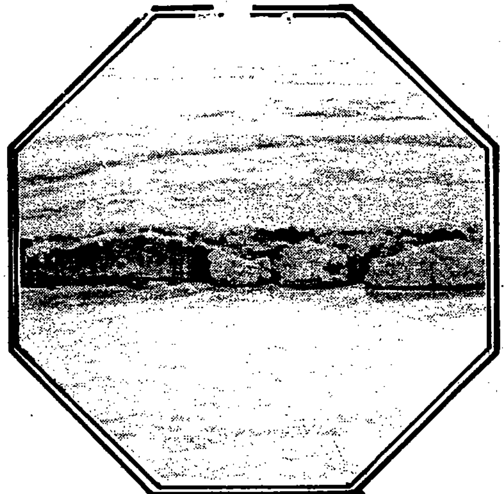
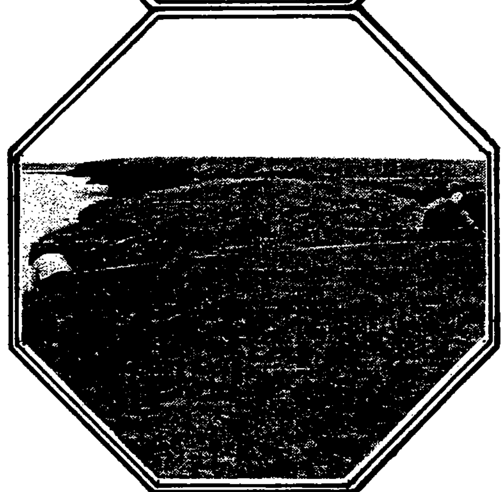
NINGLICK RIVER EROSION ASSESSMENT



airstrip in 25 to 30 yrs

1984
30
2014 in 8 yrs

1984
25
2009 in 3 yrs



ADDENDUM

NOVEMBER 29, 1984

Prepared for
The City of Newtok
Newtok, Alaska 99559

by
Woodward-Clyde Consultants
Anchorage, Alaska 99503

701 Sesame Street
Anchorage, Alaska 99503
907-561-1020

Woodward-Clyde Consultants

29 November 1984
60963A

Mr. John Charles, Mayor
City Office
Newtok, AK 99559

RE: Ninglick River Erosion Assessment
Addendum

Dear Mr. Charles:

Transmitted herewith are nine (9) copies of the addendum for the Ninglick River Erosion Assessment.

Our results indicate that providing full protection to stop the erosion process over the entire length of the bank would be extremely expensive. A more economical solution, although still expensive, would be to construct spur dikes along the bank to slow the rate of erosion. With this approach, the bank may stabilize naturally after several years of decreasing erosion rates. Monitoring the spur dikes and banks would be necessary to maintain this system. Relocating Newtok would likely be less expensive than trying to hold back the Ninglick River.

It has been a pleasure working with you on this erosion assessment. Please do not hesitate to call if you have any questions regarding this report.

Sincerely,

Larry A. Rundquist

Larry A. Rundquist, Ph.D., P.E.
Project Manager

NINGLICK RIVER

EROSION ASSESSMENT

ADDENDUM

November 29, 1984

Prepared for

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1.0

INTRODUCTION

This report presents the results of studies that supplement previous investigations of the Ninglick River bank erosion at Newtok (Woodward-Clyde Consultants, 1984). The objectives of the present and previous studies were to document the bank erosion problem and identify potential solutions to the problem.

1.1 PREVIOUS STUDY

In 1983, Woodward-Clyde Consultants conducted the only known documented study of the Ninglick River bank erosion. The following tasks were conducted:

- reviewed and evaluated existing information
- identified the processes contributing to the erosion, utilizing both input from the residents and a data collection program
- measured the amount of erosion in 1983
- identified alternative solutions to the erosion problem
- developed a preliminary design and cost estimate for the most promising erosion control structures

Local residents provided valuable assistance through their knowledge of the area and by doing much of the data collection. Included in the data collection program were measurements of rainfall, wave heights and periods, tidal fluctuations, and shoreline retreat.

1.2 SUPPLEMENTAL STUDIES

Additional studies were conducted in 1984 to support previous studies. The following tasks were conducted:

- o breakup observations
- o continuation of the measurement of the rate of bank erosion during 1984
- o survey of the availability of riprap materials on Nelson Island
- o survey of the topography of the most critical drained lake channel located upstream of the community
- o survey of the depths in Ninglick River

The methods and results of each of these studies are presented in Section 2.0. Results of the previous studies necessitated additional evaluation of design alternatives and redesign and revised costing of the recommended preliminary design. These topics are presented in Section 3.0.

2.0

METHODS AND RESULTS

2.1 BREAKUP OBSERVATIONS

2.1.1 Methods

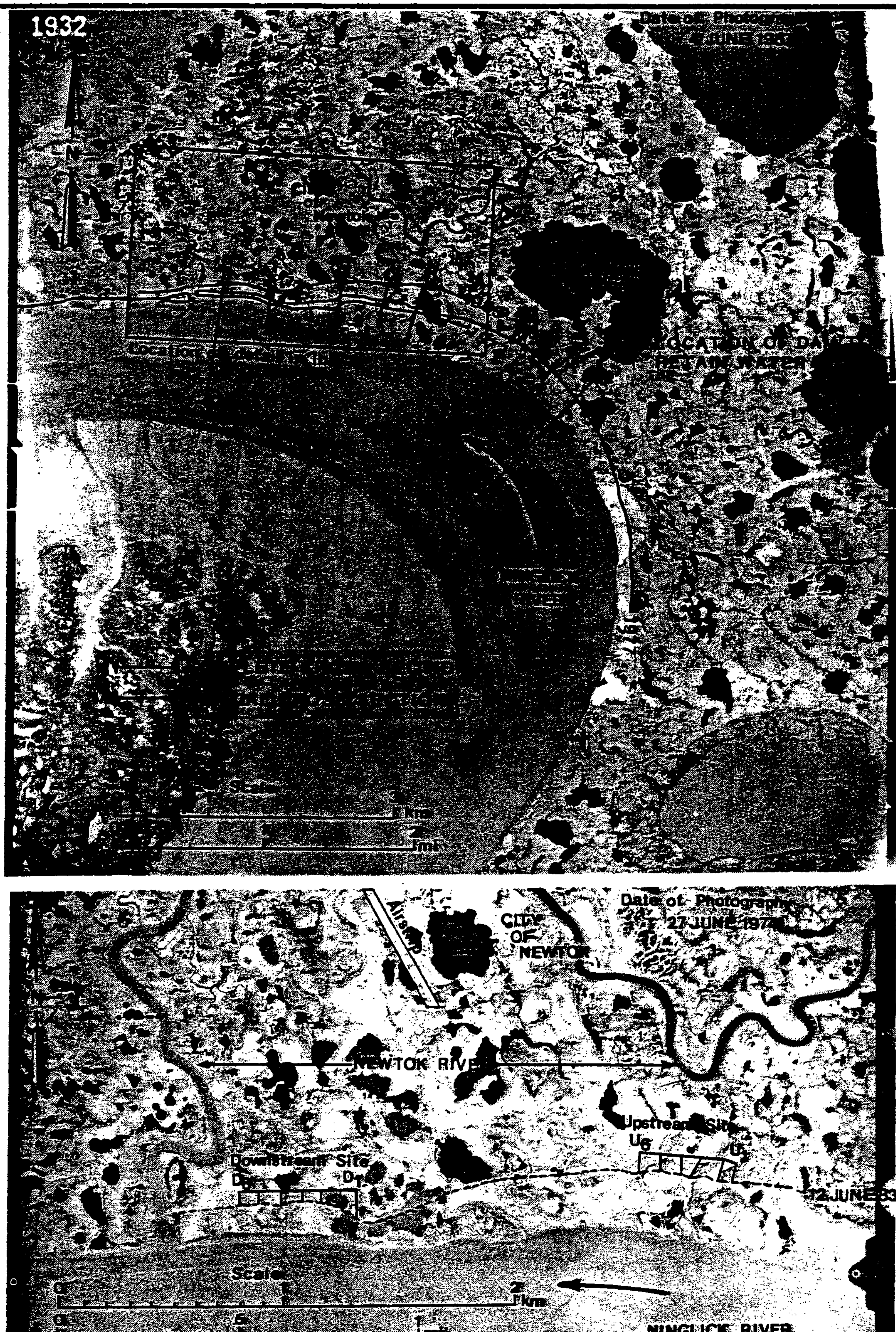
Ice floes from the upstream ice cover were observed and photographed by Joseph Tommy, a Newtok resident assigned to the breakup program. Observations by local residents during previous years were also evaluated.

2.1.2 Results

Ice cover on the Ninglick River began breaking up on 26 May 1984; the broken ice moved downstream overnight. Most of this initial breakup process took place between observations; thus, details regarding the severity of the process are not available. Newtok residents have indicated that previous breakups have been mild, with no significant impacts of ice floes.

Ice flows were reported to be relatively small, especially those floating close to the shore. Larger floes were observed farther away from the bank.

Ice floes hit the bank in areas where the bank projects into the current. A 100 x 100 ft ice flow had been pushed onto the bank at one such projection; the floe appeared to be 1-2 ft thick. The mechanism of how the ice floe got onto the bank was not observed; however, movement of ice floes was observed to be controlled by river current



AERIAL PHOTOGRAPHS ILLUSTRATING a) APPROXIMATE LOCATIONS OF DAM AND BATHEMETRIC SURVEYS b) LOCATIONS OF 1983/84 STUDY SITES

FIGURE 1

and possibly strong winds. River currents are tidally influenced, reaching a maximum at ebb tide.

Shorefast ice provides protection to the banks against moving ice floes. Approximately 5 to 10 ft of shorefast ice was present in some locations as much as six days after the initiation of breakup.

2.2 BANK EROSION RATE

2.2.1 Methods

The upstream and downstream study sites are the same as those used in 1983 (Figure 1). The base lines from which the erosion measurements were made at these sites were resurveyed in June 1984. Bank erosion measurements were made during the period 5 June through 31 October 1984 by Newtok resident Joseph Tommy.

2.2.2 Results

Average bank erosion rates at the upstream and downstream study sites during 1984 were significantly less than those measured in 1983 (WCC, 1984), and slightly less than the long term average (Table 1). At the upstream study site, [redacted] 72 percent of the [redacted] and 86 percent of the [redacted] At the [redacted]

2.3 RIPRAP IDENTIFICATION RECONNAISSANCE

Rock riprap was recommended in the preliminary design as the most economical material to use for the erosion control structure, assuming that material was available on Nelson Island. A Woodward-Clyde Consultants engineering geologist conducted a riprap identification reconnaissance in the Newtok area in early October. This reconnaissance utilized a Cessna 185 float plane chartered from

Table 1. Summary of historical, 1983, and 1984 erosion rates at Ninglick River study sites

Profile No.	1984 Total Erosion (ft)	1983 Total Erosion (ft)	Historical Erosion Rate (ft/yr) 6/4/57–6/27/74	Historical Erosion Rate (ft/yr) 5/27/74–6/14/77	Historical Erosion Rate (ft/yr) 6/14/77–5/18/83	All Years of Record (ft/yr)
U1	52	130	77	57	130	89
U2	91	120	76	50	125	86
U3	64	96	67	33	122	77
U4	83	84	61	33	95	73
U5	--	88	65	40	128	74
U6	51	49	68	40	128	74
[redacted]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
D1	22	59	23	33	50	31
D2	16	66	26	37	57	35
D3	15	58	24	47	60	36
D4	42	28	32	30	60	38
D5	25	48	26	33	58	35
D6	29	59	18	33	57	30
Average	25	53	25	41	57	34

Bethel. Landings were made near selected sites on Nelson Island that appeared to contain exposed bedrock. The zone of mapped bedrock on Nelson Island (Coonrad, 1957) was examined from the airplane at low level. These units comprise the only known bedrock within 50 mi of Newtok with any degree of accessibility.

2.3.1 Methods

Prior to the field reconnaissance, a geologic map (Coonrad, 1957) and aerial photos (BLM 1:60,000 and 1:120,000 color IR) of the region around Newtok were examined to identify alternative sources of riprap. Nelson Island, directly south of Newtok, is partially covered with basaltic flow rock. Of particular interest was the northwestern coast of Nelson Island which is comprised of basalt; this part of the island is closest to Newtok and has the advantage of a protected downstream water route (Ninglick River) to Newtok.

The entire perimeter of bedrock on Nelson Island was examined from the air. Landings and ground traverses were made only on the north side of the island where favorable landing conditions near accessible exposed bedrock occurred.

Where landings could be made, the location, accessibility, quantity, and rock mass characteristics of potential quarry sites were assessed. The rock was evaluated in the field for joint patterns, flow thickness, strength, density, and weathering; the excavation technique, and block sizes that could likely be produced were also considered. Samples were collected and brought back to Anchorage for petrographic analysis and limited laboratory testing.

2.3.2 Results

Field Observations

The reconnaissance resulted in the identification of two sites on the north side of Nelson Island near Newtok where bedrock was exposed

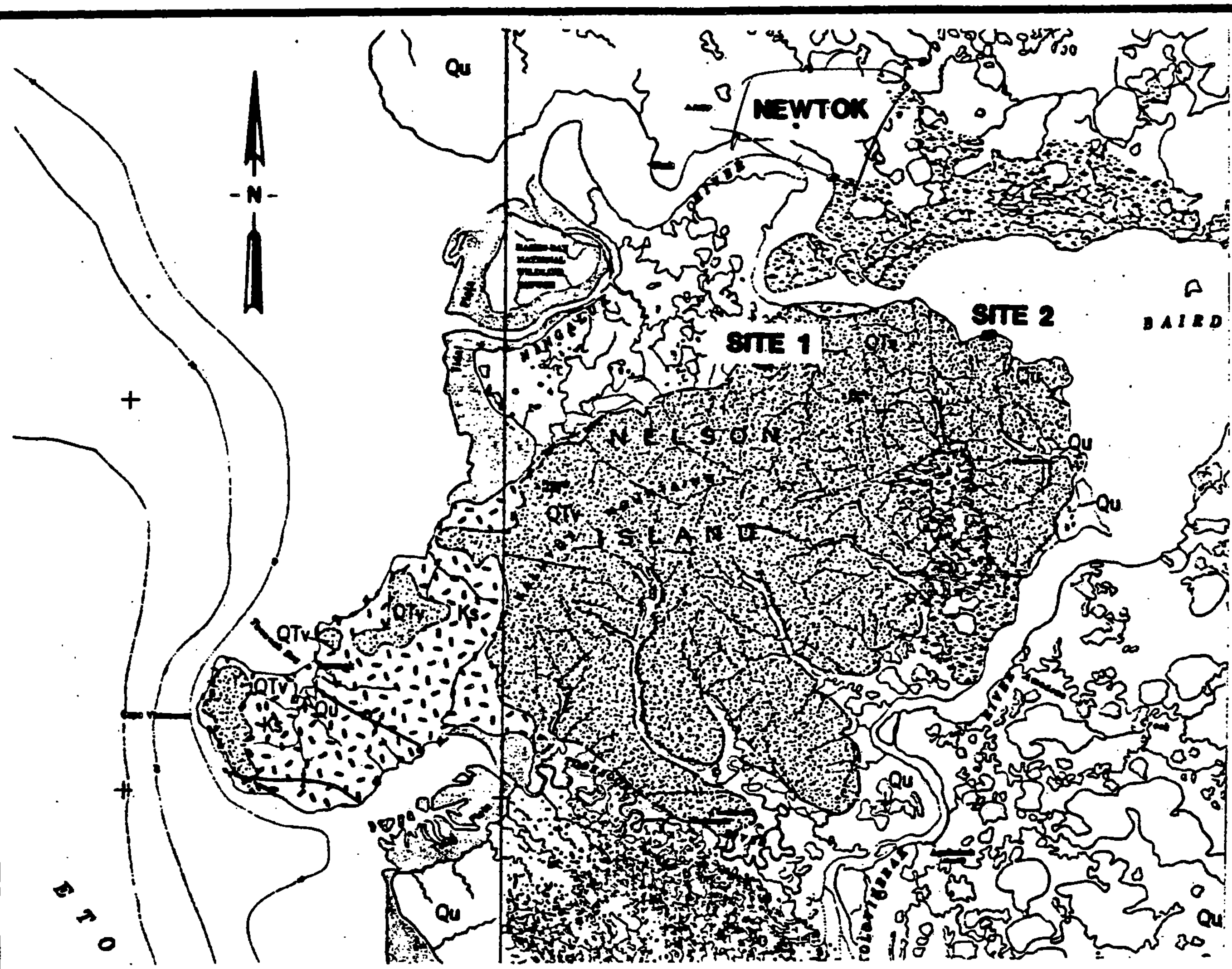
(Figure 2). Both of these sites were evaluated on the ground and documented in Field Site Description Summaries (Appendix A). The rock was evaluated according to the modified Uniform Rock Classification System (URCS) as shown on Table 2. On the east side of the island, basalt was not exposed, although it appeared to be near the surface. Along the southern limits of mapped bedrock between Toksook Bay and Nightmute on the Toksook River some basalt was exposed, however, the long haul distance and the lack of obvious high quality of rock in this area made it unfavorable to investigate further.

The west side of Nelson Island is composed predominantly of thinly bedded Cretaceous siltstone and some graywacke. These units appeared to be extensively deformed by folding and faulting and appeared to be considerably less resistant than the basalt flows which capped them. Most of the west coast was unprotected and subjected to high energy wave action. Basalt flows were generally perched several hundred feet above the less competent sedimentary rocks. Protected anchorages near competent rock outcrops were non-existent.

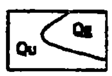
The only sites that appeared practical to develop occurred on the north side of Nelson Island. Site #1 involved about 1.5 mi overland haul to the Ninglick River and an 8 mi downstream run to Newtok (Figure 3). Although bedrock at this site was poorly exposed, topographic benches suggested the presence of resistant basalt flow layers.

Rock quality varied from basalt blocks over 1 yd^3 in size with high-strength, moderate-density and only slight weathering to low-strength, low-density, highly-weathered, vesicular basalt.

Site #2 is located on the south shore of the Ninglick River, with apparently favorable beach access (Figure 4). Basalt flows are intermittently exposed along the shore for about 0.5 mi. The westernmost exposure (A on Figure 4) appeared to have the best rock. Characteristics of this site are summarized in Appendix A.



EXPLANATION



Surficial deposits
Undifferentiated fluvial and marine gravel, sand, silt, and mud; organic materials; eolian sand and silt; and colluvium, Qu.
Glacial till deposited by alpine-type glaciers, Qg.

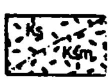
Mafic volcanic rocks
Basalt lava flows and cinder cones.

Granitic intrusive(?) rock
Structureless, homogeneous-appearing rock photointerpreted as intrusive.

QUATERNARY

TERTIARY

Upper Cretaceous (?)



Graywacke-siltstone sequence
Volcanic graywacke, siltstone, and minor amounts of pebble conglomerate and coal; probably littoral marine, Ks.
Photointerpreted contact metamorphic aureole adjacent to intrusive(?) rock, Ksm.

CRETACEOUS(?)

Bedrock, undifferentiated
Probably a crystalline complex of undifferentiated metamorphic and intrusive rocks.

PRE-CRETACEOUS(?)

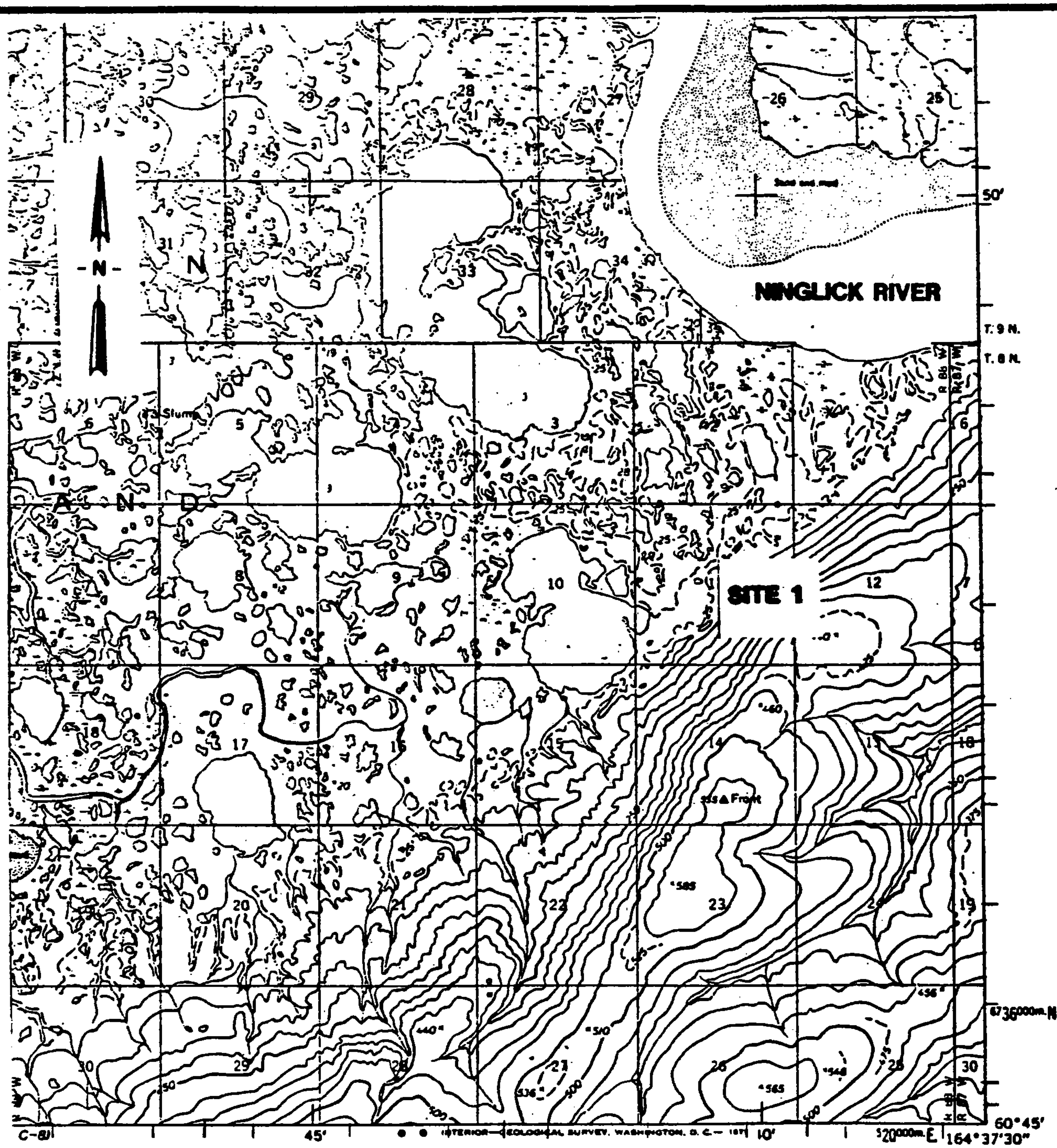
SCALE

GEOLOGIC MAP OF STUDY AREA

Woodward-Clyde Consultants | **FIGURE 2**

Table 2. Modified uniform rock classification system.

URCS Rating	Weathering	Strength	Joint Spacing	Density
5	Fresh: there is no discoloration or alteration of mineral elements. Evaluation is made with a 10-power hand lens	Very High Strength: rebound quality; shows no reaction under point of impact. UCS >15000 psi.	Massive: rock mass has homogeneous structure without stratification, fractures, cleavage, foliation, or other obvious directional weakness. Likely to produce exceptionally large blocks greater than 8 yd^3. (16 tons)	Very high density: >160 lb/ft^3
4	Slightly weathered: the rock material appears to be fresh or only faintly weathered to the naked eye. Very slight discoloration of mineral alteration may be present. This evaluation describes the general standard of rock quality for the site.	High Strength: pit quality; produces explosive departure of mineral grains under point of impact resulting in a shallow, rough pit. UCS = 8000 to 15000 psi.	Widely Spaced: planes of weakness spaced greater than 2 yds. Likely to produce large blocks from 2 to 8 yd^3 (4 to 16 tons).	High density: 150-160 lb/ft^3
3	Moderately weathered: where the rock is partly or completely discolored due to oxidation. It is not remoldable.	Moderate Strength: dent quality; produces dent under point of impact indicating pore spaces. It is equivalent in strength to concrete. UCS = 3000 to 8000 psi.	Medium Spaced: 2 to 3 intersecting planes of weakness 1-2 yd apart. Capable of producing medium sized blocks from 1 to 2 yd^3. (2 to 4 tons).	Medium density: 140-150 lb/ft^3
2	Highly weathered: refers to rock remoldable by finger pressure to gravel sized fragments.	Low Strength: crater quality; produces crater under point of impact. UCS = 1000-3000 psi.	Closely Spaced: 2 or more closely spaced intersecting planes of weakness less than 1 yd apart. Capable ot producing small blocks less than 1 yd^3. (2 tons)	Low density: 130-140 lb/ft^3
1	Completely weathered: is remoldable to sand, silt, or clay size particles.	Very Low Strength: is remoldable. UCS is less than 1000 psi.	Crushed: highly foliated, closely spaced fractures or other well developed planes of weakness unsuitable for riprap.	Very low density: less than 130 lb/ft^3



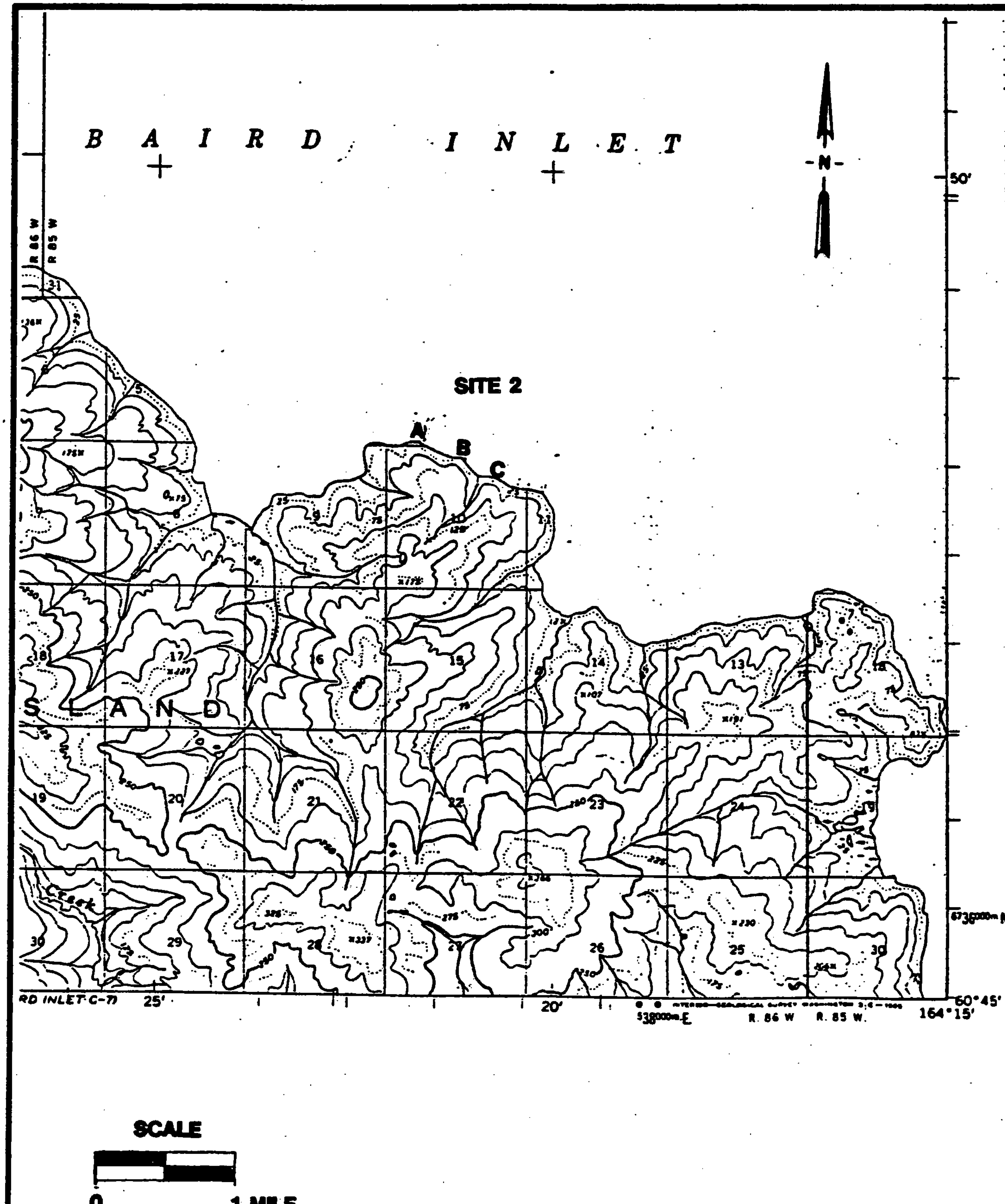
SCALE

0 — 1 MILE

LOCATION MAP OF SITE 1

Woodward-Clyde Consultants

FIGURE 3



LOCATION MAP OF SITE 2

Woodward-Clyde Consultants

FIGURE 4

Rock quality in these exposures was highly variable. The upper 10 ft of these strata were composed of soil and highly weathered, very vesicular low-density basalt that could be broken to sand by finger pressure. The rock generally became significantly more competent with depth. Height of the exposure was limited to 15 ft.

Talus beneath the outcrop was generally less than 1 ft^3 in size; however, blocks with moderate strength to 1 yd^3 in size were observed.

Laboratory Testing

Selected rock samples from the most competent units were brought back to Anchorage for petrographic analysis and testing. The petrographic analysis confirmed that rock from both sites is essentially unaltered, fresh, vesicular olivine basalt. Vesicules occupy 10-30 percent of the rock surface. Complete petrographic descriptions are provided in Appendix B.

Limited testing by sodium sulfate and ethylene glycol immersion indicates that the rock is resistant to chemical weathering (Table 3). Specific gravity of rocks in most zones is low but adequate (above 2.55). Resistance to abrasion is low.

Table 3. Summary of Laboratory Testing[a]

Test	Site 1	Site 2	Desired Minimum Specification
Specific Gravity	2.85	2.55	2.5 min.
Ethylene glycol emersion (15 day)	no loss	no loss	no loss
L.A. Abrasion (ASTM C-131)		30.5%	20% Max.
Sodium Sulfate Soundmass (ASTM C-88)		1.2%	10% Max.

[a] Laboratory testing is detailed in Appendix C.

Conclusion

Exposures of bedrock in the vicinity of Newtok are very limited and quality is variable. Site #2 on the Ninglick River (Figure 2) appears to be the best place to quarry. The quality of the rock exposed in the limited outcrop there appears to be adequate for Newtok needs. Development of this site will require removal of about 10 ft of overburden, which includes weathered, highly vesicular basalt beneath soil. More than 50 percent of the rock below this overburden may have to be wasted in order to achieve the specifications which tentatively calls for greater than 75 percent of the rock to be 260 lb (17 in. diameter).

Site 1 contains higher density rock than Site 2 and appears to be more competent overall, however, this site is more costly to develop due to its location. Material cannot be directly loaded onto a barge as at Site 2. A 1.5 mi overland haul is required in order to reach the Ninglick River. Limited exposure of the bedrock unit at this site prevented accurate appraisal of its fracture geometry or depth.

Recommendations

Further investigation is warranted in the final design phase of this project. We recommend that this effort begins with core drilling at Site 2A to determine the rock mass characteristics and quantity available. Of particular interest will be the thickness and extent of competent basalt flows. If Site 2A proves unsatisfactory, the investigation should focus on Site 1. Additional laboratory testing should include absorption, freeze-thaw and wet dry tests.

2.4 DRAINED LAKE SURVEY

2.4.1 Methods

A cross section was surveyed across the outlet channel of the large drained lake to the east of Newtok using differential leveling techniques. A preliminary design was developed for a dam to block this channel and allow the lake to refill.

2.4.2 Results

A cross section was surveyed across the degrading outlet channel of a large drained lake to the east of Newtok. Tidal variation causes the lake to fill and drain twice each day; the channel has developed a depression that is 300 ft wide and 18 ft below the surrounding terrain (Figure 5). The channel can be dammed to allow the lake to refill; the spillway of the dam is designed to be above MHHW to minimize tidal influence of lake levels (Figure 5). The dam would have a core consisting of about 900 yd^3 of silt materials located nearby to prevent leaking and a 2,800 yd^3 shell of rock from the quarry site. The spillway would be protected from scour with 500 yd^3 riprap from the quarry site. The estimated cost for constructing the dam is included in the cost summary in Section 3.2.

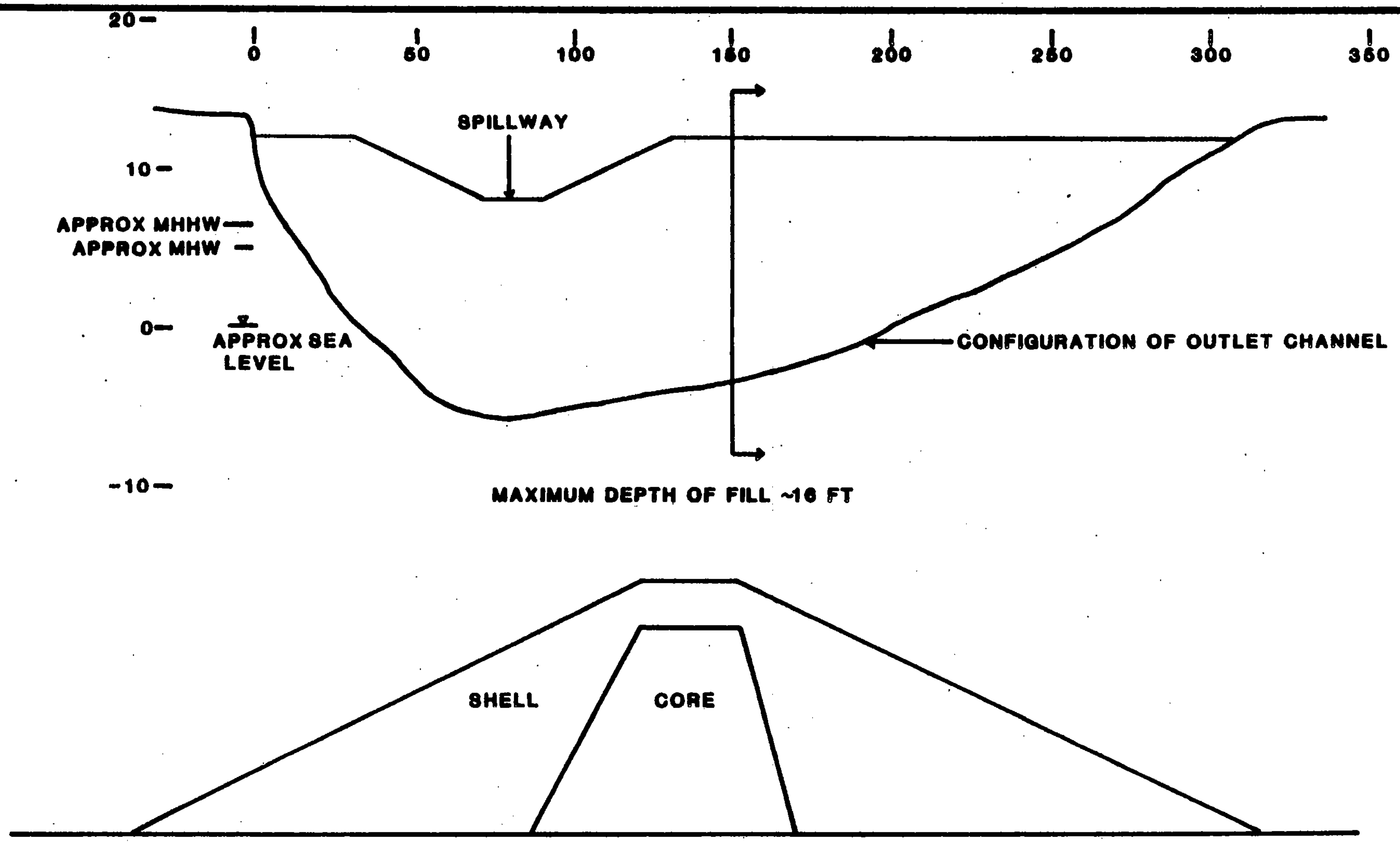
2.5 CHANNEL BATHYMETRY

2.5.1 Methods

Ninglick River channel bathymetry was surveyed to identify the potential range of channel depths. A MiniRanger system was used for identifying the location of the boat and a Raytheon DE-719B depth sounder was used to document depths. Two full cross sections were surveyed to identify the typical channel shape and six partial cross sections were surveyed to document the bed profile and maximum depth along the eroding bank. Drifting of the boat from the desired line was accounted for while analyzing the data by projecting the depths upstream or downstream to the desired line.

2.5.2 Results

Maximum channel depths were found close to the eroding bank; they ranged from 35 to 65 ft at the cross sections surveyed. Cross section plots are provided in Appendix D.



DRAINED LAKE OUTLET CHANNEL AND PRELIMINARY DESIGN OF DAM

Woodward-Clyde Consultants | FIGURE 5

3.0
ALTERNATIVE SOLUTIONS

Alternative solutions were considered in the previous report (WCC, 1984). In that report, it was concluded that bank revetment alone and bank revetment with spur dike protection were not economically feasible. Spur dikes were recommended as a solution which would reduce the erosion rate, but not stop it completely. Newtok residents asked for an evaluation of developing a cutoff channel to reduce the amount of flow past the eroding riverbank.

3.1 CUTOFF CHANNEL

A cutoff channel is not an economical nor a complete solution to the erosion of the north bank of the Ninglick River. Development of a channel with a cross-sectional area of 25 percent of the cross-sectional area of the Ninglick River would require excavation of approximately 28 million yd^3 of material. It is anticipated that most of this material would be frozen. Costs of dredging channels in the continental U.S. has ranged from \$0.75 to \$1.00 per yd^3. Unit costs to remove the frozen material of the Ninglick River cutoff channel would be greater than this cost; thus the project would cost in excess of \$30 million.

The cutoff channel would also not be a complete solution. Erosion would continue, possibly at a reduced rate, due to thawing of the ice-rich banks, wave action, and remaining currents.

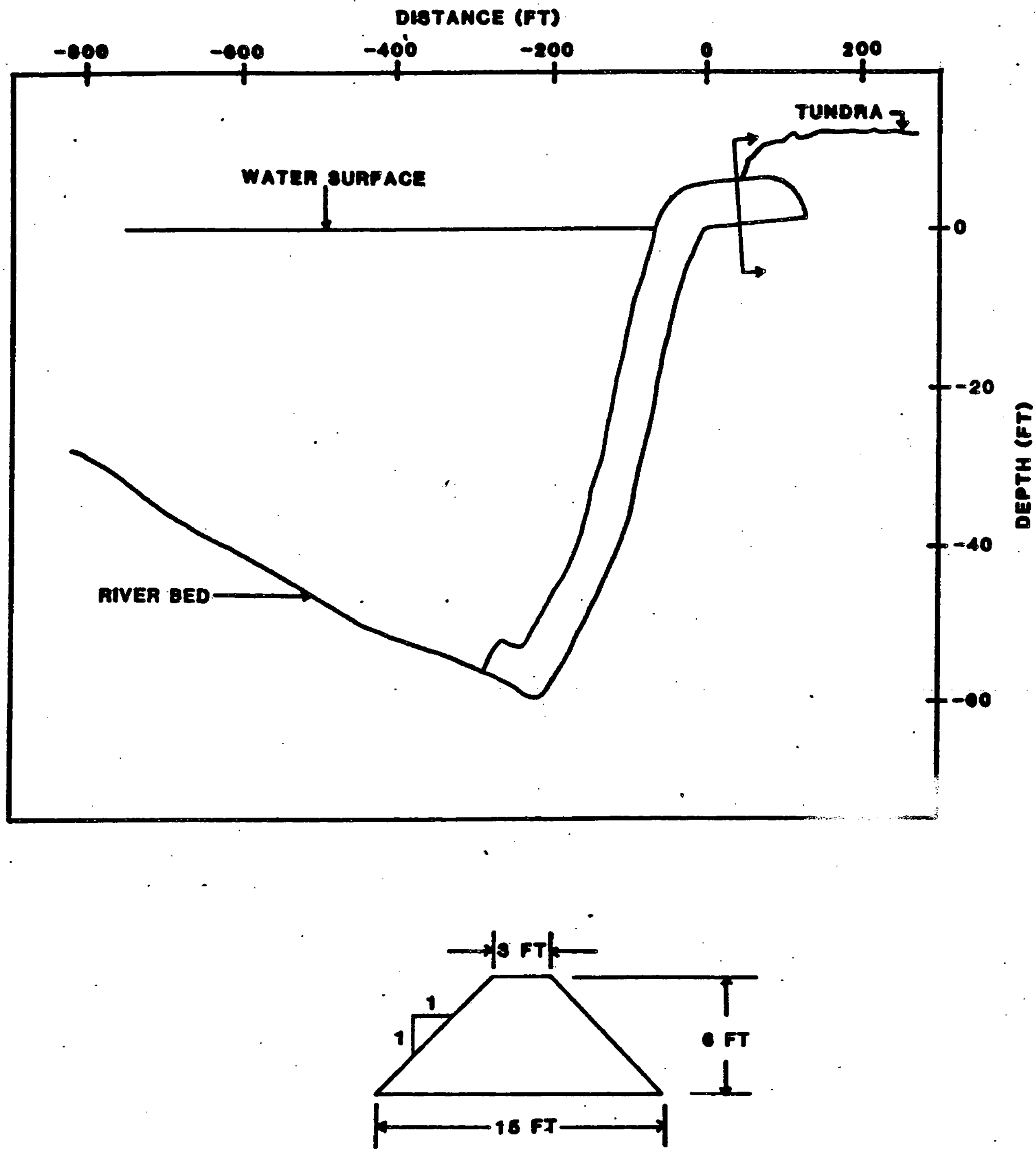
3.2 SPUR DIKES

Spur dikes remain as the most economical structural solution to the erosion problem at Newtok. Spur dikes would be a partial solution since they would reduce the bank erosion associated with river currents, but would have little impact on thawing and wave erosion processes. Bank erosion would likely continue between the spur dikes, but would largely be restricted to erosion near the water surface. It is anticipated that a cove would form with an extensive beach, much of which would be exposed at low tide. As the cove develops, maintenance of the spur dikes would likely be required to prevent erosion behind the shoreward end of the dike.

The spur dikes could be constructed by providing sufficient material in the dike structure and at its toe to launch into the deeper part of the channel or it could be placed to the maximum channel depth. Channel depths up to 65 ft would require extensive quantities of riprap material to ensure that it would provide adequate protection; although this was the recommended construction technique in the previous report (WCC, 1984), the identification of greater depths than were previously assumed limits the usefulness of this approach. The recommended construction technique is to place the riprap on the channel bed to the maximum depth.

The dike would extend 150 ft onshore and approximately 250 ft along the channel bed and have a trapezoided shape that is 6 ft high with 1:1 side slopes and 3 and 15 ft top and bottom widths (Figure 6). A dike spacing of 300 ft was recommended in the previous report (WCC, 1984); close spacing would minimize the erosion between the dikes, but would result in 70 structures required to protect the 4 mi of bank near Newtok. Though less effective, fewer structures at wider spacing would reduce the total project cost.

The costs to construct the project were estimated assuming that the project would be constructed in phases. It was assumed that the first phase of the project would involve construction of the dam at the outlet of the large drained lake and a number of spur dikes along the bank in the vicinity of the drained lake to protect the dam. Subsequent phases would involve construction of the dam at the outlet of the large drained lake and a number of spur dikes along the bank in the vicinity of the drained lake to protect the dam. Subsequent



SPUR DIKE CONFIGURATION

Woodward-Clyde Consultants

FIGURE 6

phases would involve construction of spur dikes upstream or downstream.

The cost of the first phase of construction would be approximately $1 million for the dam and 5 spur dikes. Additional or fewer spur dikes would cost or save approximately $100,000 per dike. A detailed cost summary is provided in Appendix E. Construction of subsequent phases would cost approximately $650,000 (1985 dollars) for four spur dikes. If a long-term construction project could be guaranteed, an annual cost savings of approximately $150,000 (1985 dollars) could be realized through reduction in mobilization/demobilization costs. Table 4 presents two scenarios for phased construction.

3.3 RELOCATION

The significant rates of erosion and depth of the Ninglick River cause structural solutions to be very expensive. Although relocation may be more economical than the cost of the entire bank erosion project, the initial costs would be greater. Also, the cost of relocating does not include a value for the personal impacts to the local residents. Local residents should evaluate the potential for relocation.

Advantages of relocation to the vicinity of potential quarry Site 1 on Nelson Island (Figure 3) would include:

- elimination of bank erosion problems
- well drained soils
- good foundation materials for construction
- access to wetlands at the base of the hills
- potential running water source
- good barge access from the Ninglick River

Additional study of Nelson Island as a potential site for relocation should be conducted if this alternative is selected. An estimate of the costs to build a new townsite on Nelson Island is $5.2 million (1985 dollars), which includes approximately the same number of structures as are presently in Newtok (details in Appendix E).

Table 4. Estimated costs for phased construction of 70 spur dikes.

Year	Phase	Estimated Cost[a] ($ million)	Estimated Cost[b] $ (million)
1985	1 - dam and 6 spur dikes	1.10	1.05
1986	2 - 8 spur dikes	1.09	0.94
1987	3 - 8 spur dikes	1.14	0.97
1988	4 - 8 spur dikes	1.18	1.01
1989	5 - 8 spur dikes	1.23	1.05
1990	6 - 8 spur dikes	1.28	1.09
1991	7 - 8 spur dikes	1.33	1.14
1992	8 - 8 spur dikes	1.38	1.18
1993	9 - 8 spur dikes	1.44	1.23
	TOTAL	11.17	9.66

4.0

REFERENCES

Coonrad, Warren L. 1957. Geologic reconnaissance in the Yukon-Kuskokwim Delta region, Alaska. Miscellaneous Geologic Investigations Map I-223, U.S. Geological Survey, 1 sheet.

Woodward-Clyde Consultants. 1984. Ninglick River Erosion Assessment. Final Report prepared for the City of Newtok, 24 February, 48 pp.

APPENDIX A

QUARRY SITE DESCRIPTION SUMMARIES

SITE DESCRIPTION SUMMARY

NINGLICK EROSION STUDY
RIPRAP RECONNAISSANCE

SITE: Nelson Island, Site 1

PERSONNEL: Robert Dugan

METHOD OF RECONNAISSANCE:

DATE: 2 October 1984

Ground traverse.

PROBABLE OWNERSHIP: U.S. Fish & Wildlife Service

WEATHER: Overcast, 45°F, Wind W @ 5 mph

LOCATION (Map, section, township, range): Baird Inlet D-8, SE 1/4 of NE 1/4 Section 11, T8N, R88W.

GENERAL DESCRIPTION: Tertiary - Quaternary lava flows

GEOLOGIC TYPE: Vesicular fine-grained olivine basalt

JOINT SPACING: 2 (URCS); 6 in to 2 ft spacing, orientation not determinable.

BEDDING AND PLANES OF STRATIFICATION: 1-3 ft horizontal flows

LIKELY CHARACTER OF ROCK BREAK ON BLASTING: Block size distribution not determinable. Largest blocks observable about 1 yd^3

OBSERVED SHAPE OF FRAGMENTS: Angular blocks

ESTIMATED STRENGTH: 3-4 (URCS) about 8000 psi

EXPECTED DENSITY: 4 (URCS), variable 150-190 lb/ft^3 according to vesicularity

DEGREE OF WEATHERING: 4 (URCS)

ANY PROPERTIES NOT COVERED ABOVE: Vesicular, likely variable in quality, but too poorly exposed to tell.

VOLUME ESTIMATE: Not well enough exposed to tell. Possibly infinite.

OVERBURDEN: 5 ft.

ACCESSIBILITY: 1.5 mi from Ninglick River on well-drained ground. 8 mi downstream run to Newtok.

ENVIRONMENTAL SENSITIVITY: No wildlife observed.

COMMENTS: Poorly exposed. 3 units were exposed as benches. Core drilling necessary to confirm resource. Topography suggests similar material may be found beneath overburden closer to Ninglick River.

SITE DESCRIPTION SUMMARY

NINGLICK EROSION STUDY
RIPRAP RECONNAISSANCE

SITE: Nelson Island, Site 2A   PERSONNEL: Robert Dugan

METHOD OF RECONNAISSANCE: DATE: 2 October 1984

Ground traverse.

PROBABLE OWNERSHIP: U.S. Fish & Wildlife Service

WEATHER: Overcast, 45°F, Wind W @ 5 mph

LOCATION (Map, section; township, range): Baird Inlet D-7, NW 1/4 of NW 1/4, Section 10; T8N, R86W.

GENERAL DESCRIPTION: Tertiary - Quaternary lava flows

GEOLOGIC TYPE: Vesicular fine-grained olivine basalt

JOINT SPACING: Variable 2 in to 2 ft with irregular orientation (2 URCS)

BEDDING AND PLANES OF STRATIFICATION: Horizontal flows, poorly defined, about 4 ft thick.

LIKELY CHARACTER OF ROCK BREAK ON BLASTING: Angular blocks less than 2 ft^2

OBSERVED SHAPE OF FRAGMENTS: Angular blocks

ESTIMATED STRENGTH: 3 (URCS) Variable

EXPECTED DENSITY: 4 (URCS) 140-160 lb/ft^3

DEGREE OF WEATHERING: 4 (URCS)

ANY PROPERTIES NOT COVERED ABOVE: High variability in quality; about 50% of the rock beneath the overburden is adequate for use.

VOLUME ESTIMATE: Possibly infinite but too poorly exposed to tell.

OVERBURDEN: 10 ft

ACCESSIBILITY: Excellent. Downstream barge haul to Newtok 15 miles. Beach landing, no road required.

ENVIRONMENTAL SENSITIVITY: No wildlife observed.

COMMENTS: Variable, high waste percentage due to weathered, vesicular zones. Talus size ranged .25 - 3 ft^3. Height of outcrop = 15 ft.

APPENDIX B

RIPRAP PETROGRAPHIC REPORT

PETROGRAPHIC REPORT

Sample: LAKE Site 1

Rock Name: Vesicular Olivine Basalt (Vesicles and unfilled interstitial space between grains is approximately 25-30% of the total rock surface.)

Mineralogy: Olivine - 25%; Pyroxene (augite) - 30%; Plagioclase laths - 40%; Opaques - 5%. No glass observed.

Olivine occurs usually as subhedral crystals up to 1 mm. in diam. rimmed by iddingsite. Though some minor olivine may occur as small interstitial grains, generally the olivine crystals are the larger Fe-Mg minerals in this particular rock.

Pyroxene (augite) occurs as smaller (avg. grain size is approx. .25 mm) grains, often occurring in clumps interstitially to the plagioclase. An occasional large, twinned pyroxene phenocryst is present, however.

Plagioclase is present as euhedral to subhedral laths with an average length of approx. 1 mm. and of diverse orientation. Some plagioclase crystals are anhedral, somewhat larger, and are zoned (?), these perhaps being an earlier phase of plagioclase formed in the crystallization process.

No Glass was observed.

Texture: This rock is holocrystalline; that is, the rock is entirely crystalline with no glass. The larger crystals consist of mostly olivine, an occasional large pyroxene grain, and a few larger anhedral plagioclase grains. Most of the pyroxene is finer-grained, granular, and partially fills the interstices between diversely-oriented plagioclase laths. There is quite a bit of unfilled interstitial space in this basalt.

Final report submitted 11/26/84 to Woodward-Clyde Consultants.

Carolyn Stevens

Carolyn Stevens, Petrographer

PETROGRAPHIC REPORT

Sample: RED Site 2

Rock Name: Porphyritic Vesicular Olivine Basalt (Vesicles constitute approximately 10% of the total rock surface.)

Mineralogy: Olivine - 18%; Pyroxene (augite) - 12%; Plagioclase (An content approx. 70) - 30%; Brown opaque glass - 40%.

Olivine occurs in larger subhedral crystals up to 3 mm. diam., with crystal outlines and cracks emphasized by red-brown iddingsite. Later stage olivine and pyroxene crystals are intergrown with plagioclase laths. The pyroxene and later olivine apparently acted as nucleation centers around which the later plagioclase laths crystallized as the melt cooled. Some much smaller olivine may also occur in the "groundmass", but are deeply brown-stained and difficult to distinguish.

Pyroxene (augite) - occurs usually as subhedral to anhedral patches intergrown with plagioclase laths and with the plagioclase growing away from the pyroxene centers, which formed nucleation points for the crystallizing plagioclase. Smaller pyroxene grains are also present interstitially.

Plagioclase laths (An approx. 70 = labradorite/bytownite) occur in diversely-oriented laths up to 1.5 mm. in length. Some parallel flow texture is occasionally present, especially around larger phenocrysts of Fe-Mg minerals.

Texture: This rock has porphyritic to seriate texture with occasional large olivine phenocrysts (one up to 3.2 mm. diam.) Subhedral olivine crystals up to 1 mm. diam. are brown-rimmed with iddingsite. Plagioclase laths up to 1.5 mm. long are of generally diverse orientation except for some parallel flow texture around some of the larger Fe-Mg minerals. Later Fe-Mg minerals formed nucleation points around which plagioclase laths grew during crystallization. Smaller pyroxene (and perhaps olivine) grains are present interstitially, with brown opaque glass filling the interstices. Hyalophitic texture.

Alteration: Essentially none. This is a fresh rock with very little alteration or weathering apparent. The reddish black color results from the abundance of interstitial Fe-Mg-rich glass.

Final report submitted 11/26/84 to Woodward-Clyde Consultants.

Carolyn Stevens

Carolyn Stevens, Petrographer

PETROGRAPHIC REPORT

Sample: BROWN Site 2

Rock Name: Vesicular Olivine Basalt (Vesicles constitute approx. 15-20% of the total rock surface.)

Mineralogy: Olivine - 10%; Pyroxene (augite) - 30%; Plagioclase laths (An_{35-80}) - 40%; Interstitial dark brown to black glass - 20%.

Olivine occurs as subhedral to anhedral, larger grains up to 1 mm. diam. which are often corroded, with alteration rims of deep brown iddingsite.

Pyroxene (augite) occurs as smaller grains (.05 to .15 mm diam.) usually interstitial to the larger plagioclase laths.

Plagioclase crystals are mostly lath-shaped, with An content averaging around 60. Occasionally plagioclase occurs as large (2 mm. or less) zoned crystals, but the smaller laths definitely predominate and are of diverse orientation.

Dark brown to black Glass is often opaque and somewhat devitrified, filling interstices between plagioclase laths.

Texture: This basalt may be considered to have two types of interstitial textures: 1) intersertal, where brown glass occupies the wedge-shaped interstices between diversely-oriented plagioclase laths; and, 2) intergranular texture where part of the interstitial space between plagioclase laths is occupied by smaller grains of pyroxene. The olivine is slightly altered, and therefore rimmed by deep brown iddingsite. Pyroxene and plagioclase are essentially unaltered.

Alteration: Except for the iddingsite alteration rims on the olivine, this rock is fresh and essentially unaltered.

Final report submitted 11/26/84 to Woodward-Clyde Consultants.

Carolyn Stevens

Carolyn Stevens, Petrographer

APPENDIX C

RIPRAP LABORATORY TEST RESULTS

NINGLICK EROSION STUDY

Specific Gravity/Density Test Results

Sample	Weight in Air	Weight in Water	Specific Gravity	Density 16/ft^3
<u>Site 1</u>				
a	135	89	2.94	183.5
b	43	29	3.07	191.6
c	28.5	18.5	2.85	177.8
d	29	17	2.42	151.0
<u>Site 2</u>				
e	520	316	2.55	159.1
f	490	301	2.59	161.6
g	306	185	2.53	157.9
h	172	104	2.53	157.9
i (very vesicular)	557	314	2.30	143.5

PITTSBURGH TESTING LABORATORY

ESTABLISHED 1881

700 West 58th, Unit A, Anchorage, AK 99502

LABORATORY No. 1821

CLIENT'S No.

November 15, 1984

ORDER No. ANC 304

REPORT

#1 - Final

REPORT OF: Analysis of Basalt Sample

PROJECT: Nelson Island/Site #2

CLIENT: WOODWARD-CLYDE CONSULTANTS
701 Sesame Street
Anchorage, AK 99503

SUBMITTED BY: Client

DATE RECEIVED: 10/11/84

REPORTED TO: 1 - Client

SAMPLE DESCRIPTION

One (1) sample of material identified as "Vesicular Basalt".

TEST RESULTS

I. Los Angles Abrasion (ASTM C131) Grading A

Wear = 30.5%

II. Sodium Sulfate Soundness (ASTM C88) 5 Cycles

Sieve Size	% Loss
1½" - 3/4"	1.26
3/4" - 3/8"	1.39
3/8" - #4	2.60

Respectfully submitted,

PITTSBURGH TESTING LABORATORY

Brian H. Barron, Manager
Anchorage Branch

klk

APPENDIX D

NINGLICK RIVER CROSS SECTIONS

APPENDIX E

COST SUMMARY

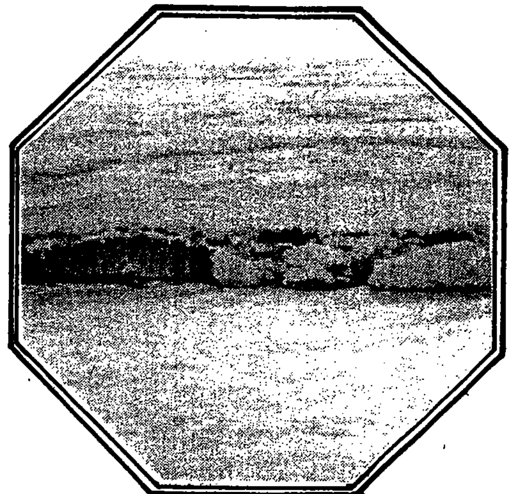
Estimated Costs for Construction
of Shore Protection at Newtok (in $1000's)

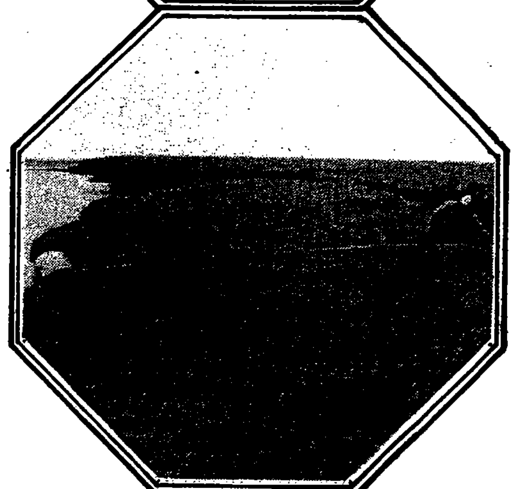
	Partial Program	Full Program 2 Years	Full Program Guaranteed Over 9 Years	Full Program Program Not Guaranteed
Number of Spurdikes and Dam	6	70	70	70
Project Duration Days	21	160	181	181
Cost Summary				
Mobilization/Demob	176	444	458	1700
Work	759	5349	7687	7687
All Contingencies	175	1101	1515	1783
Total Cost	1100	6894	9660	11,170

Estimated Cost to Build a New Townsite on Nelson Island

34 Homes at $80,000 each	$2,720,000
Washeteria and water tank	300,000
Community Hall	80,000
City Hall	80,000
2 stores	140,000
2 schools	1,200,000
Power system	150,000
Airport	350,000
2 boat docks	150,000
Total	$5,150,000

NINGLICK RIVER EROSION ASSESSMENT





FINAL REPORT

February 24, 1984

Prepared for
The City of Newtok
Newtok, Alaska 99559

by
Woodward-Clyde Consultants
Anchorage, Alaska 99503

Colonell

701 Sesame Street
Anchorage, Alaska 99503
907-561-1020

Woodward-Clyde Consultants

24 February 1984
60963A

Mr. John Charles, Mayor
City Office
Newtok, AK 99559

RE: Ninglick River Erosion Assessment
Final Report

Dear Mr. Charles:

Transmitted herewith are nine (9) copies of the final report for the Ninglick River Erosion Assessment.

Our results indicate that providing full protection to stop the erosion process over the entire length of the bank would be extremely expensive. A more economical solution would be to construct spur dikes along the bank to slow the rate of erosion. With this approach, the bank may stabilize naturally after several years of decreasing erosion rates. Monitoring the spur dikes and banks would be necessary to maintain this system.

It has been a pleasure working with you on this erosion assessment. Please do not hesitate to call if you have any questions regarding this report.

Sincerely,

Larry A. Rundquist, Ph.D., P.E.
Project Manager

NINGLICK RIVER

EROSION ASSESSMENT

FINAL REPORT

February 24, 1984

Prepared for

The City of Newtok
Newtok, Alaska 99559

by

Woodward-Clyde Consultants
Anchorage, Alaska 99503

TABLE OF CONTENTS

1.0
DESCRIPTION OF THE AREA

1.1 LOCATION

The City of Newtok is located in western Alaska about one-half mile from the north bank of the Ninglick River on the Yukon-Kuskokwim Delta within the Clarence Rhode National Wildlife Range (Figure 1). The Ninglick River is one of two channels that flow from Baird Inlet to the Bering Sea and is about 25 mi long. Bethel lies approximately 100 mi to the east with Hazen Bay 20 mi to the west. South of the Ninglick River, Nelson Island rises nearly 1500 ft above sea level and is the most prominent landform in the area.

1.2 CLIMATE

Because it is near the coast, Newtok has characteristics of both maritime and continental climates. Thus, climatic conditions at Newtok may reflect those reported by the weather station at Bethel, an inland station, and Cape Romanzof, a coastal station, located 75 m northwest of Newtok. Historical climatic data are summarized in Table 1.

Historical wind data at Cape Romanzof show prevailing northeasterlies throughout most of the year, switching to southerlies in July and August. Bethel records show prevailing northeasterly winds from September through March, westerly to northwesterly winds in April and May, and westerly to southwesterly winds from June to August (Brower et al. 1977). Records of peak instantaneous gusts for the study period indicate that the strongest and largest percentage of gusts

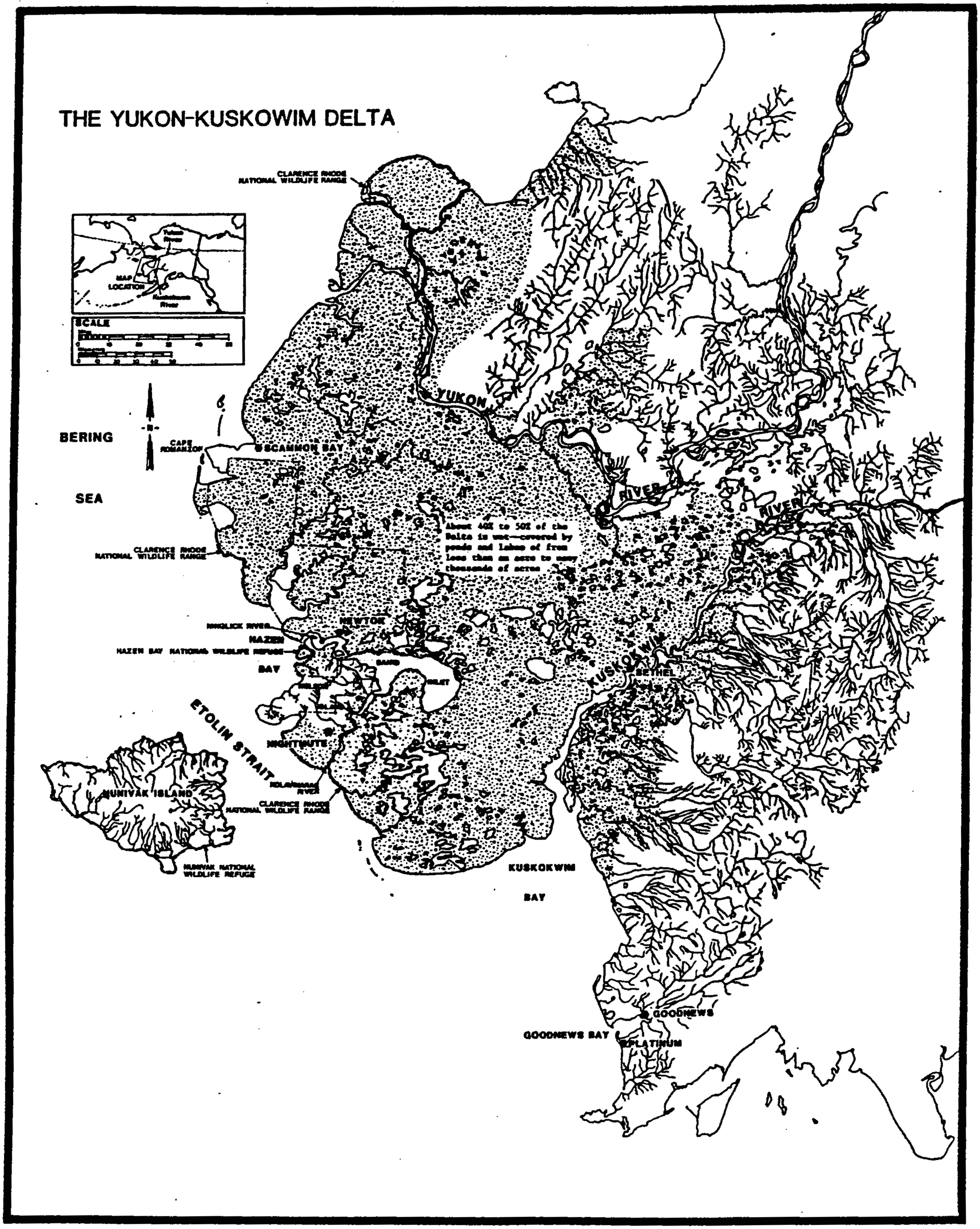


Figure 1. Location map for Ninglick River erosion assessment study.

Table 1. Historical climatic data at Cape Romanzof and Bethel (Selkregg 1975)

	Cape Romanzof	Bethel
Average Summer Temperature (°F)		
Maximum	53	62
Minimum	37	39
Average Winter Temperature (°F)		
Maximum	24	20
Minimum	6	-3
Extreme Temperature (°F)		
Maximum	79	86
Minimum	-25	-46
Average Annual Precipitation (in)		
Total Precipitation	25	16
Snowfall Only	71	50

at Cape Romanzof come from the north to northeast, although southerly gusts are also prevalent. The directional distribution of gusts at Bethel is more evenly distributed, but the strongest winds in summer and fall of 1983 came from the southwest and south. The prevailing average wind direction at Bethel was north to northeast. No average wind data were available for Cape Romanzof. Because of the many factors that can influence the wind regime of an area, these data may not provide an accurate representation of actual wind speeds and directions at Newtok. However, since no site specific data are available for Newtok, they do provide an indication of the passage of storms and other extreme wind events.

Information obtained from residents of Newtok indicates that the strongest winds are from the south. Southwesterly gusts of up to 87 mph were reported in early October 1983. Other reports from the residents indicate that the entire month of September 1983 was characterized by 15 to 30 mph predominantly southerly winds.

1.3 SOILS

Newtok is situated in a continuous permafrost zone. Ice lenses and wedges are visible along the bank of the Ninglick River and also in soil borings taken by the Alaska Department of Transportation (ADOT) at the airport site. Soils are poorly drained, leading to a generally high water table. ADOT logs indicate that the soils are ice-rich, non-plastic silts with an organic content ranging from 6 to 14 percent by weight. The surface layer would likely have a substantially higher organic content. Tests conducted on samples collected in 1983 at the river bank agreed with the ADOT findings (Figure 2).

1.4 TIDAL EFFECTS

Because it is so near to mean sea level, the Ninglick River responds to the semi-diurnal tidal fluctuations of Hazen Bay. Based on measurements made during the summer of 1983, the tidal range appears to be about 5½ ft.

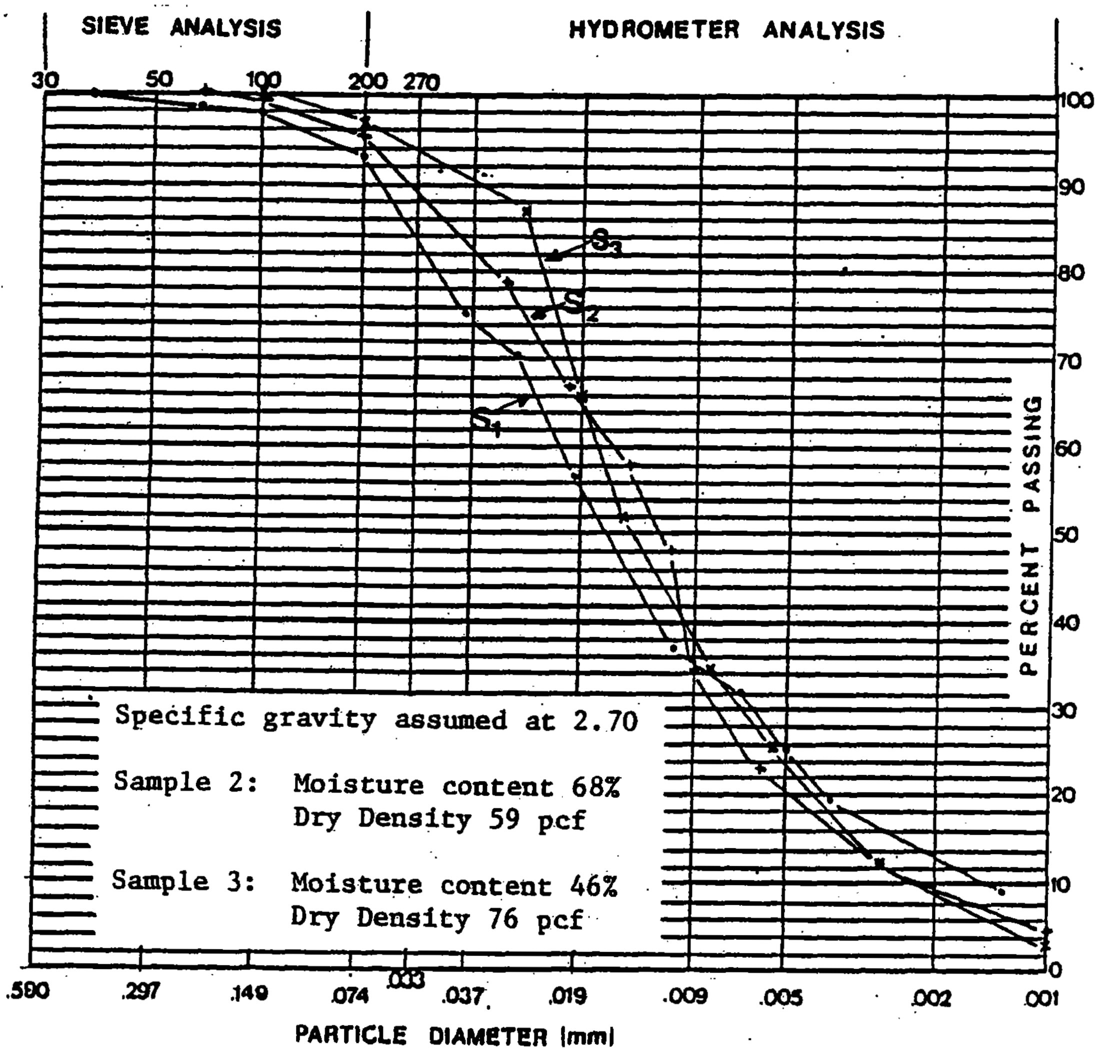


Figure 2. Grain size analysis of bank material samples.

When the wind blows onshore in the Bering Sea, the tide may rise higher than normal because of storm surge. Newtok experiences flooding from the Newtok River, a small river north of the village, about twice a year as a result of these surges. Because it is connected to the Ninglick River, the Newtok River reflects changes in water surface elevation similar to those experienced by the Ninglick River.

1.5 RIVER DISCHARGE

No river discharge measurements have been made for the Ninglick River. The river originates at Baird Inlet, which appears to be fed primarily by small channels draining the numerous lakes in the drainage basin. Because of the many lakes and flat terrain, the drainage area boundaries are indistinct. The basin area, including the area of Baird Inlet, is estimated to be about 2,700 mi^2. Balding (1976) estimates the average annual runoff for this general area to be 1 cfs per square mile, giving 2,700 cfs runoff from the Baird Inlet drainage basin. There are two outlet channels from Baird Inlet; the Ninglick River is about 25 mi in length and the Kolavinarak River is about 42 miles long. Assuming that the geometry and roughness of the two rivers are similar, an approximation of the proportion of discharge in the Ninglick River can be calculated from the ratio of river lengths, since the head between Baird Inlet and the coast is the same for both rivers. This calculation gives a mean annual discharge of 1,600 cfs for the Ninglick River.

The annual peak runoff in the area has been estimated to be 10 cfs per square mile or less (Balding 1976), resulting in a discharge in the Ninglick River of about 16,000 cfs. The discharge may be less due to the large number of lakes in the basin.

The summer and fall discharges in the Ninglick River are likely to be on the order of 5,000 to 10,000 cfs. Since the width of the river in the vicinity of Newtok is in excess of 4,000 ft and the mean depth is estimated to be 10 ft or more, the average velocity is expected to be from 0.1 to 0.3 fps. The velocity fluctuates due to tidal influence; observed surface velocities near the outside bank of the meander bend ranged from negative (upstream) velocities during incoming tides to 3 fps or more during outgoing tides.

Ice conditions on the river are not severe even though the ice forms to 6 to 8 ft (Newtok residents May 1983). Spring breakup is not accompanied by flooding, and it does not appear that the ice causes significant damage to the river banks.

1.6 HUMAN RESOURCES

The City of Newtok is a second class city and member of the Calista Native Corporation. The 154 residents (in 1981) are primarily oriented to subsistence fishing, hunting, and gathering. There is no commercial or industrial activity in Newtok.

2.0
SCOPE OF WORK

Between June 1957 and May 1983 the north bank of the Ninglick River eroded at a rate of 19 to 88 ft/yr. Unless the process can be slowed, the village airstrip, school, and homes will be endangered within 25 to 30 years. The problem is magnified by the formation of tidal channels through thawed lake basins interconnected by low spots. One such channel to the east of Newtok causes the village to be on an island during high tide because it connects the Ninglick and Newtok Rivers. As more of these channels develop or become more defined, the village could be threatened sooner than anticipated. Recognizing the severity of their problem, the residents of Newtok requested and obtained legislative funding for an erosion assessment and evaluation of erosion control alternatives for protecting about 4 mi of bank.

The objectives of Woodward-Clyde's erosion assessment were to document the erosion problem and identify potential solutions to the problem. These objectives were accomplished by conducting the following tasks:

- review and evaluate existing information,
- identify the processes contributing to the erosion, utilizing both input from the residents and a data collection program,
- measure the amount of erosion in 1983,
- identify alternative solutions to the erosion problem, and
- develop a preliminary design and cost estimate for the most promising erosion control structures.

Local residents provided valuable assistance through their knowledge of the area and by doing much of the data collection. Included in the data collection program were measurements of rainfall, wave heights and periods, tidal fluctuations, and shoreline retreat.

3.0
EROSION PROCESSES

Erosion of the Ninglick River bank is caused by the combined action of heat, waves, and currents. The erosion process is initiated by the exposure of the ice-rich soils in the river bank to the relatively warm (47 to 58°F) river water and the sun. Deep thermo-erosional niches develop in the bank at about high tide level as the ice in the soil melts, and large blocks of bank break off under the force of their own weight. The blocks melt due to their exposure to the river water, leaving the thawed silts and vegetative covering deposited on the beach. Waves subsequently suspend the sediment, allowing it to be carried away by the current. The vegetation is gradually broken up by continued wave action until it too can be transported by the river current. Once the beach is cleaned of the bulk of these materials, the process begins anew. Maximum shoreline retreat accompanies strong southerly winds because the waves are largest and have the most energy under these conditions, and thus have a greater ability to erode the bank. Actual wave height depends on the wind speed and length of "fetch" or water over which the wind blows. Along this section of river, the longest effective fetch is oriented north to south with the result that the largest waves are developed by winds from that direction.

The erosion of the Ninglick River bank is accelerated by the tidal fluctuation that causes larger portions of the bank to be exposed to the heat of the water and energy of the waves and current; it also increases the flow velocity against the bank during an ebbing tide by adding a tidal current to the natural river current. Surface currents measured during the 1983 summer season near the eroding bank ranged from 3 to 5 fps. Currents would be less than this on flood tide.

Measurements of bed profiles near the eroding bank indicate that the deeper parts of the channel are migrating in the same direction as the eroding bank. For example, the depth at the 1977 location of the bank has degraded to a depth of about 30 ft in six years (Figure 3).

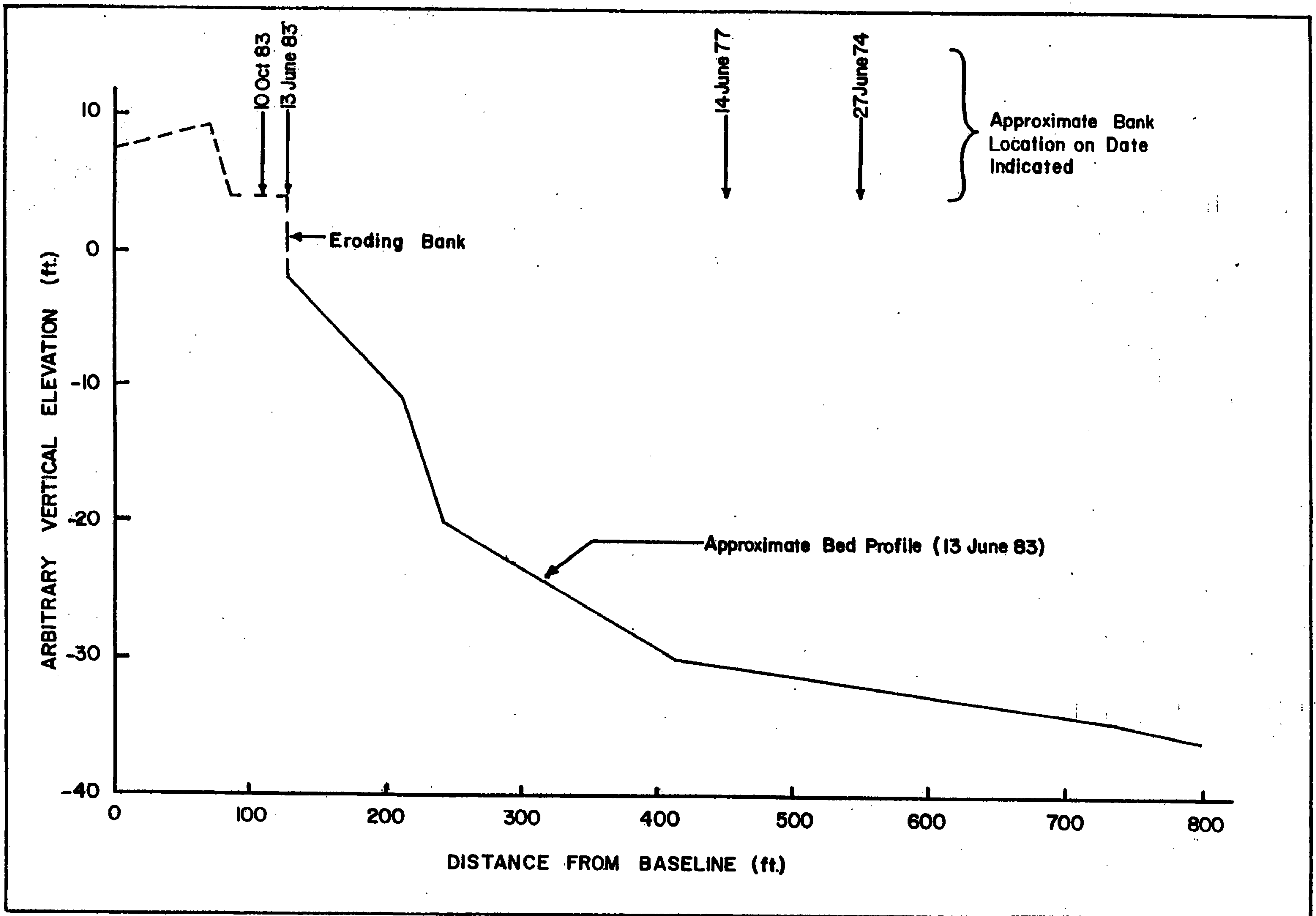


Figure 3. Ninglick River cross-section profile showing depth of bed degredation.

4.0

RATES OF EROSION

Historical bank erosion rates were evaluated from aerial photographs dated 1957, 1974 and 1977 and from a site visit prior to breakup on 18 May 1983. Erosion during the summer of 1983 was measured at 12 bank profiles, six at each of two study sites; one site was located just east of the Newtok River and the other was approximately one mile upstream (Figure 4). Bank erosion was defined as the landward migration of the position of the top of the bank (or bluff), with large block failures being included in the eroded portion of the bank. Between June 1957 and May 1983 the river bank retreated 500 to 2300 ft with maximum erosion occurring near the upstream study site. This represents an average annual erosion of 19 to 88 ft. This trend continued into the summer of 1983; profile U1 at the upstream site receded 99 ft in only two months and had a total erosion of 130 ft over a four-month period. Average erosion for the six profiles at this site was 94 ft. The downstream site was less active, with an average retreat of 53 ft. Historical and 1983 erosion rates are summarized in Table 2.

Three patterns become apparent from an examination of the historical erosion rates. First, the upstream site is eroding substantially faster than the downstream site. This probably results from the upstream section being exposed to higher energy waves. Under strong southerly winds, the waves that attack this site develop over a longer fetch than those that impact the downstream site. This site is also closer to the apex of the meander bend and so is exposed to faster currents.

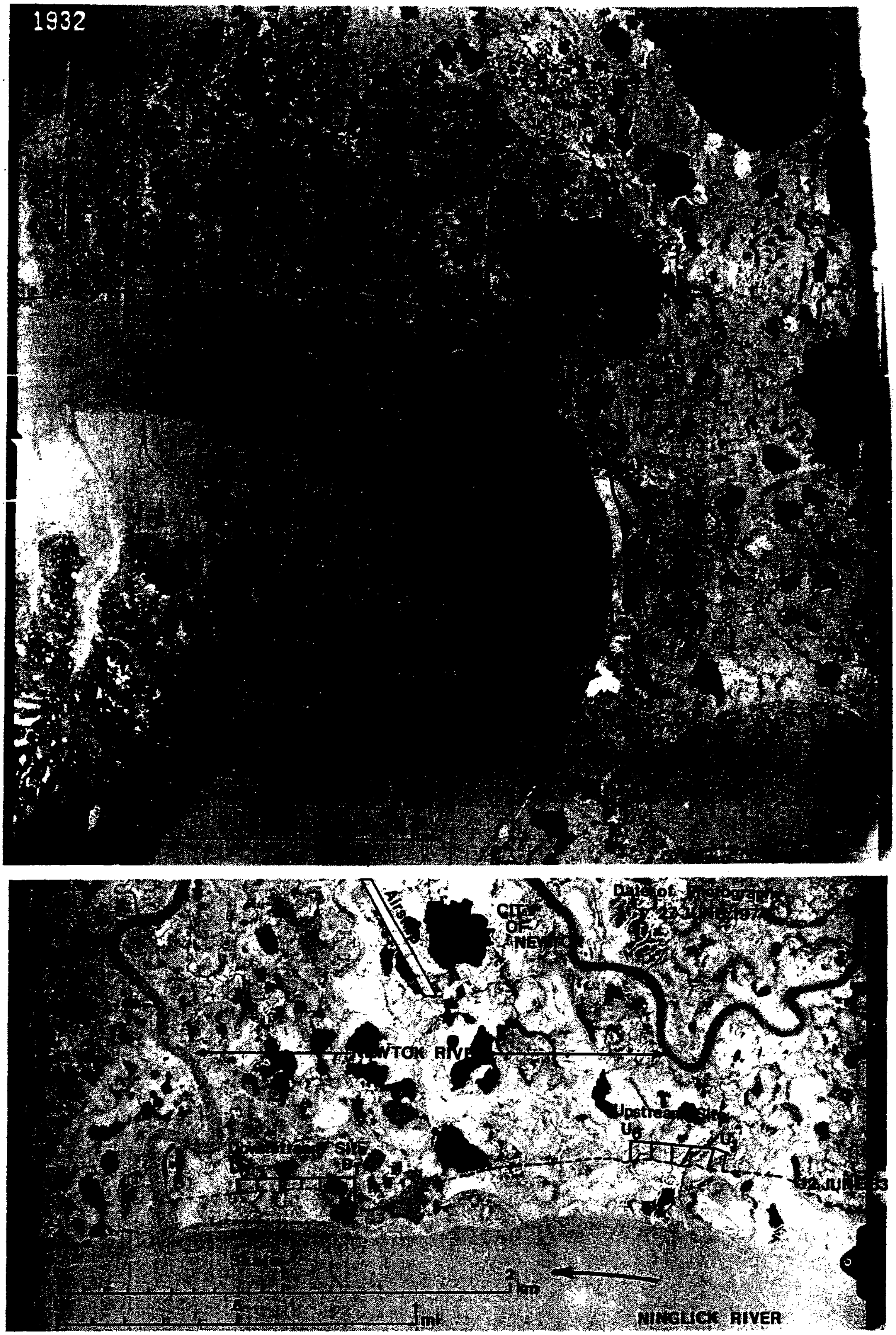


Figure 4. Aerial photographs illustrating a) approximate historic bank locations and b) locations of 1983 study sites.

Table 2. Summary of historical and 1983 erosion rates at Ninglick River study sites

Profile No.	1983 Bank Erosion Observations: Period of Measurement	Date Noticeable Erosion Stopped	Total Erosion (ft)	Historical Erosion Rates, ft/yr.: 6/4/57-6/27/74	6/27/74-6/14/77	6/14/77-5/18/83	All Years of Record
U1	6/12-12/19	10/10	130	77	57	130	89
U2	6/12-12/19	10/10	120	76	50	125	86
U3	6/12-12/19	12/1	96	67	33	122	77
U4	6/12-11/30	11/7	84	61	33	95	73
U5	6/12-12/19	12/1	88	65	40	128	74
U6	6/12-12/19	11/7	49	68	40	128	74
Average			94	69	42	113	79
D1	6/13-10/30*	10/24	59	23	33	50	31
D2	6/13-12/19	10/24	66	26	37	57	35
D3	6/13-12/19	10/15	58	24	47	60	36
D4	6/13-11/30	11/20	28	32	30	60	38
D5	6/13-12/19	10/28	48	26	33	58	35
D6	6/13-12/19	12/1	59	18	33	57	30
Average			53	25	41	57	34

* Stakes washed away after 10/30

Second, low-lying drained lake areas erode more slowly than other sections of shoreline. Since the soils beneath lakes are typically thawed, they do not depend on the bond provided by the ice for stability and are not impacted by the heat of the water or sun to the same extent as frozen soils. In addition, bluff failures along low, thawed banks are not as severe as they are in higher, frozen areas.

Finally, although there is a correlation between the occurrence of high winds (and thus, large waves) and bluff failures, the thermal condition of the bank appears to have a greater influence on its stability. Figure 5 illustrates the progression of shoreline retreat at profiles U2 and D2. A histogram of peak instantaneous wind gusts at Cape Romanzof is shown above the profiles as an indicator of relative wave height. Large, nearly vertical jumps in the graphs are due to large block failures. Note that although the strongest winds (and thus largest waves) occurred from early October through November, the only noticeable erosion that occurred during this time was in the first two weeks of October. Field notes made by Newtok residents who were involved in the data collection effort indicate that the bank remained frozen after mid-October.

The pattern of erosion prior to the bank freezing suggests that many block failures occur following higher than normal winds and waves, but generally after a lag time of one to several days. This may be because the waves generated during the storm speed up the development of the thermoerosional niche and weaken the block, but failure does not occur until after the storm passes. Often no failure is seen after a storm because blocks that have failed previously may still remain protecting the intact portion of the bluff. The storm waves expend their energy on eroding the fallen block, but may not be of sufficient duration to eliminate that block and attack the bank.

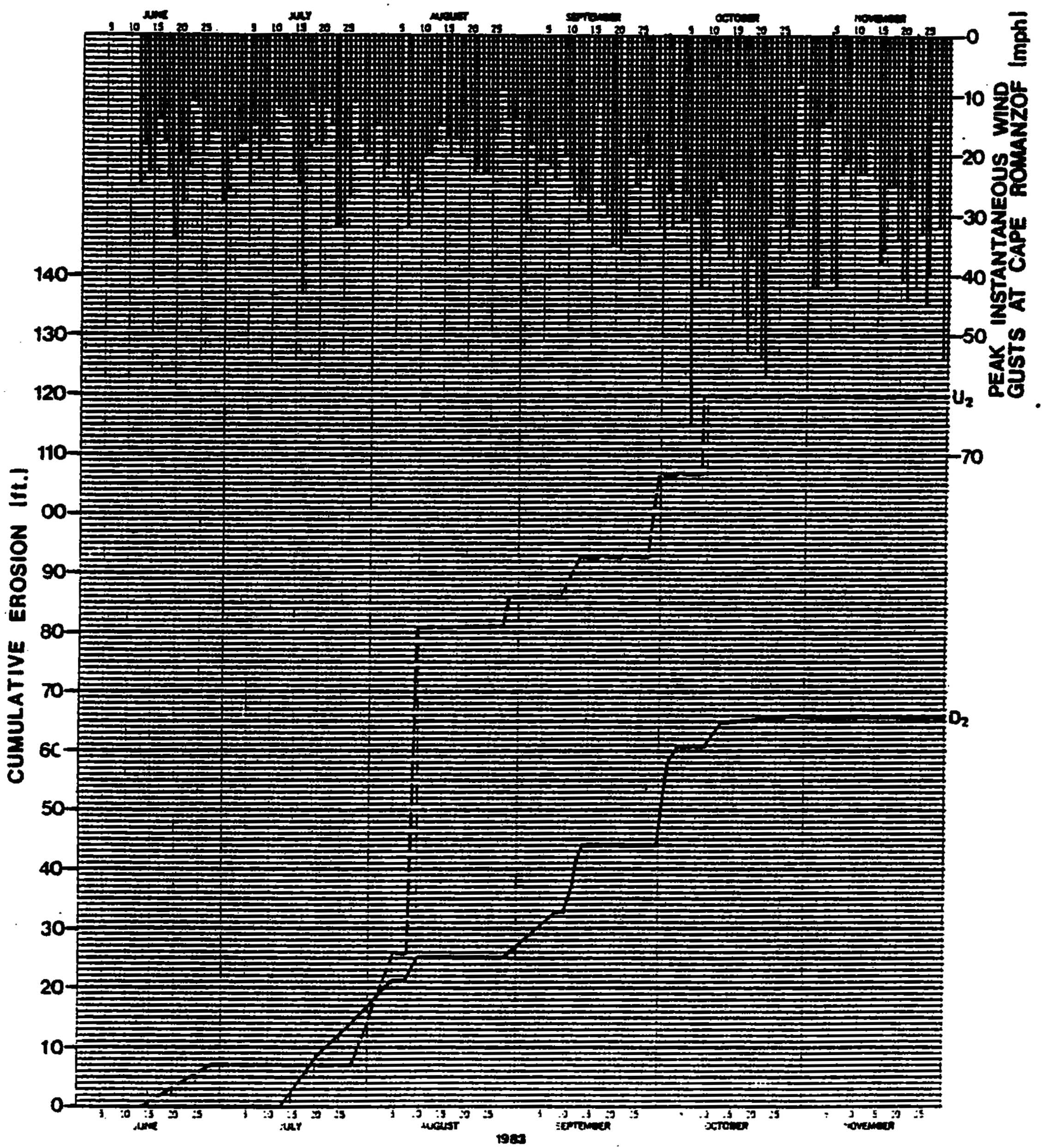


Figure 5. Chronological development of river bank erosion and recorded peak wind gusts during the period June through December 1983.

5.0 ALTERNATIVE SOLUTIONS

During the course of assessing the technical and economic feasibility of an appropriate erosion control system, numerous schemes were considered. Since the site is remote, an important consideration must be the materials and equipment available for construction. It was desirable to select construction materials that would minimize the need for heavy equipment and maximize the amount of work that could be done by local residents. The following subsections present the design criteria, the available materials, and the alternative solutions to the erosion problem at Newtok.

5.1 PRELIMINARY DESIGN CRITERIA

The bank protection structure must be designed to accommodate the range of conditions experienced at the site. Design parameters to be considered include upper and lower structure elevations, river currents, and wave heights. Preliminary design criteria are presented herein.

The upper level of the structure was selected to be at least as high as the highest debris line. This represents the level of highest combined storm surge, tides, and wave height during recent years. This level is approximately 2½ ft above the high tide level.

The lower level of the structure must take into account the maximum scour depth that will occur at the structure. Since the river currents are typically quite low, excessive scour is not expected to occur. However, it is anticipated that the thalweg, or deepest part of the channel, will migrate toward the protected bank. The thalweg may also deepen as a result of the bank protection structure; the reduced bank erosion will reduce the sediments contributed to the river and the river may replace the lost sediments with those eroded from the bed. This process is described further by Winkley (1983) and Jansen et al. (1979). To prevent undercutting of the structure, a design depth of 40 ft below water level was selected.

The preliminary design river current was selected at 8 fps. This is not significantly greater than observed surface velocities. However, floods on the Ninglick River are not likely to have high flow velocities, and maximum currents associated with ebbing tides occur only twice daily for short durations.

Preliminary wave design criteria were based on the maximum observed wind gust during the 1983 study period of 87 mph at Newtok. The corresponding gust at Cape Romanzof was 65 mph. This gust was greater than the maximum gust over 17 years of record as reported in Selkregg (1975). Data between 1975 and 1983 were not available, but it is assumed that the 87 mph gust at Newtok is an infrequent event. Based on criteria in the Handbook of Geophysics (U.S. Air Force 1961) the gust at Newtok corresponds (in a statistical sense) to an average hourly wind of 51 mph. The non-breaking wave produced by these wind conditions is 3.5 ft. This non-breaking wave height was used for preliminary design because bed degradation will cause the apron to launch at a slope steep enough to prevent the wave from breaking. This bed degradation is expected to occur rapidly enough that the probability of the design wave occurring during the period of degradation is small.

5.2 AVAILABLE MATERIALS

The feasibility of providing a cost-effective erosion control system depends largely on maximizing the use of on-site materials. Locally available materials appear to be limited to organic silts of low plasticity. One approach considered was improvement of the silts by adding Portland cement to form an erosion resistant soil cement grout to be used to fill geofabric bags. However, Portland cement is mostly effective when used with sands and gravels, and as the percentage of silts and clays increases, the effectiveness of the process decreases. Portland cement begins showing appreciable loss of effectiveness for soils containing more than about 50 percent silts and clays. As shown in Figure 2, soils tested from the Newtok area contain 90-95 percent silts and clays. While the Portland cement would reduce swell potential for the site soils, the mixture would not set up sufficiently to resist erosion. Without this resistance, the soil-filled bags would be very vulnerable to heavy damage from wave and ice attacks.

Alternatives to soil improvement are limited to importing material. Several riprap sites are located within barging distance from the site but transportation costs would dramatically increase the cost of construction. Existing riprap quarries are located in Nightmute, Scammon Bay, and the Goodnews Bay-Platinum area southeast of Kuskokwim Bay (Figure 1). A geologic map (Coonrad 1957) and aerial photos (BLM 1:60,000 color IR and 1:120,000 color IR) of the region around Newtok were examined to identify closer sources of riprap. Nelson Island, directly south of Newtok, is primarily covered with basaltic flow rocks. The presence of 8 to 20 individual flows with an aggregate thickness of 200 ft or more make it the most likely source for shore protection material. A quarry founded here would lie outside the wildlife refuge and provide a relatively protected barge access to Newtok. An additional advantage is that the loaded barges would be moving with the current.

The major volcanic rocks that form these lava sheets are part of a discontinuous volcanic belt that extends from eastern Seward Peninsula to Nunivak Island and possibly the Pribilof Islands. Thin sections indicate that the rocks are fine-grained holo crystalline olivine basalt.

5.3 DESCRIPTIONS OF ALTERNATIVES

Both spur dikes and revetments can aid in resisting erosion. A revetment is a resistant wall that is built along the eroding bank to protect it from wave and current attack. The purpose of the wall would be to halt further erosion. Because of the structure's length and extensive toe protection that would be required to prevent failure at the base of the wall, a revetment for the Ninglick River would be very expensive.

Spur dikes are long protruding structures placed approximately perpendicular to the stream flow. They reduce erosion by keeping the river current away from the bank and by providing a calm pool of water behind them where material can accumulate. Although the thermal erosion and wave action will continue, as the bank recedes between the spur dikes the wave energy will be directed more toward the protruding spur than the receded bank and energy acting on the bank will be dissipated. The beach that develops between the spurs will cause the waves to break further from the bank. In time, the wave action will likely be reduced sufficiently to allow the natural tundra vegetation to remain intact as the permafrost melts beneath it. The curtain of vegetation could provide sufficient protection to reduce the rate of thermal erosion.

A very effective, although costly, solution would be to use a combination of spur dikes and revetment. The spur dikes would require extensive toe protection, but they would reduce the amount of toe protection needed by the revetment. Because of the costs involved in constructing both the combination spur dike-revetment and revetment only alternatives, and the fact that some additional bank erosion can be tolerated, spur dikes are the preferred alternative.

Because neither a revetment nor spur dike-revetment combination appear to be economically feasible, they are not discussed in any additional detail in this report. Similarly, laboratory tests on locally available silts indicate that the material is unsuitable for use in a soil cement, so alternatives that utilize this concept have been dropped from consideration. Thus it appears that riprap spur dikes using riprap from Nelson Island are the most viable option.

The spur dikes would be placed 300 ft apart over 4 mi of bank, thus requiring 70 structures. The length of the spur dikes are designed to be 50 percent greater than the average annual erosion; they are thus longer near the upstream study site than near the downstream site. The average length would be 176 ft. Of this length, 160 ft would extend onshore in a trench excavated into the bank in order to minimize the amount of instream construction activities.

Material would be piled on the stream bed in a circular pattern around the end of each spur to allow for self-launching of the riprap to a depth of 40 ft. A launching type apron is required because of the great amount of underwater excavation that would be required to construct the toe apron in place.

Three different onshore configurations were considered (Figure 6). The first involves excavating a straight trench perpendicular to the bank and constructing the spur dike inside the trench. The dike would be exposed as the bank erodes and behave as it would if it had been initially constructed offshore. By building the structure onshore, complications of placing riprap underwater are avoided.

The second option is to excavate a shorter trench, construct the spur dike inside, and stockpile riprap on the landward end. This excess material would launch as the bank around it eroded away, thus providing end protection for the structure.

The third configuration is similar to the others except that the trench and spur dike are formed in the shape of a "Y" (Figure 6). This configuration reduces the uncertainty associated with a launching system to provide end protection for the structure. However, it requires more excavation.

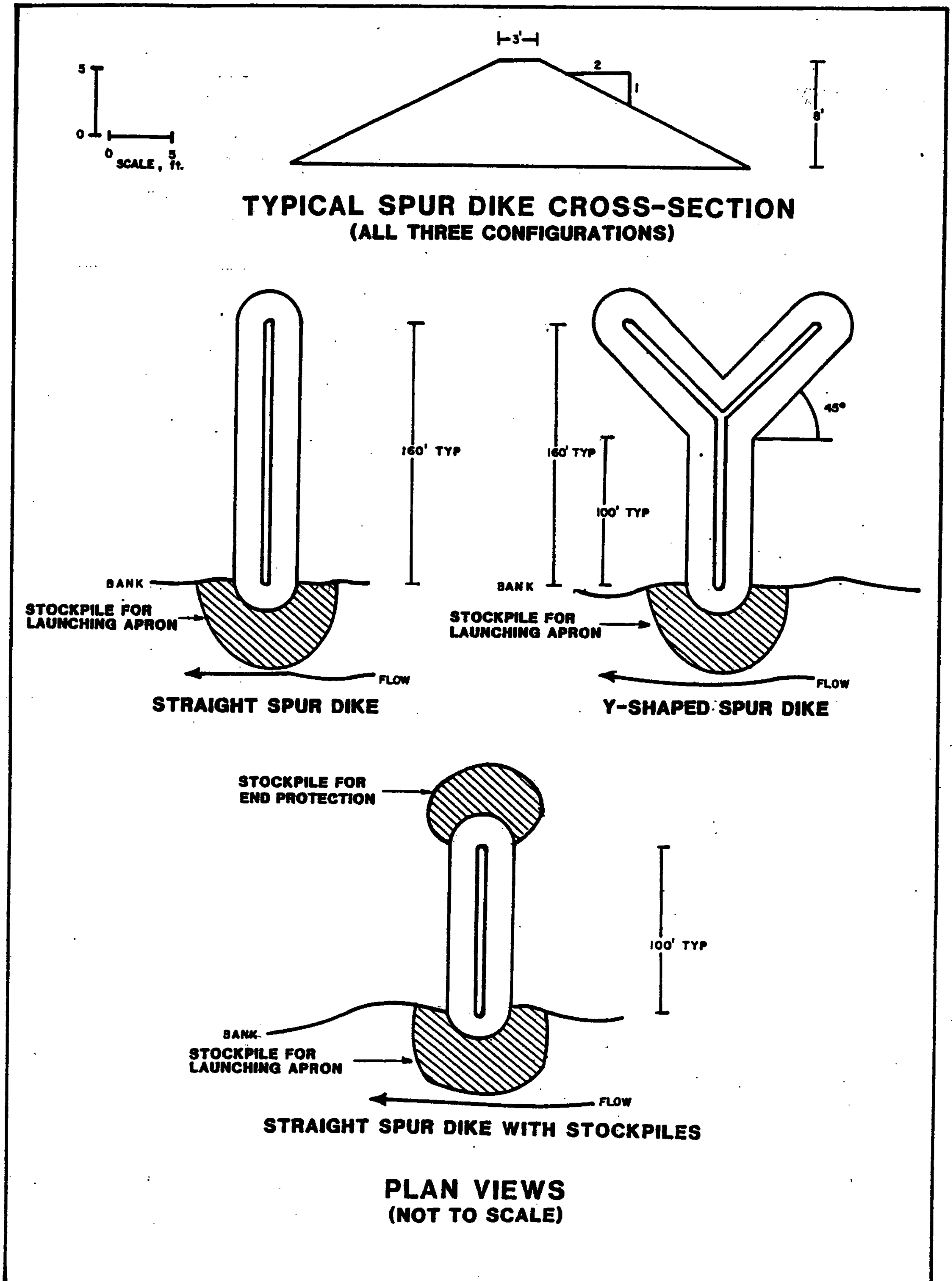


Figure 6. Alternate onshore configurations of riprap spur dikes.

5.4 ESTIMATING ASSUMPTIONS AND COST SUMMARY

The cost estimate for providing spur dikes at Newtok is based on the following assumptions:

- Riprap is obtained from Nelson Island and transported to Newtok by barge;
- Drilling for blasting of riprap is done using a pneumatic drill;
- Onshore trenches are excavated by pneumatic drilling and blasting, followed by using a backhoe to remove the loosened material;
- Riprap is placed by crane from the barge;
- Wages paid to laborers comply with Title 36 requirements;
- Contingency rate is 20 percent;
- Construction occurs during the summer of 1985, with a cost escalation of 3/4 percent per month; and
- Minimum charge for camp is for 30 days.

In addition, no allowances for civil design or quarry royalty costs were included. The ultimate cost of the described erosion control may be reduced by implementing the plan in phases rather than building all 70 dikes in one season. Instead, a smaller number of spur dikes could be built in the first phase. As the wave and thermal energy between spur dikes is reduced over time and the rate of erosion decreases, the design criteria for subsequent spur dikes can be reduced.

Table 3 summarizes the cost of providing both full and partial protection for the three spur dike configurations presented in the previous section. The cost figures for partial protection are based on a 12-spur dike system.

Table 3. Cost summary in thousands of dollars for erosion protection of Ninglick River at Newtok, Alaska.

	Y-shaped spur dikes		Straight spur dikes		Straight spur dikes with stockpiles	
No. of Spurdikes	70	12	70	12	70	12
Project Duration (days)	73	20	61	18	58	18
Cost summary						
Mobilization	$ 215	$ 198	$ 205	$ 194	$ 202	$ 185
Construction	3,317	767	2,616	648	2,460	625
Demobilization	113	108	108	105	108	100
Subtotal	$3,645	$1,073	$2,929	$ 947	$2,770	$ 910
Bonds and Insurance, 1.5%	$ 55	$ 16	$ 44	$ 14	$ 42	$ 14
Contractors Markup, 10%	365	107	293	95	277	91
Contingency, 20%	729	215	586	190	554	182
Escalation, 16 mo x 3/4% per month = 12%	437	129	352	114	333	109
Subtotal	$1,586	$ 467	$1,275	$ 413	$1,206	$ 396
Total	$5,231	$1,540	$4,204	$1,360	$3,976	$1,306

6.0
CONCLUSIONS

6.1 CONCLUSIONS

Erosion of the Ninglick River bank near the City of Newtok is caused by the combined action of heat, waves, and currents. Annual erosion rates in excess of 130 ft have been measured.

Because of the severity and nature of the erosion problem at Newtok, the protection required is extensive and expensive. By anticipating their problem well in advance, however, the residents of Newtok can approach the solution using less expensive methods designed to slow rather than stop the erosion. Stopping the erosion process completely would not be economically feasible as it would require extensive use of both spur dikes and revetments. If the objective is only to slow the erosion, however, the extent of treatment can be scaled down and the cost reduced considerably. The decreasing rate of erosion may allow the bank to stabilize naturally after several years.

Based on the preliminary cost estimates, the spur dike concept appears to be the most economically feasible. A series of 70 spur dikes would be required to protect the entire 4 mi of eroding bank. Of all the construction materials considered, riprap is probably best because it is available within a reasonable barging distance. Locally available silts cannot be used because they will not make a good soil cement.

6.2 RECOMMENDATIONS FOR FURTHER STUDIES

Further studies are needed before the design of the bank protection scheme can be finalized. A number of studies are suggested below that would contribute to the final design of the structures:

- A site reconnaissance should be conducted to verify the quality and quantity of riprap materials on Nelson Island;

- Channel bathymetry data should be collected throughout the 4 mi study reach to verify the maximum and mean depths of the river;

- Additional measurements should be made of river and tidal currents to refine the design velocity;

- Conduct bank and near-shore bed surveys to refine the estimated excavation volumes and to set bench marks for construction surveys;

- Study characteristics of drained lake tidal channels to develop design criteria for the blockage dams;

- Conduct surveys of drained lake tidal channels to provide topography for the design of blockage dams; and

- Continue monitoring the rate and mechanism of erosion before, during, and after project construction.

Potential cost reductions should be examined as part of the final design phase. Savings may be realized by lengthening the spacing between spur dikes, shortening the spur dikes, and/or constructing the project in phases.

If the project is constructed in phases, the design of structures built after the first phase should be designed from criteria based on data collected with the first phase in place. A partial revetment may be able to be used between the existing spur dikes or additional spur dikes may be designed with shorter lengths and/or smaller volumes of material in their launching apron.

Balding, G. O., 1976. Water availability, quality, and use in Alaska. USGS Open File Report No. 76-513, 236 pp.

Brower, W. A., Jr., H. W. Searby, H. F. Diaz, A. S. Prechtel, and J. W. Wise. 1977. Climatic atlas of the outer continental shelf waters and coastal regions of Alaska, Vol. 2, Bering Sea. U. S. Department of Commerce. BLM/NOAA-OCSEAP. 409 pp.

Coonrad, Warren L. 1957. Geologic reconnaissance in the Yukon-Kuskokwim Delta region, Alaska. Miscellaneous Geologic Investigations Map I-223, U.S. Geological Survey, 1 sheet.

Jansen, P. Ph., vanBendegom, L., van den Berg, J., deVries, M., and Zanan, A., editors. 1979. Principles of river engineering: the non-tidal alluvial river. Pitman, San Francisco, 509 pp.

Selkregg, Lidia L., ed. 1975. Alaska regional profiles - Southwest region. University of Alaska, Arctic Environmental Information and Data Center. 265 pp.

Winkley, Brien R. 1983. Sediment management through adequate design of river training structures. Proceedings of the D.B. Simons Symposium on Erosion and Sedimentation, co-edited by Ruh-Ming Li and Peter F. Lagasse, Fort Collins, Colorado, September, p. 6.24-6.46.

APPENDIX A

PERMIT REQUIREMENTS

State and Federal Regulatory Requirements and Permits

The proposed Ninglick River erosion control project involves disturbance to navigable waterways which are located within a wildlife refuge area. Because of these characteristics, State and Federal regulatory requirements associated with the proposed project are varied. Agencies with regulatory requirements relevant to the proposed project include the Alaska Office of Management and Budget, Alaska Department of Fish and Game, Alaska Department of Environmental Conservation, U.S. Army Corps of Engineers, and U.S. Fish and Wildlife Service. These agency responsibilities and requirements are described below:

- Alaska Office of Management and Budget has a system of reviewing and processing permits, leases and approvals for proposed resource projects and activities in the coastal area of Alaska. The process begins by obtaining and completing a "Coastal Project Questionnaire" (Form 1). This questionnaire aids the applicant in determining which state agencies may have requirements with regard to a specific project. As the questionnaire is completed, the applicant may be instructed to contact the various state agencies involved to obtain the required permit applications. Once the required permit applications are obtained and completed, a package containing originals of the questionnaire and state permit applications along with copies of the necessary federal permit applications is sent to the Alaska Office of the Governor's Office of Management and Budget. The Office of Management and Budget will distribute the state applications as necessary. This state permit process takes from 30 to 60 days. Form A is an example of the Coastal Project Questionnaire which was obtained from the Office of Management and Budget.

- Alaska Department of Fish and Game requires an Anadromous Fish Protection Permit for construction activities taking place within anadromous fish streams. The Ninglick River is an anadromous fish stream and therefore requires such a permit. Form 2 is an example of the Anadromous Fish Protection and Permit which was obtained from the Alaska Department of Fish and Game. This permit is also referred to as a Title 16 permit. The completed permit application must be submitted in the package with the questionnaire to the Office of Management and Budget. This permitting process takes from 30 to 60 days.

- Alaska Department of Environmental Conservation requires a Certificate of Reasonable Assurance (Section 401 permit) for projects requiring federal licenses and permits for proposed activities which may result in a discharge into the navigable waters of Alaska. As the Ninglick River erosion control project would involve disposal of fill into the river, such a permit would be required. The application for the certificate is made by submitting to DEC (or in this case the Office of Management and Budget) a letter requesting the certificate accompanied by a copy of the permit application being submitted to the federal agency (see discussion of U.S. Army Corps of Engineers Requirements). The public notice for this permit is run at the same time as the public notice for the Corps permit. The permitting process takes approximately 30 to 60 days.

- U.S. Army Corps of Engineers requires permits for discharge of dredge or fill material into U.S. waters (Section 404 of the Clean Water Act), structures or work in or affecting U.S. navigable waters (Section 10 of the Rivers and Harbors Act), and transportation of dredged material to dump in ocean waters (Section 103 of the Marine, Protection, Research and Sanctuaries Act). Two of these permit requirements, Section 404 - Section 10, pertain to the Ninglick River Erosion Project. A single permit application form entitled "Application for Department of the Army Permit" is required for the Section 10, 404, and 103 permits. Form 3 shows an example of this form. The completed permit application would be sent to the U.S. Army Corps of Engineers while a copy would be sent to the State Office of

Management and Budget as previously discussed. A cross sectional view and plan view of the proposed project must be submitted with the application. This application will subsequently be sent to the Alaska DEC by the Office of Management and Budget. This application may be obtained from the U.S. Army Corps of Engineers. The Corps permitting process takes 60 days from the time of application.

- U.S. Fish and Wildlife Service has jurisdiction over the proposed project area since it falls within the Clarence Rhodes National Wildlife Range Area No. 1. Any party wishing to use lands or facilities of any National Wildlife Refuge for purposes other than those designated by the manager in charge and published in the Federal Register must obtain a Special Use Permit from the U.S. Fish and Wildlife Service. In the case of the Ninglick River erosion control project, this permit application must be processed through the Regional Refuge office which is located in Bethel, Alaska. An example of this application is presented in Form 4. This application was obtained from the U.S. Fish and Wildlife Service. In addition, a copy of this application should be sent to the State Office of Management and Budget. There is no specific time frame for obtaining the special use permit from USFWS. The process could take a relatively short period of time (30 to 60 days) if the Fish and Wildlife Service has all the information available to evaluate the application. Should the Fish and Wildlife Service require additional information, the time involved to get the permit may be prolonged depending on the nature of the additional information. In order to reduce the likelihood of a delay in the permit process due to lack of information, it is best to send copies of the proposed plans, specifications, and aerial photographs (the same as those sent to Alaska Department of Fish and Game) along with the permit application.

FORM 1

STATE OF ALASKA

BILL SHEFFIELD, GOVERNOR

OFFICE OF THE GOVERNOR

POUCH AW
JUNEAU, ALASKA 99811
PHONE: (907) 465-3562

OFFICE OF MANAGEMENT AND BUDGET
DIVISION OF GOVERMENTAL COORDINATION

December 30, 1983

Dear Applicant:

The State of Alaska is embarking on a new system for reviewing and processing of permits, leases and approvals for proposed resource projects and activities in the coastal area of Alaska. This new system is designed to reduce the time taken to make permit decisions and eliminate much of the duplicative review that has occurred in the past.

The new system will make several changes that will directly affect you. These changes and major features are summarized below.

- The new system applies only to proposed projects in the coastal area of Alaska.
- A Coastal Project Questionnaire must be completed and submitted when you apply for permits, leases, or other approvals, except when applying for placer mining permits.
- Applications required for approvals from the Alaska Departments of Fish and Game, Natural Resources, and Environmental Conservation for a project (or a specific phase of a project) must be submitted together as a packet.
- Application packets will need to be submitted to the appropriate office for the region in which the proposed project is to occur. They must be submitted as follows:

    1. Packets that include applications to more than one State agency or for projects which require Federal approval(s) must be submitted to the regional Office of Management and Budget, unless fees or confidential information are included.

    2. Packets that require fees or confidential information must be submitted to the resource agency with the requirement.

3. Packets that include application(s) for a project requiring approvals from only one State resource agency and no Federal agency must be submitted to that State resource agency.

4. Placer mining activity covered by the Annual Placer Mining Application must be submitted to the Department of Natural Resources.

For your information, enclosed is a list of agency contacts and a map of the coastal area.

If you have any questions concerning the new review process or would like to receive a copy of the Administrative Order which outlines the new process, please contact the Office of Management and Budget, Division of Governmental Coordination, in Fairbanks (452-1545), Anchorage (274-3528), or Juneau (465-3562). Questions specific to a single agency should be directed to that agency. If you have general questions concerning information and agency contacts for local, State or Federal permit approvals both in and outside the coastal area, you may wish to contact the Department of Environmental Conservation Permit Information Centers in Fairbanks (452-2340), Anchorage (279-0254) or Juneau (465-2615). Collect calls are accepted.

I appreciate your cooperation in the implementation of this new system.

Sincerely,

Robert L. Grogan
Associate Director

sjn/1383

Enclosure

COASTAL PROJECT QUESTIONNAIRE

This form must be completed when applying for permits for a project or activity in the coastal zone of Alaska.

Applicant City of Newtok

Contact Person Mayor John Charles

Address City office

Newtok, Alaska 99559

Phone (907) 237-2315

Application # ______
No. of Permits required ______
Date of Submission ______
Coordinating Agency ______
Length of review period ______
------Office Use Only------

Brief description of project or activity The City of Newtok proposes to construct bank protection structures on the north bank of the Ninglick River near the village.

Location of project Ninglick River at Newtok, Alaska

Twsp 10 N Rge 87 W Meridian Seward Section 25 USGS Map Baird Inlet D-7 & D-8

Is the project on: private land ____ state land ____ federal land X municipal land X
ownership not known ______

****

EXAMPLE

PART A

	Yes	No
Do you currently have any state or federal approvals/permits for this project?		X

Permit/Approval Type	Permit/Approval #	Expiration date

	Yes	No
Will you be placing structures, or placing fills in any of the following: tidal waters, streams, lakes, wetlands?	X	
Have you applied or do you intend to apply for a U.S. Army Corps of Engineers permit?	X	
Have you applied or do you intend to apply for other permits from any Federal agencies permits for your project?	X	

Agency	Permit/Approval Type	(Expected) Date of Application
US Fish and Wildlife Service	Natl. Wildlife Refuge Special Use Permit	*

* Fill in when available

PART B **Department of Natural Resources** Yes No

1. Is the proposed project on state-owned lands or will you need to cross state lands for access? ____ X

2. Do you plan to use any of the following state-owned resources?

Sand and Gravel	Yes ____	No X	If yes, amount ____	Source ____
Water	Yes ____	No X	If yes, amount ____	Source ____
Timber	Yes ____	No X	If yes, amount ____	
Other Materials (peat, building stone, etc.)	Yes ____	No X		

	Yes	No
3. Do you plan to drill a geothermal well?	____	X
4. Will you be exploring for or extracting coal?	____	X
5. Will you be harvesting timber from 10 or more acres?	____	X
6. Will you be investigating or removing historic or archeological resources on state-owned lands?	____	X

EXAMPLE

IF YOU ANSWERED NO TO THESE QUESTIONS, YOU DO NOT NEED APPROVAL FROM THE ALASKA DEPARTMENT OF NATURAL RESOURCES (DNR). GO TO PART C.

IF YOU ANSWERED YES TO ANY OF THESE QUESTIONS, YOU MAY NEED A PERMIT OR APPROVAL FROM DNR. PLEASE CONTACT DNR TO IDENTIFY AND OBTAIN ANY NECESSARY APPLICATION FORMS.

If you have already contacted DNR, are you now submitting application(s) for permits or approvals? ____ ____

If no, indicate the reason below:

____ a. ____________ (person contacted) told me on ____________ that no DNR approvals or permit were required for this project.
____ b. DNR regulations have no requirement for a permit or approval.
____ c. Other ____________

****

PART C **Department of Fish and Game** Yes No

1. Will you be working in a stream or lake (including the running water or on the ice, within the gravel floodplain, on islands, the face of the banks, or the stream tideflats down to mean low tide)? X ____

Name of stream or lake Ningluck River

If yes, will you be doing any of the following:

	Yes	No
a) building a dam or river training structure	X	____
b) using the water	____	X
c) diverting the stream	____	X
d) blocking or damming the stream (temporarily or permanently)	____	X
e) changing the flow of the water or changing the bed	X	____
f) pumping water out of the stream or lake	____	X
g) introducing silt, gravel, rock, petroleum products, debris, chemicals, or wastes of any type into the water	X	____

		Yes	No
h)	using the stream as a road (even when frozen), or crossing the stream with tracked or wheeled vehicles, log-dragging or excavation equipment (backhoes, bulldozers, etc.)		X
i)	altering or stabilizing the banks	X	
j)	mining or digging in the beds or banks	X	
k)	using explosives	X	
l)	building a bridge (including an ice bridge)		X
m)	installing a culvert of other drainage structure		X
2.	Is your project located in a State Refuge or Critical Habitat?		X

IF YOU ANSWERED NO TO THESE QUESTIONS, YOU DO NOT NEED A PERMIT FROM THE ALASKA DEPARTMENT OF FISH AND GAME (DFG). GO TO PART D.

IF YOU ANSWERED YES TO ANY OF THESE QUESTIONS YOU MAY NEED A PERMIT FROM DFG. PLEASE CONTACT THE REGIONAL HABITAT DIVISION OFFICE TO OBTAIN NECESSARY APPLICATION FORMS.

If you have already contacted DFG, are you now submitting an application for permit(s)? Yes: X No: ____

If no, indicate the reason below.

____ a. ________________ (person contacted) told me on ________ (date) that no DFG permits were required for my project.

____ b. Other ____

****

EXAMPLE

PART D	Department of Environmental Conservation	Yes	No
1.	Will a discharge of wastewater from industrial or commercial operations occur?		X
2.	Will your project generate air emissions from the following:		
a)	diesel generator		X
b)	other fossil fuel-fired electric generator, furnace, or boiler		X
c)	asphalt plant		X
d)	incinerator		X
e)	industrial process		X
3.	Will a drinking water supply be developed?		X
4.	Will you be processing seafood?		X
5.	Will food service be provided to the public or workers?		X
6.	Will the project result in dredging or disposal of fill in wetlands or waterways?	X	
7.	Is on-lot sewage or greywater disposal involved or necessary?		X
8.	Will your project result in the development of a currently unpermitted facility for the disposal of domestic or industrial solid waste?		X
9.	Will your project require storage or transport of oil or other petroleum products in exess of 660 gallons?		X
10.	Will your project require the application of oil or pesticides to the surface of the land?		X

IF YOU ANSWERED NO TO THESE TEN QUESTIONS, YOU DO NOT NEED A PERMIT OR OTHER APPROVAL FROM THE ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION (DEC).

IF YOU ANSWERED YES TO ANY OF THESE QUESTIONS YOU MAY NEED A PERMIT FROM DEC. PLEASE CONTACT THE DEC REGIONAL OFFIC TO IDENTIFY AND OBTAIN ANY NECESSARY PERMIT APPLICATION FORMS.

If you have already contacted the Alaska Department of Environmental Conservation, are you now submitting an applica tion for permit(s)?

If no, indicate the reason below:

EXAMPLE

____ a) ____________________ (person contacted) told me on __________ (date) that no DEC permits were required for my project.

____ b) Other ____

****

To the best of my knowledge, the above information is accurate and complete.

X______________________________ Signed

X______________________________ Date

****** PLEASE ATTACH YOUR PERMIT APPLICATIONS ******

THANK YOU

State of Alaska Permitting Offices
Southcentral Region

DEPARTMENT OF NATURAL RESOURCES

Oil & Gas Activities

DNR/Oil and Gas
Pouch 7-034
Anchorage, Alaska 99510
(907) 276-2653
Contact: Ted Bond

Mining Activities

DNR/Mining
Pouch 7-034
Anchorage, Alaska 99510
(907) 276-2653
Contact: Jerry Gallagher

Forestry Activities

DNR/Forestry
Pouch 7-005
Anchorage, Alaska 99510
(907) 276-2653
Contact: Craig Olson

Agriculture Activities

DNR/Agriculture
Suite 102, Transac Bldg.
Pouch A
Wasilla, AK 99687
(907) 376-3276
Contact: Dean Brown

Activities on State Park Lands

DNR/Parks
619 Warehouse Avenue, Suite 210
Anchorage, Alaska 99501
(907) 276-2653
Contact: Sandy Rabinowitch

DEPARTMENT OF NATURAL RESOURCES

All Other Activities

Public Information
Southcentral District Office
DNR/Land and Water Management
3601 "C" Street, Frontier Bldg.
Pouch 7-005
Anchorage, Alaska 99510
(907) 276-2653
Contact: Elaine Nelson

DEPARTMENT OF FISH AND GAME

DFG/Habitat Division
333 Raspberry Road
Anchorage, Alaska 99502
Contact: Phil Brna or
Gary Leipitz at (907) 267-2285,
or Denby Lloyd or Kim Sundberg
at 267-2346

DEPARTMENT OF ENVIRONMENTAL CONSERVATION

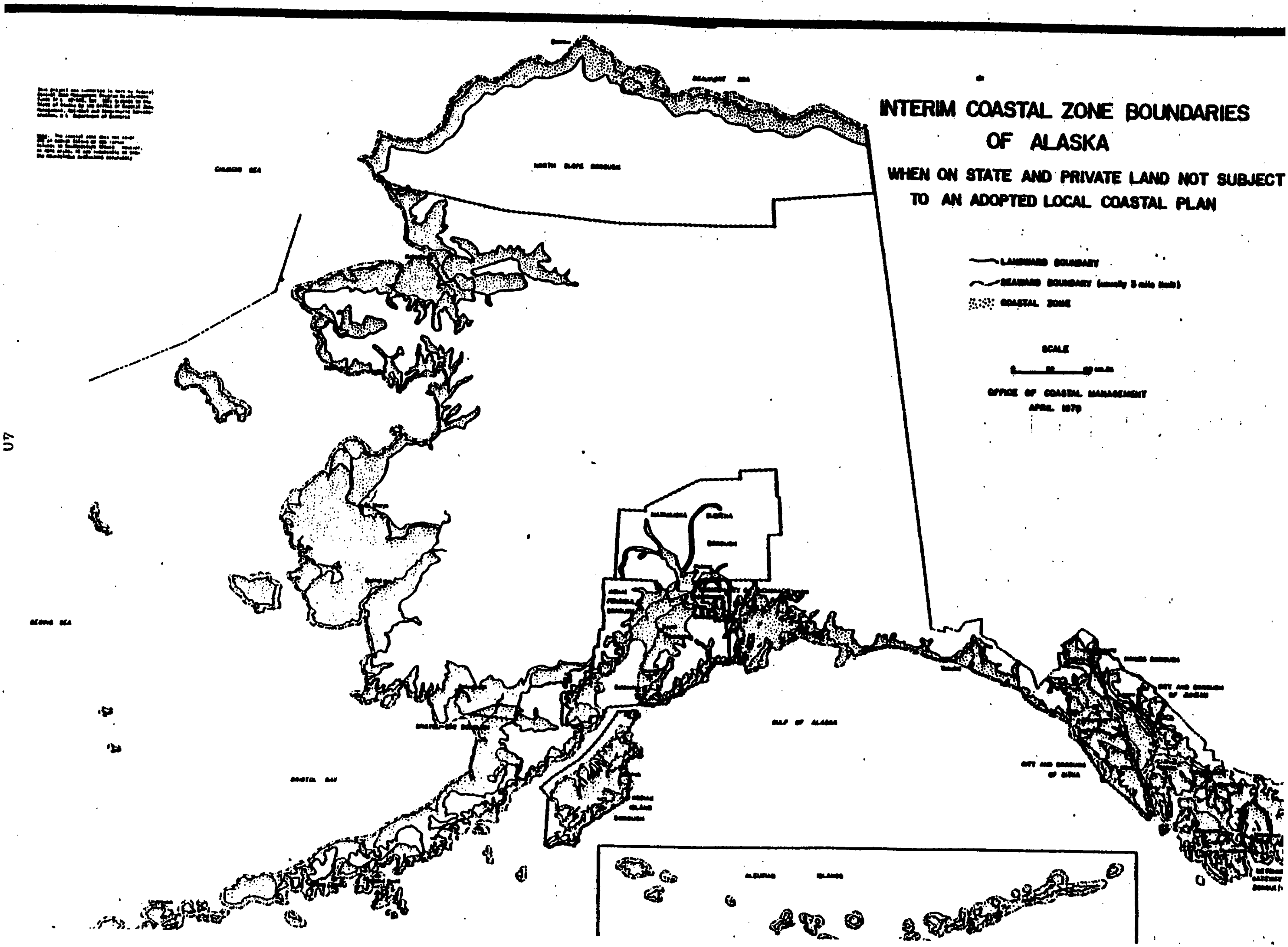
DEC/Southcentral Office
437 E. St. 2nd Floor
Anchorage, Alaska 99501
(907) 274-2533

Contact: Tim Rumfelt

OFFICE OF MANAGEMENT AND BUDGET

3301 Eagle St., Suite #307
Anchorage, Alaska 99503
(907) 274-3528
Contact: Jack Heesch

U7


INTERIM COASTAL ZONE BOUNDARIES
OF ALASKA
WHEN ON STATE AND PRIVATE LAND NOT SUBJECT
TO AN ADOPTED LOCAL COASTAL PLAN
LANDWARD BOUNDARY
COASTAL ZONE
SCALE
OFFICE OF COASTAL MANAGEMENT

333 Raspberry Road
Anchorage, Alaska 99502

FORM 2
Office Use Only

FG # ________

GENERAL WATERWAY/WATERBODY APPLICATION
ALASKA DEPARTMENT OF FISH AND GAME

A. APPLICANT

1. Name: Mayor John Charles City of Newtok
2. Address: City office
   Newtok, Alaska 99559 Telephone: (907) 237-2315
3. Project Contractor: Name *
   Address *
   Telephone: *

B. TYPE AND PURPOSE OF PROJECT: This river bank erosion project is designed to slow the northward migration of the Ninglick River Bank

EXAMPLE

C. LOCATION OF PROJECT SITE

1. Name of River, Stream, or Lake: Ninglick River
   or Anadromous Stream # 335-40-14800
2. Legal Description: Township 10N Range 87W Meridian Seward
   Section 25 USGS Quad Map Baird Inlet D-7 & D-8
3. Plans, Specifications and Aerial Photograph (See specific instructions)
   Note: This information must accompany permit application

D. TIME FRAME FOR PROJECT: * to * (dates)

E. CONSTRUCTION METHODS: Yes No

1. Will the stream be diverted? ___ X
   How will the stream be diverted? N/A
   How long? N/A
2. Will stream channelization occur? ___ X

* Fill in when available

		Yes	No
3.	Will the banks of the stream be altered or modified?	X	

Describe: Excavation is required to key the spur dikes into the bank - the majority of the structure will be keyed into the bank.

4. List all tracked or wheeled equipment (type and size) that will be used in the stream (in the water, on ice, or in the floodplain)

None are anticipated

How long will equipment be in the stream? N/A

			Yes	No
5	a.	Will material be removed from the floodplain or bed or the stream or lake?	X	
		Type excavation of bank described in 3		
		Amount *		
	b.	Will material be removed from below the water table?		X
		If so, to what depth?		
		Is a pumping operation planned?		

EXAMPLE

		Yes	No
6.	Will material (including spoils, debris, or overburden) be deposited in the floodplain or in the stream or lake?	X	

If so, type Riprap spur dike

Amount *

Disposal Site Location(s) See Plans

		Yes	No
7.	Will blasting be performed?	X	

Weight of charges *

Type of substrate *

		Yes	No
8.	Will temporary fills in the stream or lake be required during construction (e.g. for construction traffic around construction site)?		X
9.	Will ice bridges be required?		X

* Fill in when available

F. SITE REHABILITATION/RESTORATION PLAN: On a separate sheet present a site rehabilitation/restoration plan (See specific instructions).

G. WATERBODY CHARACTERISTICS:

Width of stream 4000 - 5000 ft.

Depth of Stream or Lake 35-40 ft max

Type of Stream or Lake Bottom (e.g. Sand, Gravel, Mud) silt d_{50} = 0.02 mm

Stream Gradient Mild to adverse - depends on tides

H. Hydraulic Evaluation: Yes No

1. Will a structure (e.g. culvert, bridge support, dike) be placed below ordinary high water of the stream? Yes: X No: ____

   If yes, attach engineering drawings or a field sketch, as described in Step B.

   For culverts, attach stream discharge data for a mean annual flood (Q=2.3), if available.

   Describe potential for channel changes or increased bank erosion, if applicable. The purpose of the structures is to decrease the rate of bank erosion

EXAMPLE

2. Will more than 25,000 cubic yards of material be removed? Yes: ____ No: X

   If yes, attach a written hydraulic evaluation including, at a minimum, the following: potential for channel changes; assessment of increased aufeis (glaciering) potential; assessment of potential for increased bank erosion.

I HEREBY CERTIFY THAT ALL INFORMATION MADE ON OR IN CONNECTION WITH THIS APPLICATION IS TRUE AND COMPLETE TO THE BEST OF MY KNOWLEDGE AND BELIEF.

X ______________________ Signature of Applicant

X ______________________ Date

FORM 3-1383
(REV. 11/75)

FORM 4

UNITED STATES DEPARTMENT OF THE INTERIOR
U.S. Fish and Wildlife Service

Clarence Rhode National Wildlife ~~Refuge~~ Range Area No. 1

SPECIAL USE PERMIT

Permit number	Sta. No. to be credited

Contract number

Date

Permittee *(Name and address)*

CITY OF NEWTOK
CITY OFFICE
NEWTOK, ALASKA 99559

Period of use *(inclusive)*

From (Start of Construction) 19

To Permanent Structure 19

Purpose *(Specify in detail privilege requested, or units of products involved)*

This river bank erosion project is designed to slow the northward migration of the Ninglick River.

EXAMPLE

Description *(Specify unit numbers; metes and bounds; or other recognizable designations)*

The project consists of a series of ____ spur dikes constructed with a spacing of 300 ft. for 4 miles of the Ninglick River Bank. (Note: Plans, specifications, and aerial photographs (the same as those sent to Alaska Department of Fish and Game) should be sent with this application).

Amount of fee $ * ______ If not a fixed fee payment, specify rate and unit of charge: ______

☐ Full payment

* ☐ Partial payment-Balance of payments to be made as follows:

Record of Payments

- (To be filled out by U.S. Fish and Wildlife Service)

Special Conditions

(To be filled out by U.S. Fish and Wildlife Service)

This permit is issued by the U.S. Fish and Wildlife Service, and accepted by the undersigned, subject to the terms, covenants, obligations, and reservations, expressed or implied therein, and to the conditions and requirements appearing on the reverse side.

Permittee *(Signature)*	Issuing Officer *(Signature and title)*
X	

GENERAL CONDITIONS

1. Payments. All payments shall be made on or before the due date to the local representative of the U.S. Fish and Wildlife Service by a postal money order or check made payable to the U.S. Fish and Wildlife Service.

2. Use limitations. The permittee's use of the described premises is limited to the purposes herein specified; does not unless provided for in this permit allow him/her to restrict other authorized entry on to his/her area; and permits the Service to carry on whatever activities are necessary for (1) protection and maintenance of the premises and adjacent lands administered by the Service and (2) the management of wildlife and fish using the premises and other Service lands.

3. Damages. The United States shall not be responsible for any loss or damage to property including but not limited to growing crops, animals, and machinery; or injury to the permittee, or his/her relatives, or to the officers, agents, employees, or any others who are on the premises from instructions or by the sufferance of the permittee or his/her associates; or for damages or interference caused by wildlife or employees or representatives of the Government carrying out their official responsibilities. The permittee agrees to save the United States or any of its agencies harmless from any and all claims for damages or losses that may arise or be incident to the flooding of the premises resulting from any associated Government river and harbor, flood control, reclamation, or Tennessee Valley Authority activity.

4. Operating Rules and Laws. The permittee shall keep the premises in a neat and orderly condition at all times, and shall comply with all municipal, county, and State laws applicable to the operations under the permit as well as all Federal laws, rules, and regulations governing National Wildlife Refuges and the area described in this permit. The permittee shall comply with all instructions applicable to this permit issued by the refuge officer in charge. The permittee shall take all reasonable precautions to prevent the escape of fires and to suppress fires and shall render all reasonable assistance in the suppression of refuge fires.

5. Responsibility of Permittee. The permittee, by operating on the premises, shall be considered to have accepted these premises with all the facilities, fixtures, or improvements in their existing condition as of the date of this permit. At the end of the period specified or upon earlier termination, the permittee shall give up the premises in as good order and condition as when received except for reasonable wear, tear, or damage occurring without fault or negligence. The permittee will fully repay the Service for any and all damage directly or indirectly resulting from negligence or failure on his/her part, or the part of anyone of his/her associates, to use reasonable care.

6. Revocation Policy. This permit may be revoked by the Regional Director of the Service without notice for noncompliance with the terms hereof or for violation of general and/or specific laws or regulations governing National Wildlife Refuges or for nonuse. It is at all times subject to discretionary revocation by the Director of the Service. Upon such revocation the Service, by and through any authorized representative, may take possession of the said premises for its own and sole use, or may enter and possess the premises as the agent of the permittee and for his/her account.

7. Compliance. Failure of the Service to insist upon a strict compliance with any of this permit's terms, conditions, and requirements shall not constitute a waiver or be considered as a giving up of the Service's right to thereafter enforce any of the permit's terms, conditions, or requirements.

8. Termination Policy. At the termination of this permit, the permittee shall immediately give up possession to the Service representative, reserving, however, the rights specified in paragraph 9. If he/she fails to do so, he/she will pay the Government, as liquidated damages, an amount double the rate specified in this permit for the entire time possession is withheld. Upon yielding possession, the permittee will still be allowed to reenter as needed to remove his/her property as stated in paragraph 9. The acceptance of any fee for liquidated damages or any other act of administration relating to the continued tenancy is not to be considered as an affirmance of the permittees action nor shall it operate as a waiver of the Government's right to terminate or cancel the permit for the breach of any specified condition or requirement.

9. Removal of Permittee's Property. Upon the expiration or termination of this permit, if all rental charges and/or damage claims due to the Government have been paid, the permittee may, within a reasonable period as stated in the permit or as determined by the refuge officer in charge but not to exceed 60 days, remove all structures, machinery, and/or other equipment, etc., from the premises for which he/she is responsibile. Within this period the permittee must also remove any other of his/her property including his/her acknowledged share of products or crops grown, cut, harvested, stored, or stacked on the premises. Upon failure to remove any of the above items within the aforesaid period, they shall become the property of the United States.

10. Transfer of Privileges. This permit is not transferable, and no privileges herein mentioned may be sublet or made available to any person or interest not mentioned in this permit. No interest hereunder may accrue through lien or be transferred to a third party without the approval of the Regional Director of the U.S. Fish and Wildlife Service and the permit shall not be used for speculative purposes.

11. Conditions of Permit not Fulfilled. If the permittee fails to fulfill any of the conditions and requirements set forth herein, all money paid under this permit shall be retained by the Government to be used to satisfy as much of the permittee's obligations as possible.

12. Officials Barred from Participating. No Member of Congress or Resident Commissioner shall participate in any part of this contract or to any benefit that may arise from it, but this provision shall not pertain to this contract if made with a corporation for its general benefit.

13. Nondiscrimination in Employment. The permittee agrees to be bound by the equal opportunity clause of Executive Order 11246, as amended.