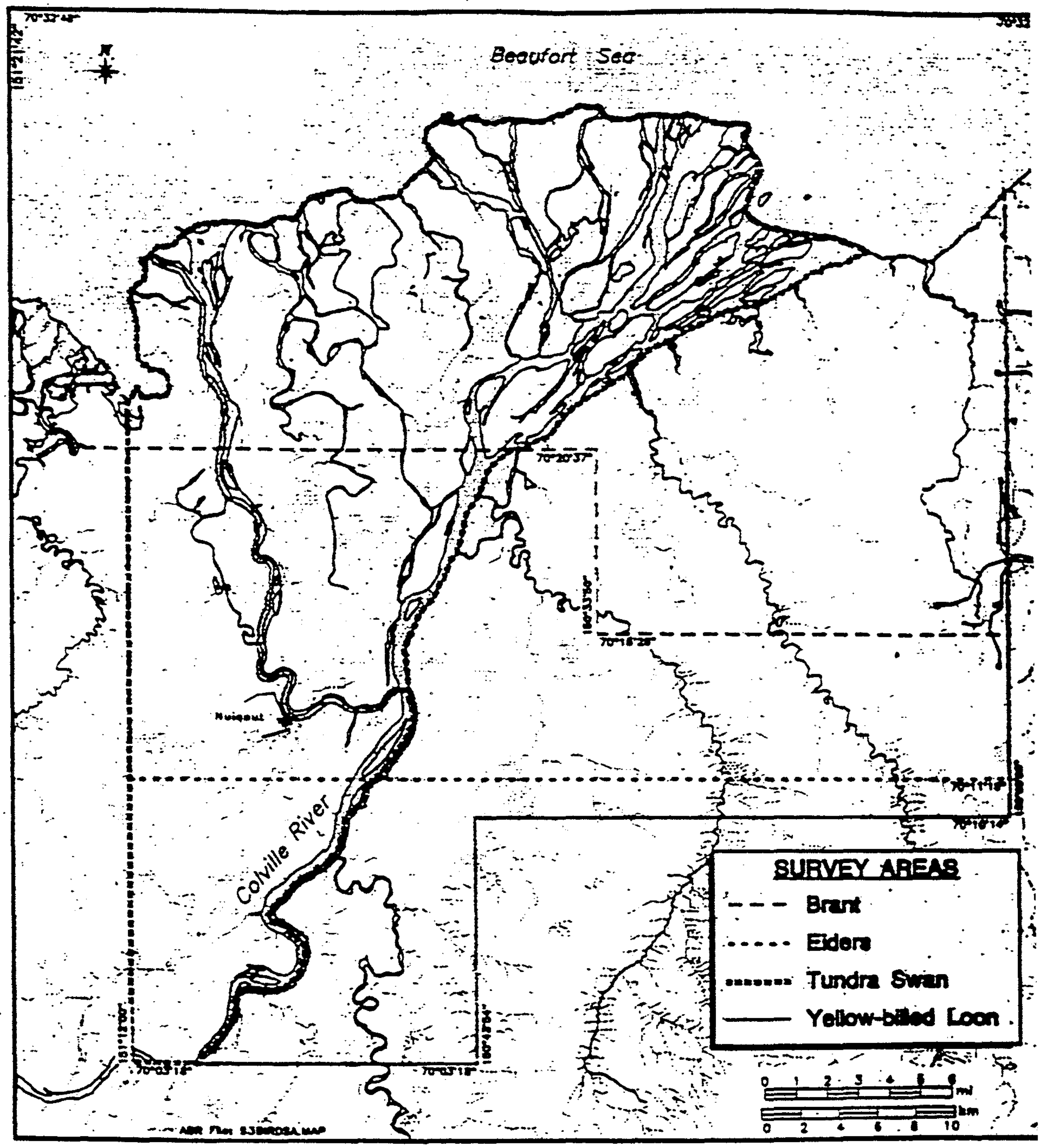

Figure 2. Boundaries of aerial survey areas for four species of waterbirds, Colville River Delta Wildlif[e]
May–October 1993.

6

Table 1. Dates and types of wildlife surveys conducted in 1992 on the Colville River Delta.

Species	Survey Type	Season	Dates	Aircraft Used[a]	Transect Width (km)	Transects Spacing (km)	Aircraft Altitude (m)	Area Surveyed[b]
BIRDS								
Loons	Aerial	Nesting	28 Jun	C185	.8	.8	75	Plots 1-3
		Brood-rearing	19 Aug	C185	.8	.8	75	Plots 1-3
Tundra Swans	Aerial	Nesting	18 Jun	C206	2.4	2.4	150-210	CRD
			28 Jun	C185	.8	.8	150	Plots 1-3
		Brood-rearing	17 Aug	C185	.8	.8	150	Plots 1-3
			28 Aug	C206	2.4	2.4	150-210	CRD
		Staging	17 Sep	C206	3.2	3.2	150-210	CRD; Plots 1-3
Brant	Aerial	Nesting	30 Jun	PA18	N/A	N/A	75	Western CRDSA
		Brood-rearing	9 Jul	PA18	.8	.8	75	Coastal CRDSA
			27 Jul	PA18	.8	.8	75	Coastal CRDSA
		Staging	20 Aug	PA18	.8	.8	75	Coastal CRDSA
Eiders	Aerial	Pre-nesting	17-19 Jun	PA18	.8	.8; 3.2	30	Plots 1-6; CRD
	Ground	Nesting	24, 30 Jun	None	N/A	N/A	N/A	Eider Plots 1 and 2
Waterfowl	Ground	Nesting	20 Jun-2 Jul	None	N/A	N/A	N/A	Plots 1-3
		Brood-rearing	18-23 Jul	None	N/A	N/A	N/A	Plots 1-3

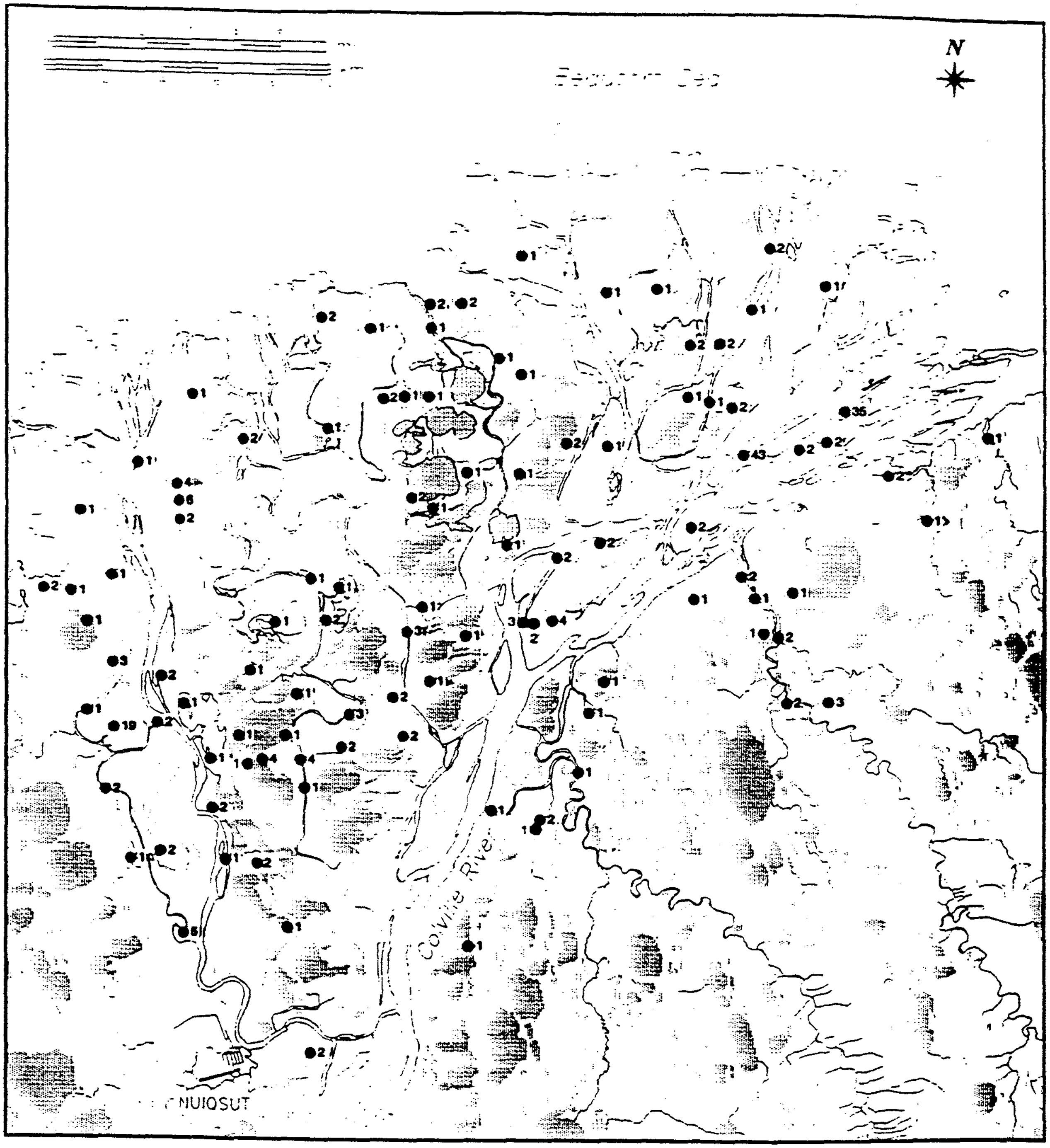

Figure 4. Distribution of Tundra Swans (adults) observed during aerial survey, 18 June 1992, Colville River Delta, Alaska. (Data supplied by ADFG, Anchorage.)

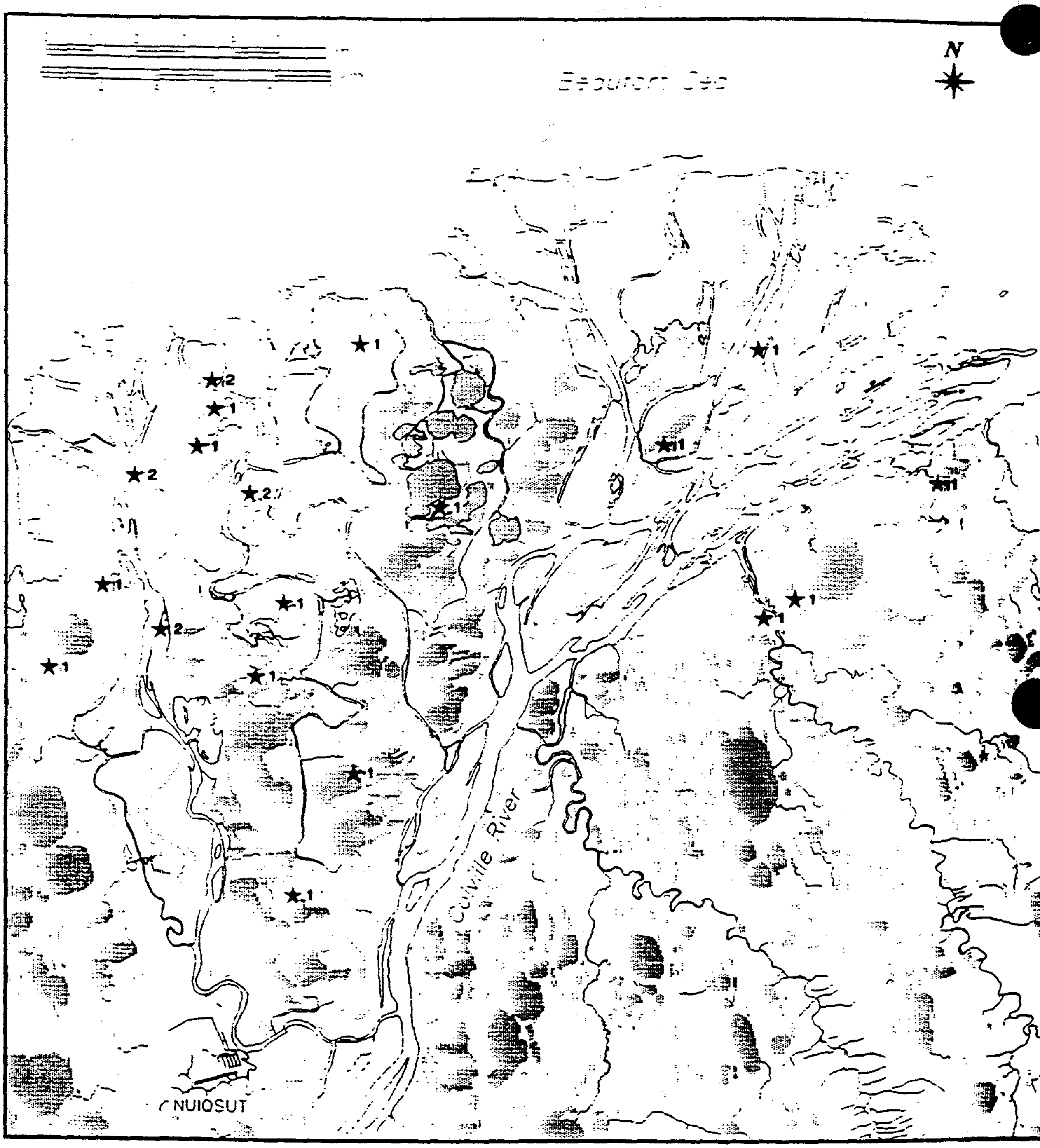

Figure 5. Distribution of Tundra Swan nests and attending adults observed during aerial survey, 18 June 1992, Colville River Delta, Alaska. (Data supplied by ADFG, Anchorage.)

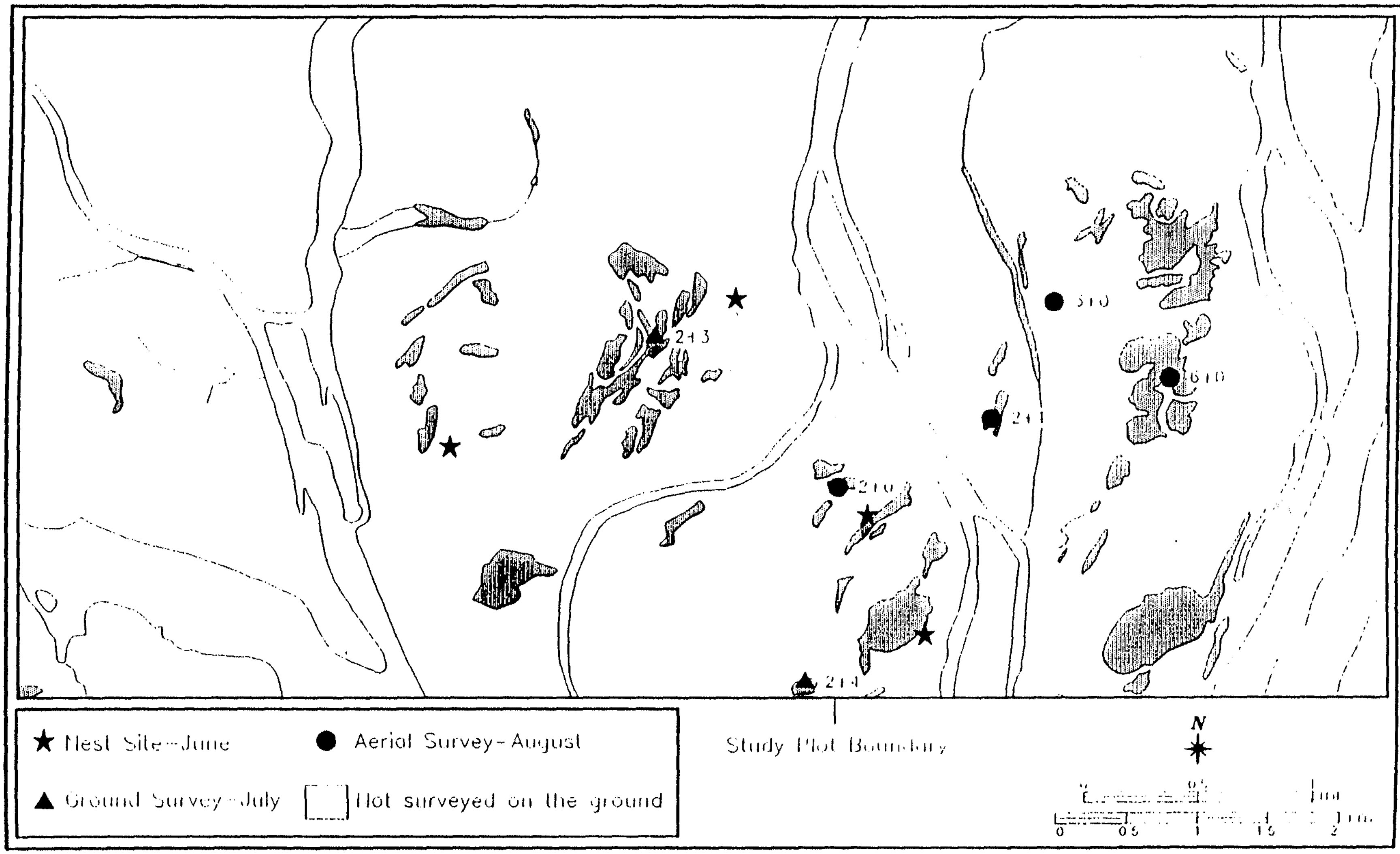

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Figure 6. **Distribution of Tundra Swan nests and broods (adults + young) in Plot 1, Colville River Delta, Alaska, 1992.**

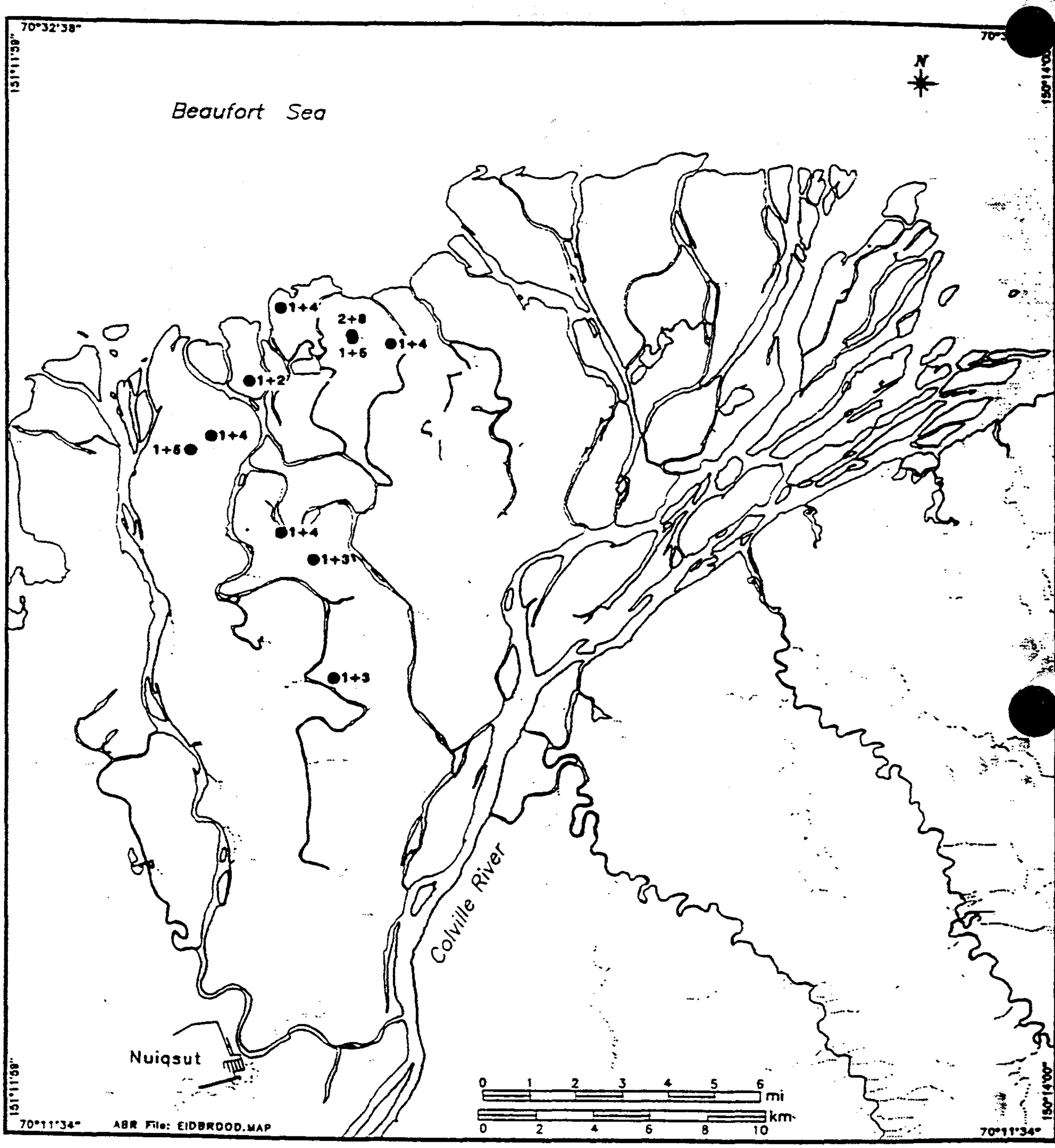


Figure 17. Distribution of Spectacled Eider broods (number of adults + number of young) located during ground surveys (20 June–2 July 1993), Colville River Delta, Alaska.

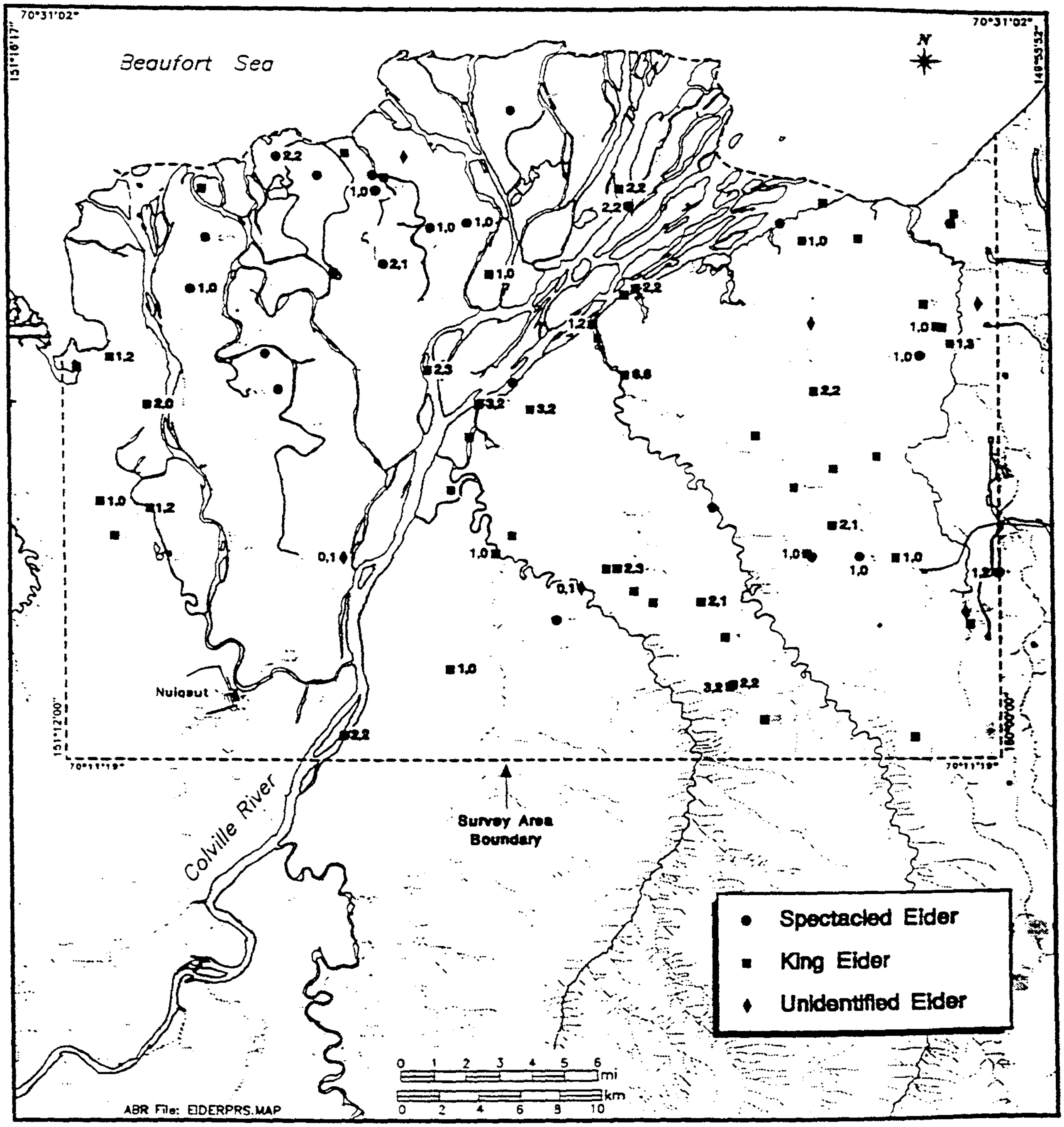


Figure 15. Distribution of Spectacled, King, and unidentified eiders (number of males, number of females) observed during aerial surveys (10–12 June 1993), Colville River Delta, Alaska. Symbols without numbers indicate a pair.

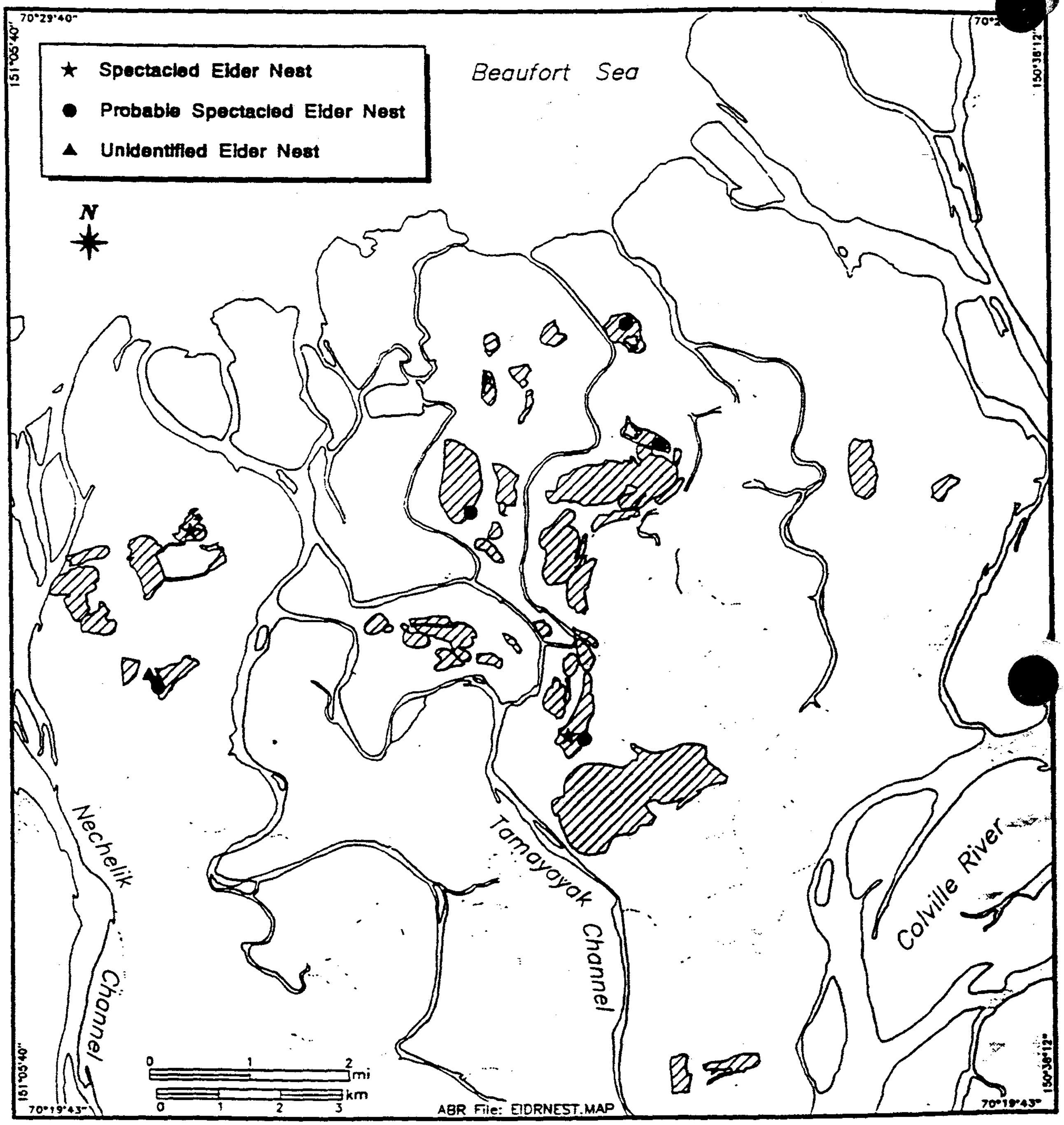


Figure 16. Distribution of Spectacled Eider, probable Spectacled Eider, and unknown eider nests located during nesting and brood-rearing surveys (20 June–20 July 1993), Colville River Delta, Alaska. Cross hatching indicates areas searched for nesting Spectacled Eiders.

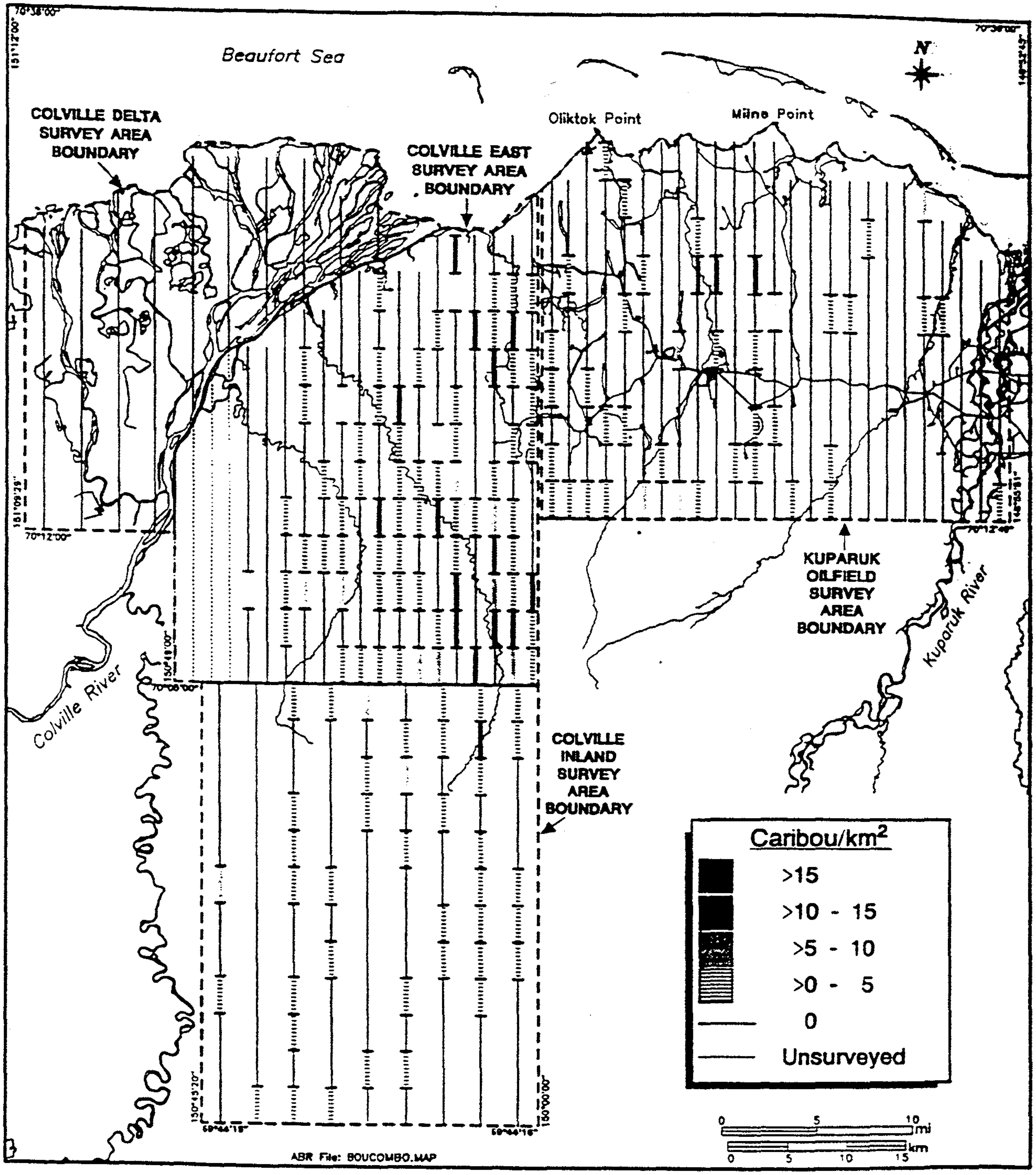


Figure 20. Distribution and density of caribou on the Colville Delta survey area (10 June), the Colville East survey area (11 June), the Colville Inland survey area (10 June, and the Kuparuk Oilfield (15 June), Alaska, 1993. The aerial surveys were conducted with the observer counting caribou on 3.2-km-long segments of 400-m-wide strip transects. Kuparuk Oilfield data from Lawhead et al. (1994).

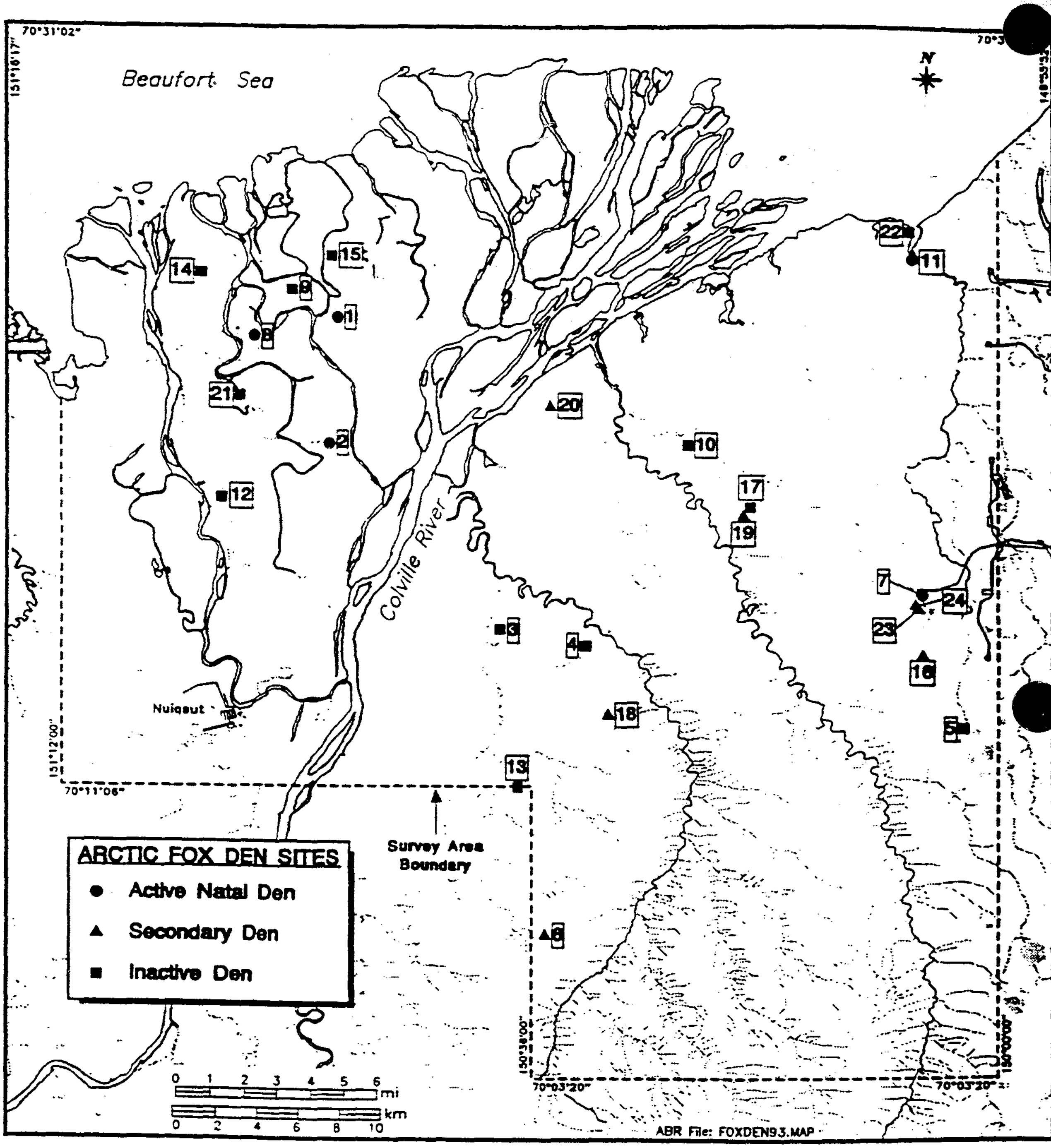


Figure 21. Location and status of arctic fox dens inspected 23 July–7 August 1993, Colville River Delta, Alaska.

15 茜 Study Are:

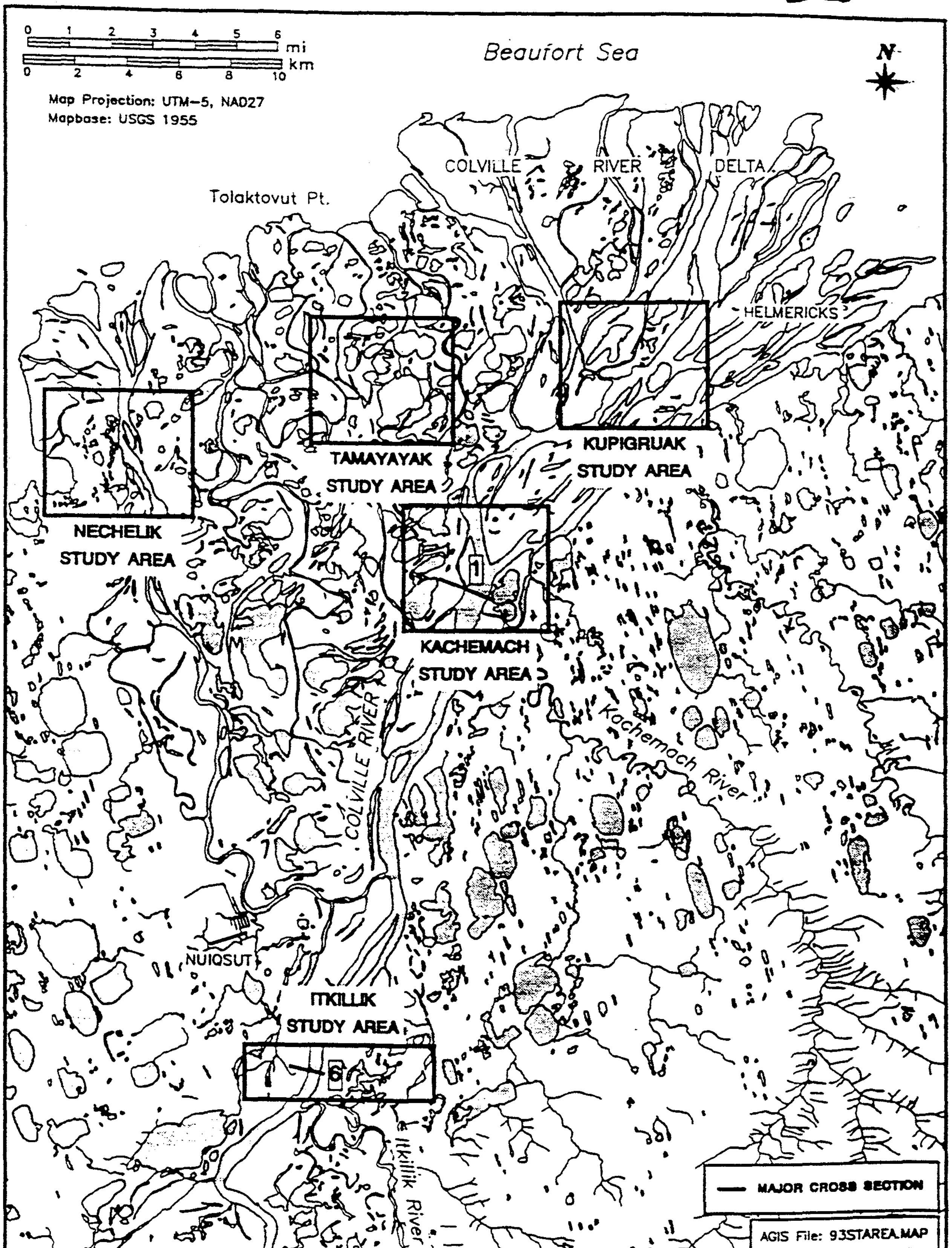


Figure 1. Map of study area showing locations of cross sections and flood distribution areas within the Colville River Delta, 1993.

Figure 10. Locations of soil sampling sites, Colville River Delta, 1992.

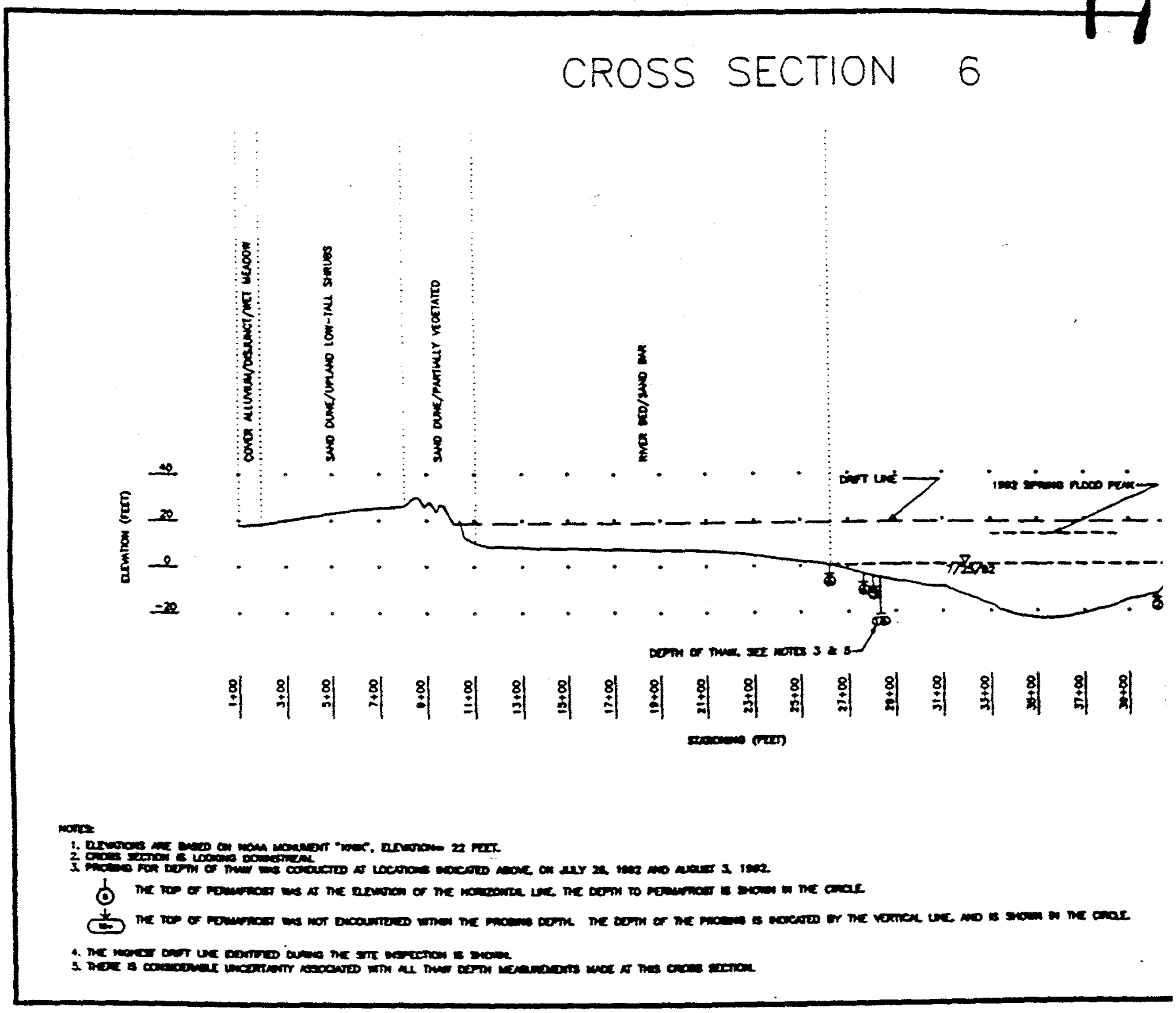


Figure 7. Profile of cross section 6 showing ground-surface elevations and depths to permafrost, Colville River Delta, 1992.

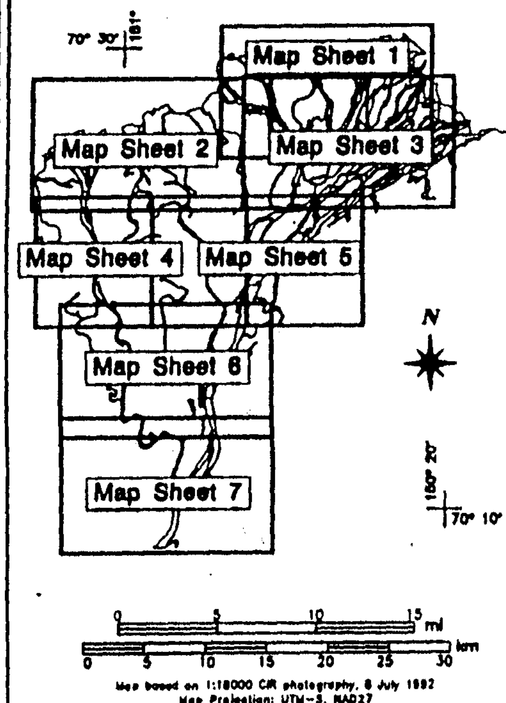
INTEGRATED TERRAIN UNIT LEGEND

- Loess/All Other Subunits Grouped
- Sand Dune/Nonpatterned/Partially Vegetated
- Sand Dune/Nonpatterned/Vegetated
- Riverbed-Sandbar/Nonpatterned/Barren
- Riverbed/Nonpatterned/Partially Vegetated
- Riverbed/Nonpatterned/Riparian Low, Tall Shrub
- Riverbed/Nonpatterned/Salt Marsh
- High-water Channel/Nonpatterned/Partially Vegetated
- High-water Channel/Nonpatterned/Wet Meadow
- High-water Channel/Nonpatterned/Riparian Low, Tall Shrub
- High-water Channel/Nonpatterned/Salt Marsh
- High-water Channel/Nonpatterned/Salt-killed Meadow
- Cover Alluvium/Nonpatterned/Wet Meadow
- Cover Alluvium/Nonpatterned/Salt-killed Meadow
- Cover Alluvium/Disjunct Polygons/Wet Meadow
- Cover Alluvium/Disjunct Polygons/Low, Tall Shrub
- Cover Alluvium/Disjunct Polygons/Salt-killed Meadow
- Cover Alluvium/L.C.P., Low Density/Wet Meadow
- Cover Alluvium/L.C.P., Low Density/Riparian Low, Tall Shrub
- Cover Alluvium/L.C.P., Low Density/Salt-killed Meadow
- Cover Alluvium/L.C.P., High Density/Wet Meadow
- Cover Alluvium/L.C.P., High Density/Riparian Low, Tall Shrub
- Thaw Lake Deposit/Nonpatterned/Barren
- Thaw Lake Deposit/Nonpatterned/Partially Vegetated
- Thaw Lake Deposit/Nonpatterned/Wet Meadow
- Thaw Lake Deposit/Nonpatterned/Low, Tall Shrub
- Thaw Lake Deposit/Nonpatterned/Salt Marsh
- Thaw Lake Deposit/Nonpatterned/Salt-killed Meadow
- Thaw Lake Deposit/Disjunct Polygons/Salt-killed Meadow
- Thaw Lake Deposit/L.C.P, Low Density/Wet Meadow
- Thaw Lake Deposit/L.C.P., Low Density/Riparian Low, Tall Shrub
- Thaw Lake Deposit/Pingo/Upland Dwarf Shrub
- Tidal Flat/Barren
- Tidal Flat/Partially Vegetated
- Tidal Flat/Salt Marsh
- Gravel Fill
- River or Stream Channel
- Channel Lake
- Thaw Lake-Pond
- Nearshore Water and Brackish Ponds

INTERGRATED TERRAIN UNIT SYSTEM

Landform / Surface Form / Vegetation

Integrated terrain units incorporate landform, surface form, and vegetation features. The primary colors denote landforms, while secondary shades denote different surface forms. Patterns represent vegetation types and are consistent across landforms. Waterbodies are classified separately. Units are described in Part II of the report.



ARCO Alaska, Inc.

COLVILLE GEOMORPHOLOGY AND HYDROLOGY

Atlas of Integrated Terrain Units
Colville River Delta, Alaska

Alaska Biological Research, Inc.
Arctic Hydrologic Consultants

Date: 5 Jan 1993	AGIS File: CRDATLAS.MAP

19

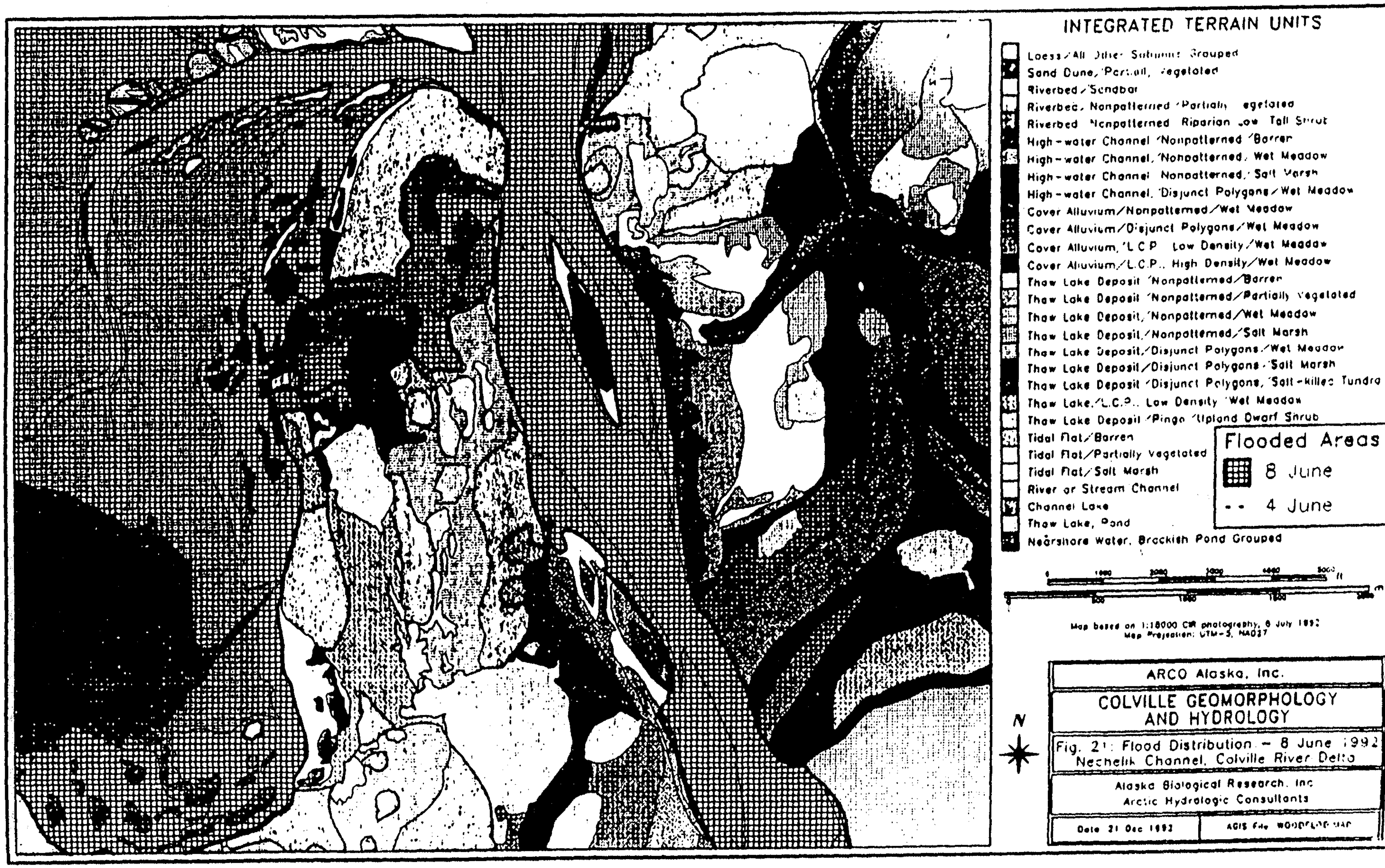
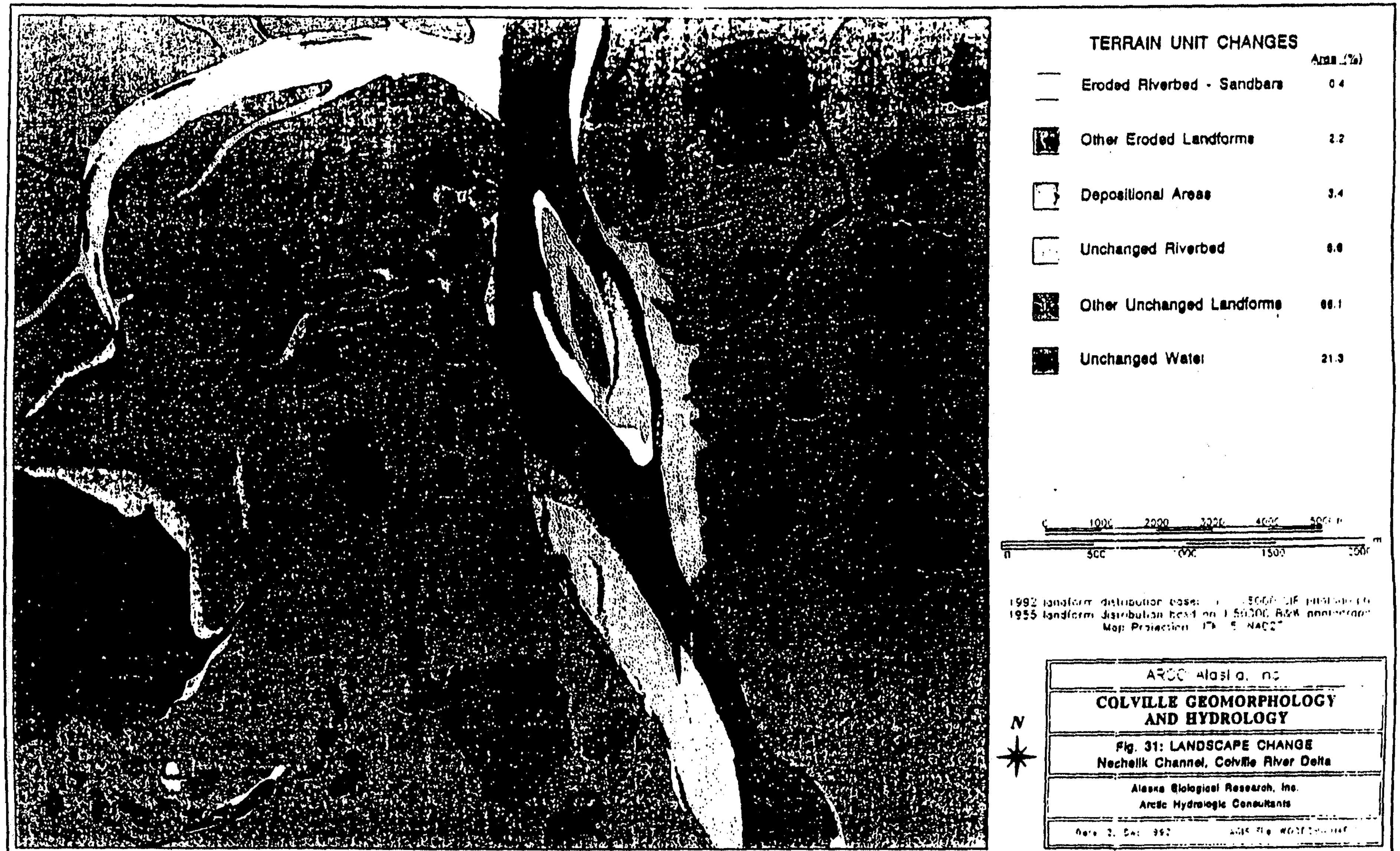


Fig. 21: Flood Distribution - 8 June 1992
Nechelik Channel, Colville River Delta

20



TERRAIN UNIT CHANGES
Area (%)
Eroded Riverbed - Sandbars 0.4
Other Eroded Landforms 2.2
Depositional Areas 3.4
Unchanged Riverbed 6.6
Other Unchanged Landforms 66.1
Unchanged Water 21.3
0 1000 2000 3000 4000 5000 ft
0 500 1000 1500 2000 m
N
ARCO Alaska, Inc
COLVILLE GEOMORPHOLOGY AND HYDROLOGY
Fig. 31: LANDSCAPE CHANGE
Nechelik Channel, Colville River Delta
Alaska Biological Research, Inc.
Arctic Hydrologic Consultants

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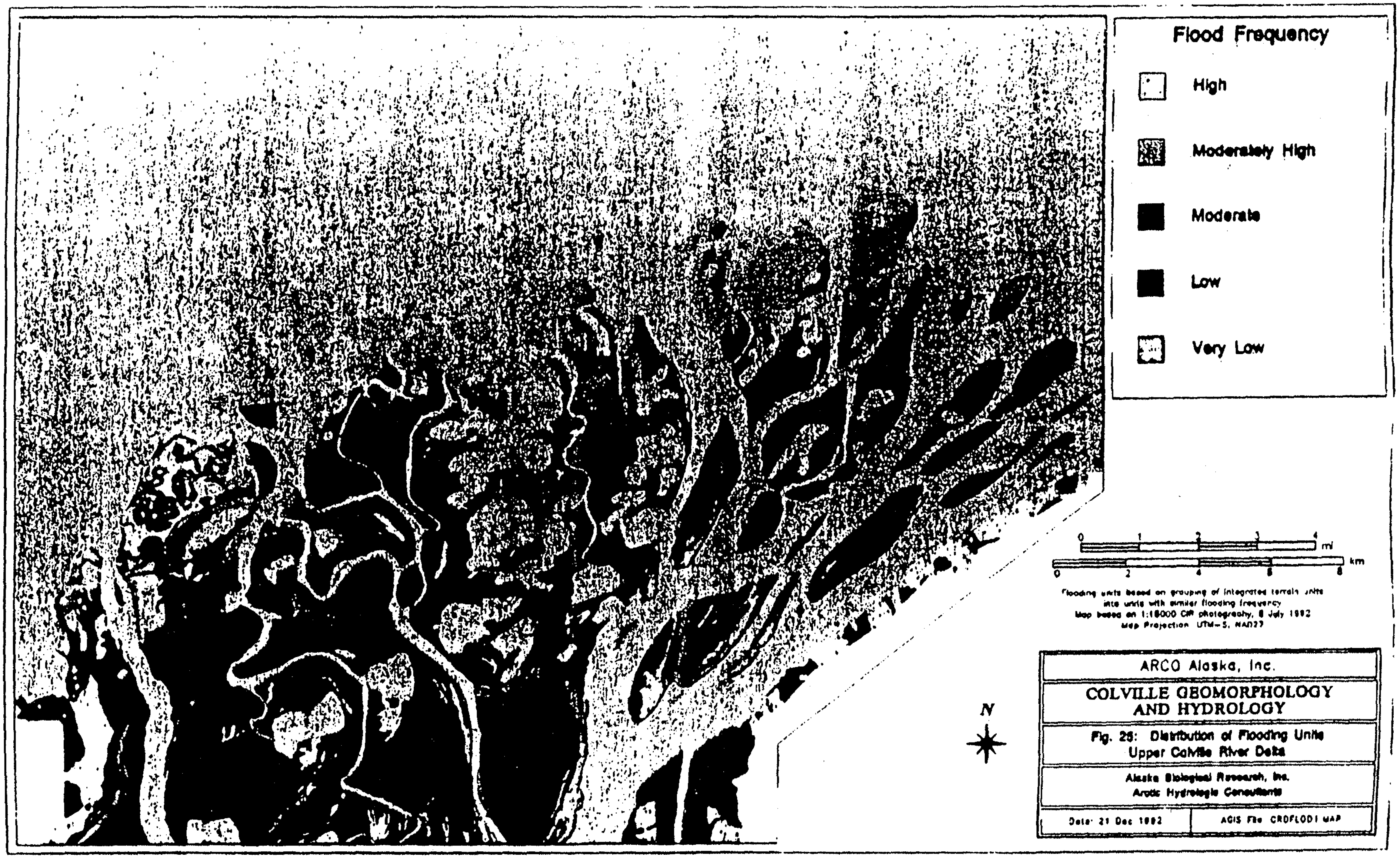

Flood Frequency
High
Moderately High
Moderate
Low
Very Low
0 1 2 3 4 mi
0 2 4 6 8 km
Flooding units based on grouping of integrated terrain units
into units with similar flooding frequency
Map based on 1:18000 CIR photography, 8 July 1992
Map Projection UTM-5, NAD27
N
ARCO Alaska, Inc.
COLVILLE GEOMORPHOLOGY
AND HYDROLOGY
Fig. 25: Distribution of Flooding Units
Upper Colville River Delta
Alaska Biological Research, Inc.
Arctic Hydrologic Consultants
Date: 21 Dec 1992
AGIS File CRDFLOD1.MAP

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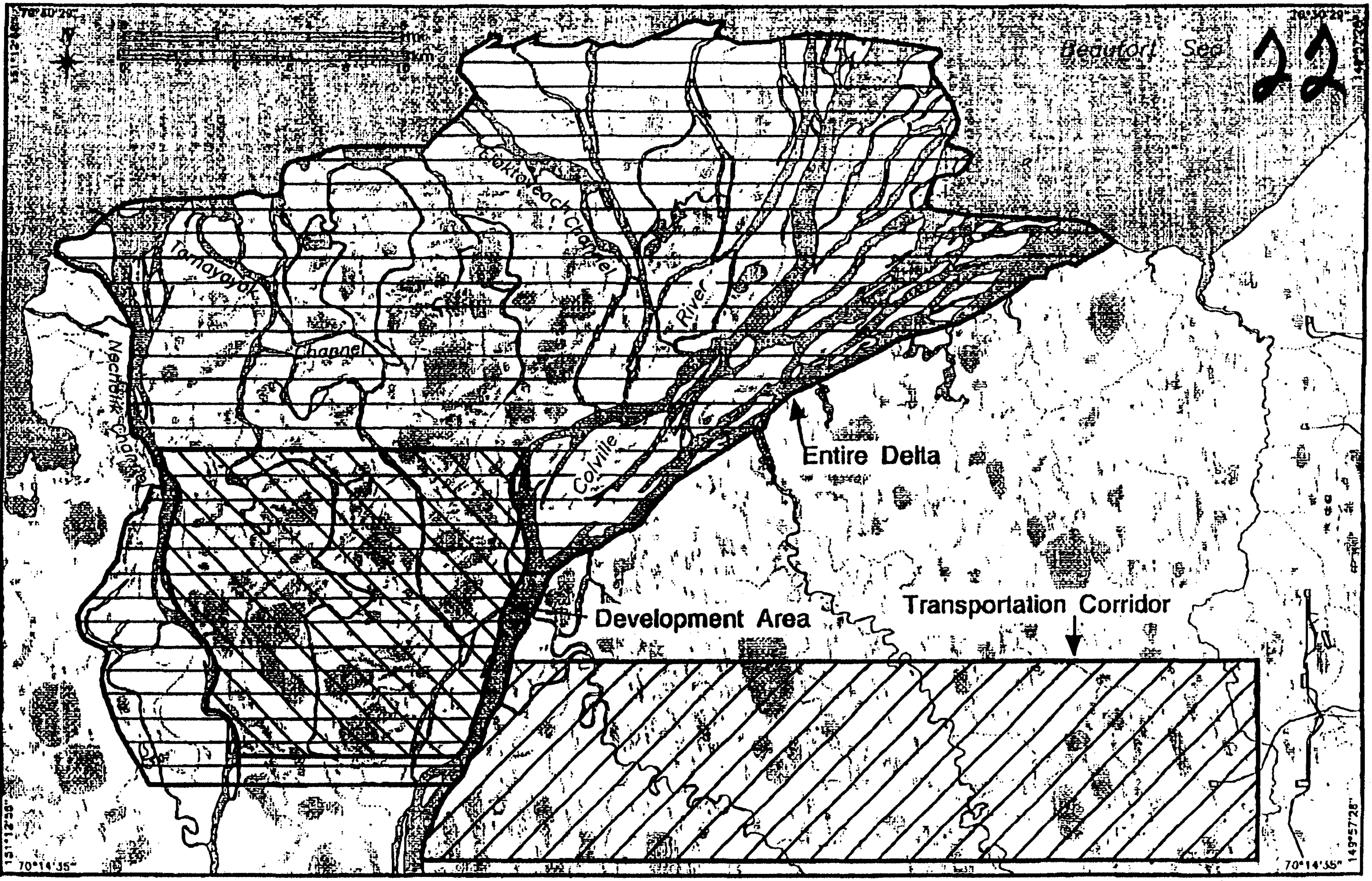

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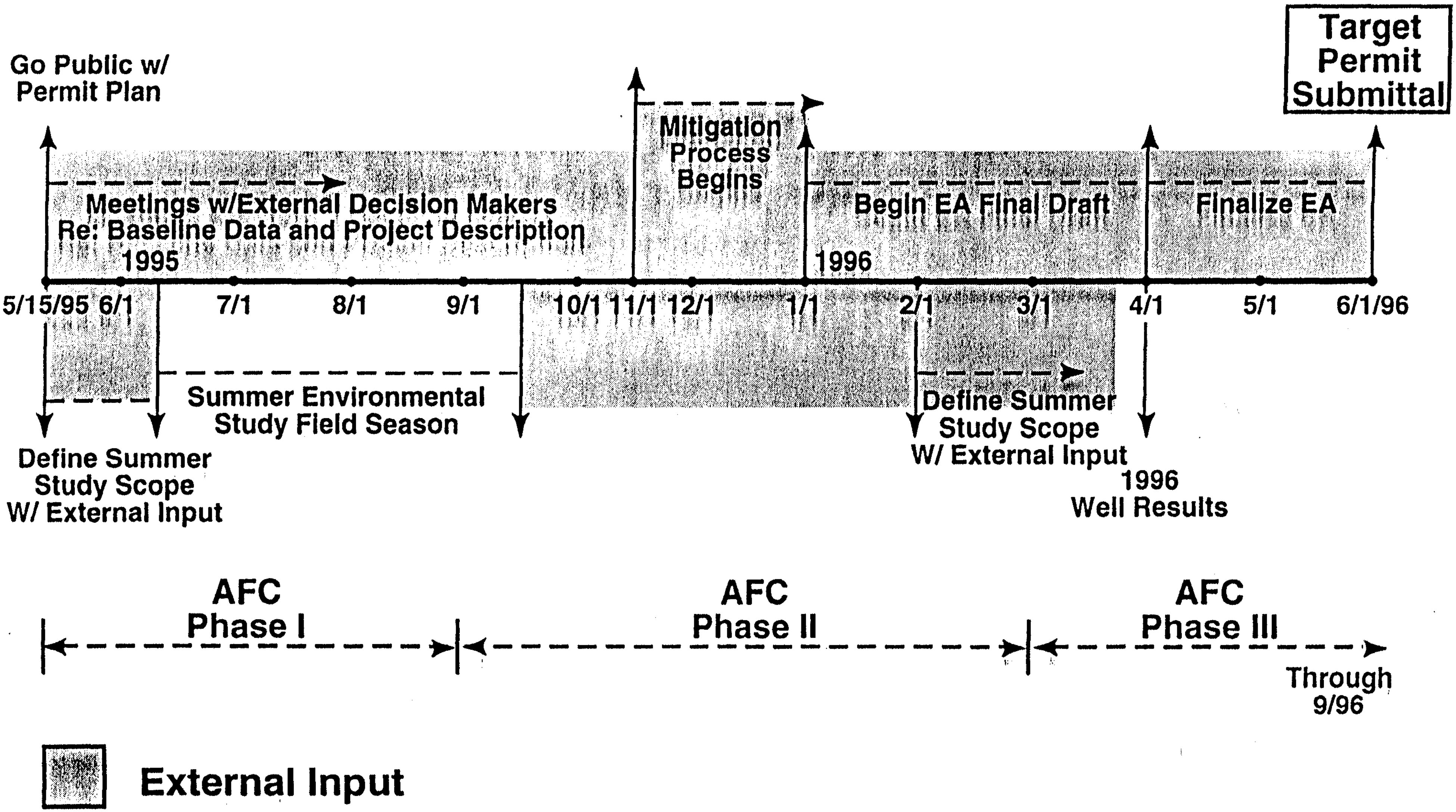
Colville River Development Project
ARCO Alaska, Inc., Operator
Anadarko and Union Texas Petroleum, Co-owners



MJS 5/22/95

APPENDIX C-2

COLVILLE ENVIRONMENTAL STUDIES 1995

ARCO Alaska Inc.
Post Office Box 100360
Anchorage, Alaska 99510-0360
Telephone 907 265-6534
Fax 907 265-6216

1 June 1995

TO THE COLVILLE PARTICIPANTS:

Attached please find a copy of our proposed technical studies plan for our 1995 environmental and geomorphology program in the Colville River Delta. We have been discussing our planning for potential Colville activity with many of you. This study scope provides more detail of our proposed continuation of a field study to gather additional information to support decisions of project viability.

As you know we are having a meeting in Anchorage to discuss these plans on 7 June 1995. We provide this copy of our technical plan to assist your preparation for that meeting. See you on 7 June.

Sincerely,

Mike Joyce
Senior Consultant
Biological Sciences

COLVILLE ENVIRONMENTAL STUDIES

1995 PROPOSED TECHNICAL PLAN

ECOLOGICAL STUDIES

FISH

BIRDS

MAMMALS

HABITAT MAPPING

PHYSICAL STUDIES

FLOOD REGIME

CHANNEL MORPHOLOGY

TERRAIN STABILITY

ARCO ALASKA, INC.

JUNE 1995

COLVILLE DELTA FISH SURVEY - 1995

by:

Lawrence L. Moulton
MJM Research
5460 NE Tolo Rd
Bainbridge Island, WA 98110

INTRODUCTION

ARCO Alaska desires to gather pre-development data on fish inhabiting lakes and river channels in and around the Colville River Development Project (Figure 1). The information gathered will be used to support requests for permits and assist with designing, siting and scheduling of facilities and activities.

Previous surveys in the Colville Delta have shown that many of the lakes across the region contain an abundance and diversity of fish species (McElderry and Craig 1980, Bendock and Burr 1986, Moulton 1994). Lakes deep enough to retain water through the winter usually contain fish, only 2 of 31 lakes sampled between 1991 and 1993 did not produced fish. The dominant species, least cisco, has a variety of growth forms that are readily distinguishable (Moulton 1994) and may represent 1) adaptation to varying lake productivity or 2) different dispersal episodes.

Use of habitats has been shown to vary across the delta, with a gradation from anadromous, more saline-tolerant species in lakes and channels near the delta front to more freshwater-associated species as one progresses southward away from the coast. The project may be in a transition area, with a diversity of habitats present.

STUDY OBJECTIVES

The objectives of the survey will be to:

1) identify fish species in the various lakes and river channels within the project area (sampling area identified on Figures 2 and 3),

2) obtain information on the relative abundance of species in the different water bodies sampled,

3) obtain basic descriptive population data for the species captured.

APPROACH

Habitats Samples

The study will be confined to lakes and channels within the sampling area identified on Figure 3. Approximately 18 of the isolated lakes in this area have water depths in excess of 8 feet, based on earlier surveys, and may provide habitat suitable for year-round use by fish. Several tapped lakes and river channels also exist in the study area and may provide areas for seasonal use. Deep areas (>8 ft) within the tapped lakes and river channels appear scarce, but if present, would also provide the potential for wintering habitat.

The strategy will be to sample the main channel that runs through the study area (Sakoonang Channel) and at least one tapped lake on a continuous basis during the study. Nets will be checked daily, fish processed and released. In addition, isolated lakes will be sampled for one to two days each, with gear moved to different lakes as sampling progresses.

Gear Utilized

The sampling strategy will be to use a wide variety of gear to sample the greatest diversity of fish present. The primary gear will be fyke nets, augmented with minnow traps, set lines and seine.

Fyke nets will be similar to those employed during coastal fish studies, but down-sized to allow greater portability, since the isolated lakes will be accessed on foot. The fyke nets will have a 3x4 ft frame (3/8" mesh in body), 25 ft wings, and 50 ft lead (3/4" mesh in wings and lead).

Minnow traps and small-mesh seines will be used to identify species and sizes that are not readily captured by fyke nets. Set lines will be used to target on burbot, which may be present in the isolated freshwater lakes.

Biological and Physical Data

Data collected will include catch rate and size data for each species captured in each set made. Associated data will include beginning and end time of each set, type of gear utilized, water temperature, conductivity or salinity, and any relevant observations. Fish will be counted by species and measured to the nearest millimeter fork length. Prior to measuring, the fish will be anesthetized in MS-222; after measuring they will be allowed to recover in a holding pen prior to release.

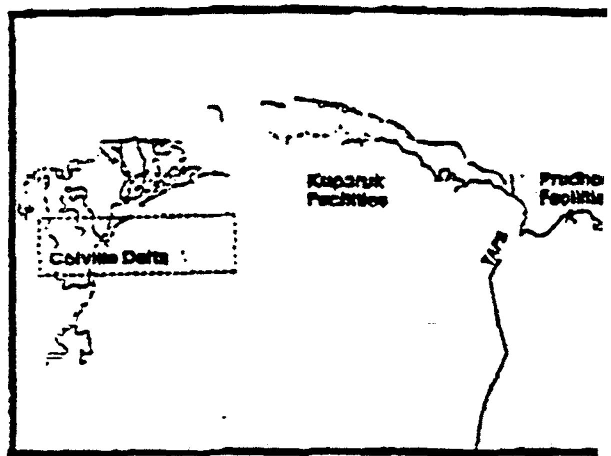
Samples of fish will be retained to obtain basic population data. These population data include condition analysis (which consists of length and weight measurements), sexual maturity, basic feeding patterns, and age determination. Up to 20 fish from each 50 mm length interval will be retained from each sample site for basic population data.

Depth surveys will be made of the lakes and channels surveyed to assess the potential for winter survival.

Analysis

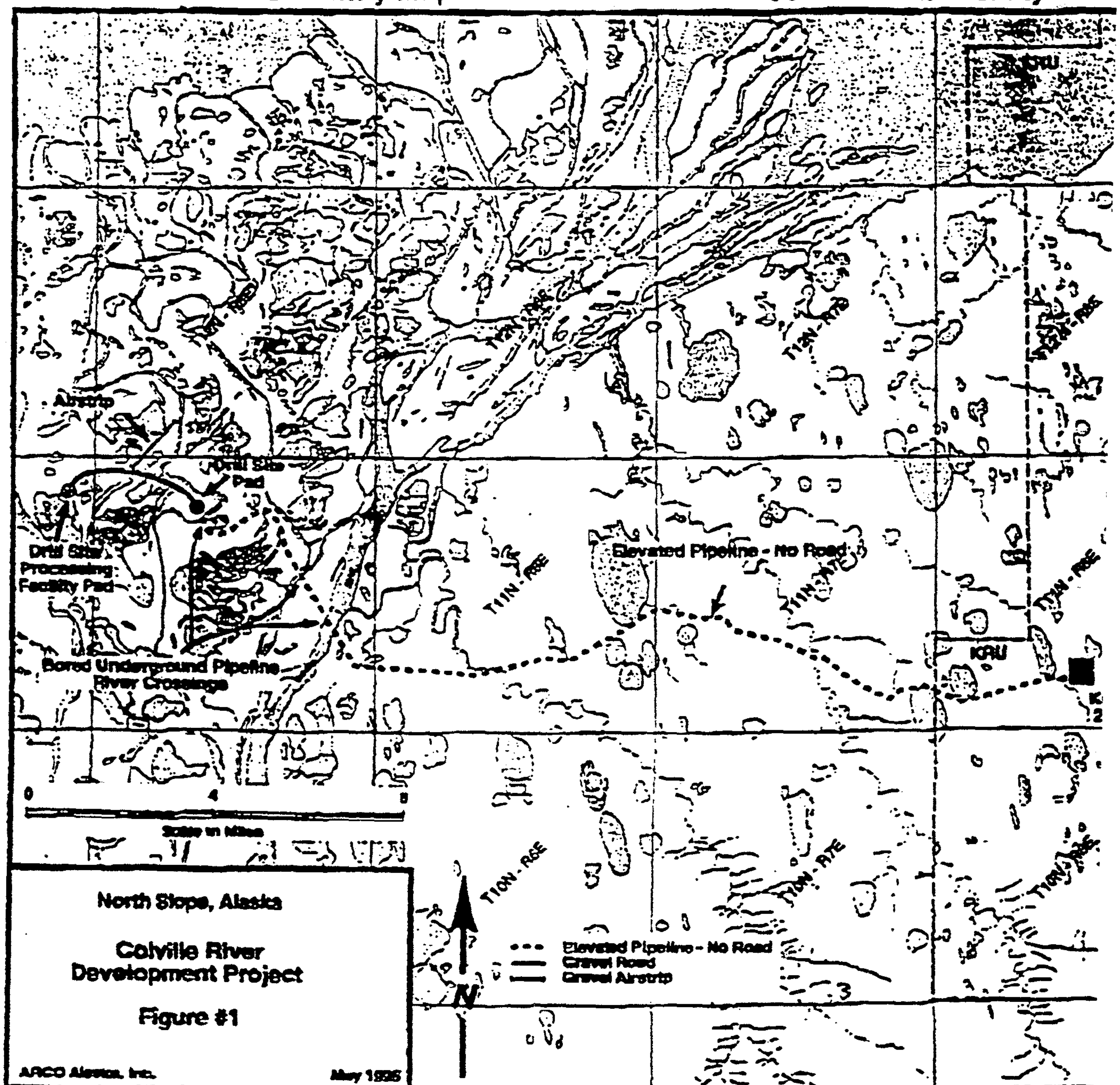
Data analysis will include a description of the catch from each sample site, with the associated population data. Fish catches will be presented as catch per effort to reveal differences in relative abundance. Information provided will include length frequency, age distribution, maturity schedules, condition analysis, and growth rates. The information will be presented by sample site and by habitat type. Species will be compared across sites and habitat types to examine for patterns of similarity or differences. Habitat classification will be by major habitat type, such as river channel, tapped lake and isolated lake. Subdivisions of these major types may be made if relevant patterns are identified.

Historical data from previous sampling in the Colville Delta and other nearby areas, such as Dease Inlet, Teshekpuk Lake and the Prudhoe Bay region, will be used for comparative assessment of the findings.



Alaska Vicinity Map

Colville Delta Vicinity



North Slope, Alaska

Colville River Development Project

Figure #1

ARCO Alaska, Inc. May 1995

AK95 0504

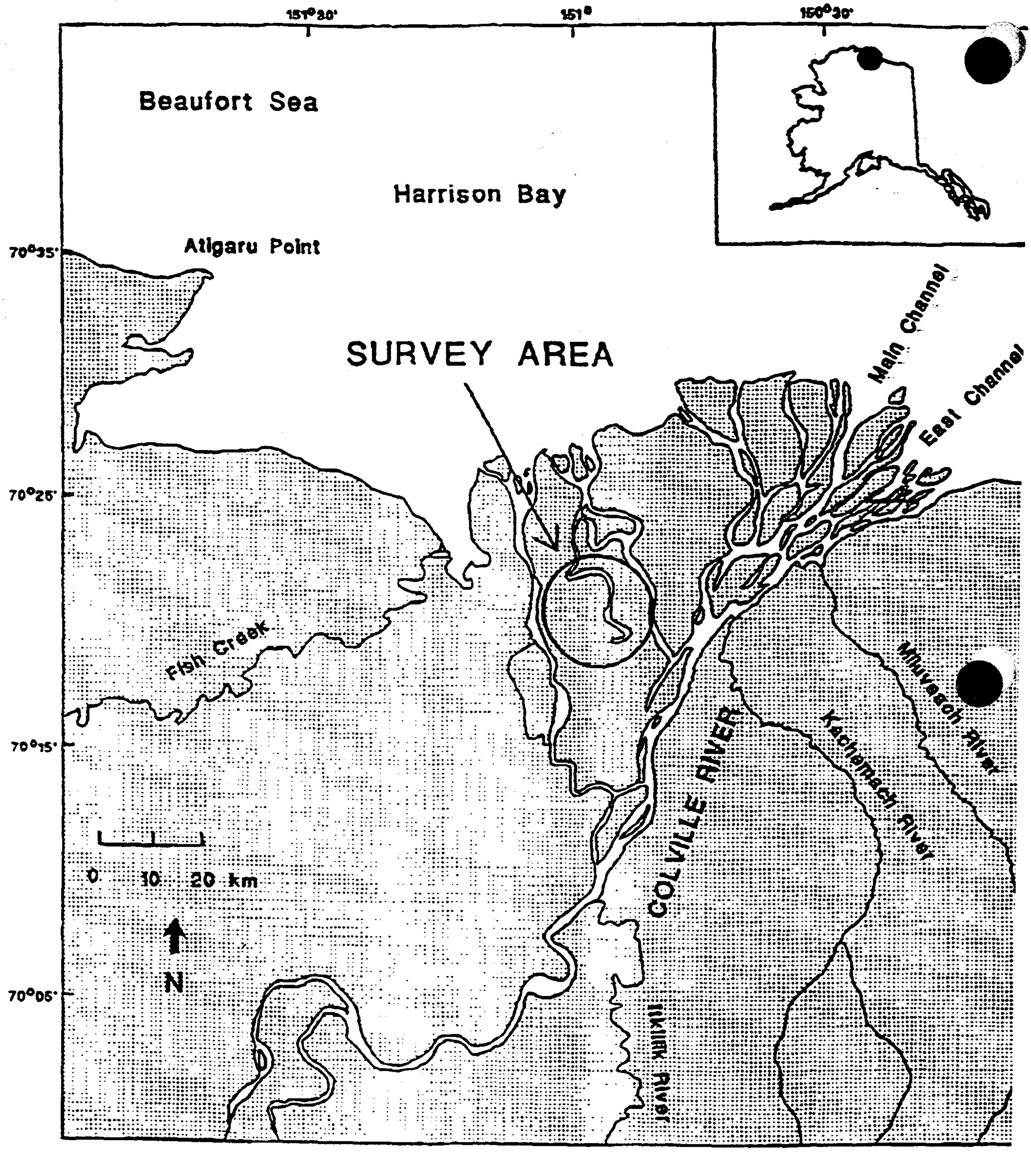


Figure 2. Area to be surveyed during the 1995 Colville Delta Fish Survey

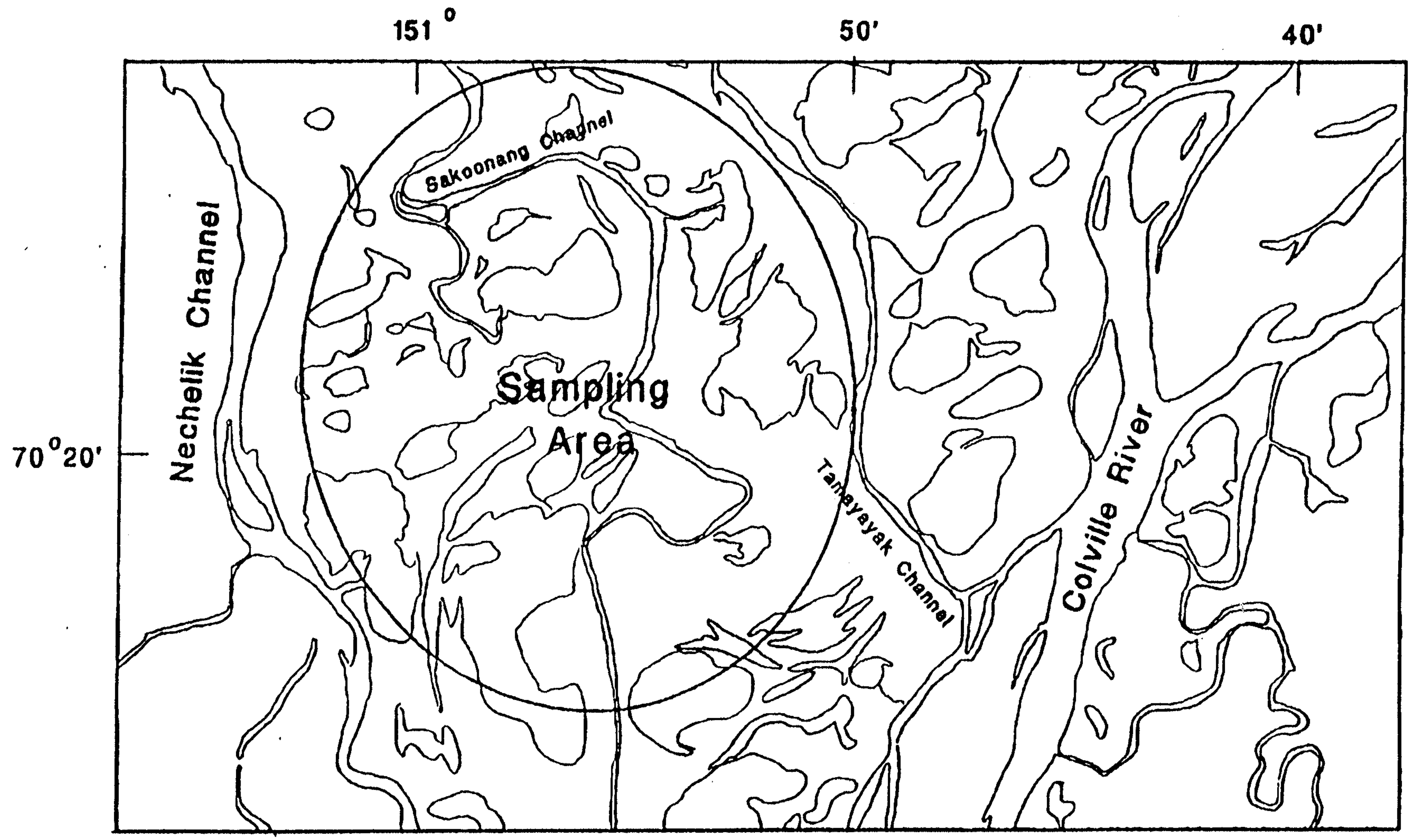


Figure 3. Detail of lakes and channels to be surveyed during the 1995 Colville Delta Fish Survey.

1995 COLVILLE ENVIRONMENTAL STUDIES

Prepared for ARCO Alaska, Inc.

By ABR, Inc.

ABR, Inc. has been conducting environmental studies for ARCO Alaska, Inc. on the Colville River Delta and adjacent areas since 1991. The goal of these studies is to develop a baseline of information on wildlife and other resources in the event that oil production facilities were constructed in the area. Because the likelihood of development as well as the predicted location of production facilities was dependent on the results of ongoing exploratory drilling, the intensity of our survey program and the study area boundaries were modified as new information on the location of the oil became available. In 1995, ARCO Alaska, Inc. and it partners have committed to a plan to construct oil production facilities on the delta and transport the oil through a pipeline to the Kuparuk Oilfield. The environmental studies in 1995 will focus on the development area on the delta and the transportation corridor between the delta and drill site 2M in the Kuparuk Oilfield.

The Colville Environmental Studies consists of three components. The first is a study of selected wildlife species that could potentially be affected by the construction and operation of oil production facilities. The second component consists of an ecological land classification that will incorporate land-form, waterbody, and vegetation classifications into a system that can be adapted to specific applications such as habitat analysis for wildlife species. The third component is a study of the geomorphology and hydrology of the delta that will be used for the placement of stream crossings and facilities, locating gravel deposits, and establishing geodetic control points.

The wildlife program will describe the abundance and distribution of a variety of focal species: Spectacled Eiders, Tundra Swans, Brant, Yellow-billed Loons, caribou, arctic fox (dens), and polar bear (dens). Species that are closely related to the focal species such as King Eiders also will be included in our surveys and analysis. Many wildlife species inhabit the Colville River Delta, but there is a wide range of variation in the timing and geographic extend of that use. We selected species that use large portions of the delta (e.g., Tundra Swans) during seasons that important to the species (e.g., nesting and brood-rearing), and species which can be easily counted by standard survey techniques so that their populations can be monitored annually over broad areas with some precision. We selected species that have special economic and social significance (e.g., caribou and polar bears) and those species with particular management problems such as Spectacled Eiders which are listed as a threatened species under the Endangered Species Act. In addition, we chose some species because the Colville River Delta is an important breeding area within the Arctic Coastal Plain (Tundra Swans, Yellow-billed Loons, and Brant).

The ecological land classification will incorporate vegetation, hydrology, surficial geology, and surface forms into an integrated ecosystem classification scheme. The database will be stored on a geographical information system (GIS) that will allow the classification to be tailored for specific needs. For example, wildlife habitat can be described using an integration of the vegetation, waterbody, and surface-form layers. The classification also can be adapted to mapping soil stability for use by engineers in selecting facility locations.

The hydrology and geomorphology program includes monitoring peak stage and discharge, photographing flood distribution, evaluating surface stability, surveying for gravel deposits, and establishing geodetic control points. The hydrology studies will be used to estimate flood frequency and flood distribution. The geomorphology studies will provide information on soil stability and gravel resources that will be critical to locating the production and transportation facilities.

The Colville Environmental Studies will produce documents and GIS databases describing the soil, water, and wildlife resources in the development area, transportation corridor, and, in less detail, over the entire delta. These documents and databases will evaluate the distribution and timing of important physical events and the distribution of physical and biological resources so that planners and managers can effectively mitigate for the location and effects of oil production and transportation facilities.

1995 COLVILLE ENVIRONMENTAL STUDIES
WILDLIFE PROGRAM

SUBJECT: Eiders — Spectacled Eiders (primary species); King, Common, and Steller's eiders (secondary species)

PERIOD: Pre-nesting (early June), nesting (late June), brood-rearing (mid- to late July)

AREA: *Pre-nesting* — Colville River Delta and transportation corridor (Figure 1-1)
Nesting — development area
Brood-rearing — Colville River Delta and transportation corridor

METHODS: Aerial surveys during pre-nesting will be flown over the entire delta and the transportation corridor (Figure 1-1) in a fixed-wing aircraft (Cessna 185). The aircraft will follow east-west transect lines spaced at 0.4 km intervals. One observer on each side of the aircraft will count all eiders within non-overlapping 200-m strips, thereby achieving a census of the entire area. All eiders will be counted by species, sex, and location (on the ground or in the air). The locations of eiders sighted on the ground will be recorded on a global positioning system (GPS), whereas the locations of eiders sighted in the air will be recorded on 1:63,360-scale maps.

During the nesting season, searches on foot will be conducted around the shorelines of selected waterbodies in the development and transportation corridor areas (Figure 1-1). Within the development area, all waterbodies within 1 km of the proposed locations for the processing facility and airstrip (facility area) will be searched intensively. At the location of the drill site pad and the connecting road, all waterbodies within 200 m will be searched intensively. Within the remainder of the development area and the transportation corridor, all waterbodies that were known to be used by nesting eiders or broods in the past, and waterbodies that were used by eiders during the current year's pre-nesting survey will be searched for nesting eiders. Nesting eiders will be identified to species, their nests will be located on aerial photos, and nest status and habitat information will be recorded.

During the brood-rearing season, aerial surveys of the entire delta and the transportation corridor will be flown with two observers in a helicopter following east-west transects spaced 0.8 km apart. Each observer will search 200-m strips for 50% coverage of the survey area. In addition to the aerial survey, we will conduct searches on foot around waterbodies within the boundaries of the facility area (Figure 1-1).

1995 COLVILLE ENVIRONMENTAL STUDIES
WILDLIFE PROGRAM

SUBJECT: Tundra Swans

PERIOD: Nesting (mid-June) and brood-rearing (mid-August)

AREA: Colville River Delta and the transportation corridor (Figure 1-1)

METHODS: Aerial surveys, following standard U.S. Fish and Wildlife Service protocol (USFWS. 1987. Trumpeter and Tundra swan survey protocol update. Unpubl. memorandum prepared by Office of Migratory Bird Management, Juneau, AK), will be conducted with two observers in a Cessna 185. The aircraft will follow east-west transect lines spaced 1.6 km apart and each observer will search 0.8-km strips on opposite sides of the aircraft so that the entire survey area is searched. Locations of swans and broods will be recorded on 1:63,360-scale maps. All nest locations also will be recorded with a GPS.

1995 COLVILLE ENVIRONMENTAL STUDIES
WILDLIFE PROGRAM

SUBJECT: Yellow-billed Loons (primary species) and Arctic and Red-throated loons (secondary species)

PERIOD: Nesting (late-June) and brood-rearing (mid- to late August)

AREA: *Nesting* — Colville River Delta (Figure 1-1)
Brood-rearing — development area

METHODS: During the nesting season, aerial surveys will be conducted for Yellow-billed Loons by flying along the shorelines of lakes larger than 1 ha. One observer will search for and count all loons and their nests.

During the brood-rearing season, we will conduct foot searches of the lakes in the development area where Yellow-billed Loons nested. The margins of the lakes will be scanned with binoculars or spotting scopes to find young loons that may be hidden in emergent vegetation.

1995 COLVILLE ENVIRONMENTAL STUDIES
WILDLIFE PROGRAM

SUBJECT: Brant (primary species) and Greater White-fronted and Canada geese (secondary species)

PERIOD: Nesting (mid-June), brood-rearing (late July), and fall-staging (mid-August)

AREA: Colville River Delta and transportation corridor (Figure 1-1)

METHODS: Aerial surveys will be conducted for Brant during the nesting season by flying a path from lake-to-lake between known colony sites and lakes with numerous islands. Two observers in a Cessna 185 will search for and count nests, which will be recorded on 1:63,360-scale maps.

During the brood-rearing season, we will conduct an aerial survey of the coastline and the shorelines of bays and deltaic islands on the delta and we will revisit all nesting colonies on the delta in the transportation corridor. At each location, the number of adult and gosling brant and other geese will be recorded.

During fall-staging, an aerial survey will be conducted of the same areas searched during brood-rearing. We will count the number of brant and other geese and record their location.

1995 COLVILLE ENVIRONMENTAL STUDIES
WILDLIFE PROGRAM

SUBJECT: Caribou

PERIOD: Calving season (early to mid-June); insect season (late June to late July)

AREA: *Calving* — Colville River Delta (including development area), "Colville East" (including transportation corridor), and "Colville Inland" areas (Figure 1-2)
Insect season — Colville development area and transportation corridor (Figure 1-1), plus Kuparuk Oilfield

METHODS: Aerial surveys during the calving season will cover the same three survey areas studied in 1993, consisting of the Colville River Delta and two adjacent areas to the east and southeast (Figure 1-2). Two surveys are planned: one near the peak of calving (approximately 3–5 June) and the other near the end of the calving (approximately 12–15 June). A small fixed-wing aircraft (Cessna 185) carrying two biologists will be used for low-altitude strip-transect sampling along fixed transect lines. The aircraft will follow north–south-oriented transects spaced at 1.6-km intervals in the Colville East area (which has contained the highest caribou densities during calving in all previous years studied) and at 3.2-km intervals in the Colville Delta and Colville Inland areas. Each observer will count all caribou seen within a non-overlapping strip 400 m in width on one side of the aircraft, resulting in sampling intensities of approximately 50% and 25% of the survey areas, depending on transect spacing. Caribou will be tallied as adults/yearlings or calves; when possible, additional data on sex and age will be recorded. A GPS receiver will ensure accurate navigation along transects.

The insect season is the period when harassment by parasitic insects (mosquitoes and oestrid flies) is the principal determinant of caribou movements in the region. During this season, aerial and ground surveys will be employed to monitor caribou movements on the Colville Delta and through the transportation corridor. A biologist will be stationed in the Kuparuk Oilfield from the end of June until late July, and will conduct daily surveys by truck in the western portion of the oilfield to monitor the activity of insects and the corresponding movements of caribou in response to insect harassment. Ground observations will provide the basis for optimal timing of aerial surveys to document large-scale movements of caribou through the study areas. Aerial surveys will be conducted periodically to sample the distribution of caribou in the study areas during different conditions of insect harassment. Aerial surveys of the facility development area and transportation corridor will follow transect lines spaced at 1-mile intervals.

1995 COLVILLE ENVIRONMENTAL STUDIES
WILDLIFE PROGRAM

SUBJECT: Arctic fox (primary species); red fox (secondary species)

PERIOD: Denning season (mid-May and mid- to late July)

AREA: Colville development area and transportation corridor (Figure 1-1)

METHODS: On May 18, an aerial survey was flown at low altitude over the area encompassing the proposed facilities and the transportation corridor (Figure 1-1) in a small fixed-wing aircraft (Piper PA-18) carrying one biologist. The survey, which was intended primarily to locate potential natal dens (used for whelping), followed east–west-oriented transect lines spaced at 0.8-km intervals to achieve a complete search of the facility development area, and checked the locations of previously used sites in the transportation corridor. The locations of den sites found during the 1992–93 wildlife studies (and earlier studies in the late 1970s and early 1980s) were checked for activity in the current year (24 fox den sites have been confirmed in the vicinity of the Colville River Delta since 1992), and several new den sites were located. The location coordinates of new den sites were recorded using a global positioning system (GPS) receiver and were marked on 1:63,360-scale topographic maps, for addition to the existing GIS database of den locations in the region.

In mid-July (following vegetation green-up), a second aerial survey of the same study areas will be flown to locate den sites that may have been missed on the May survey (for example, inactive sites that were snow-covered during the first survey). Established den sites are characterized by distinctive vegetation that stands out from the surrounding plant communities at this time of year, making the sites readily visible.

Following the second aerial survey, ground visits will be conducted in late July to inspect both previously used and newly discovered den sites on the delta (including the development area) and in the transportation corridor. These visits will be accomplished using the most efficient combination of foot, boat, floatplane, or helicopter access, depending on specific den locations. The activity status of the dens will be evaluated, and descriptive data and photographs will be recorded. Numbers of pups will be recorded opportunistically throughout the July survey period to gauge the productivity of the breeding population.

31 May 1995

1995 COLVILLE ENVIRONMENTAL STUDIES
WILDLIFE PROGRAM

SUBJECT: Polar bear dens

PERIOD: Recent times (from the historic record)

AREA: Vicinity of the Colville River Delta

METHODS: We will conduct a thorough search of the literature and other documentation of polar bear dens in the general area of the Colville River Delta. We will consult with experts in the U.S. Fish and Wildlife Service and the National Biological Service and will interview local hunters and residents for information on the location of dens

1995 COLVILLE ENVIRONMENTAL STUDIES
ECOLOGICAL LAND CLASSIFICATION

SUBJECT: ECOLOGICAL LAND CLASSIFICATION

PERIOD: 25 July - 10 August 1995

AREA: Development Area and Transportation Corridor

METHODS: The ecological land classification is an integrated approach to classifying, mapping and analyzing ecosystem characteristics. By delineating co-varying surficial geology, surface-forms, hydrology, and vegetation, the resulting maps provide a spatial stratification that is particularly useful for integrated resource management based on GIS. The project will involve a field inventory of ecosystem characteristics and classifying of those characteristics using standard classification systems developed for Alaska.

The field inventory involves two levels of effort. First, detailed sampling will be conducted of the surficial geology, hydrology, topography, soils, and vegetation along a series of topo-sequences representing the range of ecosystem development within the study area. Standard classification systems developed for Alaska will be used to classify surficial geology (Kreig and Reger 1982), hydrology (Cowardin et al. 1979), soils (Soil Survey Staff 1990), surface-form (Washburn 1973), and vegetation (Viereck et al. 1992) at sampling locations. A topo-sequence will be describe for each proposed drill site and river crossing.

The ecosystem mapping will be done on acetate overlays on 1:18,000 CIR photography using a mirror stereoscope and each ecosystem region (polygon) will be coded with its ecological attributes. The boundaries will be digitized and registered to SPOT imagery using a GIS.

A habitat map will be derived from this ecological land classification by recoding polygons into a reduced set of habitat classes. The habitat classification will use the system developed by Jorgenson for the Lisburne and Pt. McIntyre developments. This approach of deriving wildlife habitats from an ecological land classification reduces the number of classes for habitat analyses, but preserves the more detailed classification for use in other projects, such as modeling of flood distribution.

The maps will be produced as an atlas of color hard copy maps (1:50,000 scale) and in digital format. The maps will be accompanied by a report documenting landform-soil-vegetation relationships along topo-sequences in the study area.

1995 COLVILLE ENVIRONMENTAL STUDIES
GEOMORPHOLOGY AND HYDROLOGY

SUBJECT: BREAKUP MONITORING

PERIOD: 15 May - 15 June 1995

AREA: Five river locations will be monitored: the main cross-section at the head of the delta, the East Cannel where the buried pipeline crossing is proposed, the Tamayayak Channel, the Sakoonang Channel, and the Nechelik Channel.

METHODS: Breakup monitoring will provide a sixth record of peak discharge at the head of the delta. Peak stage and discharge will be determined at all the locations with the primary emphasis at the main gauging station at the head of the delta. River monitoring for determination of peak stage will involve several efforts. Initially, river stage in the Nechelik Channel near Nuiqsut will be monitored by personnel from the Kuukpik Corporation. In addition, Otter pilots from Kuparuk will perform daily overflights of the stations to take photographs of the river and assess water levels. When the river is near peak stage, all stations will be monitored daily using a helicopter based out of Kuparuk. During this helicopter monitoring, water-surface elevations will be surveyed relative to temporary bench marks (TBM). The slope of the water surface, needed for estimating discharge, will be determined by measuring water-surface elevations at approximately 2000-3000 ft distances above and below the monitoring stations. Crest gauges will be installed at each station as another method for determining peak stage in case the peak occurs between monitoring flights. The elevations of the TBMs at the monitoring stations later will be surveyed in using survey-grade differential GPS technology.

After breakup, when ice has cleared the river but water is still near peak stage, discharge measurements will be done by boat out of Nuiqsut. At the time that the discharge measurements are made, the water slope also will be measured. Using the discharge and water-surface slope measurements, the hydraulic roughness of the channel will be computed. Based on the computed hydraulic roughness, peak stage, and water-surface slope, the peak discharge will be estimated.

The percentage of the total spring peak discharge occurring at each site will be determined based on the total peak discharge estimated at the head of the delta. Using the 1995 peak discharge at the head of the delta, the flood-frequency relationship will be revised. Additionally, an estimate will be made of the water surface elevation of the 200-year flood at each site and the scour depth associated with bankfull and the 200-year flood at each site.

The data will be used to expand the long-term record and to calculate preliminary estimates of flood frequency. It also will be used to analyze the percentage of total discharge that is carried by the various distributaries. The breakup monitoring will be performed by Shannon and Wilson, Inc. with assistance from ABR, Inc. The differential GPS surveying will be done by Lounsbury and Associates.

1995 COLVILLE ENVIRONMENTAL STUDIES
GEOMORPHOLOGY AND HYDROLOGY

SUBJECT: FLOOD DISTRIBUTION

PERIOD: 15 May - 15 June 1995

AREA: Flood distribution will be monitored within three areas: the main development area which includes the proposed drill sites and pipeline crossing, the Itkillik study area that encompasses the main gauging station at the head of the delta, and the Tamayayak study area in the central portion of the upper delta.

METHODS: The distribution of peak flooding at two potential drill sites and the main river crossing will be documented by acquiring new aerial photography during breakup in 1995. In addition, photography of flood distribution will be acquired for the Tamayayak study area and at the gauging station at the head of the delta to provide comparisons with flooding during previous years. The oblique aerial photography will be obtained from a small aircraft. Due to low cloud ceilings that typically occur at that time of year, acquisition of vertical photography is unlikely.

The distribution of flood water will be delineated on the oblique aerial photography and the boundaries will be manually transferred to the 1992 vertical CIR photography before digitizing. Flood water will be differentiated from standing water on the tundra originating from snowmelt by the murky color of the sediment-laden flood water from the river channels. The boundaries of the flood water will be overlaid on the integrated-terrain-unit maps produced in 1992. The amount of the various terrain units that are covered by flood water will be determined. Oblique aerial photographs that were taken in 1994 and archived also will be analyzed.

This data, along with data from previous years, will be used to develop a model for estimating flood distribution at various flood frequencies. The spatially explicitly model will be based on the integrated-terrain-units used in previous years and estimates of flood frequency determined from stage-discharge relationships developed for the head of the delta. This work will be performed by ABR, Inc. with assistance from Shannon and Wilson, Inc.

1995 COLVILLE ENVIRONMENTAL STUDIES
GEOMORPHOLOGY AND HYDROLOGY

SUBJECT: SURFACE STABILITY

PERIOD: 25 July - 15 August 1995

AREA: The main development area surrounding the proposed drill sites and pipeline crossing.

METHODS: The surface stability of the terrain within the main development area, that includes the two drill sites and river crossings will be assessed by two approaches: an airphotos analysis of landscape change and a field survey of soil stratigraphy to analyze rates and patterns of deposition. The landscape-change analysis will compare aerial photography from 1995 and 1992 to calculate rates of change over a 37-year period. Boundaries of integrated terrain units will be delineated on both sets of photography and the boundaries will be digitized. The boundaries then will be overlaid to identify areas of erosion and deposition.

The field survey will collect information on soil stratigraphy along topo-sequences running from riverbed areas up to the potential drill sites. Radio-carbon dating will be used to establish rates of deposition and age of terrain units. All locations will be plotted on aerial photography and confirmed through differential GPS positioning Elevations of all descriptions will be determined relative to newly established bench marks. The work will be done by ABR and field work will be done in late July - early August. Consultation from H. J. Walker, LSU, during field work will be included if possible.

1995 COLVILLE ENVIRONMENTAL STUDIES
GEOMORPHOLOGY AND HYDROLOGY

SUBJECT: GRAVEL RESOURCES

PERIOD: 25 July - 15 August 1995

AREA: The area surrounding the proposed drill sites.

METHODS: A reconnaissance-level survey of gravel deposits will be performed near the drill sites. A limited number (5-10) of borings will be made near the drill sites to determine the depth to gravel deposits, if present, using a 2" auger equipped with a portable power head. The anticipated limits of this technology is 10-15 ft (max. 20 ft depending on conditions). Stratigraphy of boreholes will be noted. Samples for particle-size distribution will be obtained from the top of the gravel deposits. The elevations of each sample location will be surveyed in relative to the newly established bench marks. The work will be performed by Imanda Placer, Inc. with assistance from ABR.

SUBJECT: GEODETIC CONTROL NETWORK

PERIOD: 5-15 June 1995

AREA: River monitoring stations and drill sites

METHODS: Horizontal and vertical control is needed for the gauging station and other river cross-sections for the hydrology studies. In addition, the control can be used for future facility development. Horizontal and vertical control points will be surveyed and monumented at 6-8 locations using differential GPS technology based on survey-grade receivers. The work is anticipated to provide centimeter-level accuracy, but the accuracy will depend on satellite configuration at the time. Benchmarks will be established at the two potential drill sites, on both sides of the main river crossing, and at the main gauging station at the head of the delta. The new bench marks will be surveyed in relative to an existing USGS monument in the delta. Other locations may be added as needed. The work will be performed by Lounsbury and Associates.

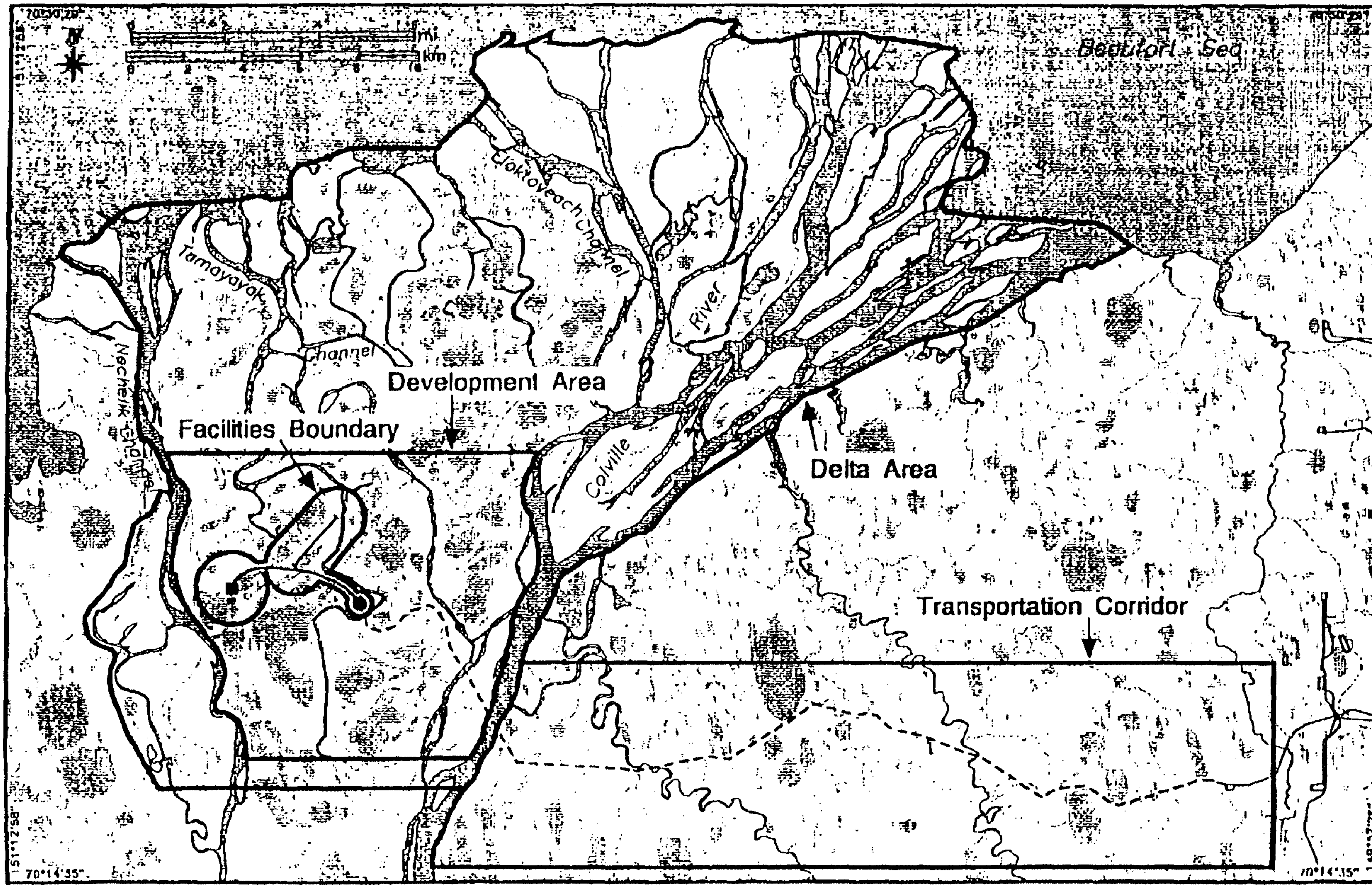


Figure 1-1. Wildlife survey areas for the 1995 Colville Environmental Studies.

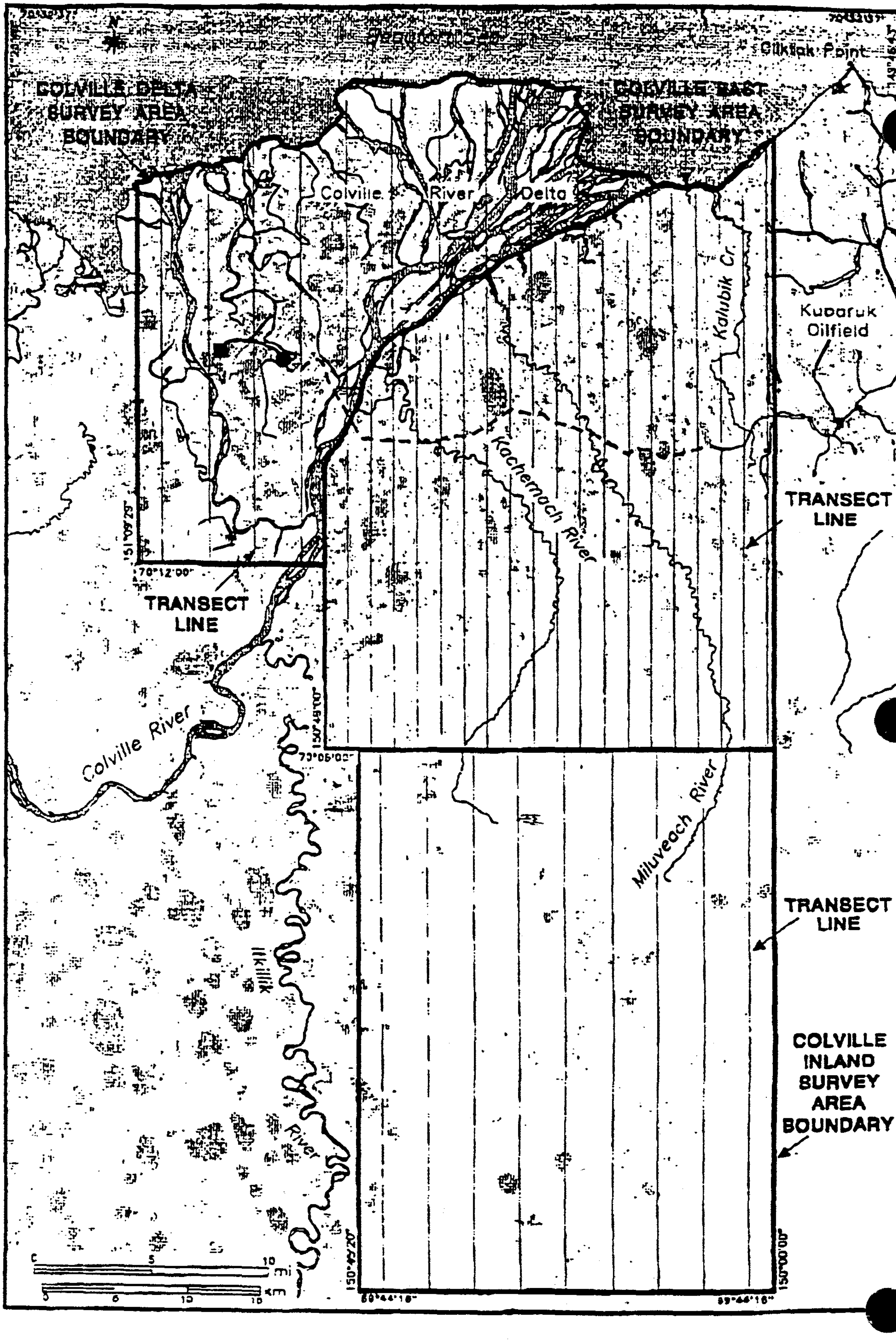


Figure 1-2. Survey areas for caribou calving in the 1995 Colville Environmental Studies.

Appendix D

APPENDIX D

LISBURNE DESIGN MANUAL

ARCO Alaska, Inc. **Internal Correspondence**

Date: June 24, 1985 **File code:**

Subject: Lisburne Development
Drainage and Erosion Control Design and Criteria Manual

From/Location: V. Manikian, ATO 1938

To/Location: M. J. Schindler, ATO 1950

Attached for your use and distribution are nine copies of the completed design and criteria manual for the drainage and erosion control structures of Lisburne Project.

The manual addresses the runoff characteristics of the North Slope, the hydraulics of all applicable drainage structures, and procedures for culvert and drainage designs of the Lisburne Project. The research and development of this section was done by Mr. G. N. McDonald, hydrologist consultant.

Section 4.0 of the manual addresses geotechnical and thermal considerations and the treatment of the subgrades for culvert structures. This section was prepared with the help of Mr. D. Miller, geotechnical consultant.

Section 5.0 of the manual addresses the deflection and stress considerations of culverts when they are imposed to large external loadings. The design procedure addresses the advantages of summer construction as opposed to winter construction. This section was prepared with the help of Mr. H. Thomas of Woodward-Clyde Consultants.

Sections 6.0, 7.0 and 8.0 were developed to address Construction Practices, Maintenance, Construction Specifications, and the detail designs of the Lisburne drainage facilities.

This document was a major task, however, it provides the basis for all the detail designs of the Lisburne Project drainage plan.

Victor Manikian

Victor Manikian, P.E.
Staff Engineer
Civil/Geotechnical

VMRPT:tlh-0001

Attachment

ARCO Alaska, Inc.

Subsidiary of AtlanticRichfieldCompany

PRUDHOE BAY UNIT
LISBURNE DEVELOPMENT

DRAINAGE AND EROSION CONTROL
DESIGN AND CRITERIA MANUAL

MAY, 1985

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1.0 PURPOSE

This manual is intended to provide guidance in the development of plans and designs for the construction and operation of stream crossings, drainage and erosion control structures associated with the Lisburne Development, Prudhoe Bay, Alaska. It provides a manual of standard practice and design aids tailored to North Slope conditions.

The design procedures in this manual produces alternative designs that satisfy environmentally acceptable criteria. The final choice among alternative designs is impacted by economics.

This manual is intended to enable compliance with the following codes and criteria.

1.1 Codes

- o United States Code, Title 16 - Conservation (Fish and Wildlife Coordination Act of 1934, as amended),
- o Code of Federal Regulations, Title 33 - Navigation and Navigable Waters,
- o Executive Order 11988 - Floodplain Management Guidelines,
- o Code of Federal Regulations, Title 18 - Conservation of Power and Water Resources,
- o Code of Federal Regulations, Title 40 - Protection of the Environment, Part 125 Discharge into Water (National Pollutant Discharge Elimination System),

- Code of Federal Regulations, Title 43 - Public Lands: Interior,
- Alaska Statutes, Title 16.05 - Fish and Game Code,
- Alaska Statutes, Title 16.10 - Fisheries and Fishing Regulations,
- Alaska Statutes, Title 46.03 - Environmental Conservation,
- Alaska Statutes, Title 46.15 - Water Use Act,
- Alaska Administrative Code, Title 5, Fish and Game, Chapter 95, and
- Alaska Administrative Code, Title 18 - Environmental Conservation, Chapter 70, Water Quality Standards, Chapter 72, Wastewater Disposal.

1.2 Criteria

1. Provide access to project facilities for vehicles and personnel during floods of up to a 50 year return period unless, by a deliberate decision, based on an analysis of operations, access is necessary only at some lessor return period or with a specified allowable delay.

2. Provide standard designs and specifications which enable effective maintenance of drainage and erosion control features during the project life and which minimize failure and replacement.

3. Site and design permanent drainage and erosion control structures so as to be hydraulicly compatible with and have no adverse impacts on adjacent structures.

4. Site and design temporary drainage structures to provide access during construction and to be removed upon completion of construction.

5. Permit small craft passage on navigable streams.

6. Minimize disturbances to wetlands and critical fish and wildlife habitat and to assure free passage of fish.

7. Minimize erosion and thermal degradation.

8. Minimize creation of icing problems.

9. Prevent unnecessary alterations to surface water hydraulics or configurations.

2.0 RUNOFF

2.1 Regional Characteristics

Knowledge of the geomorphology, soil and climatological relationships of the North Slope is necessary to the development of plans and designs for cost effective and environmentally acceptable drainage and erosion control structures. This section briefly describes these characteristics.

2.1.1 Basin Characteristics. The Arctic Coastal Plain is a region of low relief dominated by shallow drained lake basins, wind oriented lakes, and ice wedge polygons. The surface materials tend to be ice rich sands and silts. The surface has been altered by both wind and water erosion and elevated by ground ice formation.

During rainfall or snowmelt events, the first runoff is as sheet flow. Because of the frozen ground infiltration is practically nonexistent. The first minor stream channels begin by melting of near surface ground ice normally along ice wedge polygon boundaries. These first drainages do not erode soil material to form their channels. Rather, they are formed soley by the subsidence of soils due to the melt of ground ice. As the streams grow larger, they develop the capacity to erode their bed and banks and to transport sand and gravel. Arctic Coastal Plain streams of all sizes do not display the regular stream forms of temperate zone streams. Lateral erosion is controlled by frozen ground and during early breakup by snow drifts. The most important factor controlling erosion is the thermal state of the soils. Consequently, the most important action to prevent erosion is to protect the thermal state of the soils.

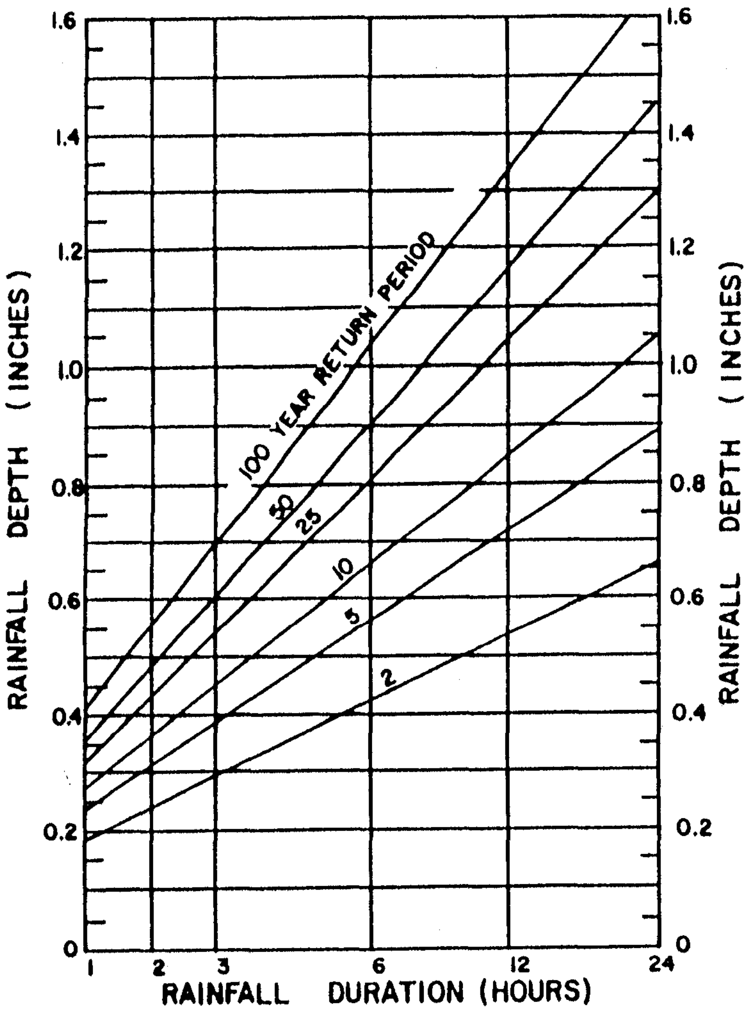
2.1.2 Precipitation. Precipitation rates are low compared with most areas of Alaska. Table 2-1 provides an estimate of average monthly precipitation and Plate 2-1 provides an estimate of probable rainfall rates. Two thirds of the precipitation falls in the form of snow.

TABLE 2-1

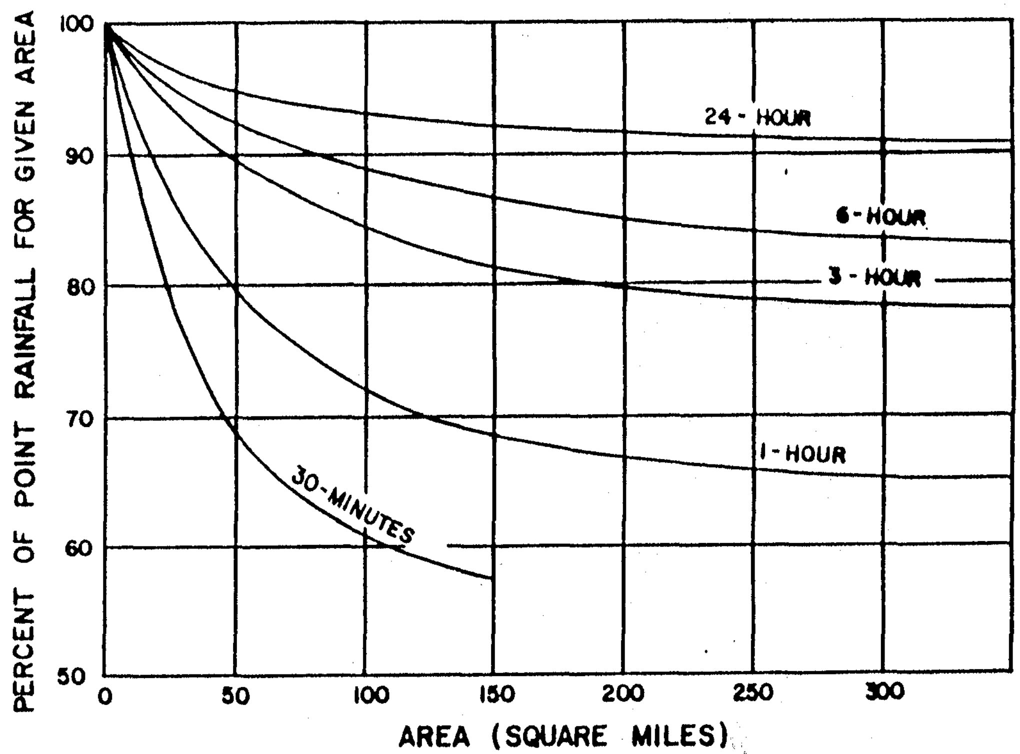
PRUDHOE BAY, ALASKA
ESTIMATED AVERAGE MONTHLY PRECIPITATION
(Inches)

January	0.5	July	2.0
February	0.5	August	2.3
March	0.4	September	1.3
April	0.5	October	1.2
May	0.4	November	0.7
June	0.8	December	0.4

NOTE: Estimates are based on limited data available from the U.S. Soil Conservation Service Wyoming - type snow gage at Prudhoe Bay, correlated with the long term monthly rainfall distribution from Barrow, Alaska.



PROBABILITY OF RAINFALL AT A POINT



ADJUSTMENT OF POINT RAINFALL FOR INCREASED AREA.

REFERENCE: NATIONAL WEATHER SERVICE TECHNICAL PAPER 47

RAINFALL FREQUENCY
PRUDHOE BAY, ALASKA

G.N.M. FEB. 1984 PLATE 2-1

2.1.3 Snowmelt Floods. During the winter period, an average of about five inches of water falls in the form of snow. This snow blows and drifts and a substantial portion is lost to evaporation. For the small coastal streams, on the average, three inches will be left available for runoff. Because of the transport of snow by drifting the actual amount available in a particular small basin can vary widely depending on the ability of the local relief to create snow drifts. During breakup the first snowmelt runs over the frozen surface of small streams and ponds behind snowdrifts. As breakup progresses, these small drifts thaw or are overtopped. The ponded water is released and flows downstream until it is again ponded in a larger stream by a larger snow drift. This storage and release process results in an extremely peaked runoff hydrograph. The hydrograph is much more peaked than could be expected from considerations of snowmelt rates alone. Because of the storage and release of water the flow during breakup is both unsteady and non uniform.

Once the breakup crest has passed a particular point on a stream, the recession is rapid. Typically, the flow on a small stream two weeks after the breakup peak will be less than one percent of the peak flow. The smallest streams will be completely dry. During breakup the stream bed and banks tend to remain frozen and erosion is limited.

2.1.4 Rainfall Floods. Summer floods have not been experienced on the smaller Coastal Plain streams within the limited available experience. However, they may be expected on the large streams. The few small rainstorms which have been known to occur on the coastal plain have not produced floods. This is because of the capacity, of the seasonly thawed tundra to absorb and retard runoff and the lack of flow accumulation by snowdrifts. Summer floods that do occur on the very large streams, such as the Sagavanirktok, are the results of large rainstorms in the Brooks Range. These floods may be larger than the breakup floods. Summer floods are important chiefly because they occur over thawed beds and are thus responsible for an inordinate amount of erosion.

2.1.5 Snow and Ice Blockages. During the long winter season thick sheets of ice form on the larger streams which sustain winter flow. Smaller streams, normally dry, become blocked by snow drifts. These winter ice and snow blockages play three important roles during breakup. The first role is in collecting and releasing runoff from snowmelt by blockages. Thus increasing the magnitude of the spring flood peak. The second role is in decreasing the channel area available to convey water thus increasing the water stage above that which would normally exist. This increased stage causes more area to be flooded and increases the freeboard which must be provided for riparian structures. The increased stage is also responsible for the third role; diversion of flow between adjacent stream channels. Construction of roads or pads crossing stream channels increases the tendency for ice or snow blockage at that point.

2.1.6 Ice Jams. Breakup ice jams as opposed to ice blockages occur as a dynamic affect of the stoppage of moving ice sheets by an obstruction in the channel. The obstruction may be either natural, such as a bend in the stream, or artificial, such as a bridge. Like blockages from winter snow and ice breakup, ice jams alter the shape of the normal flood discharge hydrograph by storing and releasing water. Breakup ice jams are also frequently responsible for diverting flow between channels of braided streams and in extreme cases of diverting flow to adjacent streams. The limiting stage for ice jam floods tend to be the elevation of the overbank. This occurs because of the large flow area overbank and the limited discharge during the early stages of breakup when ice is moving. This overbank stage is independent of discharge.

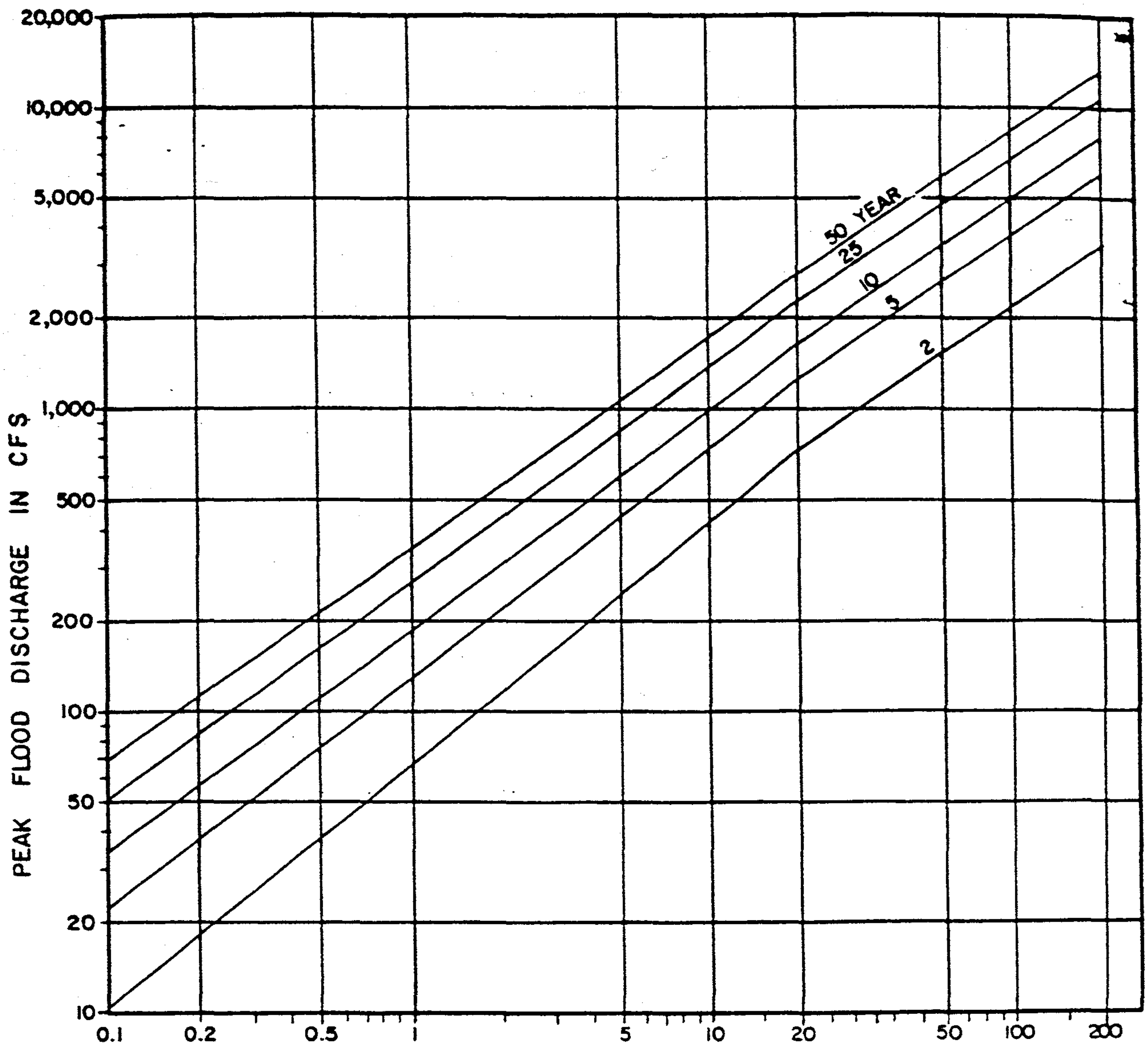
2.2 Design Floods

2.2.1 Peak Discharge. Peak discharge on the small streams draining the coastal plain have historically resulted soley from snowmelt. Larger streams originating in the Brooks Range have both snowmelt and rainfall floods. The purpose of this section is to provide guidance estimating peak discharges for small streams of less than 200 square miles draining the Coastal Plain. The only continuously gaged coastal stream in the Lisburne area is the Putuligayuk. A record of peak breakup discharge has been obtained there for the last 13 years. This record is sufficient to reasonably define the basic statistical properties of the mean and standard deviation of the flow. The record is not sufficiently long to define the skew statistic For that reason and because floods result only from snowmelt zero skew is assigned. Flow statistics are presented in the following Table 2-2. Analysis is by the method recommended by the U.S. Water Resources Council in Bulletin 11B. Plate 2-2 provides a graphical representation of the Putuligayuk flood frequency relationship.

TABLE 2-2
PUTULIGAYUK RIVER AT SPINE ROAD
Drainage Area, 176 Square Miles
Flood Frequency

Average Return Interval (years)	Peak Discharge (cfs)
100	9,400
50	8,300
25	7,200
20	6,800
10	5,800
5	4,700
2	3,200

Less extensive data has been gathered by ARCO on several other small North Slope streams. This data is sufficient to reliablely define the mean flow for those streams but not sufficient to define the remaining statistics. This data has been used to develop the regionalized peak runoff versus drainage area relationship presented on Plate 2-3. This estimate is applicable only to North Slope streams draining less than 200 square miles. This relationship is conservative and should be used only where data on the specific stream in question is not available. Because of the large variation in flows between streams of similar drainage area any estimate should be refined by field measurement of the evident channel capacity. Methods appropriate for this are presented in Section 3.1.



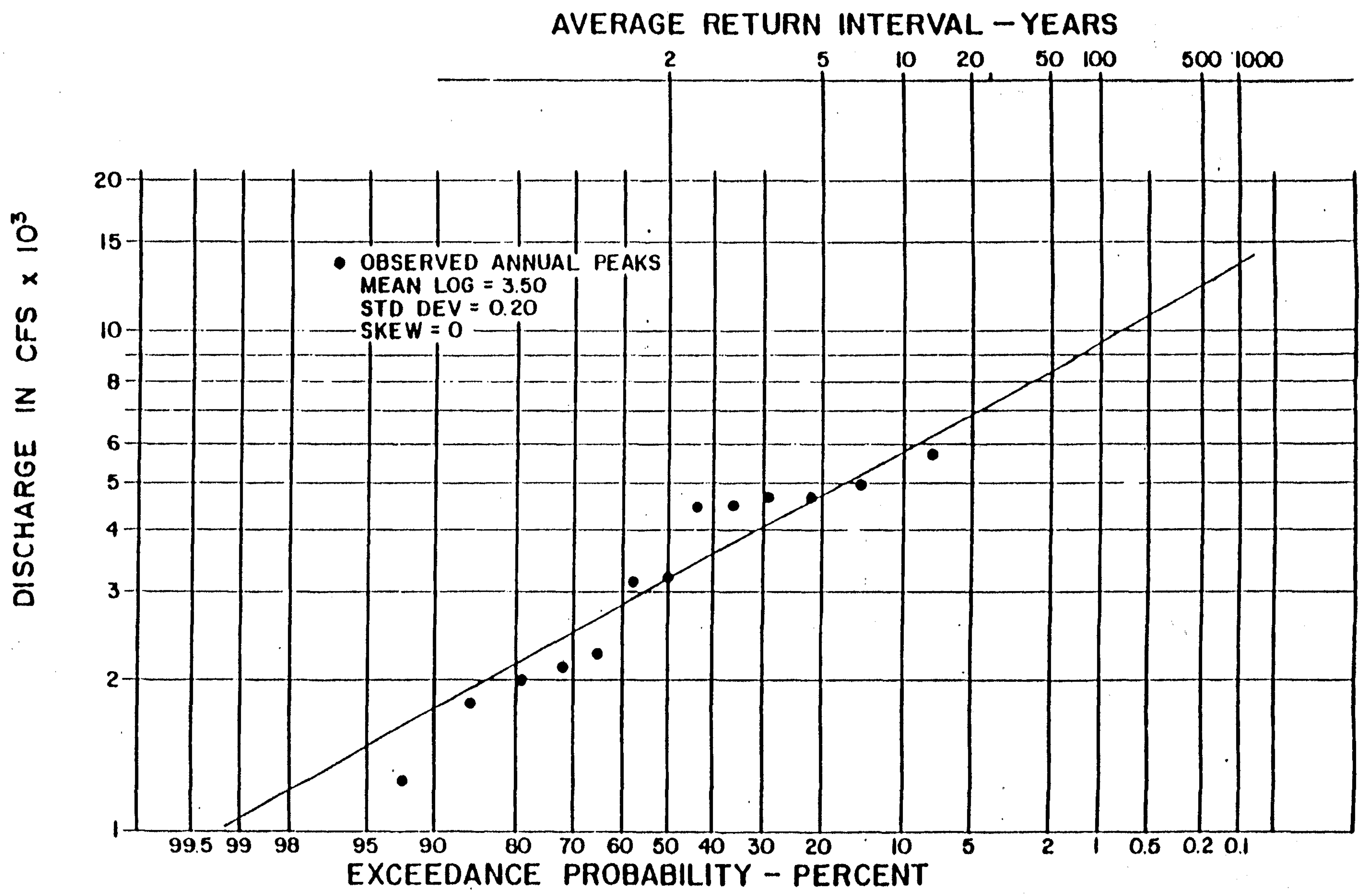
NOTE:

CRITERIA IS DERIVED FROM ARCO OBSERVATIONS ON SEVERAL SMALL NORTH SLOPE COASTAL STREAMS AND AVAILABLE U.S.G.S. DATA. THE RELATIONSHIP IS BELEIVED CONSERVATIVE FOR STREAMS DRAINING NOT MORE THAN 200 SQUARE MILES OF THE ARCTIC COASTAL PLAIN.

PEAK FLOOD DISCHARGE
VRS
DRAINAGE AREA
FOR
SMALL COASTAL STREAMS
AT
PRUDHOE BAY, ALASKA

G.N.M.

PLATE 2-3



FLOOD FREQUENCY
PUTULIGAYUK RIVER
G.N.M. JULY 1983

ATE 2-2

2.2.2 Reduction of Peak by Storage. The peak discharge described in Section 2.2.1 is a maximum instantaneous value. For the small water sheds, less than ten square miles, this value is substantially altered by pondage upstream of the drainage structure. The amount of alteration is a function of the shape of the design flood hydrograph, the hydraulic characteristics of the drainage structure, and the available water storage volume above the structure. Analysis of the amount of reduction is beyond the scope of this manual.

2.2.3 Flood Timing. North Slope floods on small streams have historically occurred soley as the result of snowmelt. Snowmelt is in turn responsive to the rapid seasonal increase in temperatures. As a result the snowmelt floods on a given stream tend to occur at the same time each spring . As an example the average date of crest discharge on the Putuligayuk is June 11 with a standard deviation about the mean of only three days. the Sagavanirktok usually crests on June 3 with a standard deviation of four days. Other streams follow a similar pattern.

2.2.4 Flood Stage. Flood stages for a given breakup discharge vary widely depending on the amount of blockage by snow and ice. Stages should be estimated by the methods of Section 3. Limiting upper stages occur with the channel completely blocked by ice and all flow in the overbank area. Extremely high flood stages may occur when the flood plain is blocked by roads or pipeline pads. In these cases the limiting stages will be the overflow elevation of the road or pad.

2.3 REFERENCES

(1) Drage, B., Hoch, D., Griffiths, L., and Gillman, J., 1983, "1983 Kuparuk Breakup Study - Kuparuk Development Area", ARCO Alaska, Inc.

(2) Jones, S. H., 1983, "Floods From Small Drainage Basins in Alaska: U.S. Geological Survey Open File Report 83-258", U.S. Department of the Interior.

(3) Lamke, R. D., 1978, "Flood Characteristics of Alaskan Streams: U.S. Geological Survey Water Resource Investigation 78-129", U.S. Department of the Interior.

(4) Miller, J. F., 1965, "Two to Ten Day Precipitation For Return Periods of Two to 100 Years in Alaska: U.S. Weather Bureau Technical Paper No. 52", U.S. Department of Commerce.

(5) Miller, J. F., 1963, "Probable Maximum Precipitation and Rainfall - Frequency Data for Alaska: U.S. Weather Bureau Technical Paper No. 47", U.S. Department of Commerce.

(6) ____________________, 1981, "Guidelines for Determining Flood Flow Frequency: Bulletin #17B of the Hydrology Committee", U.S. Water Resource Council.

3.0 HYDRAULICS

3.1 Channelized Flow

A channel is a waterway having a bed and banks confining moving water. Channels may occur naturally or be man made. Water flows in channels in response to the general laws of physics. Gravity provides energy and friction provides resistance to flow. The concepts relating to open channel flow are among the most complex in hydraulics. The intent of this section is to provide design aids for only the simpler cases normally encountered.

3.1.1 Critical flow. In any channel cross section a given discharge may flow at an infinite product of depths and average velocities. The particular depth and velocity at which it will flow is a function of the geometric properties of the section, the stream slope and the channel roughness. Each combination of depth and velocity represents a particular level of energy in the flow. There is one combination of velocity and depth which represents the minimum possible energy level for the given discharge. All other combinations have higher energy levels. The depth at this minimum energy level is called critical depth, the velocity is called critical velocity and the slope which will produce this discharge and velocity is called critical slope. The concept of critical depth provides a useful concept for hydraulic computations. For example, flow over a spillway or weir passes through critical depth. Critical flow depth for wide rectangular channels may be expressed as:

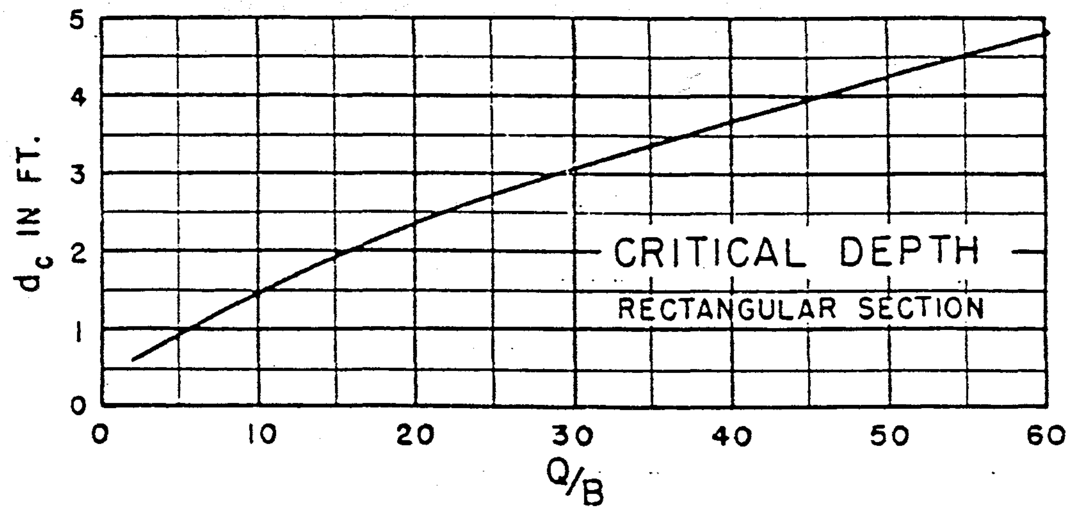
$$d_c = 0.315q^{2/3} \qquad (3\text{-}1)$$

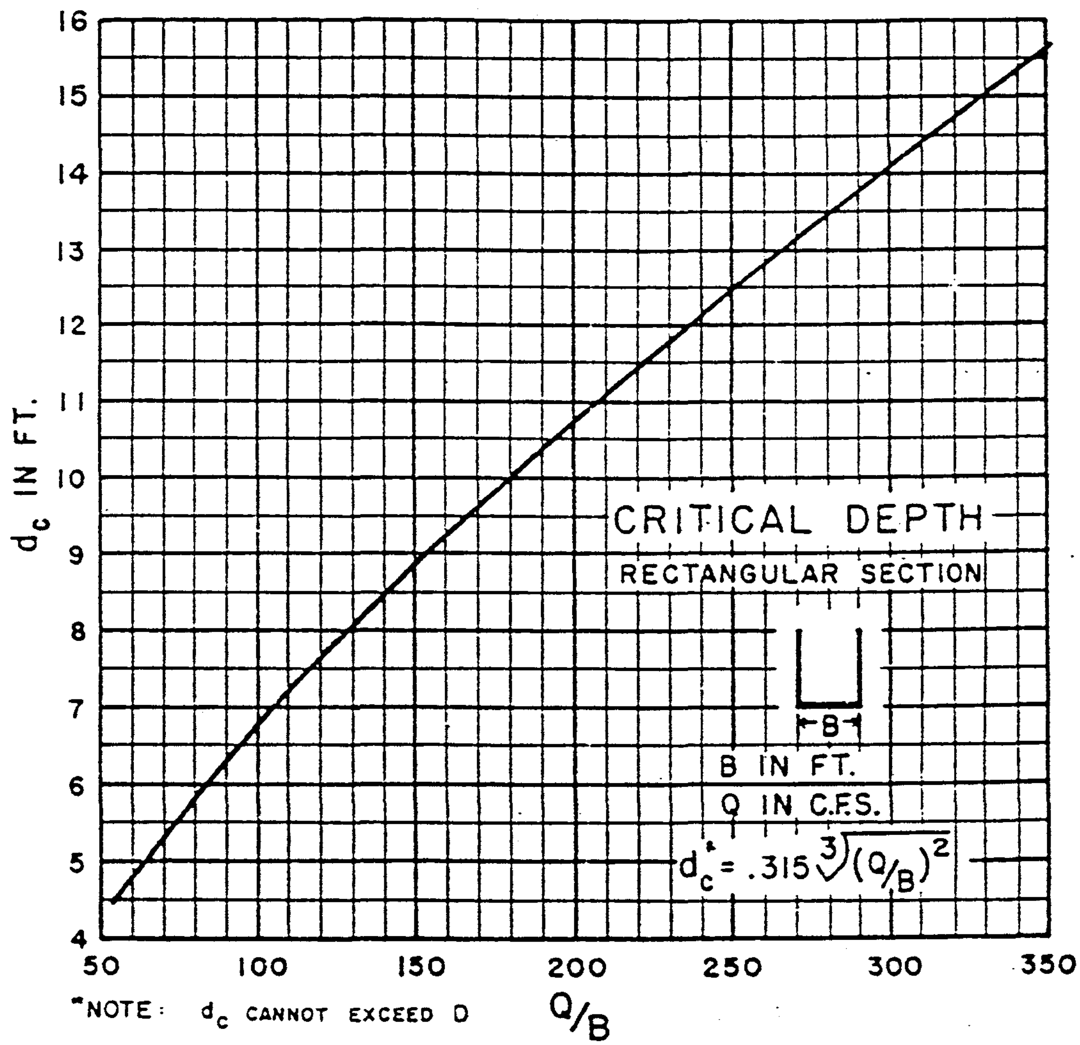
where

d_c = critical depth in feet

q = unit discharge in cfs per foot of width

For convenience, Plate 3-1 provides a graphical solution of the critical depth problem for rectangular channels. Plates 3-3 through 3-17 provide a solution for trapezoidal channels.





*NOTE: d_c CANNOT EXCEED D

CRITICAL DEPTH
FOR RECTANGULAR SECTIONS

PLATE 3-1

3.1.2 Normal Flow. Normal flow occurs in a channel when the gravitational force causing the water to flow is exactly balanced by the frictional resistance to flow. Normal flow is neither accelerating nor decelerating. Normal flow depth may be either greater or less than the critical depth discussed in Section 3.1.1. For any given consistent channel condition and initial water depth, the water depths will tend toward the normal depth. Thus normal depth provides a reasonable approximation of the flow conditions usually existing in a uniform channel. Uniform flow, normal depth, and velocities in open channels may be computed by Manning's formula which states:

$$V = Q/A = (1.486/n)\ R^{2/3}\ S^{1/2} \qquad (3\text{-}2)$$

where

V = average velocity in feet per second
Q = discharge in cubic feet per second
A = cross section area of the wetted channel in square feet
S = slope of the channel, water surface and energy grade line.
R = hydraulic radius = A/P in feet. For wide channels R is approximately the average depth
P = wetted perimeter of the channel in feet
n = Mannings roughness coefficient as given in Table 3-1

TABLE 3-1

MANNINGS ROUGHNESS COEFFICIENT FOR OPEN CHANNELS

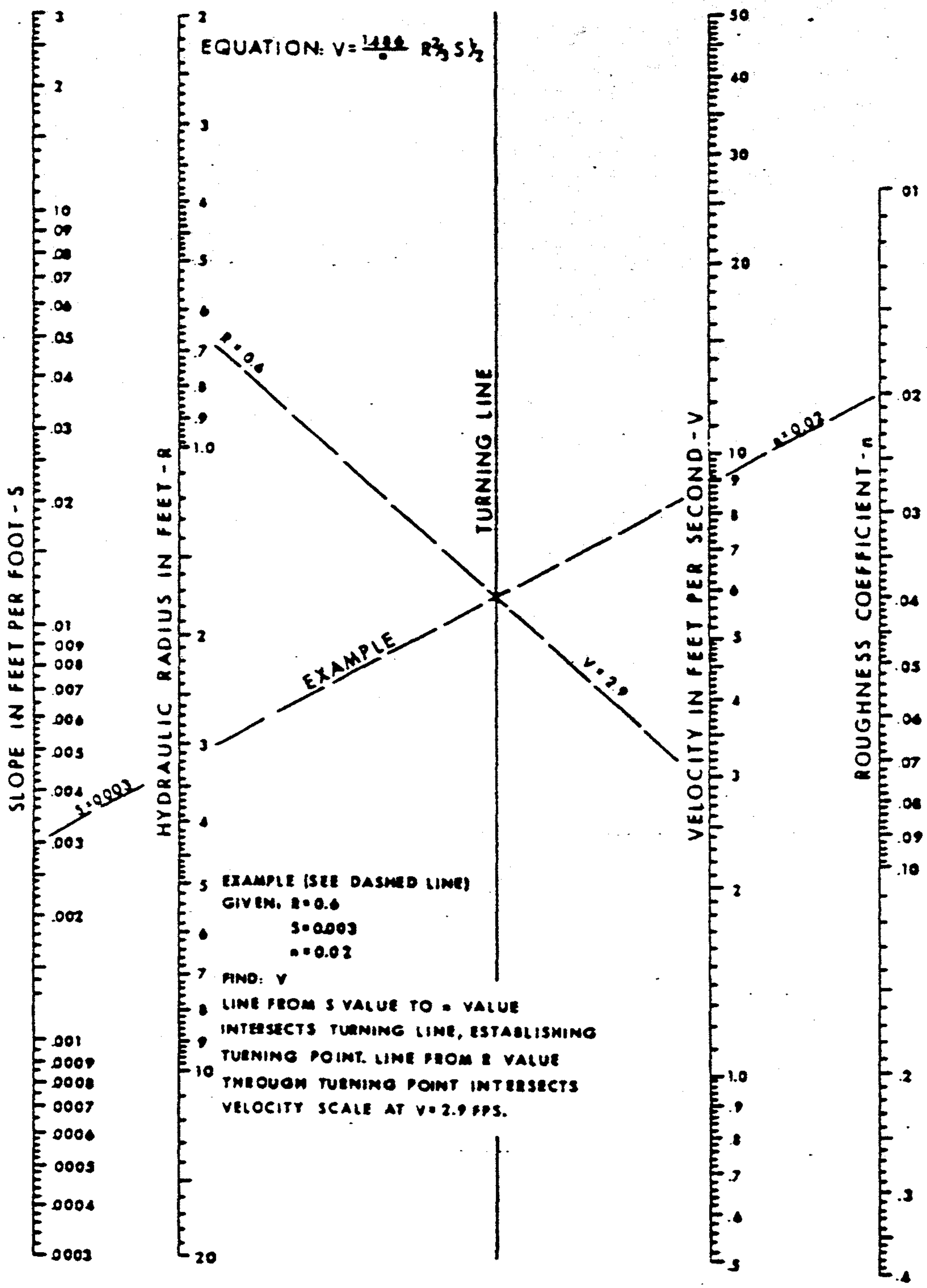
(streams less than 100 feet wide)

Type	n Value
Natural Channels	
Tundra Beaded Drainages	
Low stage	0.050
Flood stage	0.040
Gravel Bed Streams, Steep Banks	
Low stage	0.040
Flood stage	0.030
Overbank	0.020
Artificial Channels	
Frozen silt	0.020
Gravely sand	0.025
Riprap (one foot diameter)	0.035
Sand bags	0.030
Plastic filter cloth	0.015
Articulated concrete mats (Armorflex)	
Open Blocks	
30 lb Blocks	0.031
50 lb Blocks	0.032
70 lb Blocks	0.034
Flow Over Ice	
Smooth aufies	0.010
Blocky Rough Ice	0.030

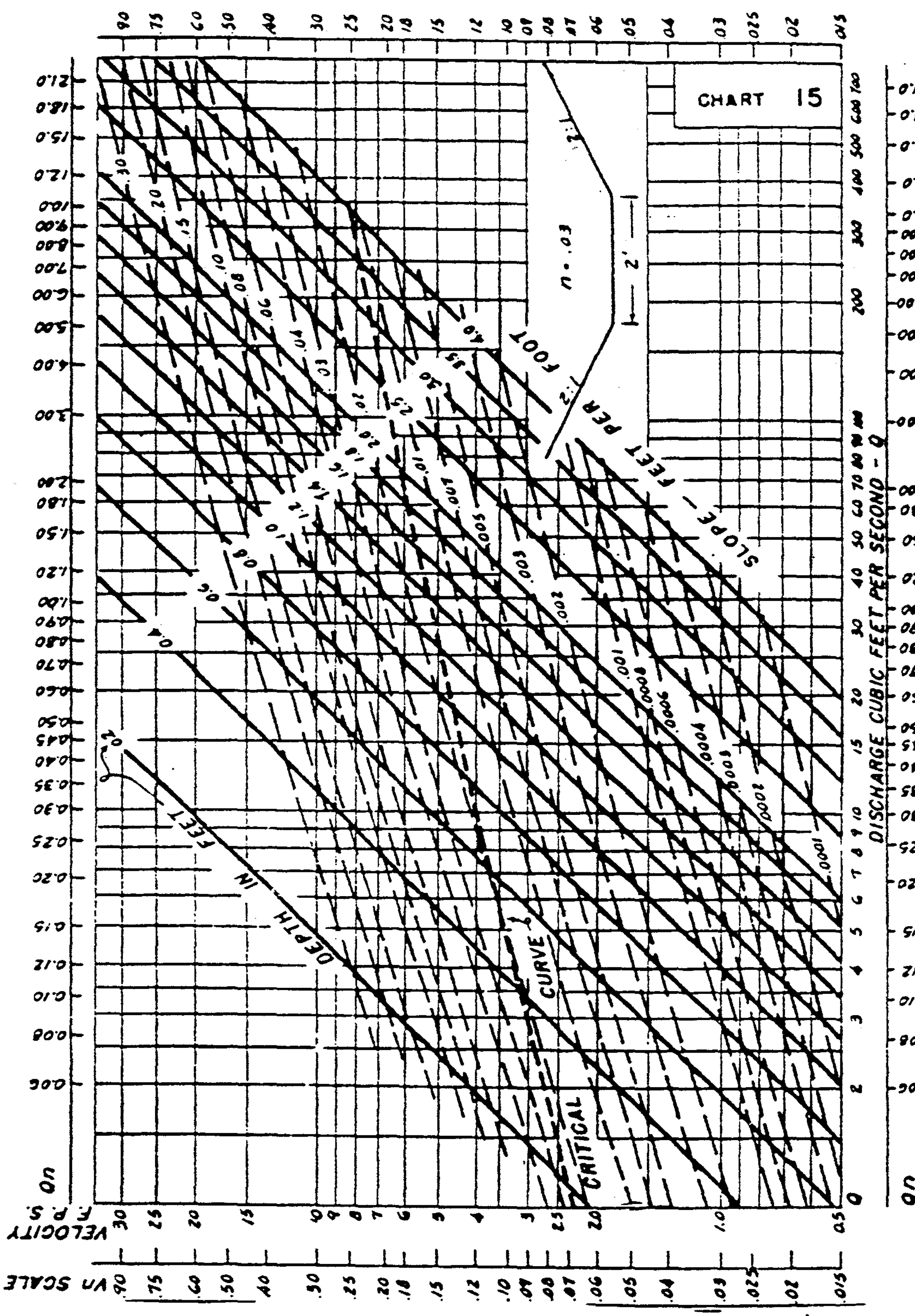
NOTE: In many cased the channel is composed of more than one material. In these cases the discharge for the composite channel may be derived by considering each portion of the composite channel as a separate subchannel, calculating the discharge for each subchannel using its own roughness, hydraulic radius, wetted permitter, and a common water surface elevation, and summing the discharges for each of the subchannels.

The above analytical relationship may be used to derive normal flow characteristics for channels of any shape. These normal flow characteristics are applicable to most flow conditions encountered provided the water surface is not significantly affected by either back water or draw down from downstream conditions or varying rapidly with time. If either of the above conditions are encountered the flow characteristics must be derived by backwater calculations beyond the scope of the manual.

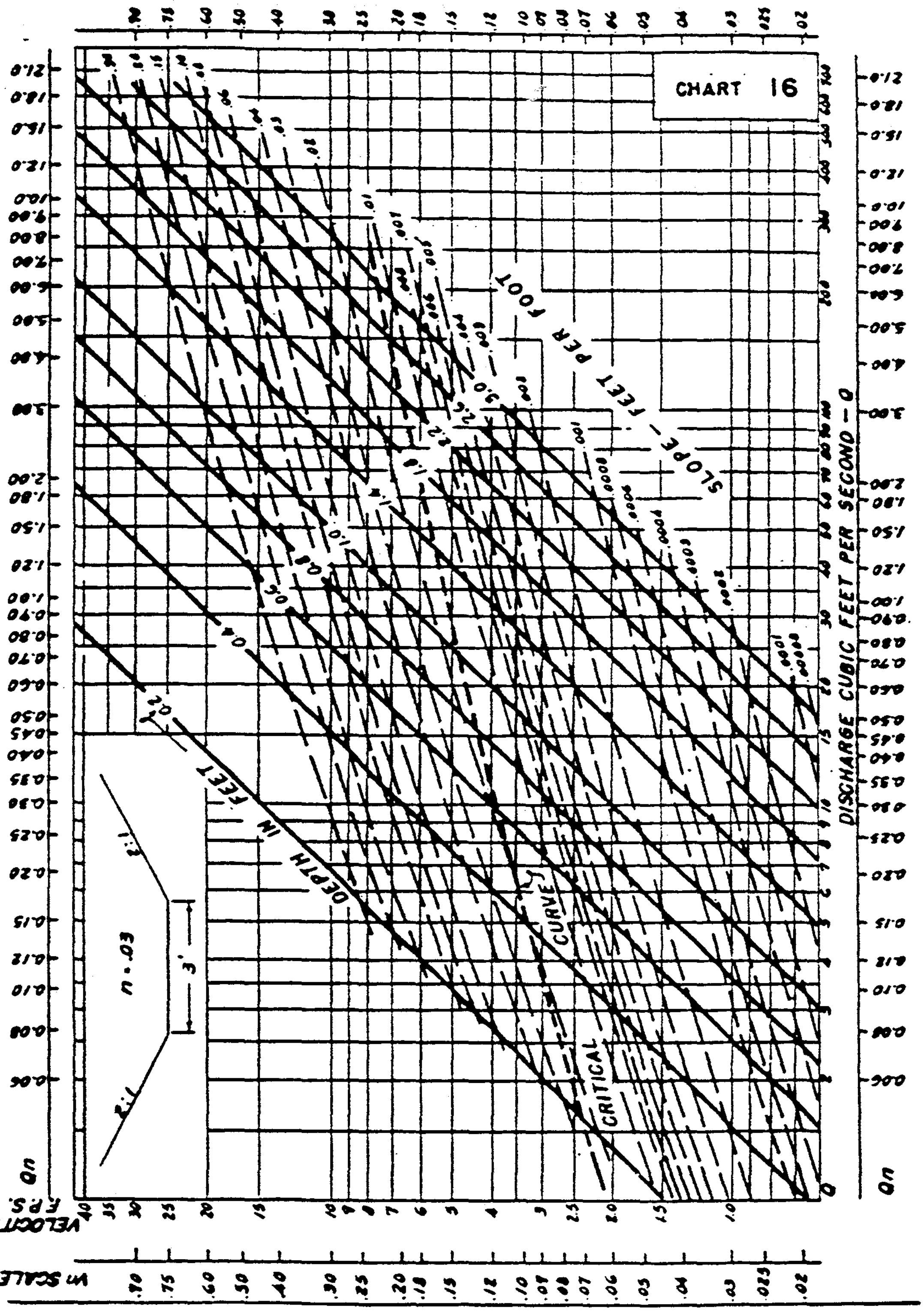
The following Plate 3-2 provides a generalized nomographic solution of Mannings equation. Plates 3-3 through 3-17 provide a graphical solution applicable to trapezoidal channels. These charts were developed by the U.S. Bureau of Public Roads and provide a direct solution of Manning's equation. The charts are based on a n value of 0.03 and a range of bottom widths from 0 to 20 feet. The following examples demonstrate use of the charts first for values of n = 0.03 and then for varying values of n.



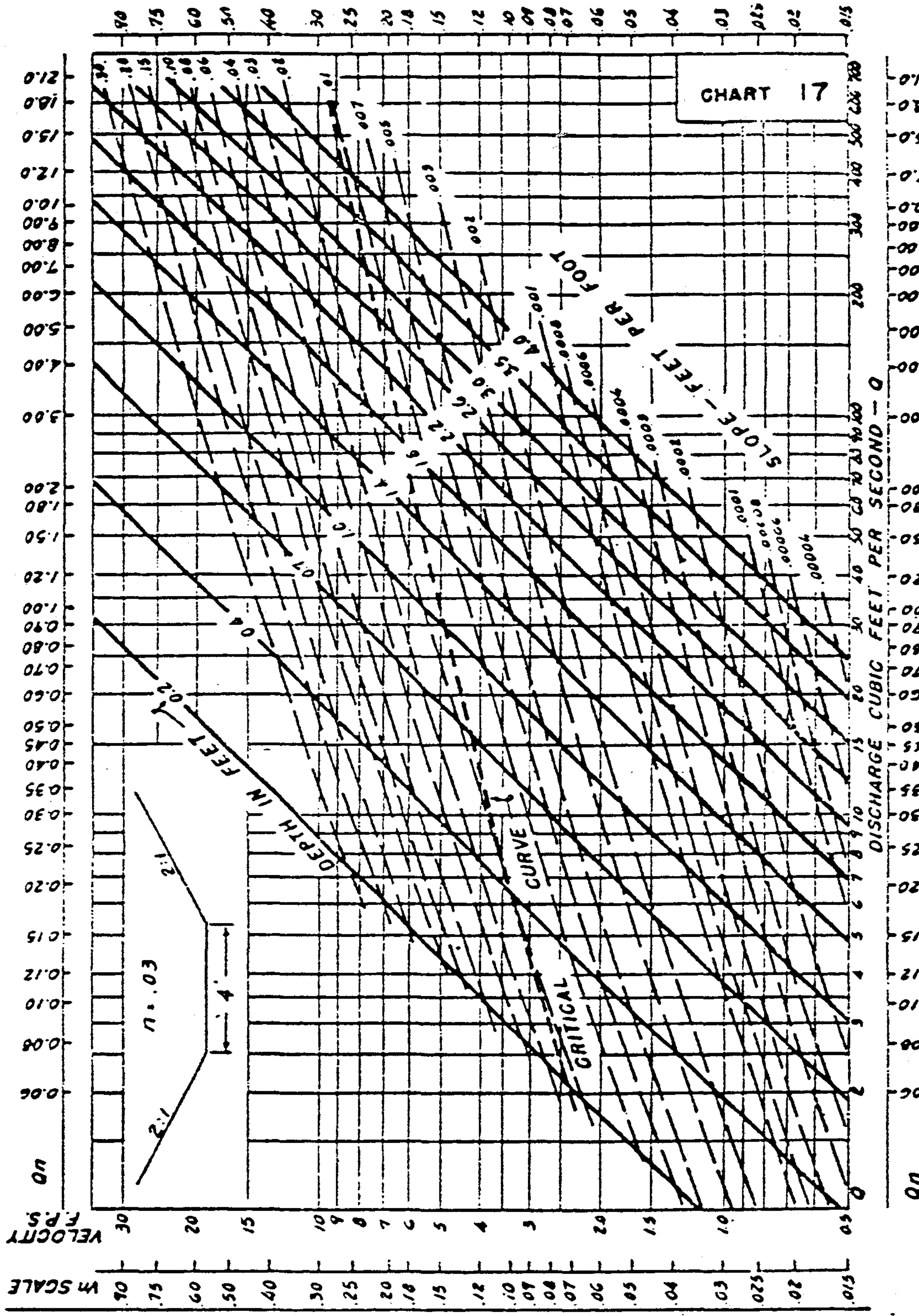
NOMOGRAPH FOR MANNING EQUATION



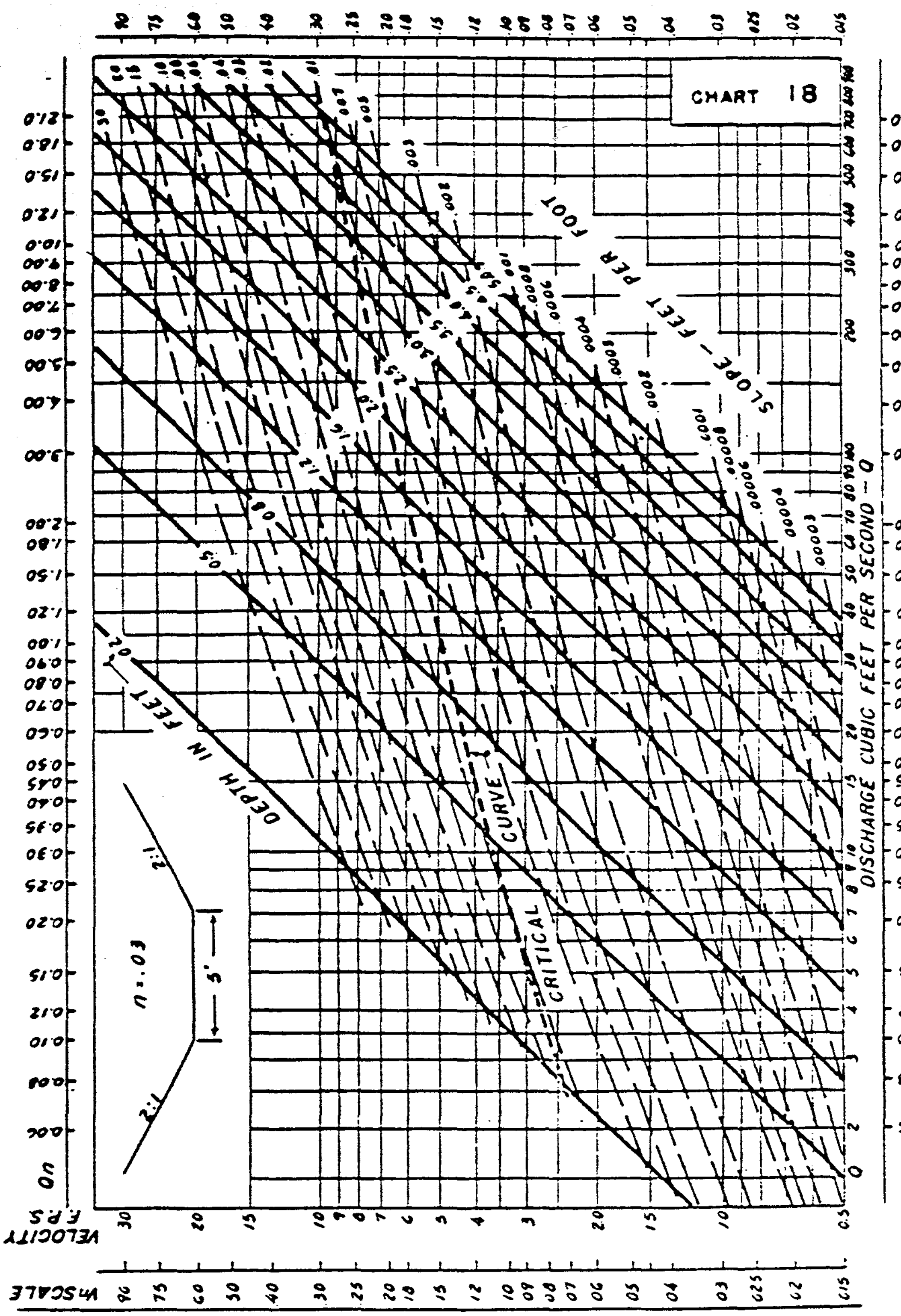
CHANNEL CHART
2:1 b = 2 FT.



CHANNEL CHART
2:1   b = 3 FT.



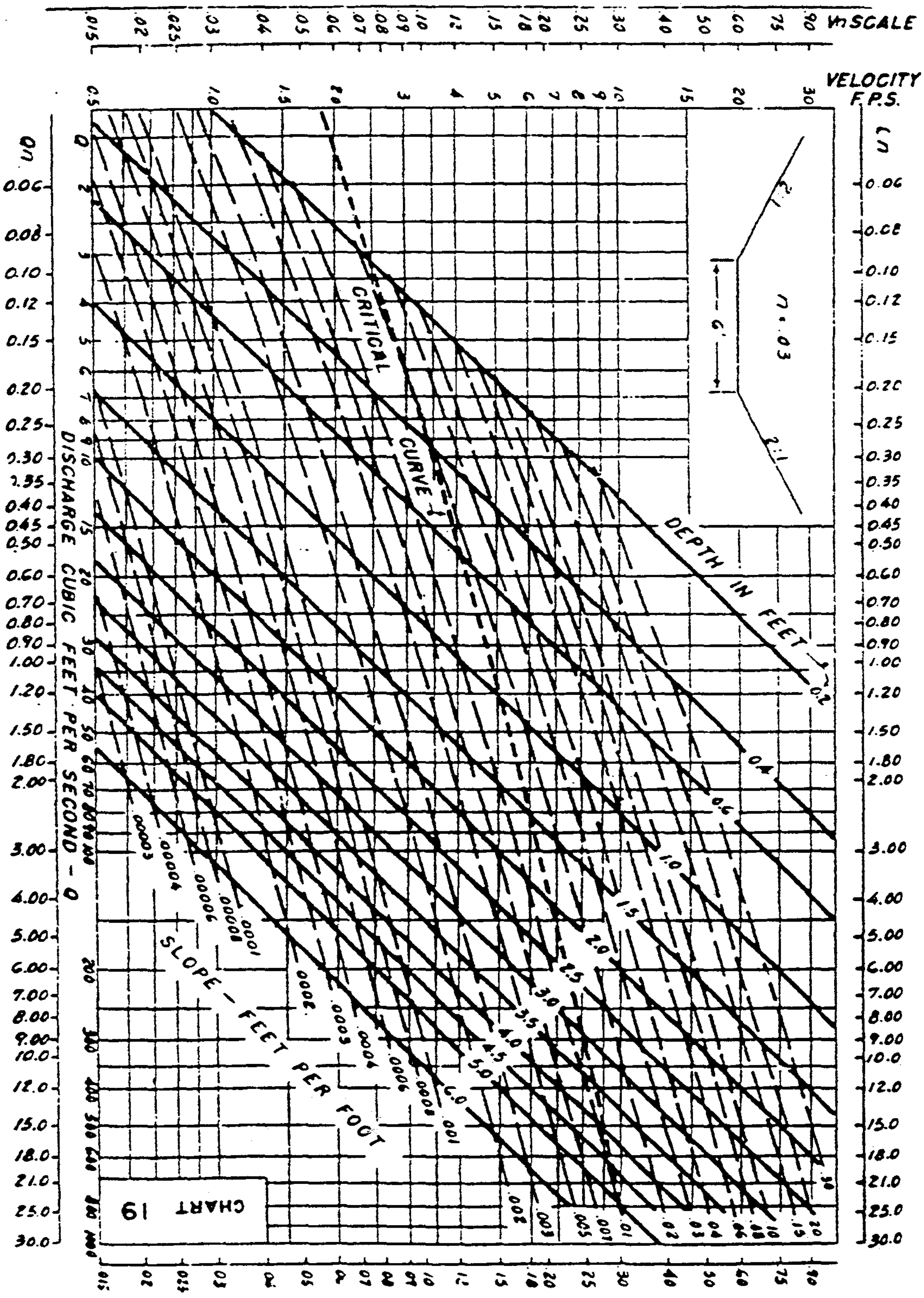
CHANNEL CHART
2:1 b = 4 FT.

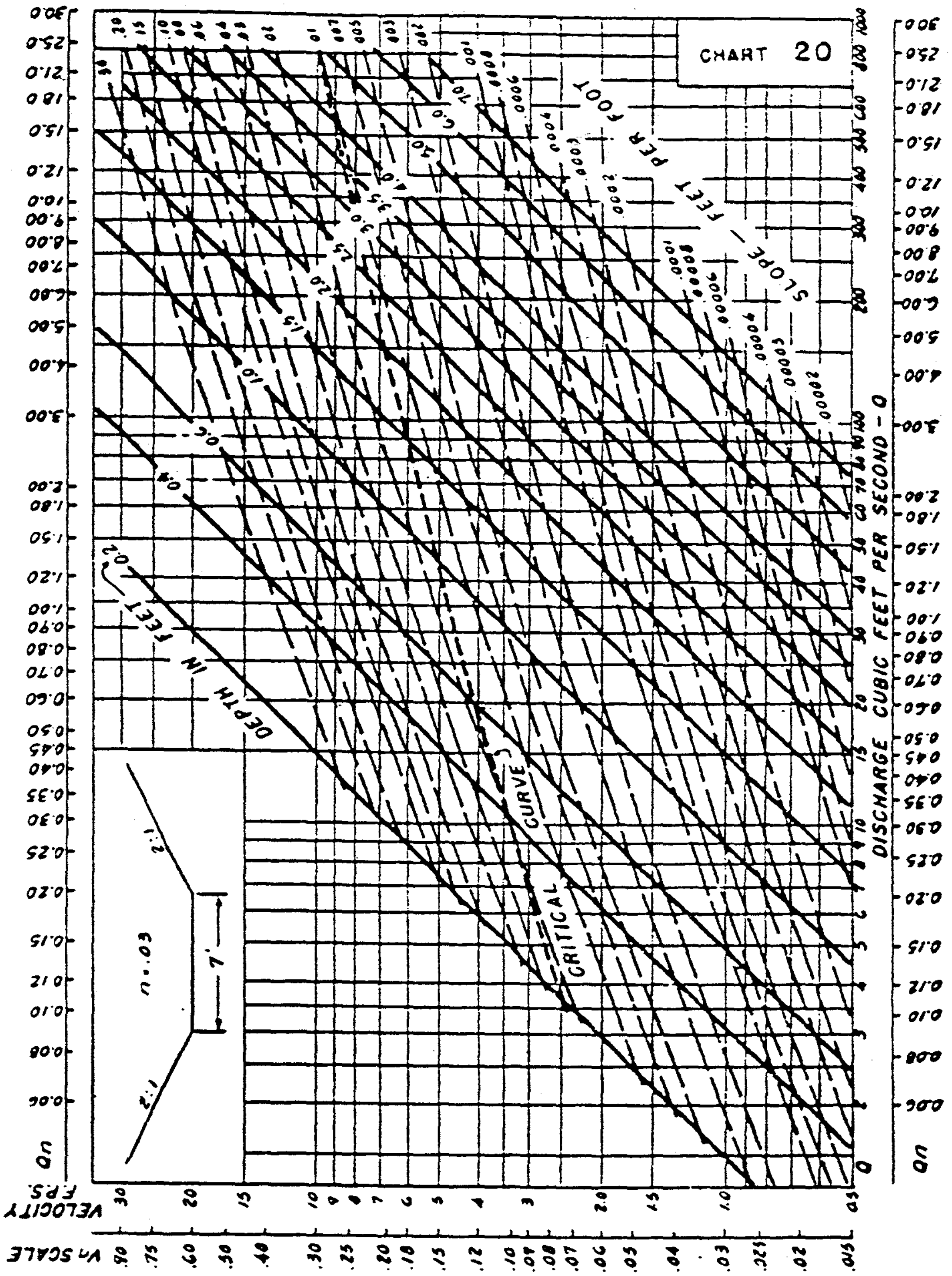


CHANNEL CHART
2:1 b = 5

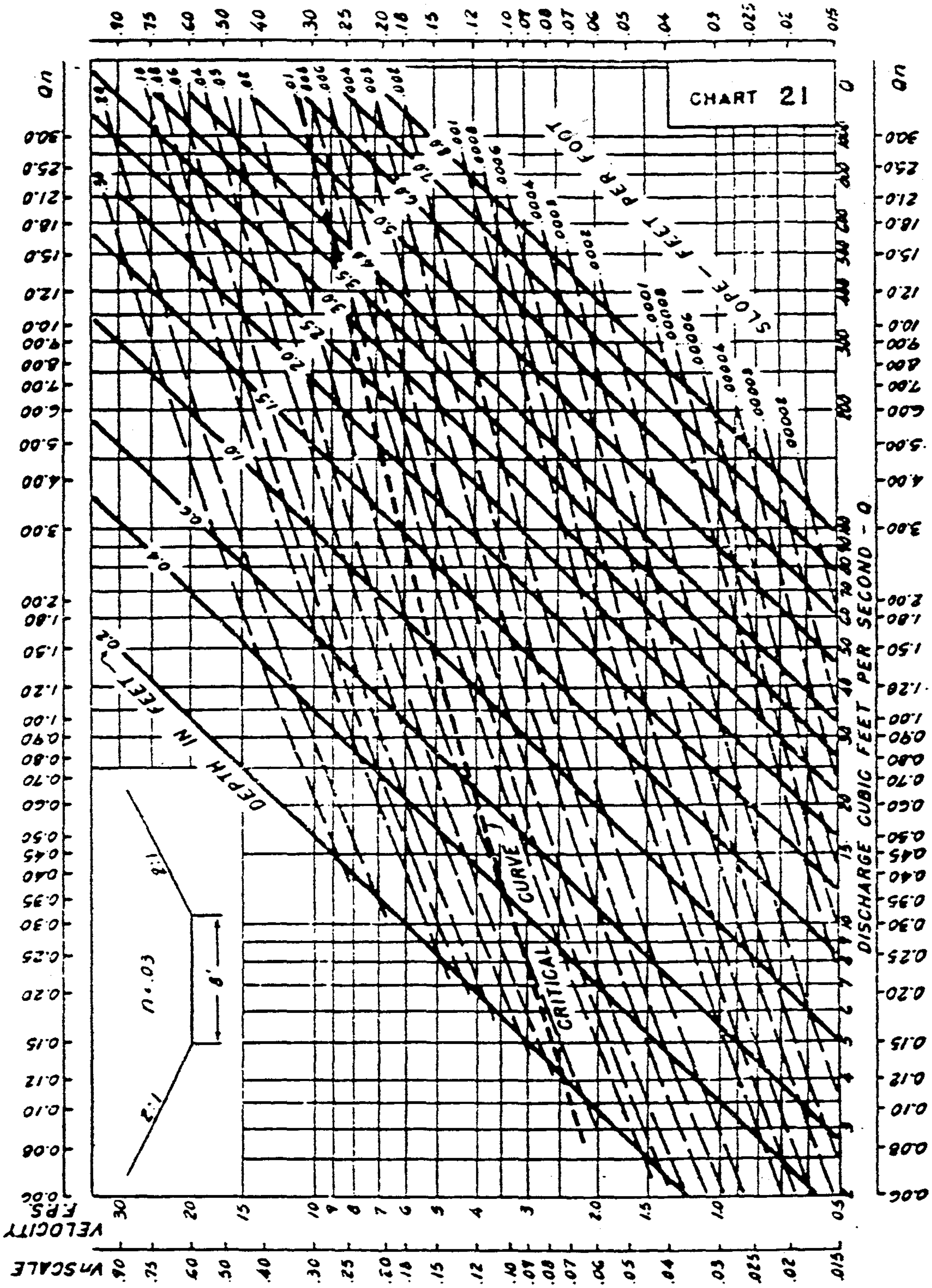
CHANNEL CHART

2:1 b = 6 FT.

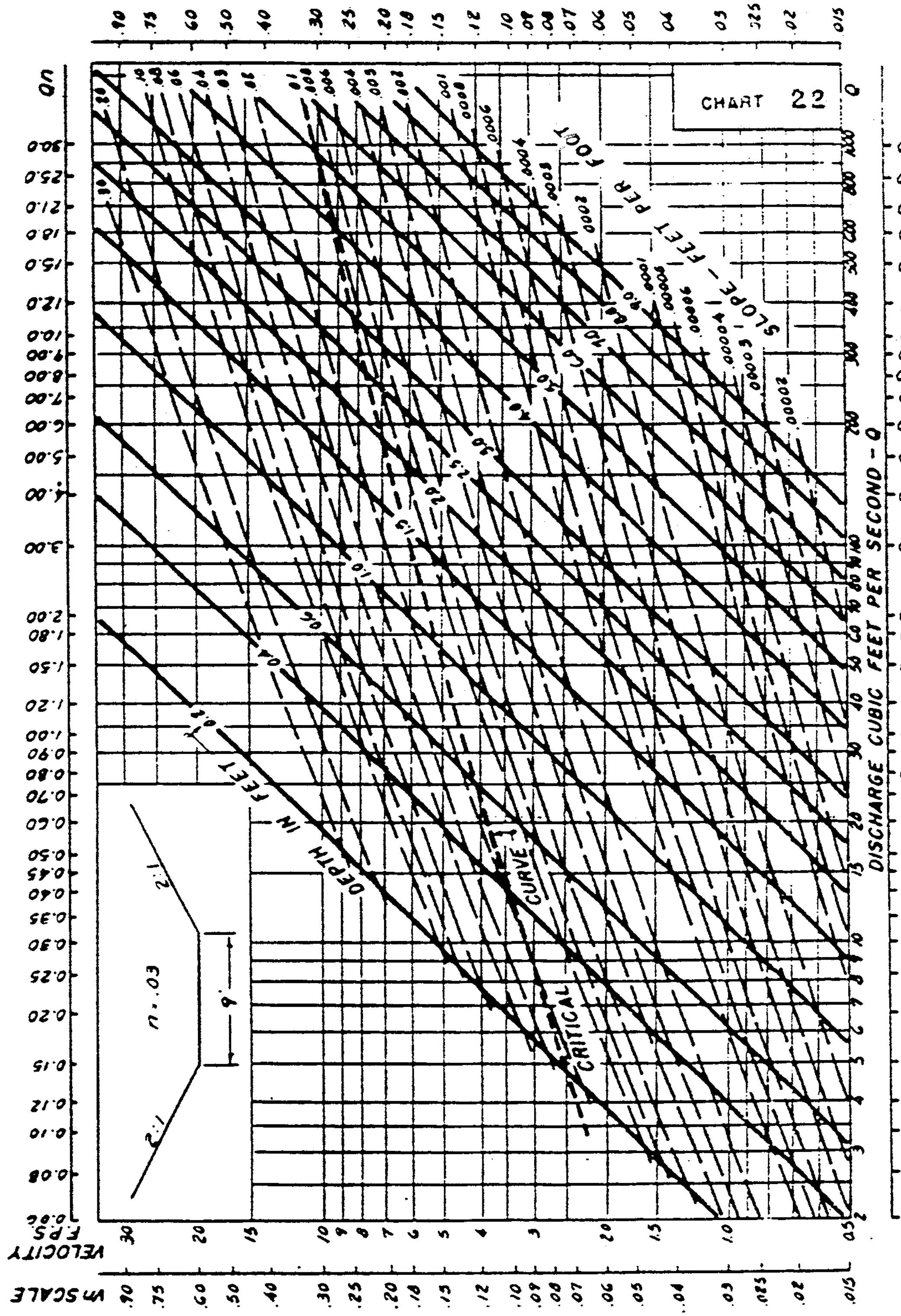




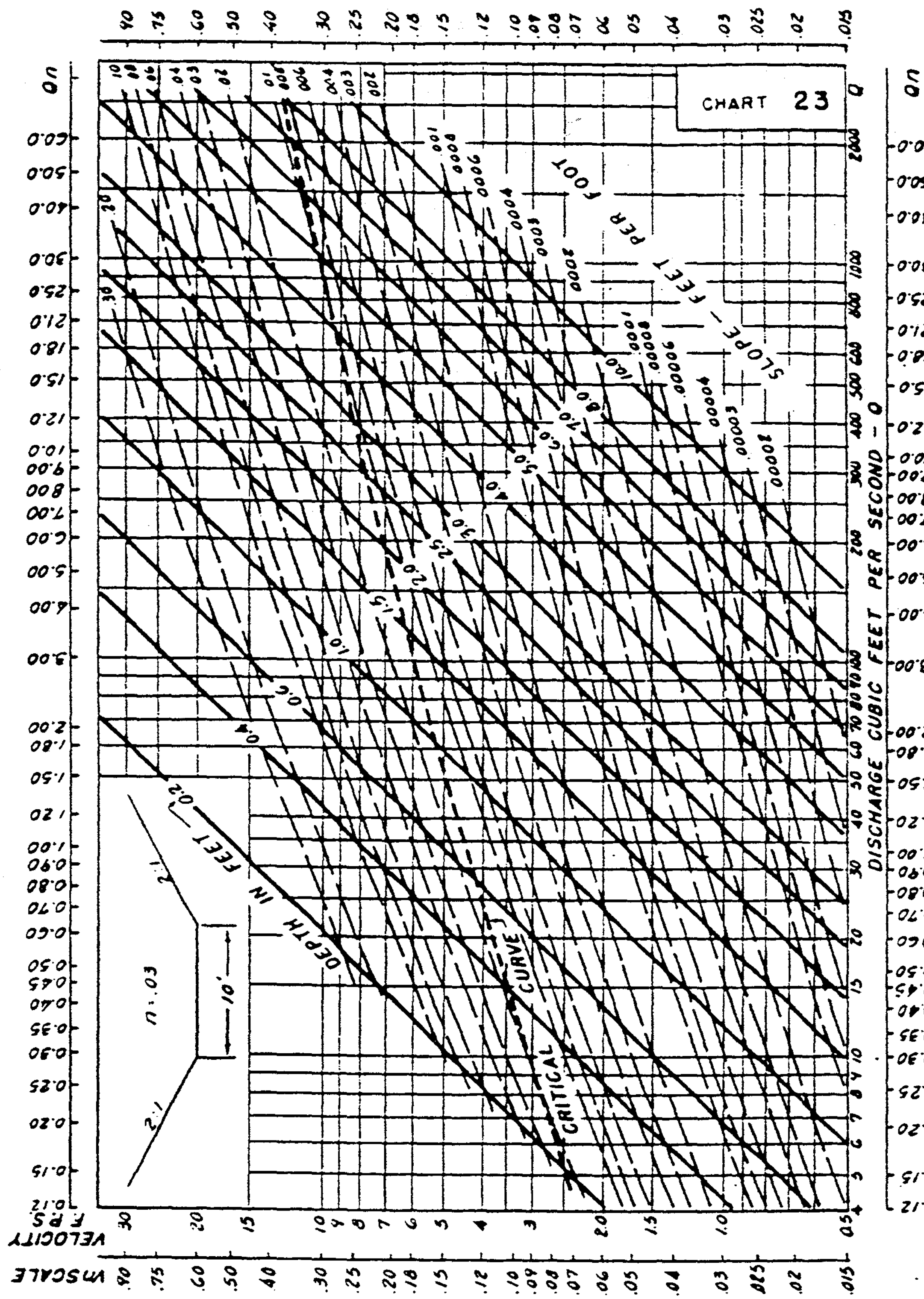
CHANNEL CHART
2:1 b = 7 FT.



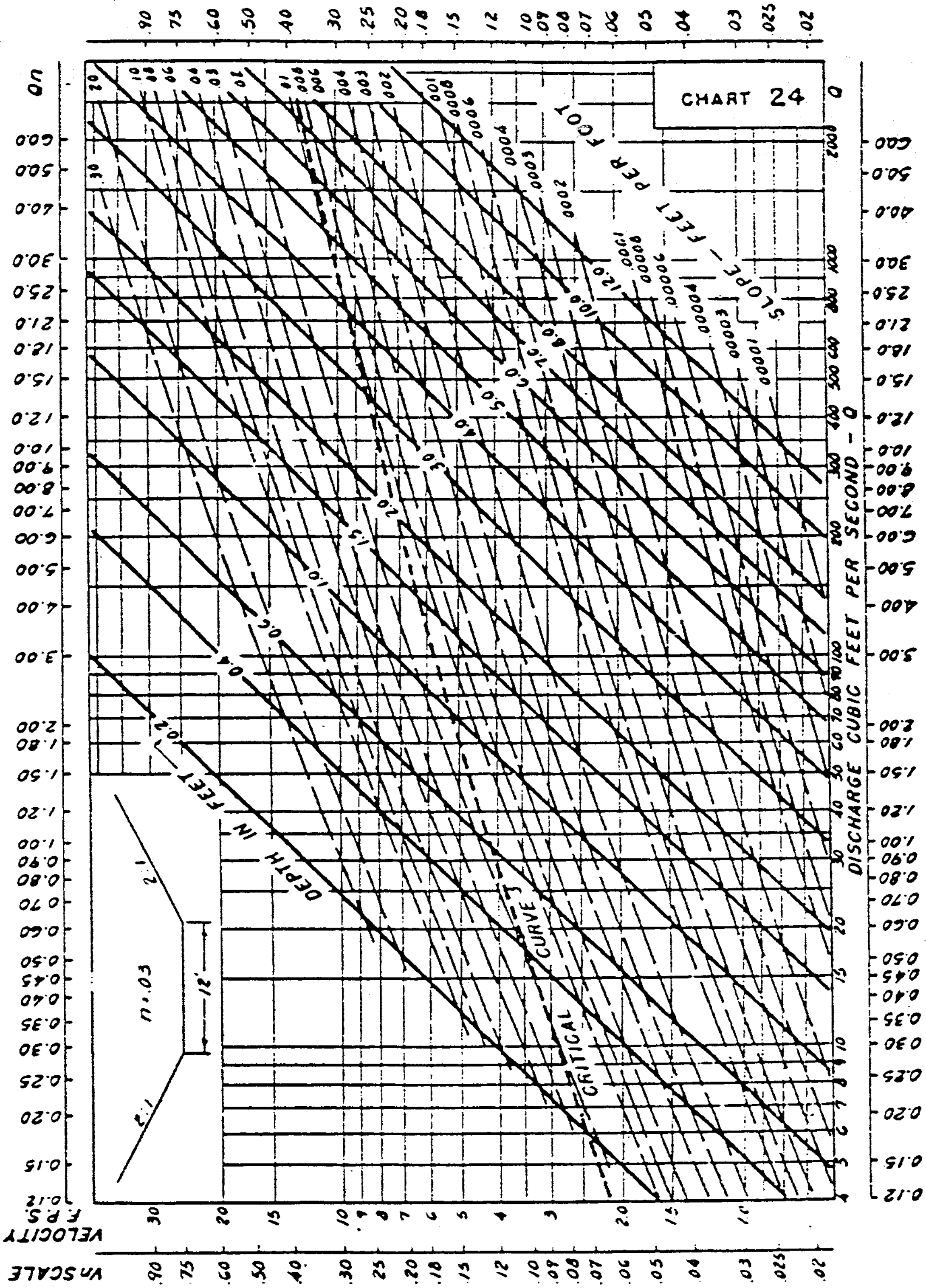
CHANNEL CHART
2:1 b = 8 FT.



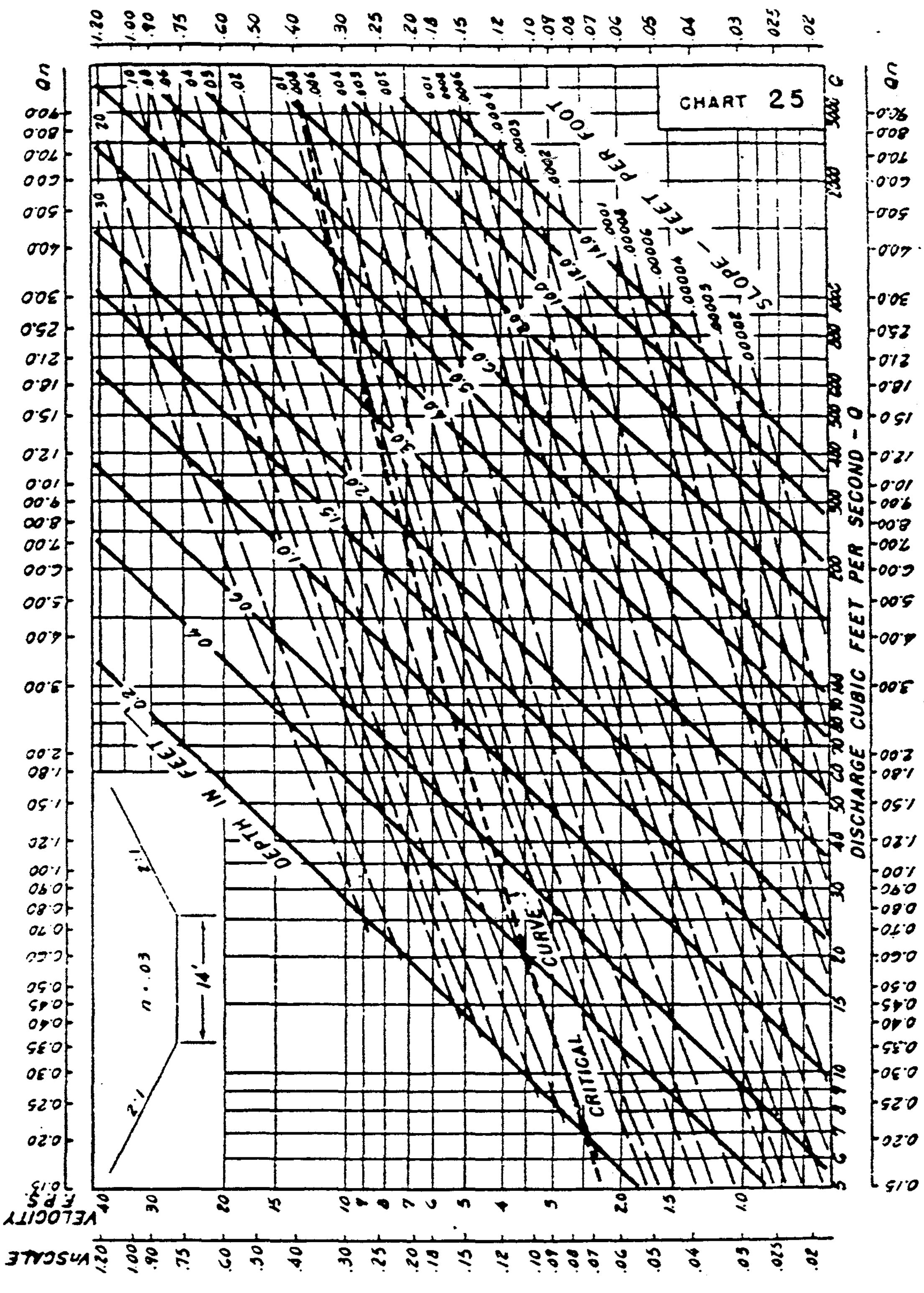
CHANNEL CHART
2:1 b = 9 FT.



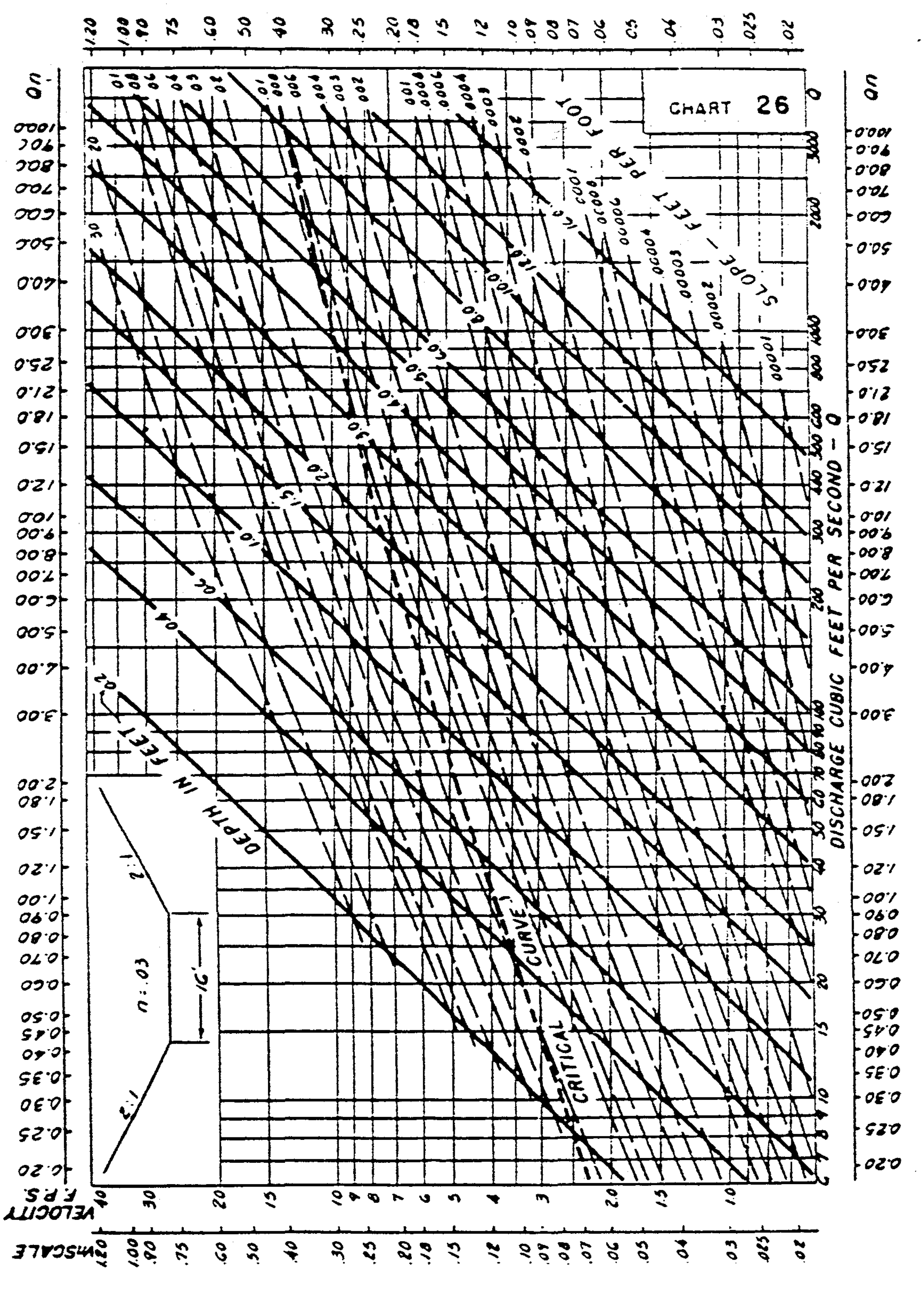
CHANNEL CHART
2:1 b = 10 FT.



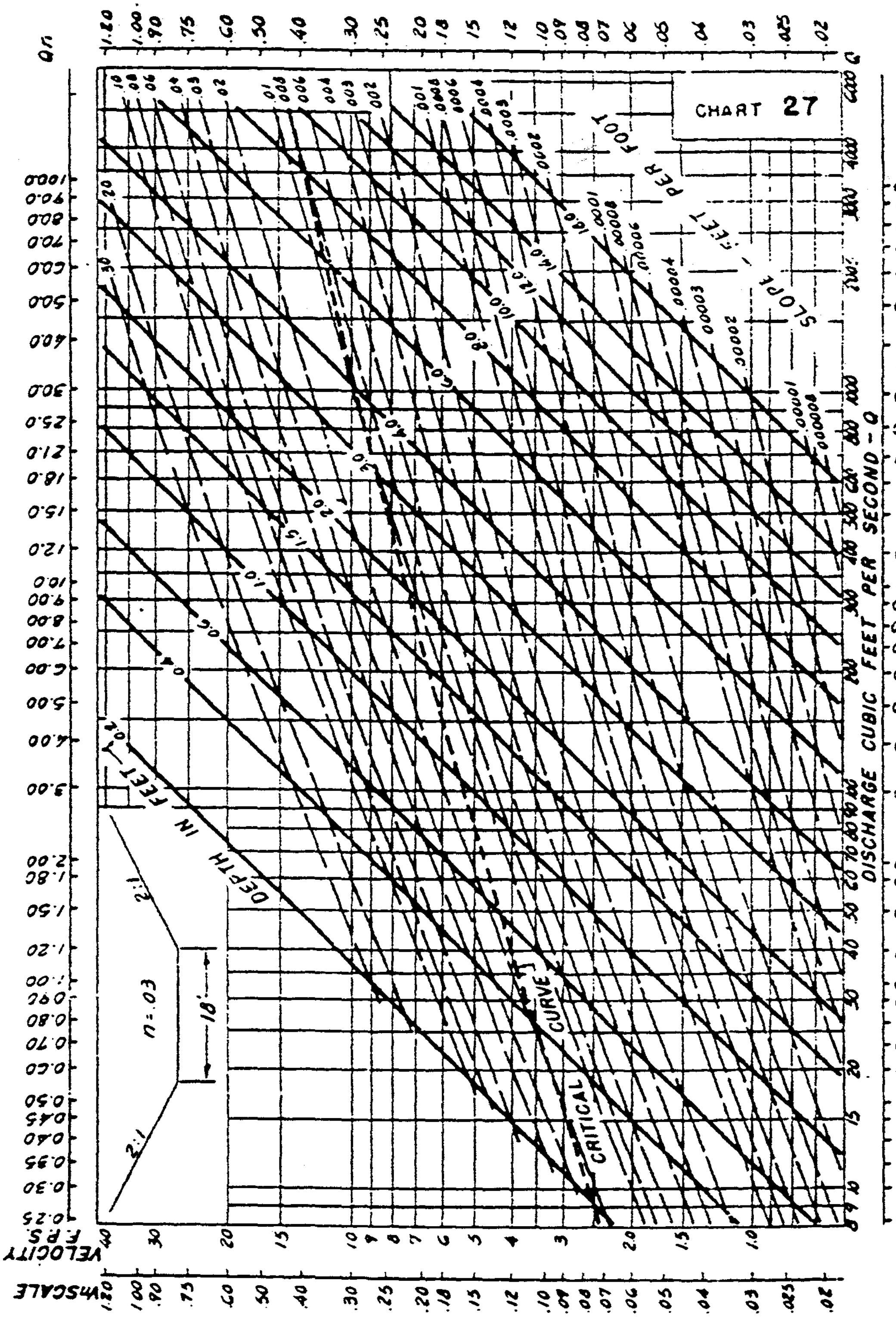
CHANNEL CHART
2:1 b = 12 FT.



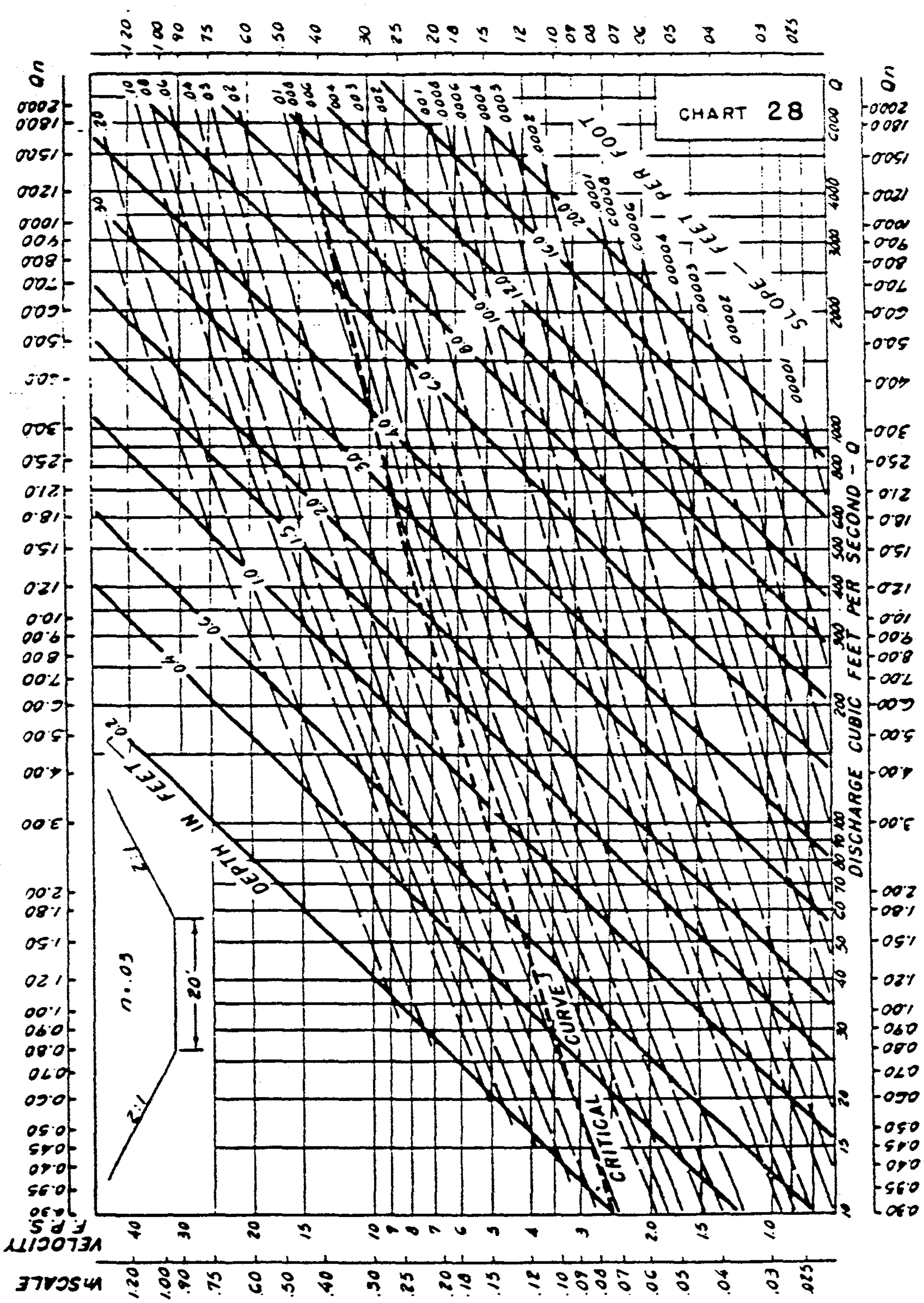
CHANNEL CHART
2:1 b = 14 FT.



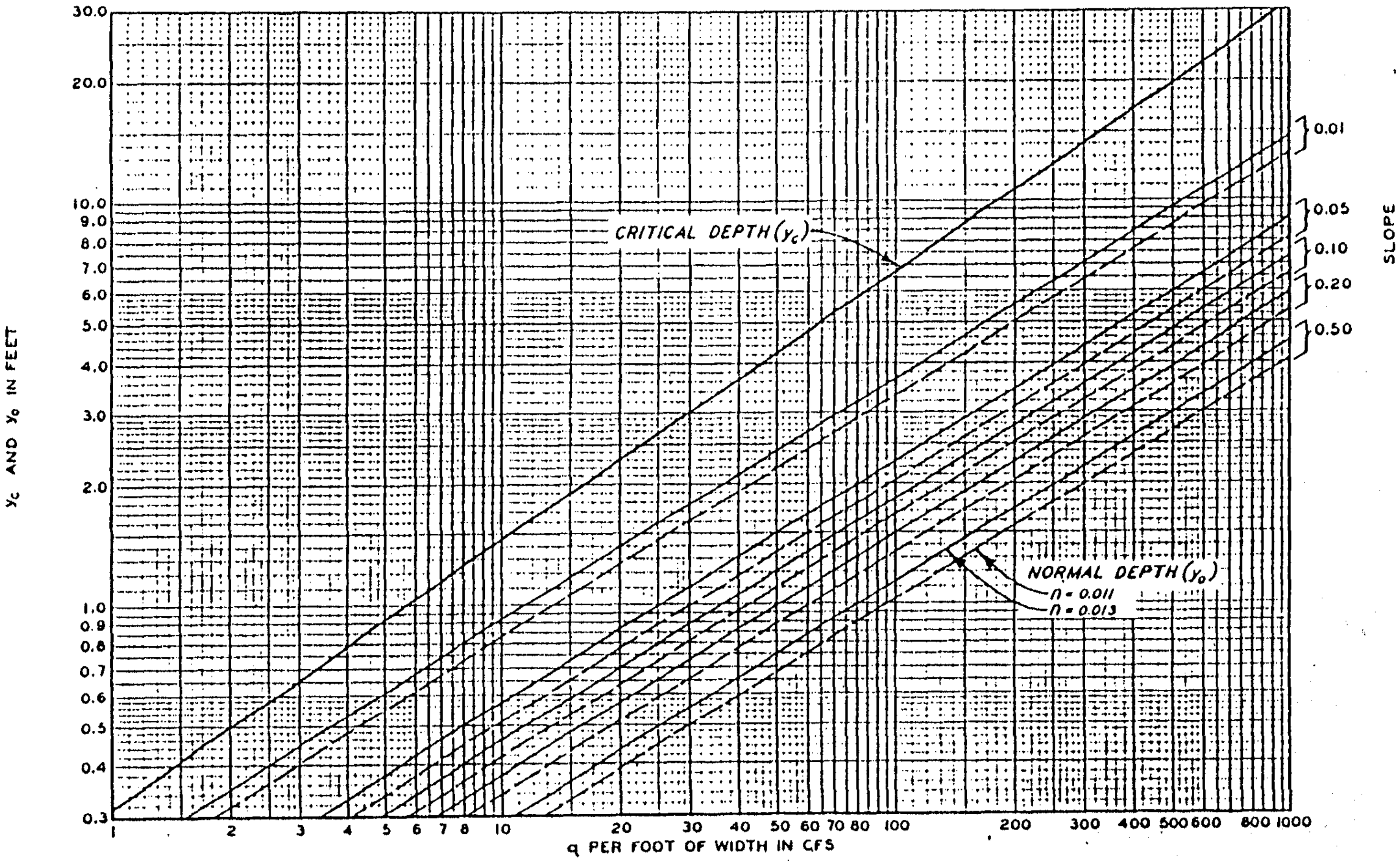
CHANNEL CHART
2:1 b = 16 FT.



CHANNEL CHART
2:1 b = 18 FT.



CHANNEL CHART
2:1 b = 20 FT.



BASIC EQUATIONS

$q = C y_o^{5/3}$; $y_c = \sqrt[3]{\frac{q^2}{g}}$

WHERE: q = DISCHARGE PER FOOT OF WIDTH

$C = \frac{1.486\, S^{1/2}}{n}$

y_o = NORMAL DEPTH IN FEET

y_c = CRITICAL DEPTH IN FEET

g = GRAVITY

OPEN CHANNEL FLOW

NORMAL AND CRITICAL DEPTHS WIDE RECTANGULAR SECTIONS

HYDRAULIC DESIGN CHART 610-8

Example 1:

Given: A trapezoidal channel with 2:1 side slopes, a six foot bottom width, and a depth of 4.0 feet, with n = 0.030, on a 0.5 percent slope (S = 0.0005). Find: Discharge, velocity, and type of flow.

1. Select the trapezoidal chart for b = six feet

2. Locate the intersection of the four feet depth line and the slope line S = 0.005 and, moving vertically to the abscissa scale, read the corresponding discharge, Q = 350 cfs

3. Move horizontally from the intersection and read the normal velocity, V = 6.1 fps, on the ordinate scale

4. The intersection lies below the critical curve, and the flow is therefore in the subcritical range

Example 2:

Given: The same channel and flow except n = 0.040

1. Select the trapezoidal chart for b = 6 feet

2. Locate the intersection of the four foot line and the slope line and move

vertically to the abscissa scale, read the corresponding Qn value, Qn = 10.5

3. Calculate Q,

   $$Qn/n = [10.5/0.040] = 262 \text{ cfs.}$$

4. Move horizontally from the intersection and read Vn = 0.19

5. Calculate V,

   $$Vn/n = [0.19/0.040] = 4.7 \text{ fps}$$

6. Critical depth and critical velocity are independent of the value of n and may be read directly from the intersection of the critical curve with a vertical line through the discharge; critical velocity, V_c = 8 fps; critical depth, d_c = 2.9 feet. Since the given water depth, four feet, is greater the flow is subcritical.

The charts may also be used to obtain rough approximations of depths and velocities in natural channels of nearly regular cross section. For such channels a straight horizontal line drawn through the irregularities of the channel bed longitudinal profile may be used to define the channel bottom. A bottom width should be chosen which will result in the same area for the assumed and existing natural channel.

3.1.3 Ice Covered Flow. As a result of the cold climate water bodies are ice covered for the greatest part of the year. The chief impact of ice is to raise the water surface level for a given discharge above the ice free water level. Ice may cause this rise by reducing the flow area and by increasing the surface exposed to friction. Stages for relatively small discharges in ice covered channels often exceed the stages of large open water floods and thus control design of riparian structures. Estimation of impacts from ice on channel flow is largely judgemental and requires intimate knowledge of local conditions. However, two of the relationships can be quantified. These are presented here.

Case 1. Flow in an ice covered channel. During early winter flowing channels become covered with a floating ice sheet. The ice sheet provides an additional friction surface, and reduces the hydraulic radius, R. The hydraulic characteristics can be estimated, for wide shallow streams, by the conventional Manning equation:

$$V = Q/A = [1.486/n]\ R^{2/3}\ S^{1/2} \qquad (3\text{-}2)$$

where

n and R are overall flow coefficients of the composite bed and ice cover.

and for wide shallow streams are approximately

$$n = \left(\frac{(n_1^{3/2} + n_2^{3/2})}{2}\right)^{2/3} \qquad (3-3)$$

$$R = \frac{H_o - T_o}{2} \qquad (3-4)$$

where

n_1 = Mannings coefficient of roughness of the bed as with free surface flow (See Table 3-1)

n_2 = Mannings coefficient of roughness of the ice cover alone (See Table 3-2)

H_o = water depth to the line of buoyancy in the ice cover, ft.

T_o = thickness of ice below the line of buoyancy (water surface), ft.

A = Cross section area of the wetted channel in square feet.

Roughness values for an ice cover, n_2, vary widely. Values are generally higher at freezeup and diminish with time as the ice cover grows. Moreover at the same site coefficients can vary widely from year to year. The following Table 3-2 provides conservative design values. During the fall period of rapid formation of the ice cover the flow is both unsteady and non-uniform because of the storage of water in the channel atributable to formation of ice. During this period, the uniform flow Mannings formula is not strictly applicable. A worked example of flow under an ice cover is provided as Example 3.

TABLE 3-2

MANNINGS ROUGHNESS COEFFICIENTS FOR

A FLOATING ICE COVER

Type	n_2 Value
Smooth Ice without drifting blocks	
beginning of winter	0.012
middle of winter	0.010
Rough ice with drifting blocks	0.025

Case 2. The second type of flow in iced channels amenable to solution by analytical methods involves flow over an iced surface. This type of flow occurs commonly during the early stages of breakup. Solution is by conventional Mannings formula allowing for the altered channel area. Roughness values are obtained from Table 3-1.

Example 3. Discharge and velocity in an ice covered channel.
Given: Flow in a gravel bed ice covered trapezoidal channel with a sixty foot bottom width, one on two side slopes, water depth to line of buoyancy of a one foot smooth ice cover of four feet and a slope of 0.0005.
Find. Discharge and velocity.

1. Find n, for a gravel bed equal 0.03 from Table 3-1.

2. Find n_2 for smooth ice equal 0.012 from Table 3-2.

3. Calculate n by Equation 3-3.

$$n = \left(\frac{n_1^{3/2} + n_2^{3/2}}{2}\right)^{2/3}$$

$$= \left(\frac{0.03^{3/2} + 0.12^{3/2}}{2}\right)^{2/3} \qquad (3\text{-}3)$$

$$= 0.022$$

4. Calculate R by Equation 3-4.

$$R = (H_o - t_o)/2 \qquad (3\text{-}4)$$

$$= (4-{}^{2}1)/2$$

$$= 1.5$$

5. Calculate V by Equation 3-2

$$V = (1.486/n)\ R^{2/3}\ S^{1/2}$$

$$= (1.486/0.022)\ 1.5^{2/3}\ 0.0005^{1/2}$$

$$= 1.98 \text{ fps say } 2 \text{ fps}$$

6. Calculate Q by Equation 3-2

$$V = Q/A$$

$$1.98 = Q/3\ \frac{(60+72)}{2}$$

$$Q = 392 \text{ cfs say } 400 \text{ cfs}$$

3.2 Culverts

Culverts are the most commonly occurring cross drainage structure in any road system. They are also responsible for an inordinate number of failures which result in loss of use of the road. This section is intended to provide a design procedure yielding an economic rational design. Both analytical and graphical design methods are presented.

3.2.1 Hydraulic Design For Ice Free Culverts.

Proper hydraulic design of a culvert includes considerations of location and alignment, hydrology, the hydraulics of the culvert its inlet and outlet, and prevention of erosion. The fundamental objective of hydraulic design of culverts is to determine the most economic diameter at which the design discharge will be passed without exceeding the allowable headwater elevation, causing erosion, or blocking fish passage. Although culverts are simple in appearance, their hydraulics are complicated. Their discharge capacity may be controlled by conditions at the inlet, friction in the barrel, or outlet conditions. Each of these components may limit the discharge capacity of the whole structure under specific conditions. It is possible, by involved hydraulic computations, to determine the probable flow type for a given set of conditions. The most efficient design procedure, however, is to determine the capacity as limited by each of the components using the design aids presented herein. The hydraulic capacity of a total culvert is then the least of the capacities as limited by any of the culvert's components.

3.2.1.1 General Classification of Flow Types. For convenience, culvert flow has traditionally been classified into six types depending on the location of the section limiting the capacity of the culvert and the relative locations of the headwater and tailwater. Figure 3-1 provides an illustration of these six types and a definition of terms. Table 3-3 provides a definition of symbols and units.

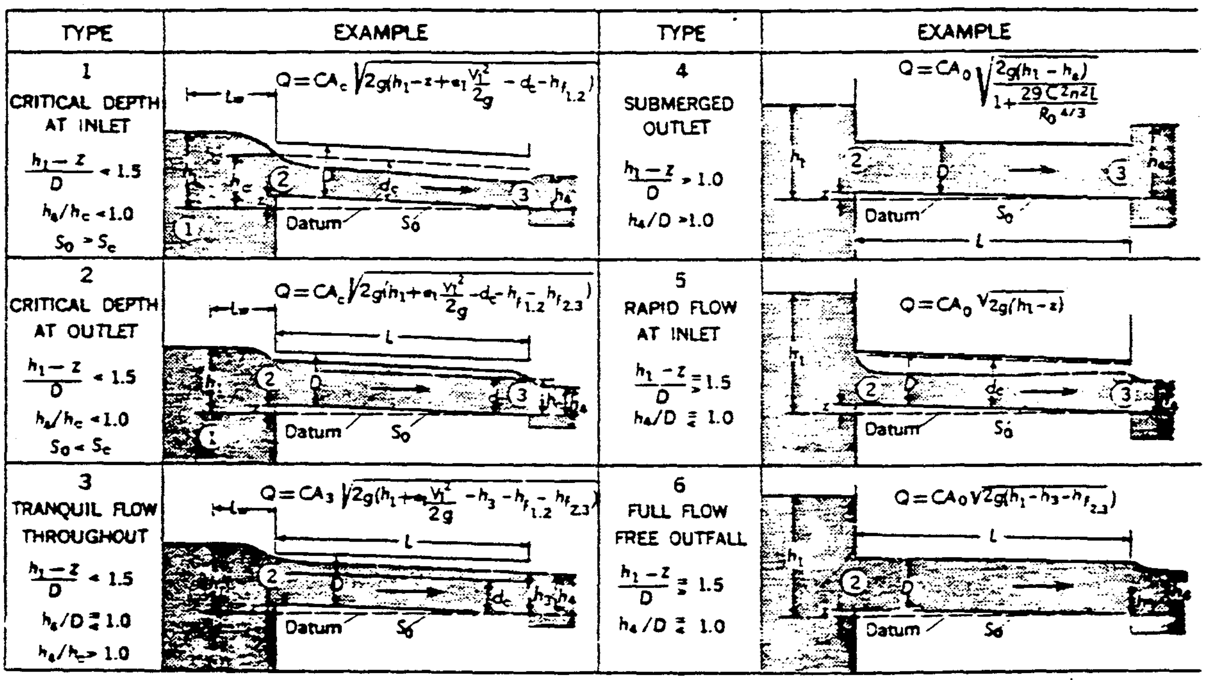


FIGURE 3-1 CLASSIFICATION OF CULVERT FLOW

CULVERT
SYMBOLS AND UNITS

Symbol	Definition	Unit
A	Area.	ft^2
A_0	Area of culvert barrel.	ft^2
A_c	Area of section of flow at critical depth.	ft^2
b	Width of contracted flow section for box culvert.	ft
C	Coefficient of discharge; also, coefficient for computing various culvert properties; subscripts refer to specific items, as a for area, k for conveyance, m for mean depth, p for wetted perimeter, q for discharge, r for hydraulic radius, and t for top width.	
D	Maximum inside vertical dimension of culvert barrel, or the inside diameter of a circular section. (For corrugated pipes, D is measured as the minimum inside diameter.)	ft
D_m	Maximum inside diameter of pipe culvert at entrance.	ft
d	Depth of flow measured from the lowest point in the cross section for culverts.	ft
d_c	Maximum depth in critical-flow section.	ft
d_m	Mean depth.	ft
F	Froude number.	
g	Gravitational constant (acceleration).	ft/sec^2
H_0	Specific energy.	ft
h	Static or piezometric head above an arbitrary datum.	ft
h_c	d_c+z for type 1 culvert flow.	ft
h_e	Head loss due to entrance contraction.	ft
h_f	Head loss due to friction.	ft
h_v	Velocity head at a section.	ft
K	Conveyance of a section.	ft^3/sec
K_c	Conveyance of critical depth section.	ft^3/sec
K_0	Conveyance of full culvert barrel.	ft^3/sec
k	Adjustment factor; subscripts refer to specific items, as a for skewed abutments with dikes, L for length, r and R for radius, w for length of wingwalls, and θ for wingwall angle.	
L	Length of culvert barrel, bridge abutment, or broad-crested weir in direction of flow.	ft
L_p	Distance a culvert barrel projects beyond a headwall or embankment.	ft
L_w	Distance from approach section to entrance of culvert, upstream side of contraction, or crest of weir.	ft
m	Channel-contraction ratio.	
n	Manning roughness of coefficient.	$ft^{1/6}$
n_c	Composite value of roughness coefficient.	$ft^{1/6}$
P	Wetted perimeter of cross section of flow.	ft
P_p	Wetted perimeter of the paved invert of a culvert.	ft
Q	Total discharge.	ft^3/sec
R	Hydraulic radius.	ft
R_0	Hydraulic radius of a culvert barrel.	ft
r	Radius of entrance rounding.	ft
S	Friction slope.	
S_c	Bed slope of culvert for which the normal depth and the critical depth are equal.	
S_0	Bed slope of culvert barrel.	
T	Width of a section at the water surface.	ft
V	Mean velocity of flow in a section.	ft/sec
V_0	Full culvert velocity.	ft/sec
w	Measure of the length of a wingwall or chamfer.	ft
x	Length of part-full flow.	ft
z	Elevation of a point above a datum.	ft
$_{1,2}$	Subscripts which denote the location of cross sections or section properties in downstream order.	
α	Velocity-head coefficient.	
θ	Acute angle between a wingwall and plane of contraction or headwall; and the bevel angle.	
$<$	Less than.	
$\leq$	Equal to or less than.	
$>$	Greater than.	
$\geq$	Equal to or greater than.	

The concept of critical depth and critical slope is basic to classification of culvert flow. Critical depth, d_c, is the depth at the point of minimum specific energy for a given discharge. The greatest discharge attainable for a given culvert cross section and available energy (H) occurs at critical depth, d_c. The velocity associated with this is the critical velocity, V_c, and the culvert slope necessary to just maintain this depth and velocity is the critical slope, S_c. These concepts are developed in many standard texts and will not be redeveloped here. The complex geometry of part full culvert sections discourages direct mathematical solutions for critical depth and other hydraulic properties. Therefore, for convenience, Table 3-4 through 3-7 providing hydraulic properties for culverts as a function of water depth and culvert size are provided. These tables are from the U.S. Geological Survey publication "Measurement of Discharge at Culverts by Indirect Methods" (Bodhaine 1968).

A second important consideration in classifying flow type is the depth of the headwater (h_1) with respect to the pipe invert at the outlet. On the North Slope, the allowable headwater elevation is limited by one of two considerations. The first is the topographic height limit created because of overtopping of the road fill or diversion into an adjacent drainage. The second is an arbitrary limit of h = 1.5D adopted because the strong vortex generated at the entrance by higher heads creates excessive erosion requiring extensive erosion protection.

For any given installation, the culverts may flow under several different flow types at different times depending on the discharge and tailwater conditions existing at that time.

PROPERTIES OF CIRCULAR PIPES

TABLE 3-4

Diam (in)	Diam D (ft)	Area A_0 (sq ft)	D^2	$D^{5/2}$	$D^{8/3}$	Diam (in)	Diam D (ft)	Area A_0 (sq ft)	D^2	$D^{5/2}$	$D^{8/3}$
6	0.500	0.196	0.250	0.177	0.157	60	5.00	19.6	25.0	55.9	73.0
8	.667	.349	.444	.363	.339	66	5.50	23.8	30.2	71.0	94.1
10	.833	.545	.694	.634	.614	72	6.00	28.3	36.0	88.2	119
12	1.00	.785	1.00	1.00	1.00	78	6.50	33.2	42.2	108	147
15	1.25	1.23	1.56	1.75	1.81	84	7.00	38.5	49.0	130	179
18	1.50	1.77	2.25	2.76	2.95	96	8.00	50.3	64.0	181	256
21	1.75	2.41	3.06	4.05	4.44	108	9.00	63.6	81.0	243	351
24	2.00	3.14	4.00	5.66	6.34	120	10	78.5	100	316	464
30	2.50	4.91	6.25	9.88	11.5	132	11	95.0	121	401	599
36	3.00	7.07	9.00	15.6	18.7	144	12	113	144	499	755
42	3.50	9.62	12.2	22.9	28.1	156	13	133	169	609	935
48	4.00	12.6	16.0	32.0	40.3	168	14	154	196	733	1,140
54	4.50	15.9	20.2	43.0	55.1	180	15	177	225	871	1,370

PROPERTIES OF MULTIPLATE PIPE ARCHES

TABLE 3-5

Nominal dimensions Inches × Inches				Span (b)	Rise (D)	Area (A)	D^2	$D^{5/2}$	$D^{8/3}$	Nominal dimensions Inches × Inches				Span (b)	Rise (D)	Area (A)	D^2	$D^{5/2}$	$D^{8/3}$
				Feet		Square feet								Feet		Square feet			
Ft	In	× Ft	In							Ft	In	× Ft	In						
6*	1	4	7	6.08	4.58	22	20.97	44.89	57.9	11	7	7	5	11.62	7.42	67	55.06	150.0	209
6	4	4	9	6.34	4.76	24	22.66	49.43	64.1	11	10	7	7	11.82	7.61	71	57.91	159.8	224
6	9	4	11	6.76	4.91	26	24.11	53.42	69.6	12	4	7	9	12.32	7.75	74	60.06	167.2	235
7*	0	5	1	7.02	5.09	28	25.91	58.45	76.7	12	6	7	11	12.52	7.93	78	62.88	177.1	250
7	3	5	3	7.24	5.27	31	27.77	63.76	84.1	12	8	8	1	12.70	8.12	81	65.93	187.9	266
7	8	5	5	7.70	5.42	33	29.38	68.39	90.6	12*	10	8	4	12.86	8.31	85	69.06	199.1	283
7	11	5	7	7.94	5.60	35	31.36	74.21	98.9	13	5	8	5	13.40	8.44	89	71.23	206.9	295
8*	2	5	9	8.14	5.78	38	33.41	80.32	108	13	11	8	7	13.94	8.58	93	73.62	215.6	309
8	7	5	11	8.62	5.92	40	35.05	85.27	115	14	1	8	9	14.12	8.77	97	76.91	227.8	327
8	10	6	1	8.84	6.11	43	37.33	92.28	125	14	3	8	11	14.28	8.96	101	80.28	240.3	346
9	4	6	3	9.32	6.26	46	39.19	98.05	133	14	10	9	1	14.82	9.10	105	82.81	249.8	361
9	6	6	5	9.52	6.44	49	41.47	105.2	144	15*	4	9	3	15.34	9.23	109	85.19	258.8	375
9	9	6	7	9.72	6.62	52	43.82	112.8	155	15	6	9	5	15.54	9.42	113	88.74	272.3	396
10	3	6	9	10.22	6.77	55	45.83	119.3	164	15	8	9	7	15.70	9.61	118	92.35	286.3	417
10	8	6	11	10.70	6.91	58	47.75	125.5	173	15	10	9	10	15.86	9.80	122	96.04	300.7	440
10	11	7	1	10.92	7.09	61	50.27	133.8	186	16	5	9	11	16.42	9.93	126	98.61	310.7	456
11*	5	7	3	11.40	7.24	64	52.42	141.0	196	16*	7	10	1	16.58	10.12	130	102.41	325.8	479

COEFFICIENTS FOR PIPE OF CIRCULAR SECTION FLOWING PARTLY FULL

[Coefficients for (1) area, (2) wetted perimeter, (3) hydraulic radius, (4) conveyance, (5) discharge for critical-depth flow, and (6) top width]

	(1)	(2)	(3)	(4)	(5)	(6)		(1)	(2)	(3)	(4)	(5)	(6)
d/D [1]	$A=C_aD^2$	$P=C_pD$	$R=C_rD$	$K=C_k\frac{D^{8/3}}{n}$	$Q=C_qD^{5/2}$	$T=C_tD$	d/D [1]	$A=C_aD^2$	$P=C_pD$	$R=C_rD$	$K=C_k\frac{D^{8/3}}{n}$	$Q=C_qD^{5/2}$	$T=C_tD$
	C_a	C_p	C_r	C_k	C_q	C_t		C_a	C_p	C_r	C_k	C_q	C_t
0.01	0.0013	0.2003	0.0066	0.000068	0.0006	0.199	0.51	0.4027	1.5908	0.2531	0.2394	1.449	1.000
.02	.0037	.2838	.0132	.000307	.0025	.280	.52	.4127	1.6108	.2562	.2472	1.504	.999
.03	.0069	.3482	.0197	.000747	.0055	.341	.53	.4227	1.6308	.2592	.2556	1.560	.998
.04	.0105	.4027	.0262	.001376	.0098	.392	.54	.4327	1.6509	.2621	.2630	1.616	.997
.05	.0147	.4510	.0325	.002228	.0153	.436	.55	.4426	1.6710	.2649	.2710	1.674	.995
.06	.0192	.4949	.0389	.00328	.0220	.475	.56	.4526	1.6911	.2676	.2791	1.733	.993
.07	.0242	.5355	.0451	.00457	.0298	.510	.57	.4625	1.7113	.2703	.2873	1.792	.990
.08	.0294	.5735	.0513	.00601	.0389	.543	.58	.4724	1.7315	.2728	.2955	1.853	.987
.09	.0350	.6094	.0575	.00775	.0491	.572	.59	.4822	1.7518	.2753	.3031	1.915	.984
.10	.0409	.6435	.0635	.00966	.0605	.600	.60	.4920	1.7722	.2776	.3115	1.977	.980
.11	.0470	.6761	.0695	.0118	.0731	.626	.61	.5018	1.7926	.2799	.3192	2.041	.975
.12	.0534	.7075	.0755	.0142	.0868	.650	.62	.5115	1.8132	.2821	.3268	2.106	.971
.13	.0600	.7377	.0813	.0168	.1016	.673	.63	.5212	1.8338	.2842	.3346	2.172	.966
.14	.0668	.7670	.0871	.0195	.1176	.694	.64	.5308	1.8546	.2862	.3423	2.239	.960
.15	.0739	.7954	.0929	.0225	.1347	.714	.65	.5404	1.8755	.2882	.3501	2.307	.954
.16	.0811	.8230	.0985	.0257	.1530	.733	.66	.5499	1.8965	.2900	.3579	2.376	.947
.17	.0885	.8500	.1042	.0291	.1724	.751	.67	.5594	1.9177	.2917	.3658	2.446	.940
.18	.0961	.8763	.1097	.0327	.1928	.768	.68	.5687	1.9391	.2933	.3727	2.518	.933
.19	.1039	.9020	.1152	.0366	.2144	.785	.69	.5780	1.9606	.2948	.3805	2.591	.925
.20	.1118	.9273	.1206	.0405	.2371	.800	.70	.5872	1.9823	.2962	.3874	2.666	.917
.21	.1199	.9521	.1259	.0446	.2609	.815	.71	.5964	2.0042	.2975	.3953	2.741	.908
.22	.1281	.9764	.1312	.0491	.2857	.828	.72	.6054	2.0264	.2987	.4021	2.819	.898
.23	.1365	1.0003	.1364	.0537	.3116	.842	.73	.6143	2.0488	.2998	.4090	2.898	.888
.24	.1449	1.0239	.1416	.0586	.3386	.854	.74	.6231	2.0714	.3008	.4157	2.978	.877
.25	.1535	1.0472	.1466	.0634	.3666	.866	.75	.6319	2.0944	.3017	.4226	3.061	.866
.26	.1623	1.0701	.1516	.0685	.3957	.877	.76	.6405	2.1176	.3024	.4283	3.145	.854
.27	.1711	1.0928	.1566	.0740	.4259	.888	.77	.6489	2.1412	.3031	.4349	3.231	.842
.28	.1800	1.1152	.1614	.0792	.4571	.898	.78	.6573	2.1652	.3036	.4415	3.320	.828
.29	.1890	1.1373	.1662	.0848	.4893	.908	.79	.6655	2.1895	.3039	.4470	3.411	.815
.30	.1982	1.1593	.1709	.0907	.523	.917	.80	.6736	2.2143	.3042	.4524	3.505	.800
.31	.2074	1.1810	.1756	.0968	.557	.925	.81	.6815	2.2395	.3043	.4578	3.602	.785
.32	.2167	1.2025	.1802	.1027	.592	.933	.82	.6893	2.2653	.3043	.4630	3.702	.768
.33	.2260	1.2239	.1847	.1088	.628	.940	.83	.6969	2.2916	.3041	.4681	3.806	.751
.34	.2355	1.2451	.1891	.1155	.666	.947	.84	.7043	2.3186	.3038	.4731	3.914	.733
.35	.2450	1.2661	.1935	.1220	.704	.954	.85	.7115	2.3462	.3033	.4768	4.028	.714
.36	.2546	1.2870	.1978	.1283	.743	.960	.86	.7186	2.3746	.3026	.4816	4.147	.694
.37	.2642	1.3078	.2020	.1350	.784	.966	.87	.7254	2.4038	.3018	.4851	4.272	.673
.38	.2739	1.3284	.2062	.1421	.825	.971	.88	.7320	2.4341	.3007	.4884	4.406	.650
.39	.2836	1.3490	.2102	.1488	.867	.975	.89	.7384	2.4655	.2995	.4916	4.549	.626
.40	.2934	1.3694	.2142	.1561	.910	.980	.90	.7445	2.4981	.2980	.4935	4.70	.600
.41	.3032	1.3898	.2182	.1631	.955	.984	.91	.7504	2.5322	.2963	.4951	4.87	.572
.42	.3130	1.4101	.2220	.1702	1.000	.987	.92	.7560	2.5681	.2944	.4966	5.06	.543
.43	.3229	1.4303	.2258	.1780	1.046	.990	.93	.7612	2.6061	.2921	.4977	5.27	.510
.44	.3328	1.4505	.2295	.1854	1.093	.993	.94	.7662	2.6467	.2895	.4979	5.52	.475
.45	.3428	1.4706	.2331	.1931	1.141	.995	.95	.7707	2.6906	.2865	.4970	5.81	.436
.46	.3527	1.4907	.2366	.2002	1.190	.997	.96	.7749	2.7389	.2829	.4963	6.18	.392
.47	.3627	1.5108	.2401	.2080	1.240	.998	.97	.7785	2.7934	.2787	.4940	6.67	.341
.48	.3727	1.5308	.2435	.2160	1.291	.999	.98	.7817	2.8578	.2735	.4902	7.41	.280
.49	.3827	1.5508	.2468	.2235	1.343	1.000	.99	.7841	2.9412	.2666	.4824	8.83	.199
.50	.3927	1.5708	.2500	.2317	1.396	1.000	1.00	.7854	3.1416	.2500	.4633	-------	.000

[1] d = maximum depth of water in feet; D = diameter of pipe, in feet.

TABLE 3-6

COEFFICIENTS FOR PIPE-ARCHES FLOWING PARTLY FULL

[Coefficients for (1) area, (2) hydraulic radius, (3) conveyance, (4) mean depth, (5) discharge for critical-depth flow]

d/D[1]	(1) $A=C_aD^2$ C_a	(2) $R=C_rD$ C_r	(3) $K=C_k\frac{D^{8/3}}{n}$ C_k	(4) $d_m=C_mD$ C_m	(5) $Q=C_qD^{5/2}$ C_q	d/D[1]	(1) $A=C_aD^2$ C_a	(2) $R=C_rD$ C_r	(3) $K=C_k\frac{D^{8/3}}{n}$ C_k	(4) $d_m=C_mD$ C_m	(5) $Q=C_qD^{5/2}$ C_q
A. Nominal size 6 feet 1 inch × 4 feet 7 inches											
0.01	0.005	0.016	0.000	0.016	0.003	0.51	0.586	0.289	0.380	0.450	2.23
.02	.009	.019	.001	.019	.007	.52	.600	.292	.393	.463	2.32
.03	.014	.025	.002	.025	.012	.53	.614	.296	.406	.476	2.41
.04	.019	.029	.003	.029	.018	.54	.628	.300	.419	.490	2.50
.05	.026	.036	.004	.035	.028	.55	.643	.304	.431	.504	2.59
.06	.033	.042	.006	.041	.038	.56	.657	.307	.445	.519	2.69
.07	.042	.048	.008	.048	.052	.57	.671	.311	.458	.535	2.79
.08	.050	.054	.011	.054	.066	.58	.686	.314	.471	.551	2.89
.09	.059	.061	.014	.061	.082	.59	.700	.318	.484	.568	2.99
.10	.068	.067	.017	.067	.099	.60	.714	.321	.497	.584	3.10
.11	.078	.075	.021	.076	.122	.61	.724	.321	.505	.597	3.17
.12	.089	.082	.025	.084	.145	.62	.733	.322	.512	.609	3.25
.13	.099	.089	.029	.091	.170	.63	.743	.322	.519	.621	3.32
.14	.110	.096	.034	.099	.195	.64	.752	.323	.526	.634	3.40
.15	.120	.102	.039	.106	.221	.65	.762	.323	.533	.647	3.48
.16	.131	.109	.044	.114	.251	.66	.776	.327	.547	.666	3.59
.17	.142	.115	.050	.122	.282	.67	.790	.330	.561	.686	3.71
.18	.154	.121	.056	.129	.314	.68	.805	.334	.576	.706	3.84
.19	.165	.127	.062	.137	.346	.69	.819	.337	.590	.727	3.96
.20	.176	.132	.068	.144	.380	.70	.833	.341	.604	.749	4.09
.21	.189	.139	.075	.153	.418	.71	.843	.341	.611	.766	4.19
.22	.201	.145	.082	.162	.458	.72	.852	.341	.619	.784	4.28
.23	.213	.151	.090	.170	.499	.73	.862	.342	.626	.803	4.38
.24	.226	.157	.098	.178	.541	.74	.871	.342	.633	.822	4.48
.25	.238	.163	.105	.186	.583	.75	.881	.342	.640	.841	4.58
.26	.252	.170	.115	.197	.635	.76	.890	.343	.649	.864	4.70
.27	.267	.177	.125	.207	.688	.77	.900	.345	.657	.889	4.81
.28	.281	.184	.135	.217	.742	.78	.909	.346	.666	.914	4.93
.29	.295	.191	.145	.227	.797	.79	.919	.347	.675	.940	5.06
.30	.309	.197	.156	.236	.854	.80	.928	.349	.684	.967	5.18
.31	.324	.203	.166	.246	.912	.81	.936	.347	.687	.998	5.31
.32	.338	.209	.177	.256	.972	.82	.944	.345	.690	1.03	5.43
.33	.352	.215	.188	.266	1.03	.83	.951	.344	.694	1.06	5.57
.34	.367	.221	.199	.276	1.09	.84	.959	.342	.697	1.10	5.70
.35	.381	.227	.210	.286	1.16	.85	.966	.341	.701	1.14	5.85
.36	.392	.231	.219	.295	1.21	.86	.973	.338	.702	1.18	6.01
.37	.404	.234	.228	.303	1.26	.87	.980	.336	.704	1.23	6.18
.38	.415	.238	.237	.312	1.32	.88	.986	.334	.706	1.29	6.35
.39	.427	.241	.246	.320	1.37	.89	.993	.332	.707	1.35	6.54
.40	.438	.245	.255	.329	1.42	.90	1.00	.330	.709	1.41	6.74
.41	.450	.249	.265	.338	1.49	.91	1.00	.326	.707	1.50	6.98
.42	.463	.252	.275	.347	1.55	.92	1.01	.323	.705	1.60	7.23
.43	.475	.256	.285	.357	1.61	.93	1.01	.319	.704	1.71	7.52
.44	.488	.260	.295	.366	1.67	.94	1.02	.316	.702	1.83	7.82
.45	.500	.263	.305	.376	1.74	.95	1.02	.313	.701	2.02	8.25
.46	.514	.268	.317	.388	1.82	.96	1.03	.304	.691	--------	--------
.47	.528	.272	.330	.400	1.90	.97	1.03	.296	.682	--------	--------
.48	.543	.276	.342	.412	1.98	.98	1.04	.288	.673	--------	--------
.49	.557	.281	.355	.424	2.06	.99	1.04	.281	.665	--------	--------
.50	.571	.285	.367	.436	2.14	1.00	1.05	.274	.658	--------	--------

[1] d=depth of water, in feet; D=rise, in feet.

TABLE 3-7

TABLE 3-7 (CON'T)

d/D[1]	(1) $A=C_aD^2$	(2) $R=C_rD$	(3) $K=C_k\frac{D^{8/3}}{n}$	(4) $d_m=C_mD$	(5) $Q=C_qD^{5/2}$	d/D	(1) $A=C_aD^2$	(2) $R=C_rD$	(3) $K=C_k\frac{D^{8/3}}{n}$	(4) $d_m=C_mD$	(5) $Q=C_qD^{5/2}$
	C_a	C_r	C_k	C_m	C_q		C_a	C_r	C_k	C_m	C_q
B. Nominal size 7 feet 0 inch × 5 feet 1 inch											
0.01	0.006	0.017	0.001	0.017	0.004	0.51	0.594	0.283	0.380	0.447	2.25
.02	.012	.022	.001	.022	.010	.52	.609	.287	.394	.462	2.35
.03	.016	.026	.002	.026	.015	.53	.625	.292	.409	.476	2.45
.04	.021	.029	.003	.029	.020	.54	.640	.296	.423	.491	2.55
.05	.028	.035	.004	.035	.029	.55	.656	.301	.437	.506	2.65
.06	.035	.040	.006	.039	.039	.56	.667	.303	.447	.518	2.72
.07	.044	.047	.009	.047	.055	.57	.679	.305	.457	.530	2.80
.08	.054	.054	.011	.054	.071	.58	.690	.307	.467	.542	2.89
.09	.064	.061	.015	.061	.089	.59	.702	.309	.476	.555	2.97
.10	.073	.067	.018	.067	.108	.60	.714	.311	.486	.568	3.05
.11	.085	.075	.022	.076	.133	.61	.725	.313	.497	.582	3.14
.12	.096	.083	.027	.084	.159	.62	.737	.315	.507	.597	3.23
.13	.108	.090	.032	.092	.186	.63	.748	.317	.517	.613	3.32
.14	.120	.096	.037	.100	.215	.64	.760	.320	.528	.628	3.42
.15	.131	.103	.043	.107	.244	.65	.771	.322	.538	.644	3.51
.16	.141	.108	.048	.114	.270	.66	.784	.324	.550	.662	3.62
.17	.151	.114	.053	.120	.298	.67	.798	.326	.562	.681	3.74
.18	.161	.119	.058	.127	.326	.68	.811	.329	.574	.701	3.85
.19	.171	.124	.063	.133	.354	.69	.824	.331	.586	.721	3.97
.20	.181	.128	.068	.139	.383	.70	.837	.333	.597	.741	4.09
.21	.194	.135	.076	.147	.422	.71	.848	.335	.608	.761	4.20
.22	.206	.141	.083	.156	.461	.72	.860	.337	.619	.781	4.31
.23	.218	.147	.090	.164	.502	.73	.872	.339	.629	.801	4.43
.24	.231	.153	.098	.172	.544	.74	.883	.341	.640	.822	4.54
.25	.243	.159	.106	.181	.586	.75	.895	.343	.651	.844	4.66
.26	.258	.166	.115	.191	.639	.76	.905	.343	.659	.868	4.78
.27	.272	.172	.125	.201	.693	.77	.915	.344	.667	.892	4.90
.28	.287	.179	.135	.211	.749	.78	.925	.345	.676	.918	5.03
.29	.302	.185	.146	.222	.806	.79	.935	.345	.684	.945	5.16
.30	.316	.192	.156	.232	.864	.80	.945	.346	.692	.972	5.29
.31	.330	.198	.167	.242	.921	.81	.956	.346	.700	1.01	5.45
.32	.344	.204	.177	.251	.979	.82	.968	.346	.709	1.04	5.61
.33	.358	.209	.188	.261	1.04	.83	.980	.345	.717	1.08	5.78
.34	.372	.215	.198	.271	1.10	.84	.991	.345	.725	1.12	5.95
.35	.386	.221	.209	.281	1.16	.85	1.003	.345	.733	1.16	6.13
.36	.401	.226	.221	.292	1.23	.86	1.009	.342	.734	1.21	6.30
.37	.417	.232	.234	.304	1.30	.87	1.015	.340	.735	1.26	6.47
.38	.432	.238	.246	.316	1.38	.88	1.021	.338	.736	1.32	6.65
.39	.447	.243	.259	.327	1.45	.89	1.027	.335	.737	1.38	6.84
.40	.463	.248	.272	.339	1.53	.90	1.034	.333	.738	1.44	7.04
.41	.474	.252	.281	.348	1.59	.91	1.039	.330	.737	1.52	7.28
.42	.486	.255	.290	.357	1.65	.92	1.044	.327	.736	1.61	7.52
.43	.498	.259	.300	.366	1.71	.93	1.050	.324	.735	1.72	7.82
.44	.509	.262	.310	.375	1.77	.94	1.055	.321	.734	1.85	8.15
.45	.521	.265	.319	.384	1.83	.95	1.061	.318	.734	2.04	8.59
.46	.532	.268	.329	.394	1.90	.96	1.064	.310	.724	--------	--------
.47	.544	.270	.338	.404	1.96	.97	1.068	.302	.715	--------	--------
.48	.555	.273	.347	.413	2.03	.98	1.072	.295	.706	--------	--------
.49	.567	.275	.357	.423	2.09	.99	1.076	.288	.698	--------	--------
.50	.579	.278	.366	.433	2.16	1.00	1.081	.282	.691	--------	--------

[1] d=depth of water, in feet; D=rise, in feet.

TABLE 3-7 (CON'T)

d/D[1]	(1)	(2)	(3)	(4)	(5)	d/D[1]	(1)	(2)	(3)	(4)	(5)
	$A=C_aD^2$	$R=C_rD$	$K=C_k\frac{D^{8/3}}{n}$	$d_m=C_mD$	$Q=C_qD^{5/2}$		$A=C_aD^2$	$R=C_rD$	$K=C_k\frac{D^{8/3}}{n}$	$d_m=C_mD$	$Q=C_qD^{5/2}$
	C_a	C_r	C_k	C_m	C_q		C_a	C_r	C_k	C_m	C_q
C. Nominal size 8 feet 2 inches × 5 feet 9 inches											
0.01	0.007	0.015	0.001	0.015	0.005	0.51	0.658	0.304	0.442	0.497	2.63
.02	.013	.021	.002	.021	.011	.52	.673	.308	.456	.511	2.73
.03	.020	.026	.003	.026	.019	.53	.688	.312	.470	.525	2.83
.04	.027	.030	.004	.030	.026	.54	.703	.315	.484	.539	2.93
.05	.036	.037	.006	.036	.039	.55	.718	.319	.498	.553	3.03
.06	.045	.044	.008	.042	.052	.56	.730	.322	.509	.566	3.11
.07	.063	.057	.014	.056	.085	.57	.742	.324	.520	.578	3.20
.08	.081	.070	.020	.070	.121	.58	.754	.326	.531	.590	3.29
.09	.087	.073	.023	.073	.133	.59	.765	.328	.541	.603	3.37
.10	.093	.077	.025	.077	.146	.60	.777	.331	.552	.616	3.46
.11	.106	.085	.030	.086	.177	.61	.789	.333	.563	.631	3.56
.12	.119	.094	.036	.096	.209	.62	.801	.335	.574	.645	3.65
.13	.132	.101	.043	.105	.243	.63	.813	.337	.585	.661	3.75
.14	.145	.109	.049	.114	.279	.64	.825	.339	.596	.676	3.85
.15	.158	.116	.056	.123	.315	.65	.837	.341	.607	.692	3.95
.16	.172	.123	.063	.132	.354	.66	.849	.342	.618	.708	4.05
.17	.185	.131	.071	.141	.394	.67	.861	.344	.628	.724	4.16
.18	.198	.138	.078	.149	.434	.68	.873	.345	.639	.740	4.26
.19	.211	.144	.086	.158	.476	.69	.885	.347	.649	.757	4.37
.20	.224	.151	.094	.166	.519	.70	.897	.348	.660	.774	4.48
.21	.239	.159	.104	.176	.570	.71	.909	.350	.671	.796	4.60
.22	.254	.166	.114	.186	.622	.72	.921	.352	.682	.819	4.73
.23	.269	.174	.124	.196	.676	.73	.933	.354	.693	.843	4.86
.24	.284	.181	.135	.205	.731	.74	.945	.355	.704	.867	4.99
.25	.299	.188	.146	.215	.786	.75	.957	.357	.716	.892	5.13
.26	.314	.194	.157	.225	.845	.76	.966	.357	.722	.916	5.24
.27	.329	.201	.168	.235	.905	.77	.975	.357	.729	.940	5.36
.28	.344	.207	.179	.245	.966	.78	.984	.357	.736	.964	5.48
.29	.359	.213	.190	.255	1.03	.79	.993	.357	.743	.990	5.61
.30	.374	.218	.201	.265	1.09	.80	1.002	.358	.750	1.02	5.73
.31	.386	.223	.211	.273	1.14	.81	1.011	.357	.756	1.03	5.83
.32	.398	.227	.220	.282	1.20	.82	1.020	.356	.761	1.05	5.93
.33	.410	.231	.229	.290	1.25	.83	1.029	.355	.767	1.07	6.03
.34	.422	.235	.239	.299	1.31	.84	1.038	.355	.772	1.08	6.13
.35	.434	.239	.248	.308	1.36	.85	1.047	.354	.778	1.10	6.23
.36	.449	.244	.260	.319	1.44	.86	1.054	.352	.780	1.17	6.46
.37	.463	.250	.273	.330	1.51	.87	1.062	.349	.783	1.24	6.71
.38	.478	.255	.286	.342	1.59	.88	1.070	.347	.785	1.32	6.97
.39	.493	.260	.299	.354	1.66	.89	1.078	.345	.788	1.41	7.26
.40	.508	.265	.312	.365	1.74	.90	1.085	.343	.790	1.51	7.58
.41	.521	.268	.322	.376	1.81	.91	1.091	.339	.789	1.60	7.83
.42	.535	.272	.333	.387	1.89	.92	1.097	.336	.788	1.69	8.10
.43	.548	.275	.344	.398	1.96	.93	1.103	.332	.787	1.82	8.45
.44	.561	.278	.355	.409	2.04	.94	1.109	.329	.786	1.97	8.85
.45	.574	.281	.366	.420	2.11	.95	1.115	.326	.785	2.17	9.32
.46	.588	.285	.378	.433	2.19	.96	1.119	.318	.775	--------	--------
.47	.602	.289	.391	.445	2.28	.97	1.123	.311	.765	--------	--------
.48	.615	.293	.403	.457	2.36	.98	1.127	.304	.756	--------	--------
.49	.629	.296	.415	.470	2.45	.99	1.130	.297	.748	--------	--------
.50	.643	.300	.428	.483	2.54	1.00	1.137	.291	.739	--------	--------

[1] d=depth of water, in feet; D=rise, in feet.

TABLE 3-7 (CON'D)

d/D[1]	(1) $A=C_aD^2$	(2) $R=C_rD$	(3) $K=C_k\frac{D^{8/3}}{n}$	(4) $d_m=C_mD$	(5) $Q=C_qD^{5/2}$	d/D[1]	(1) $A=C_aD^2$	(2) $R=C_rD$	(3) $K=C_k\frac{D^{8/3}}{n}$	(4) $d_m=C_mD$	(5) $Q=C_qD^{5/2}$
	C_a	C_r	C_k	C_m	C_q		C_a	C_r	C_k	C_m	C_q
D. Nominal sizes 11 feet 5 inches × 7 feet 3 inches and 12 feet 10 inches × 8 feet 4 inches											
0.01	0.007	0.014	0.001	0.014	0.004	0.51	0.710	.0311	0.484	0.488	2.81
.02	.013	.021	.002	.021	.011	.52	.724	.315	.498	.501	2.91
.03	.020	.027	.003	.027	.019	.53	.739	.318	.512	.514	3.01
.04	.027	.032	.004	.032	.028	.54	.754	.321	.526	.527	3.11
.05	.037	.038	.006	.038	.041	.55	.769	.324	.539	.541	3.21
.06	.046	.044	.009	.043	.054	.56	.783	.327	.553	.555	3.31
.07	.057	.050	.012	.050	.072	.57	.797	.330	.566	.569	3.41
.08	.068	.056	.015	.056	.091	.58	.811	.333	.580	.584	3.52
.09	.079	.063	.019	.063	.113	.59	.825	.336	.593	.599	3.63
.10	.091	.069	.023	.069	.136	.60	.840	.339	.607	.614	3.73
.11	.104	.078	.028	.078	.165	.61	.854	.342	.620	.630	3.85
.12	.117	.085	.034	.086	.196	.62	.867	.344	.633	.647	3.96
.13	.131	.093	.040	.094	.228	.63	.881	.347	.646	.664	4.08
.14	.144	.100	.046	.101	.261	.64	.895	.349	.659	.682	4.20
.15	.158	.107	.053	.109	.296	.65	.909	.351	.673	.700	4.32
.16	.173	.115	.061	.118	.337	.66	.921	.352	.683	.716	4.42
.17	.188	.123	.069	.127	.380	.67	.934	.354	.694	.733	4.53
.18	.203	.130	.077	.136	.424	.68	.946	.355	.704	.750	4.65
.19	.218	.137	.086	.144	.470	.69	.958	.356	.715	.767	4.76
.20	.233	.144	.095	.153	.517	.70	.970	.357	.725	.785	4.88
.21	.248	.151	.105	.162	.569	.71	.982	.358	.735	.806	5.00
.22	.264	.159	.115	.172	.622	.72	.994	.359	.746	.827	5.13
.23	.280	.166	.126	.181	.676	.73	1.005	.360	.756	.848	5.26
.24	.295	.173	.136	.191	.732	.74	1.017	.361	.766	.871	5.39
.25	.311	.180	.147	.200	.789	.75	1.029	.362	.776	.894	5.52
.26	.328	.188	.160	.211	.856	.76	1.039	.361	.783	.918	5.65
.27	.345	.195	.173	.222	.924	.77	1.048	.361	.790	.944	5.78
.28	.363	.203	.186	.233	.994	.78	1.058	.361	.796	.971	5.92
.29	.380	.210	.199	.244	1.07	.79	1.068	.360	.803	.999	6.05
.30	.397	.217	.213	.255	1.14	.80	1.077	.360	.810	1.03	6.20
.31	.411	.222	.224	.264	1.20	.81	1.086	.359	.815	1.06	6.35
.32	.425	.227	.235	.274	1.26	.82	1.096	.358	.821	1.10	6.51
.33	.440	.232	.247	.283	1.33	.83	1.105	.357	.827	1.13	6.68
.34	.454	.237	.258	.293	1.39	.84	1.114	.357	.832	1.17	6.85
.35	.468	.241	.269	.302	1.46	.85	1.123	.356	.838	1.22	7.03
.36	.484	.247	.283	.313	1.54	.86	1.132	.354	.842	1.27	7.24
.37	.499	.252	.296	.324	1.61	.87	1.140	.353	.846	1.33	7.46
.38	.515	.257	.309	.335	1.69	.88	1.149	.352	.851	1.39	7.69
.39	.530	.262	.323	.346	1.77	.89	1.158	.350	.855	1.46	7.93
.40	.546	.267	.337	.357	1.85	.90	1.167	.349	.859	1.53	8.19
.41	.561	.272	.349	.369	1.93	.91	1.173	.346	.858	1.62	8.46
.42	.576	.276	.362	.380	2.01	.92	1.179	.342	.857	1.71	8.75
.43	.591	.280	.376	.391	2.10	.93	1.185	.339	.856	1.85	9.14
.44	.605	.284	.389	.403	2.18	.94	1.191	.336	.855	2.00	9.57
.45	.620	.288	.402	.415	2.27	.95	1.197	.332	.854	2.22	10.1
.46	.635	.292	.416	.427	2.35	.96	1.203	.324	.844	--------	--------
.47	.650	.296	.429	.439	2.44	.97	1.209	.317	.835	--------	--------
.48	.665	.300	.443	.451	2.53	.98	1.215	.310	.826	--------	--------
.49	.680	.304	.457	.463	2.63	.99	1.220	.303	.818	--------	--------
.50	.695	.308	.471	.476	2.72	1.00	1.226	.297	.810	--------	--------

[1] d=depth of water, in feet; D=rise, in feet.

TABLE 3-7 (CON'T)

d/D[1]	(1)	(2)	(3)	(4)	(5)	d/D[1]	(1)	(2)	(3)	(4)	(5)
	$A=C_aD^2$	$R=C_rD$	$K=C_k\frac{D^{8/3}}{n}$	$d_m=C_mD$	$Q=C_qD^{5/2}$		$A=C_aD^2$	$R=C_rD$	$K=C_k\frac{D^{8/3}}{n}$	$d_m=C_mD$	$Q=C_qD^{5/2}$
	C_a	C_r	C_k	C_m	C_q		C_a	C_r	C_k	C_m	C_q
E. Nominal sizes 16 feet 7 inches × 10 feet 1 inch and 18 feet 4 inches × 9 feet 3 inches, and all riveted pipe-arches											
0.01	0.013	0.031	0.002	0.031	0.013	0.51	0.747	0.318	0.517	0.494	2.98
.02	0.27	0.43	.005	0.43	.031	.52	.761	.321	.531	.506	3.07
.03	.040	.053	.008	.053	.052	.53	.775	.324	.544	.518	3.17
.04	.053	.060	.012	.060	.073	.54	.789	.327	.557	.531	3.26
.05	.066	.069	.017	.069	.098	.55	.804	.330	.571	.544	3.36
0.6	.080	.076	.021	.075	.124	.56	.819	.333	.585	.558	3.47
.07	.093	.082	.026	.082	.150	.57	.834	.336	.599	.573	3.58
.08	.106	.087	.031	.087	.177	.58	.849	.339	.613	.587	3.69
.09	.119	.093	.036	.093	.205	.59	.864	.342	.627	.602	3.80
.10	.131	.098	.042	.098	.234	.60	.879	.343	.642	.617	3.92
.11	.144	.105	.048	.105	.265	.61	.892	.343	.651	.632	4.03
.12	.157	.110	.054	.111	.296	.62	.905	.344	.659	.648	4.14
.13	.169	.116	.060	.117	.329	.63	.919	.344	.668	.663	4.25
.14	.182	.121	.066	.122	.362	.64	.932	.344	.677	.679	4.36
.15	.195	.126	.073	.128	.395	.65	.945	.345	.686	.696	4.47
.16	.209	.132	.081	.135	.437	.66	.959	.345	.701	.714	4.60
.17	.223	.139	.089	.143	.480	.67	.972	.349	.716	.732	4.72
.18	.238	.145	.097	.151	.523	.68	.985	.353	.731	.751	4.85
.19	.252	.150	.106	.158	.568	.69	.998	.357	.746	.771	4.97
.20	.266	.156	.114	.165	.614	.70	1.012	.361	.762	.791	5.11
.21	.280	.162	.124	.173	.661	.71	1.024	.362	.772	.811	5.23
.22	.294	.168	.133	.181	.709	.72	1.036	.362	.783	.832	5.37
.23	.308	.173	.142	.188	.758	.73	1.049	.363	.793	.854	5.50
.24	.322	.179	.152	.196	.808	.74	1.061	.364	.803	.876	5.64
.25	.335	.185	.162	.204	.859	.75	1.073	.365	.814	.899	5.77
.26	.351	.191	.173	.213	.919	.76	1.084	.364	.821	.925	5.91
.27	.366	.197	.184	.223	.981	.77	1.094	.364	.829	.952	6.06
.28	.382	.203	.196	.232	1.04	.78	1.105	.364	.837	.979	6.21
.29	.397	.209	.208	.242	1.11	.79	1.116	.364	.845	1.01	6.36
.30	.413	.215	.220	.251	1.17	.80	1.126	.363	.852	1.04	6.51
.31	.430	.222	.234	.262	1.25	.81	1.136	.362	.858	1.07	6.68
.32	.447	.229	.248	.273	1.33	.82	1.147	.361	.864	1.11	6.86
.33	.464	.235	.262	.284	1.40	.83	1.157	.361	.871	1.15	7.04
.34	.481	.241	.277	.296	1.48	.84	1.167	.360	.877	1.19	7.23
.35	.498	.247	.292	.307	1.57	.85	1.177	.359	.883	1.24	7.43
.36	.513	.252	.305	.318	1.64	.86	1.186	.357	.886	1.29	7.65
.37	.529	.257	.318	.328	1.72	.87	1.195	.355	.890	1.35	7.88
.38	.544	.262	.331	.339	1.80	.88	1.204	.353	.894	1.41	8.12
.39	.560	.267	.345	.350	1.88	.89	1.213	.352	.898	1.48	8.37
.40	.575	.272	.358	.361	1.96	.90	1.222	.350	.902	1.55	8.64
.41	.591	.277	.373	.372	2.05	.91	1.228	.346	.900	1.64	8.93
.42	.607	.282	.388	.384	2.14	.92	1.235	.343	.899	1.74	9.25
.43	.623	.286	.402	.396	2.23	.93	1.241	.340	.898	1.87	9.64
.44	.639	.291	.417	.408	2.32	.94	1.247	.336	.897	2.02	10.0
.45	.655	.296	.432	.420	2.41	.95	1.254	.333	.896	2.22	10.6
.46	.671	.300	.446	.432	2.50	.96	1.259	.326	.886	--------	--------
.47	.686	.304	.461	.444	2.59	.97	1.264	.319	.876	--------	--------
.48	.702	.308	.475	.456	2.69	.98	1.268	.312	.867	--------	--------
.49	.717	.311	.489	.469	2.79	.99	1.273	.306	.859	--------	--------
.50	.732	.315	.504	.481	2.88	1.00	1.280	.300	.848	--------	--------

[1] d=depth of water, in feet; D=rise, in feet.

The third factor affecting culvert flow is the tailwater condition. The tailwater depth h_4 is determined by the downstream stream geometry normally beyond the control of the designer. A culvert designer must determine the tailwater conditions prior to culvert design. If the conditions cannot be reasonably determined, he should assume reasonable conditions which most restrict the flow. If the tailwater is above critical depth in the culvert at the outlet, backwater is a controlling factor in culvert flow.

3.2.1.2 Description of The Six Possible Flow Types. Type 1, Critical Depth at The Inlet - This type of flow occurs most frequently on small steep streams where the available head is limited by topography and tailwater depths are low. The capacity of the culvert is limited by conditions at the inlet. In type 1 flow, as shown in Figure 3-1-1, the water passes through critical depth near the culvert entrance. The headwater to diameter ratio (h-Z)/D must be less than 1.5. The culvert barrel flows partially full. The culvert slope, S_o, must be steeper than the critical slope, S_c so that the water depth d is less than critical depth, and the tailwater elevation, h_4, must be less than the elevation of the water surface of the culvert at the entrance, Section 2. The discharge may be calculated analytically by application of the energy relationships provided in Figure 3-2 and discussed in Section 3.2.1.3. Alternatively Plates 3-18 and 3-19 provide a graphical solution.

Type 2, Critical Depth at Outlet - Type 2 flow, as shown on Figure 3-1-2, passes through critical depth at the culvert outlet. The headwater to diameter ratio (h-Z)/D does not exceed 1.5 and the barrel flows partially full. The slope of the culvert, S_o, is less than critical, and the tailwater elevation must not exceed the elevation of critical depth at the pipe outlet. The capacity of the culvert is controlled by conditions at the outlet and to a lessor extent by friction in the barrel. This type of flow occurs principally when a culvert for a small stream is installed at a low slope with the outlet perched above the stream bed. A culvert operating under this type of flow is not as hydraulically efficient as one operating under type 1 flow. Additionally the high water velocity at the outlet will create undesirable scour. This type of installation should be avoided. Nomographs applicable to culverts with flow a critical depth at the outlet have been developed by the U.S. Bureau of Public Roads and are presented as Plates 3-20 through 3-23.

Type 3, Tranquil Flow Throughout - Tranquil flow is flow in which the depth of water exceeds critical depth throughout the length of the culvert as shown in Figure 3-1-3. The headwater diameter ratio (h-Z)/D is less than 1.5 and therefore the inlet functions as a weir and the culvert barrel flows partially full. The tailwater elevation does not submerge the culvert outlet, but it does exceed critical depth at the outlet. Because of the wide range of possible conditions, an exact nomograph solution is not possible. A rough graphical approximation can be made only for cases with the tailwater, very near the culvert crown. An analytical solution is available by the methods of Section 3.2.1.3. This type of flow is usually found in large multiple culvert installations and is by far the most common North Slope flow type.

Type 4, Submerged Outlet - In this type of flow both the outlet and inlet are submerged and the culvert flows completely full. This type of flow is hydraulically very efficient. It is not usually found on the North Slope because the high tailwater requirements are not easily obtained. Discharge for a given head may be easily obtained analytically. Graphical solutions are provided on Plates 3-20 through 3-23.

Type 5, Rapid Flow at Inlet - Type 5 flow resembles flow under a sluice gate. Capacity is controlled soley by conditions at the inlet. As a conservatively approximate criterion, the headwater-diameter ratio exceeds 1.5. This insures filling the pipe at the entrance. The entrance contracts the flow so that the pipe is not full downstream of the entrances. The culvert barrel is neither flat nor long enough so that friction losses will cause the pipe to flow full and become type 6. The tailwater depth is below the top of the pipe at the outlet. This type of flow occurs only with short steep culverts and is not apt to be encountered under North Slope conditions. This is an undesirable flow type, because the vortex associated with the high headwater-diameter ratio will cause severe erosion at the inlet. Additionally the high velocity and possibility of a hydraulic jump at the outlet will cause severe erosion downstream. This flow type requires extensive erosion protection at both the inlet and outlet. Nomographs for determination of discharge are provided on Plates 3-18 and 3-19.

Type 6, Full Flow Free Outfall - In type 6 flow the culvert is full and under pressure. The tailwater is below the top of the culvert. The headwater-diameter ratio exceeds 1.5. This insures a strong vortex and erosion at the inlet. The total head available to force water through the pipe is the headwater depth, h_1, less the friction losses in the pipe, h_f, less the pressure head, h_3, at the outlet. This type of flow evolves from type 5 flow when the contracted entrance sluice jet is able to expand and contact the top of the pipe. Once the jet expands to the top of pipe, the passage of air to the culvert is stopped, and the culvert must flow full for its entire length. Within a certain range, either type 5 or 6 flow may alternatively occur under the same conditions. Type 6 flow is hydraulically more efficient and for the same discharge type 6 flow will have a lower headwater elevation. Like type 5 flow, type 6 is undesirable because of excessive erosion at the inlet and outlet. The nomographs used for type 5 flow, Plates 3-18 and 3-19 are also used for type 6 flow. The nomographs provide the most conservative solution.

3.2.1.3 Analytical Solutions - As previously stated, the hydraulic design of a particular culvert consists of evaluating all of the possible flow types and adopting the one that produces the highest headwater elevation for a given discharge or the lowest discharge for a fixed headwater. Except for type 3 flow, reasonably accurate solutions can usually be found by use of nomographs presented in

Section 3.2.1.4 without recourse to laborious analytical computation. Analytical solutions are necessary for type 3 flow and in some special cases for the other flow types.

Analytical solutions are based on the principals of conservation of energy and continuity. Figure 3-2 provides a definition sketch.

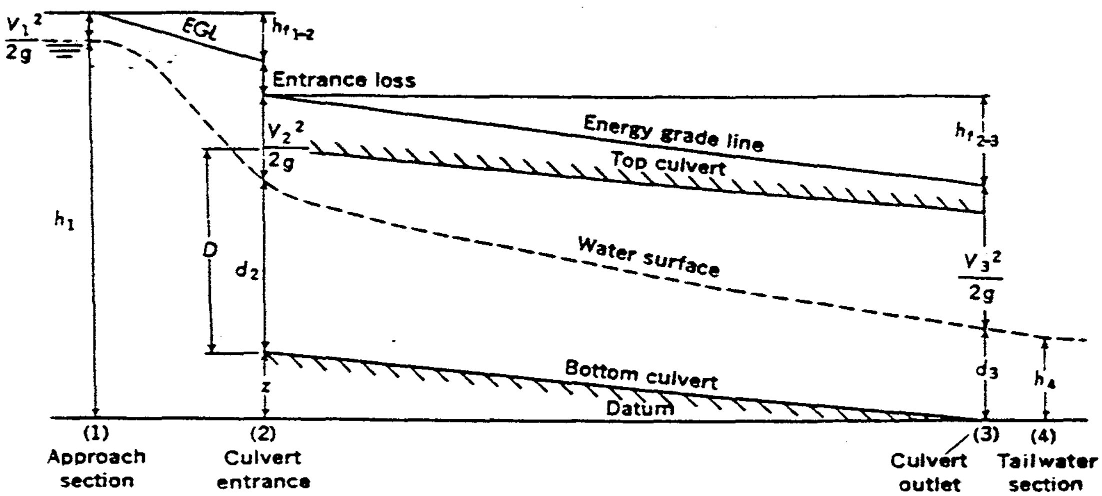


FIGURE 3-2 DEFINITION SKETCH OF CULVERT FLOW

Section 1 represents the approach channel at the point where drawn down starts. The total energy available to force water through the culvert,H, consists of the static head acting on the control section, h_1, plus the velocity head in feet, $V_1^2/2g$, of the approach flow. Section 2 represents the culvert entrance. The energy lost between Sections 1 and 2, $h_{f\ 1-2}$, is due to friction in the approach channel. This friction loss may be determined by the open channel flow formulas provided in Equation 3.7.

The energy lost at the culvert entrance is due to sudden contraction and subsequent expansion of the water stream. The geometry of the culvert entrance determines this loss. This loss is calculated as a coefficient of discharge, C, times the velocity head, h_v, in the barrel. The entrance loss coefficients are derived experimentally and are provided in Table 3-8.

An additional energy loss occurs due to friction in the barrel, h_{f2-3}. This loss may be derived by an appropriate open channel or pipe flow formula depending on flow depth. These formula are given as Equations 3.8 and 3.9.

All of the energy remining is in the velocity head at the outlet, $V_3^2/2g$, and is dissipated in the tailwater.

Summary formulas for obtaining the discharge for the six flow types are provided in Figure 3-1. A methodology for obtaining the various components of energy loss follows:

<u>Critical depth, d_c</u>: critical depth is dependent only on pipe cross section geometry and discharge. It is easily

derived it provides a starting point for culvert type 1 and 2 computations.

For rectangular sections,

$$Q = 5.67\ b\ d_c^{3/2} \qquad (3\text{-}5)$$

For circular, arch or elliptical sections,

$$Q = c_q\ D^{5/2} \qquad (3\text{-}6)$$

where

C_q is a function of the pipe diameter D and water depth d and is obtained from Tables 3-6 or 3-7. Critical depth is also discussed in Section 3.1.1.

<u>Energy head loss between the approach section and the inlet</u>:

$$h_{f\ 1-2} = L_w\ (Q^2/K_1K_2) \qquad (3\text{-}7)$$

where

$K = 1.486AR^{2/3}/n$, K_2 may be obtained from Tables 3-6 or 3-7 for pipe sections. K_1 must be calculated from section 1 properties. Since K_1, and K_2 are functions of water depth which are in turn functions of h_f Equation 3-7 must be solved by trial and error. Table 3-7 provides n values for pipe sections.

Table 3-1 provides n values for channel sections.

For type 4, 5, and 6 flow with substantial headwater h_{f1-2} is usually negligible.

TABLE 3-8
MANNINGS PIPE ROUGHNESS COEFFICIENTS, n,

Type	Diameter*	n Value
Welded steel	All	0.012
Annular Corrugations		
2-2/3" pitch 1/2" rise	All	0.024
3" pitch 1" rise	30"-144"	0.027
6" pitch 1" rise	30"- 60"	0.025
	66"- 96"	0.024
	108"-144"	0.023
6" pitch 2" rise	60"- 72"	0.034
	84"- 96"	0.033
	108"-132"	0.032
	144"-156"	0.031
	168"-180"	0.030
	192"-216"	0.029
	228"-240"	0.028
	252"-276"	0.027
Helical Corrugations		
2-2/3" pitch 1/2" rise	24"	0.016
	36"	0.019
	48"	0.020
3" pitch 1" rise	36"	0.021
	48"	0.023
	54"	0.023
	60"	0.024
	66"	0.025
	72"	0.026

*For pipe arch culverts, use rise equal to diameter

Energy loss at the entrance h_e. Flow entering a pipe is constricted. A large loss of energy results from this constriction and its subsequent expansion. This loss of energy is a function of the entrance geometry of the pipe, the headwater to pipe diameter ratio and the type of flow in the culvert. The amount of energy retained is expressed as a coefficient, C_e, times the velocity head at the culvert entrance or $h_e = C_e \, V_2^{2}/2g$. The coefficient C_e has been experimentally determined for a wide range of conditions. A summary is presented in Table 3-8. Coefficients for sizes not presented may be interpolated from given data provided so long as $Q/D^{5/2}$ exceeds the experimentally determined minimum value given in Table 3-8.

In some case a small undefined flow region exists between type 6 and type 5 flow. In these cases the culvert may operate under either condition and will easily change between the two flow types. The most conservative assumption should be used.

Type 5 flow can exist only for short steep culverts. Once the flow in the culvert barrel contacts the top of the pipe the flow of air to the culvert will be cutoff and the pipe will flow full as type 6 flow. The outlet control nomographs of Section 3.2.1.4 are based on an assumption of type 6 flow.

TABLE 3-9

ENTRANCE LOSS COEFFICIENTS

Entrance Type	$(h_1-Z)/D$ 1.60	1.40	1.20	1.00	0.80	0.60	0.40
TYPE 1, 2, AND 3 FLOW (part full pipe, low head)							
Steel Line Pipe - Any Diameter							
Flush in a vertical headwall	0.80	0.83	0.86	0.88	0.91	0.93	0.93
Mitered to a 1 on 2 slope	0.70	0.73	0.82	0.87	0.90	0.90	0.88
Projecting one diameter	0.72	0.74	0.77	0.79	0.82	0.83	0.84
24 Inch CMP							
Flush in a vertical headwall	0.86	0.87	0.92	0.93	0.93	0.93	0.93
Mitered to a 1 on 2 slope	0.70	0.73	0.82	0.87	0.90	0.90	0.88
Projecting one diameter	0.77	0.78	0.83	0.84	0.88	0.90	0.91
60 Inch CMP							
Flush in a vertical headwall	0.82	0.85	0.88	0.91	0.93	0.93	0.93
Mitered to a 1 on 2 slope	0.70	0.73	0.82	0.87	0.90	0.90	0.88
Projecting one diameter	0.74	0.77	0.79	0.82	0.84	0.86	0.86

Coefficients for pipes 72" and larger are the same as for steel line pipe.

Entrance Type	1.60	1.40	1.20	1.00	0.80	0.60	0.40
TYPE 4 AND 6 FLOW (Full pipe, high head)							
Steel line pipe - any diameter							
Flush in a vertical wall	0.84	0.84	0.84	0.84	---can not exist--		
Mitered to a 1 on 2 slope	0.74	0.74	0.74	0.74			
Projecting one diameter	0.76	0.76	0.76	0.76			

TYPE 4 AND 6 FLOW (cont.)
(Full pipe, high head)

24 Inch CMP					
Flush in a vertical headwall	0.87	0.87	0.87	0.87	--can not exist--
Mitered to a 1 on 2 slope	0.74	0.74	0.74	0.74	
Projecting one diameter	0.78	0.78	0.78	0.78	
48 Inch CMP					
Flush in a vertical wall	0.85	0.85	0.85	0.85	--can not exist--
Mitered to a 1 on 2 slope	0.74	0.74	0.74	0.74	
Projecting one diameter	0.76	0.76	0.76	0.76	

Coefficients for larger pipe are the same as for steel line pipe.

TYPE 5 FLOW
(part full pipe, high headwater)

Steel Line Pipe - any diameter			
Flush in a vertical head wall	0.47	0.44	-------can not exist---------
Mitered to a 1 on 2 slope	0.44	0.43	
Projecting one diameter	0.42	0.40	
24 Inch CMP			
Flush in a vertical head wall	0.49	0.45	-------can not exist---------
Mitered to a 1 on 2 slope	0.45	0.41	
Projecting one diameter	0.44	0.41	

Coefficients for larger pipe are the same as for steel line pipe.

NOTES:

1. For classification of culvert flow, see Figure 3-1
2. Coefficients for pipe diameters not provided may be obtained by interpolation.

Head loss to friction in the barrel, h_{f} 2-3. Head loss to friction in the barrel contributes to the energy (head) requirement for all flow types except type 5. Friction losses are minor for type 1 flow. In type 1 flow, the loss to friction in the barrel is important only insofar as it contributes to flow conditions at the outlet, for erosion control, and for fish passage. The friction loss, for full pipes, types 4 and 6, can be determined analytically by Manning's equation expressed as:

$$h_{f2-3} = L\ (Q^2/K^2) \qquad (3\text{-}8)$$

where K is obtained from Tables 3-6 and 3-7 for d/D=1 and n is obtained from Table 3-7.

For pipes flowing part full, types 1, 2 and 3, the friction loss can also be determined by Manning's equation. However, since the water depth varies gradually throughout the length of the pipe, the flow is nonuniform. A variation of the Manning equation which accommodates nonuniform flow is:

$$h_{f2-3} = L\ Q^2/K_2\ K_3 \qquad (3\text{-}9)$$

where, as before, K is obtained from Tables 3-6 or 3-7.

The water depth at the outlet must be known. For type 2 flow it is by definition critical depth. For type 3 flow it is by definition greater than critical depth. Type 3 depth is not a function of the culvert geometry, but rather solely a function of downstream, channel conditions. The downstream tailwater depth at Section 3 can be determined by the open channel methods presented in Section 3.1

The upstream water depth, Section 2, is not known and cannot easily be directly calculated. The traditional approach is to <u>assume</u> a water depth in the entrance, Section 2, calculate the friction loss by the above formula. Check the assumption by considering the conservation of energy using the following procedure.

The elevation of the water surface at Section 3 plus velocity head, $V_3^2/2g$, at Section 3 plus calculated friction loss, h_{f2-3}, less velocity head at Section 2, $V_2^2/2g$ should equal the water surface elevation assumed for Section 2. An adequate solution should be obtained in no more than three tries.

<u>Head loss at the outlet, h_{f3}.</u> All remaining energy is dissipated at the outlet. Except for types 3 and 4 flow, conditions at the outlet do not effect the culvert headwater. However, even in

these cases, knowledge of flow conditions at the outlet may be important for the design of erosion prevention structures or to insure fish passage. For type 1 flow the water depth at the pipe outlet must be calculated by backwater procedures beyond the scope of this manual. However, for practical purposes it may be estimated by assuming normal depth and uniform flow by the methods given in Section 3.1.2. For type 2 flow critical depth exists at the outlet and depth may be estimated using Tables 3-6 and 3-7. For type 3 and 5 flow, the velocity at the outlet is a function of downstream water depth. For type 6 flow, the outlet velocity is the discharge, Q, divided by the pipe area.

3.2.1.4 Graphical Solutions: Because of the complexity of the foregoing analytical solutions the U.S. Bureau of Public Roads developed simple graphical solutions (Herr, 1965). These solutions are useful for determining pipe sizes required to pass flood flows for all flow types except type 3 and type 4 when the pipe is less than 3/4 full at the outlet. Type 3 pipe sizes must be determined by analytical methods. Additionally, the nomographs do not provide information necessary to the design of outlet erosion control works or fish passage.

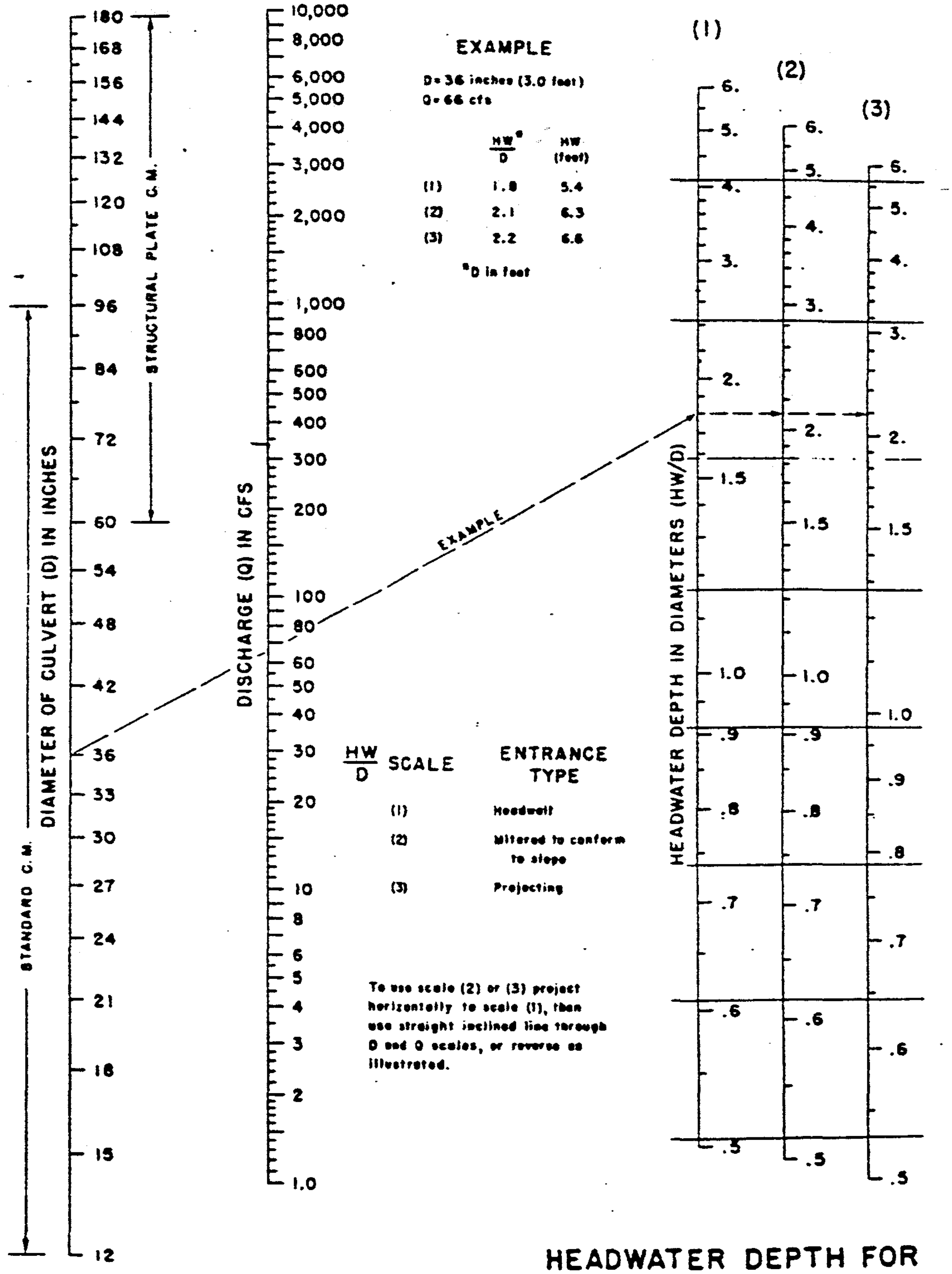
Inlet control nomographs - culvert types 1, and 5. Inlet control nomographs are based on assumptions of the foregoing analytical method. They provide an adequate solution for the intended types of flow and range of conditions. However, most large culverts at the limited head available on the North Slope will be outlet controlled and not solvable by inlet control methods. Additionally, Type 5 culverts create undesirable erosion. This erosion is discussed in Section 3.2.1.2. The following Plates 3-18 and 3-19 are nomographs for CMP inlet control culverts. Friction is not a consideration therefore, they are applicable, for practical purposes, without adjustment to steel line pipe inlet control culverts.

Outlet control nomographs - culvert types 4 and 6. The outlet control nomographs are based on the assumptions and methods presented in the previous analytical discussion. The nomographs are strictly accurate only for flow types 4 and 6. To use the nomographs, it is necessary to know the tailwater conditions. This is because the head, H_o, available to push water through the pipe is the difference between the elevation of the energy grade line upstream of the culvert and the hydraulic grade line at the exit. Because of pondage, the entrance velocity head is relatively small and, for most practical purposes, the head, H_o, is the difference in water surface elevations upstream and downstream. Tailwater conditions may be determined by the methods of Section3.1. For culverts flowing full friction is an important factor and is provided for in the nomographs by using the friction factor, n, given on the nomographs. The nomographs may be used for other friction factors by adjusting to an artificial culvert length, L, as follows:

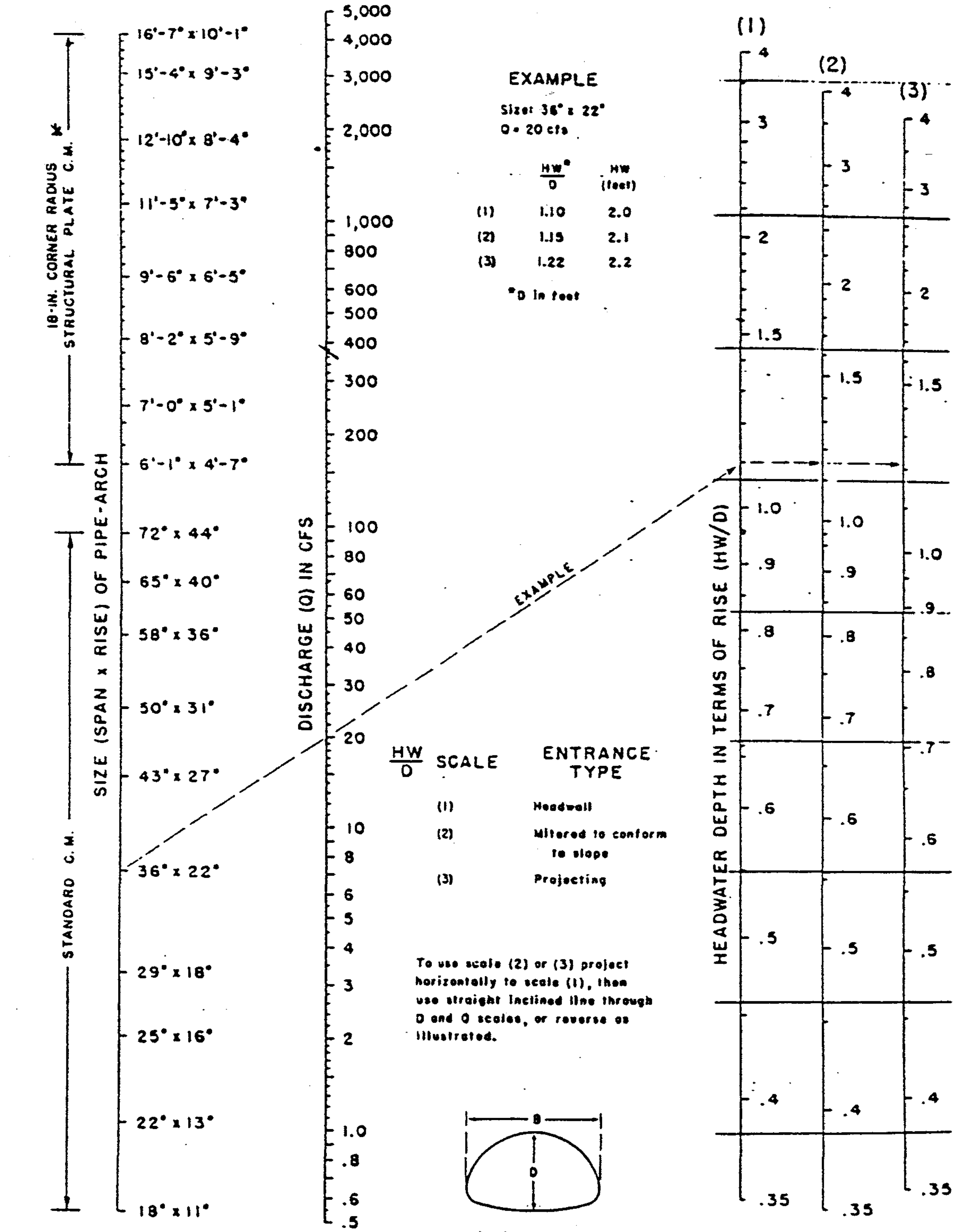
$$L_1 = L\, n_1{}^2/n^2 \qquad (3\text{-}10)$$

where

L is the actual pipe length and n is the chart roughness value and n_1 is the actual value. Thus, for the most common case of decreasing roughness values to accommodate line pipe having n values of 0.012, from corrugated pipe culverts having an "n" of 0.024, use one-fourth of the actual culvert length. Plates 3-20 through 3-23 are entrance control nomographs.



HEADWATER DEPTH FOR
C. M. PIPE CULVERTS
WITH INLET CONTROL

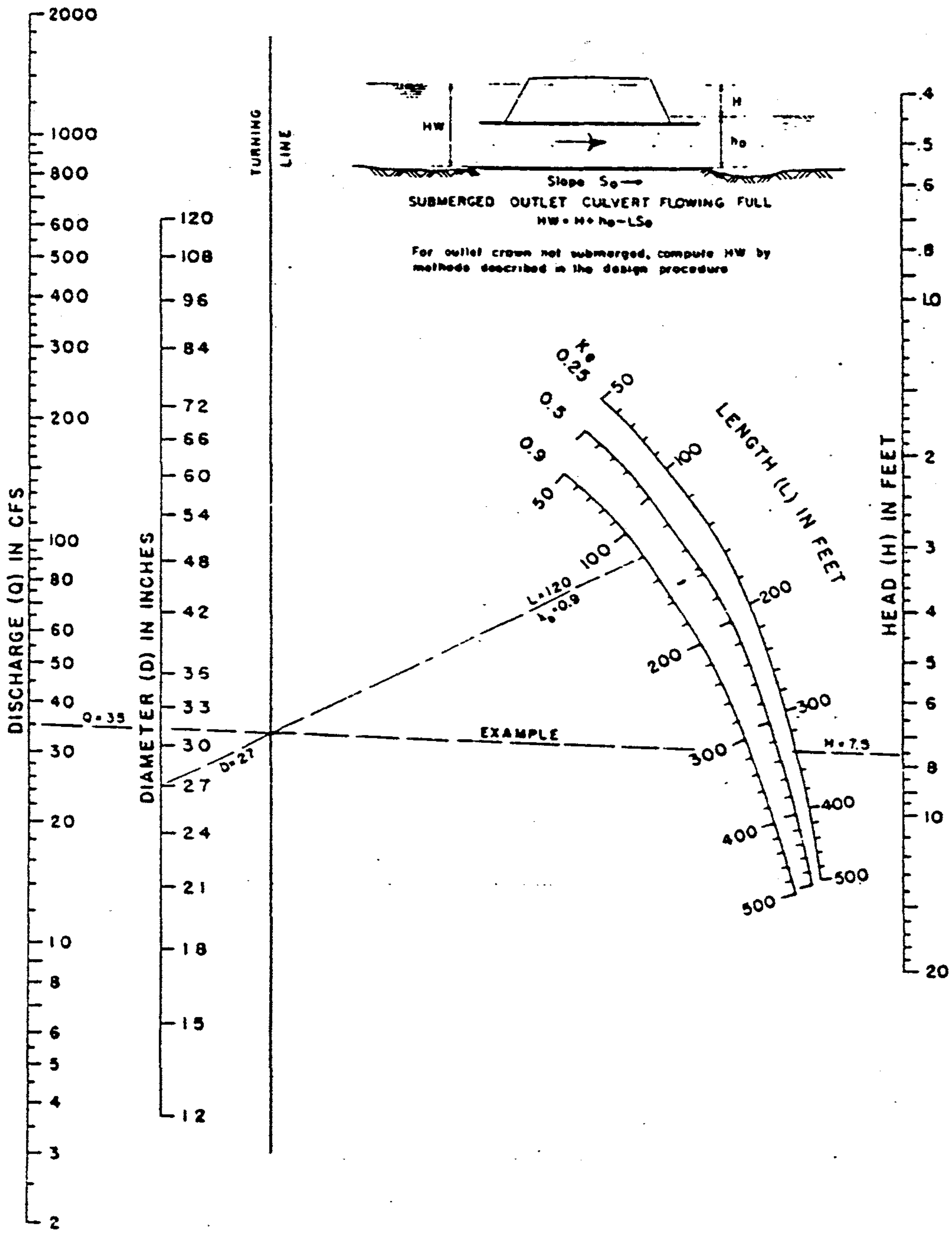


*ADDITIONAL SIZES NOT DIMENSIONED ARE LISTED IN FABRICATOR'S CATALOG

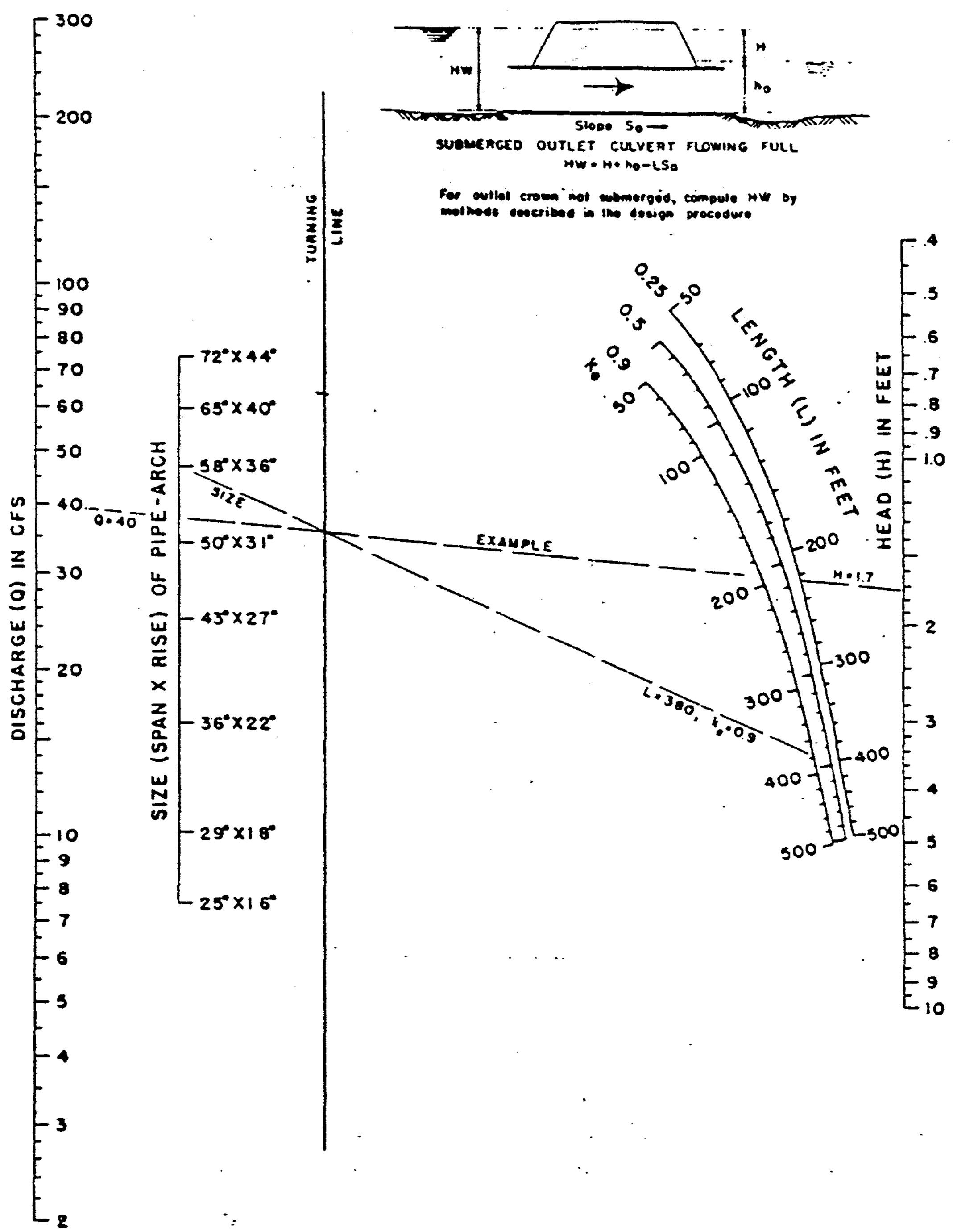
HEADWATER DEPTH FOR C. M. PIPE-ARCH CULVERTS WITH INLET CONTROL

Outlet control, culvert type 2. When critical depth exists at the outlet, as shown in Figure 3-1 (type 2). The headwater elevation is a function of both entrance losses and friction in the barrel, analytical computations are required to accurately determine head. For most practical engineering applications, a reasonable graphical solution can be obtained using Plates 3-20 through 3-23 by assuming an artificial tailwater depth equal to one-half of the distance between critical depth at the outlet and the crown of the pipe. Critical depth at the outlet is obtained from Plate 3-24. This solution becomes less reasonable with lower headwater elevations, not sufficient to fill the pipe. In these cases, an analytical solution must be made. The graphical solution should not be applied when critical depth is below 0.75D.

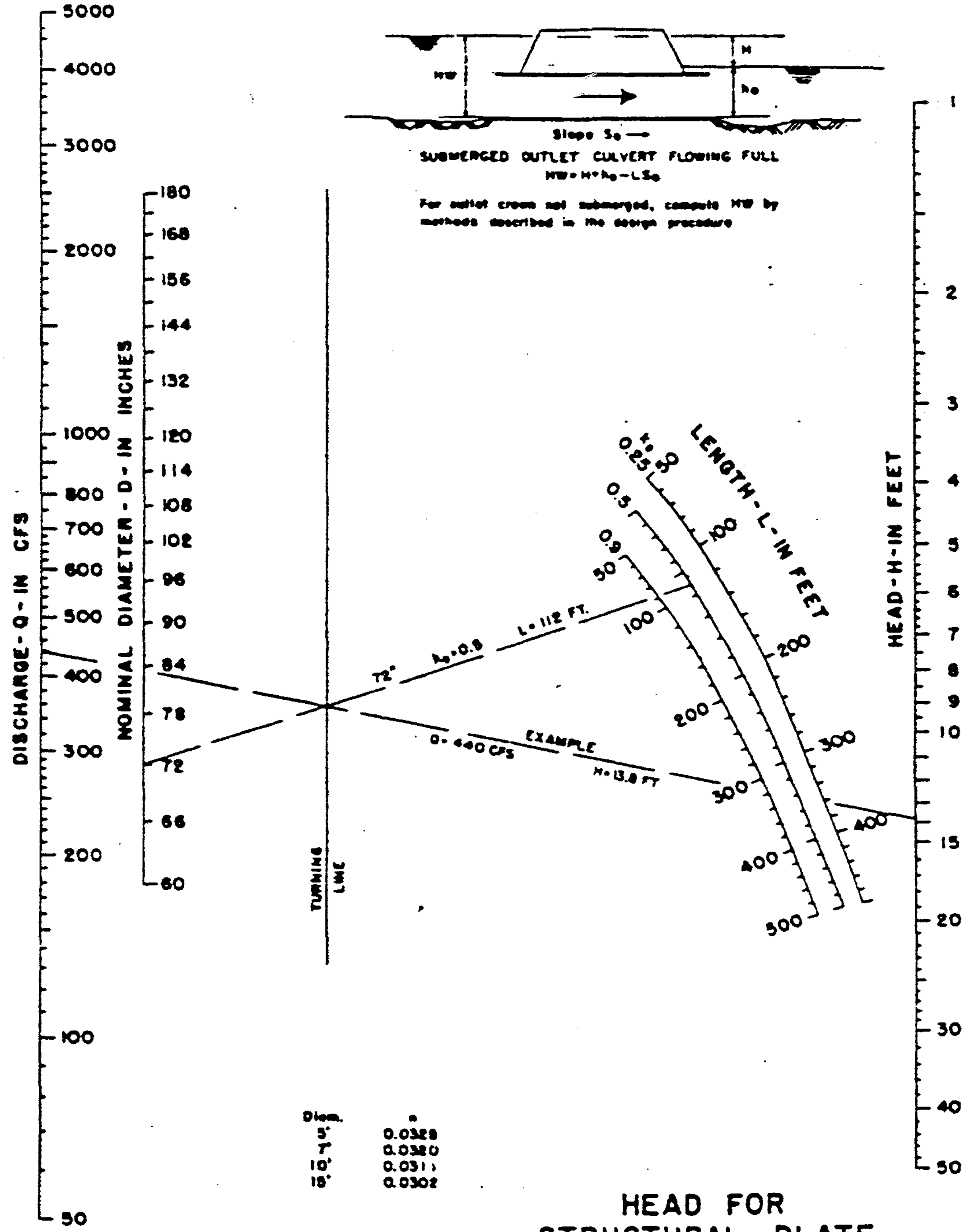
Tranquil Flow, Culvert Type 3. Analytical solutions are required for all type 3 culverts.



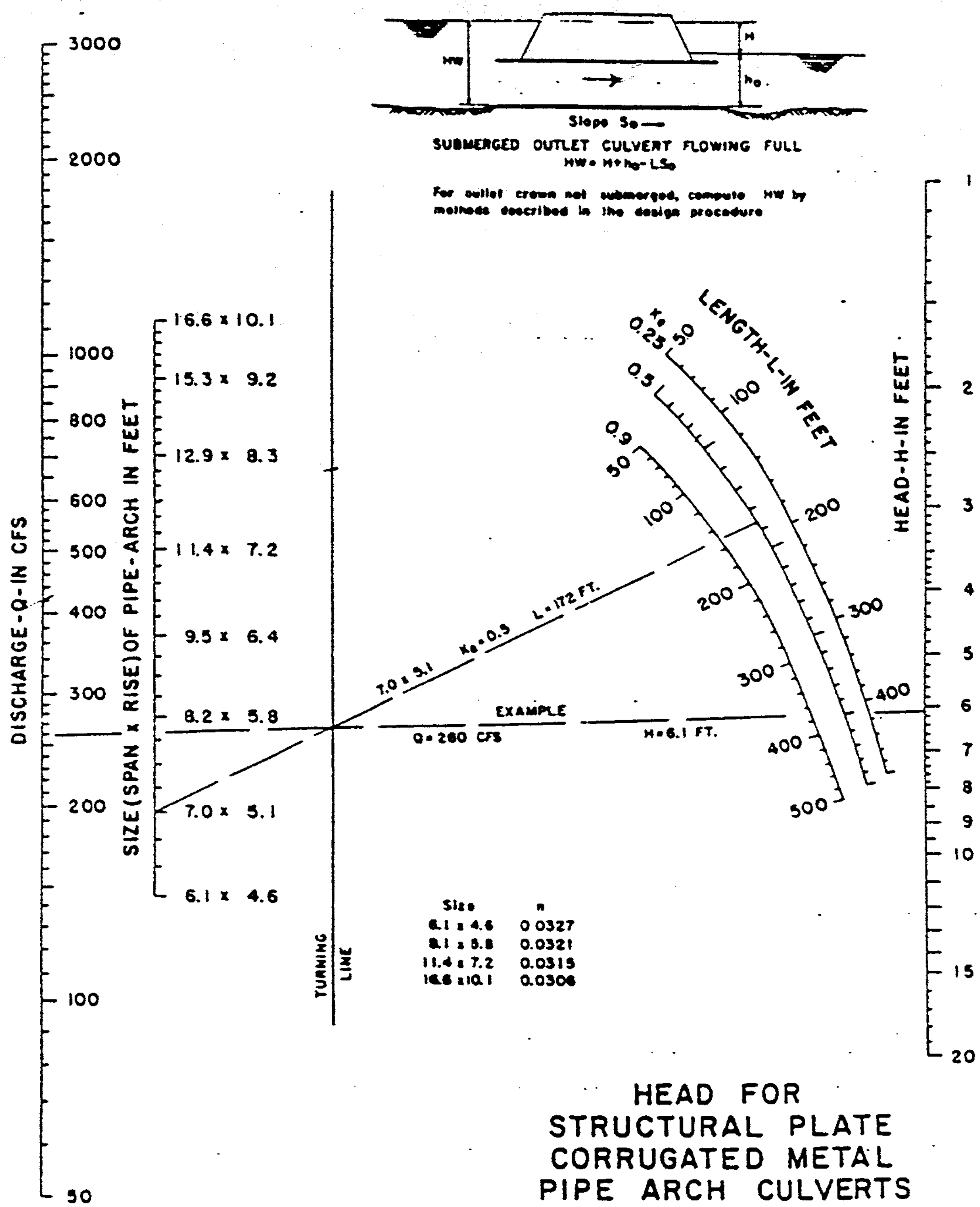
HEAD FOR STANDARD C. M. PIPE CULVERTS FLOWING FULL n=0.024



HEAD FOR
STANDARD C. M. PIPE-ARCH CULVERTS
FLOWING FULL
n=0.024



HEAD FOR
STRUCTURAL PLATE
CORR. METAL PIPE CULVERTS
FLOWING FULL
n = 0.0328 TO 0.0302



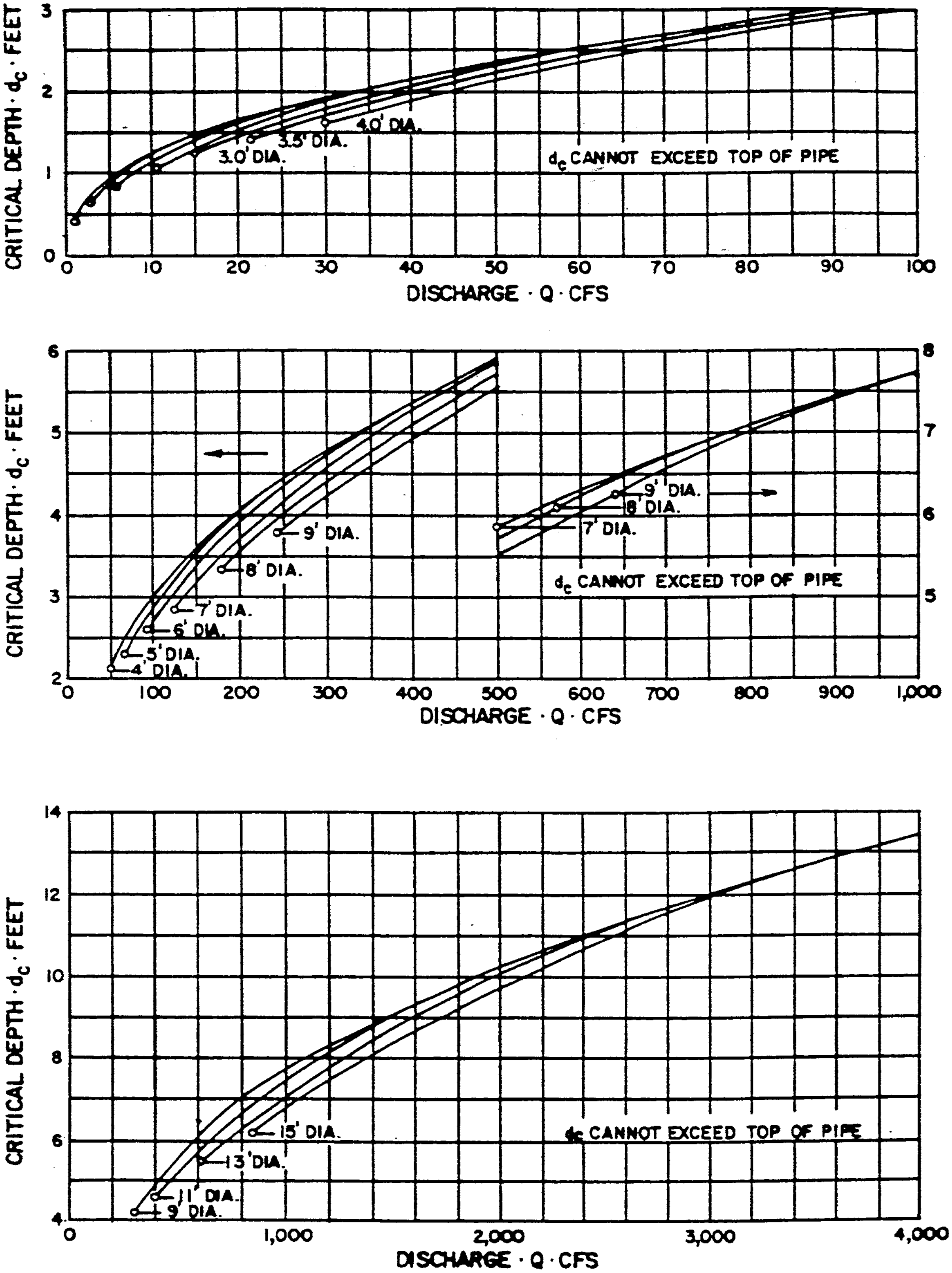
Size	n
6.1 x 4.6	0.0327
8.1 x 5.8	0.0321
11.4 x 7.2	0.0315
16.6 x 10.1	0.0306

HEAD FOR
STRUCTURAL PLATE
CORRUGATED METAL
PIPE ARCH CULVERTS
18 IN. CORNER RADIUS
FLOWING FULL
n = 0.0327 TO 0.0306

Critical depth graphs. Critical depth is the depth at the point of minimum specific energy. It has been discussed with respect to open channels in Section 3.1.1 and for culverts in Section 3.2.1.3. It provides a starting point in many hydraulic computations. It may be obtained graphically from Plates 3-24 or 3-25 for most culverts shapes. Critical depth for rectangular sections is provided on Plate 3-1.

Tailwater graphs. Tailwater elevations are difficult to access but necessary to use the outlet control nomographs. In many cases they must be calculated by involved procedures beyond the scope of this manual. A reasonable solution can be often obtained by employing uniform flow formulas. Graphs applicable to wide rectangular channels are provided as Plates 3-2 through 3-17. By using average channel depth and width, these charts can give a reasonable approximation of tailwater elevation for normal channels. Care must be exercised to consider backwater from downstream constrictions.

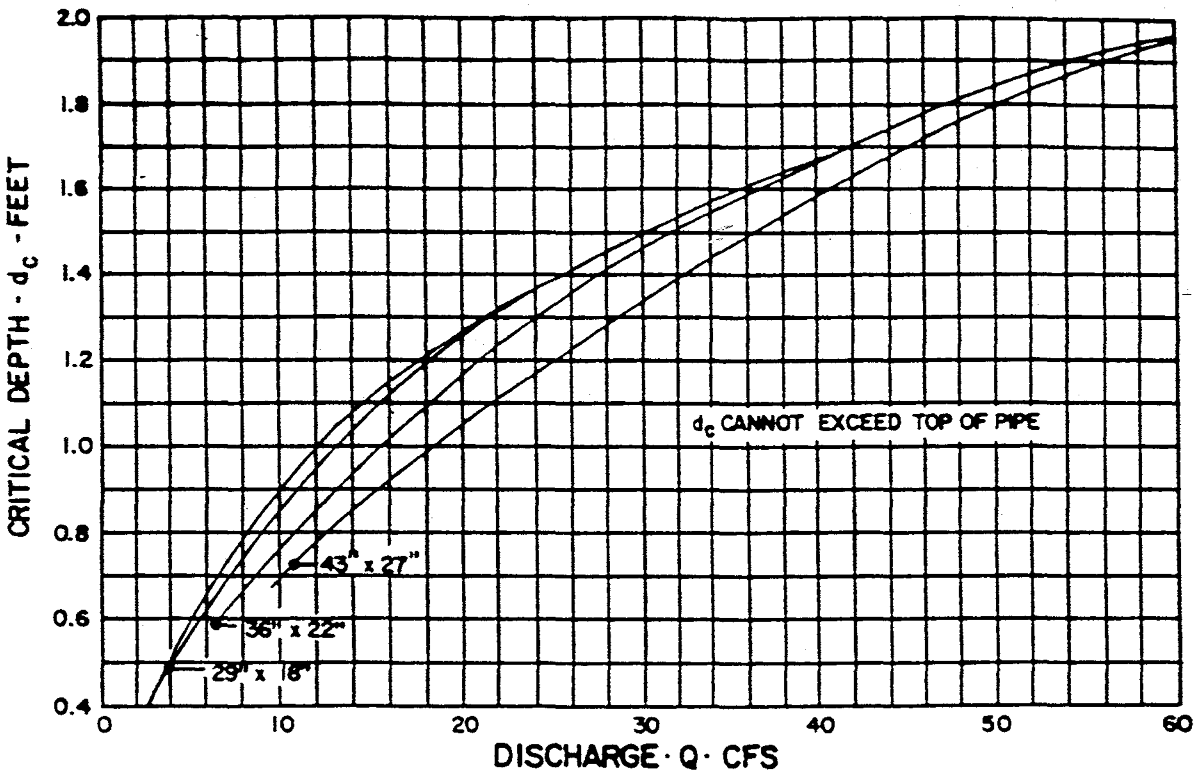
Graphic hydraulic design procedure. As previously discussed, the hydraulic design of a culvert is a trial and error process. The headwater elevation for alternative culvert types are determined for both the inlet control and outlet control cases. The highest of either the inlet or outlet control headwater elevation is the actual headwater elevation. Plate 3-26 is a form widely used to facilitate culvert sizing computations.

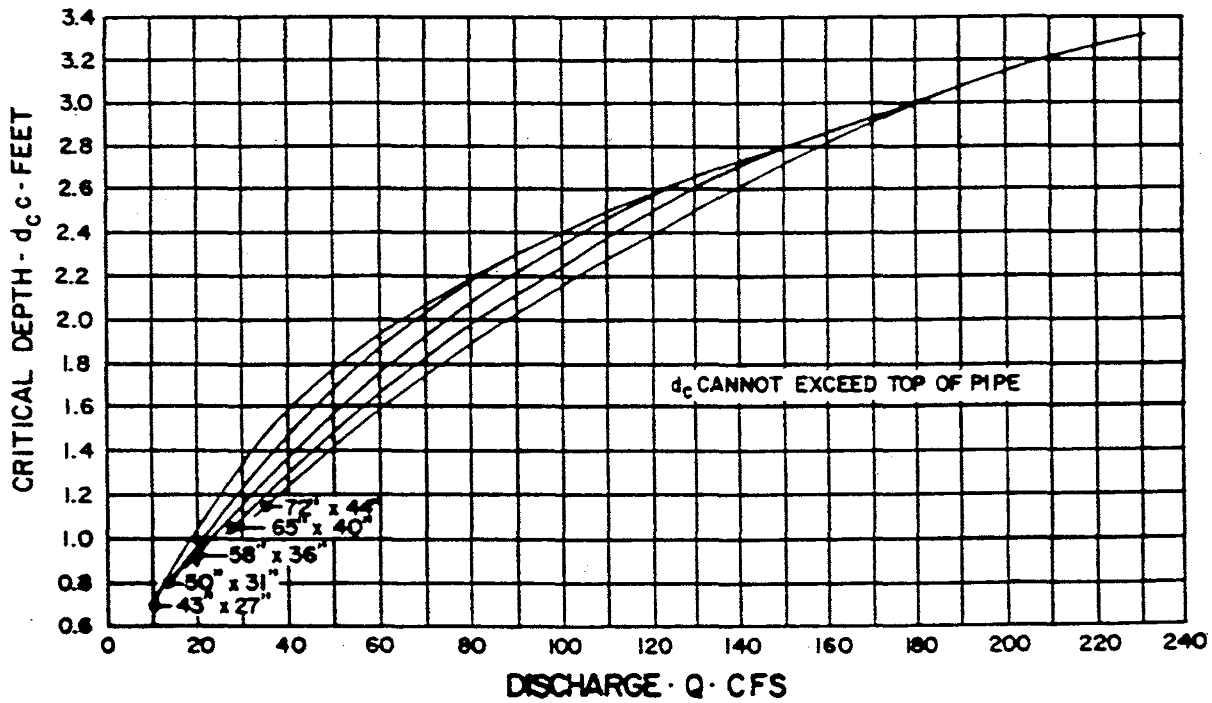


CRITICAL DEPTH
FOR C.M. PIPE CULVERT

ADAPTED FROM REFERENCE 3-5

PLATE 3-24





CRITICAL DEPTH
FOR C.M. PIPE ARCH CULVERT

ADAPTED FROM REFERENCE 3-5

PLATE 3-25

PROJECT: ______________ DESIGNER: ______________

DATE: ______________

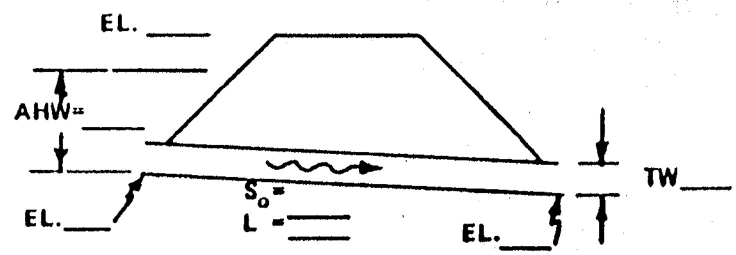
HYDROLOGIC AND CHANNEL INFORMATION

Q_1 = ________ TW_1 = ________

Q_2 = ________ TW_2 = ________

SKETCH

STATION: ______________



ALLOWABLE OUTLET VELOCITY = ________

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION										CONTROL HW	OUTLET VELOCITY	COST	COMMENTS
			INLET CONT.		OUTLET CONTROL $HW = H + h_o - LS_o$											
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c + D}{2}$	TW	h_o	LS_o	HW				

SUMMARY & RECOMMENDATIONS:

3.2.2 Hydraulic Design For Ice Covered Culverts.

The design procedures of Section 3.2.1 are applicable to culverts operating in ice free environments. These procedures are reasonably realistic for determination of culvert sizes for peak breakup discharges for large floods because by the time of peak, for large floods, the small streams are usually ice free. More severe hydraulic conditions may exist prior to the time of peak discharge. These may arise because culverts or downstream channels are blocked by snow or ice. The open channel analytic procedures of Section 3.1 may be used to size culvert approach and tailwater channels to accommodate ice blockage or, for the purpose of analysis, to alter waterway dimensions to those expected to exist. A preferred alternative solution is to maintain ice free design conditions by excavating or thawing snow and ice prior to breakup. This preferred solution is discussed in Section 7.1.

Culverts are also deliberately designed to operate under an ice cover. This is often done to enable winter ice road crossings of major rivers. Under ice covered conditions a culvert flows full with type 4 flow as shown on Figure 3-1. The head $H = (h_1 - h_4)$ is the difference between the design upstream and downstream free water surface elevations. This elevation difference should be limited to about one foot in order to minimize the tendency for upstream river flow to break through the ice cover and cause surface icings (aufies). Entrance loss coefficient, C_e, may be conservatively estimated as 0.9. Pipe friction loss values are provided in Table 3-7. Minimum design velocity in the culverts should not be less than two feet per second in order to prevent ice formation in the culvert barrel. The complete discharge equation is:

$$Q = CA_o \left(\frac{2g\,(h_1 - h_4)}{1 + \dfrac{2gC^2 n^2 L}{R_o^{4/3}}} \right)^{1/2} \qquad (3\text{-}11)$$

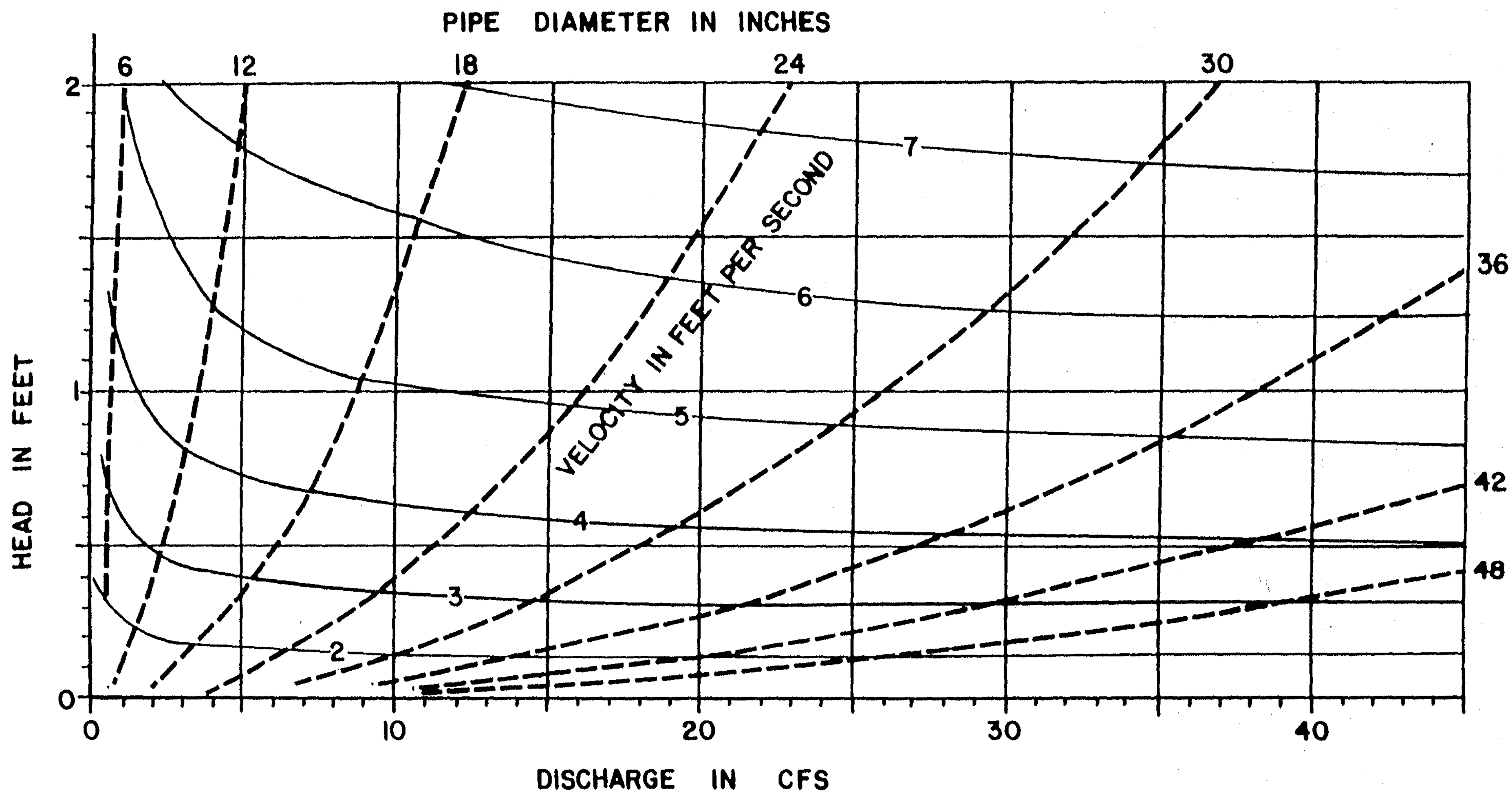
For steel line pipe, the equation reduces to:

$$Q = \frac{5.67\ D^2\ H^{7/2}}{1 + \dfrac{0.0215\ L}{D^{2/3}}} \qquad (3\text{-}12)$$

For water velocities low enough and pipes short enough to neglect friction the equation reduces to:

$$Q = 5.67\ D^2 H^{1/2} \qquad (3\text{-}13)$$

Plate 3-27 provides a graphical solution of Equation 3-12 for steel line pipe, 75 feet long, operating under one foot of head under an ice cover.



STEEL LINE PIPE

L = 75' ke = 0.9

n = 0.01

RIVER WINTER CROSSING
CULVERT CHARACTERISTICS

NOVEMBER 12, 1980

G.N.M. PLATE - 3 - 27

3.2.3 Fish Passage Through Culverts. Many streams are designated as supporting an important fish population. The purpose of this section is to provide guidance as to culvert design requirements which will enable free passage of fish.

3.2.3.1 Design discharge for fish passage - Passage of fish through culverts should be assured in both an upstream and downstream direction at all times when fish are known to be present except for 48 hours during the peak of the mean annual flood. Derivation of the discharge hydrograph for a design flood requires extensive site specific data not usually available. A conservative design procedure is to use 75 percent of the two year mean annual flood as developed by the procedures of Section 2. The estimate of the mean annual flood developed using Section 2 should be field checked for reasonability by comparison to the bank full capacity of the channel by the methods given in Section 3.1.

3.2.3.2 Design Velocities For Fish Passage - Table 3-10 provides widely accepted estimates of the swimming ability of fish in culverts of various length. These velocities should be applied to the outlet of the culverts.

3.2.3.3 Culvert Embedment - Culverts which are intended to allow fish passage are usually imbedded slightly below the stream thalweg. This embedment provides a rougher more natural bed than would a clean metal culvert. In any culvert round pipe installation intended to facilitate fish passage at least one pipe should be imbedded in the stream gravels with at least one fifth of the pipe diameter below the stream thalweg. For arch or eliptical type culverts at least one pipe should be imbedded six inches into the stream bed. The decision as to embedment depth, and the number of pipes to be imbedded must consider the consequences on low flow depth of the installation.

3.2.3.4 Alternatives structures - Velocity requirements for culverts intended to facilitate fish passage, do not apply to bridges, bottomless arch pipes, or low water crossings. These structures provide alternatives to culverts.

TABLE 3-10

AVERAGE CROSS SECTIONAL VELOCITIES IN FEET/SECOND
MEASURED AT THE OUTLET OF THE CULVERT
ALLOWING FISH PASSAGE

Length of culvert in feet	Group I Upstream migrant salmon fry and finglerlings when upstream migration takes place at mean annual flood	Group II adult and juvenile slow swimmers: grayling, long-nose suckers, whitefish, burbot, sheefish, Northern pike, Dolly Varden/Arctic Char, upstream migrant salmon fry and fingerlings when migration not at mean annual flood	Group III Adult moderate swimmers: pink salmon, chum salmon, rainbow trout, cutthroat trout	Group IV Adult high performance swimmers: king salmon, coho salmon, sockeye salmon, steelhead
30	1.0	4.6	6.8	9.9
40	1.0	4.52	5.8	8.5
50	1.0	4.04	5.0	7.5
60	0.9	3.64	4.6	6.6
70	0.8	3.31	4.2	6.0
80	0.8	3.02	3.9	5.5
90	0.7	2.77	3.7	5.1
100	0.7	2.54	3.4	4.8
150	0.5	1.8	2.8	3.7
200	0.5	1.8	2.4	3.1
200	0.5	1.8	2.4	3.0

From State of Alaska "Proposed Department of Fish and Game Draft Culvert Installation Standards - 5AAC 95.200"

3.2.4 Inlet Erosion. Vortices generated at culvert inlets can cause erosion of the gravel embankment. Vortex erosion can be prevented by provision of armor, a headwall or by limiting the headwater to pipe diameter ratio (HW/D) to less than 1.5 for culverts with projecting entrances or 1.2 for culverts with short headwalls or mitered entrances. Allowable headwater ratios are lower for mitered entrances because the vortex is closer to the embankment. Should higher headwaters be desired riprap or concrete mats should be provided to the maximum expected water surface and one pipe diameter on either side of the pipe. If flush inlets are desired so as to enable a shorter pipe and more efficient hydraulics, the pipe may be installed in a headwall. The headwall should extend a minimum of 0.2 D but not less than 12 inches above the pipe. The headwall should extend a distance below the pipe to prevent undermining from scour. Scour depths are discussed in Section 3.2.5. The slope above the headwall may be protected with riprap or alternatively the headwall may be extended to the maximum water surface elevation.

3.2.5 Outlet Erosion. Erosion frequently occurs downstream of culvert outlets. This erosion occurs as the result of dissipation of energy concentrated by the culverts. Two types of solutions exist. The first consists of estimating the size of scour hole that will naturally develop and accepting that scour. The second consists of providing a structural limit on scour by riprap concrete mattresses or preformed stilling basins.

3.2.5.1 Natural scour. Scour holes develop naturally below culvert outlets. These holes are efficient energy dissipators and tend to reach a limiting size when the hole is able to dissipate the available energy. The size of the hole is relatively independent of the nature of the bed material. However, the rate at which the hole develops is dependent on the nature of the bed material. The Corps of Engineers has developed equations for predicting scour hole dimensions (Bohen 1970). These equations were developed from studies of culverts in fine sand beds. Holes would develop more slowly in the frozen silts and gravels of the North Slope streams. It may require several large floods to develop maximum scour. The equations are

$$DS = 0.74D\ (Q/D^{2.5})^{0.375} t^{0.10} \quad (3\text{-}15)$$

$$WS = 0.72D\ (Q/D^{2.5})^{0.915} t^{0.15} \quad (3\text{-}16)$$

$$LS = 4.10D\ (Q/D^{2.5})^{0.71} t^{0.125} \quad (3\text{-}17)$$

where

DS = is the maximum lowering of the stream bed downstream of the culvert outlet in feet

WS = is the maximum width of the scour hole in feet

LS = is the maximum length of the scour hole in feet

D = is the culvert diameter in feet

Q = is the discharge in cfs sustained during the time period, t

t = is the duration of Q in minutes not to exceed 1440 minutes (24 hours)

The above equations are developed for tailwater elevations above the culvert centerline. This is typical for most North Slope applications. If the tail-water is below the pipe centerline the depth of scour, DS, should be increased by eight percent, the width of scour, WS, by 39 percent and the length of scour LS by 201 percent. The discharge, Q, in the above formulas represents sustained discharge. In natural streams, the peak flood discharge is a instantaneous value not sustained long enough to develop full scour. For most small North Slope streams the sustained scour discharge should be about 90 percent of the instantaneous peak discharge. The following Figure 3-3 provides a graphical solution for scour depth.

The specific investigations cited above were for culvert outlets without vertical walls at the outlets. Maximum scour depths occur at about 40 percent of the scour hole length. Later investigations have shown that for culverts with vertical walls at the outlet, the maximum scour depth will also occur at the wall. Headwalls must be designed to accommodate this scour.

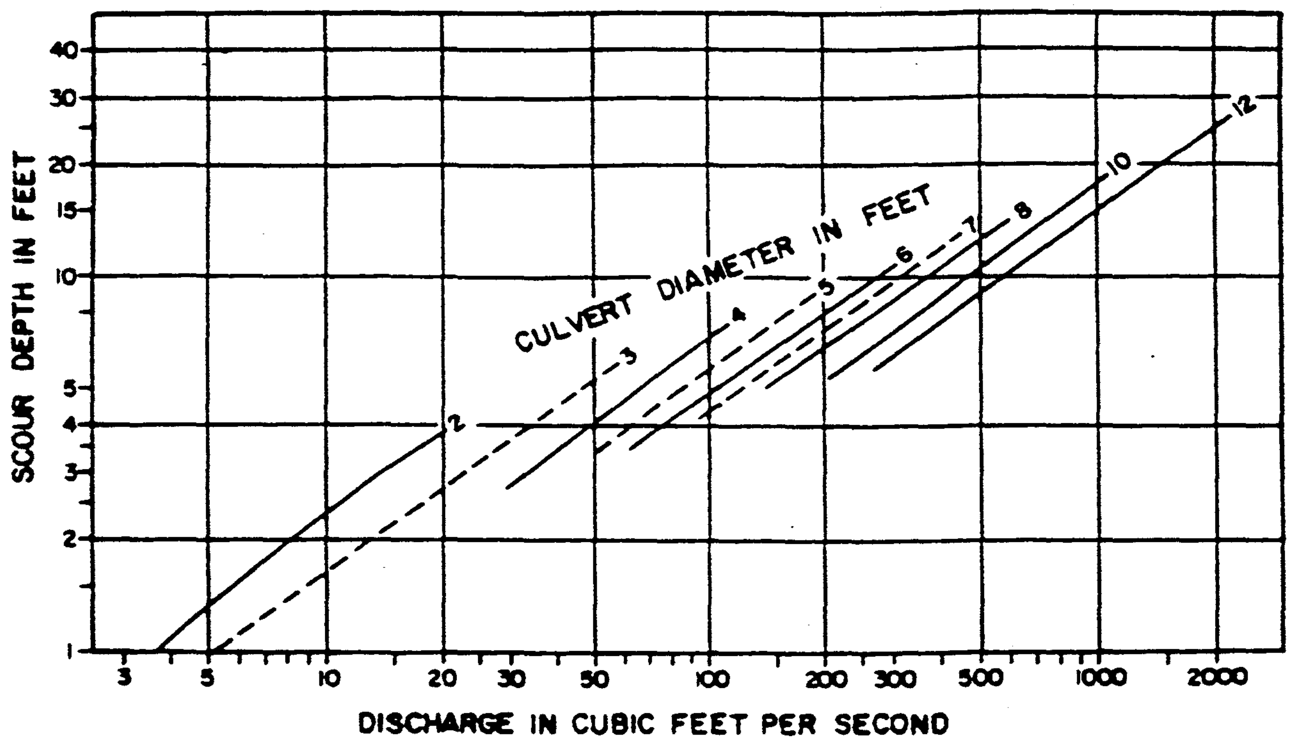
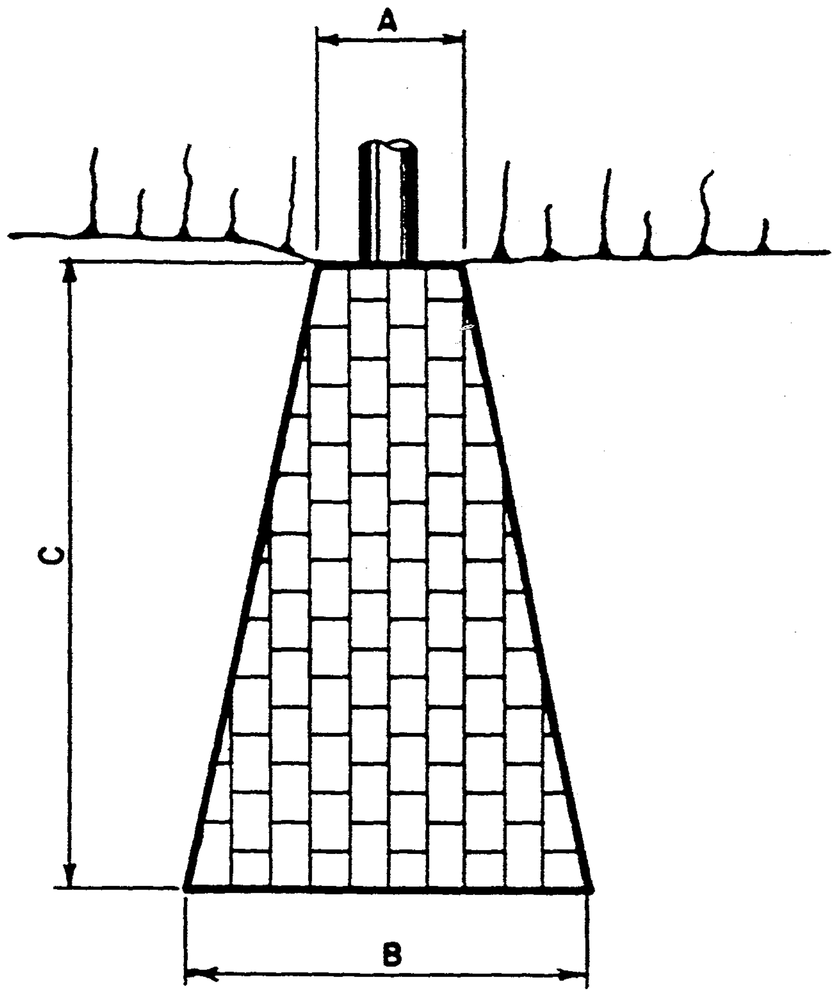


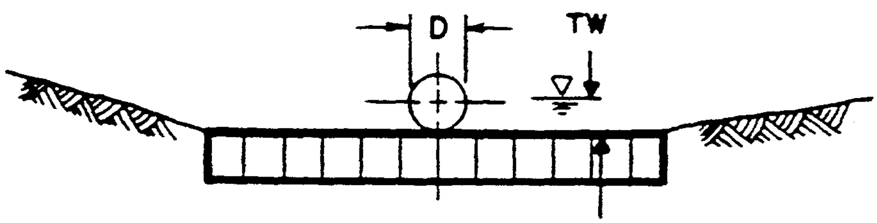
FIGURE 3-3

Maximum Scour Depth Downstream of Culvert Outlets With Tailwater Above the Pipe Centerline (Bohen 1970)

3.2.5.2 <u>Horizontal scour aprons</u>, if the naturally occurring scour hole dimensions are not acceptable a structural limit on scour must be provided. The structures traditionally consist of preformed and lined scour basins, rigid stilling basins or horizontal riprap aprons. North Slope conditions require culvert outlets be accessible for snow removal prior to breakup thus precluding basins. Riprap is not available. Therefore, a standardize concrete block mattress design, based on a Corps of Engineers riprap blanket design, is provided. Plate 3-28 provides a definition sketch and basic dimension equations. The basis for the size of apron is provided by the Corps of Engineer (Bohen, 1970). Concrete block mat alternatives to riprap are based on Armorflex Technical Bulletin BC-1.



PLAN



ELEVATION

$A = 3D$ $\quad C = 1.7\,D \quad (Q/D^{2.5}) + 8$

$B = A + 0.4C$ IF TAILWATER ABOVE PIPE CENTERLINE

$B = A + C$ IF TAILWATER BELOW PIPE CENTERLINE

$W = 79\left[(0.02\,D^2/TW)(Q/D^{2.5})^{1.33}\right]^3$

W = WEIGHT OF CONCRETE BLOCK IN POUNDS PER SQUARE FOOT ASSUMING UNIT WEIGHT OF CONCRETE IS 150 LBS. PER CUBIC FOOT.

CONCRETE MAT SCOUR BLANKET
PLAN AND DIMENSIONS

3.2.6 Inlet Flotation Control. A common cause of culvert structural failure is flotation of the inlet end. Flotation forces arise from two causes under North Slope conditions. The first and least significant is an open water case arising from the difference in hydrostatic pressure acting on the inside and outside of the culvert. Referring to Figure 3-2, for a culvert with a projecting entrance the flotation force acting on the culvert, F, is the difference between the buoyant force acting externally upward on the culvert bottom and the hydrostatic force acting internally downward on the culvert bottom. The external upward force results from d_1, the internal downward force results from d_2. The resultant force acting upward on the culvert at a point midway between the inlet and the intersection of the culvert top with the embankment is the buoyant force of the volume of the culvert between d_1 and d_2 over the length L.

The second, and most significant case, exists during breakup when the culvert entrance becomes completely blocked by ice. In that case, d_2 of Equation 3-18 becomes zero and the entire hydrostatic head, d_1, acts upward on the culvert. The upward force, F, in pounds for all round pipe cases with the headwater depth d_1 above the top of the culvert is the buoyant force of the empty pipe over the length L.

$$F = 49LD^2 \qquad (3\text{-}18A)$$

The force, F, for arch pipes is:

$$F = 62.4\ AL \tag{3-18B}$$

where A is determined from Table 3-7.

This second case should be used for design of all North Slope culverts.

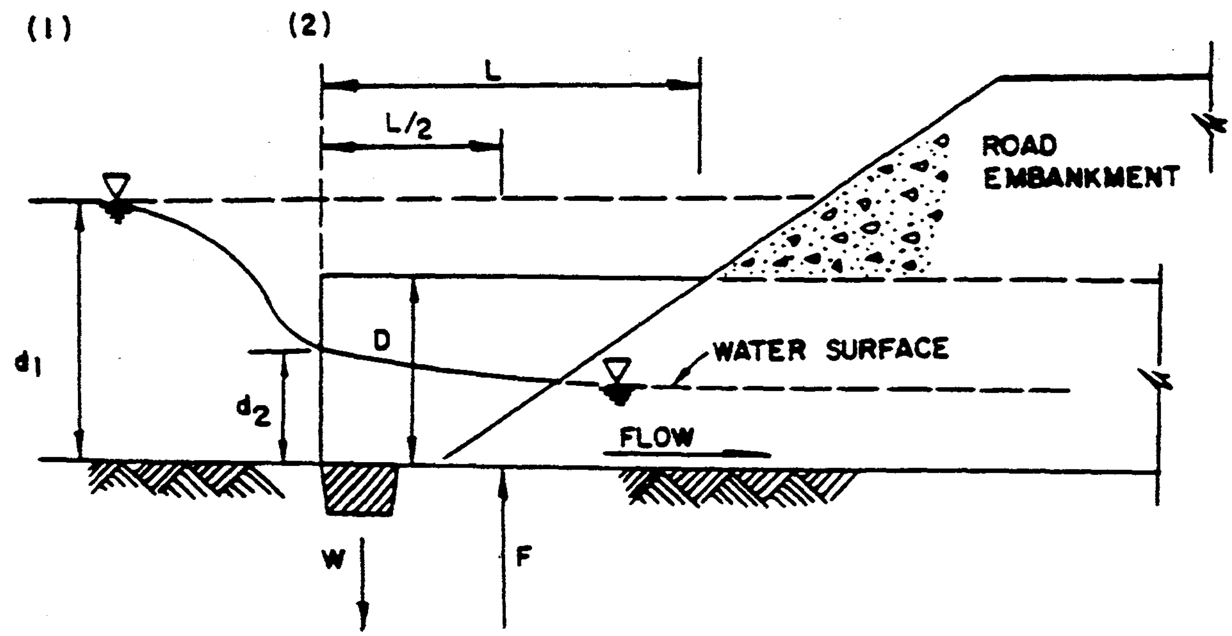


FIGURE 3-4
DEFINITION SKETCH FOR CULVERT INLET FLOTATION

F = the resultant hydrostatic force acting upward on a culvert entrance in pounds

D = the culvert diameter in feet

L = the exposed culvert length in feet

d_1 = the headwater depth above the bottom of the culvert inlet in feet

d_2 = the depth of water in the culvert barrel the inlet in feet. d_2 may be derived by the methods of Section 3.2.1.3

There are several structural solutions to the problem. These include:

1. Provision of a concrete weight at the culvert end equal to F/2 to counteract the upward moment.

2. Providing a mitered entrance so that d_1 acts downward over more of the base of the culverts thus effectively reducing L.

3. Provision of a headwall entrance to eliminate L.

4. Provision of a rigid pipe capable of resisting the upward force, F, without deformation.

5. Prevention of scour around the inlet which would have a tendency to increase L.

This problem is discussed from a structural point of view in Section 5.0.

3.2.7 Design Procedures. The following Table 3-11 provides step by step procedures for designing culverts. The procedures utilize the methods developed in the proceeding sections to produce alternative acceptable designs. The final choice among designs must be cost effective and environmentally acceptable.

TABLE 3-11

CULVERT DESIGN PROCEDURE FOR NON-FISH STREAMS

1. Determine the inlet invert elevation: Inlets should match the stream thalweg elevation. This may require limited excavation of the stream bed for multiple pipes.

2. Determine the physical limit on headwater elevation: This is the lessor of the road overflow elevation, the elevation of upstream properties, or the elevation of environmental features which may not be flooded.

3. Determine the design discharge: For permanent culverts this is the 50 year flood as determined by the procedures of Section 2.2. The design discharge for temporary culverts, intended to function through at least one breakup period and then be removed, should be a five year flood. Culverts intended to function for a short period during the summer not including a breakup period and then be removed should be designed to accommodate ten percent of the 50 year flood.

4. Determine trial culvert size: Use inlet control nomographs, Plates 3-18 or Plate 3-19. Use the lessor of

headwater depths as derived through Step 2 or 1.5 times the proposed pipe diameter. Use the largest possible pipe sizes in preference to multiple small pipes.

5. Determine the type of inlet: For pipe diameters 48 inches or smaller use projecting entrances. For pipes between 48 inches and eight feet in diameter use a vertical headwall extending from one fourth the pipe diameter below the inlet invert to the lower of the design water surface or the fill slope. Vertical headwalls facilitate snow removal, shorten pipe lengths, and reduce hydraulic flotation of the inlet. Culverts larger than eight feet should have a specifically designed headwall which need not be flush since snow removal equipment is capable of entering the culvert.

6. Determine the culvert length, skew, and slope: Culvert ends not mitered and without headwalls, should be located two feet outside of the theoretical intersection of the fill slope with the stream thalweg. Headwalls should be located with the top of the wall no lower than its intersection with the fill slope. If possible road and pad alignments should be chosen to avoid skewed crossings.

7. Determine the tailwater elevation: This may usually be accomplished by using the normal flow relationships provided in Section 3.1.2. In a few cases the downstream tailwater elevation should be adjusted upwards to accommodate possible channel snow and ice blockage. In a few other cases backwater from downstream conditions, such as a road with culverts, may cause high tailwater. Determination of realistic tailwater conditions requires more careful judgement than any other aspect of culvert

design. Under some conditions, a range of tailwater conditions may exist. The highest reasonable tailwater should be used to size the culvert and the lowest to estimate scour and outlet velocities.

8. Determine critical depth at culvert outlet: Critical depth at the outlet may be determined by the methods of Section 3.2.1.3.

9. Determine if nomographs may be used for culvert capacity determination: Nomographs may be used for all cases except type 3, tranquil flow throughout, and type 2 flow when critical depth is less than 3/4 of the diameter. For these two conditions, go to Step 13. For the remaining conditions, go to the graphical solutions in Step 10.

10. Determine the discharge assuming inlet control: Use Plates 3-18 or Plate 3-19 with the appropriate entrance type, trial culvert diameter, and allowable headwater depth in pipe diameters, from Step 4.

11. Determine the discharge assuming outlet control: Use Plate 3-19 through Plate 3-33 with the appropriate diameter, entrance coefficient (Table 3-8), head, and pipe length. If steel line pipe is used, use one fourth of the actual pipe length. If type 2 flow exists, and d_c is greater than 0.75D assume $d_3 = (D + d_c)/2$.

12. Determine the discharge and type of control for a trial culvert: The capacity of the proposed pipe is the smaller of the two estimated discharges from Steps 10 and 11. the control type is that associated with the smaller discharge. Go to Step 14.

13. Determination of culvert capacity for Type 3 flow (outlet control with backwater): For a given head differential, $h-h_4$, and culvert geometry the discharge, Q, may be computed by a trial and error process as follows:

a) Assume a trial discharge or culvert size, Q_t. A reasonable first approximation is:

$$Q_t = 0.95 \, A_3 \, (2gh)^{1/2} \qquad (3\text{-}19)$$

where

A_3 = the area at the culvert outlet below the tailwater depth. This may be obtained using Tables 3-4 or 3-5.

h = the difference in feet between the elevation of the headwater limit (Step 2) and the tailwater elevation (Step 7).

b) Compute the friction loss in the culvert barrel, h_{f2-3}: the friction loss, h_f, is determined by a trial and error process utilizing the following relationship:

$$h_f = L \, Q_t^2 / K_2 K_3 \qquad (3\text{-}9)$$

where

L = the culvert length in feet.

Q_t = the trial discharge in cfs.

K_3 = the conveyance at the outlet determined as a function of the tailwater depth and the pipe diameter and roughness "n". Mannings n is obtained from Table 3-8. K is obtained from column 4 of Table 3-6 or 3-7.

K_2 = the conveyance at the inlet as a function of the depth of flow, d_2. The depth of flow in the entrance, d_2, is unknown and not amenable to a direct solution. The most direct way to determine d_2 is to assume a trial depth, d_2, calculate K_2 using Table 3-4 or 3-5, then calculate h_{f2-3} using Equation 3-7. If the assumed d_2 does not closely match the water surface elevation computed as the tailwater elevation plus h_f assume a new trial d_2 and repeat the calculation until the assumed d_2 and calculated d_2 agree. A reasonable first trial is to assume d_2 is slightly larger than d_3.

c) Compute the discharge in the culvert using the following equation:

$$Q = CA_3[2g(h_1-h_3-h_{f2-3})]^{1/2} \qquad (3\text{-}20)$$

where

C = the coefficient of discharge which accounts for flow contraction at the entrance and is a function of the culvert entrance geometry. C is obtained from Table 3-8.

h_1-h_3 = the difference in feet between the allowable headwater and tailwater elevation.

h_{f2-3} = the friction loss obtained in Step b using the trial discharge Q_t.

d) Compare calculated and trial discharge: If Q from Step c above equals the trial Q_t from Step a the discharge for the given conditions is known. If the discharges do not agree select a new trial Q_t and return to Step a.

14. Determine the need for inlet erosion control. See Section 3.2.4.

15. Determine the need for inlet flotation control. Use Equation 3-18 with $d_2 = 0$.

16. Determine depth of the natural scour hole which will develop downstream of the culvert: Use Equation 3-15 or Figure 3-3. Use nine-tenths of the discharge obtained from Step 3. If the scour is acceptable go to Step 18.

17. Size a scour apron: Use Plate 3-28.

18. Estimate Costs: If costs are acceptable end, if not return to Step 4 with a new trial culvert size and configuration or consider a bridge or overflow section.

3.2.8 Worked Examples.

Example 4: Culvert Size by Graphic Method.

Given: A stream with a bed six feet wide, a 50 year flood discharge of 350 cfs, a centerline bed elevation of 50 feet, a bed slope of 0.005, and a flow depth of four feet is crossed at right angles by an access road 30 feet wide with one on two side slopes. The flood plain is at elevation 55. The road embankment height in the flood plain is five feet.

Find the required culvert diameter, length, and necessary end protection, use Table 3-9.

Step 1. Invert elevation - The invert at the road centerline is 50.0. The invert slope is 0.0005.

Step 2. The physical headwater limit is the lower of 1.5D or the overflow elevation of the road, elevation 60.

Step 3. The design discharge is 390 cfs.

Step 4. The trial culvert size from Plate 3-18 is 75 inches. The next larger commercially available diameter is 78 inches. 1.5D is 9.75 feet resulting in a headwater elevation of about 59.75 which is below the road overflow elevation of elevation 60.

Step 5. The pipe diameter is larger than 48 inches and less than eight feet, therefore it requires a vertical headwall to the headwater elevation.

Step 6. The culvert length, assuming a headwall at the outlet, is the top road width of 20 feet plus four times the required structural fill over the pipe. Say 30 plus four times four or 46 feet.

Step 7. The tailwater elevation is $54-0.005\ (18) = 53.91$.

Step 8. Critical depth, d_c, at the outlet is determined by Equation 3-6:

$$Q = Cq\ D^{5/2}$$

$$350 = Cq\ 6.5^{5/2}$$

$$Cq = 3.249$$

from Table 3-6 $d_c/D = 0.772$

$$d_c = 5.02$$

The elevation of critical depth at the outlet is 54.93 which is above the tailwater elevation of 53.91.

Step 9. The flow is type 5 or 6.

Step 10. The inlet control discharge for a 78" diameter pipe with a vertical headwall given by Plate 3-18 is 380 cfs.

Step 11. The outlet control discharge, for the above 36 foot long pipe may be determined from Plate 3-20. An entrance coefficient determined from Table 3-8 is 0.45 for type 5 flow and 0.84 for the type 6 flow. Since type 5 is the most conservative assumption use k = 0.45 in Plate 3-20. The head, H, is the difference in elevation between the headwater and the tailwater. Since the tailwater is below critical depth in the pipe assume a tailwater elevation 1/2 way between critical depth and the top of the pipe at the outlet (3.2.1.4), 54.93+56.41)/2 = 55.67. The head is then 59.75 - 55.67 = 4.08 feet and from Plate 3-2 the discharge is 350 cfs.

Step 12. The actual discharge is the least of the inlet and outlet control estimate. The least discharge estimate is the outlet control estimate of 350 cfs. This just satisfies the design flood requirement and is an acceptable design.

Step 13. Skip Step 13.

Step 14. Inlet erosion protection is required (3.2.4) since HW/D is greater than 1.2 and the culvert has a headwall. Either extend the headwall above the water surface or provide riprap.

Step 15. Inlet flotation control is not required since the culvert has a headwall.

Step 16. A natural scour hole ten feet deep will ultimately develop. Assume this is undesirable (Figure 3-3).

Step 17. A scour apron may be sized using Plate 3-30.

$A = 3D = 3(6.5) = 19.5$ feet
$C = 1.7D\ (Q/D^{2.5} + 8 = 1.7\ (6.5)$
$(350)/6.5^{2.5} + 8 = 43.9$
$B = A + 0.4C = 19.5 + 0.4\ (43.9) = 37'$

The apron should be of concrete mat weighing 30 pounds per square foot.

Example 5: Culvert size, Analytical Method.

Given: A stream with a design flood of 800 cfs, a bed elevation of zero feet and zero slope, a tailwater elevation of 7.5 feet and a road overflow elevation of ten feet. The road is 30 feet wide with 1 on 2 side slopes and crosses the stream at right angles. The minimum allowable fill height over the culvert is four feet.

Find the required culvert size and type using the procedural steps of Table 3-11.

1. The inlet invert elevation is at zero.

2. The limit on headwater is elevation 10.

3. The design discharge is 800 cfs.

4. The culvert type adopted should be arch-pipe because of the superior low head performance. The trial culvert size, using the entrance control

nomograph of Plate 3-19 and the limit on headwater of ten feet is 12'10"x8'4", HW/D = 1.23.

5. A headwall extending to the headwater elevation of ten feet should be used on both ends of the culvert.

6. The culvert length is the distance between headwalls. The top of the headwalls are at elevation 10, the top of the road at 14. The culvert length is then 4(4)+30 = 46 feet.

7. The tailwater elevation is given as elevation 7.5.

8. Critical depth at the outlet of the 12'10"x8'6" arch-pipe may be determined by Equation 3-6 and Table 3-7

$$Q = C_q D^{2.5}$$

$$800 = C_q 8.31^{2.5} \qquad \text{(EQUATION 3-6)}$$

$$C_q = 4.02$$

$$d_c/D = 0.622$$

$$d_c = 0.622\ (8.31) \qquad \text{(TABLE 3-7)}$$

$$= 5.17 \text{ feet}$$

9. The tailwater elevation of 7.5 feet is above critical depth and the headwater to diameter ratio is less than 1.5. Therefore, the culvert operates as type 3, tranquil flow throughout. The culvert

may not be sized by graphical methods, the analytical method must be used.

10., 11., and 12. The instructions pertain to graphical sizing and must be skipped.

13a. Develop a new trial culvert size. Since the inlet control culvert was overlarge use it for a first trial.

From Table 3-5 for a 12'10"x8'4" arch pipe

span = b = 12.86'
rise = D = 8.31'
Area = A = 85 square feet

From Table 3-8
Entrance Coef. = C = 0.86 (h-z)/D=1.2

Culvert length = L = 46 feet (Step 6)
Outlet Area = A_3 = 80.7 (Table 3-7)

13b. The friction loss in the barrel, h_f, may be computed by Equation 3-9.

$$h_f = LQ^2/K_2K_3$$

where

K_3 = The conveyance at the outlet as a function of the tailwater depth, pipe diameter and roughness. Use column 4 of Table 3-7, page 55.
$d_3/D = 7.5/8.31 = 0.903$

$C_k = 0.859$

$K_3 = C_k D^{2.67}/n$

$= 0.859\ (8.31)^{2.67}/0.031$

$= 7851$

K_2 = The conveyance at the entrance as a function of the unknown depth of flow, pipe diameter and roughness. Since the depth of flow is unknown and cannot easily be directly calculated use a trial and error solution. Assume a head lost to friction, h_f, then since there is no culvert slope, $d_2 = d_3 + h_f$. Solve Equation 3-9 to see if the assumed h_f is equal to the computed h_f. Assume $h_f = 0.4$ feet then $d_2 = d_3 + h_f = 7.5 + 0.4 = 7.9$ feet. $d_2/D = 7.9/8.31 = 0.951$

From column 4 of Table 3-7, page 55 $C_k = 0.854$

$K_2 = C_k D^{2.67}/n$

$= 0.854\ (8.31)^{2.67}/0.031$

$= 7860$

Solve for h_f and check the d_2 assumption.

$h_f = L\ Q^2/K_2K_3$

$= 46\ (800)^2/(7860)\ (7851)$

$= 0.48$ feet

This does not check the assumed h_f of 0.4 feet. Retry using an assumed h_f of 0.48 feet.

then

$$
\begin{aligned}
d_2 &= 7.98 \\
d_2/D &= 7.98/8.31 \\
&= 0.960 \text{ and from Table 3-7} \\
C_k &= 0.844 \\
K_2 &= C_k\ D^{2.67}/h \\
&= 0.844\ (8.31)^{2.67}/0.031 \\
&= 7768
\end{aligned}
$$

Recompute the the head loss, h_f.

$$
\begin{aligned}
h_f &= L\ Q^2/K_2K_3 \\
&= 46\ (800)^2/(7768)\ (7851) \\
&= 0.48
\end{aligned}
$$

The assumption checks and the head loss, h_f, is 0.48 feet

13c. Compute the discharge for the trial culvert size, 12.86x8.31, using Equation 3-20

$$
\begin{aligned}
Q &= C\ A_3\ [2_9\ (h_1-h_3-h_f0]^{0.5} \\
&= 0.86\ (80.7)\ [64.4\ (10-7.5-0.48)]^{0.5} \\
&= 791 \text{ cfs}
\end{aligned}
$$

13d. The calculated discharge of 791 cfs is slightly smaller than the required discharge of 800 cfs. Use the next larger commercial size of 13'5" by 8'5". No further size checking is necessary.

14. No inlet erosion control is necessary because the headwall extended to the water surface.

15. No inlet flotation control is required for headwall culverts.

16. The area of the selected arch pipe is from Table 3-5, 89 square feet. The pipe breadth is 13.40 feet. From Figure 3-3, the ultimate scour depth is about 12 feet. Assume this is acceptable, and that no scour apron is needed.

Example 6: Culverts Under an Ice Cover.

Given: A winter discharge of 30 cfs is to be conveyed under a winter ice road through a steel line pipe culvert with a limit on head of one foot. The pipe length is 75 feet.

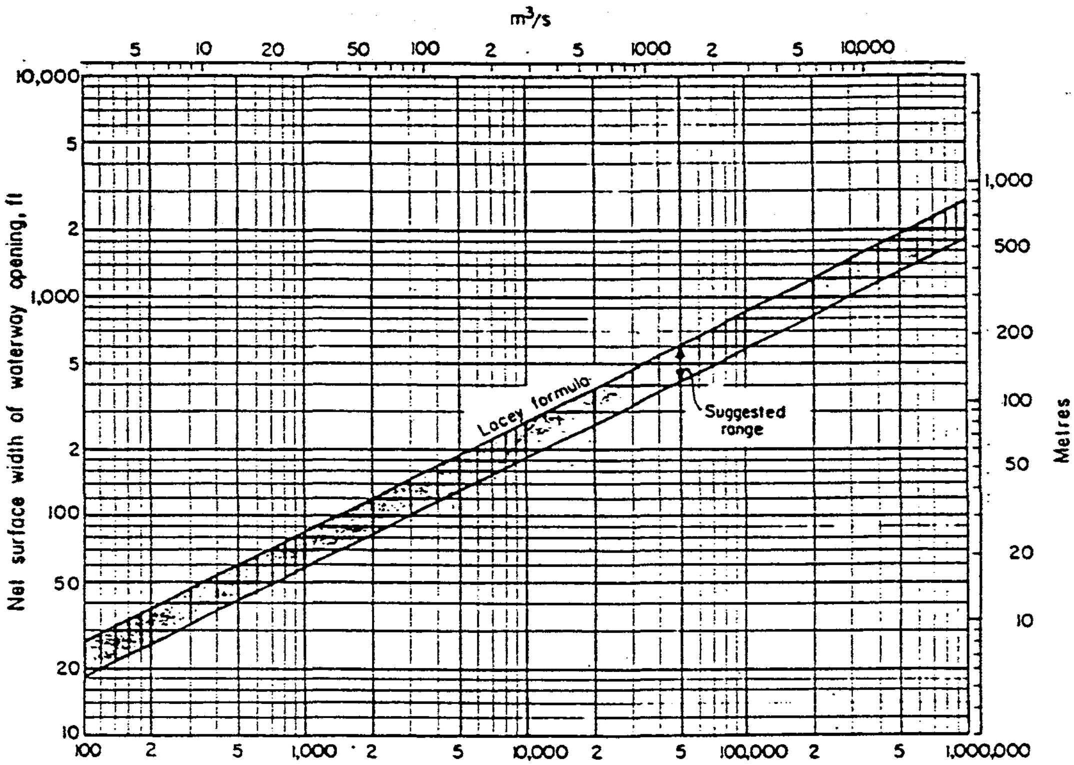
Solution: From Plate 3-27, a pipe 36 inches in diameter is required.

3.3 Bridges

Bridges are necessary for the crossing of all large streams and hydraulicly as well as environmentally desirable for the crossings of many small streams. Bridges become desirable for small streams because of the lessor maintenance costs and greater reliability as compared to culverts and because of their greater ability to allow upstream fish passage. Bridges also facilitate winter construction because of the difficulty in compacting frozen gravels around culvert barrels.

The process of major bridge design requires determination of backwater, scour, environmental impacts and costs for a variety of bridge spans and types and then selection of a bridge with acceptable impacts and minimal costs. Costs include both the first construction costs and the annual maintenance costs. The process is involved and covered satisfactorily in standard references. Plate 3-29 provides a design process flow chart with reference to these standard references.

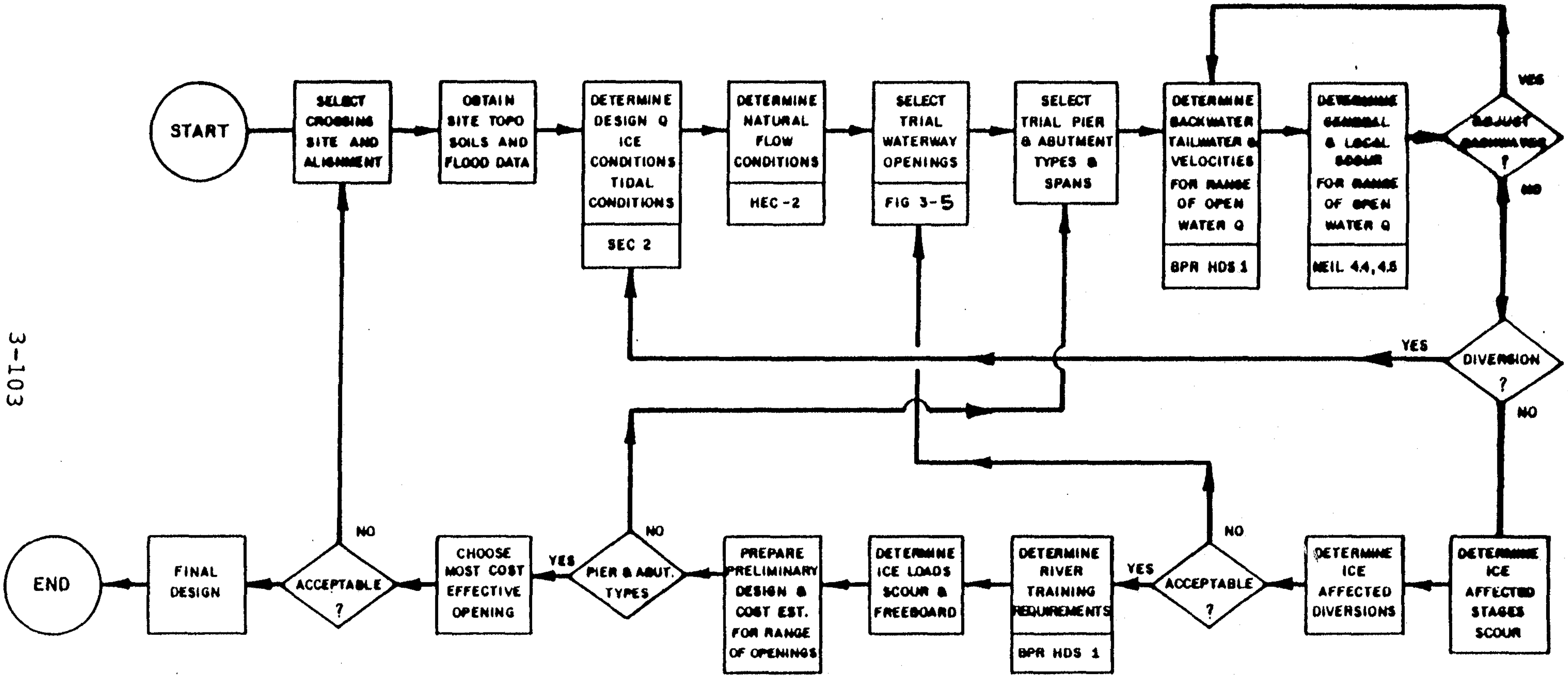
A first approximation of the required span can be determined by the Lacey Regime Equation (Neill, 1973). Figure 3-4 provides a graphical solution to the equation for bridge spans. For the reasons given in Section 2.1.1, most small North Slope Streams are not in regime, therefore, the Lacey relationship should be used only as an approximation.



Discharge in cfs

FIGURE 3-5

LACEY REGIME BRIDGE WIDTH (Neill, 1973)



REFERENCES:

C.R. NEILL - GUIDE TO BRIDGE HYDRAULICS
BUREAU OF PUBLIC ROADS - HDS No. 1, HYDRAULICS OF BRIDGE WATERWAYS
CORPS OF ENGINEERS - HEC 2, WATER SURFACE PROFILES

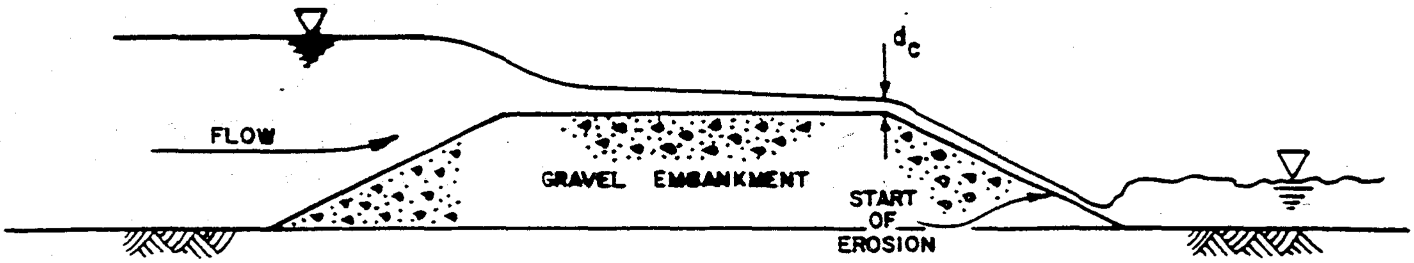
BRIDGE WATERWAY OPENING SELECTION PROCESS

G.N.M. JAN. 1984 PLATE 3-29

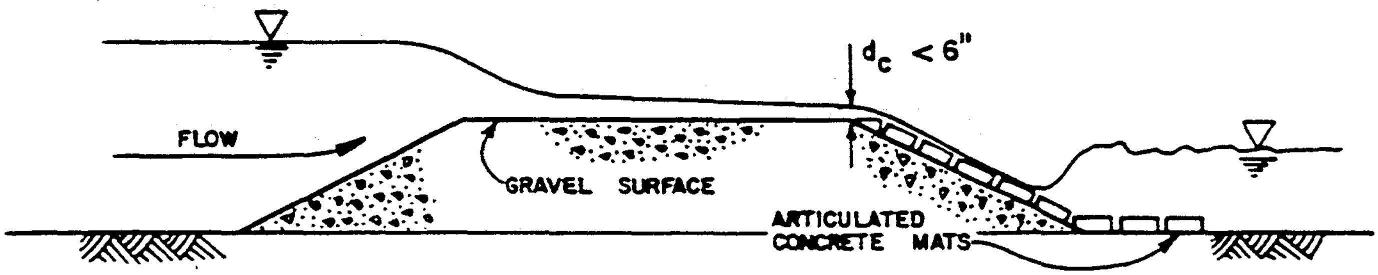
3.4 Road Overflow Sections

Overflow sections are depressed areas of roadway intended to restrict road overflow to a small area. They are also often used to reduce the amount of culvert or bridge required. They are particularly adaptable to North Slope roads because of the timing predictability and short duration of the annual breakup floods. Overflow sections have an additional benefit in that the capacity of the overflow increases at a greater rate with an increasing head than does culvert capacity. They are, therefore, particularly applicable to situations where large diverted flows must be accommodated on rare occasions. Overflow sections may be designed to fail and wash out during flood events, or they may be designed to resist failure and provide trafficability during overtopping. The decision as to type depends on operational requirements. Plate 3-30 provides typical sections of three types of overflow sections. Plates 3-31 and 3-32 provide typical sections of combined overflow and culvert structures. Road sections can convey limited light vehicle traffic with water depths of up to six inches.

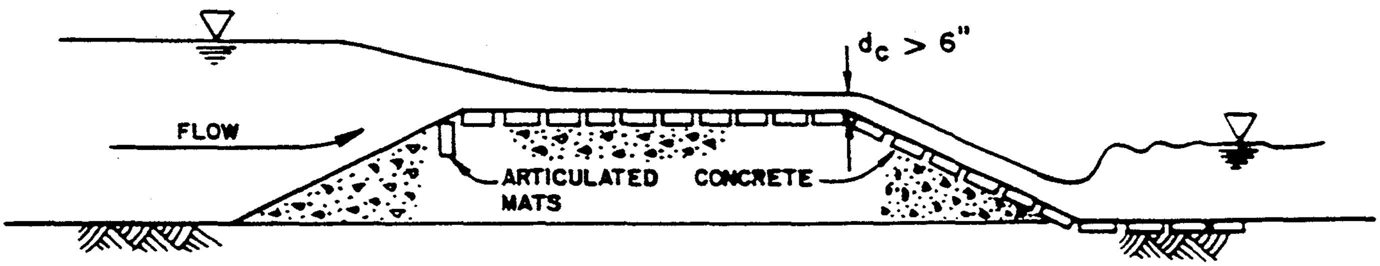
3.4.1 Hydraulic Design. An overflow section should always operate in parallel with a culvert or bridge. Therefore, the design flow for the weir is the total flow less the portion passing through the culvert or bridge. The allowable head for the combination of structures is fixed by the geometry of the road embankment or the normal limit on head at the culvert of 1.5 D. The upstream water surface elevation for the weir and culvert is the same and provides the basis for design.



UNLIMITED OVERFLOW DEPTH, SOFT PLUG OVERFLOW INTENDED TO FAIL



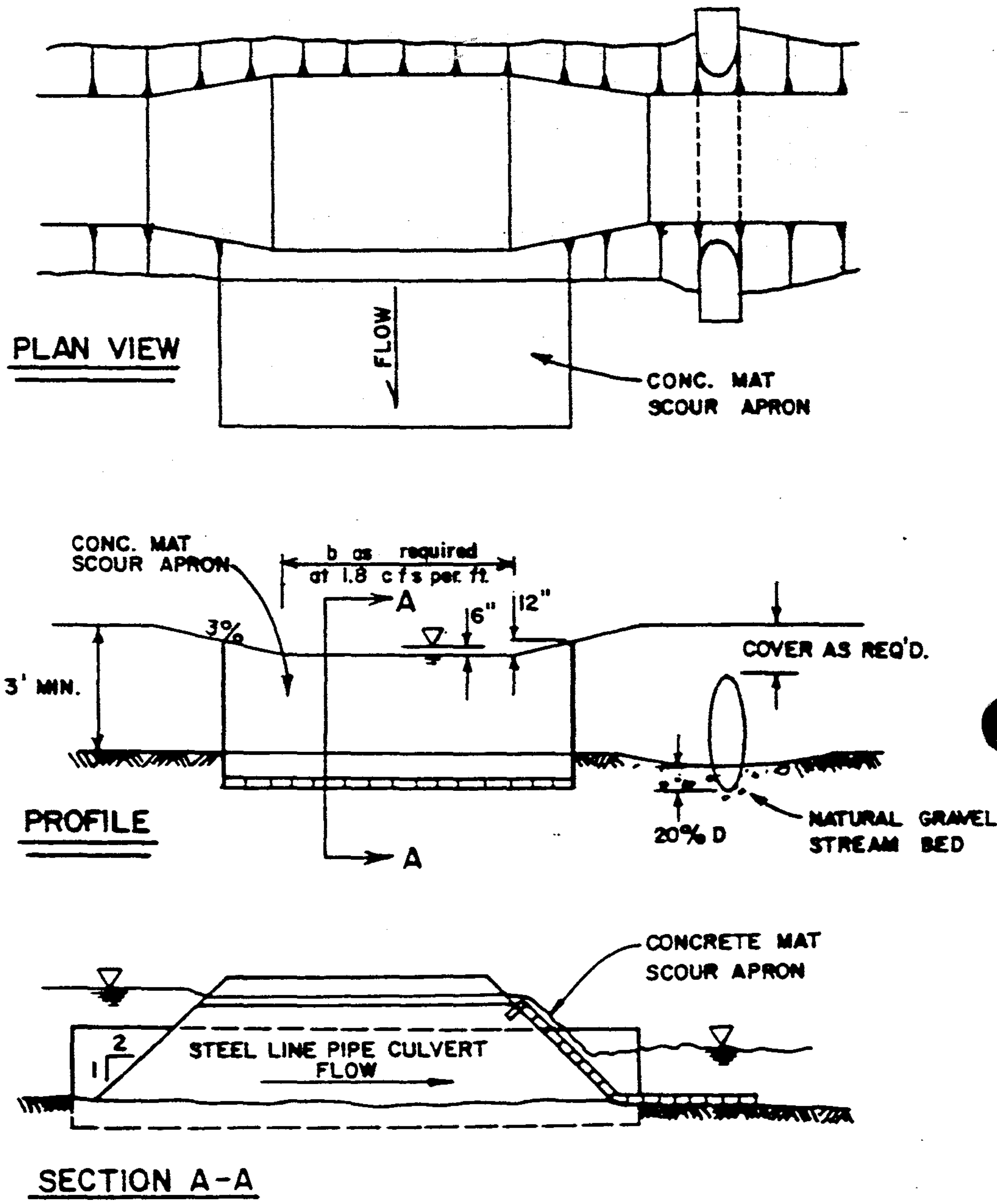
LIMITED OVERFLOW DEPTH, LIMITED CROWN EROSION



UNLIMITED OVERFLOW DEPTH, CROWN PROTECTED

ROAD OVERFLOW SECTIONS
CLASSIFICATION OF TYPES

ALL SEASON CONSTRUCTION PAD
CULVERT OVERFLOW COMBINATION
FOR POORLY INCISED GRAVEL BED STREAMS

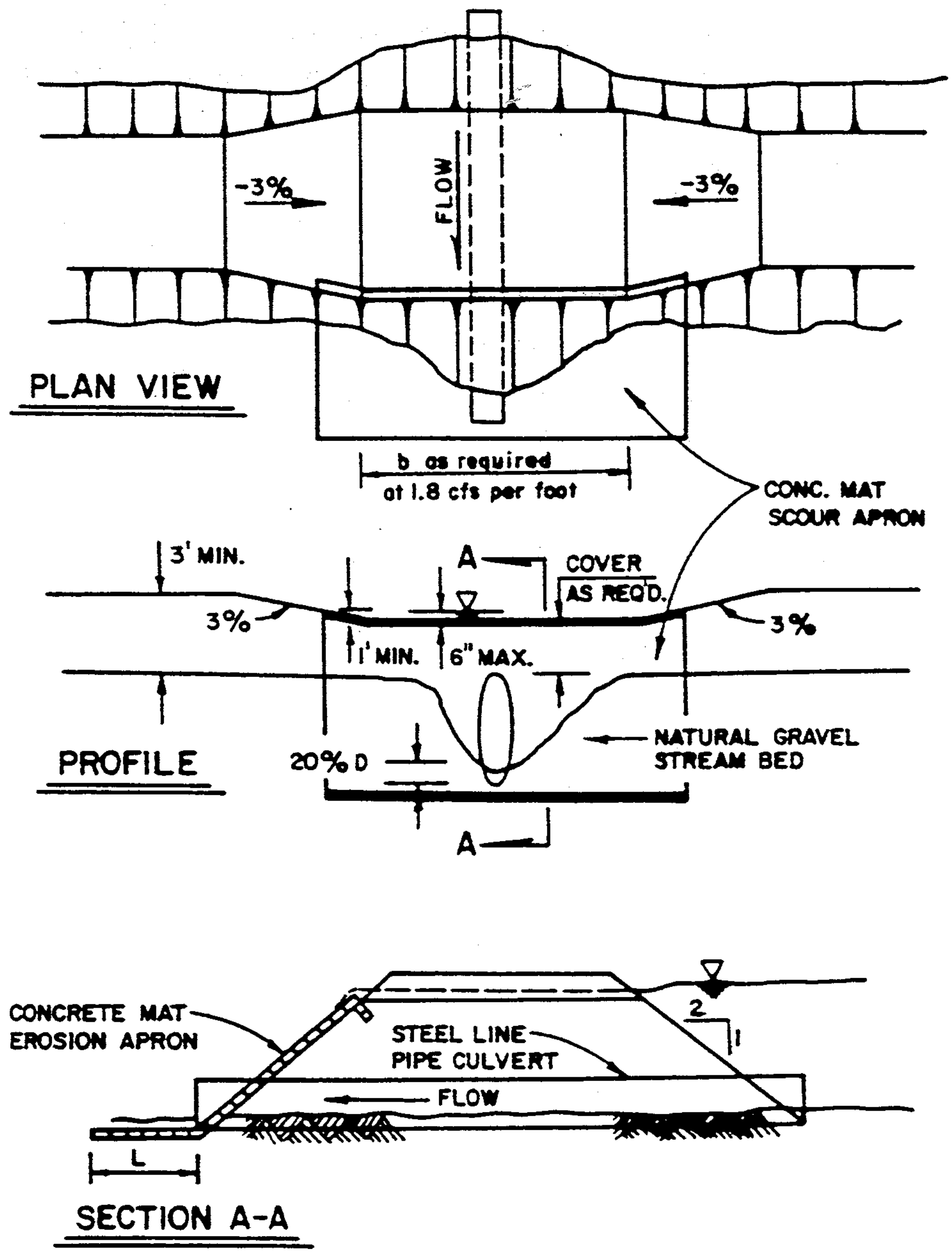


NOTE:

MINIMUM CULVERT SIZE TO CONVEY 50% OF THE 2 YEAR FLOOD. MAXIMUM CULVERT SIZE DEPENDS ON AVAILABLE SPACE. OVERFLOW ACCOMODATES THE BALANCE OF THE DESIGN FLOOD AT 6 INCHES DEPTH TO PERMIT VEHICAL PASSAGE.

CONSTRUCTION PAD
PERMANENT OVERFLOW SECTION
POORLY INCISED GRAVEL BED STREAM

ALL SEASON CONSTRUCTION PAD CULVERT OVERFLOW COMBINATION FOR INCISED GRAVEL BED STREAMS



NOTE:

MINIMUM CULVERT SIZE TO CONVEY 50% OF THE 2 YEAR FLOOD. MAXIMUM CULVERT SIZE DEPENDS ON AVAILABLE SPACE. OVERFLOW ACCOMODATES THE BALANCE OF THE DESIGN FLOOD AT 6 INCHES DEPTH TO PERMIT VEHICAL PASSAGE.

CONSTRUCTION PAD
PERMANENT CULVERT OVERFLOW COMBINATION
GRAVEL INCISED STREAM BED

G.N.M. APRIL 1984 PLATE 3-32

A road overflow section forms a broad crested weir. The discharge is related to the upstream water elevation. A definition sketch of flow over a road embankment is provided as Figure 3-6.

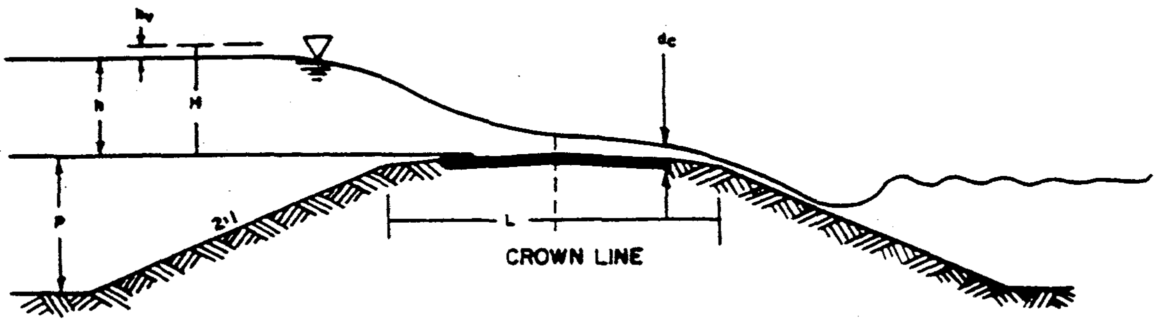


FIGURE 3-6 DEFINITION SKETCH OF FLOW OVER A ROAD

For application of a road overflow weir in parallel with culverts, the allowable water surface elevation, h_v, is fixed by design. The velocity head at the approach, h, is negligible, and the discharge which must pass the weir is the total design discharge less the portion passed through the culverts. The general formula for flow over the road embankment is

$$Q = C\ b\ H^{3/2} \qquad (3\text{-}21)$$

where

b = the length of the overflow section along the road

C = the coefficient of discharge.

H = the difference in elevation between the road crest and the upstream water surface elevation

d_c = critical depth

The equation may be solved for any combination of overflow depth or weir length provided an appropriate discharge coefficient, C, is chosen.

Discharge coefficients for flow over roadways have been experimentally obtained and published by the U.S.G.S. (Hulsing, 1967). The experiments indicate the coefficient is a function of h/L when h/L is greater than 0.15. When h/L is less than 0.15, the coefficient is a function of the head, h, and the roughness of the roadway. For the range of conditions expected on the North Slope, the conditions with h/L less than 0.15 are apt to exist. Table 3-12 provides discharge coefficients for this case.

TABLE 3-12

DISCHARGE COEFFICIENTS FOR FLOW OVER GRAVEL ROADS WHEN h/L IS LESS THAN 0.15

Head (H) (Feet)	Discharge Coefficient (C)
0.00	2.500
0.25	2.595
0.50	2.685
0.75	2.760
1.00	2.830
1.25	2.880
1.50	2.920
1.75	2.955
2.00	2.980
2.25	3.000
2.50	3.015
2.75	3.030
3.00	3.040

Submergence of the road embankment by downstream tailwater will reduce these coefficients. However, under North Slope applications submergence should not often occur and is therefore not considered further. Further discussion of C values is presented by Hulsing.

3.4.2 Road Surface Protection. Under some conditions it may not be desirable to allow the road to wash out at the overflow section. To prevent erosion two areas must be protected. The first is erosion of the relatively flat road surface. The second is erosion of the steep downstream embankment slope. This section considers the first case, erosion of the road surface. Referring to Figure 3-5 and Section 3.1.1, critical depth will occur either at the road centerline crown or at the downstream shoulder, depending on the crown slope. Neglecting minor friction losses, the critical depth, d_c, will be 2/3 H. Therefore, the maximum water velocity over the road surface will be

$$V_c = 3q/2H \tag{3-22}$$

where

q = the discharge in cfs per foot of weir length.

If erosion of the road surface is to be prevented, the velocity over the surface must be limited to that which will not erode the surface. The allowable velocity is a function of the size of the gravel material on the road surface, the depth of flow over the surface, and the slope of the energy grade line. A procedure to determine the erosion limits of gravel is:

$$d = 144\ R\ S \tag{3-23}$$

where

d = D-75 of the gravel surface which will just be eroded in inches

R = the water depth = the critical depth = 2/3 H in feet

S = the slope of the energy grade line which is conservatively 2 H/3L where H and L are in feet

Then the limitation on head, H, for the non erosion of a given gravel road surface d_{75} size in inches is

$$H = 0.0156 \ (Ld)^{1/2} \qquad (3\text{-}24)$$

Thus, two inch d-75 gravel on a road 50 feet wide would withstand a head of 1.5 feet. In some cases it may be economically feasible to allow the road to wash out in a limited overflow section (soft plug). Where failure is desired a large H must be provided. In other cases, it may be desirable to import large more stable surface material than is readily available locally to insure stability.

A second limitation on allowable head, H, is the need to sometimes limit the water depth and velocity to afford safe driving conditions. A practical limit on depth, 2/3 H, for safe driving is about six inches. This implies, for a typical case of a 20-foot road, a head of nine inches, and a d_{75} gravel of 2.6 inches the allowable discharge would be about 1.8 cfs per foot of width. The above analysis assures prevention of erosion from tractive force of water alone. Vehicle traffic will tend to disturb gravel particles which will be carried away by the flow. Therefore vehicle traffic during flood events should be limited.

3.4.3 Downstream Slope Protection. The downsteam slope of the highway embankment and the adjacent toe will experience high turbulent water velocities and rapid dissipation of energy. This will rapidly erode the embankment from the downstream toe upstream. Prevention of the erosion requires riprap or other forms of erosion protection. The detailed design of slope and toe protection is involved and requires knowledge of tailwater conditions. However, for headwater depths of two foot or less and moderate fill heights, any of the articulated concrete block mattresses commonly used on the North Slope will be adequate to protect the slope. These mattresses should be provided with a filter sufficient to retain the underlying soil.

3.4.4 Ice Affect. Ice and slush floating on the upstream water surface of approach streams tends to collect along the upstream edge of overflow sections and reduce the area available for flow. This results in higher headwater elevations to pass the same discharge. The amount of ice caused restriction depends strongly on the nature of the specific stream and the location of the overflow section with respect to the ice flow. As a general rule the overflow sections should be located in overbank areas of low approach velocity so as to not attract ice.

3.5 Low Water Crossings

Low water crossings provide an economical alternative to culverts or small bridges. They are applicable to routes with low traffic volume and the ability to utilize alternative access. Low water crossings are particularly useful on pipeline construction pads. They do not provide all season access.

3.5.1 Hydraulic Design. Low water crossings create a small constriction in the stream channel. This constriction produces a noticeable impact on very low flow. The impact is minimal on flood flow. No specific hydraulic analysis is required providing the crossing profile reasonably fits the existing streambed.

3.5.2 Crossing Design. Plate 3-33 provides a temporary winter snow pad crossing. Plates 3-34 and 3-35 provide typical designs for work pad low water crossings on gravel or frozen silt bed streams. The design provided on Plate 3-35 should be used only after a site specific thaw stability investigation has been accomplished. An alternative design replacing the board insulation with additional gravel may be adopted.

3.5.3 Fish Passage. Low water crossings are considered unsuitable for continued heavy equipment traffic use in fish streams when flow is present. This does not preclude the use of temporary low water crossings for heavy equipment during the winter when stream are dry or there use for light traffic during all seasons. Any low water crossing of fish streams must have specific approval of appropriate State and Federal Agencies. General requirements for permanent low water crossings of fish streams are:

1. Existing stream bed gradient should be matched.

2. Average water velocities in the crossing must not exceed the higher of the average velocity in the adjoining stream sections or the average cross sectional velocity provided in Table 1 of Appendix 1.

3. Road bed width in the crossing must be kept as narrow as safety permits.

4. Low water crossings in fish streams must be designed with a V-bottom so as to maintain a minimum flow depth of four inches during the open water season.

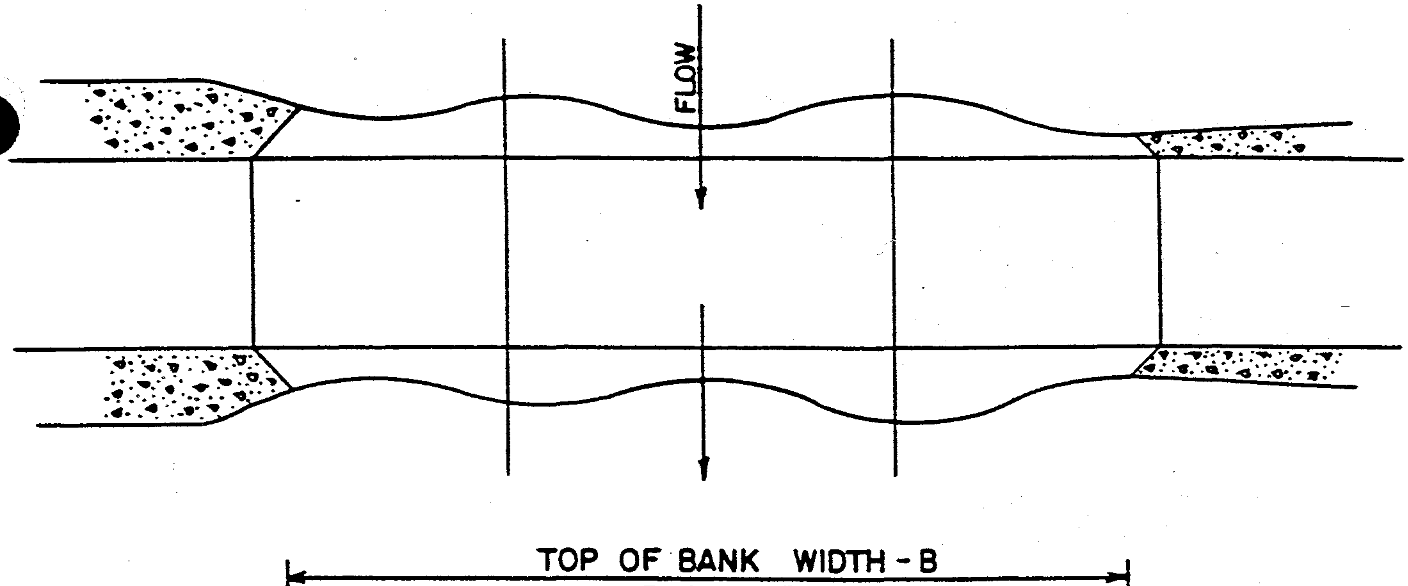
5. Fill material used in flowing streams for low water crossing construction must not contain more than ten percent fine material passing a 200 sieve (less than 0.075mm) without specific approval from the appropriate State and Federal agencies.

6. In streams where a low water crossing is planned as a permanent crossing but a culvert is planned for the construction period, the low water crossing foundation should be placed

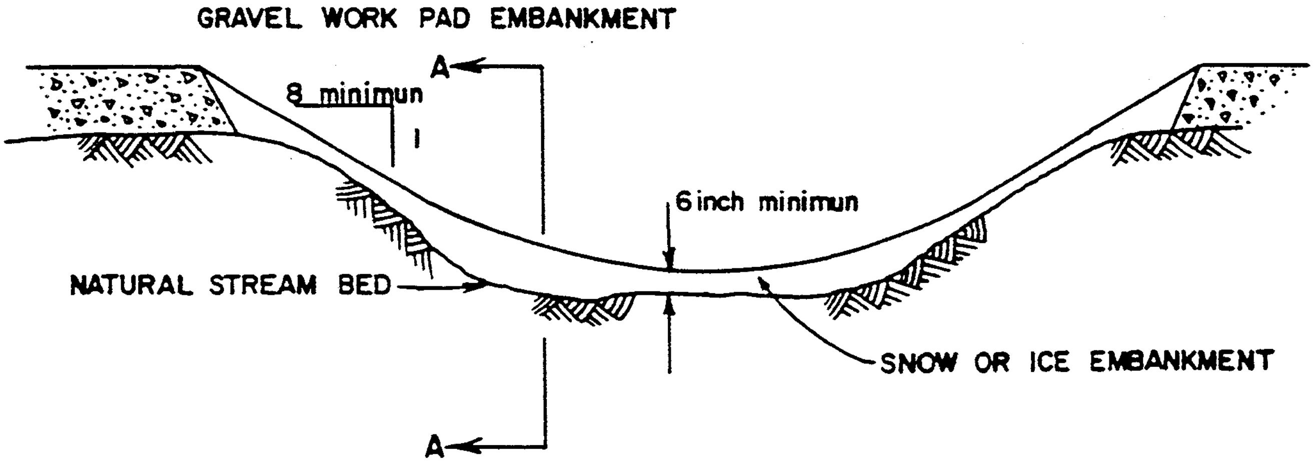
prior to installation of the culvert whenever feasible.

CONSTRUCTION PAD, WINTER

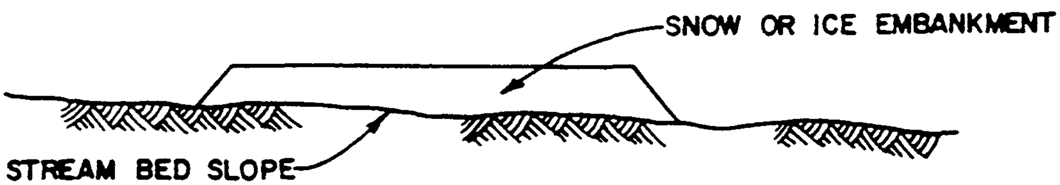
LOW WATER CROSSING



PLAN VIEW



WORK PAD PROFILE



SECTION A-A

NOTES:

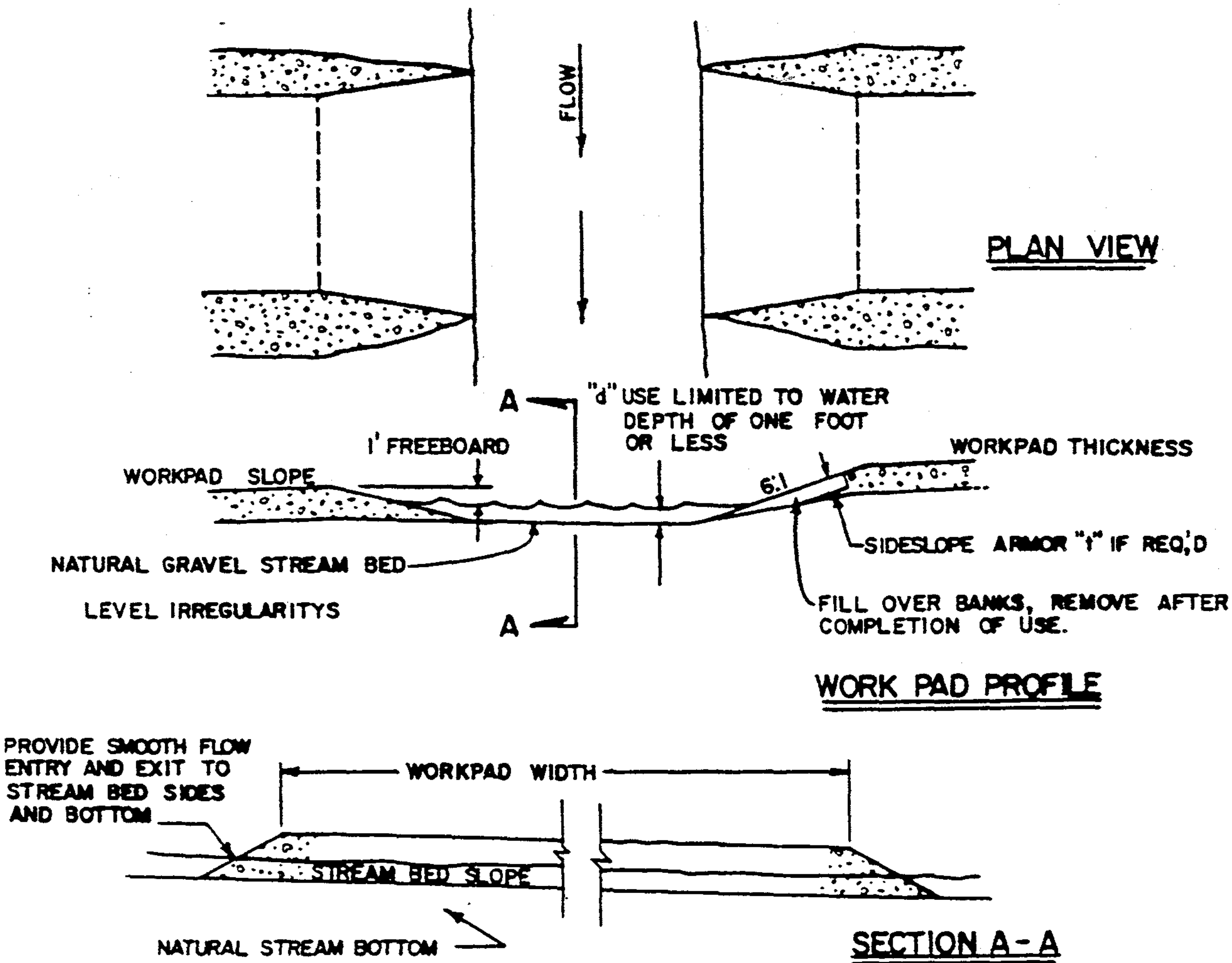
1.) SNOW OR ICE PAD AND ACCUMULATED SNOW DRIFTS MUST BE REMOVED FROM CHANNEL FOR A DISTANCE OF 3 B BUT NOT LESS THAN 100 FEET UP & DOWNSTREAM OF PAD PRIOR MAY 25.

2.) IF MINOR FLOW EXISTS UNDER ICE COVER CULVERTS MUST BE PROVIDED PEP SECTION 3.3.2.

CONSTRUCTION PAD
TEMPORARY LOW WATER CROSSING
WINTER CONSTRUCTION

G.N.M. FEB. 1984 PLATE 3-33

CONSTRUCTION PAD ALL SEASON LOW WATER CROSSING FOR WELL-DEFINED, GRAVEL BED STREAMS

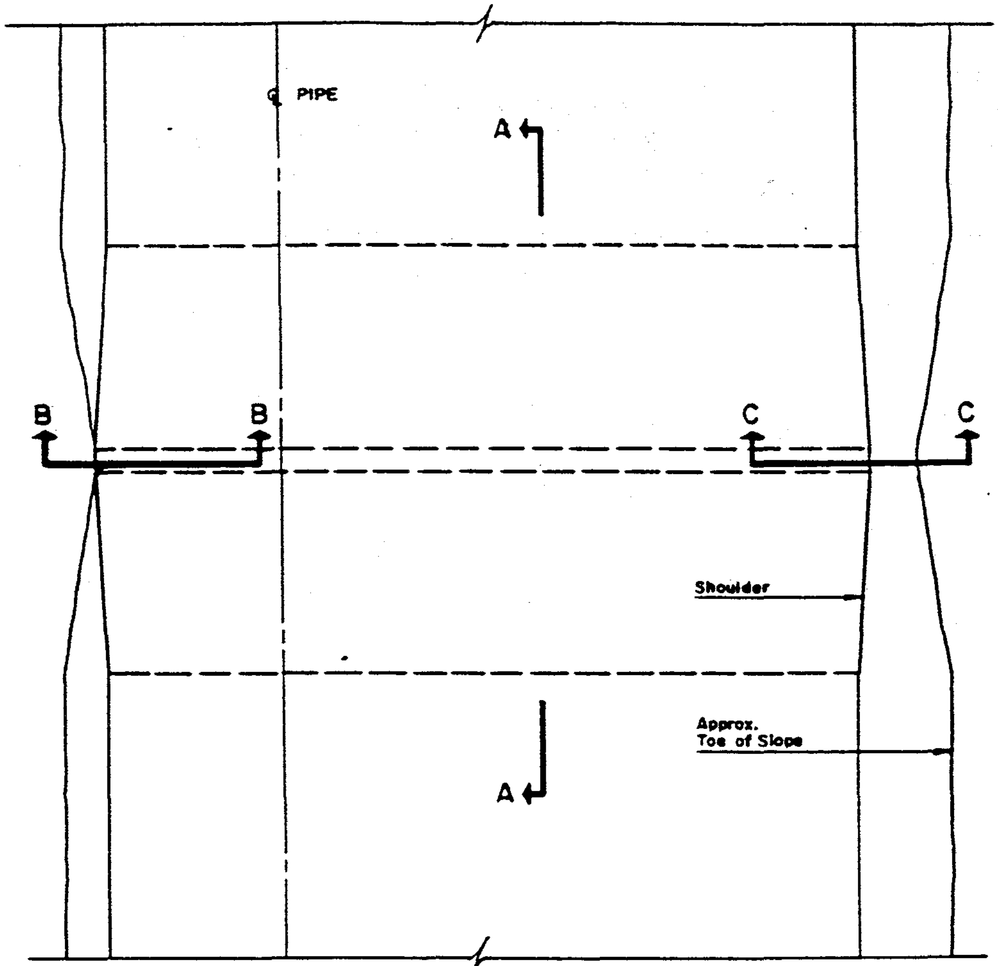


CONSTRUCTION PAD
TEMPORARY LOW WATER CROSSING
GRAVEL STREAM BED

G.N.M. FEB. 1984 PLATE 3-34

CONSTRUCTION PAD, ALL SEASON

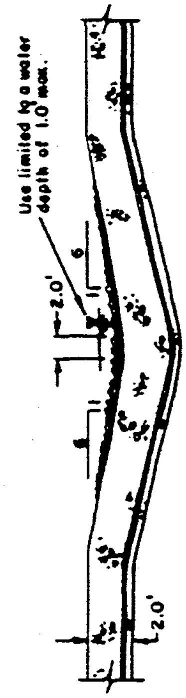
FOR LOW WATER CROSSING, THAW UNSTABLE FROZEN BED STREAMS



LOW WATER CROSSING, PLAN VIEW

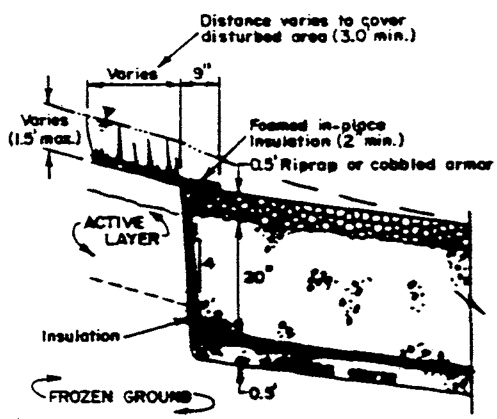
SCALE/FEET

5 0 5 10 15 20 25



SECTION A-A

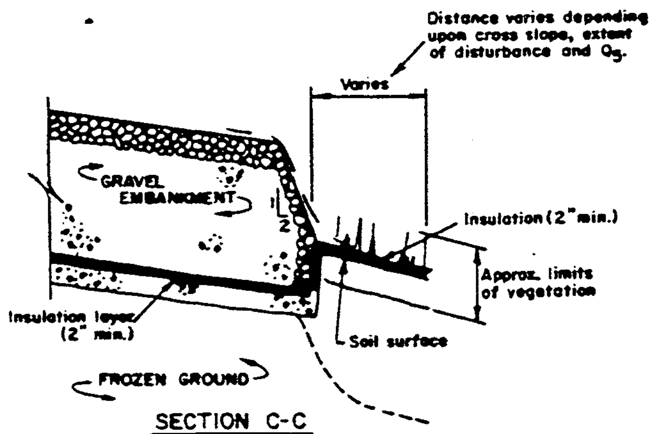
NO SCALE



SECTION B-B

NO SCALE

NOTE:
The vertical scale in sections B-B and C-C is exaggerated to emphasize details.



SECTION C-C

NO SCALE

CONSTRUCTION PAD

LOW WATER CROSSING - INSULATED WORKPAD

3.6 REFERENCES

(1) Bodhaine, G. L., 1968, "Measurement of Peak Discharge at Culverts by Indirect Methods: Techniques of Water Resources Investigation of the United States Geological Survey", Chapter A3, U.S. Department of Interior.

(2) Bohen, J. P. 1970, "Erosion and Riprap Requirements at Culvert and Storm Drain Outlets: Hydraulic Laboratory Investigation", U.S. Army Waterways Experiment Station.

(3) Bonner, V. R., 1974, "Application of the HEC-2 Bridge Routines: Training Document No. 6", The Hydrologic Engineering Center, Corps of Engineers, U.S. Army, Davis, California

(4) Bradley, J. N., 1970, "Hydraulics of Bridge Waterways, Second ed.: U.S. Bureau of Public Road Hydraulic Design Series No. 1", U.S. Department of Transportation.

(5) Herr, L. A., and Herbert G. B., 1965, "Capacity Charts For The Hydraulic Design of Highway Culverts", U.S. Bureau of Public Roads Hydraulic Engineering Circular No 10, U.S. Department of Transportation.

(6) Herr, L. A., 1965, "Hydraulic Charts for the Selection of Highway Culverts: U.S. Bureau of Public Roads Hydraulic Engineering", Circular No. 5, U.S. Department of Transportation.

(7) Hulsing, H., 1967, "Measurement of Peak Discharge at Dams by Indirect Methods: Techniques of Water Resources Investigations of the United States Geological Survey", Chapter A5, Book 3, U.S. Department of the Interior.

(8) Michel, B., 1971, "Winter Regime of Rivers and Lakes: Nomograph III-B1a", Cold Regions Research and Engineering Laboratory, Corps of Engineers, U.S. Army, Hanover, New Hampshire.

(9) Neill, C. R., 1973, "Guide to Bridge Hydraulics", Road and Transportation Association of Canada, University of Toronto Press.

(10) Simons, D. B., Fuat, S., 1977, "Sediment Transport Technology", Water Resource Publications, Fort Collins, Colorado.

(11) _____________, 1981, "Armorflex Erosion Control System - Bank and Channel Protection: Technical Bulletin BC-1," Armortech Inc., Atlanta, Georgia.

4.0 GEOTECHNICAL

The purpose of this section is to provide the following:

- o Construction aspects related to soil and climatic conditions.
- o Soil properties for calculation of culvert stresses.

4.1 Typical Soil Types

4.1.1 Natural Soil Conditions. Typical conditions consist of an organic tundra mat over silt over sand and gravel. Surface sands are also in the sand dune area. Typical soil densities, porosity and moisture (ice) contents are provided in Table 4-1.

4.1.2 Fill Material. Typical fill material available for use in the Lisburne Project is from the Put 23 Mine Site and consists of well graded sandy gravel. Typical fines content (passing #200 sieve) varies from two to ten percent, and natural ice contents in the borrow pit vary from 5 to 15 percent. Compaction characteristics of this fill material are presented in Table 4-1 and are discussed on page 4-6.

4.2 Seasonal Effect on Placement of Fill Materials For Bedding, Padding and Cover

4.2.1 Summer Placement. During summer placement when the materials are unfrozen, proper compaction procedures can achieve 95 percent relative compaction resulting in a dense fill material.

4.2.2 Winter Placement. The limitations resulting from winter placement of fill materials is caused by the reduction in maximum achievable compaction with slight increases in ice content. The estimated material densities for winter placed fill are shown on page 4-6. Based on the resulting metastable condition of winter placed gravel with ice, the gravel has a high potential for collapse and erosional washout when the materials thaw during the first thaw season.

4.3 Material Properties For Culvert Stress Analysis

Section 6.0 Construction Practices provides backfill and compaction requirements. To the extent practicable, the bedding will be shaped to fit and support the bottom of the culvert. The side fill will be select granular material, as specified in the specifications, placed in accordance with construction specifications. The soil modulus (M_s) properties of the confined soil that will control the subsequent overburden stress calculations of open conduits (culverts) have the following design values:

Padding Compaction	Design Soil Modulus M_s (psi)	Remarks
Minimum 90% Standard Proctor (AASHO Test T99)	2000	Soils in ditch wall must be granular or initially-thawed, stiff fine-grained soil, or ditch width at pipe centerline must be 2.5D.
Nominal (Cross Country)	1000	Summer placement
Nominal (Cross Country)	600*	Winter placement

*This value could be much lower than this, as indicated in the attached pages 4-6 and 4-7.

4.4 Thaw and Settlement of Subgrade

4.4.1 Estimated depths of thaw for various soil profiles beneath the culvert invert are presented. Using typical water and air temperatures of 32 to 38°F the need for insulation beneath the pipe and required thickness have been evaluated using the Modified Berggren Method (1966) and the method by Thornton (1977), both of which are simplified and conservative. Typical insulation design is shown on Plate 4-1.

4.4.2 An alternative to an insulation design, based on field determination, is overexcavation of thaw-unstable soil and replacement with thaw-stable fill as shown on Plate 4-2. The results of calculations demonstrating the need for either overexcavation or insulation under culvert base are shown on pages 4-8 through

4-11. On these pages, the overexcavation depth for single or multiple culverts are provided. In addition the width of the overexcavation is also calculated.

4.4.3 If the field determination indicates that the subgrade soils are thaw stable, the culverts can be placed on the natural soil or on a thin bedding as shown on Plate 4-3.

4.5 Piping Failure

Piping failures mostly occur due to <u>winter</u> placed poorly compacted backfill installations since ice content in the gravels prevent adequate compaction. In addition frozen gravels when they become thawed experience a loss of compaction, a tremendous increase in permeability, and thus a large increase in seepage velocities as demonstrated on pages 4-11 and 4-12. These high seepage velocities transport the thawed loose soil particles from around the culvert leading to rapid progressive failure. Based on these demonstrations properly compacted summer placed backfills will prevent piping failures and for these reasons <u>summer culvert installations are recommended</u>.

TABLE 4-1

TYPICAL SOIL CHARACTERISTICS

Depth Interval (ft)	Soil Description	Porosity* n	Moisture** Content W	Dry Density (lbm/ft^3)	Remarks
0-05	Gravel Pad	0.30	0.05	115	Compacted while frozen
0-05	Gravel Pad	0.20	0.05	135	Thawed compacted gravel
5-6 1/2	Organic Layer	0.807	1.95	25	Natural Conditions
6 1/2-19	Silt & Sandy/Silt	0.500	0.34	84	Natural Conditions

*n = void volume/total volume

**W = mass of moisture/mass of solids = $\frac{n}{1 - n} \frac{\rho_m}{\rho_s}$

Where ρ_m = moisture density, ρ_s = density of solids

NOTE: Pore spaces below the gravel pad assumed fully (100%) saturated with ice.

4.6 Effect of Ice Content on Compaction, and Modulus Thaw Strain

When culverts are installed in the winter, the soil modulus (M_s) property when the soil thaws depends on the compacted density. For typical ice contents of ten percent, the resulting thaw strain can be on the order of 20 to 30 percent. Therefore, the value of M_s = 600 could be <u>unconservative</u>, since thaw strain must occur before an M_s = 600 psi can be mobilized.

Example: Put 23 Gravel

Max dry density=140 pcf; Min dry, thawed density=115 pcf

When ice is present, assume:

Frozen Porosity, n = 1 - (vol.soil + vol ice)

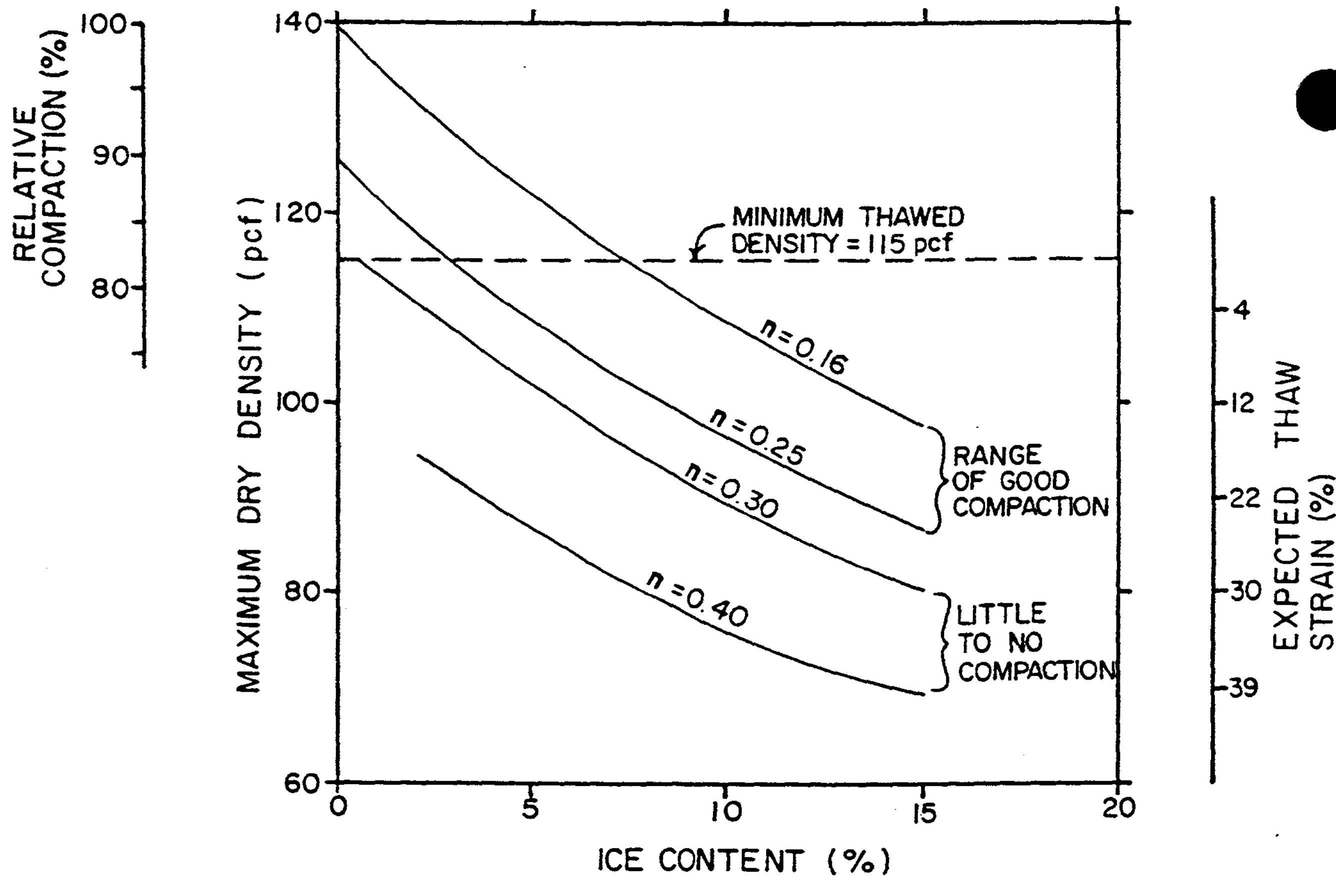


FIGURE 4-1

Assume as a worst case example that the soil collapses upon thawing to the minimum density as shown in Figure 4-2.

$$\text{Thaw Strain} = \varepsilon_T = \frac{\gamma_m - \gamma_F}{\gamma_m} \times 100 = \frac{115 - 80}{115} \times 100 = 30\%$$

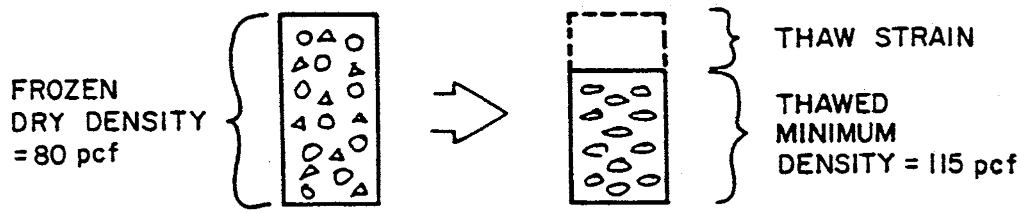


FIGURE 4-2

Before the soil modulus, M_s = 600 psi, suitable for loose gravel can be mobilized. The thaw strain must first occur as indicated in Figure 4-3.

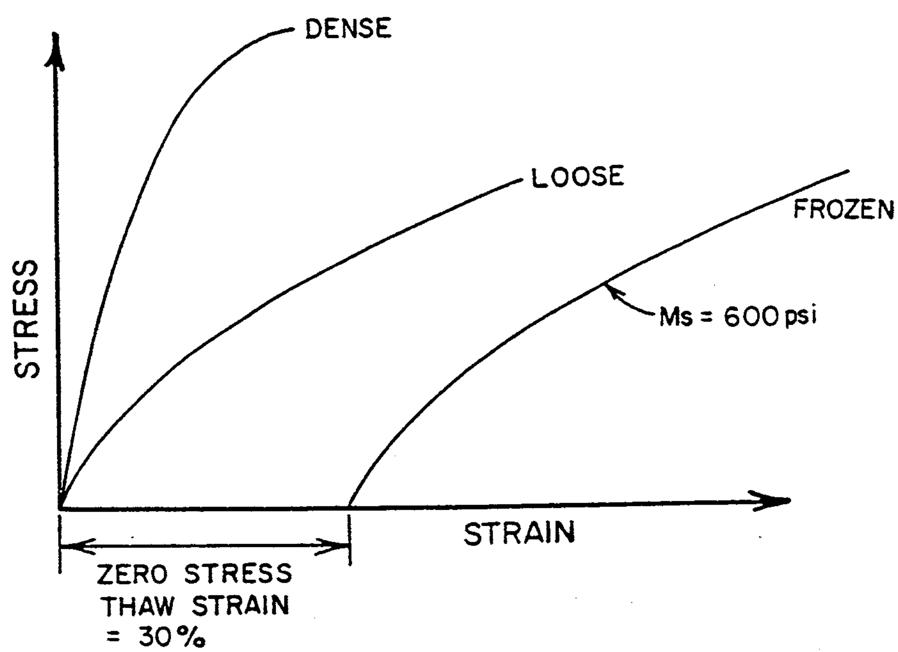


FIGURE 4-3

For conditions where the ice contents are lower and better compaction is achieved the thaw strain can be less than the example of 30 percent. Thus for the best winter placed gravel the "frozen" soil modulus curve coincides with the "loose" curve.

4.7 Thaw of Embankments and Beneath Culverts

Assume:

(1) An average ground temperature = 23°F

(2) Air thawing index = 600°F - days

The modified Berggren analysis assumes an infinite horizontal heat source (i.e., multiple culverts case). The results of the analysis are shown in Figure 4-4.

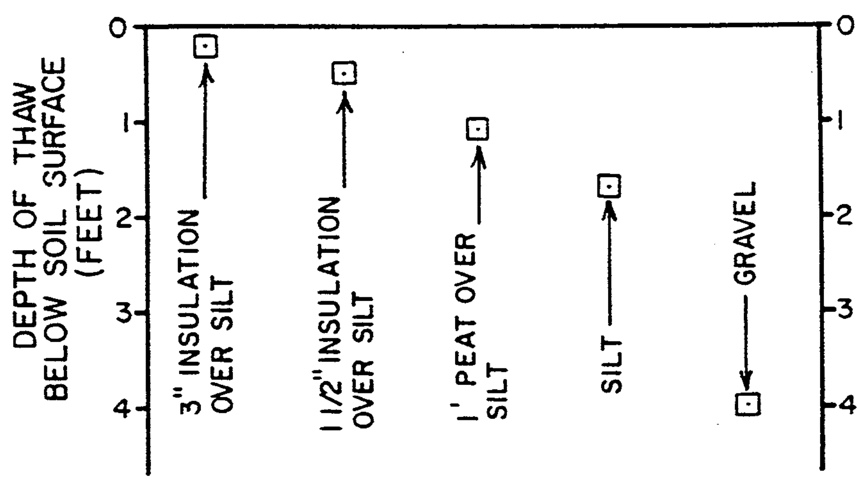


FIGURE 4-4

The Thornton Method assumes a buried pipe at steady state condition. (i.e., an infinite time of thaw). The results of the analysis are summarized in Figure 4-5.

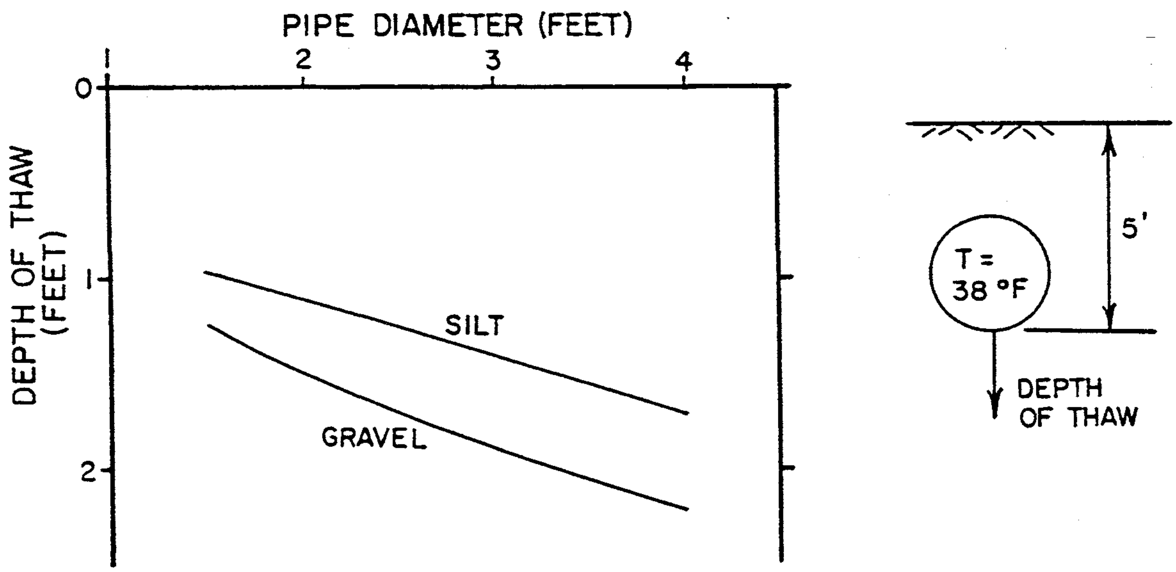


FIGURE 4-5

Thornton's method also gives the following dimensions in Figure 4-6 for the thaw bulb at infinite time.

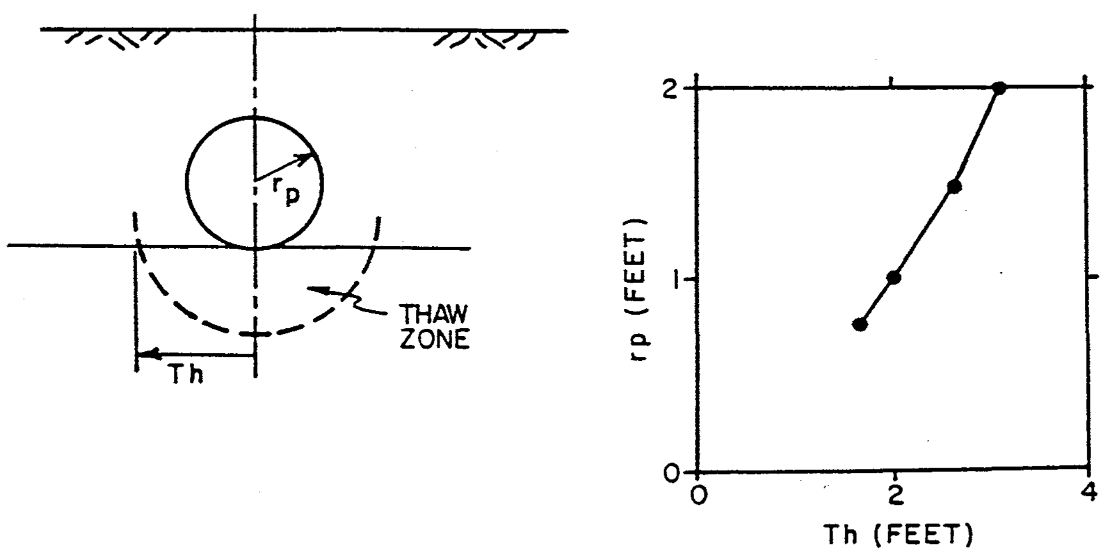


FIGURE 4-6

Based on the Thornton analysis, the following overexcavation limits are recommended for the culverts as an alternative to insulation.

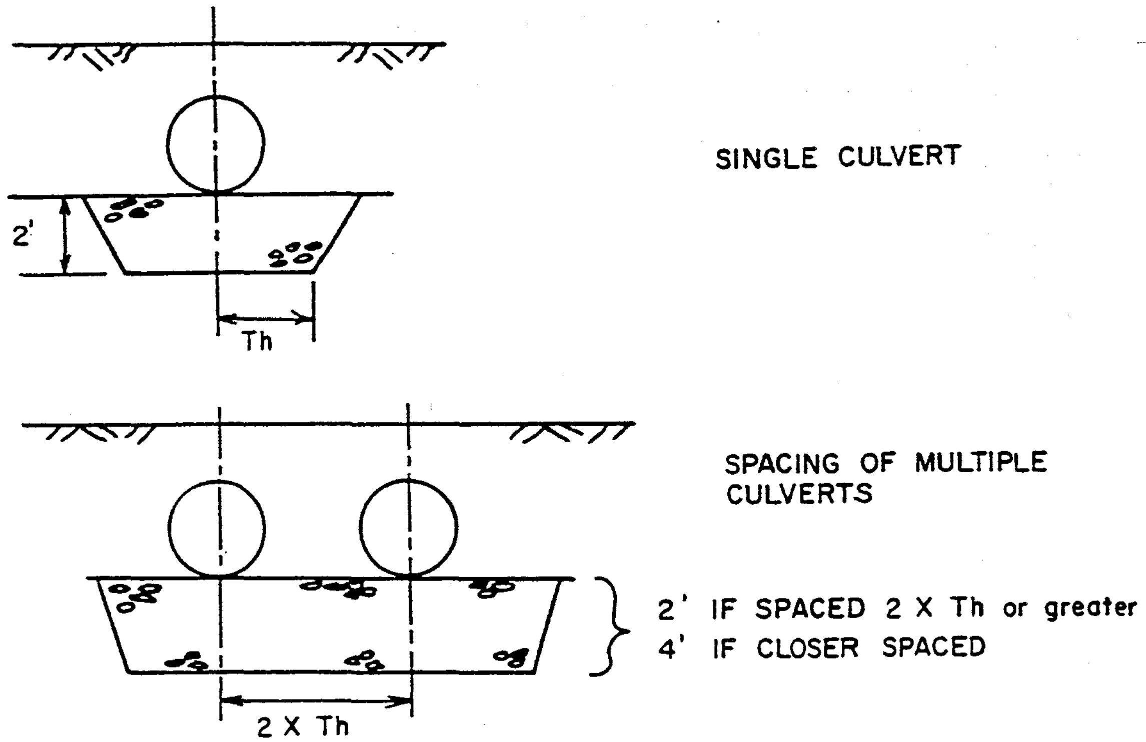


FIGURE 4-7

With the calculated depths of thaw, the thaw settlement beneath the culvert can be calculated using the thaw strain appropriate for the soil. These calculations support the "Insulated Culvert" design standard shown on Plate 4-1 or the need for overexcavation and placement of "summer placed" gravel shown on Plate 4-2.

THAW SETTLEMENT = DEPTH OF THAW X THAW STRAIN

Design Case	Depth of Thaw*	Thaw Strain**	Thaw Settlement
3" insulation over silt	0.2'	12%	0.02'
Summer placed gravel	2.0'	<2%	<0.04'
Summer placed gravel	4.0'	<2%	<0.08'
One foot peat over silt	0.9'	40%	0.36'
Silt	1.5'	12%	0.18'

*From Figures 4-4 and 4-5

**Thaw-strain values based on the dry densities from Table 4-1 and published thaw-strain correlation (Nelson et al 1983).

4.8 Discussion of Piping Failure

The flow of water, Q, through the soil adjacent to the culvert conforms to Darcy's law.

$$Q = kiA$$

The hydraulic gradient, i, can be approximated as the change in head across the embankment divided by the width of the embankment.

Values for the permeability, k, of the frozen ice-gravel fill are not known. However, the permeability is expected to increase several orders of magnitude when the ice melts. The following Figure 4-8 (from Cedergren) shows a typical change in permeability with change in density for a sandy gravel.

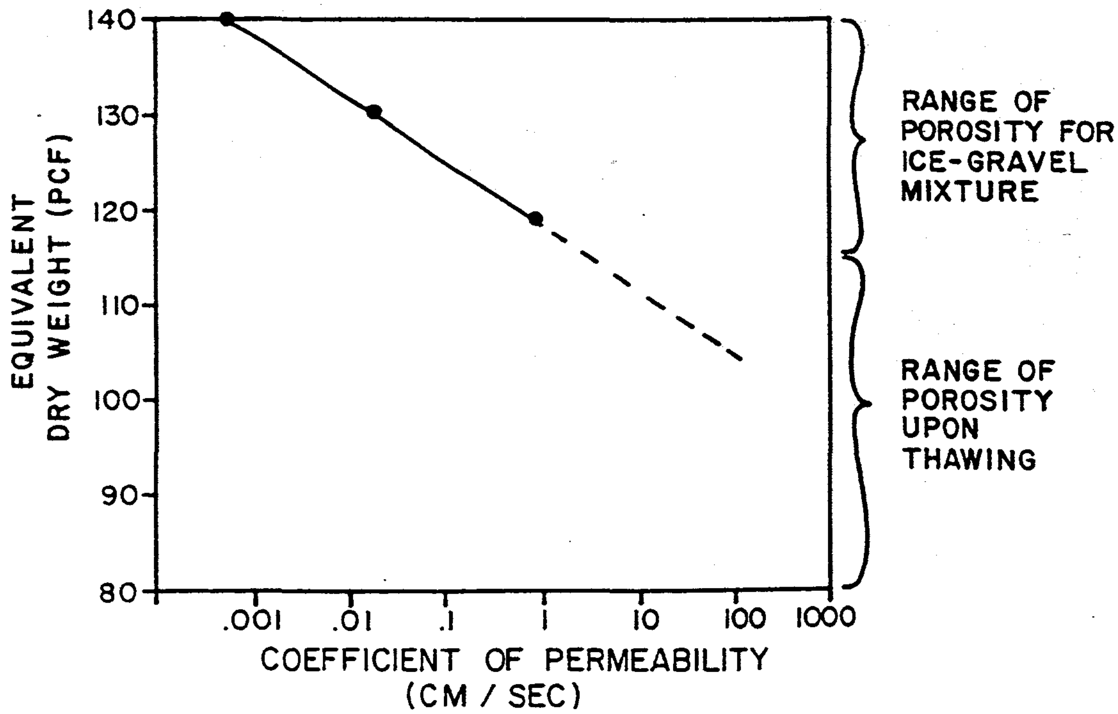
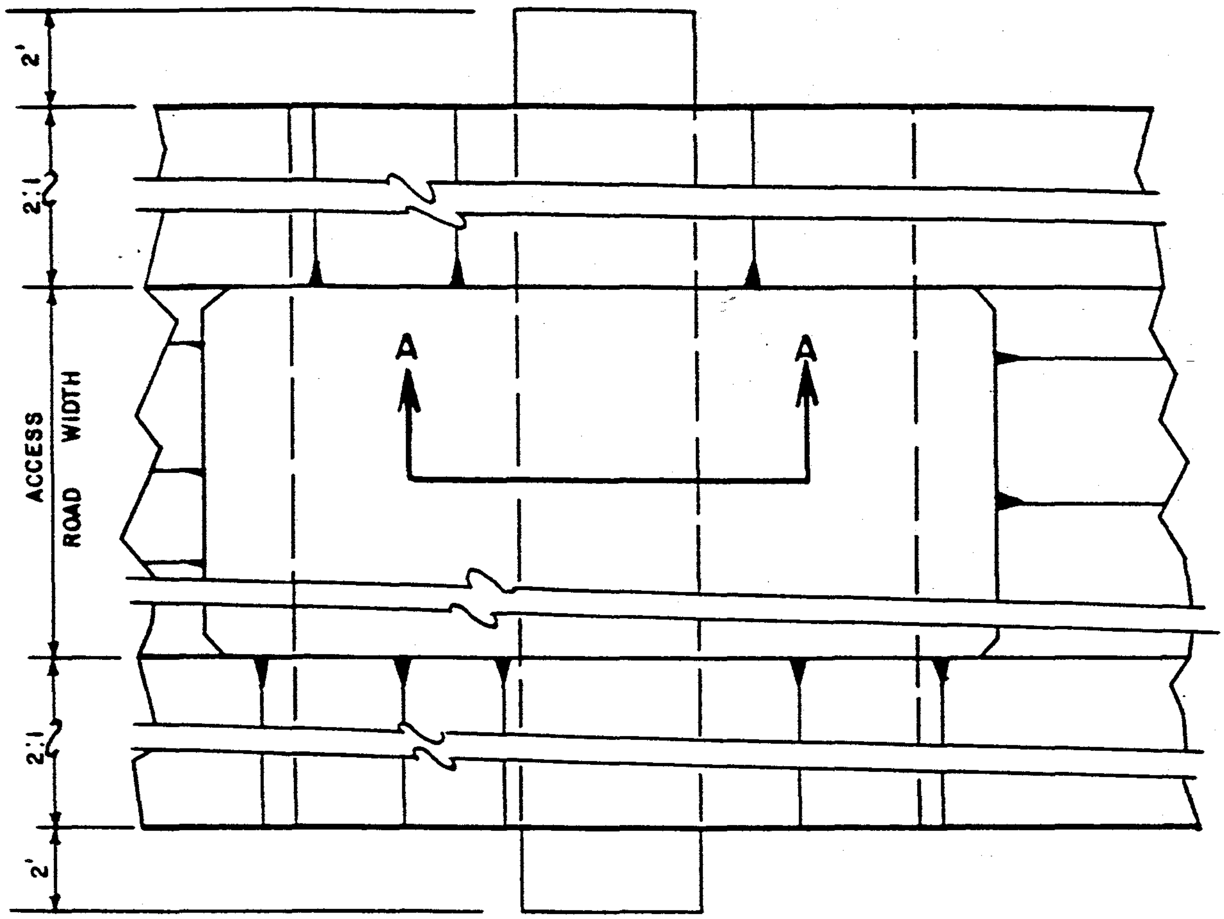
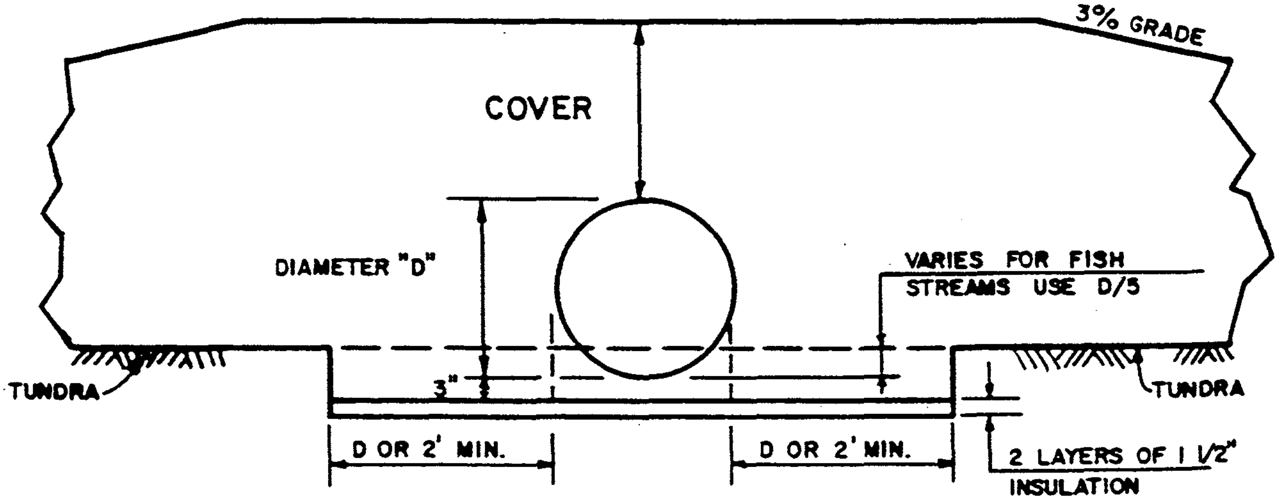


FIGURE 4-8

The effect of the large increase in permeability is to channelize the flow into the thawed zone. The initial thawed zone is small and the permeability is large. Consequently, the seepage velocities are large. The very loose sand and gravel are easily eroded and this leads to a progressive piping failure.



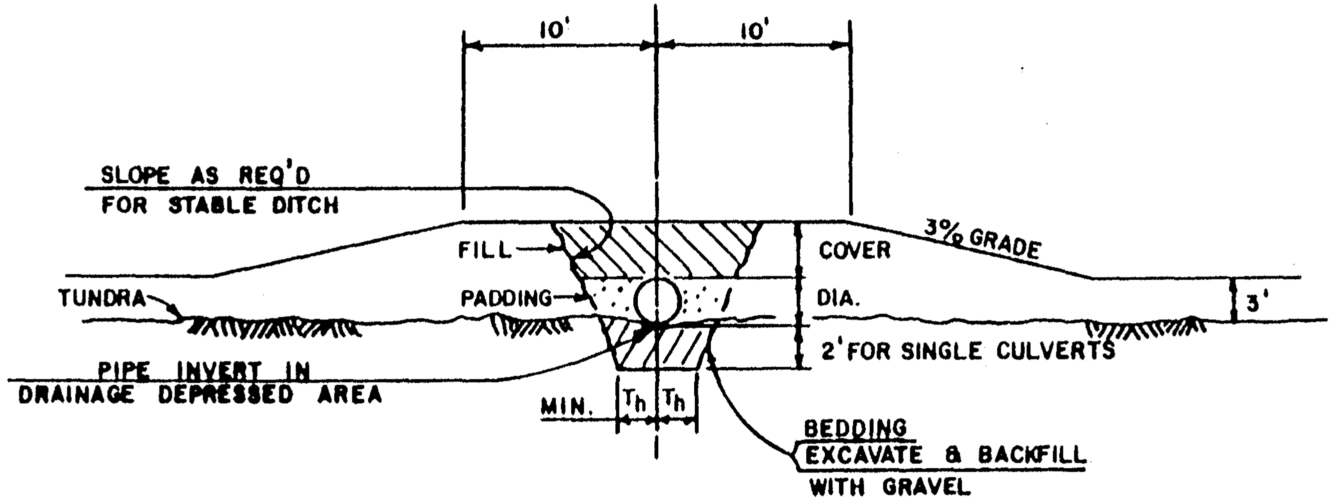
PLAN



SECTION A-A

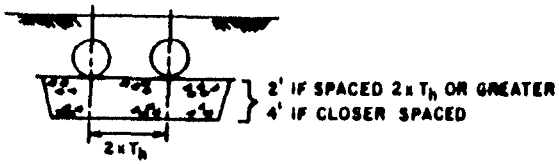
INSULATED CULVERT

PLATE 4-1



END VIEW

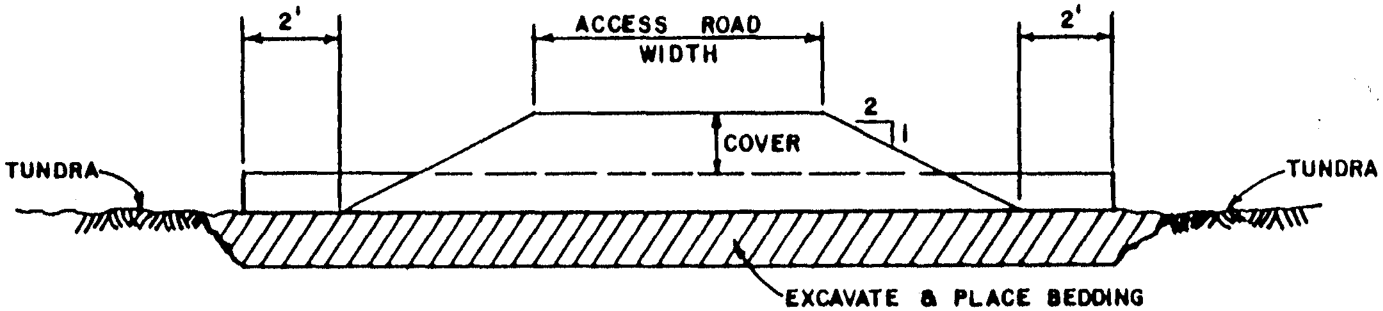
(N.T.S.)



SPACING OF MULTIPLE CULVERTS

THAW WIDTH T_h

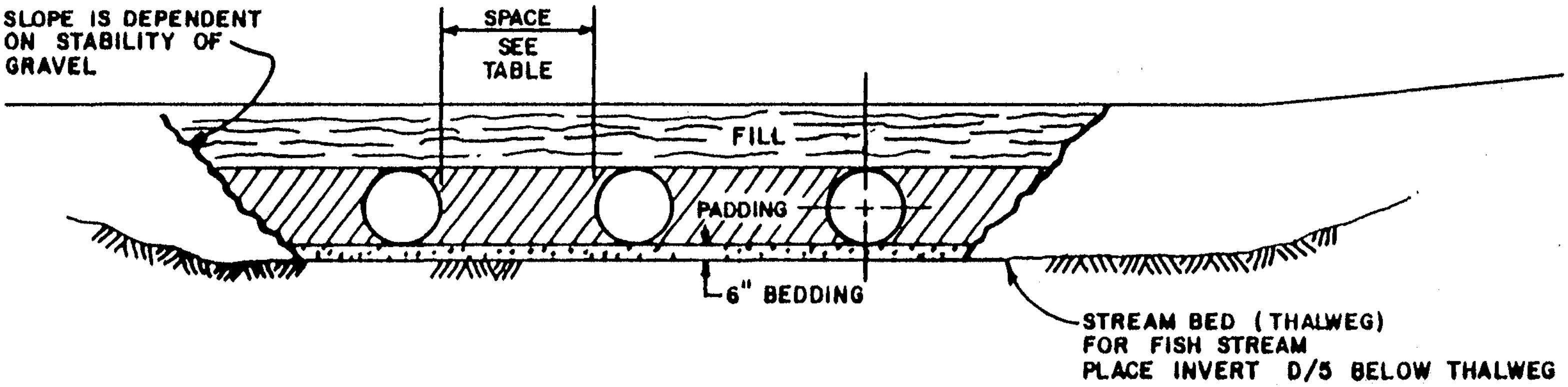
DIA.	T_h
2'	2'
4'	3'
6'	5'
>6'	SITE SPECIFIC DESIGN REQUIRED



SIDE VIEW

(N.T.S.)

CULVERT PLACEMENT ON THAW-UNSTABLE SOIL

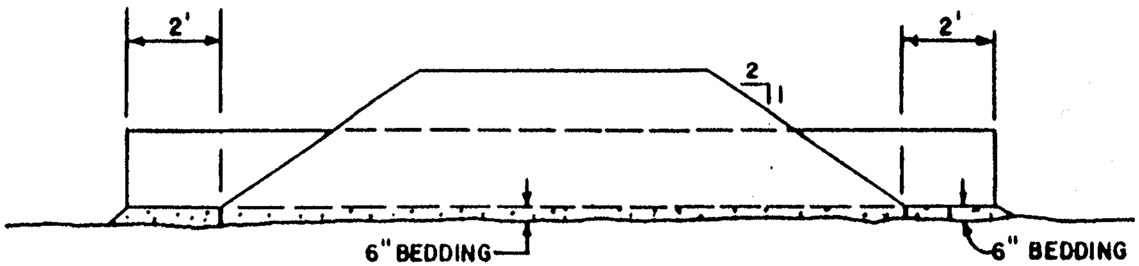


END VIEW

(N.T.S.)

SPACE TABLE

DIA.	MIN. SPACE BETWEEN PIPES
0" - 42"	24"
48" & OVER	1/2 DIA. OR 3' WHICHEVER IS L



SIDE VIEW

(N.T.S.)

CULVERT PLACEMENT ON
THAW-STABLE SOIL

PLATE 4-3

4.9 REFERENCES

(1) Bruggers, D. E., Kai, S. W., and England, J. M., 1983, "Prudhoe Bay Unit, Lisburne Development, Geotechnical Investigations, Winter 1983", 2 Vols, Harding Lawson Associates for ARCO Alaska, Inc.

(2) Cedergren, H. R., 1967, "Seepage, Drainage, and Flow Nets", John Wiley & Sons, Inc.

(3) Thorton, D. E., 1977, "Calculation of Heat Loss From Pipes - Utilities Delivery in Arctic Regions", Water Pollution Control Directorate, Environmental Protection Service, Canada.

(4) ________________, 1966, "Calculation Methods For Determination of Depths of Freeze and Thaw in Soils - TM 5-852-6", U.S. Department of the Army.

5.0 STRUCTURAL - DESIGN OF CULVERTS FOR EXTERNAL LOADS

This chapter presents a state-of-the-practice design procedure for calculating culvert ovalling deflections and stresses. Based on a recent paper by Thomas and Manikian (Ref. 5), the procedure models the soil-pipe interaction, characterizing the sidefill by an appropriate modulus value and initial pipe out-of-roundness can be taken into account.

5.1 ASSUMPTIONS

Certain fundamental assumptions are made to keep the analysis simple. First of all, ovalling of the pipe cross-section is treated as a two-dimensional problem. This is reasonable inasmuch as external loads (and corresponding resistances) are often distributed over a substantial length of the pipe. Even where concentrated loads act on the buried pipe, these can commonly be reduced to an equivalent uniform distributed load acting over a certain effective length of the pipe.

Secondly, the pipe cross section is treated as fully-flexible; i.e., it is the surrounding soil which provides the stiffness and resistance to ovalling deformations. This assumption is reasonable for most larger-diameter (say 24 in.+) pipes surrounded by compacted granular materials. However, it tends to overpredict deflections for smaller-diameter piping having D/t ratios of less than about 80.

Lastly, it is assumed that the pipe cross section (see Figure 1) deforms from a circular shape into an elliptical shape. As this is the most favorable shape from a stress standpoint, this assumption may be slightly unconservative in some cases, particularly for certain pipe bedding conditions. However, it simplifies the analysis substantially.

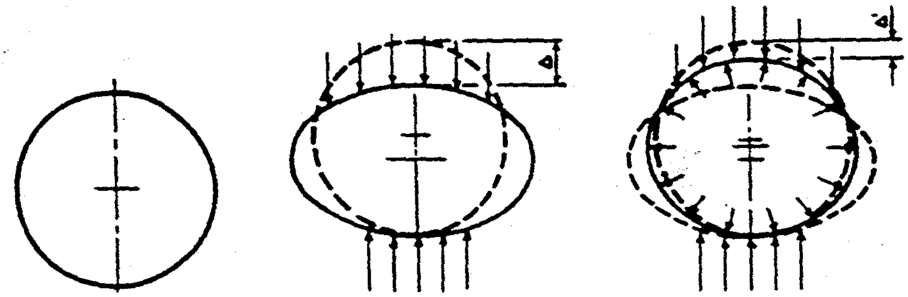


Figure 1. Deflections of Flexible Pipe Under Various Conditions of External Load and Internal Pressures

5.2 EXTERNAL LOADS

The most common sources of external loading on buried pipes are backfill and traffic. A number of years ago, Anson Marston developed the Marston Theory of Loads on Underground Conduits. This theory (see Ref. 4) subdivided underground conduits into two major classes known as "ditch conduits" and "projecting conduits". Each of these was further subdivided into several subclasses.

The basic issue addressed by these various classes was backfill arching: whether the soil on top of the pipe was partially supported by adjacent soils or further loaded by adjacent soils. Although it is a rational theory, its application in practice requires assumption of certain difficult-to-define geometric and soil-behavior parameters. To simplify the problem, the authors have used the assumption of a uniform gravity load defined by:

$$p_v \text{ (soil)} = \frac{\gamma H}{144} \quad \text{(psi)} \qquad (1)$$

where γ = backfill unit weight (pcf), and
H = depth of cover (ft).

Traffic loads can take on many different forms. Loaded tracked vehicles exert a certain average contact pressure beneath the tracks. For wheeled vehicles, the pattern (spacing, number of axles, etc.) of the wheels and their position relative to the buried pipe can be important. For some situations, the most critical positioning may not be obvious and several trial calculations, using the principle of superposition, may need to be made. Based on the classical Boussinesq solution, Spangler (ibid.) suggests the following formulation for load on the buried pipe due to a point load applied at the ground surface.

$$p_v \text{ (traffic)} = \frac{C_t Q}{12DL} \quad \text{(psi)} \tag{2}$$

where C_t = stress influence factor,

Q = wheel load in lbs.,

D = pipe outside diameter (in.), and

L = effective length (ft).

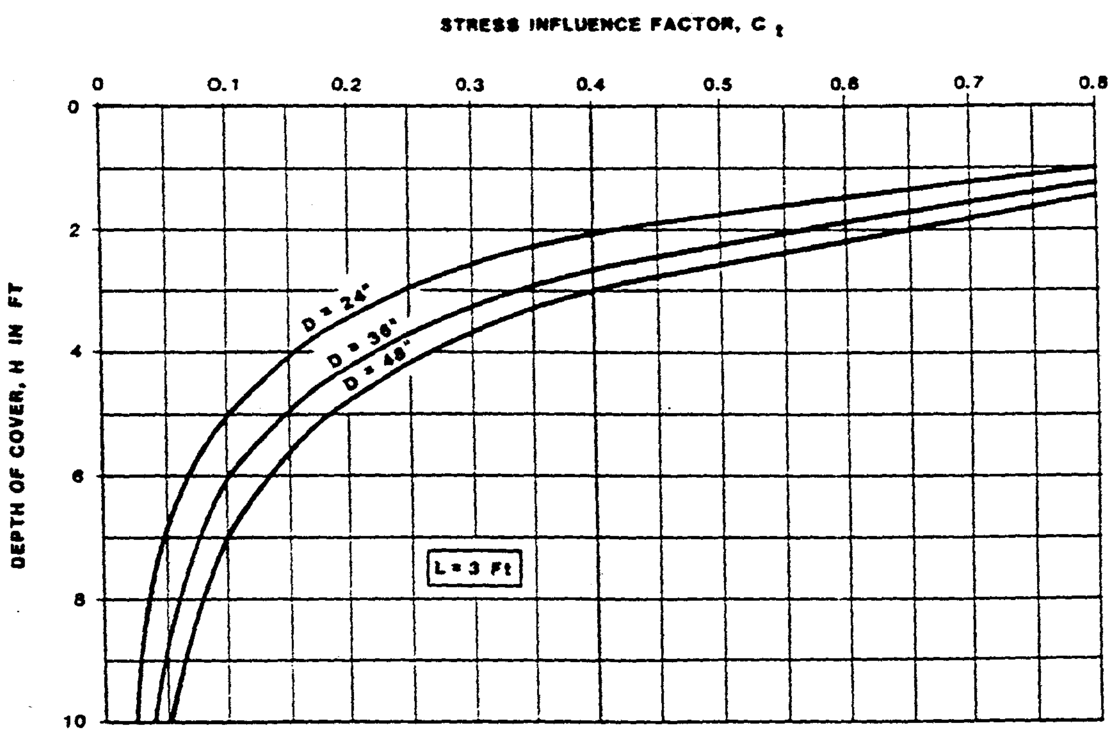


Figure 2. Influence Factor for a Concentrated Load Directly Above a Buried Pipeline

For commonly-used pipe sizes and cover depths, Spangler recommends using a constant value of L of 3 ft. Based on this value of L and application of the point load immediately above the pipe, Figure 2 presents C_t as a function of pipe diameter and depth of cover.

To account for the effects of vehicle speed, axle load, road roughness and type of pavement, Equation 2 can be rewritten as:

$$p_v \text{ (traffic)} = \frac{C_t QF}{12DL} \qquad \text{(psi)} \qquad (3)$$

where F is an impact factor, usually taken between 1.5 and 2.0 for unpaved roads.

5.3 SIDEFILL RESISTANCE

Buried flexible pipes rely to a very large degree on sidefill resistance to support superimposed external loads. In the equations which follow, sidefill resistance is characterized by the constrained soil modulus M_s. Achievement of an adequate value of M_s often requires that the construction specifications call for good granular material to be placed and compacted on both sides of the pipe. Where parallel pipes are placed in the same ditch, spacing between the pipes needs to be sufficient to enable compaction equipment to be used between the pipes.

The preferred sidefill material is a well-graded sand and gravel having the following gradation:

Sieve Size	Percent Passing by Weight
1 1/2"	90-100
3/4"	75-100
#4	30-85
#40	0-40
#200	0-10

Pit run material meeting this gradation is commonly available on the North Slope of Alaska. The material should be free of snow and ice, and preferably thawed.

In the absence of site-specific laboratory test data, the following values may be used to characterize the sidefill resistance:

Compaction	M_s (psi)	Remarks
Minimum 90% Std. Proctor (AASHO Test T99)	2000	Soils in ditch wall must be granular or initially-thawed, stiff fine-grained soil, or ditch width at pipe centerline must be at least 2.5D.
Nominal	1000	Summer placement
Nominal	600	Winter placement

The "nominal" compaction refers to a controlled placement utilizing a nominal amount of compaction energy to fill all voids around the pipe and achieve a relatively uniform sidefill density. The lower modulus value for winter placement reflects the inhibiting effect of frozen moisture as can be seen in the following figure.

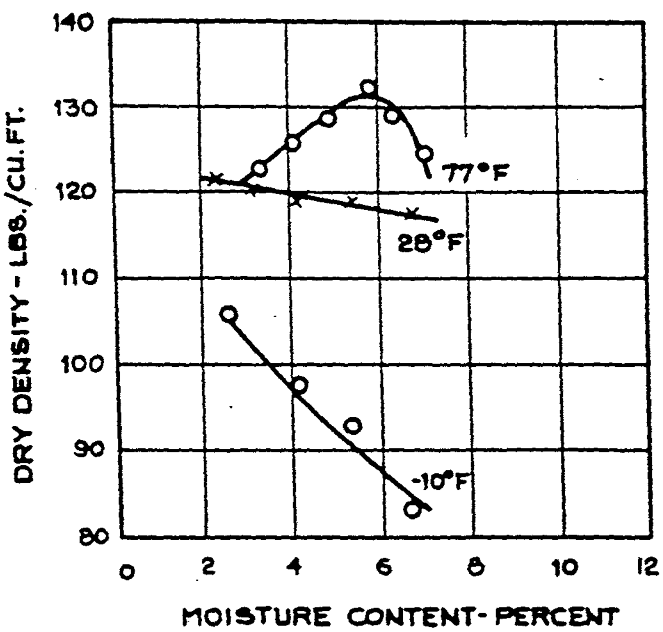


Figure 3. Moisture-Density Relationship for Standard Proctor Compaction Effort on Gravel (GP-GW) from Ref. 3

The figure shows the effect of ambient temperature on the moisture-density relationship for a typical gravel. For this material, Maximum Proctor Density is 131 pcf and 90% Proctor Density is 118 pcf. At temperatures below 28°F, 90% Proctor compaction is achievable only if the material is very dry (less than about 2% moisture).

5.4 OVALLING DEFLECTIONS

Based on the previously-stated assumptions, Allgood (Ref. 1) has recommended that unpressurized pipe diameter change Δ (see Figure 1b) be calculated as:

$$\Delta = 2.33 \frac{p_v D}{M_s} \quad \text{(in.)} \tag{4}$$

In this expression, p_v represents the total of soil and traffic pressure on top of the buried pipe.

5.5 PIPE STRESSES

For elliptical deformation, it can be shown that maximum hoop bending stress S_B is related to diameter change as follows:

$$S_B = \pm\, 3.33\, E \frac{t}{D^2} \Delta \quad \text{(psi)} \tag{5}$$

where E = modulus of elasticity (29×10^6 psi for steel), and t = pipe wall thickness (in.).

5.6 ALLOWABLE LIMITS

In general, both deflections and stresses need to be checked. A commonly-accepted limit on deflections is 5 percent of the pipe diameter. This provides a factor of safety against snap-through buckling. Because flexible pipe cross sections are seldom perfectly round to start with, it may be prudent to deduct an initial (unstressed) out-of-roundness from 0.05D to obtain a design allowable deflection. Alternately, out-of-round culvert sections should be laid with their major axis vertical.

The allowable hoop bending stress can normally be taken as 90 percent of SMY. For some cases, higher stresses may be justifiable on the basis that local extreme-fiber yielding increases the flexibility of the pipe cross section, thereby enhancing its interaction with the surrounding soil.

5.7 APPLICATION

For a given project, the procedure described above can be used to assist in selecting an appropriate pipe wall thickness, steel grade, material and compaction specification for the sidefill, and minimum depth of cover needed for protection.

For the design of circular corrugated pipe, bending stress and deflection criteria are checked. The deflection calculations assume flexible pipe and the calculations are identical to those used for smooth pipe. Bending stresses are calculated using procedures presented in the Steel Drainage and Highway Construction Products Handbook published by AISI (Ref. 2).

Calculations for multiplate structures follow procedures presented in the AISI Handbook. The required depth of cover is controlled by bearing capacity beneath the tight-radius corners when the sidefill soil strength is low to moderate. Given the soil modulus M_s, soil bearing capacity is calculated after assuming an appropriate angle of internal friction based on estimated dry densities for the side-fill. To limit deflections, a factor of safety of 2 was applied to the calculated ultimate bearing capacity. Ring deflection was not considered for the multiplate structure.

An additional cause of culvert failure is flotation of projecting ends when they experience buoyancy as a result of ice blockage. Uplift forces were computed assuming a total inlet blockage, an empty pipe, outside water level above the top of the pipe, and neglecting the weight of the pipe. The pipe was treated as a uniformly-loaded cantilever fixed at the point where the soil cover intersects the top of the pipe, and bending stresses corresponding to this characterization were calculated. For corrugated pipe, the section moduli provided in the AISI Handbook were used.

5.8 CALCULATION RESULTS

For the Lisburne Project, minimum cover depths for selected corrugated and smooth pipe culverts were calculated in accordance with the foregoing procedure. Design traffic load was taken to be a loaded B-70 gravel belly dump with one wheel located immediately above the pipe. With an axle load of 114 kips, each wheel exerts a load Q of 57 kips. Because this is a moving load, an impact factor F of 1.75 was used. The results of these calculations are as follows:

Smooth Pipe

Diameter (in.)	Wall Thickness (in.)	Minimum Cover (ft)		
		M_s=600	M_s=1000	M_s=2000
24	.281	*	4 3/4	3
36	.375	7	4	2 1/4
48	.462	6	3 3/4	1 3/4
56	.500	6	3 1/2	1 1/2
60	.500	6	3 1/2	1 1/4

* Pipe did not meet deflection requirements with any depth of cover

Corrugated Steel Pipe

Diameter (in.)	Corrugation (in.)	Gauge	Minimum Cover (ft)			AISI Recommended Depth (ft)	
			M_s=600	M_s=1000	M_s=2000	40,000 lb load	110,000 lb load
24	2 2/3 x 1/2	12	7	4 1/4	2 1/2	1*	1 1/2*
30	2 2/3 x 1/2	12	7	4	2 1/4	1	2
36	3 x 1	12	7	4	2 1/4	1	1 1/2
48	3 x 1	12	6	3 3/4	1 3/4	1	1 1/2
60	3 x 1	12	6	3 1/2	1 1/4	1	2

* Depths interpolated from AISI charts and rounded up to nearest 1/2 ft

10-gauge pipe is available in the 36" to 60" pipes. However, since deflection controlled in all cases, increasing the pipe thickness will not reduce the minimum depth of cover when assuming fully-flexible pipe.

Multiplate Structure (Culvert 20)

12 gauge 12'8" x 8'4"; 6" x 2" corrugations

Soil Modulus	Minimum Cover
600	*
1000	2 ft
2000	1 ft

* Corner bearing capacity is exceeded for all cover depths.

Calculated maximum stickout lengths before buckling for smooth and corrugated pipe are presented below. Based on a maximum allowable steel stress of 66% SMY, the calculations assume full blockage, an empty pipe, outside water level above the top of the pipe, and that the pipe has negligible self weight. Stickout is measured from the inlet to the soil fill along the top of the pipe.

Corrugated Steel Pipe

Diameter (in.)	Maximum Stickout Length (ft)	
	12 Gauge	10 Gauge
24	7	---
30	6	---
36	9	10
48	8	8
60	7	8

For smooth pipe, the calculated maximum stickout values were all in excess of 60 ft.

5.9 DISCUSSION

The minimum depth of cover calculated for the 57-kip wheel load does not take into account loads imposed during construction. It is possible that heavy construction equipment or unbalanced soil loads could damage incompleted culvert installations, especially those utilizing corrugated metal pipe. Summer placement and compaction of sidefill substantially reduce required cover depths. The reason for this is that winter construction greatly reduces the soil bearing capacity due to intergranular ice which melts during the following summer.

If the culvert must be installed in the winter, several alternatives may be considered to obtain a satisfactory installation. Kiln-dried sands and gravels could be placed and compacted at any temperature. However, it is difficult to keep gravel dry in an outdoor stockpile. Other alternatives include heating the wet gravel sufficiently such that the interstitial water is still thawed while it is placed and compacted, or attempting to heat the soil by heating the inside of the culvert with a Herman-Nelson-type heater. Alternately, the culvert could be encased in a soil-cement mixture or Poleset or load restrictions could be applied after construction until the following summer when the thawed soil could be compacted.

Corrugated culverts can experience longitudinal buckling as a result of uplift forces. To the extent possible, the calculated maximum stickout distances should not be exceeded. Alternatives include construction of a headwall, installation of a counterweight at the inlet, or provision of a mitered inlet. In addition, scour tendencies will have to be resisted to ensure that the constructed configuration remains in place. Because of their significantly-higher longitudinal bending resistance, use of smooth pipe in lieu of corrugated pipe will be advantageous in locations where uplifting is likely to occur.

5.10 REFERENCES

(1) Allgood, J.R. (1972) "Summary of Soil-Structure Interaction," Naval Civil Engineering Laboratory Technical Report R771, Ch. 4.

(2) American Iron and Steel Institute (1971) "Handbook of Steel Drainage and Highway Construction Products"

(3) Clark, J.I. (1970) "Cold Weather Compaction of Soils," 23rd Canadian Geotechnical Conference, Alberta, November.

(4) Spangler, M.G. and Handy, R.L. (1982) "Soil Engineering," 4th Ed., Intext Educational Publishers, New York.

(5) Thomas, H. P. and Manikian, V. (1985) "Effect of External Loadings on Large-Diameter Buried Pipelines," Proceeding of "Arctic '85," an ASCE Specialty Conference on Civil Engineering in the Arctic Offshore.

6.0 CONSTRUCTION PRACTICES

This section is intended to help field engineering personnel select control measures to reduce erosion and sedimentation from construction related activities. If unexpected erosion or sedimentation occurs as a result of construction activities corrective action will be taken as soon as possible. This section contains measures applicable to situations normally encountered during North Slope operations. It does not consider special situations which may rarely occur such as buried pipeline crossings of rivers.

6.1 Construction Timing

Scheduling of construction activities requires consideration of many constraints of varying importance and selection of a workable compromise. Construction timing constraints may occasionally require selection of drainage structure types which would not otherwise be the most cost effective. The following is a description of the constraints on construction timing applicable to drainage and erosion control works.

1. In-stream construction activities in fish streams are prohibited except during the times specified by permit.

2. Construction timing must accommodate the requirements of the structural design. For instance a large culvert requiring compaction of backfill to 90 percent Procter can not be conventionally installed during winter. Alternatives include summer construction, redesign of the structure with heavier gage pipe requiring attainable compaction,

importation of thawed compactable backfill, or design of an alternative structure such as a bridge or overflow section.

3. From the perspective of constructability, the preferred time to conduct in-stream work is often during periods of no or low flow. However, although the total amount of solids carried by the stream may be low the concentration of solids per unit of flow will be high and environmental impact may be high.

4. Construction of drainage, erosion and sediment control structure will normally cause less impact if they are constructed during winter when streams are frozen unless the area is immediately upstream of a fish overwintering area. Requirements for winter construction are:

   - The stream must be located and the structure staked prior to snow fall so as to assure the structure is properly located on the stream.

   - A method of achieving the soil compaction required by the structure design must be available.

   - A plan and method for removing in stream construction related snow drifts and ice formations prior to breakup must be available.

5. The construction schedule must provide time for restoration of the disturbed area as soon as practicable and in any event prior to breakup. This is particularly important for drainage and

erosion control works. Restoration includes removal of construction related snow drifts from waterways prior to breakup.

6. In-stream work on or crossings of large streams, such as the Sag or the Put, must be completed by May 15 so as to allow time for the necessary pre-breakup activities described in Section 7.1.

6.2 Hydraulic Erosion

Hydraulic erosion is the wearing away of soil by running water. Erosion is a naturally occurring process which may be undesirablely accelerated by construction activities. Erosion is undesirable because it may, if uncontrolled, destroy riparian lands and structures, and because the downstream deposition of sediment will adversely impact environmental values and reduce the hydraulic capacity of the stream. There are three ways of temporarily controlling erosion. The first consists of armoring the eroding surface so as to prevent erosion. The second consists of diverting the flow from the eroding surface. The third consists of accepting the erosion and providing a downstream method to trap and remove the sediment.

6.2.1 Erosion Prevention.

Erosion Protection consists of first identifying the hydraulic conditions which may cause erosion, secondly determining the susceptibility to erosion of the existing material and lastly provision of an alternative surface which will withstand the anticipated hydraulic effects. The hydraulic impacts may be identified by the methods of Section 3. The susceptibility of natural and artificial surfaces to erosion may be determined from Table 6-2. Use of this table requires a Soil Erosion Classification which is provided in Table 6-1.

6.2.2 Diversion

Diversion consists of bypassing water away from construction areas where erosion or environmentally unacceptable sedimentation might otherwise occur. Diversion should be employed only when construction operations are expected to last more than a few days. Common forms of diversion are fluming or pumping. Diversion structures should be sized to accommodate only the flow expected during the diversion period. In most cases this is the flow actually existing at the time of installation. An exception is work initiated just prior to breakup.

The most common and probably only need for diversion will occur during the installation of imbedded culverts used in fish streams. The following paragraphs describe typical concerns and procedures.

6.2.2.1 Fluming of Small Streams. It is often practical and desirable to install a small temporary culvert, not incised into the streambed, to convey flow while the permanent culvert is being installed properly compacted. These temporary pipes will be considerably smaller than the permanent installation and may be constructed of pipe sections or other suitable materials of sufficient size and strength to carry the existing flow and traffic loads. These temporary culverts may be sized by the methods of Section 3.

The temporary culverts should be installed in the stream prior to any other instream work. In most cases, the small temporary pipe can be laid in the streambed before any gravel fill is placed. If necessary temporary diversion dams should be constructed to divert flow into the temporary pipes and away from the work area. Any dams should be constructed of clean nonerodible material or otherwise protected from flowing water by Visqueem or other suitable material.

Discharge points for flumes should be selected so as to assure the outlet velocities will not erode the streambed and produce sedimentation. If erosion can not be other wise prevented the outlet must be armored.

TABLE 6-1
SOIL EROSION CLASSIFICATION

Soil Erosion Class (SEC)	MUSCS Classification	Description	Percent Passing Sieve 3 Inch	#4	#200
Q	SW, SP, SM	Sand Dunes, free draining, low ice content	100	25	0- 50
S	ML, SM-ML, GM-ML	Silty soils, high ice content	100	25	50-100
G	GW, GP, GW-GM GP-GM, GW-BC, CP-GC	Clean gravels or gravel sand mixtures with up to 12 percent fines. Generally free draining with low ice content	100	44	0- 10
D	GM, GM-GC, GC GL-GC	Dirty gravels, or gravel sand mixtures, generally poor draining with high ice content	100	25-44	10- 50
O	PT, OL, OH	Organic soils containing more than ten percent by weight of organic matter			

TABLE 6-2

ALLOWABLE VELOCITIES AND ROUGHNESS COEFFICIENTS
FOR EROSION CONTROL

Material	SEC	Allowable Velocity (fps) Breakup	Summer	Roughness Mannings n
Clean Gravel	G			
d_{80} = 2"		7	5.5	0.030
d_{80} = 1"		6	4.0	0.025
d_{80} = 0.5"		5	2.5	0.022
Dirty Gravels	(D)			
d_{80} = 2"		5	5.0	0.040
d_{80} = 1"		4	3.5	0.030
d_{80} = 0.5"		3	2.0	0.025
Sand	(Q)	2.0	1.0	0.025
Silts	(S)	2.5	2.0	0.020
Tundra		4.0	2.0	0.025
Geotextiles		6.0	6.0	0.015
Sacked Gravel or Sand		8.0	8.0	0.025
Sacked Cement Stabilized Gravel or Sand		10.0	10.0	0.020

NOTES: The provided allowable velocities are valid for flow depth of one foot or less. For conversion to allowable velocities for other depths multiply by the following adjustment factors:

Depth (ft)	Factor
1.0	1.0
2.0	1.1
3.0	1.2

The permanent culvert should be installed and the stream returned to its natural condition as soon as practical. If desired, the temporary flume can be left through the pad embankment as part of the permanent structure.

6.2.2.3 Pumping. Pumping is an alternative to fluming. The techniques are generally the same as for fluming. In addition, pumping may be used for dewatering. The following factors should be considered when planning a pumping operation.

Discharge of water resulting from pipeline construction activities must comply with State and Federal discharge permits issued to the project and State water quality standards.

Temporary dams for bypass pumping should employ methods that do not increase sedimentation potential.

Bypass pumps should be adequate for the flow condition to prevent excessive ponding above the dam and to assure adequate downstream flow.

If fish are present, the water intake will be centered in an enclosed screened box not to exceed

1/4 inch mesh. The box size will be sufficiently large to allow fish to escape intake suction. To assure this, the through screen velocity at the intake shall be designed to not exceed 0.5 fps even when up to 50 percent of the screened area is fouled with debris.

Discharge into a stream should be horizontal to the stream surface to avoid gas supersaturation caused by excess aeration of the water.

Discharge should be placed such that erosion of the streambed or banks is minimized or discharge points should be armored or provided with energy dissipation devices.

Discharge of sediment laden water may occur on terrestrial areas adjacent to a water course if the soils are relatively free draining, vegetation is not damaged by the sediment buildup, and the sediment laden water does not re-enter the water course.

6.2.2.4. <u>Fluming and Pumping</u>. A combination of fluming and bypass pumping may be appropriate in some circumstances.

6.2.3. Sediment Control Structures. Sediment control structures are intended to remove the sediment load from water flowing from a disturbed area and to allow only the relatively clean water to return to a stream. Sediment control structures include settling basins, filters and barriers to sediment. Each of these types of structures is discussed in the following paragraphs.

6.2.3.1. Settling Basins. Settling basins are considered as a last resort for unanticipated problem and are used only when preventive methods are clearly ineffectual. Settling basins are traditionally used to intercept runoff from large disturbed areas or they may be used to intercept sediment from point sources where sediment of known size is carried by channelized flow. Under North Slope conditions large area disturbances consist only of relatively clean gravel fills which do not erode easily. Therefore settling basin use will be restricted to point source erosion from channelized flow. This hydraulic erosion may be augmented by thermal erosion. The design process consists of identifying the particle size distribution of the eroding soils, the rate of erosion, the required allowable amount of sediment carried by the outflow, and the required basin dimensions and maintenance interval. An acceptable design process has been developed by the Environmental Protection Agency and is presented in their reference publication EPA 62513 - 76-006. Input data for the analysis is as follows:

- o Particle Size. The particle size distribution for the erodible soils may be obtained from th referenced 1983 Geotechnical investigations. The distributions provided in Table 6-3 may be used if the site specific data are not available.

- o Particle Settling Velocities. Table 6-4 provides particle settling velocities recommended by the Alaska State Department of Environmental Conservation in their "Manual of Recommended Practices".

- o Basin Inflow Rates for Hydraulic Erosion. This is dependent on the length of time for which erosion is expected (see Section 2).

Basin Inflow Rates for Ice Ablation. Ice ablation may best be determined by first estimating the total volume of ice rich material which will melt before stability is reached and the number of thawing months before stability is reached.

TABLE 6-3

TYPICAL SOIL PARTICAL SIZE DISTRIBUTION
FOR SEDIMENT CONTROL DESIGN

Soil Erosion Code (Sec)	Description	Ice Content Percent of Dry Weight	% Finer Than By Weight/Diameter in Millimeters								
			100	50	10	5	1	0.5	0.1	0.05	0.01
G	Gravel Embankment	10	100	95	70	30	15	12	7	3	0
Q	Dune Sand	30	100	100	100	100	100	90	50	30	10
Q	Fluvial Sand	40	100	100	98	95	70	50	30	20	10
S	Lacustrine Silt	100	100	100	100	100	100	100	90	80	20
S	Fluvial Silt	80	100	100	100	100	100	100	90	80	20
S	Eolian Silt	60	100	100	100	100	100	100	50	20	10

TABLE 6-4

PARTICAL SETTLING VELOCITIES

Scale Wentworth Material Class	Diameter (mm)	Approx. Sieve Size	Settling Rate (ft.sec)
Fine Gravel	5.00	-	1.0
Very Coarse Sand	1.00	10	0.38
Coarse Sand	0.50	-	0.20
Medium Sand	0.25	60	0.08
Fine Sand	0.10	140	0.03
Very Fine Sand	0.062	200	0.014
Coarse Silt	0.05	-	0.010
Coarse Silt	0.04	270	0.008
Fine Silt	0.01	-	0.0005
Very Fine Silt	0.005	-	0.0002
Medium Clay	0.001	-	0.00001
Very Fine Clay	0.0001	-	0.00000006

The inflow is then:

$$Q = V/M/7x10^6 \qquad (6\text{-}1)$$

where

Q = the inflow into the settling basin in cfs

V = the volume of ablating soil and ice

M = the number of months before ablation ceases, not more than three per year

6.2.3.2 Filters. Discharge of sediment laden water onto designated vegetated areas is the most economic method of sedimentation control, and if properly conducted, will create the least environmental disturbance. The method consists of discharging sediment laden water onto vegetated permeable flood plain soils. The rate of discharge should not exceed the capacity of the flood plain vegetation to remove sediment, nor the accumulated sediment depth exceed the capacity of the vegetation to recover.

Silt fences provide an alternative method to remove larger sediment particles. Silt fences are low woven wire fences covered with geotextiles with mesh sizes small enough to trap sediment particles.

A filler culvert is a culvert filled with straw to trap sediments being carried through the culvert. Additional filtering may be obtained at culvert inlets by constructing a temporary filter of gravel reinforced with geotextiles around the inlet. This filter should not be used during breakup.

6.2.3.3. Barriers. Temporary sediment barriers are built to retain sediment on-site by slowing runoff, causing the deposition of sediment at the structure, and filtering the effluent. Sediment barriers are berms, diversions, or other barriers, that are constructed of baled straw, sand bags, or filter gravel in filter fabric bags. Straw bales should be anchored to the ground.

Straw bales or sand bags must be installed so that runoff cannot escape freely under the bales or bags.

General guidance for planning of sediment barriers is provided in "Guidelines for Erosion and Sediment Control Planning and Implementation".

6.3 Thermal Erosion

Thermal erosion is the wearing away of and the lowering of the soil surface by the melt of ice in the soil. This process is called ablation. Thermal erosion is a naturally occurring process which may be undesirably accelerated by construction activities. Construction activities most often affect the thermal state of the soils by removing the natural insulation afforded by the tundra vegetation. The preferred method of preventing thermal erosion is by not disturbing the protective tundra. Thermal erosion, once initiated, may be controlled by providing an insulating blanket of gravel or other insulating material. The procedure for designing this protective blanket is beyond the scope of this manual.

6.4 Thermal Hydraulic Erosion

Thermal balance of ice rich soils is an important consideration in design of drainage structures. Water moves through tundra when the active zone is thawed. Construction may raise or lower the bottom of the active zone and block or accelerate flow. The hydraulic design discussed in Section 3 and the geotechnical design discussed in Section 4 discuss design to prevent this problem. However, with the uncertainties of local soil conditions, it is likely that unanticipated ponding or erosion from accelerated flow may occasionaly occur. In the event this occurs during the construction period, the design must be field modified to assure blocked flow will be moved through the thermal constriction and accelerated flows retarded or alternatively erosion protection provided. Measures to reduce concentration and acceleration of flows are discussed below.

6.4.1 Blocked Flow. Thermally blocked flow will be moved through the constriction and released to continue movement by provision of additional small culverts. Culvert spacing will be sufficient to prevent ponding of water or erosion of downstream tundra.

6.4.2 Accelerated Flow. Accelerated flow will be accommodated by one of the following three methods:

- o Filling the thermal ditch along the toe of fills with gravel
- o Lining the ditch with manufactured insulation and protective gravel
- o Providing culverts to convey the water across the embankment before sufficient flow to cause erosion can accumulate

6.5 REFERENCES

(1) Bruggers, D. E., Kai, S. W., and England, J. M., 1983, "Prudhoe Bay Unit, Lisburne Development, Geotechnical Investigations, Winter 1983", 2 Vols. Harding Lawson Associates for ARCO Alaska, Inc.

(2) ____________________, 1972, "Guideline for Erosion and Sediment Control Planning and Implementation", Maryland Department of Water Resources.

(3) ____________________, 1976, "Erosion and Sediment Control - Surface Mining in the Eastern U.S. - Technology Transfer Seminar Publication No. EPA 62513-76-006", U.S. Environmental Protection Agency.

(4) ____________________, 1980, "Manual of Recommended Practices for Transportation Corridor Development, Roads, Railroads, Pipelines, Subdivision", Alaska Department of Environmental Conservation.

(5) ____________________, 1981, "Permafrost Engineering Design and Construction", National Research Council of Canada, Associate Committee on Geotechnical Research.

7.0 MAINTENANCE

Culverts, bridges and other drainage structures require periodic inspection and maintenance in order to assure they will function as designed when needed. The purpose of this section is to discuss common failures and describe the inspection and maintenance activities necessary to preclude failure. Particular emphasis is placed on maintenance needs of the North Slope.

7.1 Pre-breakup Inspection and Maintenance Activities

Most failures of culverts and other drainage structures occur during the breakup flood. The five most common causes of failure are:

1. Culverts and approach channels blocked by snow drifts so that the culvert can not function as intended.

2. Culvert entrance or exit sections damaged by snow removal or other winter operations.

3. Excessive tailwater height because of downstream channels blocked by snow or ice.

4. Diversion of unanticipated water into the channel containing the drainage structure from adjacent channels blocked by snow and ice.

5. Erosion of supporting embankments for culverts by water piping through poorly compacted gravels.

These causes of failure can be eliminated by a pre-breakup inspection and maintenance program. The program should consist of the following elements.

1. Snow Removal; Remove snow from all culverts overflow sections and bridges and their approaches and tailwater channels so as to obtain the full design waterway dimensions. Experience has shown that cold winter snow is resistant to erosion during the early stages of breakup.

2. Culvert Ice Control; Thaw ice blocking culverts. This is usually necessary in small culverts installed in wet bog areas.

3. Bridge Ice Control; Large surface icings frequently develop upstream of bridges on major streams. These form as the result of overflow during the winter and may reach elevations approaching the five year open water flood level. Overflows form primarily as the result of thermal disturbance of the winter stream surface allowing greater freeze down to force upstream winter flow to surface. Large icings up and downstream of bridges may be weakened both thermally and mechanically by cuttings slots partly through the ice cover. Slots should be between 10 and 15 feet apart and about five feet deep. They should extend in an up and downstream direction about twice the distance of the bridge span. Ice cutting should be accomplished about 15 days prior to the expected date of breakup. An alternative, but less sure, method of weakening ice consists of modifying the surface albedo by dusting the ice surface lightly with silt or fly ash. This modification of the

surface albedo will approximately double the amount of solar radiation absorbed by the ice surface and thereby double the natural ice melt rate in the dusted areas.

4. Culvert Entrance and Exit; Inspection and repair. Culvert entrances and exits are frequently damaged during spring snow removal operations. They are also frequently damaged by the normal winter construction and field operation activities. The ends of the culverts should be inspected after the snow has been removed. Damaged culvert ends should be repaired or replaced to restore the culvert to its design condition.

5. Erosion Protection; Erosion control works will normally not be visible for inspection or repair until after breakup. However, when major damages are known to exist, temporary repairs should be made.

7.2 Maintenance Activities During Breakup

Breakup normally starts during the last week of May and is over by mid-June. During this brief period most of the years activity on the streams occur. On any individual small stream the period of maximum activity is compressed to two or three days. This compressed time span does not allow for normal maintenance. Activities must be confined to emergency actions intended to prevent failure or minimize damages. An equally important activity is the gathering of data on stream flow and on the behavior of the various structures. This data allows development of rational and cost effective designs of remedial works for failed structures and adds to the data base for future designs.

Maintenance of drainage works during breakup consists primarily of removing or breaking floating ice jamming culverts and bridges and adding gravel to embankments threatened by erosion. On infrequent occasions roads or pads must be deliberately breached to allow passage of flood winters. The key to effective maintenance during breakup is continuous surveillance of the drainage works so that problems may be anticipated and controlled before roads wash out and access is lost.

Data acquisition during breakup should consist of the following:

1. Recording the condition of drainage and erosion control works prior to breakup.

2. Recording the water stages up and downstream of each structure during the passing of the flood hydrograph.

3. Estimation of peak discharge at each structure. Note peak discharge and peak stage do not necessarily occur at the same time.

4. Observation of the nature and behavior of ice during breakup.

5. Recording of observed design deficiencies.

7.3 Summer Inspection and Maintenance Activities

During the brief summer season stream channels and structures are free of ice and snow and embankment gravels are thawed. During this period all structures should be inspected and necessary repairs completed. Of particular importance is checking and reestablishment of the grades of overflow sections. As can be seen from equation 3-22, erodeability of the road surface is extremely affected by small changes in overflow depth. Therefore, it is important that design grades be closely established prior to freezeup. Repair of riprap and concrete mattress revetment should also be accomplished under summer conditions.

Should a significant flood occur during the summer, stage and discharge observations should be obtained.

8.0 SPECIFIC DESIGNS

The purpose of this section is to provide a preliminary estimate of major drainage facilities sufficient to provide a basis for permitting and final design.

8.1 Lisburne Road Culverts

The Lisburne project has roads and pads both to facilitate construction and to provide access to project facilities after construction. These roads have been routed to be compatible with existing drainage structures and to minimize environmental impact. Drainage requirements have been identified from map studies and a field investigation was conducted during the 1984 breakup. The recommended culvert locations are shown on Map 8-1 (in pocket). Recommended sizes, skew angles, slopes and invert elevations are provided in Table 8-1. These locations are based on the field staked pipeline alignment stationing. These locations will be staked prior to construction.

Plates 8-1, 8-2 and 8-3 provide typical sections for recommended culverts. Map 8-2, Plate 8-4 and 8-5 provide location and details for a large culvert installation at location 20.

TABLE 8-1
LISBURNE DEVELOPMENT
CULVERT SCHEDULE

Culvert No.	Size	Station	Inlet Invert Elevation	Slope	Skew	Typical Section
1	1-24" IP	7+85	4.0	0.000	0	1
2	1-24" IP	-	6.2	0.000	0	1
3	1-24" IP	-	6.3	0.000	0	1
4	1-24" IP	-	-	-	-	1
5	1-24" IP	-	-	-	-	1
6	1-24" IP	164+100	6.0	-	0	1
7	1-24" IP	171+20	7.9	-	-	1
8	1-24" IP	-	-	-	0	1
9	1-24" IP	-	-	-	-	1
10	1-24" IP	-	-	-	-	1
11	1-24" IP	3+50	-	-	0	1
12	1-24" IP	-	-	-	-	-
13	1-24" IP	-	-	-	-	-
14	1-36" IP	1+25	-	-	-	2
15	1-36" IP	2+25	-	-	-	2
16	1-36" IP	3+90	-	-	-	2
17	1-36" IP	9+85	-	-	-	2
18	1-24" IP	18+95	-	-	-	1
19	1-24" IP	57+50	-	-	-	1
20	1[12'10"x8'4"]SMP	71+10	6.6	0.005	21°23'	-
21	1-24" IP	81+50	-	-	-	1
22	1-36" IP	101+10	-	-	-	2

TABLE 8-1
LISBURNE DEVELOPMENT
CULVERT SCHEDULE
(CONTINUED)

Culvert No.	Size	Station	Inlet Invert Elevation	Slope	Skew	Typical Section
23	1-36" IP	107+50	-	-	-	2
24	1-24" IP	125+00	13.2	0.005	-	1
25	1-36" IP	127+50	-	-	-	2
26	2-48" IP	140+00	10.9	0.005	-	4
27	1-24" IP	152+30	-	-	-	1
28	1-24" IP	154+90	-	-	-	1
29	2-48" IP	164+75	-	-	-	4
30	1-24" IP	149+00	-	-	-	1
31	1-48" IP	198+00	-	-	-	3
32	1-48" IP	0+50	-	-	-	3
33	1-36" IP	6+50	4.3	0.000	0	2
34	1-36" IP	19+75	-	-	-	2
35	1-36" IP	43+00	12.5	0.000	0	2
36	1-36" IP	68+50	-	-	-	2
37	1-36" IP	118+00	-	-	-	2
38	1-24" IP	135+00	-	-	-	1

LEGEND:

IP = Standard steel pipe culvert
CMP = Corrugated metal pipe culvert
SMP = Structural metal plate culvert

Typical Sections 1 and 2 are shown on Plate 8-2.
Typical Sections 3 and 4 are shown on Plate 8-3.
Details for culvert No. 20 are shown on Plates 8-4 and 8-5.

Revised 6/28/84

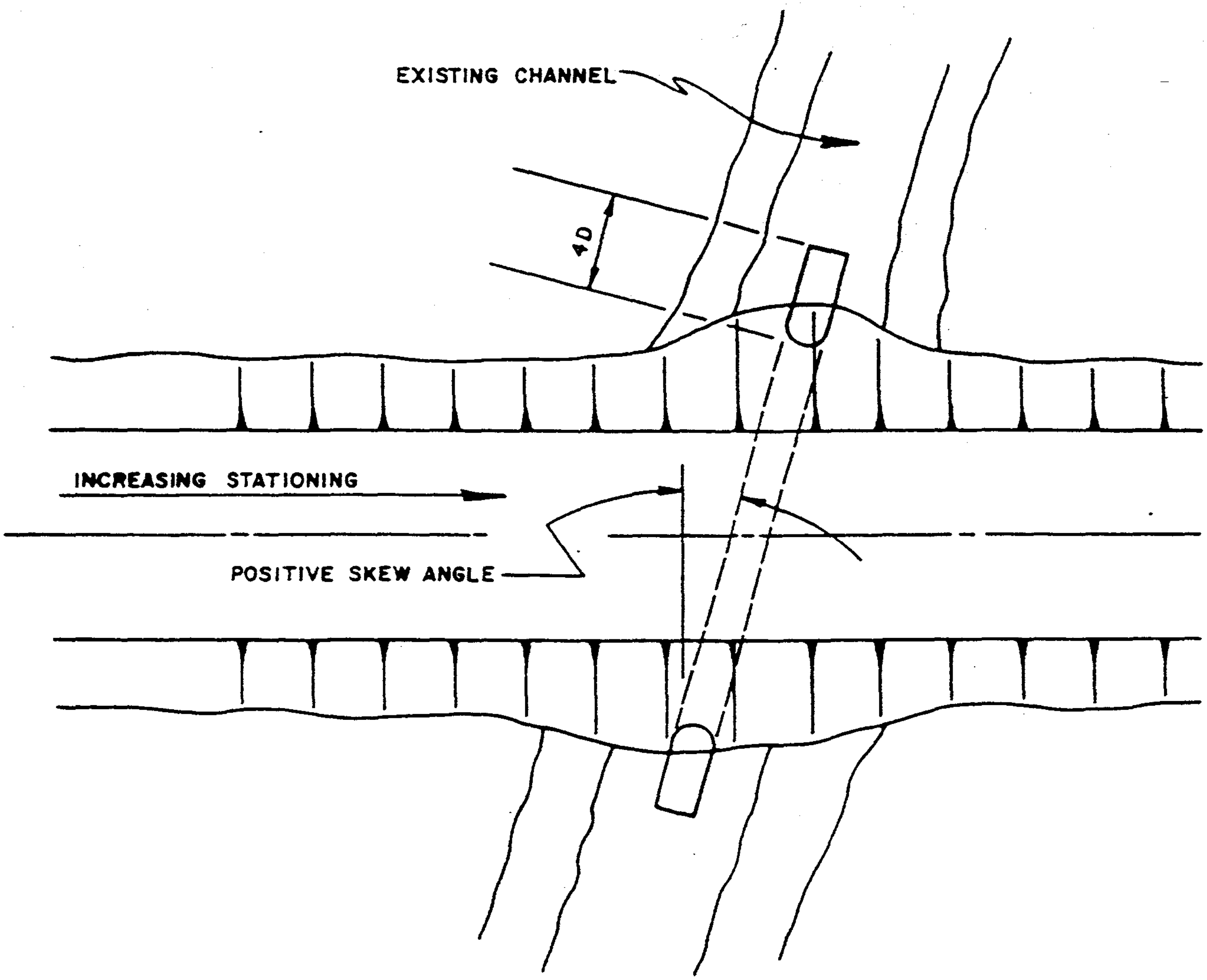
TABLE 8-2
EXISTING CULVERT SCHEDULE

No.	Size	Station	Inlet Invert Elevation
A	3-48" CMP		
B	1-14" IP, high		
C	1-24" CMP		
D	1-8"IP		
E	1-24" CMP		
F	1-24" CMP		
G	1-8" IP		
H	1-10" IP		
I	1-24" IP		
J	10-144" SMP		
K	4-96" SMP		
L	2-24" IP		
M	1-24" IP		
N	1-24" IP		
O	1-24" IP		
P	1-18" CMP	109+25	15.07
Q	1-18" CMP	79+30	14.11
R	1-18" CMP	65+98	14.43
S	1-18" CMP		
T	1-18" CMP		
U	1-36" IP	16+89.30	
V	1-36" IP		
W	1-24" CMP		
X	1-24" CMP		
Y	2-30" IP	14+80	
Z	1-30" IP		
AA	1-30" IP		
BB	1-30" IP		

LEGEND:

IP = Standard steel pipe culvert
CMP = Corrugated metal pipe culvert
SMP = Structural metal plate culvert

Revised 6/28/84

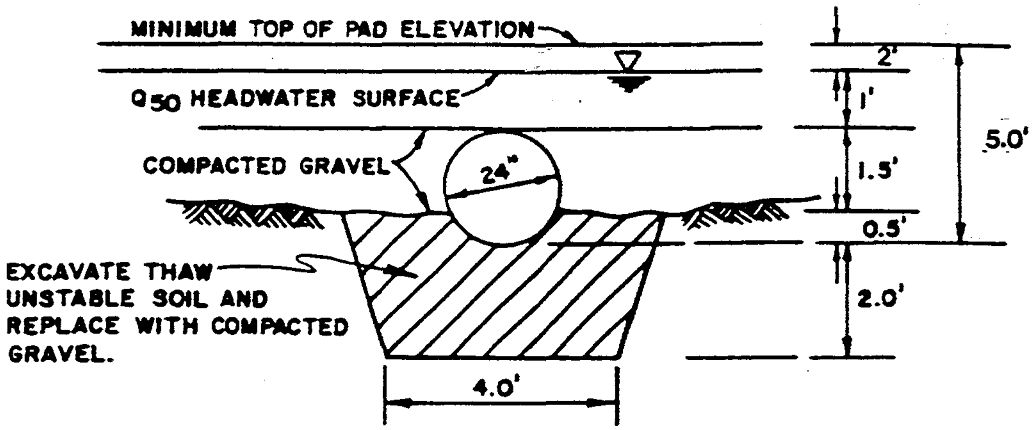


PLAN

TYPICAL CULVERT INSTALLATION

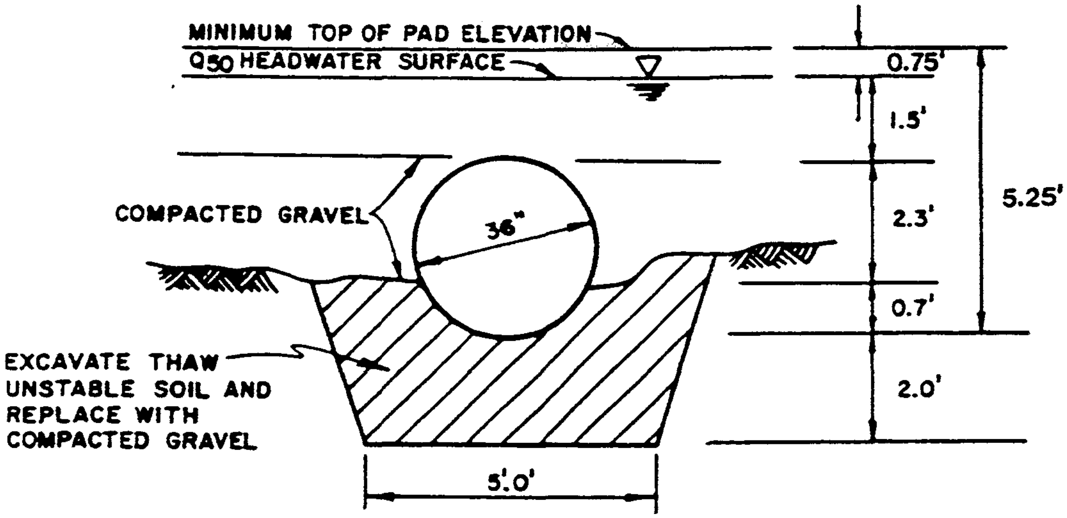
LISBURNE PROJECT
TYPICAL CULVERT INSTALLATION
PRUDHOE BAY UNIT
NORTH SLOPE BOROUGH
STATE OF ALASKA
ARCO ALASKA INC.
DATE: 6/28/84

PLATE 8-1



TYPICAL SECTION-1

24" IRON PIPE CULVERT, THAW-UNSTABLE SOIL

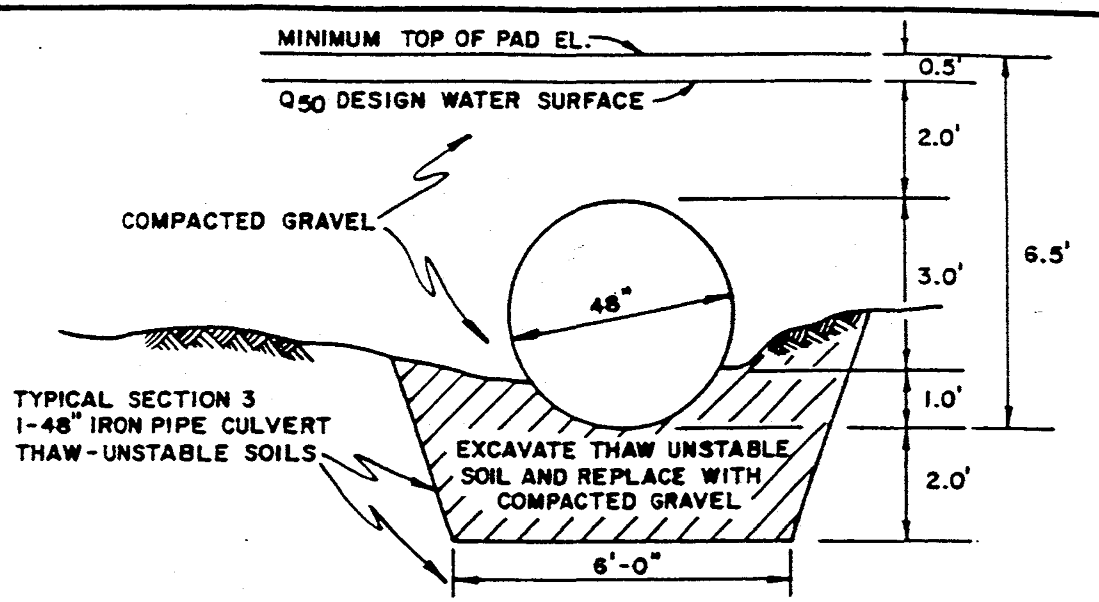


TYPICAL SECTION-2

1-36" IRON PIPE CULVERT, THAW-UNSTABLE SOIL

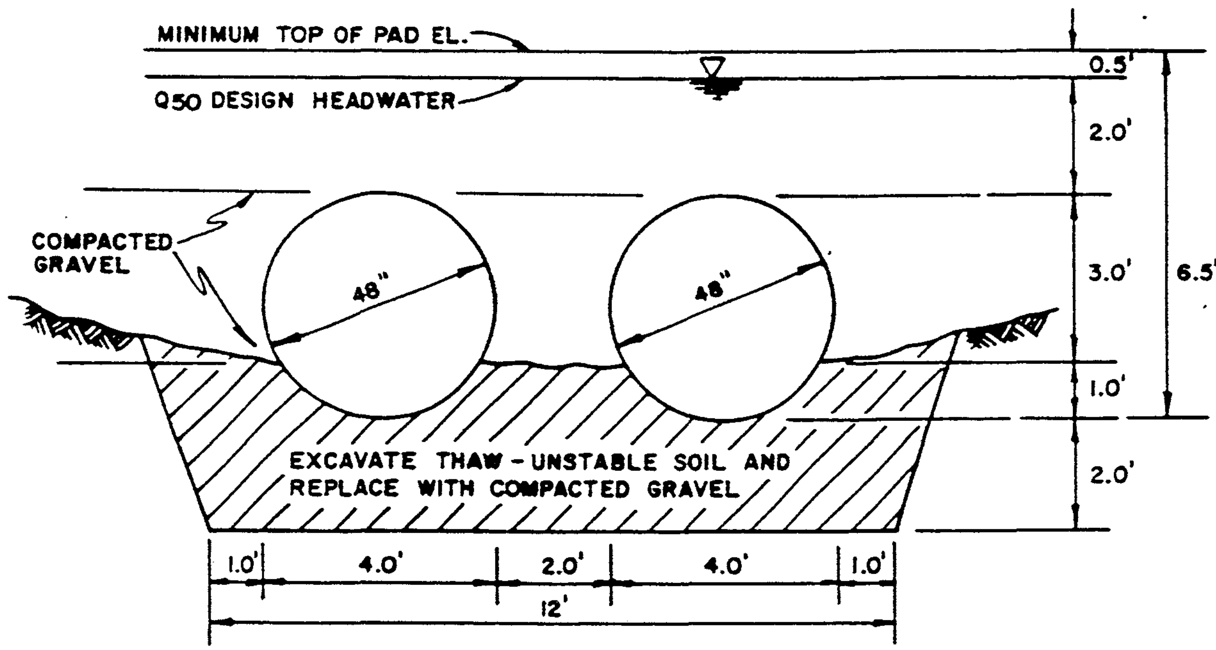
LISBURNE PROJECT
TYPICAL CULVERT DETAILS 1 & 2
PRUDHOE BAY UNIT
NORTH SLOPE BOROUGH
STATE OF ALASKA
ARCO ALASKA INC.
DATE: 6/28/84

PLATE 8-2 1



TYPICAL SECTION-3

48" IRON PIPE CULVERT, THAW-UNSTABLE SOIL

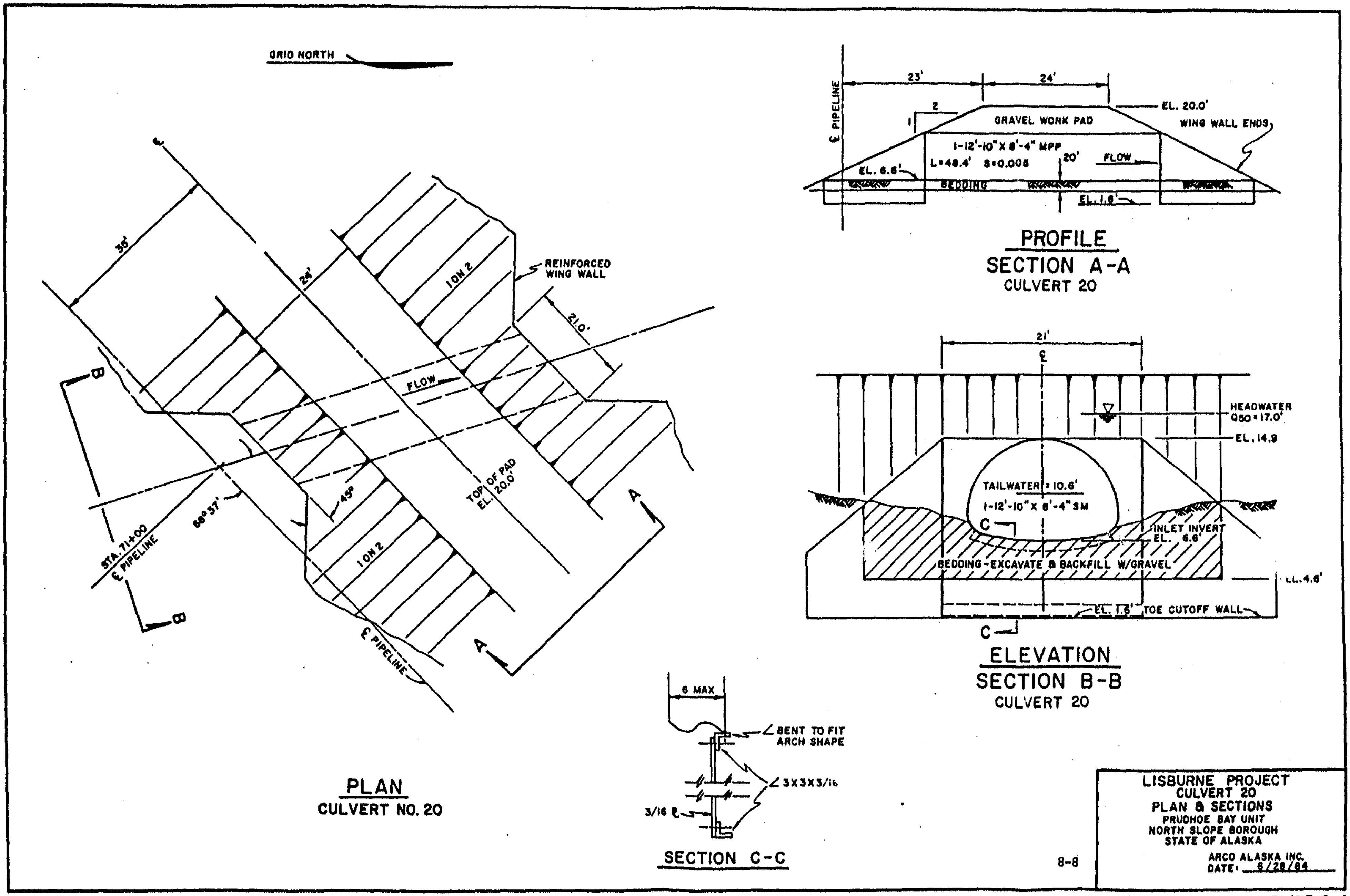


TYPICAL SECTION-4

2-48" IRON PIPE CULVERTS, THAW-UNSTABLE SOIL

LISBURNE PROJECT
TYPICAL CULVERT DETAILS 3 & 4
PRUDHOE BAY UNIT
NORTH SLOPE BOROUGH
STATE OF ALASKA
ARCO ALASKA INC.
DATE: 6/28/84

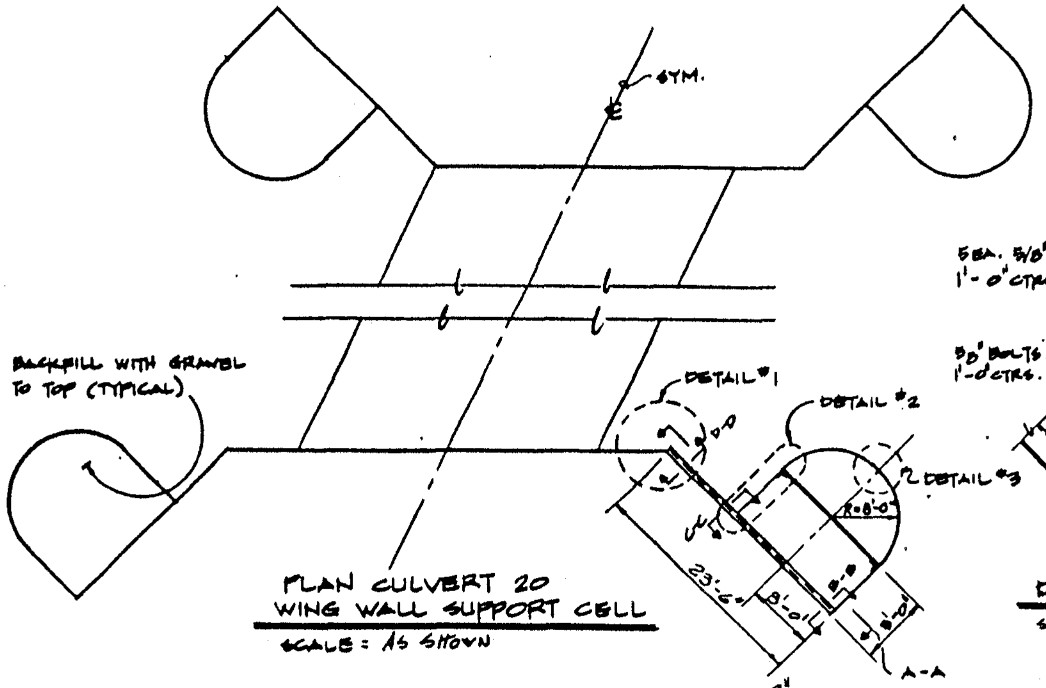
PLATE 8-3



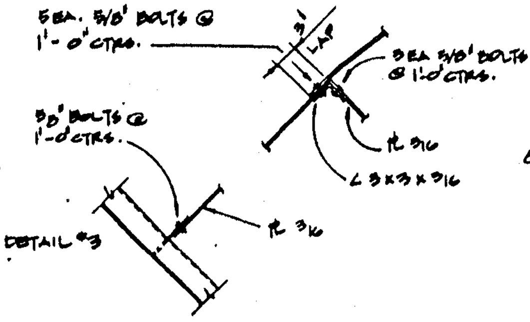
LISBURNE PROJECT
CULVERT 20
PLAN & SECTIONS
PRUDHOE BAY UNIT
NORTH SLOPE BOROUGH
STATE OF ALASKA

ARCO ALASKA INC.
DATE: 6/28/84

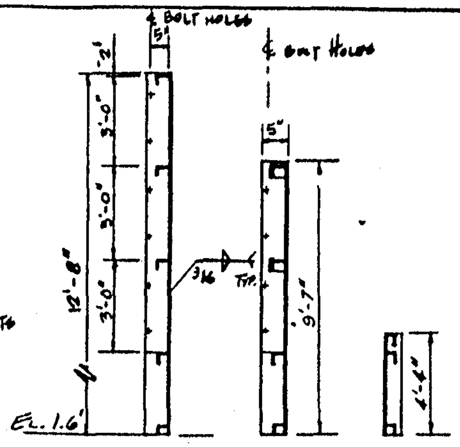
PLATE 8-4



PLAN CULVERT 20
WING WALL SUPPORT CELL
SCALE = AS SHOWN

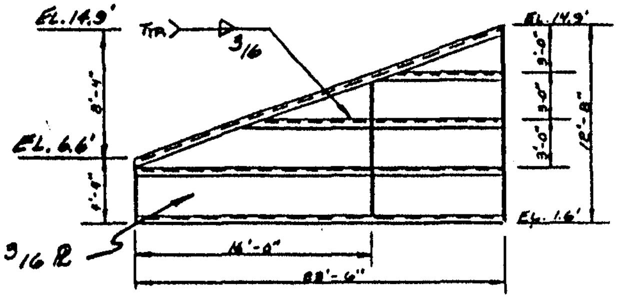


DETAIL #2
SCALE 3/4" = 1'-0"

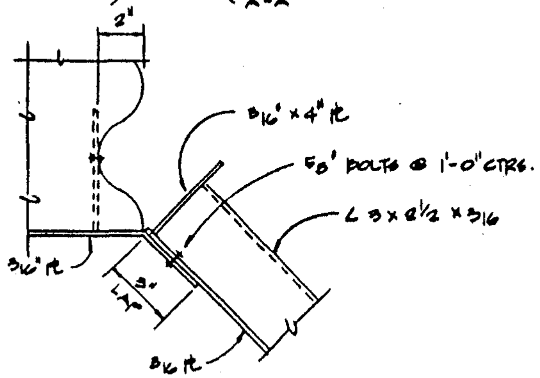


SECTIONS
SCALE = AS SHOWN

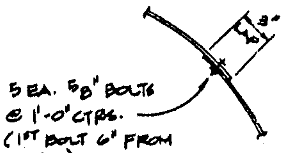
NOTES:
1. FOR FABRICATION NOTES SEE SPECIFICATIONS.



SECTION A-A
SCALE = AS SHOWN.



DETAIL #1
SCALE 3" = 1'-0"



DETAIL #3
SCALE 1" = 1'-0"

LISBURNE PROJECT
CULVERT 20
STRUCTURAL DETAILS
PRUDHOE BAY UNIT
NORTH SLOPE BOROUGH
STATE OF ALASKA

ARCO ALASKA INC.
DATE 6/28/84

8.2 Lisburne Development Specifications
Steel Pipe Culverts - Material

8.2.1 Scope. This section shall apply to steel line pipe culverts supplied by ARCO for installation by others as part of the Lisburne Development Project.

8.2.2 Material. Culverts shall be fabricated from lengths of steel pipe manufactured in accordance with ASTM A-211 or ARCO approved equal. Pipe shall be fabricated from basic carbon steel meeting the requirements of ASTM A-570 Grade D unless an equal material is approved by ARCO.

8.2.3 Dimensions. Culverts shall be fabricated in accordance with the diameters and lengths of Table 8-1. Wall thicknesses shall be no less than 0.312 inches. When individual fabricated culvert lengths required by Table 8-1 exceed 55 feet in length culverts shall be fabricated in two sections to be field joined by others.

8.2.4 Preparation for Field Welding. Short pipe sections may be field joined by a single-V-groove weld, AISC joint designation B-P2 or ARCO approved equal. Culverts intend to be field joined shall be beveled by the vendor prior to shipment.

8.3 Lisburne Development Specifications
Steel Pipe Culverts - Road and Pad Construction

8.3.1 Scope. This specification shall apply to work involved in installing steel pipe culverts including but not limited to excavation, bedding backfill, and field assembly of steel pipe sections.

8.3.2 General. With the exception of those areas where end dumping of embankment material is required, all culverts shall be installed and backfilled in advance of construction of roadway embankment. In areas where end dumping is required, sufficient embankment shall be placed to support equipment before installing culverts.

Culverts shall be installed when soil and bedding temperatures are above freezing. During installation of culverts, water shall be diverted around the work area by pumping or fluming to reduce siltation. Discharge from pumps or flumes shall be spread on erosion resistant material to prevent erosion of tundra or fine grained material. To prevent harm to fish, if present, pumps shall be screened with an approved screening device.

8.3.3 Excavation. Trenches for culverts shall be excavated to the minimum dimensions provided in Plates 8-1 through 8-4. Trenches may be overexcavated to facilitate proper compaction and joining of pipe if desired. Excavated thaw unstable material shall be hauled to an ARCO approved disposal area. Side slopes of trenches may be at the angle of repose. The completed trench bottom shall be firm for its full length and width.

8.3.4 Bedding. Bedding for steel pipe culverts shall consist of thawed selected pit-run gravels which contain no stones larger than four inches and contain no more than 12 percent passing the number 200 sieve of the fraction of the material passing the three inch sieve. The material shall be free of ice, muck, organic material and frozen clumps. Bedding shall be placed in the excavated trench in uniform six inch loose measurement layers and compacted to a minimum density of not less than 95 percent of the maximum density as determined by AASHTO T 180 method D or ARCO approved equivalent. Bedding shall be placed and compacted to the plane of the culvert invert as shown in Table 8-1. At that time the culvert shall be placed to the line and grades shown in Table 8-1 and the referenced typical section. Bedding shall than be placed and compacted to a height not less than 25 percent of the culverts diameter above the invert and to a width equal to the minimum ditch width shown on the typical drawings. Each lift shall be placed on both sides of culverts and compacted prior to placing subsequent lifts on either side.

8.3.5 Laying. The lower segment of the pipe shall be in contact with the bedding through its full length. Alignment and grades shall be as provided in Table 8-1. Pipe sections may be field joined by a single-V-groove weld, AISC joint designation B-P2 or ARCO approved equal.

8.3.6 Backfilling. The culvert shall be inspected before backfill is placed. Culvert found to be out alignment, unduly settled, or damaged shall be taken up and relaid or replaced.

Material used for backfill shall be suitable material from sources meeting the specifications for construction embankments.

Backfill of culverts in embankments shall be deposited in uniform layers, not to exceed six inches loose measurement, on each side of the culvert with no more than on lift differential. Material in each layer shall be uniformly compacted to not less than the density required for construction of embankments. A berm of compacted soil shall be formed on each side of the culvert such that the backfill berm at each side of the culvert will extend not less than one pipe diameter in width perpendicular to the longitudinal axis of the culvert and the confined slope of the backfill shall not be steeper than two (horizontally) to one (vertically).

Compacted backfill shall be placed to an elevation of at least one foot above the culvert or to the top of the road embankment, as applicable.

Construction of embankment over the previously placed culvert backfill, on either side or over top of culverts shall not be started until backfill of culverts is completed and accepted.

Any damage done to culverts as a result of superimposed loading during subsequent construction of the road shall be repaired or restored with new work.

8.3.7 Restoration. Water diversion structures must be removed and temporary plugs removed from the natural channels immediately after the backfill is one foot above the culvert. Water diversion structures must be removed and disturbed areas restored to the original condition immediately after the backfill reaches finish grade.

8.3.8 Construction Specification For Drainage Culvert No. 20. Shown on Plates 8-4 and 8-5.

This installation shall be summer placed as per Section 8.3.2, with compacted backfill meeting a minimum 95 percent Std Proctor (AASHO Test T99). Adjacent to the corrugated structural plate culvert, gravel compaction shall be done as close as possible to the culvert. Material shall be placed on both sides of the culvert to prevent lateral displacement of the culvert during compaction. There shall be no mechanical compaction of fill above the pipe for a depth of two feet. From this elevation of two feet above the top of culvert, the fill materials shall be compacted in lifts as specified by the job specs.

Appendix E

APPENDIX E

ASRC PERMIT APPLICATIONS

APPENDIX E-1

GRAVEL MINE APPLICATION

COLVILLE RIVER DELTA AREA
CONSOLIDATED USE GRAVEL MINE SITE

T10N, R5E, Sections 10, 11, 14, 15: Umiat Meridian

PROJECT DESCRIPTION, MINING, AND RECLAMATION PLAN

DESCRIPTION OF PROJECT

The proposed project is the phased development and phased reclamation of a long-term consolidated use sand and gravel material site located on private ANCSA native corporation land about 4.5 miles east of the village of Nuiqsut. The proposed material site is located near the eastern bank (right bank) of the Colville River near the confluence of the Nechelik Channel, within Sections 10, 11, 14, and 15 of T10N, R5E, Umiat Meridian.

An extensive soil boring program conducted in the Colville River Delta area during the winter of 1982-1983 located only the proposed site as having suitable building materials. The boring program identified approximately 35 million cubic yards of in-place sand and gravel materials located within the boundary of the proposed 550 acre material site. The excavation of all 35 million cubic yards (cy) of material would also produce about 13 million cy of overburden. All overburden is proposed to be placed back into the gravel excavation pits. No permanent overburden or gravel stockpiles will be placed on tundra wetlands.

All planned gravel excavation for Phase 1 and future phases will be done entirely during the winter season. In order to minimize the disturbance to tundra wetlands outside the mining area, all surface access to and from the material site will be via winter ice roads.

The anticipated start of the Phase 1 blasting, overburden removal, gravel excavation, and material hauling is the winter of 1997-1998.

PURPOSE OF PROJECT

The purpose of the proposed long-term consolidated use material site is to supply sand and gravel construction materials for:

1. Existing and future oil & gas development in the Colville River Delta area.
2. Anticipated need for gravel materials in the village of Nuiqsut for public projects.

It is expected that the operating life of the consolidated use material site will exceed 10 years.

CORPS PERMIT HISTORY

On February 18, 1983 DA permit Colville River 8, No. 4-820668, was issued to the Arctic Slope Regional Corporation (ASRC) for the placement of approximately 1.6 million cy of overburden into 130 acres of wetlands in conjunction with developing a 6 million cy gravel source owned by ASRC. Permit modification M-820668 extended the original permit expiration date for an additional 3 years until February 18, 1989. Without any development of the proposed gravel pit having yet occurred, DA permit M-820668 expired on February 18, 1989.

An application from ASRC was submitted to the Corps on May 6, 1991 for a permit modification for the same project scope as was originally permitted in 1983 and 1986. The Corps public notice was issued on October 16, 1991. Due to agency requests for substantial additional information, the permit application was temporarily withdrawn by ASRC on January 13, 1992.

The proposed project has been modified since the October 16, 1991 Corps public notice. This permit application addresses the previous written concerns of the reviewing resource agencies on the 1991 proposed project.

STATE PERMITS REQUIRED

ADGC

ACMP Consistency Determination for project modification.
General Concurrence:
GP-5, Stream Crossings.
GC-8, Temporary Use of Water.
GC-34, Ice Road and Ice Pad Construction.
GC-19, Winter Cross Country Travel.
GC-23, Temporary Camps.
GP-9440-DB002, Disposal of Wastewater From Excavations.

ADNR

Land Use Permit.
Temporary Water Use Permit.
Reclamation Plan (review)

ADF&G

Title 16, Fish Habitat.

ADEC

Section 401, for project modification under Section 404.
General Permit 9440-DB002, for disposal of wastewater from excavations.

PROPOSED PHASED DEVELOPMENT OF MATERIAL SITE

Mining Plan

Before mining is begun for Phase 1 and later phases, the proposed mining area will be first surveyed to clearly mark the intended boundary of the blasting, mining, temporary overburden stockpile, and other work areas as needed for each phase of mining. The boundaries will be determined with special consideration for the required blasting setback distances from the low water channel of the Colville River. Drilling and blasting will be required before both overburden removal and gravel mining. After blasting, the gravel will be loaded and transported over ice roads to the destination using conventional earth moving equipment.

The mining excavations will be phased and sequential (aliquot mining), with reclamation occurring after the gravel mining in each active excavation pit is completed.

Start of Mining

No gravel mining or excavation activities directly related to gravel mining will be performed unless a contract is in place for the sale of the gravel. Such activities include drilling, blasting, overburden removal, gravel excavation, and stockpiling.

Overburden

The mining plan for Phase 1 and the future mining phases is to permanently dispose of the overburden produced from the mining operation in the mined-out portions of the pit. Approximately 250,000 cy of overburden from the initial opening of the pit will need to be temporally stored on undisturbed ground adjacent to the designated excavation area. The overburden will be stored on snow or ice pads in order to protect the underlying tundra from damage. At the end of the winter mining operation, the temporary overburden will be completely backfilled into the pit and graded according to the reclamation goals that are described below.

Blasting Plan

All overburden and gravel material to be mined will be in the frozen state and will require drilling and blasting prior to excavation and hauling. All blasting done for the Phase 1 and future gravel excavation phases will comply with the blasting standards and setback requirements as established by the Alaska Department of Fish and Game (ADF&G). The ADF&G blasting standards require that the in-water instantaneous pressure change resulting from an upland blast can not be greater that 2.7 psi, or produce a peak particle velocity greater than 0.5 ips. Accordingly, based on the blasting plan that has been developed for the Phase 1 mining, the setback requirement from the main channel of the Colville River must be a minimum of 460'. This permit application has designated 500' as the minimum blasting setback requirement from the Colville River.

RECLAMATION PLAN AND PHASES

The overall objective of the reclamation plan is to reestablish and increase the wetland habitat values of the reclaimed areas with the creation of suitable features for waterfowl feeding and nesting. This on-site mitigation will result in a net increase in waterfowl habitat values for the reclaimed areas.

The proposed reclamation for the Phase 1 gravel excavation will result in the creation of a new fresh water lake with a total surface area of about 40 to 45 acres. Approximately 15% to 30% of the lake area would become shallow littoral habitat ranging from about 1 to 6 feet deep. The main gravel excavation area will become a lake up to 60 feet deep. Islands will be constructed to provide opportunities for waterfowl nesting areas.

During the initial development of the Phase 1 gravel pit, about 250,000 cy of overburden will need to be temporarily stockpiled on snow or ice pads on the undisturbed tundra adjacent to the pit. As the Phase 1 excavation of overburden and gravel proceeds, there will eventually be enough room on the floor of the pit to allow for the permanent disposal of additional overburden within the pit concurrently with the mining. After the gravel excavation is completed for the season, the temporary overburden stockpile will be dozed into the pit where it will eventually be covered with water after the yearly precipitation fills the pit with a lake.

If there is an adequate volume of overburden to backfill into the pit, the goal will be to create a bench up to 200 feet wide running the length of the pit adjacent to where the temporary overburden stockpile was located. This backfilled area would be graded to become a 1 to 6 foot deep littoral area when the future lake surface reaches a stable elevation. This backfilled shallow littoral area would be about 5 acres in size. During the backfilling operation, areas would be mounded to eventually become low lying islands about 60 feet long and wide (about 0.1 acre each) and located at least 30 feet from the anticipated shoreline. Islands will be established at no less that one per each acre of created shallow littoral area.

In addition to the intentionally created shallow littoral areas, about 5 to 10 acres of shallow areas should form naturally along most of the shoulder of the reclamation lake. The thawing of the ice rich soils and the resulting thermokarsting along the upper slope of the pit should result in the slumping and submergence of part of the tundra mat. This natural thawing along the pit edge should produce a rough shoreline and a shallow littoral zone around the entire margin of the new lake after a few years.

Detailed contour mapping of the project area is not presently available. However, based on the topographic information on the USGS map and aerial photo interpretation, the natural drainage-way for the Phase 1 lake overflow will be to the northeast along an existing track of low-centered polygonal ground. Unless this drainage-way thermally erodes into a beaded stream, the stable surface elevation of the Phase 1 lake should be about +23' MSL.

The preferred drainage direction for all natural overflow lake water from material site development should be generally eastward and away from directly flowing into the main channel of the Colville River.

Future Mining Phases and Reclamation Variations

Unless unexpected variations in gravel quantity and quality require a change in the planned mining, the subsequent mining phases will probably excavate pits in a southward direction with an undisturbed buffer area separating the active mine pit from the reclamation lakes.

With the anticipated depth of the excavations being 60' deep, it could be difficult to create and initially maintain the shallow littoral zones. If it is necessary to maintain or increase the shallow littoral zone of the lake occupying the previously mined pit, then the initial overburden stripped from the active pit may be strategically placed onto the nearshore lake ice of the previous pit. In this way, the organic rich overburden will sink into a designated area of the lake when the ice melts at spring break-up. The result can be to maintain or increase the area of shallow water and islands.

Another option for creating shallow littoral zones at a lake margin would be by blasting. If soil conditions such as massive ice made it difficult to maintain a stable littoral zone , then perhaps a specifically designed blasting program could be used to create a shallow shelf at the lake margin which could then be developed into a shallow littoral zone.

As shown on Exhibit 10, the undisturbed buffer area between the excavated pits can be breached after the present mining phase has been completed. This would create a large island or series of small islands for waterfowl nesting areas which should be relatively safe from mammalian predation.

The reclamation so far described anticipates allowing the mined gravel pits to naturally fill with precipitation and drifted snow melt. If the demand for material were constant over a several year period, then the active pit would probably not be allowed to fill with rain and snowmelt. The active pit would instead be pumped during the summer in order to maintain the pit in a mineable condition for the winter season. Once a mined pit is allowed to partially or completely fill with water, it is likely that the next mining phase would require the opening of a new active pit, instead of pumping the water out of the previously mined pit.

General Reclamation Guidelines

The phased reclamation will be initiated concurrently with the permanent completion of the mining of an individual gravel pit.

For the intentionally created shallow littoral zone, the slope from the shoreline to the deep water portion of the reclamation lake will be between 10:1 and 20:1. The shallow littoral zone should be no deeper than 6 feet below the stable surface elevation of the reclamation lake.

Large islands intended for duck nesting should be no larger than 60' by 60' (0.1 acre). Small islands intended for geese and loons should be no larger than 10' by 10'. To minimize mammalian predation, islands should be a minimum distance from shore of 30'. Ideally, the small waterfowl islands should be no higher than 3' above the stable surface elevation of the reclamation lake. The created islands should be relatively even spaced and run parallel to the shoreline, and should be far enough from shore to give some protection to the shallow near-shore littoral zone from gouging from the ice-shove of the lake ice during spring break-up.

The breach areas between individual reclamation lakes which create large islands should be no less than 30' wide. The breaching of a reclamation lake will be done with consideration of drainage patterns, and on the probable effect of the breaching on the stable surface elevation of the reclamation lake. New water overflow drainage-ways will be established as required for new reclamation lakes.

The reclamation goal for the creation of shallow littoral areas and islands is 15% of the mined pit surface area.

Reclamation Reporting

There is always a level of uncertainty with any reclamation plan because of the risk that unexpected factors could change the outcome of the reclamation goals. Variations in the overburden thickness, soil type, percent of massive ice, plus variations in the gravel deposit, can require changes in mining and handling techniques. It is anticipated that the methods, and perhaps even the ultimate outcome of the reclamation goals presented for this project may change. Accordingly, the permit applicant hereby proposes to submit to the Corps an annual report describing the mining and subsequent reclamation done the previous year. The annual report will be submitted at the anniversary date of the issued section 404 permit. The report shall show the locations of the past and present mining operations, and shall include an assessment of the reclamation efforts. The report shall also include photography to document the statements and descriptions.

MITIGATION

The proposed 550 acre mining area is comprised of wet sedge willow meadows and wet meadows, with about 25 acres of small lakes and ponds. If the entire 550 acre area that is included in the proposed gravel excavation area is eventually mined, the end result of the mining and reclamation will be a net increase in waterfowl feeding and nesting habitat. As a result of reclamation, about 400 to 450 acres of lakes of varying sizes will have been created along with some 100 to 150 acres of islands. Of the created lake area, some 60 to 130 acres will be shallow littoral habitat.

EXISTING CONDITIONS AT PROPOSED SITE

The previously permitted gravel mining operation and overburden stockpile that were located within the proposed project area were never initiated. No surface disturbance has resulted from the previously permitted mining activities.

Floodplain

The proposed gravel material site is located along the eastern bank (right bank) of the Colville River on an abandoned floodplain terrace. The estimated flooding frequency of this floodplain terrace by the spring break-up flood of the Colville River has been estimated at once in 5-25(?) years, to once in 25-100 years. Based on the floodplain geomorphology of this location, the flooding recurrence interval is probably at the less frequent end of the estimates.

Habitat Types

The location of the proposed gravel excavation area is within a transportation corridor area that has been identified by ARCO Alaska, Inc. for supporting the potential Alpine oil development within the Colville Delta. As a result, the habitat types and their observed utilization by key wildlife species has been documented by recent studies (1992-1995).

The wildlife habitats of the transportation corridor, including the proposed gravel excavation area, were mapped in 1995 to facilitate quantitative assessments of the habitats used by the key species identified for the studies The results of the habitat mapping showed that the proposed gravel excavation area is occupied about equally by wet sedge willow meadow with low relief polygonal ground, and by non-patterned wet meadow (see Exhibit 5).

Habitat Use

The pre-development wildlife studies of the Colville Delta area that have recently been done for ARCO Alaska, Inc. used the following for the key wildlife species: spectacled eiders, yellow-billed loons, tundra swans, brant, caribou, and arctic foxes. These studies relied on extensive aerial surveys to assess regional distribution, ground-based surveys to locate nests, dens, and young, and remote sensing and ground truthing to delineate wildlife habitats.

Bird Use

No nests or broods of spectacled eiders, yellow-billed loons, or brants, were found in or adjacent to the proposed gravel excavation area,. No nests or broods of tundra swans were found in the proposed gravel excavation area. In 1992, two tundra swan broods were observed in the lake to the southeast of the proposed gravel excavation area, with one brood observed in the lake to the northeast of the mining area.

Mammal Use

No arctic foxes or dens were observed in the proposed gravel excavation area. Small numbers of caribou have been observed to migrate through the area.

ANTICIPATED EFFECTS OF MINING

The recent studies indicate that the habitats of the proposed gravel excavation area are not well utilized by mammals or waterfowl. It is anticipated that the reclamation that will result from the proposed development of the area as a gravel material site will significantly increase the habitat values for some waterfowl species and somewhat increase the predation opportunities for arctic foxes.

ACCESS ROUTES

Overland access to and from the site for personnel, fuel, supplies, and equipment, will be done on winter ice roads from the Kuparuk field. An additional ice road may also need to be constructed from Nuiqsut depending upon the requirements of the specific mining operation. Access for the mined gravel to the designated delivery point will also be over winter ice roads.

For future mining phases, the access routes across state lands, including the bed and channels of the Colville River and distributary streams, will be identified and permitted at that time.

Water Requirements and Sources

The anticipated water use for winter ice roads and ice pads for the Phase 1 gravel excavation is 14 million gallons, or 40 acre feet. The lakes proposed as water sources are located to the northeast of the mine area as shown on Exhibits 4 and 6. It is anticipated that the water requirements for future mining phases will eventually be drawn from the reclamation lakes.

SUPPORT SERVICES

Housing

Other than temporary work buildings and emergency shelters, housing for project personnel will be at Kuparuk or Nuiqsut with daily transportation to and from the mine site.

Fuel

Fuel for the mining operation will be stored at the mine site in double walled fuel storage tanks. Only enough fuel for several days of operation (10,000 to 20,000 gallons) will be stored at the mine site. The fuel supply will be resupplied on a regular basis via the ice road from Kuparuk.

ALTERNATIVE MATERIAL SOURCES

As shown on Exhibit 12, there are 4 existing and permitted sand and gravel material sites located west of the Kuparuk River. The haul distance to the Colville River Delta area from these existing material sites would be considerably greater than from the proposed mine site.

Kuparuk Material Sites

ARCO Mine Site "C"

About 3,600,000 cy of material has been excavated from Mine Site "C", with another 1,000,000 cy proposed to be excavated for use in the Kuparuk area over the remaining 10 year life of the mine site. Corps permit Beaufort Sea 125.

ARCO Mine Site "E"

About 5,600,000 cy of material has been excavated from Mine Site "E", with another 300,000 cy proposed to be excavated for use in the Kuparuk area over the remaining 10 year life of the mine site. Corps permit Ugnu River 15.

ARCO Mine Site "F"

About 1,060,000 cy of material has been excavated from Mine Site "F'", with another 1,700,000 cy proposed to be excavated for use in the Kuparuk area over the remaining 10 year life of the mine site. Corps permit Kuparuk River 77.

Nuiqsut

In the past, material has been dredged for public projects from the bed of the Nechelik Channel at Nuiqsut. The dredging operation has since been completed and the dredging equipment moved from Nuiqsut. The Corps permit for the last dredging operation expired in April 1995. At the present time there is a 450,000 cy stockpile of dredged material at Nuiqsut. Within the next two to three years about 80% of this material could be used up by the North Slope Borough sewer & water project and several road projects at Nuiqsut. A past channel soil boring program near Nuiqsut showed that the previous dredge site was the only such material site near Nuiqsut. The deposit was located beneath the present Nechelik Channel and was deeper and coarser than the recent sediments of the channel. The last dredging from this location was removing the material from a depth of 60', which is deeper than the soil borehole depths that originally logged and delineated the deposit. Many soil boreholes in the area have penetrated a deposit of marine sands, silts, and clays at a depth of about 60', including many in the proposed project area. The extent of any remaining material deposits located in the Nechelik Channel at Nuiqsut that can be dredged are uncertain.

River Channels Outside the Colville Delta

Streams located to the east of the Colville River, the Miluveach and Kachemah Rivers, contain localized deposits of materials in relatively small quantities. These streams can not supply the quantity of material known to exist at the proposed material site. Impacts to fisheries resources would need to be assessed.

River Channels Within the Colville Delta

The sediment in the main Colville River channel and distributary channels is composed of fine grained sands and silts with some localized deposits of fine gravels. If adequate gravel were to be obtained from the channels, it would need to be first located and then mined by deep dredging as was once done at Nuiqsut. Impacts to fisheries resources would need to be assessed.

Tapped Lakes

Tapped lakes are a source of sands and silts, but would be generally inadequate in quality for construction purposes. Tapped lakes in the Colville River Delta are known to be high value feeding areas for fish, especially for least cisco and broad white fish.

Sand Dunes

The localized and thin deposits of fine sands would be inadequate in quality and quantity for construction purposes. These dune areas are generally vegetated to some degree with riverine and upland shrub vegetation. The excavation of these deposits would impact or destroy riparian willow habitat, which has a high habitat value for mammals.

Other Upland Locations

Except for the proposed gravel mining site, no other suitable upland sites have been identified in the area. If an alternative upland material site were identified in the Colville River Delta area, it would probably have similar or greater impacts to those of the proposed project.

Alternatives Conclusion

Other than distant existing mine sites and the proposed site, there are no known material sources for the Colville River Delta area that equal the known quantity of the proposed mining site.

PROPOSED PERMIT CONDITIONS

The following proposed conditions for the Corps permit are being presented here for consideration.

Start of Mining

No gravel mining or excavation activities directly related to gravel mining will be performed unless a contract is in place for the delivery of the gravel. Such activities include drilling, blasting, overburden removal, gravel excavation, and stockpiling.

Maintenance activities, such as de-watering active mining pits, are not prohibited by this condition. Work associated with reclamation is also not prohibited by this condition.

Reclamation Monitoring and Reporting

We are proposing that the permittee or operator shall submit a report (annually, or at intervals to be determined) describing the present limits of the gravel mining operations, and the reclamation accomplished since the submittal of the previous report. The report shall show the locations of the past and present mining operations, and shall include an assessment of the reclamation efforts. The report shall also include photography to document the statements and descriptions. The report shall be submitted to the USF&WS, ADF&G, and the Corps of Engineers.

Because of the anticipated long-term use of the proposed material site, and the proposal of progress reports to the resource agencies, we believe the request for a 10 year permit term is reasonable and justified.

INFORMATION SOURCES

Alaska Department of Fish and Game. 1991. Blasting Standards For The Protection of Fish. Unpubl.

ARCO Alaska, Inc. March 6, 1996. Alpine Development Information Package. Summaries of Fish, Wildlife, and Hydrology Studies on the Colville River Delta, Alaska, 1992-1995. Unpubl. report prepared for ARCO Alaska, Inc., Anchorage, Alaska, by Alaska Biological Research, Inc., Fairbanks, Alaska, and others.

Bendock, T.N., and J.M. Burr. 1986. Arctic Area Trout Studies Fed. Aid in Fish Rest., Project F-9-18. Annual Performance Report, Vol. 27. Alaska Department of Fish and Game, Juneau, Alaska.

McLean, R.F. 1993. North Slope Gravel Pit Performance Guidelines. Technical Report No. 93-9, Alaska Department of Fish and Game, Fairbanks, Alaska.

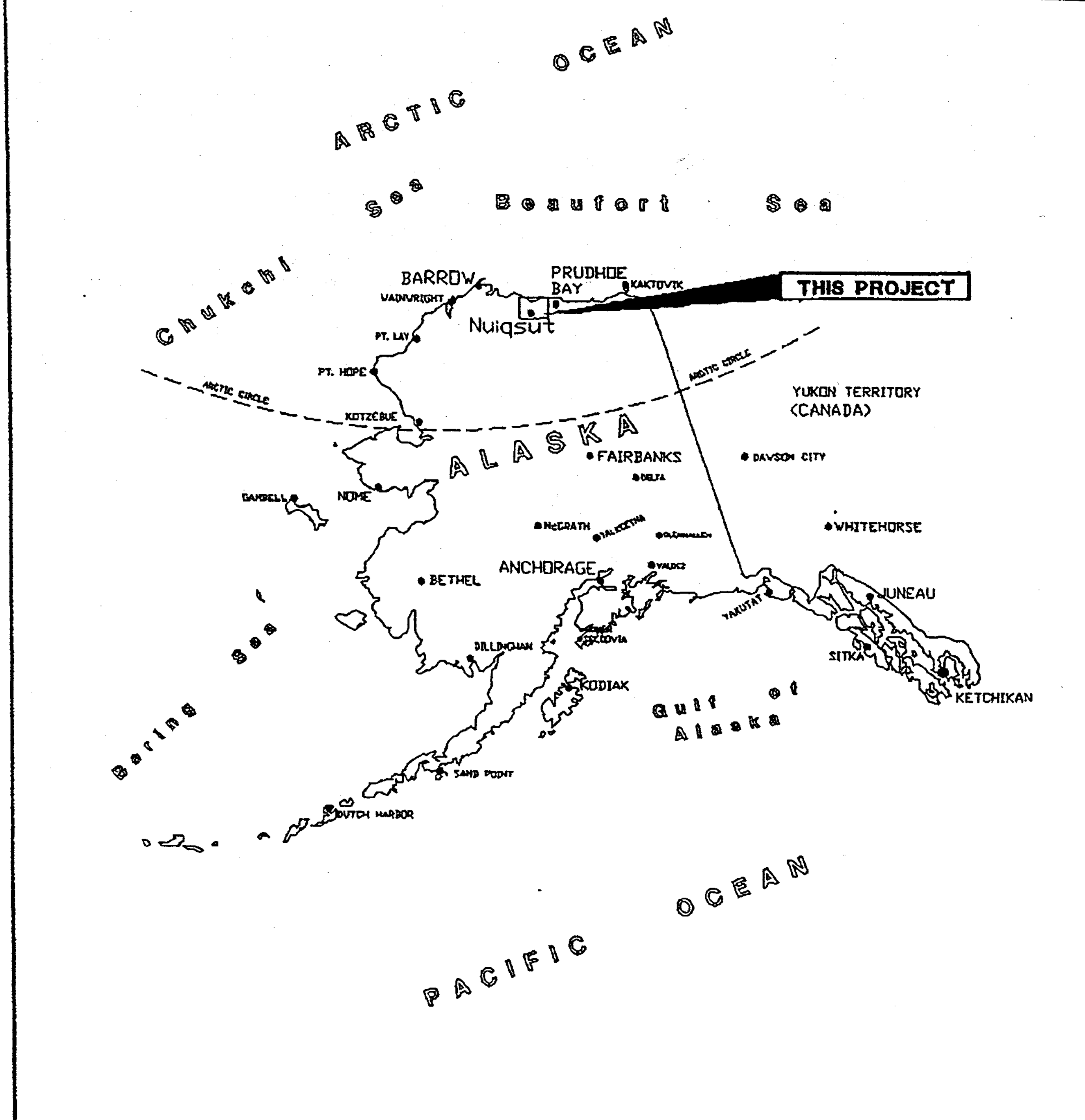
Mortensen, T.W., 1985. Flood Hazard Potential of 18 Arctic Rivers in the National Petroleum Reserve-Alaska. Unpubl. report prepared for the North Slope Borough Coastal Management Program, Barrow, Alaska.

North Slope Borough, CIPM Division. October 1994. Village Aggregate Inventory Report. CIP No. 07-186.

Walker, H.J. 1983. Colville River Delta, Alaska, Guidebook to Permafrost and Related Features. State of Alaska, Division of Geological and Geophysical Surveys, Fairbanks, Alaska.

Walker, H.J. 1994. Environmental Impact of River Dredging in Arctic Alaska (1981-89). *in* Arctic, Vol. 47, No. 2.

EXHIBIT 1



Colville River 8. N-820668

PURPOSE:
Phased development of a 35 million c.y. consolidated use gravel material site.

ADJACENT LANDOWNERS:
Kuukpik Corporation
Arctic Slope Regional Corp.
State of Alaska

LOCATION MAP

APPLICANT:
Arctic Slope Regional Corp.

AGENT:
Tom Mortensen Associates
for
Nuiqsut Constructors

PROPOSED MATERIAL SITE DEVELOPMENT.

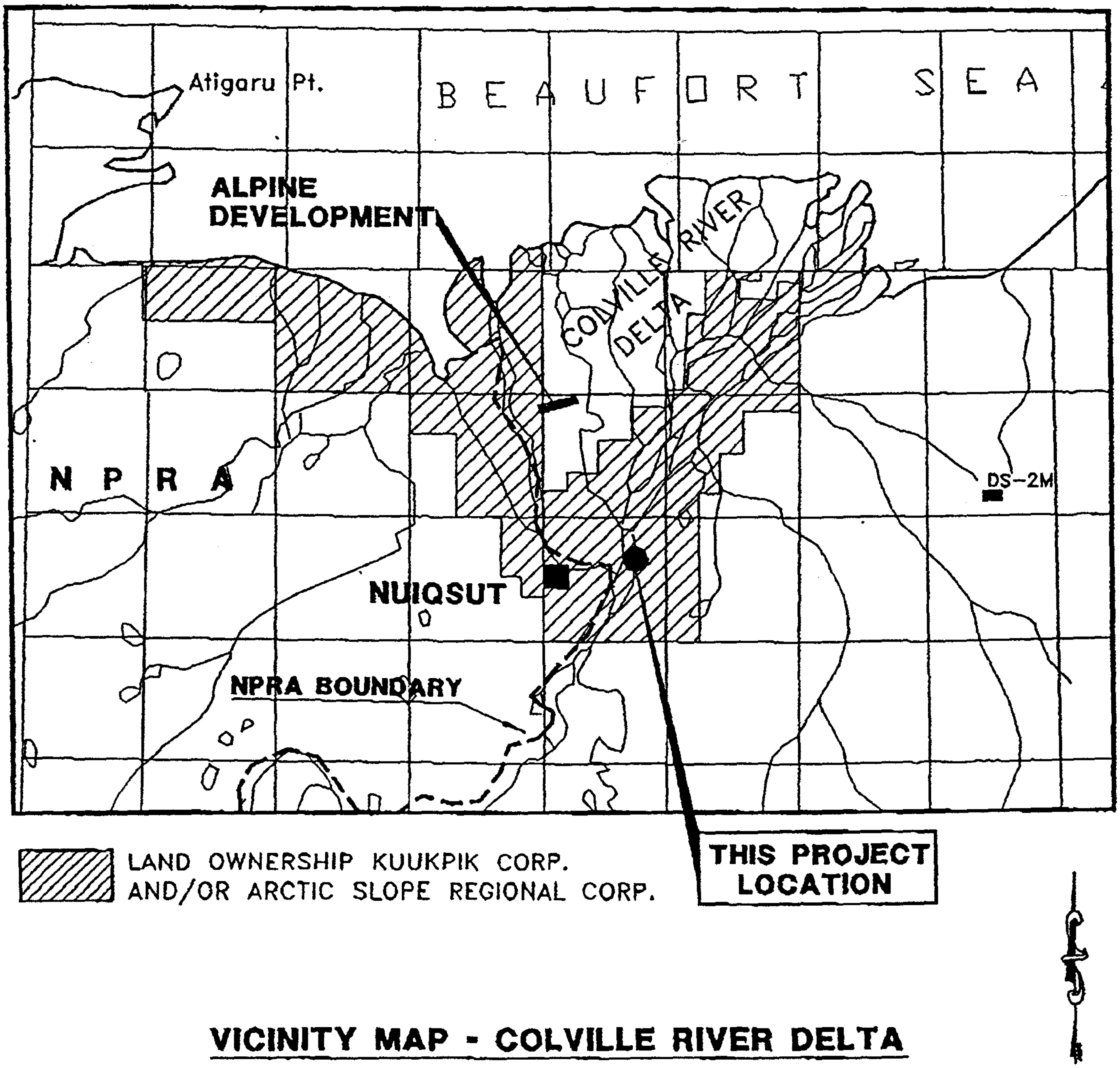
COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.

Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.

PROJECT: 96025
FILE: DAEX1

Sept. 25, 1996

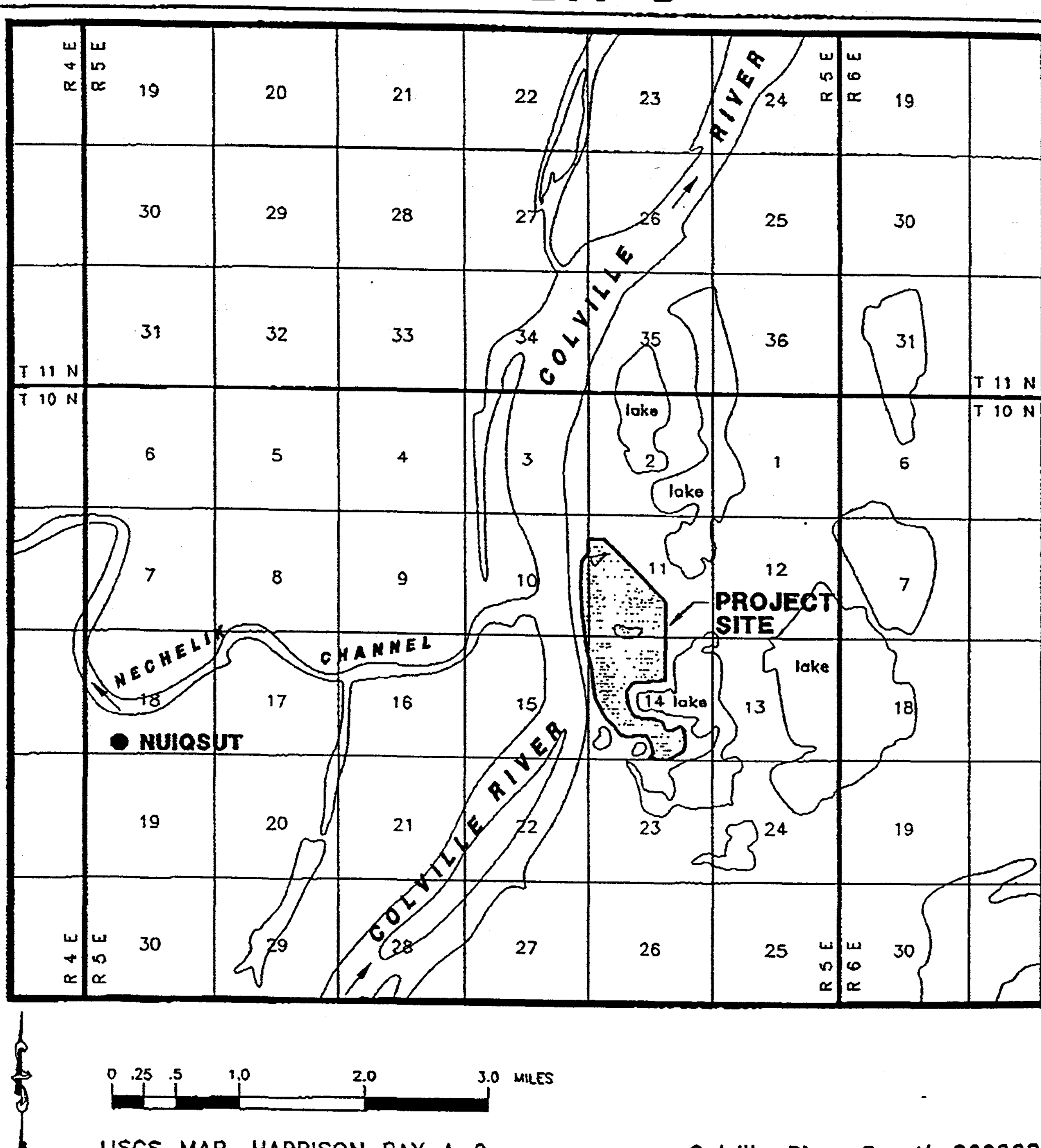
EXHIBIT 2



Colville River 8. N-820668

PURPOSE: Phased development of a 35 million c.y. consolidated use gravel material site.	**VICINITY MAP 1**	PROPOSED MATERIAL SITE DEVELOPMENT. COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.
ADJACENT LANDOWNERS: Kuukpik Corporation, Arctic Slope Regional Corp., State of Alaska	APPLICANT: Arctic Slope Regional Corp. AGENT: Tom Mortensen Associates for Nuiqsut Constructors	Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian. PROJECT: 96025 FILE: DAEX2 Sept. 25, 1996

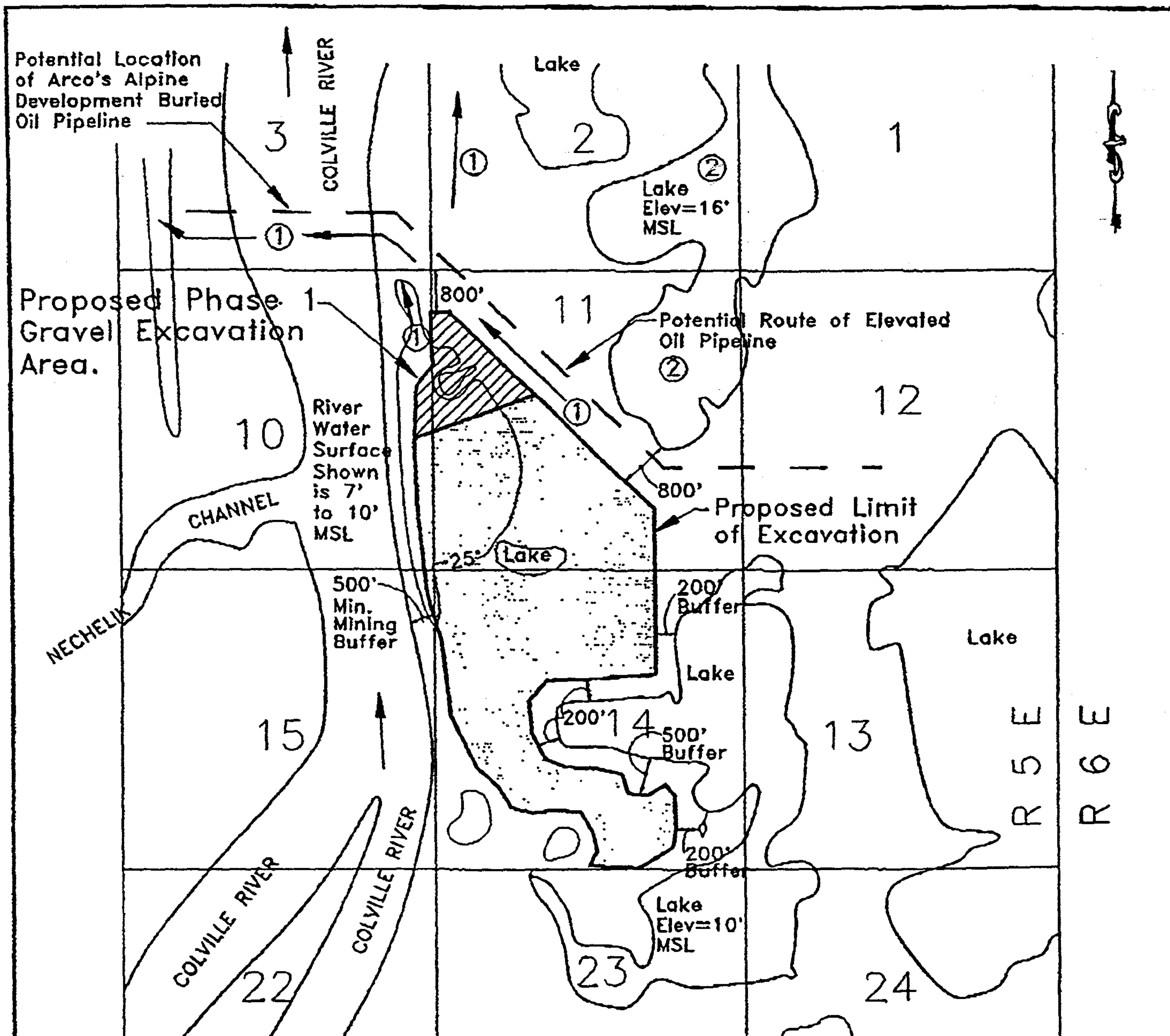
EXHIBIT 3



USGS MAP, HARRISON BAY A-2 | Colville River 8. N-820668

PURPOSE: Phased development of a 35 million c.y. consolidated use gravel material site.	**VICINITY MAP 2**	**PROPOSED MATERIAL SITE DEVELOPMENT.**
ADJACENT LANDOWNERS: Kuukpik Corporation Arctic Slope Regional Corp. State of Alaska	**APPLICANT:** Arctic Slope Regional Corp. **AGENT:** Tom Mortensen Associates for Nuiqsut Constructors	**COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.** **Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.** PROJECT: 96025 FILE: DAEX3 Sept. 25, 1996

EXHIBIT 4



① Proposed Ice Road/Bridge Corridors For Phase 1 Gravel Haul. See Exhibit 11 For Channel Cross Sections, and Exhibit 13 for Alternate Ice Road Routes.

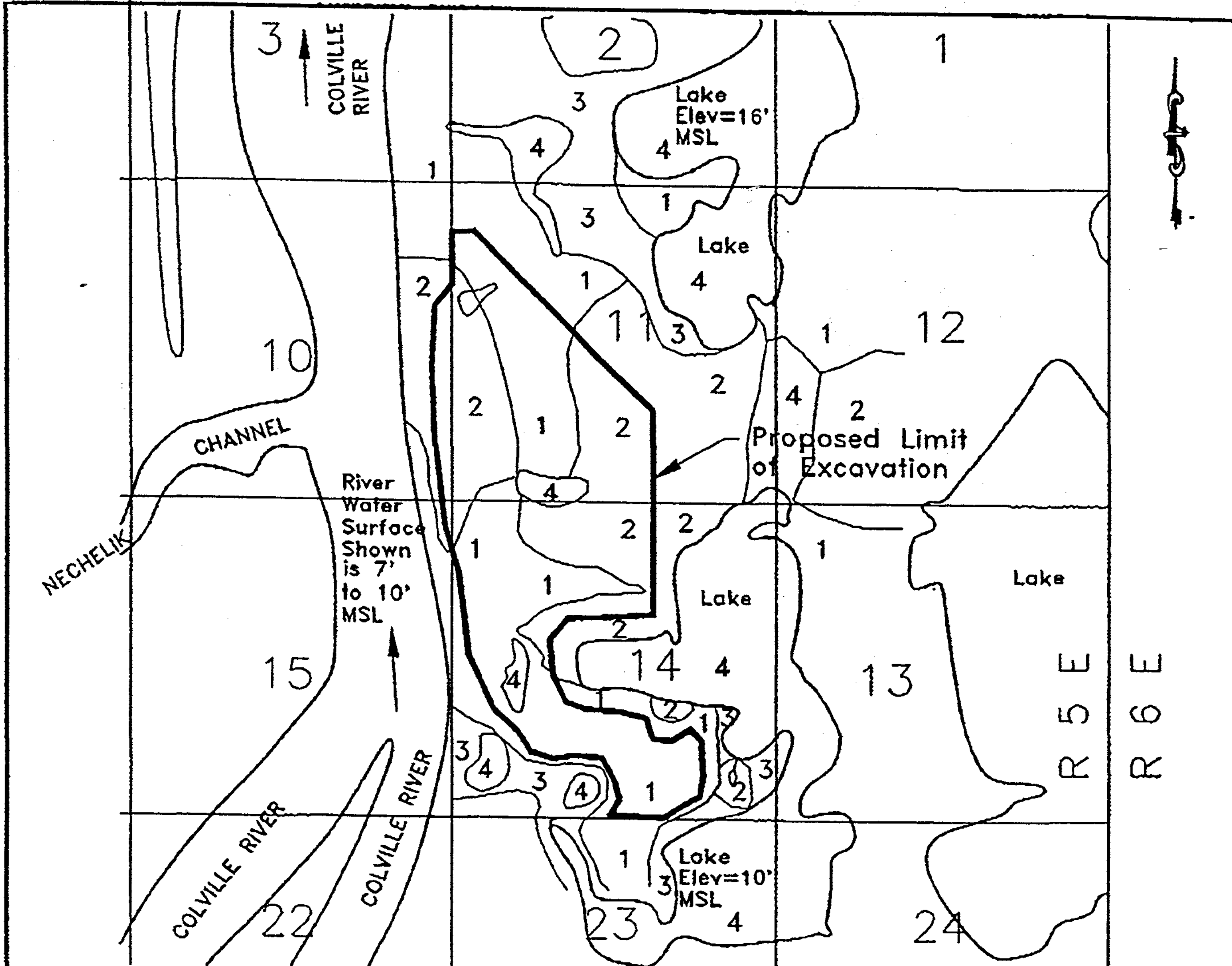
② Proposed Water Withdrawl Points. See Exhibit 6.

LOCATION OF PROPOSED MATERIAL SITE

USGS MAP, HARRISON BAY A-2 Colville River 8. N-820668

PURPOSE:	SITE PLAN 1	PROPOSED MATERIAL SITE DEVELOPMENT.
Phased development of a 35 million c.y. consolidated use gravel material site.	**APPLICANT:** Arctic Slope Regional Corp.	**COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.**
ADJACENT LANDOWNERS: Kuukpik Corporation Arctic Slope Regional Corp. State of Alaska	**AGENT:** Tom Mortensen Associates for Nuiqsut Constructors	**Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.** PROJECT: 96025 FILE: DAEX4 — Sept. 25, 1996

EXHIBIT 5



WILDLIFE HABITATS

1 = WET SEDGE – WILLOW MEADOW WITH LOW RELIEF POLYGONS.
(NWI = PALUSTRINE EMERGENT PERSISTENT SEMIPERMANENTLY FLOODED, SCRUB SHRUB BROAD LEAVED DECIDUOUS SEMIPERMANENTLY FLOODED. PEM1F/SS)
2 = NON-PATTERNED WET MEADOW.
(NWI = PALUSTRINE EMERGENT PERSISTENT SEASONALLY FLOODED. PEM1E)
3 = RIVERINE OR UPLAND SHRUB.
4 = DEEP OPEN WATER WITHOUT ISLANDS.

PROJECT AREA WILDLIFE HABITATS

USGS MAP, HARRISON BAY A-2 — Colville River 8. N-820668

PURPOSE:
Phased development of a 35 million c.y. consolidated use gravel material site.

ADJACENT LANDOWNERS:
Kuukpik Corporation
Arctic Slope Regional Corp.
State of Alaska

SITE PLAN 2

APPLICANT:
Arctic Slope Regional Corp.

AGENT:
Tom Mortensen Associates
for
Nuiqsut Constructors

PROPOSED MATERIAL SITE DEVELOPMENT.

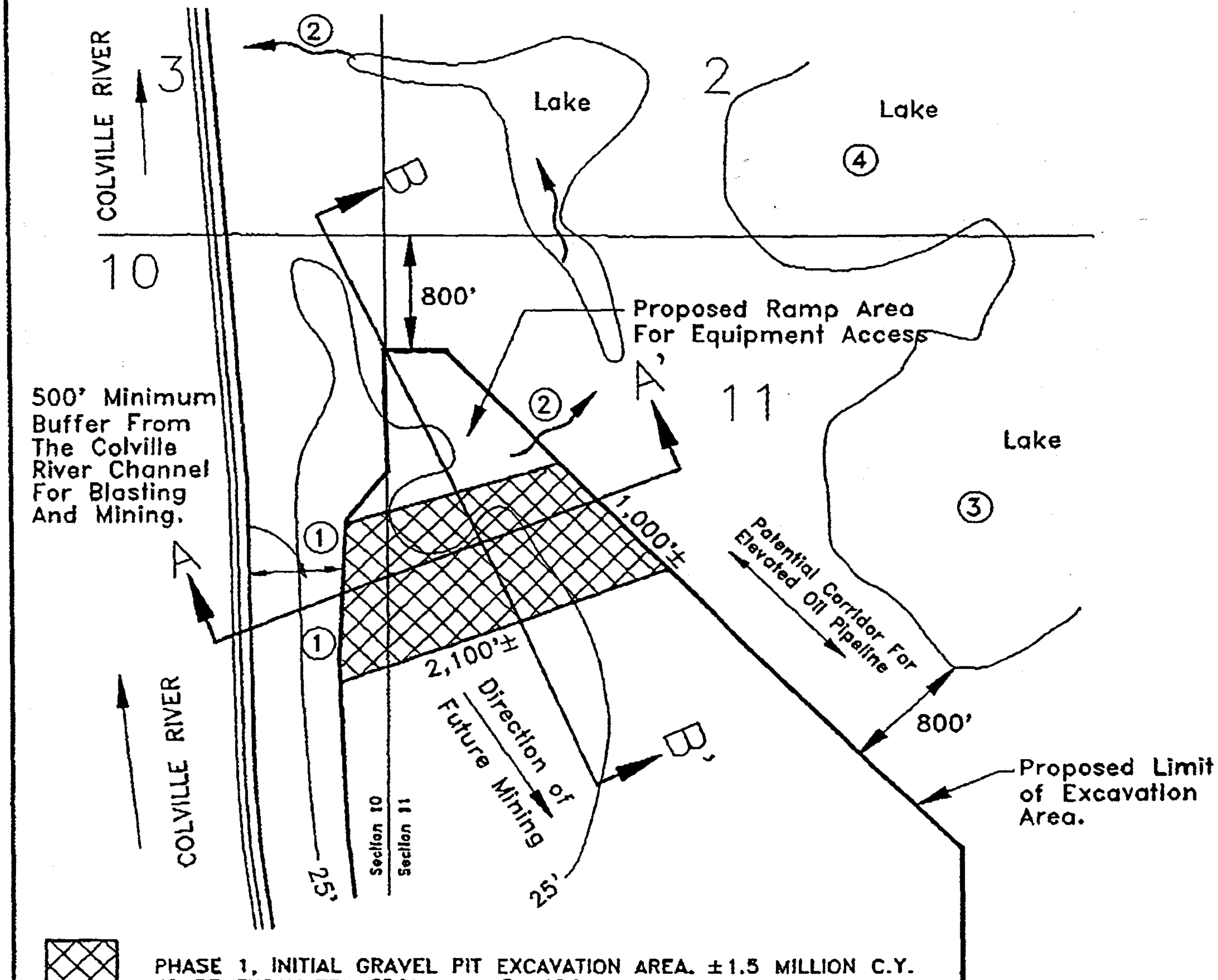
COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.

Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.

PROJECT: 96025
FILE: DAEX4

Sept. 25, 1996

EXHIBIT 6



PHASE 1, INITIAL GRAVEL PIT EXCAVATION AREA. ±1.5 MILLION C.Y. TO BE EXCAVATED FROM A ±45 ACRE AREA.

(1) APPROXIMATE 7 to 10 ACRE AREA FOR TEMPORARY OVERBURDEN STOCKPILE FOR INITIAL PHASE 1 GRAVEL EXCAVATION.

(2) NATURAL DRAINAGE ROUTE OF OVERFLOW WATER FROM FUTURE LAKE.

(3) PROPOSED ICE ROAD WATER SOURCE. 9' DEEP. 27 MILLION GAL. AVAILABLE

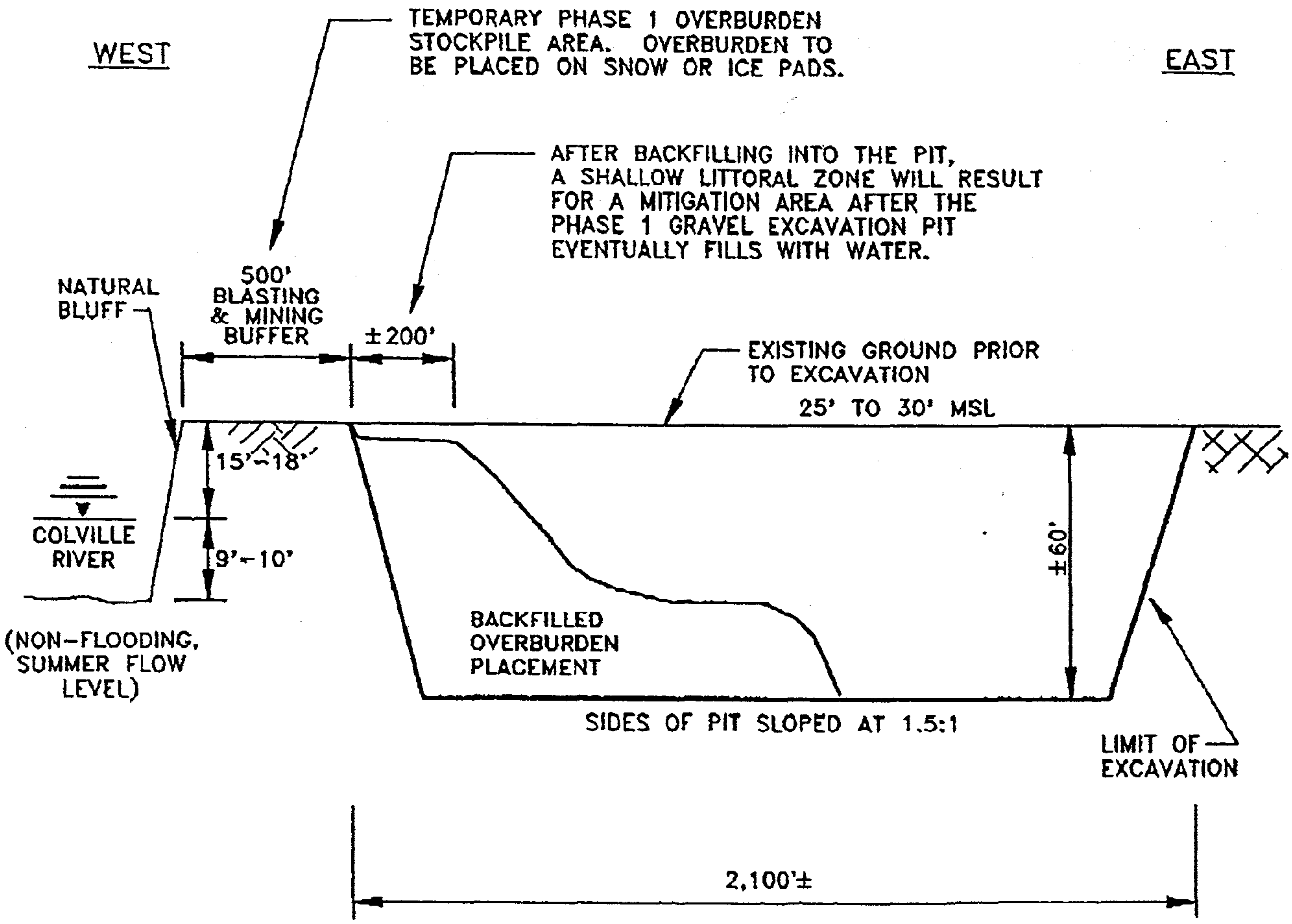
(4) PROPOSED ICE ROAD WATER SOURCE. 11.5' DEEP. 39 MILLION GAL. AVAILABLE.

DETAIL OF PHASE 1 GRAVEL EXCAVATION

Colville River 8. N-820668

PURPOSE: Phased development of a 35 million c.y. consolidated use gravel material site.	**SITE PLAN 3**	**PROPOSED MATERIAL SITE DEVELOPMENT.** **COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.**
ADJACENT LANDOWNERS: Kuukpik Corporation Arctic Slope Regional Corp. State of Alaska	**APPLICANT:** Arctic Slope Regional Corp. **AGENT:** Tom Mortensen Associates for Nuiqsut Constructors	**Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.** PROJECT: 96025 FILE: DAEX6 — Sept. 25, 1996

EXHIBIT 7



SECTION A-A'

NTS

TYPICAL EAST TO WEST CROSS SECTION

Colville River 8. N-820668

PURPOSE:
Phased development of a 35 million c.y. consolidated use gravel material site.

ADJACENT LANDOWNERS:
Kuukpik Corporation
Arctic Slope Regional Corp.
State of Alaska

CROSS SECTION 1

APPLICANT:
Arctic Slope Regional Corp.

AGENT:
Tom Mortensen Associates
for
Nuiqsut Constructors

PROPOSED MATERIAL SITE DEVELOPMENT.

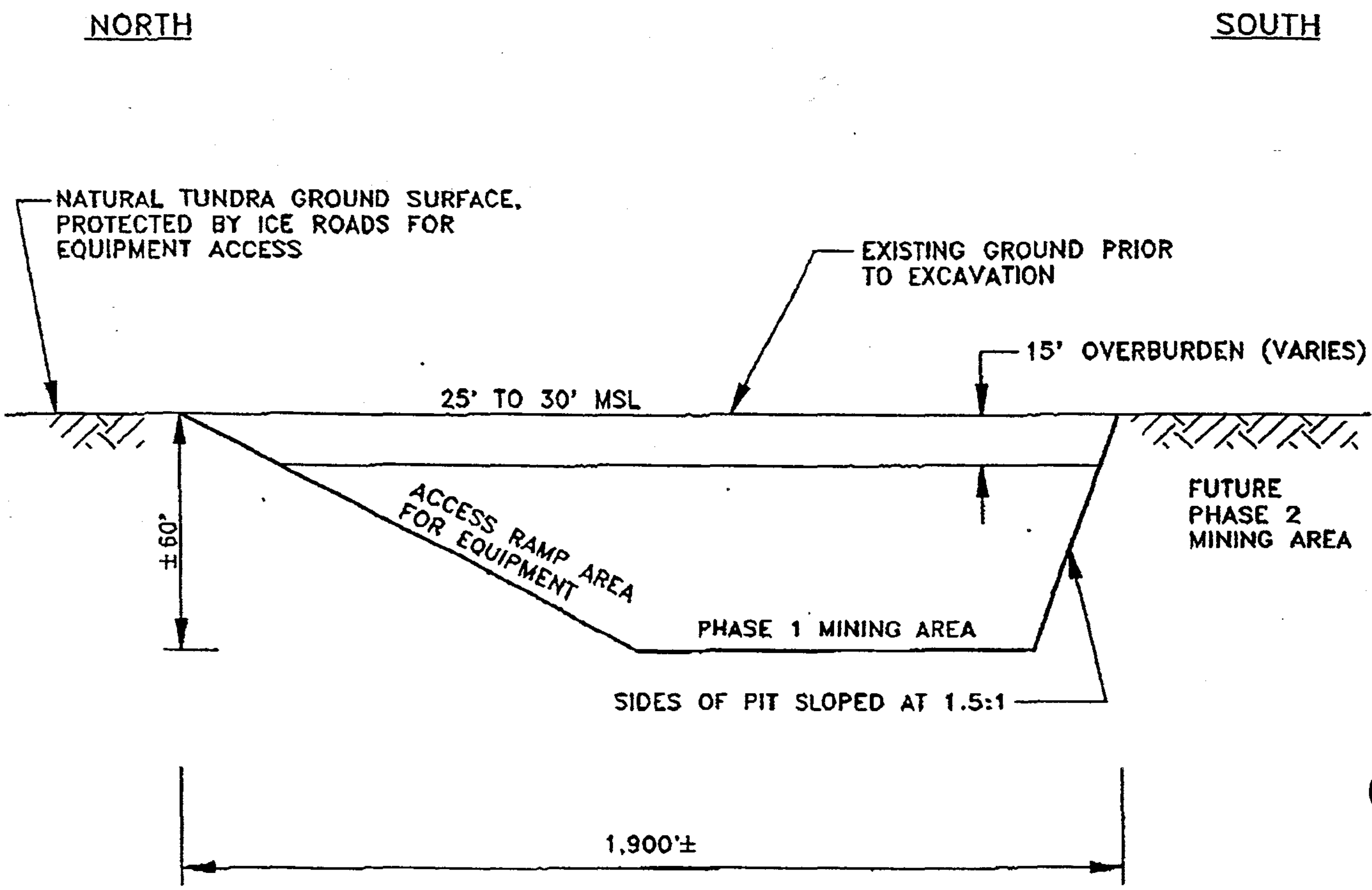
COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.

Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.

PROJECT: 96025
FILE: DAEX7

Sept. 25, 1996

EXHIBIT 8



SECTION B–B'

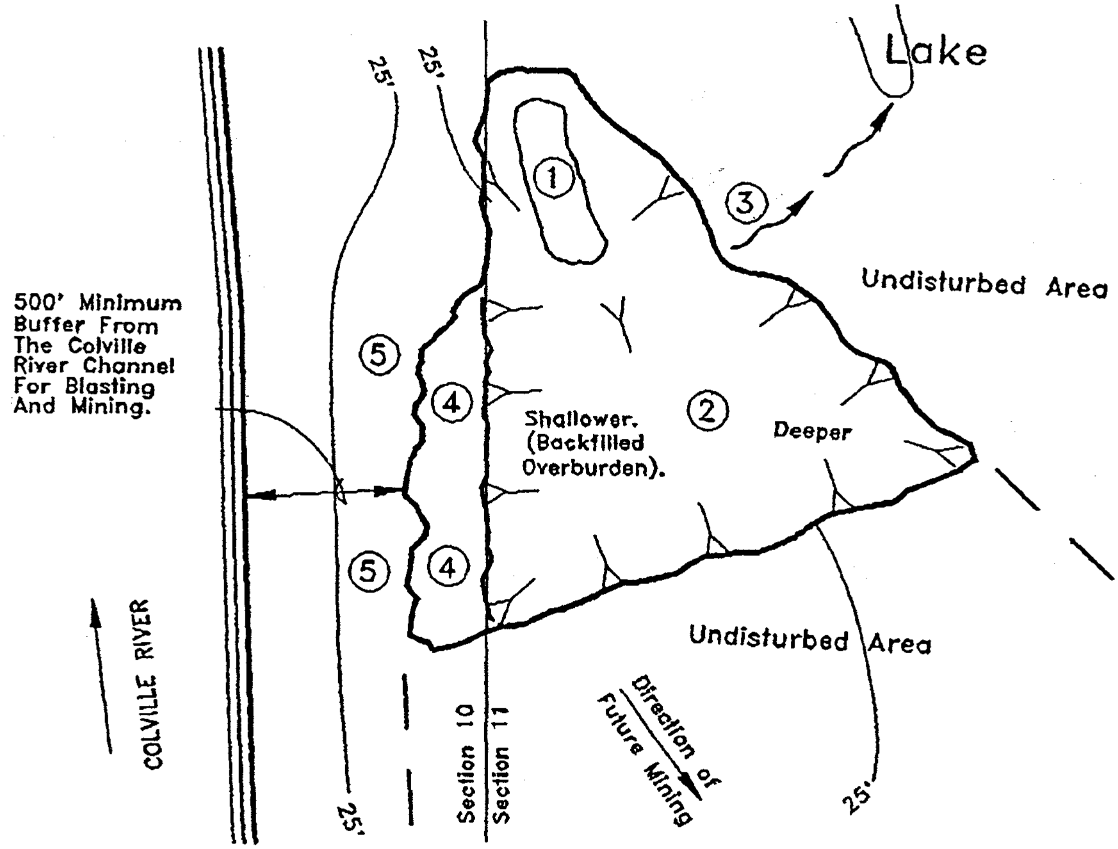
NTS

TYPICAL NORTH TO SOUTH CROSS SECTION

Colville River 8. N–820668

PURPOSE: Phased development of a 35 million c.y. consolidated use gravel material site. **ADJACENT LANDOWNERS:** Kuukpik Corporation Arctic Slope Regional Corp. State of Alaska	**CROSS SECTION 2** **APPLICANT:** Arctic Slope Regional Corp. **AGENT:** Tom Mortensen Associates for Nuiqsut Constructors	**PROPOSED MATERIAL SITE DEVELOPMENT.** **COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.** **Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.** PROJECT: 96025 FILE: DAEX8 Sept. 25, 1996

EXHIBIT 9



1. ISLAND OR PENINSULA OF UNDISTURBED GROUND RESULTING FROM THE SUBMERGING OF THE EQUIPMENT ACCESS RAMP(S).
2. LAKE UP TO 60' DEEP AFTER PRECIPATION FILLS THE EXCAVATION PIT AREA. THE MAXIMUM SURFACE AREA OF THE PHASE 1 MINING AREA IS 45 ACRES.
3. NATURAL DRAINAGE ROUTE OF OVERFLOW WATER FROM THE FUTURE LAKE.
4. APPROXIMATE 5 TO 10 ACRE SHALLOW LITTORAL MITIGATION AREA. THE 1' TO 6' DEEP LITTORAL AREA WILL BE CREATED BY THE BACKFILLING OF THE TEMPORARY OVERBURDEN STOCKPILE BACK INTO THE EXCAVATION PIT.
5. LOCATION OF TEMPORARY OVERBURDEN STOCKPILE ON SNOW OR ICE PAD.

DETAIL OF PHASE 1 RECLAMATION

Colville River 8. N-820668

PURPOSE:
Phased development of a 35 million c.y. consolidated use gravel material site.

ADJACENT LANDOWNERS:
Kuukpik Corporation
Arctic Slope Regional Corp.
State of Alaska

SITE PLAN 4

APPLICANT:
Arctic Slope Regional Corp.

AGENT:
Tom Mortensen Associates
for
Nuiqsut Constructors

PROPOSED MATERIAL SITE DEVELOPMENT.

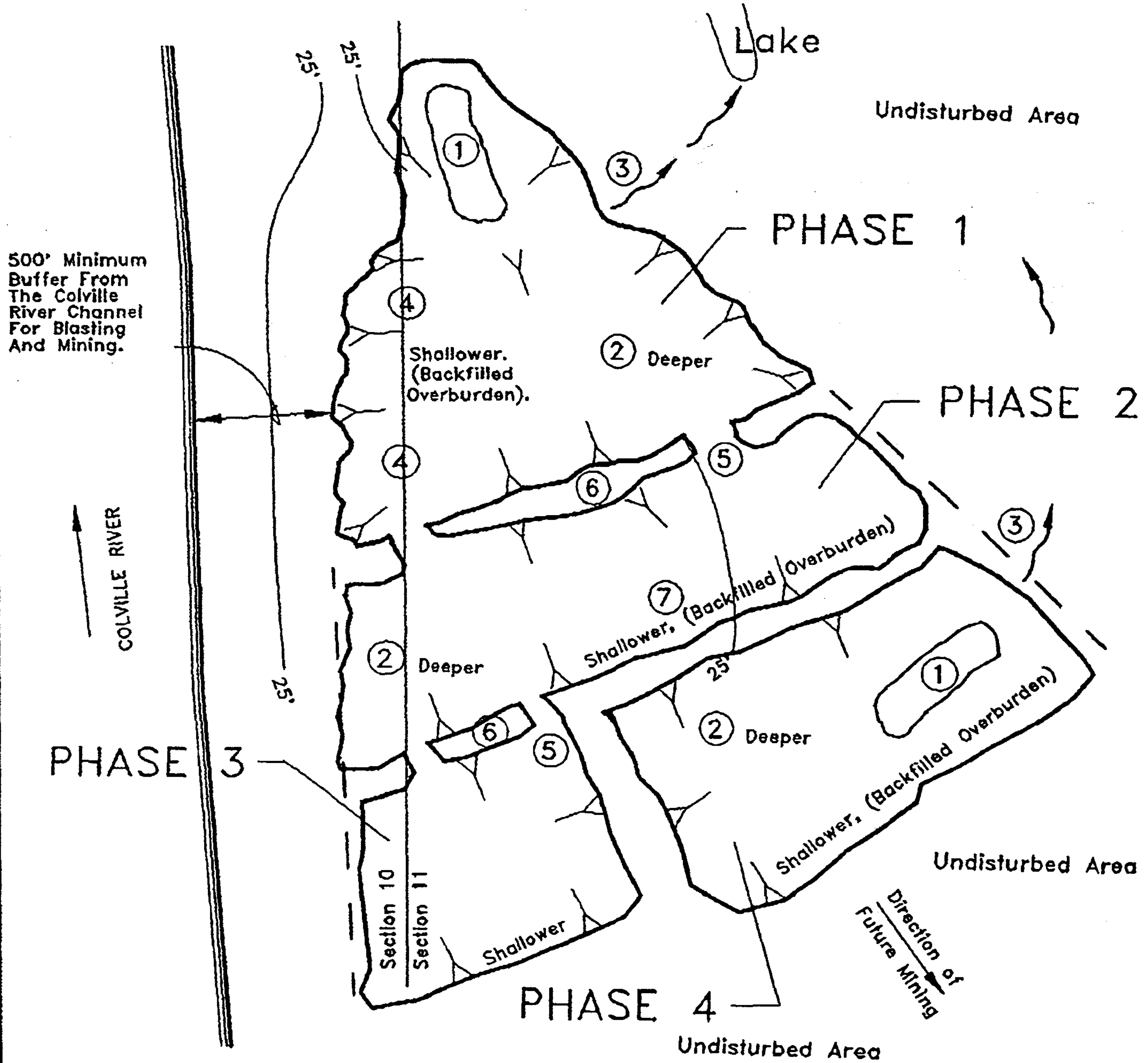
COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.

Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.

PROJECT: 96025
FILE: DAEX9

Sept. 25, 1996

EXHIBIT 10 PAGE 1 OF 2



NOTES: SEE EXHIBIT 10, PAGE 2, FOR NOTES.

CONCEPTUAL PLAN OF PHASED RECLAMATION

NTS

Colville River 8. N–820668

PURPOSE: Phased development of a 35 million c.y. consolidated use gravel material site. **ADJACENT LANDOWNERS:** Kuukpik Corporation Arctic Slope Regional Corp. State of Alaska	**SITE PLAN 5** **APPLICANT:** Arctic Slope Regional Corp. **AGENT:** Tom Mortensen Associates for Nuiqsut Constructors	**PROPOSED MATERIAL SITE DEVELOPMENT.** **COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.** **Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.** PROJECT: 96025 FILE: DAEX10 Sept. 25, 1996

NOTES:

① ISLAND OR PENINSULA OF UNDISTURBED GROUND RESULTING FROM THE SUBMERGING OF THE EQUIPMENT ACCESS RAMP(S).

② LAKE UP TO 60' DEEP AFTER PRECIPATION FILLS THE EXCAVATION PIT AREA. THE MAXIMUM SURFACE AREA OF THE PHASE 1 MINING AREA IS 45 ACRES.

③ NATURAL DRAINAGE ROUTE OF OVERFLOW WATER FROM THE FUTURE LAKE SYSTEM.

④ SHALLOW ZONE CREATED BY BACKFILLING OF 250,000 CY OF OVERBURDEN TEMP. STOCKPILED ON ICE PADS ON THE UNDISTURDED TUNDRA.
ALSO, THE INITIAL OVERBURDEN FROM THE PHASE 2 GRAVEL EXCAVATION PIT (PROBABLY ABOUT 250,000 CY) COULD BE BACKFILLED INTO THIS AREA TO DECREASE THE WATER DEPTH AND TO CREATE ISLANDS IF DEEMED NECESSARY.

⑤ BREACH AREAS CONNECTING THE LAKES.

⑥ ISLANDS OF UNDISTURDED TUNDRA AREAS CREATED FROM CONNECTING THE LAKES.

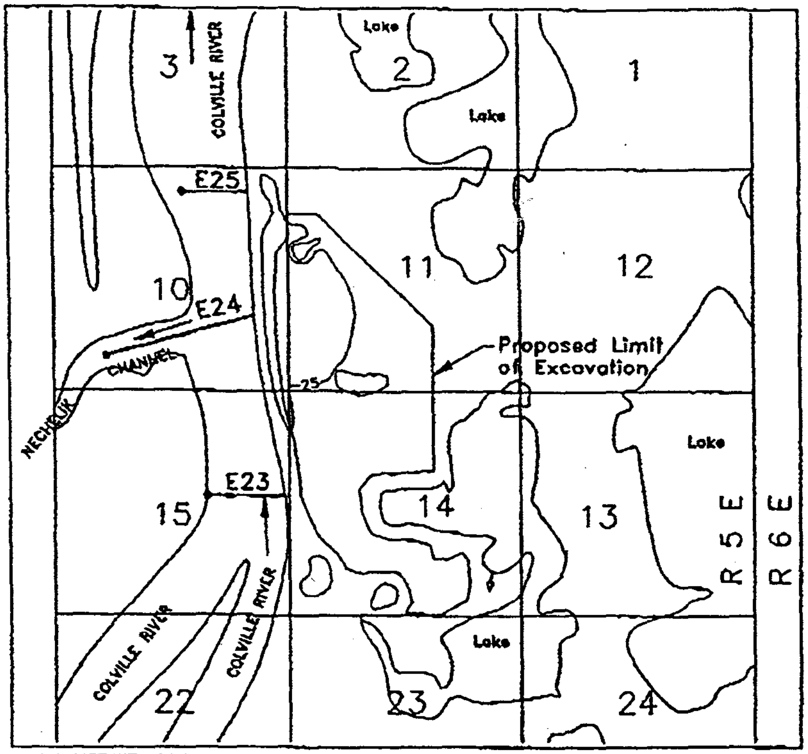
⑦ THE INITIAL OVERBURDEN FROM THE PHASE 4 GRAVEL EXCAVATION PIT (PROBABLY ABOUT 250,000 CY) COULD BE BACKFILLED INTO THIS AREA TO DECREASE THE WATER DEPTH AND TO CREATE ISLANDS IF DEEMED NECESSARY.

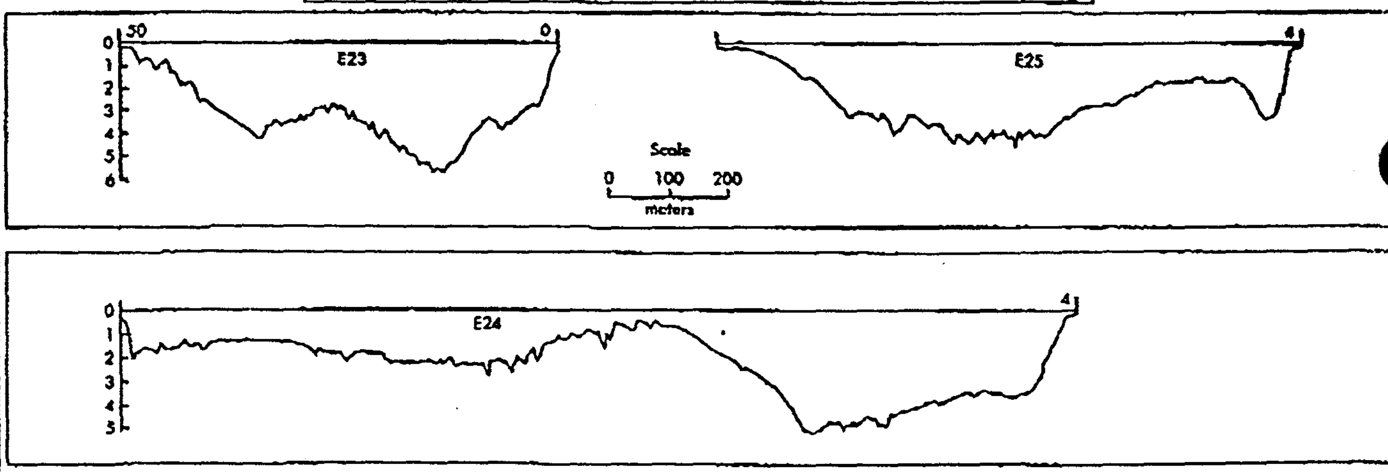
CONCEPTUAL PLAN OF PHASED RECLAMATION

Colville River 8. N-820668

PURPOSE: Phased development of a 35 million c.y. consolidated use gravel material site. **ADJACENT LANDOWNERS:** Kuukpik Corporation, Arctic Slope Regional Corp., State of Alaska	**NOTES** **APPLICANT:** Arctic Slope Regional Corp. **AGENT:** Tom Mortensen Associates for Nuiqsut Constructors	**PROPOSED MATERIAL SITE DEVELOPMENT.** **COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.** **Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.** PROJECT: 96025 FILE: DAEX10 Sept. 25, 1996

EXHIBIT 11





RIVER CHANNEL CROSS SECTIONS
DONE IN 1962 BY H.J. WALKER,
LOUISIANA STATE UNIVERSITY,
BATON ROUGE, LOUISIANA.

CROSS SECTIONS OF COLVILLE CHANNEL

Colville River 8. N-820668

PURPOSE:
Phased development of a 35 million c.y. consolidated use gravel material site.

ADJACENT LANDOWNERS:
Kuukpik Corporation
Arctic Slope Regional Corp.
State of Alaska

CROSS SECTION 3

APPLICANT:
Arctic Slope Regional Corp.

AGENT:
Tom Mortensen Associates
for
Nuiqsut Constructors

PROPOSED MATERIAL SITE DEVELOPMENT.

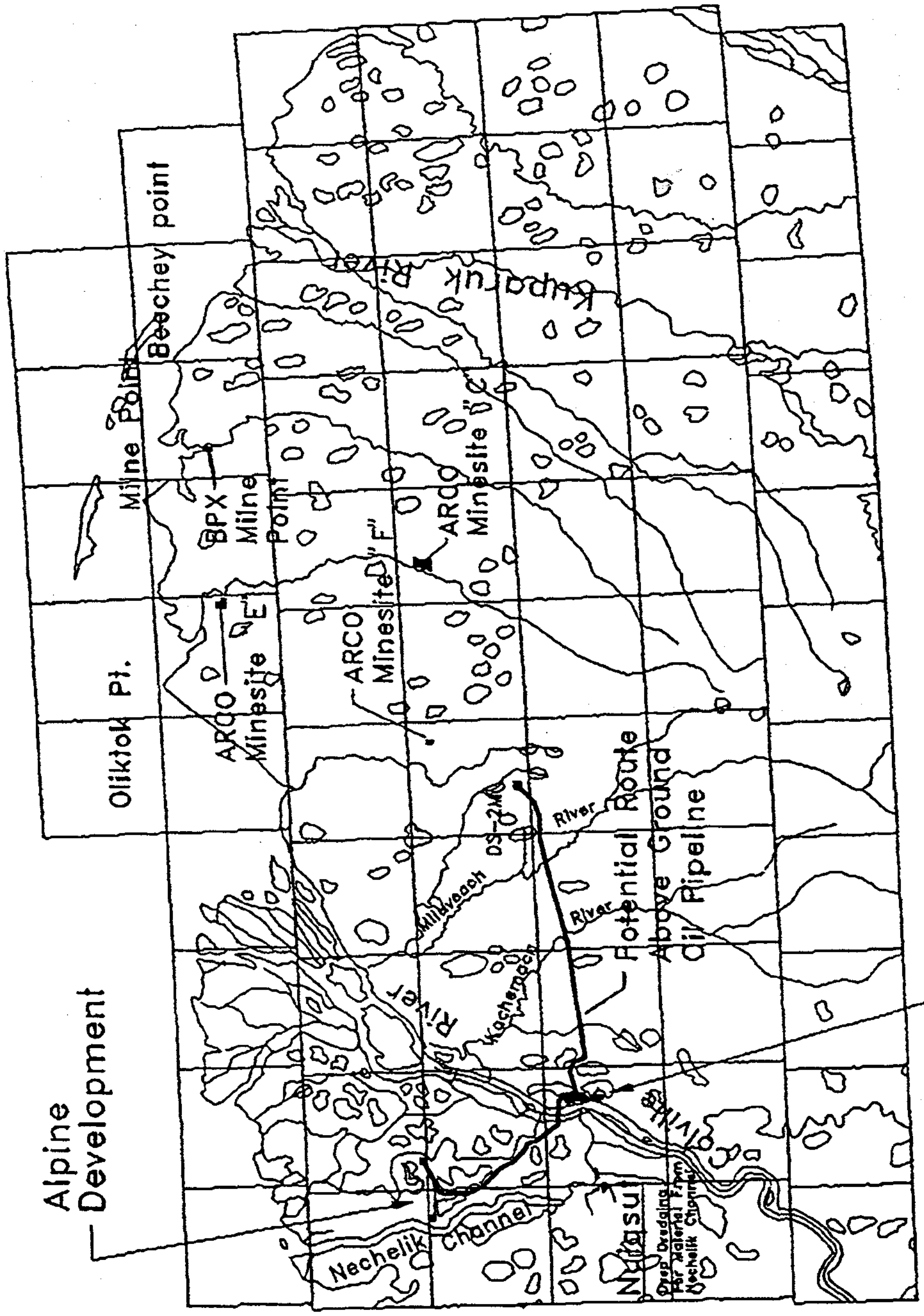
COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.

Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.

PROJECT: 96025
FILE: DAEX11

Sept. 25, 1996

EXHIBIT 12

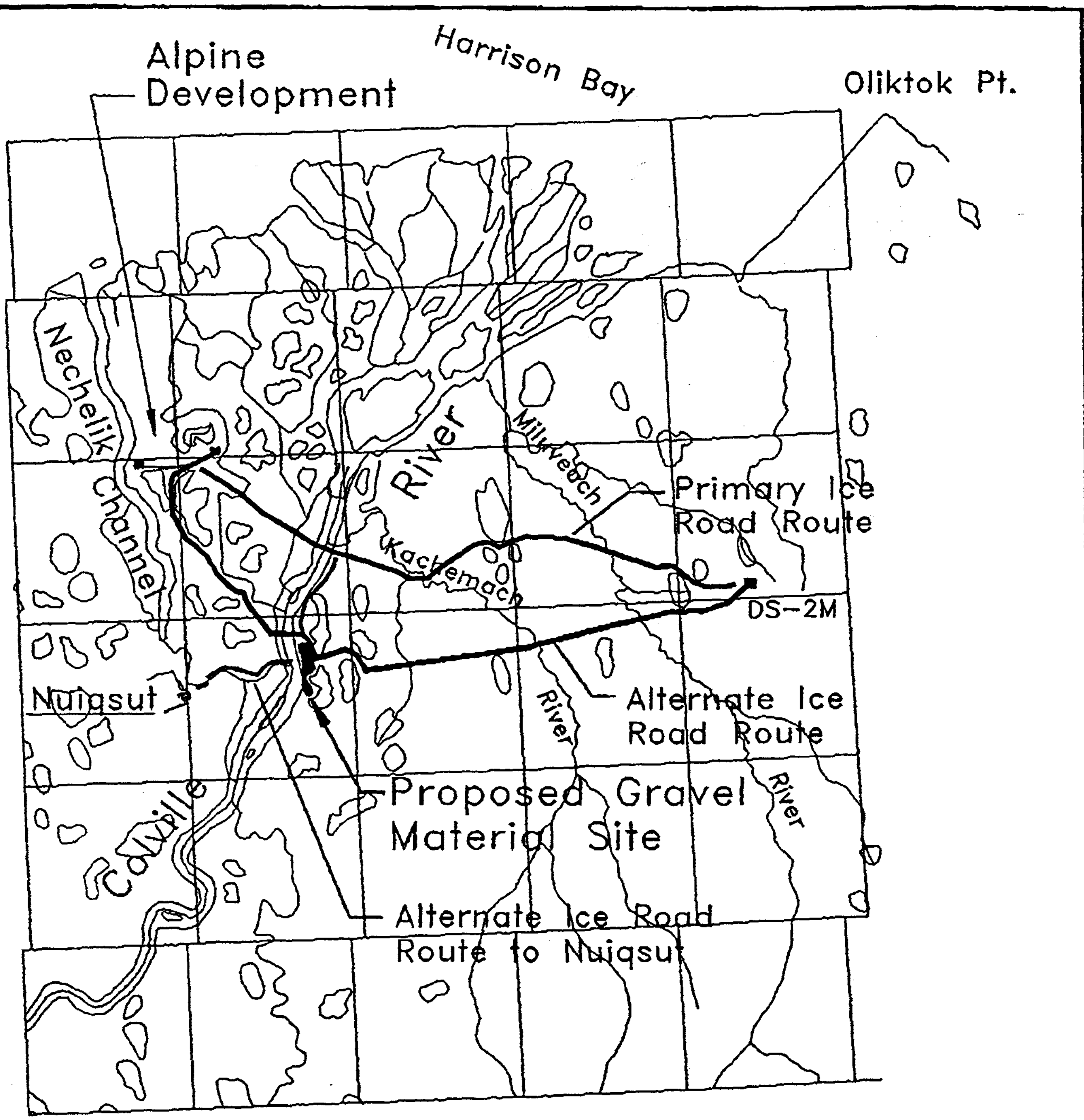


LOCATIONS OF ALTERNATIVE MATERIAL SITES

Colville River 8. N-820668

PURPOSE: Phased development of a 35 million c.y. consolidated use gravel material site.	**ALTERNATIVES**	**PROPOSED MATERIAL SITE DEVELOPMENT.**
ADJACENT LANDOWNERS: Kuukpik Corporation, Arctic Slope Regional Corp., State of Alaska	**APPLICANT:** Arctic Slope Regional Corp. **AGENT:** Tom Mortensen Associates for Nuiqsut Constructors	**COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.** **Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.** PROJECT: 96025 FILE: DAEX12 Sept. 25, 1996

EXHIBIT 13



LOCATIONS OF ICE ROAD ACCESS ROUTES

Colville River 8. N-820668

PURPOSE: Phased development of a 35 million c.y. consolidated use gravel material site. **ADJACENT LANDOWNERS:** Kuukpik Corporation Arctic Slope Regional Corp. State of Alaska	**ACCESS** **APPLICANT:** Arctic Slope Regional Corp. **AGENT:** Tom Mortensen Associates for Nuiqsut Constructors	**PROPOSED MATERIAL SITE DEVELOPMENT.** **COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.** **Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.** PROJECT: 96025 FILE: DAEX13 Sept. 25, 1996

APPENDIX E-2

GRAVEL ROAD PERMIT APPLICATION

COPY

DEPARTMENT OF THE ARMY PERMIT

Permittee U.S. Bureau of Indian Affairs

Permit No. 2-950364, Colville River 16

Issuing Office U.S. Army Engineer District

NOTE: The term "you" and its derivatives, as used in this permit, means the permittee or any future transferee. The term "this office" refers to the appropriate district or division office of the Corps of Engineers having jurisdiction over the permitted activity or the appropriate official of that office acting under the authority of the commanding officer.

You are authorized to perform work in accordance with the terms and conditions specified below.

Project Description: The project work consists of winter placement of 190,00 cubic yards of fill material in 26 acres of wetlands and floodplains for a 3.8 mile road from the village of Nuiqsut to the Colville River. Typical road cross-section footprint is 50 feet with a 30-foot crown width. The road height is approximately 3-foot high with a layer of insulation with 3H:1V side slopes. Three major culverts are included for stream crossings.

All work shall be conducted in accordance with the attached plans, 6 sheets dated July and September 1995.

Project Location: The proposed project is located in sections 13, 24, and 25 of T. 10 N., R. 4 E., sections 18, 19, 30 and 31 of T. 10 N., R. 5 E., and sections 6 and 7 of T. 9 N., R. 4 E., Umiat Meridian.

Permit Conditions:

General Conditions:

1. The time limit for completing the work authorized ends on January 30, 1999. If you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.

2. You must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of this permit from this office, which may require restoration of the area.

3. If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and state coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

4. If you sell the property associated with this permit, you must obtain the signature of the new owner in the space provided and forward a copy of the permit to this office to validate the transfer of this authorization.

5. If a conditioned water quality certification has been issued for your project, you must comply with the conditions specified in the certification as special conditions to this permit. For your convenience, a copy of the certification is attached if it contains such conditions.

6. You must allow representatives from this office to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished in accordance with the terms and conditions of your permit.

Special Conditions:

1. Activities associated with this project shall be restricted to the period 15 August to 15-May to avoid impacts to spectacled eiders. Modifications to this schedule must preceded by consultation with the Fish and Wildlife Service and will be subject to terms and conditions recommended by the Service for protection of the spectacled eiders

Continued on 2A

Further Information:

1. Congressional Authorities: You have been authorized to undertake the activity described above pursuant to:

( ) Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403).

( ) Section 404 of the Clean Water Act (33 U.S.C. 1344).

( ) Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (33 U.S.C. 1413).

2. Limits of this authorization.

a. This permit does not obviate the need to obtain other Federal, state, or local authorizations required by law.

b. This permit does not grant any property rights or exclusive privileges.

c. This permit does not authorize any injury to the property or rights of others.

d. This permit does not authorize interference with any existing or proposed Federal project.

3. Limits of Federal Liability. In issuing this permit, the Federal Government does not assume any liability for the following:

a. Damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes.

b. Damages to the permitted project or uses thereof as a result of current or future activities undertaken by or on behalf of the United States in the public interest.

c. Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity authorized by this permit.

d. Design or construction deficiencies associated with the permitted work.

COPY

e. Damage claims associated with any future modification, suspension, or revocation of this permit.

4. Reliance on Applicant's Data: The determination of this office that issuance of this permit is not contrary to the public interest was made in reliance on the information you provided.

5. Reevaluation of Permit Decision. This office may reevaluate its decision on this permit at any time the circumstances warrant. Circumstances that could require a reevaluation include, but are not limited to, the following:

a. You fail to comply with the terms and conditions of this permit.

b. The information provided by you in support of your permit application proves to have been false, incomplete, or inaccurate (See 4 above).

c. Significant new information surfaces which this office did not consider in reaching the original public interest decision.

Such a reevaluation may result in a determination that it is appropriate to use the suspension, modification, and revocation procedures contained in 33 CFR 325.7 or enforcement procedures such as those contained in 33 CFR 326.4 and 326.5. The referenced enforcement procedures provide for the issuance of an administrative order requiring you to comply with the terms and conditions of your permit and for the initiation of legal action where appropriate. You will be required to pay for any corrective measures ordered by this office, and if you fail to comply with such directive, this office may in certain situations (such as those specified in 33 CFR 209.170) accomplish the corrective measures by contract or otherwise and bill you for the cost.

6. Extensions. General condition 1 establishes a time limit for the completion of the activity authorized by this permit. Unless there are circumstances requiring either a prompt completion of the authorized activity or a reevaluation of the public interest decision, the Corps will normally give favorable consideration to a request for an extension of this time limit.

Your signature below, as permittee, indicates that you accept and agree to comply with the terms and conditions of this permit.

AREA DESIGN ENGINEER 3/11/96

(PERMITTEE) AND TITLE (DATE)

This permit becomes effective when the Federal official, designated to act for the Secretary of the Army, has signed below.

Lloyd H. Fanter March 19, 1964

FOR (DISTRICT ENGINEER) (DATE)

When the structures or work authorized by this permit are still in existence at the time the property is transferred, the terms and conditions of this permit will continue to be binding on the new owner(s) of the property. To validate the transfer of this permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below.

(TRANSFEREE) (DATE)

☆U.S. GOVERNMENT PRINTING OFFICE: 1986 — 717-425

Special Conditions Continued

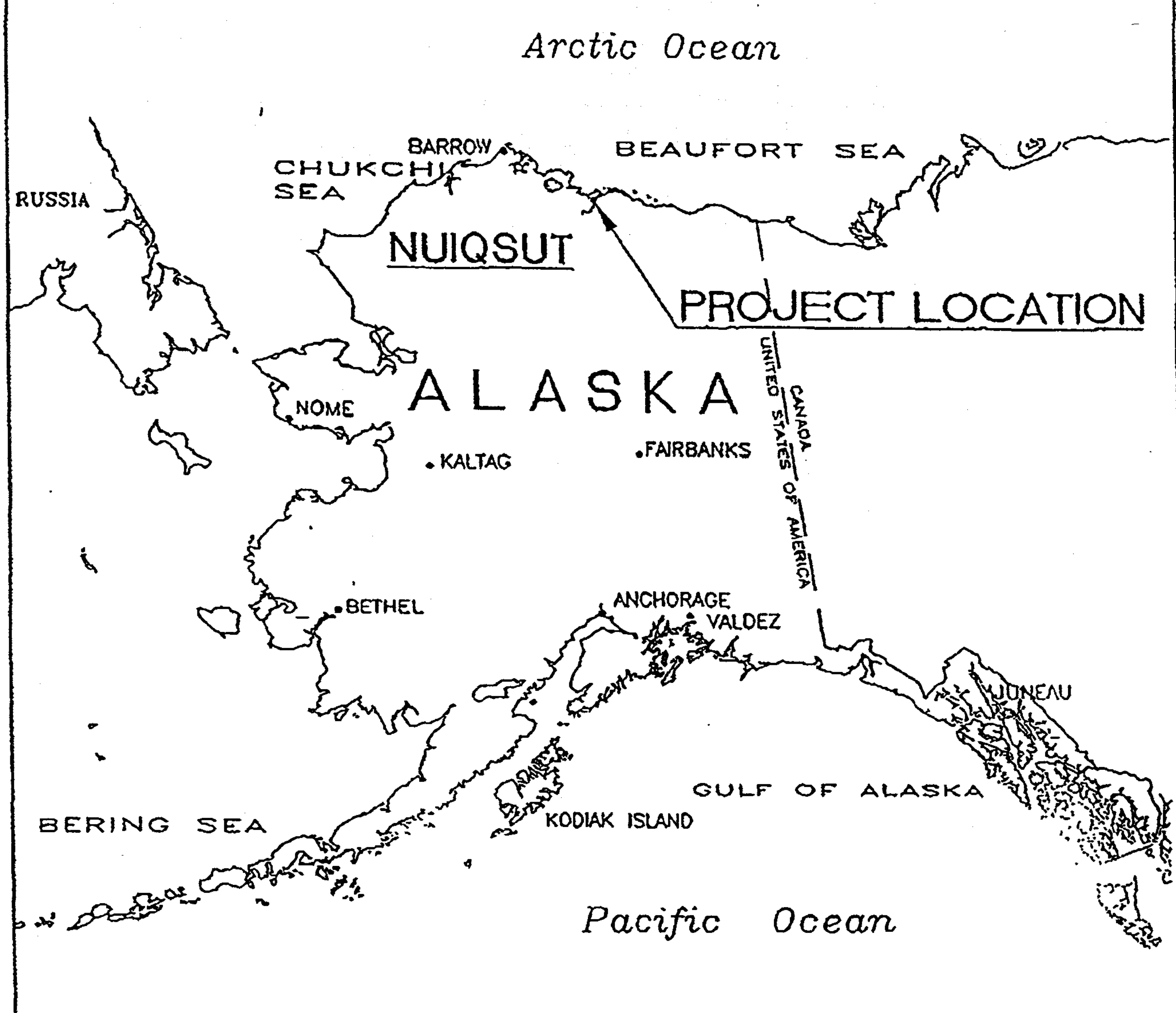
2. The road alignment shall minimize placement of fill in riparian willow (Salix spp.) stands and streams.

3. Natural drainage patterns shall be maintained to the extent practicable by the installation of culverts in sufficient number and size to prevent ponding. Culverts shall be installed and maintained so that operate efficiently for the lifetime of the project.

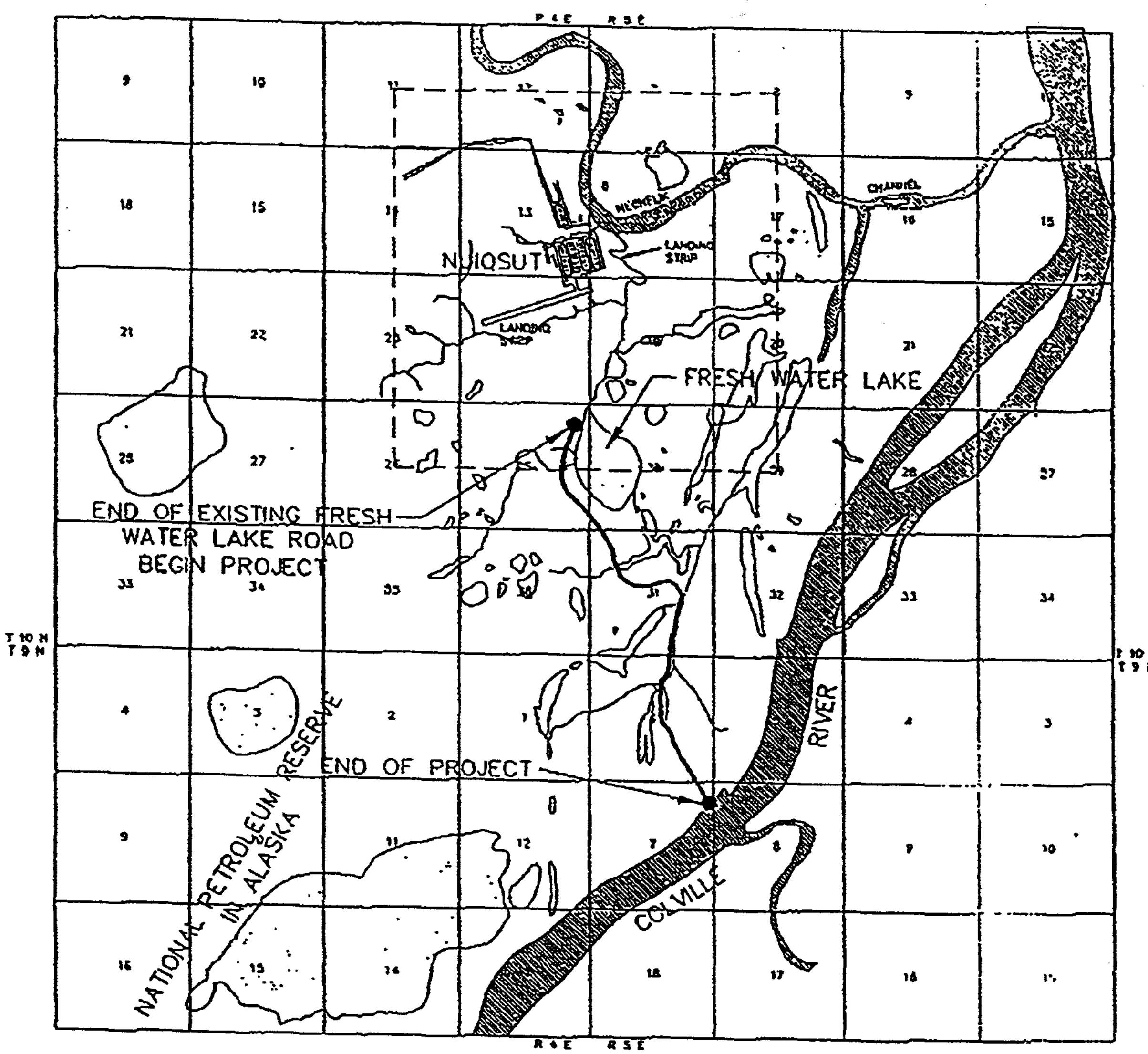
4. All heavy equipment operation will be confined to the project footprint to prevent unnecessary damage to the insulating layer of vegetation in wetlands that protects the permafrost in adjacent areas.

Special Information:

Any condition incorporated by reference into this permit by Special Condition or General Condition 5, remains a condition of this permit unless expressly modified or deleted, in writing, by the District Engineer or his authorized representative.



PURPOSE: Provide Safe Roadway Access to the Banks of the Colville River **PROPERTY OWNER:** Village of Nuiqsut Kuupik Corporation	LOCATION MAP FIGURE 1 **AGENT:** ASCG INC. 301 Arctic Slope Ave., Suite 200 Anchorage, Alaska 99518-3035	PROPOSED ROADWAY CONSTRUCTION NUIQSUT, ALASKA 2681 SEPT 1995



PURPOSE:
Provide Safe Roadway Access to the Banks of the Colville River

VICINITY MAP

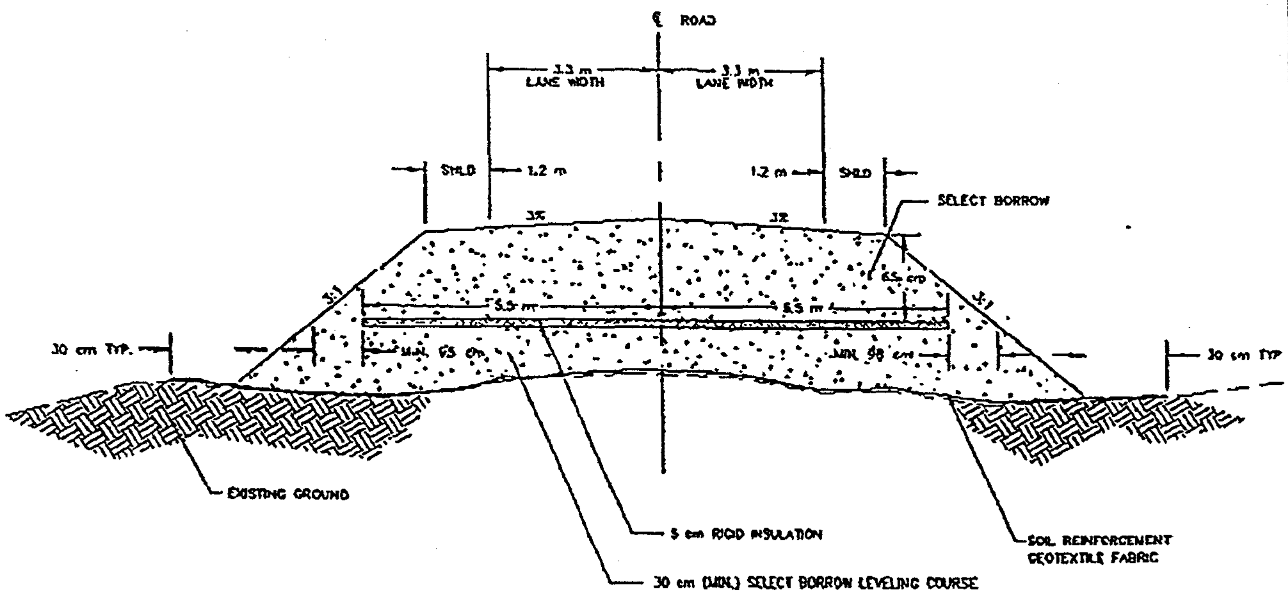
FIGURE 2

PROPOSED ROADWAY CONSTRUCTION
NUIQSUT, ALASKA

PROPERTY OWNER:
Village of Nuiqsut
Kuupik Corporation

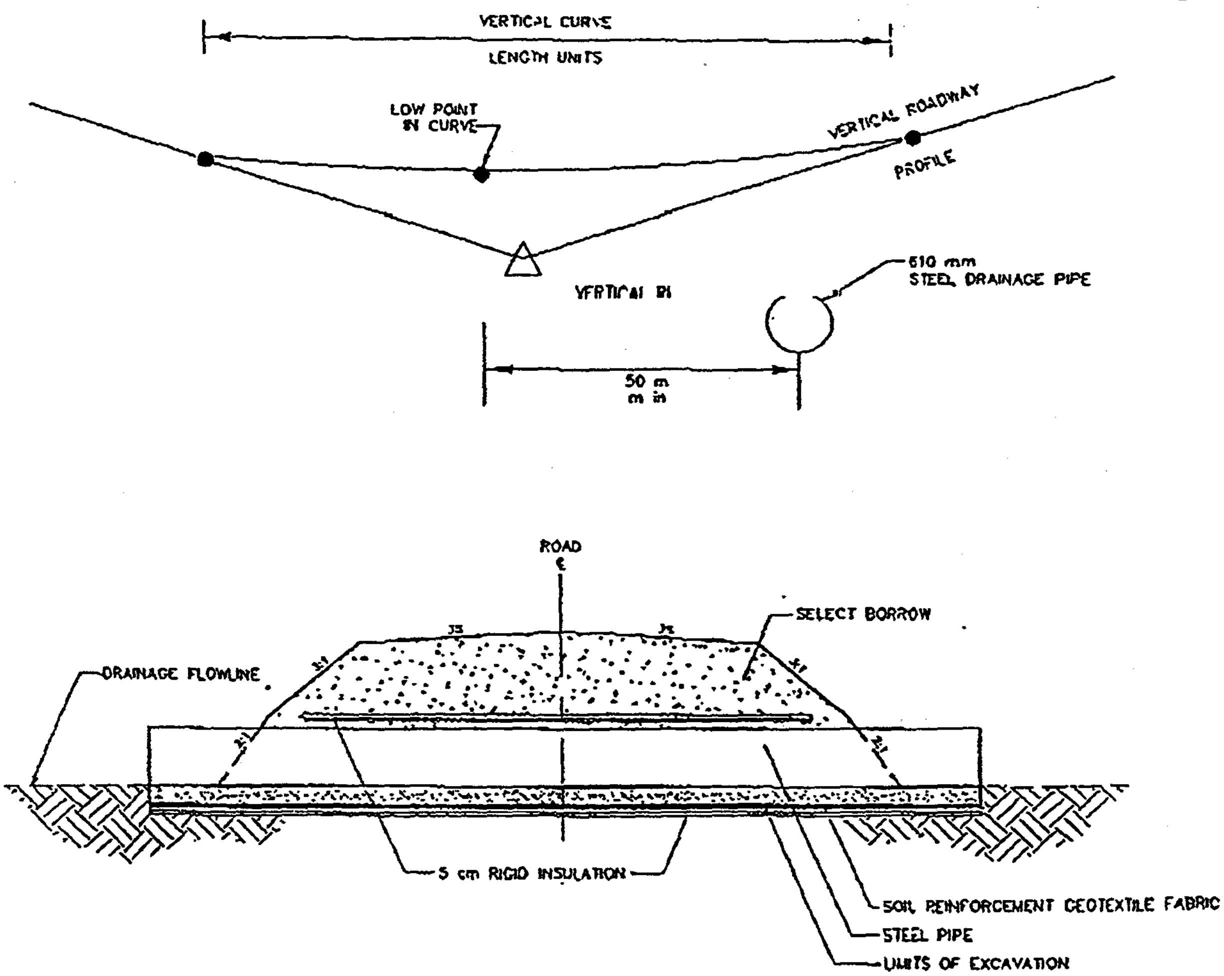
AGENT:
ASCG INC.
301 Arctic Slope Ave., Suite 200
Anchorage, Alaska 99518-3035

2681 | SEPT 1995

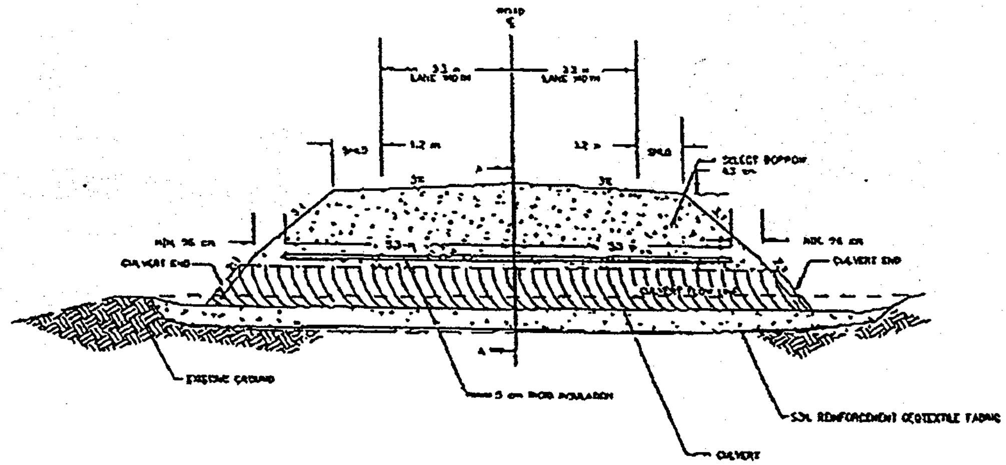


COLVILLE RIVER ACCESS ROAD STA. 1+000 TO STA. 7+082.302

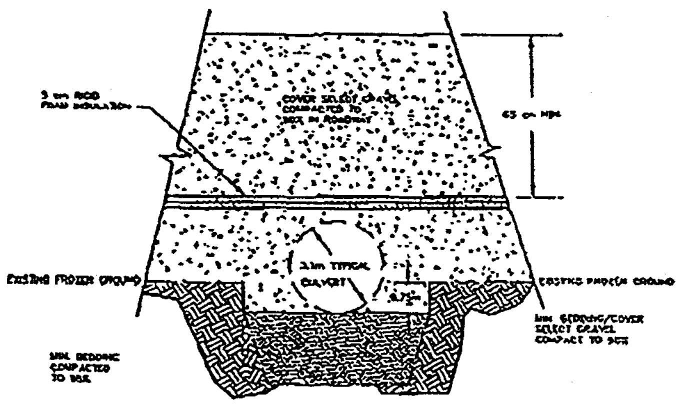
PURPOSE: Provide Safe Roadway Access to the Banks of the Colville River	TYPICAL X-SECTION	PROPOSED ROADWAY CONSTRUCTION NUIQSUT, ALASKA
	FIGURE 3	
PROPERTY OWNER: Village. of Nuiqsut Kuupik Corporation	**AGENT:** ASCG INC. 301 Arctic Slope Ave., Suite 200 Anchorage, Alaska 99518-3035	2681 SEPT 1995



PURPOSE: Provide Safe Roadway Access to the Banks of the Colville River	TYPICAL ROAD OVERFLOW SECTION	PROPOSED ROADWAY CONSTRUCTION NUIQSUT, ALASKA
	FIGURE 4	NOT TO SCALE
PROPERTY OWNER: Village of Nuiqsut Kuupik Corporation	**AGENT:** ASCG INC. 301 Arctic Slope Ave., Suite 200 Anchorage, Alaska 99518-3035	SHEET 5 OF 5
		2681 — SEPT 1995

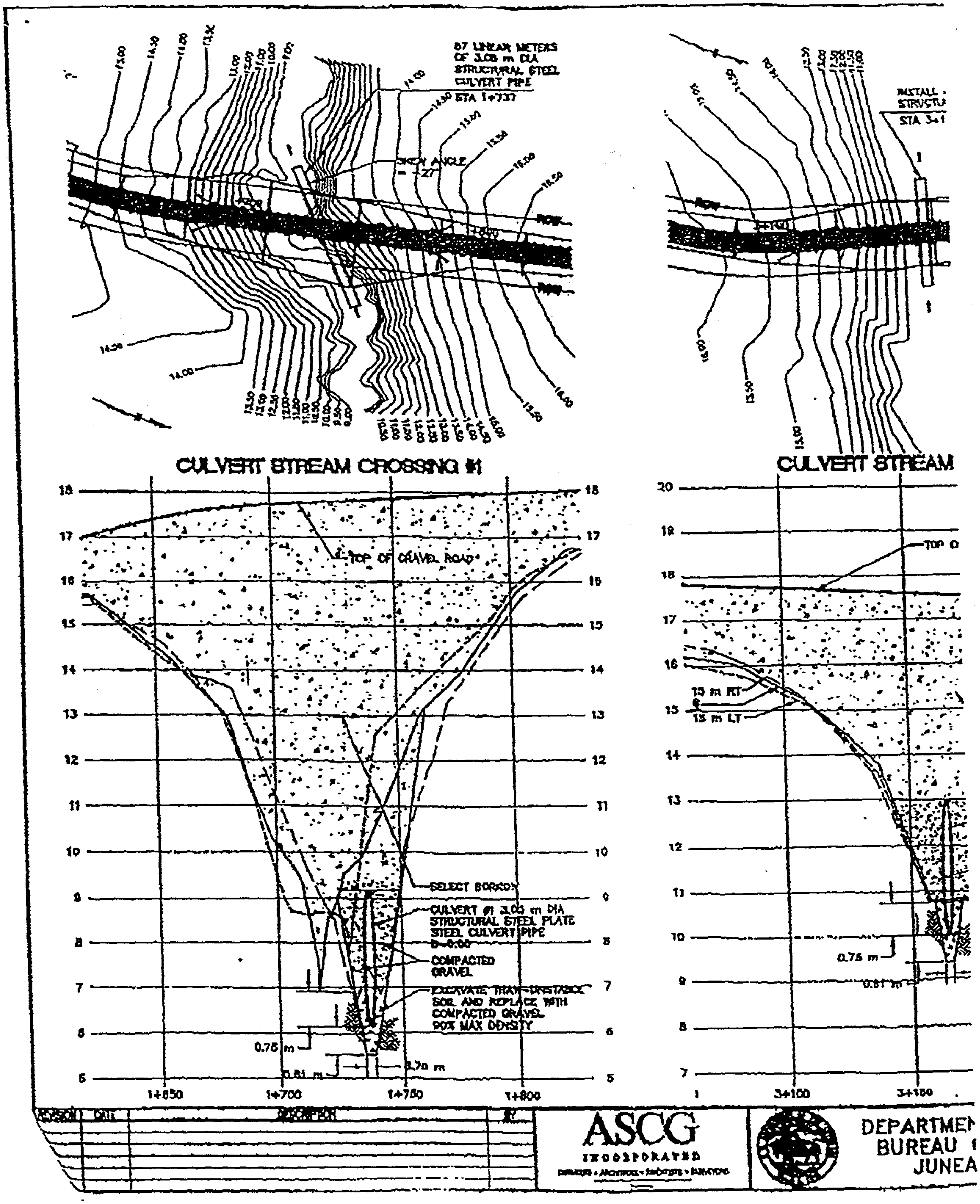


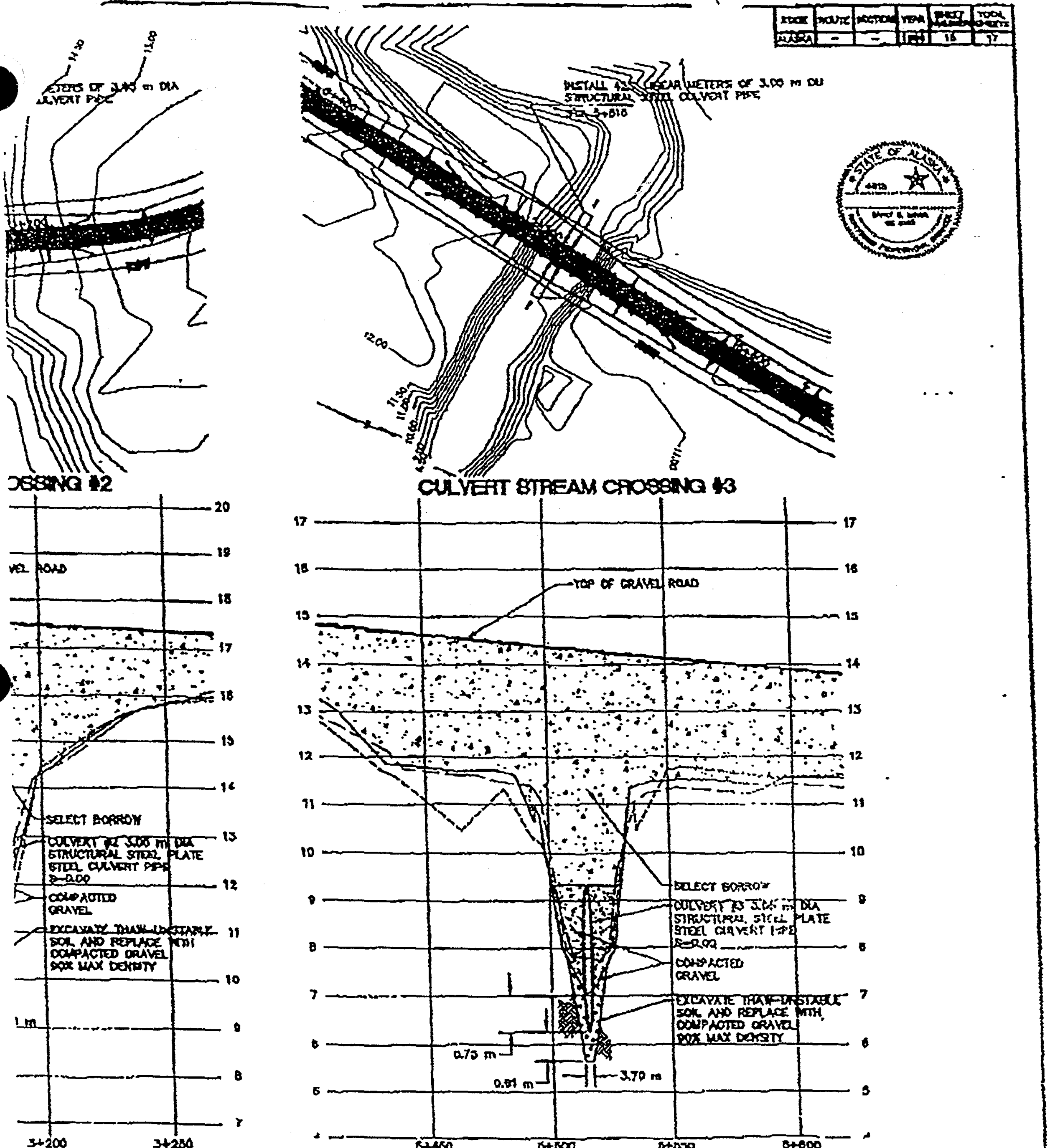
TYPICAL CULVERT CROSSING



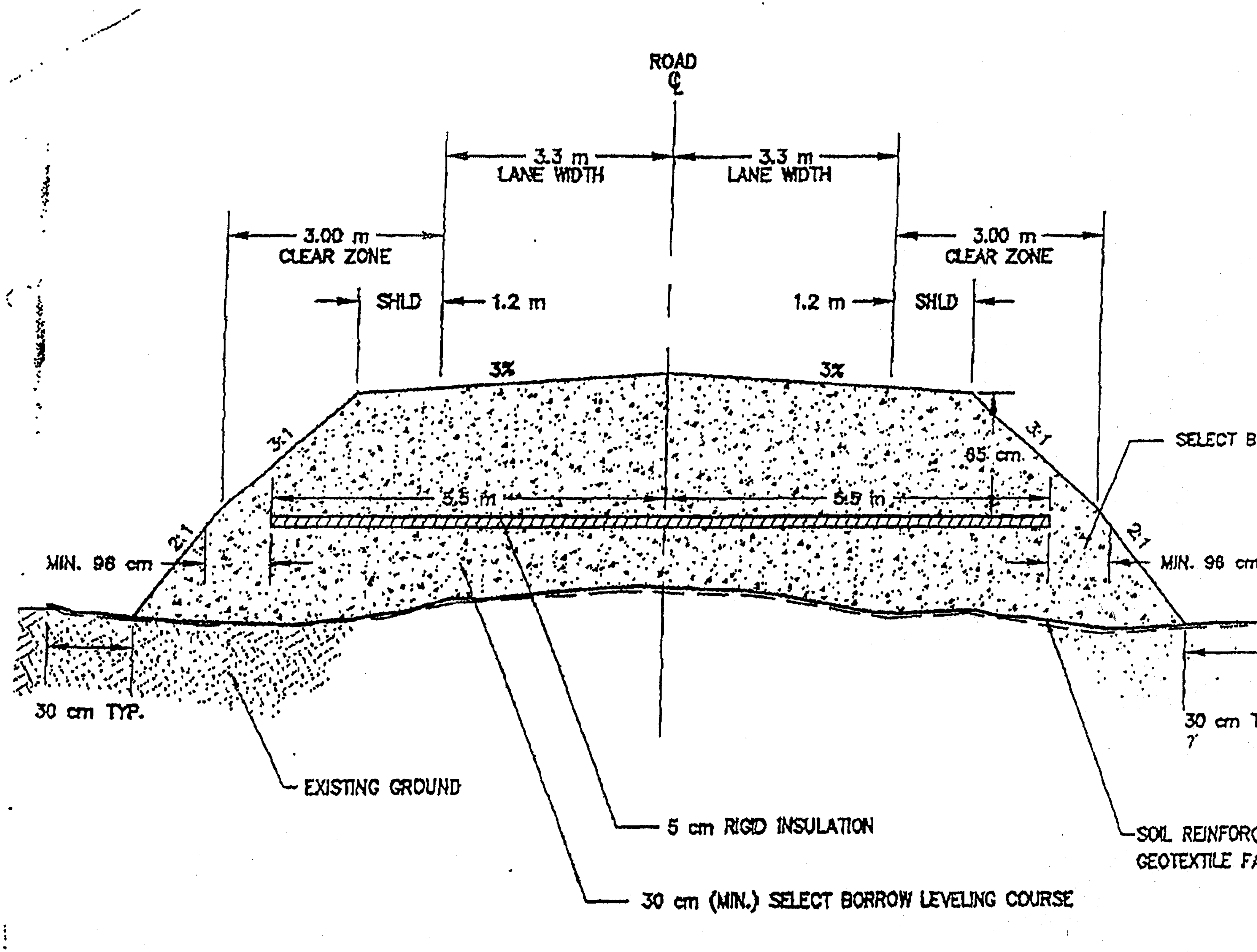
SECTION A–A CULVERT DETAIL

PURPOSE: Provide Safe Roadway Access to the Banks of the Colville River	CULVERT X-SECTION	PROPOSED ROADWAY CONSTRUCTION NUIQSUT, ALASKA
	FIGURE 5	
PROPERTY OWNER: Village of Nuiqsut Kuupik Corporation	AGENT: ASCG INC. 301 Arctic Slope Ave., Suite 200 Anchorage, Alaska 99518–3035	2681	MAY 1995


87 LINEAR METERS OF 3.05 m DIA STRUCTURAL STEEL CULVERT PIPE
STA 1+737
SKEW ANGLE = 27
ROW
INSTALL STRUCTU
STA 3+1
CULVERT STREAM CROSSING #1
TOP OF GRAVEL ROAD
SELECT BORROW
CULVERT #1 3.05 m DIA STRUCTURAL STEEL PLATE STEEL CULVERT PIPE
COMPACTED GRAVEL
EXCAVATE THAW-UNSTABLE SOIL AND REPLACE WITH COMPACTED GRAVEL 90% MAX DENSITY
0.75 m
0.61 m
3.70 m
1+650
1+700
1+750
1+800
CULVERT STREAM
TOP O
15 m RT
15 m LT
3+100
3+150
REVISION
DATE
DESCRIPTION
ASCG
INCORPORATED
DEPARTMEN
BUREAU
JUNEA



OF THE INTERIOR INDIAN AFFAIRS AREA OFFICE	NUIQSUT/COLVILLE RIVER ACCESS ROAD PLAN AND PROFILE CULVERT STREAM CROSSINGS	DESIGN BY: B.A. DRAWN BY: K.S.M APPROVED BY: C.S.M DATE: 10/17/95 SCALE: HOR. 1:100 VER. 1:20	SHEET NO. 15 15 OF 17



ASCG-ENGIN. TEL 2676395 Dec 15 11:45 No.005 P.02
ANCHORAGE, AK 1 907 345 3575 P.13

TONY KNOWLES, GOVERN

2 950364

DEPT. OF ENVIRONMENTAL CONSERVATION

DIVISION OF AIR AND WATER QUALITY
Major Facilities and Water Permits Section
410 Willoughby Avenue, Suite 105
Juneau, AK 99801-1795

Telephone: (907) 465-5276
Fax: (907) 465-5274
TTY: (907) 465-5133

NRO File: 950364

September 26, 1995

Mr. Boerger
ASCG, Inc.
301 Arctic Slope Avenue
Anchorage, AK 99518-3035

Certified Mail
Return Receipt Requested

Re: Certificate of Reasonable Assurance, Colville River 16

Dear Mr. Boerger:

In accordance with Section 401 of the Clean Water Act of 1977 and provisions of the Alaska Water Quality Standards, the Department of Environmental Conservation is issuing the enclosed Certificate of Reasonable Assurance for the proposed construction of approximately 3.8 miles of gravel access road to provide consistent boat access to the main channel of the Colville River, promote summer barge service to Nuiqsut, and provide an alternative winter route for supplies and bulky equipment.

Department of Environmental Conservation regulations provide that any person who disagrees with any portion of this decision may request an adjudicatory hearing in accordance with 18 AAC 15.200-310. The request should be hand-delivered or mailed to the Commissioner of the Department of Environmental Conservation, 410 Willoughby Avenue, Juneau, Alaska 99801-1795. Failure to file a statement of issues within 30 days of receipt of this letter shall constitute a waiver of your right to judicial review of this decision.

By copy of this letter we are advising the U.S. Army Corps of Engineers of our actions and enclosing a copy of the certificate for their use.

Sincerely,

David C Sturdevant

David C. Sturdevant
401 Certification Team Leader

Enclosure: Certificate of Reasonable Assurance

RECEIVED
OCT 0 3 1995
REGULATORY BRANCH
Alaska District Corps of Eng.

cc: USCOE/Anchorage
USFWS/Fairbanks
EPA/AOO
NMFS/Juneau
Village of Nuiqsut, c/o BIA, P.O. Box 25520, Juneau, AK 99802-5520

ADEC/Juneau
ADNR/Fairbanks
ADF&G/Fairbanks
ADEC/Fairbanks

/rg {K:\EQ\401\Batch3.pmt}

Appendix F

APPENDIX F

UNSOLICITED NATIVE CORPORATION PROPOSAL

Anchorage Office • 301 Arctic Slope Avenue • Suite 300 • Anchorage • Alaska • 99518-3035 • (907) 349-2369 • FAX (907) 349-5476 • 1-800-770-2772

arctic slope
regional corp.

→ RYAN LANCE

September 6, 1995

9/7

Mr. Ken Thompson
President
ARCO Alaska, Inc.
700 G Street
Anchorage, AK 99510-0360

Re: Colville River Delta Development

Dear Mr. Thompson:

The Arctic Slope Regional Corporation (ASRC) hereby transmits the attached proposal for development of the Colville River Delta. This proposal is unsolicited, but we believe that it provides a viable alternative to developing this economically challenged oil field.

In this proposal, ASRC will develop the more routine infrastructure and production facilities on a turnkey basis, while leaving the technical drilling and reservoir responsibilities to ARCO. ASRC brings two unique elements to this proposal that have considerable favorable impact on the project's rate of return. The first element is utilization of North Slope Borough tax exempt financing for certain aspects of the infrastructure. The second unique element is ASRC's corporate tax advantages resulting from its Net Operating Loss (NOL) settlement.

The goal of this proposal is to provide a "Win - Win" scenario for both ASRC and ARCO by increasing ARCO'S rate of return and by providing some value to ASRC for its NOL's. It also provides an opportunity for meaningful community and local government involvement. The net result would be a "Public - Private Partnership" for advancement of the oil industry on the North Slope of Alaska.

Thank you for your time in considering this proposal. We look forward to hearing from you further on the concepts presented today.

Respectfully Submitted,

ARCTIC SLOPE REGIONAL CORPORATION

Jacob Adams

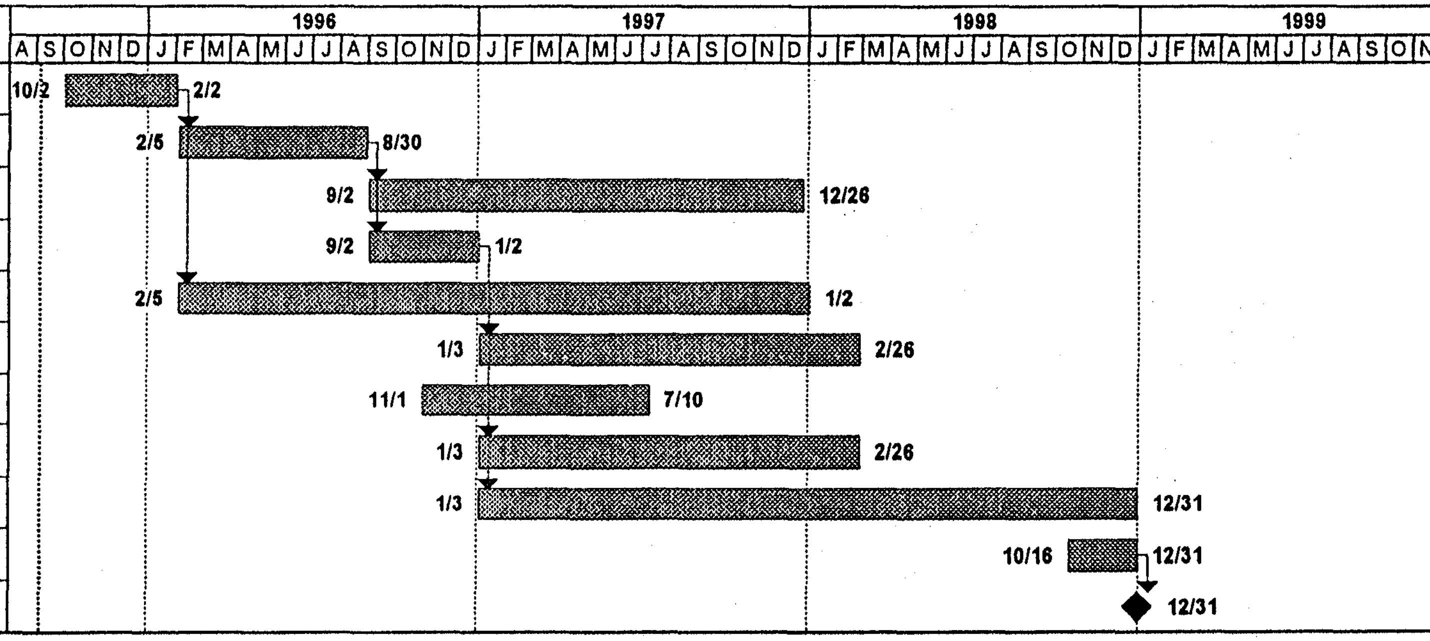
Jacob Adams
President & CEO

Corporate Headquarters • P.O. Box 129 • Barrow • Alaska • 99723-0129 • (907) 852-8533 or (907) 852-8633 • FAX (907) 852-5733

Table of Contents
ASRC Colville River Development Proposal

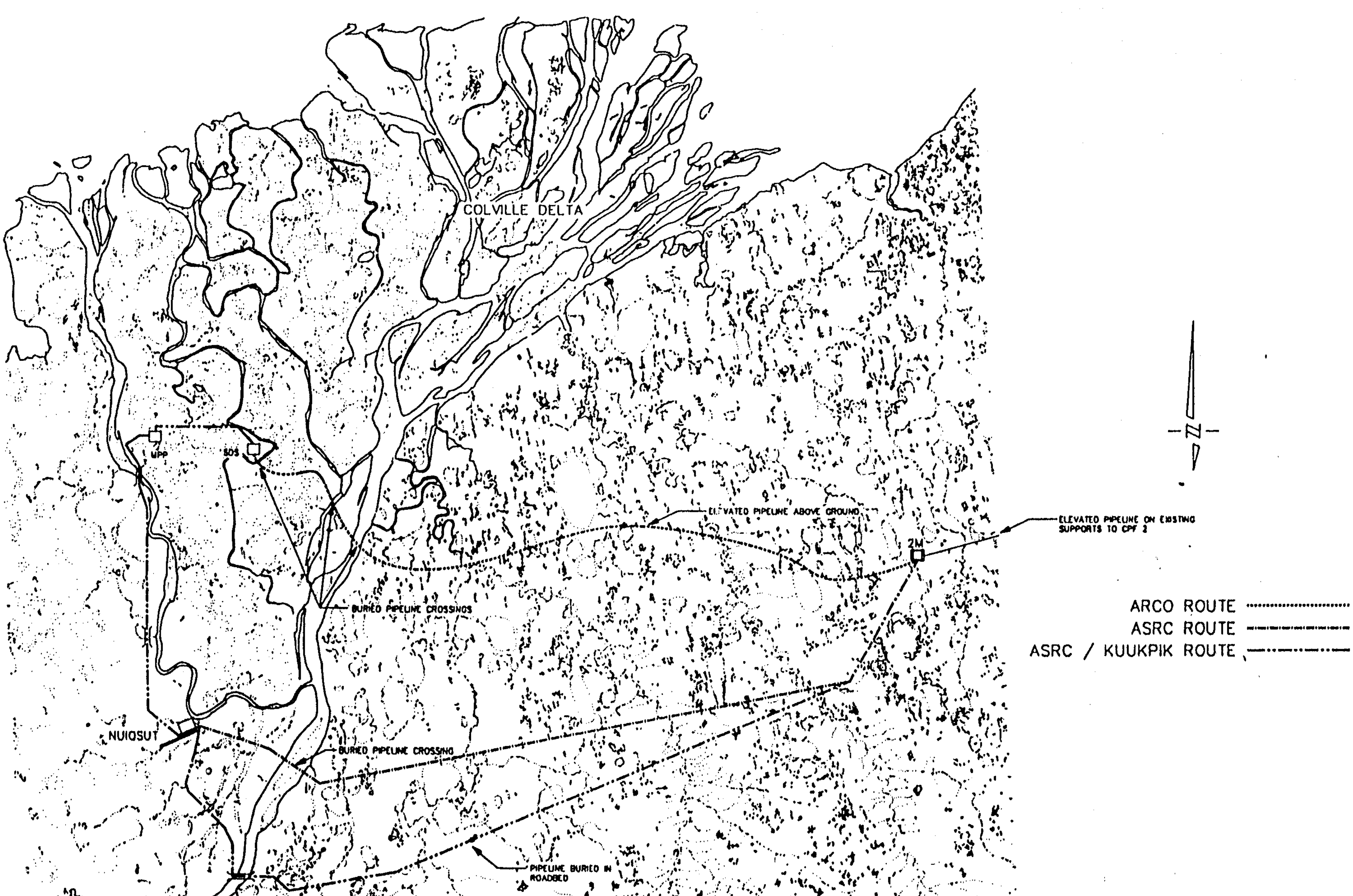
ASRC / Kuupik / ARCO Alaska
Colville River Development Project Schedule

ID	Task Name
1	Conceptual Engineering
2	Preliminary Engineering
3	Final Engineering
4	Funding
5	Permitting
6	Procurement - Long Lead Ite
7	Contracts
8	Module Fabrication
9	Construction - On Site
10	Start-Up & FCO
11	First Oil

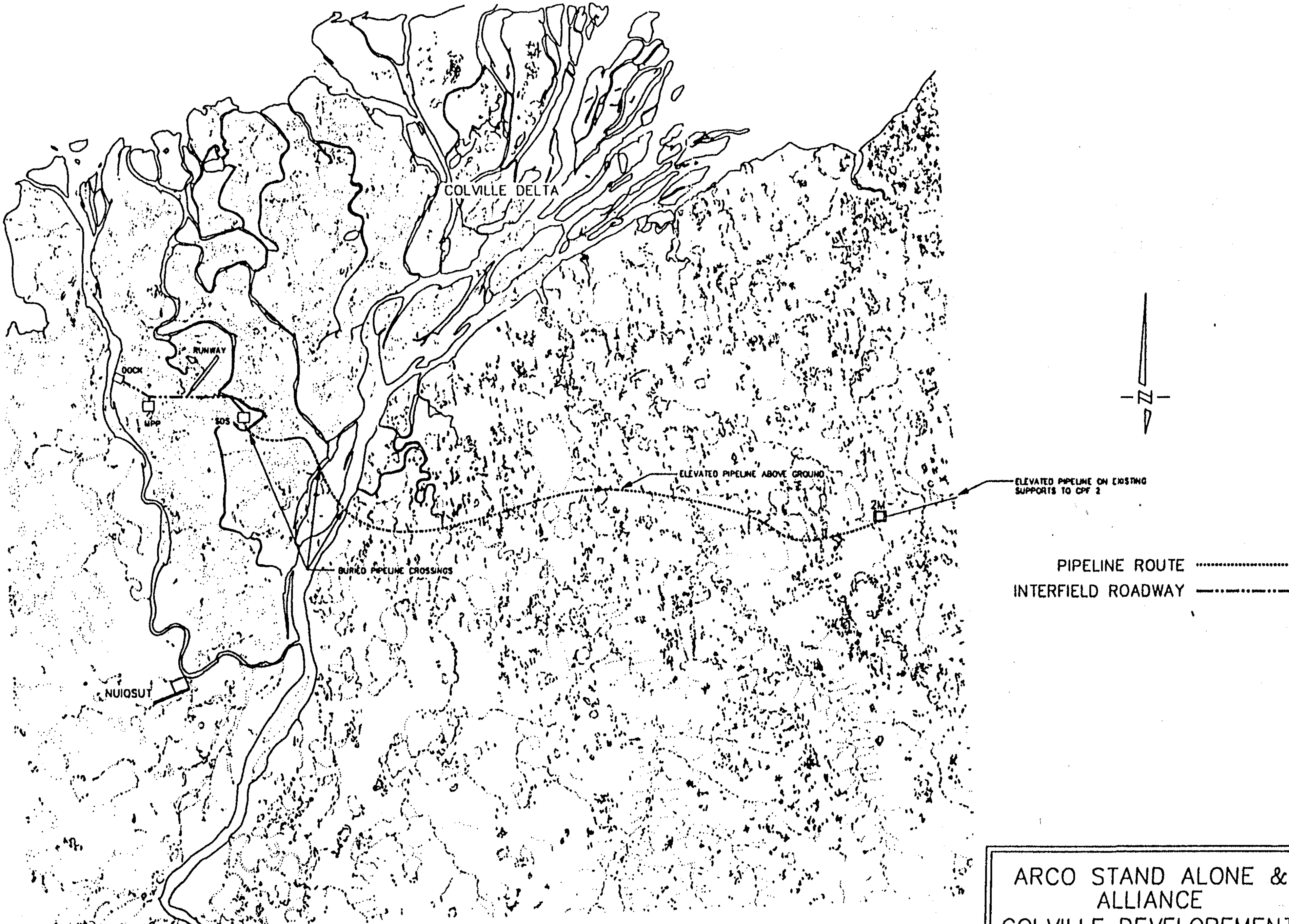


Project: Colville River Development
Date: 9/5/95

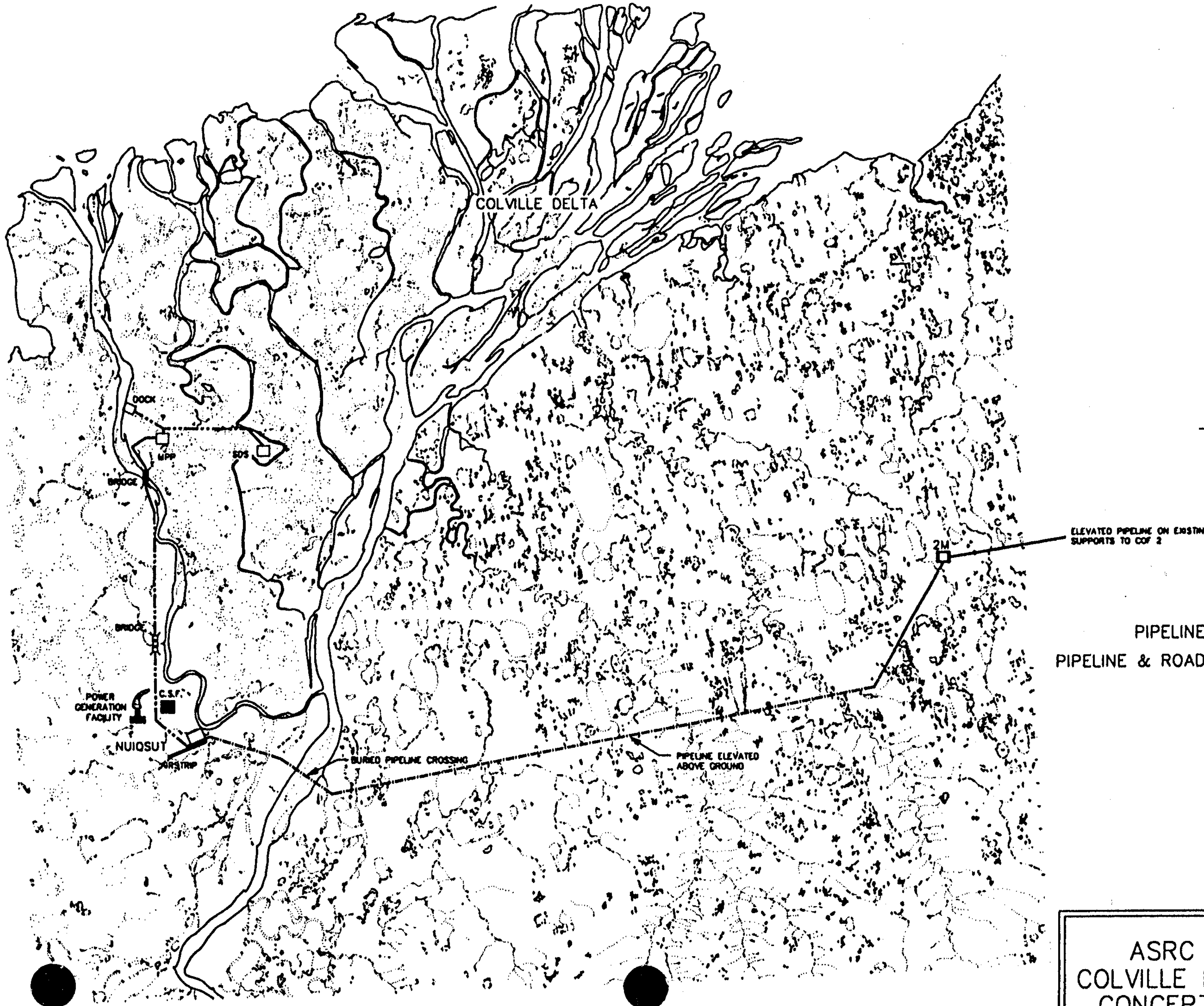
Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress



COLVILLE DEVELOPEMENT
ROUTE STUDY

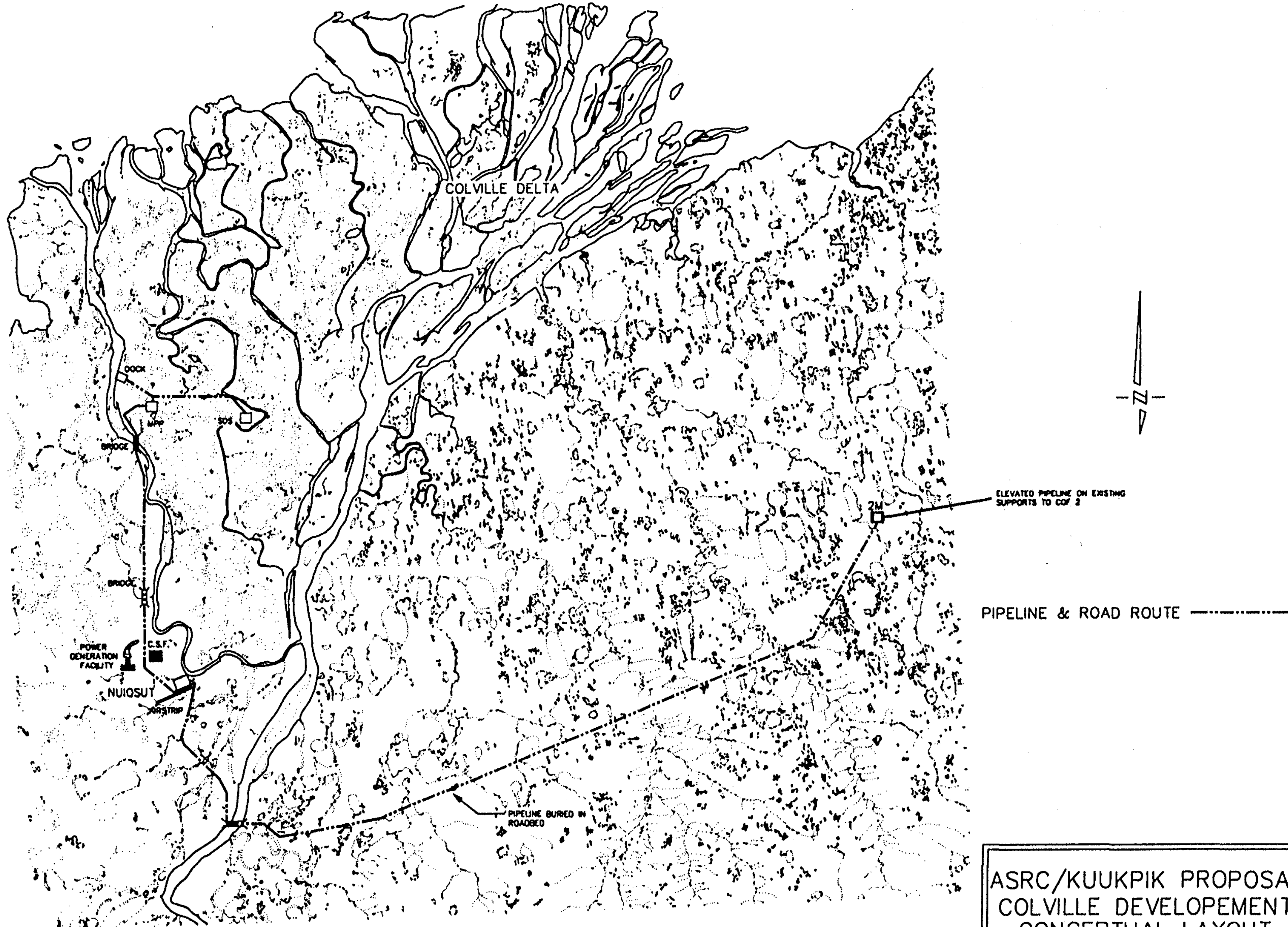


ARCO STAND ALONE &
ALLIANCE
COLVILLE DEVELOPEMENT

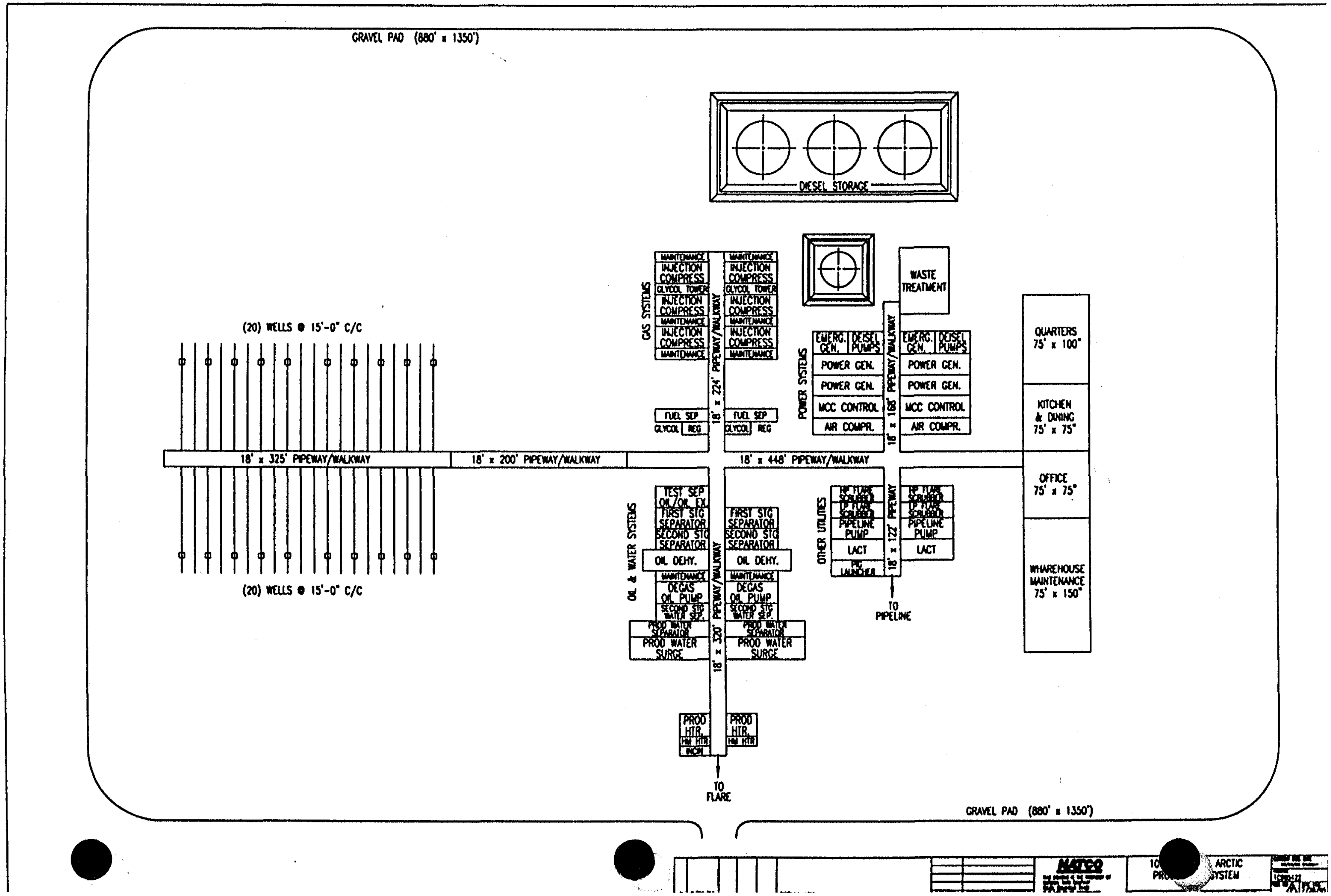


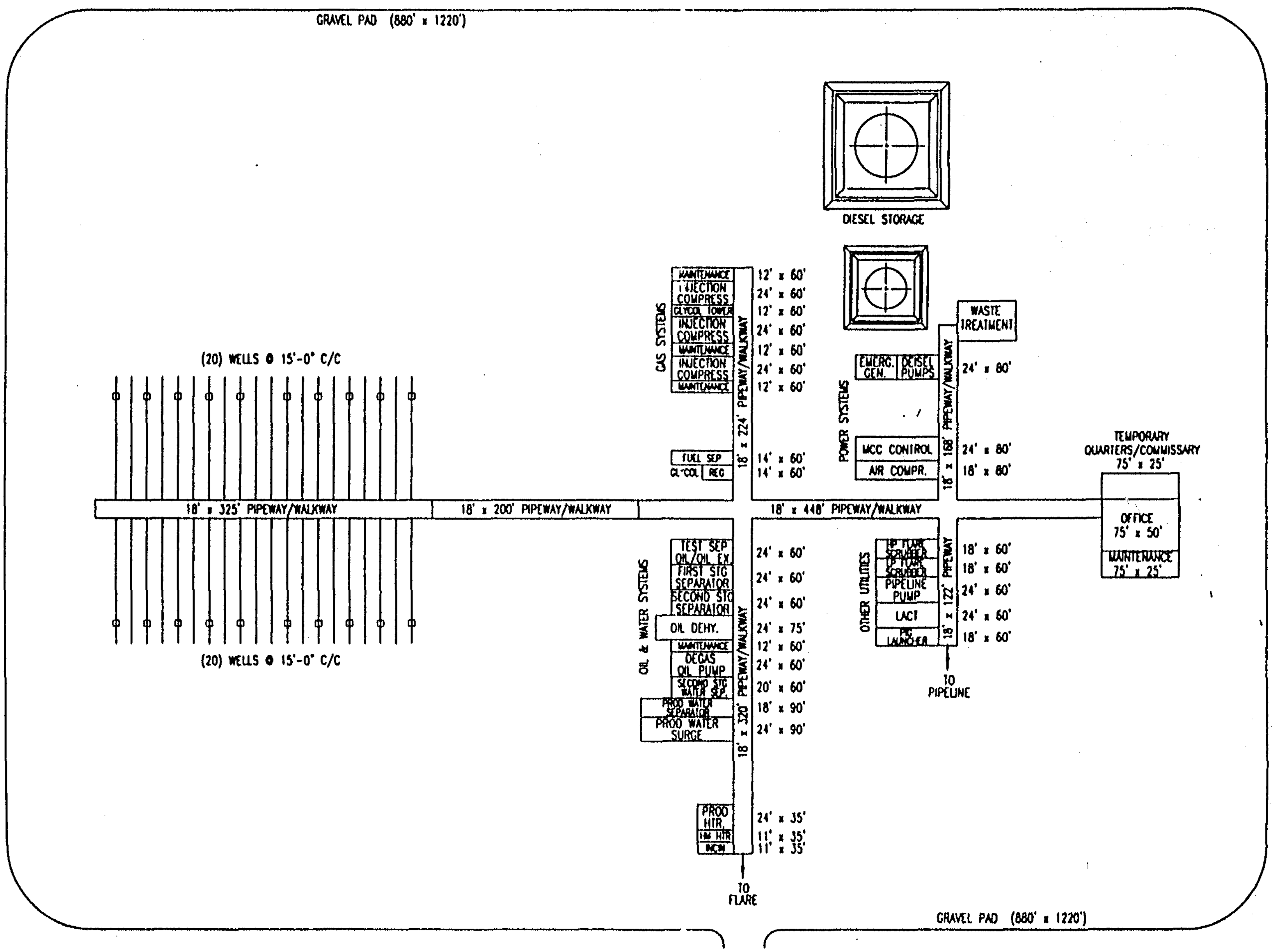
PIPELINE ROUTE
PIPELINE & ROAD ROUTE

ASRC PROPOSAL
COLVILLE DEVELOPEMENT
CONCEPTUAL LAYOUT



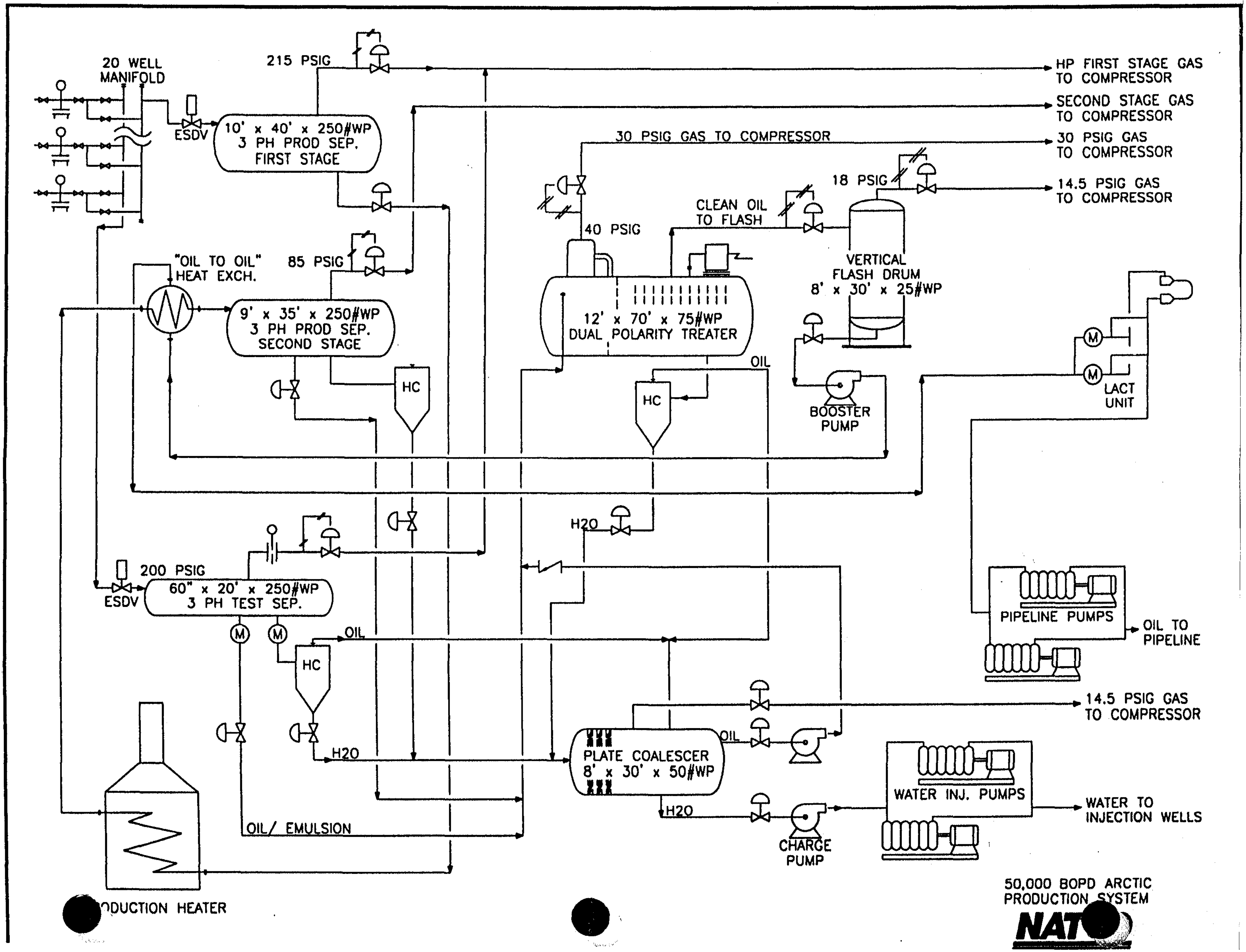
ASRC/KUUKPIK PROPOSAL
COLVILLE DEVELOPEMENT
CONCEPTUAL LAYOUT


GRAVEL PAD (880' x 1350')
DIESEL STORAGE
WASTE TREATMENT
GAS SYSTEMS
MAINTENANCE
INJECTION COMPRESS
GLYCOL TOWER
18' x 224' PIPEWAY/WALKWAY
FUEL SEP
GLYCOL
REG
POWER SYSTEMS
EMERG. GEN.
DEISEL PUMPS
POWER GEN.
MCC CONTROL
AIR COMPR.
18' x 168' PIPEWAY/WALKWAY
QUARTERS 75' x 100'
KITCHEN & DINING 75' x 75'
OFFICE 75' x 75'
WHAREHOUSE MAINTENANCE 75' x 150'
(20) WELLS @ 15'-0" C/C
18' x 325' PIPEWAY/WALKWAY
18' x 200' PIPEWAY/WALKWAY
18' x 448' PIPEWAY/WALKWAY
OIL & WATER SYSTEMS
TEST SEP OIL/OIL EX
FIRST STG SEPARATOR
SECOND STG SEPARATOR
OIL DEHY.
DEGAS OIL PUMP
SECOND STG WATER SEP.
PROD WATER SEPARATOR
PROD WATER SURGE
18' x 320' PIPEWAY/WALKWAY
PROD HTR.
HM HTR
INCIN
TO FLARE
OTHER UTILITIES
HP FLARE SCRUBBER
LP FLARE SCRUBBER
PIPELINE PUMP
LACT
PIG LAUNCHER
18' x 122' PIPEWAY
TO PIPELINE
(20) WELLS @ 15'-0" C/C
GRAVEL PAD (880' x 1350')
NATCO
ARCTIC
SYSTEM

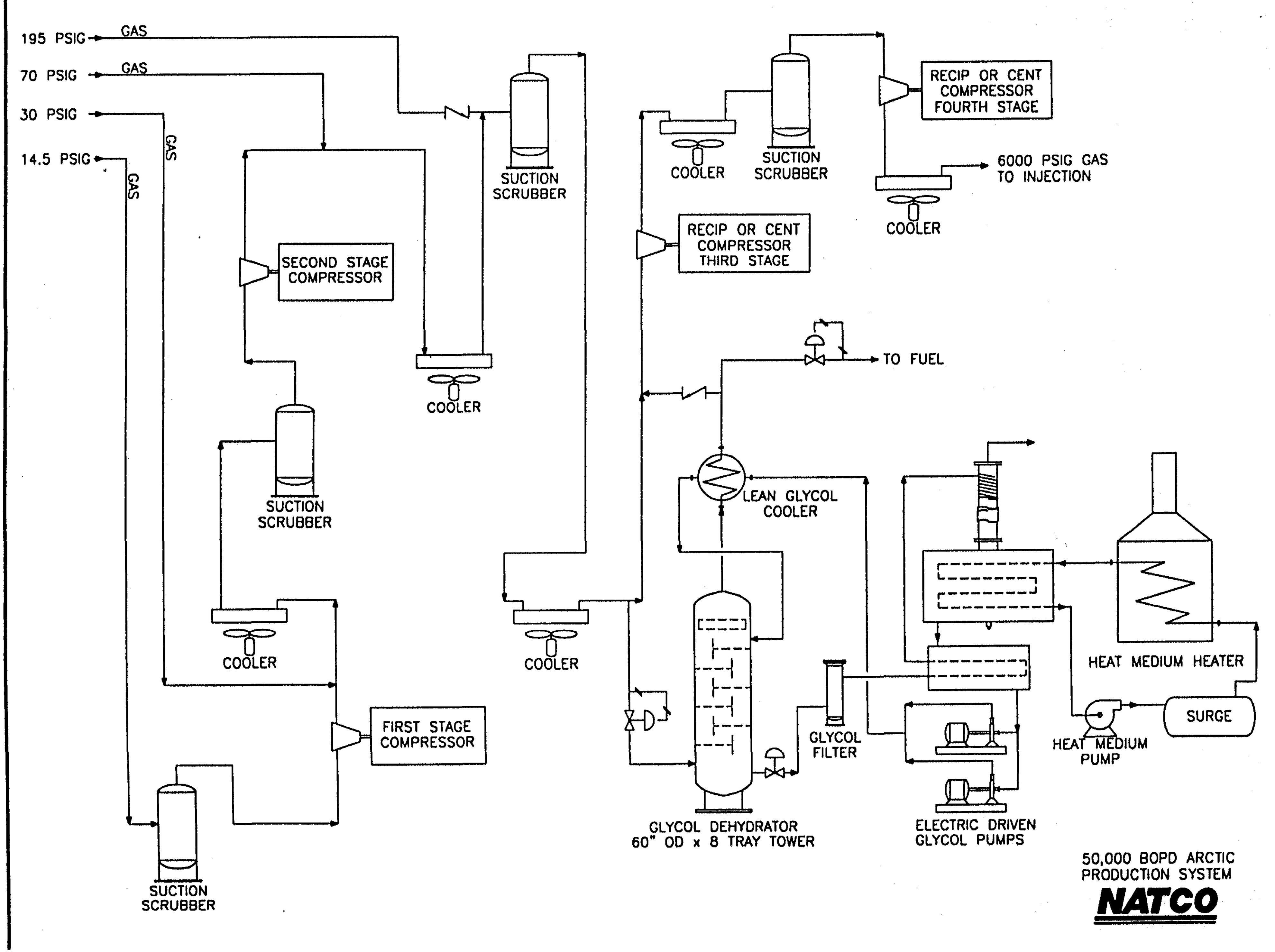


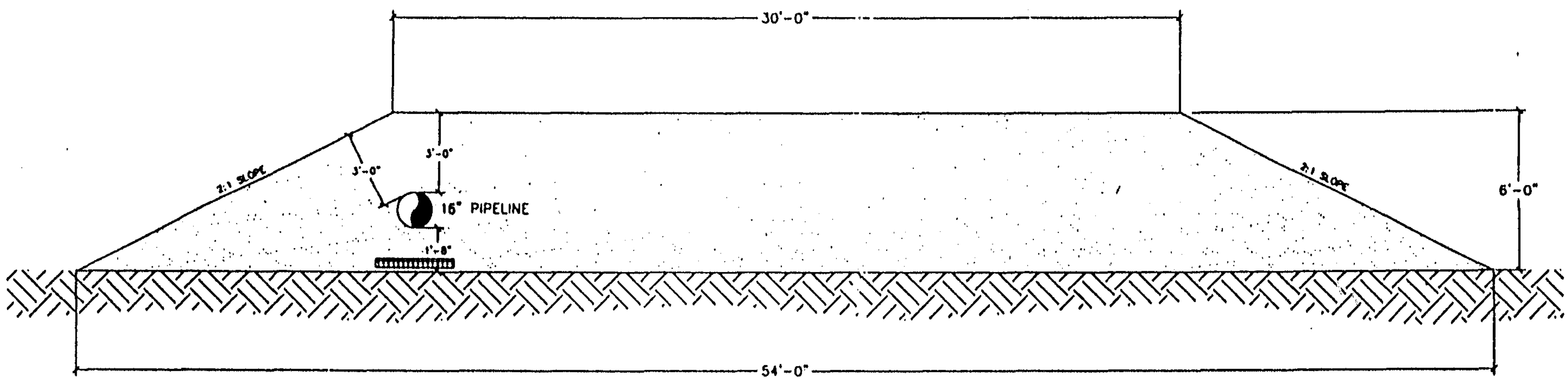
MATCO

FACILITIES LAYOUT
MPP FOR ASRC



50,000 BOPD ARCTIC
PRODUCTION SYSTEM


195 PSIG
GAS
70 PSIG
GAS
30 PSIG
GAS
14.5 PSIG
GAS
SUCTION SCRUBBER
SECOND STAGE COMPRESSOR
COOLER
SUCTION SCRUBBER
COOLER
FIRST STAGE COMPRESSOR
SUCTION SCRUBBER
COOLER
COOLER
SUCTION SCRUBBER
RECIP OR CENT COMPRESSOR FOURTH STAGE
6000 PSIG GAS TO INJECTION
COOLER
RECIP OR CENT COMPRESSOR THIRD STAGE
TO FUEL
LEAN GLYCOL COOLER
HEAT MEDIUM HEATER
SURGE
HEAT MEDIUM PUMP
GLYCOL FILTER
GLYCOL DEHYDRATOR
60" OD x 8 TRAY TOWER
ELECTRIC DRIVEN GLYCOL PUMPS
50,000 BOPD ARCTIC PRODUCTION SYSTEM
NATCO



PIPELINE IN ROAD
CROSS-SECTION
TYPICAL

ASRC/KUUKPIK PROPOSAL
COLVILLE DE OPEMENT
CONCEPTUA LAYOUT

Section 5.) Estimate Basis

This section defines the basis that the estimates contained in this proposal were derived from . The subsequent paragraphs provide a basis for each of major line items on the summary sheet .
These are ;

- **Processing Facilities**
- **Satellite Drill Site**
- **Roadways and Pads**
- **Pipelines**
- **Bridges**
- **Dock**
- **Runway**
- **Electrical System**
- **Construction Camp and Module Transport**
- **Permits**
- **Engineering and Project Management**

Processing Facilities

The processing facilities will be located on the Main Processing Pad (MPP) . The layout of the facilities in each of the four separate proposals is contained in Section 4. The facilities are based on the following

- 30 degree API crude
- 1000 GOR
- The produced fluid ranges for MPP are 50,000 BOPD , 20,000 BWPD and 50 MM SCFD . This is based on the combining both drill sites produced fluid ranges .
- The field will have gas injection at 25 MM SCFD
- Will have water injection at 25,000 BWPD , The water required for water injection is from a Water Source well at the MPP .

Satellite Drill Site

The satellite drill site will be located as shown in the conceptual drawings section of the proposal . The site will consist of a Manifold Module , Test Separator Module , E & I Module(w/ switchgear) , Pig Launcher and Receiver and Pad Piping / Electrical to the wells . We estimate ten wells at this drill site to produce the quantities of fluids of 10,000 BOPD . The drill site layout will be similar to existing North Slope layouts for individual well lines . The well lines are 4" for the P.O. lines and 2" for the G.L. lines .

Roadways and Pads

The roadways and pads vary by proposal . The table below shows which roads and pads are contained in which proposals .

Roadway or Pad	ARCO Stand Alone	Alliance Approach	ASRC Proposal	ASRC/Kuupik Proposal
Main Processing Pad	Yes	Yes	Yes	Yes
Satellite Drill Site	Yes	Yes	Yes	Yes
Interfield Roadway	Yes	Yes	Yes	Yes
Road from MPP to Nuiqsut	No	No	Yes	Yes
Road from Nuiqsut to 2M	No	No	No	Yes

The estimate for each roadway and pad are as follows ;

Main Processing Pad	880' x 1350' x 5' Thick	Approx. 275,000 c.y.
Satellite Drill Site	600' x 400' x 5' Thick	Approx. 56,000 c.y.
Interfield Roadway	45' w. x 5' Thick x 3.5 Miles	Approx. 192,500 c.y.
Road from MPP to Nuiqsut	30' w. x 5' Thick x 9.2 Miles	Approx. 340,000 c.y.
Road from Nuiqsut to 2M	30' w. x 5' Thick x 23 Miles	Approx. 850,000 c.y.

The only change between proposals is the size of the Main Processing Pad . With the ASRC and ASRC/Kuupik proposal the size of the pad can be reduced by approximately 16 % due to no camp , reduced warehouse and support facilities .

The gravel mine sites are assumed to be State and have normal state royalty payments for the gravel . In addition the mine sites are within 6 miles of each respective portion of the work .

Pipelines

The pipelines vary by proposal and the table below illustrates the differences in each respective proposal with the ARCO Stand Alone and the Alliance approach being the same for the Sales Oil Line ;

Proposal	Overall Length (Miles)	Length Insul. (AG)	Length Bare (BG)	# of River X-ings	Length of New VSMs	Length of Exst. VSMs
ARCO Stand Alone	28.0	27.5	.5	3	23.0	5.0
ASRC Proposal	35.0	34.0	1.0	1	30.0	5.0
ASRC/Kuupik	44.0	5.0	39.0	0	0.0	5.0

The Sales Oil Pipeline is estimated at 16" diameter , .375" w.t. and X65 grade pipe and a 600 # system .

The major differences are ;

- There are three different routes , these are shown in Section 4.
- The ASRC/Kuupik is buried in the Roadbed , see cross section in Section 4.
- The ARCO Stand Alone is based on 20 ft.-lbs @ -50 deg.
- All others are based on 20 ft. - lbs. @ -30 deg.

The Interfield Pipeline System transports the produced fluids from the SDS to the MPP and gas lift and water injection from MPP to SDS . These pipelines are aboveground , insulated and on VSMs . The estimated length of these pipelines are 3.5 miles . The diameters , wall thickness and grades are shown in the table below

Pipeline	Diameter	Wall Thickness	Grade	# Rating
Produced Fluids	18"	.312"	X65	300 #
Gas Lift	6"	.500"	X65	1500 #
Water Injection	10"	.594"	X65	1500 #

Another aspect of the pipeline costs is the 15KV cable from the MPP to the SDS . We estimated this as a shielded aboveground cable carried on a messenger wire on the VSMs of the Interfield pipeline system.

For the ASRC and the ASRC/Kuupik Proposals there is a 3" gas line from the MPP to Nuiqsut . This will be used to transport gas from the MPP to the Electrical Generation Facility located in Nuiqsut . The line is estimated to be 9.2 miles long with a 3" diameter and .250" wall thickness . This line will be buried in the roadway and not supported on VSMs . The construction method used for this line is coil tubing .

Bridges

In the ARCO Stand Alone and the Alliance Approach proposals there are no bridges required . In the other two proposals there will be up to two bridges (ASRC) and three bridges(ASRC/Kup) required respectively . The bridges will span the Nechelik Channel , a small channel north of Nuiqsut and the Colville River . All of the bridges will be of the same type of design as used for the new Endicott Breach . The table below shows the Crossing , overall length of span , span between piers and the number of piers .

Crossing	Overall Length	Span Between Piers	# of Piers
Nechelik Channel	1,100 ft.	275 ft.	3
Small Channel	200 ft.	NA	0
Colville River	2,200 ft.	275 ft.	6

The bridges are based on boxed girder design and have pipeline supports to carry the sales oil and the gas line to Nuiqsut . The bridges are 16' wide with a capacity of 100 Ton . The bridge designs and costs are based on primarily input from PN& D .

Dock

Included in the estimates of the ARCO Stand Alone , Alliance Approach and the ASRC Proposal is a requirement for a dock for offloading of the modules and the annual resupply of the facility . The dock is located in the Nechelik Channel by the MPP . It is a sheet pile dock with a bulkhead into the channel . Included is a short road (1/2 mile) that will connect the dock to the Interfield roadway system . There are no dredging costs included in this proposal for the subsequent landings .

Runway

Included in the ARCO Stand Alone and the Alliance Approach estimates is a Herc capacity runway . This runway is estimated to be fully instrumented and be 100' wide by 5' thick by 1.25 miles long . Included in the runway is a short road from the Interfield roadway system and the necessary electrical for instrumentation and lighting . The ASRC and the ASRC/Kuupik proposals do not include any provisions for a runway because those proposals utilize the Nuiqsut Airstrip which has Herc. capacity .

Electrical System

The portion of the respective estimates include the power generation facility , required switchgear & MCCs and a 15 KV transmission line to MPP from Nuiqsut . In the ARCO Stand Alone and the Alliance Approach estimates the power plant is at the MPP . For the ASRC and the ASRC/Kuupik Proposals the power plant is in Nuiqsut . In all alternates the capacity is 20 MW supplied by two 10MW Solar Gas turbines and a 5 MW back-up generator . The transmission line is 15 KV and is 9 miles in length .

Camp

This section includes the Construction Camp , Module Transport and Catering . The Construction Camp is a 300 person facility that will be temporarily installed in Nuiqsut . The Module Transport will be either by road (truckable modules) and / or barge (via Hayes River , Canada) .

KUUKPIK
CORPORATION

P.O. Box
Nuiqsut, Alaska 99789-
TEL: (907) 480-
FAX: (907) 480-

September 8, 1995

FAX 255-6339

Mr. Robert P. Strode
Vice President
Exploration and Land
ARCO Alaska, Inc.
P.O. Box 100360
Anchorage, AK 99510-0360

Mr. Frank Brown
Senior Vice President
Kuparuk and Cook Inlet Business Units
ARCO Alaska, Inc.
P.O. Box 100360
Anchorage, AK 99510-0360

Re: Kuukpik Corporation/Colville Delta

Dear Mr. Strode and Mr. Brown:

On July 25, Kuukpik Corporation proposed a concept for a package deal to resolve consent rights in NPR-A, lower ARCO's financing costs, satisfy environmental concerns and expedite permitting. For ease of reference, we call that approach the "western initiative." As we have since discussed the concept with ARCO, ASRC and the North Slope Borough, we have incorporated comments and made modifications to meet concerns raised by the different parties involved.

We believe that Kuukpik's concept or some variant of it continues to offer the best prospect for resolving the differences between the parties. I am writing to explain the modifications made since the concept was originally proposed, to clarify some possible misunderstandings and to discuss how these ideas relate to the surface use and financial negotiations.

ARCO's current development scenario includes three river crossings, siting of a central processing/drill pad in the highly sensitive nesting areas at Nanuk Lake and no road to Kuparuk. Kuukpik proposes a less environmentally sensitive NPR-A site for the central processing facility and possibly the associated drill pad, two river crossings instead of three, a road to Kuparuk, and Borough financing of roads and other facilities.

Kuukpik made its proposal at a very general level because we did not have cost figures for what we were suggesting. We anticipated that our approach would create both cost savings and added expenses which would have to be set off against each other. We expected that together ARCO and Kuukpik could massage the idea to maximize the savings and minimize the added expenses before taking the cost figures to the North Slope Borough to see what the Borough felt it could finance. There have been some informal discussions at the engineering level with ARCO about less costly alternatives.

ARCO's letters of August 10 focus on the original presentation, but they do not address the cost savings of any of the subsequent modifications or make any attempt to narrow or explain the basis of the cost gap that ARCO perceives. In fact, Kuukpik has already identified 60 to 70 million dollars in cost savings, based on ARCO's own cost estimates, over the original plan. Obviously, ARCO's cost figures suggest that there remains a substantial gap that would have to be eliminated before Kuukpik's proposal would be in the same cost range as ARCO's current facilities scenario. We think it makes sense for the parties to explore the options further, and we would like to ensure that the parties seek further cost savings rather than passively throwing up our hands, concluding that the cost gap cannot be solved and concluding that only drilling in NPR-A will solve the problem. Our initial sense from the August 10 letters had been that perhaps that was precisely what ARCO was doing. We have been reassured by our discussions with Bob Strode that that is not ARCO's intent. We hope to discuss these options and ways of further reducing the costs on an ongoing basis as ARCO refines its plans and cost estimates.

Kuukpik's approach can make financial sense either through increasing the amount of known reserves to fund the development or by identifying cost savings or by a combination of both approaches. The August 10 ARCO letters focus almost exclusively on increasing reserves. Obviously, everyone would like to see that happen, but that is only one side of the equation. We need to look at the Chevrolet approach and the minimum possible costs of Kuukpik's idea, rather than the Cadillac approach that is the focus of the cost figures in the August 10 letters. It now appears that we inferred too much into the August 10 letters in our initial reading of them, but we had read them to suggest that Kuukpik could only have a road if it allowed drilling this winter and additional reserves were found. It would not be a positive or constructive approach to emphasize the maximum possible cost of what Kuukpik wants, then to assert, as we had read Mr. Landt's letter to suggest, that Kuukpik could only get what it wants if it agreed immediately to what ARCO wants. We are committed to pushing forward on the necessary consent negotiations, but we also want to ensure that our discussions use realistic cost figures for only those improvements that are truly necessary.

Kuukpik wants to reach agreement on access to NPR-A, and, provided that an acceptable package of terms can be reached, Kuukpik would like to see that agreement reached sooner rather than later. We have recently made a new proposal to ASRC on what we feel is an equitable sharing of the royalty and other compensation to the subsurface owner. The Land Use Stipulations attached to Mr. Landt's letter of August 10 are a step in the right direction, and we hope to have a detailed response back to ARCO on those Stipulations shortly. We have a new proposal forthcoming shortly to ARCO on consideration for the surface use agreement. We have many questions and a number of concerns about the proposal that ASRC made to ARCO on September 6. Those questions and concerns need to be explored and, if possible, laid to rest. We need to move forward in all of these areas, including discussions with the North Slope Borough on how the Borough can facilitate an agreement and development.

We also need to move forward on a realistic assessment of the costs and benefits of Kuukpik's proposal. Kuukpik knows from its discussions with ARCO that ARCO's cost figures do not include all of the potential cost savings. Kuukpik had told ARCO personnel in late July that Kuukpik did not need a year round crossing of the Colville River on a road to Kuparuk. Mark Landt has indicated that a year round bridge would cost 60 to 70 million dollars. Having said that, he also stated that the true cost of Kuukpik's idea was more like 130 million dollars. There is a big difference between 100 million dollars and 130 million dollars, and we need to be more precise than these figures suggest if we are going to reach agreement on acceptable terms.

There are substantial cost savings which still need to be factored into our discussions and calculations. Kuukpik is agreeable to and has discussed with ARCO's engineers the idea of an ice road crossing of the Colville during the winter and a ferry crossing during the summer. This would allow ARCO, its contractors, and Nuiqsut residents access for probably eleven months of the year. This would save the 60 to 70 million dollars that ARCO suggests a year round crossing would cost. Such access should result in reduced down time for ARCO facilities, which would increase revenues and profits. Jacob Adams, who is on the Borough Assembly, and Mayor Ahmaogak have both suggested that the Borough might issue a package of revenue bonds <u>and</u> general obligation bonds for improvements as part of a Colville development. ARCO obviously has not included any cost savings for this in its figures, but they would have to be included to get a true picture of the cost of Kuukpik's approach.

Mark Landt indicated that ARCO had not calculated any cost savings for the difference between ARCO's cost of funds and the Borough's. He suspected that the savings might be half a percent at most. Officials at the Borough have said to Kuukpik that it was likely to be a percent and a half. Since ARCO did not know as of the time of our discussions with Mr. Landt even roughly how much funding the Borough is willing to supply, ARCO obviously cannot have calculated any cost savings at even the half percent savings rate that Mr. Landt assumed. As far as Kuukpik is aware, ARCO has not approached the Borough with a breakdown of its cost projections for the different parts of the development, nor has ARCO given that information to Kuukpik so that Kuukpik could approach the Borough.

The BIA has approved funding for a road between Nuiqsut and the Colville River. That three to four miles of road would be incorporated into the Kuparuk road and would cost ARCO and the Borough nothing. We have seen nothing to indicate that ARCO has factored that cost saving into its estimates. No one has yet approached the legislators or the State of Alaska to see whether State or federal road funds could be used in part to finance a road. With backing from the Borough and ARCO and presented as an access road to the village, such funds might be available. The potential problems with public access to traditional hunting grounds might foreclose this funding option, but at least it ought to be explored.

A road would benefit ARCO as well as Nuiqsut, and ARCO should include that value in its calculations. A road would increase ARCO's blowout contingency and drilling options. Weather conditions prevent helicopter and planes from flying probably 30 percent of any year on the North Slope. ARCO has suggested that the responsible agencies will allow a pipeline and drill sites with air access only and will not insist on a road. Perhaps so, but a road offers ARCO better options on spill response, an easier and faster oil spill contingency permitting process and also means that ARCO is not limited to air-transportable rigs. Road access would reduce ARCO's transportation costs, allow it to effect repairs more speedily and reduce down time and speed up the construction process, allowing the facilities to come on line sooner.

Kuukpik is not requesting a road from NPR-A across the Nechelik Channel to Nanuk Lake. We have no indication as to whether ARCO included the cost of a bridge there in its estimates, though it seems likely since such a bridge was assumed in the original presentation. Kuukpik understands from Mark Landt and other ARCO personnel that all of ARCO's road cost figures are based on hauling gravel all of the way from Kuparuk. Kuukpik believes that the gravel from the ASRC/Kuukpik gravel site on the east bank of the Colville could be made available. The savings in transportation costs would apply to pads for drill sites, a central processing facility, bunkhouses and other improvements. All of these savings add up, but it appears that they are not included in ARCO's cost estimates.

Other options need to be explored to see what costs savings may be realized through them. If there is fieldwork evaluating possible gravel sources elsewhere in the Delta, including NPR-A, this summer, we should discuss the results to see what options that field work may present. Kuukpik has knowledge of the area that ARCO does not have. Rather than ARCO simply reaching conclusions based on limited information, we need to discuss options and opportunities.

ARCO has suggested that a road would increase its permitting costs because an EIS would definitely then be required. Kuukpik believes that an EIS will be required in any event, so the road would make no difference. ARCO has asserted that it will do all of the research and studies for an EA that it would do for an EIS. There is no additional cost there. There is a substantial cost savings in the process, however, if Kuukpik, the Native Village of Nuiqsut, the City of Nuiqsut, ASRC, and the North Slope Borough all come out strongly in favor of the development. The Joint Resolution affirms that the Native Village and the City of Nuiqsut are in agreement with Kuukpik's approach. Through an agreement with Kuukpik, ARCO can have all of the local entities on board and supporting its plans. There is an enormous potential cost difference between a controversial EIS and one in which outside environmental groups, if any, were the only objecting parties. Kuukpik believes that ARCO has missed cost savings in its estimates that would result from an overall agreement along the lines proposed by Kuukpik.

In addition, the Kuukpik approach would move the greater part of the development from Nanuk Lake to the environmentally less sensitive lands to the west in NPR-A. Even if the drill pad had to remain at Nanuk Lake, an unmanned drill pad is much less intrusive once in place than a CPF with its 24-hour per day manned activity and associated housing and other facilities. This would simplify and speed up the permitting process.

There are other benefits to ARCO and cost savings from Kuukpik's idea. With a road between Nuiqsut and the CPF, there might not need to be any housing at the CPF, further reducing the footprint of the facility, the ongoing human activity level and its environmental intrusiveness. Local hire workers and perhaps even ARCO's own staff could commute from Nuiqsut, reducing the housing needs and thus ARCO's housing costs.

The North Slope Borough has committed to fund construction of sewer and water service for Nuiqsut. By locating housing in Nuiqsut, ARCO would virtually eliminate the need for costly water and sewage disposal improvements in the development. The Borough has already committed to fund an upgrade of the Nuiqsut power plant. Enlarging the power plant at the same time to supply the power needs of ARCO's development would mean that ARCO would pay far less than the cost of developing its own, stand alone power system.

The need for a separate airstrip would be eliminated, saving both the cost of construction and eliminating that activity altogether from the sensitive nesting areas in the Delta. The airstrip in Nuiqsut is already in place. As with movement of the CPF/support facilities to the higher, dryer and less sensitive lands in NPR-A, eliminating an airstrip in the nesting areas in the Delta would simplify an EA or an EIS and speed the agency review process. Any necessary improvements to that airstrip would be obvious candidates for Borough or other public funding. No one has yet approached the State as a possible source of funds, though the State, too, is a player and a direct beneficiary through royalties and taxes of any development in the Colville. We believe that ARCO should also include in its calculations the benefits to it of a road and the availability of Nuiqsut services for not only this development, but also for a possible Fiord development and for any future developments in this area and to the west. From our discussions with ARCO, it does not appear that ARCO has allowed any cost savings for these opportunities.

Kuukpik believes that ARCO has substantially underestimated the cost savings to ARCO that would result from Kuukpik's approach. In addition to direct cost savings, Kuukpik's approach gets the parties closer to an agreement. To the extent that Kuukpik's route creates value for Kuukpik in the form of increased commercial value for its land holdings at the Nuiqsut airport, in improved contracting opportunities or in other forms, Kuukpik needs a lesser package of consideration in the form of direct payments. By the same token, our concerns about land trades and development of traditional hunting lands to the west would be lessened to some extent by a reduced cost of living from better access and increased economic development in Nuiqsut. All of these questions and dealings between the parties are inseparable, which is why an overall, package deal is so appealing.

While Kuukpik believes that ARCO's cost estimates grossly overstate the cost of Kuukpik's alternative, we recognize that even seeking all possible cost savings may not equalize costs between Kuukpik's approach and the alternative currently most favored by ARCO. We are evaluating our positions in that light.

Mr. Robert P. Strode
Mr. Frank Brown
September 8, 1995
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Kuukpik remains firmly committed to the concept of risk sharing. If ARCO's confirmed reserves increase, its revenues and profits increase. With more reserves and more development and production activity, the impact on Kuukpik lands, subsistence resources and Kuukpik shareholders increases proportionately. With that in mind, we are preparing and expect to have to ARCO within a week or so a proposal structured much along the lines of ARCO's Commitment Letter of March 3, 1995 but focusing more on risk sharing and the proportionate impact on Kuukpik of various possible levels of development. That proposal will be accompanied by a separate cover letter and explanation.

In closing, I hope that ARCO will re-examine its cost figures and work closely with us on trying to reduce costs. I look forward to hearing back from ARCO. I fully recognize that ARCO's expertise and greater knowledge of both the subsurface and the construction costs and construction requirements of any development may require further modifications in our proposal. I would ask that ARCO share its expertise and knowledge as far as possible, so that we can discuss alternatives and seek solutions rather than simply state positions.

Sincerely

KUUKPIK CORPORATION

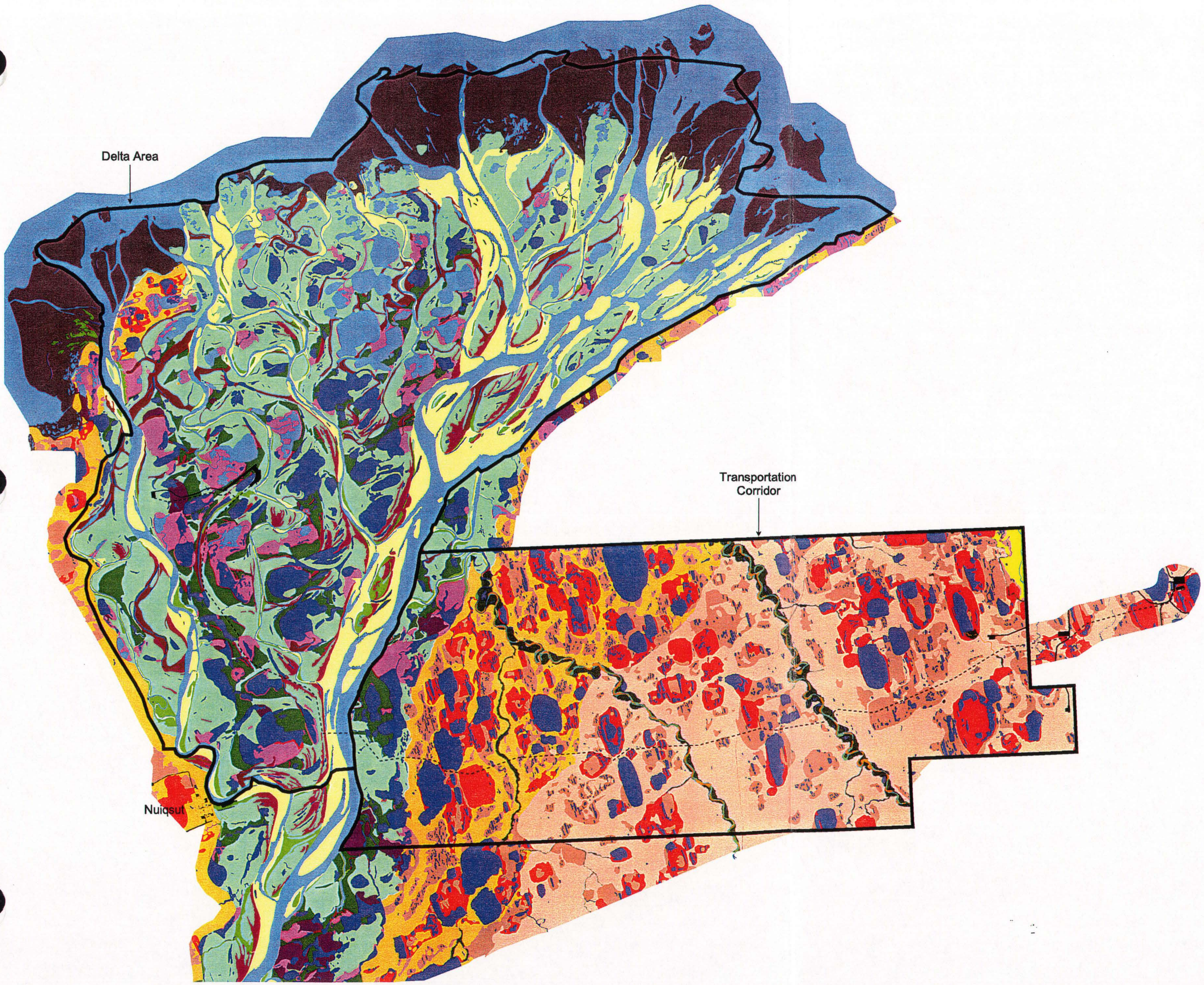
By for [signature]
Joe Nukapigak
President

cc: Mr. J. K. Thompson

Appendix G

APPENDIX G

TERRAIN UNITS



Source: Photo-interpretation of terrain units based on 1992 CIR photography (Jorgenson et al. 1996). Map registered to SPOT image base map. Projection: UTM Zone 5, Datum NAD 27

ABR File: Terrain_Unit_rf.apr

N

SCALE IN MILES

0 1 2 4

Terrain Units

- Eolian Sand Dunes
- Delta, Riverbed/Riverbars
- Delta, High-water Channel
- Delta, Active-floodplain Cover Deposit
- Delta, Inactive-floodplain Cover Deposit
- Delta, Abandoned-floodplain Cover Deposit
- Floodplain, Riverbed Deposit
- Floodplain, Active-floodplain Cover Deposit
- Floodplain, Inactive-floodplain Cover Deposit
- Alluvial Terrace
- Alluvial-Marine Terrace
- Alluvial Plain Deposit
- Thaw Basin, Ice-poor
- Thaw Basin, Ice-rich
- Delta Thaw Basin, Ice-poor
- Delta Thaw Basin, Ice-rich
- Tidal Flat
- Fill, Gravel
- Fill, Peat
- Fresh Waterbody
- Coastal Waterbody

Proposed Project

- In-field Facilities
- Pipelines

Appendix G, Figure 1.
Terrain Units

Appendix G Table 1. **Descriptions of terrain units mapped on the Colville River delta and transportation corridor for the proposed Alpine Development (after Jorgenson et al. 1993, 1996; Rawlinson 1993).**

Unit	Description
Eolian Sand	Unconsolidated, wind-deposited accumulations composed primarily of very fine and fine sand. Active sand dunes are built by deposition from adjacent sandbars and are prone to wind erosion, giving them distinctive, highly dissected patterns. Surficial patterns associated with ice aggradation generally are absent. Active dunes occur at the inner edge of extensive mudflats, the outer delta, and along the western and southwestern sides of river channel bars. Only distinct dunes are mapped, whereas smooth sand sheets overlying other deposits are not.
Delta Floodplain Riverbed Alluvium	Silty and sandy riverbed (lateral accretion) deposits laid down from the bedload of the river in areas of channeled flow. Riverbed alluvium includes point bars, lateral bars, mid-channel bars, unvegetated high-water channels, and broad riverbank and sandbars exposed during low water. In general, texture of the sediments decreases in a seaward direction along the distributaries and in a bankward direction from the thalweg. Organic matter, including driftwood (mostly small willows), peat shreds, and other plant remains, usually is found interbedded in the sediments. Only those riverbed deposits that are exposed at low water are mapped, but also occur under riverbeds and cover deposits. Frequent flooding (every 1–2 years) prevents the establishment of permanent vegetation.
Delta Floodplain High-water Channel	Riverbed deposits that occur in channels flooded only during periods of high flow. Because of river meandering, these channels no longer are active during low-flow conditions. Deposits in this unit are similar to those described for riverbed alluvium. These old channels show little surface polygonization indicative of ice-wedge development, although infrequently there are high-water channels that are older and have developed disjunct polygon rims. (Very old channels that have distinct low-centered polygons are not included in this unit.)
Delta Floodplain Active Cover Alluvium	Thin (0.5–1 ft), fine-grained cover deposits (primarily silt) that are laid down over sandier riverbed deposits during flood stages. Deposition is sufficiently frequent (estimated 3–5 years) to prevent the development of a surface organic horizon. Supra-permafrost groundwater generally is absent or occurs only at the bottom of the active layer during mid-summer. This unit usually occurs on the upper portions of point and lateral bars and supports riverine shrub vegetation.
Delta Floodplain Inactive Cover Alluvium	Fine-grained cover (vertical accretion) deposits of a braided floodplain laid down over coarser riverbed deposits by streams at bank overflow (flood) stages. The surface contains a sequence (0.5–2 ft thick) of interbedded organic and silt layers near the surface, indicating occasional flood deposition. Underneath the organic horizons is a thick layer (1–5 ft thick) of silty cover deposits overlying riverbed deposits. Surface forms range from nonpatterned to disjunct and low-centered, low-density polygons. Lenticular and reticulate forms of segregated ice and massive ice in the form of ice wedges are common.
Delta Abandoned Floodplain	Peat, silt, or fine sand, or mixtures or interbeds of all three, deposited in a deltaic overbank environment by fluvial, eolian, and organic processes. These deposits generally consist of a thick (2–6 ft) accumulation of peat that overlies cover and riverbed alluvium. Because these are older surfaces, eolian silt and sand may be common as distinct layers or as intermixed sediments. The surface layer, however, lacks interbedded silt layers associated with occasional flood deposition. Lenticular and reticulate forms of segregated ice and massive ice in the form of ice wedges are common in these deposits. The surface is characterized by low-relief, high-density polygons and represents the oldest surface on the floodplain.
Floodplain Riverbed Deposit	Sandy gravel, and occasionally sand, deposited as lateral accretion deposits in channels of active floodplains by fluvial processes. Sub-rounded to rounded pebbles and cobbles are common in the sandy gravel. Frequent deposition and scouring from flooding prevent the establishment of vegetation.
Floodplain Active Cover Deposit	Thin (0.5–1 ft), fine-grained cover deposits (primarily silt) that are laid down over sandy or gravelly riverbed deposits during flood stages. Deposition is sufficiently frequently (probably every 3–5 years) to prevent the development of a surface organic horizon. This unit usually occurs on the upper portions of point and lateral bars and supports riverine shrub vegetation.

Appendix G Table 1. **Descriptions of terrain units mapped on the Colville River delta and transportation corridor for the proposed Alpine Development (after Jorgenson et al. 1993, 1996; Rawlinson 1993).**

Floodplain Inactive Cover Deposit	Interbedded layers of peat and silt (0.5–2 ft thick) indicating a low frequency of flood deposition. Cover deposits below this layer generally consist of silt but can include pebbly silt and sand, and usually are in sharp contact with underlying gravelly riverbed deposits. This unit has substantial segregated and massive ice, as indicated by the occurrence of ice-wedge polygons.
Thaw Basin Deposit, Non-ice Rich	Thaw-basin deposits, which are caused by thawing of ground ice, typically are fine-grained and organic-rich, and the stratigraphy of the original sediments has been deformed by the subsidence. On the terraces and coastal plain west of the delta, pebbly silt or fine sand is more common. Nonpatterned ground or disjunct polygonal rims indicate that ground ice is low and that draining of the lake has occurred relatively recently. Ponds in these basin typically have irregular shorelines and are highly interconnected.
Thaw Basin Deposit, Ice Rich	Sediments similar to non-ice-rich thaw-lake deposits, but with much more ground ice, as indicated by the development of low-center or high-center polygons. Waterbodies within these basins tend to be rectangular and poorly interconnected, and have smooth, regular shorelines.
Delta Thaw Basin Deposit, Non-ice-rich	Deposit occurring in thaw lakes having a connection to a river or nearshore water (tapped lake); they occur only in deltaic environments. Most connections occur when a meandering distributary cuts through a lake bank; once connected, the lake is influenced by changes in river level. During breakup, large quantities of sediment-laden water flow into the lake, forming a lake delta at the point of breakthrough. Sediments typically consist of fine sands, silts, and clays, and are slightly saline.
Delta Thaw Basin, Ice-rich	Similar to the above unit except that sediments are ice-rich, as indicated by ice-wedge polygons. Typically, the sediments contain a sequence of a thick (1–2 ft) layer of interbedded silt and peat, overlying fine-grained cover deposits, and silty clay lacustrine deposits. They still are subject to flooding
Alluvial Terrace	Fluvial gravelly sand, sand, silty sand, and peat. The old terraces were deposited at an earlier age and are not subject to flooding under the current regime. Deposits usually are overlain by eolian silt and sand and organic-rich thaw basin deposits. This unit has high contents of segregated and massive ice, as indicated by ice-wedge polygons and an abundance of thaw ponds.
Alluvial-Marine Terrace	A sequence of alluvial and marine terraces (A, B, and C of Rawlinson 1993) that have variable composition but generally consist of undifferentiated gravelly sand overlain by fluvial gravelly sand, silty sand, and organic silt. Stratified layers of marine gravelly sand, silty sand, silt, and minor clay occur in some locations beneath the fluvial deposits. The deposits generally are overlain by pebbly eolian sand and silt and organic-rich lacustrine deposits. This unit is not subject to flooding.
Alluvial Plain Deposit	Peat, eolian loess and sand, lacustrine sediments, and sandy gravel deposited by braided river processes on an alluvial plain. A typical sequence consists of 0.5–2 ft of peat or mixed sand and peat typical of lacustrine material, 4–7 ft of sand and pebbly fine sand (Beechey Sand), and thick beds (below 5–10 ft) of sandy gravel and gravel (Ugnuravik Gravel). The surface is ice-rich, as indicated by polygon development and prevalence of thaw lakes. Water depth in thaw lakes generally is 3–7 ft, indicating that sediments have high ice contents and are not thaw-stable.
Tidal Flat Deposit	Areas of nearly flat, barren mud or sand that alternate between periodic inundations by tidal waters and subaerial conditions. Tidal flats occur on seaward margins of deltaic estuaries, leeward portions of bays and inlets, and at mouths of rivers. Tidal flats frequently are associated with lagoons and estuaries and may vary widely in actual salinity, depending on the frequency of salt-water incursion and the rate of influx of fresh water. Although affected by tidal fluctuations, most barren sediments along the fringe of the delta are mapped as riverbed sediments because they are primarily deposited during spring flooding.
Fill, Gravel and Peat	Gravel and sandy gravel that has been placed as fill for roads and pads in the village of Nuiqsut and the Kuparuk Oilfield. Peat fill includes a mixture of organic and fine-grained sediments, which has been obtained by scraping peat material from the active layer and piling it into a roadbed (peat road).

Appendix H

APPENDIX H

WATER QUALITY DATA FROM USGS GAGING STATION

Appendix H. USGS water quality data for the Colville River, Alaska.

	April 1975	Aug. 1975	June 1977	July 1977	Aug. 1977	Sept. 1977	June 1979	Aug. 1979	Sept. 1979	June 1980	Sept. 1980	Aug. 1981
Physical Characteristics												
Water temperature (°F)	34	50	43 to 55	51 to 61	45 to 64	42 to 48	48 to 17	58 to 59	43	38	40	49
Turbidity (NTU)	2.0*	--	--	--	--	--	3.1	1.2	6.9	200	1.5	0.70
Color (P-C units)	0	10	32 to 100	4	4 to 9	7 to 10	--	--	--	--	--	--
Total dissolved solids (mg/L)	--	85	38 to 56	88 to 95	88 to 91	98 to 100	55	107	120	56	118	98
Suspended sediment (mg/L)	--	--	77 to 869	3 to 39	4 to 149	4 to 9	76	31	15	910	27	16
General Chemistry												
Conductivity (μS/cm)	1,340	163	48 to 105	150 to 180	160 to 190	175 to 180	74 to 90	170 to 180	170 to 190	64	156	165
Dissolved oxygen (mg/L)	14.4	11.3	7.5 to 9.7	10.0 to 11.8	8.5 to 11.6	11.1 to 11.8	10.3 to 10.6	9.4	11.3	11.6	12.0	11.2
pH (standard units)	7.50	8.10	6.40 to 7.80	7.50 to 8.20	7.60 to 8.20	7.60 to 7.80	7.00 to 7.50	7.20	7.00	6.20	7.00	7.40 to 8.00
Total organic carbon (mg/L)	5.7	3.6	15 to 19	--	--	--	--	--	15	22	--	--
Total hardness (mg $CaCO_3$/L)	292	76	23 to 42	74 to 85	77 to 85	87 to 110	36	76	88	31	82	81
Carbon dioxide (mg/L)	9.7	1.0	1.2 to 18	0.9 to 4.0	0.9 to 3.0	2.0 to 3.2	4.0	7.1	10	37	11	--
Alkalinity (mg $CaCO_3$/L)	157	64	19 to 42	58 to 78	62 to 81	65 to 70	33	57	52	26	56	--
Biocarbonate (mg HCO_3/L)	192	78	23 to 51	71 to 95	75 to 99	79 to 85	40	70	63	32	70	--
Nutrients												
Total ammonia (mg N/L)	--	--	--	--	--	--	0.0100	0.0100	0.0500	0.0900	0.0300	0.00 to 0.0400
Total nitrate + nitrite (mg N/L)	--	--	--	--	--	--	0.030	0.070	0.13	0.14	0.69	0.030
Dissolved nitrate +nitrite (mg N/L)	0.29	0.090	0.35 to 2.3	--	0.050 to 0.12	0.050 to 0.070	--	--	0.040	0.15	0.13	0.030

Appendix H. USGS water quality data for the Colville River, Alaska.

	April 1975	Aug. 1975	June 1977	July 1977	Aug. 1977	Sept. 1977	June 1979	Aug. 1979	Sept. 1979	June 1980	Sept. 1980	Aug. 1981
Total phosphorus (mg P/L)	--	--	--	--	--	--	0.0200	<0.0100	0.0200	0.560	0.0300	0.0200
Dissolved orthophosphorus (mg P/L)	<0.0100	<0.0100	<0.0100	--	0.0100 to 0.0300	0.0100	--	--	--	--	--	--
Mineral Ions												
Dissolved calcium (mg/L)	--	22	6.1 to 12	22 to 25	23 to 26	25 to 36	10	21	24	9.3	23	23
Dissolved magnesium (mg/L)	--	5.0	1.9 to 2.9	4.7 to 5.4	4.8 to 5.0	5.8 to 5.9	2.6	5.8	6.9	1.9	5.9	5.7
Dissolved sodium (mg/L)	160	2.5	1.5 to 2.0	2.2 to 2.7	2.3 to 2.9	2.3 to 2.4	1.9	3.1	3.5	2.3	2.8	2.7
Dissolved potassium (mg/L)	6.1	0.60	0.70 to 1.0	0.60 to 0.70	0.60 to 0.90	0.60	0.70	0.60	0.70	1.1	0.70	0.80
Dissolved chloride (mg/L)	290	1.5	1.0 to 1.6	0.80 to 1.8	0.60 to 1.5	0.50 to 0.70	1.1	0.60	1.1	1.9	0.60	0.30
Dissolved sulfate (mg/L)	65	9.5	4.0 to 6.3	8.5 to 11	10 to 19	18 to 22	9.0	30	38	5.8	27	23
Dissolved fluoride (mg/L)	0.10	0.10	<0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Dissolved silica (mg/L)	4.0	2.1	1.0 to 2.0	2.2 to 2.4	2.5 to 2.8	2.7 to 2.8	1.3	3.4	3.7	7.6	3.0	2.8
Trace Metals												
Total arsenic (μg/L)	--	--	6 to 8	--	--	--	1	1	--	4	1	2
Dissolved arsenic (μg/L)	--	--	<1	--	--	--	<1	<1	--	1	0	0
Total barium (μg/L)	--	--	--	--	--	--	<100	<100	--	500	100	0
Dissolved barium (μg/L)	--	--	--	--	--	--	<100	90	--	0	70	80
Total cadmium (μg/L)	--	--	<20	--	--	--	2	<2	--	2	0	1
Dissolved cadmium (μg/L)	--	--	<2	--	--	--	2	4	--	2	<1	<1
Total chromium (μg/L)	--	--	0	--	--	--	0	<20	--	0	0	10
Dissolved chromium (μg/L)	--	--	20	--	--	--	0	0	--	20	0	0
Total cobalt (μg/L)	--	--	<100	--	--	--	0	0	--	13	0	1
Dissolved cobalt (μg/L)	--	--	<2	--	--	--	0	<3	--	1	<3	<3
Total recoverable copper (μg/L)	--	--	30 to 40	--	--	--	15	4	--	50	6	7

Appendix H. USGS water quality data for the Colville River, Alaska.

	April 1975	Aug. 1975	June 1977	July 1977	Aug. 1977	Sept. 1977	June 1979	Aug. 1979	Sept. 1979	June 1980	Sept. 1980	Aug. 1981
Dissolved copper (μg/L)	--	--	30 to 40	--	--	--	4	4	--	11	4	5
Total iron (μg/L)	--	--	22,000 to 24,000	--	--	--	2,600	1,300	--	28,000	660	670
Dissolved iron (μg/L)	--	20	200 to 250	20 to 60	30 to 220	30 to 100	200	240	--	350	100	19
Total lead (μg/L)	--	--	<200	--	--	--	24	11	--	37	10	9
Dissolved lead (μg/L)	--	--	2 to 3	--	--	--	8	5	--	21	3	5
Total manganese (μg/L)	--	--	550 to 640	--	--	--	60	20	--	700	20	20
Dissolved manganese (μg/L)	--	<10	<10 to 50	4 to 8	<10 to 50	<10	<10	6	--	20	8	6
Total nickel (μg/L)	--	--	--	--	--	--	--	--	--	46	5	5
Dissolved nickel (μg/L)	--	--	--	--	--	--	--	--	--	4	1	1
Total silver (μg/L)	--	--	--	--	--	--	0	0	--	0	1	0
Dissolved silver (μg/L)	--	--	--	--	--	--	0	0	--	0	0	0
Total zinc (μg/L)	--	--	90	--	--	--	30	<20	--	170	20	20
Dissolved zinc (μg/L)	--	--	4 to 20	--	--	--	<20	7	--	20	10	15
Total selenium (μg/L)	--	--	<1 to 1	--	--	--	<1	<1	--	1	0	0
Dissolved selenium (μg/L)	--	--	<1	--	--	--	<1	<1	--	0	0	0
Total recoverable mercury (μg/L)	--	--	<0.50	--	--	--	<0.10	<0.10	--	0.20	0	0.10
Dissolved mercury (μg/L)	--	--	<0.5	--	--	--	<0.1	<0.1	--	0.1	0	0

* Turbidity was reported in Jackson turbidity units (JTU) for April 1975, and nephelometric turbidity units (NTU) for other dates.
Source: Aldrich 1995

Appendix I

APPENDIX I-1

WILDLIFE HABITAT TYPES

Appendix I-1 Table 1. Descriptions of wildlife habitat types found on the Colville River delta and Alpine transportation corridor (from Johnson et al. 1996: Table 3).

Habitat Type	Description
Open Nearshore Water (Estuarine Subtidal)	Shallow estuaries, lagoons, and embayments along the coast of the Beaufort Sea. Winds, tides, river discharge, and icing create dynamic changes in physical and chemical characteristics. Tidal range normally is small (<0.2 m), but storm surges produced by winds may raise sea level as much as 2–3 m. Bottom sediments are mostly unconsolidated mud. Winter freezing generally begins in late September and is completed by late November. This type is heavily used by some species of waterfowl during molting and during spring and fall staging.
Brackish Water	Coastal ponds and lakes that are flooded periodically with saltwater during storm surges. Salinity levels often are increased by subsequent evaporation of impounded saline water. The substrate may contain peat, reflecting its freshwater/terrestrial origin, but the peat is mixed with flood-deposited silt and clay.
Tapped Lake (or Pond) with Low-water Connection	Waterbodies that have been partially drained through erosion of banks by adjacent river channels, but which are connected to rivers by distinct, permanently flooded channels. The water typically is brackish and the lakes are subject to flooding every year. Because water levels have dropped, the lakes generally have broad flat shorelines with silty clay sediments. Salt-marsh vegetation is common along the shorelines. Deeper lakes in this habitat do not freeze to the bottom during winter. Sediments are fine-grained silt and clay with some sand.
Tapped Lake (or Pond) with High-water Connection	Similar to preceding type except that the connecting channels are dry during low water and the lakes are connected only during flooding events. Water tends to be fresh. Small deltaic fans are common near the connecting channels due to sediment deposition during seasonal flooding.
Salt Marsh	Salt Marsh along the Beaufort Sea coast generally occurs in small, widely dispersed patches, most frequently on stable mudflats associated with river deltas. The surface is flooded irregularly by brackish or marine water during high tides, storm surges, and river flooding. Salt Marsh typically includes a complex assemblage of small brackish ponds, halophytic (salt-tolerant) sedge and grass wet meadows, halophytic dwarf willow scrub, and small barren patches. Dominant plant species usually include *Carex subspathacea, C. ursina, Puccinellia phryganodes, Dupontia fisheri, P. andersonii, Salix ovalifolia, Cochlearia officinalis, Stellaria humifusa,* and *Sedum rosea.* Salt Marsh is used heavily by brood-rearing and molting waterfowl.
Tidal Flat	Areas of nearly flat, barren mud or sand that are periodically inundated by tidal waters. Tidal flats occur on the seaward margins of deltaic estuaries, leeward portions of bays and inlets, and at mouths of river channels. Tidal flats frequently are associated with lagoons and estuaries and may vary widely in salinity levels. Tidal Flats are considered separately from other barren habitats because of their importance to estuarine and marine invertebrates and shorebirds.
Salt-killed Tundra	Coastal areas where saltwater intrusions from storm surges have killed much of the original terrestrial vegetation and are being colonized by salt-tolerant plants. Colonizing plants include *Puccinellia andersonii, Dupontia fisheri, Braya purpurascens, B. pilosa, Cochlearia officinalis, Stellaria humifusa, Cerastium beeringianum,* and *Salix ovalifolia.* This habitat typically occurs either in low-lying areas that formerly supported Wet Sedge–Willow Meadow and basin wetland complexes or, less commonly, along drier coastal bluffs that formerly supported Moist Sedge–Shrub Meadows and Upland Shrub. Salt-killed Tundra differs from Salt Marsh in having abundant litter from dead tundra vegetation, a surface horizon of organic soil, and salt-tolerant colonizing plants.
Deep Open Water (lakes and ponds) without Islands	Deep (≥1.5 m) waterbodies range in size from small ponds in ice-wedge polygons to large open lakes; most have resulted from thawing of ice-rich sediments, although some are associated with old river channels. They do not freeze to the bottom during winter. Lakes usually are not connected to rivers. Sediments are fine-grained silt and clay. Deep Open Waters without Islands are differentiated from those with islands because of the importance of islands to nesting waterbirds.

Appendix I-1 Table 1. Descriptions of wildlife habitat types found on the Colville River delta and Alpine transportation corridor (from Johnson et al. 1996: Table 3).

Habitat Type	Description
Deep Open Water with Islands or Polygonized Margins	Similar to the preceding type except that the waterbodies in this type have islands or complex shorelines formed by thermal erosion of low-center polygons. The complex shorelines and islands are important features of nesting habitat for waterbirds.
Shallow Open Water (lakes and ponds) without Islands	Ponds and small lakes <1.5 m deep with emergent vegetation covering <5% of the waterbody surface. Due to the shallow depth, water freezes to the bottom during winter and thaws by early to mid-June. Maximal summer temperatures are higher than those in deep waterbodies. Although these ponds generally are surrounded by wet and moist tundra, ponds located in barren areas also are included in this category. Sediments are fine-grained silt and clay.
Shallow Open Water with Islands or Polygonized Margins	Shallow lakes and ponds with islands or complex shorelines characterized by low-center polygons. Distinguished from Shallow Open Water without Islands because shoreline complexity is an important feature of nesting habitat for waterbirds.
River or Stream	Permanently flooded channels of the Colville River and its tributaries and smaller stream channels in the transportation corridor. Rivers and streams generally peak during spring breakup flooding and reach their lowest levels during mid-summer. The distributaries of the Colville delta are slightly saline, whereas streams in the transportation corridor are non-saline. During winter, unfrozen water in deeper channels can become hypersaline.
Aquatic Sedge Marsh	Permanently flooded waterbodies dominated by *Carex aquatilis*. Typically, emergent sedges occur in water ≤0.[illegible] m deep. Water and bottom sediments of these shallow waterbodies freeze completely during winter, but the ice melts in early June. The sediments generally consist of a peat layer (0.2–0.5 m deep) overlying fine-grained silt.
Aquatic Sedge with Deep Polygons	Primarily a coastal habitat in which thermokarst (thermal erosion) of ice-rich soil has produced deep (>1 m), permanently flooded polygon centers. Emergent vegetation, mostly *Carex aquatilis,* usually occurs around the margins of the polygon centers, although the emergent grass *Arctophila fulva* occasionally occurs in the polygon centers. Polygon rims are moderately well-drained and dominated by sedges and dwarf shrubs, including *Dryas integrifolia, Salix reticulata, S. phlebophylla,* and *S. ovalifolia.*
Aquatic Grass Marsh	Ponds and lake margins vegetated by the emergent grass *Arctophila fulva.* Due to shallow water depths (<1 m), the water freezes to the bottom in winter and thaws by early June. *Arctophila* stem densities and annual productivity vary widely among sites. Sediments generally lack peat. This type usually occurs as an early successional stage in the thaw-lake cycle and is more productive than Aquatic Sedge Marsh. This habitat tends to have abundant invertebrates and is heavily used by waterbirds.
Young Basin Wetland Complex (Ice-poor)	Basin wetland complexes (both young and old) occur in drained lake basins and are characterized by a complex mosaic of open water, aquatic sedge and grass marshes, and wet and moist meadows in patches too small (<0.5 ha) to be mapped individually. Deeper basins may be entirely inundated during spring breakup; water levels gradually recede following breakup. Basins often have distinct upland rims marking the location of old shorelines, although boundaries may be indistinct due to the coalescence of thaw basins and the presence of several thaw-lake stages. Soils generally are fine-grained, organic-rich, and ice-poor in the young type. The lack of ground ice results in poorly developed polygon rims in wetter areas and indistinct edges of waterbodies. Ecological communities within younger basins appear to be much more productive than those in older basins, which is the reason for differentiating between the two types of basin wetland complexes.

Appendix I-1 Table 1. Descriptions of wildlife habitat types found on the Colville River delta and Alpine transportation corridor (from Johnson et al. 1996: Table 3).

Habitat Type	Description
Old Basin Wetland Complex (Ice-rich)	Similar to the preceding type, but characterized by well-developed low- and high-center polygons resulting from ice-wedge development and aggradation of segregated ice. The waterbodies in old complexes have smoother, more rectangular shorelines and are not as interconnected as in young complexes. Vegetation types generally include Wet Sedge–Willow with Low-relief Polygons, Moist Sedge–Shrub Meadows, and Moist Tussock Tundra; Aquatic Sedge and Grass marshes are absent. Soils have a moderately thick (0.2-0.5 m) organic layer overlying fine-grained silt or sandy silt.
Nonpatterned Wet Meadow	Sedge-dominated meadows that typically occur within young drained lake basins, as narrow margins of receding waterbodies, or along edges of small stream channels in areas that have not undergone extensive ice-wedge polygonization. Disjunct polygon rims and strangmoor cover <5% of the ground surface. The surface generally is flooded during early summer (depth <0.3 m) and drains later, but remains saturated within 15 cm of the surface throughout the growing season. The uninterrupted movement of water and dissolved nutrients in nonpatterned ground results in more robust growth of sedges than in polygonized habitats. *Carex aquatilis* and *Eriophorum angustifolium* usually dominate, although other sedges may be present. Near the coast, the grass *Dupontia fisheri* may be present. Low and dwarf willows (*Salix lanata, S. arctica,* and *S. planifolia*) occasionally are present. Soils generally have a moderatedly thick (10–30 cm) organic horizon overlying fine-grained silt.
Wet Sedge–Willow Meadow (with Low-relief Polygons; High- or Low-density)	Occurs in lowland areas within drained lake basins, level floodplains, and swales on gentle slopes and terraces, associated with low-centered polygons and strangmoor (undulating raised sod ridges). Water depth varies through the season (<0.3 m maximum). Polygon rims and strangmoor interrupt surface and groundwater flow, so only interconnected polygon troughs receive downslope flow and dissolved nutrients; in contrast, the input of water to polygon centers is limited to precipitation. As a result, vegetation growth typically is more robust in polygon troughs than in centers. Vegetation is dominated by the sedges *Carex aquatilis* and *Eriophorum angustifolium,* although other sedges may be present, including *C. rotundata, C. saxatilis, C. membranacea, C. chordorriza,* and *E. russeolum.* Willows (*Salix lanata, S. arctica,* and *S. planifolia*) usually are abundant.
Moist Sedge–Shrub Meadow (Low- or High-relief Polygons)	Occurs on moderately well-drained uplands between thaw basins, riverbanks, old stabilized dunes, lower slopes of pingos, and foothill slopes, generally associated with nonpatterned ground, frost scars, and high-center polygons with low relief. Vegetation is dominated by *C. aquatilis, C. bigelowii, E. angustifolium, S. planifolia* and *Dryas integrifolia.* The ground is covered with a nearly continuous carpet of mosses. Soils generally have a thin layer (20–30 cm) of organic matter over silt loam.
Moist Tussock Tundra	Similar to the preceding type, except that the vegetation is dominated by the tussock-forming sedge *Eriophorum vaginatum.* This type tends to occur on the upper portions of slopes and in more well-drained conditions than Moist Sedge–Shrub Tundra.
Riverine or Upland Shrub	Stands of low (≤1.5 m high) and tall (>1.5 m high) willows along riverbanks and *Dryas* tundra on upland ridges and stabilized sand dunes, with both open and closed canopies. Tall willows, dominated by *Salix alaxensis,* occur mainly along larger streams and river channels. Low willow stands are widespread and typically have a canopy of *S. lanata* and *S. glauca.* Understory plants include the shrubs *Arctostaphylos rubra, S. reticulata,* and *D. integrifolia* and the forbs *Astragalus* spp., *Lupinus arcticus,* and *Equisetum* spp. *Dryas* tundra is dominated by *D. integrifolia* but may include abundant dwarf willows such as *S. phlebophylla.* Common forbs include *Silene acaulis, Pedicularis lanata,* and *Astragalus umbellatus,* and *Carex bigelowii* frequently is present. In Riverine Shrub, an organic horizon generally is absent or buried due to frequent sediment deposition. In Upland Shrub, soils generally have a thin (<5 cm) organic horizon.

Appendix I-1 Table 1. Descriptions of wildlife habitat types found on the Colville River delta and Alpine transportation corridor (from Johnson et al. 1996: Table 3).

Habitat Type	Description
Barrens (Riverine, Eolian, or Lacustrine)	Includes barren and partially vegetated (<30% plant cover) areas resulting from riverine, eolian, or thaw-lake processes. Riverine Barrens on river flats and bars are flooded seasonally and can have either silty or gravelly sediments. The margins frequently are colonized by the grasses *Deschampsia* caespitosa and *Elymus arenarius* and the forbs *Chrysanthemum bipinnatum* and *Equisetum arvense*. Eolian Barrens generally are located adjacent to deltaic river channels and include active sand dunes that are too unstable to support more than a few pioneering plants (<5% cover). Typical pioneer plants include *Salix alaxensis, Elymus arenarius,* and *Deschamspia caespitosa.* Lacustrine Barrens occur along margins of drained lakes and ponds. These areas may be flooded seasonally or may be well-drained. On the delta, sediments usually are clay-rich, slightly saline, and are colonized by salt-marsh plant species. Barrens may receive heavy use seasonally by caribou as insect-relief habitat.
Artificial (Water, Fill, Peat Road)	A variety of small disturbed areas, including impoundments, gravel fill, and a sewage lagoon at Nuiqsut. Gravel fill is present at Nuiqsut and at the Helmericks residence near the mouth of the East Channel of the Colville River. A peat road passes roughly north–south through the transportation corridor. Two Kuparuk drill sites (2M and 2K) are included, as are several old exploratory drilling pads.

APPENDIX I-2

BIRD STATUS

Appendix I-2, Table 1. **Names, status, and relative abundance of birds occurring in the Colville River Delta region, Alaska. Common and scientific names follow AOU (1983 and supplements 35–40), and Iñupiaq names follow Webster and Zibell (1970), MacLean (1980), Norton et al. (1993), and Kaplan (1996 personal communication).**

Common Name	Scientific Name	Iñupiaq Name	Status[a]	Relative Abundance[b]
Red-throated Loon	*Gavia stellata*	qaqsrauq	Breeder	Common
Pacific Loon	*Gavia pacifica*	malgi	Breeder	Common
Common Loon	*Gavia immer*	taasiniq	Visitant	Casual
Yellow-billed Loon	*Gavia adamsii*	tuullik	Breeder	Common
Red-necked Grebe	*Podiceps grisegena*	aqpaqsruayuuq, suglitchauraq	Visitant	Casual
Tundra Swan	*Cygnus columbianus*	qugruk	Breeder	Common
Greater White-fronted Goose	*Anser albifrons*	niglivik	Breeder	Abundant
Snow Goose	*Chen caerulescens*	kanuq	Breeder	Uncommon
Emperor Goose	*Chen canagica*	mitilugruaq	Visitant	Accidental
Brant	*Branta bernicla*	niglingaq	Breeder	Common
Canada Goose	*Branta canadensis*	iqsragutilik	Migrant	Uncommon
Green-winged Teal	*Anas crecca*	qainniq	Breeder	Uncommon
Mallard	*Anas platyrhynchos*	kurugaqtaq	Visitant	Uncommon
Northern Pintail	*Anas acuta*	kurugaq	Breeder	Common
Northern Shoveler	*Anas clypeata*	alluutaq, qaqlutuuq	Visitant	Rare
American Wigeon	*Anas americana*	kurugagnaq	Breeder	Uncommon
Canvasback	*Aythya valisineria*		Visitant	Casual
Greater Scaup	*Aythya marila*	qaqluqpalik	Breeder	Uncommon
Lesser Scaup	*Aythya affinis*	qaqlutuuq	Visitant	Casual
Common Eider	*Somateria mollissima*	amauligruaq	Breeder	Rare
King Eider	*Somateria spectabilis*	qinalik	Breeder	Uncommon
Spectacled Eider	*Somateria fischeri*	qavaasuk	Breeder	Uncommon
Steller's Eider	*Polysticta stelleri*	igniqauqtuq	Visitant	Casual
Oldsquaw	*Clangula hyemalis*	aaqhaaliq	Breeder	Common
Black Scoter	*Melanitta nigra*	tuungaagrupiaq	Visitant	Rare
Surf Scoter	*Melanitta perspicillata*	aviluqtuq	Visitant	Rare
White-winged Scoter	*Melanitta fusca*	killalik	Visitant	Rare
Common Goldeneye	*Bucephala clangula*		Visitant	Casual
Red-breasted Merganser	*Mergus serrator*	paisugruk, aqpaqsruayuuq	Breeder	Uncommon
Bald Eagle	*Haliaeetus leucocephalus*	tinmiaqpak	Visitant	Casual
Northern Harrier	*Circus cyaneus*	papiktuuq	Visitant	Uncommon
Rough-legged Hawk	*Buteo lagopus*	qilgiq	Visitant	Rare
Golden Eagle	*Aquila chrysaetos*	tingmiakpak	Visitant	Uncommon
Peregrine Falcon	*Falco peregrinus*	kirgavik	Visitant	Rare
Gyrfalcon	*Falco rusticolus*	aatqarruaq	Visitant	Rare
Willow Ptarmigan	*Lagopus lagopus*	aqargiq, nasaullik	Resident	Common
Rock Ptarmigan	*Lagopus mutus*	niksaaktuniq	Resident	Common
Sandhill Crane	*Grus canadensis*	tatirgaq	Visitant	Rare
Black-bellied Plover	*Pluvialis squatarola*	tullivak	Breeder	Common
American Golden-Plover	*Pluvialis dominicus*	tullik	Breeder	Common
Semipalmated Plover	*Charadrius semipalmatus*	kurraquraq	Breeder	Rare
Killdeer	*Charadrius vociferus*	taligvak	Visitant	Casual
Lesser Yellowlegs	*Tringa flavipes*	uviñnuayuuq	Visitant	Casual
Wandering Tattler	*Heteroscelus incanus*	sililisuqtuq	Visitant	Casual
Upland Sandpiper	*Bartramia longicauda*		Visitant	Casual

Appendix I-2, Table 1. Continued.

Common Name	Scientific Name	Iñupiaq Name	Status[a]	Relative Abundance[b]
Whimbrel	*Numenius phaeopus*	sigguktuvak	Visitant	Rare
Hudsonian Godwit	*Limosa haemastica*		Visitant	Casual
Bar-tailed Godwit	*Limosa lapponica*	turraaturaq	Breeder	Uncommon
Ruddy Turnstone	*Arenaria interpres*	tullignaq	Breeder	Uncommon
Black Turnstone	*Arenaria melanocephala*		Visitant	Casual
Red Knot	*Calidris cauntus*		Migrant	Casual
Sanderling	*Calidris alba*	kimmitquilaq	Migrant	Rare
Semipalmated Sandpiper	*Calidris pusilla*	livalivaq	Breeder	Abundant
Western Sandpiper	*Calidris mauri*		Migrant	Rare
Red-necked Stint	*Calidris ruficollis*		Visitant	Casual
Least Sandpiper	*Calidris minutilla*	livalivauraq	Migrant	Casual
White-rumped Sandpiper	*Calidris fuscicollis*		Migrant	Rare
Baird's Sandpiper	*Calidris bairdii*	puviaqtuuyaaq	Breeder	Uncommon
Pectoral Sandpiper	*Calidris melanotos*	puviaqtuuq	Breeder	Abundant
Sharp-tailed Sandpiper	*Calidris acuminata*		Visitant	Casual
Dunlin	*Calidris alpina*	qayuuttavak	Breeder	Common
Stilt Sandpiper	*Calidris himantopus*		Breeder	Uncommon
Buff-breasted Sandpiper	*Tryngites subruficollis*	satqagiilaq	Breeder	Uncommon
Ruff	*Philomachus pugnax*		Visitant	Casual
Short-billed Dowitcher	*Limnodromus griseus*		Visitant	Casual
Long-billed Dowitcher	*Limnodromus scolopaceus*	kilyaktalik	Breeder	Common
Common Snipe	*Gallinago gallinago*	saavgaq, aiviqiaq	Breeder	Uncommon
Red-necked Phalarope	*Phalaropus lobatus*	qayyiugun	Breeder	Abundant
Red Phalarope	*Phalaropus fulicaria*	auksruaq	Breeder	Common
Pomarine Jaeger	*Stercorarius pomarinus*	isunnagluk	Migrant	Common
Parasitic Jaeger	*Stercorarius parasiticus*	migiaqsaayuk	Breeder	Common
Long-tailed Jaeger	*Stercorarius longicaudus*	isunnaq	Breeder	Uncommon
Herring Gull	*Larus argentatus*	nauyavvaaq	Visitant	Casual
Slaty-backed Gull	*Larus schistisagus*		Visitant	Casual
Glaucous-winged Gull	*Larus glaucescens*		Visitant	Casual
Glaucous Gull	*Larus hyperboreus*	nauyavasrugruk	Breeder	Common
Ross's Gull	*Rhodostethia rosea*	qagmaqluaq	Migrant	Rare
Sabine's Gull	*Xema sabini*	iqirgagiaq	Breeder	Common
Ivory Gull	*Pagophila eburnea*	igirraq	Migrant	Casual
Arctic Tern	*Sterna paradisaea*	mitqutailaq	Breeder	Common
Snowy Owl	*Nyctea scandiaca*	ukpik	Breeder	Uncommon
Northern Hawk Owl	*Surnia ulula*	niaquqtuagruk	Visitant	Casual
Short-eared Owl	*Asio flammeus*	nipailuktaq	Visitant	Uncommon
Northern Flicker	*Colaptes auratus*		Visitant	Casual
Horned Lark	*Eremophila alpestris*	nagrulik	Visitant	Casual
Tree Swallow	*Tachycineta bicolor*	tulugagnauraq	Visitant	Casual
Bank Swallow	*Riparia riparia*	tulugagnaq	Visitant	Casual
Cliff Swallow	*Petrochelidon pyrrhonota*	tulugagnauraq	Visitant	Casual
Barn Swallow	*Hirundo rustica*		Visitant	Accidental
Common Raven	*Corvus corax*	tulugaq	Resident	Uncommon
Arctic Warbler	*Phylloscopus borealis*	sunaqpaluktuniq	Visitant	Rare
Bluethroat	*Luscinia svecica*		Visitant	Rare
Northern Wheatear	*Oenanthe oenanthe*	tinmiaqpauraq	Visitant	Casual
American Robin	*Turdus migratorius*	kuyapigaqturuq	Visitant	Casual
Varied Thrush	*Ixoreus naevius*	sinutlulluuq	Visitant	Casual
Yellow Wagtail	*Motacilla flava*	piigaq, misiqqaaqauraq	Breeder	Uncommon

Appendix I-2, Table 1. Continued.

Common Name	Scientific Name	Iñupiaq Name	Status[a]	Relative Abundance[b]
American Pipit	*Anthus rubescens*	piigavik, putukiuluk	Visitant	Rare
European Starling	*Sturnus vulgaris*		Visitant	Accidental
Orange-crowned Warbler	*Vermivora celata*		Visitant	Casual
Yellow Warbler	*Dendroica petechia*		Visitant	Casual
Black-and-white Warbler	*Mniotilta varia*		Visitant	Accidental
American Redstart	*Setophaga ruticilla*		Visitant	Accidental
Northern Waterthrush	*Seiurus noveboracensis*		Visitant	Accidental
Wilson's Warbler	*Wilsonia pusilla*		Visitant	Casual
American Tree Sparrow	*Spizella arborea*	misapsaq	Breeder	Uncommon
Savannah Sparrow	*Passerculus sandwichensis*	ukpisiuyuk	Breeder	Uncommon
Fox Sparrow	*Passerella iliaca*	ikligvik	Visitant	Casual
Lincoln's Sparrow	*Melospiza lincolnii*		Visitant	Casual
White-throated Sparrow	*Zonotrichia albicollis*		Visitant	Casual
Golden-crowned Sparrow	*Zonotrichia atricapilla*	qiaranatuuq	Visitant	Casual
White-crowned Sparrow	*Zonotrichia leucophrys*	nunaktuagruk	Breeder	Rare
Harris's Sparrow	*Zonotrichia querula*		Visitant	Accidental
Dark-eyed Junco	*Junco hyemalis*	kayatavaurak	Visitant	Casual
Lapland Longspur	*Calcarius lapponicus*	qupaluk, putukiuluk	Breeder	Abundant
Smith's Longspur	*Calcarius pictus*	qalguusiqsuuq	Visitant	Casual
Snow Bunting	*Plectrophenax nivalis*	amaulligaaluk	Breeder	Uncommon
Rusty Blackbird	*Euphagus carolinus*	tulukkatun ittuq	Visitant	Casual
Common Redpoll	*Carduelis flammea*	saksakiq	Breeder?	Uncommon
Hoary Redpoll	*Carduelis hornemanni*	saksakiq	Breeder	Uncommon

[a] Status definitions (Kessel and Gibson 1978):

resident — a species present throughout the year; known to breed
migrant — a seasonal transient between wintering and breeding ranges
breeder — a species known to breed; ? indicates probable or possible breeding
visitant — a nonbreeding species; also, in fall, one not directly en route between breeding and wintering ranges

[b] Abundance definitions:

abundant — species occurs repeatedly in appropriate habitats, with available habitat heavily used
common — species occurs in all or nearly all appropriate habitats, but some areas of presumed suitable habitats are occupied sparsely or not at all
uncommon — species occurs regularly, but uses little of the suitable habitat, not observed regularly even in apppropriate habitats
rare — species within its normal range, occurring regularly but in very small numbers
casual — a species beyond its normal range, but not so far that irregular observations are likely over a period of years; usually occurs in small numbers
accidental — a species so far from its normal range that further observations are unlikely; usually occurs singly

Sources:

Kessel and Gibson (1978); Simpson et al. (1982); Renken et al. (1983); Rothe et al. (1983); North et al. (1984); Meehan (1988); Nickles et al. (1987); Gerhardt et al. (1988); Andres (1989); Johnson and Herter (1989); Smith et al. (1993, 1994); Hohenberger et al. (1994); Johnson et al. (1996, 1997); ABR (unpublished data)

APPENDIX I-3

BIRD DENSITY

Appendix I-3, Table 1. Densities (birds/mi^2) of birds during the breeding season (June–July) at selected locations on the Arctic Coastal Plain of Alaska. Data from locations in bold type are portrayed in Figures 4.4.2-3 and 4.4.2-9.

Species	Meade River delta[a]	**Teshekpuk Lake[b]**	**East Long Lake[a]**	Island Lake[a]	Goose Lake[b]	**Colville River Delta[b]**	**Kuparuk 3L[c]**	Kuparuk 1M[c]	Eileen West End[d]	**Storkersen Point[a]**	Pt. McIntyre Reference Area[e]	GHX-1[f]	**Prudhoe Bay - Roads[d]**	Prudhoe Bay - Interior[d]	**Sagavanirktok River delta[d]**	**Canning River delta[g]**	Okpilak River delta[h]
Waterbirds																	
Yellow-billed Loon	0	0	0	0	0	0.9	0	0	0	0	0	0	0	0	0	0.3	0
Pacific Loon	5.4	5.0	3.6	2.1	6.0	3.9	11.4	8.0	0	4.7	6.1	2.1	0.8	3.4	0	7.5	3.4
Red-throated Loon	0.5	2.4	2.3	0.3	0.6	1.5	1.6	0	0	1.6	0.5	0.3	0.5	3.4	0	1.8	4.9
Total Loons	6.0	7.4	6.0	2.3	6.6	6.3	13.0	8.0	0	6.2	6.6	2.4	1.3	6.7	0	9.6	8.3
Tundra Swan	0.5	0.6	0.5	0	0.5	2.9	1.3	0	0	0.5	0.1	0.4	1.0	0.0	0	3.1	0.5
Canada Goose	0	7.7	6.5	17.1	4.4	0.3	0.3	0.3	0	0	0.6	9.8	7.5	3.9	0	14.0	0
Brant	0.8	6.3	18.6	24.9	6.6	10.2	0.3	0	0	1.3	0.1	10.9	1.8	0.0	0	3.6	0
Greater White-fronted Goose	1.8	4.2	2.6	2.3	13.5	16.3	12.7	27.2	6.0	4.1	8.2	9.8	45.8	9.3	0	0	0
Total Geese	2.6	18.1	27.7	44.3	24.5	26.8	13.2	27.5	6.0	5.4	8.9	30.4	55.2	13.2	0	17.6	0
Mallard	0	0	0	0	0	0.5	0	0	0	0	0	0.4	0	0	0	0	0
Northern Pintail	13.2	56.6	30.6	6.0	11.2	43.0	4.7	2.8	0	26.4	7.1	7.4	5.7	3.1	1.0	11.7	2.1
American Wigeon	0	0.1	0	0	0	1.9	0	0	0	0	0	0.2	0	0	0	4	0
Northern Shoveler	0	0	0	0	0	0.7	0	0	0	0	0	0.2	0	0	0	0	0
Green-winged Teal	0	0	0	0	0	0.6	0	0	0	0	0	0.1	0	0	0	0	0
Greater Scaup	0	0	0	0	0	0.8	0	0	0	0	0	0	1.6	0	0	0	0
Common Eider	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.8	0
King Eider	0.3	0.8	0.5	0.8	1.9	2.1	18.1	13.0	4.4	5.4	8.6	3.2	5.2	2.8	1.0	8.5	0.3
Spectacled Eider	0.8	2.0	1.6	0.3	4.0	2.5	0	0	2.1	0.5	0.7	1.2	6.0	1.0	0	1.8	0
Oldsquaw	2.8	5.4	8.3	6.0	10.5	19.3	22.0	21.0	6.5	5.2	13.6	2.5	16.3	10.4	18.4	12.7	9.8
Total Ducks	17.1	64.9	41.1	13.0	27.7	71.4	44.8	36.8	13.0	37.6	29.9	15.1	34.7	17.4	20.5	39.1	12.4
Total Waterbirds	26.2	90.9	75.2	59.6	59.3	107.4	72.3	72.3	18.9	49.7	45.6	48.3	92.2	37.3	20.5	69.4	21.2
Shorebirds																	
Willow Ptarmigan	0.3	0.1	0	0	0.5	2.2	3.6	12.4	0	0	0.7	0	2.6	0	0	0	5.2
Rock Ptarmigan	0	0	0	1.0	0	0.8	2.3	17.6	5.4	0.1	3.0	0	10.1	10.1	3.4	0	1.3
Total Ptarmigan	0.3	0.1	0	1.0	0.5	3.0	6.0	30.0	5.4	0.1	3.7	0	12.7	10.1	3.4	0	6.5

Appendix I-3, Table 1. Densities (birds/mi²) of birds during the breeding season (June–July) at selected locations on the Arctic Coastal Plain of Alaska.
Data from locations in bold type are portrayed in Figures 4.4.2-3 and 4.4.2-9.

Species	Meade River delta[a]	Teshekpuk Lake[b]	East Long Lake[a]	Island Lake[a]	Goose Lake[b]	Colville River Delta[b]	Kuparuk 3L[c]	Kuparuk 1M[c]	Eileen West End[d]	Storkersen Point[a]	Pt. McIntyre Reference Area[e]	GHX-1[f]	Prudhoe Bay - Roads[d]	Prudhoe Bay - Interior[d]	Sagavanirktok River delta[d]	Canning River delta[g]	Okpilak River delta[h]
Black-bellied Plover	16.3	-	7.3	4.4	-	11.6	26.2	29.8	8.5	4.9	3.0	-	3.6	5.7	5.4	0.0	0
American Golden Plover	0	-	7.0	1.6	-	17.7	14.2	20.2	15.5	13.1	19.4	-	4.9	13.5	9.8	5.9	7.7
Eurasian Dotterel	0	-	0	0	-	0	0	0	0	0	<0.1	-	0	0	0	0	0
Whimbrel	0	-	0	0	-	0.4	0.5	0	2.6	0	<0.1	-	0	0.8	0	0	0
Bar-tailed Godwit	0	-	0.3	0	-	3.9	0	0	0	0	0	-	0	0	0	0	0
Ruddy Turnstone	0	-	0.3	0.8	-	11.9	0	0	2.6	4.5	1.0	-	0.8	0	7.5	0	0
Sanderling	0	-	0	0	-	0	0	0	0	0	<0.1	-	0.5	0	0	0	0
Semipalmated Sandpiper	18.1	-	12.2	3.6	-	131.4	99.7	160.8	131.1	37.3	76.5	-	98.9	138.3	53.9	51.5	16.3
Least Sandpiper	0	-	0	0	-	0	0	0	0	0	0	-	0	0	0	0	1.0
Western Sandpiper	0	-	0	0	-	0	0.5	0	0	0	0.3	-	0	1.3	0	0	0
White-rumped Sandpiper	0	-	0	0	-	0	0	0	0.5	0	6.7	-	1.0	0	0	0	0
Baird's Sandpiper	0	-	0.3	0	-	0	0	0.3	0	4.7	2.4	-	1.0	0	17.4	2.5	0
Pectoral Sandpiper	59.3	-	71.0	33.7	-	111.4	148.4	79.5	57.8	57.5	80.1	-	42.0	71.5	48.7	74.0	109.8
Dunlin	54.6	-	37.3	33.2	-	43.6	36.0	35.0	32.4	40.4	48.6	-	16.8	37.3	2.1	25.2	0
Stilt Sandpiper	0	-	0	0	-	0	22.3	22.0	21.5	0	4.9	-	14.8	23.1	0	0.8	0
Buff-breasted Sandpiper	0	-	0	0	-	6.2	21.5	16.3	17.9	5.7	12.2	-	5.4	13.2	22.8	17.7	3.2
Long-billed Dowitcher	9.6	-	7.3	1.0	-	2.3	41.7	16.8	7.0	2.6	10.6	-	10.4	7.5	0	0	9.1
Red-necked Phalarope	10.9	-	30.6	2.6	-	78.6	7.3	18.4	14.5	6.7	17.8	-	60.3	28.7	21.5	11.7	37.8
Red Phalarope	53.4	-	75.4	35.5	-	39.3	62.4	14.0	22.8	68.4	34.7	-	10.4	11.7	31.3	55.8	47.6
Total Shorebirds	222.7	-	248.6	116.3	-	458.3	480.7	413.1	334.6	245.8	318.5	-	270.9	352.5	220.4	220.4	232.3
Gulls, Jaegers and Terns																	
Parasitic Jaeger	1.0	0.6	1.0	0	1.5	2.7	5.4	4.7	10.9	0.1	5.9	-	3.6	4.7	1.0	1.8	2.8
Pomarine Jaeger	0.5	0.2	0	0.3	0.4	2.1	0.8	0.5	2.1	0	0.5	-	0	0	0	0.8	1.0
Long-tailed Jaeger	0.5	0.2	0.5	0	0.2	0.7	2.6	2.1	4.9	0.5	1.9	-	0.5	0.5	4.4	0.3	8.0
Glaucous Gull	2.8	1.2	1.6	3.6	3.0	5.4	0.3	1.0	3.4	1.6	0.4	-	1.6	2.1	0	4.1	1.3
Sabine's Gull	1.8	0.5	0.8	0	2.1	1.7	0.1	2.6	0	0	0.1	-	0	0.8	0	0	0.3
Arctic Tern	1.8	2.6	1.6	0.3	3.7	4.5	0	0.3	0	0	0.5	-	0	0	1.0	1.6	1.6
Total Gulls/Jaegers/Terns	8.5	5.0	5.4	4.1	10.9	17.2	9.2	11.1	21.2	2.2	9.2	-	5.7	8.0	6.5	8.5	15.0
Owls and Ravens																	
Short-eared Owl	-	-	-	0	0	0.3	-	-	0	-	0	-	0	0	-	0.3	0
Snowy Owl	-	-	-	0.3	0.1	0.3	-	-	0.5	-	0.3	-	0	0	-	0	0.3

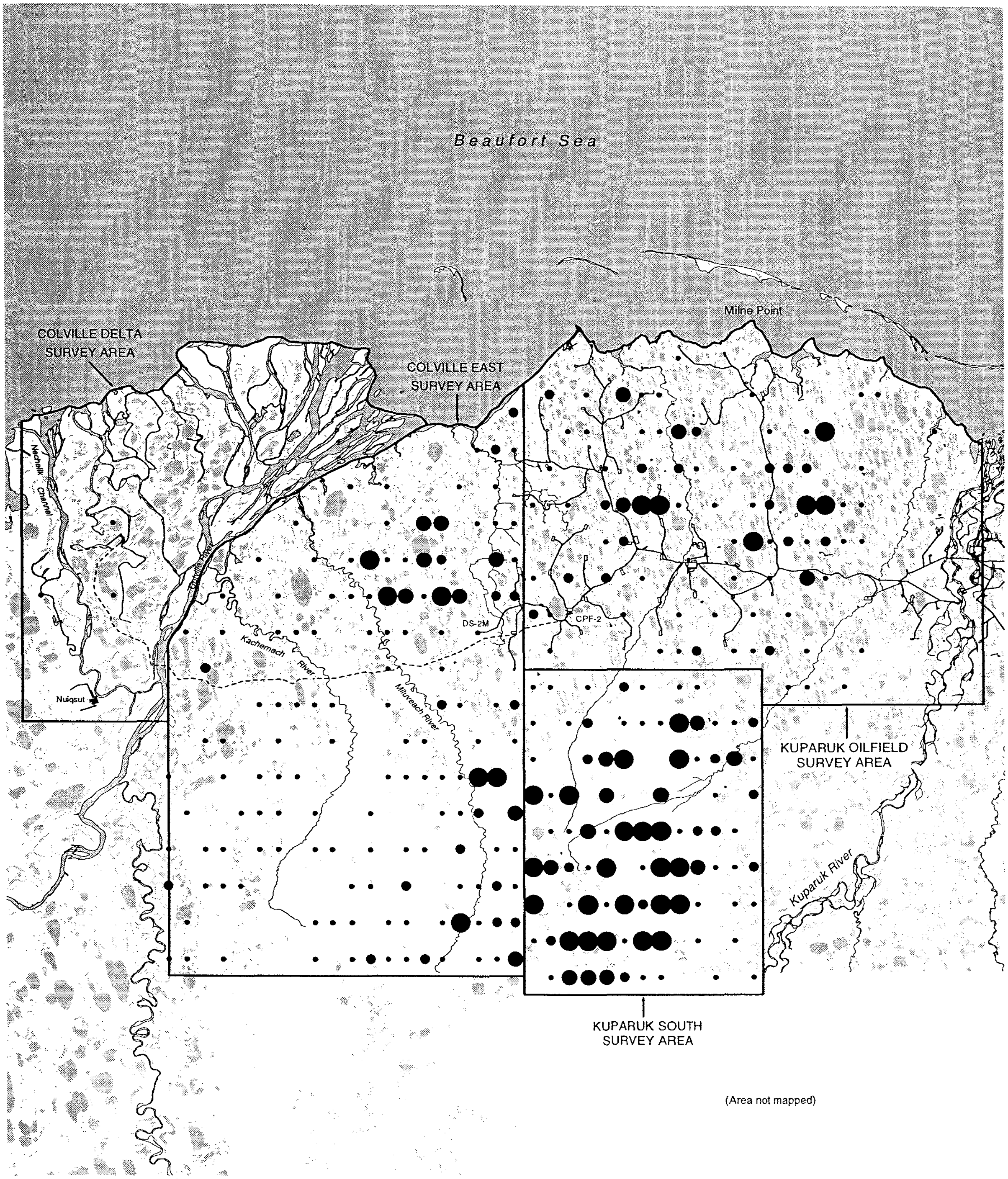
Appendix I-3, Table 1. Densities (birds/mi^2) of birds during the breeding season (June–July) at selected locations on the Arctic Coastal Plain of Alaska. Data from locations in bold type are portrayed in Figures 4.4.2-3 and 4.4.2-9.

Species	Meade River delta[a]	**Teshekpuk Lake[b]**	**East Long Lake[a]**	Island Lake[a]	Goose Lake[b]	**Colville River Delta[b]**	**Kuparuk 3L[c]**	Kuparuk 1M[c]	Eileen West End[d]	**Storkersen Point[a]**	Pt. McIntyre Reference Area[e]	GHX-1[f]	**Prudhoe Bay - Roads[d]**	Prudhoe Bay - Interior[d]	**Sagavanirktok River delta[d]**	**Canning River delta[g]**	Okpilak River delta[h]
Common Raven	-	-	-	0	0	0	-	-	0	-	0.1	-	0.3	0.5	-	0.3	0
Total Owls/Raven	-	-	-	0.3	0	0.5	-	-	0.5	-	0.3	-	0.3	0.5	-	0.3	0.3

[a] Source: Derksen et al. 1981
[b] Source: Rothe et al. 1983
[c] Source: Moitoret et al. 1996
[d] Source: Troy 1988
[e] Source: TERA 1993
[f] Source: Anderson et al. 1992
[g] Source: Martin and Moitoret 1981
[h] Source: Spindler 1978

APPENDIX I-4

CARIBOU, MOSKOXEN, AND BEAR SEASONAL DISTRIBUTION AND BIRD AND MAMMAL DENSITY AND DIVERSITY



Source: Johnson et al. (1996), using AeroMap/USGS base map

ABR File: TOTSV2RF.PRJ

N

SCALE IN MILES

0 4 8

Caribou/mi²

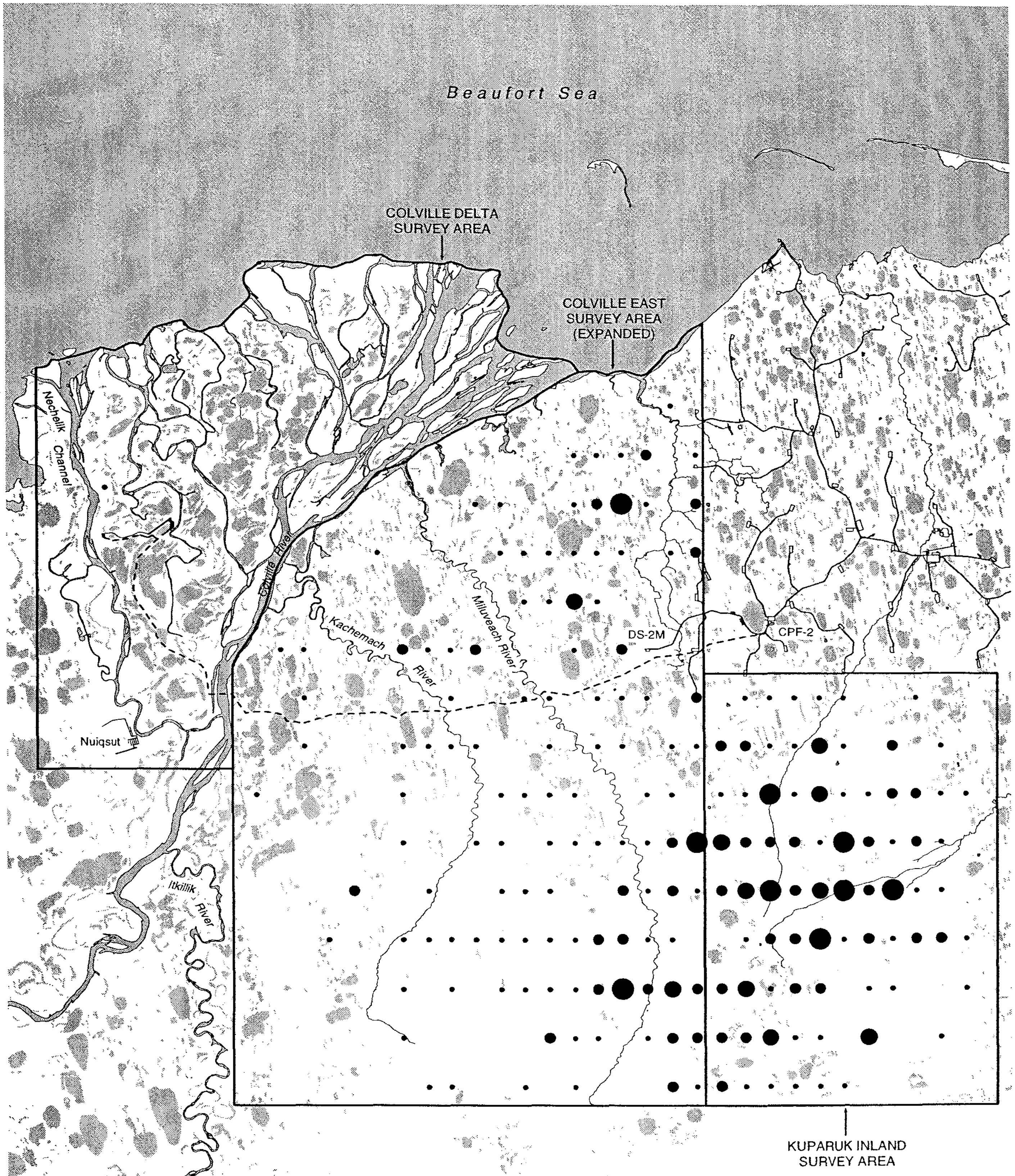
- <13
- 13 - 26
- 26 - 39
- >39

Proposed Project

■ In-field Facilities

---- Pipelines

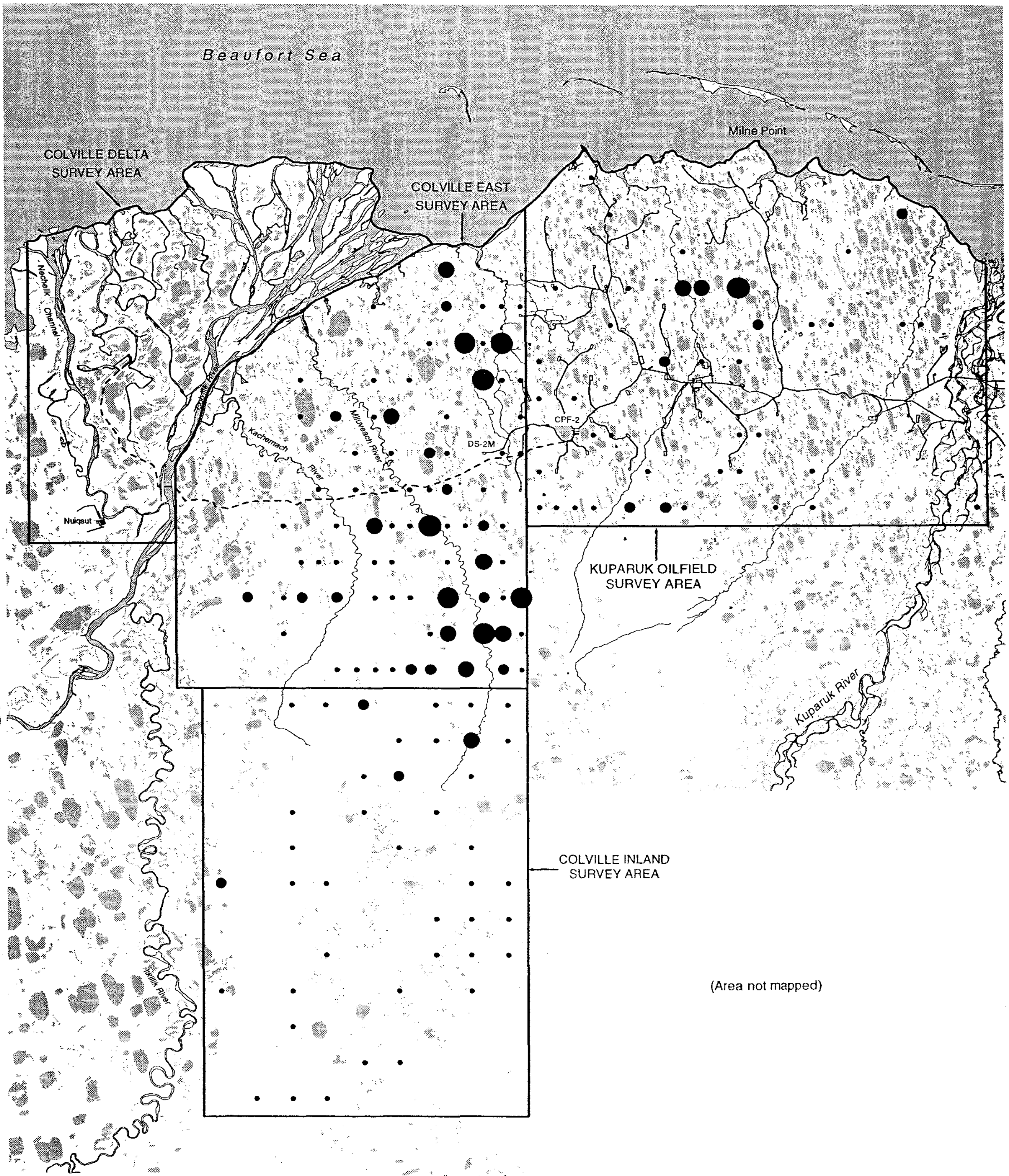
Appendix I-4, Figure 1. Caribou Calving Distribution and Density, 9-13 June 1996



Source: Johnson et al. (1996), using AeroMap/USGS base map

ABR File: BOUCAVRF.PRJ

Appendix I-4, Figure 2. Caribou Calving Distribution and Density, 12-13 June 1995



Source: Johnson et al. (1996), using AeroMap/USGS base map

ABR File: 93COLCAR.PRJ

N

SCALE IN MILES

0 4 8

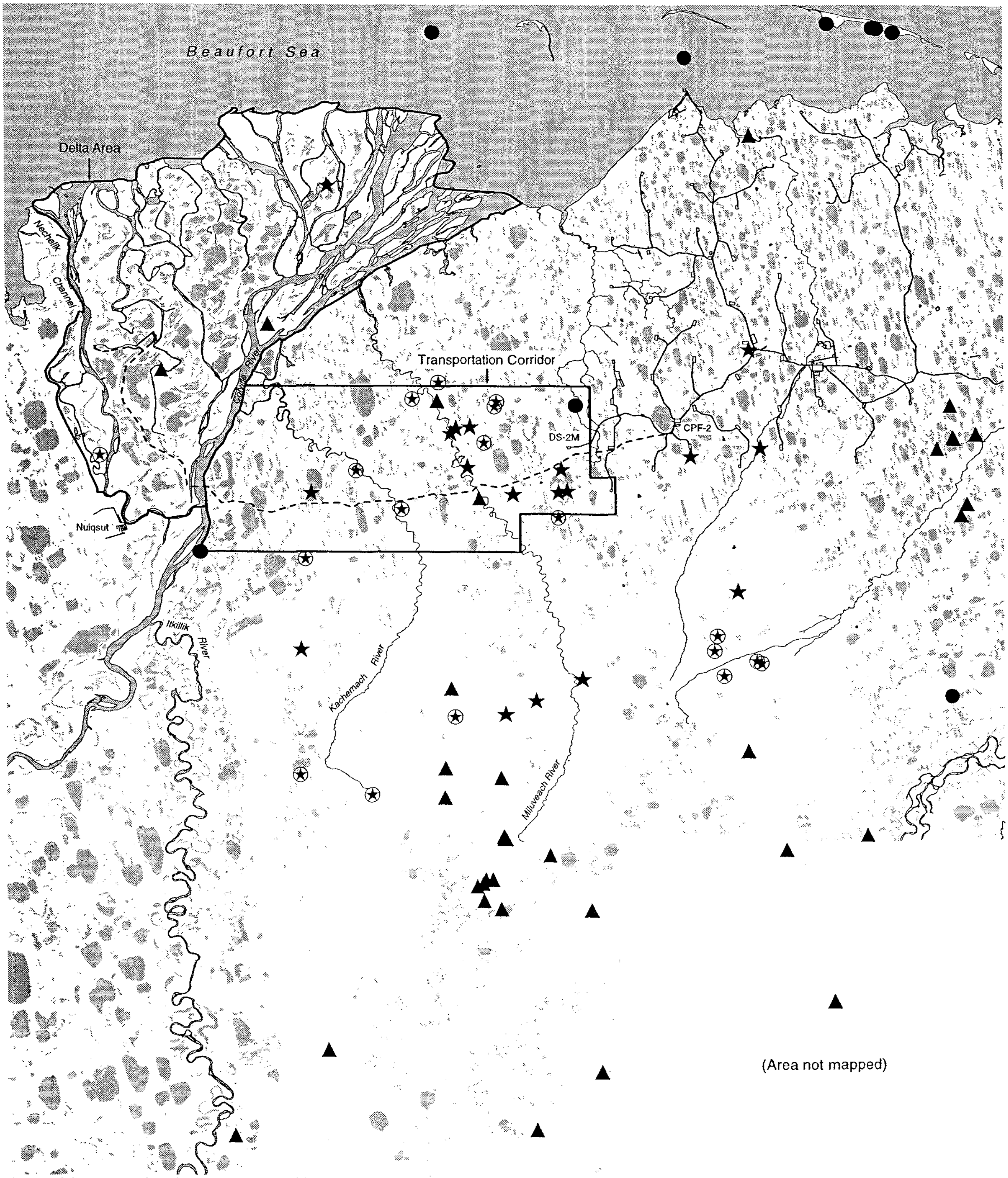
Caribou/mi^2

- <13
- 13 - 26
- 26 - 39
- >39

Proposed Project

- In-field Facilities
- ---- Pipelines

Appendix I-4, Figure 3. Caribou Calving Distribution and Density, 10-15 June 1993



Source: Johnson et al. (1996), using AeroMap/USGS base map

ABR File: BEARS_RF.PRJ

N

SCALE IN MILES

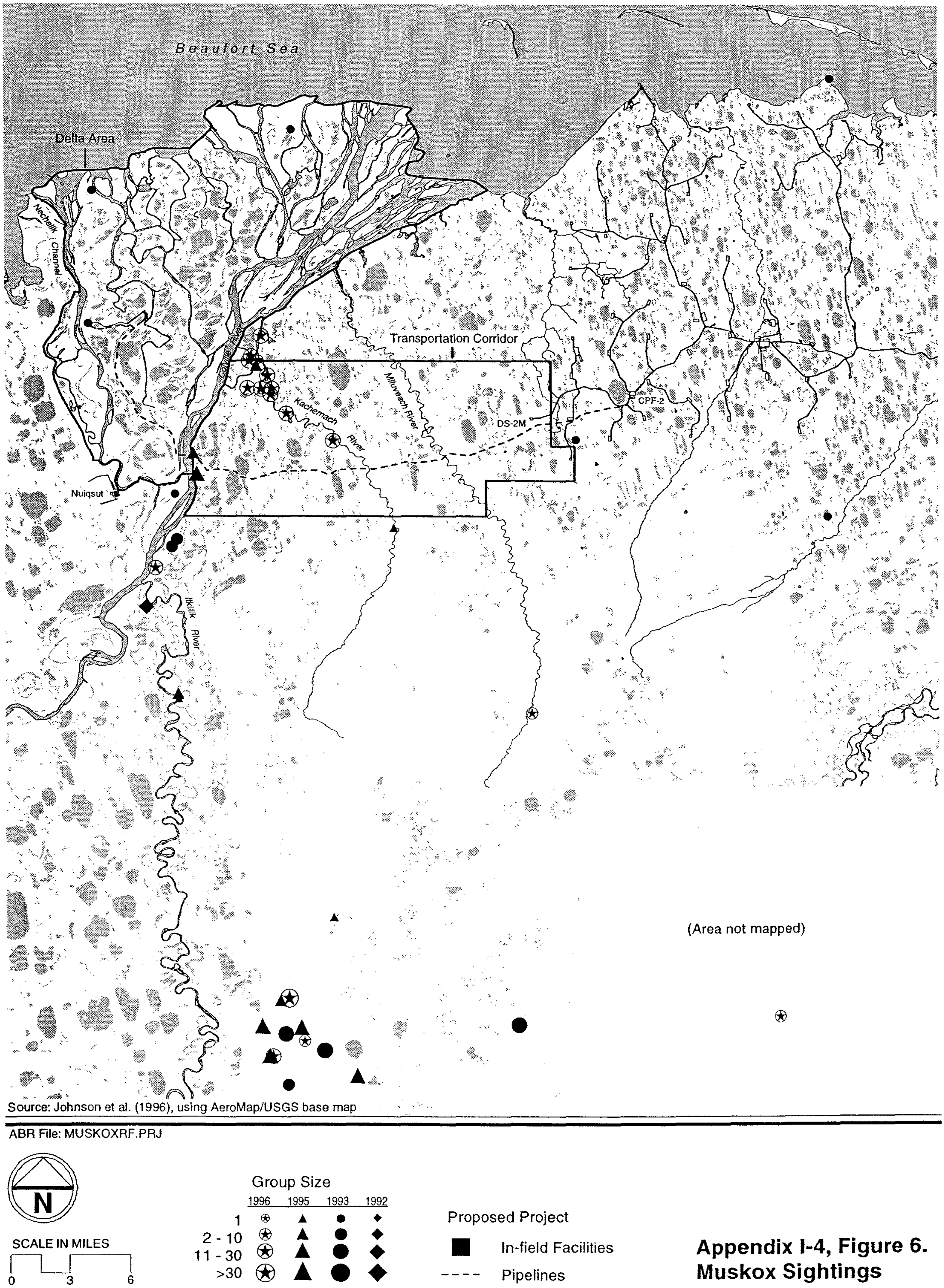
0 3 6

- Grizzly Bear Sighting (1996)
- Grizzly Bear Sighting (1995)
- Grizzly Bear Den
- Polar Bear Den

Proposed Project

- In-field Facilities
- Pipelines

Appendix I-4, Figure 5.
Bear Dens and Sightings



**Appendix I-4, Figure 6.
Muskox Sightings**

Appendix I-4, Table 1. Breeding-season densities (birds/mi^2 in June–July) of five species of birds (for which the Colville River delta provides regionally important breeding habitats) at selected locations on the Arctic Coastal Plain of Alaska.

Species	Meade River Delta[a]	Teshekpuk Lake 1977[b]	East Long Lake[a]	Island Lake[a]	Goose lake 1978[b]	**Colville River Delta[b]**	Kuparuk DS-3L[e]	Kuparuk DS-1M[e]	Eileen West End[d]	Storkersen Point[a]	Pt. McIntyre Reference Area[c]	PBU (GHX-1)[h]	PBU (Roads)[d]	PBU (Interior)[d]	Sagavanirktok Delta[d]	Canning River Delta[f]	Okpilak River (average of 4 plots)[g]
Yellow-billed Loon						0.9										0.3	
Tundra Swan	0.5	0.6	0.5		0.5	2.9	1.3			0.5	0.1	0.4	1.0			3.1	0.5
Brant	0.8	6.3	18.6	24.9	6.6	10.2	0.3			1.3	0.1	10.9	1.8			3.6	
Greater White-fronted Goose	1.8	4.2	2.6	2.3	13.5	16.3	12.7	27.2	6.0	4.1	8.2	9.8	45.8	9.3			
Bar-tailed Godwit			0.3			3.9											
No. of Years of Data	1	1	2	1	1	1	5	5	1	2	10	2	1	1	1	1	1

[a] Source: Derksen et al. 1981

[b] Source: Rothe et al. 1983

[c] Source: TERA 1993

[d] Source: Troy 1986

[e] Source: Moiteret et al. 1996

[f] Source: Martin and Moiteret 1981

[g] Source: Spindler 1978

[h] Source: Anderson et al. 1992

Appendix I-4, Table 2. Diversity of habitat use on the Colville River Delta by selected birds (subsistence-use species are italicized).

Habitat Type	Yellow-billed Loon [a]	*Tundra Swan* [a]	*Brant* [a]	Spectacled Eider [a]	*King Eider* [a]	Red-throated Loon	Pacific Loon	*Greater White-fronted Goose*	*Canada Goose*	*Northern Pintail*	*Green-winged Teal*	*Oldsquaw*
Open Nearshore Water (marine)	–		•		•							•
Brackish Water		•	•	•		•	•	•	•	•		•
Tapped Lake with Low-water Connection		•		•	•		•	•	•	•		•
Tapped Lake with High-water Connection	•	•		•	•		•	•	•	•		•
Salt Marsh		•	•	•			•	•				
Tidal Flat			•		•							
Salt-killed Tundra		•	•	•	•	•	•	•		•		•
Deep Open Water without Islands	•	•		•		•	•	•		•		•
Deep Open Water with Islands or Polygonized Margins	•	•	•	•		•	•	•				•
Shallow Open Water without Islands		•		•		•	•			•		•
Shallow Open Water with Islands or Polygonized Margins		•		•		•	•			•		•
River or Stream			•		•			•				•
Aquatic Sedge with Deep Polygons	•	•	•	•	•	•	•	•		•	•	•
Aquatic Grass Marsh	•	•	•	•		•	•			•	•	•
Young Basin Wetland Complex	–		–			•		•		•		•
Old Basin Wetland Complex	–		–									
Nonpatterned Wet Meadow	•	•		•	•	•	•	•				•
Wet Sedge–Willow Meadow	•	•	•	•	•	•	•	•		•	•	•
Moist Sedge–Shrub Meadow		•				•	•	•				•
Moist Tussock Tundra												
Riverine or Upland Shrub		•						•				
Barrens (riverine, eolian, or lacustrine)			•		•							
Artificial (water, fill, peat road)	–									•		

[a] Based on statistical analysis of habitat use versus availability (Johnson et al. 1997); dashes indicate habitats not available in the area surveyed.
Information on habitat use for other species was obtained from Simpson et al. (1982), Rothe et al. (1983), Nickles et al. (1987), Gerhardt et al. (1988), Meehan (1988), Andres (1989), and ABR (unpublished data) for studies on the Colville River Delta and from Bergman et al. (1977) and Derksen et al. (1981) for regional use.

Appendix I-4, Table 2. Diversity of habitat use on the Colville River Delta by selected birds (subsistence-use species are italicized).

Habitat Type	*Mallard*	*Greater Scaup*	*American Wigeon*	*Surf Scoter*	*White-winged Scoter*	*Red-breasted Merganser*	*Willow Ptarmigan*	*Rock Ptarmigan*	Semi-palmated Sandpiper[b]	Pectoral Sandpiper[c]
Open Nearshore Water (marine)										
Brackish Water			•	•						
Tapped Lake with Low-water Connection			•		•					
Tapped Lake with High-water Connection			•		•					
Salt Marsh									•	•
Tidal Flat			•						•	•
Salt-killed Tundra										
Deep Open Water without Islands		•	•			•				
Deep Open Water with Islands or Polygonized Margins		•	•			•				
Shallow Open Water without Islands										
Shallow Open Water with Islands or Polygonized Margins										
River or Stream	•	•	•	•	•	•				
Aquatic Sedge with Deep Polygons	•	•	•						•	•
Aquatic Grass Marsh	•	•			•	•			•	•
Young Basin Wetland Complex		•								•
Old Basin Wetland Complex							•	•	•	•
Nonpatterned Wet Meadow							•			•
Wet Sedge–Willow Meadow									•	•
Moist Sedge–Shrub Meadow							•	•	•	•
Moist Tussock Tundra							•	•	•	•
Riverine or Upland Shrub							•	•		
Barrens (riverine, eolian, or lacustrine)							•	•	•	•
Artificial (water, fill, peat road)									•	•

[b] Based on statistical analysis of habitat use versus availability for nests and encounters during breeding season (Troy 1988).

[c] Based on analysis of habitat use versus availability for encounters (insufficient data for nest analyses) during breeding season (Troy 1988).

Information on habitat use for all other species was obtained from Simpson et al. (1982), Rothe et al. (1983), Nickles et al. (1987), Gerhardt et al. (1988), Meehan (1988), and Andres (1989) for studies on the Colville River Delta and from Bergman et al. (1977) and Derksen et al. (1981) for regional use.

Appendix I-4, Table 2. Diversity of habitat use on the Colville River Delta by selected birds (subsistence-use species are italicized).

Habitat Type	Dunlin[b]	Stilt Sandpiper[c]	Red-necked Phalarope[c]	Red Phalarope[b]	Black-bellied Plover	American Golden Plover	Ruddy Turnstone	Long-billed Dowitcher	Baird's Sandpiper	Buff-breasted Sandpiper	Semi-palmated Plover
Open Nearshore Water (marine)											
Brackish Water		•					•				
Tapped Lake with Low-water Connection			•								
Tapped Lake with High-water Connection			•								
Salt Marsh		•	•	•	•	•	•	•		•	
Tidal Flat	•	•	•	•	•	•	•	•	•		•
Salt-killed Tundra											
Deep Open Water without Islands			•								
Deep Open Water with Islands or Polygonized Margins			•								
Shallow Open Water without Islands			•								
Shallow Open Water with Islands or Polygonized Margins			•								
River or Stream											
Aquatic Sedge with Deep Polygons	•		•	•		•					
Aquatic Grass Marsh	•		•	•							
Young Basin Wetland Complex	•		•	•	•		•				
Old Basin Wetland Complex	•		•	•							
Nonpatterned Wet Meadow	•	•	•	•							
Wet Sedge–Willow Meadow	•	•	•	•		•		•		•	
Moist Sedge–Shrub Meadow	•	•	•	•	•	•	•	•	•	•	
Moist Tussock Tundra	•										
Riverine or Upland Shrub					•						
Barrens (riverine, eolian, or lacustrine)			•	•	•	•	•			•	•
Artificial (water, fill, peat road)	•		•	•							

[b] Based on statistical analysis of habitat use versus availability for nests and encounters during breeding season (Troy 1988).

[c] Based on analysis of habitat use versus availability for encounters (insufficient data for nest analyses) during breeding season (Troy 1988).

Information on habitat use for all other species was obtained from Simpson et al. (1982), Rothe et al. (1983), Nickles et al. (1987), Gerhardt et al. (1988), Meehan (1988), and Andres (1989) for studies on the Colville River Delta and from Bergman et al. (1977) and Derksen et al. (1981) for regional use.

Appendix I-4, Table 2. Diversity of habitat use on the Colville River Delta by selected birds (subsistence-use species are italicized).

Habitat Type	Whimbrel	Bar-tailed Godwit	Sanderling	Glaucous Gull	Sabine's Gull	Parasitic Jaeger	Arctic Tern	Yellow Wagtail	American Tree Sparrow	Savannah Sparrow	Lapland Longspur[b]	Common/ Hoary Redpolls
Open Nearshore Water (marine)				•								
Brackish Water			•	•	•							
Tapped Lake with Low-water Connection												
Tapped Lake with High-water Connection												
Salt Marsh	•		•									
Tidal Flat			•	•								
Salt-killed Tundra												
Deep Open Water without Islands				•	•		•					
Deep Open Water with Islands or Polygonized Margins				•	•		•					
Shallow Open Water without Islands												
Shallow Open Water with Islands or Polygonized Margins							•					
River or Stream				•			•					
Aquatic Sedge with Deep Polygons		•		•		•	•				•	
Aquatic Grass Marsh				•	•		•				•	
Young Basin Wetland Complex				•	•	•	•					
Old Basin Wetland Complex											•	
Nonpatterned Wet Meadow											•	
Wet Sedge–Willow Meadow	•	•				•				•	•	
Moist Sedge–Shrub Meadow	•	•				•		•		•	•	
Moist Tussock Tundra											•	
Riverine or Upland Shrub		•						•	•	•	•	•
Barrens (riverine, eolian, or lacustrine)	•		•					•	•		•	•
Artificial (water, fill, peat road)												

[b] Based on statistical analysis of habitat use versus availability for nests and encounters during breeding season (Troy 1988).

Information on habitat use for all other species was obtained from Simpson et al. (1982), Rothe et al. (1983), Nickles et al. (1987), Gerhardt et al. (1988), Meehan (1988), Andres (1989), and ABR (unpublished data) for studies on the Colville River Delta and from Bergman et al. (1977) and Derksen et al. (1981) for regional use.

Appendix I-4, Table 3. Diversity of habitat use in the Alpine transportation corridor by selected birds (subsistence-use species are italicized).

Habitat Type	*Tundra Swan*[a]	*Spectacled Eider*[a]	*King Eider*[a]	*Red-throated Loon*	*Pacific Loon*	*Greater White-fronted Goose*	*Canada Goose*	*Northern Pintail*	*Green-winged Teal*	*Oldsquaw*
Tapped Lake with High-water Connection						•	•	•		•
Deep Open Water without Islands	•	•	•		•	•				•
Deep Open Water with Islands or Polygonized Margins	•		•		•	•				•
Shallow Open Water without Islands	•		•	•	•			•		•
Shallow Open Water with Islands or Polygonized Margins	•		•	•	•			•		•
River or Stream			•			•				•
Aquatic Sedge Marsh	•		•	•	•	•		•	•	•
Aquatic Sedge with Deep Polygons				•	•	•		•	•	•
Aquatic Grass Marsh	•			•	•			•	•	•
Young Basin Wetland Complex	•	•	•	•	•	•		•		•
Old Basin Wetland Complex	•		•		•					
Nonpatterned Wet Meadow	•	•	•		•					
Wet Sedge–Willow Meadow	•			•	•	•		•		
Moist Sedge–Shrub Meadow		•			•					
Moist Tussock Tundra										
Riverine or Upland Shrub	•		•			•				
Barrens (riverine, eolian, or lacustrine)			•							
Artificial (water, fill, peat road)								•		

[a] Based on statistical analysis of habitat use versus availability (Johnson et al. 1997).

Information on habitat use for all other species was obtained from Simpson et al. (1982), Rothe et al. (1983), Nickles et al. (1987), Gerhardt et al. (1988), Meehan (1988), Andres (1989), and ABR (unpublished data) for studies on the Colville River Delta and from Bergman et al. (1977) and Derksen et al. (1981) for regional use.

Appendix I-4, Table 3. Diversity of habitat use in the Alpine transportation corridor by selected birds (subsistence-use species are italicized).

Habitat Type	*Mallard*	*Greater Scaup*	*American Wigeon*	*Surf Scoter*	*White-winged Scoter*	*Red-breasted Merganser*	*Willow Ptarmigan*	*Rock Ptarmigan*	Semi-palmated Sandpiper[b]	Pectoral Sandpiper[c]
Tapped Lake with High-water Connection			•		•					
Deep Open Water without Islands		•	•			•				
Deep Open Water with Islands or Polygonized Margins		•	•			•				
Shallow Open Water without Islands										
Shallow Open Water with Islands or Polygonized Margins										
River or Stream	•	•	•	•	•	•				
Aquatic Sedge Marsh	•	•	•						•	•
Aquatic Sedge with Deep Polygons	•	•	•						•	•
Aquatic Grass Marsh	•	•			•	•			•	•
Young Basin Wetland Complex		•								•
Old Basin Wetland Complex							•	•	•	•
Nonpatterned Wet Meadow							•			•
Wet Sedge–Willow Meadow									•	•
Moist Sedge–Shrub Meadow							•	•	•	•
Moist Tussock Tundra							•	•	•	•
Riverine or Upland Shrub							•	•		
Barrens (riverine, eolian, or lacustrine)							•	•	•	•
Artificial (water, fill, peat road)									•	•

[b] Based on statistical analysis of habitat use versus availability for nests and encounters during breeding season (Troy 1988).

[c] Based on analysis of habitat use versus availability for encounters (insufficient data for nest analyses) during breeding season (Troy 1988).

Information on habitat use for all other species was obtained from Simpson et al. (1982), Rothe et al. (1983), Nickles et al. (1987), Gerhardt et al. (1988), Meehan (1988), and Andres (1989) for studies on the Colville River Delta and from Bergman et al. (1977) and Derksen et al. (1981) for regional use.

Appendix I-4, Table 3. Diversity of habitat use in the Alpine transportation corridor by selected birds (subsistence-use species are italicized).

Habitat Type	Dunlin[b]	Stilt Sandpiper[c]	Red-necked Phalarope[c]	Red Phalarope[b]	Black-bellied Plover	American Golden Plover	Ruddy Turnstone	Long-billed Dowitcher	Baird's Sandpiper	Buff-breasted Sandpiper	Semi-palmated Plover
Tapped Lake with High-water Connection			•								
Deep Open Water without Islands			•								
Deep Open Water with Islands or Polygonized Margins			•								
Shallow Open Water without Islands			•								
Shallow Open Water with Islands or Polygonized Margins			•								
River or Stream											
Aquatic Sedge Marsh	•		•	•							
Aquatic Sedge with Deep Polygons	•		•	•		•					
Aquatic Grass Marsh	•		•	•							
Young Basin Wetland Complex	•		•	•	•		•				
Old Basin Wetland Complex	•		•	•							
Nonpatterned Wet Meadow	•	•	•	•							
Wet Sedge–Willow Meadow	•	•	•	•		•		•		•	
Moist Sedge–Shrub Meadow	•	•	•	•	•	•	•	•	•	•	
Moist Tussock Tundra	•										
Riverine or Upland Shrub					•						
Barrens (riverine, eolian, or lacustrine)			•	•	•	•	•			•	•
Artificial (water, fill, peat road)	•		•	•							

[b] Based on statistical analysis of habitat use versus availability for nests and encounters during breeding season (Troy 1988).

[c] Based on analysis of habitat use versus availability for encounters (insufficient data for nest analyses) during breeding season (Troy 1988).

Information on habitat use for all other species was obtained from Simpson et al. (1982), Rothe et al. (1983), Nickles et al. (1987), Gerhardt et al. (1988), Meehan (1988), and Andres (1989) for studies on the Colville River Delta and from Bergman et al. (1977) and Derksen et al. (1981) for regional use.

Appendix I-4, Table 3. Diversity of habitat use in the Alpine transportation corridor by selected birds (subsistence-use species are italicized).

Habitat Type	Whimbrel	Bar-tailed Godwit	Sanderling	Glaucous Gull	Sabine's Gull	Parasitic Jaeger	Arctic Tern	Yellow Wagtail	American Tree Sparrow	Savannah Sparrow	Lapland Longspur[b]	Common/Hoary Redpolls
Tapped Lake with High-water Connection												
Deep Open Water without Islands				•	•		•					
Deep Open Water with Islands or Polygonized Margins				•			•					
Shallow Open Water without Islands												
Shallow Open Water with Islands or Polygonized Margins							•					
River or Stream				•			•					
Aquatic Sedge Marsh		•		•		•					•	
Aquatic Sedge with Deep Polygons		•		•		•	•				•	
Aquatic Grass Marsh				•	•		•				•	
Young Basin Wetland Complex				•	•	•	•					
Old Basin Wetland Complex											•	
Nonpatterned Wet Meadow											•	
Wet Sedge–Willow Meadow	•	•								•	•	
Moist Sedge–Shrub Meadow	•	•				•		•		•	•	
Moist Tussock Tundra											•	
Riverine or Upland Shrub		•						•	•	•	•	•
Barrens (riverine, eolian, or lacustrine)	•		•					•	•		•	•
Artificial (water, fill, peat road)												

[b] Based on statistical analysis of habitat use versus availability for nests and encounters during breeding season (Troy 1988).
Information on habitat use for all other species was obtained from Simpson et al. (1982), Rothe et al. (1983), Nickles et al. (1987), Gerhardt et al. (1988), Meehan (1988), and Andres (1989) for studies on the Colville River Delta and from Bergman et al. (1977) and Derksen et al. (1981) for regional use.

Appendix I-4, Table 4. Diversity of habitat use on the Colville River Delta by selected mammals (subsistence-use species are italicized), based on habitat use patterns described in the literature (see footnotes).

Habitat Type	*Caribou*[a]	*Arctic & Red Foxes* (dens)[b]	*Brown & Polar Bears* (dens)[c]	*Moose*[d]	*Muskox*[e]	*Spotted Seal*[f]	*Arctic Ground Squirrel*[g]	Collared Lemming[h]	Brown Lemming[h]	Singing Vole[h]	Tundra Vole[h]
Open Nearshore Water (marine)						•					
Brackish Water											
Tapped Lake with Low-water Connection											
Tapped Lake with High-water Connection											
Salt Marsh	•										
Tidal Flat	•					•					
Salt-killed Tundra	•										
Deep Open Water without Islands											
Deep Open Water with Islands or Polygonized Margins											
Shallow Open Water without Islands											
Shallow Open Water with Islands or Polygonized Margins											
River or Stream						•					
Aquatic Sedge with Deep Polygons											
Aquatic Grass Marsh											
Young Basin Wetland Complex	•							•	•		
Old Basin Wetland Complex	•		•		•		•	•			
Nonpatterned Wet Meadow	•	•							•		•
Wet Sedge–Willow Meadow	•	•			•			•	•		•
Moist Sedge–Shrub Meadow	•	•	•	•	•		•	•		•	
Moist Tussock Tundra	•				•			•			
Riverine or Upland Shrub	•	•	•	•	•		•	•	•	•	•
Barrens (riverine, eolian, or lacustrine)	•					•					
Artificial (water, fill, peat road)	•										

[a] Based on work at Prudhoe Bay (White et al. 1975, Skogland 1980) and at Atqasuk (White and Trudell 1980).

[b] Based on habitat selection analysis for the Colville River Delta, 1992–96 (Johnson et al. 1997).

[c] Based on work in northern Alaska by Amstrup (USFWS and BRD) and Shideler (ADFG) (1995–96 personal communications), and in NWT (Harding 1976).

[d] Based on work in the Colville River drainage (Mould 1977, Coady 1979) and in ANWR (Garner and Reynolds 1986).

[e] Based on work in ANWR (Jingfors 1980, Robus 1981, Garner and Reynolds 1986, O'Brien 1988).

[f] Based on Seaman et al. (1981).

[g] Based on work at Atqasuk (Batzli and Sobaski 1980) and in ANWR (Garner and Reynolds 1986).

[h] Based on Colville River Delta work (Garrott 1980) and other North Slope studies (Pitelka and Batzli 1993).

Appendix I-4, Table 5. Diversity of habitat use in the Alpine transportation corridor by selected mammals (subsistence-use species are italicized), based on habitat use patterns in the literature (see footnotes).

Habitat Type	*Caribou*[a]	*Arctic Fox* (dens)[b]	*Brown & Polar Bears* (dens)[c]	*Moose*[d]	*Muskox*[e]	*Arctic Ground Squirrel*[f]	Collared Lemming[g]	Brown Lemming[g]	Singing Vole[g]	Tundra Vole[g]
Tapped Lake with High-water Connection										
Deep Open Water without Islands										
Deep Open Water with Islands or Polygonized Margins										
Shallow Open Water without Islands										
Shallow Open Water with Islands or Polygonized Margins										
River or Stream										
Aquatic Sedge Marsh										
Aquatic Sedge with Deep Polygons										
Aquatic Grass Marsh										
Young Basin Wetland Complex	•						•	•		
Old Basin Wetland Complex	•	•	•		•	•	•			
Nonpatterned Wet Meadow	•							•		•
Wet Sedge–Willow Meadow	•				•		•	•		•
Moist Sedge–Shrub Meadow	•	•	•	•	•	•	•		•	
Moist Tussock Tundra	•	•			•		•			
Riverine or Upland Shrub	•	•	•	•	•	•	•	•	•	•
Barrens (riverine, eolian, or lacustrine)	•									
Artificial (water, fill, peat road)	•									

[a] Based on work at Prudhoe Bay (White et al. 1975, Skogland 1980) and at Atqasuk (White and Trudell 1980).

[b] Based on habitat selection analysis for the transportation corridor, 1992–96 (Johnson et al. 1997); no red fox dens were found in the transportation corridor.

[c] Based on work in northern Alaska by Amstrup (USFWS and BRD) and Shideler (ADFG) (1995–96 personal communications), and in NWT (Harding 1976).

[d] Based on work in the Colville River drainage (Mould 1977, Coady 1979) and in ANWR (Garner and Reynolds 1986).

[e] Based on work in ANWR (Jingfors 1980, Robus 1981, Garner and Reynolds 1986, O'Brien 1988).

[f] Based on work at Atqasuk (Batzli and Sobaski 1980) and in ANWR (Garner and Reynolds 1986).

[g] Based on Colville River Delta work (Garrott 1980) and other North Slope studies (Pitelka and Batzli 1993).

Alpine Development Project: Environmental Evaluation Document

Prepared for:
U.S. Army Corps of Engineers

Submitted by:
ARCO Alaska, Inc., Operator

Anadarko Petroleum Corporation, Co-Owner

Union Texas Petroleum Alaska Corporation, Co-Owner

APPENDICES - VOLUME 2

September 1997
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VOLUME II APENDICES

Appendix J

APPENDIX J

AAI NUIQSUT AIR QUALITY MONITORING PROGRAM

TECHNICAL SPECIFICATION
AAI NUIQSUT AIR QUALITY
MONITORING PROGRAM

Prepared by

ARCO ALASKA, INC.

Anchorage, Alaska

July 1997

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1.0 INTRODUCTION

ARCO Alaska, Inc. (AAI) proposes to establish a small oil and gas exploration and production complex approximately 14 kilometers (km) north of the native village of Nuiqsut. The project, called the Alpine Development Project, will consist of a small production facility, operating camp, and temporary drilling operation at the production complex and a second drilling site approximately 5 km to the west of the production complex. As a result of the proposed project, representatives of Nuiqsut have expressed interest in characterizing the baseline ambient air impacts in the village from potential long range transport of emissions from oil and gas production facilities at the Kuparuk River Unit (KRU), Prudhoe Bay Unit (PBU), Endicott, and the Milne Point Unit (MPU), all located between 50 km - 110 km east of the village. AAI has conducted a preliminary review of this request and has offered direct assistance in the implementation of a Nuiqsut air quality monitoring program in cooperation with the Alaska Department of Environmental Conservation (ADEC), the North Slope Borough, and the City of Nuiqsut. The spirit of this commitment is to confirm that local ambient air quality impacts at Nuiqsut from regional oil and gas operations are well below significant threshold concentrations and, therefore, do not pose a risk to the health and welfare of the local population.

AAI proposes to establish and operate a single ambient air quality monitoring station within the village to characterize impacts from regional North Slope oil and gas operations. The specific technical objectives of the program are to:

- determine if there are significant detectable air quality impacts at Nuiqsut from existing regional oil and gas operations;

- establish current baseline conditions in the village prior to operation of the Alpine complex; and

- establish potential changes to baseline air quality conditions after the Alpine facility becomes operational.

AAI proposes to conduct the ambient air quality monitoring program strictly following established U.S. Environmental Protection Agency quality assurance (QA) guidelines and the QA requirements of the ADEC. These include:

- *Ambient Monitoring Guidelines for Prevention of Significant Deterioration*

(U.S. EPA 1987).

- *Quality Assurance Handbook for Air Pollution Measurement Systems. Volume II: Ambient Air Specific Methods (Interim Edition)* (U.S. EPA 1994).

- *Quality Assurance Handbook for Air Pollution Measurement Systems. Volume IV: Meteorological Measurements* (U.S. EPA 1995a).

- *On-Site Meteorological Program Guidance for Regulatory Modeling Applications* (U.S. EPA 1995b).

- Code of Federal Register 40 CFR part 59 (U.S. EPA) Ambient Air Quality Surveillance:
  - Appendix A - *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)*
  - Appendix B - *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*
  - Appendix C - *Ambient Air Quality Monitoring Methodology*
  - Appendix E - *Probe Siting Criteria for Ambient Air Quality Monitoring*
- *Alaska Quality Assurance Manual for Ambient Air Quality Monitoring* (ADEC 1996)

AAI has made several assumptions regarding the organization and specifications of the monitoring program. Specifically, AAI will agree to provide the financial resources necessary to establish and operate the station for a period not to exceed 1 year following the official start-up of the Alpine Development Project production facility (proposed start-up is June 2000). Additionally, AAI proposes to request that the ADEC provide quarterly independent systems performance quality assurance audits as required by PSD QA guidelines. Also, AAI would like to identify and contract with a Nuiqsut resident(s) or local subcontractor who will be trained to perform routine inspection, service, and maintenance of the air quality monitoring station under the direction of AAI's air quality contractor.

AAI is very interested in ensuring that the technical objectives of the Nuiqsut air quality monitoring program are met. Therefore, AAI will require a minimum technical specification be met by the program. This specification includes the station configuration and site exposure. The required monitoring parameters for the station will include:

- Nitrogen Oxides (NO_x) as nitrogen dioxide (NO_2) and nitrogen oxide (NO) - This will require an EPA-certified equivalent method continuous sampling gas analyzer. Nitrogen dioxide is the primary criteria pollutant emitted by the gas-fired equipment at the KRU, PBU, and other North Slope oil fields.

- Sulfur Dioxide (SO_2) - This will require an EPA-certified equivalent method continuous sampling gas analyzer. Sulfur compounds present in diesel fuel and natural gas result in SO_2 emissions from combustion sources which burn these fuels.

- Particulate Matter (PM) - Primary particulate emissions from fossil fuel-burning equipment (i.e., turbines, heaters, generators, etc.) are small particles generally less than 10 µm in aerodynamic diameter. Additionally, since impacts from long range transport of emissions from the KRU, PBU, and other North Slope oil fields, are an issue of concern, the contribution to total particulate loading from gas-to-particle conversion (i.e., secondary particulate) due to the formation of nitrate particles from nitrogen dioxide will be of interest. Continuous measurements of particulate matter less than 10 µm (PM_{10}) or less than 2.5 µm ($PM_{2.5}$) will require an EPA-certified equivalent continuous particulate monitor (PM_{10}) or proposed equivalent device in the event $PM_{2.5}$ is selected. (Note: currently the National Ambient Air Quality Standard [NAAQS] for particulate is a PM_{10} standard. There is a new proposed particulate NAAQS which will be a $PM_{2.5}$ standard. However, since $PM_{2.5}$ is a subset of PM_{10}, and in general particulate concentrations on the North Slope of Alaska are very low, PM_{10} would provide higher concentration data and greater precision of the sampling methodology. Therefore $PM_{2.5}$ monitoring is not recommended, but if required in the future the proposed PM_{10} sampler could be easily modified to collect $PM_{2.5}$.)

- Dispersion Meteorology - Fundamental to an ambient measurement program is continuous monitoring of the dispersion meteorological conditions present during observed pollutant impacts. This would include 10-meter wind speed, wind direction, and the standard deviation of wind direction or sigma-theta (σ_Θ), which is a measurement of cross-wind turbulence. These meteorological parameters will aid in the interpretation of the observed air quality data by providing information on plume transport and diffusion. Included in the parameter configuration will be the measurement of ambient temperature, which would be necessary if the Nuiqsut meteorological data were ever used for air quality dispersion modeling.

(Not Recommended)

- Ozone (O_3) - This naturally occurring regional pollutant is not directly emitted from the fuel burning equipment on the North Slope. Ground-level ozone is formed by photochemical processes which require the presence of nitrogen oxides and volatile organic compounds (including hydrocarbons) in the lower atmosphere, in conjunction with strong solar radiation. Global scale ozone, however, is formed in the upper atmosphere (stratosphere) by photodissociation of molecular oxygen and is continuously injected into the lower atmosphere through complex meteorological processes. Stratospheric ozone injection is the primary source of the low background ozone levels measured on the North Slope. Because the intensity of solar radiation is low, even in summer, and the mixture of photochemical precursors is quite limited, formation of ground-level ozone is also quite limited. Additionally, at Nuiqsut, the presence of nearby fuel burning sources like the village electric generators and oil-fired house heaters and their associated nitrogen oxide (NO) emissions would have the affect of scrubbing O_3 molecules (through conversion of NO to NO_2), thereby artificially lowering ambient (background) O_3 concentrations. This would substantially limit the utility of the O_3 data collected and its representativeness to regional background levels.

The other criteria pollutant which is emitted at the KRU, PBU, and other North Slope oil fields in any significant quantity is carbon monoxide (CO). However, near-field maximum impact measurements of CO in the vicinity of major North Slope emission sources have historically shown ground-level concentrations generally several orders of magnitude below the applicable NAAQS. Based on these data, it is unlikely that the measurement of ambient CO levels near Nuiqsut would show any contribution from regional air emissions above the detectable levels of commonly used CO analyzers.

Besides the station parameter configuration requirements, AAI also proposes to site the monitoring station at Nuiqsut such that the air quality impacts from local Nuiqsut near-field sources will not overshadow that of regional sources, making it difficult to discern the regional source influence on current air quality. Impacts from near-field sources would compromise the primary objective of the monitoring program, which is to determine the effects to Nuiqsut air quality from North Slope oil and gas operations.

Based on the wind frequency distribution from the KRU presented in Figure 1-1, the primary wind directions which potentially advect or transport emissions from the KRU, PBU, and other North Slope oil fields to Nuiqsut are from the northeast through east-southeasterly directions. This is illustrated in the regional map shown in Figure 1-2. A map of Nuiqsut presented in Figure 1-3 shows the candidate area for siting the monitoring station. This general area, shown as a large circle, provides an upwind orientation for the northeasterly through east-southeasterly wind while still being isolated from the primary near-field Nuiqsut emission sources (i.e., the electrical generation facility, home heaters, etc.). This location will provide good exposure for measuring potential regional impacts from oil and gas exploration and production activities during the frequent periods of east-northeasterly winds and will also provide the benefit of measuring contributions to Nuiqsut air quality from local sources of emissions during periods of west-southwesterly winds which also occur frequently in the region. This information may prove to be useful to the local population as well. As a result, this location is preferred by AAI.

In summary, the AAI-proposed monitoring program will be a single station designed to collect ambient air quality data beginning in the summer/fall of 1997 and continuing for one complete year following start-up of the Alpine oil production complex, resulting ultimately in the collection of air quality data for a period of 4 years. The proposed parameter configuration will include continuous monitoring of:

- NO_2 and NO
- SO_2
- PM_{10}
- Wind speed at 10 meters
- Wind direction at 10 meters
- Wind direction standard deviation (σ_Θ)
- Temperature at 2 meters

KUPARUK RIVER UNIT
WIND ROSE ANALYSIS (PERCENT)
7/ 1/86 through 6/30/87
11/ 1/90 through 10/31/92
All Hours

WIND DIRECTION	WIND SPEED (MI/HR) <= 1.0	<= 2.0	<= 4.0	<= 8.0	<=16.0	>16.0	TOTAL	AVG SPEED
N	0.00	0.05	0.39	1.03	0.49	0.01	1.97	6.49
NNE	0.03	0.06	0.36	1.62	1.46	0.15	3.68	8.35
NE	0.03	0.08	0.60	2.55	5.18	1.03	9.46	10.37
ENE	0.06	0.13	0.57	3.70	9.48	6.02	19.96	13.38
E	0.05	0.08	0.53	3.12	6.09	2.94	12.80	12.38
ESE	0.01	0.11	0.57	2.02	2.12	0.20	5.03	8.32
SE	0.02	0.06	0.51	1.40	0.44	0.00	2.44	5.97
SSE	0.01	0.06	0.37	0.94	0.60	0.00	1.99	6.65
S	0.01	0.06	0.28	0.90	0.59	0.07	1.91	7.58
SSW	0.01	0.06	0.24	0.67	0.88	0.20	2.05	8.90
SW	0.00	0.07	0.30	1.08	2.93	1.25	5.64	12.26
WSW	0.00	0.05	0.61	3.96	8.70	4.00	17.32	12.47
W	0.01	0.05	0.57	2.79	3.20	1.70	8.33	11.45
WNW	0.00	0.08	0.52	1.32	1.03	0.52	3.47	9.54
NW	0.00	0.04	0.43	0.80	0.62	0.13	2.01	7.82
NNW	0.00	0.06	0.32	0.99	0.48	0.03	1.88	6.75
CALM	0.06						0.06	
TOTAL	0.30	1.08	7.18	28.88	44.29	18.26	100.00	

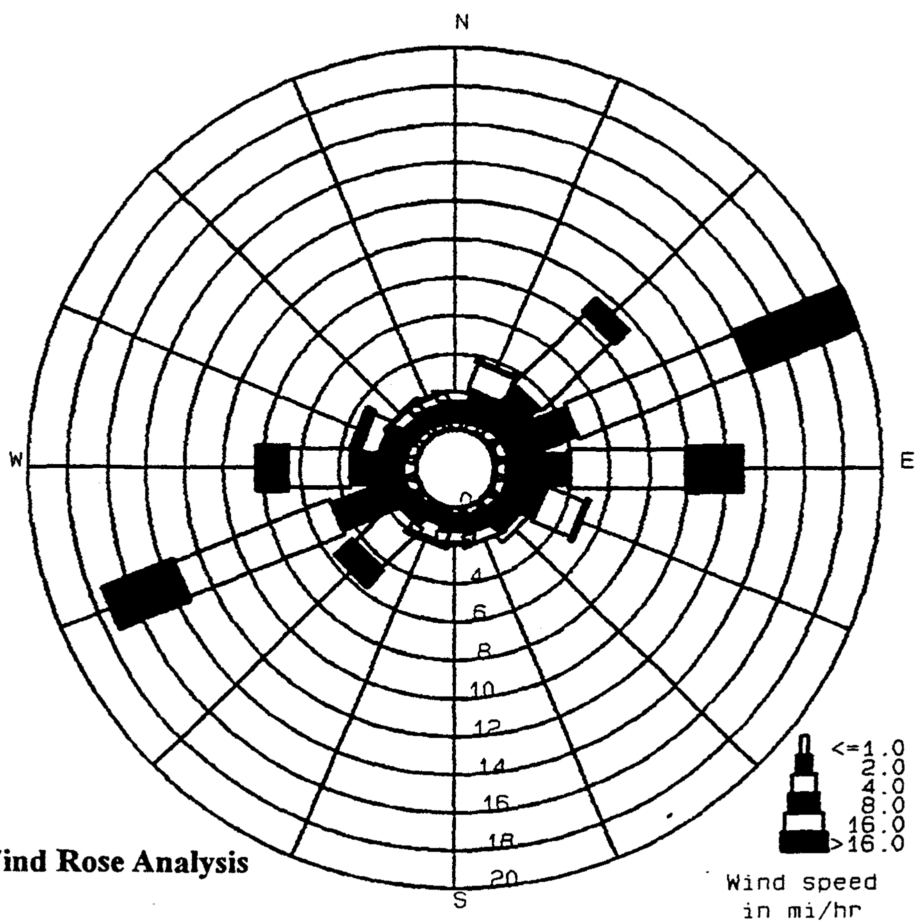
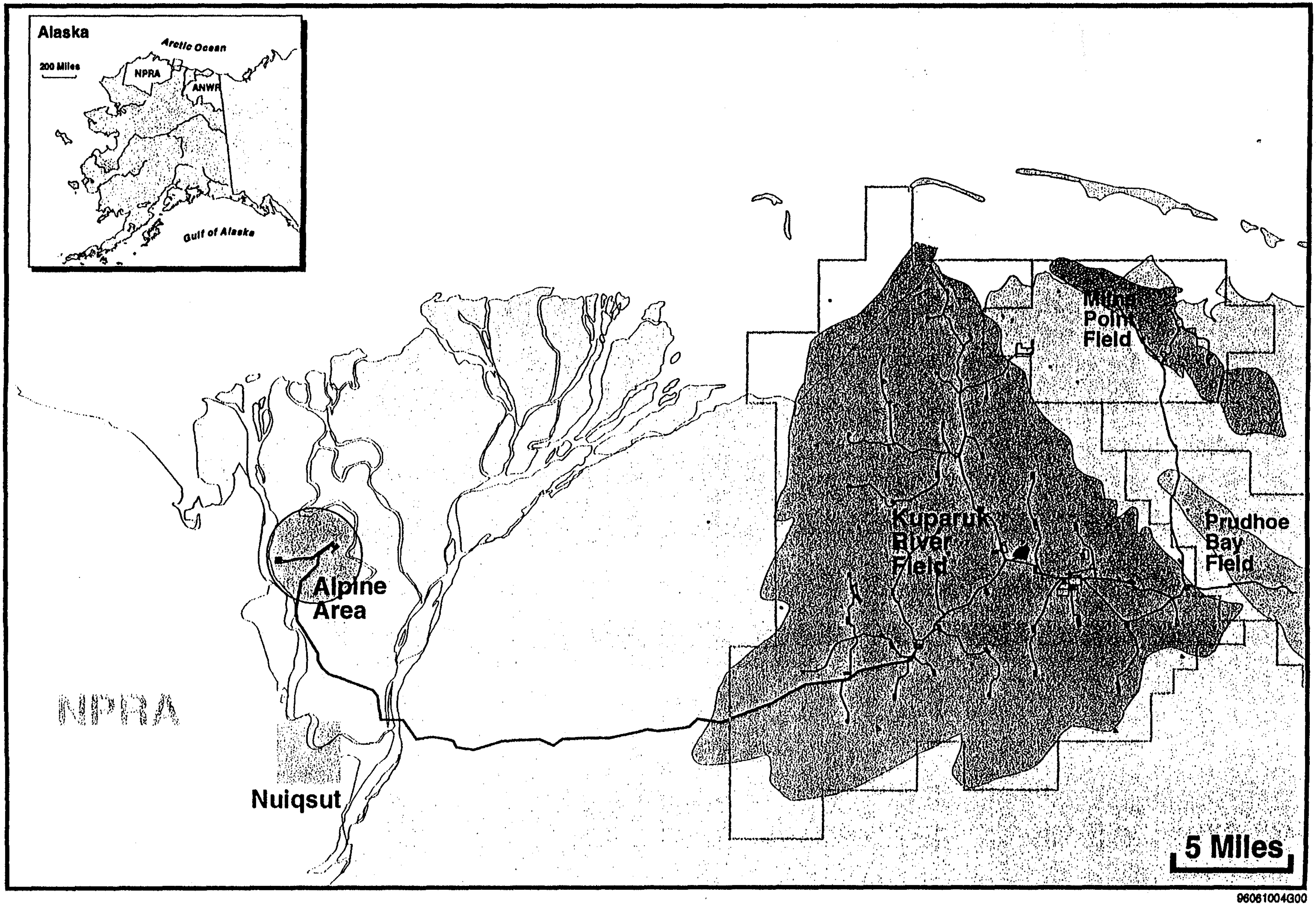


FIGURE 1-1. Wind Rose Analysis

Regio Map


Alaska
200 Miles
Arctic Ocean
NPRA
ANWR
Gulf of Alaska
Milne Point Field
Kuparuk River Field
Prudhoe Bay Field
Alpine Area
Nuiqsut
NPRA
5 Miles
96061004G00

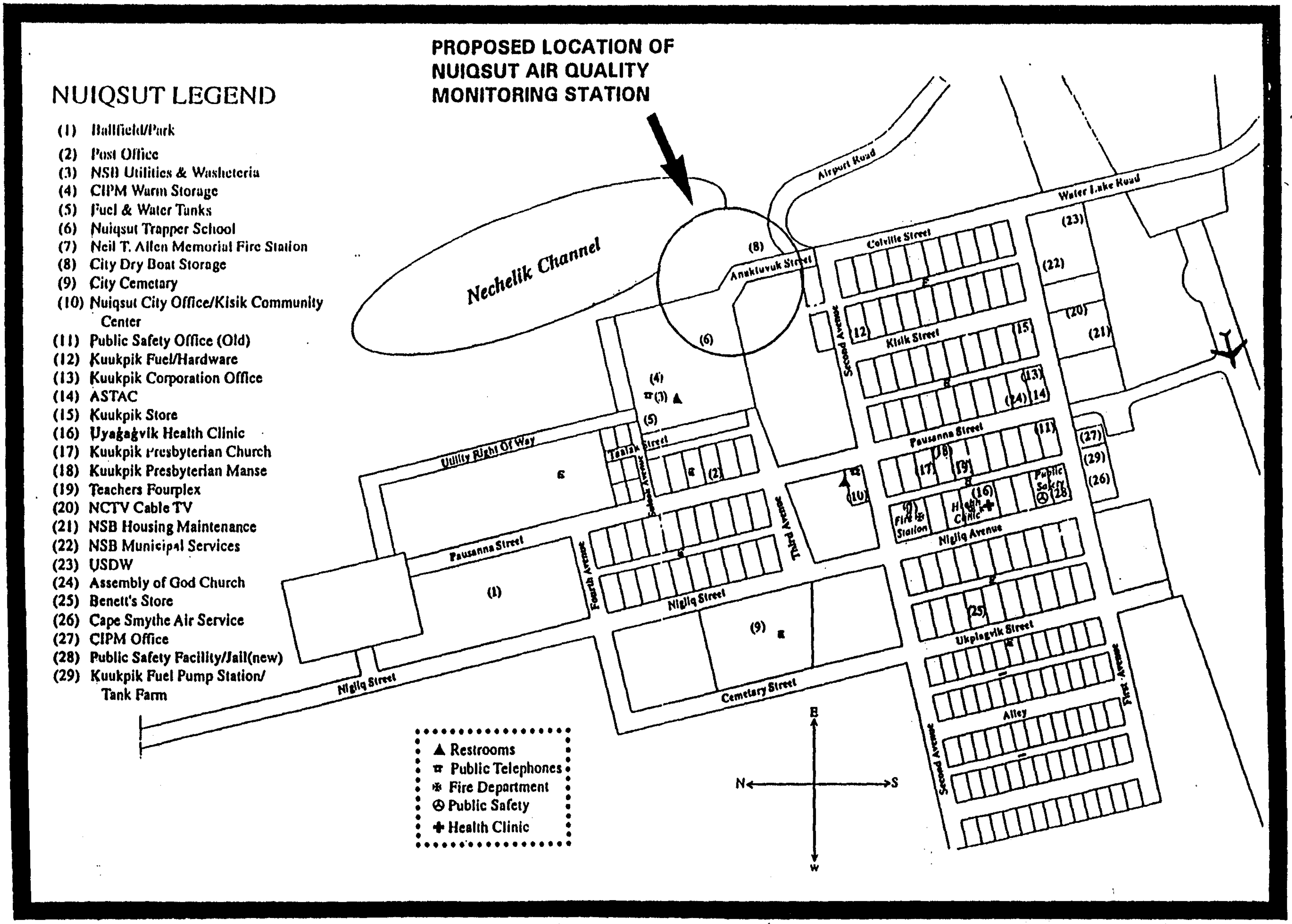


**FIGURE 1-3: ARCO ALASKA INC.
NUIQSUT AIR QUALITY MONITORING PROGRAM
CANDIDATE MONITORING AREA**

2.0 SCOPE OF WORK

The major tasks required to establish and operate the AAI Nuiqsut Air Quality Monitoring Program are summarized below. These are the activities proposed to be completed by AAI and its air quality contractor to satisfy the project requirements and project expectations.

Task 1 - Project Initiation and Reconnaissance

- AAI and its air quality contractor will work to develop a proposed Technical Specification for the Nuiqsut Air Quality Monitoring Program to achieve the goals of the program. This document will be distributed to all interested parties as appropriate to aid in the approval of a formal monitoring plan.
- AAI and AAI's contractor will meet with representatives of ADEC, the North Slope Borough, and the City of Nuiqsut to discuss the monitoring program specifications and to solicit "in-concept" approval prior to implementing the monitoring program.
- AAI's air quality contractor will travel to Nuiqsut to site the monitoring station, coordinate site preparation logistics (i.e., site access authorization, electrical power, telephone, security fencing, etc.), and interview and potentially select a local station operator(s).
- AAI will contract with a member(s) of the Nuiqsut community or a local contractor who will be trained to provide routine inspection, service, and routine maintenance of the station under the direction of AAI's air quality contractor.

Assumptions:

- AAI assumes that an agreement can be reached with all interested parties during the project start-up meeting.
- AAI assumes that a local Nuiqsut resident(s) or local subcontractor will provide routine weekly station inspection, service, and minor maintenance.

Task 2 - Monitoring Plan Preparation

- A formal monitoring plan will be prepared for submittal to the ADEC for review and approval. The plan will include a description of the source environment, sampling program, site location, monitoring equipment, operating procedures, data management, and quality assurance program. Table 2-1 lists the minimum contents of the monitoring plan. This task will include preparation of the site operations manual, project forms, and standard operating procedures (SOPs).

- AAI's air quality contractor will submit the draft monitoring plan to ADEC and other interested parties for review and approval prior to implementing the monitoring program.

- AAI's air quality contractor will submit up to five copies of the final draft of the monitoring plan to ADEC for distribution. ADEC will then be responsible for transmitting copies of the final draft to all interested parties.

Task 3 - Equipment Procurement, Integration, and Testing

- Equipment lists and specifications for instrumentation, support systems, spare parts, and expendable supplies will be prepared for AAI review and approval prior to ordering. Table 2-2 provides a summary of the recommended parameter configuration and measurement methods. This instrumentation is high quality EPA-certified equipment with a proven track record for reliability and performance. Table 2-3 provides a list of all capital equipment and expendable supplies required for the project.

- AAI's air quality contractor will procure all equipment, spare parts, and expendable supplies necessary to complete the station configuration and operate the station for up to four years. All monitoring systems will be fully integrated, calibrated, and tested in a laboratory environment prior to deployment to the Nuiqsut site.

- The monitoring station will consist of an 8 foot by 12 foot environmental shelter equipped with a self-contained heating and cooling system, arctic entry, un-interrupable power supply for line power conditioning and short-duration power interrupts, electronic instrument rack, and 10-meter meteorological tower bracketed to the side of the shelter. Instrumentation will include continuous gas and particle analyzers, calibration systems, data acquisition systems and desk-top computer, and meteorological sensors. It will also include special features such as an electronic thermal protection power relay circuit to delay instrumentation start-up in the event of extended power failure where the inside shelter temperature drops below 32°F. It will also include a desk, chair, file cabinet, indoor and outdoor lighting, and storage space for expendable supplies and spare parts.

TABLE 2-1

AAI NUIQSUT AIR QUALITY MONITORING PROGRAM MINIMUM CONTENTS OF MONITORING PLAN

1.0 Source Environment Description
- 1.1 Topographical Description
- 1.2 Land Use Description
- 1.3 Topographical Map of Sources and Environs (including location of existing and proposed stationary sources, roadways, and monitoring site)
- 1.4 Climatological Description
- 1.5 Air Quality Description

2.0 Sampling Program Description
- 2.1 Time Period for Which the Parameters Will be Measured
- 2.2 Rationale for Location of Monitoring Station
- 2.3 Data Acquisition System

3.0 Monitoring Site Description
- 3.1 Universal Transverse Mercator (UTM) Coordinates
- 3.2 Height of Meteorological Sensors and Sampler Intakes Above Ground
- 3.3 Distance from Obstructions and Heights of Obstructions
- 3.4 Distance from Sources
- 3.5 Photographs of Monitoring Site: one in each cardinal direction from the monitoring location.

4.0 Monitoring Equipment Description
- 4.1 Name of Manufacturer, Model Number, Age, and Principle of Operation
- 4.2 Description of Calibration System to be Used

5.0 Station Operational Procedures
- 5.1 Equipment Integration
- 5.2 Station Installation
- 5.3 Routine Operations

6.0 Data Validation, Processing, and Reporting
- 6.1 Minimum Standards
- 6.2 Organization, Control, and Flow of Data
- 6.3 Format of Data Submission
- 6.4 Frequency of Data Reporting

7.0 Quality Assurance
- 7.1 Calibration Frequency
- 7.2 Independent Audit Program
- 7.3 Internal Quality Control Procedures
- 7.4 Data Precision and Accuracy Calculation Procedures

8.0 Standard Operational Procedures (as an Appendix)

TABLE 2-2

ARCO ALASKA, INC.
NUIQSUT AIR QUALITY MONITORING PROGRAM
MEASUREMENT METHODS

Parameter	Suggested Manufacturer/Model	Sample Frequency	Averaging Period	Range	Lower Detection Limit	Method
Oxides of Nitrogen (NO_x, NO_2, NO)	Thermo Environmental Instruments (TECO) Model 42C	Continuous	1-Hour	0 - 500 ppb	0.4 ppb	Chemiluminescence (EPA designated method [RFNA-1289-074])
Sulfur Dioxide (SO_2)	Thermo Environmental Instruments (TECO) Model 43C	Continuous	1-Hour	0 - 500 ppb	2 ppb	Pulsed Fluorescence (EPA designated method [EQSA-0486-060])
Particulate Matter (PM_{10} or $PM_{2.5}$)	Rupprecht & Patashnich Model 1400 TEOM PM_{10}	Continuous	1-Hour	0 - 100 $\mu g/m^3$	0.1 $\mu g/m^3$	Microbalance Technology (EPA designated method [EQPM-1090-079])
Wind Speed (10 m)	RM Young Wind Monitor AQ - 05305	Continuous	1-Hour	0 to 50 m/s	0.2 m/s	Propeller/Magnetically Induced AC
Wind Direction (10 m)	RM Young Wind Monitor AQ - 05305	Continuous	1-Hour	0 to 360°	1°	Vane/Potentiometer
Sigma-Theta (σ_Θ) (10 m)	Computed by Datalogger	Continuous	1-Hour	0 to 100°	N/A	Yamartino (1984)
Temperature (2 m)	RM Young 43408	Continuous	1-Hour	-50° to 50°C	0.1°C	Platinum RTD

TABLE 2-3

ARCO ALASKA, INC.
NUIQSUT AIR QUALITY MONITORING PROGRAM
LIST OF EQUIPMENT AND SUPPLIES

	Quantity
Data Collection Equipment	
ESC Datalogger	1
Modem	1
Station Computer	1
Yokogawa Chart Recorder	1
Monitoring Equipment	
TECO 42C NO_x	1
TECO 43C SO_2	1
TECO 146 Calibration System	1
TEOM 1400 PM_{10} Particulate Sampler	1
Zero Air Supply	1
Temperature System	1
Wind Speed / Direction Sensor	1
Support Equipment	
Equipment Shelter (8 ft X 12 ft)	1
UPS Power Supply	1
Analyzer Particulate Trap	2
Regulator	1
Intake Manifold	1
10-Meter Monitoring Tower	1
Expendable Supplies (1 Year)	
Certified Gas Standard (NO/SO_2)	1
Chart Paper	12
Recorder Pens	36
Intake Particulate Filters	50
Silica Gel	4
Miscellaneous Supplies	1

Task 4 - Site Preparation

- AAI will contract to complete all site preparation activities prior to installing the monitoring station. This will include an electrical power drop and hook-up, telephone line, security fencing, and gravel pad (if necessary). It will also include a contractor to off-load and place the monitoring station shelter upon arrival.

- AAI's air quality contractor will provide specifications for site preparation and will provide oversight and coordination of these activities.

Assumptions:

- AAI assumes the City of Nuiqsut will provide site access authorization and the permits necessary to place the temporary instrument shelter and 10-meter meteorological tower in the village.

- AAI assumes that the City of Nuiqsut will provide access authorization and electric power for the monitoring station at no charge.

Task 5 - Station Installation

- All monitoring systems and support equipment will be labeled, packaged, and shipped to Nuiqsut following integration and laboratory testing. The AAI air quality contractor will make arrangements to ship the environmental shelter and tower to Anchorage for transfer to the North Slope and on to Nuiqsut.

- Upon arrival of the monitoring shelter at Nuiqsut, AAI's air quality contractor will install all equipment, power-up all systems, and perform start-up calibration activities. As part of the installation task, the on-site subcontract operator(s) will be trained to perform routine station inspections, service and maintenance.

- Installation activities will include anchoring the environmental shelter, installing all instruments in the electronic rack, anchoring the 10-meter tower to the shelter, connecting electrical power and telephone to the system, powering-up all systems, installing sensors on the tower, and performing a complete start-up calibration of all instruments.

Task 6 - Routine Operations

- The AAI air quality contractor will provide daily monitoring system evaluation via telecommunications interface to the digital data acquisition system and routine weekly and as-needed telephone contact with the on-site station operator(s).

- The on-site station operator(s) will be required to visit the station at least weekly to perform routine site inspection, analog strip chart servicing, clean air supply maintenance, and general evaluation of all systems. This will include updating the station log, preparing site inspection sheets, and periodically forwarding hard copy data to AAI's air quality contractor.

- The data acquisition system will be configured to perform automatic nightly zero/span calibration checks of the continuous gas analyzers. Remote precision checks will also be performed once per week via telecommunications interface to the digital data acquisition system.

- The AAI air quality contractor will provide emergency repair support to the station to ensure that the minimum PSD monitoring program requirements of 80 percent valid data capture for air quality parameters and 90 percent for meteorological parameters are met.

Task 7 - Calibrations

- The AAI air quality contractor will travel to Nuiqsut quarterly to perform calibration and recertification of all instrumentation and sensors as required by EPA and ADEC quality assurance guidelines. The air quality instrumentation will be calibrated quarterly and the meteorological system will be calibrated every six months. All calibrations will be fully documented and all calibration equipment will be traceable to the National Institute of Standards and Technology (NIST), or other authoritative standards.

Task 8 - Quality Assurance Audits

- As required by EPA PSD guidelines as administered by the ADEC, an independent quality assurance (QA) systems performance audit of the Nuiqsut monitoring station instrumentation should be performed within 30 days of start-up and at 3-month intervals thereafter.

- Preliminary audit results shall be made available to AAI and its air quality contractor immediately following the audit so that any required adjustments or repairs can be made without delay. Complete audit reports shall be submitted to AAI and its air quality contractor within 30 days of each audit.

Assumption:

- AAI assumes the ADEC will conduct the independent QA systems performance audit of the station at AAI's expense. AAI believes that the Nuiqsut station should be considered an extension of the Alaska State and Local Air Monitoring System (SLAMS) network and its charter to evaluate the health and welfare of the citizens of Alaska.

Task 9 - Data Management and Reports

- AAI's air quality contractor will download data from the Nuiqsut data collection system and update the project database each business day via telecommunications interface.

- The AAI air quality contractor will perform all data reduction, validation, and analysis of the air quality and meteorological data to ensure data quality is maintained. Project air quality meteorologists and field operations personnel will review and evaluate the operational status of the monitoring system each business day.

- All field documentation will be maintained by the AAI air quality contractor including records of field station logs, instrument zero/span logs, data assessment records, records of repairs, calibrations, certifications, and audits, and backup strip chart records.

- Summary data status reports will be prepared on a monthly basis for distribution by AAI. These reports will briefly describe preliminary data retrieval statistics, project activities, and significant project events.

- On a quarterly basis, the AAI air quality contractor will prepare a stand-alone bound data report communicating the validated data retrieved for the previous 3-month period. Contents of the report will include (but will not necessarily be limited to) the following:

  - Summary of project activities and significant events such as start-up, maintenance, quality assurance, repair, instrument replacement, etc.

  - Summary of missing/invalid/flagged data and steps taken to correct their cause.

  - Summary of measured air quality concentrations and comparison to applicable standards.

  - A summary of calibration and audit results with applicable data precision and accuracy statistics, and supporting documentation (calibration/audit forms, etc.).

  - An analysis and discussion of observed air quality impacts.

  - Summary of meteorological data.

  - Tabulation of all validated hourly data and a disk containing the digital files.

- At the conclusion of the Nuiqsut air quality monitoring program, all original records will be archived and maintained for a minimum period of 5 years.

Task 10 - Project Management and Administration

- The AAI air quality contractor will provide all project management, administrative assistance, and coordination of technical support required to successfully complete the monitoring program.

- AAI will require monthly progress reports be prepared by the air quality contractor updating the project budget status, project schedule, station performance, and significant project events.

3.0 SCHEDULE

The schedule for implementation and operation of the AAI Nuiqsut Air Quality Monitoring Program assumes a project initiation date of June 1, 1997. Monitoring is assumed to begin on October 1, 1997 and to continue through September 30, 2001. This schedule is based on the following Alpine Development Project schedule:

- October 1, 1997 - September 30, 1998 - Pre-construction baseline monitoring
- October 1, 1998 - September 30, 1999 - Construction monitoring
- October 1, 1999 - September 30, 2000 - Construction monitoring/facility start-up (June 1, 2000)
- October 1, 2000 - September 30, 2001 - Post-construction operations monitoring
- October 1, 2001 - Decommissioning of Nuiqsut monitoring station

4.0 REFERENCES

Alaska Department of Environmental Conservation (ADEC). 1996. Alaska Quality Assurance Manual for Ambient Air Quality Monitoring. ADEC, Division of Air and Water Quality, Air Quality Improvement. Revised August 21, 1996.

United States Environmental Protection Agency (U.S. EPA). 1987. Ambient Monitoring Guidelines for Prevention of Significant Deterioration. EPA, Office of Air Quality Planning and Standards (OAQPS), Research Triangle Park, North Carolina. EPA-450/4-87-007.

______. 1994. Quality Assurance Handbook for Air Pollution Measurement Systems. Volume II: Ambient Air Specific Methods (Interim Edition). EPA, Office of Research and Development (ORD), Research Triangle Park, North Carolina. EPA-600/R-94/038b. April 1994.

______. 1995a. Quality Assurance Handbook for Air Pollution Measurement Systems. Volume IV: Meteorological Measurements. EPA, ORD, Research Triangle Park, North Carolina. EPA-600/R-94/038d. Revised March 1995.

______. 1995b. On-Site Meteorological Program Guidance for Regulatory Modeling Applications. EPA, OAQPS, Research Triangle Park, North Carolina. EPA-450/4-87-013. Revised August 1995.

Yamartino, R. J. 1984. A Comparison of Several "Single-Pass" Estimators of the Standard Deviation of Direction. *J. Climate Appl. Meteorology; Vol. 23, pp. 1362-1366.*

Appendix K

APPENDIX K

ARCO RESPONSE TO ISSUES AND COMMENTS RECEIVED PRIOR TO JUNE 6, 1997 END OF THE PUBLIC NOTICE

APPENDIX K-1

INITIAL FEBRUARY 1997 RESPONSE TO USCOE COMMENTS

ARCO Alaska, Inc.
Post Office Box 100360
Anchorage, Alaska 99510-0360
Telephone 907 276 1215

February 27, 1997

Mr. Lloyd H. Fanter
Department Of The Army
U. S. Army Engineer District, Alaska
Regulatory Branch
North Section
P.O. Box 898
Anchorage, Alaska 99506-0898

Re: Alpine Development Project
USACE File Number 2-960874, Colville River 18

Dear Mr. Fanter:

This letter will respond to your January 29, 1997 letter (copy attached) requesting more information regarding the captioned permit application. Responses to each one of your questions are provided below. As we discussed by phone, ARCO Alaska, Inc. would also like to revise and complete its October 8, 1996 Permit Application in the following areas:

1. Gravel Footprint Dimensions, Acreage, Volume: See Attached Table, Sheet 1 of 1.

2. Alpine Pad 1 Layout: See Attached Sheets 6 & 8 of 22.

3. Airstrip Length: See Attached Sheet 9 of 22.

4. Relocate Possible Pipeline Valve Pad Location On Eastside Of Colville River Crossing Approx. 2 miles Further East: See Attached Sheet 3 of 22.

5. At HDD Crossing, Revise Above/Ground Pipeline Transitions, Modify Minimum Setback Of Pipeline Transitions From Colville River: See Attached Sheets 11, 12 and 13 of 22.

6. Add Diesel Pipeline To VSM Rack And Combine Diesel Pipeline & Fiber Optic Cable Within Same HDD Casing: See Attached Sheet 2, 10, 11, and 13 of 22.

7. Pipeline(s) Diameter: See Attached Sheets 2 of 22 And See Question a. (1) (b) Below.

8. Reroute Gathering Lines And Sales Oil Pipeline Routes (In Immediate Area Of Facilities) To Alpine Pad 1: See Attached Sheets 3, 6, 9 of 22.

9. Possible Valve Pads Layout: See Attached Sheet 15 of 22.

10. Add Diesel Pipeline To Typical Pipeline Road Crossing: See Attached Sheet 11 of 22.

11. Typical Flood Plain Culvert And Multi-Culvert Installation: See Attached Sheets 18 and 19 of 22.

12. Controlled High Water Flow Area In Gravel Road: See Attached Sheet 20 of 22.

13. Non-Grounded Ice Bridge Concept: See Attached Sheet 21 of 22.

14. Near Shore Sea-Ice Road Route (Eliminates Grounded Ice Bridge): See Attached Sheet 22 of 22.

The attached Sheets 1 through 22 reflect the above mentioned revisions and should replace Sheets 1 through 16 which accompanied ARCO's original October 8, 1996 application.

Questions From Your January 29, 1997 Letter

a. Figures

(1) Provide typical cross-section views of:

(a) Roads including typical low water crossings, culverts, bridges, etc., and....

Answer

A typical flood plain culvert installation cross section is depicted on Sheet 18 of 22. A typical multi-culvert installation cross section is depicted on sheet 19 of 22. A typical controlled high water flow area in the gravel road is depicted on sheet 20 of 22. See sheet 6 of 22 for probable locations of drainage/flood mitigation. Exact locations will be determined by the results of ARCO's hydrologic studies covering the entire delta area which are currently being finalized and integrated into extensive modeling including 2 Dimensional format. The studies and modeling could be completed by March 1997.

The Alpine development does not include any bridges.

(b) Colville River Crossing (expanded detail of pipeline crossing, Horizontal Directional Drilling [HDD], including number of pipelines, estimated quantities of dredged material removed, size of bore holes, type and quantities of fill material). Sheet 11, 12, and 13 provide a general HDD schematic for one pipeline and transitions alternative designs for the carrier pipeline, further detail is required for the t hree proposed pipelines. Additional figures on the structural aspects for oil spill control (e.g. valves, double wall piping, sensors, etc.) should also be included within description figures to assist in understanding the overall project.

Answer

Sheet 11, 12, 13, and 14 of 22 depict the typical Colville River pipeline crossing plan, above ground vertical and non-vertical transition design and HDD operations sequence which will be followed for all 3 borings. Sheet 10 of 22 depicts the Colville River pipeline crossing location for the three borings (ie. sales oil pipeline, water/gas pipeline, casing for diesel pipeline and fiber optic cable).

As mentioned above, ARCO is adding a third pipeline to be strung on the same proposed sales oil pipeline VSMs (see Sheet 2 &16 of 22) and route (see Sheet 2 of 22). This third pipeline would be a diesel pipeline 2 to 3 inches in diameter. The diesel pipeline and fiber optic cable will be combined within a single 6 to 8 inch diameter casing to complete the HDD Colville River crossing (see Sheet 11 & 13 of 22).

ARCO is reducing the diameter of the sales oil pipeline from 20 inches to 14 inches, and the water /gas pipeline diameter from a range of 8-20 inches to a range of 10-14 inches.

HDD bore holes at the Colville River crossing will be approximately 36 inches in diameter for the sales oil pipeline and the water/gas pipeline, and 20 inches in diameter for the diesel pipeline/fiber optic casing. Approximately 40,000 barrels of excess slurry and cuttings will be cumulatively produced from the 3 HDD borings. The excess slurry and cuttings would be hauled to KRU or PBU for disposal by grind and injection.

At the HDD-to -above -ground transition points for the three borings, a vertical transition cellar area would be created at each transition point by excavating approximately 420 cubic yards of material and replacing it *with non-frost susceptible (NFS) material consisting of sand and gravel (see sheets 11,12, and 13 of 22).*

Pipeline spill control design features are currently being evaluated by ARCO and the State/Federal Joint Pipeline Office as part of the review of ARCO's Alpine Right-Of-Way Permit Application, and will also be evaluated during the Alaska Dept. of Environmental Conservation's eventual review of ARCO's proposal to amend the Kuparuk River Unit Oil Discharge Prevention and Contingency Plan to include Alpine. Spill control design features under consideration include: valves, vertical elbows, periodic smart-pigging, fiber optic sensor wires, pressure sensors, corrosion inhibitors and monitoring, inlet/outlet metering, visual monitoring including ground and air (infra-red heat detection).

(2) Sheet 15 of 16 shows typical pipeline construction with three pipelines while figure 2.2.1-1, page 2-9 of the EED provides a different vertical support member detail relative to the number of pipelines. Please clarify this discrepancy.

Answer

The Attached Sheets 2, 15, and 16 of 22 depict the proposed typical pipeline configuration/construction to be placed on VSMs.

(3) Further details are needed regarding strengthened Vertical Support Members (VSM). Although sheet 15 of 16 provides a typical pipeline construction, no typical details are provided for strengthened VSMs. [note: VSM placement is not generally regulated by the Corps of Engineers. However, if strengthened VSM's require dredging or placement of fill material, they may require authorization. Additional information is requested to complete our jurisdictional determination]. Also note that VSMs and associated pipeline over navigable waters may be regulated by the U. S . Coast Guard under Section 9 of The Rivers and Harbors Act of 1899.

Answer

Strengthened VSMs will be installed using the same technique as for all other cross country VSM's (i.e. dry auger drilling , cuttings backhauled to an approved disposal site, and a sand water slurry backfill to stabilize the small area between the outside diameter of the VSM and the diameter of the augured hole).

The use and locations of "strengthened VSMs" (i.e.. larger diameter VSM's) at Alpine will be determined by the results of hydrologic studies that may be complete by March 1997. The design of strengthened VSMs will be the same as depicted in Attached Sheets 2, 15 and 16 of 22 except that the vertical member will be up to 24 inches in diameter vs the typical diameter of 8 to 12 inches. The pipeline height (from the tundra) on strengthened VSMs would range from a minimum of 5 feet to an approximate maximum of 20 feet. If strengthened VSMs are used, they would likely be located in the cross country pipeline section running west from the east line, Section 12, T10N, R5E, U.M. to the Alpine Facilities, and in the sections crossing the Kachemach and Miluveach Rivers.

(4) Figure 2.0-2, et. al. should include Township, Range, and Section markings for location identification.

Answer

Revised Figures S-1, 2.0-1, 2.0-2, 2.2.1-2 are attached and revised as you requested.

(5) page 2-10, para. 2.2.1.1, Ice Roads/Bridges. Provide typical cross sections of ice bridges on navigable waters, identify locations, indicate water depth and proposed ice depth, and bank elevations. Will culverts or other measures be included in the ice bridge design to maintain adequate flows? Will cut banks be required? If so, identify locations, quantities and provide cross-section of river, channel, and slough cut banks. Ice bridge information is required to complete our jurisdiction determination.

Answer

The attached Sheets 21 and 22 of 22 depict the location and typical cross section of the proposed non-grounded ice bridge. The non-grounded ice bridge would be approximately 11 feet thick. Water depths in this location are 13 to 16 feet. Culverts or other flow maintenance methods will not be required since the non-grounded design will allow adequate flow underneath the bridge. Cut banks are not required.

The non-grounded ice bridge would be required during the first construction season (i.e.. 97/98 Winter) to support gravel hauling trucks, equipment and materials. During the same season, a river ice crossing *would be required to haul muds and cuttings, equipment and manpower between the HDD east & west entry/exit point operations (see attached Sheet 21 of 22). This crossing will be a non-thickened river ice crossing accomplished by merely blading snow off river ice.*

The previously proposed grounded ice bridge mentioned in the EED has been eliminated from consideration to mitigate potential water quality impacts identified by the Alaska Department of Fish & Game and Nuiqsut residents and entities. ARCO is now evaluating the alternative of using a sea ice road running from Oliktok Point to a landfall point between the mouth of the Sakoonang and Nechelik Channels and then transitioning to an on-land ice road route to Alpine Pad 2. This sea ice road would be used to move a heavy development drill rig in the 98/99 Winter, and move production modules weighing up to 2000 tons in the 98/99 & 99/2000 Winters. Once moved to Alpine, the development drill rig would remain at Alpine for a period of 4-5 years. Therefore, another sea ice road would be required in the 2002-2004 time frame to drive the rig back to the KRU.

A non-grounded 11 foot thick ice bridge will be required approximately every 3 years to support major maintenance activities occurring after the year 2000 startup. The location would be in the same location depicted on Sheet 21 of 22.

The non-grounded ice bridge would exist from approximately January 15 to April 1.

b. Chapter 2, Description of the Applicant's Proposed Project

(1) EED. page 2-5, para 2.1 1, Clarify: Work would be done almost exclusively in the winter." What construction activities e.g., in water work, placement of fill material, grading of gravel fill, etc., would occur during non-winter periods?

Answer

Non-winter work would consist of compaction of newly placed gravel pads (no stockpiling of gravel is anticipated during winter or summer), surveying for facility placement on gravel pads, facility interconnect *work (piping), and additional environmental studies, as required. In-water work will not occur during non-winter periods.*

(2) EED, page 2.5, para. 2.1.1 and page 2-10, para 2.2.1.1, Ice roads and ice bridges would be constructed each winter season to support the year-round drilling operations." Request additional information concerning ice bridges (e.g., depth of ice. depth of water, is bottom fast ice required at all locations, duration of ice bridge construction, duration of the complete ice bridges, are culverts or other free flowing water structures to be included in major channels with flow? Will the Phase III production/operations phase ice road construction, estimated to be built every three years, to be of the same design as to the Phase I ice bridge construction?

Answer
See answer to question #5 in section (a.) above.

(3) EED, page 2-5, para 2.1.2, Clarify; "All wells would be located on and distributed as needed between - the two basic gravel pads?" Are the wells to be located solely on the two gravel pads? Or, will wells also be located on the gravel road between the two gravel pads?

Answer
All wells will be located solely on the two gravel pads and not on gravel roads.

(4) EED, page 2-10 para. 2.2.1.1, Pipeline/VSM installation: "Cuttings from drilling operations will be handled in accordance with USACE guidelines." Please note: The Corps does not have guidelines concerning the discharge of drill cuttings for VSMs.

Answer
The cuttings from VSM drilling and installation operations will be removed to grade around the base of each VSM. The cuttings will be transported to an approved disposal location. Depending on resource agency preference, ARCO may propose that these cuttings be placed on frozen lake surfaces in a manner that enhances waterfowl habitat when the material subsides during summer thereby creating "duck hotels " (islands) in lakes.

(5) EED, page 2-10, para. 2.2.1.1 Construction. Clarification on main channel ice bridge: "In the case of the main channel of the Colville

River, non-bottomfast ice is built into a bridge structurally capable of withstanding the weight of mobile oil field drilling, support, and camp equipment." Will the "bridge" exist as an ice bridge? If so, will mid-level culverts be installed to maintain water quality (saline and freshwater concentrations)? Or is another structure material other than ice being considered?

Answer
See answer to Question #5 in section (a.) above.

(6) EED, page 2-14, para 2.2.3.1, Construction Season. "The HDD installation would be completed in the winter." Will the HDD construction and installation begin and end during a single winter construction season? If not, what construction activities would occur outside the typical winter construction season?

Answer
Yes, the HDD installation will begin and end during a single winter construction season (i.e.. 97/98).

(7) EED, page 2-14, para. 2.2.3.2, Kachemach and Miluveach River and Stream Crossings. "If local conditions warrant, the VSM's would be strengthened to withstand the force of high flows." Please provide the details of a typical strengthened VSM structure. Include any additional dredging or discharge of fill material required for strengthened VSMs . Information is required to complete our jurisdictional determination.

Answer
See answer to Question # 3 in section (a.) above.

(8) EED, page 2-17, para. 2.4, Material Sites. "An approved gravel source would be used. Potential gravel sources include ARCO's existing mine at KRU and ASRC's proposed gravel mine located east of Nuiqsut, just east of the Colville River main channel relatively near proposed pipeline crossing X14." Is Mine Site F confirmed as the approved gravel source? Will other KRU gravel sources be used? If so, will permit modifications be needed for mine site expansions? Secondly, the ASRC's previously approved mine site authorization has expired and their recent application for the site has been withdrawn. Nuiqsut Construction has applied for DA authorization for a mine site at the

same location (4-960869, Colville River 17) . This permit application is currently under review and evaluation.

Answer

KRU Mine Site F , as currently permitted by USACE Permit # M-840481 Kuparuk River 77, has adequate gravel volumes for Alpine. ARCO's preference is to use the Nuiqsut Constructors mine site , if permitted (by Colville River 17, #4-960869) and if the gravel is competitively priced. In the alternative , ARCO will use KRU Mine Site F.

(9) EED, page 2-17, para. 2.5.1, Phase I: Construction/Pre-Start-up Development Drilling. First sentence, "... 3 to 5 million gallons for the HDD crossing of the Colville River." Is the estimate of 3 to 5 million gallons of water required of the HDD crossing of the Colville River solely for ice road and pad construction, or does this include water requirements for slurry mixture during the drilling processes? Further description of the HDD process for crossing the Colville River is required including disposal amount and location of dredged material. Additional information is also requested for the evaluation phase of your permit application concerning construction activities and associated impacts e.g., noise, vibrations, etc., associated with HDD during winter operations.

Answer

*The estimate of 3 to 5 million gallons of water includes all requirements associated with the HDD crossing (i.e. ice pad construction, and slurry mixture). See answer to Question **a.** (1) (b) above for answers to remaining questions.*

c. Additional Questions

(1) Based on ARCO's proposed road and pad design, are any portions of the road or pads designed to fail during high water events?

Answer

No portions of the road or pads are designed to fail. Overtopping of the road may occur in the road section identified as the "Controlled High Water Flow Area" on attached Sheets 6 and 20 of 22 only if 200 year flood levels are exceeded. Side slopes and the road surface in this road section will be armored to prevent washout. Armorment design has not been finalized.

(2) Based on ARCO's proposed design, minimum road and pad height of gravel fill is approximately 5 feet in depth. What is the maximum height of fill depth? What is the expected average height of fill for the road, airstrip and pads?

Answer

Road, pad, and airstrip thicknesses will range between approximately 5 to 12 feet. The base design for gravel road/pad thickness is the 50 year flood event plus 3 feet, see attached Sheets 18, 19, and 20 of 22.

(3) Based on information provided by ARCO during the Joint Pipeline Office's briefing on the HDD crossing of the Colville River, the HDD crossing transition zone and valve pad on the east side of the river is expected to be flooded during high water/flood events. Will any erosion control and protection measures be proposed and included in this application?

Answer

Erosion control/protection measures are presently proposed as described in the answer to Question **c.** *(1) above. Additional erosion control/protection measures will be determined by the results hydrologic studies and modeling which may be finalized in early March 1997.*

Thank you again for coordinating the questions required to render our application complete. Should you require additional information or have additional questions, please contact me at 263-4766.

Sincerely,

Mark J. Schindler
Director, Alpine Permits and Compliance

Attachments
(See attached distribution list)

Alpine Distribution List

Name	Fax	Phone
State of Alaska		
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Ted Rockwell U.S. Environmental Protection Agency 222 W. 7th Avenue #19 Anchorage, AK 99513-7588	271-3424	271-3689
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Jeanne Hanson National Marine Fisheries Services 222 W. 7th Avenue #43 Anchorage, AK 99513-7577	271-3711	271-3029

Name		Fax	Phone
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Mayor Nageak/Marie Adams Carroll/ John Dunham/Richard Glenn North Slope Borough (NSB) P.O. Box 69 Barrow, AK 99723	(Carroll) (Dunham) (Glenn)	852-0337 852-5991	852-2611 852-2611 852-0395
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Nuiqsut			
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Thomas Napageak Tribal Village of Nuiqsut P.O. Box 187 Nuiqsut, AK, 99789-0187			480-6133
Arctic Slope Native Association			
Michael Peterson P.O. Box 1232 Barrow, AK 99723-1232		852-2763	852-2762 x3015

Colville Village

Mark Helmericks Colville Environ Svcs. (Anchorage)	345-9095	345-9095

Other Interested Parties

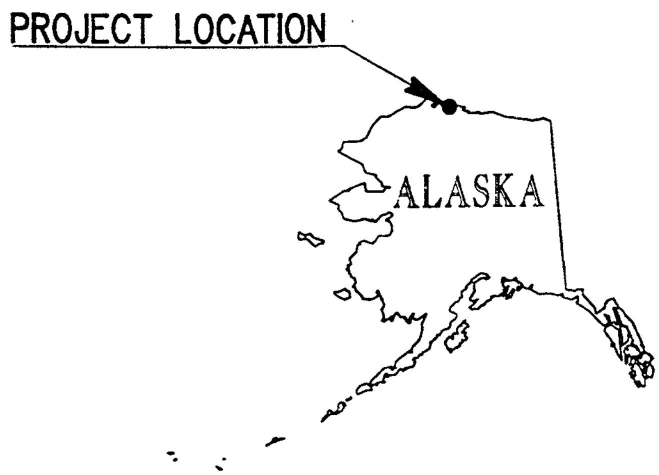
Jack & Hester Gerke
190 Rhubarb
Fairbanks, AK 99712

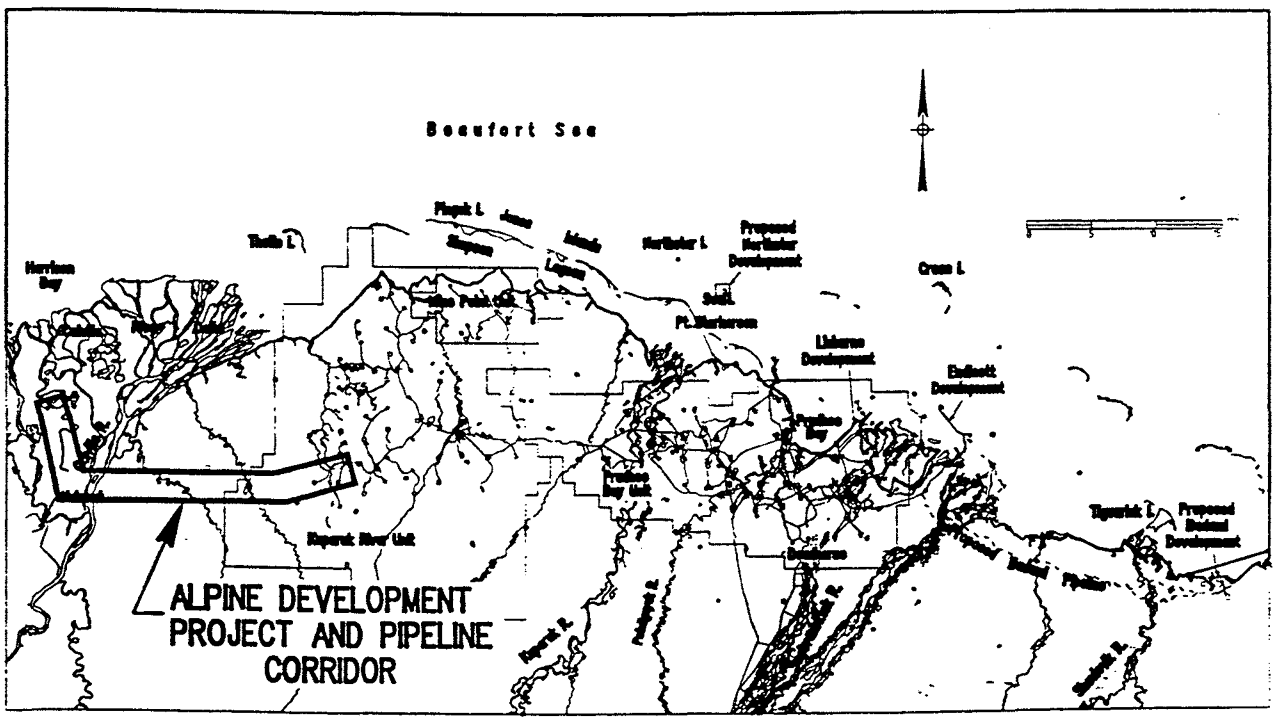
FACILITY ELEMENTS AND ESTIMATED GRAVEL REQUIREMENTS

ELEMENT	APPROXIMATE TOP OF PAD DIMENSION	ACREAGE	GRAVEL VOLUME (C.Y.)
ALPINE PAD 1			
DRILL SITE SECTION	600' x 800'	13.0	147,400
PROCESSING/CAMP SECTION	850' x 1500'	29.0	329,450
STORAGE AREA	400' x 600'	5.8	65,500
ALPINE PAD 2	600' x 900'	13.6	206,300
IN-FIELD ROAD	36' x 9986'	14.7	137,800
AIRSTRIP			
AIRSTRIP W/ROADWAY ALONGSIDE	206' x 5900'	31.7	363,300
APRON AREA	450' x 600'	6.6	73,700
HDD TRANSITION CELLARS	25' x 15' (6)	0.05	2,520
VALVE PADS (2)	30' X 30'	0.20	1,000
	TOTAL	114.65	1,326,970

PAD DEPTHS VARY TO ACCOMODATE EXPECTED FLOOD LEVELS.
MINIMUM PAD DEPTH IS 5 ft.
ACREAGE INCLUDES AREA COVERED BY GRAVEL PAD SIDE SLOPES.

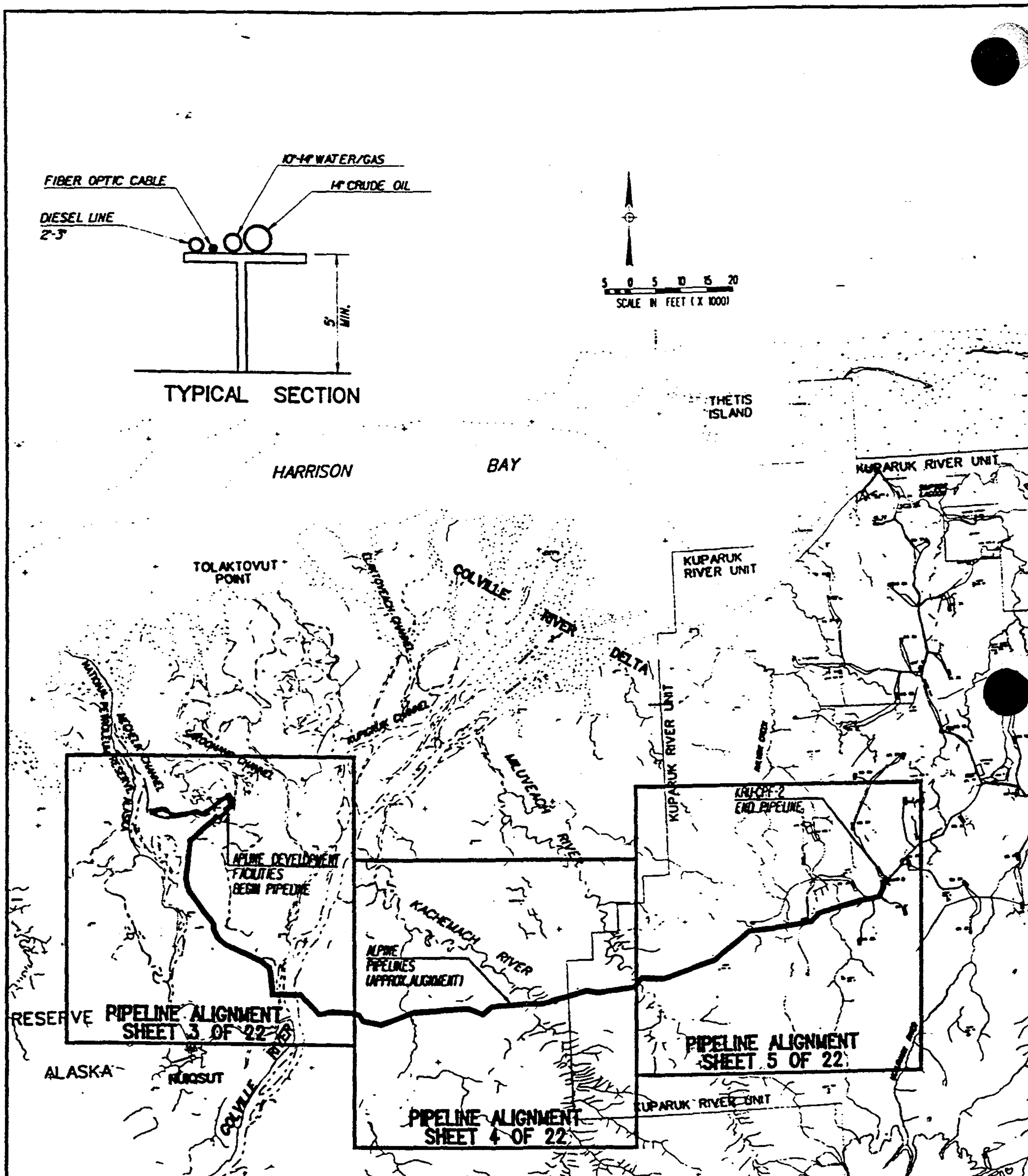
PURPOSE: PETROLEUM PRODUCTION DATUM: ADJACENT PROPERTY OWNERS: 1. STATE OF ALASKA 2. KUUKPIK CORPORATION	**QUANTITIES** ARCO ALASKA, INC. 700 G. STREET P.O. BOX 100360 ANCHORAGE, ALASKA 99510-0360	PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT BOROUGH: NORTH SLOPE APPLICATION BY: ARCO ALASKA, INC. SHEET 1 OF 1 DATE: 02/26/97



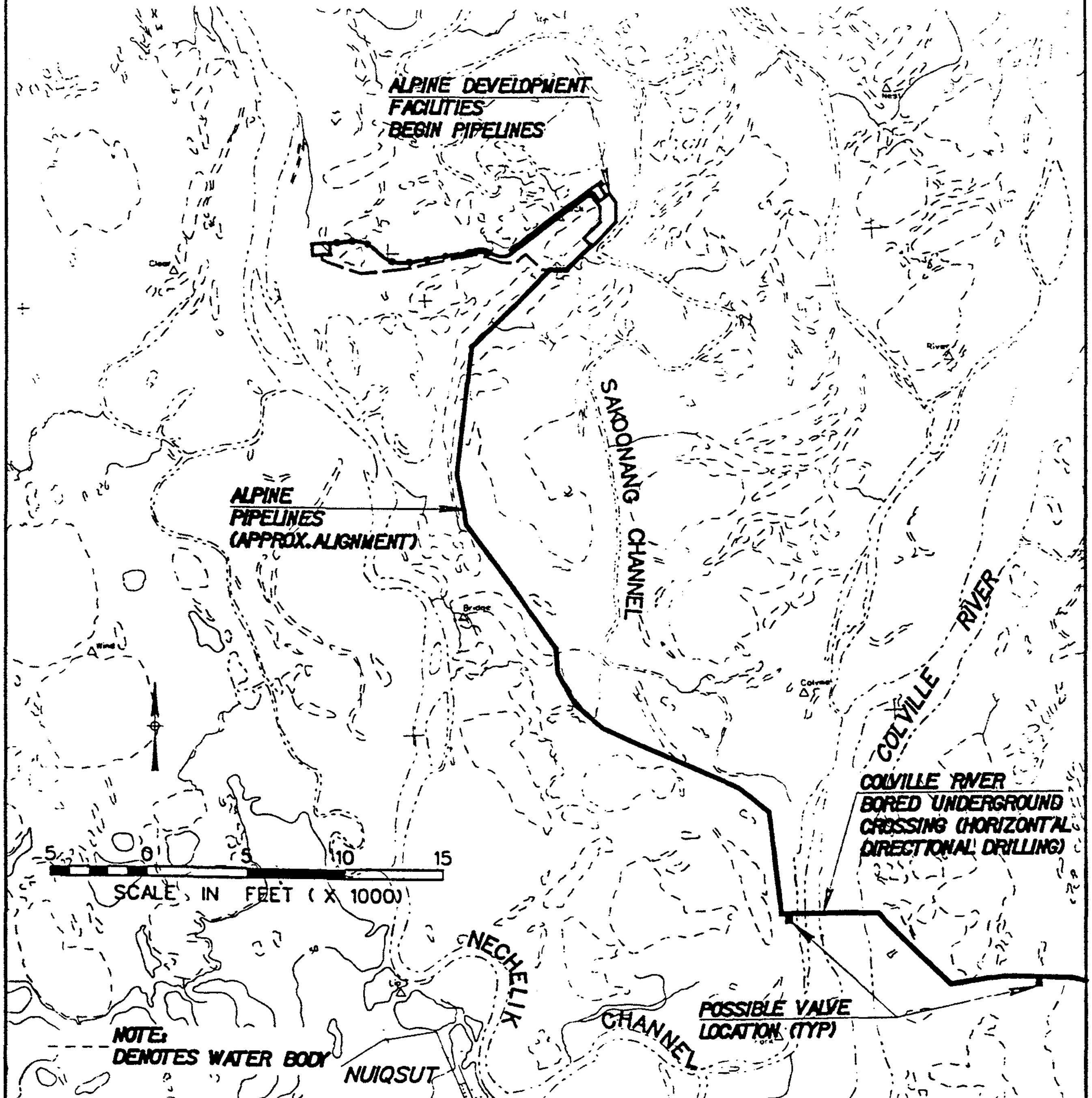


PROJECT VICINITY MAP

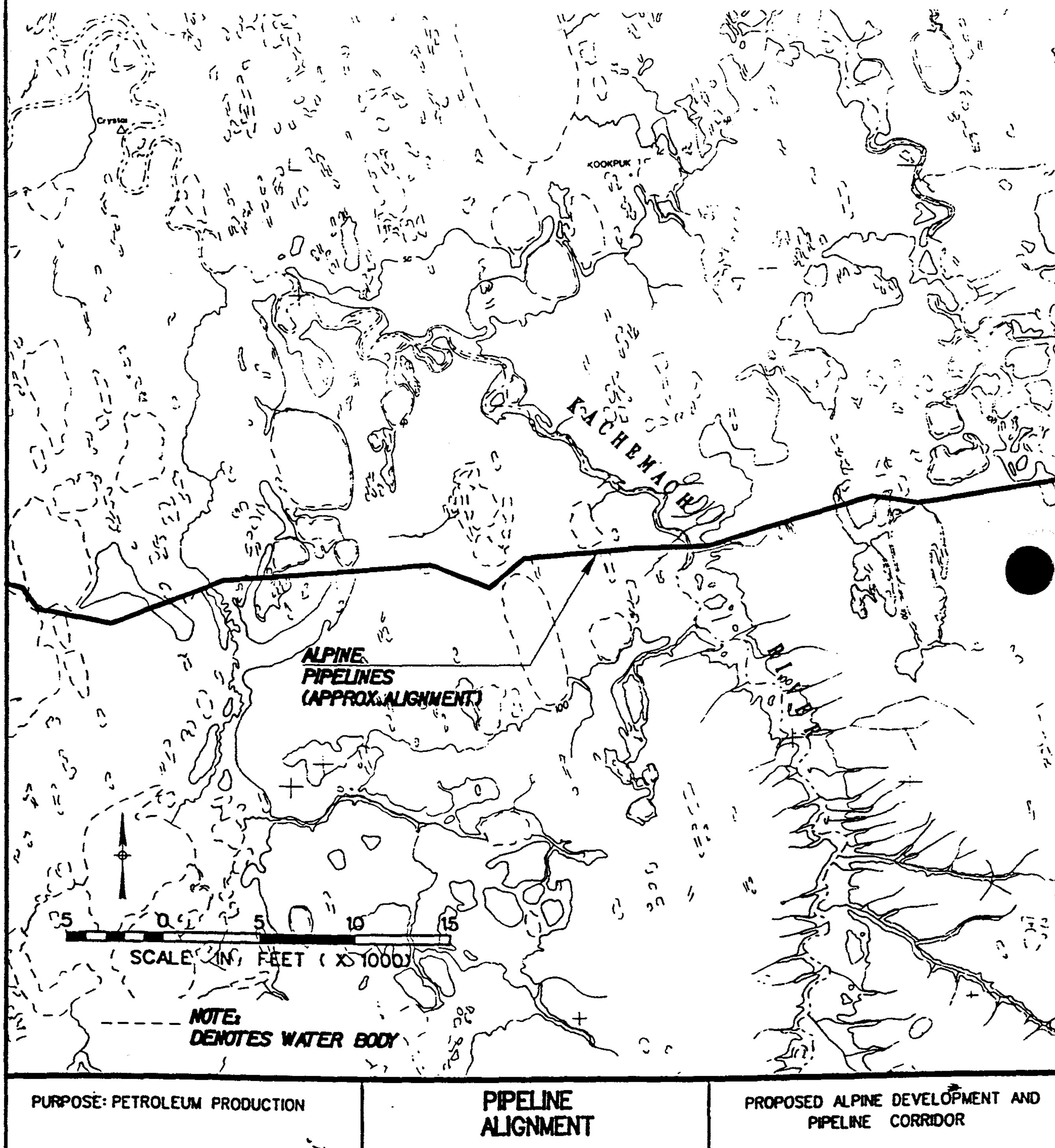
PURPOSE: PETROLEUM PRODUCTION DATUM: ADJACENT PROPERTY OWNERS: 1. STATE OF ALASKA 2. KUUKPIK CORPORATION	PROJECT LOCATION ARCO ALASKA, INC. 700 G. STREET P.O. BOX 100360 ANCHORAGE, ALASKA 99510-0360	PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT BOROUGH: NORTH SLOPE APPLICATION BY: ARCO ALASKA, INC. SHEET 1 OF 22 DATE: 02/26/97



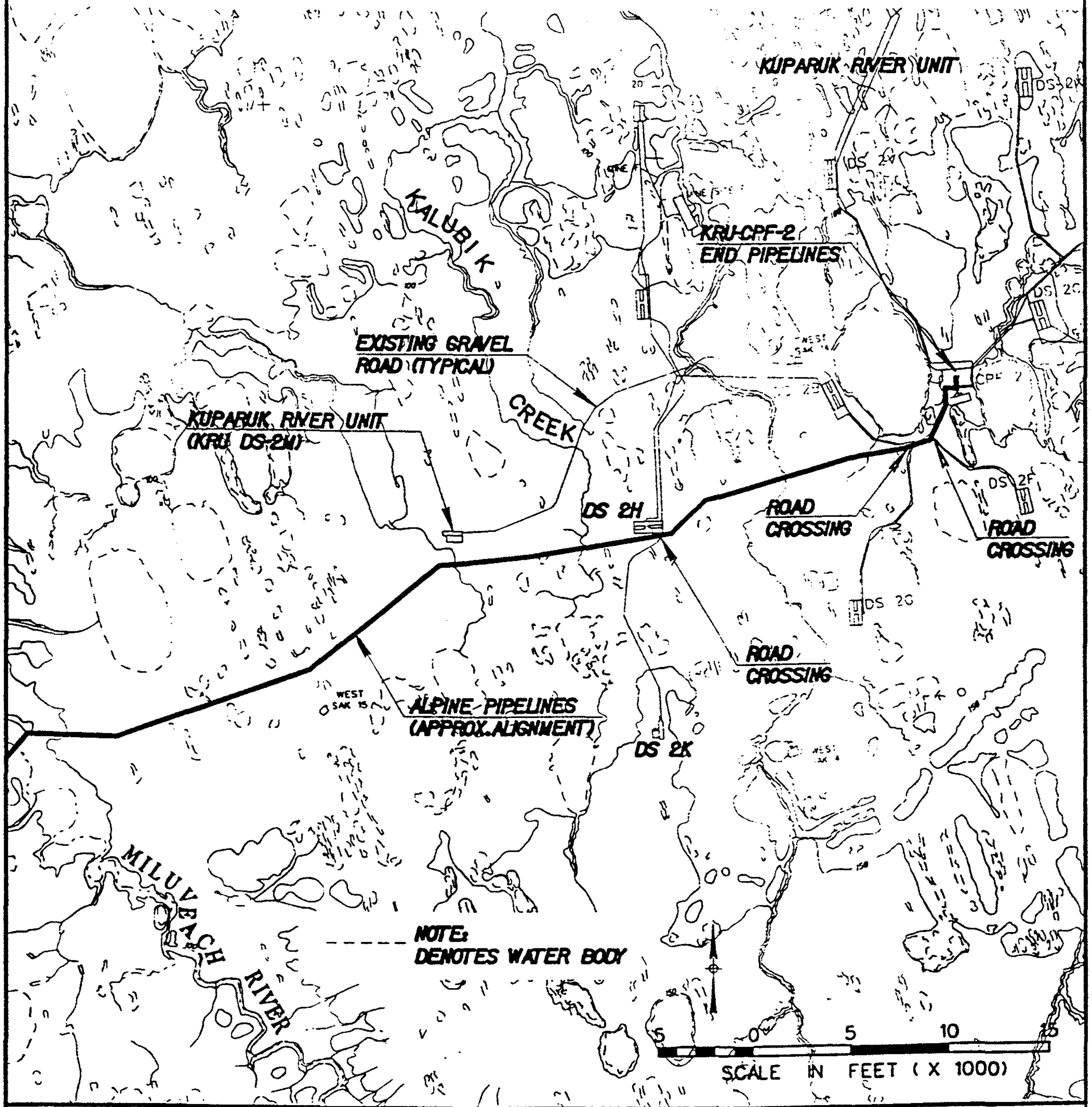
PURPOSE: PETROLEUM PRODUCTION DATUM: ADJACENT PROPERTY OWNERS: 1. STATE OF ALASKA 2. KUUKPIK CORPORATION	PIPELINE OVERVIEW ARCO ALASKA, INC. 700 G. STREET P.O. BOX 100360 ANCHORAGE, ALASKA 99510-0360	PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT BOROUGH: NORTH SLOPE APPLICATION BY: ARCO ALASKA, INC. SHEET 2 OF 22 DATE: 02/26/97



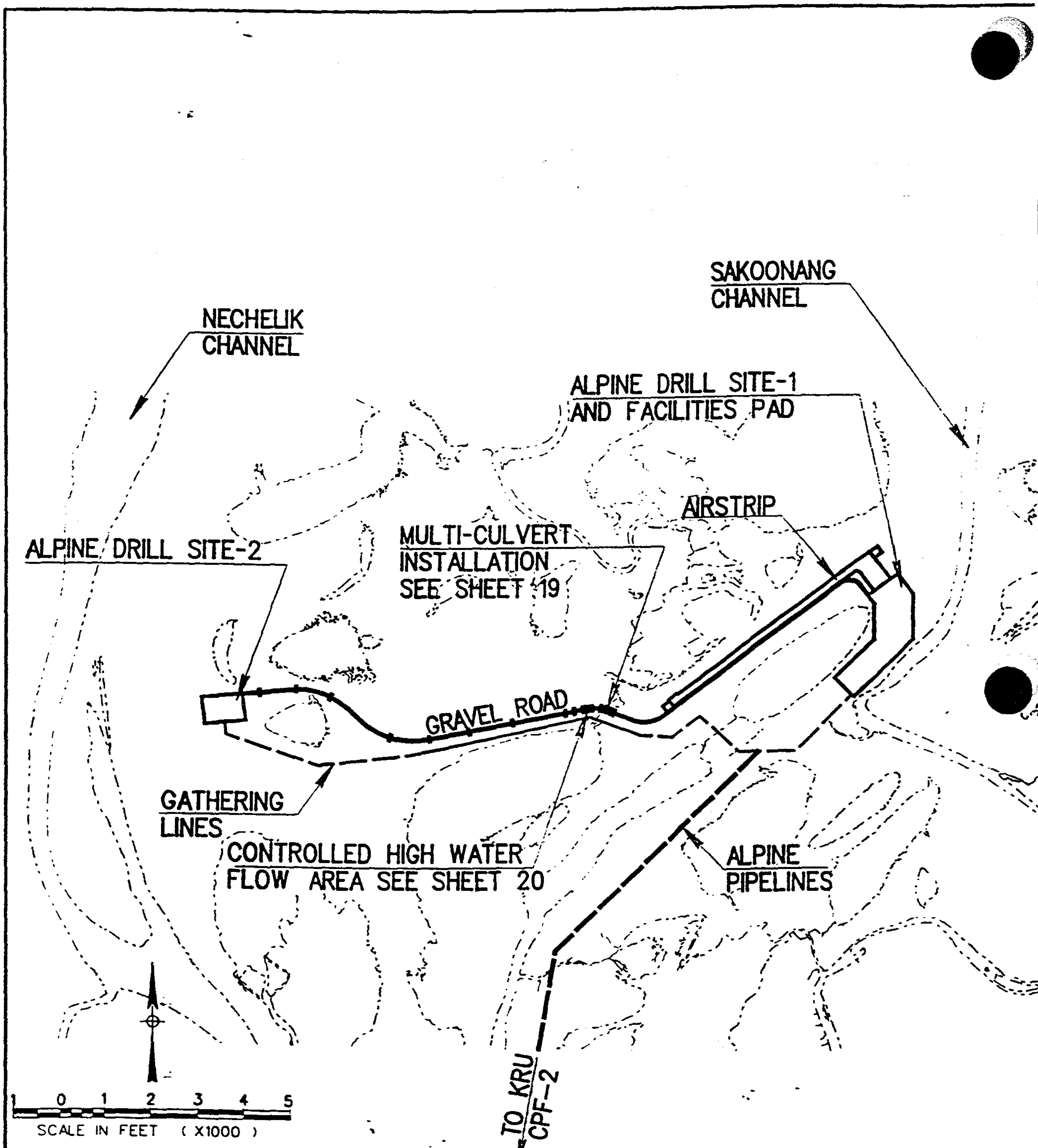
PURPOSE: PETROLEUM PRODUCTION DATUM: ADJACENT PROPERTY OWNERS: 1. STATE OF ALASKA 2. KUUKPIK CORPORATION	**PIPELINE ALIGNMENT** ARCO ALASKA, INC. 700 G. STREET P.O. BOX 100360 ANCHORAGE, ALASKA 99510-0360	PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT BOROUGH: NORTH SLOPE APPLICATION BY: ARCO ALASKA, INC. SHEET 3 OF 22 DATE: 02/26/97



PURPOSE: PETROLEUM PRODUCTION	**PIPELINE ALIGNMENT**	PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR
DATUM: ADJACENT PROPERTY OWNERS: 1. STATE OF ALASKA 2. KUUKPIK CORPORATION	ARCO ALASKA, INC. 700 G. STREET P.O. BOX 100360 ANCHORAGE, ALASKA 99510-0360	LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT BOROUGH: NORTH SLOPE APPLICATION BY: ARCO ALASKA, INC. SHEET 4 OF 22 DATE: 02/26/97

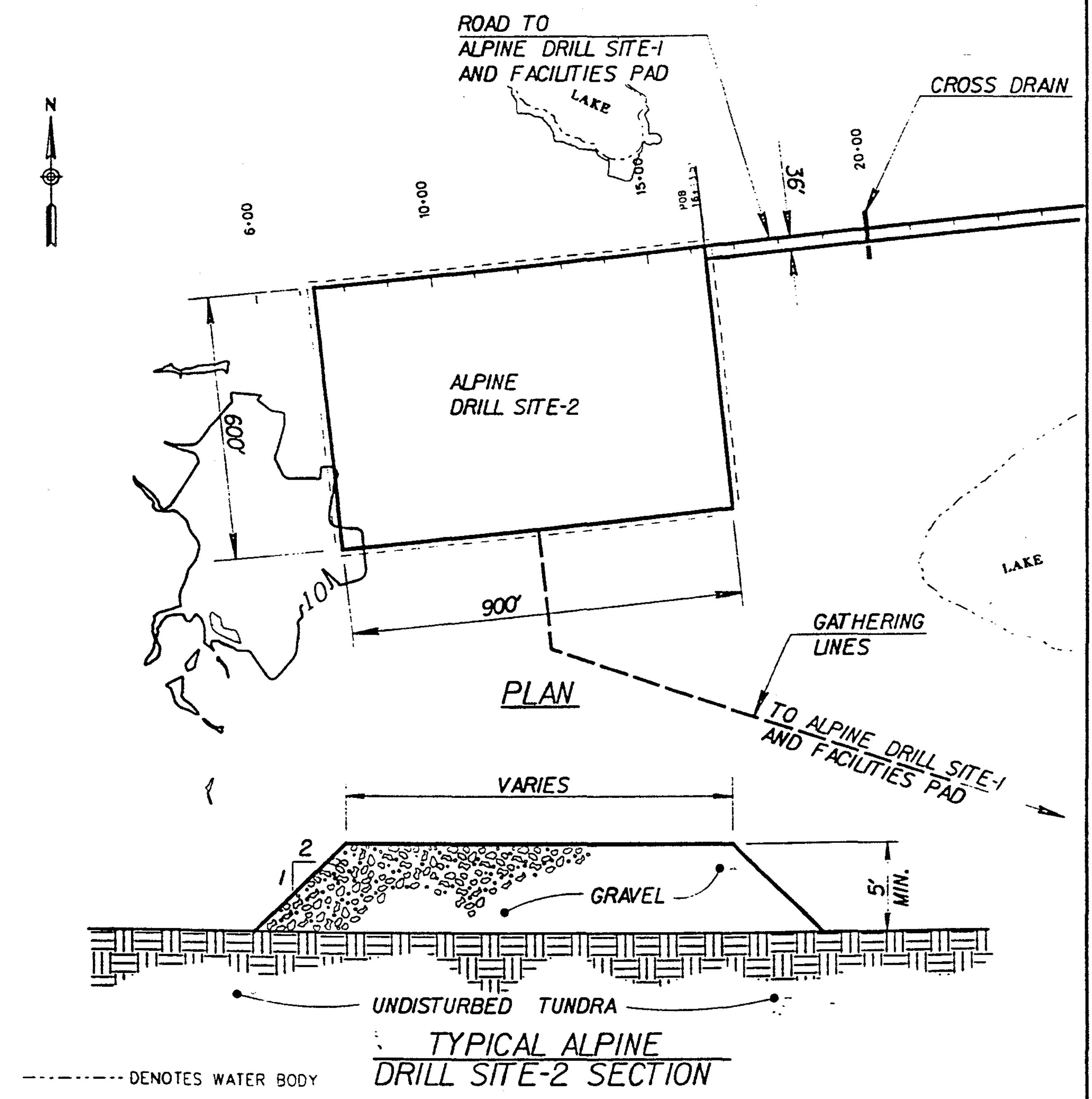


PURPOSE: PETROLEUM PRODUCTION DATUM: ADJACENT PROPERTY OWNERS: 1. STATE OF ALASKA 2. KUUKPIK CORPORATION	**PIPELINE ALIGNMENT** ARCO ALASKA, INC. 700 G. STREET P.O. BOX 100360 ANCHORAGE, ALASKA 99510-0360	PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT BOROUGH: NORTH SLOPE APPLICATION BY: ARCO ALASKA, INC. SHEET 5 OF 22 DATE: 02/26/97



DENOTES WATER BODY

PURPOSE: PETROLEUM PRODUCTION DATUM: ADJACENT PROPERTY OWNERS: 1. STATE OF ALASKA 2. KUUKPIK CORPORATION	**ALPINE DEVELOPMENT FACILITIES OVERVIEW** ARCO ALASKA, INC. 700 G. STREET P.O. BOX 100360 ANCHORAGE, ALASKA 99510-0360	PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT BOROUGH: NORTH SLOPE APPLICATION BY: ARCO ALASKA, INC. SHEET 6 OF 22 DATE: 02/26/97



PURPOSE: PETROLEUM PRODUCTION

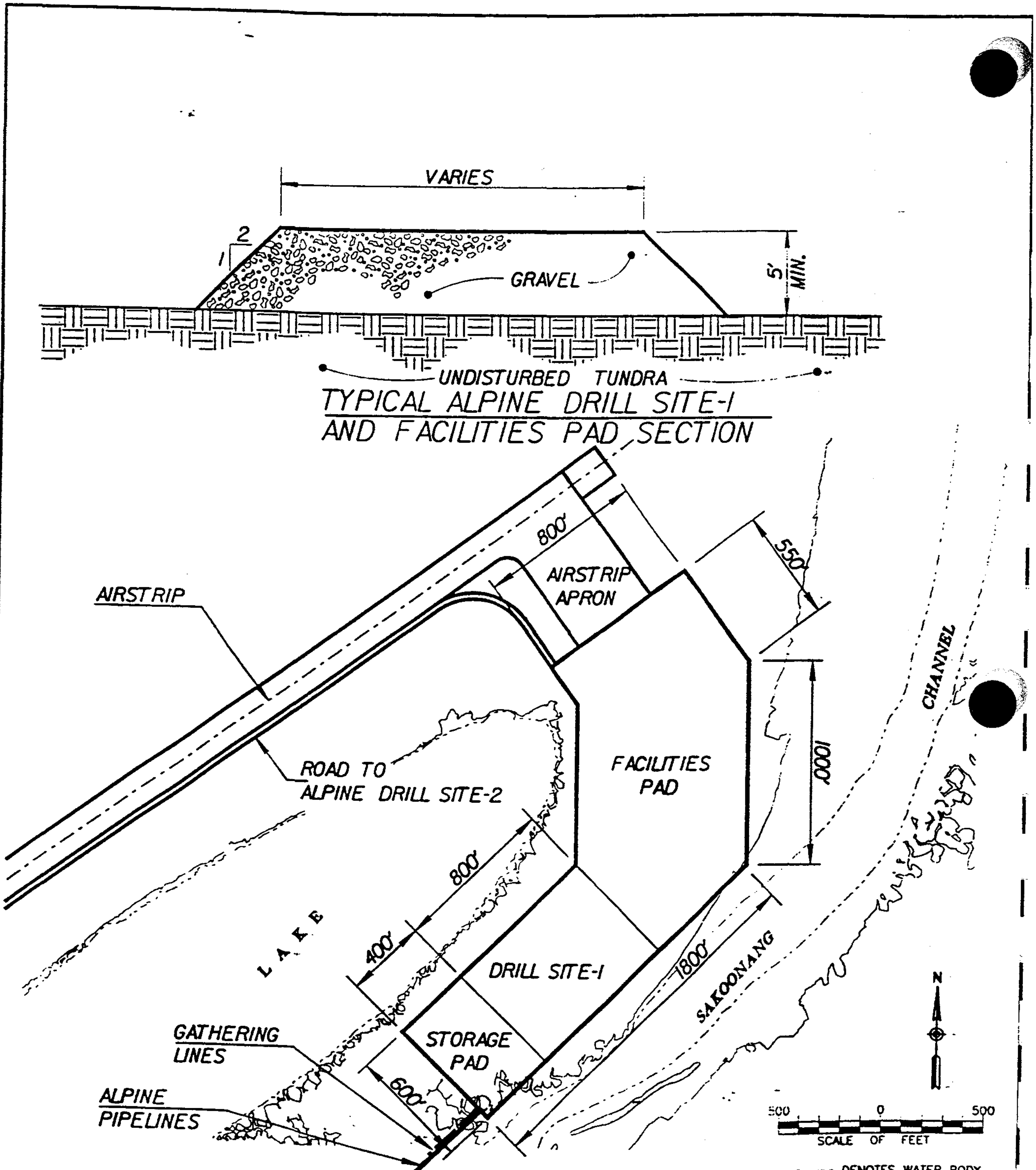
DATUM:
ADJACENT PROPERTY OWNERS:
1. STATE OF ALASKA
2. KUUKPIK CORPORATION

ALPINE DRILL SITE-2

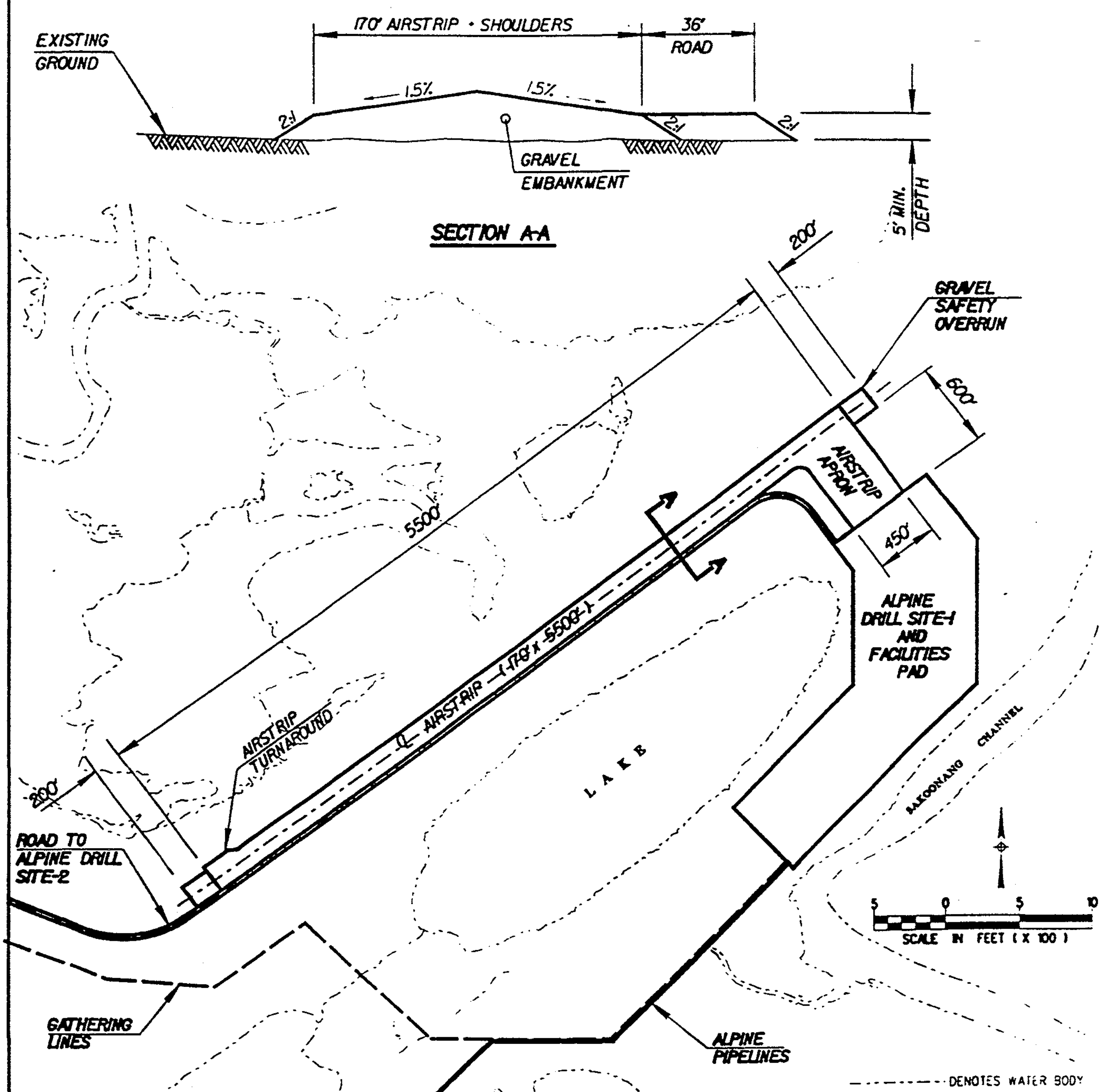
ARCO ALASKA, INC.
700 G. STREET
P.O. BOX 100360
ANCHORAGE, ALASKA 99510-0360

PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR

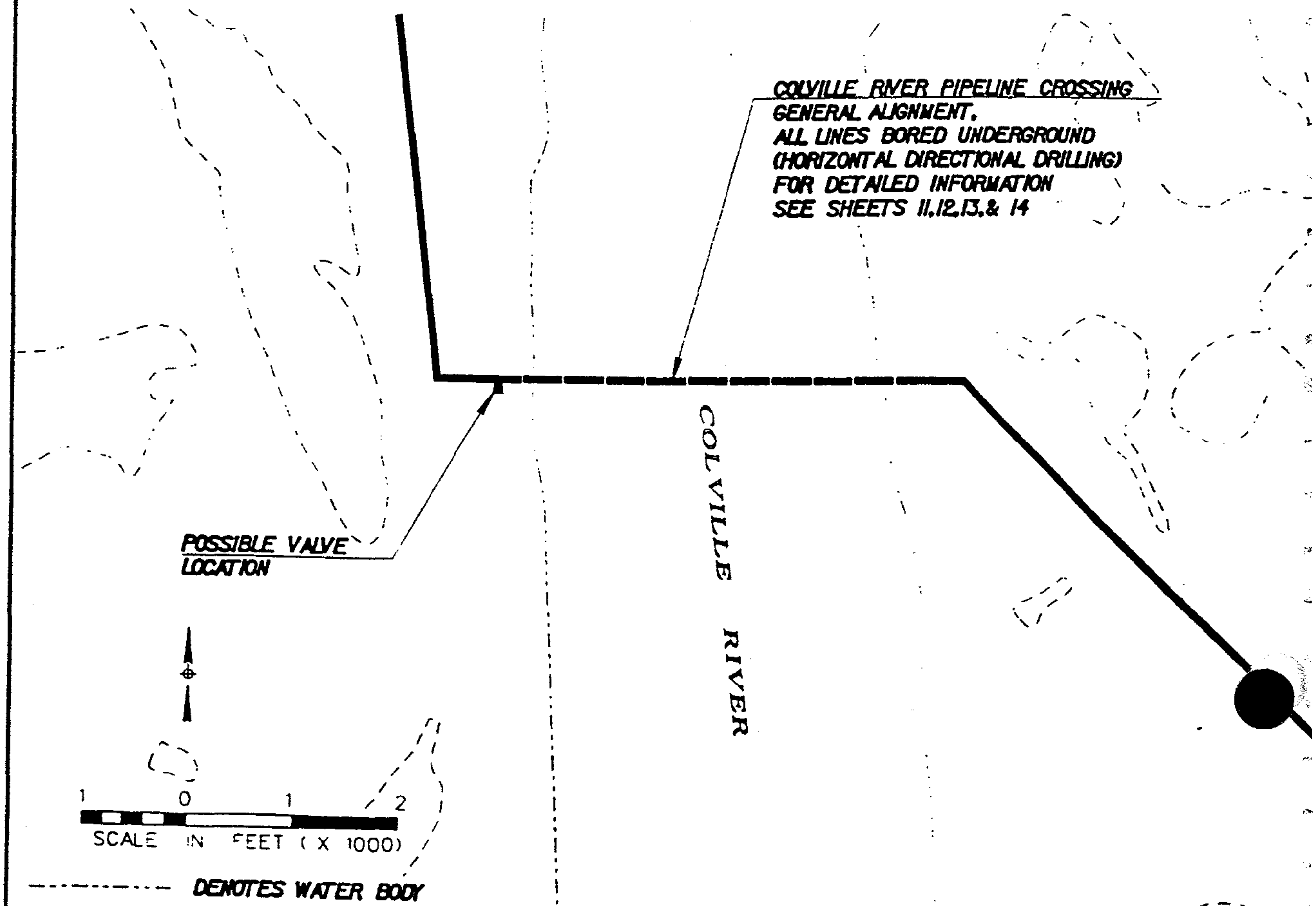
LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT
BOROUGH: NORTH SLOPE
APPLICATION BY: ARCO ALASKA, INC.
SHEET 7 OF 22 DATE: 02/26/97

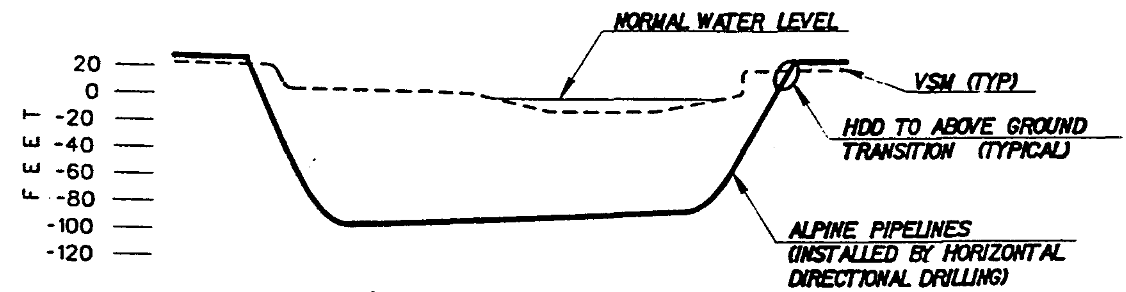


PURPOSE: PETROLEUM PRODUCTION DATUM: ADJACENT PROPERTY OWNERS: 1. STATE OF ALASKA 2. KUUKPIK CORPORATION	**ALPINE DRILL SITE-1 AND FACILITIES PAD** ARCO ALASKA, INC. 700 G. STREET P.O. BOX 100360 ANCHORAGE, ALASKA 99510-0360	PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT BOROUGH: NORTH SLOPE APPLICATION BY: ARCO ALASKA, INC. SHEET 8 OF 22 DATE: 02/26/97



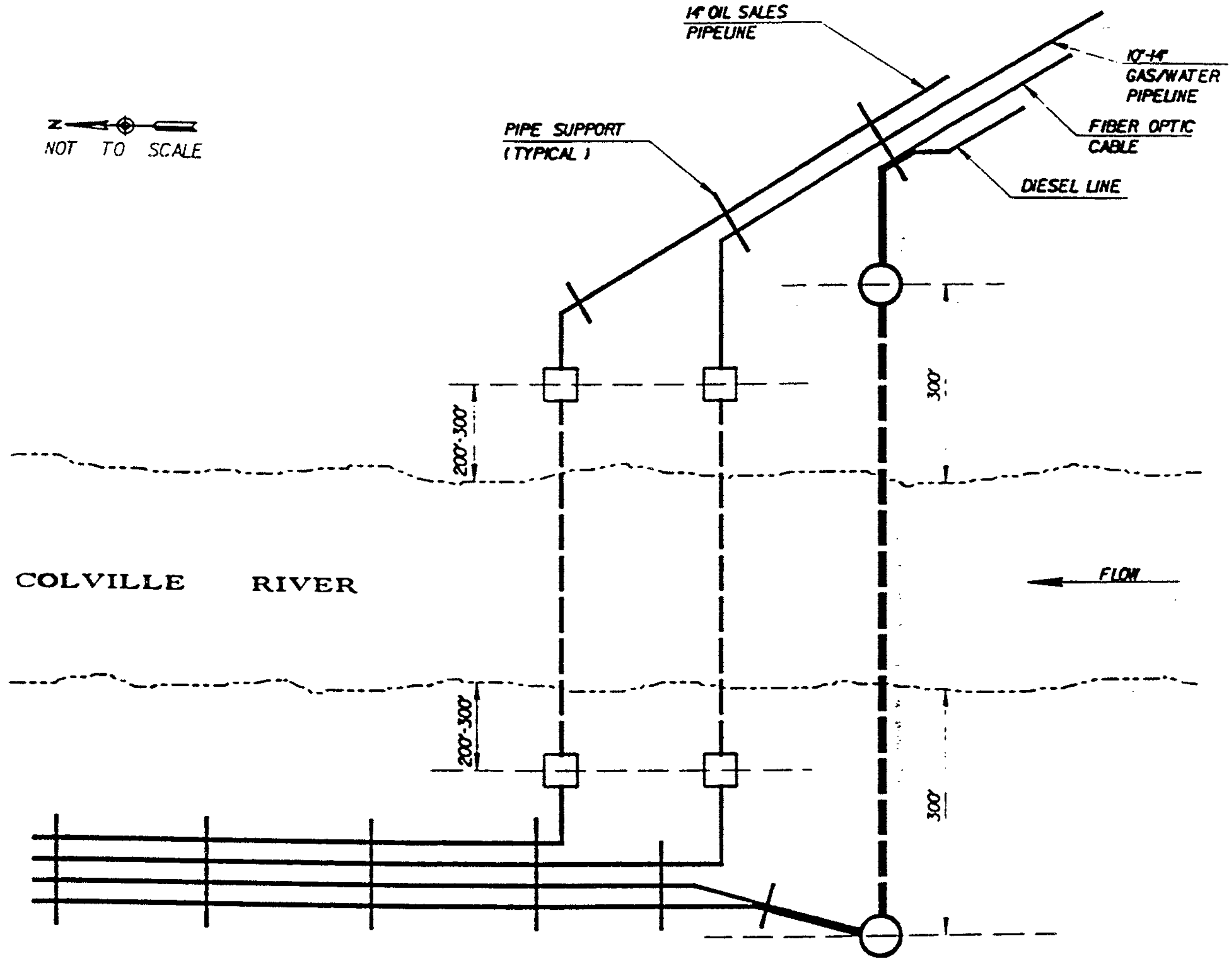
PURPOSE: PETROLEUM PRODUCTION DATUM: ADJACENT PROPERTY OWNERS: 1. STATE OF ALASKA 2. KUUKPIK CORPORATION	**AIRSTRIP LAYOUT** ARCO ALASKA, INC. 700 G. STREET P.O. BOX 100360 ANCHORAGE, ALASKA 99510-0360	PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT BOROUGH: NORTH SLOPE APPLICATION BY: ARCO ALASKA, INC. SHEET 9 OF 22 DATE: 02/26/97





PROFILE

PURPOSE: PETROLEUM PRODUCTION DATUM: ADJACENT PROPERTY OWNERS: 1. STATE OF ALASKA 2. KUUKPIK CORPORATION	COLVILLE RIVER PIPELINE CROSSING ARCO ALASKA, INC. 700 G. STREET P.O. BOX 100360 ANCHORAGE, ALASKA 99510-0360	PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT BOROUGH: NORTH SLOPE APPLICATION BY: ARCO ALASKA, INC SHEET 10 OF 22 DATE: 02/26/97



LEGEND
- ABOVE GROUND SECTION
- BELOW GROUND SECTION
- NON-VERTICAL TRANSITION
- VERTICAL TRANSITION

NOTE:
FOR DETAILED INFORMATION
SEE SHEETS 12,13,& 14

PURPOSE: PETROLEUM PRODUCTION

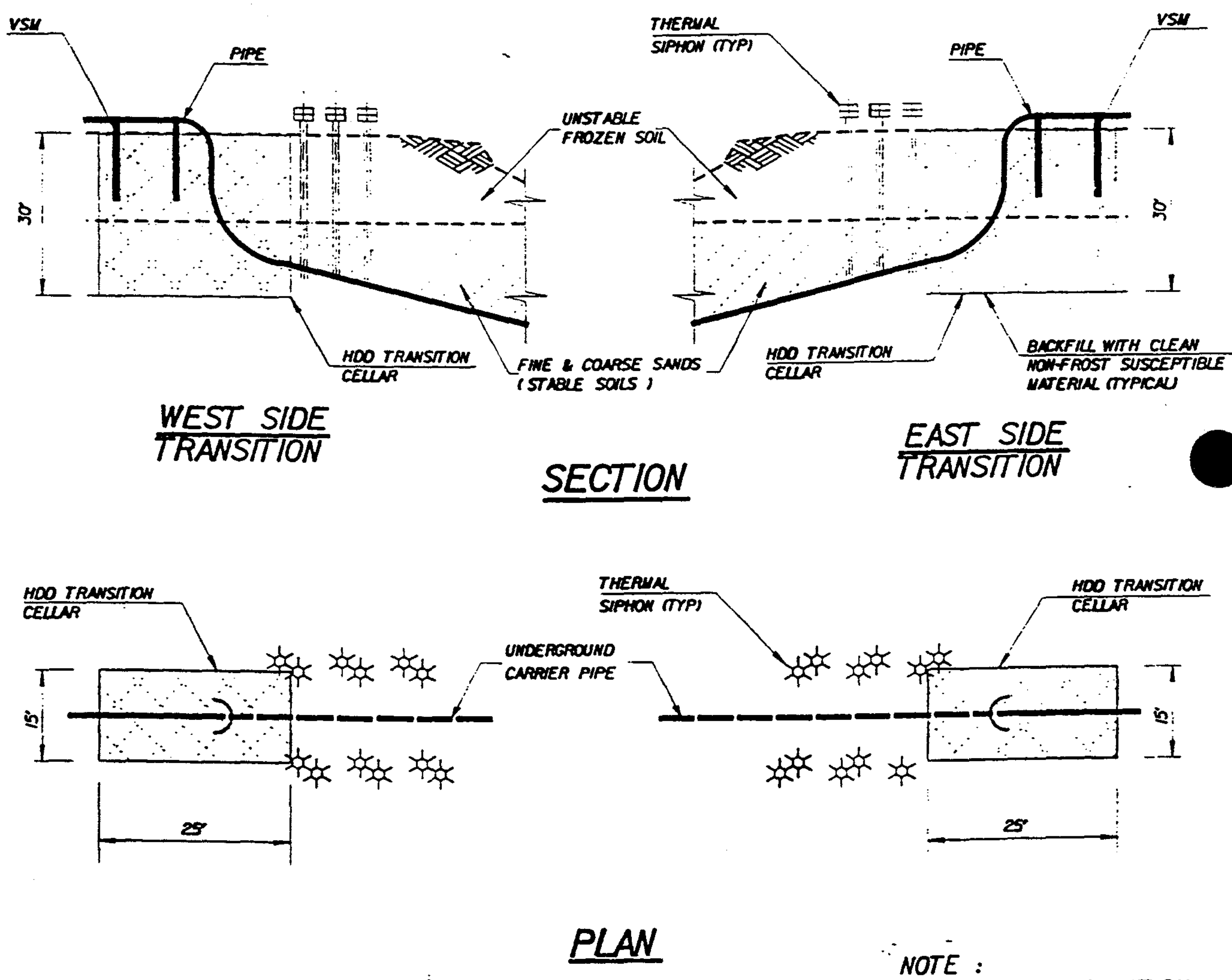
DATUM:
ADJACENT PROPERTY OWNERS:
1. STATE OF ALASKA
2. KUUKPIK CORPORATION

PLAN OF COLVILLE RIVER-PIPELINE CROSSING

ARCO ALASKA, INC.
700 G. STREET
P.O. BOX 100360
ANCHORAGE, ALASKA 99510-0360

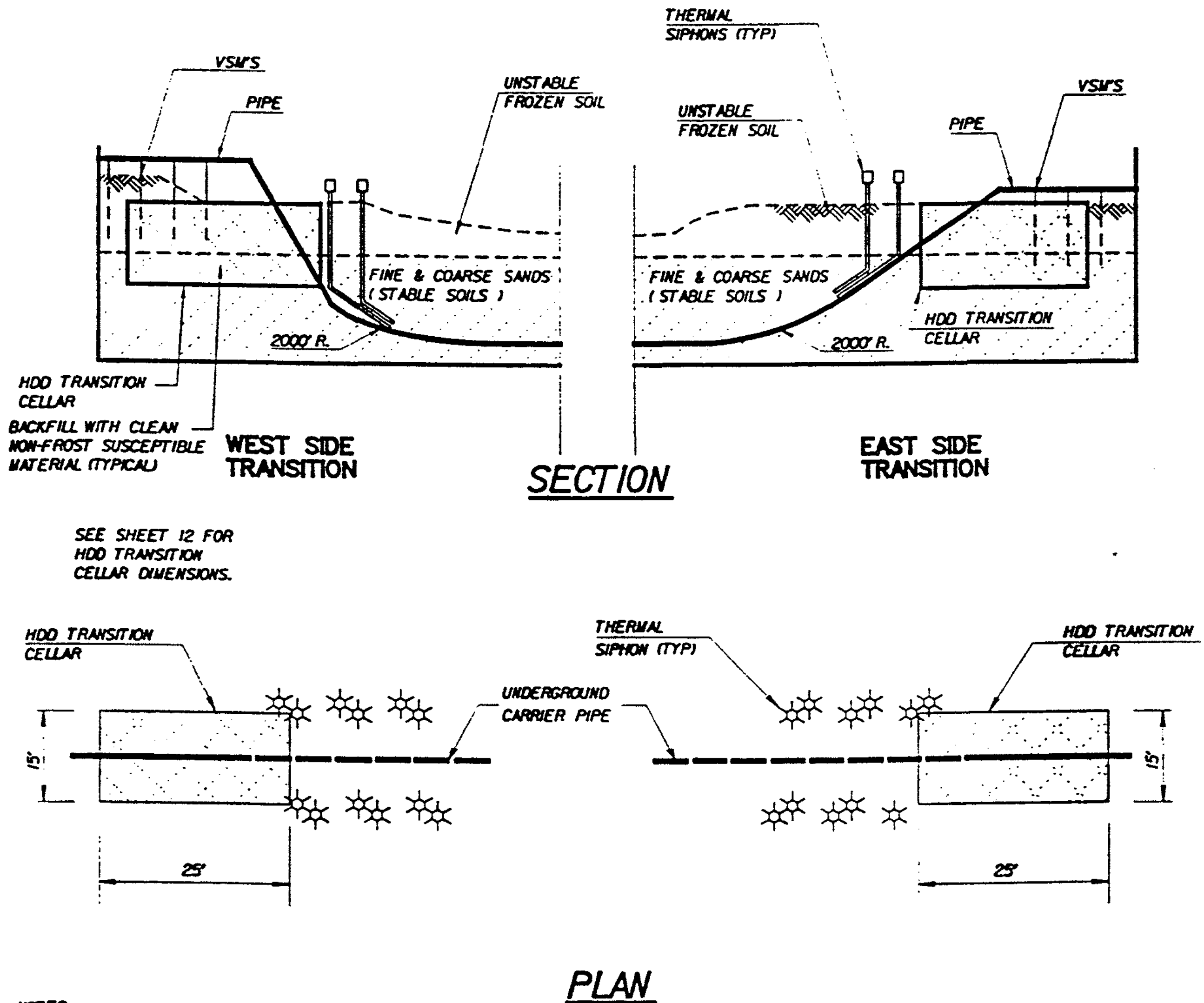
PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR

LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT
BOROUGH: NORTH SLOPE
APPLICATION BY: ARCO ALASKA, INC.
SHEET 11 OF 22 DATE: 02/26/97



NOTE :
VOLUME OF EXCAVATION
APPROX. 420 CU YD
FOR EACH TRANSITION

PURPOSE: PETROLEUM PRODUCTION DATUM: ADJACENT PROPERTY OWNERS: 1. STATE OF ALASKA 2. KUUKPIK CORPORATION	**HORIZONTAL DIRECTIONAL DRILLED (HDD) TO ABOVE GROUND VERTICAL DESIGN** ARCO ALASKA, INC. 700 G. STREET P.O. BOX 100360 ANCHORAGE, ALASKA 99510-0360	PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT BOROUGH: NORTH SLOPE APPLICATION BY: ARCO ALASKA, INC. SHEET 12 OF 22 DATE: 02/26/97



NOTES:
1. APPROXIMATE VOLUME OF EXCAVATION FOR EACH CELLAR IS 420 CUYD.

PURPOSE: PETROLEUM PRODUCTION

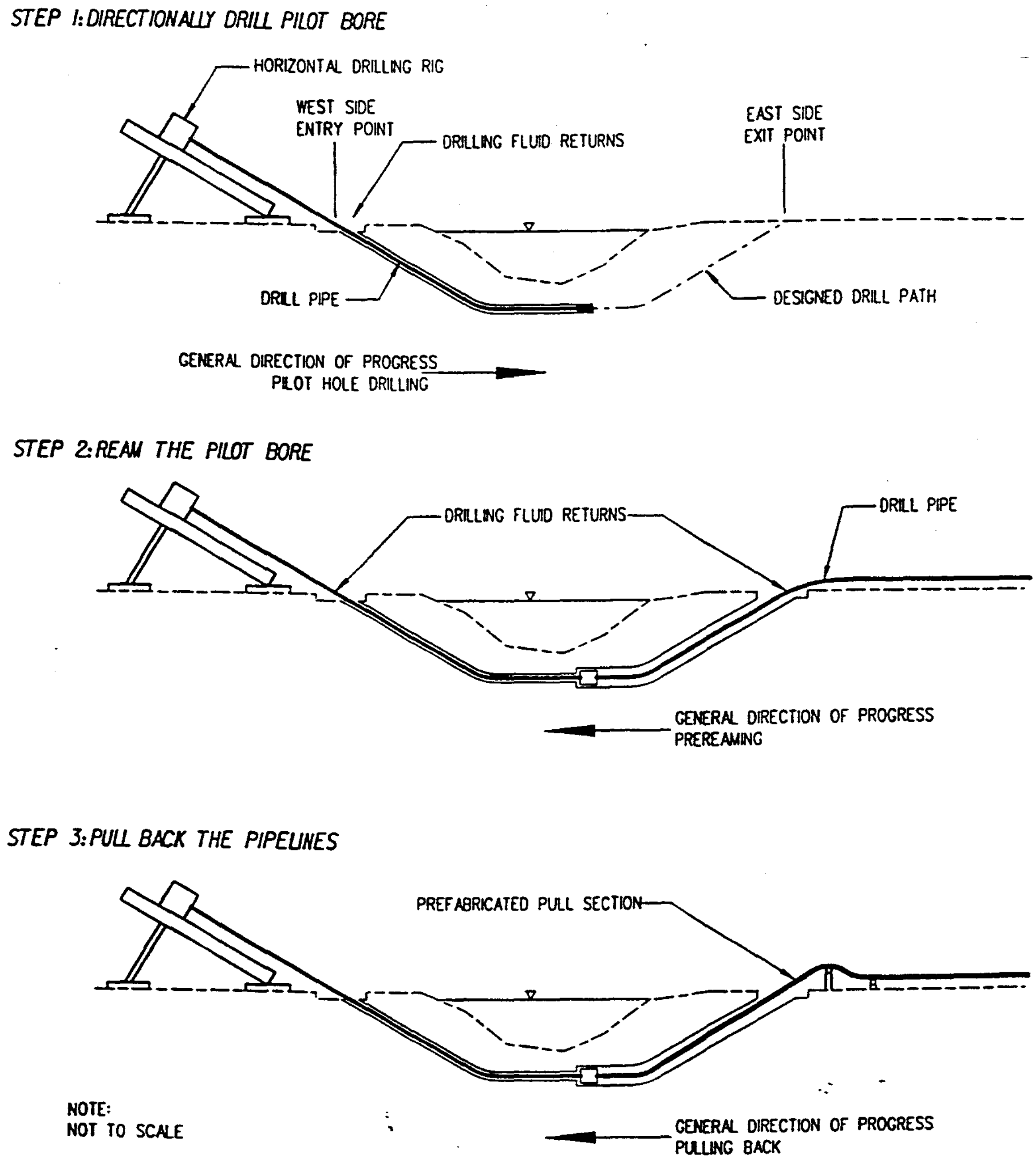
DATUM:
ADJACENT PROPERTY OWNERS:
1. STATE OF ALASKA
2. KUUKPIK CORPORATION

HORIZONTAL DIRECTIONAL DRILLED (HDD) TO ABOVE GROUND NON-VERTICAL DESIGN

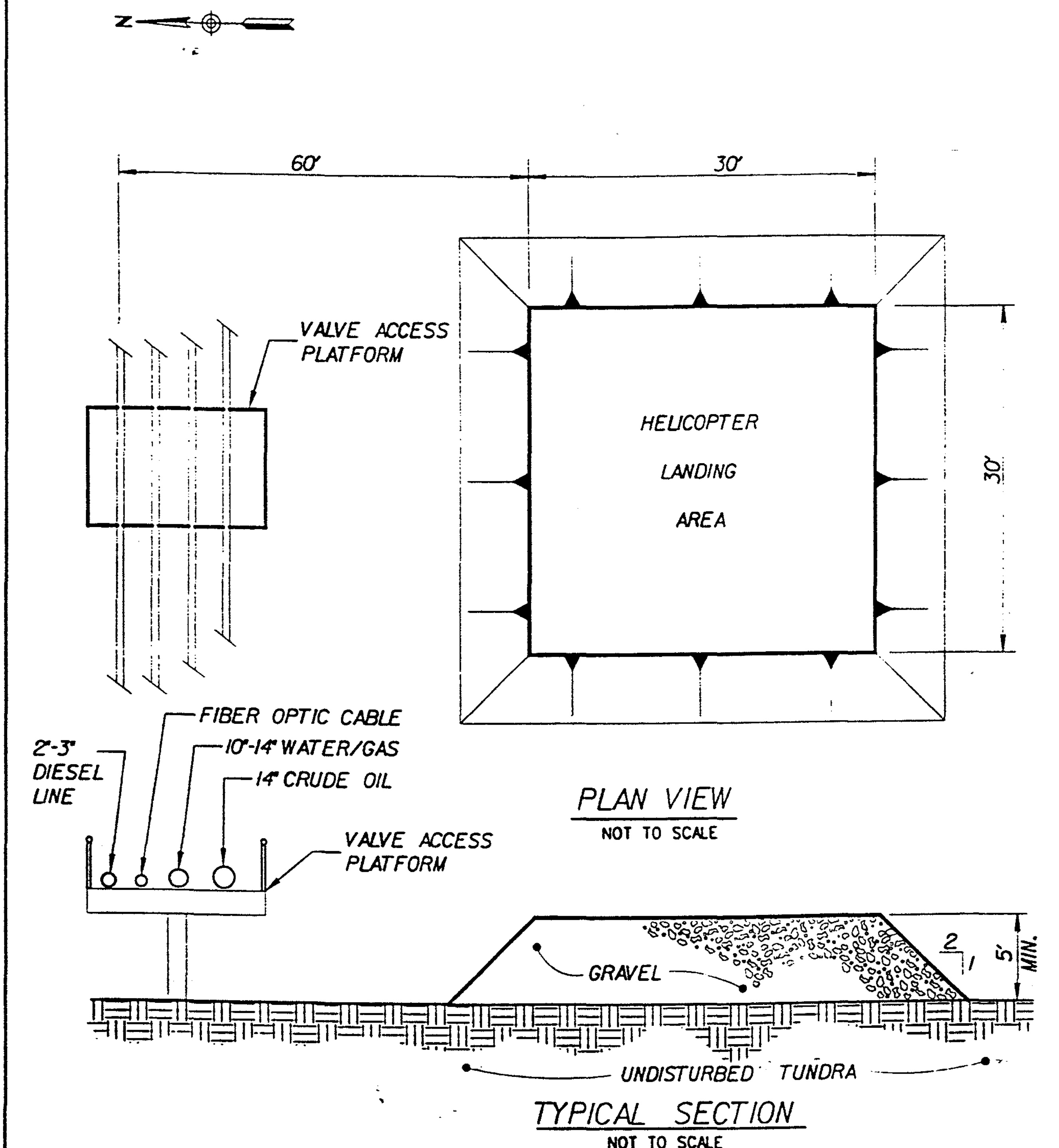
ARCO ALASKA, INC.
700 G. STREET
P.O. BOX 100360
ANCHORAGE, ALASKA 99510-0360

PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR

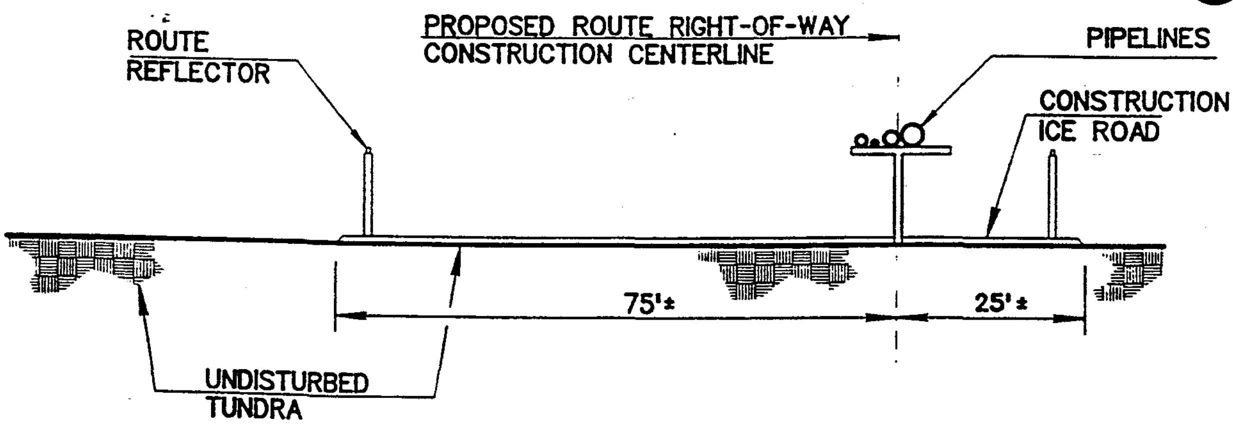
LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT
BOROUGH: NORTH SLOPE
APPLICATION BY: ARCO ALASKA, INC.
SHEET 13 OF 22 DATE: 02/26/97



PURPOSE: PETROLEUM PRODUCTION DATUM: ADJACENT PROPERTY OWNERS: 1. STATE OF ALASKA 2. KUUKPIK CORPORATION	**HORIZONTAL DIRECTIONAL DRILLED (HDD) SEQUENCE** ARCO ALASKA, INC. 700 G. STREET P.O. BOX 100360 ANCHORAGE, ALASKA 99510-0360	PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT BOROUGH: NORTH SLOPE APPLICATION BY: ARCO ALASKA, INC. SHEET 14 OF 22 DATE: 02/26/97

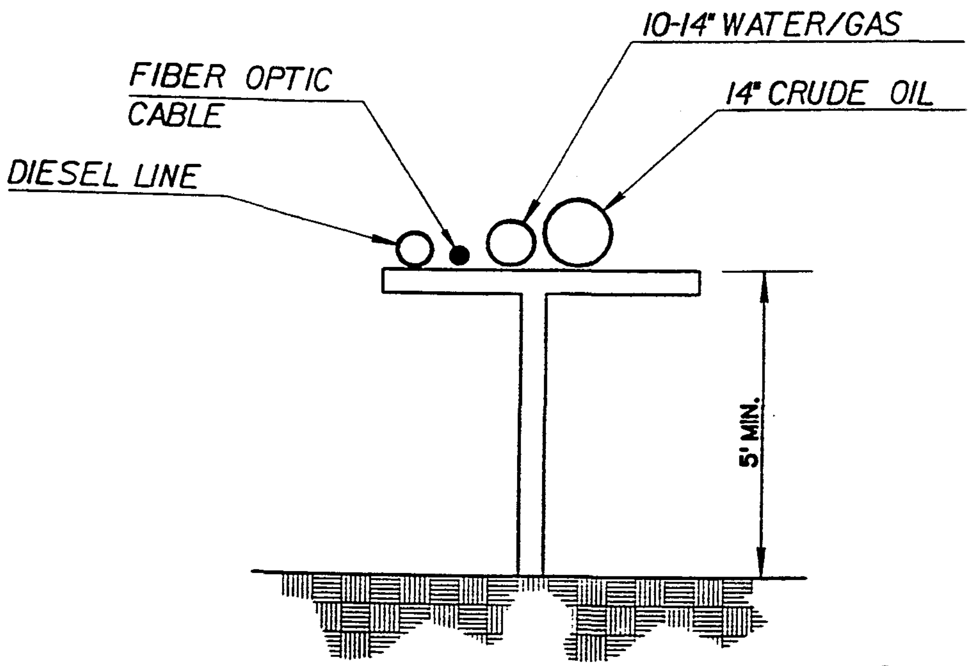


PURPOSE: PETROLEUM PRODUCTION DATUM: ADJACENT PROPERTY OWNERS: 1. STATE OF ALASKA 2. KUUKPIK CORPORATION	**TYPICAL VALVE PAD** ARCO ALASKA, INC. 700 G. STREET P.O. BOX 100360 ANCHORAGE, ALASKA 99510-0360	PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT BOROUGH: NORTH SLOPE APPLICATION BY: ARCO ALASKA, INC. SHEET 15 OF 22 DATE: 02/26/97



ALPINE PIPELINES TYPICAL SECTION

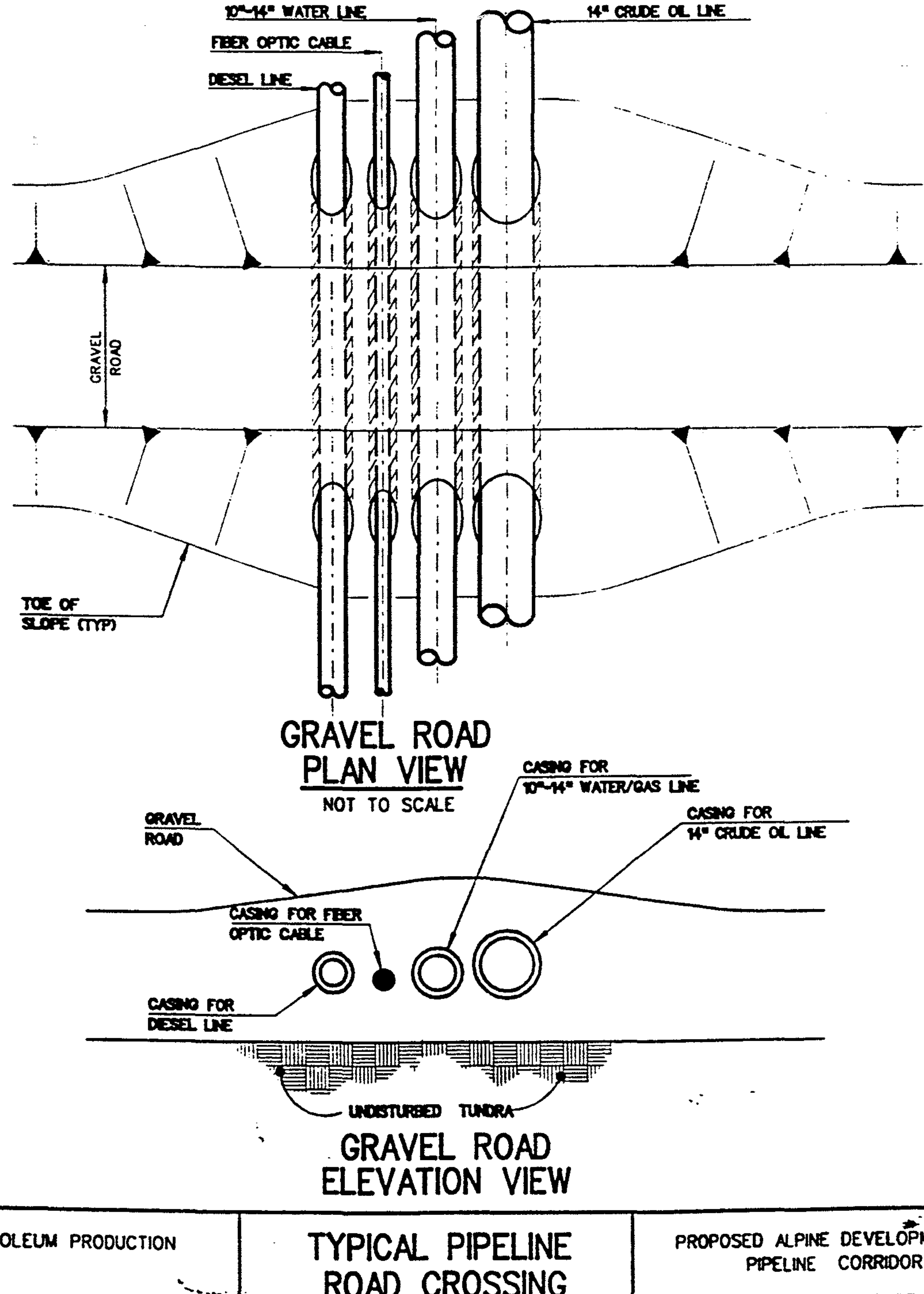
NOT TO SCALE



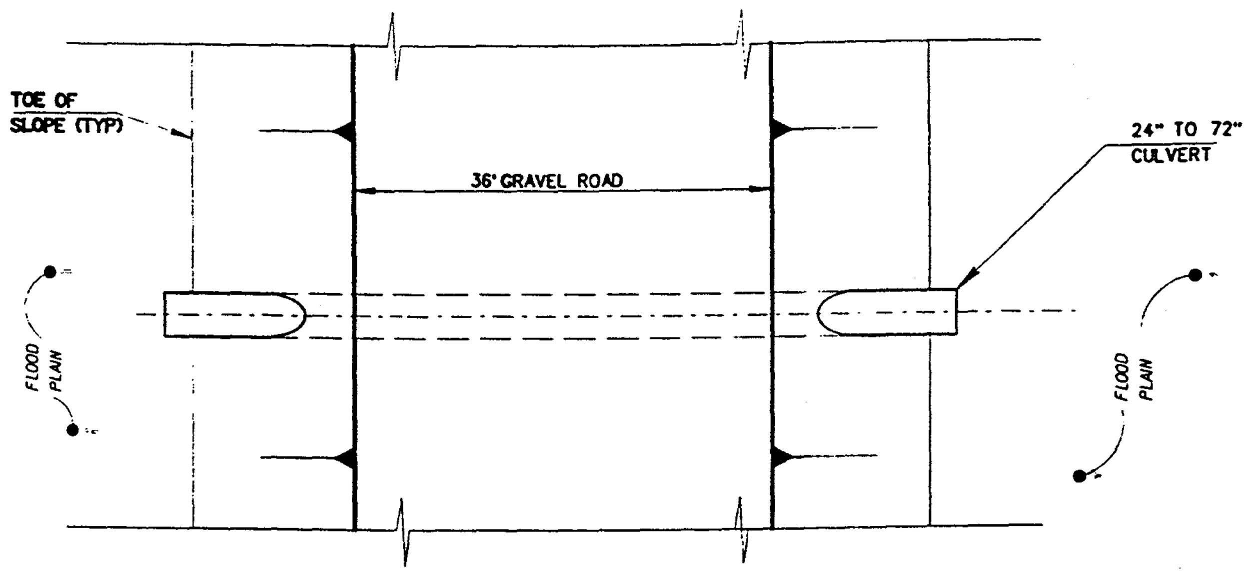
TYPICAL VSM ELEVATION

NOT TO SCALE

PURPOSE: PETROLEUM PRODUCTION DATUM: ADJACENT PROPERTY OWNERS: 1. STATE OF ALASKA 2. KUUKPIK CORPORATION	**TYPICAL PIPELINE CONSTRUCTION** ARCO ALASKA, INC. 700 G. STREET P.O. BOX 100360 ANCHORAGE, ALASKA 99510-0360	PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT BOROUGH: NORTH SLOPE APPLICATION BY: ARCO ALASKA, INC. SHEET 16 OF 22 DATE: 02/

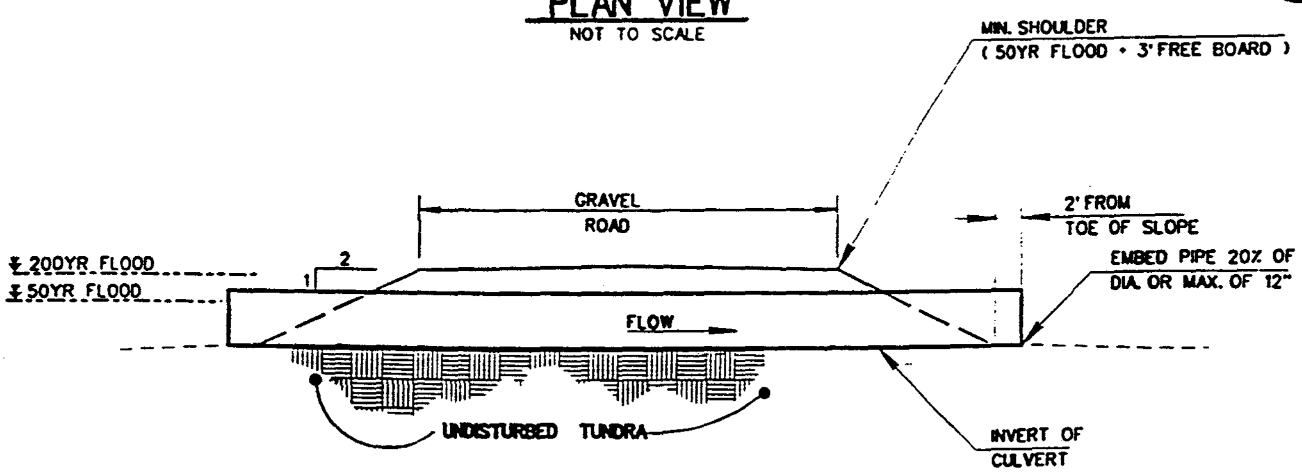


PURPOSE: PETROLEUM PRODUCTION DATUM: ADJACENT PROPERTY OWNERS: 1. STATE OF ALASKA 2. KUUKPIK CORPORATION	**TYPICAL PIPELINE ROAD CROSSING** ARCO ALASKA, INC. 700 G. STREET P.O. BOX 100360 ANCHORAGE, ALASKA 99510-0360	PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT BOROUGH: NORTH SLOPE APPLICATION BY: ARCO ALASKA, INC. SHEET 17 OF 22 DATE: 02/26/97



GRAVEL ROAD PLAN VIEW

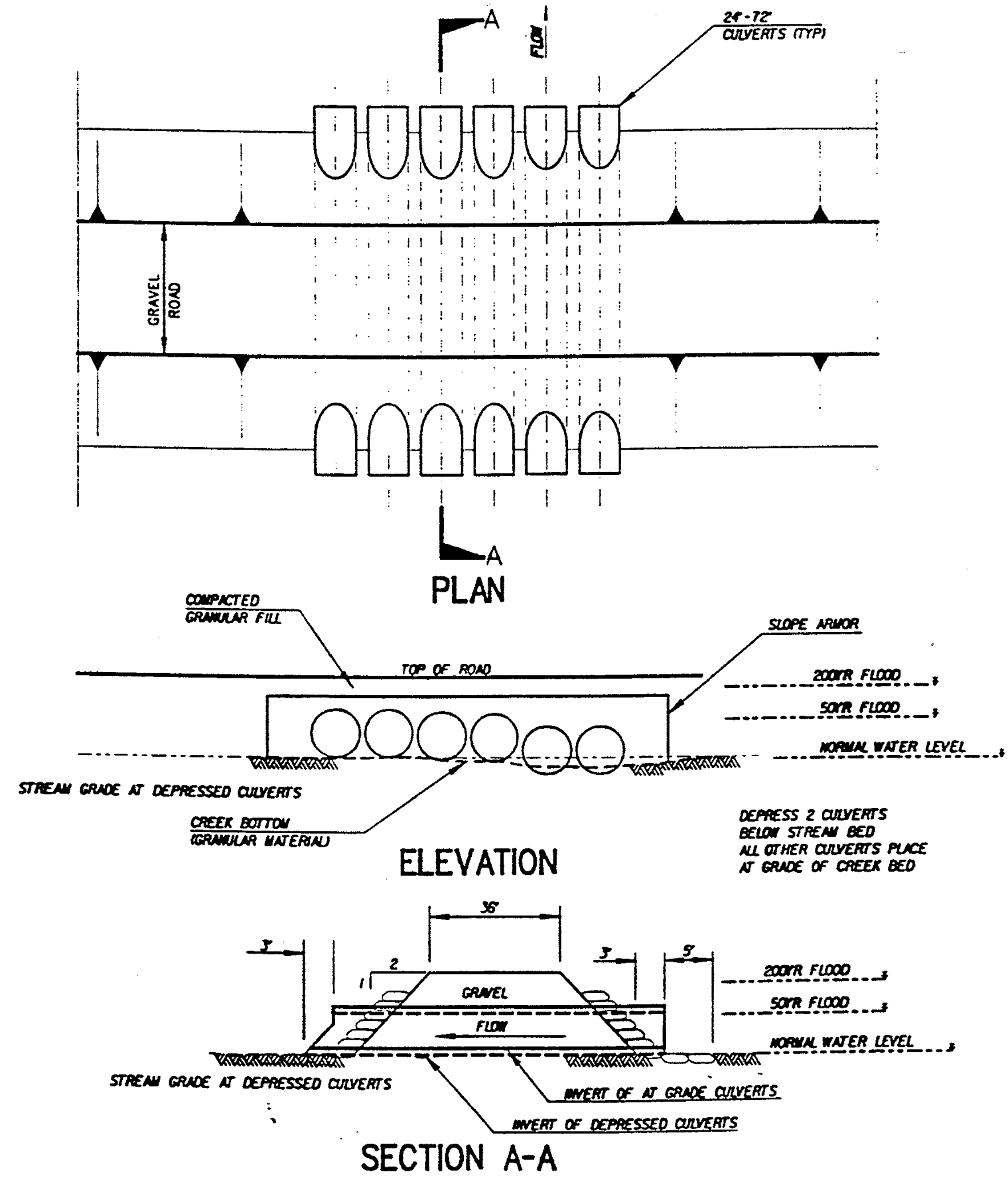
NOT TO SCALE



GRAVEL ROAD SIDE VIEW

NOT TO SCALE

PURPOSE: PETROLEUM PRODUCTION DATUM: ADJACENT PROPERTY OWNERS: 1. STATE OF ALASKA 2. KUUKPIK CORPORATION	TYPICAL FLOOD PLAIN CULVERT INSTALLATION ARCO ALASKA, INC. 700 G. STREET P.O. BOX 100360 ANCHORAGE, ALASKA 99510-0360	PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT BOROUGH: NORTH SLOPE APPLICATION BY: ARCO ALASKA, INC. SHEET 18 OF 22 DATE: 02/26/97



PURPOSE: PETROLEUM PRODUCTION

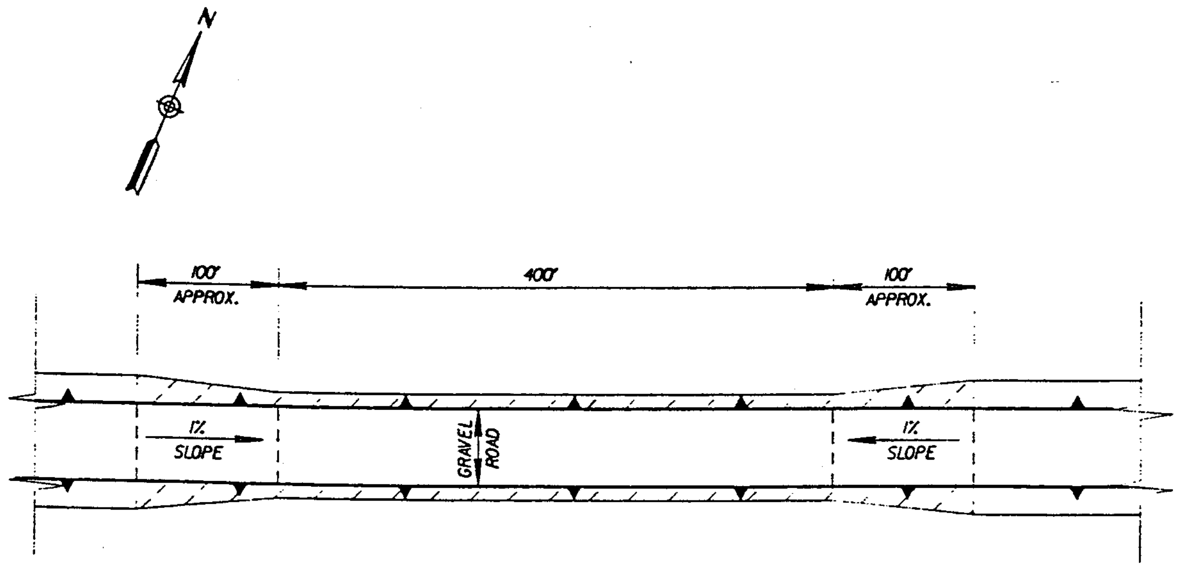
DATUM:
ADJACENT PROPERTY OWNERS:
1. STATE OF ALASKA
2. KUUKPIK CORPORATION

TYPICAL MULTI-CULVERT INSTALLATION

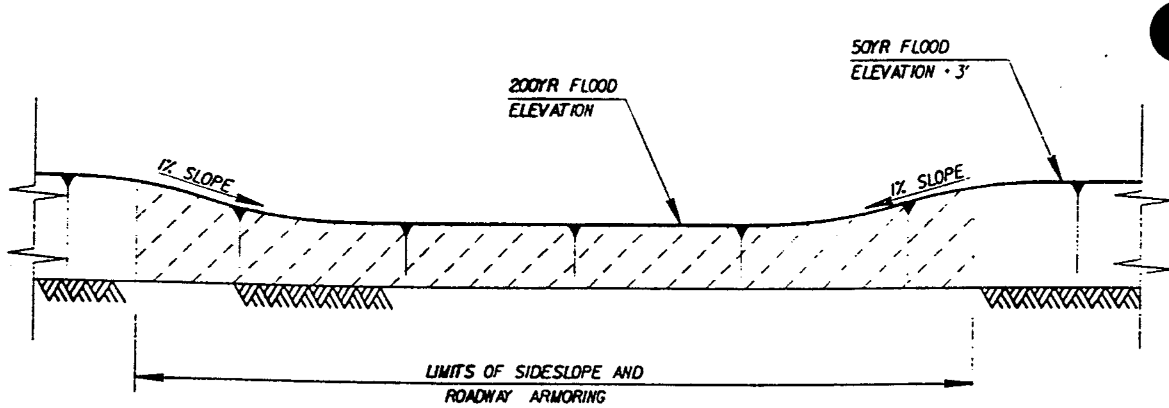
ARCO ALASKA, INC.
700 G. STREET
P.O. BOX 100360
ANCHORAGE, ALASKA 99510-0360

PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR

LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT
BOROUGH: NORTH SLOPE
APPLICATION BY: ARCO ALASKA, INC.
SHEET 19 OF 22 DATE: 02/26/97

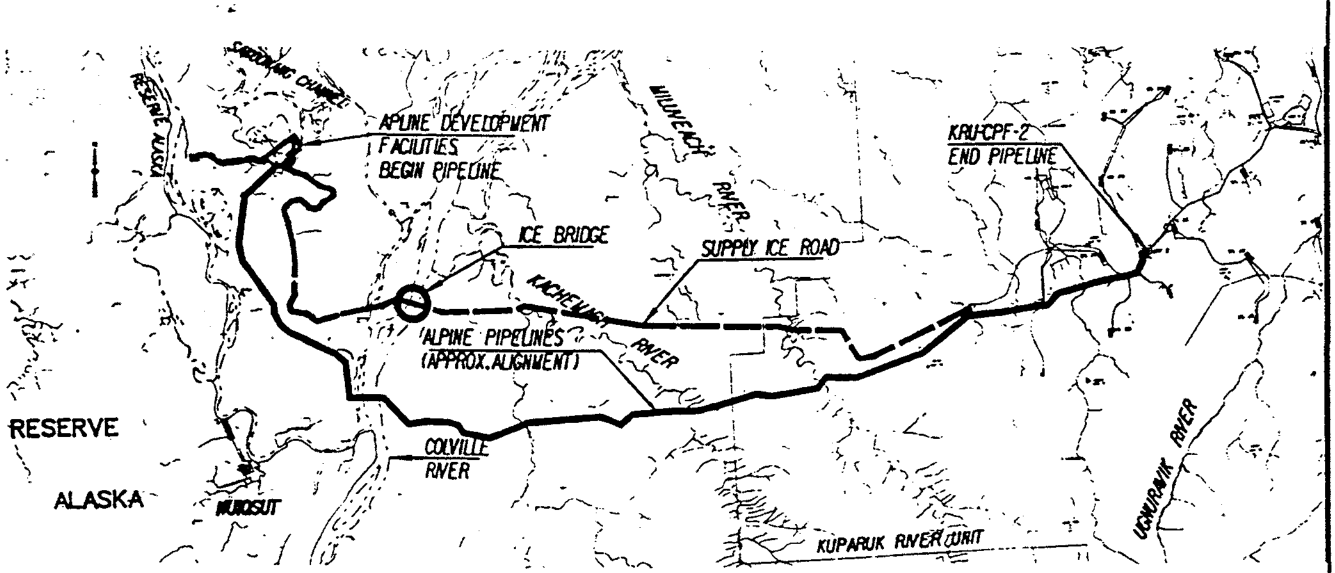


PLAN VIEW
NOT TO SCALE

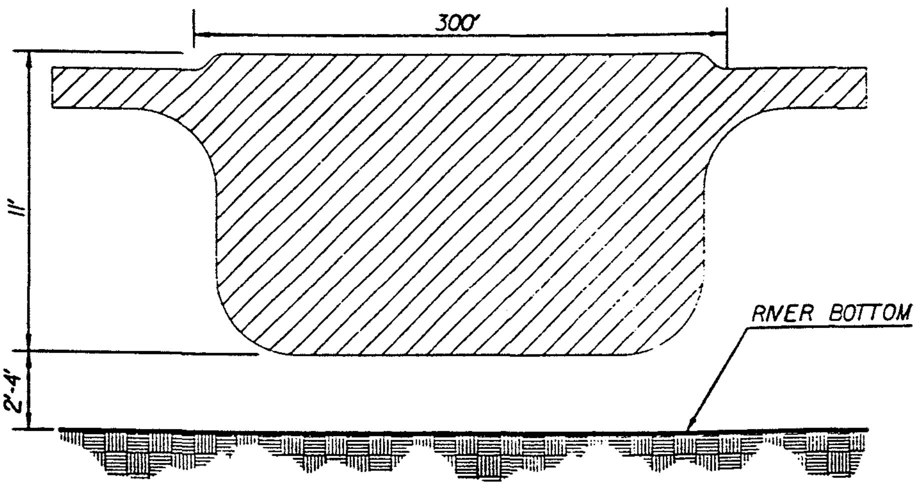


ELEVATION VIEW
NOT TO SCALE

PURPOSE: PETROLEUM PRODUCTION DATUM: ADJACENT PROPERTY OWNERS: 1. STATE OF ALASKA 2. KUUKPIK CORPORATION	**CONTROLLED HIGH WATER FLOW AREA** ARCO ALASKA, INC. 700 G. STREET P.O. BOX 100360 ANCHORAGE, ALASKA 99510-0360	PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT BOROUGH: NORTH SLOPE APPLICATION BY: ARCO ALASKA, INC. SHEET 20 OF 22 DATE: 02/26/97

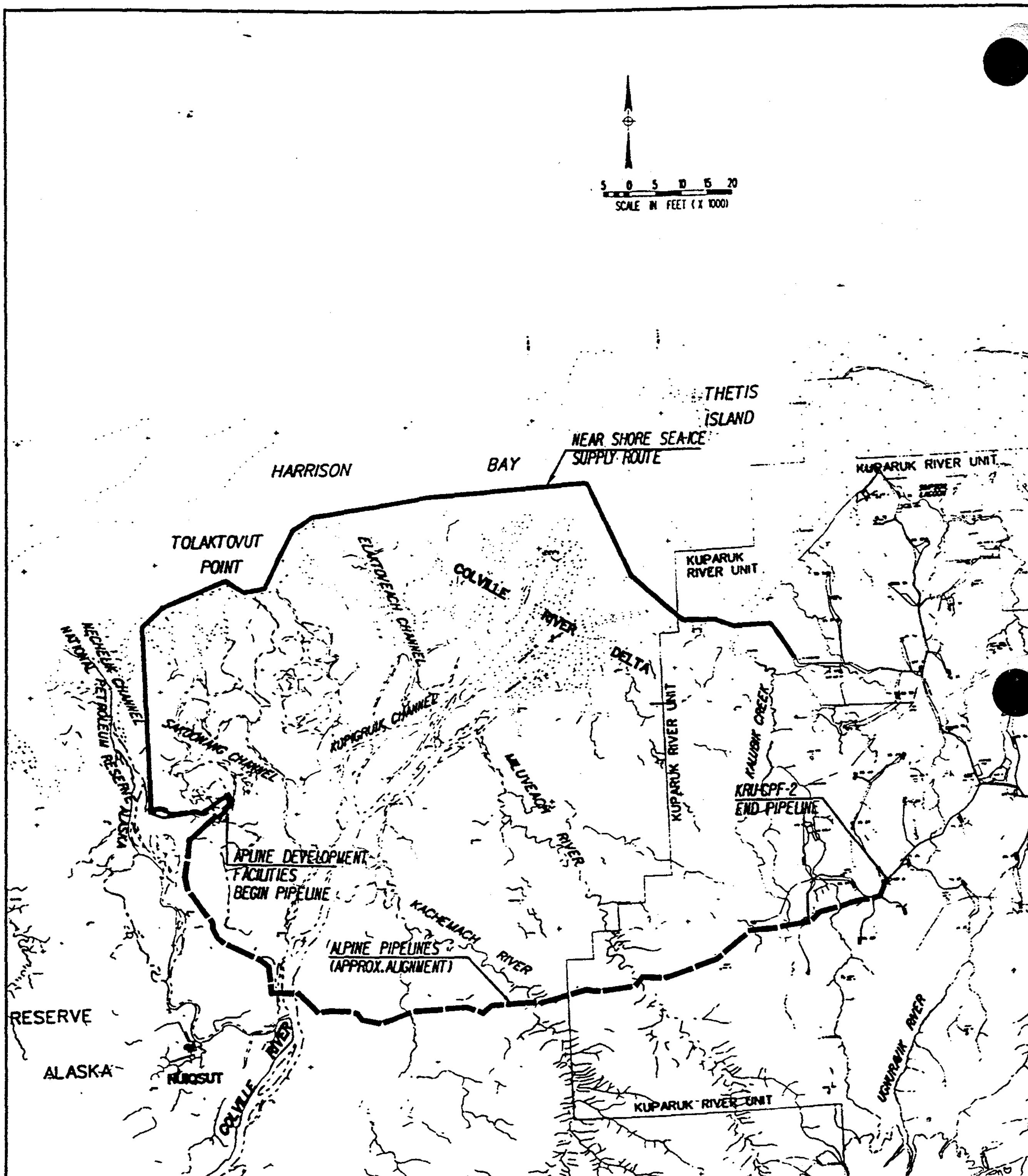


LOCATION MAP
NOT TO SCALE



UNGROUNDED ICE BRIDGE
NOT TO SCALE

PURPOSE: PETROLEUM PRODUCTION DATUM: ADJACENT PROPERTY OWNERS: 1. STATE OF ALASKA 2. KUUKPIK CORPORATION	ICE BRIDGE CONCEPT ARCO ALASKA, INC. 700 G. STREET P.O. BOX 100360 ANCHORAGE, ALASKA 99510-0360	PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT BOROUGH: NORTH SLOPE APPLICATION BY: ARCO ALASKA, INC. SHEET 21 OF 22 DATE: 02/26/97



PURPOSE: PETROLEUM PRODUCTION DATUM: ADJACENT PROPERTY OWNERS: 1. STATE OF ALASKA 2. KUUKPIK CORPORATION	**NEAR SHORE SEA-ICE SUPPLY ROUTE** ARCO ALASKA, INC. 700 G. STREET P.O. BOX 100360 ANCHORAGE, ALASKA 99510-0360	PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT BOROUGH: NORTH SLOPE APPLICATION BY: ARCO ALASKA, INC. SHEET 22 OF 22 DATE: 02/26/97

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, ALASKA
P.O. BOX 898
ANCHORAGE, ALASKA 99506-0898

REPLY TO ATTENTION OF:

JANUARY 2 9 1997

RECEIVED

FEB 3 1997

ALASKA LAND

Regulatory Branch
North Section
2-960874

Mr. Mark J. Schindler
Director
Alpine Development Permits and Compliance
ARCO Alaska, Inc.
Post Office Box 100360
Anchorage, Alaska 99510-0360

Dear Mr. Schindler:

This is in reference to our January 21, 1997, telephone conversation and a follow-up to our December 19, 1996, meeting concerning your permit application (Department of Army permit application file number 2-960874, Colville River 18) for the proposed Alpine Development Project.

We have reviewed your application and the referenced Chapter 2 Description of the Applicant's Proposed Project of your "Alpine Development Project: Environmental Evaluation Document" (EED). We have determined that more information is essential before we can issue a 30-day public notice soliciting comments on the proposed work. Please provide the following information and include any modifications/additions listed below into your project plans:

a. FIGURES

(1) Provide typical cross-section views of:

(a) Roads including typical low water crossings, culverts, bridges, etc., and

(b) Colville River Crossing (expanded detail of pipeline crossing, Horizontal Directional Drilling [HDD], including number of pipelines, estimated quantities of dredged material removed, size of bore holes, type and quantities of fill material). Sheet 11, 12, and 13 provide a general HDD schematic for one pipeline and transitions alternative designs for the carrier pipeline, further detail is required for the three proposed pipelines. Additional figures on the structural aspects for oil spill control (e.g., valves, double wall piping, sensors, etc.) should also be included within description figures to assist in understanding the overall project.

(2) Sheet 15 of 16 shows typical pipeline construction with three pipelines while figure 2.2.1-1, page 2-9 of the EED provides a different vertical support member detail relative to the number of pipelines. Please clarify this discrepancy.

(3) Further details are needed regarding strengthened Vertical Support Members (VSM). Although sheet 15 of 16 provides a typical pipeline construction, no typical details are provided for strengthened VSMs. [note: VSM placement is not generally regulated by the Corps of Engineers. However, if strengthened VSM's require dredging or placement of fill material, they may require authorization. Additional information is requested to complete our jurisdictional determination]. Also note that VSMs and associated pipeline over navigable waters may be regulated by the U.S. Coast Guard under Section 9 of The Rivers and Harbors Act of 1899.

(4) Figure 2.0-2, et. al. should include Township, Range, and Section markings for location identification.

(5) page 2-10, para. 2.2.1.1, Ice Roads/Bridges. Provide typical cross sections of ice bridges on navigable waters, identify locations, indicate water depth and proposed ice depth, and bank elevations. Will culverts or other measures be included in the ice bridge design to maintain adequate flows? Will cut banks be required? If so, identify locations, quantities and provide cross-section of river, channel, and slough cut banks. Ice bridge information is required to complete our jurisdictional determination

b. CHAPTER 2, DESCRIPTION OF THE APPLICANT'S PROPOSED PROJECT

(1) EED, page 2-5, para. 2.1.1, Clarify: Work would be done almost exclusively in the winter." What construction activities e.g., in-water work, placement of fill material, grading of gravel fill, etc., would occur during non-winter periods?

(2) EED, page 2.5, para. 2.1.1 and page 2-10, para. 2.2.1.1, Ice roads and ice bridges would be constructed each winter season to support the year-round drilling operations." Request additional information concerning ice bridges (e.g., depth of ice, depth of water, is bottom-fast ice required at all locations, duration of ice bridge construction, duration of the complete ice bridges, are culverts or other free flowing water structures to be included in major channels with flow? Will the Phase III production/operations phase ice road construction, estimated to be built every three years, to be of the same design as to the Phase I ice bridge construction?

(3) EED, page 2-5, para. 2.1.2, Clarify: "All wells would be located on - and distributed as needed between - the two basic gravel pads." Are the wells to be located solely on the two gravel pads? Or, will wells also be located on the gravel road between the two gravel pads?

(4) EED, page 2-10, para. 2.2.1.1, Pipeline/VSM installation: "Cuttings from drilling operations will be handled in accordance with USACE guidelines." Please note: The Corps does not have guidelines concerning the discharge of drill cuttings for VSMs.

(5) EED, page 2-10, para. 2.2.1.1 Construction. Clarification on main channel ice bridge: "In the case of the main channel of the Colville River, non-bottomfast ice is built into a bridge structurally capable of withstanding the weight of mobile oil field drilling, support, and camp equipment." Will the "bridge" exist as an ice bridge? If so, will mid-level culverts be installed to maintain water quality (saline and freshwater concentrations)? Or is another structure material other than ice being considered?

(6) EED, page 2-14, para 2.2.3.1, Construction Season. "The HDD installation would be completed in the winter." Will the HDD construction and installation begin and end during a single winter construction season? If not, what construction activities would occur outside the typical winter construction season?

(7) EED, page 2-14, para. 2.2.3.2, Kachemach and Miluveach River and Stream Crossings. "If local conditions warrant, the VSM's would be strengthened to withstand the force of high flows." Please provide the details of a typical strengthened VSM structure. Include any additional dredging or discharge of fill material required for strengthened VSMs. Information is required to complete our jurisdictional determination.

(8) EED, page 2-17, para. 2.4, Material Sites. "An approved gravel source would be used. Potential gravel sources include ARCO's existing mine at KRU and ASRC's proposed gravel mine located east of Nuiqsut, just east of the Colville River main channel relatively near proposed pipeline crossing X14." Is Mine Site F confirmed as the approved gravel source? Will other KRU gravel sources be used? If so, will permit modifications be needed for mine site expansions? Secondly, the ASRC's previously approved mine site authorization has expired and their recent application for the site has been withdrawn. Nuiqsut Construction has applied for DA authorization for a mine site at the same location (4-960869, Colville River 17). This permit application is currently under review and evaluation.

(9) EED, page 2-17, para. 2.5.1, Phase I: Construction/Pre-Start-up Development Drilling. First sentence, "... 3 to 5 million gallons for the HDD crossing of the Colville River." Is the estimate of 3 to 5 million gallons of water required of the HDD crossing of the Colville River solely for ice road and pad construction, or does this include water requirements for slurry mixture during the drilling processes? Further description of the HDD process for crossing the Colville River is required including disposal amount and location of dredged material. Additional information is also requested for the evaluation phase of your permit application concerning construction activities and associated impacts e.g., noise, vibrations, etc., associated with HDD during winter operations.

c. ADDITIONAL QUESTIONS

(1) Based on ARCO's proposed road and pad design, are any portions of the road or pads designed to fail during high water events?

(2) Based on ARCO's proposed design, minimum road and pad height of gravel fill is approximately 5 feet in depth. What is the maximum height of fill depth? What is the expected average height of fill for the road, airstrip and pads?

(3) Based on information provided by ARCO during the Joint Pipeline Office's briefing on the HDD crossing of the Colville River, the HDD crossing transition zone and valve pad on the east side of the river is expected to be flooded during high water/flood events. Will any erosion control and protection measures be proposed and included in this application?

Upon receipt of the requested information, we will issue a 30-day public notice soliciting comments on your proposal. Your prompt response will expedite the processing of your application. As per our conversations, additional information will be requested during the evaluation phase of your permit application.

The Corps of Engineers is authorized to issue permits at the District level in those cases in which all substantive objections have been resolved to the satisfaction of the District Engineer provided other portions of our evaluation are favorable. Periodically, letters from reviewing agencies or interested parties may be forwarded to you for your information or appropriate action. Since unresolved objections to your proposed work could result in delay or denial of the requested permit, it is suggested that you respond as soon as possible to avoid processing delay.

Also, a DA permit can be issued for your work only after you have obtained a Certificate of Reasonable Assurance, or waiver of certification, as required by Section 401(a)(1) of the Clean Water Act. This certification or waiver thereof is issued by the Alaska Department of Environmental Conservation (ADEC). For your convenience, we will forward a copy of your application to ADEC which they will accept as an application for a Certificate of Reasonable Assurance. There should be no delay in processing your application as the review processes of ADEC and the Corps of Engineers run concurrently. If you have any questions about ADEC's certification process, please contact them at 410 Willoughby Avenue, Suite 105, Juneau, Alaska 99801-1795; telephone (907) 465-5350.

For your information, a processing fee is required should a DA permit be issued. Since the planned or ultimate purpose of your proposed project is commercial in nature, the fee will be $100. You will be notified as to the time for submittal of the fee.

In review of your Alpine Development Project: Environmental Evaluation Document submitted with your application, we have determined that the document as currently written is incomplete in reference to project description, alternative analysis and environmental consequences for the proposed action, and as such can not be adopted, in total, by the Corps as an Environmental Assessment. However, portions of the document will be included by reference or modified in preparation of the Corps of Engineers' environmental assessment and Section 404(b)(1) evaluation.

I would also like to take this time to concur with the U.S. Fish and Wildlife Service's comment, dated January 2, 1997, concerning the EED:

> "The material presented in the EED is very helpful in evaluating the proposed project, and represents a standard of pre-development environmental reconnaissance seldom achieved in Northern Alaska. We particularly commend ARCO for undertaking the regional habitat mapping and extensive survey work."

We believe your active participation and constructive responses to issues and questions raised during the pre-application phase substantially contributed in enhancing the quality of the document.

We appreciate your cooperation with the Corps of Engineers' Regulatory Program. Please refer to file number 2-960874, Colville River 18, in future correspondence, or if you have any questions concerning this letter. If you have any questions, please contact me at the letterhead address, or at 753-2716.

Sincerely,

Lloyd H. Fanter

Lloyd H. Fanter
Project Manager

APPENDIX K-2

MAY 1997 RESPONSE TO AGENCY AND PUBLIC COMMENTS RECEIVED PRIOR TO THE JUNE 6, 1997 END OF THE PUBLIC NOTICE

Table K-1. **Issues from Agency and Public Comment Following Publication of the Environmental Evaluation Document and Prior to Public Notice.**

Issue No.	Agency	Topic	EED Section
1	North Slope Borough	Air pollution impacts	Section 4.3.2.2
2	North Slope Borough	Technical reviews by third party	Not applicable
3	North Slope Borough	Flooding impacts, caribou migration	Sections 4.2.1.3 and 4.4.2.2
4	North Slope Borough	Pipeline height relative to caribou crossing	Section 4.4.2.2
5	ADFG	Impacts from water withdrawal on fish	Section 4.4.1.2
6	ADFG	Fish productivity criteria evaluation	Not applicable
7	ADFG, USFWS, ADEC, EPA	Additional hydrology reports	Not applicable
8	ADFG	Water sources	Section 2.5
9	USFWS	Wildlife impact evaluation	Sections 2.10.2 and 4.4.2.3
10	USFWS	Wildlife habitat compensatory mitigation	Section 4.4.2.3
11	ADFG	Lake recharge and water withdrawal	Sections 2.5 and 4.4.1.2
12	ADFG	Impacts from gravel use	Chapter 4.4.1.2
13	NMFS	Drilling mud disposal	Table 2.9.0-1
14	NMFS	Contamination to fish	Section 4.3.1.2
15	NMFS	Water monitoring program	Section 4.4.1.3
16	Interested Parties	Nuiqsut switching to cash-based economy	Section 4.5.4
17	Interested Parties	Subsistence resource impacts	Section 4.5.4.2
18	Public Meeting, Rosie Ahtacnghavuak, Nuiqsut	Health effects of Nuiqsut residents	Sections 4.3.1.2 and 4.3.2.2
19	Public Meeting, Langston Chinn/Kuupik Corp.	Increased income effects to Native groups	Section 4.5.3.2
20	Trustees for Alaska	Future oil development in region	Section 4.7
21	Agency Communication	NPR-A development and Alpine infrastructure	Section 4.7
22	Agency Communication	Sales oil pipeline capacity	Section 2.2.1
23	Agency Communication	Future projects and oil transport	Section 4.7
24	Agency Communication	Additional future development plans for Alpine	Section 4.7
25	Agency Communication	Additional Nuiqsut infrastructure needed for project	Section 4.7
26	Agency Communication	Future roads to and from Nuiqsut	Section 4.5.1.2
27	Agency Communication	Project lifespan	Sections 2.10.2 and 4.4.2.3
28	North Slope Borough	Colville River crossing	Section 2.2.3.1
29	ADFG	Ice bridge construction	Section 2.3
30	ADFG	Deep water sites used by overwintering fish	Appendix M
31	USFWS	Colville River safeguards for preventing pipeline rupture	Table 2.9.0-1
32	USFWS	HDD and permafrost	Section 2.2.3.1
33	ADFG	Drill rig route of travel	Not yet available
34	ADFG	Detailed information on culverts	Section 2.1.2
35	ADFG	Culvert discharge estimates	Section 4.2.3
36	ADFG	Drainage structures planned	See response
37	ADFG	Hydrology reports	Appendix M
38	ADFG	Water withdrawal plans	Section 2.5
39	ADFG	Water sources	Section 2.5
40	ADEC	Pipeline design at stream crossings	Appendix M
41	ADFG	Pipeline route and elevation	Section 2.2, Table 2.9.0-1

ALPINE DEVELOPMENT PROJECT:
ARCO RESPONSE TO PUBLIC COMMENTS FOLLOWING
PUBLICATION OF THE EED AND PRIOR TO THE PUBLIC NOTICE

Note: This document has been paginated with issues numbered and formatted, and typing errors removed since initial public release in May 1997. The location of documents referenced in this response is provided in Appendix M.

1. Issue

Provide a discussion of the estimated air pollution impacts of the Alpine Development, and respond to the NSB's request to place an air quality monitoring device in the village to gather pre-Alpine development data. The issue of concern is the increasing incidence of respiratory problems in Nuiqsut and the "dark or yellow cloud" often seen over Prudhoe, which at times extends to Nuiqsut.

Response:

We recognize that Nuiqsut is concerned about potential incremental impact from Alpine. Several months ago ARCO and other North Slope operators made initial attempts to kick-start a forum in this regard. We remain committed to moving forward on this regional issue. Our pre-application work indicates that Nuiqsut will avoid or incur very minimal air quality impact from Alpine due to prevailing wind conditions, use of emissions reducing equipment and comparatively small Alpine emission profiles. In the interest of moving ahead on the Alpine air issue, we suggest a two-pronged approach. First, we invite the NSB to attend all meetings ARCO will have with the Alaska Department of Environmental Conservation (ADEC) to obtain air quality permits. We took the liberty to invite the NSB to an ARCO/ADEC meeting that occurred April 22, 1997. We appreciate the NSB's participation in this technical meeting. Future attendance and participation by the NSB should allow the NSB to better address the Alpine air quality issue. Second, we will support your suggestion that an air quality monitoring device be placed in Nuiqsut. Subject to mutual agreement, we will fund this device for a period of time, but we would recommend that a Native-owned entity manage the placement, operation, and maintenance to achieve the trust factor. Quite possibly, local resident(s) could be trained to operate the device.

2. Issue:

Respond to the suggestion that technical reviews be conducted by a disinterested third party, like the North Slope Borough Science Advisory Committee (SAC).

Response:

We continue to encourage NSB involvement in the existing public review processes associated with the state and federal permitting regimes. Four of the five issues (excluding air) already have third party reviews ongoing through the State/Federal Joint Pipeline Office (JPO) Pipeline right-of-way public process. Information generated by the JPO process and other state and federal permitting agency reviews of ARCO's permit applications will be available to the NSB for its consideration of rezoning approval.

3. **Issue:**

Provide information on the exposure of the proposed route to seasonal flooding and its potential greater impact on caribou migration patterns than alternative routes.

Response:

Over 5 years of floodplain data, including flood frequency and duration, local surface geomorphology, and over 40+ years of erosional and depositional landform information were collected prior to siting alpine facilities. This information was supplemented with additional detailed habitat mapping to ensure proposed Alpine facilities are sited in the least likely locations prone to flooding. This is an issue ARCO has not taken lightly. Very detailed floodplain studies were conducted to minimize impacts from flooding on our facilities.

With respect to the alternate routes having differential impacts on caribou migration, all transportation corridor alternatives will have similar degrees of caribou/pipeline interactions. (Judged to be minimal since there is no road, and the pipe is >5 ft above the tundra.) Since the main direction of movement for all seasons, including calving, insect season, and fall migration through the transportation corridor is north and south, caribou reaction will be identical whether the pipe alignment is a few miles north or a few miles south of the proposed route. Caribou impacts will be significantly increased at either pipeline alternative if a gravel road is constructed along any route.

4. **Issue:**

Provide a brief written report (including detailed referencing) that gives convincing evidence that the five ft height is adequate for caribou crossing.

Response:

In cooperation with ADFG and the USFWS, ARCO Alaska has been testing different caribou mitigation measures in our north slope oilfields for many years. Proper pipeline height has been one of the primary research components of this extensive study. After more than 20+ years of testing many different caribou mitigation measures, the USFWS, ADFG, NSB, and AOGA formed a caribou steering committee and charged these caribou experts to evaluate the effectiveness of all mitigation measures and recommend best design for providing free unimpeded passage of caribou. This Caribou Steering Committee reviewed the entire 20+ year literature and historical record on north slope caribou and issued its report of findings in July 1994.

A copy of that report, which was reviewed, edited, and approved in writing by the NSB Director of Department of Wildlife Management, is enclosed (see Appendix M). With respect to pipeline height it was the conclusion of the caribou scientists that a 5 ft height did not present any barrier to normal caribou movement. Page iv of the executive summary reviews this conclusion. A detailed review of the literature on this subject is then summarized beginning on page A-17. Specific design criteria are identified in that section of the steering committee report.

The caribou steering committee further found that traffic on main roads is the primary impact on caribou movement and crossing success. Further, drifting snow along a pipeline elevated to a minimum of 5 ft without adjacent gravel road was not judged to present any impediment to migrating caribou; since snow likely will not drift to any appreciable height along a pipeline without gravel road, and the tundra is mostly snow free prior to the spring calving caribou migration.

To further eliminate any potential for caribou impediments along the pipeline route, ARCO has designed four strategically placed sections with pipeline elevations raised to 8-9 ft above tundra grade at locations of key caribou north/south migration. In addition, approximately 9 vertical expansion loops (with pipe heights up to 25 ft above grade and 40-80 ft between vertical sections forming a loop) are being designed along the pipe route.

5. **Issue:**

Provide the location of non-fish bearing lakes intended for water withdrawal and the field sampling data indicating fish are not present.

Response:

Table 1 summarizes fish presence in potential water supply lakes in both the project development area and transportation corridor. Figures 1 and 2 identify the location of each lake. In general, lakes within the project development area and along the east bank of the Colville River contain a variety of species, including least cisco, broad whitefish, round whitefish, arctic grayling, Alaska blackfish, and ninespine stickleback. Shallow thaw lakes east of the Colville River that are not connected to a drainage system generally contain either ninespine sticklebacks or nothing. The large lake in the northern portion of the transportation corridor, MC7903, has a connection to the Miluveach River and has contained arctic grayling, broad whitefish, Alaska blackfish, and ninespine stickleback in low numbers.

Table 1. Fish species identified from potential water source lakes within the project development area and transportation corridor.

Lake	Maximum Depth (feet)	Least Cisco	Arctic Cisco	Broad Whitefish	Humpback Whitefish	Round Whitefish	Arctic Grayling	Alaska Blackfish	Fourhorn Sculpin	Slimy Sculpin	Ninespine Stickleback	Number of Species
Project Area Lakes												
B8533	12.3	Yes		Yes		Yes					Yes	4
L9310	24.1	Yes		Yes				Yes		Yes	Yes	5
L9311	13.1	Yes		Yes							Yes	3
L9312	12.5	Yes		Yes				Yes		Yes	Yes	5
L9313	14.1	Yes						Yes			Yes	3
L9316	12.6	Yes		Yes				Yes			Yes	
L9321	12.3	Yes		Yes							Yes	3
M9524	11.4	Yes	Yes		Yes				Yes		Yes	5
M9525	4.2	Yes		Yes							Yes	3
Transportation Corridor Lakes												
L9121	6.5										Yes	1
L9122	5.1										Yes	1
L9123	7.2											0
L9125	5.0					(not sampled)						--
L9126	5.5					(not sampled)						--
L9128	7.0											0
L9129	4.5					(not sampled)						--
L9331	13.0					(not sampled)						--
L9332	15.6					Yes	Yes				Yes	3
L9333	13.1	Yes		Yes							Yes	3
L9334	22.0	Yes		Yes	Yes	Yes	Yes				Yes	6
L9335	9.6	Yes									Yes	2
M9501	8.3	Yes				Yes	Yes					3
M9502	10.4	Yes		Yes		Yes	Yes				Yes	5
M9505	8.3	Yes									Yes	1
M9514	2.4										Yes	1
M9516	5.3											0
M9528	4.0										Yes	1
M9601	6.2											0
M9605	7.2											0
M9614	6.4											0
M9617	6.9											0
M9619	6.6											0
M9620	7.2											0
MC7903	9.3			Yes*			Yes	Yes			Yes	4

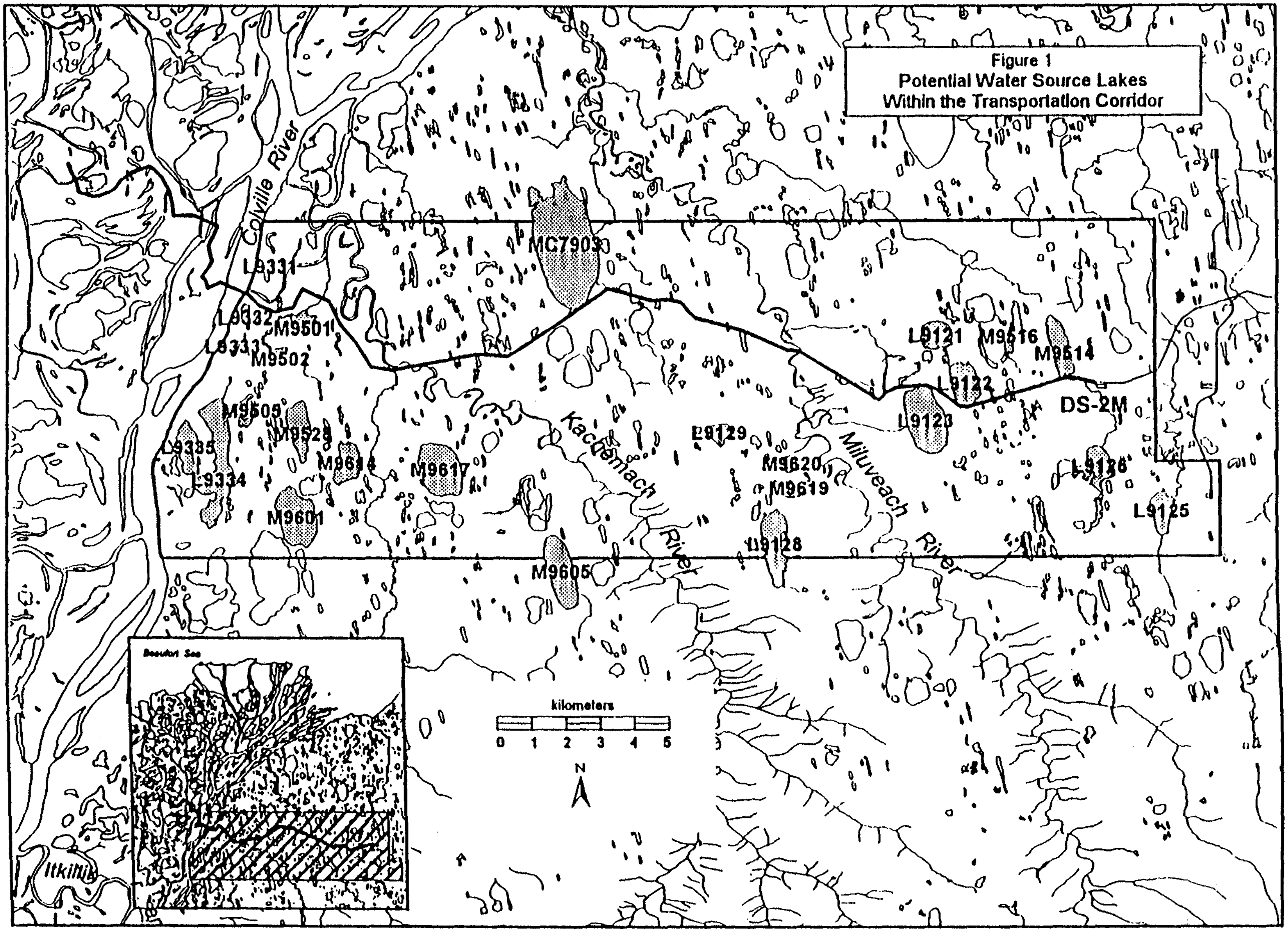


Figure 1
Potential Water Source Lakes
Within the Transportation Corridor
Colville River
MC7903
L9331
L9332
M9501
L9333
M9502
M9505
M9528
L9335
L9334
M9614
M9617
M9601
M9605
Kachemach River
L9129
M9620
M9619
L9128
Miluveach River
L9121
M9516
M9514
L9122
L9123
DS-2M
L9126
L9125
Itkillik
Beaufort Sea
kilometers
0 1 2 3 4 5
N

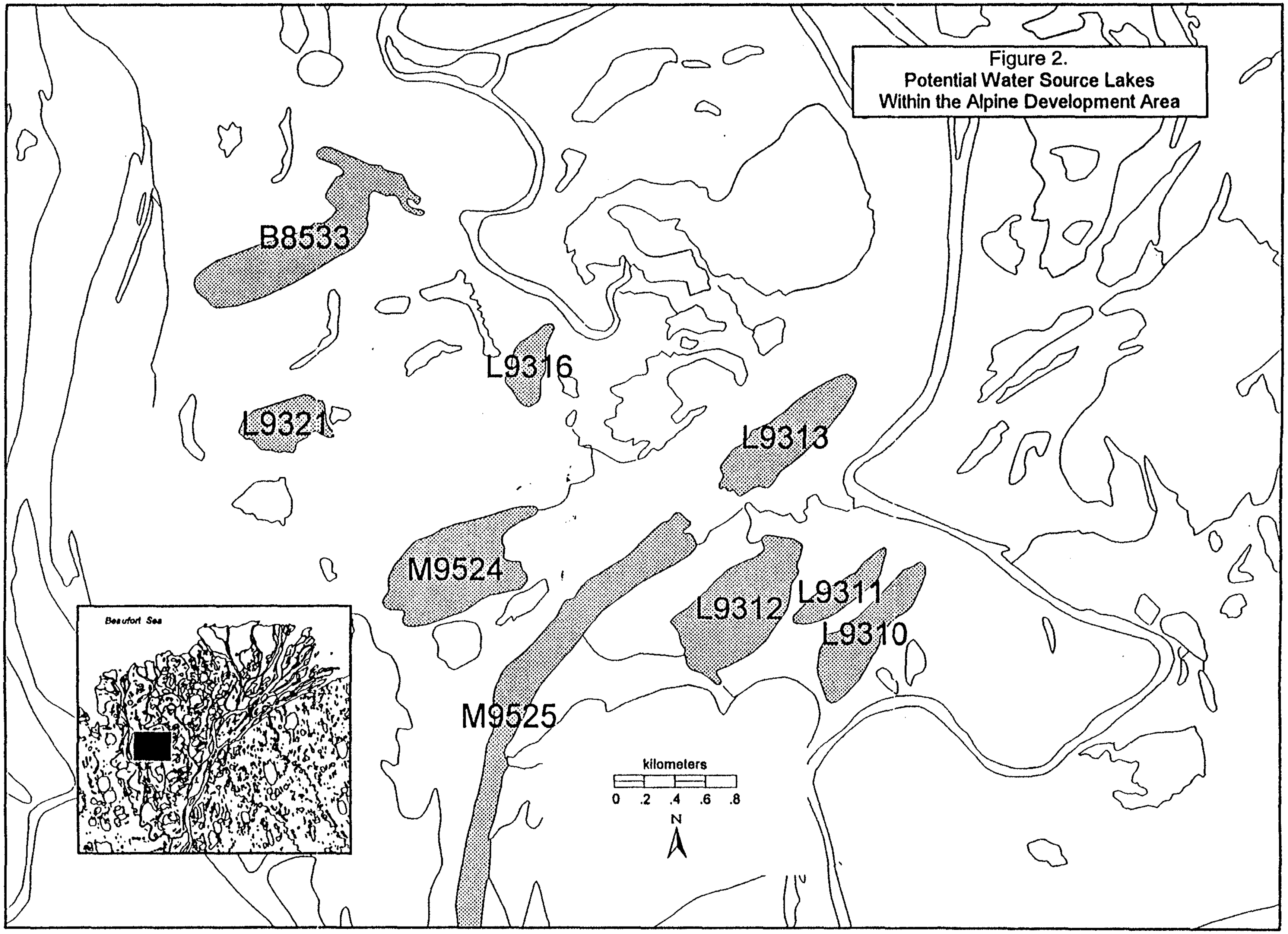


Figure 2.
Potential Water Source Lakes Within the Alpine Development Area

6. **Issue:**

Provide criteria to evaluate fisheries productivity of each of the water sources to be used during the course of the project, with the objective of directing water use to lakes with lower productivity.

Response:

Criteria are the catch rates and number of species in each lake obtained from baseline sampling. These data are contained in a volume summarizing all catch data for each lake surveyed for fish, that has been provided to ADFG.

7. **Issue:**

Provide reports describing hydrology in the project area.

Response:

Hydrology reports are enclosed with this document (see Appendix M).

8. **Issue:**

Identify water sources that will be used on a continuous basis for seasonal ice road construction, development drilling, and operations.

Response:

Potential lakes for use during the project are listed in Table 1 and shown in Figures 1 and 2. The water source and use plan, to be complete by the end of September 1997, will identify the water sources to be used on a continuous basis.

9. **Issue:**

There is a disconnect between the biological information and the facility siting in the EED. Unsupported assertions regarding avoidance of high value habitat appear relative to pipeline routing, and road, pad, and airstrip design. In addition, more attention should be given to proper timing of aircraft use restrictions. There are also unconvincing assertions in the EED that predator/scavenger populations will not be affected by the Alpine Development. Explain what measures will be adopted that are different from those in existing oilfields such that these problems will not recur in the Colville Delta. Also explain the preclusion of gravel removal as an option for habitat rehabilitation in the EED, except in isolated cases.

Response:

Prior to finalizing our preferred facility locations, ARCO met with USFWS, EPA, USACE, and ADFG (on several occasions) to discuss and design the appropriate criteria for evaluating fish and wildlife use. With this agency guidance, four habitat use (value) categories were developed.

1. Habitats of Regional Importance for Birds: five species selected (yellow-billed loons, tundra swans, brant, greater-white fronted goose, and bar-tailed godwit).

2. Habitats of Subsistence Use Species 20 birds and 9 mammal species selected.

3. Diversity of Habitat Use Among Wildlife Species.

4. Habitat Use by Threatened and Endangered Species focusing on the number of seasons of habitat use - pre-nesting, nesting, and brood rearing.

While we agree that the amount of habitat within a region is one measure of that area's importance, with guidance from the four resources agencies referenced above, ARCO used all four categories to formalize our environmental input to final facility siting. As described on page 3-8 of the EED, four options for gravel facility locations were evaluated by a team of expert scientists. Habitat use (value) was the primary criteria used in evaluating these options. We believe our statements regarding a minimization of habitat loss are supported by these evaluations. Some brief elaboration relevant to points raised in the 2 Jan 97 USFWS letter may clarify our statements.

Pipeline Routing B: While possibly not readily apparent to reviewers, due to the scale of mapping, the pipeline route was modified (over the initial engineering more direct route) in several locations to minimize habitat disturbance and fish and wildlife impacts. Environmental re-alignments are depicted on Figure 4.4.2-18, page 4-108. Modifications were made in the alignment to route around drained-lake basins (high diversity of habitat use), swan and brant nesting areas (regionally important species) and habitats used by spectacled eider during multiple seasons (threatened species). Pipe was routed on higher ground when possible to minimize flooding concerns and minimize disturbance to habitats and animals from oil spills. In scoping meetings, initial agency opinion expressed minimal concern for potential habitat impact from elevated pipe only (without road). Hence, while several modifications were made in alignment as referenced above, pipeline length and cost were also evaluated when considering lengthy alternative re-routes.

Road and Pad Design - The two drill pads and a road were sited to avoid direct encroachment on, and loss of, existing swan and brant nests (regional important birds). The road in particular was re-routed to avoid the brant nesting colony. Also, within the constraints placed by adjacent lakes, these pads and their connecting road were sited to provide appropriate buffers at those nest locations. In addition, following public input, the

Alpine #2 pad was moved away from the abundant and diverse bird activity that occurs throughout the summer season at Nanuk Lake (subsistence activity, habitat of regional important, and diversity of habitat use).

Airstrip - The airstrip occurs on a habitat type that, while very abundant in the adjacent tundra (co-dominant), occupies only about 2.5 percent of the river delta. However, "regional" or "local" abundance may not be the best single measure of overall habitat value. We analyzed all four criteria described above and selected the preferred location of the airstrip over three other locations to best maximize protection of both habitats and birds. Several evaluations led us to this preference.

- Clustering the airstrip with the processing facility with the Alpine Pad #1 places all project activity centers and noise generation sources within an approximate 0.5-mile radius. Thus habitat direct and indirect disturbance is greatly minimized, verses spreading these facilities up to 3 miles apart. This location also moves the air traffic away from concentrations of activity by regionally important birds and diverse numbers of birds at Nanuk Lake, the brant nesting colony north of Nanuk Lake, and the nesting swans also north of Nanuk Lake. As shown on Figure 4.4.2-11, if the airstrip were placed to the west (either along, north of, or south of the road), it would both directly and indirectly impact habitats that support more regionally important species, and which receive high subsistence use.

- With respect to actual habitat loss and value, the preferred airstrip location occurs in habitats (moist sedge-shrub meadow) that support only two species of the five species used in the regional important analysis (Table 4.4.2-5, page 4-87). Habitats at the western alternative airstrip locations support all five regionally important species (Figure 4.4.2-11).

- A further component we analyzed in the EED to arrive at the preferred location included knowledge based on prevailing wind, about 3/4 of all plane departures will be to the northeast and not towards the higher used bird habitats and subsistence areas near Nanuk Lake. When planes must depart towards the west, they will be at approximately 2,500-ft elevation, and will have turned east before approaching the Nanuk Lake area (personal communication with AAI aviation).

- When using the second criteria recommended by resource agencies (subsistence habitat use) the preferred airstrip location occupies habitat that is used by only 4 of the 20 analyzed bird species (Table 4.4.2-6). And finally, using the threatened species habitat analysis, the airstrip is in habitat that is used during only one season (out of three possible), while alternative location habitats are used during all three seasons (Table 4.4.3-1, Figure 4.4.3-1).

Hence, while moist sedge-shrub meadow may not be very abundant near the airstrip, using criteria recommended by the resource agencies, this habitat and the airstrip location is used less by selected important indicator species than habitats at alternate locations.

Finally, while not directly habitat related, the airstrip location also was selected based on the safety preference for prevailing winds and site elevation (to minimize flooding of the airstrip).

Predator/Scavenger Populations - As stated in the EED, ARCO does not expect to see predator problems develop at Alpine that are similar to PBU and KRU for primarily two reasons. First, all camp waste will be managed and controlled by ARCO, and not subcontracted to a third party for secondary handling. All food will be incinerated immediately following collection. And, while dumpsters are not likely, if used, they will be state of the art bear- and fox-proof containers. Second, we are estimating a small population of workers (about 50 during operation) with a single camp facility. Food will be served in only one location. These conditions are significantly different from those at PBU and KRU and hence, we believe will allow control of this issue.

Revegetating Gravel in Place - The EED references that final site rehabilitation likely will include both gravel removal and leaving some gravel in place. While rehabilitating a gravel removal footprint under some physical conditions is more conducive to successful site rehabilitation, under other physical conditions it can be more difficult than treating gravel left in place. Research in PBU and KRU has shown that in ice-rich soils, removing all gravel fill after 15 to 20+ years can greatly complicate local thermokarsting and create site conditions that are more difficult to revegetate. Soils at the Alpine gravel sites are mostly ice rich. Thaw of over 10 ft has been observed in these conditions. Creating a deep, narrow thaw trench in a long linear feature along the removed access road perpendicular to natural flow may not be the best overall site rehabilitation scheme for this area. Many physical and biological factors need to be evaluated prior to actual site rehabilitation before judging that it will be most desirable to always remove the gravel for site rehabilitation.

10. Issue:

Provide response to the need for compensatory mitigation of high value wildlife habitat affected by the in-field facility footprint.

Response:

The location of the footprint avoids most high value wildlife habitat for the groups of species identified by the USFWS as (1) regionally important species, (2) species used for subsistence, and (3) threatened/endangered species. Some high value habitat was reported in the EED to occur at the footprint. However, based on further evaluation of the site using refined engineering design and data from the 1996 field program, ARCO has determined that the footprint will not directly impact high value habitat for these groups of species.

Furthermore, aircraft traffic will be restricted to minimize disturbance to wildlife. Some of the proposed restrictions and other mitigation measures as discussed in the EED (p 2-23, 4-106 to 109 and elsewhere in Chapter 4) include:

- limiting airstrip use between June 1 - July 15 to aircraft weighing less than 105,000 lbs take-off weight (i.e., Boeing 737 prohibited) unless excepted by FAR PART 36-Stage 3 (noise level category), safety emergency, or by the Subsistence Oversight Panel (see Nuiqsut mitigation section of EED),

- minimizing aircraft use during June 1 - July 15,

- maintaining 500-ft minimum altitude except for take-off and landing patterns,

- maximizing aircraft use during winter, and

- conducting a 3-year ($150,000 per year) waterfowl monitoring program related to airstrip impacts.

- ARCO has sited and designed the project to mitigate loss or disturbance of high value wildlife habitat, and to avoid the need for compensatory mitigation.

11. Issue:

Discuss if recharge in the lakes is sufficient to compensate for planned water withdrawal.

Response:

ARCO is examining several options for ensuring water requirements are met for the project. These options all take into account the state requirements which prohibit water use from lakes less than 7 ft deep and authorize use of a maximum of 15 percent of the water beneath the ice for lakes exceeding 7 ft. The options include withdrawing water from a number of lakes meeting the criteria (see enclosed map of potential lakes for water withdrawal). Recharge of the lakes would be accomplished by overbank flooding, snow melt overland flow, groundwater flow, snow capture (fence), or piping water (as suggested by ADFG) from the Sakoonang or Nechelik channels. ARCO has conducted flood studies in the delta which suggest the lakes would recharge every year (95-24 & 25), 1-3 years (93-16), 3-5 years (93-13 & 85-33), 3-10 years (93-21), and 5-25 years (93-10,11,12). The contribution of the other water sources to recharge the lakes has not been specifically studied but snow fences could theoretically provide 10-20 percent of the estimated 3 million cubic ft of estimated annual water use. ARCO is planning a groundwater recharge study this summer.

12. Issue:

Provide discussion of impacts associated with each gravel source alternative, particularly those affecting fisheries habitat. Identify any proposed mitigation.

Response:

The preferred approach to obtaining gravel for the project is to purchase material from ASRC, which has a permitted gravel site near the project. The following discussion of potential impacts from this site is provided on page 4-54 of the EED.

The preferred material site is approximately one mile south of the crossing point of the east bank at the Colville River. Since site development would create an upland pit, there are no immediate impacts to fish. When gravel removal is completed, the site could be rehabilitated as a deep lake, thus providing potential fish habitat. The pit would need a connection to a nearby waterbody for fish passage. A large drainage lake adjacent to the mine site likely contains fish and has access to the Colville drainage system. Connecting the abandoned mine site to this lake system should provide additional lake rearing habitat and access to other habitats. Details would be developed as part of a rehabilitation plan during site permitting.

The lake (M9603) adjacent to the gravel site contains substantial shallow water habitat that provides high value rearing areas, but appears to be deficient in overwintering habitat. There is one deep channel (17 ft deep) that connects the two main basins, but the basins are generally less than 10 ft deep. Connecting a deep gravel pit to the lake could increase the availability of overwintering habitat and allow a substantially larger fish population to utilize the abundant rearing habitat.

13. Issue:

Provide discussion of disposal of drilling muds along sand banks of the Colville River from construction of the pipeline.

Response:

The EED describes the disposal of drilling muds on pages 2-12 and 4-22. There will be no disposal of drilling muds along sand banks of the Colville River. Drilling muds from the HDD will be hauled back to KRU for disposal. Drilling muds at the drill sites will be reinjected into the wells.

14. Issue:

Provide discussion of release of contaminants on fish. Discuss the need to collect fish, water, and sediment samples to obtain background levels of heavy metals and hydrocarbons.

Response:

The water quality section of the EED (4.3.1, pages 4-17 to 4-23) describes the background levels of 14 trace metals and other chemistry in the Colville River. Appendix Table H in the EED lists concentrations for samples taken by the USGS during 12 periods between 1975 and 1981. The results show that background levels of trace metals are naturally higher than the freshwater chronic aquatic toxicity criteria established by EPA. Trace metal concentrations were similarly higher than the EPA criteria in samples collected by the USGS on the Kuparuk River before development of the KRU. Fish have not been sampled to establish baseline levels of metals, but ARCO will collect and analyze a small number of fish for this purpose during the 1997 field program. This effort combined with the existing water quality data for lakes (Table 2) will provide background levels of heavy metals and hydrocarbons.

15. Issue:

Provide information on any monitoring program to regularly track the quantity of water removal and water quality in the lakes.

Response:

Water removal will be monitored two ways. A water pump will be placed at Lake 93-13 for the life of the project or until the volume of water is insufficient to supply water to the in-field facilities. The pump will have a meter that records water use in gallons. Water withdrawn from other lakes will be tracked by recording the number of truck loads of known water holding capacity. Water removal will cease once the volume monitored by the metered pumps or number of truck loads equals the state-approved limits for a given lake. Daily records of water use will be maintained by the site manager of the Alpine Development. This same process is followed at the KRU and PBU. Water quality will not be monitored because the state requirements for water removal from lakes will prevent deterioration of water quality.

Socio-Economic Impact Issues

16. Issue:

What would be the costs to Nuiqsut of switching to a cash-based economy?

Table 2. Available water quality data from potential water source lakes within the project development area and transportation corridor.

Lake	Maximum Depth (feet)	Area (acres)	Conductivity (μS/cm)	Chloride (mg/l)	Sodium (mg/l)	Calcium (mg/l)	Magnesium (mg/l)	Hardness (mg/l)	Dissolved Solids (mg/l)
Project Area Lakes									
B8533	24.1	114.5	138	19	11	4.7	2.4	22	46
L9310	13.1	60.5	97	10	4.8	11	3.7	43	130
L9311	12.5	21.5	98	10	5	14	4.7	54	100
L9312	14.1	99.9	47	8	4.5	7.2	2.1	27	150
L9313	12.3	68.9	83	19	9.3	8	3.1	33	54
L9316	12.6	22.1	98	13	7.7	4.8	2.4	22	18
L9321	12.3	37.0	113	10	5.6	4.4	1.8	18	90
M9524	11.4	129.7	95						
M9525	4.2	103.6	280						
Transportation Corridor Lakes									
L9121	6.5	138.8	206						
L9122	5.1	184.6	252						
L9123	7.2	414.0	92	6	2	19	1.3	53	88
L9125	5								
L9126	5.5								
L9128	7	347.2	125	5	1.9	22	1.4	61	72
L9129	4.5								
L9331	13	16.1		2	1.8	5	1.6	19	38
L9332	15.6	32.4	73	3	2.3	10	2	33	40
L9333	13.1	12.5	109	2	2.4	8.5	2.2	30	49
L9334	22.0	514.8	113	2	1.8	9	1.5	29	27
L9335	9.6	167.7	58	2	4.1	7.6	1.6	26	<10
M9501	8.3	65.9	88						
M9502	10.4	32.6	90						
M9505	8.3	67.0	66						
M9514	2.4	175.4	234						
M9516	5.3	31.4	172						
M9528	4	206.8	329						
M9601	6.2	360.9	144						
M9605	7.2	307.8	137						
M9614	6.4	162.6	125						
M9617	6.9	382.8							
M9619	6.6	88.1							
M9620	7.2	43.9							
MC7903	9.3	1197.3	165	10	3.9	25	2	70	144

Response:

As discussed in the EED (Sec. 4.5.3, pp. 4-126-131), Nuiqsut is characterized as a dual economy in which both cash and subsistence resources play central and interdependent roles. One interesting feature of this dual system is that contemporary successful subsistence practices are directly correlated to the amount of cash the hunter/fisherman has at his/her disposal to acquire the necessary tools and equipment to pursue subsistence activities (firearms and ammunition, transport snowmachines, ATV's, boats and motors, fuel--fishing gear, etc.). A detailed examination of household expenditures in Nuiqsut for subsistence purposes is contained in R.C. Harcharek. 1994. *North Slope Borough 1993/94 economic profile and census report.* Vol. VII. North Slope Borough Department of Planning and Community Services, Barrow, AK, pp. NUI-35-6. This correlation between cash income and the ability to pursue marine mammal hunting (especially the bowhead whale) is particularly important since the costs to Nuiqsut whalers of conducting the hunt from Cross Island, located some 90 boating miles from the village, are much higher than are those of the other two Beaufort Sea whaling communities of Barrow and Kaktovik.

Therefore, with regard to the connection between the cash and subsistence sectors of Nuiqsut's dual economy, the most important presently foreseen impact would consist of increasing cash-earning opportunities through employment on Alpine related activities, and increasing dividend payments through regional and village corporations providing contracting services, or realizing Alpine production revenues.

It is not a question of switching from a subsistence/barter economic system to one of cash-based maintenance. As noted in the detailed summaries contained in Harcharek, *ibid.,* pp. NUI-1-36, Nuiqsut's present socio-economic circumstances primarily involve household incomes derived from local wage employment where, although under-employment is locally perceived as high, unemployment is low (5.2 percent of a local workforce of 193 individuals in a population of approximately 425 in 1996). It is more a question of increasing household cash incomes which would then, presumably, be reflected in additional expenditures on subsistence pursuits as, clearly, subsistence activities occupy the primary position in the spectrum of Kuukpikmiut socio-cultural and nutritional preferences.

17. **Issue:**

What would be the costs associated with the loss of fish, caribou, waterfowl as subsistence resources?

Response:

Various efforts have been made in studies conducted by ADFG Subsistence Division and other agency commissioned studies (as, for example, M. Galginaitis. *Subsistence harvest resource patterns: Nuiqsut.* OCS Study MMS 90-0038 (Special Report No. 8), prepared by Impact Assessment, Inc., La Jolla, CA) to measure the cash replacement costs of foods consumed from the subsistence harvest. Taking into account the actual cash costs of subsistence activities (as discussed in the issue, above), this question seems to be what would be the increased net cash expenditures for acquiring food by purchase as in contrast to the cost of those products produced from hunting and fishing. There is no adequate answer to this question except to state that in the case of Nuiqsut, subsistence items as a percent of total diet are among the highest of any village in Alaska (Harcharek, *ibid.,* pp. NUI-31-36) and their replacement costs with purchased food items would likely be higher than average even when compared to other rural communities. The areas in which the costs of replacement would be greatest are for locally caught fish (which constitute roughly one third of household consumption of subsistence items), caribou (again, one third), and marine mammals (which normally make up one third of the subsistence component of household diets during those years when a successful bowhead whale hunt is achieved). Other subsistence species (moose, waterfowl and birds, bear) make up much smaller components of normal household diets. However, this in no way lessens the importance of these species to the practice of the subsistence lifestyle. Losses of any of them on either a seasonal or long-range basis would constitute impacts measured primarily as adverse cultural costs rather than as expensive cash replacement needs.

Mitigation measures proposed to date have been developed with an overwhelming consideration of subsistence and cultural activities. Nothing in the design, projected facilities, and operations associated with the Alpine Development Project will have a greater than negligible effect on the habitats or subsistence resources upon which the Kuukpikmiut base their subsistence lifestyle. Consequently, projected impacts are best assessed in light of potential increases in local incomes derived from Alpine-related employment, service contracting, and indirect production revenue, and the opportunities which those may provide for increased local subsistence hunting and fishing. There will be no increase in hunting pressure from non-local project employees since the oil company operator's policy prohibits such activity while they are on duty at their oilfield work locations.

18. Issue:

What will be the health effects on Nuiqsut residents as a consequence of possible new pollution sources: air, water, food supplies?

Response:

Nuiqsut and the NSB have raised questions relating to air quality both on a regional and a local basis. Both parties have asked, in effect, if the Alpine development will cause a deterioration of air quality in the village. This matter is responded to above. Emissions from the proposed facility will be kept well within federal and state minimum air quality standards. The physical location of the facilities which will add incremental levels of air pollutants to the delta region is such that any plume produced by the facilities will rarely reach Nuiqsut (prevailing winds, distance from facility dispersion occurs, etc.). In any event, legitimate public concerns regarding health effects from deterioration in air quality are to be addressed by expert health professionals in seminars scheduled to be held in Nuiqsut. These seminars will address effects from all potential sources of air quality deterioration, including those presently generated within the village (indoor air quality, for example) as well as those which may be produced at Alpine. In addition, ARCO has agreed to support an in-village air quality monitoring program (see Response 1, above).

Numerous questions regarding water quality have been posed by reviewing agencies as well as Nuiqsut residents (see Response 8, above). Except in the event of an oil spill from either facility operations or the pipeline, there will be no pollutants discharged to the waters of the Colville delta and pipeline transportation corridor. In addition, water which is to be withdrawn from lake sources for oilfield development and operations purposes will be strongly regulated by the state to insure that no deterioration of fish habitat quality occurs.

Obviously, health effects produced by consumption of contaminated <u>food</u> are directly related, in the case of Nuiqsut, to the health of the subsistence species upon which such a large component of the diet is based. Here again, maintenance of air quality standards eliminates one possible source of the introduction of contaminants to the food supply chain. In the case of water quality, the only potential for degrading quality would result from an oil spill which could adversely effect limited fish habitat and waterfowl use areas. Discussions of these possible adverse effects appear in the appropriate sections of the EED.

19. Issue:

Industrial developments in frontier areas have often given rise to increased use of drugs and alcohol by Native groups as well as by immigrant workers. Won't the Alpine Development also have the effect of providing income enhancements to local people which may then be spent on alcohol and drugs thus creating the attendant social dislocations which accompany such use?

Response:

All North Slope industrial operators, including those companies owned and managed by Native corporations, have and enforce strict policies prohibiting drug and alcohol importation and use. Such will certainly be the case with Alpine related operations in all phases. The operator, as a direct source of drugs and alcohol, is not at issue as security measures have insured that its operations have effectively enforced its prohibition policies. Control of employees behavior when they are not present at their work locations, are off-shift, or, in the case of employees who may permanently reside in Nuiqsut, Barrow, or one of the other NSB villages is clearly outside either the operator's capability or the employee's rights and interests. However, the operator has commonly provided social, medical, and counseling services to employees who require or request them. In addition, revenues received by the NSB from its taxes upon oilfield properties will be enhanced and may, in some measure, be devoted to the areas of health and social services where drug and alcohol related problems are treated.

The problem of drug and alcohol abuse and the accompanying socio-cultural disruptions they cause are features of society at large and are not limited to rural and frontier communities. However, it is unlikely that the provision of more money in the form of employee wages from Alpine associated activities will be used primarily to acquire drugs and alcohol. Indeed, the operator's strict prohibition policies have the effect of controlling access to and thereby decreasing locally available supplies. This is not to say that a project such as the Alpine Development will eliminate drug and alcohol related problems. On the other hand, it will not exacerbate what is currently recognized by the social service and health care agencies of the NSB as a major set of problems in all its constituent communities.

Cumulative Impact Issues

20. Issue:

"How will Alpine development influence the probability of further oil development in the region, and expansion of the community of Nuiqsut and its infrastructure?"

Response:

As stated in the EED Section 4.7.1.3, further development in the region is a function of availability of access to prospective lands, pre-lease and post-lease exploration/delineation, production testing, engineering analyses, economic evaluation, permitting, construction, and development operations. The EED discusses specific tasks associated with the above considerations, and provides estimated time frames for completion of these tasks and potential development of different regional areas.

Alpine influences the probability of further oil development in two ways: (1) it pays for and proves viable the application of horizontal directional drilling (HDD) technology for pipeline river crossings, and (2) for projects using Alpine infrastructure, it may reduce prospective project(s) costs by eliminating approximately 35 miles of required pipeline, one major and two minor pipeline river crossings, and may eliminate the cost of standalone processing facilities. However, co-use of Alpine would be dependent on resolution of a number of issues including but not limited to: status of Alpine production rate, displacement of Alpine production, crude oil characteristics, and gas-to-oil ratios. The attached Alpine production curve depicts a rather quick production decline affording opportunities for non-Alpine production capacity.

As Section 2.9 Mitigation Measures and Section 4.0 Affected Environment, Environmental Consequences, and Mitigation Measures of the EED discuss, ARCO has specifically designed Alpine to avoid or minimize impact to the community and infrastructure in

Nuiqsut. Community and/or infrastructure expansions in Nuiqsut, if they occur, would be the result of native contractors' discretionary decision to locate construction personnel/equipment in Nuiqsut, and/or other non-ARCO decision makers. ARCO has no plans in this regard. Therefore, expansion of Nuiqsut's community or infrastructure is speculative. Please see related responses below for additional information.

21. Issue:

Compare the likelihood of NPR-A development with and without the infrastructure proposed for Alpine. For economically recoverable oil deposits of various sizes, at what range from Alpine would it be profitable to develop?

Response:

Alpine's limited influence on NPR-A oil and gas prospects, as noted above, may extend for up to a 25 mile radius from Alpine, most particularly northwest, west, and southwest of Alpine. This radius is primarily driven by pipeline hydraulics and reservoir characteristics including pressure and gas-to-oil ratios. Fundamental considerations for facility sharing between Alpine and NPR-A prospects would include crude oil type, corrosive characteristics of produced fluids (major cost impact) and gas, and likelihood of resultant slug flow in a cross country pipeline. Issues regarding the need for standalone on-site separation of oil, gas, and water (i.e. shipping 3-phase oil vs. sales quality oil) and pipeline sizing would be the primary decision points taking into account the cost saving opportunities provided by Alpine processing facilities and sales quality pipeline. If a future discovery occurs in NPR-A, the loading status of Alpine's oil and gas processing equipment at that point in time will become a key issue in designing future development scenarios.

However, the overall likelihood of NPR-A development is based each prospect's profitability after completion of the many tasks noted in Section 4.7.1.3 of the EED. The range from Alpine alone cannot determine profitability. Exploration drilling success is essential to begin evaluation of profitability. Since private sector drilling in the NPR-A has been prohibited to-date, and previous government sponsored drilling is limited and technologically outdated, successful NPR-A exploration and development is speculative and not within the reasonably foreseeable future (see Section 4.7.1.3 of EED).

22. Issue:

Considering the capacity of the sales oil pipeline and the capacity of the Alpine processing facility, how much additional product might be handled through the Alpine infrastructure? Will expansion of the footprint at Alpine be necessary? How much development would be necessary, at what distance, before additional processing facilities/airports/personnel camps would be required?

Response:

Current design of the pipeline provides an upper production limit of 93,000 barrels per day. The process facility is designed to handle Alpine's peak production of 70,000 barrels of oil per day in the year 2001. Initial startup rates of 40,000 barrels of oil per day are expected in year 2000. The attached Alpine production curve predicts future production rates and the corresponding rate of production decline. It is possible to increase the Alpine pipeline capacity to approximately 200,000 barrels per day and the processing facility to above 70,000 barrels per day with incremental investment and equipment. Both increases in capacity could be achieved without increasing the gravel footprint as currently proposed. Incremental equipment would be placed on existing gravel pads. The question regarding how much development and at what distance has been addressed above.

23. Issue:

Is there a point (south of the Colville Delta) at which it would no longer be economic to transport oil via Alpine? Would additional crossings of the Colville be necessary? Might one end up with an additional pipeline crossing of the Colville River just south of Nuiqsut that would handle all oil from NPR-A?

Response:

ARCO may be among a number of oil and gas operators in the NPR-A, therefore, the following answer is solely ARCO's perspective. The above mentioned 25 radius discussion applies to this question. The 25-mile radius extends approximately 17 miles south of Nuiqsut and would intersect the Colville River approximately 2 1/2 townships (15 miles) west to southwest of Nuiqsut due to the natural meandering of the Colville River. The economic viability decision of an additional pipeline crossing within this radius is discussed above. Additionally, it is possible that a pipeline from NPR-A may run west instead of east. The ultimate route will depend on considerations such as the size, location, ownership, and number of discoveries in NPR-A. The environmental impact statement(s) for NPR-A will address these pipeline alternatives, which at this time are speculative and beyond the foreseeable future.

24. Issue:

What assurances can ARCO provide regarding incremental increases in the footprint of development within the Colville Delta? Is enough known about the geology of the mid- and outer delta to rule out additional roads and production pads (aside from Fiord)?

Response:

ARCO's discussion in Section 4.7.1.3 of the EED is the best available forecast of cumulative impact and timing for that impact within the Colville Delta.

25. **Issue:**

What infrastructure will be associated with the project to provide gas to the village of Nuiqsut? What additional gravel fill, structures, activities, and impacts are associated with this project?

Response:

In Section 2.9 Mitigation Measures of the EED, ARCO committed to making available, free of cost, up to 500,000 cubic ft per day of natural gas for Nuiqsut's domestic, governmental, and other uses within the City limits of Nuiqsut. The gas would be made available at a custody metering outlet at the Alpine processing plant. ARCO has no obligation beyond this outlet other than (1) a verbal agreement to provide space on its pipeline vertical support members extending to the west side of the Colville River HDD crossing for a potential gas line (or electric line as ARCO has subsequently recommended), and (2) a commitment to coordinate with and assist the North Slope Borough and Nuiqsut regarding their planning. No additional gravel footprint is associated with ARCO's obligations.

The North Slope Borough has expressed an interest in transporting gas or electricity to Nuiqsut and is working on a preliminary engineering report.

26. **Issue:**

"To what extent does the existence of Alpine increase the likelihood of an expanded road network to and from Nuiqsut? If production wells are built on the west side of the Nechelik Channel, is it likely that there will be a road to Nuiqsut? If Nuiqsut serves as a base for development on the west side, will there be a need to expand the Nuiqsut airport?"

Response:

The Alpine Development, as conceived in the EED and supporting documents, does not require or need: (1) a permanent gravel road, with bridge(s) from Kuparuk to Nuiqsut or Kuparuk to Alpine or from Nuiqsut to Alpine, (2) an expansion of the Nuiqsut airport. Alpine has no impact on the likelihood of an expanded road network to Nuiqsut. Alpine can not afford, and does not need under any known conditions, a gravel road and associated rig-capable/vehicular river crossings (see Section 3.0 Alternatives To The Proposed Action in EED). A road to or from Nuiqsut is speculative in nature and in ARCO's estimation, beyond the foreseeable future.

Alpine reserves, as currently mapped, that lie west of the Nechelik Channel of the Colville River could be produced from the proposed Alpine Pad #2. Non-Alpine production wells that may eventually be located west of the Nechelik are discussed in Section 4.7.1.3 of the EED, however, these wells are speculative in nature and beyond the foreseeable future. Non-Alpine production facilities in this area would be subject to the 25 mile radius discussion above.

27. Issue:

What is the expected lifetime of the project? What restoration techniques will be used to return the facility area to productive wildlife habitat?

Response:

The attached Alpine production curve depicts potential production rates as far as 30 years into the future, although the current economic life of the project is estimated to be 20 to 25 years.

Please refer to Section 2.10.2 of the EED for a discussion of restoration techniques.

28. Issue:

Provide a written explanation on insulation of the pipe, distances where the pipe goes under and comes back up, and the natural erosion by ice jams that could possibly expose or have some impact on the line.

Response

The oil sales pipeline and casing will not be insulated in the thaw stable areas of the river crossing. There will be insulation applied to the outside of the casing to protect against thawing of the thaw unstable soils in the above ground to below ground transition zones on both sides of the river.

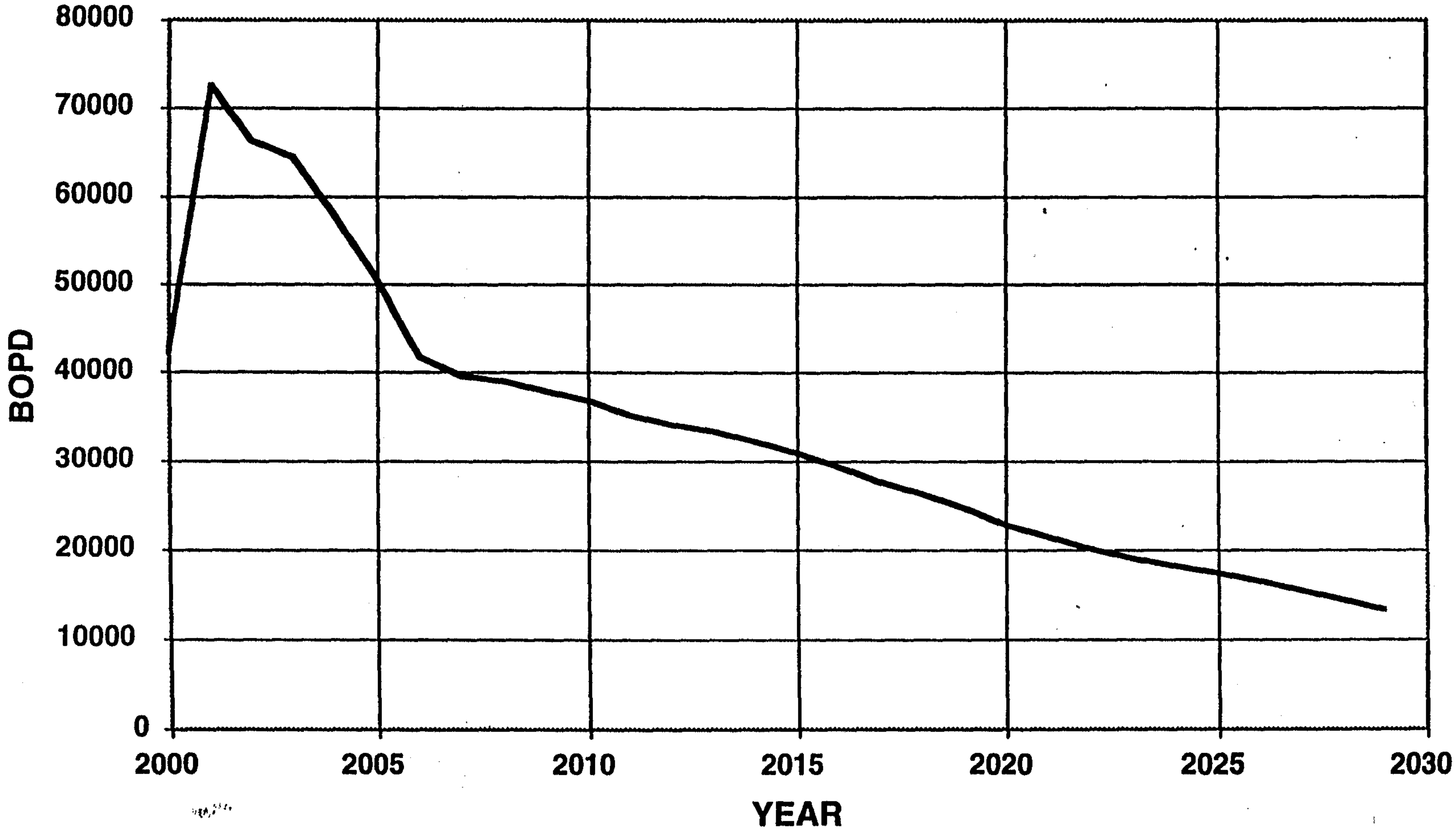
The above ground to below ground transition point on the west bank of the river crossing will be approximately 200 ft from the river bank. The transition point on the east bank will be approximately 300 ft from the river bank. Based on historical evidence the west bank will be stable. A conservative analysis of the east bank concludes the bank could migrate as much as 125 ft due to all causes including erosion caused by ice jams. i.e., less than half of the design setback. We do not anticipate exposure of the pipeline by either erosion or scour since the pipeline installation depth will range between 45 ft to 80 ft below the river bed.

See attached figure, marked Sheet 13 of 25, which depicts the drilled crossing.

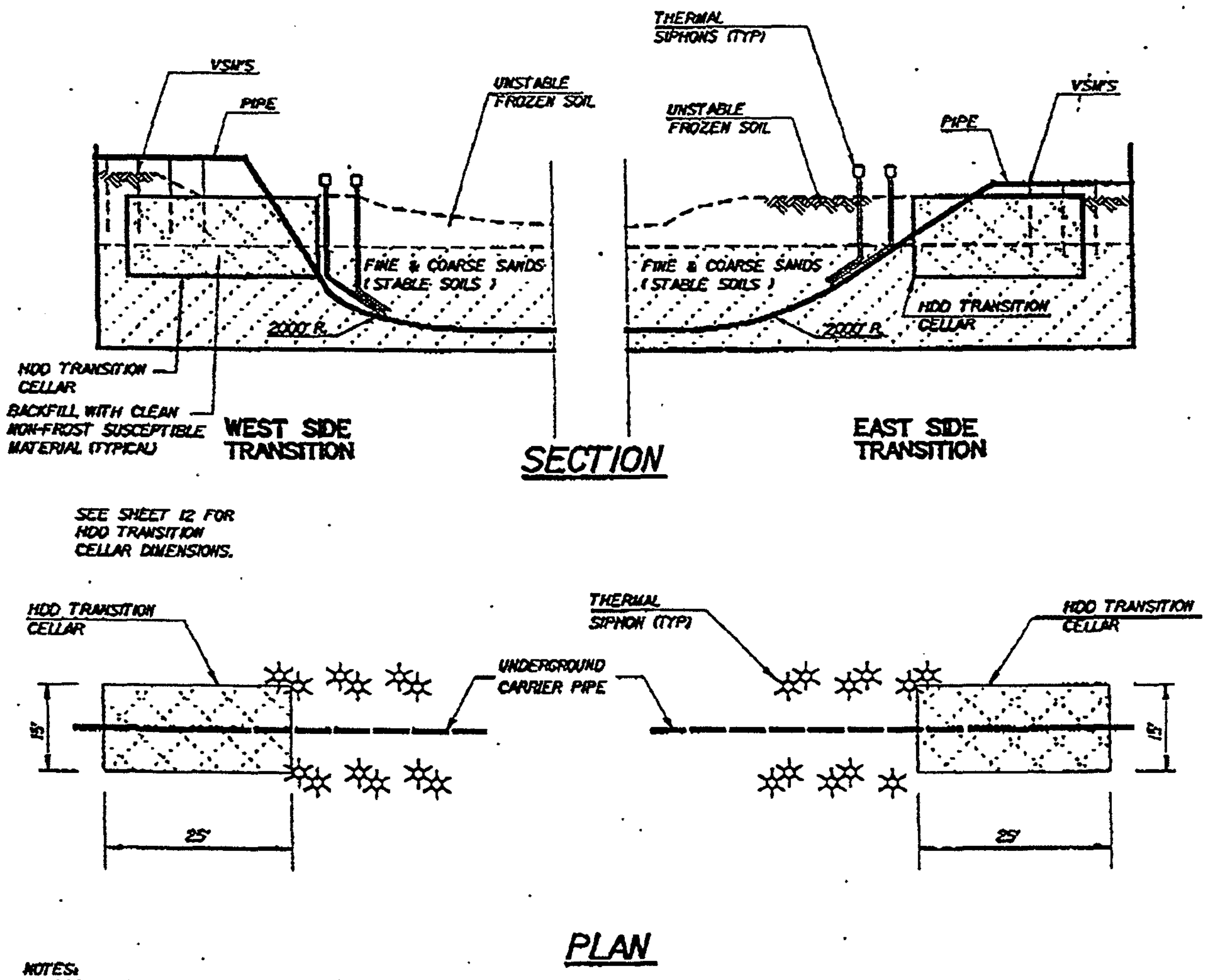
ARCO Alaska, Inc.
Anadarko
UnionTexas Petroleum

ALPINE MANAGEMENT REVIEW

FIGURE 5
ALPINE DEVELOPMENT OIL RATE FORECASTS



Total 94 well development



NOTES:
1. APPROXIMATE VOLUME OF EXCAVATION FOR EACH CELLAR IS 420 CU.YD.

PURPOSE: PETROLEUM PRODUCTION

DATUM:
ADJACENT PROPERTY OWNERS:
1. STATE OF ALASKA
2. KUUKPIK CORPORATION

HORIZONTAL DIRECTIONAL DRILLED (HDD) TO ABOVE GROUND NON-VERTICAL DESIGN

ARCO ALASKA, INC.
700 G. STREET
P.O. BOX 100360
ANCHORAGE, ALASKA 99510-0360

PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR

LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT
BOROUGH: NORTH SLOPE
APPLICATION BY: ARCO ALASKA, INC.
SHEET 13 OF 25 DATE: 02/26/97

29. **Issue:**

Provide a detailed description of the ice bridge for construction and operations, and a description of the ice bridge for the HDD crossing. Include plans that clearly state ice thickness required at the Colville crossing for three activities: (1) early construction, (2) construction, and (3) operations.

Response:

The ice bridge construction for this project is similar to the typical North Slope ice bridges constructed to support previous Colville exploration drilling operations. Several ice bridges will be required over the life of the project.

For additional information please refer to the Feb. 27, 1997 ARCO letter to the USACE.

30. **Issue:**

Provide a map of the river bathymetry for use by Larry Moulton to identify deep water sites used by overwintering fish.

Response:

The available channel profiles are contained in Appendix B of the 1996 Colville River Delta Channel Assessment (see Appendix M).

31. **Issue:**

Provide information on engineering safeguards for preventing a pipeline rupture under the Colville River. What conditions could cause a rupture and where would the oil surface? How would a subterranean leak be detected, and what is the potential for oil to percolate upward through the sediments into the river channel?

Response:

To prevent a pipeline rupture under the Colville River, the sales oil pipeline will be installed inside a high strength casing pipe. The worldwide industry practice for Horizontal Directional Drilled (HDD) pipeline crossings of environmentally sensitive areas does not include casings. However, ARCO has elected to install a casing as an added safeguard against leaks into the Colville River. Simultaneous failure of both the sales oil pipeline and the casing pipe is highly improbable.

In the event of a sales oil pipeline failure under the Colville River, the oil released would be contained within the casing pipe. The first level of leak detection is the Alpine sales oil pipeline leak detection system. The Alpine leak detection system is a state-of-the-art system equal to or better than the existing Kuparuk River Pipeline system. The second level of leak detection is visual inspection as is typical for above ground North Slope pipeline installations. The casing will redirect any oil spilled such that it could only reach the environment at the ends of the casing at the surface transition points which are located 200 ft to 300 ft from the river banks. The situation for the sea water pipeline and its casing is identical to the sales oil pipeline.

Due to the conservative design of the cased HDD river crossing we do not anticipate the possibility of oil being released into the subterranean environment with subsequent percolation into the river. However, in the highly unlikely event that the casing failed and a leak was possible to the subterranean environment, any oil released would take the path of least resistance to the surface. The least resistant path remains the annular space inside the casing due to the hydrostatic pressure outside the casing and the stiff confining soils. The oil would then fill the annulus to emerge at the ends of the casing which are 200 ft to 300 ft from the river banks.

In conclusion, crossing the Colville River by HDD was chosen only after careful consideration of alternative crossing techniques. The method is consistent with state of art practice for crossing rivers and environmentally sensitive areas. In addition, and unlike other HDD crossings and subsea pipelines, a casing was added to the design for the sole purpose of providing an extraordinary level of environmental protection. Careful technical review and selection of materials, coatings, and protections has been conducted and included in the design and will be reported in the technical summary to be transmitted to the JPO 6/2/97 (Appendix M). The Alpine monitoring plans include "smart pigs" to ensure timely detection of any problems throughout the life of the pipeline. ARCO has gone beyond standard industry practice to ensure a safe crossing, and confidently conclude that a spill scenario to the environment is not realistic.

32. Issue:

Describe the proven technological methods to prevent thaw settlement in the zone of transition from permafrost to thawed soils in the Colville River floodplain relative to HDD. Describe the circumstances that these methods have been used, and state whether the geotechnical considerations are analogous to the Colville River. Also identify if there are pockets of permafrost under the river at the pipeline crossing locations.

Response:

There are two thaw settlement transition zones in the HDD river crossing. One is the transition between the thaw bulb under the active river channel and the permafrost on each side of the river thaw bulb. Settlement in this area is addressed by the installation of a high strength casing pipe which can withstand the anticipated settlement.

The other thaw settlement area is the transition between the permafrost and the surface which occurs in thaw unstable soils. The thaw unstable soil in those areas will be excavated and replaced with thaw stable materials as shown in Sheet 13 of 25. In addition, insulation will be installed on the outside of the casing to minimize growth of the thaw bulb in the flood plain. Finally, thermal syphons for passive refrigeration will also be installed. Each one of these three techniques are proven technology used on the Trans-Alaska Pipeline System, North Slope foundation designs and is consistent with worldwide Arctic practice. The combination of all three exceeds standard North Slope practice. Based on the geotechnical investigations to date we have not identified nor do we anticipate any pockets of permafrost within the Colville River thaw bulb. Consequently we do not anticipate thaw settlement to be an issue.

33. Issue:

Provide a map of the proposed route of travel for moving the drill rig from Oliktok Point to the Alpine oilfield. Information is also needed on whether ice grounding or thickening will be required, and where these measures will be necessary to safely move the drill rig.

Response:

It is anticipated that a near shore sea ice route will be utilized as shown on Sheet 25 of 25 in the Alpine USACE public notice. Information with regards to locations where ice grounding or thickening will be required will not be available until 3/98 since further winter season field work is required. However, it is anticipated that ice thickening and/or ice grounding will be in areas where ice grounding naturally occurs later in the year. It should be noted that the sea ice route will not be utilized until the winter of 1998/1999. The preliminary logistics plan is currently under development. This plan is scheduled to be issued 7/15/97.

<u>Drainage Structures</u>

34. Issue:

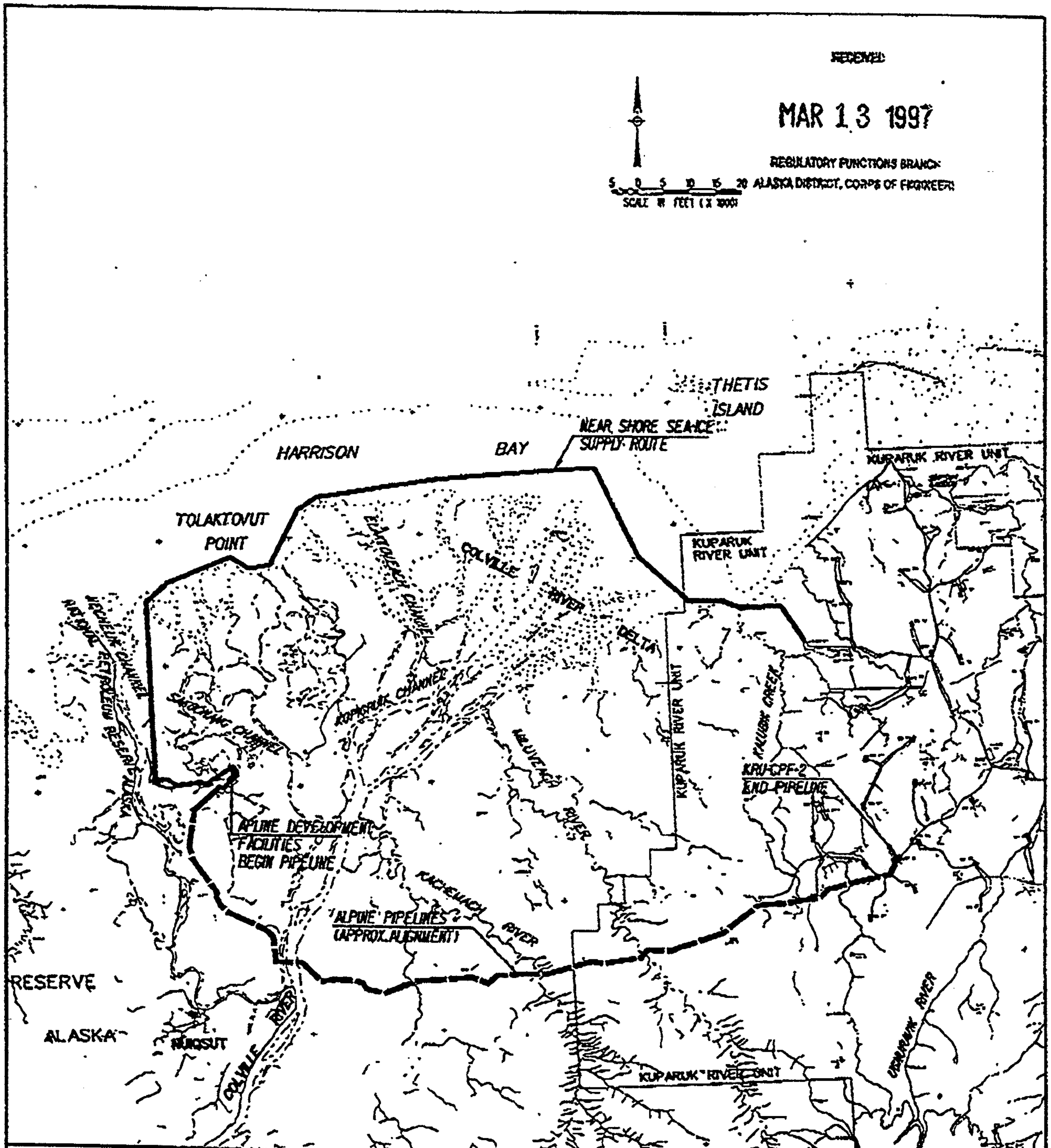
Provide information on location, alignment, size, corrugations, slope, burial depth, and armor protection for each culvert or culvert battery.

Response:

See the attached Table 3 and Drawing Sheets 5, 6, 7, 8, 10 & 16 for the preliminary alignment, size, corrugations, slope, burial depth and armor protection for the project culvert plan. Final culvert locations will be established during the 1997 summer staking program.

35. Issue:

Provide discharge estimates and predicted water velocity for culvert and culvert battery.

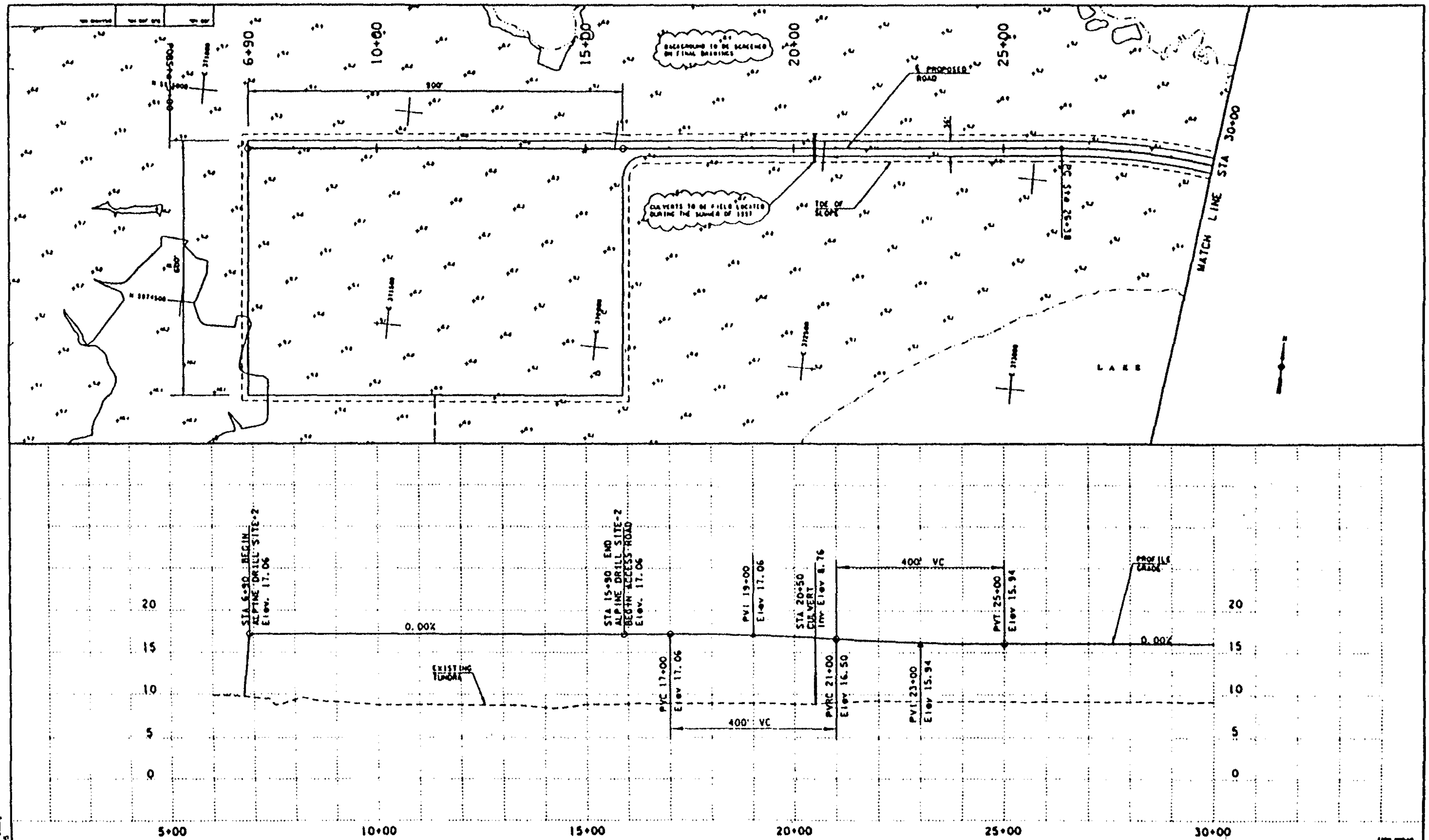


PURPOSE: PETROLEUM PRODUCTION DATUM: ADJACENT PROPERTY OWNERS: 1. STATE OF ALASKA 2. KUUKPIK CORPORATION	**NEAR SHORE SEA-ICE SUPPLY ROUTE** ARCO ALASKA, INC. 700 G. STREET P.O. BOX 100360 ANCHORAGE, ALASKA 99510-0360	PROPOSED ALPINE DEVELOPMENT AND PIPELINE CORRIDOR. LOCATION: COLVILLE RIVER DELTA/ KUPARUK RIVER UNIT BOROUGH: NORTH SLOPE APPLICATION BY: ARCO ALASKA, INC. SHEET 25 OF 25 DATE: 02/26/97

Table 3. Preliminary Culvert Characteristics.

Culvert Sta.	Size (in)	Corrugations (in)	Slope (%)	Skew Angle	HWEL50 (ft)	TWEL50 (ft)	Q-Culvert (cfs)	V-Culvert (fps)	Burial Depth
20+50	48	2-2/3x1/2	<5%	90	12.4	11.36	45	5.1	0
30+50	48	2-2/3x1/2	<5%	90	12.4	11.36	45	5.1	0
40+50	48	2-2/3x1/2	<5%	90	12.4	11.36	55	5.2	0
50+50	48	2-2/3x1/2	<5%	90	12.4	11.36	61	5	0
61+50	48	2-2/3x1/2	<5%	90	12.4	11.36	45	5.1	0
71+00	48	2-2/3x1/2	<5%	90	12.4	11.36	45	5.1	0
79+50	48	2-2/3x1/2	<5%	90	12.4	11.36	45	5.1	0
92+00	48	2-2/3x1/2	<5%	90	12.4	11.36	61	4.8	0
100+30	12'10"x8'4"	12'10"x8'4"	<5%	90	12.4	11.36	527	11.21	1
160+06	8'7"x5'11"	8'7"x5'11"	<5%	50	12.4	11.36	102	7.1	1
160+29	8'7"x5'11"	8'7"x5'11"	<5%	50	12.4	11.36	102	7.1	1
11+76,133'rt	48	2-2/3x1/2	<5%	90	12.4	11.36	45	5.1	0
12+00,131.8'rt	48	2-2/3x1/2	<5%	90	12.4	11.36	45	5.1	0

Notes
1) Invert elevations are approximate.
2) A 0.005% slope was assumed.
3) Shannon & Wilson's 50-year water surface elevation was used.
4) FHWA culvert analysis used to evaluate velocities.



PRELIMINARY
NOT FOR
CONSTRUCTION

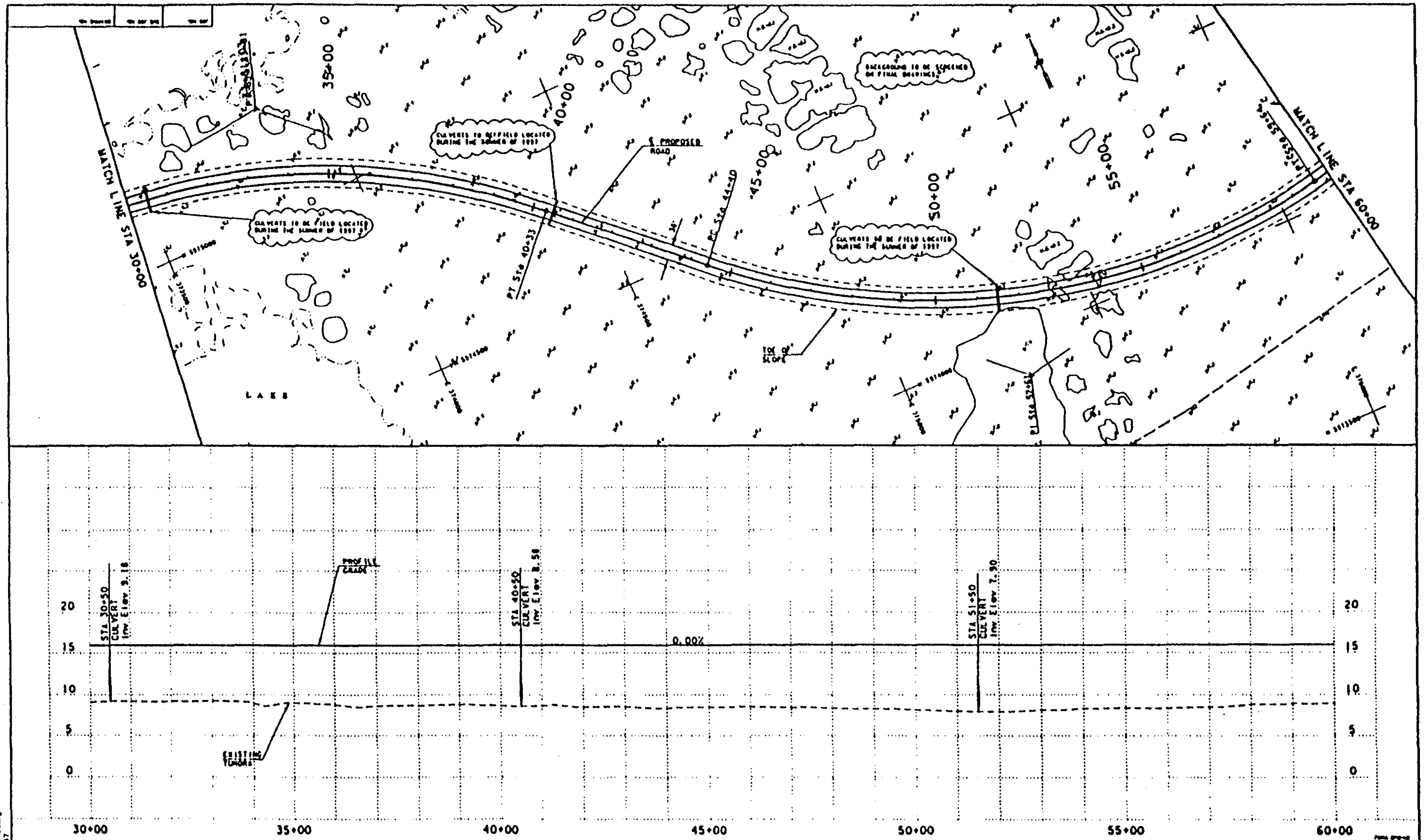
Baker
Michael Baker Jr., Inc.

ARCO Alaska, Inc.

MODULE:
ALPINE DEVELOPMENT
PLAN AND PROFILE
STA. 6+90 TO STA. 30+00

UNIT:

5 of 36



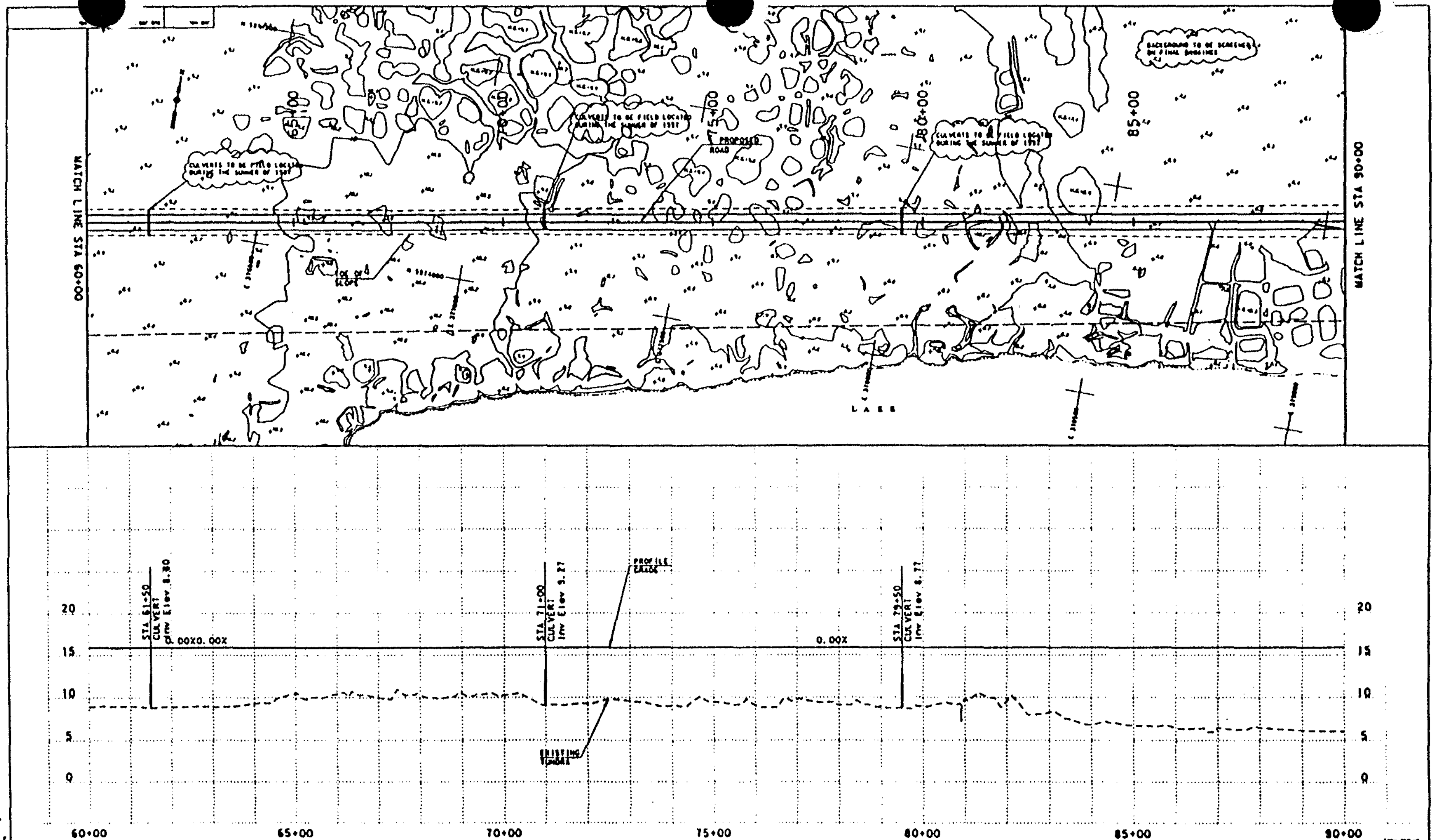
PRELIMINARY
NOT FOR
CONSTRUCTION

Baker Michael Baker Jr., Inc.

ARCO Alaska, Inc.

PLAN AND PROFILE
STA. 30+00 TO STA. 60+00

6 of 56



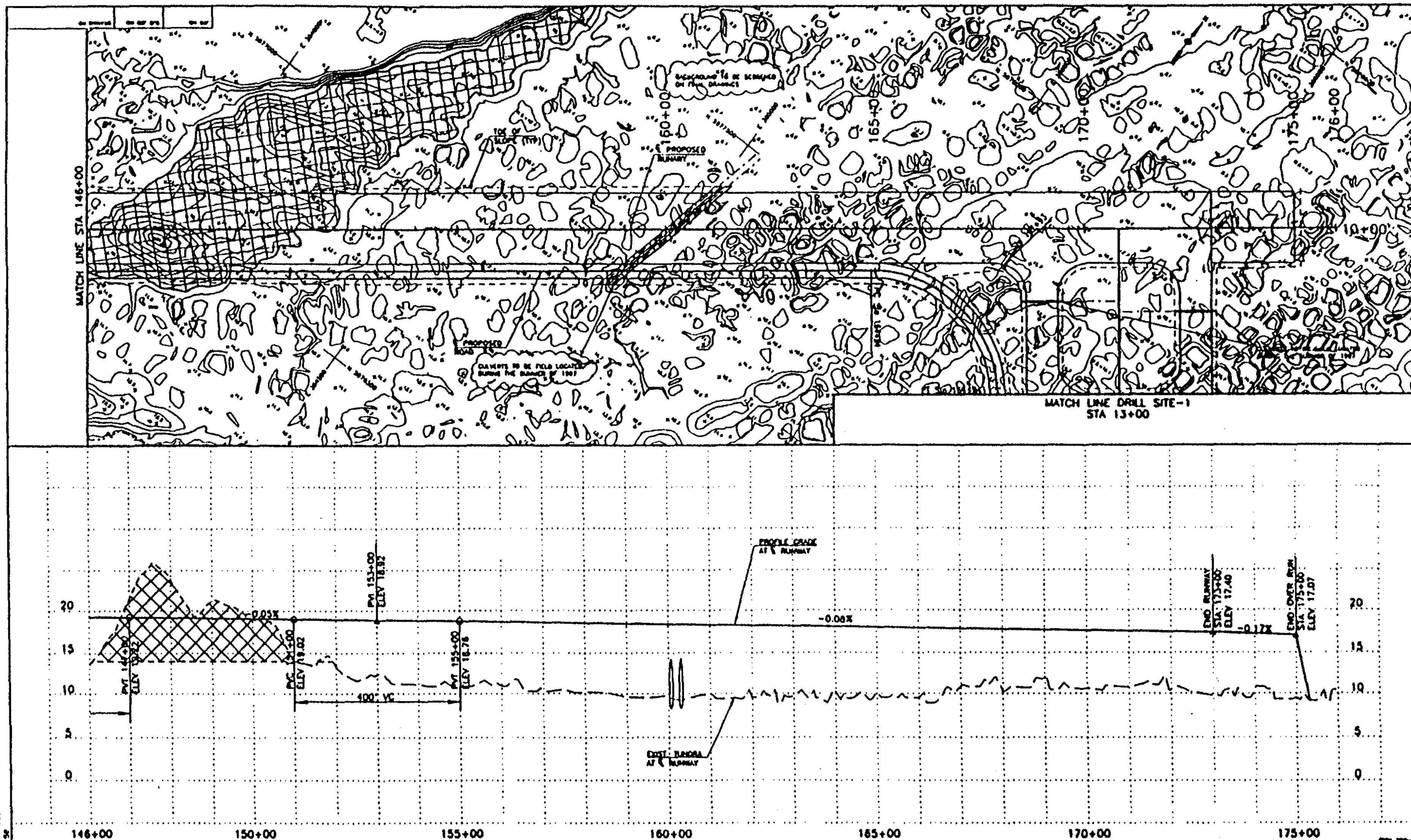
PRELIMINARY
NOT FOR
CONSTRUCTION

Baker Michael Baker Jr., Inc.

ARCO Alaska, Inc.

PLAN AND PROFILE
STA. 60+00 TO STA. 90+00

7 - 36



PRELIMINARY
NOT FOR
CONSTRUCTION

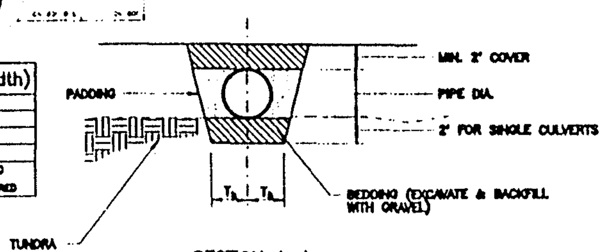
Baker Michael Baker Jr., Inc.

ARCO Alaska, Inc.

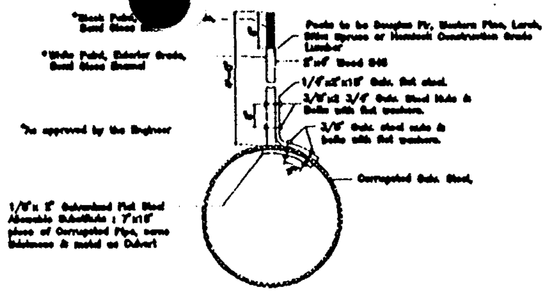
RUNWAY PLAN AND PROFILE
STA. 146+00 TO STA 175+00

10 - 36

T_h (Thaw Width)	
DIA	WIDTH
3'	3'
4'	3'
6'	5'
6'	SITE SPECIFIC DESIGN REQUIRED



SECTION A-A
NOT TO SCALE



CULVERT MARKER POST

DRAINAGE PIPES S[illegible]						
STATION	SKEW	DIAMETER	LENGTH	TYPE	[illegible]	CORR.
[illegible]						
[illegible]	[illegible]	[illegible]	[illegible]	CMP	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	CMP	[illegible]	[illegible]
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71+00	[illegible]	[illegible]	[illegible]	CMP	[illegible]	[illegible]
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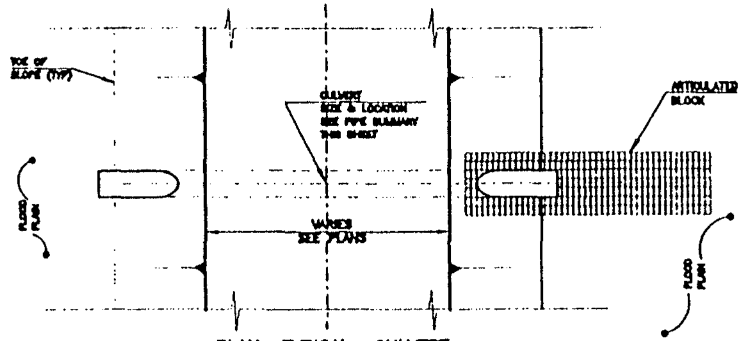
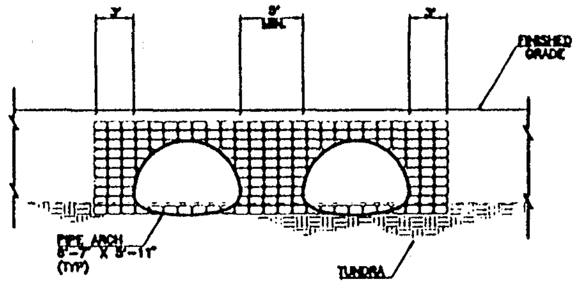
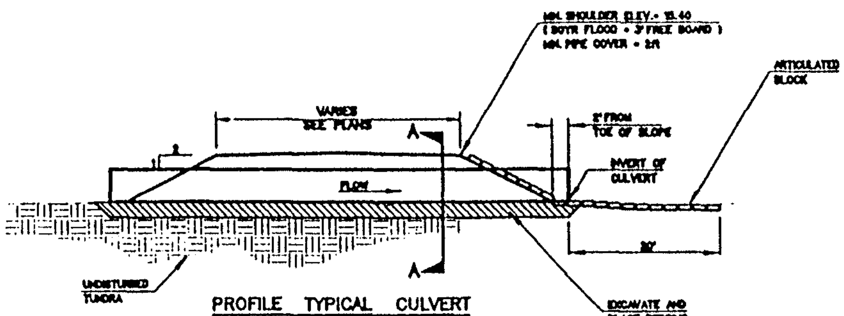


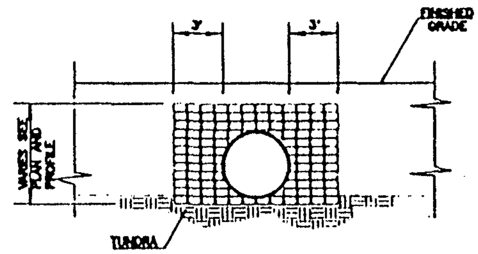
PLAN TYPICAL CULVERT
NOT TO SCALE



DUAL PIPE-ARCH
OUTLET ELEVATION
NOT TO SCALE



PROFILE TYPICAL CULVERT
NOT TO SCALE



SINGLE PIPE
OUTLET ELEVATION
NOT TO SCALE

PRELIMINARY
NOT FOR
CONSTRUCTION

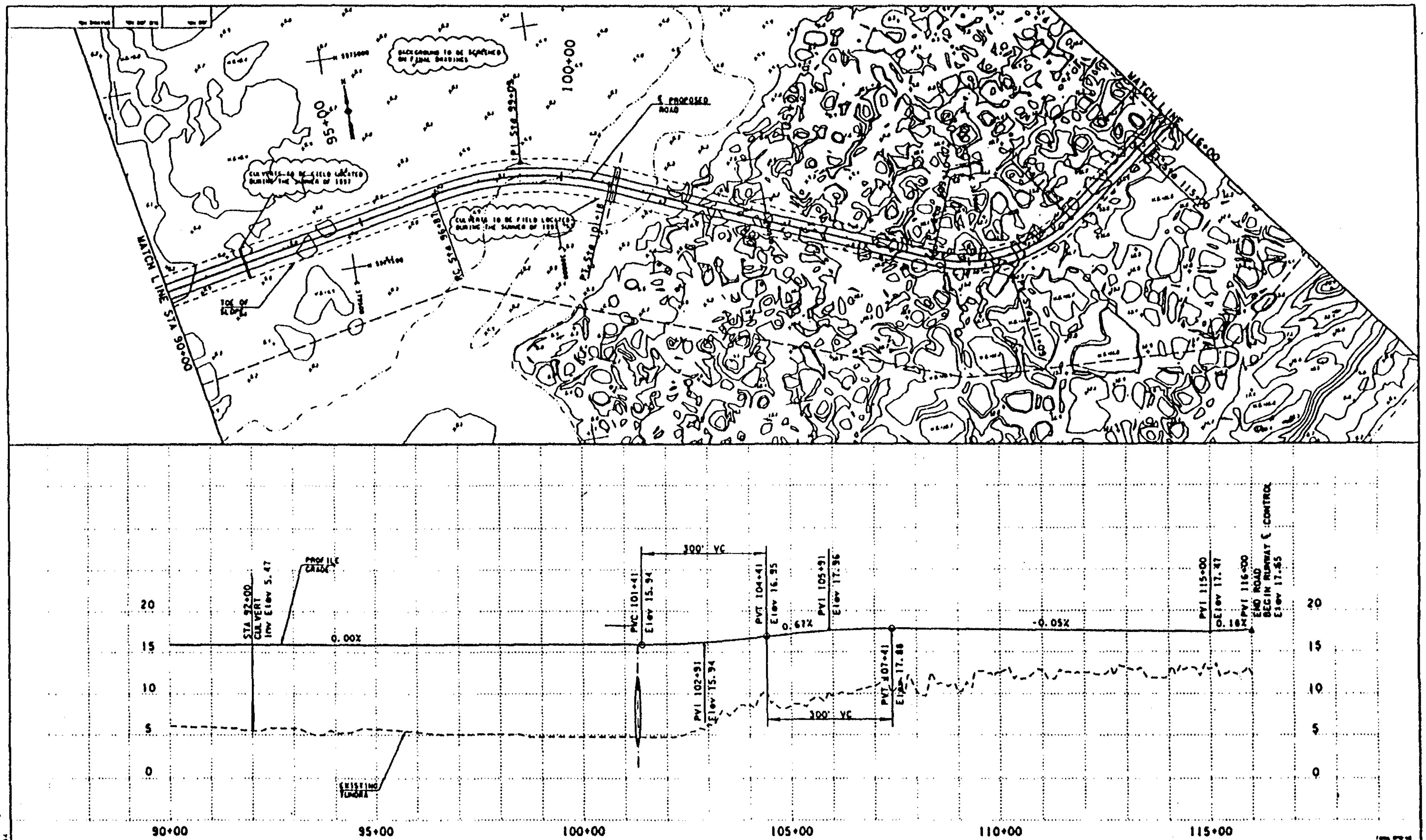
Baker
Michael Baker Jr., Inc.

ARCO Alaska, Inc.

MODULE
DRAINAGE
DETAILS

16 of 36

d:\temp\drainage1.dgn May. 14, 1997 17:55:47



PRELIMINARY
NOT FOR
CONSTRUCTION

Baker Michael Baker Jr., Inc.

ARCO Alaska, Inc.

ROAD PLAN AND PROFILE
STA. 90+00 TO STA. 116+00

SHEET: 8 of 36

Response:

Discharge estimates and predicted water velocities for the project culvert plan are provided in Table 3.

36. Issue:

Provide detailed cross sectional drawings depicting all drainage structures and information for operations and maintenance (e.g. keeping culverts free of snow, snow removal prior to breakup, etc.).

Response:

The typical cross sectional drawing is shown on the attached drawing Sheet 16. The additional information required to complete the design are shown on the attached plan and profile sheets.

Spring break-up O&M plans have not yet been developed. However, we anticipate that the traditional North Slope practice of installing plywood in front of the culverts before freeze-up will be used. The plywood will then be removed before break-up.

37. Issue:

Provide reports describing hydrology in the project area.

Response:

Please see the hydrology reports in Appendix M.

<u>Water Withdrawal</u>

38. Issue:

Provide design specifications (pumping rates, volume of water, location, screening, etc.) and construction procedures (streambank and streambed modifications) for an intake structure to be used for withdrawing water from Sakoonang channel during spring high water to refill lake 9313. The intake structure should prevent entrainment and impingement of juvenile fish.

Response:

The use of Sakoonang Channel water is only one of several options being evaluated. At this time no detailed design of an intake structure for this source or any other is available. However, any water intake structures constructed in fish bearing waters will be designed to comply with Rationale for Water Intake Standards (5 AAC 94.270) which will prevent entrainment and impingement of juvenile fish. The water source and use plan is anticipated to be complete by the end of September 1997.

39. Issue:

Identify water sources that will be used on a continuous basis for seasonal ice road construction, development drilling, and operations.

Response:

Refer to response to Issue 30.

40. Issue:

Provide details of the risers versus valves in the pipeline design at stream crossings.

Response:

The risers referenced are known as vertical loops. Please see the report oil Pipeline Spill Isolation Strategy (Appendix M) which describes these loops and their impact on spills in detail. These loops are artificial terrain breaks that create a terraced effect in the pipeline to reduce the chance of a spill by removing one of the primary spill sources, valves, from the pipeline and to reduce the size of any spill that does occur. Please note that the use of vertical loops in place of valves is dependent on regulatory approval by the U.S Dept. of Transportation, Office of Pipeline Safety and the Alaska Dept. of Environmental Conservation (Oil Spill Contingency). As of this date, ARCO has not received approval from either agency.

41. Issue:

Provide map of the pipeline route showing pipeline elevation above the tundra. Calculate length of pipeline at 5 ft above the tundra, greater than 5 ft above the tundra, and less than 5 ft above the pipeline.

Response:

The pipeline profile was completed 5/1/97. However, the 30 percent complete pipeline alignment sheets will not be issued until 8/15/97. The minimum elevation of the pipe in the above ground pipeline sections is 5 ft above the tundra. In some areas such as streams and the floodplain on the east side of the Colville River the pipe will be 10 ft to 12 ft above the tundra. The pipe will be 15 ft to 25 ft above the tundra at the nine vertical loops.

Other Agency Cumulative Impact Questions Received And Discussed In The Above Responses

EPA

"This is the first opening development in the Colville River Delta.....As a consequence, the cumulative effects of this project with other future projects will need to be considered."

NMFS

"...cumulative impacts associated with building a new infrastructure... The incremental environmental changes caused by the proliferation of new development projects are of concern.....For example, the infrastructure for Alpine is already being viewed as the "gateway" for development in the NPRA."

Tarn Project

The Tarn Project, as presently conceived, will have no impact on the Alpine project design other than the possibility of shared VSMs from a point on the Alpine sales oil pipeline located immediately north of Tarn then easterly to Kuparuk infrastructure.

APPENDIX K-3

COMMENT LETTERS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
Alaska Operations Office
Room 537, Federal Building
222 W. 7th Avenue, #19
Anchorage, Alaska 99513-7588

September 10, 1996

Mr. Lloyd Fanter
Regulatory Branch (1145b)
Alaska District, Corps of Engineers
P.O. Box 898
Anchorage, Alaska 99506-0898

Re: ARCO's Colville River Alpine Development

Dear Mr. Fanter:

As you know ARCO is working on the development of an oil reservoir located in the Colville River Delta near the Village of Nuiqsut approximately 35 miles west of the existing Kuparuk Unit Development. While ARCO has not yet submitted its final proposal for development there are likely to be a pad or pads for 100 to 150 wells, oil and gas processing facilities, operations and support camp facilities and an approximately 35 mile long oil sales pipeline, and perhaps a water pipeline. The development will likely require the construction of a Hercules capable airstrip as well. The gravel for this development will need to come from somewhere and could involve locating and opening a gravel mine somewhere in the Colville River Delta.

For several months now, ARCO has been working with you at the Alaska District with pre-application meetings for the resource agencies and public. This effort has been very useful and should be applauded. The Colville River Delta is a unique and valuable environment along the coast of the Alaskan Beaufort Sea, a fact evidenced by the joint public notice which our agencies issued April 1989 announcing a draft Advanced Identification study.

The introduction of a development the size and magnitude of an oil development into any area results in changes to that area and affects the quality of the human environment. These changes are not always large and there are not always significant effects to the human environment.

Based upon the information available to date, and recent field visits, it seems that the introduction of oil development into the Colville River Delta will result in changes significantly affecting the human environment. This is especially true when considering the fact that this is the first opening development in the Colville River Delta and that oil industry and State of Alaska estimates indicate that there are producible oil reserves, and as recently cited in the 9 September 1996 Anchorage Daily News the reserves are at least lucrative if not gigantic. As a consequence, the cumulative effects of this project with other future projects will need to be considered.

The ARCO Alpine Development is located approximately 6 miles north of the Village of Nuiqsut. The people in the Village of Nuiqsut live a subsistence lifestyle with a subsistence economy and social structure which is predicated upon obtaining their needs from the land, air and water resources surrounding them. The Village of Nuiqsut has been consistent in expressing their concern for their continued way of life when asked for their comments and concerns on oil development projects 35 an more miles away from their village. They have repeatedly expressed concern about ARCO's Alpine project, which, is located six miles away and will be visible from their homes. A thorough and complete evaluation of the Alpine project's effect upon the human environment for the people of Nuiqust will be required. Such an evaluation process must be done in public and involve the people of Nuiqsut as well as other North Slope and State of Alaska residents.

The Colville River Delta is widely recognized as an area of diverse high-value habitat for a wide range of animals and plants. ARCO has been working on an environmental evaluation for the Alpine project and has involved EPA and other resource agencies in the development of this environmental evaluation. This evaluation documents diverse habitats and their high value to a wide range of species. Unlike development elsewhere on the North Slope of Alaska, the Alpine project would involve a major oil development in the middle of a large coastal river delta. This type of landscape, ie: large river delta, has not had oil development and we have very, very little experience to draw upon when assessing impacts and mitigation measures which might be necessary. No oil spill contingency plan has ever had to be developed for development in the middle of such a large river delta that has such high habitat values and is the basis of a subsistence economy.

Based upon the above considerations it seems likely that the Alpine project as it is known at present will significantly affect the quality of the human environment and that it is only reasonable to expect that Federal permitting actions would be predicated upon the completion of the Environmental Impact Statement (EIS) public process as prescribed by the National Environmental Policy Act (NEPA). While acknowledging that it is too early to make a final decision regarding the need to prepare an EIS because we do not have a final project from ARCO, it seems reasonable to communicate to you our current project assessment.

Recognizing that ARCO has stated the intention of building their project in the 1997-1998 time frame, there is time for a focused, efficient EIS before a permit decision would have an effect upon their project schedule. There is a substantial amount of information regarding the natural environment of the Colville River Delta. While I will have to reserve judgement until the report is finalized and made available for review, it is possible that ARCO's environmental evaluation report could serve as the basis for an affected environment chapter of an EIS. The Cumulative Effects and Socio-Economic portions of an EIS would have to be developed by the EIS in total, however, these issues and concerns are the very ones that cry out for formalized public participation.

Thank you for your efforts in arranging preapplication meetings and the free and open exchange of information among agencies and ARCO. Please notify me of any significant new information generated during your agency's evaluation. If there are any questions, please contact me at (907) 271-5083. I continue to look forward to working with you on this project.

Sincerely,

T. L. Rockwell Jr.

Theodore L. Rockwell, Jr.
Environmental Scientist

cc: ADEC, Anchorage (J.P.O.)
ADGC, Anchorage
NMFS, Anchorage
ADFG, Fairbanks
USFWS, Fairbanks

TONY KNOWLES, GOVERNOR

STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

HABITAT & RESTORATION DIVISION

1300 COLLEGE ROAD
FAIRBANKS, ALASKA 99701-1599
PHONE: (907) 459-7289
FAX: (907) 456-3091

December 12, 1996

Mr. Mark J. Schindler, Director
Colville Permits and Compliance
ARCO Alaska, Inc.
P.O. Box 100360
Anchorage, AK 99510-1215

Dear Mr. Schindler:

RE: Water Use in the Colville River Delta, Alpine Project

ARCO Alaska Inc. (AAI) has requested, and the Department of Fish and Game has approved water use from numerous lakes in the Colville River Delta in support of winter exploratory drilling. This approach to permitting was deemed appropriate when ice road alignments and exploratory drill sites were subject to frequent change. Criteria to mitigate the impacts of winter water use on fish were developed for lakes within the Colville Delta. These criteria prohibit water use from lakes less than 7 feet deep and authorize use of a maximum of 15% of the water beneath the ice for lakes exceeding 7 feet.

Commercial quantities of oil have been found and the Alpine Development Project has been proposed. As part of this project fisheries and water quantity data have been collected in the Alpine facility area and transportation corridor. Rather than continue the approach of permitting numerous lakes in the project area we would like to apply existing environmental data to selectively permit water sources for each stage of development. Our initial thoughts on this process are listed below:

(1) Identify water sources that will be used on a continuous basis for seasonal ice road construction, development drilling, and operations.

(2) Develop criteria to evaluate fisheries productivity of each of the listed watersources with the objective of directing water use to lakes with lower productivity. Note: Existing information can be applied in this process or additional data collected where information is not available.

(3) Present the biological and water quantity data available for each source identified.

(4) For sources identified for year round use (e.g. those proposed for the Alpine facilities area), permanent water withdrawal structures should be designed to ensure that fish impingement and entrainment do not occur.

(5) Where water use is expected to impact fish populations (perched infrequently flooded lake 93-13) measures to ensure water recharge are suggested. One approach might be to refill the perched lake by pumping water from the Sakoonang Channel of the Colville River during the spring flood. A similar approach is used at Webster Reservoir using the Sagavanirktok River to refill the lake.

AAI has identified water needs and sources, volumes have been have estimated and biological information has been collected. At this point available information needs to be integrated to form a basis for decision making that will protect fish resources as well as provide water needed for the various phases of development. We are prepared to work with AAI to mitigate impacts to fish and wildlife resources. We envision the end result to be authorizations for water use that cover life of the project. If there are any questions regarding this letter, please contact either me or Mr. Carl Hemming at 459-7289.

Sincerely,

Alvin G. Ott, Regional Supervisor
Habitat and Restoration Division
Department of Fish and Game

cc: Mayor Gordon Brown/Leonard Lampe, Village of Nuiqsut, Nuiqsut
Joe Nukapigak/Laston Chinn, Kuukpik Corp., Nuiqsut
Warren Matumeak/Dee Olin Hoffman, NSB, Barrow
Bill Thomas, ASRC, Barrow
Mark Helmericks, Colville Environ Svcs, Anchorage
Steve Murphy/Brian Lawhead, ABR, Fairbanks
Larry Moulton, Seattle
Dan Reed, ADF&G, Fairbanks
Carl Hemming, ADF&G, Fairbanks
Molly Birnbaum, DGC/SPCO, Anchorage
Nancy Welch, ADNR, Fairbanks
Ted Rockwell, EPA, Anchorage
Jeanne Hanson, NMFS, Anchorage
Phillip Martin, USFWS, Fairbanks
Patrick Sousa, USFWS, Fairbanks
Carl Hemming/Dick Shideler, ADF&G, Fairbanks
Keith Shultz, ADF&G, Fairbanks
Fred Andersen, ADF&G, Fairbanks

AGO/ago

United States Department of the Interior
Fish and Wildlife Service
NORTHERN ALASKA ECOLOGICAL SERVICES
101 12th Ave., Box 19, Room 110
Fairbanks, Alaska 99701
January 2, 1997

RECEIVED
JAN 7 1997
ALASKA LAND

Colonel Peter A. Topp
District Engineer, Alaska District
U.S. Army Corps of Engineers
Post Office Box 898
Anchorage, Alaska 99506-0898

Re: ARCO Alpine Development

Dear Colonel Topp:

The U.S. Fish and Wildlife Service met with Lloyd Fanter, of your staff, on 25 November 1996, to discuss the status of ARCO Alaska's proposed Alpine Development Project on the Colville River delta. Service biologist Philip Martin participated in a follow-up meeting on 2 December, at which Tim Jennings was also present. The topic addressed at both meetings was the Corps' preliminary decision to proceed with a standard permit review process, rather than embarking on the preparation of an Environmental Impact Statement (EIS). The purpose of this letter is to reiterate the Service's position on this issue, and to provide a preliminary reaction to the material presented by the applicant in their Environmental Evaluation Document (EED). The material presented in the EED is very helpful in evaluating the proposed project, and represents a standard of pre-development environmental reconnaissance seldom achieved in northern Alaska. We particularly commend ARCO for undertaking the regional habitat mapping and extensive biological survey work.

Despite the substantial accomplishment of the applicant in preparation of the EED, the Service has identified several major environmental issues that have not been satisfactorily explored. Taken together, the Service believes that these issues may warrant preparation of an EIS. Our primary goal is to ensure that these concerns are given careful attention, and that sufficient information is provided as the basis for an informed decision. The three most important issues are: cumulative and indirect effects, oil spill prevention and detection, and socioeconomic impacts to the village of Nuiqsut.

The EED provides some information on cumulative and indirect impacts but avoids the central question of how the Alpine development may influence the probability of further oil development in the region, and expansion of the community of Nuiqsut and its infrastructure. Presumably, the costs of constructing infrastructure (especially the Colville crossing) are a major barrier to developing small fields in the Colville delta or National Petroleum Reserve-Alaska (NPRA), and possibly areas between the Kuparuk field and the Colville River. With the Alpine project in place, it should be economically viable to develop small fields within a radius of Alpine that would not otherwise have been considered. Certainly, some of the renewed interest in leasing NPRA is predicated on the ability to tie into Colville delta infrastructure. It is particularly important to consider the extent to which the Alpine development would channel exploration and development support operations onto the Colville delta. In another example of the deficiency of the EED, provision of natural gas to the village of Nuiqsut is discussed in the section on mitigation (it is presented as mitigation for impacts to the village of Nuiqsut), but not in terms of impacts. No details are presented regarding the expected infrastructure, despite the fact that construction of a gas line is a reasonably foreseeable indirect effect (the North Slope Borough has stated its intention to construct such a line). Similarly, there is no discussion of the likelihood that an all-season road might be constructed, connecting Nuiqsut with the existing oil field network. The EED makes it clear that building such a road is not ARCO's preferred alternative, but a complete review should address the question of whether another entity might build a road as a separate, but indirectly related project. Rather than dismissing future effects on the basis of an arbitrary time-line, the environmental review should examine whether the existence of the Alpine facility would enhance the probability of other projects in the region. Part of that analysis should be the expected community development that might be undertaken in Nuiqsut.

Scant attention is given to oil spill prevention and detection. No consideration at all is given to the scenario of a spill that contaminated under-ice habitats supporting overwintering fish. The lower Colville River is the most important fish overwintering area on the Alaska North Slope. A major proportion of the Alaska Beaufort Sea population of several anadromous fish species (arctic cisco, least cisco, broad whitefish) overwinter at this location, making the lower Colville a unique and irreplaceable fish habitat resource. Given that the habitat is scarce, that alternative habitat is not available, and that winter conditions may pose natural stresses, we consider contamination of major fish overwintering areas to be the worst-case scenario. Therefore, we believe that extraordinary efforts should be undertaken to prevent spills and leaks at the point where the pipeline crosses the Colville River floodplain. The discussion of horizontal directional drilling (HDD) as the preferred crossing method is insufficient in detail. What are the proven technological methods to prevent thaw settlement in the zone of transition from permafrost to thawed soils in the Colville River floodplain? Presumably strategies include lowering the fluid temperature or insulating, or dissipating the heat from the pipeline. Under which circumstances have these techniques been used, and are the geotechnical considerations analogous to the Colville crossing? Are there pockets of permafrost under the river at the crossing location? How would a subterranean leak be detected, and what is the potential for oil to percolate upward through the sediments into the river channel? Some or all of these issues will undoubtedly be addressed in the pipeline right-of-way process conducted by the Joint Pipeline Office. It would be beneficial to all agencies to link the pipeline right-of-way process with the Corps permit review process, so that information developed through either of the processes is available to all.

There is no question that the construction of the Alpine project would have a major economic and social impact on the village of Nuiqsut. The Service has little, if any, oversight responsibility in this arena, other than the protection of fish and wildlife that are used for subsistence purposes. However, it is striking that ARCO is in the position of arguing that its preferred alternative will minimize adverse impacts to Nuiqsut more effectively than the alternatives presented by Nuiqsut and Arctic Slope Regional Corporation. It seems essential for the Corps to sort through these issues directly with the stake-holders, rather than relying on the interpretation of the applicant.

In addition to these major issues, there are a number of lesser deficiencies in the portions of the Alpine EED dealing with mitigation and biological resources. In general, there is a disconnect between the biological information and proposed facility siting. Although reference is made to siting decisions being made on the basis of minimizing habitat loss, that concept is not supported by the presentation. Unsupported assertions regarding avoidance of high value habitat appear on p. 2-20 in regard to pipeline routing, and p.2-22 in regard to road and pad design. Another example is found on p. 2-23 in regard to airstrip design. The proposed airstrip is situated on moist sedge-shrub meadow, a relatively uncommon (2.5% of delta) and high-value (high diversity of birds, mammals) habitat. Yet text on p. 2-23 indicates that the airstrip was sited by mapping wildlife habitat and use. This is either an incomplete or inaccurate statement. Based on the habitat value maps, it would appear very difficult to avoid relatively high value habitat, as it has been defined in this document. If that is the case, then compensatory mitigation would be appropriate.

Other issues of mitigation will require further discussion. The Service appreciates ARCO's offer to consider airstrip use restrictions, and to study the impact of aircraft noise on nesting waterfowl. More attention should be given to the proper timing of aircraft use restrictions. Bird use of Nanuk Lake may be related more to migrating and staging waterfowl, rather than nesting birds. Waterfowl staging almost certainly occurs later in the summer than the proposed 1 June-15 July period.

The EED appears to preclude gravel removal as an option for habitat rehabilitation, except in isolated cases. ARCO's own research does not support the contention (p. 2-28) that "revegetating gravel in place" is the most appropriate means of achieving rehabilitation. Gravel removal is a more promising technique for restoring reasonable growing conditions for most native plants. The EED commits to gravel removal only as a possibility if the gravel can be re-used. Gravel removal is appropriate in cases where restoration of hydrology or return to a wetland habitat is desirable.

Consideration should be given to "hot-spots" that are important to species (or life-history stages) that were not explicitly incorporated into the studies accomplished for the EED (e.g. Nanuk Lake and neighboring "Sakoonang Lake", the tapped lake to the east of Nanuk).

Regarding attraction of wildlife to facilities (p. 4-103, 4-160) the EED provides a good synopsis of the problem but is unconvincing in its assertion that predator/scavenger populations will not be affected by the Alpine development. What measures will be adopted that are different from those in existing oil fields, such that the problem will not recur in the Colville delta? Given the high nesting densities of water birds on the delta, this is an important management problem that cannot be waved away by wishful thinking.

In regard to water withdrawal (p. 4-52), is 3 million ft^3 the annual water needs for all in-field facilities? Is the recharge to that lake sufficient to compensate for such a withdrawal?

The designation of habitats as regionally common or uncommon seems arbitrary (Table 4.4.2-1, p. 4-55). The cutpoints and definitions should be explicit. This terminology is important to the Service, because our mitigation policy is based on habitat scarcity and value.

The above comments are not intended as an exhaustive critique of the EED. Our intention is to identify areas that we feel will need further effort in order to complete the environmental review associated with this permit process. The Service believes that the preparation of an EIS would be one effective way to address the issues identified. If an alternative process is chosen, it should be recognized that a substantial effort in fact-finding and analysis will still be required for a satisfactory treatment of these issues. If you have questions regarding these comments, please contact Philip Martin (456-0325).

Sincerely,

Larry Bright

Larry K. Bright
Acting Field Supervisor

cc: Mark Schindler, ARCO Alaska, Inc.
Deborah Williams, DOI, Anchorage
Jeanne Hanson, NMFS, Anchorage
Ted Rockwell, EPA, Anchorage
Keith Quintavell, NSB, Barrow
Carl Hemming, ADF&G, Fairbanks
Jerry Brossia, SPCO, Anchorage
Bill Thomas, ASRC
Nuiqsut Mayor's Office, Nuiqsut
Kuukpik Corporation, Nuiqsut

FROM: CENPA CO R N FAX NO.: 907 753 2788 01-30-97 11:33 P.01

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, ALASKA
P.O. BOX 898
ANCHORAGE, ALASKA 99506-0898

REPLY TO ATTENTION OF:

JANUARY 29 1997

Regulatory Branch
North Section
2-960874

OPTIONAL FORM 99 (7-90)

FAX TRANSMITTAL	# of pages ▶
To MARK Schindler	From Lloyd W. Fanter
Dept./Agency ARCO	Phone # 753-5554
Fax # 265-1515	Fax # 753-5567
NSN 7540-01-317-7368 5099-101	GENERAL SERVICES ADMINISTRATION

Mr. Mark J. Schindler
Director
Alpine Development Permits and Compliance
ARCO Alaska, Inc.
Post Office Box 100360
Anchorage, Alaska 99510-0360

Dear Mr. Schindler:

This is in reference to our January 21, 1997, telephone conversation and a follow-up to our December 19, 1996, meeting concerning your permit application (Department of Army permit application file number 2-960874, Colville River 18) for the proposed Alpine Development Project.

We have reviewed your application and the referenced Chapter 2 Description of the Applicant's Proposed Project of your "Alpine Development Project: Environmental Evaluation Document" (EED). We have determined that more information is essential before we can issue a 30-day public notice soliciting comments on the proposed work. Please provide the following information and include any modifications/additions listed below into your project plans:

a. FIGURES
(1) Provide typical cross-section views of:

(a) Roads including typical low water crossings, culverts, bridges, etc., and

(b) Colville River Crossing (expanded detail of pipeline crossing, Horizontal Directional Drilling [HDD], including number of pipelines, estimated quantities of dredged material removed, size of bore holes, type and quantities of fill material). Sheet 11, 12, and 13 provide a general HDD schematic for one pipeline and transitions alternative designs for the carrier pipeline, further detail is required for the three proposed pipelines. Additional figures on the structural aspects for oil spill control (e.g., valves, double wall piping, sensors, etc.) should also be included within description figures to assist in understanding the overall project.

(2) Sheet 15 of 16 shows typical pipeline construction with three pipelines while figure 2.2.1-1, page 2-9 of the EED provides a different vertical support member detail relative to the number of pipelines. Please clarify this discrepancy.

(3) Further details are needed regarding strengthened Vertical Support Members (VSM). Although sheet 15 of 16 provides a typical pipeline construction, no typical details are provided for strengthened VSMs. [note: VSM placement is not generally regulated by the Corps of Engineers. However, if strengthened VSM's require dredging or placement of fill material, they may require authorization. Additional information is requested to complete our jurisdictional determination]. Also note that VSMs and associated pipeline over navigable waters may be regulated by the U.S. Coast Guard under Section 9 of The Rivers and Harbors Act of 1899.

(4) Figure 2.0-2, et. al. should include Township, Range, and Section markings for location identification.

(5) page 2-10, para. 2.2.1.1, Ice Roads/Bridges. Provide typical cross sections of ice bridges on navigable waters, identify locations, indicate water depth and proposed ice depth, and bank elevations. Will culverts or other measures be included in the ice bridge design to maintain adequate flows? Will cut banks be required? If so, identify locations, quantities and provide cross-section of river, channel, and slough cut banks. Ice bridge information is required to complete our jurisdictional determination

b. CHAPTER 2, DESCRIPTION OF THE APPLICANT'S PROPOSED PROJECT

(1) EED, page 2-5, para. 2.1.1, Clarify: Work would be done almost exclusively in the winter." What construction activities e.g., in-water work, placement of fill material, grading of gravel fill, etc., would occur during non-winter periods?

(2) EED, page 2.5, para. 2.1.1 and page 2-10, para. 2.2.1.1, Ice roads and ice bridges would be constructed each winter season to support the year-round drilling operations." Request additional information concerning ice bridges (e.g., depth of ice, depth of water, is bottom-fast ice required at all locations, duration of ice bridge construction, duration of the complete ice bridges, are culverts or other free flowing water structures to be included in major channels with flow? Will the Phase III production/operations phase ice road construction, estimated to be built every three years, to be of the same design as to the Phase I ice bridge construction?

(3) EED, page 2-5, para. 2.1.2, Clarify: "All wells would be located on - and distributed as needed between - the two basic gravel pads." Are the wells to be located solely on the two gravel pads? Or, will wells also be located on the gravel road between the two gravel pads?

(4) EED, page 2-10, para. 2.2.1.1, Pipeline/VSM installation: "Cuttings from drilling operations will be handled in accordance with USACE guidelines." Please note: The Corps does not have guidelines concerning the discharge of drill cuttings for VSMs.

(5) EED, page 2-10, para. 2.2.1.1 Construction. Clarification on main channel ice bridge: "In the case of the main channel of the Colville River, non-bottomfast ice is built into a bridge structurally capable of withstanding the weight of mobile oil field drilling, support, and camp equipment." Will the "bridge" exist as an ice bridge? If so, will mid-level culverts be installed to maintain water quality (saline and freshwater concentrations)? Or is another structure material other than ice being considered?

(6) EED, page 2-14, para 2.2.3.1, Construction Season. "The HDD installation would be completed in the winter." Will the HDD construction and installation begin and end during a single winter construction season? It not, what construction activities would occur outside the typical winter construction season?

(7) EED, page 2-14, para. 2.2.3.2, Kachemach and Miluveach River and Stream Crossings. "If local conditions warrant, the VSM's would be strengthened to withstand the force of high flows." Please provide the details of a typical strengthened VSM structure. Include any additional dredging or discharge of fill material required for strengthened VSMs. Information is required to complete our jurisdictional determination.

(8) EED, page 2-17, para. 2.4, Material Sites. "An approved gravel source would be used. Potential gravel sources include ARCO's existing mine at KRU and ASRC's proposed gravel mine located east of Nuiqsut, just east of the Colville River main channel relatively near proposed pipeline crossing X14." Is Mine Site F confirmed as the approved gravel source? Will other KRU gravel sources be used? If so, will permit modifications be needed for mine site expansions? Secondly, the ASRC's previously approved mine site authorization has expired and their recent application for the site has been withdrawn. Nuiqsut Construction has applied for DA authorization for a mine site at the same location (4-960869, Colville River 17). This permit application is currently under review and evaluation.

(9) EED, page 2-17, para. 2.5.1, Phase I: Construction/Pre-Start-up Development Drilling. First sentence, "... 3 to 5 million gallons for the HDD crossing of the Colville River." Is the estimate of 3 to 5 million gallons of water required of the HDD crossing of the Colville River solely for ice road and pad construction, or does this include water requirements for slurry mixture during the drilling processes? Further description of the HDD process for crossing the Colville River is required including disposal amount and location of dredged material. Additional information is also requested for the evaluation phase of your permit application concerning construction activities and associated impacts e.g., noise, vibrations, etc., associated with HDD during winter operations.

c. ADDITIONAL QUESTIONS

(1) Based on ARCO's proposed road and pad design, are any portions of the road or pads designed to fail during high water events?

(2) Based on ARCO's proposed design, minimum road and pad height of gravel fill is approximately 5 feet in depth. What is the maximum height of fill depth? What is the expected average height of fill for the road, airstrip and pads?

(3) Based on information provided by ARCO during the Joint Pipeline Office's briefing on the HDD crossing of the Colville River, the HDD crossing transition zone and valve pad on the east side of the river is expected to be flooded during high water/flood events. Will any erosion control and protection measures be proposed and included in this application?

Upon receipt of the requested information, we will issue a 30-day public notice soliciting comments on your proposal. Your prompt response will expedite the processing of your application. As per our conversations, additional information will be requested during the evaluation phase of your permit application.

The Corps of Engineers is authorized to issue permits at the District level in those cases in which all substantive objections have been resolved to the satisfaction of the District Engineer provided other portions of our evaluation are favorable. Periodically, letters from reviewing agencies or interested parties may be forwarded to you for your information or appropriate action. Since unresolved objections to your proposed work could result in delay or denial of the requested permit, it is suggested that you respond as soon as possible to avoid processing delay.

Also, a DA permit can be issued for your work only after you have obtained a Certificate of Reasonable Assurance, or waiver of certification, as required by Section 401(a)(1) of the Clean Water Act. This certification or waiver thereof is issued by the Alaska Department of Environmental Conservation (ADEC). For your convenience, we will forward a copy of your application to ADEC which they will accept as an application for a Certificate of Reasonable Assurance. There should be no delay in processing your application as the review processes of ADEC and the Corps of Engineers run concurrently. If you have any questions about ADEC's certification process, please contact them at 410 Willoughby Avenue, Suite 105, Juneau, Alaska 99801-1795; telephone (907) 465-5350.

For your information, a processing fee is required should a DA permit be issued. Since the planned or ultimate purpose of your proposed project is commercial in nature, the fee will be $100. You will be notified as to the time for submittal of the fee.

UNITED STATES DEPARTMENT OF COMMER
National Oceanic and Atmospheric Administratior
National Marine Fisheries Service
222 W. 7th Avenue, #43
Anchorage, Alaska 99513-7577

February 24, 1997

RECEIVED
MAR 10 1997
REGULATORY FUNCTIONS BRANCH
ALASKA DISTRICT, CORPS OF ENGINEERS

Colonel Peter A. Topp
District Engineer
U.S. Army Corps of Engineers
Alaska District
P.O. Box 898
Anchorage, Alaska 99506-0898

Re: ARCO Alpine Development Project: Environmental Evaluation Document and Colville Delta Fish Habitat Study

Attn: Lloyd H. Fanter

Dear Colonel Topp:

The National Marine Fisheries Service (NMFS), Protected Resources
the purpose of the documents is to assist the Corps of Engineers' (Corps) permit review and environmental compliance process, for proposed oil and gas production facility and associated pipeline (Alpine Development Project), located in the Colville River Delta, on Alaska's North Slope. It is our understanding that the goal of ARCO Alaska Incorporated (ARCO) is to have the Corps adopt, or adopt with modifications, ARCO's Environmental Evaluation Document (EED), as the NEPA (National Environmental Policy Act) document for the Alpine Development Project.

The proposed project site is located in the Colville River Delta approximately 34 miles west of the Kuparuk River Unit Central Processing Facility (CPF-2). It is bounded by the Nechelik Channel of the Colville River to the west, and the Sakoonag Channel of the Colville River to the east. The Village of Nuiqsut lies approximately eight miles south of the Alpine Development Project. The Colville River Delta front is located approximately eight miles north of the proposed project.

As proposed by ARCO, the development would roughly have an 80-acre footprint, with two facility pads connected by a three mile long gravel road. The eastern pad (Alpine Pad 1) would include a processing facility/camp drilling site, and the western pad (Alpine Pad 2) a satellite drilling site. A 5,420' airstrip would be built as a wide spot in the road adjacent to the gravel road nearest Alpine Pad 1. A total of approximately 100 to 150 wells would be drilled at the Alpine Development. A sales oil pipeline and utility pipeline would extend from the Alpine Development some 34.2 miles to CPF-2, via an above ground pipeline placed on vertical support members. The Alpine Development project is expected to have a peak production of 50,000 to 80,000 barrels of oil per day.

To bring the proposed project into production, ARCO has investigated several different project designs. While the amount of gravel needed for construction varies, as well as the various facilities and structures, the designs all involve the construction of similar features, including but not limited to: a material source, well pads, central processing units, flare pads, an airstrip and apron, in-field road systems, pipelines with river crossings, freshwater sources, and valve pads. In addition, some of the alternatives involve inter-field connecting roads, that would necessitate the use of ice bridges, ferries, or permanent bridges.

In general, we found the EED and the supporting reference documents to be beneficial in identifying the fisheries data available in the proposed development area. Together, these documents identify the requirements needed to protect fish and habitat in the Arctic: 1) maintain adequate wintering areas, 2) maintain suitable feeding and spawning areas, and 3) maintain access to seasonally used habitats. However, the NMFS believes that the proposed project will create changes to the aquatic ecosystem that the EED does not adequately address.

The document does not sufficiently address the indirect and cumulative impacts associated with building a new infrastructure. While there have been some minor perturbations to the system, this area has been left virtually untouched until now. The incremental environmental changes caused by the proliferation of new development projects are of concern to the NMFS. The proposed project will forever change the landscape, and while ARCO will endeavor to minimize those changes, there will be no mitigation that will be able to replace the functions and the values of this area as it now exists. Also, should a commercial operation be realized the subsequent development to bring the field into full production could be substantial. For example, the infrastructure for the Alpine Development Project is already being viewed as the "gateway" for development in the National Petroleum Reserve.

In addition, some of the other concerns not addressed by the EED include the following:

1. The issue of gravel source has not yet been resolved. Impacts associated with each of the alternatives presented should be fully discussed, including any significance to fisheries habitat and any proposed mitigation.

2. Will there be a monitoring program in place to regularly track the quantity of water removal and water quality in lakes? In some years, removal of water in winter could lead to adverse water quality (e.g., low oxygen). Thus, identification of rechargeable sources appears to be very important. Also, it would be helpful to have a figure like 4.4.1-10, in the EED, showing all lakes that may be affected by the proposed project including those in the proposed transportation corridors.

3. River crossings are technically challenging and could affect fish habitat and migration. In a worst case scenario, a rupture of the proposed pipeline underneath the Colville River could greatly impact fisheries habitat from the pipeline crossing downstream to the Beaufort Sea. What would the impacts be, including those associated with clean up, and how long would they last?

4. Disposal of drilling muds along sand banks of the Colville River from construction of the pipeline will likely enter the river during high flows. Whether or not this increased turbidity poses a problem to fish migration or causes siltation needs to be addressed.

5. Contaminant releases are also of a concern to fisheries. Fish, water, and sediment samples need to be collected now to obtain background levels of heavy metals and hydrocarbons. This baseline information is necessary for comparison after the project is operational.

We recognize that our review and comments on the EED and associated documents does not constitute the full public interest review required of the Corps of Engineers. Thus, while the NMFS acknowledges ARCO's efforts in compiling the EED, the NMFS believes that the EED does not sufficiently address the complex issues surrounding development on this scale. The NMFS believes that additional opportunities for public input and review beyond the normal review process associated with an individual permit process are needed to satisfy the requirements of NEPA.

Thank you for the opportunity to comment. Should you have any questions regarding these comments, please contact Ms. Jeanne L. Hanson at (907) 271-5006.

Sincerely,

Ronald J. Morris
Western Alaska Office Supervisor
Protected Resources

NMFS Contact Person: Jeanne L. Hanson

cc: EPA - Anchorage
ADEC, ADF&G, USFWS - Fairbanks
Applicant

STATE OF ALASKA

TONY KNOWLES, GOVERNOR

DEPARTMENT OF FISH AND GAME

HABITAT & RESTORATION DIVISION

1300 COLLEGE ROAD
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RECEIVED

MAR 1 8 1996

ALASKA LAND

March 13, 1996

Mr. Mark J. Schindler, Director
Colville Permits and Compliance
ARCO Alaska, Inc.
P.O. Box 100360
Anchorage, AK 99510-1215

Dear Mr. Schindler:

RE: Oil and Gas, Colville River Delta

On March 7, 1996, I met with you and Mr. Murphy (Alaska Biological Research) to discuss proposed oil and gas activities in the Colville River delta. You provided us with several maps showing alternative routes, location of facilities (drill pads, road, airstrip), and habitat types. Executive summaries with maps of the key environmental and technical findings, the draft 1996 wildlife studies plan, and a preliminary report on wildlife studies (1995) were given to the department for review.

During our March 7 meeting we discussed several aspects of the proposed development of oil and gas in the Colville River delta. A summary follows:

(1) Several alternatives are being considered to move modules into the delta. One alternative involves dredging in the lower river to move barges up the channel to the project area. This alternative would then include a gravel road from the barge landing site to the drill pads. A second alternative is to move modules across the Colville River main channel. Depending on loads this might require grounding of the ice. Module movement may occur in multiple years depending on development. If the ice must be completely grounded to move the modules, methods to pass water will be needed and water quality and quantity monitoring should be part of the plan.

(2) Results of geotechnical work (soil boring) in the main channel of the Colville River at two potential crossing sites is being done. General alignment of the pipeline from the development to the Kuparuk River Unit is determined by the Colville River crossing.

(3) At least four alternative designs are being considered for crossing the Colville River. These include elevated (vertical support members), a cabled suspension bridge, trenched buried pipeline, and directional drilled buried pipeline. We believe the cabled suspension bridge because of the high potential for bird strikes is not viable. A buried mode using directional drilling and the elevated mode on vertical support members can be permitted by the department. Open trenching of the Colville River would present water quality issues for the construction period. The corrosive effects of saline intrusions on a buried pipe should be thoroughly investigated.

(4) The focus of wildlife studies has been on tundra swans, black brant, yellow billed loons, and spectacled eiders. Fox den surveys have been done to establish a data base for post-construction monitoring to assess changes due to development. Shorebird work planned by the USFWS was not done due to budget cuts. Observations on grizzly bear and caribou use have been made. Fisheries work and habitat typing are ongoing.

(5) If direction drilling is used for the Colville River crossing, disposal of cuttings from the operation needs to be addressed. We requested that ARCO Alaska Inc. (AAI) provide a list of additives (e.g., bentonite) and concentrations in order to make a determination on whether on-ice disposal is a viable and permittable option.

(6) Alternatives for crossing Kachemach and Miluveach Rivers include aboveground and buried pipeline (conventional trenching for belowground). We again recommended that an elevated mode be used and that the pipeline height remain level across the floodplain and riparian zone thus increasing pipe to ground clearance to more than 5 feet to facilitate caribou movements. This design approach was used at the Kalubik Creek crossing in the Kuparuk-River Unit. We strongly suggested that burial using conventional trenching not be used due to potential problems associated with instream work, stream rehabilitation, and post-construction monitoring and maintenance.

(7) We suggested that a mitigation package be developed as part of project permit application package. For example, if fox denning studies are done for post-construction then the commitment to conduct such should be made up front in the permit package. Further input from our department regarding mitigation and studies will be provided in future correspondence.

Our March 7 meeting was productive and I thank you for taking the time to meet with me. We encourage you to start the interagency-public review process as soon as possible so that all parties can actively interface with AAI on the environmental, engineering, construction, and human use aspects of the project.

Sincerely,

Alvin G. Ott, Regional Supervisor
Habitat and Restoration Division
Department of Fish and Game

cc: Mayor Gordon Brown/Leonard Lampe, Village of Nuiqsut, Nuiqsut
Joe Nukapigak/Laston Chinn, Kuukpik Corp., Nuiqsut
Warren Matumeak/Keith Quintavell, NSB, Barrow
Bill Thomas, ASRC, Barrow
Jim Haynes/Steve Schmitz, ADNR, Anchorage
Terry Haynes, ADF&G, Fairbanks
Molly Birnbaum, DGC/SPCO, Anchorage
Nancy Welch, ADNR, Fairbanks
Ted Rockwell, EPA, Anchorage
Jeanne Hanson, NMFS, Anchorage
Patrick Sousa, USFWS, Fairbanks
Mark Helmericks, Colville Environ Svcs, Anchorage
Steve Murphy/Brian Lawhead, ABR, Fairbanks
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Carl Hemming/Dick Shideler, ADF&G, Fairbanks
Dan Reed, ADF&G, Fairbanks
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AGO/ago

ALASKA

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DEPARTMENT OF FISH AND GAME

HABITAT & RESTORATION DIVISION

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March 25, 1997

Mr. Mark J. Schindler, Director
Colville Permits and Compliance
ARCO Alaska Inc.
PO Box 100360
Anchorage, AK 99510-1215

RECEIVED
APR 3 1997
ALASKA LAND

Dear Mr. Schindler:

RE: Fish Habitat Permits for the Alpine Development Project

The Alaska Department of Fish and Game (ADF&G) has reviewed your March 25, 1997 letter requesting AS 16.05.870(b) permit authorization for the Alpine project and we have reviewed the Environmental Evaluation Document (EED) and other project information provided by ARCO Alaska Inc. (AAI). The purpose of this letter is to address permit needs for early construction activities and provide AAI with a list of all fish habitat permits needed for the proposed project and describe the information needed to obtain the permits. In general, information currently available provides an overview of the project but lacks the detail necessary to issue all of the required fish habitat permits. The letter is organized according to similar types of activities requiring fish habitat permits and includes early authorization issues under the specific activity type.

The proposed pipeline alignment east of the Colville River delta will require fish passage permits under AS 16.05.840. Project activities include seasonal ice road construction and use, placement of vertical support members and elevated pipelines, and possible summer access by low ground pressure vehicles. The EED indicates that the pipeline corridor will cross Kalubik Creek, West Fork Kalubik Creek, East Branch Miluveach River, Miluveach River, and Kachemach River. Although not currently listed in the Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes, we anticipate that future field work will document the presence of anadromous fish in these waters. We plan to issue permits for these crossings for the life of the project covering all project-related activities, including construction, operations, and maintenance. Five separate permits will be issued. Adequate information is available to process the fish habitat permits for Kalubik Creek, West Fork Kalubik Creek, East Branch Miluveach, Miluveach River, and Kachemach River.

A fish habitat permit under AS 16.05.870 will be required for the ice road crossing (construction, maintenance, and use) and the Horizontal Directional Drilled (HDD) pipeline crossing of the main channel Colville River. It is our understanding after review of the February 27, 1997, letter to the U.S. Army Corps of Engineers (ACOE) that the ice bridge crossing of the Colville River will not be grounded. A detailed description of the ice bridge for construction and operations and the HDD crossing are needed for the processing of the fish habitat permit. AAI should submit plans to the department clearly stating ice thickness required at the Colville crossing for early construction, construction, and operational activities.

A fish habitat permit under AS 16.05.870 will be required for the movement of the drill rig which we understand will be from Oliktok Point to the Alpine oilfield. A map of the grounding or thickening will be required and where these additional measures will be necessary to safely move the drill rig. We [redacted] minimized.

The Alpine project pads, gravel road, and airstrip facilities intersect fish bearing waterbodies. To process fish habitat permits, specific information is needed on the drainage structures in the road system. Required information includes the location, alignment, size, corrugations, slope, burial depth, and armor protection for each culvert or culvert battery. Discharge estimates and predicted water velocities for each culvert installation are needed. Detailed cross sectional drawings depicting all drainage structures and information for operations and maintenance (e.g., keeping culverts free of snow, snow removal prior to breakup, etc.) are needed. It is our understanding that reports are available describing hydrology in the project area. This information would aid in our evaluation of fish passage and cross drainage. Because all waters in the Colville River delta are designated as being important to the spawning, rearing or migration of anadromous fishes, each culvert or culvert battery will require a fish habitat permit.

All water site lakes in the Colville River Delta that will be used for ice roads and other project needs will require fish habitat permits under AS 16.05.870. We previously provided AAI with the information needed to process permits for water use in the Alpine Project area (Letter Ott to Schindler, December 12, 1996). For non-fish bearing lakes a letter should be submitted showing the lake location and field sampling data indicating that fish are not present. For pre-development drilling water we suggest use of lake L 9313 as a source. Because the lake is a perched, infrequently flooded habitat type with a fish population we suggest recharge of the lake from the Sakoonang channel during the spring high water period and use of a intake structure that prevents entrainment of juvenile fish. Water use from the Sakoonang and Nechelik channels will be authorized only during the ice free season (June 1 to Sept 15) with proper mitigation to prevent entrainment of fish. It should be noted that the Sakoonang channel is heavily used by juvenile coregonid fish during the ice free season and deeper areas in the channel provide wintering habitat. Complete design specifications (pumping rates, volume of water, location, screening, etc.) and construction procedures (streambank and streambed modifications) are required to obtain a fish habitat permit.

It is our understanding the gravel for the project (road construction, drill pads, airstrip) will come from the Arctic Slope Regional Corporation (ASRC) material site located on the east side of Colville River (Colville River 17). It also is our understanding that natural gas will be made available to Nuiqsut. We are assuming that all permits associated with gravel mining, gravel transport, and gas pipeline construction, operations, and maintenance from Alpine to Nuiqsut will be handled by ASRC, the North Slope Borough, and Nuiqsut. Please confirm for the department your involvement from a permit standpoint with gravel mining and the gas pipeline.

Some of the fish habitat permits for the Alpine project require additional detailed information. Our intent, as discussed with you, is to issue each permit for the life of the project. We therefore will include stipulations relating to abandonment and rehabilitation (e.g., culverts will be removed and stream channels rehabilitated). Changes in the future will occur and we propose to handled these by permit amendment or the issuance of new permits. We look forward to working with you and suggest that we get together soon and begin to address the two major areas, water use sites, and cross drainage design. If there are any questions please contact either me or Mr. Hemming at 459-7289.

Sincerely,

Alvin G. Ott, Regional Supervisor
Habitat and Restoration Division
Alaska Department of Fish and Game

Enclosure: Letter Dated December 12, 1997

cc: w/enclosure
Mayor Gordon Brown/Leonard Lampe, Village of Nuiqsut, Nuiqsut
Joe Nukapigak/Laston Chinn, Kuukpik Corp., Nuiqsut
Jon Dunham, NSB, Barrow
Bill Thomas, ASRC, Barrow
Mark Helmericks, Colville Environ Svcs, Anchorage
Steve Murphy/Brian Lawhead, ABR, Fairbanks
Larry Moulton, Seattle
Dan Reed, ADF&G, Fairbanks
Terry Haynes, ADF&G, Fairbanks
Brad Fristoe, ADEC, Fairbanks
Molly Birnbaum, DGC/SPCO, Anchorage
Nancy Welch, ADNR, Fairbanks
Jim Haynes, ADNR, Anchorage
Ted Rockwell, EPA, Anchorage
Jeanne Hanson, NMFS, Anchorage
Phillip Martin, USFWS, Fairbanks
Patrick Sousa, USFWS, Fairbanks
Carl Hemming/Dick Shideler, ADF&G, Fairbanks
Lloyd Fanter, ACOE, Anchorage
Fred Andersen, ADF&G, Fairbanks

AGO/ago

NORTH SLOPE BOROUGH
PLANNING DEPARTMENT
P.O. Box 69
Barrow, Alaska 99723
Phone: 907-852-2611
907-852-0320
Fax: 907-852-0322

RECEIVED
APR 04 1997
ALASKA LAND

March 28, 1997

Frank Brown, Vice President
ARCO Alaska. Inc.
P.O. Box 100360
Anchorage, AK 99510-0360

RE: Alpine Development Project

Dear Mr. Brown:

As I would for any good neighbor, I want to be open with you about concerns expressed to me concerning ARCO's work on the North Slope. As you are no doubt aware, some controversy still remains regarding the specific details of ARCO's proposed Alpine Development Project. I want you to know that the North Slope Borough supports environmentally sound onshore oil and gas development, and looks forward to the safe development of Alpine in the very near future. We join the residents of Nuiqsut, however, in their disappointment at the seeming inability of all parties to finally resolve some remaining issues which must be satisfactorily addressed before the project can move forward.

A December 7, 1996 Barrow meeting between ARCO and officials of the North Slope Borough, the City of Nuiqsut, Arctic Slope Regional Corporation, Kuukpik Village Corporation, the tribal government for Nuiqsut and the Army Corps of Engineers was held specifically to identify and discuss unresolved issues concerning the Alpine Project. These issues were defined jointly by Nuiqsut and Borough representatives at the meeting, and presented to ARCO representatives in the form of a single page attached to this letter. I can confidently say that we all left this meeting with the expectation that these issues would be fully addressed by ARCO.

In the interests of putting at least some of these questions to rest in a way which might build much needed trust between all interested parties, I offer the suggestion that appropriate technical reviews by a disinterested third party, like the North Slope Borough Science Advisory Committee (SAC), be conducted.. The benefit of such a review by an organization like the SAC is that the people of Nuiqsut are familiar with the structure and operation of the SAC based on its work on bowhead whale issues, and should have the confidence in conclusions reached by such a panel. I believe the issues of minimum necessary pipeline height and extent of any regional air pollution caused by industrial oil field operations lend themselves to a focused review by such a panel. If we can all agree on specific questions to pose to this third party reviewer, we should be able to live with and implement any recommendations proposed.

I bring these issues to your attention because it is important that you understand that they must be resolved not only for the direct benefit of the residents of Nuiqsut, but also because my staff must make a recommendation to the Planning Commission on ARCO's application to rezone the Alpine area from Conservation to Resource Development.

I look forward to your response on this matter and if you have any questions regarding these issues, please call either Karen Burnell, Planning Director at (907) 852-0320 or Jon Dunham, Permitting & Zoning Manager at (907) 852-0440.

Sincerely,

Benjamin P. Nageak
Mayor
North Slope Borough

cc: Mark Schindler, ARCO
Jacob Adams, ASRC
Bill Thomas, ASRC
George Sielak, Mayor, City of Nuiqsut
Joe Nukapigak, President, Kuukpik Corporation
Thomas Napageak, Tribal Council of Nuiqsut
Marie Adams-Carroll, Chief Administrative Officer
Leonard Lampe, NSB Village Coordinator, Nuiqsut
Charles D.N. Brower, Wildlife Management Director
Taqulik Opie, Deputy Wildlife Management Director
Dr. Tom Albert, Senior Scientist, Wildlife Management
Tom Lohman, Environmental Resource Specialist, Wildlife Management
Lloyd Fanter, USA/COE
Molly Birnbaum, Office of the Governor/ DGC
Karen Burnell, Planning Director
Earl Finkler, Deputy Planning Director
Jon Dunham, Permitting & Zoning Manager, Planning

1) **Oil Spill** - Please describe how ARCO will handle a civil/oil spill emergency at Alpine with respect to notification, response and potential evacuation of the Nuiqsut population as well as ARCO employees?

2) **Pipeline Height** - There is widespread concern that the proposed 5 foot height of the pipeline is not enough to allow adequate caribou crossing. Information in the EAD does not satisfy our concerns. We ask ARCO to provide a brief written report (including detailed referencing) that provides convincing evidence that the five foot height is adequate. If ARCO cannot elevate or bury the pipeline, how about extra caribou crossings, locations should be identified by the village residents.

3) **Pipeline Route** - There is concern over the proposed pipeline route. We need to be assured that the route chosen is the most environmentally sound and has adequately taken into account the input of the community. We have heard concerns of the local residents regarding the exposure of the proposed route to seasonal flooding and its potential greater impact on caribou migration patterns than alternate routes.

4) **Colville River Crossing** - There is a concern about the method of how the river crossing plans are proposed. We need a written explanation on insulation of the pipe, distances where the pipe goes under and comes back up, and the natural erosion by ice jams that could possibly expose or have some impact on the line.

5) **Air pollution** - There is a significant concern regarding air pollution impacts to the health of Nuiqsut people. There is an increasing incidence of respiratory problems in Nuiqsut residents and the "dark or yellow cloud" often seen over Prudhoe is now sometimes seen extending to Nuiqsut. In view of this, we are very worried that the added air pollution from the Alpine development (processing plant, various emissions, etc, will cause even more problems). Therefore we ask for a more thorough evaluation of estimated air pollution impacts and want an air quality monitoring device placed in the village. We suggest an air quality monitor be placed within the city limits of Nuiqsut to gather pre-Alpine development air quality data. If there is no air pollution threat from the project, that air monitoring device will provide a documented proof each year.

ARCO Alaska, Inc.
Post Office Box 100360
Anchorage Alaska 99510-0360
Telephone 907 265 6513

Frank M. Brown
Senior Vice President

April 25, 1997

Mayor Benjamin P. Nageak
North Slope Borough
P.O. Box 69
Barrow Alaska 99723

Re: Alpine Development Project
Your Letter Dated March 28, 1997

Dear Mayor Nageak:

Thank you for your recent communication. We appreciate your support for environmentally sound and safe onshore oil and gas development and your enthusiasm for near term development of the Alpine reservoir. ARCO is striving to commence construction of the Alpine project this coming winter. Commencement would create many benefits for all involved in the development. We strongly agree that a level of trust between all interested parties will be a prerequisite to obtaining timely approvals from the people of the North Slope. To that end I would like to suggest a way forward.

First, prior to triggering the official North Slope Borough (NSB) rezoning process we would like to bring the Alpine Development Science Fair to Barrow. After conducting numerous planning meetings in Nuiqsut, we have been trying to improve our communications with the Nuiqsut residents. As you can see in the video production sent to you earlier, the Fair's atmosphere seemed to facilitate cross-cultural communication and clarify some of the more technical issues involved with this project. If you agree that the Fair would be beneficial, we would propose trying to hold the Fair by mid May and would appreciate your thoughts about the setting for holding the Fair in Barrow.

In regard to the five issues jointly defined at the December 7, 1996 Barrow meeting, I assure you that ARCO has been diligently working these issues. I too have personally witnessed Nuiqsut's frustration with the timing and pace of resolution of these issues as well as other more complicated land and financial issues. Final resolution of the five issues you have noted, and those of State and Federal agencies, will require the patience and participation of all parties in the regulatory approval process. This process feeds upon information generated by our engineering efforts which are now moving into a detailed phase. As this detailed engineering phase gains momentum and as the regulatory process proceeds, we feel all issues will be discussed publicly and ultimately resolved.

With respect to your suggestion that the NSB Science Advisory Committee become engaged in separate technical reviews, we continue to encourage NSB involvement in the existing public review processes associated with the state and federal permitting regimes. Four of the five issues (excluding air) already have third party reviews ongoing through the State/Federal Joint Pipeline Office (JPO) Pipeline Right-Of-Way public process. Information generated by the JPO process and other state and federal permitting agency reviews of ARCO's permit applications will be available to the NSB for its consideration of rezoning approval.

Regarding the two issues that you have suggested deserve focused review, the pipeline height issue was the subject of recent (1994) peer review in which the NSB was a key player and approver of the final report. We are not aware of any new information that would render this report obsolete. Your letter describes the air pollution issue as primarily being a regional pre-Alpine issue. Several months ago ARCO and other North Slope operators made initial attempts to kick-start a forum in this regard. We remain committed to moving forward on this regional issue.

We recognize, however, that Nuiqsut is concerned about potential incremental impact from Alpine. Our pre-application work indicates that Nuiqsut will avoid or incur very minimal air quality impact from Alpine due to prevailing wind conditions, use of emissions reducing equipment and comparatively small Alpine emission profiles. In the interest of moving ahead on the Alpine air issue, we suggest a two-pronged approach. First, we invite the NSB to attend all meetings ARCO will have with the Alaska Department of Environmental Conservation (ADEC) to obtain air quality permits. We took the liberty to invite the NSB to an ARCO/ADEC meeting that occurred April 22, 1997. We appreciate the NSB's participation in this technical meeting. Future attendance and participation by the NSB should allow the NSB to better address the Alpine air quality issue. Second, we will support your suggestion that an air quality monitoring device be placed in Nuiqsut. Subject to mutual agreement, we will fund this device for a period of time, but we would recommend that a Native owned entity manage the placement, operation and maintenance to achieve the trust factor. Quite possibly, local resident(s) could be trained to operate the device.

Please be assured that we do not expect Nuiqsut or the NSB to grant their trust without assurance that monitoring of Alpine impact will occur and corrective action will be taken after construction is complete. ARCO has already offered a comprehensive Alpine mitigation package which includes monitoring proposals such as 3 years of waterfowl monitoring and creation/funding of a subsistence oversight panel. These up front commitments will be joined with other monitoring systems we expect to be mandated in the suite of state, federal and local permits.

Mark Schindler, Director, Alpine Permits and Compliance is preparing a more detailed response to the five issues contained in your March 28, 1997 letter. I look forward to discussing these issues in person. Thank you again for the friendly exchange of concerns.

Sincerely,

Frank M Brown

Frank M. Brown
Senior Vice President
Kuparuk/Cook Inlet

cc: Jacob Adams, ASRC
Bill Thomas, ASRC
George Sielak, Mayor, City of Nuiqsut
Joe Nukapigak, President, Kuukpik Corporation
Thomas Napageak, Tribal Council of Nuiqsut
Marie Adams-Carroll, Chief Administrative Officer
Leonard Lampe, NSB Village Coordinator, Nuiqsut
Charles D.N. Brower, Wildlife Management Director
Taqulik Opie, Deputy Wildlife Management Director
Tom Lohman, Environmental Resource Specialist, Wildlife Management
Lloyd Fanter, USA/COE
Molly Birnbaum, Office of the Governor/DGC
Karen Burnell, Planning Director
Earl Finkler, Deputy Planning Director
Jon Dunham, Permitting & Zoning Manager, Planning

Appendix L

APPENDIX L

ARCO RESPONSE TO ISSUES FOLLOWING THE APRIL 7 TO JUNE 6, 1997 PUBLIC NOTICE

Table L-1. Issues from Agency and Public Comment Following the Public Notice.

Issue No.	Agency	Topic	EED Section
1	USFWS	Gravel fill impacts	Table 2.1.2-1
2	USFWS	Rehabilitation of all habitats affected by project	Section 2.10.2
3	USFWS	Spill detection and response	Section 2.7, Table 2.9.0-1
4	USFWS	Airstrip impacts on wildlife and vegetation	Section 4.4.2.2
5	USFWS	Rehabilitation techniques concerning gravel removal	Section 4.4.2.2
6	USFWS	Solid waste disposal	Sections 4.4.2.2 and 4.4.2.3
7	USFWS	Cumulative impacts	Section 4.7
8	USFWS	Additional oil and gas development	Section 4.7
9	USFWS	Cross-drainage structures	Attachment 1
10	USFWS	Pipeline design	Sections 2.1.3, 2.2
11	USFWS	Waterfowl monitoring	Section 2.10.3
12	USFWS	Aircraft restrictions	Table 2.9.0-1
13	USFWS	Construction activities to avoid spectacled eider nesting	Section 4.4.2.3
14	USFWS	Oil spill impacts to fish and wildlife	Sections 4.6.3.4 and 4.6.3.5
15	USFWS	Water impoundment affects to fish and wildlife	Sections 4.2.1.2 and 4.4.2.2
16	USFWS	Waterbird habitat impacts	Section 4.4.2.2
17	USFWS	Long-term ecosystem health and productivity	Section 2.10.2
18	NMFS	Collect data on sediment, fish, water	See response
19	NMFS	Oil spill prevention and response	Section 2.7, Table 2.9.0-1
20	NMFS	Special Area Management Plan and EIS	See response
21	USEPA	Cumulative Impacts	Section 4.7
22	USEPA	Oil and pollutants discharged into Colville ecosystem	Sections 2.7, 4.6.3.4, and 4.6.3.5
23	ADF&G	Culvert installation	See response
24	ADF&G	Pipe size and water movement	See response
25	ADF&G	Cross drainage structures in swale area	See response
26	ADF&G	Cross drainage	See response
27	ADEC, Air and Water Quality	Flood waters, floating ice and gravel fill	Appendix M
28	ADEC, Air and Water Quality	Flooding affects on gravel structure	Section 4.2.2
29	ADEC, Air and Water Quality	Map flood events	Appendix M
30	ADEC, Air and Water Quality	Drainage plan	Attachment 1
31	ADEC, Air and Water Quality	Sedimentation from water velocities	Section 4.3.1.2
32	Alaska Division of Governmental Coordination	Ice and gravel road, seasonal access	Sections 2.3 and 3.2.3
33	Alaska Division of Governmental Coordination	HDD method for crossing Colville River	Section 2.2.3.1
34	Alaska Division of Governmental Coordination	Fish use and critical areas in delta	Table 4.4.1-1, Figure 4.4.1-10
35	Alaska Division of Governmental Coordination	Subsistence fishery use impacts	Section 4.5.4.2
36	Alaska Division of Governmental Coordination	Drilling wastes from horizontal drilling	Table 2.9.0-1
37	Alaska Division of Governmental Coordination	Flying water to site during summer construction	Sections 2.5, 3.2.5, and 3.2.6
38	Alaska Division of Governmental Coordination	Pipeline size	Section 2.1.3
39	Alaska Division of Governmental Coordination	Leak detection	Section 2.7.2
40	Alaska Division of Governmental Coordination	State standards for water quality	Section 4.3.1.1
41	Alaska Division of Governmental Coordination	Groundwater	Section 4.3.1.1
42	Trustees for Alaska	Preparation of EIS	See response

Table L-1. Issues from Agency and Public Comment Following the Public Notice.

Issue No.	Agency	Topic	EED Section
43	Trustees for Alaska	Preparation of EIS	See response
44	Trustees for Alaska	Wetland mitigation	Sections 2.10.2 and 4.4.2.3
45	Trustees for Alaska	Saltmarshes susceptible to oil spill	Sections 4.6.3.4 and 4.6.3.5
46	Trustees for Alaska	Wetland habitat degradation	Section 4.4.2.2
47	Trustees for Alaska	Oil spill risk with buried pipeline	Section 2.7
48	Trustees for Alaska	Drilling under delta	Section 2.2.3
49	Trustees for Alaska	Water quality impacts	Section 4.3.1.2
50	Trustees for Alaska	Surface flow alteration and hydrology	Section 4.2.2
51	Trustees for Alaska	Flooding and hydrology impacts	Section 4.2.2
52	Trustees for Alaska	Permafrost and soliflution impacts	Section 4.2.2
53	Trustees for Alaska	Pipeline corrosion and leaks	Section 2.2.2
54	Trustees for Alaska	Leak prevention in diesel line	Section 2.7
55	Trustees for Alaska	Storage tank spill response	Section 2.7
56	Trustees for Alaska	Groundbird surveys	Section 4.4.2.1
57	Trustees for Alaska	Diversity of waterfowl, shorebirds, and passerines	Section 4.4.2.1, Appendix I
58	Trustees for Alaska	Airstrip impacts to wildlife	Section 4.4.2.2
59	Trustees for Alaska	Water requirements for project	Section 2.5
60	Trustees for Alaska	Subsistence effects	Section 4.5.4.2
61	Trustees for Alaska	Project is "gateway" to NPR-A	Section 4.7
62	Trustees for Alaska	Indirect impact of natural gas pipeline	Section 4.7
63	Trustees for Alaska	Indirect impact of future plans for road from Kuparuk to Alpine or Nuiqsut	Section 4.7
64	Trustees for Alaska	Cumulative effects to caribou and from other potential developments	Section 4.7
65	Trustees for Alaska	Protection of spectacled eider	Section 4.4.3.2
66	North Slope Borough	Colville River designation	See response
67	North Slope Borough	Public hearings for rezone	See response
68	North Slope Borough	Oil spill response planning	Section 2.7
69	North Slope Borough	Pipeline height during snow conditions	Section 2.2.1
70	North Slope Borough	Colville River hydrology	Section 4.2.1.1
71	USEPA	Cumulative effects	Section 4.7
72	USEPA	Nuiqsut subsistence	Section 4.5.4
73	USEPA	Colville River delta of high value habitat	Section 4.4.2.2
74	USEPA	Oil spill contingency plan	Section 2.7
75	USEPA	Project requires an EIS	See response
76	Pamela Miller	Wetland habitat impacts	Section 4.4.2.2
77	Pamela Miller	Noise impacts to birds from aircraft	Section 4.4.2.2
78	Pamela Miller	Oil spill potential	Section 4.6
79	Pamela Miller	Nuiqsut subsistence	Section 4.5.4
80	Pamela Miller	Cumulative impacts and future NPR-A effects	Section 4.7
81	Pamela Miller	Preparation of EIS	See response

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, ALASKA
P.O. BOX 898
ANCHORAGE, ALASKA 99506-0898

REPLY TO
ATTENTION OF:

Regulatory Branch
North Section
2-960874

JULY 2 3 1997

TO ALL INTERESTED PARTIES:

This is in reference to Department of the Army permit application, file number 2-960874, Colville River 18, concerning ARCO Alaska, Incorporated (AAI) proposed Alpine Development Project (ADP). Enclosed are AAI's responses to comments received in reply to the Corps of Engineer's public notice, dated April 7, 1997. Comments from interested parties regarding the enclosed responses will be considered by the Corps of Engineers in preparation of the permit evaluation and decision document for the proposed activity.

AAI submitted to the Alaska District, Corps of Engineers, its responses to comments received during the public notice comment periods concerning AAI's project proposal supported by a draft Environmental Evaluation Document (EED). The EED was part of AAI's permit application as an attempt to assist in the environmental evaluation for the proposed ADP. The Corps of Engineers determined that draft EED was inadequate to be adopted as the environmental assessment for the permit evaluation and decision document. The Corps of Engineers did acknowledge that portions of the EED, especially those for base condition could be used in preparation of the Corps of Engineers' environmental assessment. AAI has informed the Corps of Engineers that it plans to update and revised the EED.

AAI requested that the enclosed response package be provided to interested parties for review and comment, and/or for informational purposes. AAI's responses do not necessarily reflect the Corps of Engineers' responses in consideration of comments received. AAI's responses are provided in two formats. The first format provides responses to each commentor's letter. The second is formatted to address commentors issues by subject categories.

The Corps of Engineers will consider AAI's responses in preparation of the permit evaluation document. The Corps of Engineers will also consider comments received in response to AAI's responses. In order for your comments to receive appropriate consideration, we request that your comments be received within 15 days from the date of this letter.

Please contact me at 753-2716, by FAX at 753-5567, or at the letterhead above if you have any questions.

Sincerely,

Lloyd H. Fanter

Lloyd H. Fanter
Project Manager

Enclosure

ARCO Alaska, inc.
Post Office Box 100360
Anchorage Alaska 99510-0360
Telephone 907 276 1215

July 25, 1997

Mr. Lloyd Fanter
U. S. Army Corps of Engineers (USACE)
Regulatory Branch
P. O. Box 898
Anchorage, AK 99506-0898

Re: Alpine Development Project
USACE File # 2-960874, Colville River 18
North Slope, Alaska

Dear Mr. Fanter:

In response to your coordination and direction, ARCO Alaska Inc. (AAI) hereby submits the attached responses to comments received by the U.S. Army Corps of Engineers (USACE) in response to its April 7, 1997 public notice of Colville River 18, Alpine Development Project permit application (October 8, 1996) which included the "Alpine Development Project: Environmental Evaluation Document" (October 1996). Other general questions are also addressed in the responses. We would appreciate your consideration of providing these responses to public notice commentors and other appropriate interested parties for their review.

As we discussed earlier this week, the responses are organized in two formats: 1.) by the resource agency, local government entity, public interest group or individual which provided the comments, and 2.) by subject category (e.g. hydrology and drainage, pipelines etc.) to which the comment applies. The comment letters and other correspondence are attached for convenient reference.

Public notice comments and related correspondence addressed twelve main subject categories:

Subject Category	# Of Comments	% Of Total
In-field Facilities	6	7
Pipelines	2	3
HDD/River Crossing	4	5
Oil Spill Preparedness/Response	14	17
Water Resources	3	4
Subsistence	5	6
Mitigation/Monitoring/Studies	13	16
Cumulative Impacts	11	14
EIS Related Matters	5	6
Rehabilitation	2	3
Hydrology and Drainage	14	17
Other	2	2
	81	100%

As noted in the above table, the subject category of hydrology and drainage received a great deal of attention. The attached responses reference an attached text from a draft Colville River Two-Dimensional Surface Water Model Report (July 1997). The graphics to this report are currently under revision and are therefore omitted from this distribution, however, the attached text provides an informational base from which more specific analyses can be conducted. These specific analyses will determine what drainage structures are required to address three concerns: 1.) structural integrity of the gravel structures, 2.) fish passage, and 3.) wetlands maintenance. From a general standpoint, drainage structures in the western portion of the gravel road appear to be basically resolved other than exact placement and the possibility of a battery of culverts in between the two lakes. The attached responses provide a range of culvert sizes to be installed in the 3 1/2 mile gravel road. Drainage structures in the road section traversing the swale area (an area just west of the airstrip; confirmed by the Alaska Department of Fish & Game during a June 1997 field visit) are unresolved.

Accordingly, AAI is evaluating several options for drainage in the swale area. In response to public notice comments, coordination discussions with yourself and interested parties, a combination of large diameter culverts and a bridge is currently being evaluated but is not elaborately discussed in the attached responses. AAI will finalize its evaluation within the next several days and formally propose a swale area drainage design at the beginning of the field trip scheduled for 29-30 July 1997 at which time agency specialists and others will visit the Alpine locations where they have raised questions about hydrology and drainage.

The subject category of oil spill preparedness and response also received a great deal of attention. The attached responses are directed toward issues that are being addressed by the State/Federal Joint Pipeline Office and issues that can be resolved or at least delineated prior to receiving an approved oil discharge prevention and contingency plan approval from the Alaska Department of Environmental Conservation.

The cumulative impacts subject category is addressed in the attached responses to extent it can be until AAI receives more specific direction from the USACE.

With regard to the other high interest subject category of mitigation/monitoring/studies, AAI has attempted to systematically mitigate the Alpine Development Project both in the pre-application phase and during the permit processing phase. In addition to the mitigation provided in the October 1996 EED and AAI's February 27,1997 response to the USACE, you will recall AAI's May 21, 1997 submittal to the USACE in which major mitigation proposals were made regarding casing the Colville River Pipeline crossings and inclusion of vertical pipeline loops in the pipeline corridor. These mitigation proposals, when combined with the upcoming culvert/bridge proposal, represent strong response to interested parties concerns, USACE direction, and applicant identified project impacts. Please be advised that AAI will include all mitigation proposals (including refined Nuiqsut mitigation) and their impact assessments in the updated and revised EED to be submitted to the USACE on or before September 1, 1997. The attached responses, revised project description, and various evaluations of project design alternatives will also be integrated.

Thank you again for your cooperation and the opportunity to provide the attached responses.

Sincerely,

Mark J. Schindler
Director, Alpine Permits and Compliance

Attachments:

Responses by Agency/Interest Group/Local Government/Individual
Responses by Subject Category
Attachment #1, ABR Text
Attachment #2, Shannon & Wilson Report
Comment Letters/Other Correspondence

ARCO ALASKA, INC. (AAI) RESPONSES TO U. S. ARMY CORPS OF ENGINEERS (USACE) PUBLIC NOTICE COMMENTS RECEIVED ON COLVILLE RIVER, #18, File #2-960874, ALPINE DEVELOPMENT PROJECT AND OTHER GENERAL QUESTIONS

COMMENTS OF UNITED STATES DEPARTMENT OF INTERIOR, FISH AND WILDLIFE SERVICE, JUNE 6, 1997

1. Issue:

Provide the exact area of habitat to be affected by gravel fill since the applicant made revisions to the proposed facility layout reflected in the current public notice.

Response:

The area of wildlife habitats affected by the revised in-field facilities as currently proposed have been recalculated. Consolidation and design refinements of Alpine Pad 1 (drill site), the processing/camp facility pad, and the airstrip resulted in a total gravel footprint of 111.3 acres: 2.3 acres less than amount originally proposed for the footprint in the public notice. Seven habitat types would be affected by gravel placement:

1. Deep Open Water without Islands, 0.5 acre;
2. Shallow Open Water without Islands, 0.5 acre;
3. Aquatic Grass Marsh, 0.3 acre;
4. Nonpatterned Wet Meadow, 3.3 acres;
5. Wet Sedge-Willow Meadow, 60.6 acres;
6. Moist Sedge-Shrub Meadow, 42.6 acres;
7. Riverine or Upland Shrub, 3.5 acres.

A map showing these areas is in Attachment 1.

2. Issue:

Comment on the recommendation that all habitats impacted by this project be rehabilitated to the greatest extent possible, especially the airstrip and roadway due to their potential for disrupting surface water flow and long-term implications for post-development access.

Response:

Upon abandonment (as defined in oil and gas leases) of the Alpine Project facilities, AAI will rehabilitate and restore the affected habitat areas by utilizing various gravel removal and plant cultivation techniques.

AAI will remove gravel from lower portions of the floodplain (including delta thaw basins, active- and inactive-floodplain cover deposits) to eliminate impedance of floodwater. Complete gravel removal in these areas is appropriate because the cover deposits have low to moderate ice content and are not, therefore, particularly susceptible to thermokarsting.

AAI will selectively remove gravel from portions of the higher floodplain. Complete gravel removal in these areas might result in the development of long, linear, deep waterbodies in the ice-rich abandoned floodplain cover deposits, which in turn could lead to larger thermokarst development. In order to minimize this thermokarst effect, AAI will remove gravel from the roads, pads and airstrip on the higher, abandoned floodplain cover deposits to two depths. AAI will completely remove gravel on approximately two-thirds of this area, and partially removal gravel on the remaining one-third so that a 2-3 foot layer of gravel remains. The scattered distribution of moderately thick gravel will help prevent deep thermokarst development and prevent drainage of the long, linear water bodies that are otherwise likely to develop in areas of complete gravel removal. This two-depth approach to gravel removal on the higher floodplain will facilitate passage of water during major floods, and create a mosaic of aquatic and gravelly upland habitats.

AAI will fertilize areas where it has removed gravel in order to facilitate natural plant colonization. Studies indicate that natural colonization of bare tundra soil or a thin gravel till may be accomplished in at least five years, and that the resulting species composition resembles the dominant species in the adjacent tundra. AAI will also plant aquatic grass (*Arctophila fulva*) and aquatic sedge (*Carex aquatilis*) in portions of the ice-rich areas where gravel has been completely removed to aid colonization of the ponds that are likely to result from thermokarst development. AAI will seed areas of moderately thick gravel fill with a mixture of native-grass cultivars and indigenous legumes. The grasses will rapidly improve productivity, and the legumes will prove a long-term nitrogen source, through symbiotic relationship with nitrogen-fixing bacteria, that will improve diversity and sustainability. This approach will create a mix of aquatic, wet, moist, and dry habitats that will resemble the structure, function and patchiness of the surrounding tundra.

Following AAI's restoration and rehabilitation efforts, areas in which gravel pads and the airstrip were located will not disrupt the natural surface flow of water. The airstrip will also no longer provide a means of access to the area.

3. Issue:

Respond to comment that various aspects of spill detection (schedule of visual inspection and inspection by infra-red sensor) and spill response are still unresolved.

Response:

AAI will implement sophisticated spill prevention, spill detection and spill response programs.

A. Spill Prevention Measures

AAI has designed the above ground pipelines and the underground Colville River crossing to minimize the possibility of spills, and AAI will implement an employee spill prevention training program and a pipeline maintenance and inspection program to further reduce the likelihood of spills occurring.

Above Ground Pipeline Design Features

AAI will design and construct the pipeline to comply with all state, federal, and local regulations, and will go beyond those minimum requirements as described below.

AAI will incorporate vertical loops into the pipeline design to reduce the potential for oil spills and reduce the potential spill volumes. In an idealized vertical loop, the pipeline line takes a 90 degree upward turn, followed by a 90 degree horizontal turn which causes the pipe to continue horizontally at an elevation for some distance, following which it returns to normal elevation through two more 90 degree bends. This elevated segment, the height of which is dependent upon the topography (slope) along the line, provides a constant valveless spill limitation device. This design, which has been conceptually approved by the DOT, will reduce potential spill volumes by as much as 50-55% as compared to a valved pipeline design.

Underground River Crossing Design Features

To further prevent a pipeline leak under the Colville River, the sales oil pipeline will be installed inside a high strength casing pipe. This "pipeline-within-a-pipeline" approach is fairly unique for horizontal directional drilled pipeline river crossings. Simultaneous failure of both the sales oil pipeline and the casing pipe is highly unlikely. However, in the unlikely event oil leaks from the primary pipeline, it would be captured within the "annulus" space (the space between the outer wall of the sales oil pipeline and the inner wall of the high strength casing pipe) rather than reaching the under river environment. This design is comparable to the secondary storage provided as a spill prevention technique for storage tanks. The same encasement design is used for the sea water pipeline, and the diesel fuel line, each of which is separately encased, with similar benefits.

The casing performs a second function in that it is designed to accommodate the external loads that would normally be carried by the carrier pipe. The casing and carrier pipe do not distribute loads between each other, due to the spacer design included, which means that a deformation of the casing pipe would not cause deformation of the pipeline carrying crude oil. This effectively provides double integrity against external loads.

All of the casing pipes and carrier pipes are protected by a mechanically tough state-of-the-art fusion-bonded epoxy external coating to prevent external corrosion. In addition, and in response to comments regarding additional prevention, another 8" pipe parallel to and near all of the casing pipes provides the anode portion of a cathodic protection system to prevent corrosion of the casing pipes. This cathodic protection system is itself the most advanced system available.

Careful technical review and selection of materials, coatings, and protections have been conducted and included in the design and were reported in the technical summary transmitted to the JPO on June 2, 1997 (see Appendix M).

Employee Spill Prevention Training

AAI will continue to provide regular training to its employees regarding the importance of avoiding oil spills at AAI facilities as well as training employees in appropriate spill prevention procedures.

Pipeline Inspection Program

An important component of AAI's spill prevention program is a regular program of pipeline maintenance and inspection. At regular intervals, AAI will utilize a "corrosion pig," which is a form of "smart pig" technology that involves inserting a mechanical device called a "pig" with sensing and telemetry devices into the pipeline. The pig data identifies anomalies in the pipeline that require closer investigation. AAI will use the inspection data to perform appropriate maintenance to correct problems before they result in a spill.

B. Spill Detection Methods

Although the special design features referred to above will avoid or minimize the likelihood of a spill, AAI will also employ spill detection techniques that give early warning of potential problems. The spill detection program has two key elements: a computerized leak detection system and frequent aerial infrared inspections.

AAI will utilize a state-of-the-art computerized leak detection system. For several years, advanced oil pipelines have used mass balance leak detection systems. Although these systems are quite effective, the fluid velocity and the accuracy of the fluid flow meters limit the ability of these systems to detect small leaks. AAI will, therefore, utilize a much more sensitive and faster system, called Pressure Point Analysis (PPA), which depends upon sampling frequency and the speed of sound in the liquid. The PPA system detects leaks by comparing instantaneous pressure data to trended pressure data using a computer algorithm to determine if there is evidence of a leak. If so, the PPA system compares the data set used to define the current operations with the data set used to define the current trend. The current trend data are also compared to characteristic leak profiles. The PPA system determines the probability it has found a leak and checks to determine if the anomaly could be from known events in progress. If the anomaly cannot be explained then the operator is notified. The PPA system is supplemented by use of the traditional mass balance leak detections system. Both of these systems use a fiber optic communications network for data transmission since it is more reliable and has more data capacity than microwave systems.

AAI will also monitor the pipeline by conducting overflights at a frequency that exceeds the 26 times per year specified by DOT regulations. Inspection aircraft will fly at a maximum elevation of five hundred feet, and the pipeline will be inspected visually and with the aid of forward-looking-infrared (FLIR) technology. Although not all the flights will have FLIR technology, a number of them will. Infrared technology permits identification of potential spills based on the temperature "signature" that would be presented if warm crude oil leaks onto the ground. It has the advantage over visual inspection of being able to detect warm spots in conditions of darkness or other situations involving limited visibility. This technology has the ability to identify trouble spots such as damaged or wet insulation before a problem occurs. In addition to these DOT-required inspection flights, AAI will conduct overflights as part of regular small-plane flight operations out of the Kuparuk airstrip.

In addition, as discussed in the Pipeline Isolation Strategy (e.g. vertical pipeline loops) a potential leak volume exists below the sensitivity of the leak detection system. AAI is evaluating the possibility of an independent hydrocarbon sensor to monitor below threshold oil leaks in the annular space and the cased-river crossings. Systems under review include:

- Pressure sensors
- Flow sensors
- Vapor detectors
- Hydrocarbon liquid detectors

Final selection of a system will be based on accuracy, reliability, and sensitivity. There is considerable concern about the reliability of the devices especially considering the low ambient temperature and the remote site. The decision to install any mechanism will require a feasibility and practicality evaluation.

C. Spill Response Plan

AAI is working with state, federal, local agencies and Nuiqsut to develop appropriate spill response plans. In general, AAI intends to refine its identification of sensitive environmental areas that might be affected by a spill, collect specific biological and physical information about those areas, and then develop plans as to how a spill potentially reaching each such area would be addressed through measures to limit, contain or channel flows containing oil.

The measures to be adopted will necessarily give rise to the development of lists of equipment and supplies necessary to support any spill response activities, along with specific plans for executing a spill response in all potentially affected areas.

AAI has retained Dr. Ed Owens, a world renowned and highly respected expert in the area of spill response plan design, to conduct additional field survey activities in mid-August 1997. Dr. Owens will be examining channel characteristics, flow conditions, bank character, oil behavior, resources at risk and response alternatives. He will also be looking at the question of prestaging equipment and supplies at various locations so as to speed spill response and ensure availability of necessary items. AAI will use the information obtained by Dr. Owens to design a Spill Response Plan that incorporates existing resources at Kuparuk and Alaska Clean Seas (ACS), and includes resources at nearby Alpine, including Nuiqsut.

Although equipment prestaging analysis must await Dr. Owen's field trip and report, AAI currently contemplates prestaging equipment and supplies at Miluveach and Kachemach rivers, and along Colville Channel and Sakoonang Channel.

4. **Issue:**

The airstrip siting is not optimal with respect to wildlife impacts, as moist sedge-shrub meadow receives considerable wildlife use, and because it is a scarce habitat in the project area: the airstrip will fill approximately 38 acres of moist-sedge shrub meadow.

Response:

The original remarks in the October 8, 1996 permit application about airstrip siting require elaboration. The decision to site the airstrip in its proposed location was not based solely on an assessment of impacts on wildlife habitats, although that was an important consideration. The term "optimal" was used in the sense that avoidance and minimization of impacts on other, less common wetland habitats (than Moist Sedge-Shrub Meadow) supporting high levels of use by wildlife was an objective in airstrip siting. For this reason, it is desirable to locate the airstrip away from Aquatic Sedge with Deep Polygons, Aquatic Grass Marsh, Salt Marsh, and Nonpatterned Wet Meadow habitats in the central and western portions of the facility area. Other important criteria were considered as well, including consolidation of facilities in the eastern portion of the Alpine facility area (e.g. away from highest human subsistence use channel: Nechelik Channel); location of the airstrip on higher, better-drained ground less likely to be affected by major flood events and to pose cross-drainage challenges; and minimization of aircraft disturbance to waterbird nesting areas located in the western portion of the Alpine facility area. Moist Sedge-Shrub Meadow is of high importance to mammals and moderate-to-high importance to a number of birds, as was pointed out in the agency comment. In view of its regional abundance on the central Arctic Coastal Plain, however, siting the airstrip largely in this habitat type will result in a lower level of wildlife impact than if the structure were located in lower, wetter portions of the Alpine facility area. The 42.6 acres of this habitat affected by gravel placement for the revised design is 1.3 percent of the total area of this habitat type available on the Colville River delta (3,327 acres).

5. **Issue:**

Respond to AAI's position that gravel removal is an appropriate rehabilitation technique only in the context of recycling gravel into future projects. Poorly vegetated thick gravel pads will not provide acceptable replacement habitat value.

Response:

See response to Issue No. 2.

6. **Issue:**

Solid waste disposal has not been resolved. The primary issue is to ensure food wastes do not attract wildlife to the facilities (potential predator impact), which will be a condition of the permit. The preferred disposal method is composting.

Response:

AAI has researched historical problems caused by inefficient handling of waste and is committed to preventing increases in predator populations in the project area from access to food waste. In response to concerns about air-quality impacts, however, AAI's original proposal to incinerate organic waste may be changed to require shipment of organic waste to Kuparuk or Prudhoe for disposal. Moreover, existing prohibitions on feeding wildlife will be strictly enforced. In any case animal-proof dumpsters will be used at all Alpine facilities for temporary storage of food wastes.

In addition, AAI is pursuing other options for waste disposal. The principal possibility being examined in a pilot program at Prudhoe Bay is composting. If this pilot program proves successful at Prudhoe and can be practically adapted to Alpine, AAI will use this waste disposal technique.

7. **Issue:**

Cumulative impacts have not been addressed in a thorough, careful manner.

Response:

AAI addressed cumulative impacts in Section 4.7 of its EED dated 10/96. In consideration of new information related to projects or issues evolving since 10/96, and in consideration of agencies' requests for additional cumulative impact analysis, the USACE has circulated a proposal to the lead federal agencies regarding the analysis of cumulative impact. The proposal outlines an analytical procedure for cumulative impact analysis, which asks the following questions:

> What oil and gas development is reasonably foreseeable?
>
> Of the oil and gas development that is reasonably foreseeable, what projects are related to or induced by the Alpine Project?
>
> Of the reasonably foreseeable oil and gas development projects that are related to or induced by the Alpine Project, what are the specific additional construction implications (e.g., additional gravel roads, other Colville River crossings, pipeline segments, gravel pads and other facilities) and what impact do they have on the environment (e.g., fisheries, wildlife, water quality and oil spill effects)?
>
> Will a further environmental assessment be required before such future oil and gas development is permitted to take place?

AAI can not finalize its cumulative impact response to the USACE until it receives direction from the USACE on: (1) agency acceptance of the USACE proposal, and (2) the integration of additional cumulative impact information as provided by other resource agencies (e.g. BLM, MMS, DOE, ADNR).

The decision as to the scope of matters to be considered in assessing cumulative impact of the Alpine project is the responsibility of the USACE, with inputs to that decision from other agencies. Once the USACE has advised AAI of the approach it has adopted for purposes of preparing an EA and reaching its decision (such as the time horizon and geographic areas to be included in the process) AAI will provide information to the USACE with respect to potential future field developments or other subjects to assist the USACE in discharging its responsibilities.

8. Issue:

Additional oil and gas development between the East and Nechelik channels of Colville River delta with pipeline connections to Alpine shall be accomplished with minimum of additional gravel fill. Designs of fields with pipeline connections to Alpine shall incorporate concept of roadless satellite production facilities, except where environmentally preferable designs exist or roadless design infeasible.

Response:

At present, Fiord is the only reasonably foreseeable oil and gas development project (within the East and Nechelik channels) which may utilize the Alpine processing/pipeline facilities. As discussed in AAI's 10/96 EED, the most likely development scenario would adhere to the above referenced concepts.

Although AAI is the dominant oil and gas lessee of record in the delta, it is conceivable that other oil and gas operators could become lessees and potential operators. AAI can only commit to restrictions placed on permits for its own operations. However, it should be noted that the state of Alaska placed conceptual development restrictions in its existing oil and gas leases, and additionally, any prospective developments would require additional environmental assessments by the USACE in which cumulative impacts would be evaluated. Therefore, the concepts of facility consolidation and impact avoidance/minimization are existing planning standards which will be judged in future individual permit actions.

9. Issue:

Discuss use of cross-drainage structures across the in-field road and airstrip to prevent impoundment or dewatering of adjacent wetlands, and allow unimpeded fish passage between documented fish-bearing waterbodies.

Response:

The use of cross-drainage structures to prevent impoundment or dewatering of adjacent wetlands is addressed in Attachment 1, Cross Drainage Structures—See "Assessment of Potential Effects of Alteration of Cross-drainage on Wetland Habitats Near In-field Facilities" by M.T. Jorgenson (9 July 1997). Also see response to Issue No. 30.

10. Issue:

Design of the Colville River pipeline crossing shall include a cased pipeline and vertical expansion loops, subject to appropriate agency approvals. If design is infeasible, AAI shall provide alternative design with equivalent spill protection. Design modifications will require additional USACE public notice.

Response:

AAI has proposed the cased pipeline and vertical expansion loop designs (AAI May 1997 letter to the USACE), subject to appropriate agency approvals. Preliminary reviews by agencies are very positive and AAI is hopeful full approval will be rendered.

11. Issue:

AAI shall submit findings of monitoring study of waterfowl disturbance by aircraft to FWS. AAI in consultation with FWS and USACE will modify operating procedures as practicable to mitigate identified negative impacts.

Response:

The October 8, Alpine USACE permit application includes mitigation measures that minimize waterfowl disturbance by aircraft and ensure no significant negative impacts will occur. (See generally EED section 4.4.2.2.). These mitigation measures already propose a multi-year study to monitor disturbance of waterfowl by aircraft during construction and the first year of operations. (See EED section 2.10.3.). Accordingly, AAI agrees to comply with the above issue.

12. Issue:

AAI to adhere to aircraft restrictions described in public notice.

Response:

AAI volunteered the restrictions in the public notice and agrees to comply with this condition.

13. Issue:

Filling of wetlands, major construction and gravel-hauling shall be avoided during pre-nesting and nesting season (20 May – 1 August) of spectacled eiders. If activities must be conducted during that period, FWS-approved nest surveys shall be required to determine if nests are in or within 200 meters of project footprint, and if so, further consultations with FWS is required.

Response:

The proposed condition presumes that the pre-nesting and nesting seasons extend from May 20 to August 1. In fact, AAI's environmental studies (See Chapter 4 of the EED) demonstrated that the nesting season typically concludes by the second week in July.

No major construction activities are planned to occur in the transportation corridor during the pre-nesting or nesting season. The Alpine project will, however, involve some construction activities at the in-field facilities during the May 20 through August 1 time period. During the first summer season, AAI plans to compact gravel. During the second summer season, AAI plans site preparation for module installation.

As detailed in the EED, prior annual surveys of the Colville River delta indicate that spectacled eiders generally do not occur in the project area. (See EED sections 4.4.3.1 and 4.4.3.2.). In particular, no nests or broods were observed within the project area in 1995 or 1996. (See EED section 4.4.3.2.). AAI agrees nonetheless to follow the FWS-approved nest survey protocol and to further consult with FWS in the event that any spectacled eider nests are observed within 200 meters of project facilities (or major construction activities).

COMMENTS OF UNITED STATES DEPARTMENT OF INTERIOR, FISH AND WILDLIFE SERVICE, JULY 2, 1997

14. Issue:

Oil spills pose a significant threat to unique and irreplaceable fish overwintering habitat, as well as high value waterbird habitat such as salt marsh and tidal flats. Significant impacts to these resources will occur if pipelines and facilities are improperly engineered or located.

Response:

A major oil spill into the Colville River delta could result in serious environmental consequences; however, the likelihood of such an event is remote and its impact would depend upon the quantity of oil, the proximity of sensitive habitat and the time of year. AAI has evaluated the most likely worst case scenario (e.g. catastrophic pipeline failure at the Colville River east channel), and incorporated spill prevention and spill detection considerations into project design. Spill response plans are under development. Also see response to Issue No. 3.

15. Issue:

Impoundment of water upstream of the proposed facilities will likely alter valuable waterbird habitat and disrupt fish passage.

Response:

As explained in the response to Issue No. 9, the Alpine project will be designed to minimize impacts on water flow, and will not significantly alter waterbird habitat in the delta or disrupt fish passage.

16. Issue:

Significant impacts will occur to the high value waterbird habitats of the delta and surrounding area if further development is not carefully evaluated and mitigated through conditions on this permit.

Response:

As explained in the EED and in response to Issue No. 11, the Alpine Project will be designed to avoid or minimize and mitigate impacts on waterbird habitat. Although the EED addresses the potential for further development in the Colville delta area, AAI does not believe it is appropriate to include conditions in the Alpine Project permit designed to address speculative impacts of potential developments that may occur beyond the reasonably foreseeable future

17. **Issue:**

Long-term health and productivity of this ecosystem will be impacted if conditions are not explicit and effective regarding the ultimate reclamation of this site. Abandoned gravel will likely be washed into adjacent habitats by frequent flooding.

Response:

See the response to Issue No. 2, which addresses AAI's plans for restoration and rehabilitation of the Alpine project site.

COMMENTS OF UNITED STATES DEPARTMENT OF COMMERCE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, NATIONAL MARINE FISHERIES SERVICE, JUNE 9, 1997

18. **Issue:**

Conduct a larger study that entails obtaining background levels of information, including sediments, and fish and water samples at the proposed Colville River crossing.

Response:

Considerable baseline water quality data from the Colville River already exists and is summarized in the October 8, 1996, EED. AAI is compiling water quality data for lakes in the project area and will transmit this data in August, 1997.

AAI does not believe that sediment sampling would provide helpful baseline information. The Colville River sediments are extremely dynamic as a consequence of seasonal flooding, scouring and channel migration. Given the substantial sediment transport within the river, analysis of the sediment found at the river crossing location at any particular time would not provide meaningful baseline information.

AAI does not believe that sampling fish tissue for baseline levels of contaminants would prove useful either. Most fish found at the crossing location are migratory fish, and there is no evidence to suggest that these fish remain feeding in the area long enough to accumulate contamination. Even during the winter, these fish move around in response to changing salinity and are not likely to remain in any location for a significant length of time. As a result, if a fish captured in the area of the proposed crossing were found to have elevated levels of a contaminant in its tissues, it would be impossible to determine where the fish had been exposed to the contamination.

Despite these limitations on the usefulness of baseline fish tissue data, however, AAI has already committed to AF&G to analyze a limited number of fish tissue samples. Samples are being collected this summer.

19. Issue:

Provide additional preventative and response measures including the pre-staging of equipment and monitoring of an oil spill in the pipeline crossing the Colville River.

Response:

See response to Issue No. 3.

20. Issue:

With respect to cumulative impacts, recommends that USACE, in coordination with the resource agencies and other interested stakeholders, initiate a Special Area Management Plan, or a similar comprehensive areawide management process utilizing a watershed approach, in conjunction with EIS to evaluate cumulative impacts of pending and future §404 and §10 permitting actions.

Response:

The decision to prepare an environmental impact statement rests with the USACE which consults with commenting agencies, interested parties and landowners.

COMMENTS OF UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, JUNE 5, 1997 (Also see p. 40 for responses to September 6, 1996 EPA letter, pre-EED)

21. Issue:

Consider cumulative impacts.

Response:

See response to Issue No. 7.

22. Issue:

Consider effects of oil and other pollutants discharged into the Colville ecosystem.

Response:

See the response to Issues No. 3 and No. 14.

COMMENTS OF ALASKA DEPARTMENT OF FISH AND GAME, JUNE 16, 1997

23. Issue:

Recommend that culverts are installed around West Drill Pad to provide for fish movement and water transport including a combination of bridge and culverts at the swale area located at the facility footprint. A criterion for distance between culverts should be established.

Response:

AAI is undertaking a comprehensive evaluation of various alternatives to provide for fish movement and water transport in the project area. AAI will supplement this response as soon as possible. AAI is evaluating drainage structures and will be prepared to discuss them during the July 29 and 30 site visits.

24. Issue:

Recommend placement of a standard size pipe in selected areas (e.g., match the natural troughs) to provide for water movement. Need more discussion on how to deal with the high-center polygon area.

Response:

See the response to Issue No. 23.

25. Issue:

Strongly recommend that cross drainage structures in swale area include a combination of a bridge and culverts. Bridge should handle project design flood (e.g., 50 year) without altering water flow.

Response:

See the response to Issue No. 23.

26. Issue:

Recommend adequate cross drainage in high-center polygons between airstrip and sand dunes and between Monument Black and processing facility.

Response:

See the response to Issue No. 23.

COMMENTS OF ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION; DIVISION OF AIR & WATER QUALITY, JUNE 6, 1997

27. Issue:

The consistency review, including the state's certification of the §404 permit must be stopped because more information is needed concerning interaction of flood waters and floating ice with the gravel fill within the delta area.

Response:

AAI has not objected to the consistency review stoppage and will endeavor to satisfy ADEC's request for additional information. Many of these issues are addressed in this response document. In addition, AAI will distribute a two-dimensional predictive hydrology report and discussion documents (Appendix M) addressing alternative drainage structure designs and the expected performance of these designs with respect to gravel fill structural integrity, wetlands systems maintenance and fish passage. It is AAI's goal to have these materials distributed to the agencies prior to an Alpine field trip scheduled for July 29 and 30, 1997. The intent of the field trip is to provide agencies an on-site opportunity to validate AAI's assessment of on-site base conditions and to conceptualize AAI's drainage structure design proposals.

COMMENTS OF ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION; DIVISION OF AIR & WATER QUALITY, JUNE 13, 1997

28. Issue:

Discuss how flooding affects the gravel structure and what affects the gravel structure will have on flooding. The latter should discuss the water height differences caused by the structure considering that there is only a foot difference in water elevation between a 50-year and 200-year flood event. It should also include information on the aerial extent, both up gradient and down gradient of the structure, that the structure would have on water levels, and any affects flooding caused by the structure may have on the pipeline and its support members.

Response:

The gravel road and pads are designed to withstand the current, wave and ice forces that are expected during the design flood. The actual difference between the 50-200 year flood is approximately 2 feet because of the amount of area available and the flat topography in the delta for the water to spread.

A two-dimensional, finite element mode of the Colville Delta during the 50-year flood was performed to evaluate the effect the proposed gravel structures in the delta will have on water levels during flooding. At first, the model was run without the Alpine gravel structures in place, then the model was run with the gravel structures in place at a sample of locations (Tables 1 and 2, and Figure 1). Initially it was assumed that no water would flow through the structure. This provided valuable insight to conditions during flooding, but is unrealistic since drainage structures (some combination of culverts, a low water crossing, and/or a bridge) will transmit water through the road.

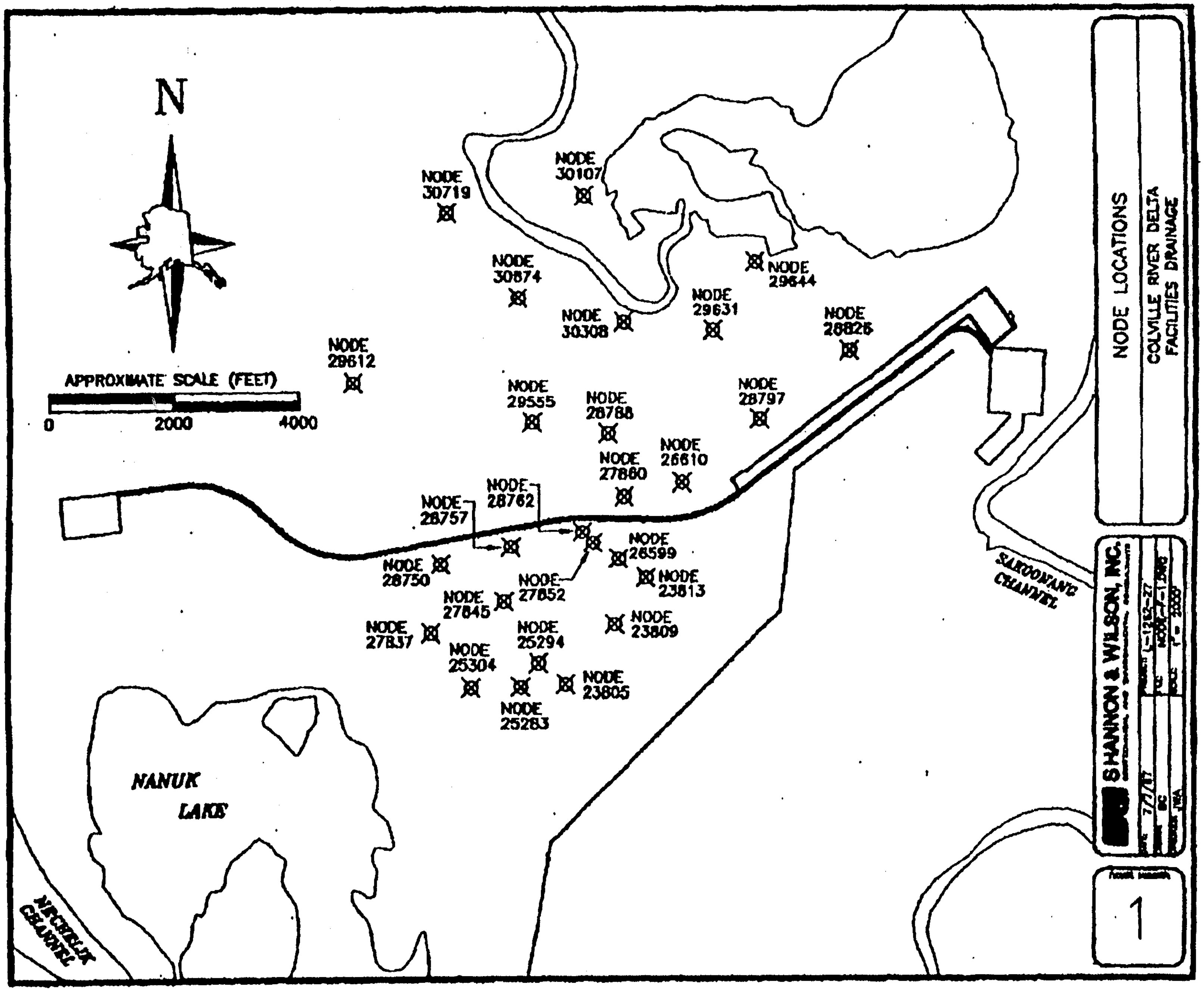
Table 1. Water surface elevations on upstream side of road, in vicinity of swale, during the peak discharge of the 50-year flood.

Node	Northing	Easting	Elevation (BPMSL) (ft)	Water Surface Elevation Without Facilities (BPMSL) (ft)	Water Surface Elevation (In BPMSL) for Selected Discharge Through Facilities (cfs)				
					0	1,000	5,000	10,000	15,000
23805	5971955	379229	10.0	11.2	12.5	12.4	12.3	12.2	12.0
23809	5972867	380027	10.0	11.2	12.5	12.4	12.3	12.1	11.9
23813	5973607	380523	10.0	11.2	12.5	12.4	12.3	12.1	11.9
25283	5971911	378512	7.5	11.3	12.5	12.4	12.3	12.2	12.0
25294	5972273	378798	5.0	11.2	12.5	12.4	12.3	12.2	12.0
25304	5971902	377725	5.0	11.3	12.5	12.4	12.3	12.2	12.0
25588	5973908	380070	7.5	11.0	12.5	12.4	12.2	12.1	11.8
27537	5972732	377082	5.0	11.1	12.5	12.4	12.3	12.1	12.0
27845	5873236	378247	5.0	11.2	12.5	12.4	12.3	12.1	12.0
27852	5974164	379880	5.0	11.0	12.5	12.3	12.0	11.5	10.9
28750	5973827	377223	5.0	11.3	12.5	12.4	12.3	12.1	11.9
28757	5947094	378340	5.0	11.2	12.5	12.4	12.2	12.1	11.8
28762	5974335	379481	5.0	10.9	12.5	12.4	12.4	12.5	12.5
Notes: 1. The drainage structure inlet was modeled at node 27882.									

Table 2. Water surface elevations on downstream side of road, in vicinity of swale, during the peak discharge of the 50-year flood.

Node	Northing	Easting	Elevation (BPMSL) (ft)	Water Surface Elevation Without Facilities (BPMSL) (ft)	Water Surface Elevation (In BPMSL) for Selected Discharge Through Facilities (cfs)				
					0	1,000 [2]	5,000	10,000	15,000
26610	5975093	381092	5.0	10.5	8.9	8.8	9.0	9.5	9.9
27860	5974883	380155	5.0	10.6	8.3	8.8	9.1	9.8	10.8
28755	5975858	379901	5.0	10.5	8.9	8.8	9.0	9.5	9.9
28797	5978070	382360	2.5	10.5	8.9	8.8	9.0	9.4	9.9
28826	5977128	383793	4.0	10.5	8.9	8.8	9.0	9.4	9.9
29555	5976035	378680	6.5	10.8	8.9	8.8	9.0	9.5	10.0
29612	5976791	375881	8.5	10.7	8.9	8.8	9.5	9.4	9.4
29631	5977448	381605	1.0	10.5	8.9	8.8	9.0	9.4	8.9
29644	5978522	382297	2.8	10.5	8.9	8.8	9.0	9.4	9.9
30107	5979549	379534	0.5	10.5	8.9	8.8	9.0	9.4	9.9
30308	5977582	380162	4.0	10.5	6.9	8.8	9.0	9.4	9.9
30674	5977961	398484	6.6	10.5	8.9	8.8	9.0	9.4	9.9
30719	5979287	377348	6.3	10.4	8.6	8.8	9.0	9.4	9.8

Notes:
1. The drainage structure inlet was modeled at node 27860.
2. Although the results of the analysis suggest the water surface elevation on the downstream side of the road would lower about 0.1 feet if 1,000 cfs were passed through the road, this result is unrealistic. The difference between the results with no flow through the road and the 1,000 cfs flowing through the road are less than the accuracy of the model, and should therefore be interpreted as being insignificantly different.


N
APPROXIMATE SCALE (FEET)
0
2000
4000
NODE 30719
NODE 30107
NODE 30874
NODE 30308
NODE 29631
NODE 29644
NODE 28826
NODE 29612
NODE 29555
NODE 28788
NODE 28797
NODE 27860
NODE 26610
NODE 28762
NODE 28757
NODE 28750
NODE 26599
NODE 23813
NODE 27852
NODE 27845
NODE 27837
NODE 25294
NODE 23809
NODE 25304
NODE 23805
NODE 25283
NANUK LAKE
SAKOONANG CHANNEL
NODE LOCATIONS
COLVILLE RIVER DELTA FACILITIES DRAINAGE
SHANNON & WILSON, INC.
7/7/97
1

If no water passed through the road during the 50-year flood, water levels immediately upstream of the road could be as much as 2 feet higher than if there was no road, and water levels immediately downstream of the road could be as much as 2 feet lower than if the road was not there. Water level differences decreased when the model accounted for flow through the road. Analyses were performed with discharges of 1,000 cfs, 5,000 cfs, 10,000 cfs, and 15,000 cfs passing through the gravel structure to more accurately predict water levels. Water levels upstream of the road for the discharges of 1,000, 5,000, 10,000, and 15,000 cfs were lowered by 0.1 ft, 0.2 ft, 0.4 ft, and 0.6 ft, respectively. Water levels downstream of the road were raised less than 0.1 feet for the 1,000 cfs discharge, and raised 0.1 ft, 0.6 ft, and 1.0 ft for the 5,000, 10,000, and 15,000 cfs discharges. We expect the actual discharge passing through the road (via drainage structures) will be between 5,000 and 10,000 cfs during the 50-year flood. In summary, as the discharge passing through the road increases, the difference in water level upstream and downstream of the road becomes smaller.

The effect the gravel structures have on flood water levels diminishes with distance upstream and downstream from the structures. For example, during the 50-year flood, water level increased at a point 4 miles upstream by 6 inches and decreased at a point 9 miles downstream by 6 inches. Therefore, the structure has very localized effect on flood water levels.

Pipelines will be built at an elevation well above the predicted water levels during the design flood. Therefore, there will be no lateral loads on the pipelines due to water or ice forces. Pipeline supports will be designed and approved by the JPO to withstand the predicted loads resulting from water and ice.

29. Issue:

Map water elevations, water depths, and water velocities during the 2-year, 50-year, and 200-year flood events. If other years of comparable timing are more readily available, these would be acceptable to the department. This information should include maps for these events with and without the structure.

Response:

The 2-year flood is essentially the average breakup runoff. The discharge of the 2-year flood is predicted to be 233,000 cfs. The map of water levels presented in "Geomorphology and Hydrology of the Colville River Delta in 1995" (Appendix M) for the 1995 runoff (240,000 cfs) is a good approximation of the 2-year flood water levels.

Maps of water levels for the 50-year and 200-year floods, with and without Alpine structures, are presented in "Colville River Two-Dimensional Surface Water Model" by Shannon and Wilson, July 1997 (Appendix M). AAI is also evaluating modeling results using different pass through structure scenarios. These results will be reviewed during the upcoming July 29 and 30 field visits.

30. Issue:

Prepare a drainage plan that considers the passage of fish and the ability to simulate natural flows especially into wetland areas that could be adversely affected by the gravel structure. The drainage plan should also address the effects of gravel structure on special flood events that infrequently influence certain wetlands ecosystems but are necessary for the survival of the ecosystem. The plans should include water velocities in any pass through structures.

Response:

The potential effects of the gravel structure on the wetland habitats will be minor. They are specifically addressed in Attachment 1, "Assessment of Potential Effects of Alteration of Cross-drainage on Wetland Habitats Near In-field Facilities" by M.T. Jorgenson (9 July 1997). Also see response to USFWS Issue No. 9.

The drainage plan considers gravel fill structural integrity, fish passage and natural flows in wetland areas. Cross-drainage in the development area is addressed by installing culverts, during initial gravel placement, in pre-construction identified areas where ponding or dewatering may occur due to construction of gravel structures. In the summer season immediately following initial gravel placement, additional culverts will be installed in areas where water ponding or dewatering is observed. Flood events have been extensively modeled to determine the mutual effect the floods and the development have on each other and to develop the project design criteria. The effort is documented in Attachment 2, "Colville River Two-Dimensional Surface Water Model (7/97)". The text of this report is the only attachment at present since the corresponding graphics are being revised due to a printing error. The design of passthrough structures considers water velocities for fish passage. The fish design used is a 250mm grayling. The design water flow rate conforms to the 2-year return period flood event, however, other events are being considered. Passthrough structures such as large diameter multi-plate culverts (diameter range 4 ft. – 12ft.) are being considered for the gravel road. However, for the high flow area (swale) near the west end of the airstrip, alternative drainage structures such as a combination of culvert batteries plus distributed culverts and a bridge plus distributed culverts are being considered. Other structures such as a low water crossing and an earthen bridge are being further evaluated, but early reviews of these options are not favorable. AAI will propose an overall drainage plan design during the upcoming July 29 and 30, 1997 Alpine field visit.

31. Issue:

Discuss possible sedimentation due to reduced water velocities in places and, in the reverse, erosion due to increased water velocities in other places. Will there be increased erosion in the Nechelik Channel if water that cannot flow through the gravel structure routes around the structure and into the channel? Also, the effects of river ice on the gravel structure and the pipeline should be discussed.

Response:

AAI does not expect the project to cause significant changes in water velocities. AAI intends to minimize the impact on water velocity and corresponding sedimentation and erosion by designing adequate draining structures, taking slope protection and maintenance measures, and timing construction properly. The project, therefore, is not likely to affect erosion rates. During large flood events, however, the road and pads associated with the project could affect the movement of flood water, and cause some sedimentation on the inactive and abandoned floodplain cover deposits.

As discussed in the responses to Issues No. 27, No. 28 and in Attachment 1, AAI will design the gravel structures and pipeline supports to withstand anticipated water and ice forces.

COMMENTS OF OFFICE OF THE GOVERNOR, OFFICE OF MANAGEMENT AND BUDGET, DIVISION OF GOVERNMENTAL COORDINATION, JUNE 18, 1997

32. Issue:

The summary section of the EED has a discussion on access, where one option is a gravel road to Kuparuk but with no bridge across the Colville. Since this would limit road access to winter, when an ice bridge could be constructed, wouldn't the same be accomplished with an ice road.

Response:

The Alpine Development does not include any gravel roads beyond the $3^1/_2$ mile road connecting the facilities. AAI evaluated and rejected road alterations in the October 8, 1996 EED (See Chapters 3 and 4). Ice roads, including an over-the-ice Colville River Crossing, will be constructed as necessary for construction and operations.

33. Issue:

On page S-5 of the EED, the HDD method for crossing the Colville River is not listed as an alternative, even though this is what is currently being proposed.

Response:

The preferred Alpine pipeline crossing of the Colville River is proposed to be via horizontal directional drilling (HDD). The EED will be revised to address this issue.

34. Issue:

On page S-8 of the October 8, 1996 EED, Biological Resources, Fisheries, what resources use the delta? Are there critical areas near the project site?

Response:

Fish use of the delta is described in Section 4.4.1 of the EED. Any of the species listed in Table 4.4.1-1 of the EED can be found within the delta at some time during the year. Yes, critical areas occur near the project site which include any waters used by wintering fish. These include the main Colville River near the pipeline crossing and the various perched lakes within the Alpine facilities area (see Figure 4.4.1-10 of the EED). Page S-8 of the EED will be revised to reflect this information.

35. Issue:

How would the project itself increase the number of subsistence fishery users? Would access to subsistence fisheries be improved, if so, does AAI anticipate that more people would participate?

Response:

The Alpine project will result in no direct impact upon the subsistence fishery in the project area through increased access or use. Moreover, the project will, at most, have a minimal indirect impact through the potential addition of a small number of subsistence fishers residing in Nuiqsut.

The Alpine Project does not include facilities that would improve subsistence use access. The proposed pipeline connection with existing Kuparuk facilities will not provide or improve human access to the area (e.g. no connecting road is proposed). Accordingly, the only land access associated with the project would be via ice roads during winter, which is outside the principal fishing season. Moreover, the Alpine Project will not increase competition between local and non-resident oil company employees or contractors transported to the project via aircraft because AAI has agreed to apply a no fishing policy to non-residents. AAI's airstrip will not be open to the public. (See EED section 4.5.4.2.).

At present, project area subsistence fishers consist primarily of Nuiqsut residents, with some participation by other North Slope residents primarily from Barrow. Although the area experiences the normal cycles of abundance and scarcity for subsistence species, subsistence harvests in the area have not resulted in reduced fish populations due to over-fishing. While it is possible that the Alpine project will create a limited number of new jobs, which may attract new residents from Barrow or other North Slope villages to reside permanently in Nuiqsut, the number of potential new permanent residents attributable to the project is small. Given the existing capacity of the resources and the small number of potential additional subsistence users attributable to the project, the Alpine project employment opportunities are not anticipated or likely to have any adverse affect upon the present subsistence fishery.

36. Issue:

Drilling wastes from horizontal drilling are not regulated by DEC's solid waste regulations. However, due to the proximity of the drilling operations to the Colville River and the unknown qualities of the mud that will be used, the state's certification of the §404 permit will require a plan review of the mud handling facilities for the horizontal drilling.

Response:

AAI will submit a plan of the mud handling facilities for the horizontal drilling to DEC for review. AAI recognizes the importance of proper handling of drilling mud used during horizontal directional drilling ("HDD") under the Colville River, as well as in all other instances where drilling muds are used. The following handling and disposal practices will be used for the HDD drilling: (1) bentonite/water drilling mud without additives will be used unless conditions determined at the time of drilling require additives to maintain a safe and effective mud weight and viscosity; (2) drilling mud will be continuously circulated during drilling; (3) coarse drill cuttings will be removed from the mud at the surface before the mud is recirculated; (4) with ADEC approval, drill cuttings removed from the mud may be recycled into gravel used to construct Alpine gravel facilities may be disposed of as overburden at a gravel mine site; and (5) drilling mud will be transported back to Kuparuk for disposal by subsurface injection.

37. Issue:

Does AAI plan to do any work on Alpine during the summer following the winter pad construction? If so, the proposition of flying potable water to the site and wastewater back to Kuparuk seems to be cost prohibitive.

Response:

During the summer of 1998, AAI plans to blade and compact the gravel laid the previous winter and install culverts as noted in Issue No. 30. This will require 6-12 people, who will be temporarily based at Nuiqsut. During the summer of 1999 AAI will be conducting site preparation for model 7S. However, a fully self contained, permitted construction camp with potable water and sewage disposal facilities will be operational. Therefore, no aircraft transport of potable water or wastewater between Alpine and Kuparuk is foreseen.

38. Issue:

AAI claims in the EED that the pipeline is adequately sized while at the same time the EED states the pipeline diameter will be between 8 and 20 inches. The EED needs to be updated to clearly state the size and need of the pipeline.

Response:

As stated in AAI's February 27, 1997 letter to the USACE, the Alpine oil pipeline will be 14 inches in diameter. This diameter was chosen because of pipeline hydraulic considerations (see Alpine Project Overland Hydraulics Report June 1997, Appendix M). The EED will be revised as requested.

39. Issue:

The EED discusses infrared cameras and pigging as being the preferred methods of leak detection, but says it will use state of the art leak detection. What else is involved in the state of the art leak detection? In a recent presentation at the JPO, it was stated that a small leak may not be detected by the SCADA system and would be visually observed before it was found. Is this with an ordinary SCADA system or one enhanced with the use of fiber optics? How would small leaks be detected under the Colville River? Has there been any thought on placing sensors in the HDD bore or in the pipe casing that are sensitive to hydrocarbons so a leak could be detected.

Response:

See the response to Issue No. 3.

40. Issue:

On page 4-17 in the EED, it states that the natural conditions replace the numerical criteria as the State standards for water quality. The statement implies that the natural conditions automatically take the place of the existing criteria. This is not true. According to the Water Quality Standards 18 AAC 70.024(b), the Department can find that this is the case but it is not automatic.

Response:

AAI acknowledges and agrees with the clarification provided by this comment. Alaska Water Quality Standards (18 AAC 70), as amended on March 28, 1997, provide that "upon application or on its own initiative, the department will determine whether a natural condition should be approved as a site-specific water quality criterion." ADEC regulations further provide such a determination by the department is appropriate if the natural condition of the waterbody is of lower quality than the water quality standards, and if the natural condition of the waterbody is fully protective of designated beneficial uses.

ADEC should adopt a site-specific water quality criterion in this case because natural conditions do not meet the numerical water quality standards. For example, elevated concentrations of some trace metals have been found in Colville River water, elevated suspended sediment concentrations have been found during June floods, pH levels below 6.5 have been detected, elevated water temperatures have been measured during the summer in shallow clear lakes, high total dissolved solids concentrations have been detected in some lakes and in Colville River distributory channels, and low dissolved oxygen concentrations have been found in winter. See EED section 4.3.1. Despite these natural conditions in excess of state water quality standards, continued beneficial uses, including the growth and propagation of fish, shellfish, aquatic life and wildlife, have been documented in the project area.

41. Issue:

In the section on Groundwater, the EED says there is no information for the project area. How does AAI intend to apply for a Class I, UIC permit from EPA and a wastewater disposal permit from DEC with no information on the groundwater that could potentially be affected.

Response:

The project area lies within a zone of continuous permafrost, as does the entire North Slope. Accordingly, groundwater is restricted to either the thin active layer (thawed) above the permafrost or to zones below or within the permafrost. Permafrost ranges from 700 to over 2,100 feet deep on the North Slope. Groundwater within the permafrost occurs in discontinuous confined locations where dissolved salts depress the freezing point of the water. The saline quality of groundwater ensures that it is unsuitable for drinking water. Groundwater below the permafrost ranges in quality from brackish to saline, again ensuring that such sources are unsuitable for potable water use. Consistent with the poor quality of groundwater throughout the North Slope region, no North Slope potable water, for industrial or domestic use, originates from any underground source. Existing UIC permits and related applications for North Slope injection wells confirm this information.

In the project area, permafrost is approximately 800 feet deep. Well logs demonstrate that all the rock formations between the permafrost and the oil reservoir are dense shales, mudstones and siltstones, with a few thin sandstone intervals. These formations contain high salinity groundwater generally inaccessible due to very low permeability, and that is unusable for potable water. Consistent with these data, there are no underground sources of drinking water in the Alpine project area.

Insofar as the EED suggests that there is a lack of information regarding groundwater quality in the project area, the EED will be corrected.

COMMENTS OF TRUSTEES FOR ALASKA, JUNE 6, 1997

42. Issue:

Respond to the issue of preparing an EIS because the project will have a significant impact on the human and natural environment.

Response:

See response to Issue No. 20, NMFS

43. Issue:

A full EIS should be prepared for the proposed Alpine Project.

Response:

See response to Issue No. 20, NMFS.

44. Issue:

AAI has not provided any evidence of intent to perform appropriate and practicable compensatory mitigation to compensate the public for the wetlands values the Alpine development will destroy.

Response:

The location of the footprint will impact a small amount of high use wetland habitat for the groups of wildlife species identified by the USFWS as (1) regionally important species, (2) species used for subsistence, and (3) threatened/endangered species. Based on further evaluation of the site using refined engineering design and data from the 1996 field program, AAI has determined that the footprint will impact even less high use wetland habitat than stated in the Public Notice for these groups of species. For example, reanalysis of habitat use (including refined mapping and using 1996 data) showed that moist sedge-shrub meadow is not used by Spectacled Eiders on the Colville River delta. In all cases, the footprint will impact only a small proportion of high use wildlife habitat on the delta. Aircraft traffic will also be restricted to minimize disturbance to wildlife. Some of the proposed restrictions and other mitigation measures as discussed in the EED (p. 2-23, 4-106 to 109 and elsewhere in Chapter 4) include:

- limited airstrip use between June 1 – July 15 to aircraft weighing less than 105,000 lb take-off weight (i.e., Boeing 737 prohibited) unless excepted by FAR PART 36-Stage 3 (noise level category), safety emergency, or by the Subsistence Oversight Panel (see Nuiqsut mitigation section of EED),

- minimizing aircraft use during June 1 – July 15,
- maintaining 500-ft minimum altitude except for pipeline monitoring and take-off and landing patterns,
- maximizing aircraft use during winter, and
- conducting a 3-year ($150,000 per year) waterfowl monitoring program related to airstrip impacts.

AAI has sited and designed the project to mitigate loss or disturbance of high value wetland habitat, and to avoid the need for compensatory mitigation.

45. Issue:

The Colville delta saltmarshes would be particularly susceptible to an oil spill.

Response:

See response to Issue No. 14.

46. Issue:

The gravel fill, noise disturbance from aircraft support, and chronic spills will irreversibly degrade wetlands habitats.

Response:

As explained in response to Issues No. 30 and No. 49, the gravel fill will be designed to minimize interference with water flow or habitat in the delta. Moreover, as explained in response to Issue No. 2, AAI will restore and rehabilitate areas of gravel fill upon abandonment of the Alpine project.

As explained in response to Issue No. 58, noise associated with aircraft will be mitigated by imposing aircraft restrictions during the nesting period (1 June-15 July). Furthermore, as indicated in response to Issue No. 12, AAI agrees to comply with the aircraft restrictions described in the USACE's public notice.

As explained in response to Issue No. 3, AAI will implement design features and training programs to avoid "chronic spills." AAI will also implement inspection and maintenance programs, state-of-the-art leak detection measures and appropriate spill response plans to avoid, detect and respond to spills.

47. Issue:

What is the possibility of oil spills or other risks associated with the buried pipeline crossing.

Response:

Potential risks evaluated and subsequently rendered insignificant where seismic effects, corrosion, river channel scour and migration, flood, thaw subsidence and vandalism. The project has been designed to minimize these risks as described in Issue No. 3.

48. Issue:

Although it is proposed that the pipeline will be constructed by drilling under the delta, this technology is unproved and may not be feasible. Need EIS for thorough environmental and technical review.

Response:

The decision to use HDD technology to cross under the Colville River with the pipelines was based on extensive study of the technology. AAI and its HDD contractor have closely evaluated early applications of HDD technology, some of which produced structural failure. HDD is now a proven technology that has been used throughout the world, including areas where soil conditions are similar to the Alpine site. Although soils are frozen at the Alpine site and HDD technology has not been used in permafrost, the subsurface soil type (not the frozen/unfrozen condition) is the primary factor determining the feasibility of HDD. The subsurface soils beneath the Colville River are high in silts and clays which are similar to areas where HDD technology is commonly used. Detailed case study comparisons were done of these areas to confirm the feasibility of drilling under the Colville River. In addition, the plan to use HDD has been deemed feasible by panels of pipeline industry experts, the Joint Pipeline Office, and through site-specific studies at the proposed Colville River crossing. The results of these studies are documented in the Colville River Crossing Summary Report for Selection and Feasibility, September 1996, submitted to the JPO and USACE (Appendix M).

HDD is the preferred crossing method to more traditional methods. Trenching, bridging, or laying pipeline along the river bottom require in-water construction and do not provide the environmental safeguards of HDD technology. These safeguards and HDD technology are more fully discussed in the response to Issue No. 3.

49. Issue:

Respond to the comment that the potential for erosion, spills from the storage pad, effects of the gravel dust shadow, thermokarsting effects, or other changes in hydrological patterns, relative to valve locations in the highly active flood zone and the production pad occurring within 100 ft from the Sakoonang Channel and lake shores, has not been addressed.

Response:

Erosion, spills, thermal degradation, and hydrology have been evaluated in siting the Alpine facilities and in other design features.

Current development plans will not cause significant erosion problems. Floodwater velocities throughout the Colville River delta outside the stream channels are generally very low. The maximum expected water velocities during the 50-year flood conditions are less than 2 feet per second around the margins of the gravel pads; below erosional velocities. For the 200-year flood conditions those water currents are calculated to be approximately 2.5 feet per second. These velocities are documented in "Colville River Two-Dimensional Surface Water Model (7/97)." While the 200-year water velocities are high enough to move fine sand, the gravel constituent of the gravel pads protects the sand fraction and no erosion is expected. The effects of wind waves during flood conditions are currently being analyzed to determine if armoring the gravel side slopes is warranted to minimize erosion. This information will be available by August 15, 1997.

The storage pad will be used primarily to store non-liquid oilfield materials such as dry bentonite and oil field tubulars which include casing and well tubing. The only liquid in the storage pad will be small amounts of hydrocarbon-based drilling chemicals; it will be stored within a lined containment area on the storage pad. This containment area will be constructed in compliance with Alaska Dept. of Environmental Conservation (ADEC) regulation 18 AAC 75.075. Consequently, spills from this pad are not a major issue.

Dust levels from traffic will be low. Dust generation is closely associated with high traffic levels on gravel roads. It is anticipated 4-6 vehicles will use the 3.3 mile road between the main production pad and Drill Site 2 on a daily basis. Furthermore, 12-15 round trips are anticipated on the road per day during construction and drilling with significantly fewer during operation.

Thermokarst topography results from thawing and caving of thaw-unstable permafrost. Alpine Development facility gravel pads and roads will be nominally 5 feet thick. Thermal analysis shows that this is the thickness of gravel that will thaw in a typical summer, without the thaw penetrating the underlying permafrost. This will prevent thermokarst formation at the pad sites. The Alpine pipelines will not affect the ground thermal regime, and thus will not cause thermokarsts to form.

Extensive hydrologic modeling has been performed to predict both the effects of the Alpine Development on hydrologic patterns and the hydrologic patterns on the Alpine Development. The results are documented in "Colville River Two-Dimensional Surface Water Model (7/97) (Appendix M)." The potential locations of valves with respect to the flood zone and regulations have been closely examined. In order to reduce the concerns about valves and the associated risk of spills we have proposed a "vertical loop" system. This concept is presently being reviewed by the US DOT. If our proposal for the loops is not adopted by DOT then we will proceed with our current plan. Our current design incorporates valves sited outside the flood zone. The production pad location was carefully evaluated considering habitat and hydrology. The production pad is set back at least 135 feet from the Sakoonang Channel. The production facilities on the pad are at least 200 feet from the Sakoonang Channel. A Sakoonang Channel bank migration study is underway to determine the long term stability of the bank and if mitigative actions must be performed. This study is anticipated with the results available by September 1, 1997. All the facilities on the production pad are set back at least 200 feet from the adjacent lake to the west (#9313). A small portion of the production pad, used as roadway, is within the 200 foot set-back from the lake. In addition, the production pad will be graded to direct storm water runoff or a spill to a collection sump on the pad.

50. Issue:

Respond to the comment that alteration of surface flow caused by the gravel pit, or the transition zone where the pipeline goes underground could lead to rapid changes to the thermal regime of the adjacent areas or to downstream hydrology.

Response:

The gravel mine site referenced is a regional pit that will be developed, excavated and closed out by Nuiqsut Constructors pursuant to USACE Permit Colville River 17. Its operations are therefore outside AAI's control. We assume this issue was resolved during the processing of Colville River 17. AAI is one of several customers that will purchase gravel from the mine site developers. It is AAI's understanding, based on the permit granted to Nuiqsut Constructors, that each gravel pit cell will be developed and closed out each winter season. The overburden removed for gravel extraction will be returned to the pit during pit close out and prior to breakup with none left on the surrounding tundra to affect surface water flows. As a result, there should be no hydrologic impacts of the gravel mining process. Moreover, the mine site is to be rehabilitated to improve nesting and rearing habitat for waterfowl by the construction of islands in water too deep for foxes to wade and the addition of shallow water areas around the site perimeter for potential fish habitat.

The pipeline transitions have been designed to have minor changes to the surface water flows due to the small transition zone footprints and their locations on terrain above average flood levels. Consequently, there will not be any measurable thermal regime changes. Similarly, the transitions will not alter the non-flood surface flows or the thermal regime.

Design of the pipeline transitions is based upon extensive, three-dimensional, thermal modeling that accounted for heat input from the pipelines, heat removal by thermal siphons, heat transfer through the soil and insulation, and other pertinent factors. Modeling results were used to design the below ground to above ground transitions. The design limits thawing of unstable permafrost and maintains the stability of each transition. Details of the analysis and transition design are documented in the "Alpine Development Colville River Crossing Design Report (6/2/97) (Appendix M)," submitted to the JPO and USACE. Important design Report details related to stability of the transitions are summarized below.

- Thaw unstable soils in the transitions that would be affected by the pipeline will be excavated and replaced with the thaw stable materials.
- Insulation will be installed on the outside of the casing to minimize growth of the thaw bulb.
- Insulation will be installed near the surface of the backfill to control surface heat flow.
- Thermal siphons for passive refrigeration will be installed along the length of the pipeline between the high river bank and exit point on each side. These siphons will extract heat from the ground above the pipeline and maintain the thermal stability of the transitions.
- The transitions will be instrumented with thermistors that will be used to periodically monitor the performance of the transition design.

These techniques are proven technology and are widely used on the Trans-Alaska Pipeline System, North Slope foundation designs, and are consistent with worldwide arctic practice.

51. Issue:

Respond to the comment that flooding and attendant hydrological changes could affect the structural integrity of the river crossing where the pipelines come out of the ground, as these locations are within the floodplain.

Response:

The design of the pipeline transition areas ensures that hydrological changes and flooding will not affect the structural integrity of the pipeline. Details of the Colville River crossing transition design are provided in the "Alpine Development Colville River Crossing Design Report (6/2/97) (Appendix M)," submitted to the JPO and USACE. The following design elements, documented in the report, address structural integrity of the pipeline transitions as related to hydrology and hydrological changes:

- cased pipelines will extend above the design 200-year flood elevation;
- ground elevations surrounding the transition pads preclude thick ice from reaching the pipelines;
- cased pipelines will be located beyond the scour and long term bank migration limits; and

- thermal stability will be ensured through the project life.

Further discussion about thermal stability is included in response to Issue No. 50.

52. Issue:

The transition zone where the pipeline comes out of the ground, and is still within the floodplain, is vulnerable to melting permafrost and solifluction.

Response:

See response to Issue No. 50. Conditions for solifluction do not exist at either transition.

53. Issue:

Respond to the concern that corrosion (resulting from carrying a mixture of oil, water, and natural gas) of the sales pipeline may cause a leak.

Response:

The sales oil pipeline will not transport a mixture of oil, water and natural gas. The sales oil pipeline will transport clean sales quality crude oil, which is similar to that transported by the Alyeska pipeline, and is not corrosive.

54. Issue:

What precautions will be taken to prevent a leak in the diesel line?

Response:

The diesel pipeline has been designed in conformance with all applicable codes and regulations. It will be constructed of 2-inch diameter by 0.156 inch wall thickness, 52 ksi yield strength coiled tubing, with a maximum allowable operating pressure of 2160 psi. The wall thickness of the pipeline will be several times greater than the wall thickness required to withstand the loads expected during construction and operation. (Alpine Project Overland Hydraulics Report June 1997, Appendix M). No additional preventative measures are warranted considering the fluids being transported do not have significant corrosive tendencies and the line will be operating at low ambient temperatures, which will further limit corrosion potential.

55. Issue:

Mention is made of storage tanks for fuel and hazardous materials at the production site, but nothing is said about the spill response for these.

Response:

AAI will emphasize spill prevention regarding hazardous materials. AAI's facilities will include secondary containment structures as required by state and federal regulatory requirements. AAI intends to locate its storage tank and processing facilities away from the Nechelik Channel to avoid and minimize any potential spill impact. AAI will provide employee training and its operating procedures will comply with state and federal regulatory requirements.

AAI will also develop an approved oil discharge prevention and contingency plan prior to start-up of production at Alpine. As explained in response to Issue No. 3, the plan will provide for a response team and the pre-staging of response equipment and materials.

56. Issue:

Respond to the comment that most of the ground bird surveys conducted during 1992 and 1993 took place in the northern area of the delta, not in the current project area. In 1995, the ground survey work shifted to the vicinity of the proposed Alpine facilities, but during the 1995 studies, the drill site and pipeline locations were not the same as in the current proposal.

Response:

Each year bird surveys were conducted in locations where oil development was expected, given the best information that was available at the time. The location of the oil reservoir has been more reliably defined, from continued exploration and testing. In 1992, ABR, Inc. did not conduct ground surveys at the currently proposed project area, but conducted surveys on 3 plots (4.8 x 9.6 km each) where development was then likely to occur. In 1993, ABR conducted brood surveys around the lakes just south of the proposed airstrip (thus the southern portion of the project area), where they found Tundra Swans, Yellow-billed Loons, Pacific Loons, and a brood of Red-throated Loons. In 1995, ABR did conduct nest and brood surveys in the proposed project area. Although the location of the footprint that year was not the same as the one currently proposed, the area searched on the ground encompassed the current footprint including the 200-m and 1,000-m buffers around the footprint (termed the Facility Area). In 1996 and during the 1997 field season, ABR again searched on the ground the area encompassing the currently proposed Facility Area. In addition to the 3 years of ground surveys in the project area, aerial surveys have been conducted over the project area since 1992.

57. Issue:

Studies by AAI did not include the rich diversity of other waterfowl, shorebirds, and passerines.

Response:

Prior to initiating studies on the Colville delta in 1992, AAI, ABR, and the USFWS conferred on the scope of studies that should be conducted. The group agreed that ABR should collect baseline data on the distribution and abundance of those species of regional importance, rare or sensitive status, and for which government agencies had special concerns. At that time, shorebirds, passerines, and waterbirds other than Tundra Swans, Brant, Yellow-billed Loons, and Spectacled Eiders did not meet those criteria for inclusion in the study. Nonetheless, ABR collected information on many of these other species during aerial and ground surveys. In 1995, ABR began systematically collecting nesting information on all waterfowl in the Facility Area. Beginning in 1996, ABR conducted separate aerial surveys for brood-rearing and fall-staging geese on the delta. In 1996, ABR also initiated an intensive ground-based breeding bird survey to enumerate the birds of all species that nest in or inhabit the project footprint. This survey was designed specifically to investigate species diversity in the footprint area.

58. Issue:

AAI's statement that mitigation on airstrip construction and operation avoids sensitive wildlife use periods, is simply not true because aircraft restrictions would not be in effect during the onset of the breeding season, nor during the sensitive molting, fall staging, or migratory periods.

Response:

Birds can be sensitive to noise disturbance during any life history stage. However, during nesting, waterbirds are restricted to one site for 2 to 4 weeks, and disturbance during this period can lead to nest failure. Most waterfowl and loons tend to nest after 1 June and all but a few species hatch by 15 July. Following nesting, waterbirds typically move from nest sites to other locations and different habitats, and generally are capable of moving away from disturbance sources (e.g., an airstrip) if necessary. Following consultation with resource agencies, it was judged that activity at the airstrip would likely be the primary disturbance to nesting birds, with minimal disturbance associated with other project facilities. Thus, with concurrence from resource agencies, AAI concluded it was most appropriate to focus mitigation for birds on aircraft activity during the nesting season. The restriction on aircraft operation from 1 June to 15 July primarily alleviates disturbance to nesting birds. The period of aircraft restriction is a compromise between the needs of the project to maintain its operation and safety considerations, and the need to mitigate disturbance to birds.

59. Issue:

Specify the amount of water needed for drilling and operations during the life of the project.

Response:

Approximately 10 million gallons of water will be needed for one season (1997-98) to support the HDD crossing construction. Approximately 42 to 65 million gallons of water will be required for ice road construction each year during Phase I and II of project, but during Phase III of the project an ice road will only be needed every 3 to 5 years. The estimated annual potable water requirements for drilling, service contractors, construction and production are as follows:

1998 Pad Construction	3.2 million gallons
1999 Pre-Startup Drilling	5.6 million gallons
2000 Facility Construction	8.9 million gallons
2001 - 2003 Drilling and Production	5.2 million gallons
2004 and Long-term Production	2.7 million gallons

AAI will be able to satisfy the Alpine Project's demands for water through nearby available water. Based on ADF&G's limitation of withdrawals to 15% of the volume of water under ice in lakes greater than seven feet deep, the projected annual water available through permittable withdrawal in the Alpine Development area is 447 million gallons; six times more water than the projected water requirements in any year. This permittable volume assumes annual recharge under normal weather conditions.

In the vicinity of the Alpine facilities, the proposed water source (Lake 9313) is characterized as a perched lake with infrequent flooding and it has a permittable volume of 4.0 million gallons. ADF&G has indicated that recharge of this lake may be permitted from the Sakoonang Channel. Other lakes are available in the facilities area as potable water sources capable of providing 30 million gallons.

In the vicinity of the HDD crossing, approximately 53.7 million gallons of water are available from nearby drainage sources (Lakes L9334 and M9603). See Figures 2 and 3.

There are many lakes spaced along the route of the ice road from which water could be withdrawn, thereby lessening the impact to any single lake. For example, Lake 9123 near KRU contains 31.8 million gallons of permittable water; Lake 9116 between KRU and the Colville River contains 42.4 million gallons; moving across the river toward the Alpine facilities, Lake 92-73A contains 34.3 million gallons; and moving north towards the facilities, Lake 92-82 east of Sakoonang contains 41.4 million gallons. A fraction of each of the volumes listed about could be utilized in any given year.

60. Issue:

There would be a significant direct effect to the subsistence economy of North Slope residents. Give serious attention to the diverse mix of river and wetland habitats in the Colville delta for maintaining the Native Socioeconomic systems needs.

Response:

There will be two types of direct effects on the economy of the subsistence user community of the Colville River delta as a consequence of the Alpine Development project. One, enhanced incomes of some subsistence users as a result of employment and wages earned from Alpine related work or native corporation dividends may be in part invested in subsistence gear and equipment (boats and motors, snow machines, fuel, fishing and hunting gear) that are essential elements of contemporary subsistence practices. Two, such investment may produce increased pressure on some basic subsistence resources (e.g., caribou, moose, waterfowl, fish).

However, any anticipated increase in such pressure on resources is not likely to be significant other than the contribution which may be made to greater efficiency in subsistence harvests. There will be no distortion of the subsistence economy nor of subsistence users' heavy and direct dependence on it for supplying food and basic cultural needs as a foreseeable consequence of the Alpine Development. The principal mechanism for insuring that local subsistence practices, access, areas, and time periods are not adversely impacted will be the basic work and concern of the Subsistence Oversight Panel formed jointly between members of the subsistence user's community and the project operator (AAI).

Matters involving the maintenance of the diverse mix of river and wetland habitats are being addressed directly in the proposed design of the facilities planned for Alpine (see Environmental Evaluation Document and supplementary documents and studies). The only conceivable impact to streams and rivers which might result from the project are linked to oil spill scenarios in which pollutants could enter watercourses and possibly render small areas unusable for subsistence harvest in the course of the season in which the spill occurred. There will be minimal loss of wetlands habitat in the delta (111.3 acres) owing to the placement of gravel for pad, facility, and road construction. Engineering characteristics designed specifically to preserve delta wetlands functions and waterflow (i.e., culverting, facility alignment and site placement to avoid obstructions, etc.) are fundamental components of the project. Therefore, wetlands habitats utilized principally by migratory waterfowl will be affected only minimally.

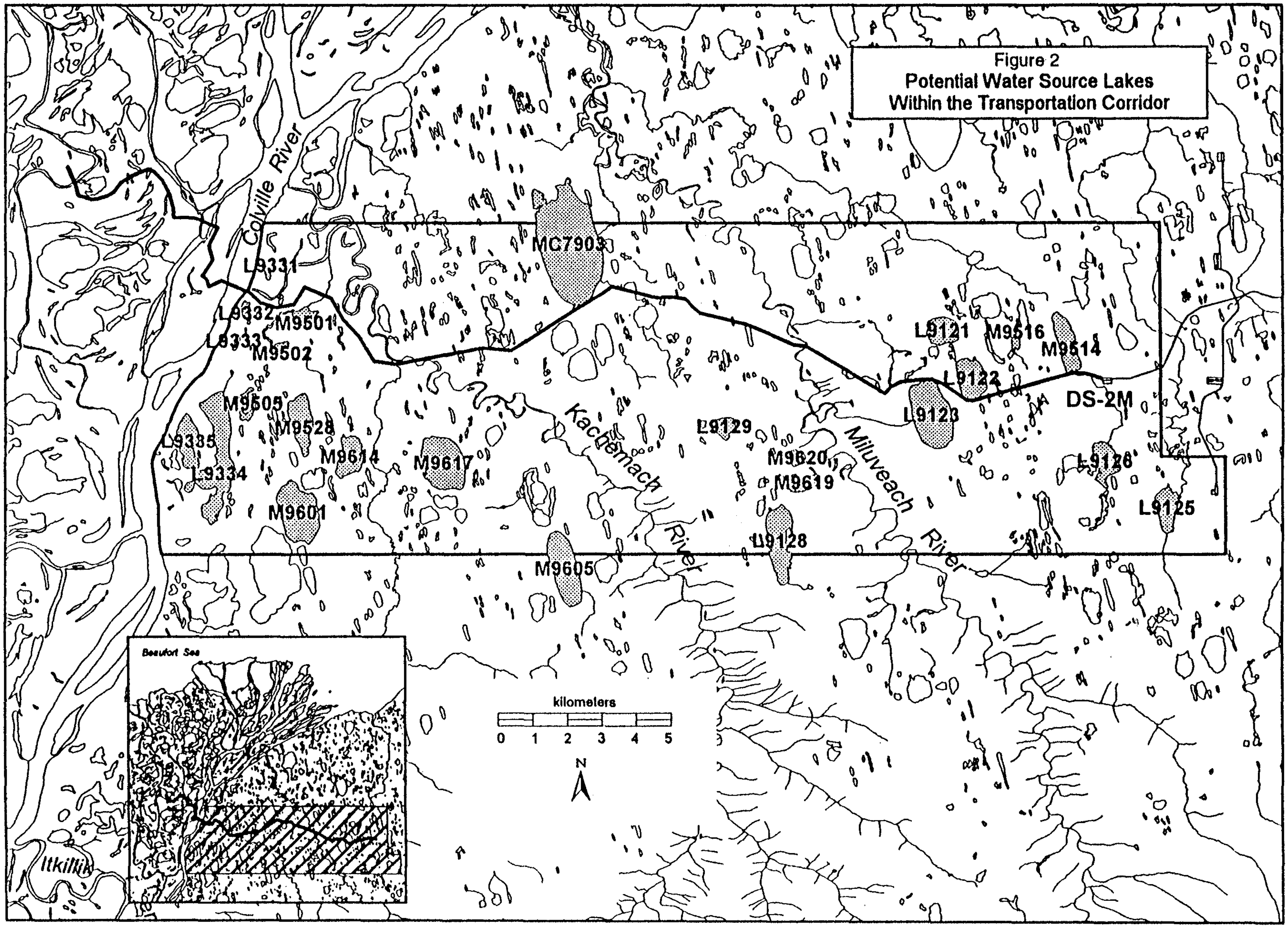


Figure 2
Potential Water Source Lakes
Within the Transportation Corridor
Colville River
Kachemach River
Miluveach River
Itkillik
MC7903
L9331
L9332
L9333
M9501
M9502
M9505
M9528
L9335
L9334
M9614
M9617
M9601
M9605
L9129
M9620
M9619
L9128
L9121
M9516
M9514
L9122
L9123
DS-2M
L9126
L9125
kilometers
0 1 2 3 4 5
N
Beaufort Sea

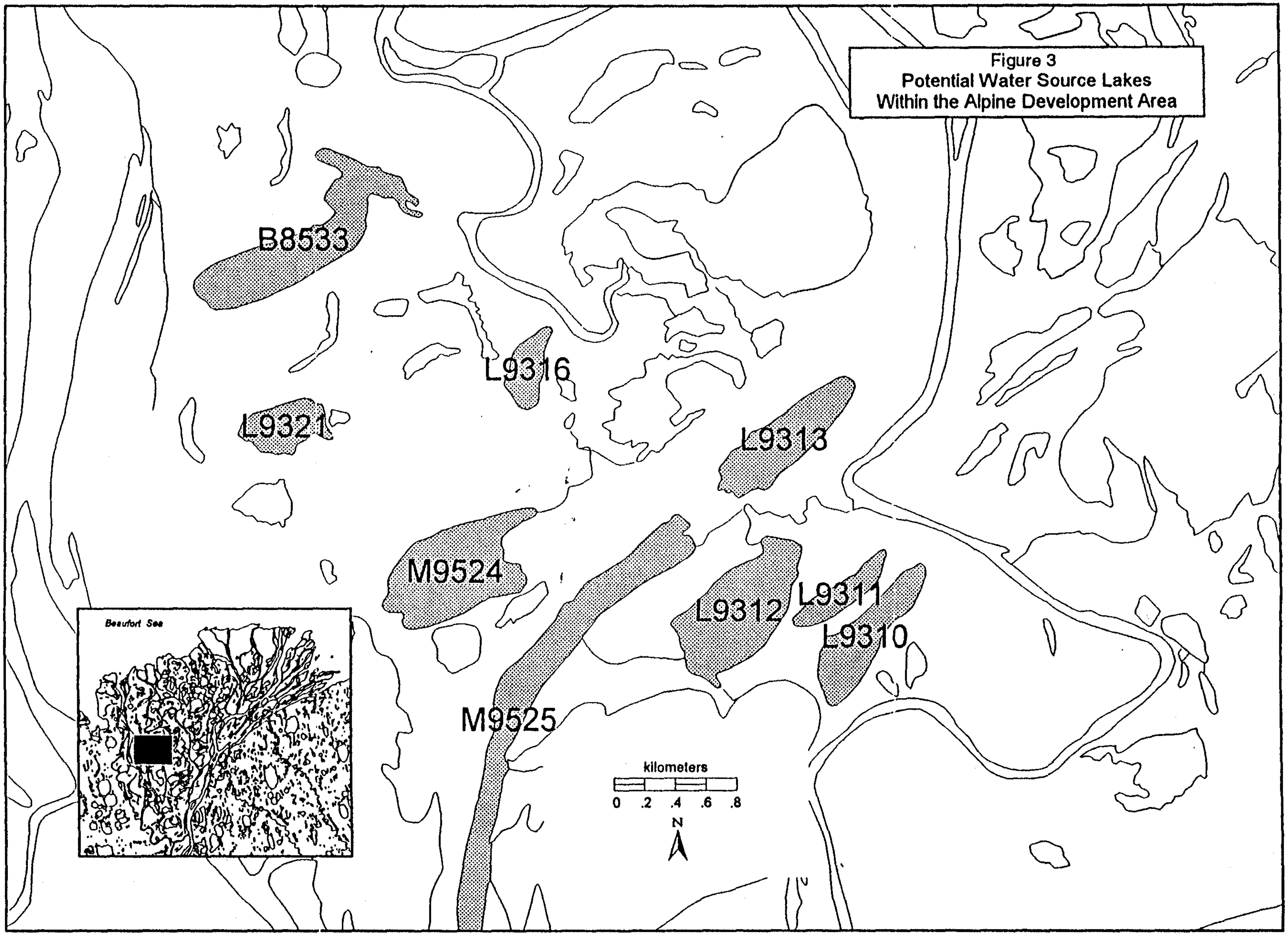


Figure 3
Potential Water Source Lakes
Within the Alpine Development Area
B8533
L9321
L9316
L9313
M9524
M9525
L9312
L9311
L9310
Beaufort Sea
kilometers
0 .2 .4 .6 .8
N

61. Issue:

The Alpine development is the "gateway" to the NPR-A, a driving force for more oil extraction to the west.

Response:

AAI does not believe that Alpine is the "gateway" to the NPR-A. Alpine is a stand-alone project that is not dependent on the leasing, exploration or development of NPR-A. AAI proposes to develop at Alpine a relatively small oil field using state-of-the-art technology. These technological advances allow AAI to develop this field with a much smaller footprint and with no significant environmental impact. Moreover, the possible development of NPR-A, an area where there are currently no scheduled lease sales and where previous drilling did not find commercial deposits of oil and gas, is highly speculative. Finally, the Department of Interior is undertaking an extensive EIS effort to examine closely the environmental impact of the possible development of NPR-A. That EIS should carefully examine the existence of Alpine as it looks at the cumulative impacts of possible further development in the region.

62. Issue:

The proposed natural gas pipeline to Nuiqsut is an indirect impact and its environmental impact should be evaluated in EIS.

Response:

As more fully described in the response to USFWS, Issue No. 7, AAI will consider in its revised EED all proposed and potential developments that are "reasonably foreseeable."

63. Issue:

Need to analyze in an EIS the indirect impact of future plans for road from Kuparuk to Alpine or Nuiqsut.

Response:

As more fully described in the response to USFWS Issue No. 7, AAI will consider in its revised EED all proposed and potential developments that are "reasonably foreseeable."

64. Issue:

With respect to cumulative impact, need to consider (1) possible further impacts to caribou calving distribution and reproductive success of the Central Arctic herd; (2) impact of pending offshore oil development proposals, such as BP's Northstar and Liberty; (3) fact that indirect impacts can lag behind planned development and the total area eventually disturbed can greatly exceed the planned area of construction.

Response:

See responses to Issues No.7, No. 8, No. 16, and No. 61.

65. Issue:

The spectacled eider is a threatened species which is likely to be impacted by the Alpine project. The Corps must consult with the FWS to ensure the project will not jeopardize the bird.

Response:

As indicated in USFWS's letter to the Corps dated June 6, 1997, the Corps has informally consulted with USFWS regarding the spectacled eider. USFWS has concluded that neither a Biological Assessment nor further consultation is necessary at this time.

COMMENTS OF THE NORTH SLOPE BOROUGH, JUNE 9, 1997

66. Issue:

Under Special Area Designation, the Colville River has not been designated as an Area Meriting Special Attention within the North Slope Borough's Coastal Management Program. This was proposed for this designation, but not formally adopted as part of the program.

Response:

Comment noted. No response required.

67. Issue:

The area where the Alpine field is located and the pipeline access route will require public hearings before the NSB Planning Commission and Borough Assembly to rezone the area from Conservation District to Resource Development District.

Response:

AAI is preparing to submit an application to NSB for the re-zone of the project area and pipeline Right-of-Way. from the Conservation District to Resource Development District classification. The application should be submitted the week of July 21, 1997.

68. Issue:

Respond to the comment that oil spill response planning appeared to be inadequately funded to respond to an emergency.

Response:

Local knowledge will be incorporated through consultation with the Subsistence Oversight Panel. Also see response to Issue No. 3.

69. Issue:

Respond to the comment that concerns over the minimum height of the pipeline at 5 feet is less than 5 feet during winter snow conditions. This situation could unreasonably hinder caribou migration and subsistence hunter access during the winter months. AAI has suggested an alternative to provide vertical expansion loops in the pipeline which will have to be weighted on its merits by the Planning Commission and Borough Assembly.

Response:

AAI addressed this comment in its May 21, 1997 letter to the USACE. Design specifications for pipeline heights and configuration (e.g., vertical expansion loops) have been engineered to meet concerns regarding all season wildlife and human use passage. Also see response to Issue No. 3 for discussion of vertical loops.

70. Issue:

The route proposed for the pipeline and under river crossing of the pipeline are concerns because the planning for the route and crossing appear to have gaps in information regarding Colville River hydrology and local knowledge on the river dynamics regarding breakup and ice damming events. The NSB is concerned that failing to account for local knowledge in these events could significantly increase the likelihood for an oil pipeline rupture and spill. The Colville River is a significant source of subsistence food for the people of Nuiqsut and provides critical habitat to fish, waterfowl and wildlife. Significant damage to the Colville would likely result in severe hardships on all who depend on it for food.

Response:

See response to Issues No. 3 and No. 60.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, SEPTEMBER 6, 1996. (These comments were submitted prior to completion of the EED. In addition, it should be noted that EPA has had extensive verbal communication with the USACE that has been coordinated with AAI and is reflected throughout this document.)

71. **Issue:**

Consider the cumulative effects of this project and other future projects.

Response:

See response to Issue No. 7.

72. **Issue:**

The effect of the Alpine Project on the subsistence culture of the area, most particularly in the village of Nuiqsut.

Response:

See response to Issue No. 60. Section 4.3 of the EED provides an extensive discussion of the subsistence culture and the effect of the Alpine Project on it.

73. **Issue:**

The Colville River delta is widely recognized as an area of diverse high value habitat for a wide range of animals and plants. Impacts will have to be assessed and mitigation measures developed for this landscape where there is little information to draw upon.

Response:

AAI has conducted multi-year studies of the fish, wildlife, and habitat of the Colville River delta to compile a baseline of information. This information combined with consultation with the agencies, local communities, and other interested parties will provide the foundation for assessing impacts and developing mitigation. AAI has also committed to implementing a monitoring program to update the database and provide an opportunity to adjust operations to avoid or minimize impacts and assess the effectiveness of mitigation measures. Sections 4.4 and 4.7 of the EED address impacts and Sections 2.9 and 2.10 discuss mitigation. Additional information is provided in responses to Issues No. 2, No. 11, No. 13, and No. 58.

74. **Issue:**

No oil spill contingency plan has ever had to be developed for development in the middle of such a large river delta that has such high habitat value and is the basis of a subsistence economy.

Response:

AAI appreciates the concern expressed in this comment. In order to address an oil spill event, AAI is committed to developing a comprehensive base of information for designing an effective oil spill contingency plan. In addition to fish and wildlife studies, AAI is also conducting a delta-wide project to map delta features necessary to determine critical locations for staging a spill response. Furthermore, development of the plan will be closely coordinated with the effected communities and agencies so that local knowledge is fully incorporated into the plan. This process combined with a state-of-the-art spill prevention and detection program as described in response to Issue No. 3 will greatly reduce the likelihood of a spill event.

75. Issue:

It seems likely that the Alpine Project, as it is presently known, will require EIS.

Response:

See Issue No. 20.

COMMENTS OF PAMELA A. MILLER, JUNE 6, 1997 AND AUGUST 12, 1997

76. Issue:

The Alpine Development Project will negatively impact wetlands habitats used by waterfowl, shorebirds, and other waterbirds (e.g. loons). Specific areas that will be impacted are based on field studies conducted by Ms. Miller in 1986 and lie within the Alpine project area and pipeline corridor.

Response:

AAI has incorporated all information available for the Colville delta to describe wetland habitats including the USFWS reports describing studies referred to by Ms. Miller (i.e. Some Bird Observations on the Colville River Delta, 1986, in the Proposed Alpine Oilfield Area, by Pamela A. Miller). This information, in combination with AAI and other studies was used to develop wildlife habitat use. All habitats in the delta and transportation corridor were mapped at a high resolution to assess the project impacts. This approach was developed in conjunction with USFWS, EPA, ADF&G, NMFS and the USACE. This is discussed in detail in section 4.4.2.1, pp. 4-85 of the Alpine EED. Also see response to Issue No. 57.

77. **Issue:**

Disturbance to birds from aircraft noise and operations is not adequately addressed in the EED.

Response:

See Issues No. 2, No. 44, and No. 58 for detailed responses to this issue.

78. **Issue:**

There is potential for a catastrophic oil spill at the main Colville River pipeline crossing. Other spills may occur in sensitive flood plain areas.

Response:

See response to Issue No. 3 for discussion of oil spill issues.

79. **Issue:**

The Alpine project will impact the subsistence livelihood of Nuiqsut residents.

Response:

See response to Issue No. 60 for discussion of subsistence impact issue.

80. **Issue:**

The proposed Alpine project reaches a significant "threshold" of cumulative impacts from oil and gas development on the North Slope generally and will serve as a "doorway" to future development in the NPR-A.

Response:

See response to Issue No. 61 for discussion on cumulative effects.

81. **Issue:**

The Alpine project will cause significant negative effects on the human and natural environments and therefore requires preparation of an EIS.

Response:

See response to Issue No. 20.

APPENDIX L-1

ATTACHMENT 1

ATTACHMENT 1

ASSESSMENT OF POTENTIAL AFFECTS OF ALTERATION OF CROSS-DRAINAGE ON WETLAND HABITATS NEAR IN-FIELD FACILITIES

Prepared by Torre Jorgenson, ABR, Inc., 9 July 1997

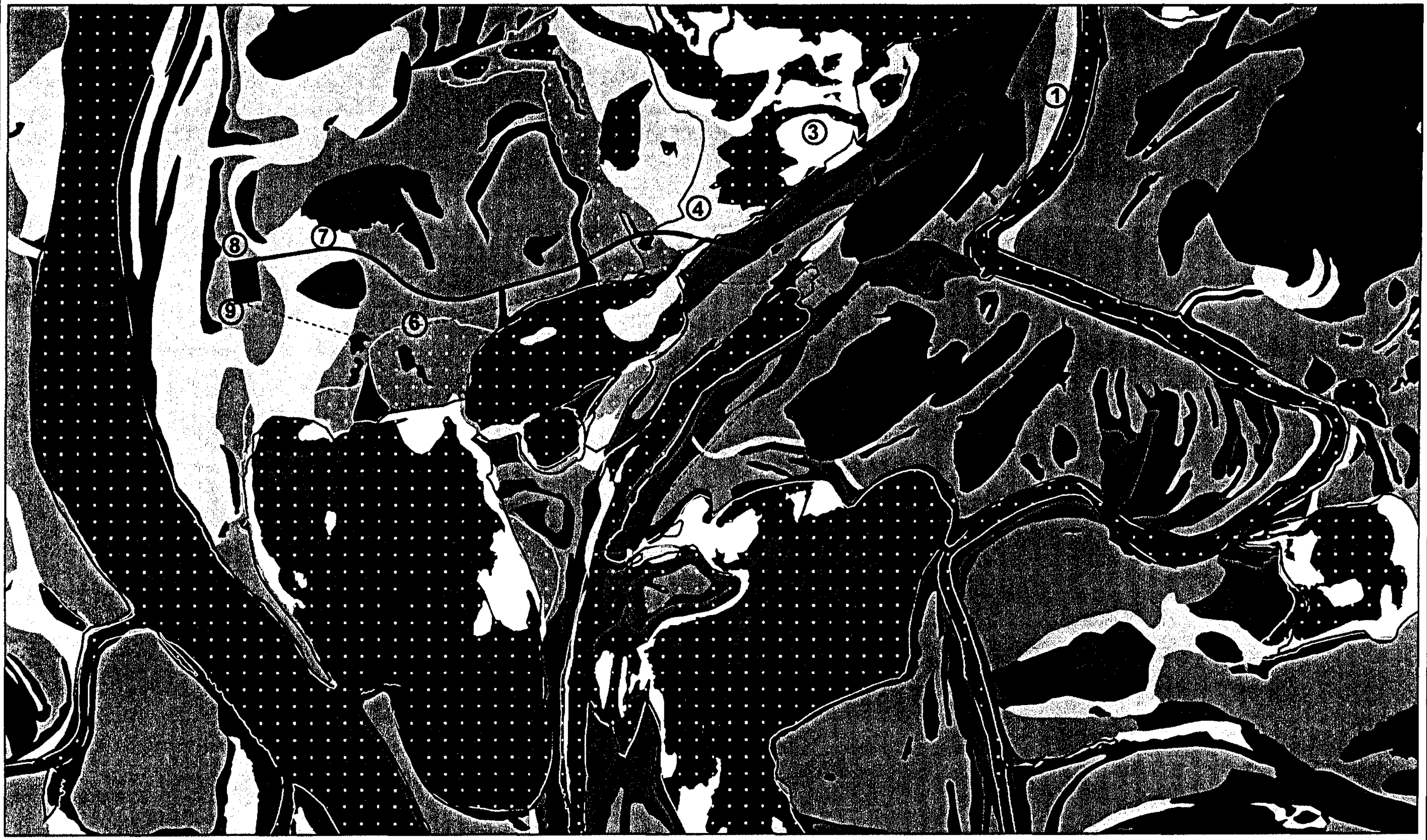
INTRODUCTION

The placement of gravel pads and roads within the in-field facilities area of the Alpine Development Project potentially could have some minor effect on the wetland habitats above and below the proposed facilities. To evaluate these potential impacts, this assessment provides a description of the affected environment and qualitative predictions of what changes may be expected to occur due to changes in hydrology and sedimentation. The description of the affected environment shows how past events have affected wetland habitats, including 1) a description of ecological changes that presently are occurring in the area due to tapping of Nanuk Lake, and 2) a delineation of areas that were observed to be flooded in 1995 and 1996. The description of the affected environment also identifies the ecological conditions required by the various wetland habitats. The assessment of potential impacts includes 1) predictions of changes in water depths and water velocities during the 2-, 50-, and 200-year flood events and 2) predictions of how wetland habitats may respond to those changes at specific locations that are most likely to be affected.

AFFECTED ENVIRONMENT

Habitat Changes Due to Tapping of Nanuk Lake

Nanuk Lake is one of the more recently drained lakes in the delta and was tapped sometime before 1949 (Walker 1983). Since 1955, the entrance to the lake has enlarged, and rapid sedimentation has increased the amount of barren mudflats in the basin from approximately 10% of the basin area in 1955 to 50% of the basin area in 1992 (Jorgenson et al. 1996). Even at relatively low flood stages (2-yr event) water moves through the basin and continues through a Tapped Lake with a High-Water Connection (Location 5, Lake No. M9524) and a Tapped Lake with a Low-Water Connection northeast of Nanuk Lake (Location 3, Lake No. L9278, Figure 1). The amount of barren flats in the Tapped Lake with Low-water Connection (near Location 3) has increased approximately 5% since 1955. Rapid sedimentation in these newly drained lake basins over the past several decades has elevated the surface and created a variety of new wetland habitats including Barrens, Salt Marsh, and Nonpatterned Wet Meadows. The input of saline nearshore marine water into the basins has contributed to the establishment of halophytic vegetation in these areas.



Tapped Lake w/ Low-water Connection
Tapped Lake w/ High-water Connection
Salt Marsh
Salt-killed Tundra
Deep Open Water w/o Islands
Deep Open Water w/ Islands or Polygonized Margins
Shallow Open Water w/o Islands
Shallow Open Water w/ Islands or Polygonized Margins
River or Stream
Aquatic Sedge w/ Deep Polygons
Aquatic Grass Marsh
Nonpatterned Wet Meadow
Wet Sedge-Willow Meadow
Moist Sedge-Shrub Meadow
Riverine or Upland Shrub
Barrens (riverine, eolian, lacustrine)
Artificial (water, fill, peat road)
1995 Flooding Extent
1996 Flooding Extent

1 Potentially Affected Areas

N

0 0.25 0.5 0.75
Miles

ARCO Alaska, Inc.

Alpine Development

Areas Potentially Affected by Drainage Changes

ABR, Inc.
Environmental Research and Services

15 Aug 1997 | File: Hab4_95-96Flood_Infield.apr

Past Flooding Observations

Direct observations of the distribution of floodwaters in the facilities area were made during 1995 and 1996 (Jorgenson et al. 1997). In both 1995 (233,000 cfs) and 1996 (160,000 cfs), discharge at the head of the delta (Cross Section 6) was near or below the discharge (240,000 cfs) estimated to be associated with a 2-yr flood event. During these two years, flooding mostly was limited to Tapped Lakes, Barrens, and Salt Marsh and Nonpatterned Wet Meadows within drained lake basins (Figure 1).

Ecological Characteristics of Wetland Habitats

Wetland habitats within the delta are influenced by abiotic (e.g., hydrologic regime, sedimentation, nutrient input, soil moisture, salinity) and biotic (e.g., competition, grazing) factors, and the life history traits of the individual organisms. Overall, vegetation on the floodplain is adapted to periodic flooding and forms a mosiac of diverse patches that are constantly responding to changes in environments due to erosion and sedimentation. Some of the physical factors affecting plant distributions on the delta are presented in Table 1.

Habitats that occur at lower levels of the floodplain include Riverine Barrens, Salt Marsh, and Aquatic Grass Marsh. They are subject to frequent flooding and groundwater near or above the surface. The lack of organic matter accumulation indicates that sedimentation is frequent. Presumably, the sediment is a source of nutrients and a natural disturbance that promotes growth of plant species that can respond rapidly to increased nutrient input.

Riverine Shrubs occur on Active-floodplain Cover Deposits at slightly higher relative elevations. This habitat is flooded approximately every 3–4 years and the frequent sedimentation prevents the buildup of organic matter. The shrubs are associated with well-drained soil along point bars and cutbanks. Groundwater typically is absent during mid-summer and soils are nonsaline.

Inactive-floodplain Cover Deposits support a variety of habitats including Aquatic Sedge-Marsh with Deep Polygons, Nonpatterned Wet Meadows, and Wet Sedge-Willow with Low Relief Polygons. They are flooded infrequently, approximately every 5-25 years. The interbedded organic and mineral horizons in the soil indicate that sedimentation is infrequent. Groundwater typically is near the surface throughout the growing season.

The highest portion of the floodplain has Abandoned-floodplain Cover Deposits that support Wet Sedge Willow with Low Relief Polygons (high density) and Moist Sedge-Shrub Meadow. The habitats are rarely flooded. The soils typically have a thick organic horizon at the surface reflecting rare sedimentation. Groundwater is near the surface in wet meadows and slightly deeper in moist meadows. The abundance of evergreen shrubs indicates nutrient availability is low and that flooding is too rare to have substantial ecological effects.

POTENTIAL IMPACTS

Nine areas above and below the facilities that are most likely to be affected by changes in hydrologic regime and sedimentation were identified (Figure 1). These areas were identified based on changes in water depths and water velocity predicted from a two-dimensional hydrologic model developed by Shannon and Wilson, Inc. and knowledge of ecological conditions in the area. Predictions are based on the assumption that culvert design will allow passage of water associated with a 2-yr flood event. The likely response of habitat conditions to hydrologic changes at these locations is presented in Table 2 and is discussed below.

Location 1, situated at the eastern end of the facilities and along the Sakoonang Channel, will not be affected by 2-yr-flood events. During larger flood events, a small portion of the gravel pad may be inundated and cause small, localized changes in water velocity and sedimentation. This area already is subject to infrequent sedimentation, however, and its characteristics are unlikely to change as a result of the facilities.

Location 2, situated upslope of the proposed airstrip, supports Moist Sedge-Shrub Meadows on an Abandoned-floodplain Cover Deposit. It is not affected by 2- and 50-year flood events and it is uncertain whether it is affected by a 200-yr event. Due to the gentle nothernly slope, the area can be affected by impoundment of water from snowmelt. The high-centered polygons and the dense network of polygonal troughs makes delineation of surface-water drainage difficult. Culvert placement will prevent development of large impoundments. However, small impoundments limited to a few troughs is likely. Such impoundments are likely to increase thaw depths within the troughs and lead to small, localized occurrences of thermokarst over a period of decades. The potential effect is minor.

Location 3, situated in a drained thaw lake basin, supports Salt Marsh and shallow brackish ponds. During a 2-yr-flood event, the hydroperiod, water depths, and sedimentation rates are unlikely to be substantially affected by the road and culverts upstream of the site, although there may be some minor redistribution of flow because flow is restricted through culverts. During larger flood events, limiting flow to the capacity of the culverts will slightly reduce flow and sedimentation in the distal portions of the basin. Reduced sedimentation will slow sediment accretion and likely will cause the salt marsh vegetation and shallow ponds to persist for more decades than would otherwise occur. Even at the normal sedimentation rates, sediment accretion gradually will raise the surface and facilitate the development of wet sedge vegetation as the soils become less saline. This development will be slightly delayed by the road. These potential effects at Location 3 are minor.

Location 4, situated in a drained thaw lake basin, supports Wet Sedge-Willow Meadows. During a 2-yr-flood event, the hydroperiod, water depths, and sedimentation rates are unlikely to be substantially affected by the road and culverts upslope from the site, although there may be some minor redistribution of flow because it is channelized through culverts. During larger flood events, limiting flow to the capacity of the culverts will moderately reduce flow and sedimentation in the basin. The vegetative composition of Wet Sedge-Willow Meadow is unlikely to be altered by the decrease in sedimentation, however, because the vegetation is adapted to a wide range of flooding conditions. Productivity, however, could be expected to be reduced slightly due to reduced sediment and nutrient input. These potential effects at Location 4 are minor.

Location 5, situated in shallow water within a thaw lake basin, supports the Aquatic Grass Marsh with the emergent *Arctophila fulva*. During a 2-yr-flood event, the hydroperiod, water depths, and sedimentation rates are unlikely to be substantially affected by the road and culverts downslope from the site. During larger flood events, limiting flow to the capacity of the culverts will reduce overall flow and sedimentation in the basin. Reduced sedimentation will slow sediment accretion and will likely cause the grass marsh to persist for more decades that would otherwise occur. At normal sedimentation rates, sediment accretion eventually will raise the surface and allow the development of a Wet Sedge-Willow Meadow as the surface water becomes shallower. This natural process probably will be delayed. These potential effects at Location 5 are minor.

Location 6, situated in an old thaw lake basin where the surface has been raised by infrequent sediment deposition over centuries, has undergone recent changes in sedimentation due to the tapping of Nanuk Lake. The area now has a thick mineral layer over buried organics. During a 2-yr-flood event, the hydroperiod, water depths, and sedimentation rates are unlikely to be substantially affected by the road. During larger flood events, there is likely to be a slight increase in sedimentation. However, the vegetation already has responded to a large change in sedimentation and is unlikely to show much additional change in composition. In any events, these potential effects at Location 6 are minor.

Location 7, situated in the same ice-rich thaw basin described above, supports Wet Sedge-Willow Meadows. The area is not affected by 2-yr-flood events. During larger flood events, there may be a decrease in flow of water across the site and a slight to moderate decrease in sedimentation. Because sedimentation is already infrequent, there probably will be little change in vegetation. In any event, these potential effects at Location 7 are minor.

Locations 8 and 9 are situated at the western end of the facilities and support Wet Sedge-Willow Meadows. The area is not affected by 2-yr-flood events. During larger flood events, particularly a 200-yr-flood event, there will be increased flow of water around the end of the facility. Slackwater areas above and below the end of the gravel pad will be subject to slightly to moderately higher sedimentation. The increased sedimentation and nutrient input probably will lead to small periodic increases in graminoids better adapted to early successional habitats, such as *Dupontia fisheri*. Most of the time, however, the vegetation probably will show no effects. These potential effects at Locations 8 and 9 are minor.

Overall, the in-field facilities of the Alpine Development Project likely will have minor effects on the composition and function of wetland habitats in the area. Potential impacts include a slowing of the successional change of Aquatic Grass Marsh and Salt Marsh to Wet Sedge-Willow Meadow in the tapped thaw-lake basins due to decreased sedimentation. There also likely will be a slight decrease in productivity above and below the road in the swale due to decreased sedimentation associated with large flood events. Over most of the area, however, changes likely would be negligible because 1) the areas would only be affected by infrequent, large flood events, 2) changes in sedimentation on the higher portions of the floodplain would be negligible, and 3) the habitats are adapted to periodic flooding events.

LITERATURE CITED

Jorgenson, M. T., J. W. Aldrich, E. Pullman, S. Ray, M. D. Smith, and Y. Shur. 1996. Geomorphology and hydrology of the Colville River Delta, Alaska, 1995. Final Report prepared for ARCO Alaska, Inc., Anchorage by ABR, Inc. and Shannon and Wilson, Inc., Fairbanks.

Jorgenson, M. T., E. R. Pullman, T. Zimmer, Y. Shur, A. A. Stickney, and S. Li. 1997. Geomorphology and hydrology of the Colville River Delta, Alaska, 1996. Draft Report prepared for ARCO Alaska, Inc., Anchorage by ABR, Inc., Fairbanks., AK

Jorgenson, M. T., J. E. Roth, E. R. Pullman, R. M. Burgess, M. Raynolds, A. A. Stickney, M. D. Smith, and T. Zimmer. 1997. An ecological land survey for the Colville River Delta, Alaska, 1996. Draft Report prepared for ARCO Alaska, Inc., Anchorage, AK by ABR, Inc., Fairbanks, AK.

Walker, H. J. 1983. Colville River Delta, Alaska, guidebook to permafrost and related features. Alaska Division of Geological and Geophysical Surveys, Fairbanks, AK. 34 p.

Table 1. Environmental characteristics of wildlife habitats within the vicinity of the in-field facilities, Alpine Development Project. Data from Jorgenson et al. 1997a, 1997b.

	Terrain Unit		Hydrology			Sedimentation		Vegetation
Habitat	Terrain Unit	Relative Elev-ation	Approx-imate flooding frequency	Water depth	Electrical Cond-uctivity (mS/m)	Surface organic horizon	Cumul-ative organic horizons	Dominant or Common Plant Species
Tidal River	Tidal River	0.04	1	ND	ND	ND	ND	None
Tapped Lake with Low Water Connection	Tapped Lake with Low Water Connection	0.04	1	ND	ND	ND	ND	None
Riverine Barrens	Riverbed/sandbar or Delta Thaw Basin	0.32	<2	-22	733	0	0	Deschampsia caespitosa, Elymus arenarius, Salix ovalifolia, Puccinellia phryganodes
Aquatic Grass Marsh	Delta Thaw Basin	0.47	2	+18	85	5	8	Arctophila fulva
Salt Marsh	Delta Thaw Basin	0.65	2	-12	523	0	4	*Carex subspathacea, Puccinellia phryganodes, Dupontia fisheri, Carex ursina, Puccinellia andersonii*
Tapped Lake with High Water Connection	Tapped Lake with High Water Connection	0.75	2	ND	ND	ND	ND	None
Riverine Shrub	Active-floodplain cover deposit	0.71	3-4	-39	69	1	2	*Salix alaxensis, Equisetum arvense, Astragalus spp., Aster sibericus*
	Inactive-floodplain Cover Deposit	0.97	5-35	ND	69	1	2	*Salix lanata , Salix reticulata, Arctostaphylos rubra, Dryas integrifolia, Equisetum sp.*, legumes
Aquatic Sedge Marsh w/ Deep Polygons	Inactive-floodplain Cover Deposit	0.97	5-25	ND	59	6	6	*Carex aquatilis, Arctophila fulva*
Nonpatterned Wet Meadow	Delta Thaw Basin	ND	3-4	ND	ND	ND	ND	*Carex aquatilis, Eriophorum angustifolium, Salix lanata, Dupontia fisheri, Equisetum scirpoides*
	Inactive-floodplain Cover Deposit	0.97	5-25	-3	58	4	14	*Carex aquatilis, Eriophorum angustifolium, Salix lanata, Dupontia fisheri, Equisetum scirpoides*
Wet Sedge-Willow Meadow w/ Low Relief Polygons	Inactive-floodplain Cover Deposit	0.97	5-25	-3	58	4	14	*Carex aquatilis, Eriophorum angustifolium, Salix lanata, Dupontia fisheri, Equisetum scirpoides*
	Abandoned-floodplain Cover Deposit ·	1.12	26-150	-7	40	8	19	*Carex aquatilis Eriophorum angustifolium, Salix lanata, S. planifolia, Dryas integrifolia, S. reticulata,*
Moist Sedge-Shrub Meadow	Mostly Abandoned-floodplain Cover Dep.	1.12	26-150	-24	35	5	10	*Carex aquatilis, C. bigelowii, Eriophorum angustifolium, Dryas integrifolia., Salix reticulata*
	Eolian Sand Dune	1.50	Not flooded	-75	11	8	8	*Carex bigelowii, Dryas integrifolia,Salix glauca, Tomenthypnum nitens, Thamnolia sp.* and *Cetraria sp.*
Deep Open Water without Islands	Deep Open Water	0.75	5-25	ND	ND	ND	ND	None

Table 2. Potential effects of drainage changes from in-field facilities of the Alpine Development Project on water depth and velocity, hydroperiod, sedimentation rates, and vegetation composition at selected areas considered to be most affected by change.

Flood recurrence Interval (yr)	Area ID	Water Depth Change	Water Velocity Change	Hydroperiod	Sedimentation	Vegetation
2	1	Not Present	None	Not Present	Not Present	None
	2	Not Present	None	Sporadic impoundments	Not Present	None
	3	Negligible	Negligible	Negligible	Slight redistribution	Negligible
	4	Negligible	Negligible	Negligible	Slight redistribution	Negligible
	5	Negligible	Slight increase	Negligible	Slight redistribution	Negligible
	6	Negligible	Negligible	Negligible	Negligible	Negligible
	7	Not Present	None	Not Present	Not Present	None
	8	Not Present	None	Not Present	Not Present	None
	9	Not Present	None	Not Present	Not Present	None
50	1	None	None	Not Present	None	None
	2	None	None	Sporadic impoundments	None	None
	3	-1.5 ft	-0.5 fps	Negligible	Slight decrease	Persistence of halophytic species
	4	-1.5 ft	-1.5 fps	Negligible	Moderate decrease	Same species, reduced productivity
	5	+1.0 ft	-2.0 fps	Negligible	Moderate decrease	Earlier replacement by *Carex aquatilis*
	6	+1.0 ft	-0.5 fps	Negligible	Slight increase	Negligible
	7	-1.0 ft	-0.5 fps	Negligible	Slight Decrease	Negligible
	8	Negligible	-1.0 fps	Negligible	Moderate increase	Increase in *Dupontia fisheri*
	9	Negligible	-0.5 fps	Negligible	Moderate increase	Increase in *Dupontia fisheri*
200	1	Negligible	Negligible	Negligible	Negligible	Negligible
	2	Negligible	Negligible	Sporadic impoundments	Negligible	Negligible
	3	-2 ft	-0.5 fps	Negligible	Slight decrease	Persistence of halophytic species
	4	-2 ft	-2.0 fps	Negligible	Large decrease	Same species, reduced productivity
	5	+1.5 ft	-2.5 fps	Slight increase	Large decrease	Earlier replacement by *Carex aquatilis*
200	6	+1.5 ft	Negligible	Slight increase	Negligible	Negligible
200	7	-1.5 ft?	-1.5 fps	Negligible	Mod. Decrease	Negligible
200	8	Negligible	-1.0 fps	Negligible	Moderate increase	Increase in *Dupontia fisheri*
200	9	Negligible	-1.0 fps	Negligible	Moderate increase	Increase in *Dupontia fisheri*

APPENDIX L-2

COMMENT LETTERS

United States Department of the Interior
Fish and Wildlife Service
NORTHERN ALASKA ECOLOGICAL SERVICES
101 12th Ave., Box 19, Room 110
Fairbanks, Alaska 99701
June 6, 1997

Colonel Peter A. Topp
District Engineer, Alaska District
U.S. Army Corps of Engineers
Post Office Box 898
Anchorage, Alaska 99506-0898

Re: 2-960874
Colville River 18

Dear Colonel Topp:

The U.S. Fish and Wildlife Service has reviewed the referenced Public Notice. The applicant, ARCO Alaska, Inc. (ARCO), proposes placement of 1, 326, 970 cubic yards of gravel fill material into 114.65 acres of wetlands to construct an oil production facility (referred to as the Alpine project) on the Colville River delta, approximately 8 miles north of the village of Nuiqsut. The project includes an elevated pipeline connecting the Alpine facility to Central Processing Facility-2 (CPF-2), approximately 35 miles east of Alpine in the Kuparuk Oil Field. The proposed Alpine facility would consist primarily of two gravel pads for drilling and operations connected by a 3-mile road with a 5,900-foot road width expansion for an airstrip.

Fish and Wildlife Resources

Fish and wildlife use of the Colville River delta (Delta) has been documented extensively over the past 25 years. The regional importance of the Delta to a variety of species, particularly anadromous fish and waterbirds, is well recognized, and further documented by the applicant (ARCO Alaska, Inc. 996). The Colville River, which drains the largest watershed on Alaska's North Slope, forms the largest (550 km^2) and most complex river delta of the Alaska portion of the Beaufort Sea coast. The Delta provides extensive overwintering habitat for arctic cisco, and overwintering and spawning habitat for least cisco and broad whitefish. The deep channels and lakes of the Delta are unique and irreplaceable fish overwintering habitat in arctic Alaska, a habitat that is considered critical to the maintenance of fish populations. The Delta provides over 22,000 acres of deep channel, and over 14,000 acres of deep lake habitat suitable for fish overwintering. In contrast, the Sagavanirktok River delta provides less than 200 acres of channel habitat (based on Schmidt et al.'s [1989] estimate of 1.2 km of deep pool habitat and an assumed channel width of 400 m). It is a reasonable guess that the overwintering habitat on the Delta exceeds the total of such habitat across the rest of the Alaska North Slope. Approximately 20 fish species are found in the Delta; in addition to the whitefishes and ciscos, Dolly Varden char and Arctic grayling are abundant.

Waterbird use of the Delta has been studied since the early 1980s (Rothe et al. 1983, Meehan and Jenning 1988) and most recently by ABR, Inc., under contract to ARCO, as part of pre-construction environmental studies conducted for this project (ARCO Alaska Inc. 1996). These studies have all highlighted the unique collection of habitats on the Delta that, together, create a rich biological community providing exceptional habitat value for numerous species. The Delta supports the largest known North Slope colony of nesting brant, one of only two known concentrations of yellow-billed loons in Alaska, high nesting densities of tundra swans and white-fronted geese, and large numbers of staging swans and geese. The Delta supports high numbers and species diversity of ducks (Rothe et al. 1983). The spectacled eider, listed as threatened under the Endangered Species Act of 1973, as amended, has all but disappeared from western Alaska where it was once numerous, and it now appears that the North Slope supports the majority of the breeding population of spectacled eiders in Alaska. Spectacled eiders are widely distributed throughout the Delta, but are most numerous within 5 miles of the coast (ARCO Alaska Inc. 1996). The Delta has the most extensive system of salt marsh and tidal flats along the Alaska Beaufort Sea coast, and this system is used annually by tens of thousands of shorebirds during fall migration (Andres 1994). The Delta also supports a diverse community of breeding shorebirds.

Besides the species mentioned above, the Delta provides habitat for a variety of other fish and wildlife species, including birds of prey and over 30 species of mammals. Mammals of the region include caribou (primarily members of the Central Arctic Herd), brown bear, polar bear, ringed seal, spotted seal, wolf, arctic and red foxes, and muskox. Subsistence harvest of several fish species, caribou, seals, and the bowhead whale play an important role in the culture of the local Inupiat people of Nuiqsut.

Habitat Value

The habitats of the proposed Alpine Development site and the greater Delta area were classified and mapped by ABR, Inc. for ARCO Alaska, Inc., as part of the environmental study and analysis conducted for this project. Although known to the applicant, the exact area of habitats to be affected by gravel fill has not been provided to us since the applicant made the revisions to proposed facility layout reflected in the current public notice; therefore, the following discussion is imprecise. Terminology in the following discussion follows that of ABR Inc.'s habitat classification, described in ARCO Alaska, Inc. (1996). The two primary habitats impacted by the Alpine Colville River delta facilities are Wet Sedge-willow Meadow and Moist Sedge-shrub Meadow, followed by Non-patterned Wet Meadow and Riverine /Upland Shrub. Lesser amounts of Aquatic Grass Marsh and Riverine/upland Shrub, and Shallow Water without Islands will also be lost to gravel fill. Tapped and untapped lakes, as well as Deep Open Water, are in close proximity to the proposed facilities. The pads and the connecting road are generally perpendicular to the flow of surface water.

ARCO has sponsored extensive surveys for selected species in the vicinity of the proposed project site, other areas of the Delta, and the pipeline transportation corridor since 1992. As a result, there are habitat selection data (specific to the Delta) for some important wildlife species, and habitat relationships of other species may be inferred from the literature. In 1996, ARCO, along with federal resource agencies and the Alaska Department of Fish and Game cooperatively identified criteria used to assess use of wildlife habitats on the Colville River delta. Habitats were ranked with respect to species abundance and diversity, use by threatened/endangered species (spectacled eiders), use by important subsistence species, and use by five identified waterbird species of regional importance (tundra swan, brant, white-fronted goose, yellow-billed loon, and bar-tailed godwit).

The Service's Mitigation Policy classifies habitat by its value to indicator species, and its prevalence in the region. Thus, the Service is particularly concerned with loss of habitat that is both valuable to an indicator species (or species group) and scarce. Aquatic Grass Marsh (*Arctophila fulva* stands), and Riverine or Upland Shrub are clear examples of scarce habitats on the arctic coastal plain which are widely recognized as important to waterfowl and passerines, respectively. The proposed project will cause loss of small quantities of these habitats. Of the habitat types most affected by the proposed project, Wet Sedge-willow Meadow may be characterized as receiving moderate to high use by birds and mammals (based on species richness and use by regionally important species, including spectacled eiders), but relatively abundant. By the same criteria, Non-patterned Wet Meadow may be characterized as receiving low to moderate wildlife use, and of moderate abundance. Characterization of Moist Sedge-shrub Meadow is more problematic. The analysis by the applicant (ARCO Alaska, Inc. 1996) indicates that this habitat receives use by a diverse assemblage of bird species (primarily shorebirds, with only a small waterfowl component), and a wide diversity of mammals, including several that are important to subsistence users. As noted by the applicant (ARCO Alaska, Inc. 1996: 4-90), "the elements that account for the high use of [Riverine or Upland Shrub and Moist Sedge-shrub Meadow] by mammals are the presence of shrubs (used for foraging and cover) and well-drained soils on banks and upland sites (used for denning and burrowing)." Moist Sedge-shrub Meadow is not preferred habitat on the Delta for tundra swans, yellow-billed loons, or brant, though it receives use by nesting white-fronted geese (Johnson et al. 1997) and by bar-tailed godwits (ARCO Alaska, Inc. 1996). This habitat is relatively rare on the Delta (comprising only 2.4% of the area), but is the second-most abundant habitat in the pipeline corridor (comprising almost 25% of the area). Thus, Moist Sedge-shrub Meadow can be characterized as high-value based on species diversity (particularly of mammals), but not based on habitat preferences of regionally important species. It is a scarce habitat on the Delta, but relatively abundant in other portions of the arctic coastal plain.

The habitat delineation, classification and assessment work conducted on the Delta, particularly that completed by ABR, Inc. and the Advanced Identification process (see Corps of Engineers Public Notice, dated April 19, 1989) completed by the Service and the Environmental Protection Agency, has identified a unique, interrelated mosaic of habitats. This mix of habitats on the Delta has proven to be a very rich biological environment, supporting dense populations of a variety of waterbirds, as well as anadromous and resident fish species. The effort of ranking habitats according to their relative value to wildlife has been a difficult one, and largely dependent upon the species selected for assessment. An understanding of the value of these habitats collectively may be of greater importance than a ranking of selected habitats by value to selected species. The habitat work completed on the Delta has illustrated the importance of protecting the diverse mixture of habitats found there. The work of Meehan and Jennings (1988), for example, resulted in a recommendation by the Service that much of the Delta be classified as unsuitable for fill. Therefore, the Service recommends that all habitats impacted by this project be rehabilitated to the greatest extent possible, especially the airstrip and roadway due to their potential for disrupting surface water flow and long-term implications for post-development access .

Endangered Species

The proposed project site is within the range of the spectacled eider (*Somateria fischeri)*, which is listed as threatened under the Endangered Species Act of 1973, as amended. ARCO has conducted surveys and nest searches in the area of the proposed project. Nests have not been found, but a brood was observed in 1993 in a lake just north of the proposed airstrip location. Based on the aerial survey data provided by the applicant (Johnson et al. 1977), spectacled eider distribution on the Delta exhibits a strong coastal gradient, with most sightings within 5 km of the coast. The habitat preferences of pre-nesting spectacled eiders included saline-influenced areas, Shallow Open Water with Islands, and Aquatic Sedge with Deep Polygons. The project area, including both the production facilities and the transportation corridor, does not appear to support many spectacled eiders, although nesting in this area is possible. While the aerial surveys and foot surveys have been useful to document general distribution, they were not conducted at sufficient intensity to rule out the possibility of disturbance to nests as a result of oil field construction and operation. The Service does not anticipate adverse impacts to spectacled eiders as a result of this project provided that gravel fill is placed during the winter season (as proposed).

Steller's eiders, currently proposed for listing as a threatened species, probably occur irregularly near the project area. Small groups of Steller's eiders have been reportedly observed within the Delta, but none in the transportation corridor. ARCO has surveyed both the central Delta and the transportation corridor, but no nests or broods were found near the project area. Because of the limited occurrence of Steller's eiders in the project area, no adverse impacts to Steller's eiders are anticipated as a result of this project.

This letter constitutes informal consultation under the Endangered Species Act. Preparation of a Biological Assessment or further consultation regarding this project is not necessary at this time. If project plans change, additional information on listed or proposed species becomes available, new species are listed that may be affected by the project, or listed species are observed on the project site, consultation should be reinitiated by your agency.

Resource Issues

Beginning with a letter to the Director of the Alaska Division of Minerals and Energy Management in December 1982, the Service has consistently opposed oil and gas leasing on the Colville River delta due its high value to migratory birds. Our position has not changed. We continue to believe that oil and gas production within the Delta presents significant risks to a highly productive biological community. We also recognize the major strides ARCO has taken in recent years to characterize the biological resources of the Delta, to design a facility of minimal size and disturbance to fauna, and to design a pipeline, particularly at the Colville River crossing, to offer maximum protection against the potential of oil spills. The Service has and will continue to work with ARCO, the Corps of Engineers, and other agencies to minimize the impacts of development on the resources of the Delta.

In a letter to the Corps dated January 2, 1997, we expressed our primary concerns regarding the draft Environmental Evaluation Document produced by ARCO for the Alpine project, and delivered to the Corps for use in preparing a Public Notice. In that letter, the Service argued that the Alpine Development Project warranted an Environmental Impact Statement or similar process in order to thoroughly examine several important issues. Those issues were cumulative and indirect effects, oil spill prevention and detection, and socioeconomic impacts to the village of Nuiqsut. We have also raised the issues of appropriate habitat restoration and rehabilitation, and minimization of attraction of wildlife to facilities by proper handling of food wastes. We review the current status of these issues, below, with the exception of socioeconomic impacts, which are largely outside our jurisdiction.

An oil spill in the floodplain of the Colville River would pose immense risk to fish and wildlife resources, because of the potential for damage to unique and irreplaceable fish overwintering habitat and the extensive system of salt marsh and tidal flats used by migrating and staging birds. We have argued that this proposed development presents a unique case, in that the entire facility area lies within the floodplain, and that, consequently, the Corps should carefully consider oil spills as a prominent potential indirect effect of the project. ARCO has done a commendable job in addressing the safety of the Colville River crossing with a proposal for casing the carrier pipeline (creating secondary containment) and substituting vertical expansion loops for the more failure-prone valves. The design is under review by the Joint Pipeline Office (JPO). We are very interested in the JPO review, and urge the Corps to coordinate closely with the JPO to ascertain whether the proposed design provides the degree of protection appropriate for resource values of this importance. We rely on the JPO to provide the technical review for this proposal, but we are encouraged by the extra attention ARCO is giving to minimizing spill risk at the pipeline crossing. Various aspects of leak detection (schedule of visual inspection and inspection by infra-red sensor) and spill response are still unresolved.

The issue of mitigation for habitat loss, including appropriate restoration and rehabilitation, has not been fully addressed. ARCO has taken some measures to minimize loss of habitat value, and incorporated them into the facility design. The road connecting the airstrip to the western production pad was routed to avoid an area of Aquatic Sedge with Deep Polygons, in which brant and other waterfowl nest. Aquatic Sedge with Deep Polygons is a regionally and locally scarce habitat of high value to nesting waterbirds, including spectacled eiders (Johnson et al. 1997; Jon Bart, BRD, pers. comm.), therefore, the Service is pleased with this project modification. The Service also concurs with the general philosophy of facility consolidation which is evident in the co-location of the airstrip, processing facility, camp, and eastern drill pad. We also recognize as significant mitigation the voluntary restrictions on aircraft use during the waterfowl nesting season. The proposed study of aircraft disturbance, while not mitigation *per se*, has the potential to make a valuable contribution to our understanding of the potential for displacement and reduced reproductive success of water birds as a result of aircraft overflights. We do not concur, however, with the contention that airstrip siting is optimal with respect to wildlife impacts, as Moist Sedge-shrub Meadow receives considerable wildlife use, and because it is a scarce habitat in the project area; the airstrip will fill approximately 38 acres of Moist-sedge Shrub Meadow. We also disagree with ARCO's proposition (ARCO Alaska, Inc. 1996: 2-28) that gravel removal is an appropriate rehabilitation technique only in the context of recycling gravel into future projects. The applicant's studies in other North Slope oil fields have indicated that gravel removal (at least partial removal to no more than 1 foot above tundra grade) is the most effective way to restore suitable growing conditions for native vegetation. We do not believe that poorly vegetated thick gravel pads will provide acceptable replacement habitat value. The high densities and diversity of wildlife species in the Delta argue for a high standard of habitat restoration. Furthermore, the presence of an uncontrolled airstrip post-abandonment will most likely conflict with the goals of minimizing long-term disturbance to wildlife and conflict with subsistence activivities. For these reasons, gravel removal should be the presumptive method of choice for rehabilitation in the Delta. Gravel retention, rather than gravel removal, should be considered on a case-by-case basis.

The issue of solid-waste disposal is still unresolved. The issue is particularly critical in the Delta because of the high waterfowl densities and the potential for catastrophic impact on nest success by predators such as foxes, bears, ravens and gulls. These species are all attracted to facilities by the opportunity to use artificial nest and den sites and for supplemental food. The applicant has indicated, in various contexts, that food wastes would be incinerated, back-hauled to Kuparuk, or composted on site. Our primary interest is in ensuring that food wastes do not attract wildlife to the facilities, and we will request that the permit be conditioned to require this outcome. We remain open-minded as to the method for achieving this goal, but note that composting has significant advantages over the other two methods. Composting avoids the air quality detriments and the ultimate disposal problems associated with incineration, and avoids merely "exporting" the problem back to Kuparuk where wildlife access to garbage is an on-going problem. Composting may also have some limited benefits in providing organic material for habitat rehabilitation.

The issue of cumulative effects has not been addressed in a thorough, careful manner. Due to the exceptional fish and wildlife value of the Colville Delta and surrounding habitats, particularly those immediately to the west of the Delta, the Service believes it is imperative to examine all reasonably foreseeable indirect and cumulative impacts of this project. The goal is to ensure that all significant effects are examined in order to make enlightened decisions that will preserve the biological integrity of this area well into the future.

The Service believes that a ten-year threshold for identifying a reasonably foreseeable future is too short in North Slope oil and gas development. If taken from lease sale to actual production, few reservoirs can be brought on-line that quickly. Using a ten-year threshold in this fashion assumes that any given oil production facility has no influence on further development. This is certainly not the case, particularly with regard to the Alpine project and the Delta. The Service is actively involved in the development of the National Petroleum Reserve-Alaska (NPR-A) Environmental Impact Statement and we are fully aware of how closely NPR-A development scenarios are associated with the Alpine project. We believe a 15-year threshold is more reasonable in the arctic and incorporates the normal lead time required to bring a field to production.

There are innumerable scenarios that could be addressed in a cumulative impacts analysis. We offer the following suggestions to guide the selection of development scenarios. The Service is most concerned with proliferating development in the Delta as a result of the proximity of the Alpine infrastructure. Based on the information provided to date, the most likely scenarios for development are smaller "satellite developments" using the Alpine processing facility. The presence of the Alpine facility will also affect the probability of development of reservoirs that may be located within NPR-A. We assume that the "zone of influence" of Alpine extends at least 30 miles into NPR-A. The draft Reasonable Foreseeable Development Scenario for the NPR-A EIS predicts 1-4 "Alpine-sized" fields, most probably within the northern tier between the Colville River delta and Smith Bay. It is reasonable to postulate that at least one such field might be located within 30 miles of the proposed Alpine project. The influence of additional developments upon the Alpine facility depend, in part, on whether the Alpine processing facilities are used. We assume that a field within 20 miles of Alpine is likely to incorporate a multi-phase pipeline bringing product to the Alpine facility, whereas a field beyond 20 miles is likely to have its own stand-alone processing facility. Given these considerations, we suggest that the Corps assess, at minimum, the following three development scenarios:

1. A reservoir smaller than the Alpine reservoir, developed by a satellite production pad and oil delivered to the Alpine facility. This scenario should consider a field north of the proposed Alpine facility (such as the Fiord reservoir) and a possible find directly to the south of Alpine between Alpine and Nuiqsut. The impacts of facility and infrastructure (such as roads, pipelines, and their stream crossings) development, as well as operational impacts should be carefully considered.

2. A reservoir equal to, or smaller than Alpine, within 20 miles due west of the Alpine facility (across the Nechelik Channel). This scenario should consider the potential demand for a road (from either the Alpine facility or Nuiqsut), a gravel source, and a pipeline crossing of the Nechelik Channel.

3. A reservoir of approximately equal size with Alpine, 20-30 miles southwest of the proposed Alpine facility. This scenario should examine the possible route of a pipeline and other infrastructure and the potential impact on Nuiqsut.

The goal of considering potential cumulative impacts is good decision making. The intention is not to make this proposal untenable due to the potential of future development impacts. The intent is to examine reasonably foreseeable developments that are rendered more likely to be developed given the existence of Alpine, and to assess their impact on the Alpine facility itself and the surrounding environment. The placement of the pipeline or other infrastructure may be affected by potential developments in the surrounding region. These influences may not be recognized unless a careful examination of scenarios is completed.

Conclusion

The Service cannot fully evaluate the potential impacts of this project until the cumulative impacts analysis is complete, and other issues (outlined above) are resolved. We are disappointed that concerns raised early in the process have not been fully addressed. Because of these reservations, we find it necessary to recommend more detailed special conditions than would otherwise have been necessary. Based on the information available, the Service does not object to permit issuance, provided the following special conditions are included in the permit:

1. The handling and disposal of putrescible waste shall be accomplished in a manner which prevents attraction of wildlife. Feeding of wildlife shall be prohibited.

2. Rehabilitation upon abandonment shall be accomplished in a manner which is consistent with maximum benefit to wildlife. Gravel removal is the presumed method of choice. Exceptions will be granted in cases where gravel retention is demonstrated to be the environmentally preferable alternative. At minimum, sufficient gravel will be removed to restore natural hydrology, and to render the airstrip and road unusable for access by fixed-wing aircraft.

3. Additional oil and gas development between the East and Nechelik channels of the Colville River delta with pipeline connections to the Alpine facility shall be accomplished with a minimum of additional gravel fill. Within this area, the design of fields with pipeline connections to the Alpine facility shall incorporate the concept of roadless satellite production facilities. Exceptions may be granted in cases where alternative designs are environmentally preferable, or if roadless design is infeasible.

4. Cross-drainage structures across the infield road and airstrip shall prevent impoundment or dewatering of adjacent wetlands, and allow unimpeded fish passage between documented fish-bearing waterbodies.

5. The design of the Colville River pipeline crossing shall include a cased pipeline and vertical expansion loops, subject to appropriate agency approvals. Should this design prove infeasible or if approval for this design is not obtained, then the applicant shall provide an alternative design which will afford an equivalent level of protection with respect to spill prevention and detection. Modification of the design will require an additional Corps of Engineers public notice.

6. The applicant shall submit the findings of the monitoring study of waterfowl disturbance by aircraft (as described in the Public Notice, Attachment C) for review by the U.S. Fish and Wildlife Service. In consultation with the Corps of Engineers and the U.S. Fish and Wildlife Service, the applicant will modify operating procedures to the extent practicable, in order to mitigate identified negative impacts.

7. The applicant shall adhere to the restrictions on aircraft use as described in the Public Notice.

8. To avoid disturbance to spectacled eiders, filling of wetlands, major construction and gravel-hauling shall be avoided during the pre-nesting and nesting season (20 May - 1 August). If such activities must be conducted during the nesting season, Service-approved nest surveys shall be required to confirm the absence of nests in,

or within 200 m of, the project footprint. If nests are present, further consultation will be required.

In addition, the Service offers the following recommendation. Once an Environmental Assessment is completed, including a cumulative effects analysis, the public should be provided the opportunity to review and comment on this document for a minimum of 30 days. This is a benchmark development proposal for the people of the North Slope and comes when several other important developments are being presented. An extra effort should be taken to assure all interested parties are given the opportunity to provide comment on this project. The additional input may prove important in minimizing the long-term impacts of this development.

We recognize that you must consider other aspects of the public interest in meeting your responsibilities under provisions of Section 404 of the Clean Water Act. As a consequence of full public interest review, you may determine that it is necessary to deny this permit or require other special conditions.

These comments are submitted in accordance with provisions of the Endangered Species Act of 1973 (87 Stat. 844) and the Fish and Wildlife Coordination Act (48 Stat. 401, as amended: 16 U.S.C. 661 et seq.) and constitute the report of the Department of the Interior. These comments are also for use in your determination of 404 (b)(1) guidelines compliance (40 CFR 230), and in your public interest review (33 CFR 320.4) relating to protection of fish and wildlife resources. In the opinion of the Department, the project may result in substantial and unacceptable impacts to aquatic resources of national importance. We appreciate this opportunity to comment. Please contact Philip Martin (456-0325) if you have questions regarding these comments.

Sincerely,

Patrick Sousa

Patrick J. Sousa
Field Supervisor

cc: Mark Schindler, ARCO Alaska, Inc., Anchorage
Mike Joyce, ARCO Alaska, Inc., Anchorage
Deborah Williams, DOI, Anchorage
Ron Morris, NMFS, Anchorage
Ted Rockwell, EPA, Anchorage
Keith Quintavell, NSB, Barrow
Molly Birnbaum, DGC, Anchorage
Al Ott, ADF&G, Fairbanks
Pete McGee, ADEC, Fairbanks
Nancy Welch, ADNR, fairbanks
Jim Haynes, ADNR-DO&G, Anchorage
Bill Thomas, ASRC
Nuiqsut Mayor's Office, Nuiqsut
Kuukpik Corporation, Nuiqsut

Literature Cited

Andres, B.A. 1994. Coastal zone use by postbreeding shorebirds in northern Alaska. J.Wildl. Manage. 58: 206-213.

ARCO Alaska, Inc. 1996. Alpine development project environmental evaluation document. Prepared for U.S. Army Corps of Engineers, Alaska District, Anchorage, Alaska by ARCO Alaska, Inc., Anchorage, Alaska. v.p. + appendices.

Meehan, R., and T.W. Jennings. 1988. Characterization and value ranking of waterbird habitat on the Colville River delta, Alaska. Unpublished report by U.S. Fish and Wildlife Service, Alaska Investigations, Branch of Wetland and Marine Ecology, Anchorage, Alaska. 105 pp.

Johnson, C.B., B.E. Lawhead, J.R. Rose, A.A. Stickney, and A.M. Wildman. 1997. Wildlife studies on the Colville River delta, Alaska, 1996. Fifth annual report prepared for ARCO Alaska, Inc., Anchorage, by ABR Inc., Fairbanks. 139 pp.

Rothe, T.C, C.J. Markon, L.L. Hawkins, and P.S. Koehl. 1983. Waterbird populations and habitats of the Colville River delta, Alaska. 1981 Summary report. U.S. Fish and Wildlife Service, Special Studies, Anchorage, Alaska. 67pp.

Schmidt, D.R., W.B. Griffiths, and L.R. Martin. 1989. Overwintering biology of anadromous fish in the Sagavanirktok River delta, Alaska. Biol. Pap. Univ. Alaska No 24:55-74.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
1011 E. Tudor Rd.
Anchorage, Alaska 99503-6199

RECEIVED
JUL 09 1997
REGULATORY FUNCTIONS BRANCH
ALASKA DISTRICT, CORPS OF ENGINEERS

IN REPLY REFER TO:

NAES/ESO

JUL 2 1997

Colonel Peter A. Topp
District Engineer, Alaska District
U.S. Army Corps of Engineers
Post Office Box 898
Anchorage, Alaska 99506-0898

Re: 2-960874
Colville River 18

Dear Colonel Topp:

Based on current available information, it is the Department of the Interior's opinion that the above referenced discharge will have a substantial and unacceptable impact on aquatic resources of national importance. I refer you to the enclosed comment letter of June 6, 1997, which describes in detail our concerns regarding the impacts of this project on the unique fish and wildlife resources of the Colville River Delta. Specifically, we believe that there will be substantial and unacceptable impacts to the following resources if this project goes forward without adequate study and conditioning:

1. Oil spills pose a significant threat to unique and irreplaceable fish overwintering habitat, as well as high value waterbird habitat such as salt marsh and tidal flats. Significant impacts to these resources will occur if pipelines and facilities are improperly engineered or located.

2. Impoundment of water upstream of the proposed facilities will likely alter valuable waterbird habitat and disrupt fish passage.

3. Significant impacts will occur to the high value waterbird habitats of the Delta and surrounding area if further development, made possible by this project, is not carefully evaluated and mitigated through conditions on this permit.

4. The long-term health and productivity of this ecosystem will be impacted if conditions are not explicit and effective regarding the ultimate reclamation of this site. Abandoned gravel will likely be washed into adjacent habitats by frequent flooding.

Due to the high value of the resources involved, the Fish and Wildlife Service must reserve the option of negotiating to resolve outstanding issues and/or elevating this project to the Washington level for further review. This reservation complies with requirements of Part IV, paragraph 3(b), of the Memorandum of Agreement signed December 12, 1992 between the Department of the Interior and the Department of the Army, regarding Section 404(q) of the Clean Water Act.

The Service appreciates the work accomplished to date by both the applicant and your staff in association with this project. We will continue to work with you to resolve problems, and believe the concerns expressed above can be resolved in the near future; however, at this time we do not wish to preclude our option of elevating an unacceptable permit decision. If you have further questions or wish to discuss issues related to this proposal, please contact Mr. Larry Bright at (907) 456-0324.

Sincerely,

Robyn Thorson

for David B. Allen
Regional Director

Enclosure

National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99802-1668

June 9, 1997

Colonel Peter A. Topp
District Engineer
U.S. Army Corps of Engineers
Alaska District
P.O. Box 898
Anchorage, Alaska 99506-0898

Re: Colville River 18
2-960874

Attn: Lloyd H. Fanter

Dear Colonel Topp:

Reference is made to your public notice dated April 7, 1997 regarding a request from ARCO Alaska Inc. (ARCO) to place 1,326,970 cubic yards of gravel fill material into 114.65 acres of the United States including wetlands, to construct the Alpine Development Project (ADP) for oil and gas production.

The proposed project site is located in the Colville River Delta approximately 34 miles west of the Kuparuk River Unit Central Processing Facility (CPF-2). It is bounded by the Nechelik Channel of the Colville River to the west, and the Sakoonag Channel of the Colville River to the east. The Village of Nuiqsut lies approximately eight miles south of the ADP. The Colville River Delta front is located approximately eight miles north of the proposed project. The purpose of the proposed project is to construct an infrastructure which would allow the recovery of oil from the Alpine reservoir, process it, and transport it through a common carrier pipeline to the Trans Alaska Pipeline System for transport to market. The ADP is expected to have a peak production of 50,000 to 80,000 barrels of oil per day.

To bring the proposed project into production, ARCO has investigated several different project designs. While the amount of gravel needed for construction varies, the designs all involve the construction of similar features, including but not limited to: a material source, well pads, central processing units, flare pads, an airstrip and apron, in-field road systems, pipelines with river crossings, freshwater sources, and valve pads. In addition, some of the alternatives involve interfield connecting roads, that would necessitate the use of ice bridges, ferries, or permanent bridges. These alternatives along with supporting environmental and engineering information have been compiled into an Environmental Evaluation Document (EED) by ARCO.

On February 24, 1997 the National Marine Fisheries Service (NMFS) provided comments to the Corps of Engineers (Corps) regarding our review of ARCO's EED for the ADP. While some of the original concerns regarding the lack of information in the EED have been resolved, others remain and will need to be addressed. Those that have been resolved include the designation of the gravel source, and disposition of drilling muds. In addition, ARCO has submitted a proposal for additional fish survey work which includes obtaining additional water quality data from lakes that may be used as water sources, and sampling a small number of fish for analyses of metals. This study partially addresses our concern over contaminant releases. We continue to recommend a larger study that entails obtaining background levels of information, including sediments, and fish and water samples at the proposed Colville River crossing.

However, there are two larger issues which remain. These include: a) oil spill prevention and detection, and b) cumulative and indirect effects. With regard to oil prevention and detection, ARCO has committed to several design elements to address the reliability and integrity of the horizontal directional drilling (HDD) crossing of the Colville River. The incorporation of these elements will reduce the risk of oil spills and undetected leaks, but does not eliminate them. Additional preventative and response measures need to be discussed, including the pre-staging of equipment and monitoring.

With respect to the issue of cumulative impacts, the NMFS is fully aware that the Corps evaluates whether or not permit applications comply with the Section 404(b)(1) Guidelines of the Clean Water Act and are in the public interest. As part of this public interest review, the Corps then prepares an Environmental Assessment under the National Environmental Policy Act[1] (NEPA) to determine if the project has significant environmental impacts. In determining significance it must be kept in mind that a "significant effect may exist even if the Federal agency believes on balance the effect will be beneficial."[2] Also, the "degree to which the effects on the quality of the human environment are likely to be highly controversial,"[3] is important in the consideration of impacts for the ADP as has been indicated by the Public Scoping of responses of the other ongoing and proposed oil exploration and development projects across the North Slope (e.g. NPRA and Northstar).

An action is defined to be significant if "it is reasonable to anticipate a cumulatively significant impact on the human environment. Significance cannot be avoided by breaking it down into small component parts."[4] Accordingly, the NMFS believes that the ADP in combination with other oil exploration, development and production projects across the North Slope that are reasonably foreseeable in the near future, could result in significant and adverse impacts, and therefore, recommends the following action be undertaken prior to the realization of the ADP:

> "The Corps, in coordination with the resource agencies, and other interested stakeholders, initiate a Special Area Management Plan, or similar comprehensive area wide management planning process utilizing a watershed approach, in conjunction with the preparation of an Environmental Impact Statement to provide a larger framework in which to analyze the cumulative impacts of pending and future Section 404 and Section 10 permitting actions. "

The purpose in doing such a plan is to have coordinated involvement in identifying issues and options, setting priorities and protecting resources. This is necessary in order to adequately consider cumulative impacts of the simultaneous interregional development on migratory species (i.e. anadromous fish and marine mammals). This information would then be used in develop agreements to devise a coordinated state and Federal permitting processes, promoting responsible development and prudent resource management.

Thank you for the opportunity to comment. Please contact Jeanne Hanson in our Anchorage Office

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[1] 42 U.S.C. § 4321 (1994)

[2] 40 C.F.R. § 1508.27(1)

[3] 40 C.F.R. § 1508.27(4)

[4] 40 C.F.R. § 1508.27(7)

(907-271-5006) if you have any questions regarding our comments.

Sincerely,

Steven T. Zimmerman Ph.D.
Chief, Protected Resources
Management Division

cc: EPA - Anchorage
ADEC, ADF&G, USFWS - Fairbanks
Applicant

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
Alaska Operations Office
Room 537, Federal Building
222 W. 7th Avenue, #19
Anchorage, Alaska 99513-7588

RECEIVED
JUN 09 1997
REGULATORY FUNCTIONS BRANCH
ALASKA DISTRICT, CORPS OF ENGINEERS

June 5, 1997

Mr. Robert K. Oja, Chief
Regulatory Branch (1145b)
Alaska District, Corps of Engineers
P.O. Box 898
Anchorage, Alaska 99506-0898

Re: Colville River 18 (2-960874)
ARCO Alaska, Inc.

Dear Mr. Oja:

The Environmental Protection Agency (EPA) has reviewed the above referenced public notice and available documents pertaining to ARCO's Alpine Development in the Colville River Delta. As proposed this project will involve placement of over 1.3 million cubic yards of gravel fill into over 110 acres of waters of the United States, including wetlands. This gravel will be used to construct drill pads, production facilities, storage, roads, an airstrip, and other facilities required for the full production of the Alpine Development.

The Colville River Delta is widely recognized as an area of diverse high-value habitat for a wide range of animals and plants. The Colville River, its many channels and consequent delta support and sustain populations of plants, land animals, birds, and fish that are of importance commercially and as critical subsistence resources. EPA remains very concerned for the protection of the unique resources that the Colville River Delta encompasses. We encourage everyone involved in resource development in the Colville River, its channels and delta to 1. thoroughly assess all alternatives to actual disturbance in the delta, 2. to give great consideration to the development of projects which minimize the size of the disturbance that will be associated with their project, and 3. to develop and implement plans that provide adequate mitigation and consequent protection of this resource.

As we have expressed in previous letters and in meetings with ARCO, the Alaska District, and other agencies, EPA believes that there must be thorough, thoughtful, and fully informed deliberations brought to the decision making process that is necessary for the Alpine Development to go forward. EPA continues to recommend full public participation in the permitting process and we encourage you to continue to keep the interested public involved as we proceed in this process. We have identified significant issues that will need to be fully addressed and incorporated into permit decision making. These issues are most completely expressed in our previous letters and in meeting minutes for those meetings where we participated. Briefly, the biggest issues involve:

-consideration of cumulative impacts associated with this project,

-consideration of the effects of oil and other pollutants discharged into the Colville River Delta ecosystem, the assessment needed here is to the level of detail necessary to determine if an industrial project of type should be built in an active river delta and is not to level of specificity contained in an oil spill contingency plan (C-PLAN),

-consideration of the effects of the proposed industrial development on the subsistence culture of the area, most particularly on the Village of Nuiqsut which is only a few miles from the proposed development,

-consideration of the effect this proposed development will have on other, future, development in the Delta as well as the National Petroleum Reserve, Alaska,

-consideration of the engineering requirements necessary to construct and maintain an operational oil production facility with pipeline crossings in and across an active floodplain of one of the major arctic Alaskan rivers.

EPA has worked cooperatively with the Alaska District and other agencies from the very beginning of this project. We have agreed to work with the Alaska District in identifying salient issues and reviewing proposed resolutions to those issues. We understand that the Alaska District has yet to make a final determination on the need for an Environmental Impact Statement(EIS); this decision will be made, consistent with NEPA regulation and guidance, following your preparation of an Environmental Assessment (EA). EPA has pledged our support in working with you, as needed, as you develop your EA, and we renew that pledge at this time.

Through our continuing coordination with your staff we are working on the issues identified above and will continue to work to resolve the issues. We have work meetings scheduled, including one next week with ARCO and the Federal agencies. We remain confident that in a collaborative manner we can provide the information that you will need to both determine if an EIS will be required and make permit decisions when they are appropriate.

We appreciate the opportunity to comment on this matter. Please continue to notify us as new information is generated during your agency's evaluation. If there are any questions, please contact me at (907) 271-5083.

Sincerely,

T.L. Rockwell Jr.

Theodore L. Rockwell, Jr.
Environmental Scientist

cc: ADEC, Fairbanks
ADEC, North Slope District Office
ADGC, Anchorage
NMFS, Anchorage
ADFG, Fairbanks
USFWS, Fairbanks

TONY KNOWLES, GOVERNOR

DEPARTMENT OF FISH AND GAME

HABITAT & RESTORATION DIVISION

1300 COLLEGE ROAD
FAIRBANKS, ALASKA 99701-1599
PHONE: (907) 459-7289
FAX: (907) 456-3091

RECEIVED

JUN 20 1997

ALASKA LA...

June 16, 1997

Mr. Mark J. Schindler, Director
Colville Permits and Compliance
ARCO Alaska, Inc.
P.O. Box 100360
Anchorage, AK 99510-1215

Dear Mr. Schindler:

RE: Alpine Oil Development Project, Field Trip

On June 11, 1997, I accompanied Mr. Larry Moulton (MJM Research) and Mr. Jim Aldrich (Shannon and Wilson) on a field inspection and overflight of the Alpine Oil Development Project. We flew the proposed pipeline alignment from Kuparuk to the Colville River Delta; and then to the facilities and along the access road/airstrip connecting the West Drill Pad with the East Drill Pad and Processing Facility. We walked virtually the entire length of the access road/airstrip. A summary of my observations and recommendations regarding cross drainage follow:

(1) Beginning at the West Drill Pad we encountered standing water in sedges. Average water depth throughout this area was 4 to 10 inches. Water was contiguous from Lake 93-22 to 93-21 but directional flow was not observed. Both lakes were completely ice covered with some water along the margins. Walking east I estimated the distance along the alignment that was flooded was about 3,000 feet. I recommend that in this reach culverts be installed to provide for fish movement and water transport. A criterion for distance (e.g., every 200 feet) between culverts should be established. Fish Habitat Permits pursuant to AS 16.05.870 (Anadromous Fish Act) will be required.

(2) Continuing to walk east, we crossed an area where the ground surface was partially covered with water, but within a relatively short distance (maybe 500 feet) we encountered high-center polygons. The troughs between the polygons were about 1 to 3 feet deep and 2 to 4 feet wide. Several of the natural troughs crossed perpendicular to the staked centerline of the access road. Water movement in the troughs was not observed. Placement of a standard size pipe in selected areas (e.g., match the natural troughs) is suggested to provide for water movement. Additional discussion on how to deal with the high-center polygon area is warranted.

(3) Leaving the high-center polygons, we dropped down into a swale where water flow had been observed this breakup. Flow through this swale area was measured by Shannon and Wilson in spring 1997 (a preliminary estimate was 390 cubic feet per second) and was judged to be representative of a flow that would be expected to occur at least once every two years. The entire swale area had been flooded as there was evidence of silt on the vegetation following this year's high water. A drift line was noted as we entered the swale that was about three to four feet above the dwarf willow band. The total distance across the swale exceeds 1000 feet.

The first 300 yards of the swale moving from west to east contained dwarf willow with clearly defined channels (about 1 foot wide and 6 inches deep) oriented southeast. At least six channels were seen and minor flow was observed in two (flow was to the southeast). The remainder of the swale was drier with isolated pockets of water; but this area had been inundated during breakup 1997 and had drained. The lowest spot in the swale was still flooded with water near the eastern edge with a wetted width of about 100 feet. The swale is fed by water from the Nechelik Channel which enters Nanuk Lake and overflows the lake into the swale. At higher discharges in the Colville River this area will undoubtedly receive even higher flows. We strongly suggest that cross drainage structures in this area include a combination of a bridge and culverts. The bridge should be designed to handle the project design flood (e.g., 50 year) without altering water flow. Culverts should be placed in the clearly defined channels within the dwarf willow band and depending on the bridge span, additional pipes may be needed. The objective in this reach should be to provide for cross drainage at the crossing such that the inundation and draining of the wetlands and anadromous fish habitat in the various lake complexes remains in a natural condition. Because these waters have been designated as being important to anadromous fish, a Fish Habitat Permit pursuant to AS 16.05.870 will be required.

(4) Beginning on the east side of the swale we walked toward the airstrip. We immediately entered an area of high-center polygons. The general direction of surface flow between the swale and Monument Black was to the northwest and flow, although very minor, was observed in several troughs. The airstrip is located in wetland complexes and high-center polygons. Between the airstrip and Lake 93-13 there is a ridge of sand dunes. Water will pond in the high-center polygons between the airstrip and the sand dunes if adequate cross drainage is not provided.

From Monument Black we walked along the airstrip to the processing facility. Flowing water was not seen but the general slope through the high-center polygons appeared to be to the south. Adequate cross drainage also should be provided in this reach.

(5) Flow into Lake 93-13 was observed at the inlet area of the lake which was the only area where open water existed. Some pooled water along the lake margins was seen but the lake was still 90% ice covered.

In summary, we believe that ARCO Alaska Inc. should proceed with the design of adequate cross drainage for the entire access road/airstrip. Fish Habitat Permits are not required for the high-center polygons. Permits are required under AS 16.05.870 for the flooded area in the West Drill Pad area and in the swale. Because of the importance of flood waters providing fish movement, sediment and nutrient distribution to waters of the delta, and maintenance of fish habitat, we are requesting that the design accommodate the project design flood without restricting the flow of water.

I want to thank ARCO Alaska Inc. for providing logistical support which enabled us to walk the actual alignment of the facilities in the Colville River delta. I was extremely pleased to have the opportunity to visit with and discuss cross drainage with Larry Moulton and Jim Aldrich. Larry's knowledge of the fisheries resources and Jim's work with river hydrology are extremely valuable to the department in making decisions regarding the proper protection of anadromous fish and their habitat. If you have questions, please give me a call at 459-7289. Thank You.

Sincerely,

Alvin G. Ott, Regional Supervisor
Habitat and Restoration Division
Department of Fish and Game

cc: Mayor Gordon Brown/Leonard Lampe, Village of Nuiqsut, Nuiqsut
Joe Nukapigak/Laston Chinn, Kuukpik Corp., Nuiqsut
Jon Dunham, NSB, Barrow
Bill Thomas, ASRC, Barrow
Stan Pavlas, ARCO, Anchorage
Mike Joyce, ARCO, Anchorage
Mark Helmericks, Colville Environ Svcs, Anchorage
Steve Murphy/Brian Lawhead, ABR, Fairbanks
Larry Moulton, Seattle
Jim Aldrich, Shannon and Wilson, Fairbanks
Dan Reed, ADF&G, Fairbanks
Molly Birnbaum, DGC/SPCO, Anchorage
Nancy Welch, ADNR, Fairbanks
Ted Rockwell, EPA, Anchorage
Jeanne Hanson, NMFS, Anchorage
Phillip Martin, USFWS, Fairbanks
Patrick Sousa, USFWS, Fairbanks
Carl Hemming/Dick Shideler, ADF&G, Fairbanks
Terry Haynes, ADF&G, Fairbanks
Keith Shultz, ADF&G, Fairbanks
Fred Andersen, ADF&G, Fairbanks

AGO/ago

MEMORANDUM

State of Alaska
Department of Environmental Conservation
Division of Air & Water Quality

To:	Molly Birnbaum Project Review Coordinator Division of Governmental Coordination/JPO	Date: File:	June 6, 1997 300.69.001
		Telephone: Fax:	(907) 451-2360 (907) 451-2187
From:	Bradley R. Fristoe Alpine Project Leader ADEC/Fairbanks	Subject:	Alpine Project 401 Certification Review

BRF

RECEIVED
JUN 09 1997
REGULATORY FUNCTIONS BRANCH
ALASKA DISTRICT, CORPS OF ENGINEERS

The Alaska Department of Environmental Conservation (DEC) has reviewed the Environmental Evaluation Document (EED) and support documents that ARCO Alaska Inc. (ARCO) has submitted to the U.S. Army Corps of Engineers (Corps) for the Alpine project in support of issuance of the Clean Water Act Section 404 permit. As a result of this review, the Department of Environmental Conservation is requesting that the consistency review that includes the states certification of the Section 404 permit be stopped. This request is based on the need for information concerning interaction of flood waters and floating ice with the gravel fill within the delta area. We understand that an evaluation of the interaction and hydraulic action plan is being developed. This will need to be reviewed and approved before the Department can provide agreement of consistency.

Following are other comments on the EED. We request that ARCO also address these comments and questions.

Permits and Authorizations

401 Certification of the Corps permit
Wastewater disposal permit for a Class I injection well
Contingency Plan
PSD permits (Air)
Plan review of wastewater treatment facilities
Temporary storage of solid wastes

The EED discusses the disposal of sanitary and domestic wastewater by back hauling to Kuparuk or a combination of incineration and injection. If this is the case, no coverage by an Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) permit for these discharges would be necessary. If coverage under EPA's North Slope General Permit (GP) for these discharges is contemplated, the National Environmental Policy Act (NEPA) would need to be followed in order to gain coverage under the GP. This could be accomplished by EPA cooperation with the Corps in preparing the Environmental Assessment with EPA issuing their own decision document regarding use of the GP.

General Comments

The summary section of the EED has a discussion on access. where one option is a gravel road to Kuparuk but with no bridge across the Colville. Since this would limit road access to winter, when an ice bridge could be constructed, wouldn't the same be accomplished with an ice road?

On page S-5, the HDD method for crossing the Colville River is not listed as an alternative, even though this is what is currently being proposed.

On page S-8. Biological resources. fisheries. what resources use the delta? Are there critical areas near the project site?

How would the project itself increase the number of subsistence fishery users? Would access to subsistence fisheries be improved, so ARCO anticipates that more people would participate?

Drilling wastes from horizontal drilling are not regulated by DEC's solid waste regulations. However due to the proximity of the drilling operations to the Colville River and the unknown qualities of the mud that will be used. the State's certification of the 404 permit will require a plan review of the mud handling facilities for the horizontal drilling.

Does ARCO plan to do any work on Alpine during the summer following the winter pad construction? If so. the proposition of flying potable water to the site and wastewater back [to Kuparuk, in this case] seems to be cost prohibitive.

ARCO claims in the EED that the pipeline is adequately sized while at the same time the EED states the pipeline diameter will be between 8 and 20 inches? The EED needs to be updated to clearly state the size and need of the pipeline.

The EED discusses infrared cameras and pigging as being the preferred methods of leak detection, but says it will use state of the art leak detection. What else is involved in the state of the art leak detection? Infrared cameras have limitations in that they cannot penetrate cloud cover, fog, or through water. Pigging is a good tool, but if pigging is done in spans of years, is it really leak detection or just preventative maintenance? In a recent presentation at the Joint Pipeline Office, it was stated that a small leak may not be detected by the SCADA system and would be visually observed before it was found. Is this with an ordinary SCADA system or one enhanced with the use of fiber optics? How would small leaks be detected under the Colville River? Has there been any thought on the possibility of placing sensors in the HDD bore or in the pipe casing that are sensitive to hydrocarbons so a leak could be detected?

On page 4-17, the EED, in the section of the Water Quality Affected Environment, states "in such cases, the natural conditions replace the numerical criteria as the State standards for water quality." This is a portion of a discussion on elevated and naturally occurring levels of metals in the Colville. The statement implies that the natural conditions automatically take the place of the existing criteria. This is not true. According to the Water Quality Standards 18 AAC 70.025(b), the Department can find that this is the case but it is not automatic.

In a section on Groundwater, the EED says there is no information for the project area. How does ARCO intend to apply for a Class I, UIC permit from EPA and a wastewater disposal permit from DEC with no information on the groundwater that could potentially be affected?

I appreciate your assistance in coordinating this important project. Please contact me at (907) 451-2159 if you have any questions concerning these comments or DEC's request to stop the clock on the consistency determination.

BRF/rg (K:\AWQ\AIRWATER\ALPINSTP.WPD)

cc: John Wolfe, ADNR/JPO/Anchorage
Al Ott, ADFG/Fairbanks
Robert Watkins, ADEC/Anchorage
Cindi Godsey, ADEC/Anchorage
Mark Schindler, ARCO/Anchorage
Bill Fowler, ARCO/Ancorage
Judd Peterson, ADEC/Anchorage
Llyod Fanter, USCOE/Anchorage
Keith Quintavell, NSB/Barrow
Tony Braden, ADNR/JPO/Anchorage
Leon Lynch, ADNR/DL/Fairbanks
Steve Schmitz, ADNR/DOAG/Anchorage
Kate Moitoret, USFWS/NAES/Fairbanks
Jeanne Hanson, NMFS/Anchorage
Ted Rockwell, EPA/Anchorage
Carl Hemming, ADF&G/Fairbanks

STATE OF ALASKA

TONY KNOWLES, GOVERNOR

DEPT. OF ENVIRONMENTAL CONSERVATION
Division of Air and Water Quality
Watershed Management
610 University Avenue
Fairbanks, AK 99709-3643

Director's Office: (907) 465-5260
Fairbanks Office: (907) 451-2360
Fax: (907) 451-2187
File: 300.69.001

June 13, 1997

RECEIVED
JUN 16 1997
ALASKA LAND

Mr. Mark Schindler, Director
Alpine Permits and Compliance
ARCO Alaska, Inc.
P.O. Box 100360
Anchorage, Alaska 99510-0360

Dear Mr. Schindler:

I would like to take this opportunity to thank ARCO Alaska, Inc. for taking the time to present the Colville River hydrology findings to date for the Alpine project on June 11, 1997. The presentation made it possible for me to better define DEC's needs in order to proceed with the consistency determination. The information requirements are as follows:

Report: Discuss how flooding affects the gravel structure and what affects the gravel structure will have on flooding. The latter should discuss the water height differences caused by the structure considering that there is only foot difference in water elevation between a 50-year and 200-year flood event. It should also include information on the aerial extent, both up gradient and down gradient of the structure, that the structure would have on water levels, and any affects flooding caused by the structure may have on the pipeline and its support members.

Maps: Information on water elevations, water depths and water velocities during the 2-year, 50-year and 200-year flood events. If other years of comparable timing are more readily available, these would be acceptable to the department. This information should include maps for these events with and without the structure.

Plan: A drainage plan that considers the passage of fish and the ability to simulate natural flows especially into wetland areas that could be adversely affected by the gravel structure. The drainage plan should also address the effects of the gravel structure on special flood events that infrequently influence certain wetlands ecosystems but are necessary for the survival of the ecosystem. The plan should include water velocities in any pass through structures.

Other issues: A discussion of possible sedimentation due to reduced water velocities in places and, in the reverse, erosion due to increased water velocities in other places. Will there be increased erosion in the Nechelik Channel if water that cannot flow through the gravel structure routes around the structure and into the channel? Also, the effects of river ice on the gravel structure and the pipeline should be discussed.

If you have any questions, please contact me at (907) 451-2159.

Sincerely,

Bradley Fristoe

Bradley R. Fristoe
Alpine Project Leader

BRF/rg {K:\AWQ\AIRWATER\HYDROLET.WPD}

cc: John Wolfe, ADNR/JPO/Anchorage
Leon Lynch, ADNR/DL/Fairbanks
Carl Hemming, ADF&G/Fairbanks
Judd Peterson, ADEC/Anchorage
Jeanne Hanson, NMFS/Anchorage
Bill Fowler, ARCO/Anchorage
Tony Braden, ADNR/JPO/Anchorage
Steve Schmitz, ADNR/DOAG/Anchorage
Robert Watkins, ADEC/Anchorage
Lloyd Fanter, USCOE/Anchorage
Ted Rockwell, EPA/Anchorage
Molly Birnbaum, ADGC/JPO/Anchorage
Al Ott, ADF&G/Fairbanks
Cindi Godsey, ADEC/Anchorage
Kate Moitoret, USFW/NAES/Fairbanks
Keith Quintavell, NSB/ Barrow

BP EXPLORATION

BP Exploration (Alaska) Inc.
900 East Benson Boulevard
P.O. Box 196612
Anchorage, Alaska 99519-6612
(907) 561-5111

June 6, 1997

Mr. Lloyd Fanter
U.S. Army Corps of Engineers
Alaska District
Regulatory Branch (1145b)
P.O. Box 898
Anchorage, Alaska 99506-0898

Colville River 18. Ref.# 2-960874
Alpine Development Project

Dear Mr. Fanter:

BP Exploration (Alaska) Inc. (BPXA) is pleased to submit this letter supporting the Alpine Development Project (Alpine). ARCO Alaska, Inc. (AAI) is continuing the very important task of promoting responsible and well-planned oil development in Alaska. With declining Prudhoe Bay oil production, developments like Alpine are necessary to increase the domestic supply of oil and gas in the United States and to supplement declining oil production on the North Slope. Alpine will also support continued economic growth in Alaska. BPXA supports issuance of the Department of the Army (DA) permit for the Alpine Development Project

AAI has been planning the Alpine project for five years and has conducted environmental and technical field studies, held public meetings and consulted with agencies to identify the project's significant issues and environmental impacts, and develop design features that address the issues. AAI submitted an Environmental Evaluation Document (EED) with their DA permit application that summarized the five years of study results and identified and addressed environmental issues. BPXA is also aware that an environmental assessment (EA) will be prepared by the U.S. Army Corps of Engineers (USACE) for this project.

BPXA notes that significant benefits will accrue to the state and North Slope Borough (NSB) from the Alpine project including production royalty earnings, severance and corporate taxes to the state and enhanced property tax revenues to the NSB at a time when their overall tax base is decreasing. Nuiqsut, a NSB village, may also acquire the benefits of a cheaper local energy source. In addition, Arctic Slope Regional Corporation and Kuukpik Corporation, Alaska Native for-profit business corporations, are owners of various surface and subsurface rights included in the proposed development area. They would earn income from hydrocarbon production and may earn revenues from oil field contracting services provided to AAI.

AAI incorporated the information collected from the environmental and technical studies and from the informational meetings with interested parties into the project design, including mitigation measures. The pre-development baseline data will serve to benchmark the effectiveness of these mitigation measures and identify additional mitigation, if required. BPXA also supports AAI's commitment to ensure overall pipeline integrity through compliance with U.S. Department of Transportation pipeline design standards to minimize the probability of pipeline failure and scheduling most construction during winter to decrease the potential for surface erosion and significant adverse impacts to water quality.

BPXA is aware that the USACE must determine whether issuance of this permit would be a major Federal action having significant or insignificant effect on the human and natural environment. BPXA believes the Alpine Development Project would have an insignificant effect on the environment and supports issuance at the earliest possible date. Any questions should be directed to Peter Hanley at 907-564-5202

Sincerely,

Eric Luttrell, Vice President
Alaska Exploration and Development

lcf/PTH/EL

TONY KNOWLES, GOVERNOR

OFFICE OF THE GOVERNOR

OFFICE OF MANAGEMENT AND BUDGET
DIVISION OF GOVERNMENTAL COORDINATION

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June 18, 1997

Mr. Mark Schindler
ARCO Alaska Inc.
Environmental and Regulatory Affairs
P.O. Box 100360
Anchorage, AK 99510-0360

Dear Mr. Schindler:

SUBJECT: ALPINE DEVELOPMENT PROJECT REVIEW
REQUEST FOR ADDITIONAL INFORMATION
STATE I.D. NO. AK9703-03OG

The Division of Governmental Coordination has received the project proposal Alpine Development Project, State I.D. Number AK9703-03OGH for review under the Alaska Coastal Management Program 6 AAC 50. The consistency review for this project addresses the design, construction, drilling and operations of the Alpine Development Project as described in the Alpine Development Project: Evaluation Document (2 Volumes), U.S. Army Corps of Engineers public notice dated April 7, 1997, the ROW application submitted to the state of Alaska on August 29, 1996, the Alaska Coastal Management Program Coastal Project Questionnaire and other permit application submittals. DGC initiated the review process for this project and instructed resource agencies and the coastal district, the North Slope Borough, to advise DGC by April 12 if any additional information was needed for the project to evaluate this project for consistency with the ACMP.

On June 9, the Department of Environmental Conservation (DEC) requested that DGC extend the review time frames as allowed under 6 AAC 50.110(b)(6) until the following information was received and determined adequate to complete the consistency analysis. ARCO was forwarded a copy of this request and on June 11 was advised that DGC would be sending you a letter describing the reason for the review extension. DEC has expressed a need for information concerning interaction of flood waters and floating ice with the gravel fill within the delta area. It is the state's understanding that this information will be submitted in a report on hydraulic action. Although DEC has requested the ACMP clock to be stopped until this report is submitted, the information that will be included in this report could be submitted to DEC in draft form to address their questions as soon as possible. DGC encourages ARCO to contact Brad Fristoe at 451-2159 to address his specific concerns. The following are additional concerns and information requests that need to be addressed:

1. The summary section of the Environmental Evaluation Document (EED) includes a discussion on access where one of the mentioned options is a gravel road to Kuparuk with no bridge across the Colville. Since this would limit road access in the winter when an ice bridge could be constructed, please explain the reasoning for not constructing an ice road.

2. General Comment: Page S-5, Access of the EED - the horizontal directional drilling (HDD) method for crossing the Colville River is not listed as an alternative. It is the state's understanding that the HDD is the current proposal.

3. Page S-8, Biological Resources, Fisheries - there is no mention of which fish actually use the delta.

4. How would the project increase the number of subsistence fishery users? Based on the assumption that access to subsistence fisheries is improved, does ARCO anticipate that more people would be able to participate in subsistence activities?

5. Drilling wastes from HDD are not regulated by DEC's solid waste regulations. Due to the proximity of the drilling operation to the Colville River and the unknown qualities of the muds that will be used, the state's certification of the Section 404 permit will require a plan review of the mud handling facilities for the horizontal drilling.

6. Does ARCO plan to do any work on Alpine during the summer following the winter pad construction? If so, the proposition of flying potable water to the site and wastewater back to Kuparuk seems to be cost prohibitive. Are there any alternatives?

7. In the EED, ARCO claims that the pipeline is adequately sized while at the same time the EED states that the pipeline diameter will be between 8 and 20 inches. Please provide information to clearly state the size and need of the pipeline.

8. The EED discusses infrared cameras and pigging as being the preferred method of leak detection but also states that it will use "state-of-the-art" leak detection. What else is involved in the "state-of-the-art" leak detection? Infrared cameras have limitations in that they cannot penetrate cloud cover, fog, or operate through water. Pigging is a good tool; however, if pigging is done in spans of years, is it really leak detection or rather preventative maintenance? In a recent presentation at the Joint Pipeline Office it was stated that a small leak may not be detected by the SCADA system and would be visually observed before it was found. Is this with an ordinary SCADA system or one enhanced with the use of fiber optics? How would small leaks be detected under the Colville River? Has there been any thought on the possibility of placing sensors in the HDD bore or in the pipe casing that are sensitive to hydrocarbons so a leak could be detected?

9. Page 4-17 of the EED, Water Quality Affected Environment, it is stated that "in such cases, the natural conditions replace the numerical criteria as the state standards for water quality." This is an excerpt from a discussion on elevated and naturally occurring levels of

Mr. Mark Schindler
Alpine Development Project
State I.D. AK9703-03OG

June 19, 1997

metals in the Colville. The statement implies that the natural conditions automatically take the place of the existing criteria. This is not true. According to the Water Quality 18 AAC 70.025(b), DEC can find that this is the case but is not automatic.

10. In a section on groundwater, the EED says that there is no information for the project area. How does ARCO intend to apply for a Class I, UIC permit from the Environmental Protection Agency (EPA) and a wastewater disposal permit from DEC with no information on the groundwater that could potentially be affected?

11. General Comment: The EED discusses the disposal of sanitary and domestic wastewater by backhauling it to Kuparuk or a combination of incineration and injection. If this is the case, no coverage by an EPA National Pollutatn Elimination System (NPDES) permit for these discaharges would be necessary. If coverage under EPA's North Slope General Permit (GP) for these discharges is contemplated, the National Environmental Poilcy Act (NEPA) would need to be followed in order to gain coverage under the GP. This could be accomplished by EPA cooperation with the U.S. Army Corps of Engineers in preparing the Environmenal Assessment with EPA issuing their own decision document regarding the use of the GP.

Please note that when these questions are satisfied the review schedule will be reestablished. Thank you for your cooperation in this review process. Please contact me at 271-4317 or by E-Mail at MBIRNBAU@pipeline.state.ak.us if you have further questions.

Sincerely,

Molly K. Bi

Molly Birnbaum
Project Review Coordinator

Alpine Distribution List:

Jon Dunham, NSB/Barrow
Tom Lohman, NSB/Anchorage
Mayor George Sielik, Nuiqsut
Joe Nukapigak, Lanston Chin, Kuukpik Corp.
Michael Pederson, ASNA
Bill Thomas ASRC
Thomas Napageak, Native Village of Nuiqsut
Glenn Gray, DGC/Juneau
Steve Schmitz, DNR/DOG
Nancy Welch, DNR/Lands
Jack Kerin, DNR/Water

Al Ott, DFG/Fairbanks
Brad Fristoe, DEC/Fairbanks
Cindi Godsey, DEC/Anchorage
Jim Baumgartner, DEC/AQ/Juneau
Al Bohn, DEC/AQ/Anchorage
Joe Sautner, DEC/SPAR
John Wolfe, DNR/SPCO
Tony Braden, DNR/SPCO
Greg Swank, DNR/SPCO
Vic Manikian, DNR/SPCO
Lloyd Fanter, COE
Ted Rockwell, EPA
Phil Martin, Bruce Batton, USFWS/Fairbanks
Jeanne Hanson, NMFS

TRUSTEES FOR ALASKA

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SENT VIA FAX AND MAIL

June 6, 1997

RECEIVED
JUN 09 1997
REGULATORY FUNCTIONS BRANCH
ALASKA DISTRICT, CORPS OF ENGINEERS

Colonel Peter A. Topp
District Engineer, Alaska District
U.S. Army Corps of Engineers
Attn: CENPA-CO-R
P.O. Box 898
Anchorage, Alaska 99506-0898
Attn. Lloyd Fanter

RE: 2-960874
Colville River 18

Dear Colonel Topp:

We write to e comment on ARCO Alaska, Inc.'s application for a Clean Water Act Section 404 permit for the proposed Alpine oil field project in the Colville River Delta. These comments are submitted on behalf of the members of the Alaska Center for the Environment, Alaska Wildlife Alliance, LightHawk, Greenpeace, National Wildlife Federation, Natural Resources Defense Council, Northern Alaska Environmental Center, Sierra Club, The Wilderness Society, and Trustees for Alaska. These non-profit, public interest organizations are dedicated to the conservation and protection of unique Alaskan environments, including the Colville River Delta. Together, these organizations represent well over a million members.

We request that the Corps of Engineers deny the permit because it is not in the public interest and does not comply with the, the National Environmental Policy Act, 42 U.S.C.A. §§ 4321 to 4370d, Clean Water Act, 33 U.S.C.A. §§ 1251 to 1387, the Rivers and Harbors Act[1], 33 U.S.C. § 403, the Endangered Species Act, 16 U.S.C. §§ 1531 to 1544, the Alaska National Interest Lands Conservation Act, 16 U.S.C. 3120, or the Coastal Zone Management Act, 16 U.S.C. §§1451-1464.

We have organized our comments by the laws to which they relate. Under the National Environmental Policy Act, we have several issues of concern. First, an EIS should be prepared because this is a major federal action significantly affecting the human environment. Second, the direct, indirect, and cumulative impacts of the project have not been adequately evaluated. Direct effects include the hazards of oil spills, flooding, erosion, and habitat loss. Indirect effects include Alpine's role in future development of NPRA and other oil and gas developments. Assessment of cumulative impacts requires

[1] The Rivers and Harbors Act (RHA) requires permits for placement of structures in navigable waters. 33 U.S.C. 403. Because RHA consideration is really only a subset of Clean Water Act considerations, we hereinafer refer only to the Clean Water Act. 33 U.S.C. §§ 1251 to 1387.

evaluating the effect of Alpine development together with past, present, and reasonably foreseeable future developments that will impact water quality, vital wildlife habitat, and important subsistence resources.

We have also addressed a number of Clean Water Act issues. ARCO has not provided any evidence of intent to perform appropriate and practicable compensatory mitigation to compensate the public for the wetlands values the Alpine development will destroy.

Rigorous analysis of the effect of the proposed project on the threatened Spectacled Eider is required under the Endangered Species Act. 16 U.S.C.A. §§ 1531 to 1544. Also, the Alaska National Interest Lands Conservation Act requires under Section 810 that a subsistence evaluation be prepared to evaluate Alpine's impact on subsistence resources. Finally, the Coastal Zone Management Act requires the Corps to make a finding of consistency with the specific standards of the Alaska Coastal Management Program, including the district coastal management program.

Factual and Procedural Background

The Colville River is the largest river flowing into the Arctic Ocean in Alaska and one of eight major rivers in the circumpolar Arctic. It has long been regarded as having unique values, and is particularly important habitat for numerous birds. The Colville River was designated as a potential addition to the national wild and scenic rivers system by the Alaska National Interest Lands Conservation Act. *see sec. 604 of ANILCA*, 16 U.S.C. 3120. The Colville Delta has been identified as a "unique ecological area" by the U.S. Geological Survey (U.S.G.S., 1979), and was recommended as a potential natural landmark (Koranda and Evans, 1975).

Studies by the U.S. Fish and Wildlife Service have documented the special importance of the Colville Delta to migratory birds due to an extensive and diverse array of interspersed lakes, ponds, and other wetland types (Meehan and Jennings, 1988). The saltmarshes bordering the ocean are the most extensive on the North Slope and are heavily used by migrating shorebirds and waterfowl in the fall. The saltmarshes would be particularly susceptible to an oil spill. (Personal communication, J. Bart, Biological Resources Division, U.S.G.S., June 5, 1997). The Colville River delta is of special significance for overwintering ciscoes, whitefishes, and international populations of Arctic char which support subsistence and commercial fisheries. The area also has tremendous recreational qualities which would be lost or degraded by the project.

In the 1980's the Environmental Protection Agency and the U.S. Army Corps of Engineers recognized that the unique wetland values of the Colville River Delta warranted special planning. The two agencies released a draft Colville Advanced Site Identification by public notice on April 19, 1989 which mapped areas potentially suitable or generally unsuitable for fill founded on habitat rankings primarily based on high value waterbird habitats. This Advanced Identification process was an important recognition by the EPA and Corps of the widespread extent of extremely sensitive wetlands where avoidance of impacts should be the highest priority. Regrettably, the effort was dropped due to political controversy.

Between 1991 and 1994 ARCO drilled twelve exploration wells in the Colville River Delta. During the winter of 1996 another seven wells were drilled and ARCO concluded that the Alpine project may produce 50,000 to 80,000 barrels of oil per day. ARCO now wants to place 1,326,970 cubic yards of gravel fill material into 114.65 acres of the Colville River Delta to develop an infrastructure for the Alpine Development Project. This infrastructure includes a pipeline that will be placed below the Colville River using untested technology. Before ARCO may discharge fill material into waters of the U.S. they must obtain a Section 404 permit under the Clean Water Act. 33 U.S.C. § 1344. Section 404 requires notice and opportunity for public hearings before such a permit is issued. *Id* at 1344(e)(1). Due to the extremely sensitive nature of the Colville River Delta, and the fact that Alpine appears designed as the gateway for oil and gas development to its west, this coalition of eleven regional, statewide, and national, and international organizations joined together to submit these comments.

LEGAL CONCERNS WITH THE ALPINE PROJECT

As noted above, we have serious concerns about the Alpine project, concerns which arise under NEPA, CWA, ESA, ANILCA, and CZMA. In order to put our comments in the proper context, we will begin each section by providing the legal standards which form the foundation for the Corps' duties and our concerns.

A. National Environmental Policy Act

Legal Background

The National Environmental Policy Act, 42 U.S.C. §§ 4321-4370a, is "our basic national charter for protection of the environment." 40 C.F.R. § 1500.1(a). Section 2 of NEPA expressly declares Congress' purpose of promoting efforts "which will prevent or eliminate damage to the environment." 24 U.S.C. § 4321.[2] NEPA accomplishes these environmental protection goals by forcing federal agencies to consider the environmental consequences of their actions and by informing the public, including Congress, of those consequences. Jones v. District of Columbia Redev. Land Agency, 499 F.2d 502, 512 (D.C. Cir. 1974), cert.den., 423 U.S. 937 (1975); Illinois Commerce Comm'n v. I.C.C., 848 F.2d 1246, 1260 (D.C. Cir. 1988), cert.den., 488 U.S. 1004 (1989).

The heart of NEPA is its requirement that federal agencies prepare a detailed "environmental impact statement" ("EIS") for all major federal actions significantly affecting the quality of the human environment. 42 U.S.C. § 4332(2)(C). The Council on Environmental Quality (CEQ) regulations implementing NEPA require federal agencies to follow both "the letter and spirit" of the law. 40 C.F.R. § 1500.1(a). In order to do so, agencies must read the CEQ regulations in conjunction with NEPA. Id. § 1500.3. The Supreme Court has held that "CEQ's interpretation [of NEPA] is entitled to substantial deference." Andrus v. Sierra Club, 442 U.S. 347, 358 (1979).[3]

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[2] NEPA was passed by Congress in response to citizen indignation over federal agency mismanagement of the environment. See S.Rpt. No. 296, 91st Cong., 1st Sess. 8 (1969). NEPA's Senate author, Sen. Henry Jackson, described it as "the most important and far-reaching environmental and conservation measure ever enacted...". 115 Cong. Rec. 40416 (1969).

[3] The CEQ regulations allow federal agencies to adopt regulations to supplement those adopted by CEQ. Id. § 1507.3. However, an agency's own supplementary regulations may not conflict with the CEQ regulations. Id. The Corps adopted its current regulations for implementing NEPA in 1988. See 53 Fed. Reg. 3127 (Feb. 3, 1988). The purpose of the Corps regulations is to supplement the CEQ regulations; they are intended only to be used in conjunction with them. 33 C.F.R. § 230.1.

CEQ regulations require that agencies prepare an Environmental Assessment ("EA") to determine whether an EIS needs to be prepared. Id. § 1508.9. If an agency properly concludes based on an EA that the proposed action will not significantly affect the environment, the agency will issue a Finding of No Significant Impact ("FONSI"). A FONSI indicates that an EIS is unnecessary. Id. While not as comprehensive as an EIS, the EA must include a discussion of the need for the proposed action, alternatives to the proposal, and the environmental impacts of the proposal and its alternatives. Id.

A federal "action" under NEPA includes "new and continuing activities, including projects...entirely or partly...regulated by federal agencies..." (emphasis added). Id. § 1508.18(a). Projects include "actions approved by permit...as well as federal and federally assisted activities." Id. § 1508.18(b)(4). Determining whether a site-specific action significantly affects the environment includes looking at short and long-term effects in the locale, the unique characteristics of the geographic area including proximity to parks and ecologically critical areas, and adverse effects on endangered or threatened species or their habitat. Id. § 1508.27. The agency must also consider direct, indirect, and cumulative effects including effects related to induced changes in the pattern of land uses and related effects on ecosystems. Id. §§ 1502.16(a), 1502.16(b), 1508.8(a), 1508(b), 1508.7.

1. The Proposed Alpine Project Will Have Significant Effects On The Environment and Subsistence Resources, and an EIS Should be Prepared.

A full Environmental Impact Statement should be prepared for the proposed Alpine project. NEPA requires that an EIS be prepared for any "major Federal actions significantly affecting the quality of the human environment." 42 U.S.C.A. § 4332(2)(C). Because "federal actions" include "actions approved by permit...as well as federal and federally assisted activities," the Alpine project must comply with NEPA. 40 C.F.R. §1508.18(b)(4). This project will negatively impact the wetlands, floodplain, and river of the Colville River Delta. The gravel fill, noise disturbance from aircraft support, and chronic spills will irreversibly degrade wetlands habitats that are important for fish, wildlife, and subsistence users. There is great potential for catastrophic oil spills from the Colville River pipeline crossing. All development and production activities will take place in the floodplain itself for the first time in North Slope oil field history. There will be severe impacts to the subsistence economy and livelihood of the North Slope residents, and cumulative effects from this project along with existing and future oil field development projects onshore and offshore in the Beaufort Sea. All of these impacts add up to long-term significant effects on the human and natural environment

An EIS would foster informed decision making and provide for full public process. The CEQ regulations implementing NEPA dictate use of high quality, accurate science, and attention to public scrutiny before decisions are made and actions are taken. 40§ C.F.R. 1500.1(b). Although it is proposed that the pipeline will be constructed by drilling under the Delta, this technology is unproved and may not be feasible. An EIS would give the project a thorough environmental and technical review and ensure that impacts will be fully minimized and mitigated, if the technology is determined to be feasible. Furthermore, if the below-river pipeline is not acceptable or feasible, then the alternatives for above-ground pipeline crossing would benefit from the rigorous analysis of an EIS.

We concur with the Corps of Engineer's finding that ARCO's "Environmental Evaluation Document" is "incomplete in the evaluation of impacts," and strongly agree with the Corp's decision that "it will not adopt the EED as the environmental assessment for evaluation of the proposed project," (public notice p.8). An EIS, not an environmental assessment, is required for this major and complex project in order to provide adequate consideration of alternatives to avoid negative impacts to wetlands, the floodplain, and the coastal zone. An EIS could adequately consider mitigation measures and provide opportunity for public scrutiny and informed decision making.

2. A Comprehensive EIS Should Examine All of the Impacts of the Alpine Project

An Environmental Impact Statement on the Alpine Development Project should include evaluation of direct, indirect, and cumulative impacts of the proposed action. CEQ regulations require that an EIS contain such an analysis. 40 § C.F.R. 1502.16.

a. Direct effects

An EIS should examine all of the direct effects of the proposed Alpine project. CEQ regulations define direct effects as those "which are caused by the action and occur at the same time and place." 40 C.F.R. §1508.8(a). There are several direct effects of the proposed project that are not adequately addressed and must be more carefully analyzed before any development is permitted.

The Colville Delta is a dynamic system where shifting mudflats and regular floods create a very unstable environment for development. There has been substantial loss of the outer mudflats region over the past 20 years. The northeast corner of the NPRA was adjusted recently due to shifts in the river channel flow of the Nechelik Channel. Proposed valve locations are still within a highly active flood zone. The primary production pad is located only about 100' from the Sakoonang Channel and lake shores. The potential for erosion, spills from the storage pad, effects of the gravel dust shadow, thermokarsting effects, or other changes in hydrological patterns have not been addressed.

The associated gravel pit (Arctic Slope Regional Corporation lease area and permit) has very little buffer with the Colville River which increases the potential effects from erosion and thermokarsting. As well, the pipeline is routed through the proposed gravel mine site and the gravel lease area is sited very near the transition zone of the bored pipeline river crossing. All this infrastructure may exacerbate negative effects to the permafrost zone, the river banks, and increases the risk of oil spills from pipeline buckling, settling, or flooding. The alterations in surface flow caused by the gravel pit, or the transition zone where the pipeline goes underground, could lead to rapid changes to the thermal regime of adjacent areas or to downstream hydrology. Little research into post-construction hydrologic effects has been done.

There is also a high risk of flooding, including potential damage from ice during spring breakup, which could spread oil and other hazardous materials across a vast area of the Delta. A report by a prominent hydrologist shows that "typical flooding in late May," covers most of the area of the proposed road linking the two production pads and the entire site of the smaller one (Fig. 3, H.J. Walker, 1983). Flooding and attendant hydrological changes could affect the structural integrity of the river crossing where the pipelines come out of the ground, as these locations are within the floodplain.

We are particularly concerned about the need to address the very real possibility of oil spills and other risks associated with the buried pipeline crossing. The Alpine project involves the use of unprecedented new technology in the U.S., with a below-river pipeline in continuous permafrost. An oil spill during breakup or flooding could be catastrophic. During spring break up, travel can be impossible and therefore containment of spilled oil would be impossible. A major spill during spring flooding could have devastating effects by spreading oil across the extensive salt marshes and mudflats which are used by large populations of migrating shorebirds and waterfowl. Both chronic and accidental spills associated with the permanent pipelines and production pad, as well as from continued winter seismic operations and support travel could result in long-term contamination of the river channels and mudflats.

These risks and the oil spill contingency plans need to be analyzed in the EIS. We are concerned about risks to structural integrity of the pipeline below the river because the thaw bulb under the river is deeper than expected (in fact, the pipeline would not be within solid permafrost). The transition zone where the pipeline comes out of the ground, and is still within the floodplain, is vulnerable to melting permafrost and solifluction and there is no evidence in the application package that these problems have been adequately addressed. Furthermore, technology that is as yet untested in the arctic will be used to bore the buried pipeline holes. There are concerns about how to keep the warm drilling mud from destabilizing the hole and how problems with corrosion in the buried line would be detected and fixed.

Corrosion of the pipeline is another major concern. The sales pipeline will be carrying a more corrosive liquid (a mixture of oil, water and natural gas which flows out of the wells) than the crude oil shipped down the Trans-Alaska Pipeline, where the most serious corrosion problems and settlement of the pipe necessitating repairs have been in sections of buried pipeline. ARCO's experts said that the diesel line will also be used for other chemicals which would be "batch-filled, then tanked at Alpine" (briefing with conservationists, April 22, 1997). Leaks from the diesel line, and the other chemicals and hazardous materials which may flow through it, are of concern due to the long-term persistence of these types of spills.

Oil spill risk and response in the Colville Delta will be different than the other existing North Slope operations and needs special consideration prior to permit authorization because of the sensitive fish, wildlife, and subsistence resources at risk. Mention is made of storage tanks for fuel and hazardous materials at the production site, but nothing is said about spill response for these. A NEPA analysis would not be complete without a thorough examination of oil spill risk and potential impacts on wildlife, subsistence users, and sensitive ecosystems.

Another direct impact of the proposed project will be the unavoidable loss to wildlife and fisheries resources of national and international importance. The Colville delta is comprised of a complex maze of lakes, ponds, river channels, and a variety of wetland types that are unique on the North Slope. The information presented in ARCO's EED fails to elucidate this because its maps show little of the adjacent Kuparuk or Prudhoe Bay areas. The habitat maps which are included make it clear, however, that the habitats are very distinct from the adjacent area to the east that is out of the Colville floodplain. The diversity of wetland types, and micro-sites within an area, for example the extensive fields of polygon ponds (e.g. wet-sedge willow meadow with low-relief polygons habitat type) contribute to high bird use of the delta. It is important to evaluate bird use by individual habitat types, but also to study the diversity of habitats found in an area because this greatly increases the importance of an area to birds at different times in the year.

Although ARCO sponsored bird surveys in the delta, most of the ground bird surveys conducted during 1992 and 1993 took place in the northern area of the delta, not the current project area. In 1995, the ground survey work shifted to the vicinity of the proposed Alpine facilities, but even during the 1995 studies, the drill-site and pipeline locations were not the same as the current proposal (Johnson, et al. 1996). The 1995 studies were quite limited with respect to field work on the ground -- only 7 days were devoted to eider nest searches, 2 days to ground brood-rearing observation, and one additional day for loon ground searches. Therefore, there are no time-series data from many years on key bird species from which to assess site-specific impacts from direct habitat loss, nor from noise or other disturbance or habitat degradation.

As well, site-specific bird use data collected on the ground during the molting or staging period in fall was very limited. Despite their threatened species status, intensive spectacled eider nest searches were only done in the "facility area," not all areas where proposed pipelines, gravel pit, and pipeline crossing pads would be located, nor in the entire area that may be negatively affected by aircraft noise. In addition to brant, tundra swans, loons, and other waterfowl for which aerial surveys were done, the delta is important to other species which were not studied by ARCO, including a rich diversity of other waterfowl, shorebirds, and passerines.

The U.S. Fish and Wildlife Service conducted field studies in the Delta in 1986 which had study plots covering the large lake and other areas close to the proposed Alpine production pad and the pipeline route near the Sakoonang Channel. The raw data from that study shows that a wide variety of waterfowl nested in the areas within 2.5 miles of the proposed facilities: red-throated and pacific loons, tundra swans, greater-white fronted goose, brant, northern pintail, American wigeon, oldsquaw. Broods were documented for tundra swan, oldsquaw, green-winged teal, northern pintail, pacific loon, red-throated loon, and greater scaup, oldsquaw.

Furthermore, bar-tailed godwits and stilt sandpipers, species defined as rare and sensitive species by the Alaska Natural Heritage Program, were documented nesting on these study plots (personal communication Pamela A. Miller, 1986 field notes). There were also "hot spots" along the proposed pipeline route (about 1 ½ mile from Colville river) where bar-tailed godwits, whimbrels, stilt sandpipers, and other species defended their broods, and yellow-billed loons were observed in a lake here . (observations on 7/13/86 and 7/19/97, personal communication P.A. Miller.)

ARCO's EED asserts that impacts to bird habitat are mitigated, but the maps in this document show that in fact, high quality habitats as defined by their studies would be unavoidably covered by gravel, lost from gravel extraction, and severely degraded by aircraft traffic all year round. The proposed aircraft restrictions would not be in effect during the onset of the breeding season, nor during the sensitive molting, fall staging, or migratory periods; therefore ARCO's description of mitigation on airstrip construction and operation, "avoids sensitive wildlife use periods," is simply not true. As well, there would still be aircraft flights almost daily during the breeding season. Furthermore, there are no restrictions listed for helicopter travel, at any time in the year, despite the fact that these could be very extensive, especially during the construction phase.

The effects of water withdrawals on fish and bird habitats and wetland hydrological patterns and functions could be severe. The water withdrawals are underestimated in the public notice. Furthermore, the 52 lakes which may have been permitted for withdrawals for exploration ice roads may not have been evaluated for long-term use for building annual ice roads for the development and production phases, nor for other water uses. The amount of fresh water for each type of activity (ice roads and pads, drilling of the HDD bored river crossing, hydro-testing the pipeline, temporary camps, and drilling wells throughout the life of the project) and the quantities available at site specific sources needs to be specified.

The public notice states that ice roads and bridges would be built for the construction seasons (2 years), and during development and start-up (5 years) and for long-term operations (20 years). The application assumes 40-50 million gallons would be needed for ice road construction, but it is unclear what period of time that is assumed to cover. The 1995 and 1996 exploratory seasons used 42 million gallons and 65 million gallons for ice roads and pads. Therefore, using the lower estimate, ice roads and bridges for future work would require over 1.1 billion gallons over the life of the project. Additional water is also needed for the HDD drilling (3-5 million gallons), and drilling development wells (77- 114 million gallons - 42,000 -63,000 gpd x 365 days x 5 years). Therefore, these identified needs total 1,253,000,000 gallons of fresh water. Other water needs, such as drilling enhanced recovery wells, in-fill and other new production wells after the first five years of development, and well work-overs, are not addressed.

The public notice states that only 447 million gallons of water would be available from the 52 existing permitted lakes (considering only about 15% of water that exists under typical ice conditions is available for use under typical ADF&G restrictions). Therefore, roughly a third of the amount of water needed would be in those lakes, if they can provide that amount of water over such a long time period. The Corps must address impacts to fish, wildlife, and wetlands from water withdrawals from the identified water sources, as well as water withdrawals from lakes within the delta or from the river. Even lakes without much fish use provide bird habitats that could be affected.

There would be significant direct effects to the subsistence economy of North Slope residents. The wetlands of the Colville Delta provide the foundation for a dynamic system focused on the use of local resources for social, cultural, economic, and other aspects of the existing subsistence-based economy (see Alana and Wheeler, 1989 for more about the socio-economic values of wetlands). The vital role played by the diverse mix of river and wetland habitats in the Colville Delta for the maintaining the Native Socioeconomic systems needs to be given serious attention.

The gravel mine and its overburden fill area should also be considered as an integral part of the project for the impact analysis. This mine would have only a narrow buffer with the Colville River and would contribute to the loss of high value wetlands. We are concerned about risks of erosion and hydrological changes to the Colville River due to the narrow buffer between the site and the river. In 1991, the U.S. Fish & Wildlife Service requested denial of the permit because of the project's impacts from gravel extraction to habitats considered the most biologically productive types in the Colville River Delta (based on a study "Characterization and value ranking of waterbird habitat on the Colville River Delta, Alaska by Meehan and Jennings, 1988), particularly for a project with no identified, immediate need and where other less damaging alternatives had not been considered (November 14, 1991 letter by P. Sousa, Field Supervisor, Northern Alaska Ecological Services, to Colonel J.W. Pierce, Corps of Engineers).

The Alpine project will have numerous direct effects on the Colville River Delta ecosystem, water quality, wildlife and bird habitat, and subsistence lifestyles. A comprehensive EIS should examine all of these direct effects of the Alpine project prior to a decision whether or not to issue a permit.

b. Indirect effects

An analysis of environmental impacts must also address the myriad indirect effects that the Alpine project will have on the arctic ecosystem. NEPA regulations define "indirect effects" as those "which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable." 40 C.F.R. § 1508.8(b). Indirect effects include "induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems." *Id.*

One of the most significant indirect effects will be Alpine's role in future oil and gas development. The Alpine field is the "gateway" to the National Petroleum Reserve-Alaska (NPRA), a driving force for more oil extraction to the west. ARCO's Mike Joyce stated at the BLM's Science Symposium on the NPRA on April 16, 1997, that "Alpine is one of the prime reasons we're here [at this symposium]." The proposed pipeline corridor, especially the Colville River crossing, is the first step of development for a much larger area.

That this is so is evident from many facts, including that the Alpine pipeline will not only be used only for oil from the Alpine project, but is planned to hold extra capacity for other fields to the west brought on line in the future. ARCO acknowledges this in its application package, listing the extra capacity as a mitigation measure. However, the full long-term environmental implications of channeling future development activities through the pipeline under the Colville Delta are ignored.

Other evidence that this pipeline is intended to facilitate other major developments is demonstrated by the fact that the pipeline is being permitted as a common carrier. Also, the permit drawings show space on the VSM's for placement of an extra pipeline, and ARCO's engineers said that the 14" pipeline could be increased to three times the projected throughput if additional pumps were used (briefing to conservationists on April 22, 1997). ARCO has said that the Colville crossing is a key aspect of economic viability and once it is in place, then many other fields which might not be economically feasible to develop could be considered. This could reasonably include additional facilities and fields on adjacent Native Corporation lands, in the State and Federal waters of the Beaufort Sea, and across the NPRA.

The proposed natural gas pipeline to Nuiqsut is another indirect impact of the project, and its environmental impacts should be evaluated in the EIS. ARCO lists this as mitigation in Attachment C: Applicant proposed comprehensive mitigation plan, revised March 11, 1997. In ARCO's video, "Alpine Development Project: Opportunities for the Future" which was sent to all Nuiqsut residents, the narrator states, "

> the proposal was to build a pipeline to transport crude oil into Kuparuk, and then into the Trans Alaska Pipeline System, at the same time making natural gas available to the village of Nuiqsut as a new, clean-burning and efficient energy source... ARCO will make available up to 500,000 cubic feet per day to the North Slope Borough for transport to Nuiqsut."

Furthermore, the road from Kuparuk to Alpine or Nuiqsut is an indirect effect of the project if it is built as a consequence of Alpine development. Although we support the creative project design of an oil field without road connection to existing oil fields, it does not appear in this case that the entire project, when viewed in terms of reasonably foreseeable consequences, will actually be roadless. It is unclear how the alternative road proposals put forward by the Kuukpik Corporation and Arctic Slope Regional

Corporation are being considered as part of the whole package of compensation or mitigation measures resulting from negotiations between the Native corporations and ARCO.

Alpine's role in future oil and gas development in NPRA and other locations on the western North Slope, the impact of the new pipeline, and future road plans, all deserve thorough analysis in an EIS. These indirect effects of the project may be as destructive to wildlife habitat and subsistence users as the project itself.

c. Cumulative impacts

Cumulative impacts are not adequately addressed in the environmental evaluation. NEPA regulations define "cumulative impacts" as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions....[c]umulative impacts can result from individually minor but collectively significant actions taking place over a period of time." 40 C.F.R. § 1508.7. This project cannot be viewed in isolation from the past, present and future proposed oil development. Within the Colville Delta itself, ARCO has acknowledged that it expects to put into production the Fiord #1 well, located to the north of Alpine, within a 7-10 year window. The Kuukpik Unit, located in the northwest part of the Colville River Delta, would affect additional habitats in the Delta. Satellite fields, such as ARCO's proposed Tarn development, and many others are expected to come on line with incremental construction of more pipelines, roads, gravel pads, and facilities in the foreseeable future between the Colville and Kuparuk. The incremental expansion of oil field roads and pipelines from Kuparuk to the Colville, as well as the use of Kuparuk facilities for the Alpine project, is relevant to this impact analysis and public interest review because there may be further impacts to caribou calving distribution and movements, and reproductive success of the Central Arctic herd. This would further harm the subsistence resources upon which the people of the North Slope depend.

The environmental impacts for most of the existing Kuparuk oil field were never evaluated in an environmental impact statement. Rather, the field grew on a piecemeal basis. Scientists from the Alaska Department of Fish and Game continue to document major changes to caribou calving distributions and reproductive rate in the new Kuparuk and Milne Point fields. A sharp decline (23%) in the Central Arctic herd population was discovered by 1995 surveys. The decline occurred in the caribou's range in the vicinity of oil development infrastructure, with 41% declines found in the Kuparuk oil field vicinity, while the part of the herd using the undeveloped range to the east of the Trans-Alaska Pipeline is increasing. (Nellemann and Cameron, in press; Cameron, 1995). The effects of oil field development on calving caribou distribution and reproductive success have long been documented (Cameron et al. 1979; Cameron et al. 1995). The fact that the Alpine field is a major extension from Kuparuk, and will rely on processing and support facilities which have not been included in a past EIS, provides additional rationale for the need for an EIS.

Simultaneously, the pending oil development proposals offshore, such as British Petroleum's Northstar and Liberty, will further affect the fish and wildlife resources and cause conflicts with the subsistence livelihood of the residents of the North Slope and greatly contribute to the cumulative effects. The Alpine project will extend the reach of oil field development another 34-miles to the west, while many other projects are currently in play which will cause loss of habitat and increased disturbance across the North Slope to the east and to offshore areas on the north.

Furthermore, some indirect impacts can lag behind planned development and the total area eventually disturbed can greatly exceed the planned area of construction (Walker et al. 1987). In particular, flooding and thermokarst in the wettest part of the oil field was found to cover twice the area directly covered by roads and other construction activities. These factors need to be included in consideration of cumulative effects.

3. Alternatives to Developing in the Colville River Floodplain Must Be Considered

The Alpine proposal should include an alternative that does not involve development in the floodplain. NEPA regulations require consideration of a range of reasonable alternatives. *Council on Environmental Quality, "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations,"* Question 1, 46 Fed. Reg. 18026, 18027 (1981); *see also* 40 C.F.R. §1505.1(e). Executive Order 11988 also requires that alternatives to floodplain development be considered. Because floodplains play an essential environmental role in many ecosystems, and because floodplains are, by definition, subject to destructive flooding, the federal government has adopted policies intended to avoid development in floodplains when possible. Executive Order 11988, issued May 24, 1977, requires that:

> Each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of flood on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities for . . . conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating and licensing activities.

In order to provide leadership and take action to restore and preserve the natural and beneficial values served by floodplains, "[i]f an agency has determined to, or proposes to, . . . allow an action to be located in a floodplain, the agency shall consider alternatives to avoid adverse effects and incompatible development in the floodplains." Id.

As proposed, all development and production activities for the Alpine project will take place in the floodplain. In light of the latest technology for directional and extended reach drilling, a careful analysis of practicable alternatives for locating the Alpine development outside of the Colville River flood plain must be performed before the Corps can approve the project.

B. The Clean Water Act

Legal Background

Congress passed the Clean Water Act ("CWA") in 1972 with the objective of "restor[ing] and maintain[ing] the chemical, physical, and biological integrity of the Nation's waters." 33 U.S.C. § 1251(a). In order to achieve that objective, Congress declared, as a "national goal," that "the discharge of pollutants into the navigable waters be eliminated by 1985." 33 U.S.C. § 1251(a)(1) (emphasis added).

Congress' enactment of the CWA in 1972 "marked the ascendancy of water-quality control to the status of a major national priority." Monongahela Power Co., et al. v. Alexander, 809 F.2d 41, 45-46 (D.C. Cir. 1987), cert. denied, 108 S. Ct. 68 (1987). The cornerstone of Congress' mechanism to achieve these sweeping goals is section 301(a), 33 U.S.C. § 1301(a), which states that, "[e]xcept as in compliance with [several specified sections, including sections 402 and 404], the discharge of any pollutant by any person shall be unlawful."

Section 404(a) of the CWA, 33 U.S.C. § 1344(a), authorizes the Corps to "issue permits, after notice and opportunity for public hearings" for the discharge of "dredged or fill material" into U.S. waters. Section 404(b)(1) requires that the Corps decide whether or not to issue a permit in accordance with "guidelines" developed by the Administrator of the U.S. Environmental Protection Agency ("EPA") in conjunction with the Corps.

EPA's guidelines provide, as a "fundamental precept," that dredge or fill material "should not" be discharged into "aquatic ecosystems" unless it can be demonstrated that such a discharge "will not have an unacceptable adverse impact either individually or in combination with known and/or probable impacts of other activities affecting the ecosystems of concern." 40 C.F.R. § 230.1(c). See also 40 C.F.R. § 230.7(c) (referring to section 230.1 as providing a "presumption" against permitting discharges into U.S. waters).

EPA and the Corps have articulated a "mitigation sequence" to be used to determine compliance with the 404(b)(1) guidelines. Memorandum of Agreement Between the Environmental Protection Agency and the Department of the Army Concerning the Determination of Mitigation Under the Clean Water Act Section 404(b)(1) Guidelines (MOA). The mitigation sequence requires that an applicant make practicable and appropriate efforts to avoid adverse impacts, practicable and appropriate efforts to minimize unavoidable adverse impacts, and finally, practicable and appropriate efforts to compensate for unavoidable impacts. *Id.*

Assuming that ARCO has engaged in practicable and appropriate avoidance and minimization, there is no suggestion in the public notice that ARCO will perform appropriate and practicable compensatory mitigation to compensate the public for the wetlands values the Alpine development will destroy.

Footnote 7 of the mitigation MOA recognizes that "avoidance, minimization, and compensatory mitigation may not be practicable where there is a high proportion of land which is wetlands." *Id.* However, the 404(b)(1) guidelines place the burden of demonstrating that a proposed discharge complies with the guidelines on the applicant, 45 Fed. Reg. 85338, Dec. 24, 1980, and footnote 7 does not alter that burden of proof. To receive a permit, ARCO must demonstrate that it will provide practicable and appropriate compensatory mitigation, or demonstrate that there is no practicable and appropriate compensatory mitigation for this project. ARCO has made no attempt to make either of these demonstrations.

Under the MOA,

> "the determination of what level of mitigation constitutes 'appropriate' mitigation is based solely on the values and functions of the aquatic resource that will be impacted. This determination shall not be based upon characteristics of the proposed project such as need, societal value, or the nature or investment objectives of the project's sponsor." MOA at 2.

Once it is determined that a certain level of mitigation is appropriate, the Corps must determine the level of mitigation that is practicable. Mitigation is practicable if it is "available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes." 40 C.F.R. § 230.3(q).

It is appropriate and practicable for ARCO to compensate for the over 114 acres of high-value wetlands the Alpine project will destroy. Under the 404(b)(1) guidelines and the MOA signed by the Corps and EPA, ARCO is required to compensate the public for the loss of wetlands caused by the Alpine development.

1) Compensatory mitigation is appropriate

Both the Corps and EPA recognize the special value of wetlands, and begin the 404(b) evaluation with a presumption that wetlands are valuable and that compensation for their loss is appropriate. In the 404(b)(1) Guidelines, EPA singled out wetlands as a resource especially deserving of protection:

> From a national perspective, the degradation or destruction of special aquatic sites, such as filling operations in wetlands, is considered to be among the most severe environmental impacts covered by these Guidelines. The guiding principle should be that degradation or destruction of special sites may represent an irreversible loss of special aquatic resources.

40 C.F.R. § 230.1(d) (emphasis added).

Under the MOA, the Corps will "strive to avoid adverse impacts and offset unavoidable adverse impacts to existing aquatic resources, and for wetlands will strive to achieve a goal of no overall net loss of functions and values. In focusing the goal of no overall net loss to wetlands only, EPA and the Corps have explicitly recognized the special significance of the nation's wetlands resources." MOA at 2 (emphasis added). Thus, the MOA and 404(b)(1) Guidelines presume that wetlands are valuable and that compensation should be required for their loss. Compensation is not required only in the special cases in which it is not "feasible, practicable, or would accomplish only inconsequential reductions in impacts." *Id.*

A full analysis of the impacts the Alpine project will have on wetlands has not been, and will not be, completed until an EIS has been done. Despite this, it is clear that the Alpine project will result in the destruction of significant wetlands values. According to the public notice, 114.65 acres of high value wetlands will be filled. Secondary impacts, such as chronic oil spills and noise pollution, will be far more extensive.

The environmental values of the Colville River Delta, as detailed earlier, have been well documented. As with most wetlands, it is difficult to point to the exact consequences of the loss of a particular portion of wetlands. Because of this, wetlands in the lower 48 and in more developed areas of Alaska have been incrementally destroyed until they can no longer perform their functions. As a result, EPA and the Corps presume that wetlands are valuable, deserve protection, and should be compensated for if destroyed. Unless ARCO affirmatively demonstrates that wetlands impacted by the Alpine project are valueless. an impossibility given the information already collected on the Colville River Delta, it is appropriate for ARCO to provide compensatory mitigation for the wetlands Alpine will destroy.

2. Compensatory mitigation is practicable

ARCO Alaska, Inc.'s parent company, Atlantic Richfield, reported profits of $1,663,000, millions upon millions of which are based in Alaska. Given this fact, it must be assumed that compensatory mitigation is financially feasible until ARCO provides the information necessary to convincingly rebut this presumption.

ARCO is in a better position than commentators to suggest alternatives for compensatory mitigation on the North Slope, and should bear that burden. Nevertheless, some obvious opportunities for rehabilitation include plugged and abandoned exploratory pads and reserve pits elsewhere on the North Slope. If ARCO intends to rehabilitate its North Slope facilities when oil can no longer be profitably removed, then it must have data as to what types of rehabilitation are effective. Old pads can be used as the sites for independent, peer reviewed research concerning the most effective means of rehabilitation and the effects of rehabilitation on the Slope.

Another possibility for rehabilitation is the restoration or permanent acquisition for conservation of wetlands in Anchorage, Alaska, the site of ARCO's Alaska headquarters. Anchorage wetlands provide habitat for migratory birds that pass through Anchorage on their way to the North Slope. If migratory birds cannot reach the North Slope due to degraded habitat along their traditional flyways, then the value of North Slope wetlands as habitat for those birds is meaningless. As a result, enhancing or protecting wetlands along the flyway can be an important method of North Slope compensatory mitigation.

Ultimately, ARCO's use of the North Slope deprives the public of the values of those wetlands. ARCO should, as is reflected in the Corps and EPA's regulations and the MOA, compensate the public for the loss of those values. In the unlikely event it is not practicable to provide compensation on the North Slope, then compensation should be provided in a location where it is practicable. To comply with its own regulations and MOA, the Corps must require compensatory mitigation before granting ARCO a section 404 permit for the Alpine development project.

3. Public Interest Review

In addition to meeting the 404(b)(1) guidelines, the Corps' own regulations require that it determine that a project is in the public interest. In the Corps' words:

> "the program has evolved to one involving the consideration of the full public interest by balancing the favorable impacts against the detrimental impacts. This is known as the 'public interest review.' The program is one which reflects the national concerns for both the protection and utilization of important resources." 33 C.F.R. § 320.1(a).

The Corps cannot properly perform the delicate balancing of factors required by its own regulations to determine the public interest with the information currently available on the Alpine project. Given the many technical factors related to the current Alpine project yet to be fully considered, and the significance of the project as "gateway" to the NPRA, an EIS will be necessary for the Corps to consider "all relevant factors" and determine whether the Alpine project is in the public interest. The commentors suggest, however, that given the valuable habitat the Alpine project will directly destroy, the project's secondary impacts, cultural impacts, the lack of compensatory mitigation, and Alpine's role as "gateway to the NPRA," it is extremely unlikely the project is in the public interest.

C. Endangered Species Act

Congress enacted the Endangered Species Act for the express purpose of conserving endangered and threatened species. See 16 U.S.C. § 1531. The ESA imposes numerous substantive and procedural requirements on all federal agencies. A paramount substantive requirement imposed by Congress in the ESA is the requirement that each federal agency

> shall . . . insure that any action authorized, funded or carried out by such agency . . . is not likely to jeopardize the continued existence of any endngered species or threatened species.

16 U.S.C. § 1536(a)(2).

The spectacled eider is listed as a threatened species and is likely to be impacted by the Alpine Project. Therefore, before the Alpine project can be permitted, the Corps must consult with the FWS to ensure that the Alpine Project will not jeopardize the spectacled eider.

C. Section 810 ANILCA

Congress enacted the Alaska National Interest Land Conservation Act (ANILCA) to preserve scenic Alaskan lands, to maintain wildlife species and undisturbed ecosystems, and to protect the interests of individuals engaged in subsistence lifestyles. *see Kunaknana v. Clark*, 742 F.2d 1145, 1150 (9th Cir. 1984), 16 U.S.C. § 3101. Section 810 of ANILCA provides the procedural mechanism for protecting subsistence users in the administrative decision-making process. *Id.* Section 810(a) requires that prior to issuance of a permit, the agency

> "shall evaluate the effect of such use, occupancy, or disposition on subsistence uses and needs, the availability of other lands for the purposes sought to be achieved, and other alternatives which would reduce or eliminate the use, occupancy, or disposition of public lands needed for subsistence purposes." 16 U.S.C. § 3120.

Prior to issuance of the permit for the Alpine project, a subsistence evaluation (SE) under Section 810 of ANILCA should be produced. This SE, included in an EIS, should evaluate the effect of the Alpine project on the subsistence uses and needs of Alaskan Natives in the area, particularly the village of Nuiqsut. The Colville River Delta provides habitat for numerous wildlife species vital to these subsistence users.

D. Coastal Zone Management Act

The Coastal Zone Management Act of 1972 (CZMA) established a unique state-federal partnership for the protection and management of coastal areas and resources. 16 U.S.C. §§1451-1464. The CZMA created a process which encourages coastal states to develop and implement management plans for their coasts, crafted to the unique needs of each state's coastal areas and residents. *Id.* The state program, the Alaska Coastal Management Program, has been approved by the federal government and was designed to protect the numerous environmental, coastal, and cultural values in Alaska's coastal area. AS 46.40.010-210; 44.19.891.894. Prior to issuance of a permit, the ACMP requires that the Corps make a finding of consistency with the specific standards of the ACMP, including the district coastal management programs. 6 AAC 80.010; AS 46.40010(c)(1); *see also Trustees for Alaska v. State, DNR*, 851 P.2d 1340, 1342, n.2 (Alaska 1993). This has not been done.

Conclusion

We want to ensure that the valuable fish and wildlife, recreation, historical, subsistence, and scenic resources of the Colville River Delta are adequately protected for all Americans. Because the proposed Alpine project violates NEPA, the CWA, ANILCA, and the CZMA, the permit should be denied pending a comprehensive environmental impact statement. Thank you for your consideration, we appreciate this opportunity to comment. Please keep us notified and involved in future consideration of the permit and associated environmental reviews.

Sincerely,

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References Cited:

Koranda, J.J. and C.D. Evans. 1975. Sites Recommended as Potential Natural Landmarks. Ecological geological or other features of scientific, educational of historical value, Plate no. 6, National Petroleum Reserve - Alaska, Sec. 105(b) studies, U.S. Department of the Interior.

Cameron, R.D. 1995. Can petroleum development depress the productivity of Arctic caribou? Proc. Of the Second International Arctic Ungulate Conf. Aug. 15-18, 1995. Univ. Of Alaska, Fairbanks, AK, p. 36.

Cameron, R.D., K.R. Whitten, W.T. Smith, and D.D. Roby. 1979. Caribou distribution and group composition associated with construction of the Trans-Alaska Pipeline. Can. Field - Nat. 93:155-162.

Cameron, R.D., E.A. Lenart, D.J. Reed, K.R. Whitten, and W.T. Smith. 1995. Abundance and movements of caribou in the oil field complex near Prudhoe Bay, Alaska. Rangifer 15(1): 3-8.

Craig, P.C. 1984. Fish use of coastal waters of the Alaskan Beaufort Sea: A review. Transactions of the American Fisheries Society 113: 265-282.

Alana, L.J. and P.C. Wheeler. 1989. Wetlands and subsistence-based economies in Alaska, U.S.A., Arctic and Alpine Research, Vo. 21, No.4: 329-340.

Ford, J. And B.L. Bedford. 1987. The hydrology of Alaskan wetlands, U.S.A.: a review. Arctic and Alpine Research, Vol. 19, no. 3: 209-229.

Johnson, C.B., M.T. Jorgenson, R.M. Burgess, B.E. Lawhead, J.R. Rose, and A.A. Stickney. Wildlife Studies on the Colville River Delta, Alaska, 1995. August 1996. Prepared for ARCO, Alaska Inc. And Kuukpik Unit Owners by ABR, Inc.

Meehan, R. and T.W. Jennings. 1988. Characterization and value ranking of waterbird habitat on the Colville River delta, Alaska. U.S. Fish & Wildlife Service, Anchorage, Alaska, 105 pp.

Nellemann and Cameron, (in press). Effects of petroleum development on terrain preferences of calving caribou. Arctic 49(1): in press.

U.S. Geological Survey, 1979. An environmental evaluation of potential petroleum development on the National Petroleum Reserve in Alaska. Report prepared under section 105(b) of the Naval Petroleum Reserves Production Act of 1976, 238 pp.

Walker, H.G. 1983. Colville River Delta, Alaska. Guidebook to Permafrost and Related Features. Guidebook 2. Fourth International Conference on Permafrost, Fairbanks. Division of Geological and Geophysical Surveys, Alaska Department of Natural Resources.

Walker, D.A., P.J. Webber,, E.F. Binnian, K.R. Everett, N.D. Lederer, E.A. Nordstrand, and M.D. Walker. 6 Novemeber 1987. Cumulative impacts of oil fields on northern Alaskan landscapes. Science Vol. 238: 757-238.

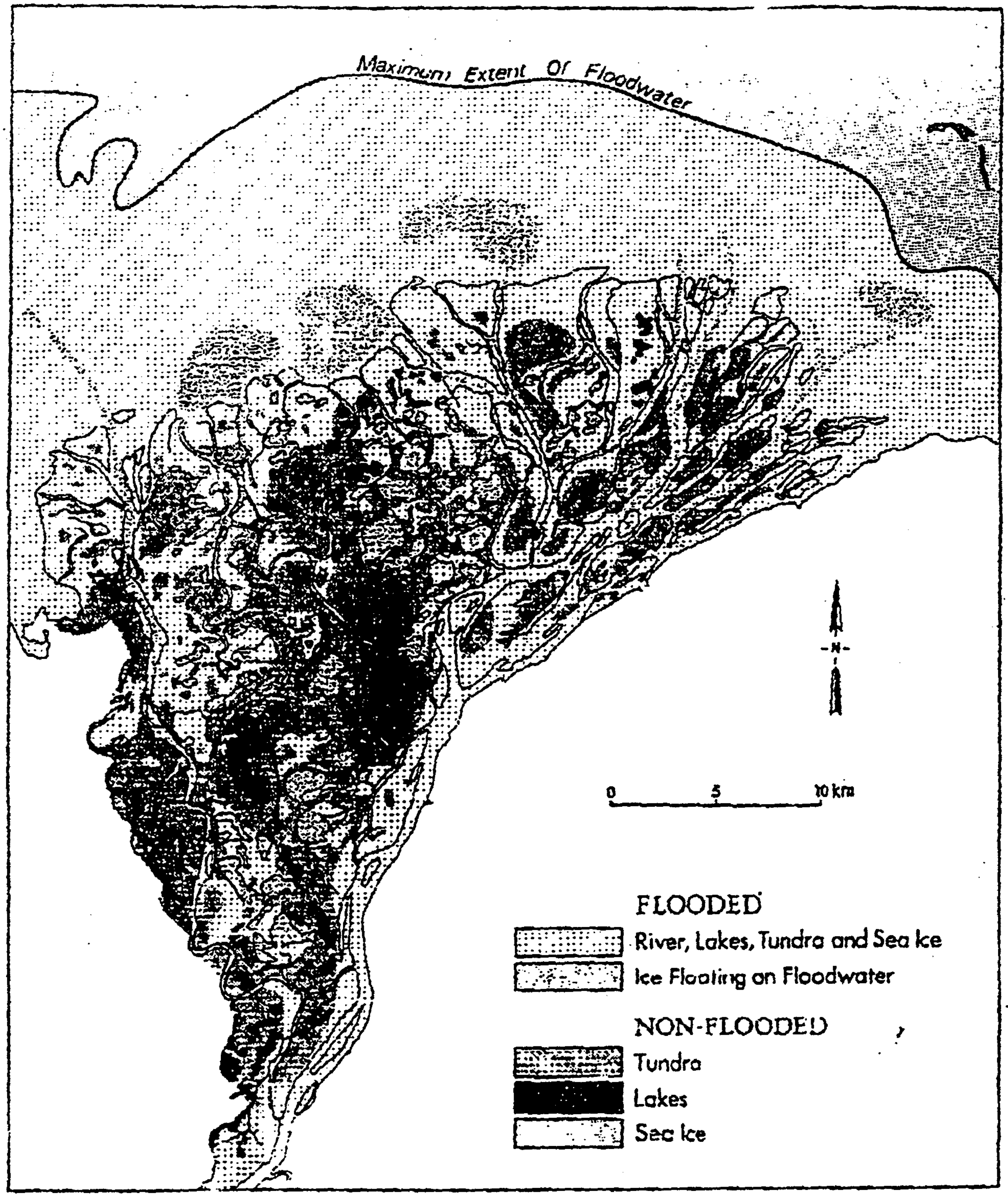


Figure 3. The Colville River Delta, Alaska, during typical flooding in late May.

From: H.J. Walker 1983.

Author: jdunham@co.north-slope.ak.us at Internet
Date: 6/9/97 4:21 PM
Priority: Normal
TO: Lloyd H Fanter at NPA-A
Subject: Alpine Comments (Colville River 18)

--- Message Contents ---

The North Slope Borough has the following comments on ARCO Alaska Inc.'s Alpine Project as described in the US Army Corps of Engineers Public Notice:

1) Under Special Area Designation, the Colville River has not been designated as an Area Meriting Special Attention within the North Slope Borough's Coastal Management Program. This was proposed for this designation, but not formally adopted as part of the program.

2) The area where the Alpine field is located and the pipeline access route will require public hearings before the NSB Planning Commission and Borough Assembly to rezone the area from Conservation District to Resource Development District.

3) A number of issues were identified by community leaders as areas requiring further review.

A) Oil spill response planning appeared to inadequately funded to respond to an emergency;

B) Concerns over the minimum height of the pipeline at 5 feet is less than 5 feet during winter snow conditions. This situation could unreasonably hinder caribou migration and subsistence hunter access during the winter month. AAI has suggested an alternative to provide vertical expansion loops in the pipeline which will have to be weighed on its merits by the Planning Commission and Borough Assembly; and

C) The route proposed for the pipeline and the under river crossing of the pipeline are concerns because the planning for the route and crossing appear to have gaps in information regarding Colville River hydrology and local knowledge on the river dynamics regarding breakup and ice damming events. The NSB is concerned that failing to account for local knowledge in these events could significantly increase the likelihood for an oil pipeline rupture and spill. The Colville River is a significant source of subsistence food for the people of Nuiqsut and provides critical habitat to fish, waterfowl and wildlife. Significant damage to the Colville would likely result severe hardships on all who depend on it for food.

Thank you for this opportunity to comment.

P.O. Box 101811
Anchorage, AK 99510
(907)292-1909

June 6, 1997

RECEIVED

JUN 06 1997

REGULATORY FUNCTIONS BRANCH
ALASKA DISTRICT, CORPS OF ENGINEERS

Colonel Peter A. Topp
District Engineer
Department of the Army
Alaska District, Corps of Engineers
Attn: CENPA-CO-R
P.O. Box 898
Anchorage, Alaska 99506-0898
Attn: Lloyd Fanter

RE: 2-960874
Colville River 18

Dear Colonel Topp:

As a concerned member of the public, I wish to register my comments on your public notice for ARCO Alaska, Inc.'s proposed Alpine oil field development project in the Colville River delta. This river delta is an extraordinary and unique place. I was privileged to spend an entire summer there, as a biologist for the U.S. Fish & Wildlife Service conducting bird/habitat studies.

This project undeniably will cause significant negative effects on many aspects of the human and natural environment and therefore, an environmental impact statement is necessary to fulfill the requirements of the National Environmental Policy Act. An EIS is legally required in order for the public to have a way to provide meaningful comment on the draft document which gives a rigorous analysis of the alternatives to the proposed action and adequate analysis of the cumulative effects of the project.

This proposed project will negatively impact the wetlands, floodplain, and river of the Colville River delta. The gravel fill, noise disturbance from the aircraft support and other facilities, and chronic spills will irreversibly degrade wetlands habitats that are important for fish, wildlife, and subsistence users. The potential for catastrophic oil spills from the Colville River pipeline crossing, the fact that all development and production activities will take place in the floodplain itself, despite alternatives, the severe impacts to the subsistence livelihood of the Nuiqsut residents, and the cumulative effects of this project along with other past and present oil field development projects onshore and offshore in the Beaufort Sea add up to long-term significant effects on the human and natural environment.

I understand that the Corps is still evaluating whether the "threshold" of "significant" impacts will be met by this project. Anywhere else in the nation that an oil field was proposed to be plunked smack in the middle of a river delta of international significance to migratory waterfowl, anadromous fish, and where there was a complex array of unique wetlands with no industrialization, there would be no question. It helps to look at the terms themselves, as they apply to this situation.

and the poor understanding of the reason for their decline. Furthermore, Arco's Environmental Evaluation Document notes that studies in the Prudhoe Bay oil fields showed 80% declines in spectacled eider numbers from 1981 to 1992 (p. 4-110 EED; based on Warnock and Troy, 1992 and TERA 1993).

Clearly the Alpine field is the doorway to the National Petroleum Reserve- Alaska, a driving force for more oil extraction to the west. Arco's Alpine is this "place of entering or beginning" -- a threshold according to Webster's. Perhaps we are numbed to this threshold of significant effects because so long ago "the point at which a physiological or psychological effect begins" disappeared in an Alaska dominated by the oil companies.

The impression of incredibly rich life supported by an extraordinarily diverse assemblage of wetlands in this largest river delta in the U.S. arctic that one is left with after spending an entire summer season in the area is not easily forgotten. Spring breakup carries massive icebergs down the river and rides them up onto the river banks. Birds stop here in great numbers early in the season because the snow melts out so much earlier than the Kuparuk or Prudhoe regions in the open channels of the Colville river and the exposed polygon ridges. Broods of loons, swans, and other waterfowl stay until after the ice starts getting solid.

I participated in field studies by the U.S. Fish & Wildlife Service in the delta during 1986 which had study plots which covered the large lake and other areas about a ½ mile from the proposed Alpine production pad and also part of the pipeline route near the Sakoonang Channel. Regrettably, the study reports did not summarize the raw data in a way that facilitates an easy look for individual study plots most relevant to analysis of the Alpine project. However, there are some observations on bird habitat use that I would like to offer from my professional experience in the delta, and highlights from my field journal and some raw data summaries that I made during 1986.

There were "hot spots" bird breeding and staging birds comprised of a variety of habitat types (small lakes, flooded low-center polygons, wet sedge along narrow drainages, and irregular shorelines or narrow peninsulas of larger lakes) that would not necessarily be identified using the habitat classification done for the Colville Delta. The mix of habitats can be as important as a single type itself. This seems to be especially true for some of the larger shorebirds (bar-tailed godwits, whimbrels, stilt sandpiper, and long-billed dowitchers) which seem to be more common than elsewhere on the North Slope, based on my experience with bird studies in the Prudhoe Bay area, and other sites to the east (see attached field note summary). Furthermore, the delta has tall riparian shrub habitats in the dunes that provide unusual habitats for the North Slope which support yellow wagtails, redpolls, tree sparrows, savannah sparrows, and other passerines.

Use of habitats in the Alpine vicinity by yellow-billed loons deserves more than one year of ground surveys, as the Colville Delta is an important nesting area that is one of the few concentrations for nesting by this species in Alaska. As well, more than one season of ground surveys for spectacled eiders should be conducted, given their listed status as threatened under the Endangered Species Act, and the paucity of information on habitat preferences for this species and the poor understanding of the reason for their decline. Furthermore, Arco's Environmental Evaluation Document notes that studies in the Prudhoe Bay oil fields showed 80% declines in spectacled eider numbers from 1981 to 1992 (p. 4-110 EED; based on Warnock and Troy, 1992 and TERA 1993).

The raw data from the 1986 field season shows that a wide variety of waterfowl nested in the areas within 2.5 miles of the proposed facilities: red-throated and pacific loons, tundra swans, greater-white fronted goose, brant, northern pintail, American wigeon, oldsquaw. Broods were documented for tundra swan, oldsquaw, green-winged teal, northern pintail, pacific loon, red-throated loon, and greater scaup, oldsquaw. Furthermore, bar-tailed godwits and stilt sandpipers, species defined as rare and sensitive species by the Alaska Natural Heritage Program were documented nesting on these study plots (personal communication Pamela A. Miller, 1986 field notes). There were also "hot spots" along the proposed pipeline route (about 1 ½ mile from Colville river) where bar-tailed godwits, whimbrels, stilt sandpipers, and other species defended their broods, and yellow-billed loons were observed in a lake here (see attached map; observations on 7/13/86 and 7/19/97, personal communication P.A. Miller.)

ARCO's EED asserts that impacts to bird habitat are mitigated, but the maps in this document show that in fact, high quality habitats as defined by their studies would be unavoidably covered by gravel, lost from gravel extraction, and severely degraded by aircraft traffic all year round. As well, it calls "negligible" the potential effects of a major oil spill to shorebirds whereas in fact, this could be a very major effect during the fall staging period. As well, the effects of chronic pollution, including very small amounts of crude oil could have widespread, though difficult to measure, impacts by impairing reproductive success. The seasonal "restrictions" in aircraft use discussed by ARCO do not even extend for the full nesting season, as the attached bird observations note. There would also be effects of noise from aircraft during the early spring migration period when the Colville habitats are more available for feeding birds than other tundra area, and during the molting and brood-rearing seasons late in the season. Lakes within a mile of the proposed airport host birds during this period and would be affected by the project.

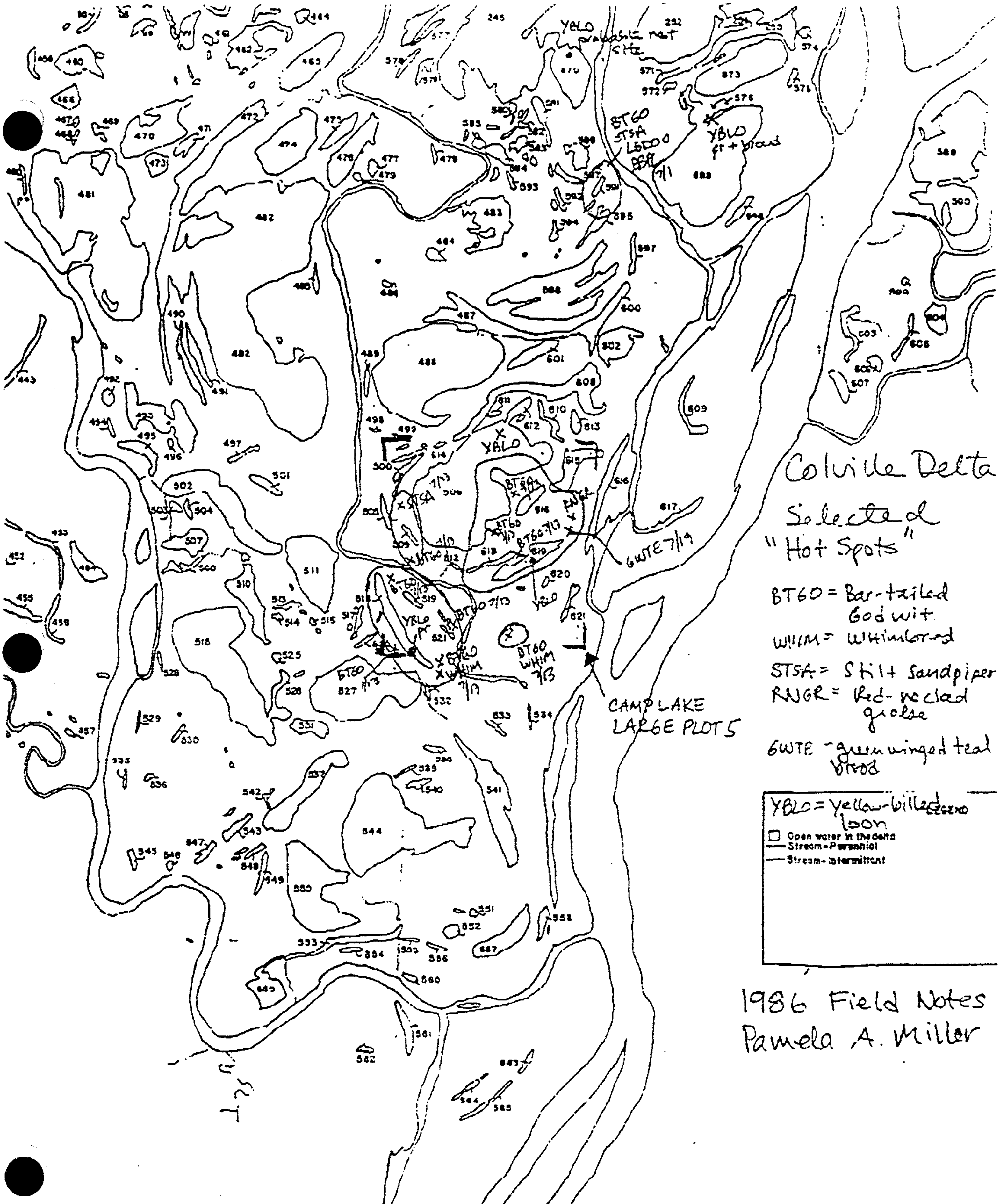
I regret that this letter only scratches the surface of the significant issues involved in your public notice. I appreciate this opportunity to comment. Once an environmental impact statement is released, I will be able to provide more in-depth review regarding this proposal.

Sincerely,

Pamela A. Miller

Pamela A. Miller

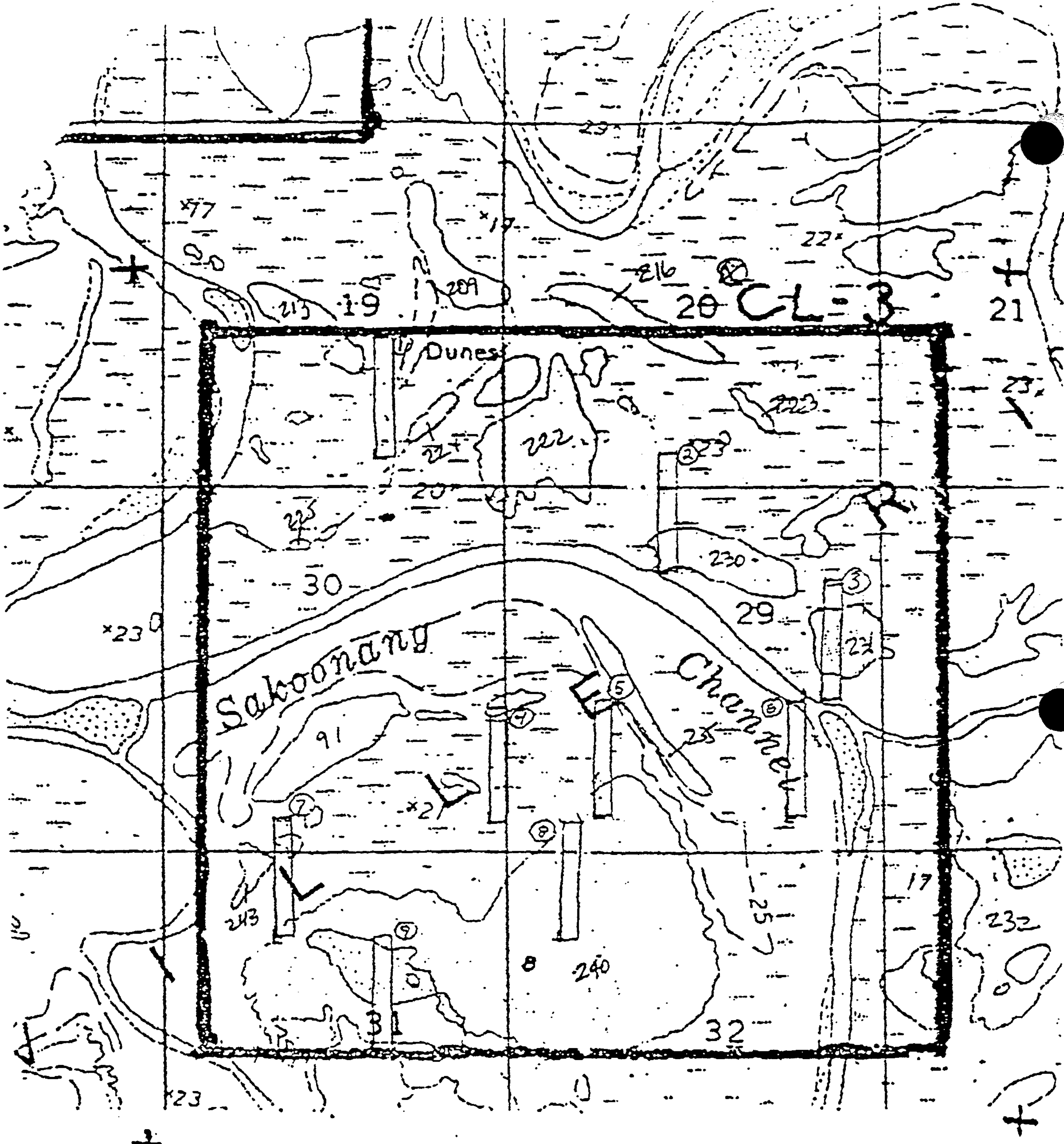
Attachements



Colville Delta
Selected
"Hot Spots"

BTGO = Bar-tailed Godwit
WHIM = Whimbrel
STSA = Stilt sandpiper
RNGR = Red-necked grebe
GWTE – green winged teal brood
YBLO = Yellow-billed loon

1986 Field Notes
Pamela A. Miller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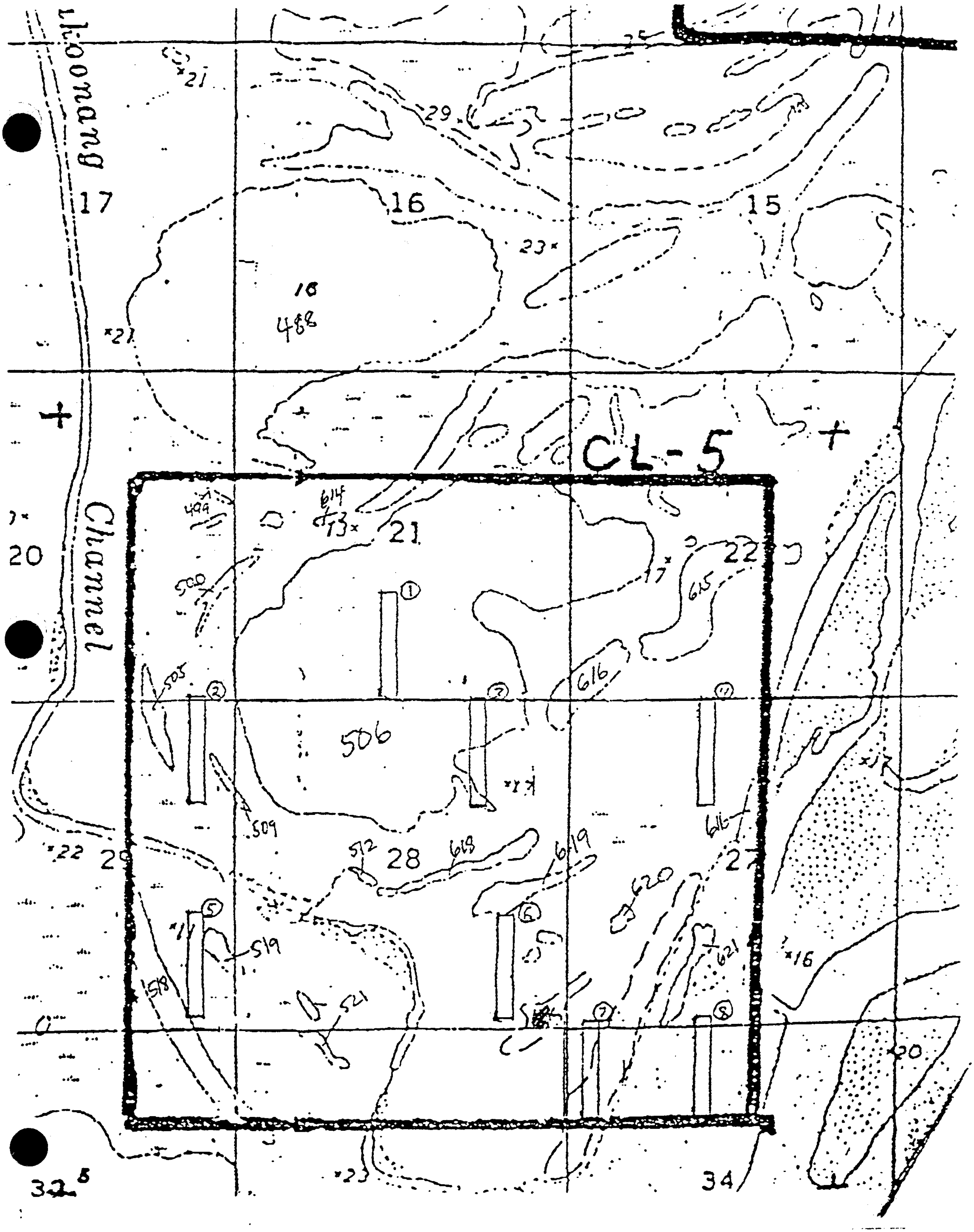

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Some Bird Observations on the Colville River Delta, 1986
in the Proposed Alpine oil field area
Pamela A. Miller

These observations were noted in a daily field journal, incidentally to the systematic data collected on bird study plots in 1986. See the attached maps for the locations of study plots. This summary is not intended to be exhaustive, but only to highlight some of the more interesting observations for areas that were "hot spots" throughout the season. Unfortunately, our plots were not located in the exact site of the proposed production pads, road, and airport, although plot 3 was just north of it. These observations point out that in specific places there is high bird use by a variety of species that was accentuated by the repeated ground observations, and that certain wetland habitat areas are important to a variety of species -- especially large shorebirds-- that have not been studied in detail on the Colville Delta.

May 30, 1986 - Flew from Deadhorse to Colville Delta camp along Tamayayak Channel. In Prudhoe Bay and Kuparuk areas snow cover was still 99%, with only a few scattered pingos, ridges and river bluffs exposed, while at Camp Lake, there were significantly more snow-free areas. About 20% of polygon ridges were exposed, and there were some small patches of open water. There was ponding along the exposed mudflats of the Tamayayak Channel. There were many birds in the area: willow and rock ptarmigan, Lapland longspur, tundra swans courting (pairs, 5 on open water in river), northern pintails, king eiders, dunlin, flocks of long-billed dowitchers, ruddy turnstones, black-bellied and lesser golden plovers, pectoral sandpipers, weasel, arctic fox, 5 caribou, arctic ground squirrel.

Large Plot 5 highlights:

June 15, 1986 - Between lakes #619 and #615 the low-center polygons were flooded and were heavily used by birds, especially near #619. In this area there were four pairs of tundra swans courting, 5 red-breasted mergansers, a pair of greater scaup, 2 pairs oldsquaw, and pair of Pacific loons. North of lake #619 we saw fish in the flooded polygon ponds. At the south end of lake #619, the lake was partially melted with Arctophila visible, and some blades of this plant washed along the shore, and a yellow-billed loon swan here. The area south of #619 had many birds. In the high relief low-center polygons, we found a willow ptarmigan nest.. The class I and II wetlands (low and medium relief low-center polygons-wet sedge south of lake #619 were busy with pairs of displaying bar-tailed godwits, whimbrels, long-billed dowitcher, stilt sandpiper, pectoral sandpipers, pair of oldsquaw in a small pond and pairs of red-necked phalaropes. Small plot #7 was near the Sakoonang Channel and had high rolling sand dunes with tall willows on them, and denser willows along the western flanks where there were yellow wagtails, savannah sparrows, redpolls, and tree sparrows. Also saw 2 red foxes in this area. There are grounded icebergs along the river (Tamayayak Channel).

June 19, 1986 - In lake #619 saw 12 tundra swans at the south end and 8 at the north end. There was lots of bird activity in this area between lakes #618, 619 and 506.

July 5, 1986 - The bar-tailed godwit's nest was empty with egg shells in the area, with 4 pairs of defensive godwits in the vicinity. Lakes 506, 6116, and 615 were still 90% ice covered, but lakes #619, 618, 620, and 621 were open.

July 13, 1986 - Suspect a yellow-billed loon nest at lake #619 as a loon was agin sighted there. The wetland complex near lake #500, with deep Carex and a little Arctophila, had a concentrated activity including a glaucous gull nest with 3 eggs, a defensive red-breasted merganser female, red-throated loon nest, and a Pacific loon. Lake #506 was still 30% ice covered but had arctic terns feeding, surf scoter male and 3 Pacific loon nests on a peninsula along the se corner of the lake. Again there was a concentration of large shorebirds, including at least 6 pairs of bar-tailed godwits, pectoral sandpipers, and 2 Pairs of suspicious whimbrels neat lake #518 and south of #619 and #621.

July 21, 1986 - Saw oldsquaw with brood of 6 very young ducklings (small plot #6, south of lake # 619), flock of long-billed dowitchers. Song sparrow and yellow wagtail in willows along Sakoonang Channel. Wolf tracks in the sand along Sakoonang channel, south end of plot [next to pipeline route].

August 8, 1986 - Red-breasted merganser female with 5 downy young from edge of large lake where willows overhang. 8 tundra swans on the lake. Along the shore of the lake (#506) in areas with lush <u>Carex aquatilis</u> and some <u>Arctophila</u> there was evidence of heavy goose use with torn up leaves and lots of droppings, and moderate grazing in wet sedge-low willow/ non patterned ground.

August 15, 1986 - There were flocks of pectoral sandpipers, flock of 7 bar-tailed godwits and flocs of red-necked phalaropes. At lake #615 there was a greater-white fronted goose pair with 7 young, which later moved to lake #506. A red-breasted merganser female with 5 just hatched young is probably a different brood than seen last week. 1 whimbrel seen. Flock of 40 willow ptarmigan.

Large Plot 3 highlights

3 July - At small plot #8 there were flocking glaucous and Sabine's gulls. Lake #243 had 4 pairs of nesting brant, Pacific loon, arctic tern. Flocks of shorebirds gathered in Carex along the shores and on a high pingo/ ridge at the south end in groups as large as 50, with red-necked phalaropes, semipalmated sandpipers, pectoral sandpipers. A peregrine falcon flew over this lake, chasing arctic terns. Today we found the first long-billed dowitcher nest with 3 eggs, about 20 meters from where I suspected a bar-tailed godwit nest. The greater-white fronted goose nests e had found previously were predated, but a new one was found on the edge of a mound. Green-winged teal were seen along the se corner of this plot [near proposed Alpine production pad].

11 July - Stilt sandpiper nest with 4 chicks being brooded, red phalarope nests, semipalmated sandpiper nests, dunlin nest, long-billed dowitcher nest. Lapland longspur nest hatching, arctic tern nest hatching, brant nests still active, tundra swan cygnets, and another tundra swan nest still

active. Near our camp, there are many yellow-billed loons on Tamayayak Channel.
July 17 - Two pectoral sandpiper nests, one with eggs, one with 3 chicks; semipalmated sandpiper nest with 3 newly hatched chicks. Glaucous gull chick along shoreline of lake. First lesser golden plover nest hatching and another with eggs. Many mixed flocks of shorebirds, (including long-billed dowitchers, red and red-necked phalaropes, semipalmated and pectoral sandpipers) are especially abundant in Class II polygon ponds south of a lake east of #91 and along the deep Arctophila lake.

July 30 - Swan brood with 1 adult, 11 young in lake #222. Brood of 7 oldsquaw in lake #231. Red-throated loon still incubating. Greater-white fronted goose pair with 2 young. Many juvenile semipalmated sandpipers.

August 6 - On the south half of the plot there were defensive flocks of long-billed dowitchers, pectoral sandpipers, red phalaropes, and semipalmated sandpipers. Also defensive dunlin, black-bellied and lesser golden plovers. One pair of tundra swans on the tapped lake #240. Highlight of the day was seeing flocks of geese feeding on the Puccinellia/ Carex subpathacea flats on an island and bordering tapped lake #240 [this is near Alpine facilities]. All the geese were flight capable. There were more than 340 greater-white fronted geese and 19 Canada geese.
The geese also fed along the shores of lake #463, and #84.

August 13 - At the north end of the plot, on lake #231 there was a tundra swan pair with brood of three and 100 red-necked phalaropes. Along the river bank in riparian low-growing willows there were 40 Lapland longspurs feeding. On tapped lake #243 there was a tundra swan pair with 2 young where seen last week and two other pairs of tundra swans. Along the shore of tapped lake #232 there were 300 greater-white fronted geese and 70 American widgeon. There were 40 greater white-fronted and 50 Canada geese in tapped lake #240. We also saw 4 common golden eyes flying over. The area east of lake #222 and #221 has standing water with sparse Carex and low-center polygons and was the hottest area on the north side of the plot for shorebirds. Flocks of pectoral sandpipers, dunlin, stilt sandpipers, juvenile red-necked phalaropes, and flock of lesser golden plovers seen here. After the survey we explored south on the Sakoonang Channel where there were several tapped lakes. [These lakes would be in flight path of the runway for Alpine]. #584 had sparse Arctophila long the shoreline and semipalmated sandpipers fed along the exposed mud shores. Lake #483 had a long creek-like entrance. This and the entire lake shoreline was covered by lush Arctophila about 2' high. In this protected area there was a tundra swan pair with at least one cygnet. Lake #482 had fairly recently been tapped and was mostly exposed mudflats much traveled by caribou. Near to the entrance there are some good sized bluffs/ dunes where a golden eagle was sighted. The river level was high today which enabled us to travel into these areas.

To

P.O. Box 101811
Anchorage, AK 99510
(907)272-1909
August 12, 1997

Colonel Peter A. Topp
District Engineer, Alaska District
U.S. Army Corps of Engineers
Attn: CENPA-CO-R
P.O. Box 898
Anchorage, Alaska 99506-0898
Attn: Lloyd Fanter

RECEIVED
AUG 13 1997
REGULATORY FUNCTIONS BRANCH
ALASKA DISTRICT, CORPS OF ENGINEERS

RE: 2-960874
Colville River 18

Dear Colonel Topp:

I wish to provide brief comment on ARCO's responses to the public notice comments sent out by the Corps of Engineers on July 28, 1997. I offer these comments as a concerned member of the public who is familiar with the project location and oil industry activities. Due to the short time frame for review, I only am raising issues prompted by ARCO's documents that I may not have addressed in my earlier comment letter on the proposed Alpine development project.

It is still quite clear from the responses that not all relevant information has yet been submitted by the applicant, and that the issues are complex enough that a full environmental impact statement for which the public will have adequate time to review the project in its entirety is necessary. It is inappropriate that the public be asked to spend its time reviewing responses to the applicants' "environmental evaluation document," instead of a complete environmental impact statement prepared by the lead agency under the requirements of the National Environmental Policy Act.

I remain concerned that the Alpine project as proposed in the Corps of Engineers' Colville River 18 public notice is being analyzed in a piecemeal approach, and that not all oil field developments in the delta likely to occur in the reasonably foreseeable future are being analyzed (e.g. Fiord, Kalubik and others in Kuukpik Unit, etc.-- these are not described by ARCO in Issue # 62- Cumulative impacts, nor are the gravel pit or potential road to Nuiqsut or the natural gas pipeline to Nuiqsut). Furthermore, the cumulative impacts of the Alpine project, along with past oil field development and other currently permitted proposals (Northstar, Liberty, Tarn, Badami, etc.) need to be assessed in much more detail than has been addressed by ARCO. The Corps of Engineers, in conjunction with the other natural resource agencies, should conduct a complete and rigorous cumulative impact analysis.

In particular, it is clear that the oil spill risk for the below-river crossing and floodplain facility sites has not been modeled, nor has the spill response plan been completed so that the public can assess the environmental risks associated with the response. ARCO's response still fails to provide adequate information about the size of spills that are expected to be noticed with the leak detection system and their estimated frequency, and it also fails to address spills of other hazardous materials. ARCO's response to concerns about oil spills on salt marshes fails to assess the potential risk if there is a spill and so this concern was not meaningfully addressed.

There are also numerous other instances where ARCO states that additional field work will be conducted yet this summer to collect needed information (e.g. July 29-30 site visits regarding drainage structures and other site inspection; water quality data for lakes in the project area that will be transmitted in August, 1997 (see ARCO's NMFS - Issue #18); ARCO's still needs to submit a plan for mud handling for the HDD (see issue #24). Furthermore, the "Colville River Two-Dimensional Surface Water model" study dated July 1997 is still a draft document, even though this is a key issue for analysis.

I wish to offer the following additional concerns and recommendations based on this recent information sent to "interested parties":

+ Because the hydrology studies are still draft and drainage issues are still unresolved, the State's clock for consistency review should remain stopped until those final documents are in.

+ This new information further supports my earlier recommendations that an EIS is needed.

+ Once the final revisions to the project design are made, a new 30-day public notice for the revised permit should be circulated to the public, as any new permit would be.

+ Despite ARCO's claims, mitigation measures are not adequate. Compensatory mitigation should be required for the unavoidable losses of fish and wildlife habitat.

+ Impacts to rare wildlife species found in the project area (such as bar-tailed godwits), as well the full diversity of fish and wildlife still need to be addressed, and ARCO's baseline studies are inadequate.

+ The requirement to compost waste, or to have animal-proof dumpsters, at a minimum, should be a permit stipulation.

+ Bridges, not culverts, should be built for the "swale area" and crossing the other streams between Kuparuk and the Colville River.

+ ARCO's comments about the potential synergist impacts of pipelines, the river crossing, and the gravel pit (that the gravel pit "operations are therefore outside AAI's control,") reveal that more analysis of this situation is needed.

+ If the sales oil pipeline will be transporting "clean sales quality crude oil" (see Issue #35) where is the discussion of the processing plant (including its air and water emissions) that will refine the oil to that quality?

+ ARCO seems to assume high rates of "natural recharge" of lakes -- higher than may actually occur since no data is provided about these rates-- which would underestimate the potential impacts to fish and wildlife habitat from water withdrawals. ARCO's statement that "recharge of this lake may be permitted from the Sakoonang Channel," (Issue #43) means that vast quantities of water might be withdrawn from the river channel, but this impact is never analyzed. Better analysis of water quantities is needed, and the long-term impacts of withdrawing water from the proposed sources is needed.

+ The applicant should be required to fund U.S. Fish & Wildlife Service to conduct nesting and brood-rearing monitoring studies for spectacled eiders, and other wildlife monitoring studies, instead of ARCO doing their own studies.

I appreciate this opportunity to comment and look forward to reviewing the environmental impact statement.

Sincerely,

Pamela A. Miller

Pamela A. Miller

cc: Molly Birnbaum, DGC

Appendix M

APPENDIX M

DIRECTORY OF SUPPORTING REPORTS AND TECHNICAL MEMORANDA

Directory of Supporting Reports and Technical Memoranda

The following reports and technical memoranda have been prepared to support the Alpine Development Project. Many have been submitted to the U. S. Army Corps of Engineers (USACE) or Federal State Joint Pipeline Office (JPO).

Document	Location
Arco Alaska, Inc., Technical Specification, AAI Nuiqsut Air Quality Monitoring Program, July 1997	USACE
Baker, Michael Jr., Inc., Alpine Development Hydrology and Drainage Plan, August 1997	USACE
Baker, Michael Jr., Inc., Alpine Development, Colville River Crossing, Summary Report for Selection and Feasibility, September 1996	JPO
Baker, Michael Jr., Inc., Alpine Development, Colville River Crossing Design Report, June 1997	JPO
Baker, Michael Jr., Inc., Alpine Project Overland Hydraulics Report, June, 1997	JPO
Baker, Michael Jr., Inc., Alpine Project, Oil Pipeline Spill Isolation Strategy, April, 1997	JPO
Brower, H. 1996. North Slope Borough Subsistence Harvest Report.	USACE
Burgess, R. M., Johnson, C. B., Jorgenson, M. T., Lawhead, B. E., Rose, J.R., and Stickney, A.A. 1996. Wildlife Studies on the Colville River Delta, Alaska, 1995. Unpublished report by Alaska Biological Research, Inc., to ARCO Alaska, Inc., Anchorage	USACE
Galginatitis, M., Subsistence harvest resource patterns: Nuiqsut. OCS Study MMS 90-0038 (Special Report No. 8)	USACE
Johnson, C. B., et.al. 1997. Wildlife Studies on the Colville River Delta, Alaska, 1996. 6th Annual Report in progress, Unpublished report by Alaska Biological Research, Inc., to ARCO Alaska, Inc., Anchorage.	USACE
Johnson, M. T., Lawhead, B. E., Rose, J.R., Stickney, A.A., and Wildman, A. M. 1996. Wildlife Studies on the Colville River Delta, Alaska, May, 1997. Unpublished report by Alaska Biological Research, Inc., to ARCO Alaska, Inc., Anchorage	USACE
Jorgenson, T., 1997. Hydrologic Characteristics of Wetland Habitats Affected by the Alpine Development Project and Design Criteria for Maintaining Normal Hydrologic Regimes, August 1997, revision of Assessment of Potential Effects of Alteration of Cross-Drainage on Wetland Habitats Near In-Field Facilities, July, 1997. Unpublished report by Alaska Biological Research, Inc., to ARCO Alaska, Inc., Anchorage	USACE
Jorgenson, T.M., et.al. 1996. Geomorphology and Hydrology of the Colville River Delta, Alaska, 1995. Prepared by Alaska Biological Research, Louisiana State University and Shannon and Wilson to ARCO Alaska, Inc., and Kuukpik Unit Owners, Anchorage, Alaska.	USACE
Jorgenson, T.M., et.al.. 1997. Geomorphology and Hydrology of the Colville River Delta, Alaska, 1996. Preparation in progress by Alaska Biological Research to ARCO Alaska, Inc., and Kuukpik Unit Owners Anchorage, Alaska.	USACE
Miller, Duane & Associates, Alpine Development Project, Geotechnical Exploration 1996, Colville River, Alaska	JPO
Miller. Duane & Associates, Alpine Development Project, Geotechnical Exploration 1997 Supplement, Colville River, Alaska	JPO
Moulton, L. L. 1996. 1995 Colville delta fish habitat study. Prepared by MJM Research for ARCO Alaska, Inc., Bainbridge Island, Washington.	USACE
Moulton, L. L. 1996. Lakes Sampled for Fish in and near the Colville River Delta.	USACE

Prepared by MJM Research to ARCO Alaska, Inc., Bainbridge Island, Washington.	
Moulton, L. L. 1997. 1996 Colville delta fish habitat study. Under preparation by MJM Research to ARCO Alaska, Inc., Bainbridge Island, Washington.	USACE
Moulton, L. L. 1997. 1997 Tarn fish habitat study. Under preparation by MJM Research to ARCO Alaska, Inc., Bainbridge Island, Washington.	USACE
Moulton, L. L. 1997. Lakes Sampled for Fish in and near the Colville River Delta, 1979-1996. Prepared by MJM Research to ARCO Alaska, Inc., Bainbridge Island, Washington.	USACE
Caribou Steering Committee findings, July 1994	USACE
Shannon & Wilson, Alpine Development, Technical Memoranda, Changes in Headwater and Tailwater Elevations as a Result of Passing Water through the Facilities, July 1997	USACE
Shannon & Wilson, Inc., 1996 Colville River Delta Channel Assessment, Colville River Delta, North Slope, Alaska, July 1996, Revised November 1996	USACE
Shannon & Wilson, Inc., Colville River Two-Dimensional Surface Water Model, Revised July 1997	USACE
Shannon & Wilson, Inc., Flood-Frequency Analysis for the Colville River, North Slope, Alaska, November 1996	USACE
Kuparuk Oil Discharge Spill Contingency Plan	AAI

Appendix N

APPENDIX N

ASRC LETTER AGREEING TO SUPPORT THE AAI PREFERRED ROUTE

Mr. Loyd H. Fanter
U.S. Army Corps of Engineers
Alaska District
Regulatory Branch
P.O. Box 898
Anchorage, Alaska 99506-0898

Re: Alpine Development Project
Colville Delta Area
North Slope, Alaska

Dear Mr. Fanter:

On October 8, 1996, ARCO Alaska, Inc. submitted a U.S. Army Corps of Engineers (USACE) permit application and Environmental Evaluation Document (EED) for construction and operation of the proposed Alpine Development Project. The EED contains ARCO's proposed action, other ARCO alternatives, and an analysis of "Native Alternatives" which were proposed by Arctic Slope Regional Corporation (ASRC) and Kuukpik Corporation. This letter pertains to ASRC's "ASRC/Kuukpik" and "ASRC" alternatives as outlined in the EED.

On September 6, 1995, ASRC made a conceptual proposal to ARCO for development of the Alpine Project in the Colville River Delta. This proposal has been incorporated into the EED's appendices. When ASRC submitted its proposal, we did not have refined cost figures and other relevant information to fully support its proposal. Over the past 18 months, ARCO has worked closely with ASRC to conclude a realistic assessment of the costs and benefits of ASRC's proposals, include all cost considerations, and reach a mutual understanding of the subsurface considerations. Public workshops in and outside of Nuiqsut, and many focused meetings with ARCO have also helped us to better understand the technical, financial, and environmental considerations.

Since we now have realistic cost figures, and have explored the options further, we now know what facilities are truely necessary, affordable, and feasible. ARCO has not overestimated the costs of the ASRC and ASRC/Kuukpik alternatives, and since we have also seen ARCO's known oil and gas reserves mapping, we now have a better understanding of Alpine's subsurface characteristics. Accordingly, ASRC is withdrawing its support for the ASRC/Kuukpik and ASRC alternatives, and redirecting its attention to optimizing ARCO's preferred alternative..

In regard to our preference for USACE processing of ARCO's Alpine permit application, please be advised that ASRC is working closely with the City of Nuiqsut, the Native Village of Nuiqsut, Kuukpik Corporation, and Nuiqsut residents to better understand ASRC's role in the overall process. It is ASRC's position that if the above mentioned parties become an integral part of a public review process prior to issuance of Alpine permits, then an expanded environmental assessment process will be sufficient in-lieu of an environmental impact statement (EIS).

Please place this letter in the Alpine administrative record. If you have any questions or comments, please call me at (907) _________.

Sincerely,

Arctic Slope Regional Corporation

Appendix O

APPENDIX O

USCOE PERMIT 4-960869 COLVILLE RIVER 17 ISSUED TO NUIQSUT CONSTRUCTORS

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, ALASKA
P.O. BOX 898
ANCHORAGE, ALASKA 99506-0898

REPLY TO ATTENTION OF:

JUNE 2 4 1997

Regulatory Branch
North Section
4-960869

Mr. Tom Mortensen
Tom Mortensen Associates
Environmental Permitting and Management
P.O. Box 113192
Anchorage, Alaska 99511-3192

Dear Mr. Mortensen:

Enclosed is the signed Department of the Army permit, file number 4-960869, Colville River 17, authorizing development of a gravel mine site approximately 4.5 miles east of Nuiqsut, Alaska.

If changes in the location or plans of the work are necessary for any reason, plans should be submitted to this office promptly. If the changes are unobjectionable, the approval required by law before construction is begun will be issued without delay.

Nothing in this letter shall be construed as excusing you from compliance with other Federal, State, or local statutes, ordinances, or regulations which may affect the proposed work.

In an effort to determine the level of customer satisfaction with the services provided to you, the Regulatory Branch asks that you take a few moments to provide us with any constructive comments you feel are appropriate by filling out the enclosed questionnaire. Our interest is to see how we can continue to improve our service to you, our customer, and how best to achieve these improvements. Additional comments may be provided through the use of an oral exit interview, which is available to you upon request. Your efforts and interest in evaluating the regulatory program are much appreciated.

Please contact me at 753-2716, or by mail at the address above, if you have questions.

Sincerely,

Lloyd H Fanter

Lloyd H. Fanter
Project Manager

Enclosures

This notice of authorization must be conspicuously displayed at the site of work.

United States Army Corps of Engineers JUNE 2 4 1997

COLVILLE RIVER 17

A permit to DEVELOP A MATERIAL SITE INVOLVING THE EXCAVATION OF UP TO 5 MILLION CUBIC YARDS OF SAND AND GRAVEL, AND EXCAVATION AND PLACEMENT OF 2.9 MILLION CUBIC YARDS OF OVERBURDEN MATERIAL WITHIN A 150-ACRE FOOTPRINT. **19**

at SECTIONS 10, 11, 14, & 15 OF UMIAT MERIDIAN OF NORTH SLOPE BOROUGH

has been issued to NUIQSUT CONSTRUCTORS JUNE 2 4 1997 **19**

Address of Permittee 620 EAST WHITNEY ROAD, ANCHORAGE, ALASKA

Permit Number

4-960869

Lloyd H. Fanter

FOR: *District Commander*
LLOYD H. FANTER
PROJECT MANAGER
NORTH SECTION

ENG FORM 4336, Jul 81 (33 CFR 320-330) EDITION OF JUL 70 MAY BE USED (Proponent: CECW-O)

DEPARTMENT OF THE ARMY PERMIT

Permittee Nuiqsut Constructors

Permit No. 4-960869, Colville River 17

Issuing Office U. S. Army Engineer District, Alaska

NOTE: The term "you" and its derivatives, as used in this permit, means the permittee or any future transferee. The term "this office" refers to the appropriate district or division office of the Corps of Engineers having jurisdiction over the permitted activity or the appropriate official of that office acting under the authority of the commanding officer.

You are authorized to perform work in accordance with the terms and conditions specified below.

Project Description: A 10-year phased development of a consolidated sand and gravel material site involving the excavation of up to 5 million cubic yards (cy) of sand and gravel, and excavation and placement of 2.9 million cy of overburden material within a 150-acre footprint in waters of the United States. Placement of 2.9 million cy of overburden into the gravel excavation pits and contouring of the material to create 122 acres of lakes of varying sizes with about 30 acres of islands.

All work will be performed in accordance with the attached plans, 16 sheets dated October 4 and 6, 1996.

Project Location: East bank of the Colville River, near the confluence of the Nechelik Channel, approximately 4.5 miles east of village of Nuiqsut within sections 10, 11, 14, and 15 of Township 10 North, Range 15 East, Umiat Meridian, North Slope Borough, Alaska.

Permit Conditions:

General Conditions:

1. The time limit for completing the work authorized ends on June 1, 2007. If you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.

2. You must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of this permit from this office, which may require restoration of the area.

3. If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and state coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

4. If you sell the property associated with this permit, you must obtain the signature of the new owner in the space provided and forward a copy of the permit to this office to validate the transfer of this authorization.

5. If a conditioned water quality certification has been issued for your project, you must comply with the conditions specified in the certification as special conditions to this permit. For your convenience, a copy of the certification is attached if it contains such conditions.

6. You must allow representatives from this office to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished in accordance with the terms and conditions of your permit.

Special Conditions:

1. No gravel mining development activities involving the excavation, disposal of dredged material, or the placement of fill material shall occur in waters of the U.S., including wetlands, until a written and enforceable contract is in place for sale and delivery of the gravel.

Continued on 2A

Further Information:

1. Congressional Authorities: You have been authorized to undertake the activity described above pursuant to:

( ) Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403).

(X) Section 404 of the Clean Water Act (33 U.S.C. 1344).

( ) Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (33 U.S.C. 1413).

2. Limits of this authorization.

a. This permit does not obviate the need to obtain other Federal, state, or local authorizations required by law.

b. This permit does not grant any property rights or exclusive privileges.

c. This permit does not authorize any injury to the property or rights of others.

d. This permit does not authorize interference with any existing or proposed Federal project.

3. Limits of Federal Liability. In issuing this permit, the Federal Government does not assume any liability for the following:

a. Damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes.

b. Damages to the permitted project or uses thereof as a result of current or future activities undertaken by or on behalf of the United States in the public interest.

c. Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity authorized by this permit.

d. Design or construction deficiencies associated with the permitted work.

Special Conditions Continued

2. A 500-foot buffer zone from the material site construction area to the Colville River shall be maintained free of development activities. A 300-foot buffer zone from the Colville River shall be maintained free of placement of excavated materials including temporary stockpiling of overburden.

3. All temporary stockpiled material placed on the tundra shall be removed prior to spring break-up. Carry-over sand, gravel and/or overburden which results in tundra vegetation mortality within 5 percent or more of the temporary stockpile footprint area shall be sufficient reason for a noncompliance determination requiring corrective action for vegetation recovery (e.g., material clean-up, seeding, fertilizing, etc.).

4. To avoid disturbances to spectacled eiders, excavation and high-noise activities such as blasting shall be avoided during pre-nesting and nesting seasons (20 May through 1 August). If project activities must be conducted during the nesting season, a U.S. Fish and Wildlife approved nest survey shall be conducted to confirm the absence of nests in or within 600 feet (200 meters) of the project footprint.

5. At least three months prior to initiation of Phase 1 mining activities and a minimum of one month prior to initiation of additional development phases, the applicant shall convene a Technical Reclamation Review Committee (TRRC) consisting of the U.S. Fish and Wildlife Service, the Alaska Department of Fish and Game, and the permittee. The TRRC may recommend procedures necessary to achieve the goals of the reclamation plan. The TRRC's shall concur with the permittee's reclamation plan prior to initiation of mining activities. The TRRC shall establish performance standards for determining satisfactory vegetation establishment; evaluate the effectiveness of the reclamation activities in meeting the reclamation goals; review and concur prior to implementation, proposed reclamation plans; and develop a consensus for recommended change in reclamation design or implementation, if necessary. Any major design changes or changes in performance standards established by the TRRC shall be submitted to the Alaska District for concurrence. If a conflict arises between the permittee and the TRRC, the Alaska District, Regulatory Branch shall provide a decision and direct appropriate course of action based on the goals, standards and intent of the reclamation plan in consideration of regulatory and statutory authorities of the Corps of Engineers.

6. Voluntary attendance to the TRRC meetings shall be open to the North Slope Borough's (NSB) Planning and Wildlife Departments for purpose of compliance determination with the intent and purpose of NSB's ordinances, and the Kuukpik Corporation.

7. Design Performance Standards:

a. At least 20 percent of the phase 1 reclamation lake area, and a cumulative total of at least 20 percent for the remaining reclamation phase(s) shall consist of shallow water littoral habitat of less than 6 feet (2 meters) in depth, as measured during July or August, with at least 50 percent of the reclamation lake(s) littoral habitat surface area, less than one and a half feet (0.5 meters) in depth, which does not include waterfowl nesting islands.

Special Conditions Continued

b. At least 25 percent of the shallow water littoral habitats shall be revegetated to establish emergent vegetation by artificial and enhanced natural colonization techniques, such as the use of aquatic vegetation transplants, fertilizer application and other best practice methods, approved by the TRRC. Satisfactory emergent vegetation establishment performance standard shall be established by the TRRC and shall be based on plant species numbers and live plant density during a performance period of 3, 5 and 10 years.

c. At least 15 percent of the reclamation lake surface area shall include waterfowl nesting islands with side slope of 10H:1V to 20H:1V to adjacent shallow water. Nesting islands shall be designed and constructed in accordance with the Alaska Department of Fish and Game's "North Slope Gravel Pit Design Guidelines" (Technical Report 93-9)and modified as necessary by the TRRC. Nesting islands shall be maintained for a period of five years after construction or three years after the last major repair, if required.

8. Phase 1, material site development shall: not exceed a 50-acre footprint area, including equipment access area; not to exceed 1.5 million cubic yards of sand/gravel excavation within a 32-acre area to a maximum depth of 60 feet; and, shall not exceed 1.01 million cubic yards overburden excavation and replacement into the excavated material site. Phase 1 shall not exceed a two-year period.

9. Initiation of Phase 2 sand and gravel mining activities involving disposal of dredged or excavated materials in waters of the U.S., authorized herein shall not occur without satisfactory initiation and progression of Phase 1 reclamation activities. Satisfactory reclamation initiation and progression shall be determined by the District Engineer in consideration of the reclamation plan's goals, objectives and performance standards, and in consultation with the Alaska Department of Fish and Game, U.S. Fish and Wildlife Service and the North Slope Borough.

10. The permittee shall submit an annual report of mining construction, operation, and reclamation activities conducted between September 1 to August 31, and those activities proposed or planned for the following period. The annual report shall delineate: the locations of past, current and projected (next year) mining operations; reclamation activities completed, on-going, and proposed; and, an assessment of reclamation activities implemented which specifically relate to status in complying to performance standards. Supportive documentation shall be submitted, including photographs, summary data tables, etc., in sufficient detail to determine permit compliance. The annual reports shall be submitted directly to the TRRC members no latter than October 1, each year for review, comment, and acceptance. Upon TRRC acceptance and not later than January 15, the annual report shall be submitted to the Alaska District, Corps of Engineers for concurrence. The annual reports shall be submitted for a period of three years following the end of gravel removal operations.

e. Damage claims associated with any future modification, suspension, or revocation of this permit.

4. Reliance on Applicant's Data: The determination of this office that issuance of this permit is not contrary to the public interest was made in reliance on the information you provided.

5. Reevaluation of Permit Decision. This office may reevaluate its decision on this permit at any time the circumstances warrant. Circumstances that could require a reevaluation include, but are not limited to, the following:

a. You fail to comply with the terms and conditions of this permit.

b. The information provided by you in support of your permit application proves to have been false, incomplete, or inaccurate (See 4 above).

c. Significant new information surfaces which this office did not consider in reaching the original public interest decision.

Such a reevaluation may result in a determination that it is appropriate to use the suspension, modification, and revocation procedures contained in 33 CFR 325.7 or enforcement procedures such as those contained in 33 CFR 326.4 and 326.5. The referenced enforcement procedures provide for the issuance of an administrative order requiring you to comply with the terms and conditions of your permit and for the initiation of legal action where appropriate. You will be required to pay for any corrective measures ordered by this office, and if you fail to comply with such directive, this office may in certain situations (such as those specified in 33 CFR 209.170) accomplish the corrective measures by contract or otherwise and bill you for the cost.

6. Extensions. General condition 1 establishes a time limit for the completion of the activity authorized by this permit. Unless there are circumstances requiring either a prompt completion of the authorized activity or a reevaluation of the public interest decision, the Corps will normally give favorable consideration to a request for an extension of this time limit.

Your signature below, as permittee, indicates that you accept and agree to comply with the terms and conditions of this permit.

Thomas W. Mortensen | 13 JUNE 1997

(PERMITTEE) AND TITLE AGENT | *(DATE)*

This permit becomes effective when the Federal official, designated to act for the Secretary of the Army, has signed below.

Lloyd H Fanter | 23 June 1997

FOR *(DISTRICT ENGINEER)* Colonel Peter A. Topp | *(DATE)*

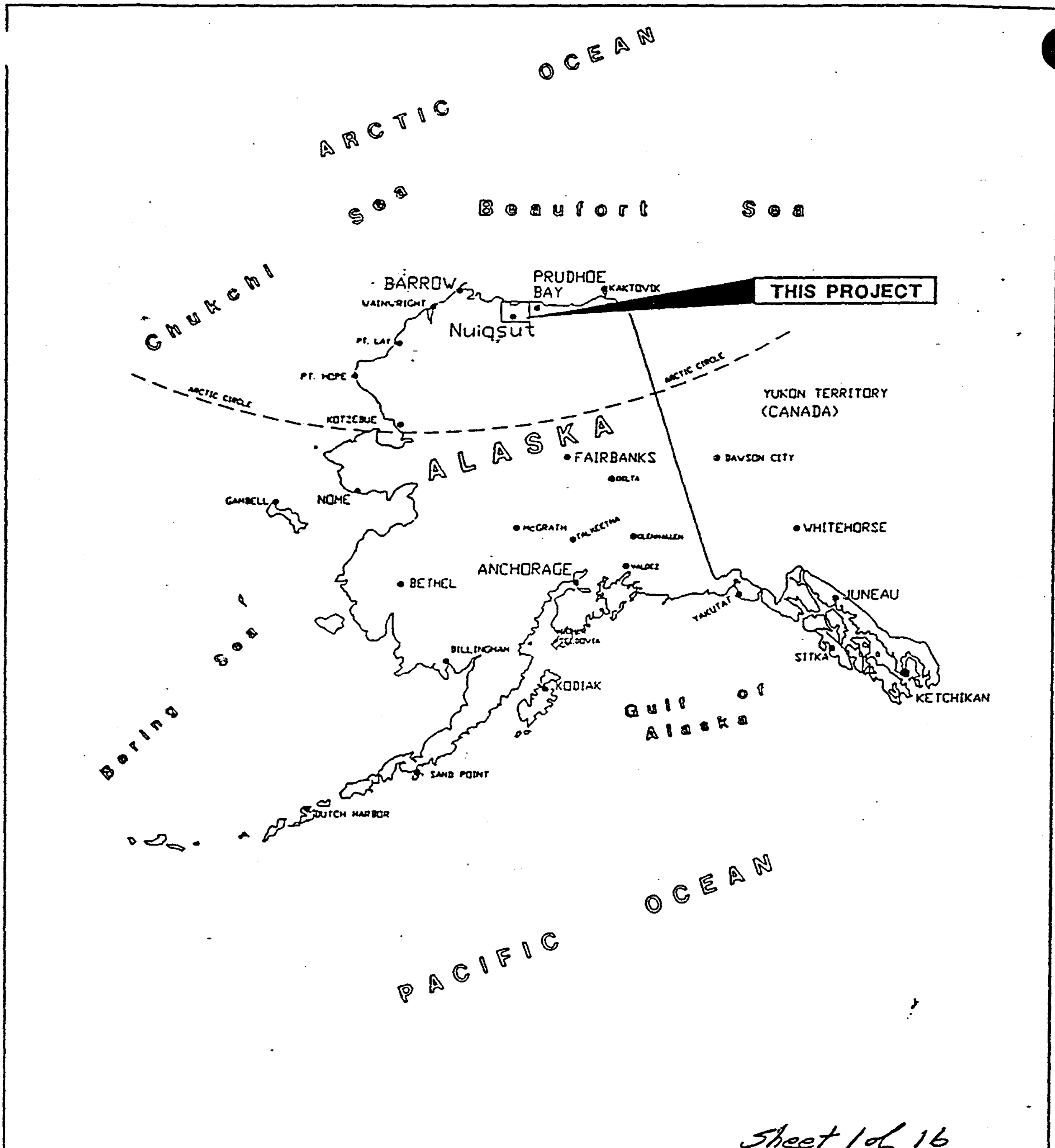
Lloyd H. Fanter, Project Manager
North Section, Regulatory Branch

When the structures or work authorized by this permit are still in existence at the time the property is transferred, the terms and conditions of this permit will continue to be binding on the new owner(s) of the property. To validate the transfer of this permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below.

(TRANSFEREE) | *(DATE)*

☆U.S. GOVERNMENT PRINTING OFFICE: 1986 — 717-425

EXHIBIT 1



Sheet 1 of 16

PURPOSE:
Phased development of a 5 million c.y. consolidated use gravel material site.

ADJACENT LANDOWNERS:
Kuukpik Corporation
Arctic Slope Regional Corp.
State of Alaska

LOCATION MAP

APPLICANT:
Nuiqsut Constructors

AGENT:
Tom Mortensen Associates
P.O. Box 113192
Anchorage, Alaska 99511

PROPOSED MATERIAL SITE DEVELOPMENT.

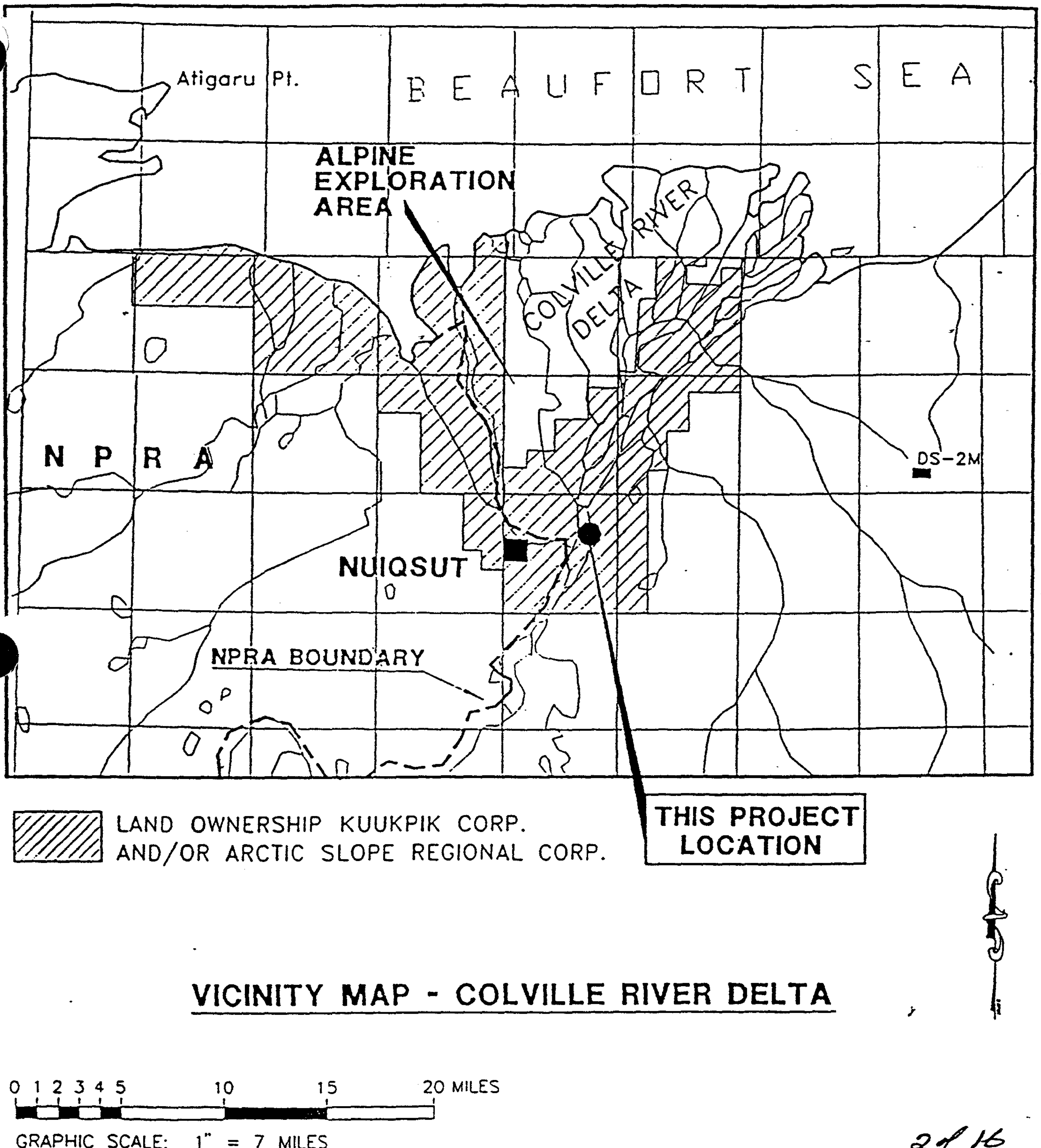
COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.

Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.

PROJECT: 96025
FILE: DAEX1

Oct. 4, 1996

EXHIBIT 2



VICINITY MAP - COLVILLE RIVER DELTA

2 of 16

PURPOSE:
Ph~sed development of a
llion c.y. consolidated
gravel material site.

ADJACENT LANDOWNERS:
Kuukpik Corporation
Arctic Slope Regional Corp.
State of Alaska

VICINITY MAP 1

APPLICANT:
Nuiqsut Constructors

AGENT:
Tom Mortensen Associates
P.O. Box 113192
Anchorage, Alaska 99511

PROPOSED MATERIAL SITE DEVELOPMENT.

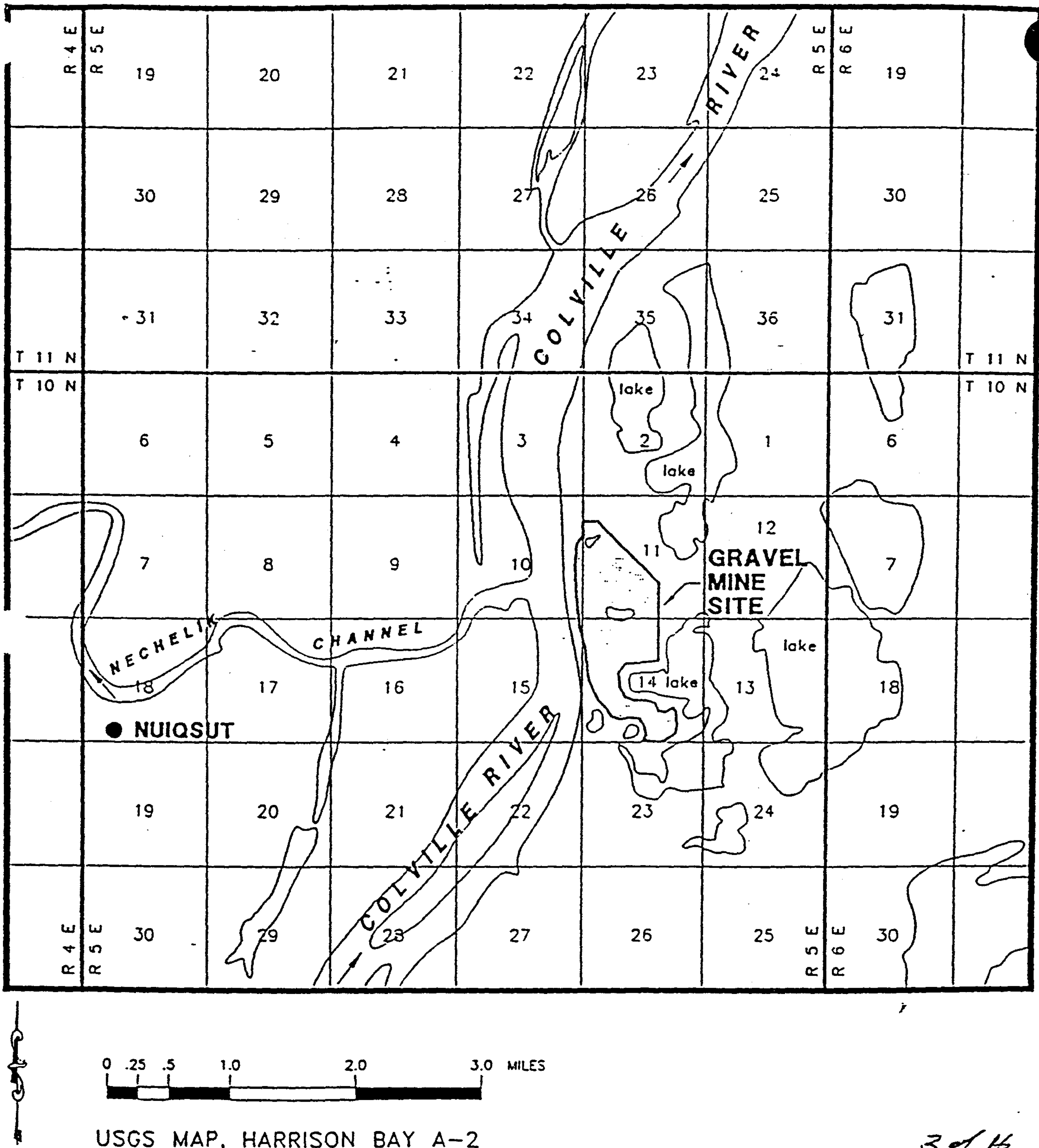
COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.

Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.

PROJECT: 96025
FILE: DAEX2

Oct. 4, 1996

EXHIBIT 3

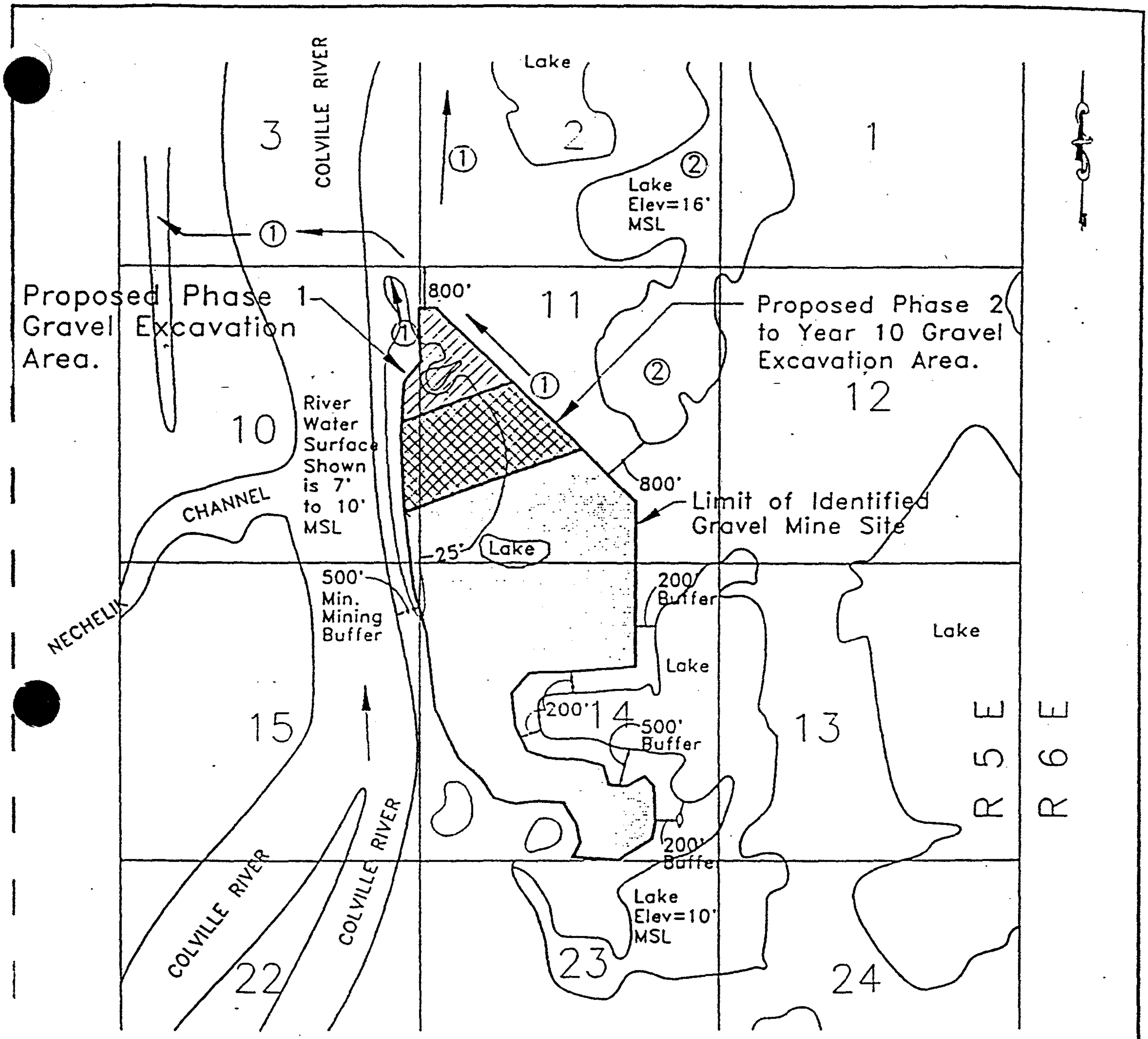


USGS MAP, HARRISON BAY A-2

3 of 15

PURPOSE: Ph~sed development of a 5 illion c.y. consolidated use gravel material site. **ADJACENT LANDOWNERS:** Kuukpik Corporation Arctic Slope Regional Corp. State of Alaska	**VICINITY MAP 2** **APPLICANT:** Nuiqsut Constructors **AGENT:** Tom Mortensen Associates P.O. Box 113192 Anchorage, Alaska 99511	**PROPOSED MATERIAL SITE DEVELOPMENT.** **COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.** **Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.** PROJECT: 96025 FILE: DAEX3 Oct. 4, 1996

EXHIBIT 4 PAGE 1 OF 2



NOTES: SEE EXHIBIT 4, PAGE 2 OF 2, FOR NOTES.

LOCATION OF PROPOSED MATERIAL SITE

USGS MAP, HARRISON BAY A-2

4 of 16

PURPOSE:
Ph–sed development of a
5 llion c.y. consolidated
gravel material site.

ADJACENT LANDOWNERS:
Kuukpik Corporation
Arctic Slope Regional Corp.
State of Alaska

SITE PLAN 1

APPLICANT:
Nuiqsut Constructors

AGENT:
Tom Mortensen Associates
P.O. Box 113192
Anchorage, Alaska 99511

PROPOSED MATERIAL SITE DEVELOPMENT.

COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.

Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.

PROJECT: 96025
FILE: DAEX4

Oct. 4, 1996

Limit of Potential Gravel.
In–Place: 35 million cy within 550 acres.

Proposed 10 Year Permit:
5 million cy of Gravel
From 150 Acre Area.

PHASE 1 GRAVEL EXCAVATION. ABOUT 1.5 MILLION CY OF GRAVEL FROM ABOUT 32 ACRES. ALSO INCLUDES THE EXCAVATION OF ABOUT 770,000 CY OF OVERBURDEN FROM WETLANDS.

PHASE 1 ALSO INCLUDES THE EXCAVATION OF ABOUT 240,000 CY OF OVERBURDEN FROM ABOUT 10 ACRES OF WETLANDS FOR EQUIPMENT ACCESS RAMPS. ALSO SEE EXHIBIT 6.

PROPOSED EXTENT OF ADDITIONAL PHASES FOR THE 10 YEARS AFTER PERMIT ISSUED. FROM THIS AREA A TOTAL OF ABOUT 3.5 MILLION CY OF GRAVEL WILL BE EXCAVATED FROM ABOUT 80 ACRES OF WETLANDS.

IN ADDITION, ABOUT 1.9 MILLION CY OF OVERBURDEN WOULD BE EXCAVATED FROM THE 80 ACRES OF WETLANDS.

<u>TOTALS</u>. YEAR 1–10: 5 MILLION CY OF GRAVEL. 2.9 MILLION CY OF OVERBURDEN EXCAVATED FROM ABOUT 122 ACRES OF WETLANDS, WITHIN A FOOTPRINT AREA OF 150 ACRES.

REMAINING AREA OF IDENTIFIED GRAVEL DEPOSIT.

① PROPOSED ICE ROAD/BRIDGE CORRIDORS FOR PHASE 1 GRAVEL HAUL. SEE EXHIBIT 11 FOR CHANNEL CROSS SECTIONS, AND EXHIBIT 13 FOR ALTERNATE ICE ROAD ROUTES.

② PROPOSED WATER WITHDRAWL POINTS. SEE EXHIBIT 6.

LOCATION OF PROPOSED MATERIAL SITE

5 of 16

PURPOSE:
Phased development of a 5 million c.y. consolidated use gravel material site.

ADJACENT LANDOWNERS:
Kuukpik Corporation
Arctic Slope Regional Corp.
State of Alaska

NOTES

APPLICANT:
Nuiqsut Constructors

AGENT:
Tom Mortensen Associates
P.O. Box 113192
Anchorage, Alaska 99511

PROPOSED MATERIAL SITE DEVELOPMENT.

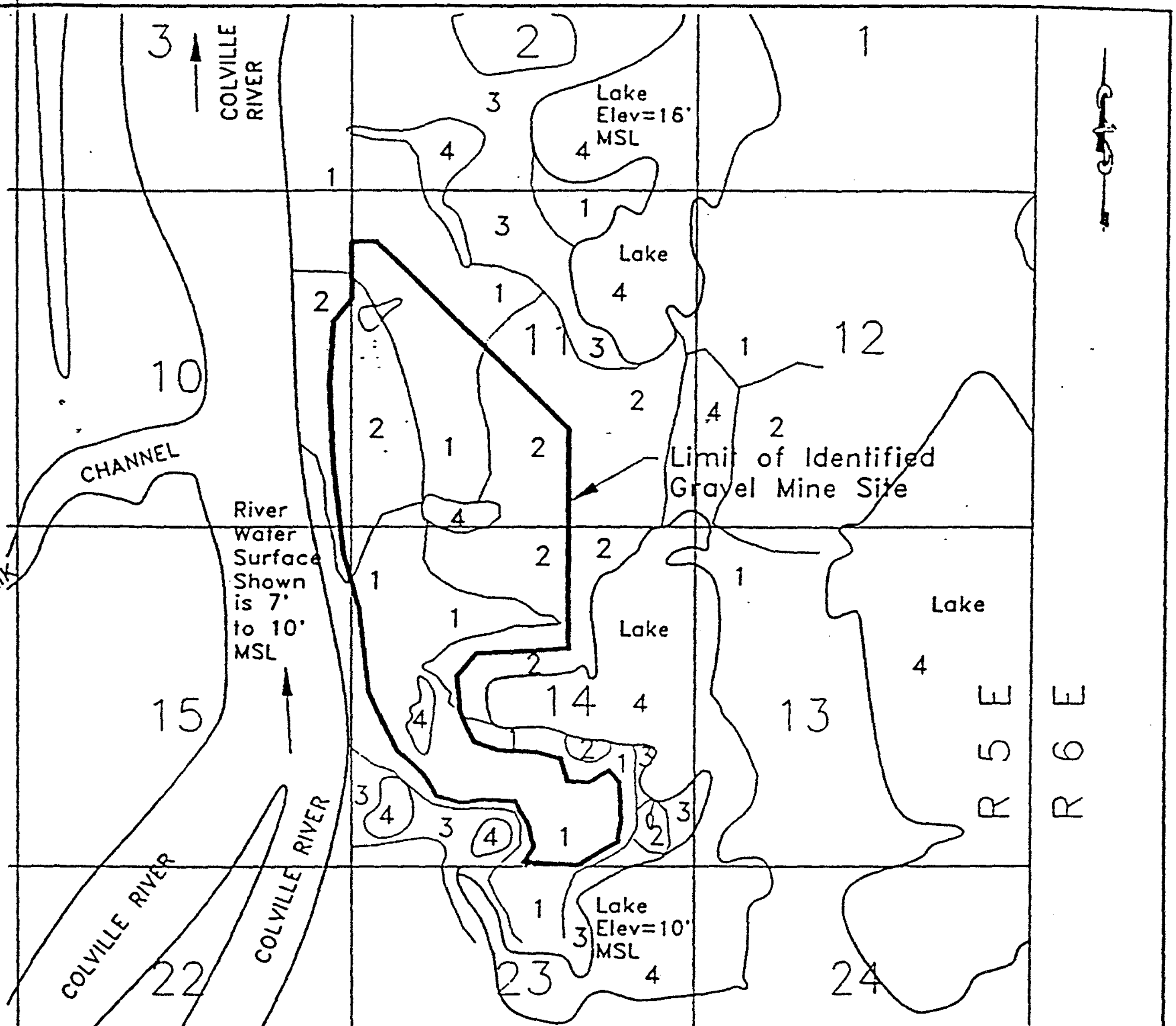
COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.

Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.

PROJECT: 96025
FILE: DAEX4

Oct. 4, 1996

EXHIBIT 5



WILDLIFE HABITATS

1 = WET SEDGE – WILLOW MEADOW WITH LOW RELIEF POLYGONS. (NWI = PALUSTRINE EMERGENT PERSISTENT SEMIPERMANENTLY FLOODED, SCRUB SHRUB BROAD LEAVED DECIDUOUS SEMIPERMANENTLY FLOODED. PEM1F/SS)

2 = NON-PATTERNED WET MEADOW. (NWI = PALUSTRINE EMERGENT PERSISTENT SEASONALLY FLOODED. PEM1E)

3 = RIVERINE OR UPLAND SHRUB.

4 = DEEP OPEN WATER WITHOUT ISLANDS.

PROJECT AREA WILDLIFE HABITATS

USGS MAP, HARRISON BAY A-2

6 of 16

URPOSE:
h--ed development of a
5 lion c.y. consolidated
gravel material site.

DJACENT LANDOWNERS:
Kuukpik Corporation
Arctic Slope Regional Corp.
tate of Alaska

SITE PLAN 2

APPLICANT:
Nuiqsut Constructors

AGENT:
Tom Mortensen Associates
P.O. Box 113192
Anchorage, Alaska 99511

PROPOSED MATERIAL SITE DEVELOPMENT.

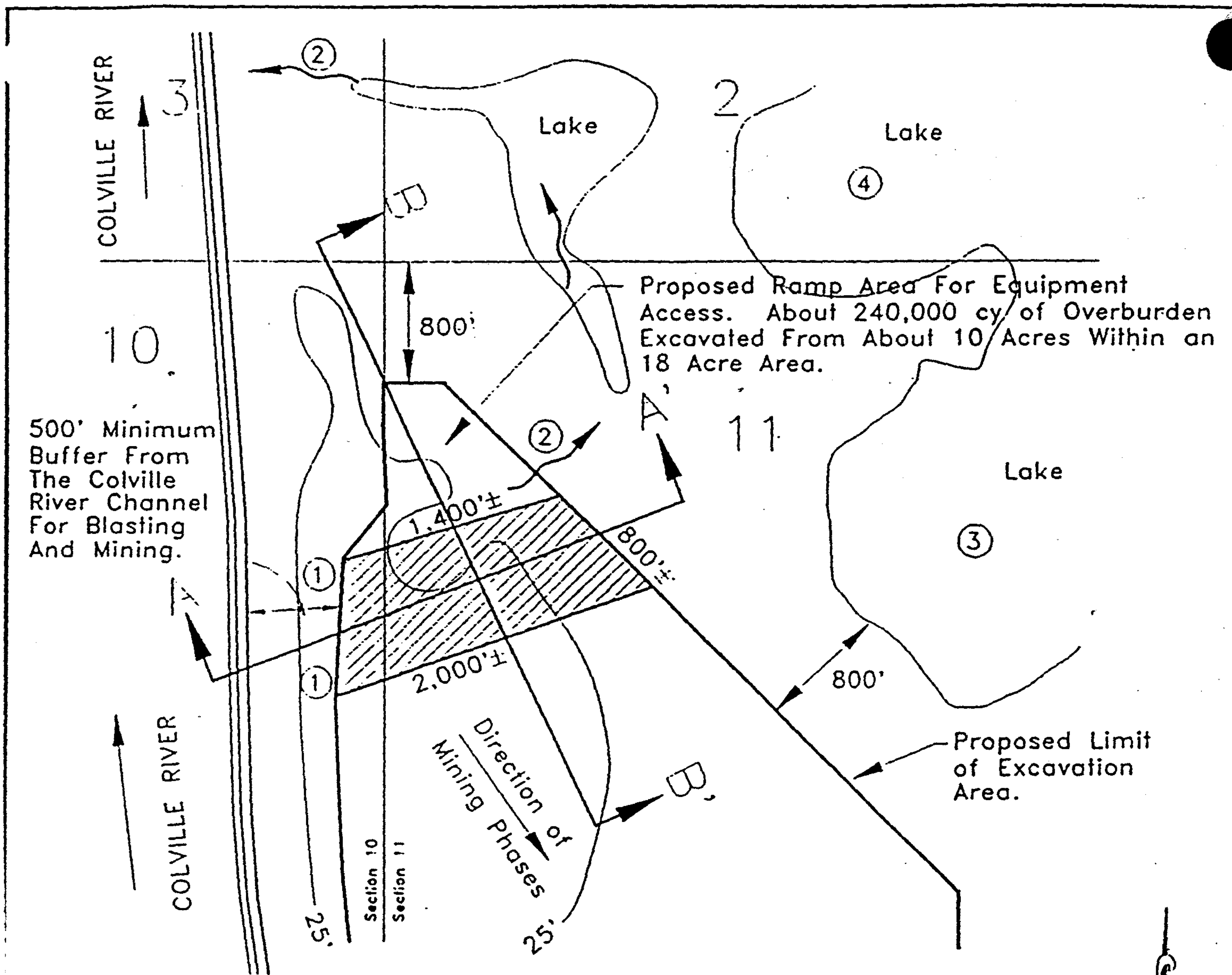
COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.

Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.

PROJECT: 96025
FILE: DAEX5

Oct. 4, 1996

EXHIBIT 6a



PHASE 1, INITIAL GRAVEL PIT EXCAVATION AREA. ±1.5 MILLION CY OF GRAVEL AND 770,000 CY OF OVERBURDEN TO BE EXCAVATED FROM A ±32 ACRE AREA.

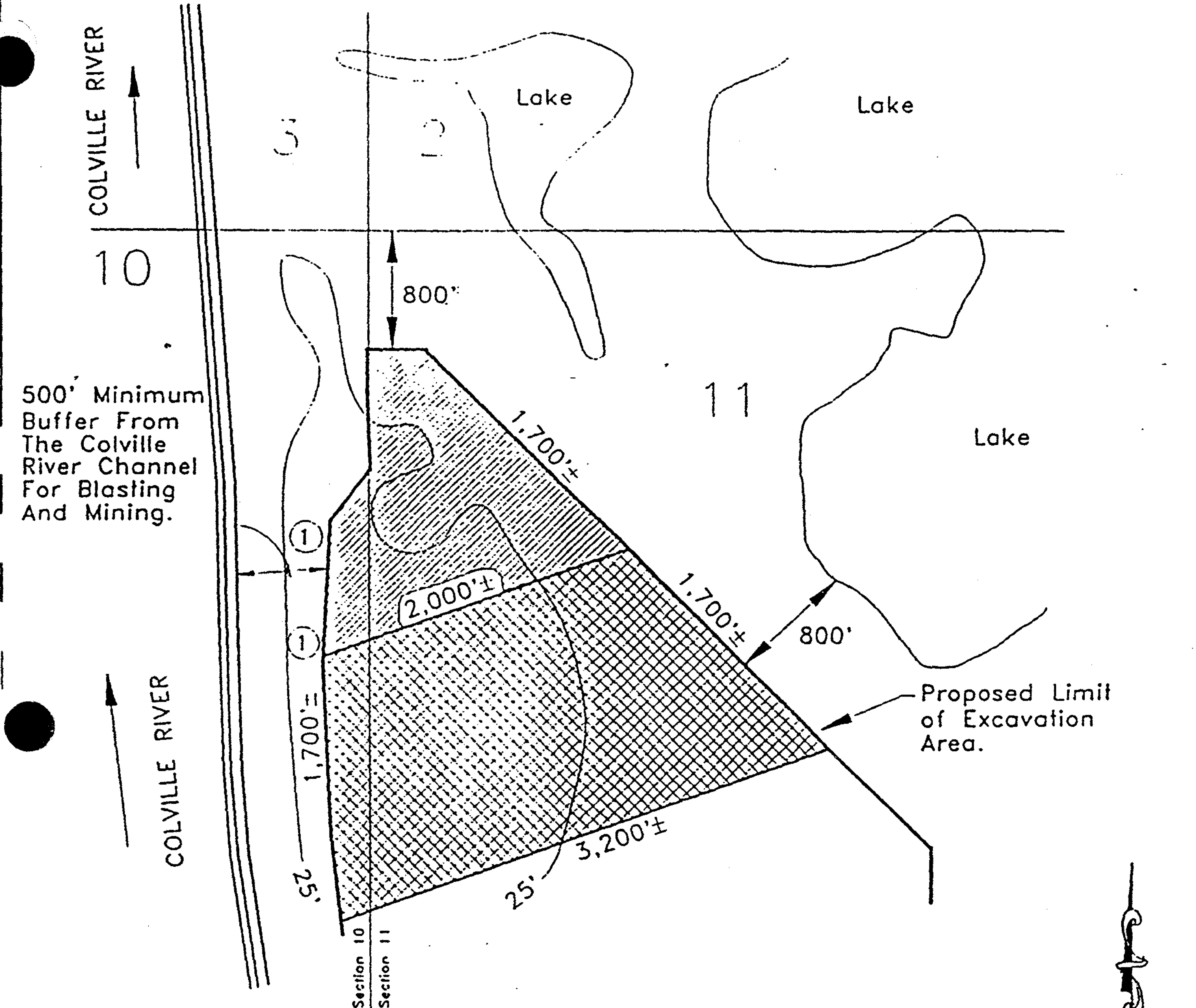
1. APPROXIMATE 7 to 10 ACRE AREA FOR TEMPORARY OVERBURDEN STOCKPILE FOR INITIAL PHASE 1 GRAVEL EXCAVATION. TO BE BACKFILLED PRIOR TO BREAK-UP.
2. NATURAL DRAINAGE ROUTE OF OVERFLOW WATER FROM FUTURE RECLAMATION LAKE.
3. PROPOSED ICE ROAD WATER SOURCE. 9' DEEP, 27 MILLION GAL. AVAILABLE.
4. PROPOSED ICE ROAD WATER SOURCE. 11.5' DEEP, 39 MILLION GAL. AVAILABLE.

DETAIL OF PHASE 1 GRAVEL MINING

7 of 16

URPOSE: hased development of a ion c.y. consolidated se gravel material site. **DJACENT LANDOWNERS:** uukpik Corporation rctic Slope Regional Corp. tate of Alaska	**SITE PLAN 3a** **APPLICANT:** Nuiqsut Constructors **AGENT:** Tom Mortensen Associates P.O. Box 113192 Anchorage, Alaska 99511	**PROPOSED MATERIAL SITE DEVELOPMENT.** **COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.** **Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.** PROJECT: 96025 FILE: DAEX6a Oct. 8, 1996

EXHIBIT 6b



PHASE 1: INITIAL GRAVEL PIT MINING AND EQUIPMENT ACCESS RAMP AREAS. ±1.5 MILLION CY OF GRAVEL AND ±1.01 MILLION CY OF OVERBURDEN FROM A TOTAL FOOTPRINT AREA OF ±50 ACRES.

PHASE 2 TO 10 YEAR: GRAVEL PIT MINING AND EQUIPMENT ACCESS RAMP AREAS. ±3.5 MILLION CY OF GRAVEL AND ±1.9 MILLION CY OF OVERBURDEN FROM A TOTAL FOOTPRINT AREA OF ±100 ACRES.

DETAIL OF 10 YEAR GRAVEL MINING

8 of 16

'URPOSE:
hased development of a
'ion c.y. consolidated
gravel material site.

JACENT LANDOWNERS:
uukpik Corporation
rctic Slope Regional Corp.
ate of Alaska

SITE PLAN 3b

APPLICANT:
Nuiqsut Constructors

AGENT:
Tom Mortensen Associates
P.O. Box 113192
Anchorage, Alaska 99511

PROPOSED MATERIAL SITE DEVELOPMENT.

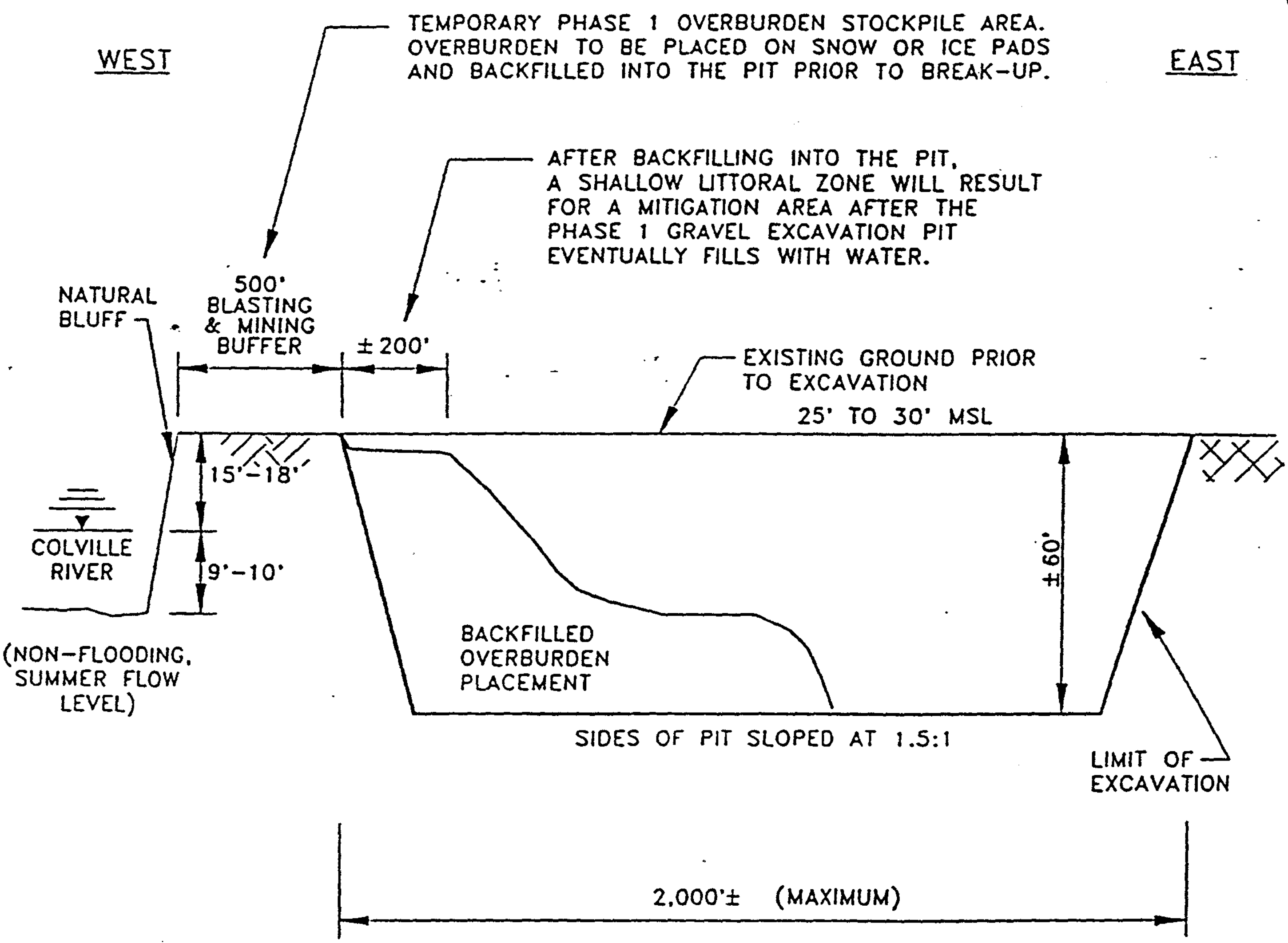
COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.

Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.

PROJECT: 96025
FILE: DAEX6b

Oct. 8, 1996

EXHIBIT 7



SECTION A-A'

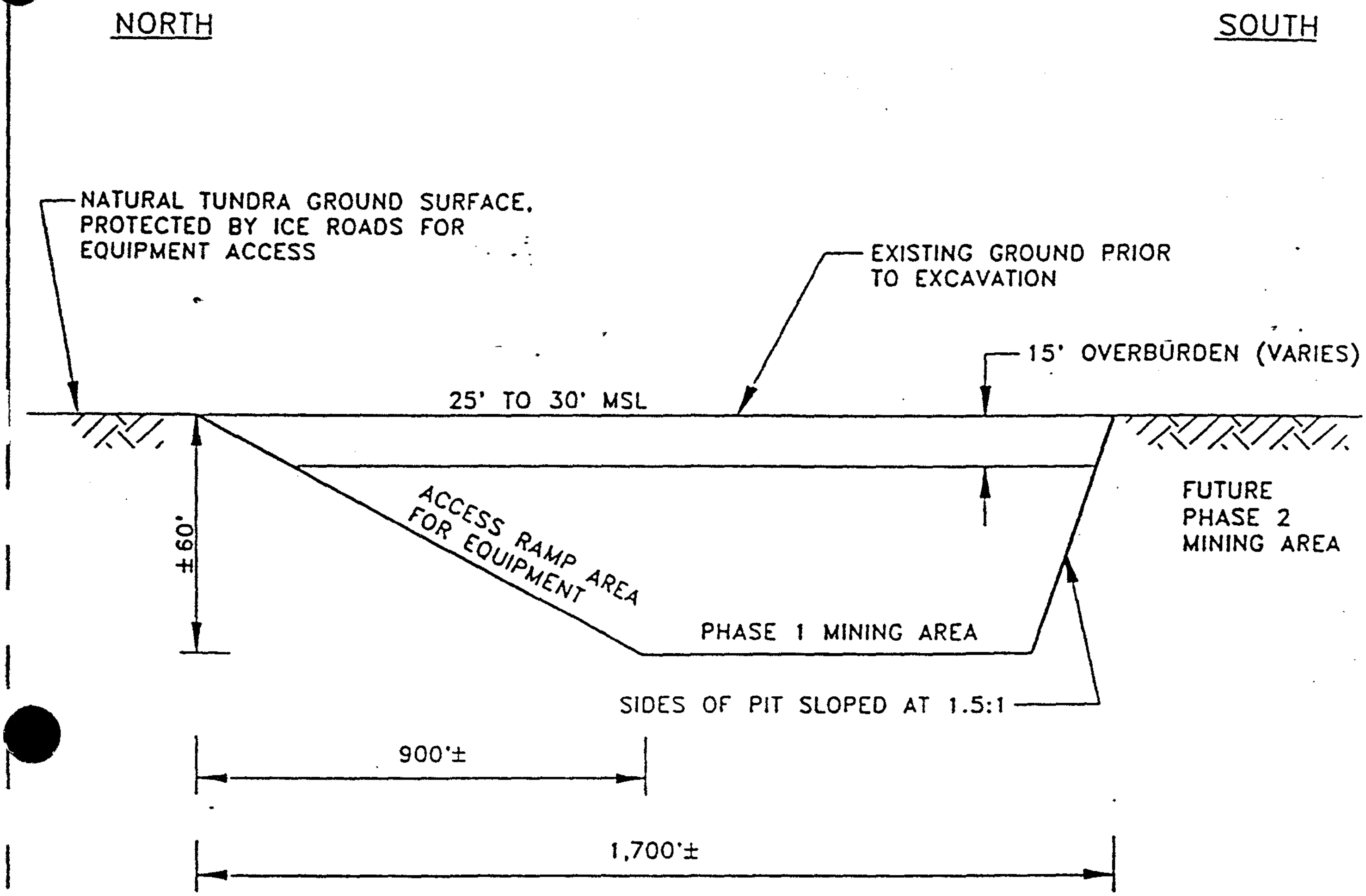
NTS

TYPICAL EAST TO WEST CROSS SECTION

90 of 16

'URPOSE: hased development of a r 'ion c.y. consolidated se ,ravel material site.	**CROSS SECTION 1**	**PROPOSED MATERIAL SITE DEVELOPMENT.**
DJACENT LANDOWNERS: uukpik Corporation rctic Slope Regional Corp. tate of Alaska	**APPLICANT:** Nuiqsut Constructors	**COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.**
	AGENT: Tom Mortensen Associates P.O. Box 113192 Anchorage, Alaska 99511	**Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.**
		PROJECT: 96025 FILE: DAEX7 — Oct. 4, 1996

EXHIBIT 8



SECTION B–B'

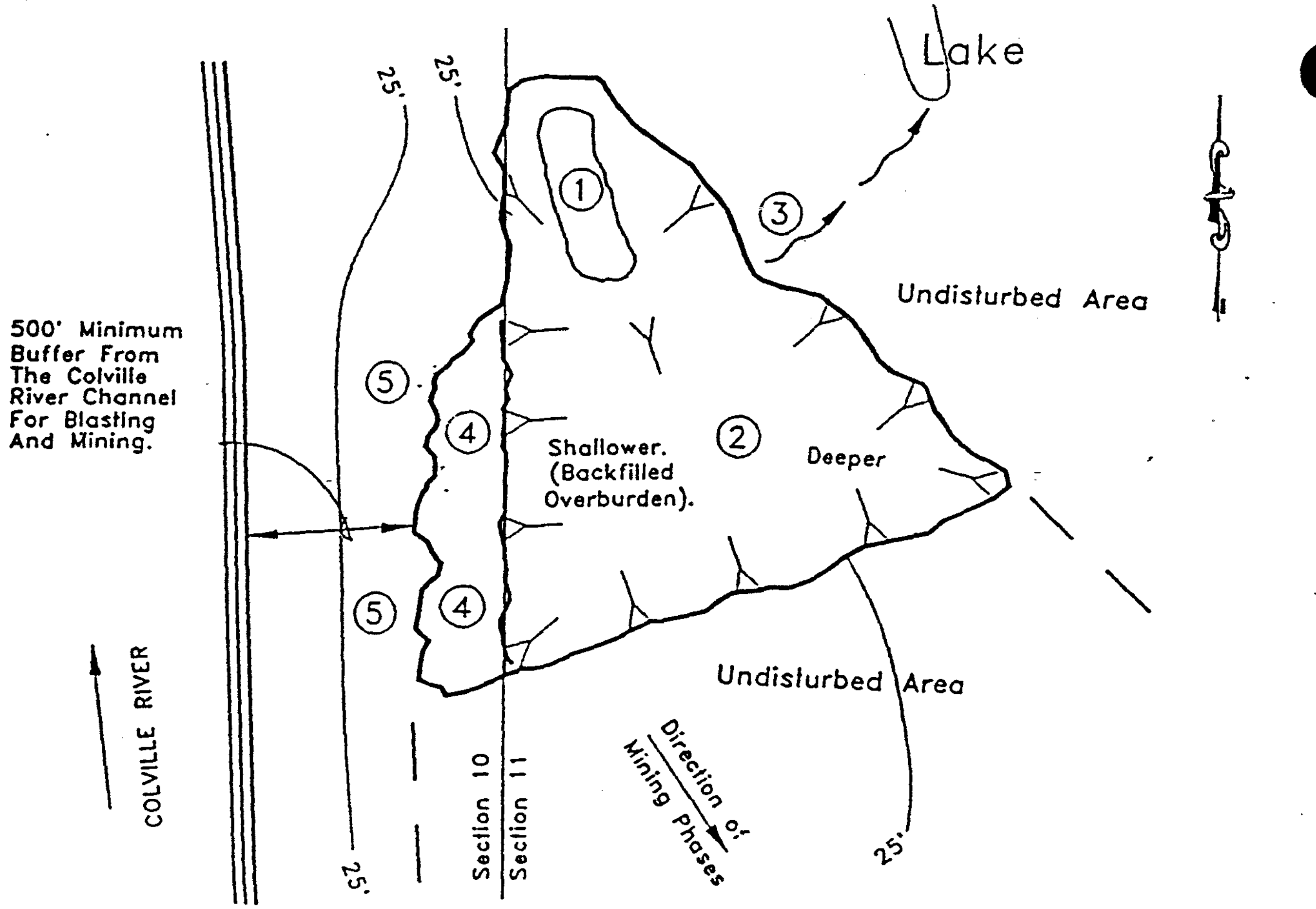
NTS

TYPICAL NORTH TO SOUTH CROSS SECTION

Sheet 10 of 16

PURPOSE: Phased development of a [illegible]lion c.y. consolidated [illegible] gravel material site. **ADJACENT LANDOWNERS:** Kuukpik Corporation Arctic Slope Regional Corp. State of Alaska	**CROSS SECTION 2** **APPLICANT:** Nuiqsut Constructors **AGENT:** Tom Mortensen Associates P.O. Box 113192 Anchorage, Alaska 99511	**PROPOSED MATERIAL SITE DEVELOPMENT.** **COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.** **Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.** PROJECT: 96025 FILE: DAEX8 Oct. 4, 1996

EXHIBIT 9

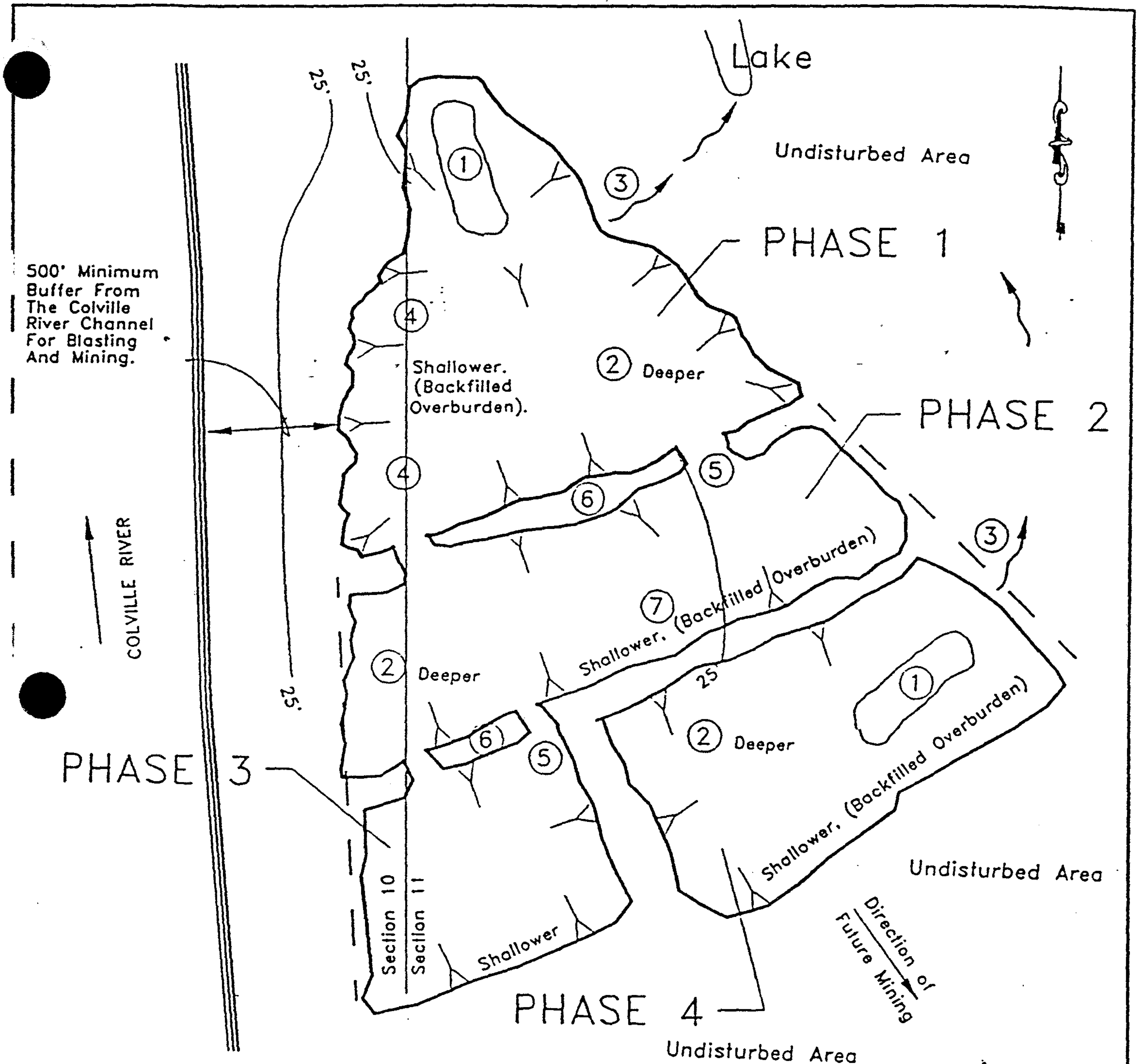


1. ISLAND OR PENINSULA OF UNDISTURBED GROUND RESULTING FROM THE SUBMERGING OF THE EQUIPMENT ACCESS RAMP(S).
2. LAKE UP TO 60' DEEP AFTER RAIN AND SNOWMELT FILL THE EXCAVATION PIT AREA. THE LAKE SURFACE AREA OF THE PHASE 1 MINING AND EQUIPMENT RAMP AREAS IS ABOUT 42 ACRES.
3. NATURAL DRAINAGE ROUTE OF OVERFLOW WATER FROM THE FUTURE LAKE.
4. APPROXIMATE 5 TO 10 ACRE SHALLOW LITTORAL MITIGATION AREA. THE 1' TO 6' DEEP LITTORAL AREA WILL BE CREATED BY THE BACKFILLING OF THE TEMPORARY OVERBURDEN STOCKPILE BACK INTO THE EXCAVATION PIT.
5. LOCATION OF TEMPORARY OVERBURDEN STOCKPILE ON SNOW OR ICE PAD. ALL OVERBURDEN WILL BE BACKFILLED INTO THE PIT PRIOR TO BREAK-UP.

DETAIL OF PHASE 1 RECLAMATION

11 of 16

PURPOSE: Phased development of a 5 'lion c.y. consolidated us. gravel material site. ADJACENT LANDOWNERS: Kuukpik Corporation Arctic Slope Regional Corp. State of Alaska	SITE PLAN 4 APPLICANT: Nuiqsut Constructors AGENT: Tom Mortensen Associates P.O. Box 113192 Anchorage, Alaska 99511	PROPOSED MATERIAL SITE DEVELOPMENT. COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA. Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian. PROJECT: 96025 FILE: DAEX9 Oct. 4, 1996



NOTES: SEE EXHIBIT 10, PAGE 2 of 2, FOR NOTES.

CONCEPTUAL PLAN OF PHASED RECLAMATION

NTS

12 of 16

JRPOSE: ..nc..d development of a ... ion c.y. consolidated ...gravel material site. **..JACENT LANDOWNERS:** ..uukpik Corporation ..ctic Slope Regional Corp. ..ate of Alaska	**SITE PLAN 5** **APPLICANT:** Nuiqsut Constructors **AGENT:** Tom Mortensen Associates P.O. Box 113192 Anchorage, Alaska 99511	**PROPOSED MATERIAL SITE DEVELOPMENT.** **COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.** **Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.** PROJECT: 96025 FILE: DAEX10 Oct. 4, 1996

NOTES:

1. ISLAND OR PENINSULA OF UNDISTURBED GROUND RESULTING FROM THE SUBMERGING OF THE EQUIPMENT ACCESS RAMP(S).
2. LAKE UP TO 60' DEEP AFTER RAIN AND SNOWMELT FILLS THE EXCAVATION PIT AREA. THE SURFACE AREA OF THE PHASE 1 MINING AND RAMP AREA IS ABOUT 42 ACRES.
3. NATURAL DRAINAGE ROUTE OF OVERFLOW WATER FROM THE FUTURE LAKE SYSTEM.

SHALLOW ZONE CREATED BY BACKFILLING OF 250,000 CY OF OVERBURDEN TEMP. STOCKPILED ON ICE PADS ON THE UNDISTURDED TUNDRA.
ALSO, THE INITIAL OVERBURDEN FROM THE PHASE 2 GRAVEL EXCAVATION PIT (PROBABLY ABOUT 250,000 CY) COULD BE BACKFILLED INTO THIS AREA TO DECREASE THE WATER DEPTH AND TO CREATE ISLANDS IF DEEMED NECESSARY.

5. BREACH AREAS CONNECTING THE LAKES.
6. ISLANDS OF UNDISTURDED TUNDRA AREAS CREATED FROM CONNECTING THE LAKES.
7. THE INITIAL OVERBURDEN FROM THE PHASE 4 GRAVEL EXCAVATION PIT (PROBABLY ABOUT 250,000 CY) COULD BE BACKFILLED INTO THIS AREA TO DECREASE THE WATER DEPTH AND TO CREATE ISLANDS IF DEEMED NECESSARY.

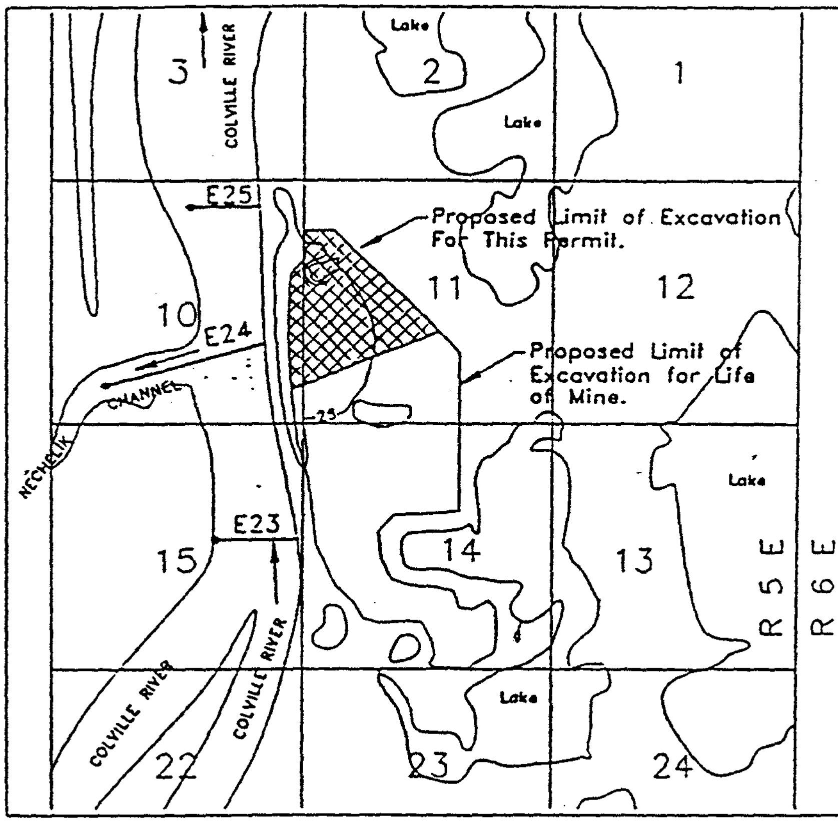
THE RECLAMATION PHASES SHOWN ON THIS EXHIBIT ARE CONCEPTUAL, INTENDED TO SHOW THE GENERAL RECLAMATION GOALS, AND MAY VARY FROM THE ACTUAL MINING PHASES.

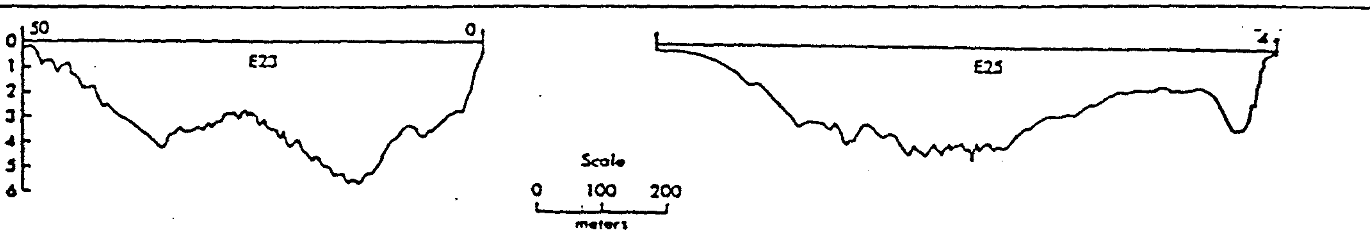
CONCEPTUAL PLAN OF PHASED RECLAMATION

136/16

PURPOSE: Phased development of a 5 lion c.y. consolidated use gravel material site.	**NOTES**	**PROPOSED MATERIAL SITE DEVELOPMENT.**
ADJACENT LANDOWNERS: Kuukpik Corporation, Arctic Slope Regional Corp., State of Alaska	**APPLICANT:** Nuiqsut Constructors **AGENT:** Tom Mortensen Associates, P.O. Box 113192, Anchorage, Alaska 99511	**COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.** **Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.** PROJECT: 96025 FILE: DAEX10 — Oct. 4, 1996

EXHIBIT 11





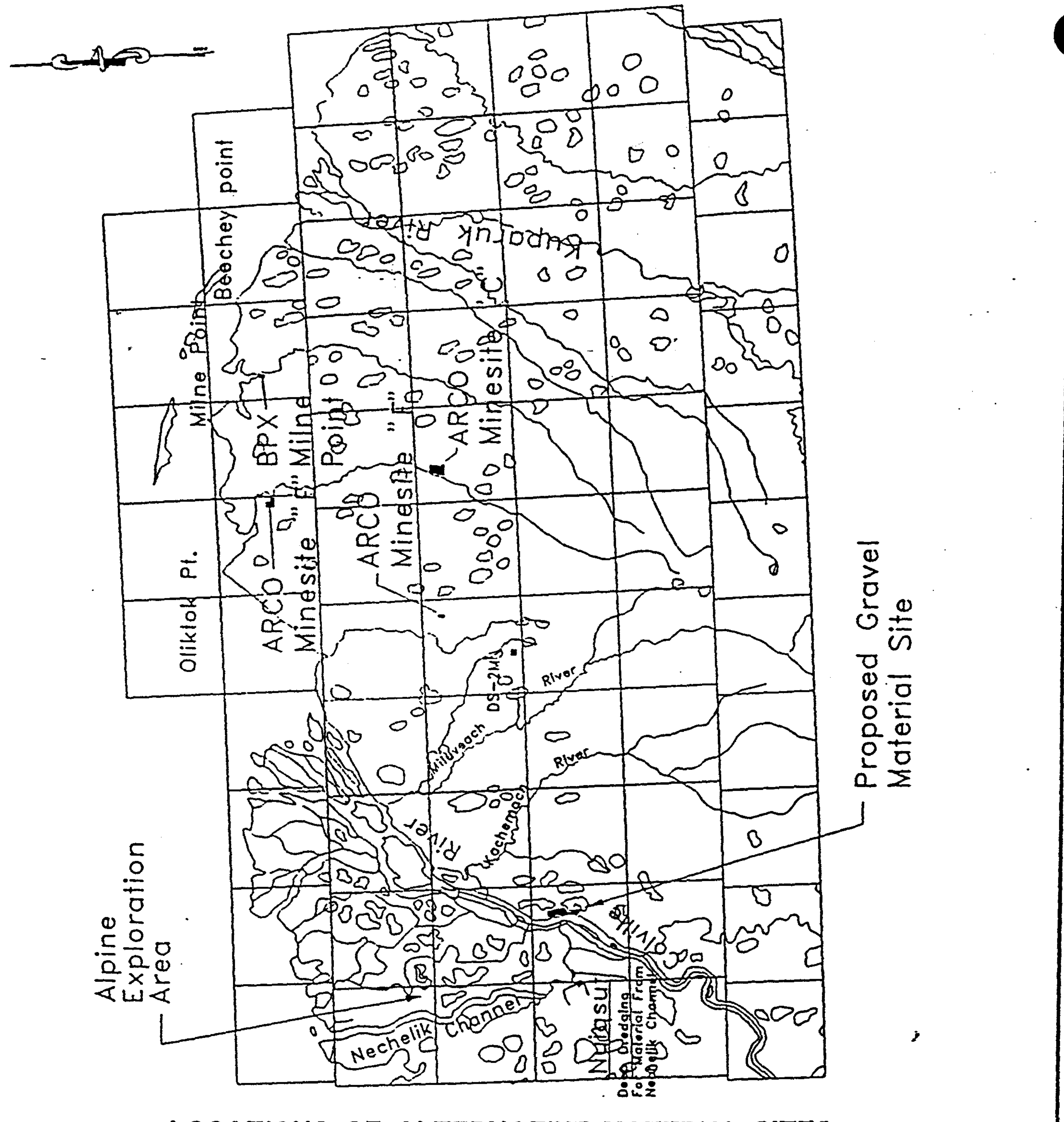
RIVER CHANNEL CROSS SECTIONS
MEASURED IN 1962 BY H.J. WALKER,
LOUISIANA STATE UNIVERSITY,
BATON ROUGE, LOUISIANA.

CROSS SECTIONS OF COLVILLE CHANNEL

14 of 16

RPOSE: ...d development of a ...ion c.y. consolidated ...ravel material site.	**CROSS SECTION 3**	**PROPOSED MATERIAL SITE DEVELOPMENT.**
JACENT LANDOWNERS: ...ukpik Corporation ...tic Slope Regional Corp. ...te of Alaska	**APPLICANT:** Nuiqsut Constructors **AGENT:** Tom Mortensen Associates P.O. Box 113192 Anchorage, Alaska 99511	**COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.** Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian. PROJECT: 96025 — Oct. 4 1996

EXHIBIT 12

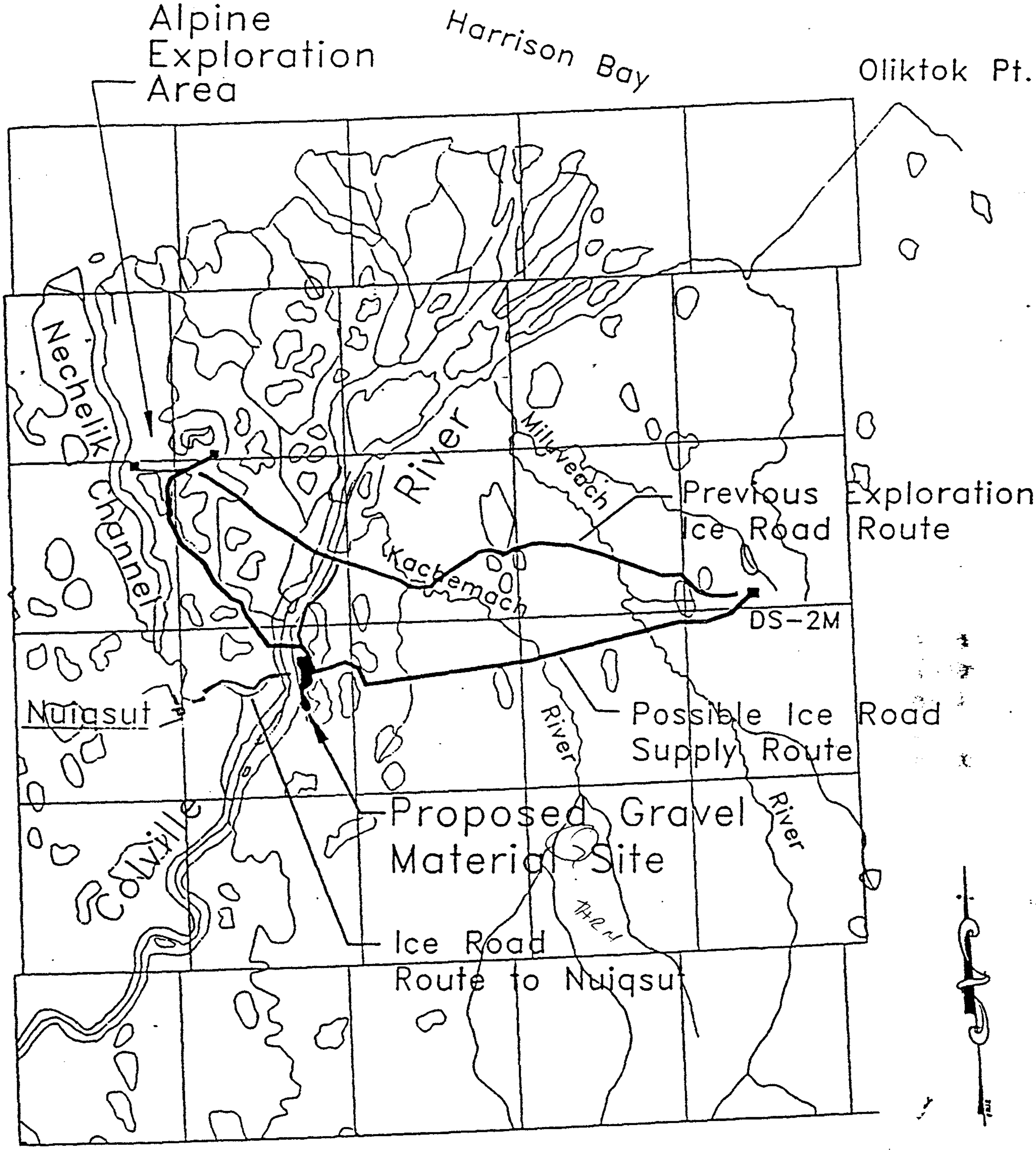


LOCATIONS OF ALTERNATIVE MATERIAL SITES

15 of 16

PURPOSE: Ph[illegible]d development of a 5 [illegible]ion c.y. consolidated use gravel material site. **ADJACENT LANDOWNERS:** Kuukpik Corporation Arctic Slope Regional Corp. State of Alaska	**ALTERNATIVES** **APPLICANT:** Nuiqsut Constructors **AGENT:** Tom Mortensen Associates P.O. Box 113192 Anchorage, Alaska 99511	**PROPOSED MATERIAL SITE DEVELOPMENT.** **COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.** **Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian.** PROJECT: 96025 FILE: DAEX12 Oct. 4, 1996

EXHIBIT 13



LOCATIONS OF ICE ROAD ACCESS ROUTES

Sheet 16 of 16

PURPOSE:	ACCESS	PROPOSED MATERIAL SITE DEVELOPMENT.
P ed development of a illion c.y. consolidated gravel material site.	APPLICANT: Nuiqsut Constructors	COLVILLE RIVER DELTA, NORTH SLOPE, ALASKA.
ADJACENT LANDOWNERS: Kuukpik Corporation, Arctic Slope Regional Corp., State of Alaska	AGENT: Tom Mortensen Associates, P.O. Box 113192, Anchorage, Alaska 99511	Located Within Sections 10, 11, 14, 15, T10N R5E, Umiat Meridian. PROJECT: 96025 FILE: DAEX13 Oct. 4, 1996

Appendix P

APPENDIX P

APPLICATION FOR ZONING MAP AMENDMENT

ARCO Alaska, Inc.
Post Office Box 100360
Anchorage, Alaska 99510-0360
Telephone 907 276 1215

August 20, 1997

Ms. Karen Burnell
Director, Planning Department
North Slope Borough
P.O. Box 69
Barrow, AK 99723

Mr. Jon Dunham
Planning Department
North Slope Borough
P.O. Box 69
Barrow, AK 99723

Dear Ms. Burnell and Mr. Dunham:

Thank you again for your August 4 letter reaffirming your assessment of ARCO Alaska, Inc.'s draft Alpine Zoning Map Amendment Application.

ARCO Alaska, Inc. hereby requests that specified North Slope Borough lands of the Colville Delta and adjacent eastern areas up to the Kuparuk River Unit be rezoned from Conservation District to Resource Development District classification in order to allow construction and operation of the Alpine Development Project, an oil and gas field and associated production facilities and pipeline. The following materials are attached for your review and processing: a completed Questionnaire and Application for Zoning Map Amendment (with supporting attachments) and a rezoning request fee of $5000 (check #205076524). The lands of interest for development of production facilities lie within the Colville River Delta. Lands needed for the pipeline right-of-way lie within the delta proper and extend east of the main channel of the Colville River to the western boundary of the Kuparuk River Unit. A map is included which shows the proposed locations for facilities and pipeline. Surface ownership of these lands is in part by Kuukpik Corporation and in part by the State of Alaska. ARCO and Kuukpik Corporation are in the final stages of negotiating a surface use agreement covering all Kuukpik surface ownership.

The detailed proposal to construct the Alpine facilities and pipeline is contained in a US Army Corps of Engineers October 8, 1996 permit application which was supported by the *Alpine Development Project: Environmental Evaluation Document* (EED). Numerous public meetings and workshops have been held in Nuiqsut and Barrow on the Alpine Project. Also, major submittals have been made under the USACE process that address questions, comments and concerns raised by the NSB, Nuiqsut, and regulatory agencies. The NSB has received ARCO's submittals of February 27, May 21, and July 25, 1997 which respond to these matters. The EED is also being updated and revised to reflect changes and other detailed responses made since October 1996. The above referenced submittals contain significant mitigation designed to avoid or minimize impact. Please be aware that the eventual surface use agreement between Kuukpik and ARCO will contain more specific descriptions of mitigation . As discussed with the North Slope Borough, ARCO is attempting to design Alpine in an environmentally responsible manner which avoids or minimizes impacts to the Colville River Delta and its residents, with special consideration of the cultural and subsistence values of the Kuukpimiut people. We are aware that the interested parties of Nuiqsut have requested that all rezoning hearings be conducted in Nuiqsut. We would appreciate your confirmation that Nuiqsut's request has been granted.

ARCO, and its native corporation contracting alliance will be prepared to commence construction of the Alpine project this coming winter if the necessary local government, state and federal permits are issued. In your consideration of scheduling hearings, we would appreciate this optimal construction commencement goal.

In accordance with your request, we are submitting full packets containing all relevant material required for the re-zoning application and are sending each member of the Planning Commission and the North Slope Borough Assembly an individual packet. Therefore, I would appreciate learning how many packets should be prepared. I would, upon receipt of your list of those who should receive packets, be happy to take responsibility for assembling them and mailing them out.

I would greatly appreciate your review of the application and your determination of its completeness and adequacy for the zoning request.

Sincerely yours,

Mark J. Schindler
Director, Alpine Permits and Compliance

Attachment:
Application for Zoning Map Amendment w/attachments
Alpine Project Master Plan w/technical attachments

NSB - Application for Zoning Map Amendment **QUESTIONNAIRE**

Answers to questions based on Land Management Policies of the North Slope Borough (NSBMC 19.60.040) and the Planning Commission's approval criteria.

- Does the proposed zoning map amendment and/or master plan conform with the Land Management Policies of the North Slope Borough (NSBMC 19.70)? Please list each policy that you believe applies.

1. **Section 19.70.010 VILLAGE POLICIES**
   (C) Development and uses are encouraged which provide or materially contribute to lower-cost fuel or power.
   (D) Development and uses are encouraged which provide local employment in the villages.
2. **Section 19.70.030 ECONOMIC DEVELOPMENT POLICIES**
   (A) through (G)
3. **Section 19.70.050 COASTAL MANAGEMENT AND AREA-WIDE POLICIES**
   (D) Development shall not preclude reasonable subsistence user access to a subsistence resource.
   (E) through (G) Protection of archaeological, cultural, historical resources.
   (H) Development shall comply with state or federal land, air and water quality standards or regulations.
   (I) Following features are required for all applicable development.
      (1) Restrictions based on vehicle, vessel and aircraft disturbance.
      (3) Development resulting in water or airborne emissions.
      (4) Solid waste disposal facilities.
      (5) Impoundment and processing of effluent
      (10) Residential development associated with industrial resource extraction development.
      (11) Impermeable lining and diking for fuel storage facilities.
   (J) Best efforts practices applied to all applicable situations described
      (e.g., (j) Placement of structures in floodplains.
   (L) Minimization of negative impacts
      (e.g., (5) (a) Providing for unimpeded wildlife crossing.
4. **Section 19.70.060 TRANSPORTATION CORRIDOR POLICIES**
   (A) through (K)

- Does the proposed zoning map amendment and/or master plan conform with the dimensional & density standards for buildings (NSBMC 19.40.100)?

  Not applicable to this application.

- Does the proposed zoning map amendment and/or master plan have an appearance compatible with the surrounding land uses and does not interfere with solar access?

  Gravel placement, gas and oilfield facility construction and pipeline routing will be visible additions to the low-lying landscape horizons. These will be similar in type and external appearance to exisitng structures in the neighboring Kuparuk River Unit, but will be much smaller in scale and extent. Please see *Attachment 1*, MAP, Titled "North Slope Basin, 14 (f) Settlement Agreement Surface Access," Produced by ARCO Alaska, Inc. 6/28/97 on which is indicated the land sections which are being requested for re-zone.

Solar access will not be affected.

- Does the proposed zoning map amendment and/or master plan demonstrate reasonable traffic control to prevent overloading of public streets and creation of unsafe pedestrian conditions?

  Not applicable to this application as no public streets are a part of the planned development.

- Does the proposed zoning map amendment and/or master plan provide enough parking for the proposed use of the land (NSBMC 19.40.100)/

  Not directly applicable to this application. Suitable vehicle parking and storage will be provided for the development facilities. There is no public access which would produce additional vehicles for the site requiring parking spaces.

- Does the proposed zoning map amendment and/or master plan provide adequate utility service (water, sewer, electricity and others) and handles drainage in such a way that it does not affect surrounding uses of land?

  Yes. All utility services will be incorporated in the design and operation of all facilities. Electrical generation, natural gas fuel utilization, water supplies, and sewage disposal are all engineered components of the development and will meet all applicable state and federal standards for air emissions, water withdrawals, and waste disposal (gray water, sewage, solid waste).

  Facility, pad and road, and pipeline design have been based upon extensive geomorphological and hydrological studies. A principal aim of these studies is to insure that appropriate drainage standards are met (e.g. heighth of gravel placement as related to flood stages, culverting to insure water flows within wetlands micro-environments, no blockage of stream and river flows, etc.) Please see *Attachment 2*, "Colville River Two-Dimensional Surface Water Model (July 1997)," Prepared by Shannon & Wilson, Inc., Fairbanks, AK, and *Attachment 3* "Alpine Development Project: Environmental Evaluation Document (October 1996)," Secs. 2.1.2 and 3, 2.2.1-3, 2.9, 4.2.1.

- Does the proposed zoning map amendment and/or master plan present significantly different peak use or occupaancy characteristics than the surrounding uses of land?

  Yes. During construction phases of the Alpine Development Project a temporary workforce wil be housed in camp quarters. During development drilling and operational phases of the project, shift work employees will be housed at the Alpine facilities site.

- Does the proposed zoning map amendment and/or master plan involve an historic or culturally significant site? If so, provide information dealing with those resources in a way that will not adversely impact the historic or culturally significant site. The Inupiat History, Language and Culture Commission may be able to help uou identify a historic or culturally significant site.

The sites proposed for development have been surveyed by a professionally qualified archeologist who concluded that they do not contain historic remains. This survey and its findings have been reviewed and approved by the State Historic Preservation Officer. See Attachment 4, DNR Office of History and Archaeology Letter, May 13, 1997; "Supplemental Report: Alpine Development Project Archaeological and Cultural Resources Reconnaissance, North Slope Alaska (1996)," Prepared by John E. Lobdell, PhD.

The general area of the development constitutes a small segment of the Colville River Delta traditional subsistence use lands and is therefore culturally important. Continued post development subsistence uses of the area will be managed through a Subsistence Oversight Panel established between the project operator and representatives of the subsistence user community (Nuiqsut).

- Does the proposed zoning map amendment and/or master plan impact an identified watershed?

  Yes. The project is being planned and engineered to avoid serious impacts on Colville Delta hydrologic functions (e.g. stream flow).

- How does the proposed zoning map amendment and/or master plan address fire safety and emergency vehicle access?

  Fire safety and response equipment is a component of the engineered design of the proposed oil and gas production facilities. Emergency access will be insured by the presence of a permanent airstrip sufficient to accomodate medical emergency aircraft and relief well rig, if ever required.

- Does the proposed zoning map amendment and/or master plan generate noise or nuisances greater than that expected for the surrounding uses of the land?

  Yes. Facility operation and drilling noise will exceed present ambiant noise conditions, but will be mitigated by means of engineered noise suppression measures. Aircraft and vehicle noise will be mitigated by restricting movements during critical wildlife life cycle events and seasons.

- If the proposed zoning map amendment and/or master plan involve Tundra Travel, describe in detail how this will be accomplished to minimize impact on tundra.

  All tundra travel will be undertaken during times when the surface is frozen with adequate snow cover.. Material and equipment movement will be by means of seasonally constructed ice roads.

1. Legal Description of Petitioned Property

   See attached description describing surface property ownership of the Kuukpik Corporation and of the State of Alaska upon which the proposed Alpine Development Project is to be constructed

2. Property Owners and 3. Mailing Adresses and Telephone

Kuukpik Corporation
P. O. Box 187
Nuiqsut, AK 99789
(907) 480-6220

State of Alaska
Department of Natural Resources
Division of Land - Northern Region
3700 Airport Way
Fairbanks, AK 99709-4699
(907) 451-2732.

4. Current Zoning of Petitioned Property: Resource Conservation District

Requested Zoning District: Resource Development District

Petitioned Property Acreage: Alpine Development Facilities, 114 acres
Alpine Pipeline Right-of-Way, *segments* of 24
Sections (24 x 640 acres = 15,300 acres)
See Attached "Surface Land Ownership Listings" for proposed Alpine Facility Locations and Pipeline ROW

5. Petitioner/Developer's Agent/Representative

Mark J. Schindler
Director, Colville Permits and Compliance
ARCO Alaska, Inc.
P. O. Box 100360
Anchorage, AK 99510
(907) 263-4766

6. Petitioner/Developer (individual or company name) if different from Property Owner

ARCO Alaska, Inc.
P. O. Box 100360
Anchorage, Ak 99510
(907) 263-4766

7. Closest city or village to Petitioned Property

Nuiqsut, Alaska

I hereby certify that I have been authorized to act for the owner(s) of the property described above and that I desire to rezone it in conformance with Title 19 of the North Slope Borough Municipal Code of Ordinances.

Aug 20, 1997
Date

Signature (provide written proof of authorization)

MASTER PLAN

ALPINE DEVELOPMENT PROJECT, AN OIL AND GAS PRODUCTION FACILITY WITH ASSOCIATED PIPELINES, LOCATED IN THE COLVILLE RIVER DELTA REGION AND ADJACENT EASTERN AREAS, ALL WITHIN THE NORTH SLOPE BOROUGH, STATE OF ALASKA.

I. ALPINE DEVELOPMENT PROJECT DESCRIPTION.

The Project will be developed by ARCO Alaska, Inc. and its partners, Anadarko Petroleum Corporation and Union Texas Petroleum Alaska Corporation. ARCO will be the Operator. Arctic Slope Regional Corporation and Kuukpik Corporation and their appropriate and qualified subsidiaries have major roles in the planning, design, and construction activities associated with the project. North Slope Borough resident hire policies will be applied to all relevant aspects of the project (Ref. NSBMC 19.70.010, Village Policies, and NSBMC 19.70.030, Economic Development Policies).

The project will have two distinct components: a drillsite and oil and gas production complex in the Colville Delta, and a 34 mile pipeline running from the production facilities eastward to the Kuparuk River Unit oilfield.

(a) Two oil an gas drillsite and production facility pads will be connected by a 3 mile gravel road. A 5,900 ft airstrip is adjacent to the eastern end of the road. The Project will require placement of 97 acres of gravel fill (approximately 1 million cu yds of gravel). The gravel will be supplied from the Kuukpik/ASRC gravel mine located on the east bank of the Colville River directly across from the Putu connecting channel and will be placed during winter months via ice road access. Drainage structures designed to maintain waterflow to adjacent wetlands areas will be incorporated in the project. Please see **Attachment 2**, A map of facility siting; **Attachment 3**, An elevation drawing of production, drilling and associated structures; **Attachment 4**, Map and elevation drawing of drainage structures. See also *Alpine Development Project: Environmental Evaluation Document* (EED) prepared for US Army Corps of Engineers by ARCO Alaska, Inc. (October 1996), Chapter 2 and previously distributed to all members of the NSB Planning Commission and the NSB Assembly.

(b) A cross country vertical support member (VSM) supported pipeline carrying a crude oil pipe, a seawater pipe, a small diameter diesel fuel pipe, and a fibre-optic cable. There will be no gravel road adjacent to the cross-country pipeline which commences at the Alpine production facility and extends to the Central Production Facility Number 2 (CPF-2) in the Kuparuk River Unit oilfield, a distance of 34 miles. See **Attachment 5,** Map of Pipeline Right of Way, and **Attachment 6,** Elevation drawings of special features (vertical expansion loops, maintenance of minimum 5 foot vertical clearances to insure caribou and snowmachine passage).

The pipelines will cross the main channel of the Colville River near the Putu junction. The crossing will be achieved using horizontal directional drilling technology (HDD) in which the pipes are buried to average depths of 70 feet under the river bottom and enter and come out from the ground at distances of approximately 200-300 feet in from the river banks. The HDD will be drilled in winter from ice pads. See **Attachment 7,** Cross section view of HDD placement, and **Attachment 8**, Drawing of Above Ground Pipeline Transition Cellars.

II. DESCRIPTION OF LAND OWNERSHIP AND PROPOSED USE

The surface ownership of all lands proposed for reclassification from Conservation District to Resource Development Disitrict for use by the Alpine Development Project is with either the Kuukpik Corporation or the State of Alaska. All lands requested in the Application for Zoning Map Amendment lie westward from the western boundary of the Kuparuk River Resource Development District which boundary is located at the dividing line of Sections 8 and 9, Township 10 North, Range 7 East, Umiat Meridian, Alaska. Oil and gas leases held on these lands are shown in **Attachment 9.**

These lands are desribed as follows (See **Attachment 1**, Application for Zoning Map Amendment *Map*):

Township 10 N, Range 7 East, Sections 7, 8, State of AK, owner; pipeline ROW
Township 10 N, Range 6 East, Sections 9, 10 11, 12, 17, State of AK owner; pipeline ROW
Township 10 N, Range 6 East, Sections 7, 18, Kuukpik owner; pipeline ROW
Township 10 N, Range 5 East, Sections 2, 3, 4, 10, 11, 12 Kuukpik owner with the exception of that portion of Section 3 containing lands submerged under the Colville River (and the HDD crossing location) which are State of AK owned; pipeline ROW and HDD crossing
Township 11 N, Range 5 East, Sections 19, 29, 30 32, 33 Kuukpik owner; pipeline ROW
Township 11 N, Range 5 East, Sections 7, 8 State of AK owner; pipeline ROW; and Sections 5, 6 State of AK owner; pipeline ROW and portions of Alpine Development main production pad, road, airstrip, gathering lines.
Township 12 N, Range 5 East, Sections 31, 32, State of AK owner; portions of Alpine Development main production pad, road, airstrip, gathering lines.
Township 11 N, Range 4 East, Sections 12, 13, 24 Kuukpik owner, pipeline ROW; Sections 1, 2 Kuukpik owner; Alpine Development satellite production pad, road, gathering lines.

A total of 32 Sections lying within 6 Townships make up the area requested for reclassification as Resource Development District. Twenty six sections are proposed for the pipeline ROW and in most instances only small portions are actually utilized for pipeline placement. No gravel is to be laid down in these sections and placement of pipeline VSM's will occur from an ice road during winter tundra freeze-up. Six sections are affected by gravel placement for facility, road, airstrip, and gathering line construction. Sections are made up of 640 acres per section. The placement of gravel will occur on a maximum of 97 acres out of an available total of 3,840 acres in the six affected sections, or approximately 3% of that available six section total acreage.

III. ENVIRONMENTAL PROTECTION MEASURES

A.Maintenance of Air Quality Standards. Air quality standards will be insured as a result of meeting all state and federally mandated emission standards in all facilities. Beyond that, there are two steps being taken to insure adequate knowledge of air quality characteristics as they might affect the village of Nuiqsut. The first of these is the program to monitor air quality in Nuiqsut. See **Attachment 10**, *Technical Specification AAI Nuiqsut Air Quality Monitoring Program* (July 1997).The second is an on-going consultation conducted between North Slope oil and gas operating companies, health professionals of the North Slope Borough, and community residents of Nuiqsut to address concerns and questions related to health effects arising from air quality problems.

B. Maintenance of Water Quality Standards. No waters utilized or produced as a result of any phase of the Alpine Development project will be introduced to the natural waterbodies, streams or rivers of the project area. Waste water streams will be managed through reinjection wells.

The protection of waters and landforms of the project area and all areas potentially affected by it will be accomplished through implementation of an Oil Spill Contingency Plan designed to meet any impacts produced as a consequence of accidental oil spills. During the construction phase of the project reliance will be placed on an extension of the exisiting *Kuparuk Field Oil Discharge Prevention and Contingency Plan.* The vast, readily accessible inventories of appropriate oil spill response equipment that are a part of the Kuparuk infrastructure will be available for use in the Alpine project. The spill response cooperative, Alaska Clean Seas, will provide the trained personnel to manage all stages of any spill from detection to containment to clean-up. The Nuiqsut village OSRT is also a major element of the oil spill preparedness plan.

Planning is already underway for creation of an Alpine ODPCP when the production facilities begin to operate. This plan will become a part of the larger, region wide effort to create an oil spill plan with individual components (e.g. Prudhoe Bay, Kuparuk, NSB, etc). The effort to create the area-wide plan is presently in progress with participation by the NSB, regulatory agencies, response organizations (ACS for example), and oil field operators.

In addition, appropriate equipment will be prestaged at critical locations at the production facilities, along the pipeline route, at the main river crossing, and downstream from the production area. This prestaged equipment (normally contained in a steel Conex unit) is designed with the concept that all access will be by air (helicopter), by boat in open water season, or by ATV after hard freeze-up if tundra travel is involved since there is no road access to the major portion of the pipeline. See **Attachment 11**, Remote Prestaged Oil Spill Response Equipment Package, for an example.

C. Protection of Subsistence Lifestyle and Resources. The applicant recognizes the special importance which all parties attach to the protection of subsistence resources (wildlife, birds, fish) and their habitats, and to the Kuukpikmiut cultural and nutritional needs upon which the subsistence lifestyle is based. As a consequence, a large range of mitigation measures have been proposed to insure that no significant impacts on subsistence will arise from the Alpine project. Please see the appropriate sections of the *Alpine EED* (Sections 4.4, Biological Resources, 4.5 Human Use Resources, and 2.9 Mitigation Measures) for a full discussion of subsistence-related matters. One major element of the subsistence protection strategy is the formation of a Subsistence Oversight Panel in Nuiqsut which will address all questions relating to subsistence use of the project area, avoidance of sensitive areas and seasons, and similar relevant questions.

ARCO Alaska, Inc.
AAI PAYABLES
P.O. BOX 102776
ANCHORAGE, AK 99510-2776

PAGE 1 OF 1
JULY 21, 1997
TRACE NUMBER: 205076524
CHECK NUMBER: 205076524

205076524

NORTH SLOPE BOROUGH
P.O. BOX 69
BARROW AK 99723

AMOUNT PAID : $5,000.00

PAY ENTITY: 0201

INQUIRIES: (907) 263-4422/4988 (FAX)
P.O. BOX 103240
ANCHORAGE, AK 99510-3240

VENDOR NO: N00073064002

INVOICE DATE	INVOICE NUMBER	VOUCHER	GROSS AMOUNT	DISCOUNT/ADJUSTMENT	NET AMOUNT
07/09/97	VR070997SJH01	C084S9707SJH	$5,000.00		$5,000.
		FEE FOR REZONING THE LAND ENCOMPASSED BY THE ALPINE DEVELOPM			

LEASE DETACH BEFORE DEPOSITING CHECK

Patent No. 4227720 and 4310180

ARCO Alaska, Inc.
AAI PAYABLES
P.O. Box 102776
Anchorage, AK 99510-2776

CHECK NUMBER 205076524

73-426
839

09975

JULY 21, 1997

PAY TO THE ORDER OF: NORTH SLOPE BOROUGH

*** VOID AFTER 90 DAYS ***

*EXACTLY *********5,000 DOLLARS AND 00 CENTS $*********5,000.00*

The First National Bank of Chicago-0710
Chicago, Illinois
Payable Through Republic Bank
Shelbyville, Kentucky

George S. Davis

TRACE NUMBER: 205076524

⑈205076524⑈ ⑆083904262⑆ 0997579⑈

Appendix Q

APPENDIX Q

ALPINE DEVELOPMENT HYDROLOGY AND DRAINAGE PROPOSAL

APLINE DEVELOPMENT HYDROLOGY

AND DRAINAGE PLAN PRPOSAL

Prepared for

ARCO ALASKA, INC.,
P.O. Box 100360
Anchorage, Alaska 99510

and Co-Owners

ANADARKO PETROLEUM CORPORATION
and
UNION TEXAS PETROLEUM ALASKA CORPORATION

Prepared by

Michael Baker, Jr., Inc.
4601 Business Park Blvd.
Suite 28
Anchorage, Alaska 99503

September 1997

TABLE OF CONTENTS

INTRODUCTION

This document summarizes the hydrology, drainage, erosion, and sedimentation issues related to ARCO Alaska Inc.'s proposed Alpine Oil Field Development in the Colville River Delta on Alaska's North Slope. Addressed are (1) concerns raised by regulatory agencies and other parties during the Alpine Development permit review process, and (2) criteria for designing drainage structures for the Alpine Development.

Engineering and environmental studies have been ongoing in the Colville River Delta for many years[1]. Since 1991, ARCO has commissioned environmental and hydrologic studies on the Colville Delta to assist in planning the Alpine Development. The studies have focused on gaining an understanding of the environment that could be affected by the proposed project. Studies of the physical environment and biological resources have been particularly important in defining potential effects and mitigative measures that should be considered in the project hydrologic and drainage design.

Presented in Part A of this plan is a summary of issues related to hydrology and drainage identified in the public process, and ARCO's responses to these issues. The issues and responses have been grouped by specific topic, such as "pipelines," and "in-field drainage structures."

Part B presents the design approach and criteria for providing drainage through the Alpine Development in-field gravel structures. Issues raised during the public process have been accounted for in the design process described in Part B.

PART A.
Summary of Issues Raised by Agencies and other Parties during the Public Comment Process, and ARCO's Responses

Hydrology and drainage have been extensively studied to determine the effect that various flood events and the Alpine Development Project may exert on each other, and to develop the project design criteria. The project will be designed to minimize both water impoundment and dewatering of wetlands adjacent to the in-field facilities.

The in-field gravel road, pads, and pipeline supports have been designed to withstand the current, wave, and ice forces that are expected during the design flood.

[1] A complete list of references, including hydrologic and environmental studies, is contained in Section 6 of the Alpine Development Environmental Evaluation Document (EED).

1. FLOOD STUDIES

1.1 INFIELD FACILITIES

Maps of water levels for the 50-and 200-year floods, with and without Alpine in-field structures, are presented in "Colville River Two-Dimensional Surface Water Model" by Shannon and Wilson (Revised July 1997). The actual predicted difference between the 50- and 200-year flood is approximately 2 ft because the delta is flat and there is a great deal of area available for the water to spread.

The discharge of the 2-year flood is predicted to be 240,000 cfs. The map of water levels presented in "Geomorphology and Hydrology of the Colville River Delta in 1995" for the 1995 runoff (233,000 cubic ft per second [cfs]) is a good approximation of the 2-year flood water levels.

A two-dimensional, finite-element model of the Colville River Delta during the 50-year flood evaluated the effect that the proposed gravel structures in the delta will have on water levels during flooding. The model was first run without the Alpine gravel structures in place, then re-run with the gravel structures in place. Initially it was assumed that no water would flow through the structure. This provided valuable insight to conditions during flooding but was unrealistic since drainage structures (some combination of culverts and a bridge) will transmit water through the road.

If no water passed through the road during the 50-year flood, water levels immediately upstream of the road could be as much as 2 ft higher than if no road existed, and water levels immediately downstream of the road could be as much as 2 ft lower than if the road were not there. Water level differences decreased when the model accounted for flow through the road. Analyses were performed (with discharges of 1,000 cfs, 5,000 cfs, 10,000 cfs, and 15,000 cfs passing through the gravel structure) to more accurately predict water levels. Water levels upstream of the road for the 1,000, 5,000, 10,000, and 15,000 cfs discharges were lowered by 0.1 ft, 0.2 ft, 0.4 ft, and 0.6 ft, respectively. As the discharge passing through the road increases, the differences in water level upstream and downstream of the road diminishes. Water levels downstream of the road were raised less than 0.1 ft for the 1,000 cfs discharge, and raised 0.1 ft, 0.6 ft, and 1.0 ft for the 5,000, 10,000, and 15,000 cfs discharges.

1.2 PIPELINES

Pipelines will be built at an elevation well above the predicted water levels during the design flood, so that no lateral loads will be exerted on the pipelines by water or ice forces. Pipeline supports will be designed, and approved by the State/Federal Joint Pipeline Office, to withstand the predicted loads resulting from water and ice.

1.3 COLVILLE RIVER CROSSING

The horizontal directionally drilled (HDD) pipeline crossing of the Colville River will be below-ground and designed to avoid or minimize effect on surface water flows. The pipeline will transition above ground on either side of the river. The pipeline transition pads will cause minor changes to surface flows because they are small and located at elevations above frequent floods. The cased pipelines will be placed well below predicted scour depths beneath the river, and transitions will be set back well beyond predicted long-term bank migration limits (approximately 200-300 ft). Ground elevations surrounding the transition pads preclude thick ice from reaching the pipelines.

2. IN-FIELD DRAINAGE STRUCTURES

Project drainage structure design criteria, based on environmental considerations, are presented in Part B. A bridge and numerous culverts will provide cross drainage through the Alpine Road. In the swale, and in the area of low-center polygons, more culverts will be installed to ensure adequate cross-flow.

3. EROSION & SEDIMENTATION

The project will be designed to avoid adding to existing erosion and sedimentation rates. The use of well-designed drainage structures with effective slope protection (where needed) and good maintenance will minimize water velocity impacts and prevent a significant change in sedimentation and erosion in the project area.

Erosion problems are not foreseen. Outside the stream channels, floodwater velocities throughout the Colville River Delta are generally very low. The maximum expected water velocities during the 50-year flood conditions are figured at less than 2 ft per second around the margins of the gravel pads; this is below erosional velocity. For the 200-year flood conditions, the water currents are calculated to be approximately 2.5 ft per second (fps). These velocities are documented in "Colville River Two-Dimensional Surface Water Model" (Revised July 1997). While the 200-year water velocities are high enough to move fine sand, the gravel constituent of the gravel pads protects the sand fraction, and thus no erosion is expected. The effects of wind waves during flood conditions are being analyzed to determine whether armoring of the gravel side slopes to minimize erosion is warranted.

PART B.
Hydrology and Drainage Plan

4. DRAINAGE APPROACH AND DESIGN CRITERIA

In designing drainage through the Alpine structures, it is critical to provide drainage conveyances that (1) are hydraulically satisfactory, (2) do not contribute to embankment instability, and (3) satisfy environmental criteria.

This translates to design criteria that provide for sufficient water passage, embankment stability, fish passage, and preservation of wetland habitat. These criteria are discussed in the following sections.

4.1 CRITERIA FOR DRAINAGE THROUGH THE ROAD ACROSS THE SWALE

The swale is a linear depression that connects a lake to the south and a lake to the north of the road during periods of flow. The Alpine Road will cross the swale near the southwest end of the airstrip. The swale is an environmental feature because it provides a route between the lakes for fish migration and a flow of water to wetlands downstream of the road. A bridge and numerous culverts will provide cross-road drainage through the swale, in accordance with the criteria described below.

4.1.1 Hydraulic Criteria

Culvert design criteria, including hydraulic criteria, are described in Section 2. Criteria and determination of the necessary water discharge and velocity through the swale are presented in the Final Drainage Plan to be submitted to ARCO 9/23/97.

4.1.2 Fish Criteria

Fish passage criteria are likewise described in Section 2. Evaluations of drainage structures in the swale have shown that properly designed culverts, a bridge/culvert combination, or an at grade crossing/culvert, can meet the fish passage criterion.

4.1.3 Wetland Habitat Maintenance Criteria

The governing design criteria for drainage through the swale are those required to maintain the wetland habitats upstream and downstream of the road. Criteria that address the hydroperiod (i.e., frequency of inundation and sedimentation regimes required to maintain normal characteristics of wetland habitats) are described in detail in the Final Drainage Plan to be submitted to ARCO 9/23/97. These issues are briefly described below.

4.1.3.1 Hydroperiod (Duration of Inundation) Criterion

The hydroperiod is the least critical of the three wetland maintenance criteria. The lowland habitats in the Colville River Delta are well adapted to inundation for varying periods, extending from days to weeks. Drainage structures designed to meet the sedimentation criterion described below will satisfy the hydroperiod criterion. Additional measures to address the hydroperiod are not required.

4.1.3.2 Frequency of Inundation Criterion

Frequency of inundation is important in that certain habitats require periodic inundation and sedimentation (described below) to maintain their normal structure and function. Drainage structures designed to meet the sedimentation criterion described below will satisfy the frequency of inundation criterion so that additional measures to address this criterion are not required.

4.1.3.3 Sedimentation Criterion

Sedimentation is the most critical habitat maintenance criterion. Sediment layers at the surface, or interbedded with organic layers below the surface, were frequently observed in soil profiles from low-lying habitats near the project site. This interbedding of sediment suggests that these areas are routinely (every one to five years) inundated during break-up, and that the water is sufficiently deep, slow, and sediment-laden to allow sedimentation. This sediment provides nutrient recharge and contributes to ongoing habitat health and stability.

The need for a sedimentation criterion is based on extensive field studies and observations. Certain low-lying habitats require periodic inundation during break-up to receive the sedimentation necessary for sustenance. Salt marshes, wet meadows, and riverine shrub habitats in a basin north of the Alpine Road could be affected. To maintain adequate inundation and sedimentation, a criterion was developed that the bridge and culverts through the road must be capable of passing at least 80 percent of the 5-year flood. The 5-year flood volume has been determined through hydrological modeling to be 8,047 acre-ft. Eighty percent of this volume is 6,438 acre-ft. The proposed 440-ft-long bridge with a 402 ft. opening width measured at the abutment toes will pass this volume. The proposed drainage structures are designed to: (1) allow low-lying areas downstream of the road to be flooded, (2) allow sufficient flow and sediment to enter the basin to maintain adequate deposition, and (3) avoid backing up water and causing overbank flow.

4.2 CRITERIA FOR DRAINAGE THROUGH THE ROAD OUTSIDE SWALE

Culverts will serve as the only drainage structures through the road outside the swale. These culverts will also be designed in accordance with the applicable criteria presented in Section 3.

4.2.1 Drainage to Reduce Ponding

One goal of culvert design and location is to minimize ponding along the toe of the road. Culverts will be placed as required along the road alignment to provide sufficient cross-drainage and minimize ponding on the higher side of the road. Initial culvert locations will be based on an analysis of survey data and observations of an ARCO/agency field trip. Culvert locations are proposed in low points along the alignments. Culvert locations have been field-staked, and then reviewed by engineers in the field. Locations have been optimized based on this field engineering review. Further details relating to culverts are presented in the Final Drainage Plan. The need for additional culverts through the road will be assessed in a monitoring program, described in Section 3 of this plan.

4.2.2 Fish Passage Between the Western Lakes

The road near Pad 2 will separate two closely spaced lakes. Three fish-passable culverts will be installed between these lakes to maintain the hydraulic connection during periods of high water and provide for fish passage.

4.2.3 Fish Passage Through Other Culverts

Because none of the other culverts through the Alpine Road connect fish-bearing waters, it is not necessary to design them for fish passage.

4.2.4 Polygon Flow Paths

An area of wet, polygonal ground is located near the Alpine Road midpoint. It is important to provide flow between the polygonal ground on each side of the road to maintain habitat. Culverts will be spaced more closely in this area than in other areas along the road to fulfill this requirement.

4.3 CRITERIA FOR DRAINAGE THROUGH THE AIRSTRIP

Long culverts in North Slope applications are problematic, and so efforts will be made to eliminate any need for them in the airstrip. If culverts are installed through the airstrip, they will be designed wherever possible in accordance with applicable criteria set forth in Section 2.

4.3.1 Drainage To Reduce Ponding

The goal of culvert design and siting across the airstrip is to minimize ponding. If culverts are to be placed through the airstrip, they will be sited as described in Section 1.2.1 of the EED. Initial culvert locations will be based on analysis of low points along the airstrip. These culvert locations will be field-staked, then undergo field engineering review. Culvert locations will be adjusted as necessary based on field engineering.

4.4 CRITERIA FOR DRAINAGE AT PADS 1 AND 2

The orientation and natural drainage conditions at the proposed drill site locations are generally favorable. It does not appear they will significantly block drainage, and drainage structures will not be required.

5. CULVERT DESIGN CRITERIA

Criteria for culvert design, based on hydraulic performance and fish passage, are summarized below. Culverts placed simply to maintain hydraulic cross-communication (not to pass significant flow during large flood events or provide fish passage) will not necessarily be designed to the criteria set forth below.

- Top of culvert inlets will be set at the 50-year flood water surface elevation. Any culvert inlets set lower than this elevation will include design aspects to offset potential vortexing.
- Round culverts designed for fish passage will be buried to 20 percent of their diameter.
- Arch culverts will be buried 1 ft. No arch culverts are currently planned on this project.
- Drainage structures designed for fish passage will be designed to meet ADF&G requirements for passage of a 240 mm grayling.

6. CULVERT MONITORING PROGRAM

Culverts installed in Alpine Development gravel structures will be monitored during the first season after installation to ensure that they work properly. After the spring breakup, weekly observations will be made along the length of the structures. Those locations where the difference in water elevation across the road exceeds 6 inches will be noted. Areas where water level differences of 6 inches or more persist for one week (two measurement periods) will be designated for more detailed investigation. This investigation will consider impacts and potential solutions. The monitoring program will continue until the number and location of detailed investigation areas stabilizes.

7. CULVERT MAINTENANCE PROGRAM

North Slope culverts may be clogged with ice or snow during break-up, when they are needed the most. A maintenance program will be used to ensure that culverts are functioning when break-up occurs. The base plan is to block culverts in the fall to keep them clear, then to remove the blocking just prior to break-up. Alternatively, the culverts may be opened with steam prior to break-up if they have filled with ice or snow during the winter.

8. EROSION AND SCOUR

Placing gravel structures in the Colville River Delta will effect water flows under some conditions. Flow changes have been evaluated to assess erosion potential. These evaluations are described in the following sections.

8.1 SAKOONANG CHANNEL EROSION PROTECTION

The southeast side of Pad 1 faces the Sakoonang Channel. Overbank flow from this channel may reach to the edge of the pad. The two-dimensional finite element model predicts water velocities in this area, from the 50-year flood, to be about 2 fps. Because this is below erosional velocity, erosion of this face is not expected.

8.2 WIND AND WAVE EROSION PROTECTION

Analyses are currently underway to evaluate the need to protect the gravel structures from wind and wave erosion. The analyses consider a range of combinations of wind and high water (the 50-year combined water and wind event). Erosive forces on the gravel structures will be evaluated to determine whether protective measures are necessary.

8.3 EROSION AT THE EDGES OF THE GRAVEL STRUCTURE

Under high flow conditions, the land upstream of the gravel structures will be inundated, and water will begin to spill around the east edge of Pad 1 and the west edge of Pad 2. The erosion potential of these flows has been modeled (water velocities of about 2 fps), and it has been determined that erosion protection will not be required to guard against this event.

8.4 SCOUR AT BRIDGES AND CULVERTS

Water flowing through culverts or a bridge installed in the Alpine Road will accelerate as it flows through these constrictions. Under certain flow conditions, velocities are expected to exceed the velocities that the natural ground can tolerate, and scour may occur. Scour protection will, therefore, be installed. Scour protection will be described in greater detail in the Final Drainage Plan to be submitted to ARCO 9/23/97.

Appendix R

APPENDIX R

SCOPE OF ARCO ANNUAL ENVIRONMENTAL STUDIES

ALPINE DEVELOPMENT PROJECT—1997
FISH SURVEY
PROPOSED SCOPE OF WORK

Prepared for ARCO, Alaska, Inc.

by Lawrence L. Moulton
MJM Research

27 May 1997

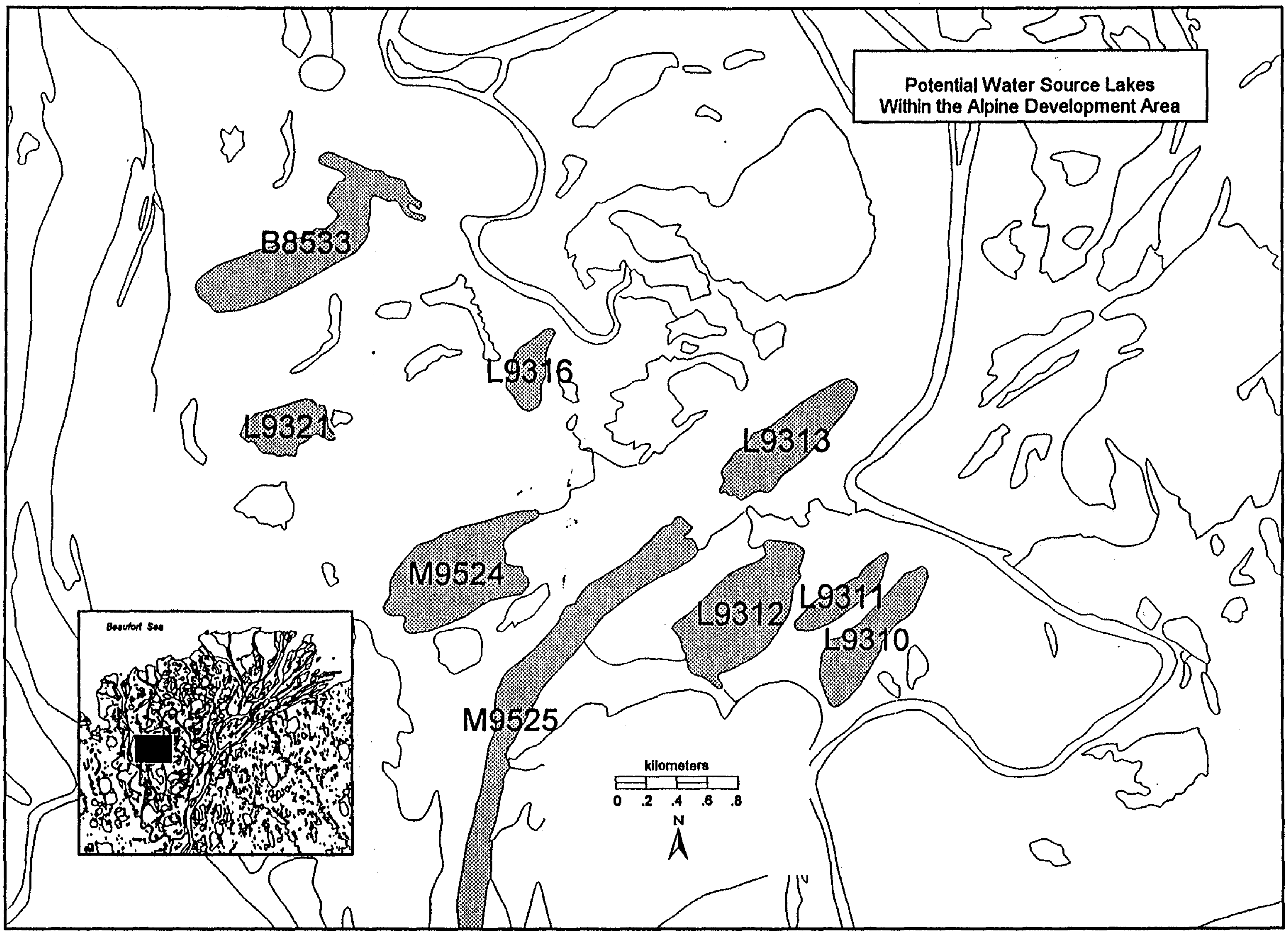
During 1997, the survey of fish and fish habitats within the Colville Delta will consist of four study elements: 1) continuing to inventory fish populations in lakes not previously surveyed, 2) obtaining estimates of the population size of least cisco and broad whitefish in lakes within the Alpine Development area, 3) obtaining additional water quality data from lakes that may be used as water sources for various elements of the Alpine Development, and 4) sampling a small number of fish for analyses of metals.

Inventory of Fish Populations in Lakes—Lakes not previously surveyed for fish presence will be sampled with multi-mesh gill nets and minnow traps. Bathymetric and water quality data will be collected at each lake. Gill net sets will be limited to 2 to 4 hours, with nets attended continuously during the sets, to ensure that waterfowl are not entangled. All fish captured will be measured. Those that are alive and judged to have only minor injuries will be released. Fish that are dead or unlikely to survive will be retained for detailed biological analysis, including weight, sex, maturity, age and feeding evaluations.

Population Estimates—The main lakes in the Alpine Development Area that are prime candidates for use as water sources will be sampled with fyke nets. At present, the lakes planned for study include B8533, L9310, L9311, L9312, L9313, L9316, L9321, and M9524. Fish captured by fyke net will be identified, counted and measured. Fish 250 mm long or larger will be tagged with a numbered Floy anchor tag; fish smaller than 250 mm will be marked with an adipose clip. Fish will be released into the lake of origin after tagging. Sampling will be conducted for approximately two weeks after ice-out in early July and again in early August. Data analysis will be contingent on the number of tag recoveries, but will likely be a modified Petersen population estimate or similar procedure.

Water Quality Data—The collection of water quality data is incomplete on some lakes and has not included collection of pH measurements, which are needed to evaluate the suitability of water sources for the horizontal drilling program. Data needs for various lakes will be determined and water samples obtained to allow the needed analysis.

Metal Analysis—A small number of fish will be sampled to obtain a measure of baseline levels of metals.


Potential Water Source Lakes
Within the Alpine Development Area
B8533
L9316
L9321
L9313
M9524
L9312
L9311
L9310
M9525
kilometers
0 .2 .4 .6 .8
N
Beaufort Sea

ALPINE DEVELOPMENT PROJECT—1997
OIL SPILL RESPONSE STUDIES
PROPOSED SCOPE OF WORK

Prepared for ARCO, Alaska Inc.

by OCC Ltd.,

27 May 1997

The goal of the oil spill response studies in 1997 for the Alpine project is to develop a data base that will enable response strategies to be developed for a possible spill adjacent to one of the river or stream channels. The focus of the proposed study will be on specific features of the waterways, such as flow conditions and navigability, and on feasibility and constraints with respect to oil spill response operations and strategies, rather than on response objectives or priorities. These latter items may be included in the data base at a later time. The report that will be generated is intended to be an Addendum or Appendix to the Oil Spill Contingency Plan that will be prepared for this project.

The data base will be generated from existing data and from field measurements and observations. All information will be recorded on a standard form to be developed specifically for this proposed study, and will be entered into MS Access software. These data files can be imported into existing GIS systems for graphic presentation. The general headings for the topics to be included in the data base for each segment are as follows:

A) CHANNEL CHARACTER

1) Dimensions
2) Geomorphology
3) Flow Conditions
4) Navigability
5) Bank Character

B) RESPONSE AND OPERATIONAL CONSIDERATIONS

6) Staging Potential
7) Oil Control or Collection Points
8) Resources at Risk

Methods—The first task will be to use the existing aerial videotapes, flown in 1995 and 1996, to divide the channels and streams that are downstream of the proposed activities into "segments" or "reaches". This initial subdivision will be based on physical characteristics so that each segment will be relatively homogeneous. Each segment will be assigned an alpha-numeric identification which will be unique (e.g., ML-07) to avoid any miscommunication or misunderstanding regarding the location of that segment. Information that can be taken from the videotapes will be entered into the data sheets.

The second task will be to obtain field observations and measurement to ground-truth and expand on the data sets. It is proposed that this field work be carried out with the active participation of the Nuiqsut Oil Spill Response Team and Alaska Clean Seas, as these two groups will be the ultimate users and benefactors of the study. The proposed 1997 field study will involve ten days (August) of data collection and will attempt to complete coverage of the following waterways:

Sakoonang Channel below the proposed Alpine project site
lower Tamayayak Channel below the Sakoonang confluence
Nechelik Channel below the proposed Alpine project site
Kachemach River below the proposed pipeline routing
Miluveach River below the proposed pipeline routing
Colville East Channel below the Kachemach confluence.

If time permits, additional surveys will be carried out in the:

Colville East Channel between the pipeline crossing and the Kachemach confluence, and in the Colville distributary system.

Sections not surveyed in the proposed field program will be surveyed in the summer of 1998.

Field observations and a photographic record will be taken at potential staging sites and control locations. Current and water depth measurements (see Shannon & Wilson scope) will be taken in segments with potential control locations. Upon completion of the field survey, potential staging areas and control points will be reviewed in the context of resources at risk from an oil spill and the potential effects on the environment of the possible response activities. This evaluation will include review of existing terrain and habitat maps and of bird, fish, and subsistence activity data that have been generated to date. All response actions to control the oil and to mitigate the effects of a spill will themselves incur some alteration of the environment and possibly some damage. This next stage will evaluate the trade-offs associated with these possible response options.

The end product will be the identification of a set of practical staging and control points. Each location will be described in terms of:

- the physical character,
- the objectives of operational activities at that location,
- the advantages associated with the site, and
- any constraints that might be appropriate to minimize the effects of staging or operations.

ALPINE DEVELOPMENT PROJECT—1997
SPRING BREAKUP PROGRAM
PROPOSED SCOPE OF WORK

Prepared for ARCO, Alaska, Inc.

by Shannon & Wilson, Inc.

27 May 1997

This program consists of two parts: monitoring spring breakup on the Colville River Delta and monitoring spring breakup at streams within the access corridor that were not monitored last year. On the Colville River Delta, monitoring will include estimating the spring peak discharge at the head of the delta, identifying locations where culverts should probably be placed within the facilities embankment, monitoring the movement and impact of ice jams, and observing the bank stability along the Sakoonang Channel in the vicinity of the proposed facilities. Monitoring in the access corridor will be to obtain data that will be used during design to estimate the design water surface elevation and scour depth at the pipeline crossings, and to identify cross sections to be surveyed at a later time.

Extended Spring Breakup Program—This program will be initiated if discharge is estimated at greater than 220,000 cfs. The purpose of this program is to obtain information to verify the water surface elevation predictions of the 2-D surface water model that has been prepared for the Colville River Delta.

1997 Channel Bathymetry Program—The purpose of this program is to obtain bathymetry data that can be used to determine the depth of the Nechelik Channel. Data will be also collected within the East Channel and in the Sakoonang Channel.

Water Level Recorder Installation & Maintenance Program—Establishment of two water level recorders near the coastline of the Colville River Delta to provide data on water surface elevation for use in estimating the depth of water.

ALPINE DEVELOPMENT PROJECT—1997
WILDLIFE STUDIES
PROPOSED SCOPE OF WORK

Prepared for ARCO, Alaska Inc.

by ABR, Inc.

27 May 1997

The goal of the 1997 wildlife studies on the Colville River delta is unchanged from previous years: to collect data on the abundance, distribution, and habitat use of important wildlife species, for use in the environmental documentation required by the permit process and for use as a baseline for post-development monitoring. Although this overall goal remains the same as in previous years, the technical approach has been modified this year for a few of the species and the geographic areas of interest. Specifically, we have added tasks to: 1) monitor nest density and success of large waterbirds in a zone around the proposed airstrip, 2) monitor annual trends in Spectacled Eiders nesting on the outer delta, and 3) monitor vegetation responses to seismic exploration trails. In addition, we have eliminated the ground searches that were conducted at the ASRC gravel mine site and the ecological land classification program, which was completed this spring. As in 1996, the geographic emphasis of our aerial surveys will be the delta proper and the transportation corridor, which includes the pipeline route to the Kuparuk Oilfield. Below is a brief overview of the preliminary scope of work. This scope of work is under review and will be modified as necessary.

Spectacled Eiders—Similar to 1996, an aerial survey of the pre-nesting distribution of Spectacled Eiders will be conducted during 8-15 June, followed by a ground survey for nests in the facility area in late June. During mid-July, we will conduct ground surveys for Spectacled Eider broods in the proposed facility area. In 1997, we will establish several Spectacled Eider nest plots on the outer delta, where numerous nests were found in 1994 and earlier. We will use these plots to monitor annual trends in numbers of nesting Spectacled Eiders on the delta because their current status on the Arctic Coastal Plain is uncertain.

Other Birds—During the eider ground survey, we also will search for the nests of all large waterbirds (swans, geese, ducks, and loons) and Bar-tailed Godwits, a relatively rare nesting shorebird on the delta. Our searches will focus on the area of the footprint within a 1-km boundary and the approach paths to the airstrip, where noise disturbance from aircraft could affect nesting birds. Follow-up surveys to monitor nest success in these areas will serve as a baseline for post-development monitoring.

Tundra Swans—Aerial surveys will be conducted for Tundra Swans during the nesting, brood-rearing, and fall-staging seasons. The only ground surveys will be conducted in the facility and airstrip areas as part of the eider survey and nest monitoring.

Brant and Other Geese—Aerial surveys will be conducted for Brant during nesting, brood-rearing, and fall-staging. We also will conduct aerial surveys for other goose species during brood-rearing and fall-staging. We will search for all goose nests in the facility and airstrip areas during the eider nest search.

Yellow-billed Loons—We will conduct aerial surveys for Yellow-billed Loons during the nesting and brood-rearing seasons. We will search for nests in the facility and airstrip areas during the eider nest search and will search for broods in the same area in August.

Caribou—We will fly two caribou surveys to record distribution and abundance during the calving season in early to mid-June. These surveys will be coordinated with similar surveys in the Kuparuk Oilfield. An addition to previous years' caribou tasks will be the experimental use of forward-looking infrared imagery (FLIR) mounted on an airplane to locate and count caribou under varying snow conditions. The FLIR program will be conducted concurrently with calving surveys and is a shared effort with the Tarn project. From late June through the end of July, we will be conducting aerial surveys for caribou that move through the study area in response to insect harassment. Surveys will be conducted every day that caribou are present in the study area to keep track of their movements.

Foxes—We will monitor fox dens to determine the number that are active and their litter sizes, based on information collected from a combination of aerial survey and ground visits. We will use the aerial survey to find active dens and the ground visits to these dens to count fox pups.

Spotted Seals—We will conduct aerial surveys for spotted seal haul-out areas during late July, August, and September. The survey period is timed to span the dates when spotted seals occur in the lower Colville River.

Seismic Trail Vegetation Assessment—Visible damage to tundra vegetation from vehicles associated with seismic exploration during the winter of 1995-1996 was observed during the summer of 1996. We will assess the level of vegetation damage and rate of recovery at 24 sites (3 replicates of 4 vegetation types), using photo-trend plots and point sampling along 10-m-long transects.

Appendix S

APPENDIX S

NATIONAL WETLANDS INVENTORY HABITAT EQUIVALENT

National Wetland Inventory (NWI) equivalents for wildlife habitat types (as identified in ARCO's "Alpine Development Project Environmental Evaluation Document") affected by gravel footprints for the proposed Alpine in-field facilities on the Colville River Delta.

Wildlife Habitat Type	**NWI Equivalent**	**NWI Definition**
Shallow Open Water without Islands	PUBH	Palustrine, unconsolidated bottom, permanently flooded
Aquatic Grass Marsh	PEM2H	Palustrine, emergent, nonpersistent, permanently flooded
Nonpatterned Wet Meadow	PEM1E	Palustrine, emergent, persistent, seasonally flooded/saturated
Wet Sedge–Willow Meadow	PSS/EM1E	Palustrine, scrub shrub, broadleaf deciduous, emergent, persistent, seasonally flooded/ saturated
Moist Sedge–Shrub Meadow	PSS/EM1B	Palustrine, scrub shrub, broadleaf deciduous, emergent, persistent, saturated
Riverine or Upland Shrub	PSS1A, PSS1B, and U (upland)	Palustrine, scrub shrub, broadleaf deciduous, temporarily (PSS1A) or seasonally (PSS1B) flooded *[upland shrub habitats also were lumped in this wildlife habitat type for the Alpine environmental analysis]*

Prepared by Janet G. Kidd, ABR, Inc., 14 November 1996.

Alpine EED wildlife habitat types and corresponding NWI code equivalents.

Wildlife Habitat Type	NWI Code	NWI Definition
Open Nearshore Water (coastal marine water)	M1UBL	Marine, subtidal, unconsolidated bottom, subtidal
Brackish Water (deep or shallow)	E1UBL	Estuarine, subtidal, unconsolidated bottom, subtidal
Tapped Lake (deep or shallow) with Low-water Connection	E1UBL	Estuarine, subtidal, unconsolidated bottom, subtidal
Tapped Lake (deep or shallow) with High-water Connection	L1UBH or PUBH	Lacustrine, limnetic, unconsolidated bottom, permanently flooded; or Palustrine, unconsolidated bottom, permanently flooded
Salt Marsh (coastal wetland complex)	E2EM1N	Estuarine, intertidal, emergent, persistent, regularly flooded
Tidal Flat	E2USN	Estuarine, intertidal, unconsolidated shore, regularly flooded
Salt-killed Tundra	E2EM1P	Estuarine, intertidal, emergent, persistent, irregularly flooded
Deep Open Water without Islands	L1UBH	Lacustrine, limnetic, unconsolidated bottom, permanently flooded; or Palustrine, unconsolidated bottom, permanently flooded
Deep Open Water with Islands or Polygonized Margins	L1UBH	Lacustrine, limnetic, unconsolidated bottom, permanently flooded; or Palustrine, unconsolidated bottom, permanently flooded/Palustrine scrub shrub/emergent, persistent, saturated
Shallow Open Water without Islands	PUBH	Palustrine, unconsolidated bottom, permanently flooded
Shallow Open Water with Islands or Polygonized Margins	L1UBH or PUBH	Lacustrine, limnetic, unconsolidated bottom, permanently flooded; or Palustrine, unconsolidated bottom, permanently flooded/Palustrine scrub shrub/emergent, persistent, saturated
River or Stream	R2UBH	Riverine, lower perennial, unconsolidated bottom, permanently flooded
Aquatic Sedge Marsh	PEM1F or PEM1H	Palustrine, emergent, persistent, semipermanently flooded; or Palustrine, emergent, persistent, permanently flooded
Aquatic Sedge with Deep Polygons	PEM1/UBH	Palustrine, emergent, persistent/unconsolidated bottom, permanently flooded
Aquatic Grass Marsh	PEM2H	Palustrine, emergent, nonpersistent, permanently flooded
Young Basin Wetland Complex (ice-poor)	PUBH or PEM1E	Palustrine, emergent, persistent, permanently flooded
Old Basin Wetland Complex (ice-rich)	PUBH or PEMI/UBH or PSS/EM1E or PSS/EM1B or PEM1B	Palustrine, emergent, persistent/unconsolidated bottom, permanently flooded
Nonpatterned Wet Meadow	PEM1E	Palustrine, emergent, persistent, seasonally flooded/saturated
Wet Sedge–Willow Meadow (low-relief polygons)	PSS/EM1E	Palustrine, scrub shrub, broadleaf deciduous, emergent, persistent, seasonally flooded/saturated
Moist Sedge–Shrub Meadow (low- or high-relief polygons)	PSS/EM1B	Palustrine, scrub shrub, broadleaf deciduous, emergent, persistent, saturated
Moist Tussock Tundra (low- or high-relief polygons)	PEM1B	Palustrine, emergent, persistent, saturated
Riverine or Upland Shrub	PSS1A, PSS1B, and *u* (upland)	Palustrine, scrub shrub, broadleaf deciduous, temporarily (PSS1A) or seasonally (PSS1B) flooded [upland shrub habitats also were lumped in this wildlife habitat type for the Alpine environmental analysis]
Barrens (riverine, eolian, lacustrine)	R3USC or L2USC or *u* (upland)	Riverine, lower perennial, unconsolidated shore, seasonally flooded; or Lacustrine, littoral, unconsolidated shore, seasonally flooded; or upland
Artificial (water, fill, peat road)	PUBHh or PUSBs or *u* (upland)	Palustrine, unconsolidated bottom, permanently flooded, impounded; or Palustrine, unconsolidated shore, saturated; or upland

Appendix T

APPENDIX T

USACE PERMIT 2-950364 COLVILLE RIVER 16 ISSUED TO ASCG FOR THE BIA ROAD

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, ALASKA
P.O. BOX 898
ANCHORAGE, ALASKA 99506-0898

REPLY TO ATTENTION OF:

FEBRUARY 01 1996

ASCG Incorporated
301 Arctic Slope Ave.
Suite 200
Anchorage, AK 99518
RECV'D

Regulatory Branch
North Section
2-950364

Mr. Carey S. Meyer, PE
ASCG Incorporated
301 Arctic Slope Avenue, Suite 200
Anchorage, Alaska 99518-3055

Dear Mr. Meyer:

As the authorized agent for the US Bureau of Indian Affairs, enclosed are two copies of Department of the Army permit 2-950364, Colville River 16 , which would authorize the placement of 190,000 cubic yards of fill material for the construction of a 3.8-mile access road from the village of Nuiqsut to the Colville River.

The Alaska Department of Environmental Conservation has issued a Certificate of Reasonable Assurance pursuant to Section 401 of the Clean Water Act for your project and they have found it to be in accordance with the Alaska Water Quality Standards. In addition, the Alaska Division of Governmental Coordination has certified that your project is consistent with the Alaska Coastal Management Program. These certifications are attached to the Department of the Army permit and will become a part of this permit when it is finalized.

If you accept the conditions of the enclosed permit, please sign and date both copies and return them to us. Since this is a federal project, there is no permit fee. The permit will not be valid until we have returned a finalized copy of the permit to you. No work is to be performed in the waterway or adjacent wetlands until you have received a finalized copy of the permit.

Nothing in this letter shall be construed as excusing you from compliance with other Federal, State, or local statutes, ordinances, or regulations which may affect this work.

Please contact me at 753-2716, or at the address above, if you have questions concerning this matter.

Sincerely,

Lloyd H. Fanter

Lloyd H. Fanter
Project Manager

Enclosure

e. Damage claims associated with any future modification, suspension, or revocation of this permit.

4. Reliance on Applicant's Data: The determination of this office that issuance of this permit is not contrary to the public interest was made in reliance on the information you provided.

5. Reevaluation of Permit Decision. This office may reevaluate its decision on this permit at any time the circumstances warrant. Circumstances that could require a reevaluation include, but are not limited to, the following:

a. You fail to comply with the terms and conditions of this permit.

b. The information provided by you in support of your permit application proves to have been false, incomplete, or inaccurate (See 4 above).

c. Significant new information surfaces which this office did not consider in reaching the original public interest decision.

Such a reevaluation may result in a determination that it is appropriate to use the suspension, modification, and revocation procedures contained in 33 CFR 325.7 or enforcement procedures such as those contained in 33 CFR 326.4 and 326.5. The referenced enforcement procedures provide for the issuance of an administrative order requiring you to comply with the terms and conditions of your permit and for the initiation of legal action where appropriate. You will be required to pay for any corrective measures ordered by this office, and if you fail to comply with such directive, this office may in certain situations (such as those specified in 33 CFR 209.170) accomplish the corrective measures by contract or otherwise and bill you for the cost.

6. Extensions. General condition 1 establishes a time limit for the completion of the activity authorized by this permit. Unless there are circumstances requiring either a prompt completion of the authorized activity or a reevaluation of the public interest decision, the Corps will normally give favorable consideration to a request for an extension of this time limit.

Your signature below, as permittee, indicates that you accept and agree to comply with the terms and conditions of this permit.

(PERMITTEE) AND TITLE (DATE)

This permit becomes effective when the Federal official, designated to act for the Secretary of the Army, has signed below.

FOR (DISTRICT ENGINEER) (DATE)

When the structures or work authorized by this permit are still in existence at the time the property is transferred, the terms and conditions of this permit will continue to be binding on the new owner(s) of the property. To validate the transfer of this permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below.

(TRANSFEREE) (DATE)

*U.S. GOVERNMENT PRINTING OFFICE: 1986 — 717-425

DEPARTMENT OF THE ARMY PERMIT

Permittee U.S. Bureau of Indian Affairs

Permit No. 2-950364, Colville River 16

Issuing Office U.S. Army Engineer District

NOTE: The term "you" and its derivatives, as used in this permit, means the permittee or any future transferee. The term "this office" refers to the appropriate district or division office of the Corps of Engineers having jurisdiction over the permitted activity or the appropriate official of that office acting under the authority of the commanding officer.

You are authorized to perform work in accordance with the terms and conditions specified below.

Project Description: The project work consists of winter placement of 190,00 cubic yards of fill material in 26 acres of wetlands and floodplains for a 3.8 mile road from the village of Nuiqsut to the Colville River. Typical road cross-section footprint is 50 feet with a 30-foot crown width. The road height is approximately 3-foot high with a layer of insulation with 3H:1V side slopes. Three major culverts are included for stream crossings.

All work shall be conducted in accordance with the attached plans, 6 sheets dated July and September 1995.

Project Location: The proposed project is located in sections 13, 24, and 25 of T. 10 N., R. 4 E., sections 18, 19, 30 and 31 of T. 10 N., R. 5 E., and sections 6 and 7 of T. 9 N., R. 4 E., Umiat Meridian.

Permit Conditions:

General Conditions:

1. The time limit for completing the work authorized ends on January 30, 1999. If you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.

2. You must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of this permit from this office, which may require restoration of the area.

3. If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and state coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

4. If you sell the property associated with this permit, you must obtain the signature of the new owner in the space provided and forward a copy of the permit to this office to validate the transfer of this authorization.

5. If a conditioned water quality certification has been issued for your project, you must comply with the conditions specified in the certification as special conditions to this permit. For your convenience, a copy of the certification is attached if it contains such conditions.

6. You must allow representatives from this office to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished in accordance with the terms and conditions of your permit.

Special Conditions:

1. Activities associated with this project shall be restricted to the period 15 August to 15-May to avoid impacts to spectacled eiders. Modifications to this schedule must preceded by consultation with the Fish and Wildlife Service and will be subject to terms and conditions recommended by the Service for protection of the spectacled eiders

Continued on 2A

Further Information:

1. Congressional Authorities: You have been authorized to undertake the activity described above pursuant to:

( ) Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403).

( ) Section 404 of the Clean Water Act (33 U.S.C. 1344).

( ) Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (33 U.S.C. 1413).

2. Limits of this authorization.

a. This permit does not obviate the need to obtain other Federal, state, or local authorizations required by law.

b. This permit does not grant any property rights or exclusive privileges.

c. This permit does not authorize any injury to the property or rights of others.

d. This permit does not authorize interference with any existing or proposed Federal project.

3. Limits of Federal Liability. In issuing this permit, the Federal Government does not assume any liability for the following:

a. Damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes.

b. Damages to the permitted project or uses thereof as a result of current or future activities undertaken by or on behalf of the United States in the public interest.

c. Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity authorized by this permit.

d. Design or construction deficiencies associated with the permitted work.

Special Conditions Continued

2. The road alignment shall minimize placement of fill in riparian willow (*Salix* spp.) stands and streams.

3. Natural drainage patterns shall be maintained to the extent practicable by the installation of culverts in sufficient number and size to prevent ponding. Culverts shall be installed and maintained so that operate efficiently for the lifetime of the project.

4. All heavy equipment operation will be confined to the project footprint to prevent unnecessary damage to the insulating layer of vegetation in wetlands that protects the permafrost in adjacent areas.

Special Information:

Any condition incorporated by reference into this permit by Special Condition or General Condition 5, remains a condition of this permit unless expressly modified or deleted, in writing, by the District Engineer or his authorized representative.

TONY KNOWLES, GOVERNOR

STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

HABITAT & RESTORATION DIVISION

1300 COLLEGE ROAD
FAIRBANKS, ALASKA 99701-15
PHONE: (907) 459-7289
FAX: (907) 456-3091

June 6, 1995

JUN 1995
ASCG Incorporated
301 Arctic Slope Ave.
Suite 200
Anchorage, AK 99518
RECV'D

Mr. Nicholas Boerger, PE
Transportation Engineer
ASCG Incorporated
301 Arctic Slope Avenue, Suite 200
Anchorage, AK 99518-3035

Dear Mr. Boerger

RE: Nuiqsut/Colville River Access Road

The Alaska Department of Fish and Game Habitat and Restoration Division has reviewed the environmental assessment for the Colville River access road project. We support the proposed extension of the existing road system to the Colville River. We feel this alternative will provide access to the river while eliminating the need for additional instream dredging which has the potential to disturb aquatic habitat used by freshwater and anadromous fish. The proposed project will use existing gravel resources stockpiled from channel dredging.

It should be noted that the three stream systems crossed by the road system are likely to contain fish. Drainage structures at these crossings will require fish passage permits from the Alaska Department of Fish and Game.

Sincerely,

Alvin G. Ott
Regional Supervisor
Habitat and Restoration

cc: Nancy Welch, ADNR, Fairbanks
Patrick Sousa, USFWS, Fairbanks
Keith Quintavell, NSB, Barrow
John Burr, ADF&G/SF, Fairbanks
Terry Haynes, ADF&G, Fairbanks
Pete McGee, ADEC, Fairbanks

AGO/crh

TONY KNOWLES, GOVERNOR

STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

HABITAT & RESTORATION DIVISION

1300 COLLEGE ROAD
FAIRBANKS, ALASKA 99701-1599
PHONE: (907) 459-7289
FAX: (907) 456-3091

FISH HABITAT PERMIT

FG95-III-0207

ISSUED: August 4, 1995
EXPIRES: December 31, 1998

Mr. Carey Meyer
ASCG Incorporated
301 Arctic Slope Avenue, Suite 200
Anchorage, AK 99518-3035

Dear Mr. Meyer:

RE: Culvert Installation; Three Unnamed Tributaries to the Colville River; Section 6, T9N, R5E, UM; Section 25, T10N, R4E, UM; Section 31, T10N, R5E, UM.

Pursuant to AS 16.05.840, the Alaska Department of Fish and Game (ADF&G) has reviewed the proposal submitted by you on behalf of the U.S. Bureau of Indian Affairs to install a single 10-foot diameter corrugated steel culvert at the referenced locations. The culverts will be installed in conjunction with construction of a 3.8 mile gravel road from the existing Nuiqsut fresh water lake road to the Colville River. In-water construction activities will occur during the winter months. No stream diversions will be required. A complete description of the proposed project was provided to the ADF&G by letter dated July 31, 1995, and by copy of the Army Corps of Engineers Public Notice Colville River 16 dated August 2, 1995 (enclosed).

The unnamed streams support resident fish species in the area of your proposed activity. In addition they are believed to seasonally support anadromous whitefish and Dolly varden which are present in the adjoining Colville River. However, to date, these streams have not been cataloged or legally designated under AS 16.05.870(a). Based upon our review of your plans, your proposed project has the potential to obstruct the efficient passage and movement of fish.

In accordance with AS 16.05.840, project approval is hereby given subject to your proposed scope of work and the following stipulations:

(1) Each culvert shall be constructed, operated, and maintained for the life of the structure(s) in accordance with the terms of this permit such that free passage of fish is assured. Any obstruction to the free passage of fish (e.g., perched culvert, outwash gravels, excessive water velocities) shall be restored to the satisfaction of the ADF&G;

(2) Locations for culvert installation shall be properly located and staked prior to winter construction to facilitate accurate location after snow cover and drift occurs; and

(3) Culvert inverts shall be depressed 18 inches below the stream thalweg elevation and shall be sloped to match the existing stream channel.

The permittee is responsible for the actions of contractors, agents, or other persons who perform work to accomplish the approved plan. For any activity that significantly deviates from the approved plan, the permittee shall notify the ADF&G and obtain written approval in the form of a permit amendment before beginning the activity. Any action taken by the permittee, or an agent of the permittee, that increases the project's overall scope or that negates, alters, or minimizes the intent or effectiveness of any stipulation contained in this permit will be deemed a significant deviation from the approved plan. The final determination as to the significance of any deviation and the need for a permit amendment is the responsibility of the ADF&G. Therefore, it is recommended that the ADF&G be consulted immediately when a deviation from the approved plan is being considered.

This letter constitutes a permit issued under the authority of AS 16.05.840. This permit must be retained on site during construction. Please be advised that this approval does not relieve you of the responsibility of securing other permits, state, federal or local.

This permit provides reasonable notice from the commissioner that failure to meet its terms and conditions constitutes violation of AS 16.05.860; no separate notice under AS 16.05.860 is required before citation for violation of AS 16.05.840 can occur.

Pursuant to 6 AAC 80.010(b), the conditions of this permit are consistent with the Standards of the Alaska Coastal Management Program and the North Slope Borough Coastal District Program (specifically General Concurrence GC-7).

In addition to the penalties provided by law, this permit may be terminated or revoked for failure to comply with its provisions or failure to comply with applicable statutes and regulations. The department reserves the right to require mitigation measures to correct disruption to fish and game created by the project and which were a direct result of the failure to comply with this permit or any applicable law.

The recipient of this permit (permittee) shall indemnify, save harmless, and defend the department, its agents and its employees from any and all claims, actions or liabilities for injuries or damages sustained by any person or property arising directly or indirectly from permitted activities or the permittee's performance under this permit. However, this provision has no effect, if, and only if, the sole proximate cause of the injury is the department's negligence.

Sincerely,

David Benton, Deputy Commissioner

Phyllis Weber Scannell

BY: Alvin G. Ott, Regional Supervisor
for Habitat and Restoration Division
Alaska Department of Fish and Game

Enclosure:

cc: w/o enclosure
Nancy Welch, ADNR, Fairbanks
Pete McGee, ADEC, Fairbanks
Don Kohler, ACOE, Anchorage
Patrick Sousa, USFWS, Fairbanks
Molly Birnbaum, SPCO/DGC, Anchorage
Keith Quintavell, NSB, Barrow
Fred Andersen, ADF&G, Fairbanks
Keith Schultz, ADF&G, Fairbanks
Terry Haynes, ADF&G, Fairbanks
Carl Hemming, ADF&G, Fairbanks

AGO/BM

TONY KNOWLES, GOVERNOR

OFFICE OF THE GOVERNOR

OFFICE OF MANAGEMENT AND BUDGET
DIVISION OF GOVERNMENTAL COORDINATION

SOUTHCENTRAL REGIONAL OFFICE
3601 "C" STREET, SUITE 370
ANCHORAGE, AK 99503-5930
PH: (907)269-7470/FAX: (907)561-6134

CENTRAL OFFICE
P.O. BOX 110030
JUNEAU, ALASKA 99811-0030
PH: (907) 465-3562/FAX: (907) 465-3075

PIPELINE COORINDATOR'S OFFICE
411 WEST 4TH AVENUE, SUITE 2C
ANCHORAGE, ALASKA 99501-2343
PH: (907) 271-4336/FAX: (907) 272-0690

December 26, 1995

Carey Meyer
ASCG Incorporated
301 Arctic Slope Avenue
Anchorage, AK 99518-3035

Dear Mr. Meyer:

Subject: <u>FINAL CONSISTENCY DETERMINATION</u>
Colville River 16
STATE I.D. NUMBER AK9505-52AA

The Division of Governmental Coordination (DGC) has completed coordinating the State's review of this Bureau of Indian Affairs' project for consistency with the Alaska Coastal Management Program (ACMP). On December 15th you were issued a proposed consistency finding for this project.

The project is to construct approximately 4.0 miles of gravel road from the existing fresh water lake road, proceeding southerly along the western bluff of the Colville River. Construction of the 3' high road will require the discharge of approximately 190,000 cy of fill material on approximately 26 acres of wetlands/waters of the U.S. Typical road cross-section consists of a 48' footprint, with a 30' crown width and side slopes of 3:1. The proposed roadway will include three 10' diameter culverts and 25 2-3' culverts for stream crossings and to maintain drainage patterns.

The purpose of the project is to provide an access road from the Village of Nuiqsut to the Colville River to allow consistent boat access to the main channel of the Colville River. During the summer it will promote barge service to Nuiqsut. During the winter, in combination with ice roads from the Colville River to Oliktuk Point, it will connect with existing gravel roads, to provide an alternative winter route for supplies and bulky equipment. The roadway will provide year-round access to the Colville River for commercial, subsistence and recreational use.

The road will terminate in a cul-de-sac atop the bank of the Colville River. The construction of a ramp down from the river and an off-loading facility will be the responsibility of others.

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Mitigation measures include three culverted stream crossings to maintain hydrology and reduce impacts to the aquatic environment, winter construction to minimize construction impacts and the use of insulation in the roadway to minimize gravel quantities and reduce the fill footprint.

The project is located at T. 10 N., R. 4 E., Sections 13, 24 and 25; T. 10 N., R. 5 E., sections 18, 19, 30 and 31 and; T. 9 N., R 5 E., Sections 6 and 7, Umiat Meridian, near the Village of Nuiqsut.

This final consistency determination, developed under 6 AAC 50, applies to the following State and federal authorizations:

U.S. Army Corps of Engineers (COE)
Sections 10 & 404
Permit No. 2-950364

Alaska Department of Environmental Conservation (DEC)
Section 401
Certificate of Reasonable Assurance

Alaska Department of Fish and Game (DFG)
Fish Habitat Permit

Your project was reviewed for consistency by the Alaska Departments of Natural Resources, Environmental Conservation, and Fish and Game, and the North Slope Borough. Based on modifications to your project that represent a consensus between you and the State, as provided for under 6 AAC 50.070(k), the State concurs with your certification that the project is consistent with the ACMP. These modifications will appear as stipulations on the State permits noted:

1. The fill material shall be placed in a layer at least four feet thick, and if less than four feet of fill is used, Typar material must be placed before sufficient amount of fill be placed on the ground and have a ratio with maximum side slopes of 2:1 (horizontal:vertical).

   RATIONALE: This measure is necessary to protect the integrity of the permafrost and /or the natural contour of the land surface from degrading. (6 AAC 80.140. Air, Land, and Water Quality)

2. Natural drainage patterns shall be maintained in the area by the installation of drainage structures of adequate number and size to prevent flooding or excessive drainage of

adjacent wetlands.

RATIONALE: The intent of this stipulation is to assure adequate drainage of the area to be filled and to protect the water quality of the Colville River and adjacent wetlands. (6 AAC 80.140. Air, Land, and Water Quality)

3. All fill and equipment operation shall remain within the footprint of the project.

   RATIONALE: The intent of this stipulation is to minimize the loss of wetlands, prevent unnecessary damage to the insulating vegetation layer and to protect the water quality of the Colville River and adjacent wetlands. (6 AAC 80.140. Air, Land, and Water Quality)

4. All cuts, fills stockpiles and disturbed areas shall be stabilized to minimize erosion and subsequent sedimentation of streams and wetlands. Runoff during construction may need to be controlled to prevent sediments from entering wetlands and other surface water bodies.

   RATIONALE: The intent of this stipulation is to protect the water quality of the Colville River and adjacent wetlands by preventing erosion. (6 AAC 80.140. Air, Land, and Water Quality)

5. Any potential fuel storage areas on or near the road terminus should be lined and bermed in accordance with 18 AAC 75, Oil and Hazardous Substances Pollution Control. A copy of these regulations can be obtained by contacting Mr. Bill Smyth in the Public Service Area Office at the Department of Environmental Conservation, 610 University Avenue, Fairbanks, Alaska 99809-3643.

   RATIONALE: The intent of this stipulation is to protect the water quality of the adjacent wetlands and the Colville River from hydrocarbon contamination. (6 AAC 80.140. Air, Land, and Water Quality)

Copies of the applicable ACMP statewide standards and district policies were previously provided.

As provided under 15 CFR 930.64(c), federal authorization of your project will be made with the full understanding that your original project proposal has been modified as described above.

If changes to the approved project are proposed prior to or during its siting, construction, or operation, you are required to contact this office immediately to determine if further review and approval of the revised project is necessary.

The State reserves the right to enforce compliance with this final consistency finding if the project is changed in any significant way, or if the actual use differs from the approved use contained in the project description. If appropriate, the State may amend the State approvals listed in this final consistency finding.

Other Concerns/Advisories:
The Department of Natural Resources, Office of History and Archaeology reviewed the Environmental Assessment for this project and commented that the word "dig" should be deleted from line 2, page 12.

If cultural or paleontological resources are discovered as a result of this activity, we request that work which would disturb such resources be stopped and that the State Historic Preservation Office (762-2626) and the U.S. Army Corps of Engineers (COE) (753-2712) be contacted immediately so that consultation per section 106 of the National Historic Preservation Act may proceed.

Please be advised that although the State has found your project consistent with the ACMP, based on your project description and any stipulations contained herein, you are still required to meet all applicable State and federal laws and regulations. Your consistency determination may include reference to specific laws and regulations, but this in no way precludes your responsibility to comply with other applicable laws and regulations.

By a copy of this letter we are informing the COE of our determination.

If you have questions regarding this determination, please contact me at 269-7475.

Sincerely,

Arlene Murphy

Arlene Murphy
Project Review Coordinator

cc: Lloyd Fanter, COE
Tim Wingerter, DEC
Michele Jesperson, DNR, SHPO
Dee Olin Hoffman, NSB
City of Kaktovik
Al Ott, DFG
Judy Chapman, DNR
Edward Hopson, ASRC
Dee Ritchie, BLM
Bureau of Indian Affairs, Juneau

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DEPT. OF ENVIRONMENTAL CONSERVATION

DIVISION OF AIR AND WATER QUALITY
Major Facilities and Water Permits Section
410 Willoughby Avenue, Suite 105
Juneau, AK 99801-1795

Telephone: (907) 465-5276
Fax: (907) 465-5274
TTY: (907) 465-5133

NRO File: 950364

September 26, 1995

Mr. Boerger
ASCG, Inc.
301 Arctic Slope Avenue
Anchorage, AK 99518-3035

Certified Mail
Return Receipt Requested
P 990 954 267

Re: Certificate of Reasonable Assurance, Colville River 16

Dear Mr. Boerger:

In accordance with Section 401 of the Clean Water Act of 1977 and provisions of the Alaska Water Quality Standards, the Department of Environmental Conservation is issuing the enclosed Certificate of Reasonable Assurance for the proposed construction of approximately 3.8 miles of gravel access road to provide consistent boat access to the main channel of the Colville River, promote summer barge service to Nuiqsut, and provide an alternative winter route for supplies and bulky equipment.

Department of Environmental Conservation regulations provide that any person who disagrees with any portion of this decision may request an adjudicatory hearing in accordance with 18 AAC 15.200-310. The request should be hand-delivered or mailed to the Commissioner of the Department of Environmental Conservation, 410 Willoughby Avenue, Juneau, Alaska 99801-1795. Failure to file a statement of issues within 30 days of receipt of this letter shall constitute a waiver of your right to judicial review of this decision.

By copy of this letter we are advising the U.S. Army Corps of Engineers of our actions and enclosing a copy of the certificate for their use.

Sincerely,

David C. Sturdevant

David C. Sturdevant
401 Certification Team Leader

Enclosure: Certificate of Reasonable Assurance

cc: USCOE/Anchorage
USFWS/Fairbanks
EPA/AOO
NMFS/Juneau
ADEC/Juneau
ADNR/Fairbanks
ADF&G/Fairbanks
ADEC/Fairbanks
Village of Nuiqsut, c/o BIA, P.O. Box 25520, Juneau, AK 99802-5520

/rg {K:\EQ\401\Batch3.pmt}

STATE OF ALASKA

DEPARTMENT OF ENVIRONMENTAL CONSERVATION

CERTIFICATE OF REASONABLE ASSURANCE

This Certificate of Reasonable Assurance, in accordance with Section 401 of the federal Clean Water Act and the Alaska Water Quality Standards, is issued to Mr. Boerger, ASCG, Inc., 301 Arctic Slope Avenue, Anchorage, AK 99518-3035, for the proposed construction of approximately 3.8 miles of gravel access road to provide consistent boat access to the main channel of the Colville River, promote summer barge service to Nuiqsut, and provide an alternative winter route for supplies and bulky equipment.

In order to prevent and minimize present and future pollution, when making management decisions that effect waste generation, the permittee shall consider the following order of priority options as outlined in AS 46.06.021, which include waste source reduction, recycling of waste, waste treatment, and waste disposal.

Public Notice of the application for this certification has been made in accordance with 18 AAC 15.140.

Water Quality Certification is required for the proposed activity because the activity will be authorized by a Department of the Army permit identified as Colville River 16, 950364, and a discharge may result from the proposed activity.

Having reviewed the application and comments received in response to the public notice, the Alaska Department of Environmental Conservation certifies that there is reasonable assurance that the proposed activity, as well as any discharge which may result, is in compliance with the requirements of Section 401 of the Clean Water Act and the Alaska Water Quality Standards, 18 AAC 70, provided that:

1) Natural drainage patterns shall be maintained in the area by the installation of drainage structures of adequate number and size to prevent flooding or excessive drainage of adjacent wetlands.

   Rationale: The intent of this stipulation is to assure adequate drainage of the area to be filled and to protect the water quality of the Colville River and adjacent wetlands. (18 AAC 70 Alaska Water Quality Standards).

2) All fill and equipment operation shall remain within the footprint of the project.

   Rationale: The intent of this stipulation is to minimize the loss of wetlands, prevent unnecessary damage to the insulating vegetation layer and to protect the water quality of the Colville River and adjacent wetlands (18 AAC 70 Alaska Water Quality Standards).

3) All cuts, fills stockpiles and disturbed areas shall be stabilized to minimize erosion and subsequent sedimentation of streams and wetlands. Runoff during construction may need to be controlled to prevent sediments from entering wetlands and other surface water bodies.

   Rationale: The intent of the stipulation is to protect the water quality of the Colville River and adjacent wetlands by preventing erosion (18 AAC 70 Alaska Water Quality Standards).

4) Any potential fuel storage areas on or near the road terminus should be lined and bermed in accordance with 18 AAC 75, Oil and Hazardous Substances Pollution Control. A copy of these regulations can be obtained by contacting Mr. Bill Smyth in the Public Service Area Office at the Department of Environmental Conservation, 610 University Avenue, Fairbanks, Alaska 99709-3643, Phone No.451-2360.

Rationale; The intent of this stipulation is to protect the water quality of the adjacent wetlands and the Colville River from hydrocarbon contamination, (18 AAC 70 Alaska Water Quality Standards).

September 26, 1995
Date

David C Sturdevant
David C. Sturdevant
401 Certification Team Leader

Appendix U

APPENDIX U

RIGHT OF WAY PERMIT APPLICATION FOR ALPINE DEVELOPMENT

ARCO Alaska, Inc.
Post Office Box 100360
Anchorage Alaska 99510-0360
Telephone 907 276 1215

August 15, 1997

To: Distribution

Re: ARCO Alaska, Inc.
Kuparuk River Unit
Tarn Project Application

ARCO Alaska, Inc. (AAI) requests approval for the construction of two drill sites and access road near the Kuparuk River Unit for the development of the Tarn Project. Enclosed is a plan of operations, environmental evaluation, and associated permit application forms. Application fees will be forwarded to individual agencies at a later date.

AAI is seeking approval to begin construction activities in late November of 1997. The proposed drill sites (DS 2L and DS 2N) are outside the current Kuparuk River Unit boundaries; however, AAI is preparing an application to extend the unit boundaries to include the Tarn Project.

Please contact the Kuparuk Environmental Department at 265-1173 if there are any questions regarding this application or by electronic mail at lpekich@mail.arco.com.

Sincerely,

Lisa L. Pekich

Lisa L. Pekich
Environmental Coordinator

Distribution List
Kuparuk River Unit
Tarn Project

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Jeanne Hanson
National Marine Fisheries Services
222 W. 7th AVenue #43
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Jon Dunham
North Slope Borough
P.O. Box 69
Barrow, AK 99723

Commissioners
Alaska Oil and Gas Conservation Commission
3001 Porcupine Dr.
Anchorage, AK 99501

Commander (oan)
17th Coast Guard District
P.O. Box 25517
Juneau, Alaska 99802-5517

ARCO Alaska, Inc.
Kuparuk River Unit
Tarn Project

Plan of Operations

Applicant: ARCO Alaska, Inc. (AAI), Post Office Box 100360, Anchorage, Alaska 99510-0360. Point of Contact: Lisa L. Pekich, Environmental Coordinator, Kuparuk Environmental Department, telephone: (907)265-1173, FAX (907)263-4035.

Location: Sections 28, 33, and 34 Township 11 North, Range 8 East. Sections 4, 5, 7, 8, and 18 Township 10 North, Range 8 East. Sections 13, 14, 23, 22, 27, and 34 Township 10 North, Range 7 East. Section 3 Township 9 North, Range 7 East. North Slope Borough, Alaska. The proposed Drillsite 2L is located approximately 6.2 miles from the existing Drillsite 2M on the Kuparuk River Unit. The proposed Drillsite 2N is located approximately 2.9 miles from proposed DS 2L and 8.3 miles from the existing Drillsite 2M on the Kuparuk River Unit. AAI is preparing an application to the State of Alaska to expand the Kuparuk River Unit to include the proposed facilities.

Work: AAI proposes placement of 505,670 cubic yards (cy) of gravel fill material into 72.8 acres of waters of the United States (U.S.), including wetlands, to construct two drillsites, an access road, pipelines and powerlines in the Kuparuk River Unit for oil and gas production:

	acreage	cubic yards	top of pad dimensions
1. Drillsite 2L access road from DS 2M	41.2	285,600	30' x 37,800'
2. Drillsite 2L	8.1	63,040	320' x 985'
3. Drillsite 2N access road (from DS 2L)	16.8	105,600	30' x 15,200'
4. Drillsite 2N	6.7	51,430	240' x 1070'
Total	72.8	505,670	

Note: Gravel road depth varies from 4.0' to 6.0'; an average depth of 4.8' was used to calculate fill quantities. Acreage includes area covered by gravel pad side-slopes. All volume is final grade estimate. DS 2L access road includes gravel fill at bridge crossings.

Purpose and Need: AAI's purpose for placement of fill material is to: construct access to positions (drill sites) which can be supported from the Kuparuk River Unit and to transport oil, gas and water produced from the Tarn reservoir to the Kuparuk Central Production Facility #2 (CPF-2) for processing. Sales quality crude will then be transported from CPF-2 by the Kuparuk Pipeline to the Trans-Alaska Pipeline and ultimately to market. Injection fluids from Kuparuk will be transported to the proposed drill sites by a pipeline. Since the oil will be processed at CPF-2, the drill sites do not require 24-hour operator manned oversight; however, year-round access is required to allow for daily operation checks and well maintenance. The proposed drill sites will be operated by the Kuparuk River Unit.

Additional Information: Initial signs of oil in this area were first noted in the Bermuda well in 1991. A subsequent three well exploration program in early 1997 confirmed the oil accumulation was economic to develop. Current estimated reserve is estimated in the 30-40 million barrels of oil. At peak production, Tarn Development will add 10,000 to 20,000 barrels of oil per day to KRU production. The current KRU production is approximately 300,000 barrels per day.

Drillsite 2L and 2N Development Schedule. AAI proposes to construct the gravel facilities, pipelines and powerlines during the winter of 1997-98. Drilling operations are proposed to commence during April 1998. Optimal production start-up is during 1998. Construction of drillsite facilities will occur concurrently with drilling operations.

Drillsite Design and Facilities. DS 2L is located approximately 2.9 miles north of DS 2N and 6.2 miles southwest of DS 2M. The proposed drill site is designed to accommodate 15 wells on 30' spacing. The proposed gravel pad measures 320' by 985' (8.1 acres). The gravel pad will be constructed of five feet of gravel fill. The estimated volume of gravel fill required for DS 2L is 63,040 cubic yards. DS 2L was sized to provide additional storage space for drilling and construction materials. AAI is evaluating the material storage space requirements in order to minimize the gravel footprint. The proposed size of 8.1 acres was determined to be the maximum space requirements at this time. (See Drawing No. CEA-R1XX-3947.)

DS 2N is located approximately 8.3 miles southwest of DS 2M. It is estimated 25 wells on 30' spacing will be drilled from DS 2N. The proposed drillsite will consist of a gravel pad approximately 240' by 1070' (6.7 acres). The gravel pad will be at least five feet thick. The estimate volume of gravel fill required for DS 2N is 51.430 cubic yards. AAI proposes 30' spacing to accommodate future in-fill drilling at 15' spacing should additional reserves be identified during development. (See Drawing No. CEA-R1XX-3947.)

The surface facilities currently planned for both drillsites are: metering skid, emergency shut-down module, electrical control room module, trunk and lateral piping, well head shelters, and chemical injection skid. These facilities will be typical of other Kuparuk drillsite facilities. Space on the gravel pads will be provided for drill site facilities, wellhead shelters, area for rig movement, drilling material storage, and well work equipment. No reserve pits will be constructed. At this time, no processing of the production fluids is planned at DS 2L and 2N. However, AAI may install facilities for gas separation at one of the proposed drill sites in the future.

The drillsite locations were optimized to allow development of the reserves discovered in the 1997 exploration season and other potential areas of interest to the north and south shown by the 3D seismic data. Additional 3D data was collected during the spring of 1997 to identify any other potential accumulations in the area.

Production and Miscible Injectant (MI) Gas Pipelines. A 16" pipeline will be constructed to transport produced fluids (crude oil, gas and water) to DS 2M. A 8" MI gas line from DS 2M to project area will be constructed on the same pipe rack. The pipelines will be elevated on VSMs at least five feet above the tundra to mitigate impacts to caribou passage. At the Miluveach River crossing, the pipeline will be maintained at the same elevation thus providing higher pipe height across the stream and adjacent riparian habitat. The VSMs are designed to accommodate four pipelines to allow for the two proposed pipelines and two future pipeline installations.

Pipeline Route. The pipeline route will parallel the proposed road route as much as possible. The pipelines will be constructed at least 450 feet away from the road to minimize caribou disturbance and to prevent excessive snow accumulation. A maximum separation distance of 1000' will be maintained to allow visual surveillance from the road.

Access Road. The proposed road route joins DS 2M to DS 2L and DS 2N. The entire route is approximately 10.03 miles long (See Drawing No. CEA-R1XX-3937 and 3938). The route chosen for the road provides the least amount of disturbance to wetlands. The road will have a crown width of 30 feet, and have a minimum gravel thickness of 4 feet with 2:1 side slopes. (See Drawing No. CEA-R1XX-3939) Estimated average gravel thickness is 4.8' based on field surveys of the proposed alignment. An estimated 391,200 cubic yards of gravel will be required to cover 58.0 acres of tundra. Vehicle traffic is expected to be about five vehicles per hour ding construction and four vehicles per day after construction.

The northern portion of the route will go directly through the existing West Sak 15 drill site. The West Sak 15 drillsite is 2.0 miles from DS 2M along the proposed route. The existing gravel pad is approximately 450' by 300'. This site was evaluated in 1993 by Woodward-Clyde and AAI as part of the Inactive Reserve Pit Program. The environmental information collected during that is presented in Appendix A. The construction of the Tarn road through West Sak 15 allows consolidation of gravel facilities. The existing gravel pad will be utilized as a construction staging area. After construction is complete, the site will be rehabilitated to the approval of the agencies. A proposed rehabilitation plan and a schedule of activities at this site is included in Appendix B.

Hydrology Studies. A field study was conducted during the 1997 spring breakup. Data on water surface elevation, velocity and hydrologic condition were collected at Trouble Creek, Miluveach River, Miluveach River Tributary, and Kachemach River Tributary No. 1. Additionally, the road corridor was walked to identify other drainage features for consideration during design. In general, flow begins on top of a snow filled channel. As the flow increases it cuts through the snow to the bottom of the channel. For this reason, the peak water surface elevation does not always coincide with the peak discharge. It appeared that the flood peaks observed during the 1997 spring breakup were comparable to the 2- to 5-year flood peak discharge. Data from 11 north slope streams, which have been gauged for 5 to 26 years, were used to develop a set of regional regression equations to predict flood peak discharge frequency and magnitude for project design.

Of special interest are Trouble Creek, Miluveach River, Miluveach River Tributary and Kachemach River Tributary No. 1. Trouble Creek is estimated to have a drainage area of approximately 7.3 square miles, above the proposed road alignment, and a 50-year flood peak discharge of 613 cfs. The Miluveach River is estimated to have a drainage area of approximately 107 square miles, above the proposed road alignment, and a 50-year peak discharge of 6410 cfs. The Miluveach River Tributary is estimated to have a drainage area of approximately 4.2 square miles, above the proposed road alignment, and a 50-year peak discharge of 380 cfs. The Kachemach River Tributary No. 1 is estimated to have a drainage basin area of 5.8 square miles, above the proposed road alignment, and a 50-year flood peak discharge of 977 cfs. The data report is available from AAI upon request.

Culvert Placement. The proposed road route crosses several drainage features; the largest being the Miluveach River. A bridge will be constructed at this crossing location. The drainage directly to the west of DS 2M, "Trouble Creek" will also be crossed with a bridge. These bridges are discussed in the following section. Throughout the remainder of the road route, numerous culverts will be placed in the road to maintain natural surface drainage patterns. Culvert locations have been optimized using 1994 aerial photography and site inspections by the design engineers during break-up.

Other than the Miluveach River and Trouble Creek, the Alaska Department of Fish and Game have identified three other locations that may be fish streams: a tributary to the Miluveach, and two tributaries to the Kachemach River. Fish studies are being conducted this summer to determine fish use in these areas. All fish stream crossings will be designed as specified in Stream Crossing Design Procedure for Fish Streams on the North Slope Coastal Plain (McDonald, et al., 1984). Permanent culverts will be installed prior to break-up in 1998. No temporary culverts will be installed. (See Drawing No. CEA-R1XX-3940 through 3944).

Miluveach River and Unnamed Creek (Trouble Creek) Road Crossings. Bridge crossings are proposed at both Trouble Creek and the Miluveach River. The proposed crossing sites and crossing structure configurations were determined based on several field visits, topographic surveys, and engineering analyses to minimize impacts to streams and roadway approaches. The proposed bridges will be supported by approximately 26-inch and 30-inch diameter steel piles, and will include steel sheet pile cell abutments to retain road fill and protect the bridge abutments from ice and erosion. Erosion protection will be provided along a portion of the roadway. The finished bridges are expected to look and function similar to the 12-year-old Central Creek Bridge at Milne Point.

The two similar bridge superstructures will consist of multiple, steel wide-flange girders in 40-ft. span configurations. The bridge decks will consist of precast concrete deck panels. The girders, panels, and foundation piles will be designed for drill rig type loads. The bottom chord of the bridges will be set a minimum of 3-ft. above the 100-year flood elevations. In stream bridge piers will be designed for expected ice conditions.

The Trouble Creek bridge is proposed as a single-span 40-ft. bridge. With the addition of the sheet pile abutments, the minimum clear opening for stream flow would be 25-ft. Based on hydraulic analyses, the clear opening is adequate for expected snow, ice, and runoff conditions.

The Miluveach River bridge is proposed as a three span 120-ft. bridge. The expected clear opening for stream flow is 105-ft. Based on hydraulic analyses, the clear opening is adequate for expected snow, ice, and runoff conditions.

Stream bed scour of bridge piling and abutment sheet pile is not considered to be significant because the river bed and banks are expected to be frozen at breakup, and peak 100-year velocities are not expected to exceed 10-feet per second, but 5-ft. of scour will be assumed.

The bridges will be designed in accordance with applicable industry and ARCO design specifications and standards. (See Drawing No. CEA-R1XX-3945 and 3946.)

Material Source. The gravel required for construction of the two drillsites and the access road will obtained from Mine Site F on the Kuparuk River Unit. The open cell of Mine Site F is being dewatered under the NPDES No. AKG-31-005 (General NPDES Permit for Facilities Relating to Oil and Gas Extraction). The remaining gravel in the open cell of Mine Site F should be sufficient to meet the needs of the proposed development; however, a future aliquot to the north has already been permitted for expansion. If necessary, this aliquot may need to be opened to support this project. Gravel removal from Mine Site F is authorized under State of Alaska Material Sales Contract ADL 415353 and COE permit number M-840481.

AAI is also evaluating other material sources to supplement gravel from Mine Site F and gravel quality at the proposed drill sites. These sources are Kuparuk Mine Site C and a gravel stockpile located at Nuiqset. The Nuiqset gravel may be unavailable due to the potential BIA-sponsored road.

Road Stabilization. AAI requests approval to apply a soil stabilization product to the gravel roads and pads during break-up of 1998. The product identification name is EMC Squared Stabilizer. It is an earth materials catalyst (biocatalyst) designed to improve the cementation and stability of compacted aggregate and earth materials. The gravel mined from Mine Site F will frozen and not have an opportunity to drain. This will cause the road to be extremely unstable once it thaws. Therefore, AAI proposes to grade EMC Squared Stabilizer into the gravel surface during break-up. Product information and environmental testing results are included in Appendix C.

Powerline. The electric power for DS 2L and DS 2N will be provided by upgrading the existing powerlines from CPF-2 to DS 2M. From this point, a new line will be trenched next to the access road. The line will run along the same route as the road. The line will need to be spliced at regular intervals, incorporating surface mounted splice boxes. AAI is still evaluating the technical details of this method of installation. Should this method of power transmission prove unfeasible, an overhead line will be proposed to be constructed to the same standards as existing Kuparuk overhead powerlines.

Spill Prevention And Response. AAI will amend the Kuparuk River Unit Oil Discharge Prevention and Contingency Plan to include DS 2N and DS 2L and the associated pipelines.

Drilling. One rig will be utilized to perform all initial drilling on DS 2L and DS 2N. The rig will be conducting drilling operations beginning as early as the end of April 1998 and completing in October, 1998. AAI is working with the rig owners and operators to evaluate the potential to use highline electrical power during drilling operations.

Ice Roads. The Tarn Development will require an ice road to support construction of the pipeline during the winter of 1997-98. The ice road route the same as the proposed pipeline route. The Kuparuk River Unit has authorization for ice road construction in the Kuparuk River Unit. This land use authorization requires prior notification to ADNR of specific tundra travel projects. The land use permit is subject to seasonal restrictions. The water requirement for construction of the ice road is estimated at 15,000,000 gallons.

Fresh Water Requirements and Water Sources. Fresh water is required for the construction of ice road, drilling activities, and road maintenance. Ice roads will only be required during construction of the road and pipeline. Sources authorized in temporary water use permit LAS 18597 will be used for ice road construction. A ten mile ice road requires approximately 15,000,000 gallons of water for construction.

The sources listed in LAS 18597 will also be evaluated for long term use to support drilling activities. Approximately 1,840,000 gallons of water will be required to support drilling operations including camp requirements from April to November, 1998. Currently permitted sources within the Kuparuk River Unit are also identified as potential water sources.

During summer drilling operations, a temporary HDPE pipe will be laid on the tundra approximately 0.75 miles from DS 2L to the nearest permitted water source (LAS 18597). A remote pump and control will be used to supply water to the drillsite without need for a permanent access road.

Snow Removal. A snow removal plan will be developed prior to commencement of drilling activities and incorporated in the Kuparuk Field Services Snow Removal Procedures. Kuparuk standard operating procedures require the use of snow blowing equipment to minimize gravel carry over to the tundra. As long as snow blowers are used, no snow removal restrictions should apply. If equipment other than snowblowers are used, snow will not be plowed into the drained basin on the northeast corner of DS 2N. DS 2L is not proposed to have any restrictions.

Waste Disposal. Drilling wastes (i.e., muds and cuttings) will be disposed of through annular injection on-site and/or transported to a Class II disposal well either on the Kuparuk River Unit or to the Prudhoe Bay CC-2 facility. In the future, a Class II disposal well may be drilled on either DS 2L or DS 2N. No reserve pits are required. Well work waste materials will be managed according to the Kuparuk Waste Management Plan. During break-up of 1998, a temporary storage facility will be constructed to store cuttings while the road is being conditioned. A storage plan will be submitted to ADEC for approval as required in 18 AAC 60.430.

All other solid wastes will be hauled off-site for handling according to the procedures in the Kuparuk Waste Management Plan. Materials will be reused and recycled to the extent possible. All other materials will be disposed of either at the North Slope Borough SA-10 landfill in Deadhorse, or managed at Kuparuk. Sanitary wastes that may be generated from the temporary drilling camp will either be hauled to the Kuparuk Operations Center wastewater treatment system or will be permitted under the General NPDES Permit for Facilities Related to Oil and Gas Extraction on the North Slope (effective April 10, 1997).

Fuel Storage. No permanent fuel storage is currently planned at either DS 2L or DS 2N. Temporary storage tanks will be used to support drilling and well work operations.

The secondary containment for all fuel storage tanks will be minimum of 110 percent of the single largest tank or group of tanks manifolded together. Spill prevention details will be contained in each contractor's Spill Prevention Control and Countermeasures Plan (SPCC). North Slope best management practices will be used during all construction and production operations.

Air Emissions. At this time there will be no significant air emission sources installed at DS 2N and DS 2L. Any future sources will be evaluated under the air construction and operating permitting requirements. Emissions from sources other than nonroad engines used to support drilling operations were evaluated under AS 46.14.130 (facilities requiring permits) and determined that no construction or operating permit is required. Use of electrical power to support drilling operations is currently being evaluated.

Cultural Resources. Due to past exploration activities in the past, numerous archaeological assessments have been conducted in the Tarn Development area. In addition, an archaeological reconnaissance was conducted in the proposed project area on August 6-10, 1997 by Dr. John Lobdell of Lobdell & Associates. The SHPO was verbally contacted on August 11, 1997 by Dr. Lobdell and a verbal clearance received. A final report will be submitted upon completion.

Camp Requirements. Since no production processing will be conducted at DS 2N and DS 2L, no permanent camp facility is required. All construction crews will be housed at the Kuparuk Operations Center. A small camp will be used during drilling operations to support 24 hour drilling operations.

Native Hire Policy. AAI has an aggressive affirmative action employment program that seeks out minority interest potential employees, including native Alaskans. At present, approximately 5% of AAI employees are Alaska natives. In addition, AAI has established strategic contracts with native owned corporations such as Alaska Petroleum Contractors and Houston Contractors. These companies are alliance contractors with the Kuparuk River Unit.

Environmental Evaluation. A detailed environmental evaluation of the Tarn development area is contained in Appendix D. This evaluation was prepared for AAI by Alaska Biological Research, Inc. This evaluation includes a discussion on predicted impacts.

Mitigation. AAI has incorporated mitigation measures listed in Table 1 into the design of the proposed project. These design features are the result of years of technical and environmental studies conducted on the North Slope. Table 2 lists the proposed actions to minimize environmental impacts during construction and operation of DS 2L and DS 2N.

Cumulative Impacts. The proposed development is located outside the current Kuparuk River Unit (KRU)boundaries; however, prior to unit boundary contraction in 1992, this area was inside the KRU. Therefore, the potential impacts of development in this area were considered in initial permit approvals associated with the KRU. In addition, advances in drillsite design technology have resulted in smaller pad requirements and reduced associated impacts.

In the last few years, AAI has begun actively seeking smaller "satellite" oil accumulations in and near existing North Slope infrastructure. A 3-D seismic program conducted along the western bounded acreage of the KRU (extended approximately 6 miles west of the existing KRU boundary) has identified several satellite prospects which will be evaluated during future exploration drilling programs. Until exploration drilling is conducted, it is impossible to determine which prospects may become economic to develop. However, if proven, development will be coordinated and consolidated with the Kuparuk River Unit existing infrastructure.

Future on-shore satellite development may possibly be conducted from existing gravel pads; however, new gravel pads (beyond DS 2L and DS 2N) may be required. In determining any potential development scenarios, AAI will evaluate new emerging technologies which could reduce/eliminate gravel pad footprint, eliminate access roads and reduce air emissions and apply these technologies as applicable to avoid and mitigate environmental impact. AAI will attempt to consolidate pipeline routes and utilize existing routes whenever possible. The addition of a new central production facility (CPF) is not foreseen at this time.

Table 1. Design features used for avoidance and minimization of environmental impacts from the Kuparuk River Unit Tarn Project, Alaska.

Design Feature	Expected Benefit
GENERAL DESIGN	
Review historical data on wildlife use within the proposed project area	Identify critical issues and wildlife species early in design process
Collect baseline data from field surveys of fish, mammals (caribou), and birds (Tundra Swans, Spectacled Eiders)	Identify important fish streams and locations for stream crossings to avoid or minimize impacts on fish; avoid or minimize use of areas used by Spectacled Eiders (a threatened species)
Obtain current low-altitude aerial photography (true color and CIR) of proposed project area	Enhance environmental assessment and spill response planning; optimize facility siting
Identify and map vegetation types and wildlife habitats in the proposed project area from aerial photography	Identify vegetation types or habitats types for avoidance or minimization; avoid and minimize impacts to higher-value wetland types
Coordinate with U.S. Fish and Wildlife Service on Spectacled Eider surveys (1993–1997)	Ensure protection of threatened species; optimize sampling of habitats along proposed alternatives during baseline surveys
Use existing production and power generation facilities in the Kuparuk Oilfield	Eliminate need for additional facilities, minimize facility size
DRILL SITE DESIGN	
Minimize size of drill site pad; 30' wellhead spacing allowing for future in-fill drilling at 15' spacing	Minimize habitat loss
Provide powerline to drill site pad	No significant air emission sources required
Drill sites designed for no reserve pits	Reduced pad size and eliminate potential for contaminant release from reserve pits
Zero permanent discharge from drill sites of solid and liquid wastes to tundra or other waters (no permanent camp required)	Reduce impacts to tundra and wetlands, reduce contaminant release
Align drill sites with prevailing winds.	Minimizes snow accumulation and snow removal requirements. Potentially avoids need for snow fence.
ROAD DESIGN	
Route road through existing gravel pad at West Sak 15	Consolidates gravel facilities on the North Slope
Future development potential considered during selection of road alignment	Minimize need for future additional facilities; minimize additional road length
Identify potential culvert and stream crossing (bridges) requirements for road and incorporate into project design	Reduce alterations to surface drainage patterns; avoid or minimize effects of road on existing streams; allow free passage of fish; protect spawning sites
PIPELINE DESIGN	
Design vertical support members (VSMs) to carry additional pipelines beyond original project	Minimize number of VSMs and potential impediments to wildlife (caribou) movements; reduce future

requirements	construction needs
Elevated pipeline, minimum 5' above ground; space pipeline at 400–1000' from road	Allow free passage of caribou and other wildlife under pipeline; avoid need for caribou ramps
Elevate pipeline height to greater than 5' at Miluveach River	Avoids impacts to fish, wildlife, habitat, and water quality. Enhances free passage for migrating caribou.
Space pipeline at least 450' and up to 1,000' maximum from road, where practicable.	Minimizes passage obstruction for caribou. Incorporates NSB management standard for visual spill detection.
Connect proposed gathering line into existing production line at DS 2M to CPF-2.	Minimizes the amount of habitat crossed by new pipeline.

Table 2. Proposed actions for avoidance and minimization of environmental impacts during construction and operation of the Kuparuk River Unit Tarn Project, Alaska.

Proposed Action	Expected Benefit
Conduct all major activities (e.g., pipeline construction, bridge construction, gravel mining, place road gravel) during winter	Eliminate impacts of construction on wildlife; minimize impacts to tundra and wetlands
Construct pipeline during winter from ice road	Eliminate impacts of construction on wildlife; minimize impacts to tundra and wetlands during construction and eliminate impacts from an access road
Provide on-site environmental presence during construction to ensure compliance with permit requirements	Minimize variances from permitted activities
Employ construction and operation technological advances and lessons learned through AAI's 20-plus years of experience on the North Slope	Minimizes overall impact, reduces probabilities of human, equipment, and design failure
Require secondary containment for all temporary fuel storage locations during construction	Minimizes or avoids spills to tundra and wetlands
Restrict on-tundra activities to permitted areas	Minimize impacts to tundra outside of areas authorized by permit
Prohibit work in streams during fish spawning runs	Reduce impacts to fish
Coordinate with U.S. Fish and Wildlife Service on historical and recent locations of polar bear den sites	Avoid actions that would disturb denning polar bears
Strictly enforce speed limits within project construction areas	Reduce potential impacts to wildlife; reduce accidents both on road surface and onto tundra; reduce accidental spills of contaminants during accidents
Prevent icing of culverts by method of installation (during construction period), proper maintenance, and thawing as deemed necessary	Avoid flooding and impoundments during breakup; minimizes thermokarst; avoid gravel deposition on tundra
Strictly enforce speed limits on roads and pads, and employ dust controls	Reduce potential impacts to wildlife; reduce accidents both on road surface and onto tundra; reduce accidental spills of contaminants during accidents; minimize dust generation
Use existing KRU facilities for accommodating workers	Reduce duplication of facilities
Prohibit hunting by oil field personnel and restrict public access	Protect fish and wildlife
Train personnel in proper interactions with wildlife	Reduce potential for harassment of wildlife; reduce adverse effects on personnel from interactions
Provide powerline to drill sites	Avoids significant air emission sources. Reduces noise in the area.

<u>Informational Meetings and Previous Coordination.</u> AAI held an information meeting on April 1, 1997 after the Tarn discovery was announced. A summary of this meeting and a list of attendees is included in Appendix E. The alternatives identified at this meeting and associated AAI responses are listed below:

<u>Road, pipeline and powerline routing and construction:</u>

- ***"No road" development.*** AAI evaluated production of these drillsites without construction of a road connecting them to the KRU road system. This alternative would eliminate the need for 7.13 miles of access road from DS 2M to DS 2L including the two bridge crossings. However, the 2.90 mile road would still be required to connect DS 2L to DS 2N. In addition, larger pad space would be required for worker housing and storage of materials. An airstrip would also be required to allow for year round support and access to the drillsites. An airstrip and housing operations create additional noise disturbance to the wildlife in the area, require access to permanent water source (e.g., access road), and additional fuel storage, waste handling, and ice road requirements.

  These additional gravel fill requirements were estimated to be approximately 6 acres (65,000 cy) for the storage and camp, plus 32 acres (363,000 cy) for the airstrip (total of 38 acres, based on Alpine design information). The elimination of the access road from DS 2M to DS 2L would save 41.2 acres (285,600 cy). Therefore, reduction of impacts due to gravel placements are not substantially minimized by choosing the "no road" development. Construction of the road also avoids the impacts due to an airstrip, camp and fuel and materials storage and increased frequency of visual observations of the pipeline route.

- ***A single-lane road.*** AAI considered construction of a single-lane road to support development activities. However, the size requirement for drill rig and workover equipment transportation does not allow for movement on a single lane road. Restriction to drill rig movement on ice roads creates a need for multiple years of ice road construction in the same area. This increases the cost of operation of the facility versus the cost of full road. Use of this option could also require the need for installation of an airstrip to provide year-round emergency drilling support.

- ***Evaluate culvert placement approach to alleviate cross-drainage impounding (pre-stake, arbitrary placement, place culverts in post-construction phase).*** The entire road route was walked by the design engineers during break-up in 1997. Cross road drainage locations were staked for installation during road construction. In addition, the road will be monitored during break-up of 1998 to determine if additional culvert placement is required.

- ***Need hydrological data to support thickness of gravel on road.*** Hydraulic studies at the Miluveach River, Trouble Creek and cross tundra drainage areas were conducted during break-up and summer of 1997. The data from these studies were incorporated into the road and crossing designs. The final reports have not yet been finalized; however, will be available upon request.

<u>Pipeline and powerline routing and construction:</u>

- ***Pipeline height needs to be determined at a relatively early stage.*** NSB expressed concerns over 5' height. Elevated height at selected strategic locations is a possible scenario. AAI has been working this issue through the Alpine Development permitting process. An elevated VSM height at the Miluveach River crossing similar to the Alpine crossing was incorporated into the project based on the NSB concerns.

- ***Pipeline and VSM sharing with existing and proposed (i.e. Alpine) facilities will be considered in project design.*** This option was evaluated with the Alpine design team but determined to not be economical. Currently, the pipelines are not on the same construction schedule. The proposed pipeline to DS 2L and DS 2N will be constructed during the winter of 1998; the Alpine construction schedule is proposed for VSM placement in the winter of 1999. In addition, the proposed pipeline will tie into an existing production line at DS 2M. Sharing of VSMs with Alpine would require additional pipeline construction to CPF-2 (approximately xx miles). Also, the VSM spacing design for Alpine is greater due to the transportation of sales quality crude oil. A shorter VSM spacing is required for three-phase oil transportation due to the additional pressure swings associated with gas production.

Drillsite location:

- ***Requires analysis of habitat value and wildlife use of the area.*** An environmental evaluation was conducted in the proposed development area. See Appendix x.

Road crossing at Miluveach River:

- ***Involve ADF&G and JPO early on with discussion of options for road crossing and pipeline at Miluveach River.*** Meetings were held on May xx, 1997 and July 15, 1997 with ADF&G. These meetings included discussion of proposed studies and bridge design. The JPO was contacted in early August but due to their limited involvement in the permitting activities, declined a project summary. JPO requested a copy of the permit application package.

- ***In the absence of adequate fisheries data, assume that Miluveach is fish-bearing.*** Fish studies are being conducted this summer of 1998. Daily information on the study areas has been provided to ADF&G via e-mail from Dr. L. Mouton.

In addition to the April 1, 1997 multi-agency information meeting, individual meetings were held with ADNR-Oil and Gas, ADF&G, USF&W, USCOE, ADNR-Lands, and ADEC. Input received at these meetings was either incorporated into the project design or included in the project plan of operations summary.

AAI Alternatives Considered and Eliminated

Full processing at the drillsites. AAI evaluated installation of a small scale production facility to separate the produced fluids and transport sales quality crude to CPF-2. This alternative was eliminated due to the determination that CPF-2 has the capability to process the fluids. This eliminated additional air emission sources at DS 2L and DS 2N.

Culverts at Miluveach River. AAI conducted hydrology studies during break-up in 1997 to determine the appropriate road crossing at the Miluveach River. These studies indicated that culverts may not be adequate to protect the road crossing during spring break-up. Therefore, a bridge design has been incorporated into the project.

Culverts and alternative road route at Trouble Creek. AAI evaluated four potential crossings for the drainage at Trouble Creek. Due to the incised banks, a culvert design required the road to go further south to cross Trouble Creek which included some tight curves. This route required relocation of energized powerlines at DS 2M plus additional gravel road. A bridge crossing provided a simplified crossing approach and was determined to be approximately the same cost.

Different pad locations. AAI evaluated several different pad locations. The proposed locations were selected based on confirmed and potential reservoir development and environmental habitat protection.

Powerline option. An engineering study evaluated three potential options for providing electrical power to DS 2L and DS 2N; an overhead powerline, trenching the cable, and installing the cable along the pipeline VSMs. The option to use the VSMs was eliminated due to concerns with cable sagging and caribou migration. AAI has chosen the trenching alternative based on similar costs as powerline installation; however, the technical considerations with installation of a 35 KVA line under the access road, surface splicing requirements, and the Trouble Creek and Miluveach River crossing as still be evaluated. AAI will hopefully have this final decision by September 30, 1997. All agencies will be notified should the method of powerline installation deviated from the trenching alternative proposed.

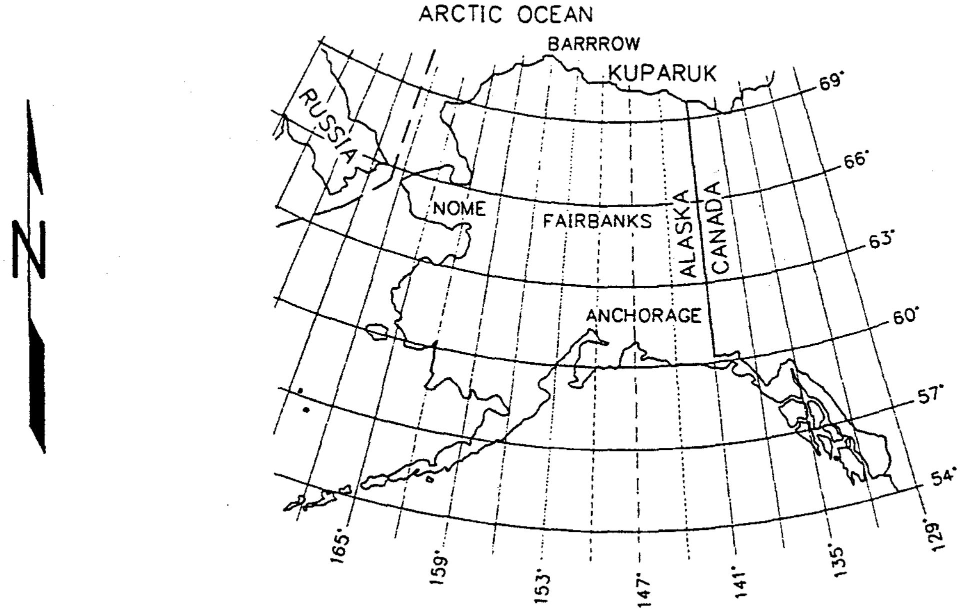
Miluveach River gravel borrow locations. Aerial photos indicated a potential gravel borrow location along the Miluveach.. A surface sample taken of the material in May, 1997 indicates the material may possibly be suitable for road fill. However, due to the expedited timing of this project, a thorough evaluation was not able to be conducted. AAI will keep this potential gravel source in mind for road maintenance and future gravel needs at Kuparuk.

One drillsite vs. Two drillsites. AAI evaluated the feasibility of development of the reservoir from a single drillsite. However, it was determined that construction of one central drillsite location would require extremely high angle deviated well constructions. Drilling costs and problem areas are increased for these higher angle well deviations. In addition, based on 3-D seismic data, additional reserves may be discovered which could be developed from the proposed two drillsite locations.

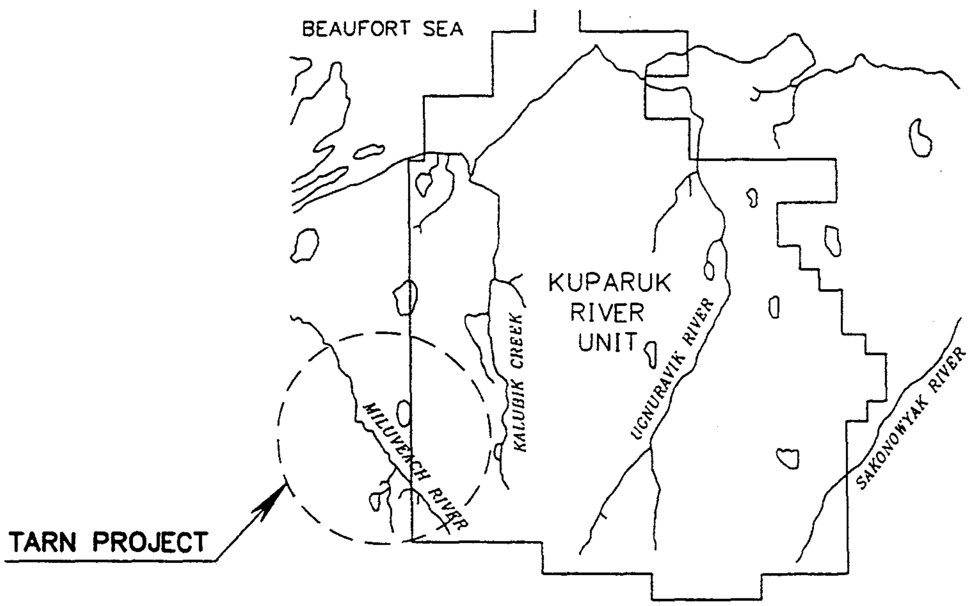
List of Permits Required for the Proposed Project:

USCOE 404 Permit
USCG Bridge Permit/Navigability Determination
ADEC 401 Certification
ADGC Consistency Determination
ADNR Land Use
ADNR Lease Operations
ADNR ROW
ADEC ODPCP Amendment Approval
ADF&G Title 16 Permit
ADEC Temp. Storage of Drilling Waste Plan Approval
NSB Development Permit
NSB Conditional Use Permit (DS 2N)

REV	DATE	BY	CK	APP	DESCRIPTION	REV	DATE	BY	CK	APP	DESCRIPTION
0	8/15/97	r2g	JIB	JC	ISSUE FOR PERMIT						



ALASKA VICINITY MAP



KUPARUK VICINITY MAP

Alaska Anvil Inc.
Anvil Job No.: AE7562
Acad File No.: 33EBA9B5
Date & Time : 08/15/97 08:48

ARCO Alaska, Inc.

AREA: 00
MODULE: XXXX
UNIT: R1

KUPARUK RIVER UNIT
TARN PROJECT
KEY MAP

CADD FILE NO. 1997
DRAWING NO: CEA-R1XX-3935
SHEET: 001 OF 1
REV: 0

REV	DATE	BY	CK	APP	DESCRIPTION	REV	DATE	BY	CK	APP	DESCRIPTION
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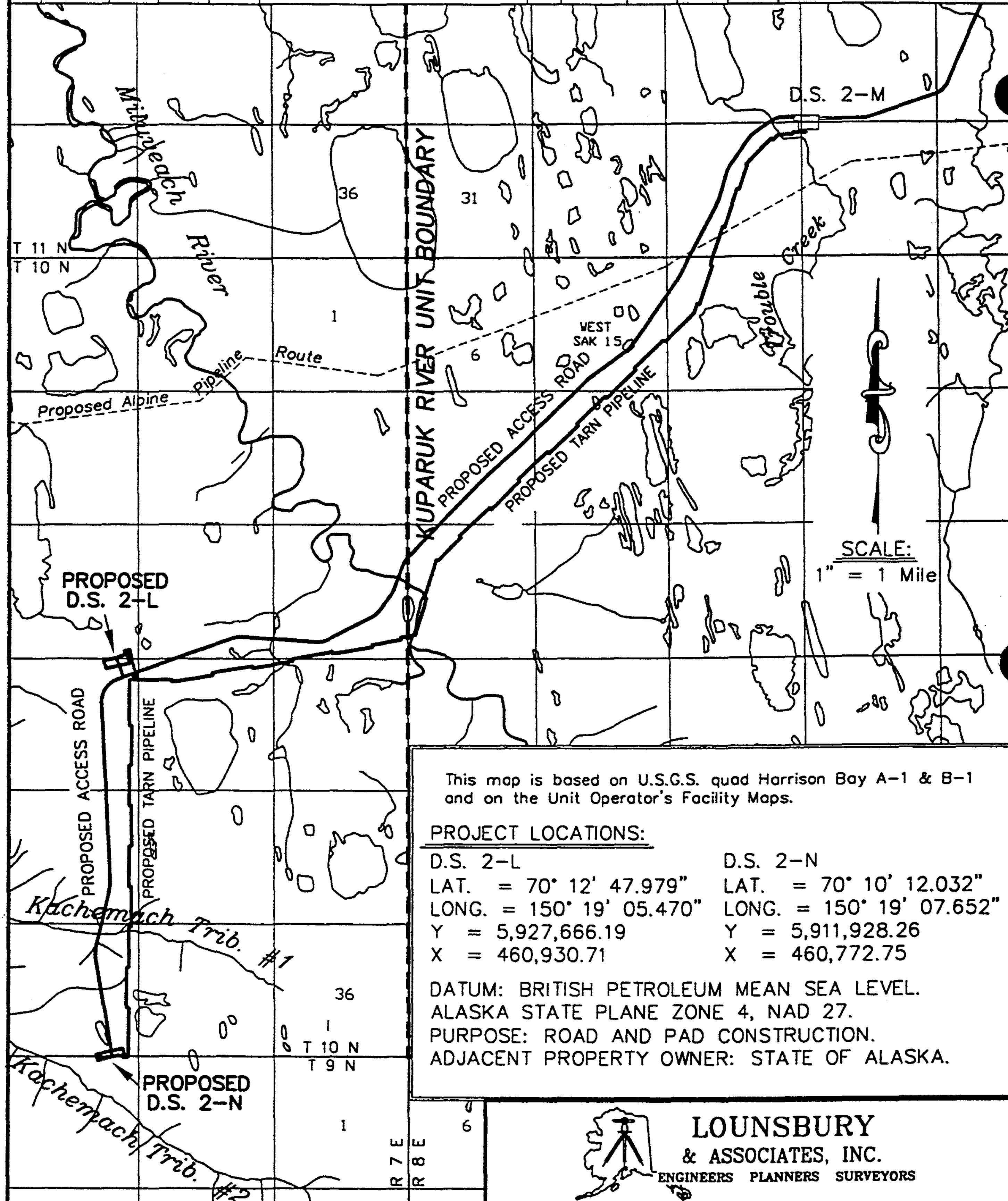


This map is based on U.S.G.S. quad Harrison Bay A-1 & B-1 and on the Unit Operator's Facility Maps.

PROJECT LOCATIONS:

D.S. 2-L	D.S. 2-N
LAT. = 70° 12' 47.979"	LAT. = 70° 10' 12.032"
LONG. = 150° 19' 05.470"	LONG. = 150° 19' 07.652"
Y = 5,927,666.19	Y = 5,911,928.26
X = 460,930.71	X = 460,772.75

DATUM: BRITISH PETROLEUM MEAN SEA LEVEL.
ALASKA STATE PLANE ZONE 4, NAD 27.
PURPOSE: ROAD AND PAD CONSTRUCTION.
ADJACENT PROPERTY OWNER: STATE OF ALASKA.

LOUNSBURY & ASSOCIATES, INC.
ENGINEERS PLANNERS SURVEYORS

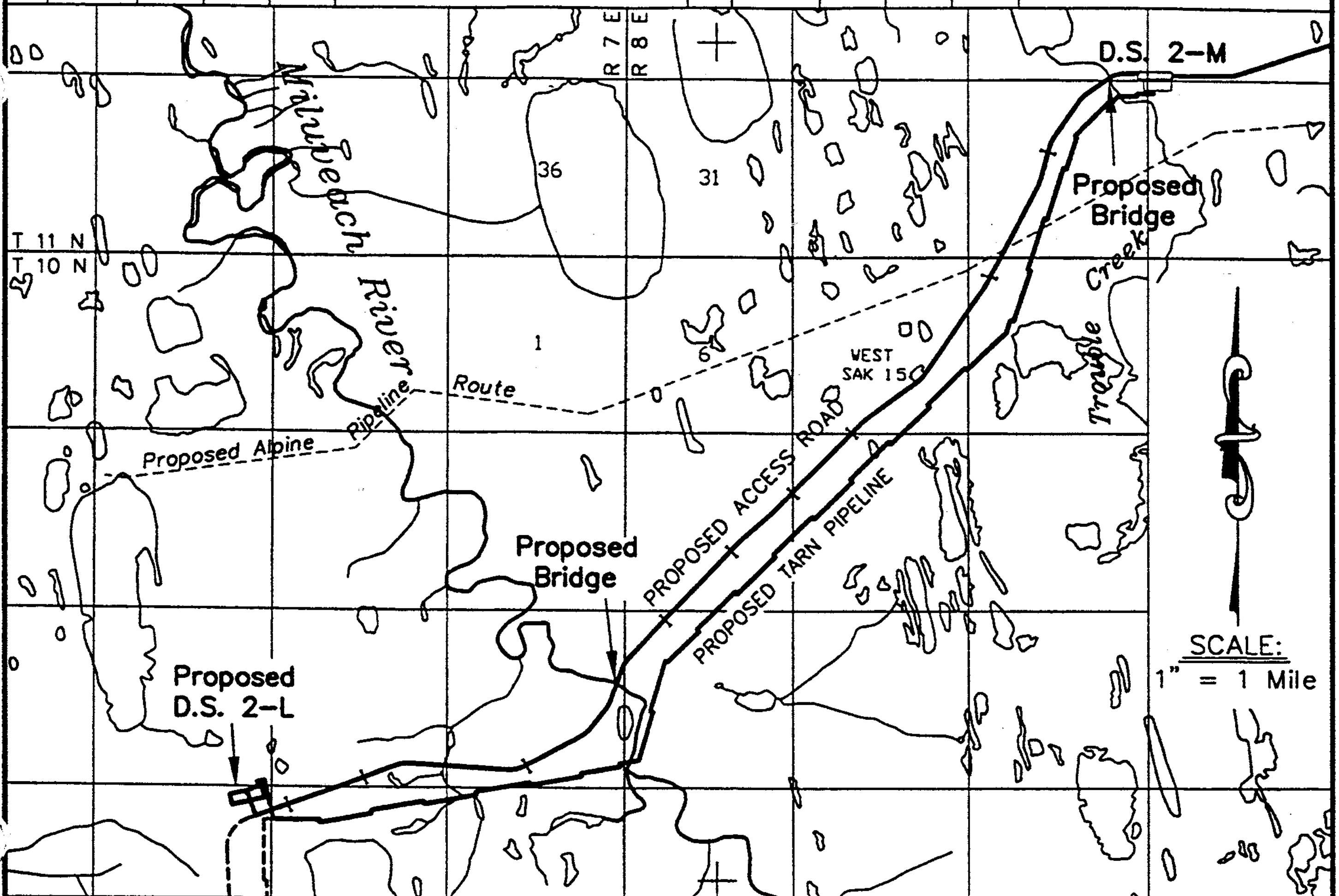
ARCO Alaska, Inc.
Subsidiary of Atlantic Richfield Company

AREA 00 MODULE XXXX UNIT R1

KUPARUK RIVER UNIT
TARN PROJECT
PROJECT MAP

CADD FILE NO.		DRAWING NO:	SHEET:	REV:
-	-	CEA-R1XX-3936	1 OF 1	0

REV	DATE	BY	CK	APP	DESCRIPTION	REV	DATE	BY	CK	APP	DESCRIPTION
0	8/15/97	AR	JWS	SLC	ISSUE FOR PERMIT						



This map is based on U.S.G.S. quad Harrison Bay A-1 & B-1 and on the Unit Operator's Facility Maps.

D.S. 2L ACCESS ROAD

ROAD LENGTH: 37,800 LF
ESTIMATED AREA OF TUNDRA COVER: 41.2 ACRES
ESTIMATED QUANTITY OF GRAVEL: 285,600 CY

2L PIPELINE

PIPELINE LENGTH: 39,600 LF

POSSIBLE CULVERT LOCATION
EXACT LOCATION TO BE DETERMINED BY FIELD SURVEY
37 CULVERTS ARE EXPECTED ALONG THE D.S. 2L ACCESS ROAD

LOUNSBURY
& ASSOCIATES, INC.
ENGINEERS PLANNERS SURVEYORS

ARCO Alaska, Inc.
Subsidiary of Atlantic Richfield Company

AREA 00 MODULE XXXX UNIT R1

KUPARUK RIVER UNIT
TARN PROJECT
2L ACCESS ROAD

CADD FILE NO.		DRAWING NO:	SHEET:	REV:
-	-	CEA-R1XX-3937	1 OF 1	0

REV	DATE	BY	CK	APP	DESCRIPTION	REV	DATE	BY	CK	APP	DESCRIPTION
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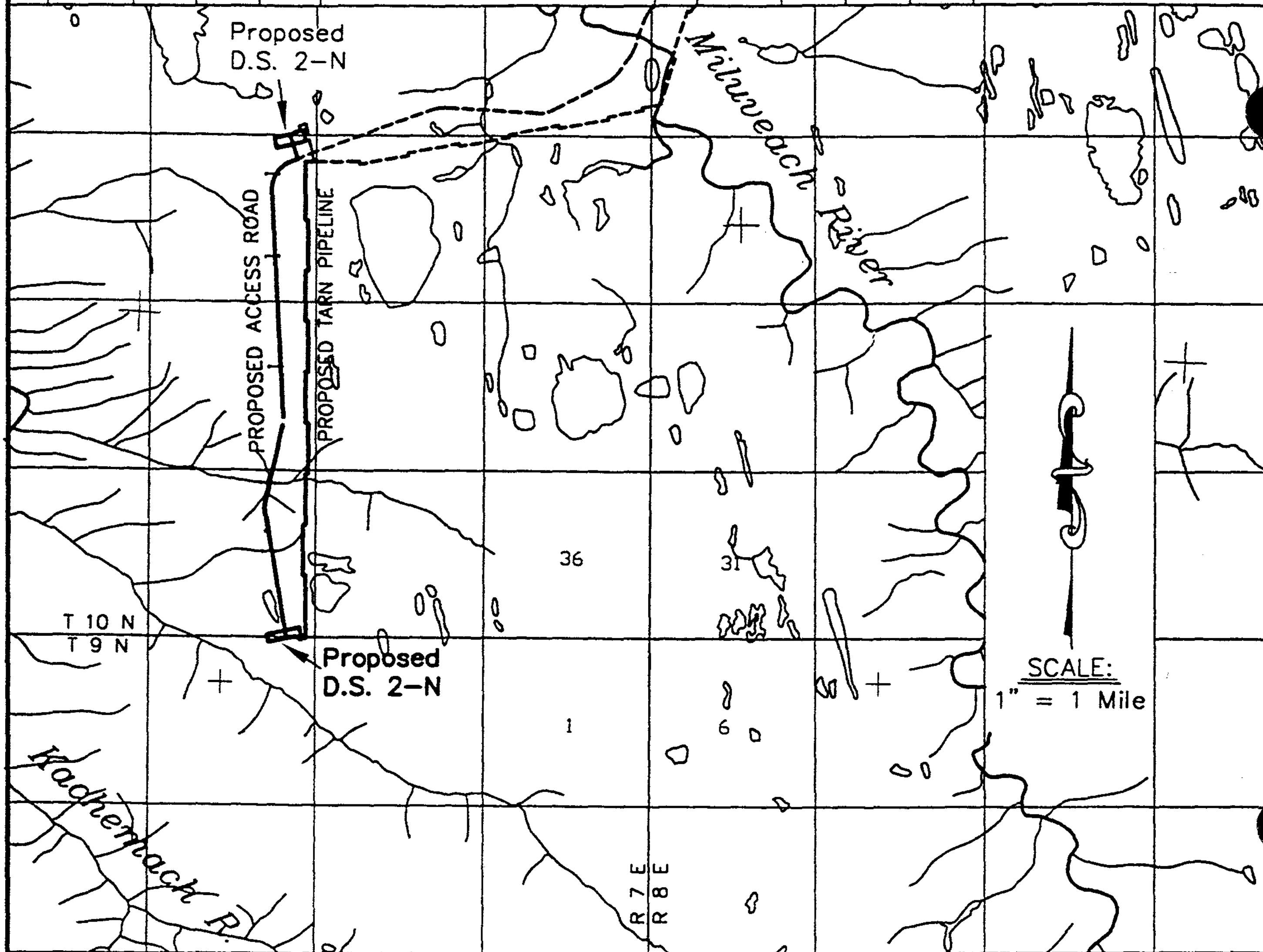

This map is based on U.S.G.S. quad Harrison Bay A-1 & B-1
and on the Unit Operator's Facility Maps.

D.S. 2N ACCESS ROAD

ROAD LENGTH:	15,200 LF
ESTIMATED AREA OF TUNDRA COVER:	16.8 ACRES
ESTIMATED QUANTITY OF GRAVEL:	105,600 CY

2N PIPELINE

PIPELINE LENGTH: 16,300 LF

—— POSSIBLE CULVERT LOCATION
EXACT LOCATION TO BE DETERMINED BY FIELD SURVEY
14 CULVERTS ARE EXPECTED ALONG THE D.S. 2N ACCESS ROAD

LOUNSBURY
& ASSOCIATES, INC.
ENGINEERS PLANNERS SURVEYORS

ARCO Alaska, Inc.
Subsidiary of Atlantic Richfield Company

AREA 00 MODULE XXXX UNIT R1

KUPARUK RIVER UNIT
TARN PROJECT
2N ACCESS ROAD

CADD FILE NO.		DRAWING NO:	SHEET:	REV:
-	-	CEA-R1XX-3938	1 OF 1	0

REV	DATE	BY	CK	APP	DESCRIPTION	REV	DATE	BY	CK	APP	DESCRIPTION
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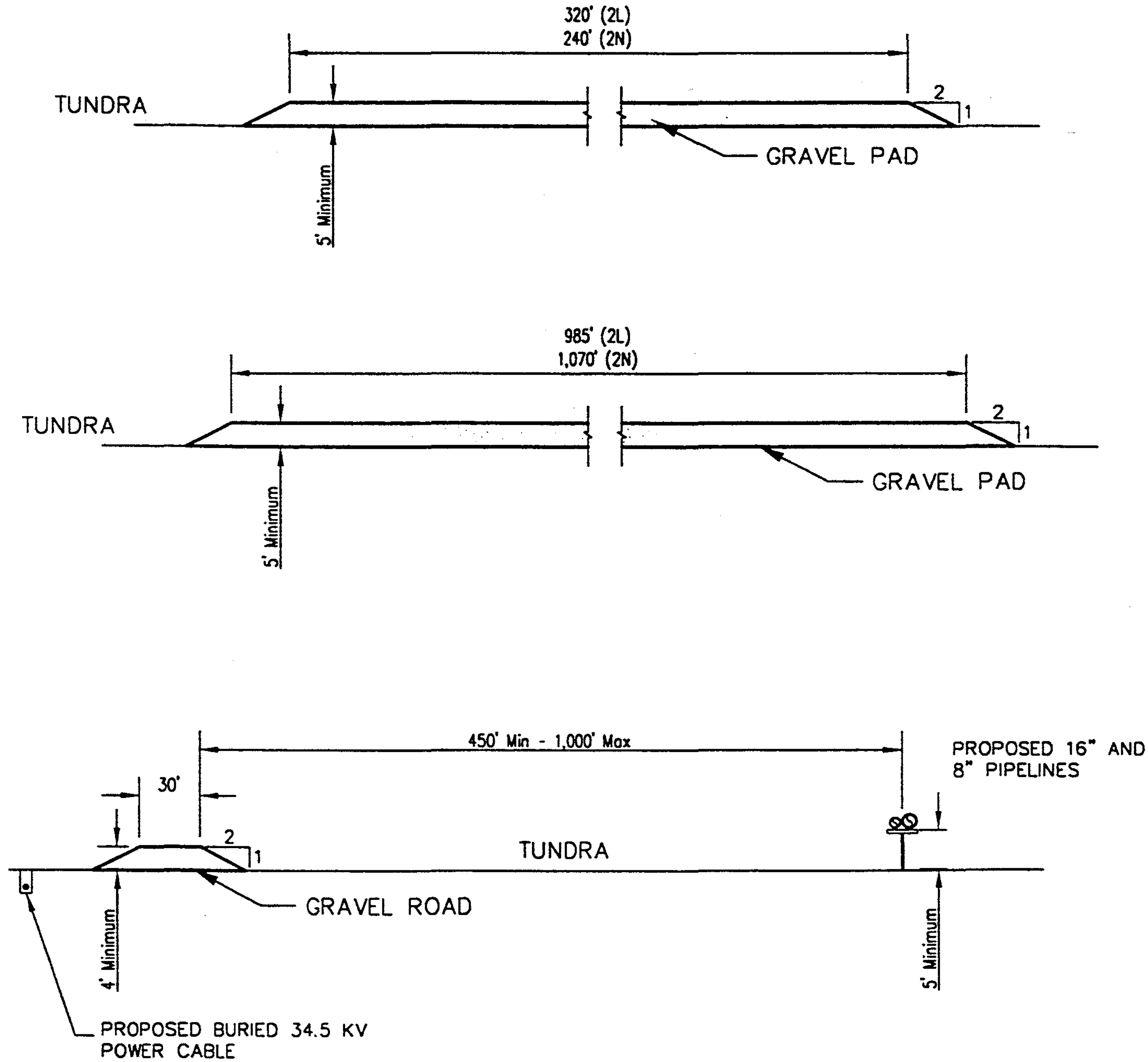

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& ASSOCIATES, INC.
ENGINEERS PLANNERS SURVEYORS

ARCO Alaska, Inc.
Subsidiary of Atlantic Richfield Company

AREA 00 | MODULE XXXX | UNIT R1

KUPARUK RIVER UNIT
TARN PROJECT
CROSS-SECTIONS

CADD FILE NO.		DRAWING NO:	SHEET:	REV:
–	–	CEA-R1XX-3939	1 OF 1	0

REV	DATE	BY	CK	APP	DESCRIPTION	REV	DATE	BY	CK	APP	DESCRIPTION
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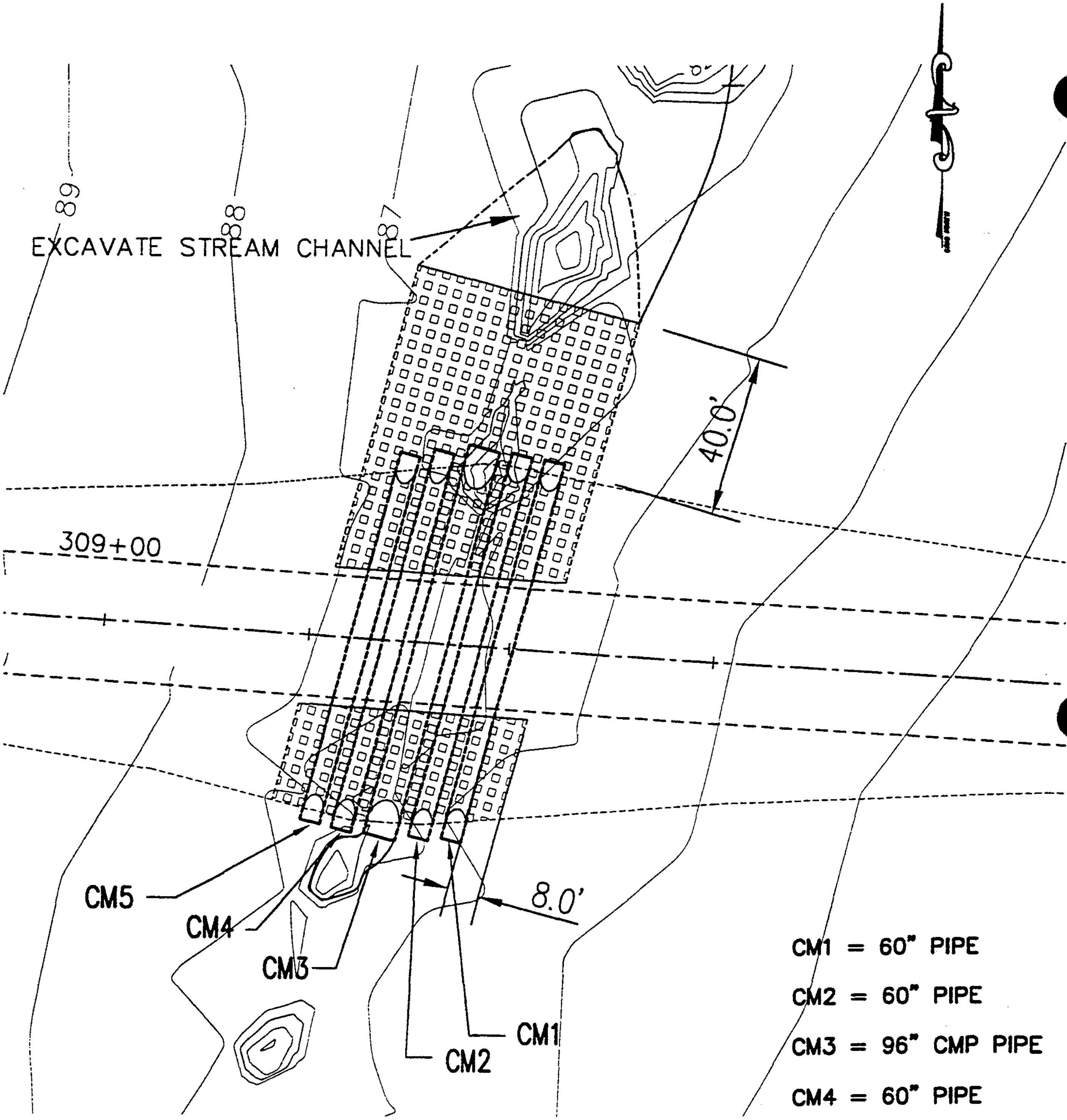


CM1 = 60" PIPE

CM2 = 60" PIPE

CM3 = 96" CMP PIPE

CM4 = 60" PIPE

CM5 = 60" PIPE

LOUNSBURY
& ASSOCIATES, INC.
ENGINEERS PLANNERS SURVEYORS

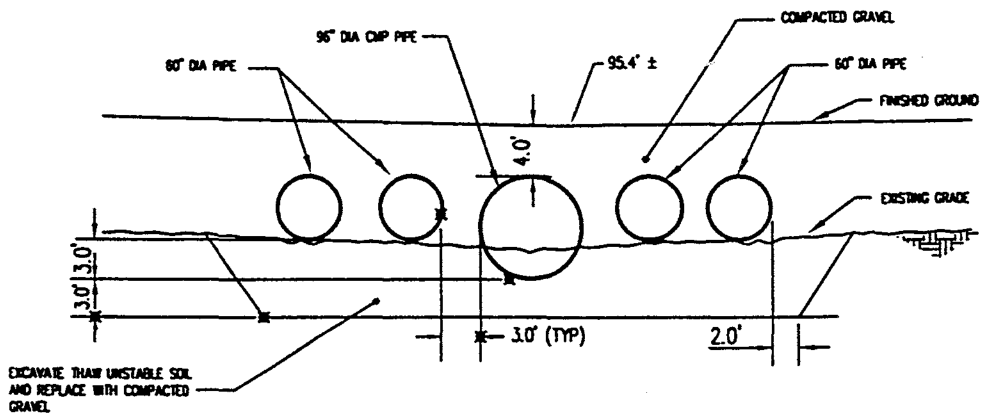
ARCO Alaska, Inc.
Subsidiary of Atlantic Richfield Company

AREA 00 | MODULE XXXX | UNIT R1

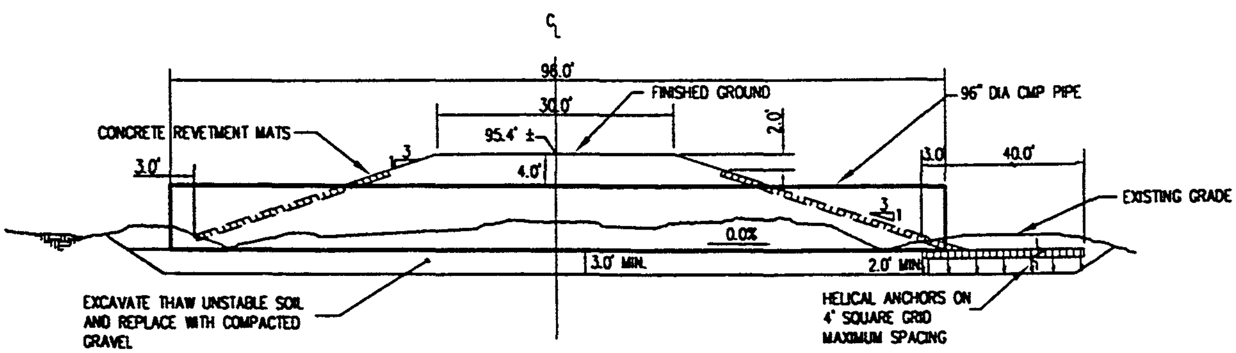
KUPARUK RIVER UNIT
TARN PROJECT
MILUVEACH RIVER TRIBUTARY CULVERT PLAN

CADD FILE NO.		DRAWING NO:	SHEET:	REV:
–	–	CEA-R1XX-3940	1 OF 1	0

REV	DATE	BY	CK	APP	DESCRIPTION	REV	DATE	BY	CK	APP	DESCRIPTION
0	8/15/97	AR	JWS	SC	ISSUE FOR PERMIT						



CULVERT INSTALLATION: CROSS SECTION
NTS



CULVERT INSTALLATION: CROSS SECTION
NTS

LOUNSBURY
& ASSOCIATES, INC.
ENGINEERS PLANNERS SURVEYORS

ARCO Alaska, Inc.
Subsidiary of Atlantic Richfield Company

AREA 00 MODULE XXXX UNIT R1

KUPARUK RIVER UNIT
TARN PROJECT
MILUVEACH RIVER TRIBUTARY CULVERT DETAILS

CADD FILE NO.		DRAWING NO:		SHEET:	REV:
–	–		CEA-R1XX-3941	1 OF 1	0

REV	DATE	BY	CK	APP	DESCRIPTION	REV	DATE	BY	CK	APP	DESCRIPTION
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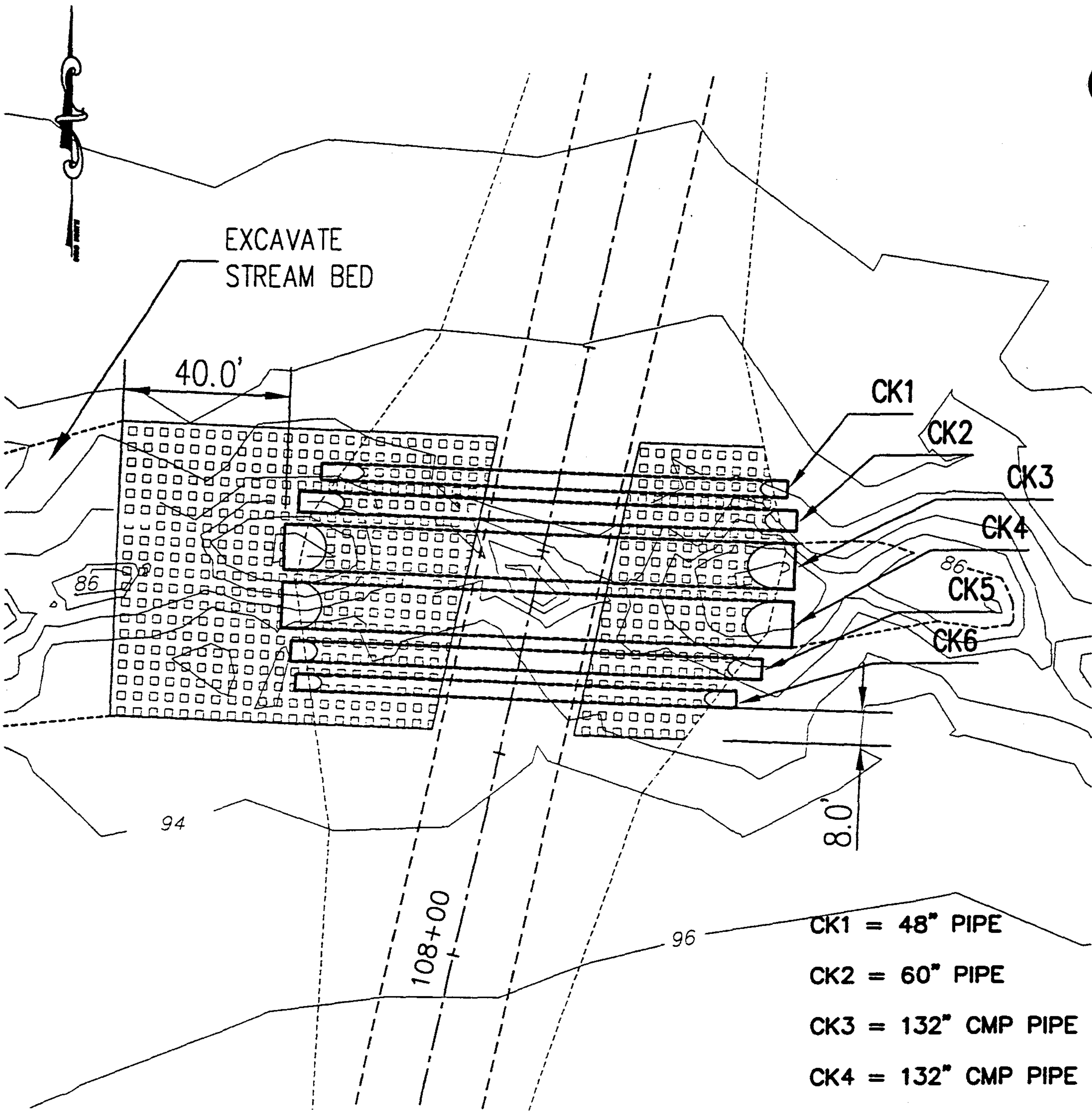


CK1 = 48" PIPE

CK2 = 60" PIPE

CK3 = 132" CMP PIPE

CK4 = 132" CMP PIPE

CK5 = 60" PIPE

CK6 = 48" PIPE

LOUNSBURY
& ASSOCIATES, INC.
ENGINEERS PLANNERS SURVEYORS

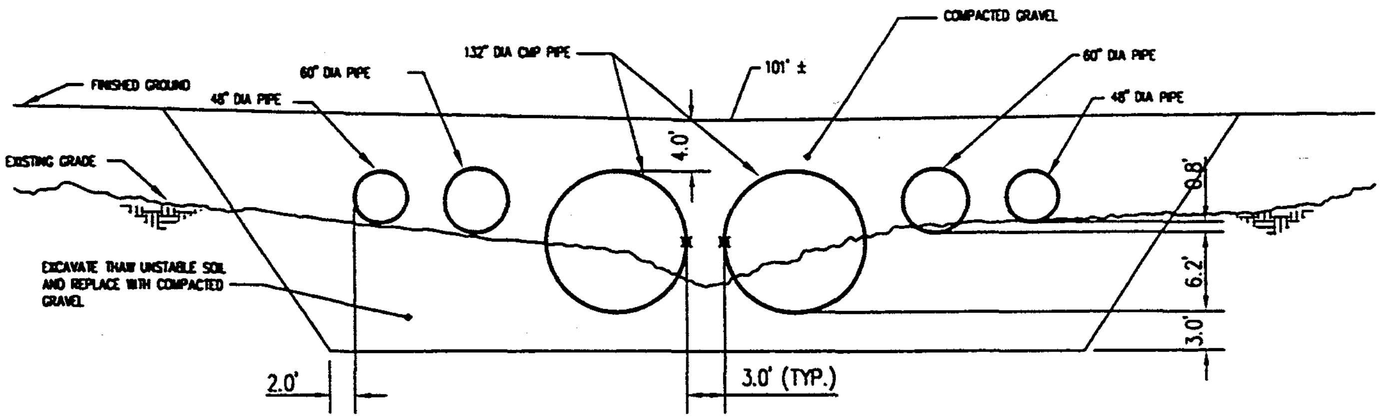
ARCO Alaska, Inc.
Subsidiary of Atlantic Richfield Company

AREA 00 MODULE XXXX UNIT R1

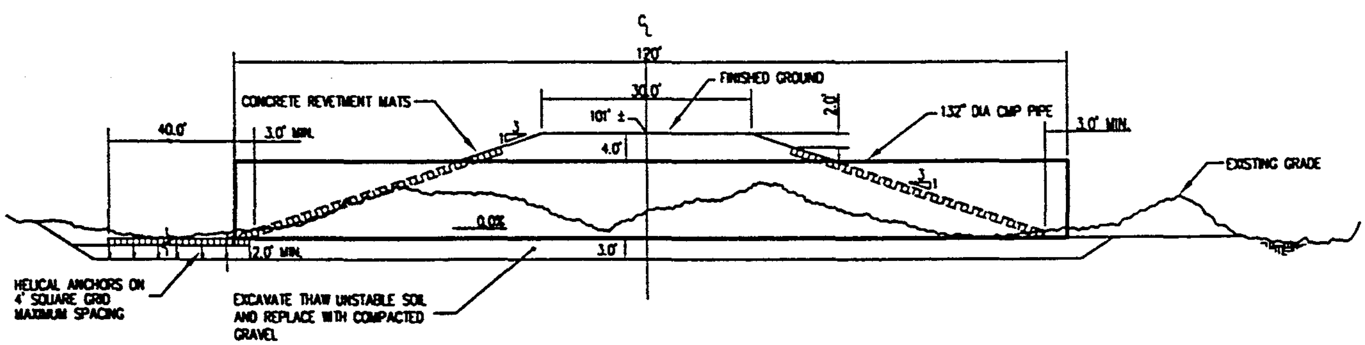
KUPARUK RIVER UNIT
TARN PROJECT
KACHEMAK RIVER TRIBUTARY CULVERT PLAN

CADD FILE NO.		DRAWING NO:	SHEET:	REV:
-	-	CEA-R1XX-3942	1 OF 1	0

REV	DATE	BY	CK	APP	DESCRIPTION	REV	DATE	BY	CK	APP	DESCRIPTION
0	8/15/97	AR	JWS	SLC	ISSUE FOR PERMIT						



CULVERT INSTALLATION: CROSS SECTION
NTS



CULVERT INSTALLATION: CROSS SECTION
NTS

LOUNSBURY
& ASSOCIATES, INC.
ENGINEERS PLANNERS SURVEYORS

ARCO Alaska, Inc.
Subsidiary of Atlantic Richfield Company

AREA 00 MODULE XXXX UNIT R1

KUPARUK RIVER UNIT
TARN PROJECT
KACHEMACK RIVER TRIBUTARY CULVERT DETAILS

CADD FILE NO.		DRAWING NO:		SHEET:	REV:
–	–		CEA-R1XX-3943	1 OF 1	0

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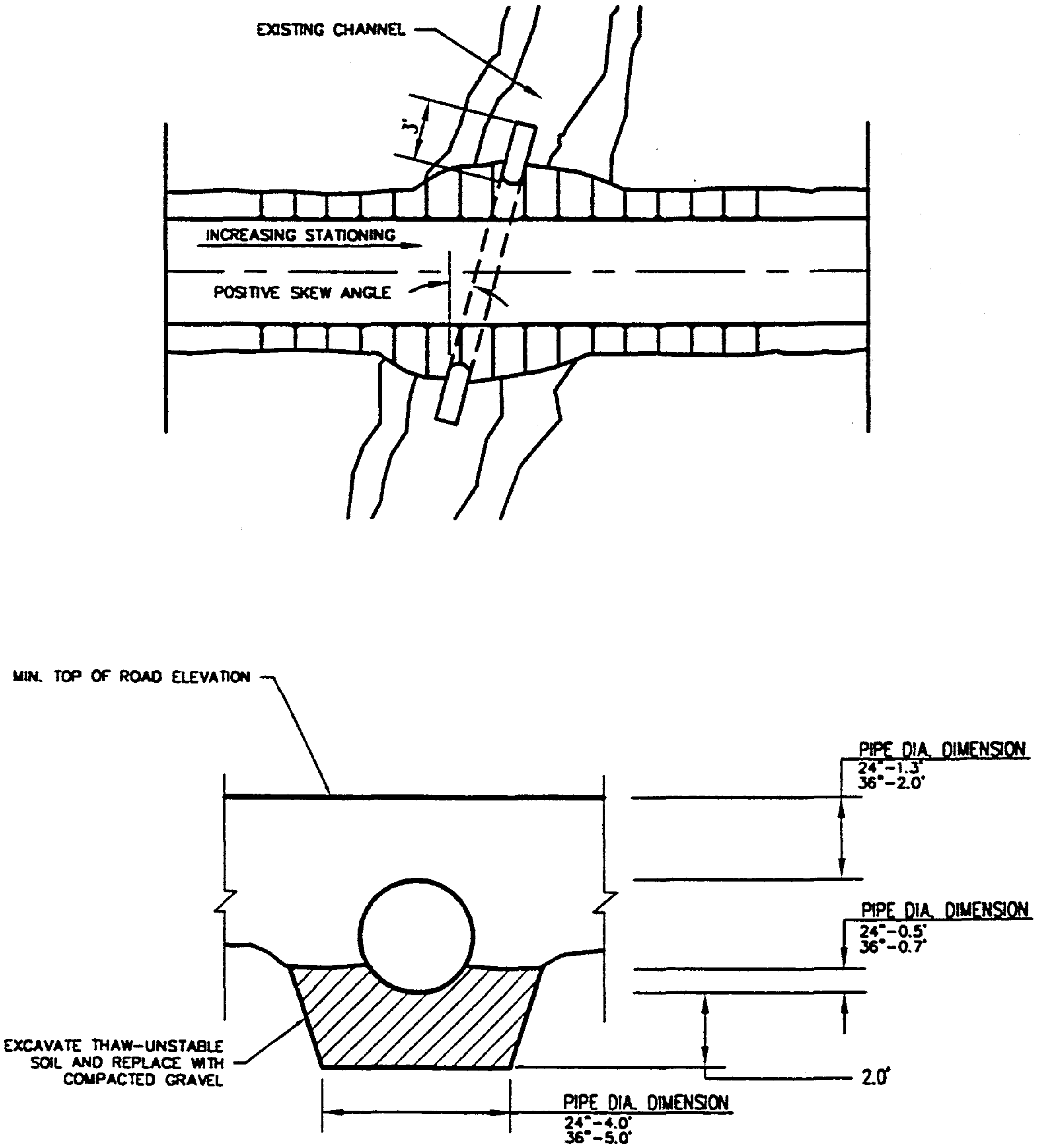

IRON PIPE CULVERT INSTALLATION DETAIL

NTS

LOUNSBURY & ASSOCIATES, INC.
ENGINEERS PLANNERS SURVEYORS

ARCO Alaska, Inc.
Subsidiary of Atlantic Richfield Company

AREA 00 MODULE XXXX UNIT R1

KUPARUK RIVER UNIT
TARN PROJECT
TYPICAL CULVERT DETAILS

CADD FILE NO.		DRAWING NO:	SHEET:	REV:
-	-	CEA-R1XX-3944	1 OF 1	0

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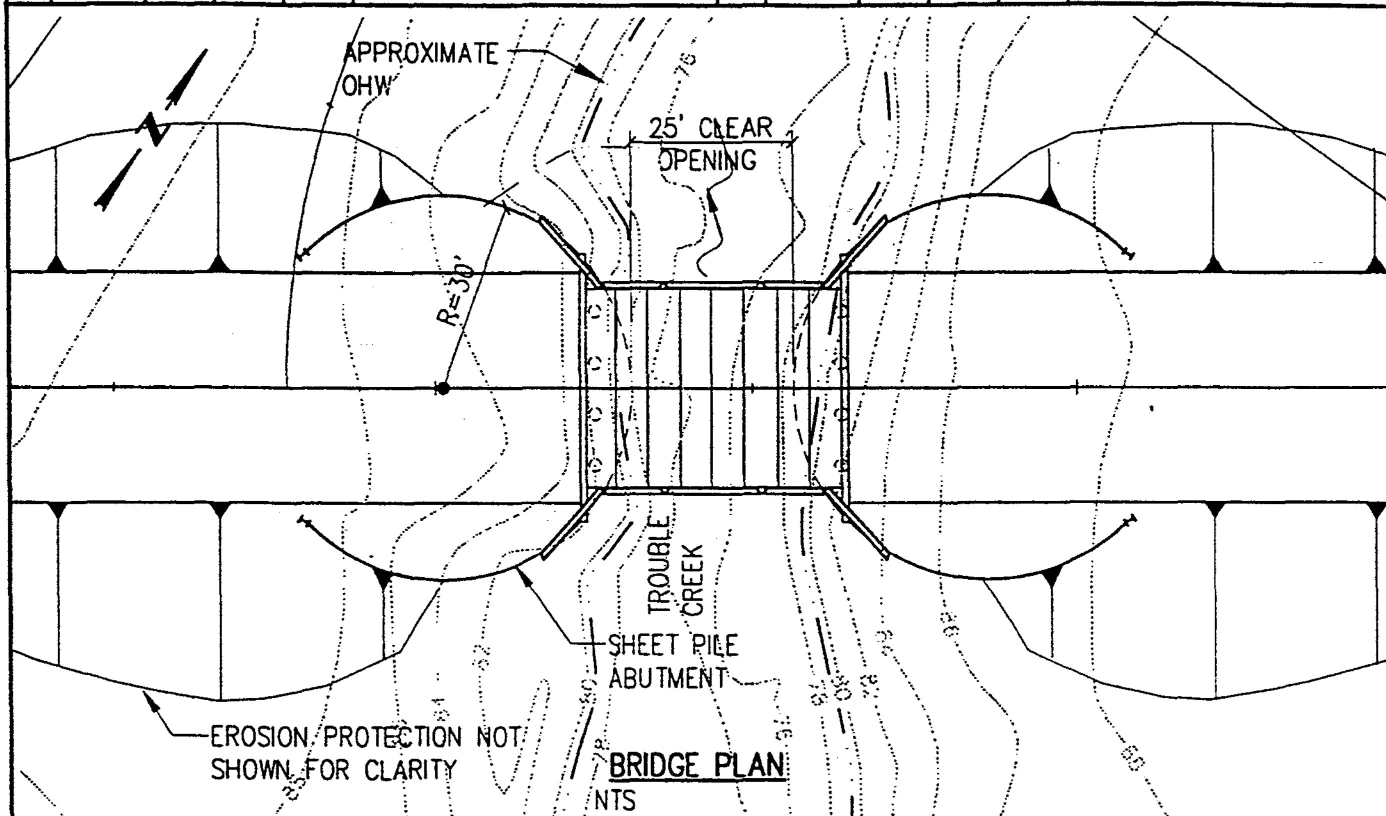
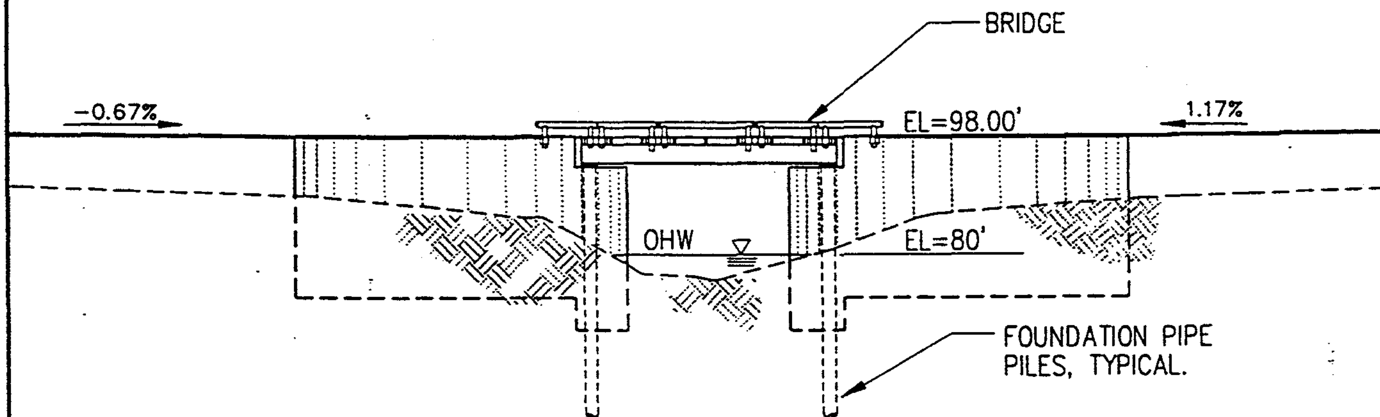
0	8/15/97	SA	DTK	ABC	ISSUE FOR PERMIT						



BRIDGE PLAN
NTS



BRIDGE ELEVATION AT CENTERLINE
NTS

PURPOSE:
PLACE FILL AND STEEL PILE AS PART OF THE CONSTRUCTION OF AN ACCESS ROAD BRIDGE

DATUM:
BRITISH PETROLEUM MEAN SEA LEVEL

ADJACENT PROPERTY OWNERS:

HYDROLOGIC DATA

APPROX. ORDINARY HIGH WATER (OHW) ELEVATION = 80'

QUANTITIES SUMMARY

NFS GRAVEL BELOW OHW	100 CY
FILL AREA BELOW OHW	0.015 ACRE

Peratrovich, Nottingham & Drage, Inc.
Engineering Consultants

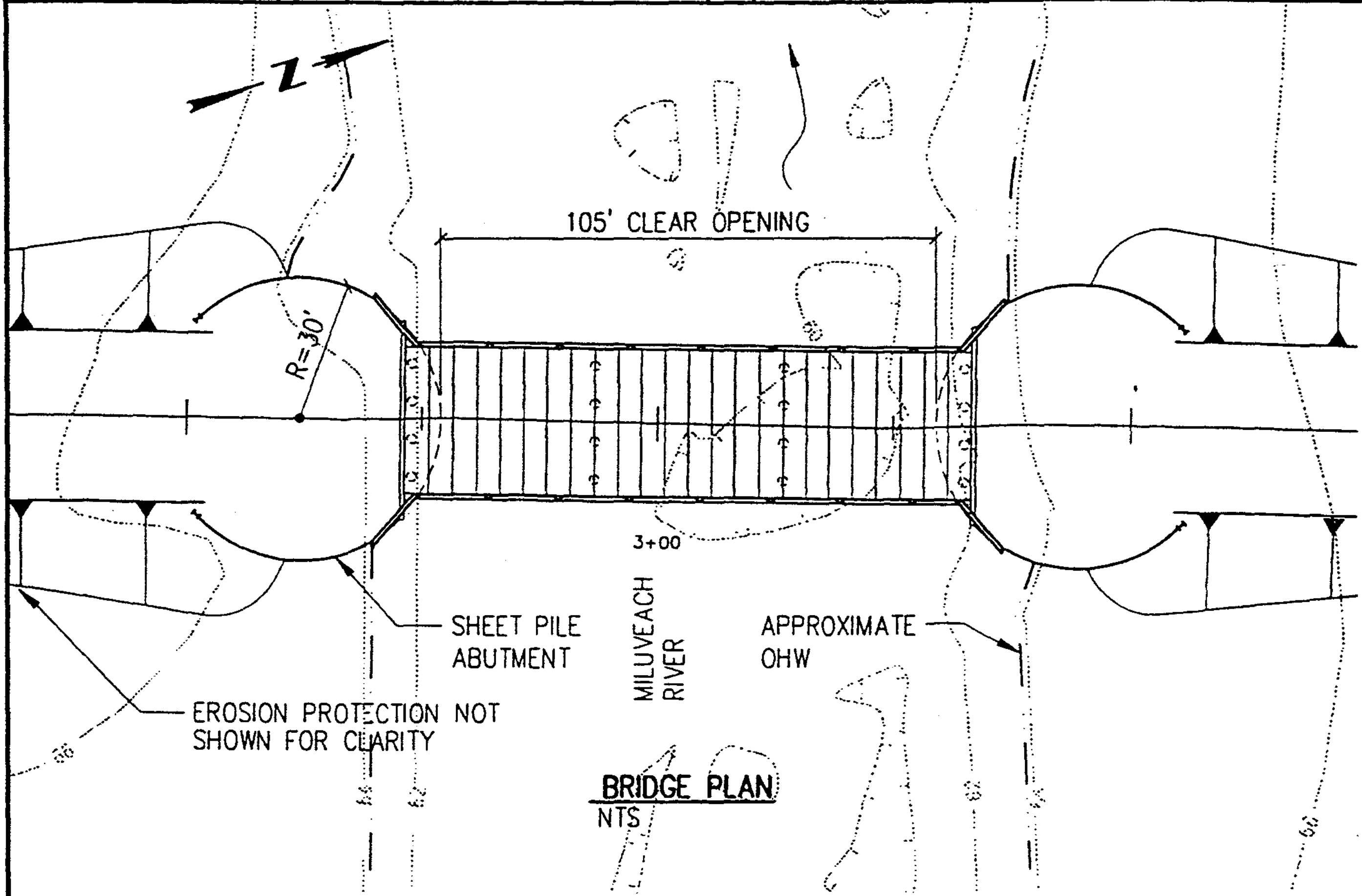
ARCO Alaska, Inc.

AREA: 00 MODULE: XXXX UNIT: R1

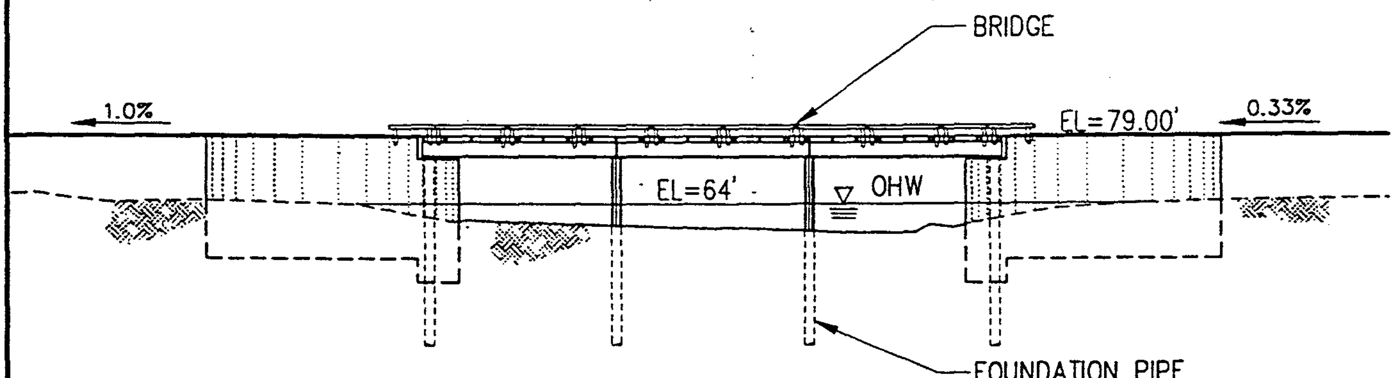
KUPARUK RIVER UNIT
TARN PROJECT
TROUBLE CREEK BRIDGE

CADD FILE NO.	DRAWING NO.	SHEET:	REV:
– –	CEA-R1XX-3945	001 OF 1	0

REV	DATE	BY	CK	APP	DESCRIPTION	REV	DATE	BY	CK	APP	DESCRIPTION
0	8/15/97	SA	DTK	ABC	ISSUE FOR PERMIT						



BRIDGE PLAN
NTS



BRIDGE ELEVATION AT CENTERLINE
NTS

PURPOSE:
PLACE FILL AND STEEL PILE AS PART OF THE CONSTRUCTION OF AN ACCESS ROAD BRIDGE

DATUM:
BRITISH PETROLEUM MEAN SEA LEVEL

ADJACENT PROPERTY OWNERS:

QUANTITIES SUMMARY

NFS GRAVEL BELOW OHW	100 CY
FILL AREA BELOW OHW	0.015 ACRE

HYDROLOGIC DATA

APPROX. ORDINARY HIGH WATER (OHW) ELEVATION = 64'

Peratrovich, Nottingham & Drage, Inc.
Engineering Consultants

ARCO Alaska, Inc.

AREA: 00 MODULE: XXXX UNIT: R1

KUPARUK RIVER UNIT
TARN PROJECT
MILUVEACH RIVER BRIDGE

CADD FILE NO.	DRAWING NO:	SHEET:	REV:
– –	CEA-R1XX-3946	001 OF 1	0

REV	DATE	BY	CK	APP	DESCRIPTION	REV	DATE	BY	CK	APP	DESCRIPTION
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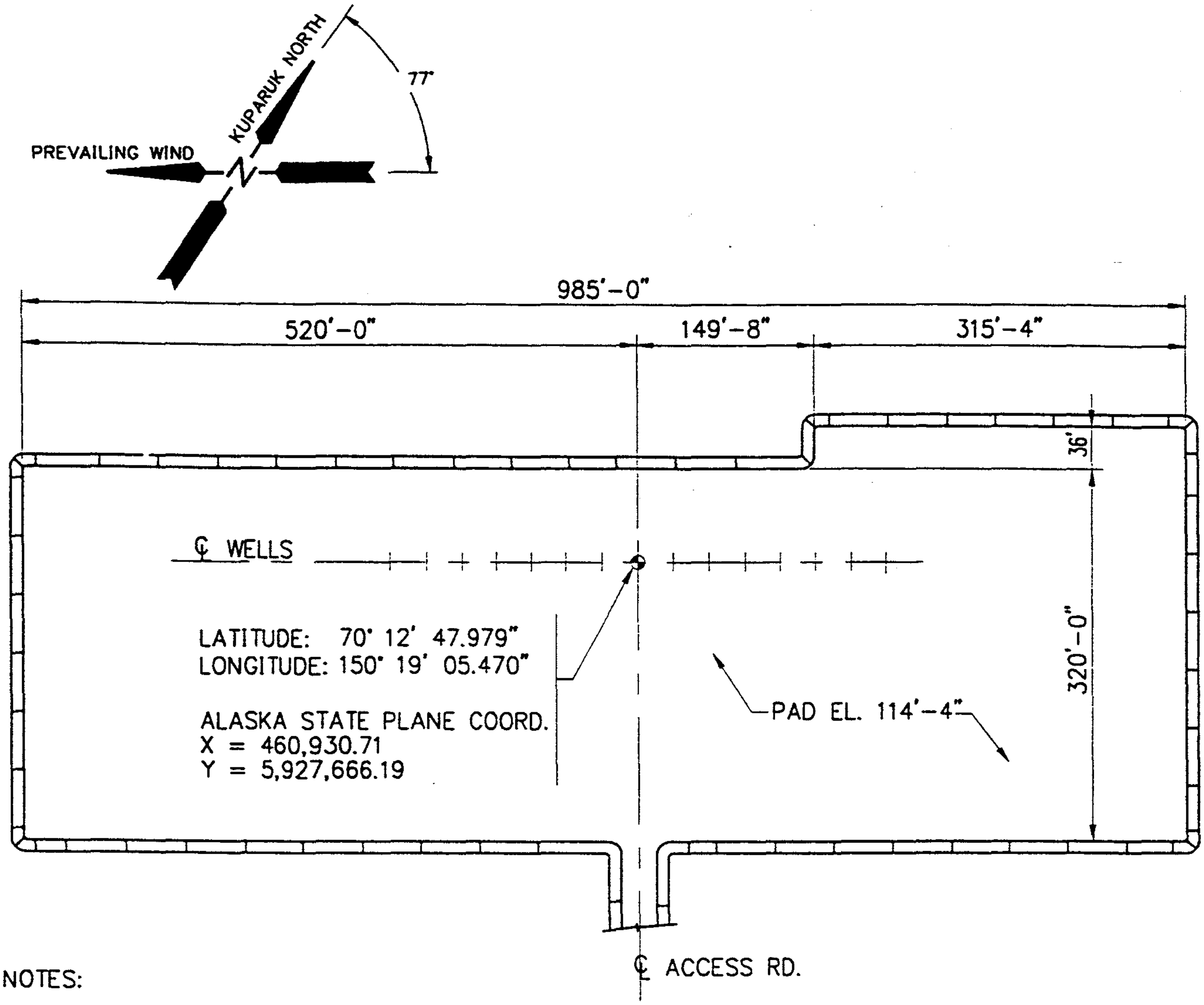
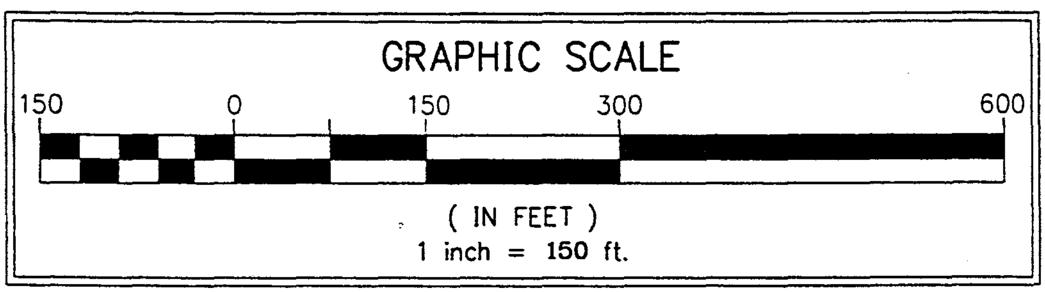


NOTES:

1. DATUM: BRITISH PETROLEUM MEAN SEA LEVEL.
2. ESTIMATED AREA OF TUNDRA COVER: 8.12 ACRES.
3. ESTIMATED QUANTITY OF GRAVEL: 63,040 CY.



Alaska Anvil Inc.
Anvil Job No.: AE7600
Acad File No.: 33EB8D16
Date & Time : 08/11/97 16:29

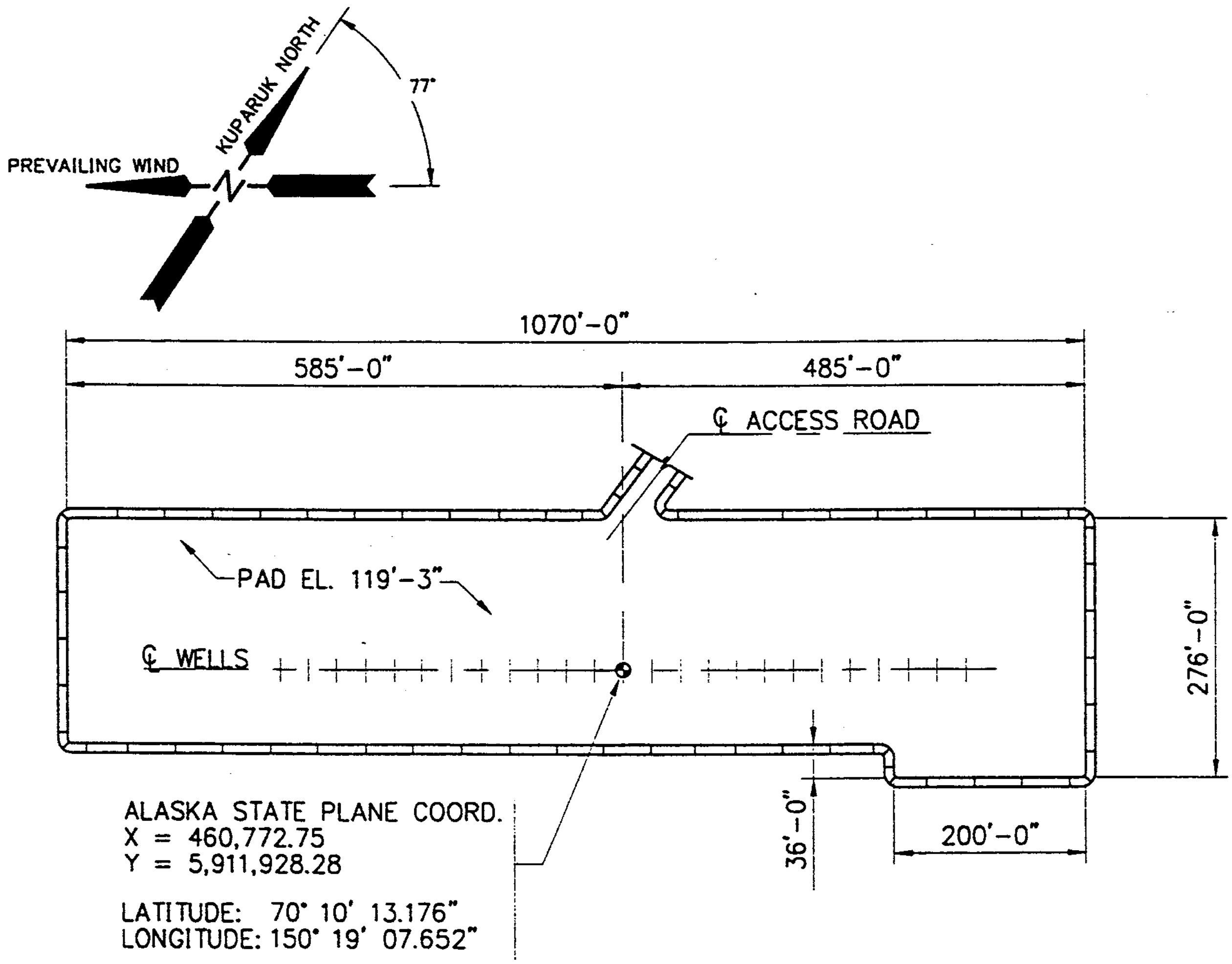
ARCO Alaska, Inc.

AREA: 2L | MODULE: XXXX | UNIT: D2

KUPARUK RIVER UNIT
TARN PROJECT
DS2L PAD

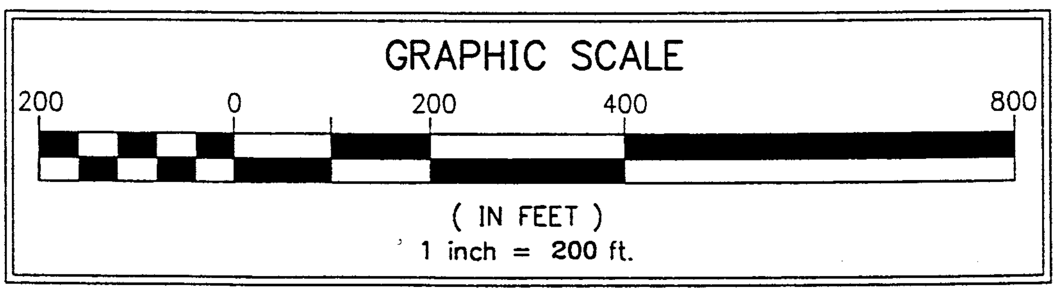
CADD FILE NO.		DRAWING NO:	SHEET:	REV:
-	1997	CEA-R1XX-3947	001 OF 1	A

REV	DATE	BY	CK	APP	DESCRIPTION	REV	DATE	BY	CK	APP	DESCRIPTION
0	8/15/97	R2G	JIB	SLC	ISSUE FOR PERMIT						



NOTES:

1. DATUM: BRITISH PETROLEUM MEAN SEA LEVEL.
2. ESTIMATED AREA OF TUNDRA COVER: 6.70 ACRES.
3. ESTIMATED QUANTITY OF GRAVEL: 51,430 CY.



Alaska Anvil Inc.
Anvil Job No.: AE7600
Acad File No.: 33EBA80B
Date & Time : 08/11/97 16:21

ARCO Alaska, Inc.

AREA: 2N MODULE: XXXX UNIT:

KUPARUK RIVER UNIT
TARN PROJECT
DS2N PAD

CADD FILE NO.	DRAWING NO:	SHEET:	REV:
– 1997	CEA-R1XX-3948	001 OF 1	A

Appendix V

APPENDIX V

USACE PUBLIC NOTICE FOR TARN DEVELOPMENT

US Army Corps
of Engineers

Alaska District

Regulatory Branch (1145b)
Post Office Box 898
Anchorage, Alaska 99506-089:

Public Notice of Application for Permit

PUBLIC NOTICE DATE: 26 AUGUST 1997

EXPIRATION DATE: 25 SEPTEMBER 1997

REFERENCE NUMBER: 4-970705

WATERWAY NUMBER: **Kuparuk River 124**

Interested parties are hereby notified that an application has been received for a Department of the Army (DA) permit for certain work in waters of the United States, as described below and shown on the attached plan.

APPLICANT: ARCO Alaska, Inc. (AAI), Post Office Box 100360, Anchorage, Alaska 99510-0360. Point of Contact: Lisa L. Pekich, Environmental Coordinator, Kuparuk Environmental Department, telephone: (907) 265-1173, FAX (907) 263-4035.

LOCATION: Sections 28, 33, and 34, Township 11 North, Range 8 East; sections 4, 5, 7, 8, and 18, Township 10 North, Range 8 East; sections 13, 14, 23, 22, 27, and 34, Township 10 North, Range 7 East; and section 3, Township 9 North, Range 7 East, Umiat Meridian, North Slope Borough, Alaska. The proposed Drillsite 2L is approximately 6.2 miles from the existing Kuparuk River Unit (KRU) Drillsite 2M. The proposed Drillsite 2N is approximately 2.9 miles from proposed DS 2L and 8.3 miles southwest from the existing Drillsite 2M.

WORK: AAI proposes placement of 505,670 cubic yards (cy) of gravel fill material into 72.8 acres of waters of the United States (U.S.), including wetlands, to construct two drillsites (DS), an access road, and 10 miles of buried powerlines. Powerlines would be installed by the use of a ditch-witch or similar equipment.

	acreage	cubic yards	top of pad/crown dimensions
1. Drillsite 2L access road from DS 2M	41.2	285,600	30' x 37,800'
2. Drillsite 2L	8.1	63,040	320' x 985'
3. Drillsite 2N access road from DS 2L	16.8	105,600	30' x 15,200'
4. Drillsite 2N	6.7	51,430	240' x 1070'
Total	72.8	505,670	

Note: Gravel road depth varies from 4.0' to 6.0'; an average road depth of 4.8' was used to calculate fill quantities. Acreage includes area covered by gravel pad side-slopes (2H:1V). All volume is final grade quantities. DS 2L access road quantities include gravel fill at bridge crossings.

approximately 2.0 miles from DS 2M. The construction of the road through West Sak 15 allows consolidation of gravel facilities and utilization of the pad as a construction staging area. After construction is complete, the site would be rehabilitated. A proposed rehabilitation plan and schedule of activities at this site are included in Appendix B, of AAI's permit application. Vehicle traffic is expected to be about four vehicles per day after construction.

Miluveach River and Unnamed Creek (Trouble Creek) Road Crossings. Bridge crossings are proposed at both "Trouble Creek " (the drainage directly to the west of DS 2M) and the Miluveach River. The proposed 40' Trouble Creek bridge and the 120' Miluveach River bridge would be supported by approximately 26-inch and 30-inch diameter steel piles, and would include steel sheet pile cell abutments to retain road fill and protect the bridge abutments from ice and erosion. Erosion protection would be provided along a portion of the roadway. The finished bridges are expected to look and function similar to the Central Creek Bridge at Milne Point.

The two bridge superstructures would consist of multiple, steel wide-flange girders in 40-ft. span configurations. The bridge decks would consist of precast concrete deck panels. The girders, panels, and foundation piles would be designed for drill rig type loads. The bottom chord of the bridges would be set a minimum of 3-ft. above the 100-year flood elevations. Bridge piers are designed for expected ice conditions.

Material Source. The gravel required for construction of the drill sites and access roads would be obtained from Mine Site F on the Kuparuk River Unit. The open cell of Mine Site F is being dewatered under the NPDES No. AKG-31-005 (General NPDES Permit for Facilities Relating to Oil and Gas Extraction). The remaining gravel in the open cell of Mine Site F should be sufficient to meet the needs of the proposed development; however, a future aliquot to the north has already been permitted for expansion. If necessary, this aliquot may need to be opened to support this project. Gravel removal from Mine Site F is authorized under State of Alaska Material Sales Contract ADL 415353 and COE permit number M-840481.

Road Stabilization. AAI proposes to apply a soil stabilization product to the gravel roads and pads during break-up of 1998. The product identification name is EMC Squared Stabilizer. It is an earth materials catalyst (biocatalyst) designed to improve the cementation and stability of compacted aggregate and earth materials. The gravel mined from Mine Site F would be frozen and would not have an opportunity to drain. This would likely cause the road to be extremely unstable once it thaws. Therefore, AAI proposes to grade EMC Squared Stabilizer into the gravel surface during break-up.

Powerline. The electric power for DS 2L and DS 2N would be provided by upgrading the existing powerlines from CPF-2 to DS 2M. From this point, a new line would be trenched next to the access road. The line would run along the same route as the road. The line would need to be spliced at regular intervals; incorporating surface mounted splice boxes. AAI is still evaluating the technical details of this method of installation. Should this method of power transmission prove unfeasible, an overhead line would be proposed to the same standards as the Kuparuk overhead powerlines.

Spill Prevention and Response. AAI proposes to amend the Kuparuk River Unit Oil Discharge Prevention and Contingency Plan to include DS 2N and DS 2L and the associated pipelines.

WATER QUALITY CERTIFICATION: A permit for the described work will not be issued until a certification or waiver of certification as required under Section 401 of the Clean Water Act (Public Law 95-217), has been received from the Alaska Department of Environmental Conservation.

COASTAL ZONE MANAGEMENT ACT CERTIFICATION: Section 307(c)(3) of the Coastal Zone Management Act of 1972, as amended by 16 U.S.C. 1456(c)(3), requires the applicant to certify that the described activity affecting land or water uses in the coastal zone complies with the Alaska Coastal Management Program. A permit will not be issued until the Office of Management and Budget, Division of Governmental Coordination has concurred with the applicant's certification.

CULTURAL RESOURCES: The latest published version of the Alaska Heritage Resources Survey (AHRS) was consulted for the presence or absence of historic properties, including those listed in or eligible for inclusion in the National Register of Historic Places. Consultation of the AHRS constitutes the extent of cultural resource investigations by the District Engineer at this time, and he is otherwise unaware of the presence of such resources. The applicant contracted an archaeological and cultural resources reconnaissance study for the Tarn project. Dr. John Lobdell of Lobdell & Associates conducted an archaeological reconnaissance in the proposed project area on August 6-10, 1997. This application and a copy of the reconnaissance report are being coordinated with the State Historic Preservation Office (SHPO). Any comments SHPO may have concerning presently unknown archeological or historic data that may be lost or destroyed by work under the requested permit will be considered in our final assessment of the described work.

ENDANGERED SPECIES: The project area is within the known or historic range of the Steller's eider (Polysticia stelleri), and the spectacled eider (Somateria fischeri). No threatened or endangered species are known to use the project area. Preliminary, the described activity will not affect threatened or endangered species, or their critical habitat designated as endangered or threatened, under the Endangered Species Act of 1973 (87 Stat. 844). This application is being coordinated with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. Any comments they may have concerning endangered or threatened wildlife or plants or their critical habitat will be considered in our final assessment of the described work.

FEDERAL SPECIES OF CONCERN: The following Federal species of concern may use the project area: Polar Bear, Black Brant, Canada Goose, Lesser Canada Goose, Lesser Snow Goose, White-fronted Goose, Tundra Swan, and Arctic Peregrine Falcon.

FLOOD PLAIN MANAGEMENT: Evaluation of the described activity will include conformance with appropriate State or local flood plain standards; consideration of alternative sites and methods of accomplishment; and weighing of the positive, concentrated and dispersed, and short and long-term impacts on the flood plain.

SPECIAL AREA DESIGNATION: Formerly part of the Kuparuk River Unit.

EVALUATION: The decision whether to issue a permit will be based on an evaluation of the probable impacts including cumulative impacts of the proposed activity and its intended use on the public interest. Evaluation of the probable impacts which the proposed activity may have on the public interest requires a careful weighing of all those factors which become relevant in each particular case. The benefits which reasonably may be expected to accrue from the proposal must be balanced against its reasonably foreseeable detriments. The decision whether to authorize a proposal, and if so, the conditions under which it will be allowed to occur, are therefore determined by the outcome of the general balancing process. That decision should reflect the national concern for both protection and utilization of important resources. All factors which may be relevant to the proposal must be considered

ATTACHMENT A
4-970705, KUPARUK 124

Table 1. Design features used for avoidance and minimization of environmental impacts from the Kuparuk River Unit Tarn Project, Alaska.

Design Feature	Expected Benefit
GENERAL DESIGN	
Review historical data on wildlife use within the proposed project area	Identify critical issues and wildlife species early in design process
Collect baseline data from field surveys of fish, mammals (caribou), and birds (Tundra Swans, Spectacled Eiders)	Identify important fish streams and locations for stream crossings to avoid or minimize impacts on fish; avoid or minimize use of areas used by Spectacled Eiders (a threatened species)
Obtain current low-altitude aerial photography (true color and CIR) of proposed project area	Enhance environmental assessment and spill response planning; optimize facility siting
Identify and map vegetation types and wildlife habitats in the proposed project area from aerial photography	Identify vegetation types or habitats types for avoidance or minimization; avoid and minimize impacts to higher-value wetland types
Coordinate with U.S. Fish and Wildlife Service on Spectacled Eider surveys (1993–1997)	Ensure protection of threatened species; optimize sampling of habitats along proposed alternatives during baseline surveys
Use existing production and power generation facilities in the Kuparuk Oilfield	Eliminate need for additional facilities, minimize facility size
DRILL SITE DESIGN	
Minimize size of drill site pad; 30' wellhead spacing allowing for future in-fill drilling at 15' spacing	Minimize habitat loss
Provide powerline to drill site pad	No significant air emission sources required
Drill sites designed for no reserve pits	Reduced pad size and eliminate potential for contaminant release from reserve pits
Zero permanent discharge from drill sites of solid and liquid wastes to tundra or other waters (no permanent camp required)	Reduce impacts to tundra and wetlands, reduce contaminant release
Align drill sites with prevailing winds.	Minimizes snow accumulation and snow removal requirements. Potentially avoids need for snow fence.
ROAD DESIGN	
Route road through existing gravel pad at West Sak 15	Consolidates gravel facilities on the North Slope
Future development potential considered during selection of road alignment	Minimize need for future additional facilities; minimize additional road length
Identify potential culvert and stream crossing (bridges) requirements for road and incorporate into project design	Reduce alterations to surface drainage patterns; avoid or minimize effects of road on existing streams; allow free passage of fish; protect spawning sites

Table 2. Proposed actions for avoidance and minimization of environmental impacts during construction and operation of the Kuparuk River Unit Tarn Project, Alaska.

Proposed Action	Expected Benefit
Conduct all major activities (e.g., pipeline construction, bridge construction, gravel mining, place road gravel) during winter	Eliminate impacts of construction on wildlife; minimize impacts to tundra and wetlands
Construct pipeline during winter from ice road	Eliminate impacts of construction on wildlife; minimize impacts to tundra and wetlands during construction and eliminate impacts from an access road
Provide on-site environmental presence during construction to ensure compliance with permit requirements	Minimize variances from permitted activities
Employ construction and operation technological advances and lessons learned through AAI's 20-plus years of experience on the North Slope	Minimizes overall impact, reduces probabilities of human, equipment, and design failure
Require secondary containment for all temporary fuel storage locations during construction	Minimizes or avoids spills to tundra and wetlands
Restrict on-tundra activities to permitted areas	Minimize impacts to tundra outside of areas authorized by permit
Prohibit work in streams during fish spawning runs	Reduce impacts to fish
Coordinate with U.S. Fish and Wildlife Service on historical and recent locations of polar bear den sites	Avoid actions that would disturb denning polar bears
Strictly enforce speed limits within project construction areas	Reduce potential impacts to wildlife; reduce accidents both on road surface and onto tundra; reduce accidental spills of contaminants during accidents
Prevent icing of culverts by method of installation (during construction period), proper maintenance, and thawing as deemed necessary	Avoid flooding and impoundments during breakup; minimizes thermokarst; avoid gravel deposition on tundra
Strictly enforce speed limits on roads and pads, and employ dust controls	Reduce potential impacts to wildlife; reduce accidents both on road surface and onto tundra; reduce accidental spills of contaminants during accidents; minimize dust generation
Use existing KRU facilities for accommodating workers	Reduce duplication of facilities
Prohibit hunting by oil field personnel and restrict public access	Protect fish and wildlife
Train personnel in proper interactions with wildlife	Reduce potential for harassment of wildlife; reduce adverse effects on personnel from interactions
Provide powerline to drill sites	Avoids significant air emission sources. Reduces noise in the area.

REV	DATE	BY	CK	APP	DESCRIPTION	REV	DATE	BY	CK	APP	DESCRIPTION
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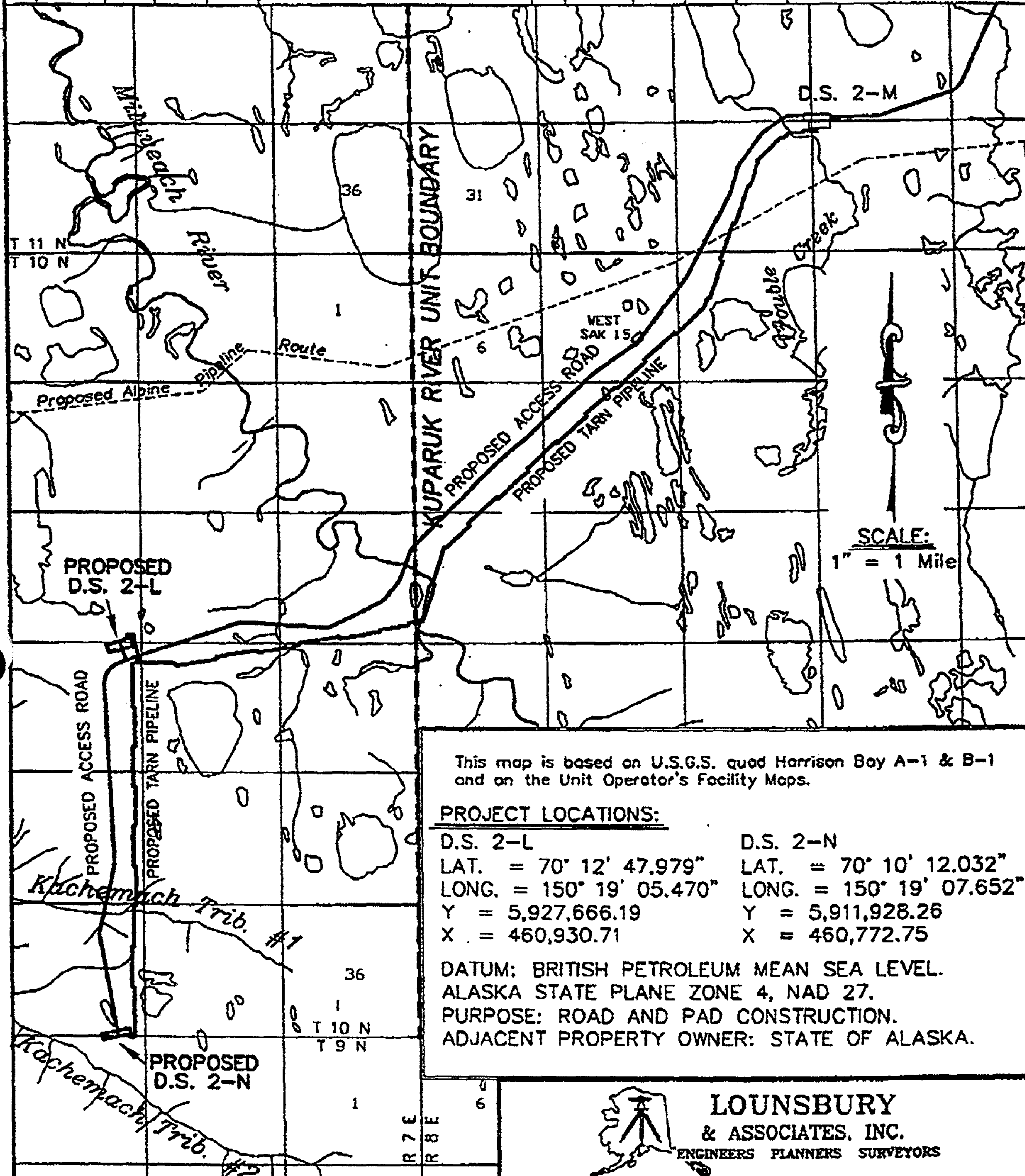

This map is based on U.S.G.S. quad Harrison Bay A-1 & B-1 and on the Unit Operator's Facility Maps.

PROJECT LOCATIONS:

D.S. 2-L	D.S. 2-N
LAT. = 70° 12' 47.979"	LAT. = 70° 10' 12.032"
LONG. = 150° 19' 05.470"	LONG. = 150° 19' 07.652"
Y = 5,927,666.19	Y = 5,911,928.26
X = 460,930.71	X = 460,772.75

DATUM: BRITISH PETROLEUM MEAN SEA LEVEL.
ALASKA STATE PLANE ZONE 4, NAD 27.
PURPOSE: ROAD AND PAD CONSTRUCTION.
ADJACENT PROPERTY OWNER: STATE OF ALASKA.

LOUNSBURY & ASSOCIATES, INC.
ENGINEERS PLANNERS SURVEYORS

ARCO Alaska, Inc.
Subsidiary of Atlantic Richfield Company

AREA 00 MODULE XXXX UNIT R1

KUPARUK RIVER UNIT
TARN PROJECT
PROJECT MAP

4-970705

CADD FILE NO.		DRAWING NO.	SHEET:	REV:
–	–	CEA-R1XX-3936	1 OF 1	0

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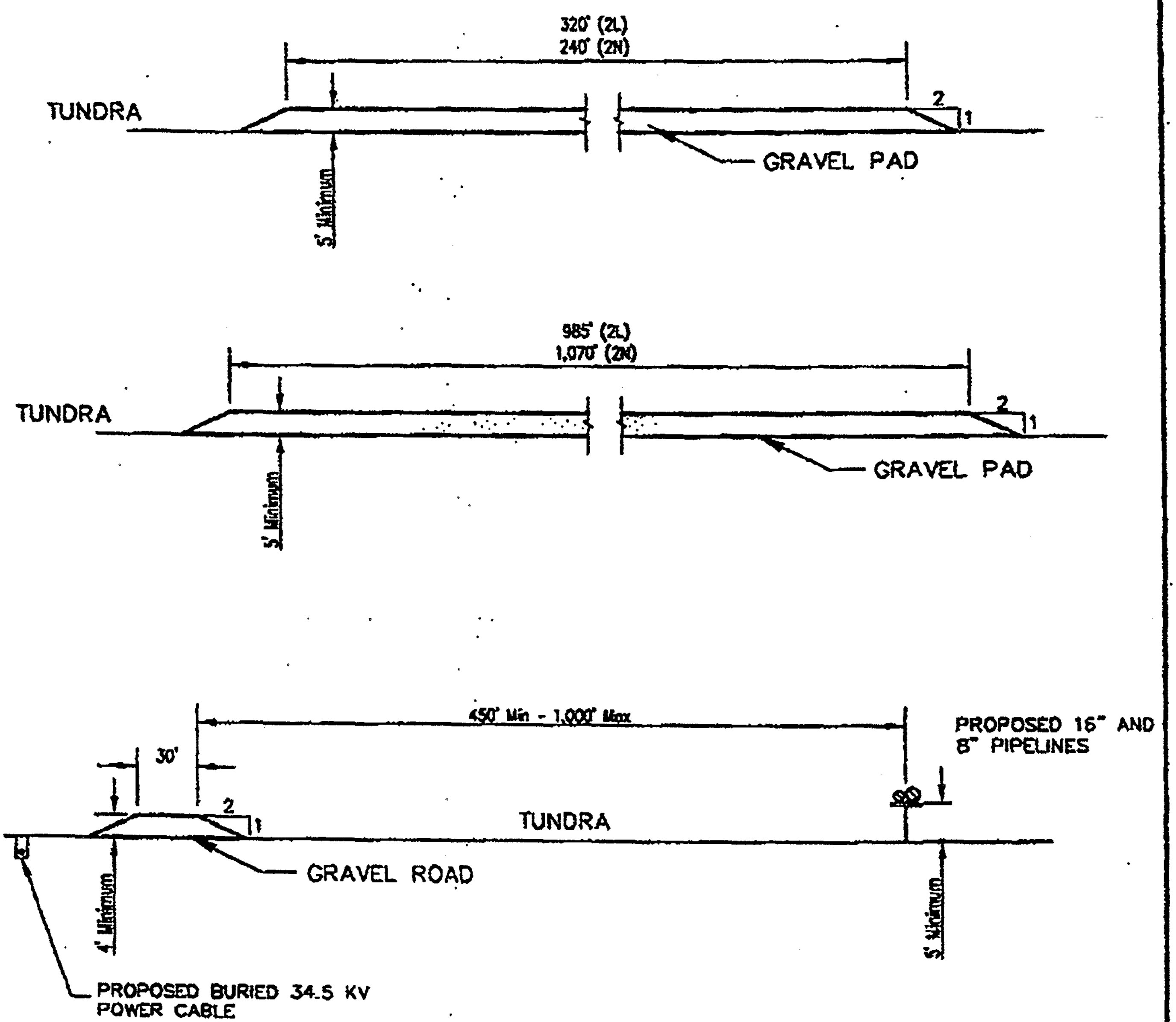

LOUNSBURY & ASSOCIATES, INC.
ENGINEERS PLANNERS SURVEYORS

ARCO Alaska, Inc.
Subsidiary of Atlantic Richfield Company

AREA 00 MODULE XXXX UNIT R1

KUPARUK RIVER UNIT
TARN PROJECT
CROSS-SECTIONS

4-970705

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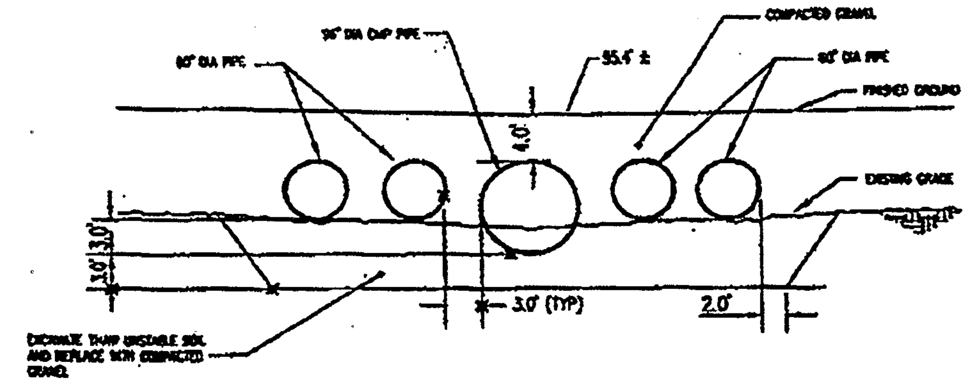
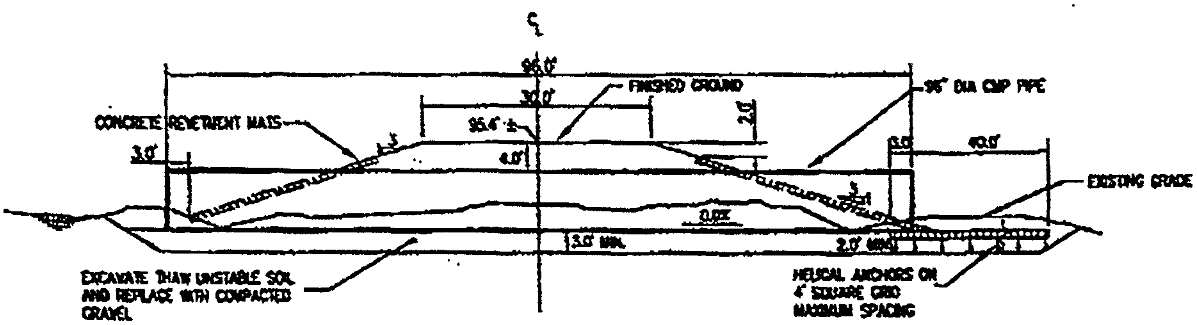


CULVERT INSTALLATION: CROSS SECTION
NTS



CULVERT INSTALLATION: CROSS SECTION
NTS

LOUNSBURY
& ASSOCIATES, INC.
ENGINEERS PLANNERS SURVEYORS

ARCO Alaska, Inc.
Subsidiary of Atlantic Richfield Company

AREA 00 MODULE XXXX UNIT R1

4-970705

KUPARUK RIVER UNIT
TARN PROJECT
MILUVEACH RIVER TRIBUTARY CULVERT DETAILS

CADD FILE NO. | DRAWING NO: | SHEET: | REV:

REV	DATE	BY	CK	APP	DESCRIPTION	REV	DATE	BY	CK	APP	DESCRIPTION
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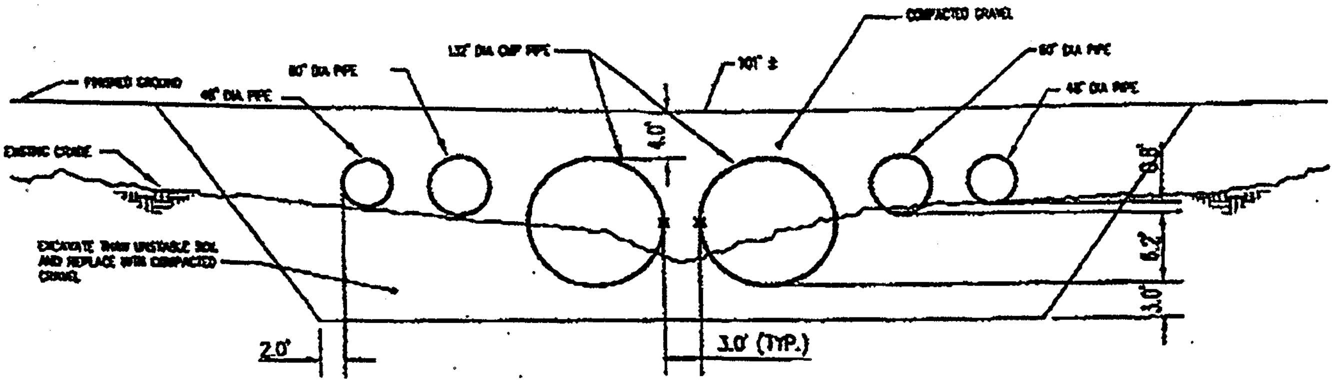
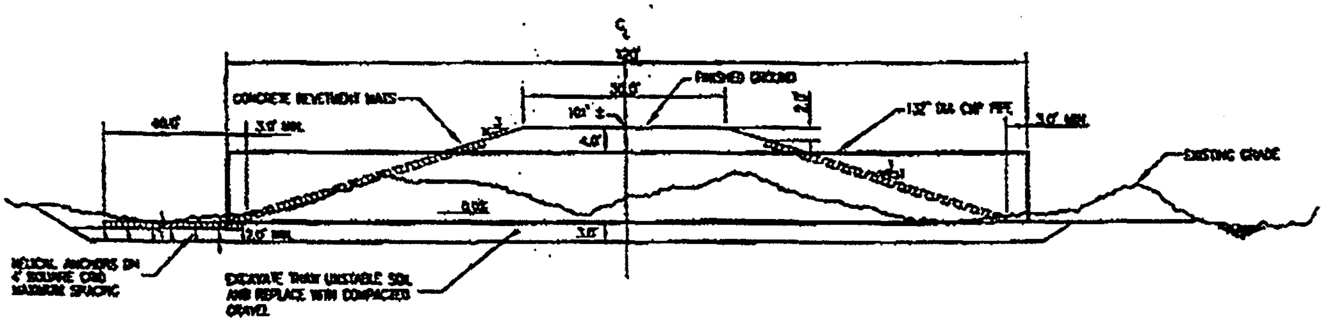


CULVERT INSTALLATION: CROSS SECTION
NTS



CULVERT INSTALLATION: CROSS SECTION
NTS

LOUNSBURY
& ASSOCIATES, INC.
ENGINEERS PLANNERS SURVEYORS

ARCO Alaska, Inc.
Subsidiary of Atlantic Richfield Company

AREA 00 MODULE XXXX UNIT R1

4-970705 KUPARUK RIVER UNIT
TARN PROJECT
KACHEMACK RIVER TRIBUTARY CULVERT DETAILS

DRAWING NO: SHEET: REV:

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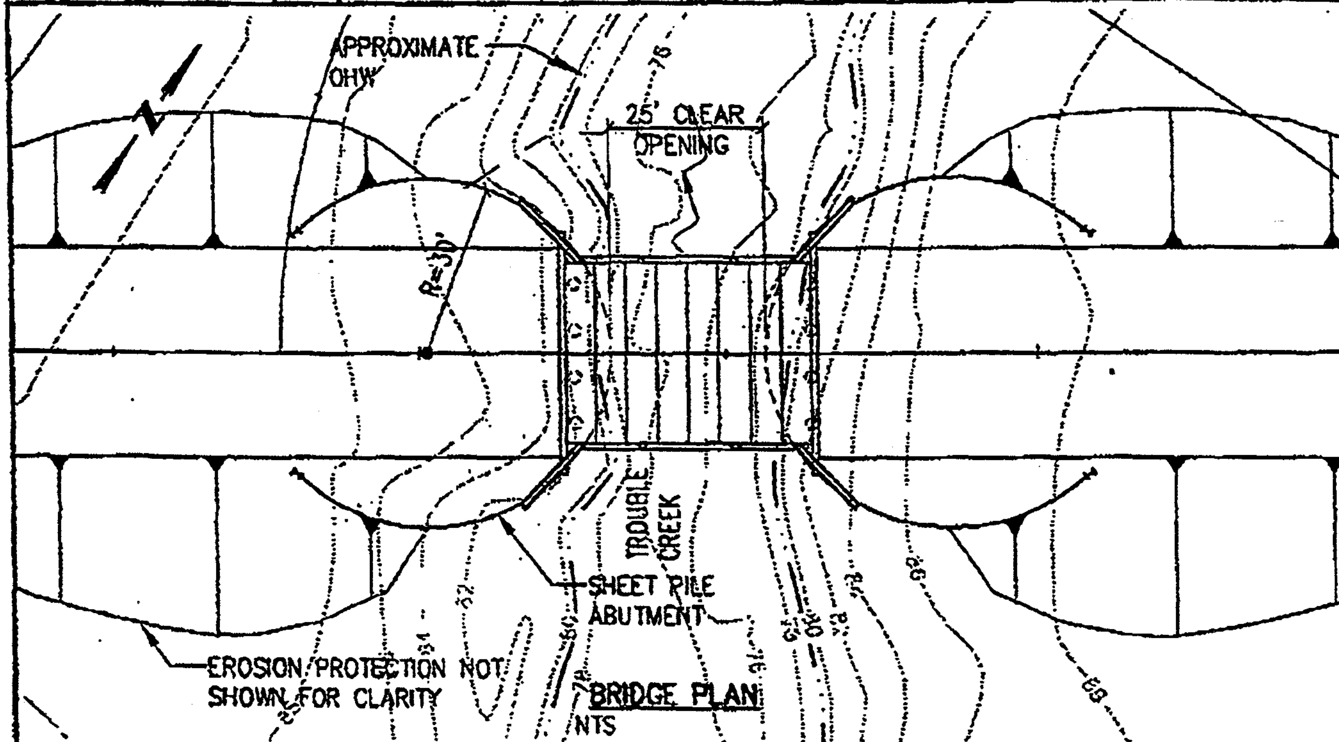
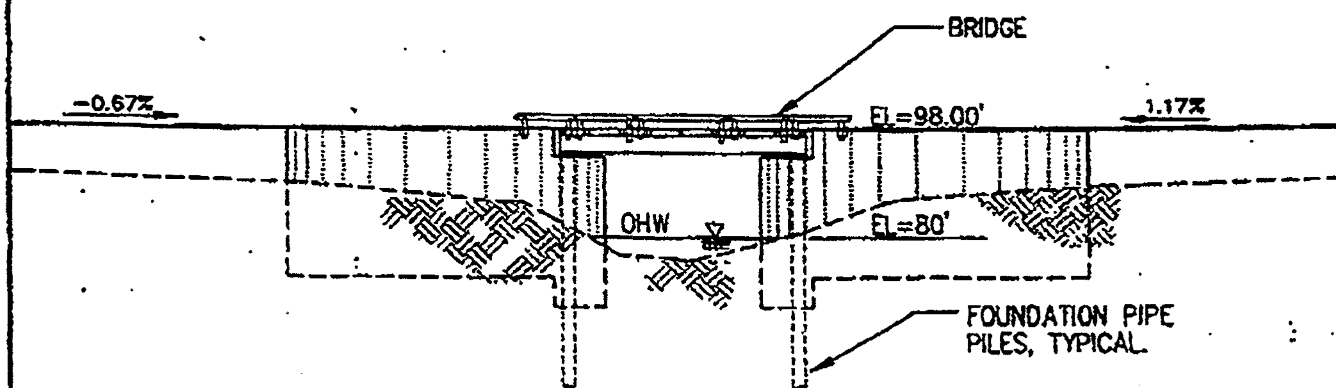
0	8/15/97	SA	DTK	ABC	ISSUE FOR PERMIT						



BRIDGE PLAN
NTS



BRIDGE ELEVATION AT CENTERLINE
NTS

PURPOSE:
PLACE FILL AND STEEL PILE AS PART OF THE CONSTRUCTION OF AN ACCESS ROAD BRIDGE

DATUM:
BRITISH PETROLEUM MEAN SEA LEVEL

ADJACENT PROPERTY OWNERS:

HYDROLOGIC DATA

APPROX. ORDINARY HIGH WATER (OHW) ELEVATION = 80'

QUANTITIES SUMMARY

NFS GRAVEL BELOW OHW	100 CY	
FILL AREA BELOW OHW	0.015 ACRE	

Peratrovich, Nottingham & Drage, Inc.
Engineering Consultants

ARCO Alaska, Inc.

AREA: 00 MODULE: XXXX UNIT: R1

KUPARUK RIVER UNIT
TARN PROJECT
TROUBLE CREEK BRIDGE

4-970705

CADD FILE NO. - -

DRAWING NO: CEA-R1XX-3945

SHEET: 001 OF 1

REV: 0

REV	DATE	BY	CK	APP	DESCRIPTION	REV	DATE	BY	CK	APP	DESCRIPTION
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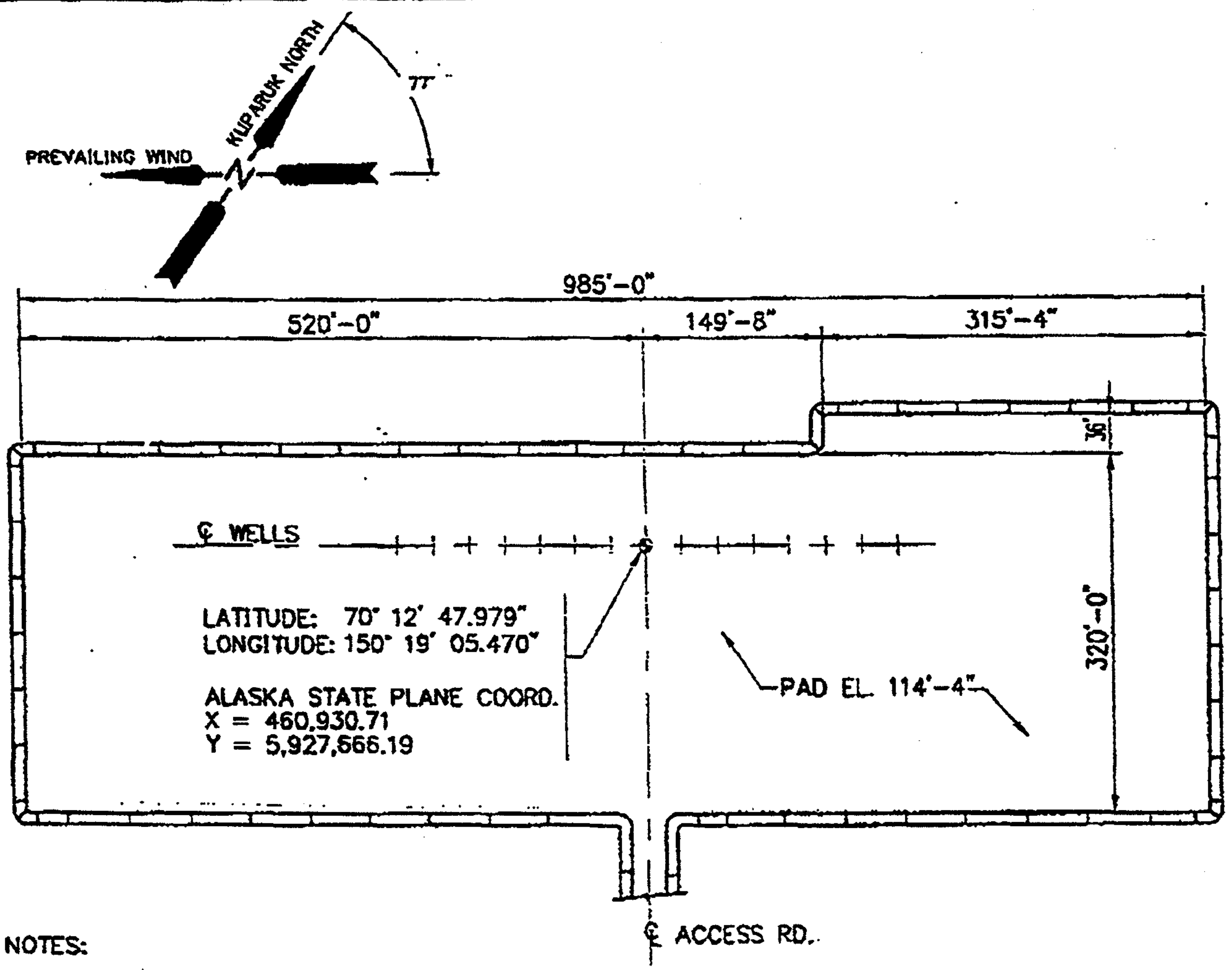
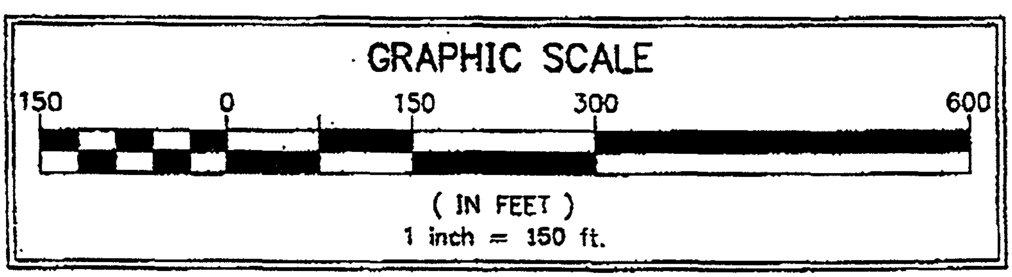


NOTES:

1. DATUM: BRITISH PETROLEUM MEAN SEA LEVEL.
2. ESTIMATED AREA OF TUNDRA COVER: 8.12 ACRES.
3. ESTIMATED QUANTITY OF GRAVEL: 63,040 CY.



Alaska Anvil Inc.
Anvil Job No.: AE7600
Acad File No.: 33EB8D16
Date & Time : 08/11/97 16:29

ARCO Alaska, Inc.

AREA: 2L MODULE: XXXX UNIT: D2

4-970765

KUPARUK RIVER UNIT
TARN PROJECT
DS2L PAD

CADD FILE NO. DRAWING NO: SHEET: REV:

STATE OF ALASKA

Tony Knowles, Governor

OFFICE OF THE GOVERNOR

OFFICE OF MANAGEMENT AND BUDGET
DIVISION OF GOVERNMENTAL COORDINATION

☐ SOUTHCENTRAL REGIONAL OFFICE
3601 "C" STREET, SUITE 370
ANCHORAGE, ALASKA 99503-5930
PH: (907) 561-6131/FAX: (907) 561-6134

☐ CENTRAL OFFICE
P.O. BOX 110030
JUNEAU, ALASKA 99811-0300
PH: (907) 465-3562/FAX: (907) 465-3075

☑ PIPELINE COORDINATOR'S OFFICE
411 WEST 4TH AVENUE, SUITE 2C
ANCHORAGE, ALASKA 99501-2343
PH: (907) 278-8594/FAX: (907) 272-0690

STATE OF ALASKA

DIVISION OF GOVERNMENTAL COORDINATION

Notice of Application for
Certification of Consistency with the
Alaska Coastal Management Program

Notice is hereby given that a request is being filed with the Division of Governmental Coordination for concurrence, as provided in Section 307 (c)(3) of the Coastal Zone Management Act of 1972, as amended [P.L. 94-370; 90 Stat. 1013; 16 U.S.C. 1456 (c)(3)], that the project described in the Corps of Engineers Public Notice Number 4-970705, will comply with the Alaska Coastal Management Program and that the project will be conducted in a manner consistent with that program.

The Division of Governmental Coordination requests your comments on the proposed project's consistency with the Alaska Coastal Management Program. For more information on the consistency review process and the comment deadline, or to submit written comments, please contact the Division of Governmental Coordination, State Pipeline Coordinator's Office, 411 W. 4th Avenue, Suite 2-C, Anchorage, Alaska 99503-2798.

Attachment 2

Appendix W

APPENDIX W

KUUKPIK CORPORATION SURFACE AGREEMENT NEWS ANNOUNCEMENT AND SUPPORT LETTER

ARCO Alaska, Inc. and the Kuukpik Corporation signed a historic agreement this afternoon that allows for the development of the Alpine discovery on native owned lands.

The following news announcement was released by the Kuukpik Corporation earlier today.

NEWS

For immediate release
August 27, 1997

Kuukpik agreements protect subsistence,
allow Alpine field development

ANCHORAGE -- Kuukpik Corporation today announced agreements with Arctic Slope Regional Corporation (ASRC) and ARCO Alaska, Inc. that protect the subsistence lifestyle of the Nuiqsut community while ensuring that Nuiqsut residents benefit from development of the nearby Alpine oil field.

A portion of the 365-million-barrel Alpine oil field underlies Kuukpik lands. While Kuukpik received the surface estate, under the Alaska Native Claims Settlement Act ownership of the oil and gas was conveyed to ASRC, the local regional corporation.

Under the agreement with ASRC, Kuukpik will receive an overriding royalty interest for consenting to oil and gas production on Kuukpik lands. The terms of the agreement with ASRC are confidential.

A companion surface use agreement with ARCO Alaska, Inc. guarantees that subsistence hunting and fishing will be allowed in the Alpine field and creates a special subsistence oversight panel composed of Nuiqsut residents to monitor the health of subsistence resources on Kuukpik lands.

"The agreements reached today between the Inupiat community and ARCO Alaska for the Alpine development project are historic," said Joe Nukapigak, president of Kuukpik Corporation.

"Alaska Native leaders should be encouraged by the political significance and the social importance of the contractually guaranteed subsistence hunter access and resource protections that the Kuukpikmuit have achieved.

"The establishment of the Kuukpikmuit subsistence oversight panel will set a new standard in local control, self-determination and co-management of subsistence resources," Nukapigak said.

"I am pleased to say, that with ARCO's cooperation the voice and the will of Nuiqsut have been heard, our needs understood and our stewardship of the land accepted."

Under the agreement, ARCO and its partners Union Texas Petroleum Corporation and Anadarko Petroleum Corporation are granted the right to build and operate on Kuukpik lands the oil production and transportation facilities required to develop the Alpine field.

"This agreement is another important step towards development of the Alpine oil field and a major milestone in what is sure to be a long and positive partnership with Kuukpik and the people of Nuiqsut," said Frank Brown, senior vice president for ARCO Alaska's Kuparuk Business Unit.

Most of the terms and conditions of the agreement are confidential. However, ARCO Alaska, Union Texas Petroleum Corporation and Anadarko Petroleum Corporation - the owners of the Alpine field - have agreed:

• To make annual rental payments to Kuukpik for use of its surface estate.

• To provide natural gas at no cost to Kuukpik for use by Nuiqsut residents.

• To fund, with Kuukpik, scholarships and training grants which will allow Kuukpik shareholders to acquire the skills or professional certifications required for employment in the oil and gas industry on the North Slope.

• To fund, with Kuukpik, a comprehensive Alaska Native Employment Services Program to encourage the hiring, retention, training and promotion of Kuukpik shareholders and permanent Nuiqsut residents in the oil and gas field support services.

• To assist Kuukpik in its business development activities by ensuring that Kuukpik-owned and Kuukpik-affiliated companies have the chance to compete for work in the Alpine field and across the North Slope.

Nuiqsut Constructors, a joint venture between Kuukpik and SKW Eskimos, Inc., has already been selected to perform the civil construction work necessary for Alpine development. Other Kuukpik companies and joint ventures - Kuukpik/Pool Arctic drilling, Kuukpik/Carlyle Transportation, Kuukpik Arctic Catering and LCMF, Inc. are active on the North Slope.

For additional information contact:

Lanston Chinn 907-480-6220
Kuukpik Corporation

Ronnie Chappell 907-263-4102
ARCO Alaska, Inc.

KUUKPIK
CORPORATION

P.O. Box 187
Nuiqsut, Alaska 99789-0187
TEL: (907) 480-6220
FAX: (907) 480-6126

September 22, 1997

The Honorable Benjamin P. Nageak
Mayor
North Slope Borough
P.O. Box 69
Barrow, Alaska 99723

Dear Mayor Nageak:

On August 27, 1997, Kuukpik Corporation, Arctic Slope Regional Corporation (ASRC), and ARCO Alaska, Inc., participated in the signing of a series of agreements that will allow the Alpine oil field discovery to be developed. These milestone agreements provide the basis upon which Kuukpik Corporation, the Native Village of Nuiqsut, and the community of Nuiqsut as a whole, predicate their support for the safe and environmentally responsible development of Alpine.

The Surface Use Agreement entered into between Kuukpik Corporation and ARCO Alaska, Inc., is precedent setting both in it's comprehensiveness and scope, in establishing the general parameters and specific guidelines of a responsible approach to oil and gas development. A principal term is the contractually, guaranteed protection of subsistence resources and the lands throughout the former 11(a) Kuukpik Withdrawal Area; as delineated by the Alaska Native Claims Settlement Act of 1971. Additionally, ARCO Alaska Inc., has agreed to fund in part, the Kuukpikmuit Subsistence Oversight Panel composed of five local Nuiqsut residents, whose responsibility will be to monitor and provide for the protection of the wildlife resources and habitat that are such vital elements to the Inupiat Culture. The panel is also charged with recommending preventative and corrective measures which are required in order to mitigate both anticipated and unanticipated impacts.

Other primary terms of the Kuukpik - ARCO Surface Use Agreement include: a commitment to employ qualified, Kuukpik Shareholders and village residents, North Slope residents, and Alaska Natives; funding to offset the costs for training and retention of shareholders and residents through innovative monetary incentives for participating oil field support service contractors; partial funding for a Native Employment Program; natural gas to meet the heating and power generation needs of the Nuiqsut community; a matching scholarship fund; and ARCO's pledge to assist Kuukpik in the development of competitive business opportunities.

Of equal importance, Kuukpik Corporation and ASRC finally reached agreement after at least ten years of negotiations, that gives ASRC the right to develop the mineral estate under Kuukpik surface lands in the National Petroleum Reserve-Alaska (NPR-A).

Kuukpik Corporation's granting of it's consent right will now permit that portion of the Alpine oil field under Kuukpik lands in NPR-A to be developed and produced. The agreement known as the 1431(o) Agreement, (a reference to Section 1431(o) of the Alaska National Interest Lands Conservation Act of 1980 (ANILCA), provides Kuukpik with a share of the oil and gas royalties from the development of the Alpine oil field. More importantly, under the terms of the 1431(o) Agreement, all of the subsistence and environmental protection standards delineated in the Kuukpik - ARCO Surface Use Agreement will also apply to ASRC and it's subsidiary companies doing business anywhere within Kuukpik's former 11(a) withdrawal area.

Finally, Alpine is the first actual oil and gas development to occur in such close proximity to a local community on Alaska's North Slope. Because of this fact, fundamental considerations for the impact(s) on the socio-cultural fabric of the Nuiqsut community have been integrated into these agreements, along with terms that address preservation of the environment, subsistence resources, and the land. The Surface Use Agreement and the 1431(o) Agreement are now in place, and the demands of development have been balanced with the need for conservation of Kuukpikmiut subsistence values. With this in mind, Kuukpik Corporation, the Native Village of Nuiqsut, and the community of Nuiqsut overall, support the development of the Alpine oil field.

Sincerely,

Joe Nukapigak

Joe Nukapigak, President
Kuukpik Corporation

Thomas Napageak

Thomas Napageak, President
Native Village of Nuiqsut

cc: NSB Planning Commision
Karen Burnell, NSB Planning Director
J.K. "Ken" Thompson, President
ARCO Alaska, Inc.
Frank M. Brown, Senior Vice President
Mike Richter, Vice President

Appendix X