Contents

Alaska Outer Continental Shelf

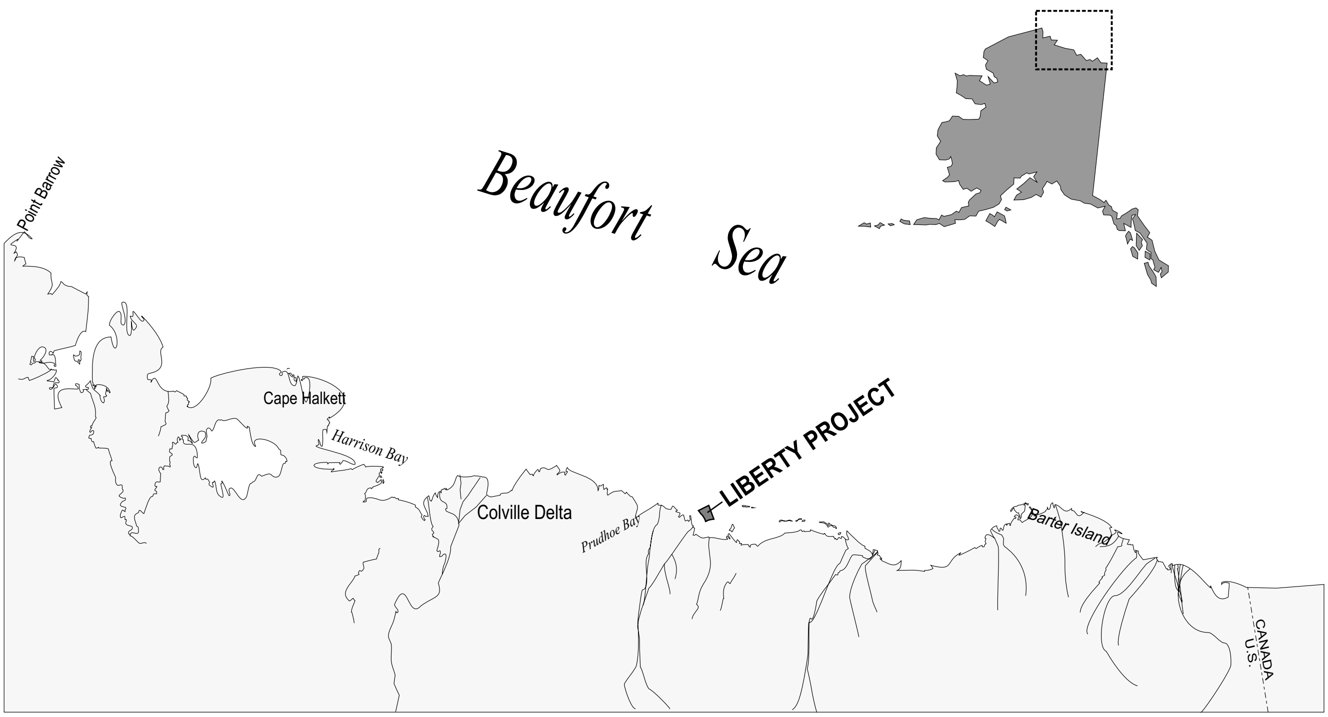
OCS EIS/EA
MMS 2001-001

Liberty Development and Production Plan

Draft Environmental
Impact Statement

Volume II

(Tables, Figures, and Maps for Volume I)



U.S. Department of the Interior
Minerals Management Service
Alaska OCS Region

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Liberty Development and Production Plan, Draft Environmental Impact Statement,
OCS EIS/EA, MMS 2001-001, in 3 volumes:
Volume I, Executive Summary, Sections I through IX, Bibliography, Index
Volume II, Tables, Figures, and Maps for Volume I
Volume III, Appendices

The summary is also available as a separate document:
Executive Summary, **MMS 2001-002.**

The complete EIS is available on CD-ROM (**MMS 2001-001 CD**) and on the Internet (**http://www.mms.gov/alaska/cproject/liberty/**).

This Environmental Impact Statement (EIS) is not intended, nor should it be used, as a local planning document by potentially affected communities. The exploration, development and production, and transportation scenarios described in this EIS represent best-estimate assumptions that serve as a basis for identifying characteristic activities and any resulting environmental effects. Several years will elapse before enough is known about potential local details of development to permit estimates suitable for local planning. These assumptions do not represent a Minerals Management Service recommendation, preference, or endorsement of any facility, site, or development plan. Local control of events may be exercised through planning, zoning, land ownership, and applicable State and local laws and regulations.

With reference to the extent of the Federal Government's jurisdiction of the offshore regions, the United States has not yet resolved some of its offshore boundaries with neighboring jurisdictions. For the purposes of the EIS, certain assumptions were made about the extent of areas believed subject to United States' jurisdiction. The offshore-boundary lines shown in the figures and graphics of this EIS are for purposes of illustration only; they do not necessarily reflect the position or views of the United States with respect to the location of international boundaries, convention lines, or the offshore boundaries between the United States and coastal states concerned. The United States expressly reserves its rights, and those of its nationals, in all areas in which the offshore-boundary dispute has not been resolved; and these illustrative lines are used without prejudice to such rights.

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Alaska OCS Region

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TABLES

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Table I-1 The Relationship between the Component Alternatives and Combination Alternatives

Component Alternative	Combination Alternative A	Combination Alternative B	Combination Alternative C	Liberty DPP
Alternative Drilling Island Location and Pipeline Route				
Alt. I – Use Liberty Island Location and Pipeline Route (Liberty DPP)	✔	–	–	✔
Alt. III.A – Use Southern Island Location and Eastern Pipeline Route	–	✔	–	–
Alt. III.B – Use Tern Island Location and Pipeline Route	–	–	✔	–
Alternative Pipeline Design				
Alt. I – Use Single Wall Steel Pipe System (Liberty DPP)	–	–	–	✔
Alt. IV.A – Use Pipe-in-Pipe System	✔	–	✔	–
Alt. IV.B – Use Pipe-in-HDPE System	–	✔	–	–
Alt. IV.C – Use Flexible Pipe System	–	–	–	–
Alternative Upper Island Slope Protection System				
Alt. I – Use Gravel Bags (Liberty DPP)	–	✔	–	✔
Alt. V – Use Steel Sheetpile	✔	–	✔	–
Alternative Gravel Mine Sites				
Alt. I – Use Kadleroshilik River Mine Site (Liberty DPP)	–	✔	–	✔
Alt. VI – Use Duck Island Gravel Mine Site	✔	–	–	–
Alternative Pipeline Burial Depths				
Alt. I – Use a 7-Foot Burial Depth (Liberty DPP)	✔	*	–	✔
Alt. VII – Use a 15-Foot Pipeline Trench Depth	–	*	✔	–

* The burial depth for the HDPE System is a 6-foot minimal depth as designed by INTEC (2000).
Note: Each of the above component and combination alternatives is a complete project. That is, each has all of the project elements needed to develop the liberty prospect and therefore can be compared to each other on an equal footing.

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Table I-2 Key Scoping Issues Analyzed in this EIS

Issue	Section(s) Containing Information or Analysis
Oil Spills from Pipelines or Structures	
Risk of oil spills from buried pipelines	II.A.1.c, III.C.1, III.C.2, III.D.3, IV.C.1, IV.C.2, V, IX.A., Appendix A
Capability to detect oil spills from buried pipeline	II.A.1.b, IV.C.2
Effects of a potential oil spill on the various resources	III.A.2, III.C.2, III.D.3, , IV, V, IX
Effects of an extremely large (catastrophic) but unlikely oil spill	IX
Effects of an oil spill in broken ice	III.C.2, III.D.3, V, IX
Pipeline design (Pipe-in-Pipe, Pipe-in-HDPE, Flexible Pipe, Single-Wall Pipe)	II.C.2, IV.C.2
Oil-spill-response capabilities and contingency planning	II.A.2, II.A.3,II.A.4, III.C.1
Effects on Key Resources Resulting from Project-Related Disturbances	
Effects of potential oil spills, discharges, noise from industrial activities, and increased human interaction	III.A.2, III.C, III.D, V, IIX, Appendix A
Effects of the proposed activities on the Boulder Patch, including proposed pipeline construction (trenching and backfilling)	IIII.A.2.e, III.C.2.e, III.C.3.e, III.D.1.e, III.D.2.e, III.D.3.e, III.D.6.e, , IV, V.C.5, VI.A.5, IX.A.6.e
Effects on polar bears, especially denning bears, and concerns about having enough baseline information about polar bears	III.A.2.b, III.C.2.b, III.C.3.b, III.D.1.b, III.D.2.b, III.D.3.b, III.D.6.b, , IV,V.C.2, VI.A.2, IX.A.6.b
Effects of the proposed activities on birds, especially to oldsquaw, from helicopter flights during nesting and molting periods; potential risks to nesting birds by predators from increased activities	III.A.2.c, III.C.2.c, III.C.3.c, III.D.1.c, III.D.2.c, III.D.3.c, III.D.6.c, , IV,V.C.3, VI.A.3, IX.A.6.c
Effects on marine mammals, including bowhead and beluga whales; ringed, spotted, and bearded seals; and walruses	III.A.2, III.C.2, III.C.3, III.D.1, III.D.2, IV,V.C,VI.A, IX
Effects on caribou and other terrestrial species	III.A.2.d, III.C.2.d, III.C.3.d, III.D.1.d, III.D.2.d, III.D.3.d, III.D.6.d, , V.C.4,VI.A.4, IV, IX.A.6.d
Effects on fish, including proposed pipeline construction (trenching and backfilling)	III.A.2.f(1), III.C.2.f.(1), III.C.3.f.(1), III.D.1.f. (1), III.D.2.f.(1), III.D.3.f.(1), III.D.6.f. (1), IV, V.C.6.b,VI.A.6.a, , IX.A.6.f
Effects on essential fish habitat	III.A.2.f. (2), III.C.2.f.(2), III.C.3.f.(2), III.D.1.f.(2), III.D.2.f.(2), III.D.3.f.(2), III.D.4.b, III.D.6.f(2), III.D.7.f(2), III.D.9.f(2), V.C.6.b, VI.A.8
Effects on known archaeological sites in the area onshore, and the impacts of silt from island construction to the area near Tigvarik Island	III.A.2.j, III.C.2.j, III.C.3.j, III.D.1.j, III.D.2.j, III.D.3.j, III.D.6.j, IV, V.C.10, VI.B.3, IX.A.6.j
Cumulative Effects on Biological and Physical Resources and Social Systems	
Cumulative effects of the Plan and activities, including pipelines, on the habitat and key species (particularly displacing bowhead whales) in the Beaufort Sea and people of the North Slope	V
Effects of future projects on the resources and people of the North Slope	V
Effects of the Plan compared to other ongoing and potential new activities	V
Petroleum-Development Activities and Effects on Subsistence Harvests	
How the Proposal affects subsistence hunting and gathering on the North Slope	III.A.2.h, III.C.2.h, III.C.3.h, III.D.1.h, III.D.2.h, III.D.6.h,, V.C.8, VI.B.1, IX.A.6.h
Effects of noise on the feeding and migration routes of marine mammals, especially the bowhead whale	III.A.2.a(1), III.C.3, IV, V.C.1.a
Effects of potential emissions from onshore construction (stacks) on whales' feeding and migration	III.A.2.m, III.D.1.a
Effects of onshore pipelines and how they may interfere with using traditional subsistence sites	II.A.1, III.A.2.h, III.C.1.c, III.C.2.h, III.C.3.h, , IV, V.C.8, IX.A.6.h, , Appendix A

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Table I-2 Key Scoping Issues Analyzed in this EIS (continued)

Issue	Section(s) Containing Information or Analysis
Sociocultural and Economic Effects on Villages and Native Communities	
Include traditional knowledge in our analysis and as information for the decisionmaker	I.C.1, III.B, III.C, III.D, , IV, V, VI
Population growth (non-Native) and balance between traditional and modern lifestyles of the Inupiat people	III.A.2, III.C,2, III.C.3, III.D.1, III.D.2, III.D.3, III.D.6, , IV, V, IX
Timing and size of the project's workforce and how they will affect the community's economy	II.A.1.f, III.A.2, III.C.2.k, III.C.3.k, III.D.1.k, III.D.2.k, III.D.5, III.D.6.k, , IV, V.C.11IX.B.11
How well subsistence whalers will be accepted if they land on the island	II.A.1.b, III.C.3.i
Methods/locations for waste disposal and whether it will affect communities	II.A.1.3, III.D.1
Effects of the Pipeline and Gravel Island	
How pipeline construction may affect the Boulder Patch and nearby fish	II.A.1.c, II.A.4, III.C, III.D, , IV, V.C.5
How development may affect known archaeological sites	II.A.1.j, III.C.2.j, III.C.3.j, III.D.1.j, III.D.2.j, III.D.3.j, III.D.6.j, , IV, V.C.10, IX.B.10
How burying the pipeline may change the environment	II.A.1.c, II.A.4, III.C.3, III.D.6,., IV.C.5, V
What are the effects of dredging/excavation, placement of dredged material or fill, and what are the effects of disposing of the excess dredged material in the ocean.	II.A.1, III.C.3, III.D,1, III.D.2, , IV, V, VI., Appendix G and H
How gravel bags and the silt from island construction may affect the area near Tigvariak Island	I.D.2.c, III.C.3.e, , IV.C.1,IV.C.5, V.C.5
How pipeline design integrity reduces risks of a pipeline leak from rupturing	I.D.1., II.A.1.c, II.A.4, III.C.1.d, IV.C.2
How island facility design standards minimize risks of a blowout	II.A.1.c, II.A.4, III.C.1.d
How island design standards reduce risks of ice override	II.A.1.b, III.C.1.c
Effects on Air and Water Quality	
Emissions into the air	III.A.2.m, III.D.1.m, , IV, V.C.13, IX.B.13
Marine water discharges	III.A.2.l, III.C.2.l, III.C.3.l, III.D.1l, III.D.2.l, III.D.4, III.D.6.l, IV, V.C.12, IX.B.12
Discharges from the seawater treatment plants for seawater and domestic wastewater	III.D.1., III.D.4
Effects of Facilities Abandonment	
Effects of abandonment of the production facility at the end of the project's life	III.D.6
Effects of pipeline removal at abandonment	III.D.6
Other Agency Permits and Requirements	
What other Federal and State Agency permits are required	Appendix B – Table B-1

Source: USDOI, MMS, Alaska OCS Region

Table I-3 Measures BPXA Incorporated into their Liberty Development and Production Plan (Alternative I–BPXA's Proposal) to Avoid or Minimize Potential Impacts to the Biological, Physical, and Sociocultural Resources Within the Study Area

Action	Benefit
Mitigation by Design	
Smaller facility size; reduced wellhead spacing to 9 feet, directional drilling.	Minimize impacts associated with size of the offshore island.
Designed facility for zero discharge of drilling wastes; no reserve pits.	Reduce island size and impacts to benthos; eliminate potential for contaminant release from reserve pits; avoid water quality impacts; avoid impacts to fish and essential fish habitat.
Locate island as close to shore as possible.	Reduce length of pipeline necessary to reach shore, thereby minimizing disturbance to the marine environment and essential fish habitat.
Use filter fabric to reduce leaching of fine particulates downstream onto sensitive marine habitat.	Minimize redistribution of fine sediments from the gravel island following construction.
Process design incorporated measures to minimize CO_2 emissions by using natural gas and electrical power for drilling (long term) .	Reduce emissions of "greenhouse" gases.
Mine gravel and construct island and pipeline during winter from ice roads.	Eliminate impacts to wildlife; reduce sediment input effects, eliminate dust effects, eliminate impacts to tundra wetlands from a permanent access road; minimize impacts to essential fish habitat subsistence; and facilitate abandonment and reclamation of mine site.
Dispose of solid wastes onshore.	Minimize waste storage on the island. Reduce fox and polar bear encounters.
Impose restrictions to spring helicopter overflights of Howe Island.	Avoid disturbance to breeding and nesting snow geese and brant.
Route helicopter traffic to minimize effects to wildlife. Route vessel traffic inside the barrier islands.	Minimize disturbance to seals, bowhead whales, polar bear dens, and subsistence whaling activities.
Consult with Alaska Eskimo Whaling Commission if bowhead whales are observed inside the Midway Islands barrier island group.	Minimize disturbance to migrating bowhead whales or subsistence whaling activities.
Prohibit hunting by project personnel, and restrict public access.	Protect wildlife and cultural resources.
Train personnel in interactions with wildlife. Establish an environmental awareness program.	Reduce potential for disturbance to wildlife and essential fish habitat Increase awareness of risks and means to reduce impacts on wildlife.
Train personnel to recognize and avoid cultural resources.	Ensure that cultural resources are preserved.
Develop Conflict and Avoidance Agreement with local subsistence users.	Avoid unreasonable conflicts to subsistence activities.
Use ice roads to access Liberty Project and resources.	Minimize impacts to the tundra.
Use sea ice to support island construction and pipeline placement. Install pipeline during winter, when water currents are low.	Avoid barge traffic in summer for gravel transport, reducing air emissions. Reduce sedimentation of disturbed materials from the pipeline trench on adjacent benthic environments and essential fish habitat. Reduce noise disturbance to marine mammals.
Minimize Island size.	Reduce footprint of island and impacts on benthic environment.
Coordinate with the Alaska Department of Fish and Game on studies of fish and brown bears within project area. Identify and avoid den locations.	Minimize interactions with bears; identify important fish resources in project area.
Coordinate with U.S. Fish and Wildlife Service on historic and recent locations of polar bear den sites.	Avoid actions that would disturb denning polar bears.
Archaeology Surveys.	Avoid disturbance of potential archaeology sites.

Source: BPXA (2000a)

Table II.A-1 Key Project Component Summary for All Alternatives[1]

	I Proposal	III.A Southern Island	III.B Tern Island	IV.A Pipe-in- Pipe	IV.B Pipe-in-HDPE	IV.C Flexible Pipe	V Steel Sheetpile	VI Duck Island. Gravel Mine	VII Bury Deeper
GRAVEL ISLAND									
a. Location	Liberty Island	Southern Island	Tern Island	Liberty Island	Liberty Island	Liberty Island	Liberty Island	Liberty Island	Liberty Island
b. Upper Slope Protection	Gravel Bags	Gravel Bags	Gravel Bags	Gravel Bags	Gravel Bags	Gravel Bags	Steel Sheetpile	Gravel Bags	Gravel Bags
c. Lower Slope Protection	17,000Cement Mats	16,000 Cement Mats	18,000 Cement Mats	17,000Cement Mats	17,000Cement Mats	17,000Cement Mats	22,500 Cement Mats	17,000Cement Mats	17,000Cement Mats
d. Amount of Gravel	797,600 cu yd	684,800 cu yd	599,500 cu yd	797,600 cu yd	797,600 cu yd	797,600 cu yd	855,000 cu yd	797,600 cu yd	797,600 cu yd
e. Maximum Footprint	835' * 1170'	825' * 1155'	850' * 1190'	835' * 1170'	835' * 1170'	835' * 1170'	905' * 1240'	835' * 1170'	835' * 1170'
f. Maximum Footprint Area	22.4 acres	21.9 acres	23,3 acres	22.4 acres	22.4 acres	22.4 acres	25.8 acres	22.4 acres	22.4 acres
g. Working Surface	345' * 680'	345' * 680'	345' * 680'	345' * 680'	345' * 680'	345' * 680'	345' * 680'	345' * 680'	345' * 680'
h. Water Depth at Island	22 feet	18 feet	23 feet	22 feet	22 feet	22 feet	22 feet	22 feet	22 feet
PIPELINE									
a. Pipe Design	1 Steel pipe	1Steel pipe	1 Steel pipe	1 Steel pipe in a steel pipe	1 Steel pipe in an HDPE pipe.	1 Flexible pipe	1 Steel pipe	1 Steel pipe	1 Steel pipe
b. Route	Liberty Route	Eastern Route	Tern Route	Liberty Route	Liberty Route	Liberty Route	Liberty Route	Liberty Route	Liberty Route
c. Average Trench Depth /Range in (Feet)	10.5 / (8 -12)	10.5 / (8-12)	10.5 / (8-12)	9 / (6.5-10.5)	10 / (7.5 - 11.5)	8.5 / (6-10)	10.5 / (8 -12)	10.5 / (8 -12)	15 feet
d. Quantity of Trench Dredge/ Excavation Material *	724,000 cu yds	499,025 cu yd	652,800 cu yd	557,300 cu yd	673,920 cu yd	498,960 cu yd	724,000 cu yd	724,000 cu yd	1,438,560 cu yd
e. Quantity of Trench Backfill Material *	724,000 cu yds	499,025 cu yd	652,800,000 cu yd	557,300 cu yd	673,920 cu yd	498,960 cu yd	724,000 cu yd	724,000 cu yd	1,438,560 cu yd
f. Minimum Burial Depth	7 feet	7 feet	7 feet	5 feet	6 feet	5 feet	7 feet	7 feet	11 feet
g. Surface Area Disturbed by Trench	59 acres	37 acres	59 acres	52 acres	57 acres	49 acres	59 acres	59 acres	81 acres
h. Offshore Length	6.1 miles	4.2 miles	5.5 miles	6.1 miles	6.1 miles	6.1 miles	6.1 miles	6.1 miles	6.1 miles
i. Onshore Length	1.5 miles	3.1 miles	3.1 miles	1.5 miles	1.5 miles	1.5 miles	1.5 miles	1.5 miles	1.5 miles
j. Construction Seasons	Winter	Winter	Winter	Winter	Winter	Winter	Winter	Winter	Winter
k. Leak-Detection System	MBLPC, PPA, LEOS or Equiv.	MBLPC, PPA, LEOS or Equiv.	MBLPC, PPA, LEOS or Equiv.	MBLPC, PPA, LEOS or Equiv.	MBLPC, PPA, LEOS or Equiv.	MBLPC, PPA, LEOS or Equiv.	MBLPC, PPA, LEOS or Equiv.	MBLPC, PPA, LEOS or Equiv.	MBLPCPPA, LEOS or Equiv.
l. Engineering Calculation of Pipeline Failure Rate but no oil released	3.1%	3.1%	3.1%	2.1%	3.2%	4.6%	3.1%	3.1%	2.2%
m. Engineering Calculation of Pipeline Failure Rate with oil released (any size spill)	0.001%	0.001%	0.001%	0.01%	0.01%	0.1%	0.001%	0.001%	0.0003%
n. Engineering Calculation of Probability of a Spill Larger than 1,000 bbls during project life[2]	1.38%	1.38%	1.38%	0.234%	1.38%	1.38%	1.38%	1.38%	1.38%
GRAVEL MINE SITE									
a. Location	Kadleroshilik River	Kadleroshilik River	Kadleroshilik River	Kadleroshilik River	Kadleroshilik River	Kadleroshilik River	Kadleroshilik River	Duck Island Mine	Kadleroshilik River
b. Number of Haul Days	45-60	40-57	30-45	45-60	45-60	45-60	45-60	90 -120 or use more equipment	45-60
c. Distance from Island	6 miles	5 miles	6 miles	6 miles	6 miles	6 miles	6 miles	20 miles	6 miles

1 Unless otherwise noted all information in this table is from INTEC (2000)
2 Information from Fleet (2000)

Shading indicates components or quantities that are different from Alternative I -- Proposal

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Table II.A-2 Pipeline Trench Excavation and Backfill Quantities for Alternatives I, III, IV, and VII

	I Proposal- Liberty Island and Single-Walled Steel Pipe	**III.A Southern Island**	**III.B Tern Island**	**IV.A Steel Pipe in Steel Pipe**	**IV.B Steel Pipe in HDPE**	**IV.C Flexible Pipe**	**VII Bury Pipe Deeper**
PIPELINE TRENCH							
a. Length							
Island to 3-mile limit	8,000 feet	2,376 feet	11,616 feet	8,000 feet	8,000 feet	8,000 feet	8,000 feet
3-mile limit to shoreline	24,400 feet	19,900 feet	17,524 feet	24,400 feet	24,400 feet	24,400 feet	24,400 feet
Total	32,400 feet	22,276 feet	29,140 feet	32,400 feet	32,400 feet	32,400 feet	32,400 feet
b. Width	61-132 feet	61-132 feet	61-132 feet	53-115 feet	53-115 feet	50-110 feet	120-152 feet
c. Fill area							
Island to 3-mile limit	18.2 acres	5.3 acres	25.8 acres	15.4 acres	17.0 acres	14.7 acres	24.9 acres
3-mile limit to shoreline	55.4 acres	44.1 acres	38.9 acres	47.1 acres	51.8 acres	44.9 acres	76.1 acres
Total	73.6 acres	49.4 acres	64.7 acres	62.5 acres	68.8 acres	59.6 acres	101.0 acres
d. Onshore transition zone							
Length and width	150 x 25 feet	205 x 25 feet	205 x 25 feet	150 x 25 feet	150 x 25 feet	150 x 25 feet	150 x 25 feet
Area	0.3 acres	0.41 acres	0.41 acres	0.3 acres	0.3 acres	0.24 acres	0.4 acres
e. Quantity of dredged/ excavated material							
Island to 3-mile limit	(179,000 cu yd)	(53,225 cu yd)	(260,200 cu yd)	(137,600 cu yd)	(166,400 cu yd)	(123,200 cu yd)	(355,200 cu yd)
3-mile limit to shoreline	(545,000 cu yd)	(445,800 cu yd)	(392,600 cu yd)	(419,700 cu yd)	(507,520 cu yd)	(375,760 cu yd)	(1,083,360 cu yd)
Total	(724,000 cu yd)	(499,025 cu yd)	(652,800 cu yd)	(557,300 cu yd)	(673,920 cu yd)	(498,960 cu yd)	(1,438,560 cu yd)
f. Quantity of backfill							
Select backfill							
Island to 3-mile limit	17,000 cu yd	5,800 cu yd	24,250 cu yd	None	17,000 cu yd	17,000 cu yd	17,000 cu yd
3-mile limit to shoreline	50,000 cu yd	40,800 cu yd	36,050 cu yd	None	50,000 cu yd	50,000 cu yd	50,000 cu yd
Total select backfill	67,000 cu yd	46,600 cu yd	60,300 cu yd	None	67,000 cu yd	67,000 cu yd	67,000 cu yd
Native backfill							
Island to 3-mile limit	162,000 cu yd	47,425 cu yd	235,950 cu yd	137,600 cu yd	149,400 cu yd	106,200 cu yd	338,200 cu yd
3-mile limit to shoreline	495,000 cu yd	405,000 cu yd	356,550 cu yd	419,700 cu yd	457,520 cu yd	325,760 cu yd	1,033,360 cu yd
Total native backfill	757,000 cu yd	452,425 cu yd	592,500 cu yd	557,300 cu yd	606,920 cu yd	431,960 cu yd	1,371,560 cu yd
Total native and select backfill	724,000 cu yd	499,025 cu yd	652,800 cu yd	557,300 cu yd	673,920 cu yd	498,960 cu yd	1,438,560 cu yd

Source: BPXA (2000a)

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Table II.A-3 Oil-Spill Volumes BPXA Estimates for Planning Spill Response and Cleanup

Spill Source	Regulatory Reference	Spill Volume
Pipeline	U.S. Department of Transportation 49 CFR 194.105(b)(1)	1,764 barrels
Diesel storage-tank	State of Alaska, Dept. of Environmental Conservation 18 AAC.75.432	5,000 barrels
Tanks, flowlines, pipeline, and daily production	Minerals Management Service 30 CFR 254.47	36,123 barrels
Well Blowout	State of Alaska, Dept. of Environmental Conservation 18 AAC 75.434	178,800 barrels
Pipeline leak (offshore)	State of Alaska, Dept. of Environmental Conservation 18 AAC 75.436	1,764 barrels
Pipeline leak (onshore)	State of Alaska, Dept. of Environmental Conservation 18 AAC 75.425 (e)(2)©	1,142 barrels

Source: UDOI, MMS, Alaska OCS Region

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Table II.A-4 Guidance for Preparing Marine On-Water Response Scenarios

VARIABLE	VALUE TO BE USED FOR SPILL RESPONSE PLANNING
1. Blowout oil lost to evaporation from wells producing more than 5,500 barrels per day	20% applied to atomized well blowout, where evaporation occurs before impact to land or water. Adjusted RPS volume is not to decline below 5,500 barrels/day.
2. Blowout-discharge rate from existing production wells	Annual average daily oil production for the maximum producing well (rounded to nearest thousand barrels), as reported by the Alaska Oil and Gas Conservation Commission (AOGCC).
3. Blowout-discharge from new reservoirs	16,500 barrels for the first 72 hours. If rate is higher after initial production, use AOGCC data and submit c-plan amendment. ADEC condition of c-plan approval will specify timing of submission of production data.
4. Duration of planning period for a blowout	15 days, based on consideration of historical duration of blowouts. This does not mean response to a blowout ends after 15 days. C-plan will include ability to sustain response indefinitely.
5. Out-of-region resources	ADEC will consider use of limited out-of-region resources, including off-shift in-state specialists and specialists from other response organizations, to meet 72-hour adjusted RPS based on verifiable contracts and sharing agreements. Out-of-region supplement beyond RPS demonstration is to be fully described. The c-plan will include mobilization plan, equipment list, and phone numbers. (Reference Prince William Sound Regional Citizens Advisory Council out-of-region report).
6. Realistic maximum wind speed	20 knots (based on 95th percentile of wind speed for season).
7. Realistic directional persistence	First 24 hours: wind from southwest (based on historical data). Next 48 hours: wind from northeast (based on historical data).
8. Realistic maximum wave height in mature fetch	1.5 meters (based on historical data for Northstar, NOAA atlas, and assumed 4-mile fetch for wave height.
9. Ice coverage during broken ice periods	Simulated ice movement and changes in ice percentage cover rather than constant percentage.
10. Oil-to-water ratio of emulsion for storage purposes	60 parts oil to 40 parts water (i.e., oil volume x 1.67). Based on Prince William Sound c-plan and S.L. Ross report.
11. Portion of oil entering open water	S.L. Ross (1997) blowout model's prediction of oil falling to water on site map *plus* oil falling to other surfaces in quantities greater than 0.5 gallon per square foot. Existing on-site containment such as gravel berms can reduce the volume entering open water.
12. Slick size	Fallout footprint based on S.L. Ross (1997) blowout model using a blowout well with an open orifice. Width of downwind zone of scattered oil = 0.25 x length. Farfield zone contains windrows of oil.
13. On-water trajectory	Vector sum of local current (speed and direction) and wind (direction and 3% of speed).
14. Safety zone boundary (permissible exposure limit)	5 milligrams of oil particulate per cubic meter of air.
15. Encounter rate.	Use the Anvil model in lieu of the MEC model.
16. Derated oil-recovery rate for skimmers	(a) 20% of pump's nameplate capacity based on State DEC guidelines, except for rates specified in (b) below. (b) Skimmer-specific rates: LORI SCS-3: 80% x 271 barrels/hr = 217 barrels/hr. Foxtail: 30% x nameplate pump capacity (based on CISPRI test). Vikoma 30K: 10barrels/hour.
17. Throughput efficiency (boom containment)	Marine open water: 100%. River system: minimum of 3 control sites with open-water marine backup.
18. Advancing skimmer speed	0.7 knots.
19. Barge-storage capacity	95% of rated capacity.
20. Utilization time of recovery systems	10 hours in each 12-hour shift; 2 shifts per day. Utilization time in first 72 hours = 60 hours minus time to deploy.
21. Minibarge fill time (with weir skimmer and 2 decants)	1 hour (based on ACS field tests with DOP 250 pump and 249-barrels barge, Prince William Sound c-plan, and S.L. Ross Environmental Research Ltd. [1997]).
22. Minibarge transit time	5 knots laden and unladen (based on USCG and ACS field tests).
23. Minibarge offload time	1.5 hours to hook, pump, and unhook (based on ACS field tests).
24. Decant from barges	Large recovery and storage barges: 80% of free water. Mini-barges: 60% of free water. Based on Prince William Sound c-plan and ADEC guidelines.
25. Delivery mixture from 249-barrel minibarge coupled with weir skimmer	79 barrels oil, 53 barrels water-in-oil emulsion, and 104 barrels free water (2 decants required). Based on Prince William Sound c-plan.

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Table II.C-1 Comparison of Gravel Islands—Maximum Dimensions, Number of Concrete Blocks, Total Fill Volume, and Area Between EIS Alternatives

EIS Alternative	Maximum Dimensions of Gravel Island (feet)	Number of Concrete Blocks - Slope Protection	Fill Volume for Gravel Island (cubic yards)	Fill Volume for Gravel Bags in Slope Protection (cubic yards)	Fill Volume Gravel for Concrete Blocks (cubic yards)	Total Fill Volume (cubic yards)	Fill Area of Gravel Island (acres)
Alternatives I , IV.A, IV. B, IV.C, VI, and VI Proposed Liberty Island	835 x 1,170	17,000	773,000	17,000	7,600	797,600	22.4
Alternative III.A - Southern Island	825 X 1,155	16,000	661,000	17,000	6,800	684,800	21.9
Alternative III.B. - Tern Island	855 X 1,185	18,000	574,500	17,000	8,000	599,500	23.3
Alternative V - Use Steel Sheetpile to Protect the Upper Slope of the Island	905 X 1,240	18,000	845,000	N/A	10,000	855,000	25.8

Source: BPXA, 2000a

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Table II.C-2 Pipeline Construction

Activity	Alternative I Single-Wall Steel Pipe	Alternative IV.A Pipe-In-Pipe System	Alternative IV.B Pipe-In-HDPE System	Alternative IV.C Flexible Pipe
Mobilizing Equipment, Material, and Workforce				
Mobilization time (days)				
Liberty Pipeline Route	3	6	6	
Eastern Pipeline Route	3	6	6	
Tern Pipeline Route	3	6	6	
Constructing the Ice Road and Thickening the Ice				
Pipe weight (pounds/foot)	90	210	104	85
Required Ice thickness (feet)	8 – 9	10 – 11	8 – 9	8 – 9
Ice-road construction (days)				
Liberty Pipeline Route	47	56	47	47
Eastern Pipeline Route	32	39	32	32
Tern Pipeline Route	42	50	42	42
Ice Slotting				
Ice slotting (days)				
Liberty Pipeline Route	11	14	11	11
Eastern Pipeline Route	8	10	8	8
Tern Pipeline Route	10	13	10	10
Trenching				
Minimum cover (feet)	7	5	6	5
Trench depth (feet)	10.5	9	10	8.5
Preparing a Site for Making Up Pipeline Strings				
Size (yd^2)	426,500	566,000	533,000	416,500
Time (days)				
Liberty Pipeline Route	37	47	47	37
Eastern Pipeline Route	26	33	33	26
Tern Pipeline Route	42	42	42	42
Making Up Pipeline Strings				
Non-destructive examination of welds	Yes	Yes	Yes	NA
Sandblasting and FBE coating of welds	Yes	Yes	Yes	NA
Installing sacrificial anodes	Yes	Yes	NA	NA
Crew days				
Liberty Pipeline Route	17	47	34	NA
Eastern Pipeline Route	12	33	24	NA
Tern Pipeline Route	15	42	31	NA
Transporting Strings to the Ice Slot and Tying In				
Transporting and welding (days)				
Liberty Pipeline Route	10	33	22	9
Eastern Pipeline Route	7	23	15	6
Tern Pipeline Route	9	30	20	8
Installing the Pipeline				
Installation time (days)				
Liberty Pipeline Route	35	29	33	26
Eastern Pipeline Route	24	20	23	18
Tern Pipeline Route	32	26	30	23
Backfilling the Trench				
Backfilling time (days)				
Liberty Pipeline Route	36	30	44	38
Eastern Pipeline Route	25	21	30	26
Tern Pipeline Route	32	27	40	34
Trench footprint size (acres)				
Liberty Pipeline Route	73.6	62.5	68.8	59.6
Eastern Pipeline Route	49.4	41.9	46.2	40.0
Tern Pipeline Route	64.7	54.9	60.5	48.3
Demobilizing Equipment				
Demobilization time (days)				
Liberty Pipeline Route	2	4	4	2
Eastern Pipeline Route	2	4	4	2
Tern Pipeline Route	2	4	4	2

Source: INTEC (1999a) and MMS Calculations

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Table II.C-3 Comparison of Trench Excavation and Backfill for Different Pipeline Designs and Routes

Pipeline Design	Trench Characteristic	Island Location and Pipeline Route								
		Alternative I Liberty Island/Liberty Pipeline			Alternative III.A Southern Island Eastern Pipeline Route			Alternative III.B Tern Island Tern Pipeline Route		
		Gravel Island to 3-Mile Limit	3-Mile Limit to Shoreline	Onshore Transition Pipeline	Gravel Island to 3-Mile Limit	3-Mile Limit to Shoreline	Onshore Transition Pipeline	Gravel Island to 3-Mile Limit	3-Mile Limit to Shoreline	Onshore Transition Pipeline
Alternative 1 Single-Wall Pipe	**a.** Trench Length (ft)	8,000	24,400	150	2,376	19,900	205	11,616	17,524	205
	b Trench Width (ft)	61'-132'	61'-132'	25	61'-132'	61'-132'	25	61'-132'	61'-132'	25
	c. Trench Excavation (yd^3)	(179,000)	(545,000)	(2,200)	(53,225)	(445,800)	(3,000)	(260,200)	(392,600)	(3,000)
	d. Select Backfill (yd^3)	17,000	50,000	2,500	5,800	40,800	3,450	24,250	36,050	3,450
	e. Native Backfill (yd^3)	162,000	495,000	400	47,425	405,000	550	235,950	356,550	550
	f. Total Trench Backfill (yd^3)	179,000	545,000	2,900	53,225	445,800	4,000	260,200	392,600	4,000
	g. Trench Fill Area (acres)	18.2	55.4	0.3	5.3	44.1	0.41	25.8	38.9	0.41
	h. Trench Depth (ft)	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
Alternative III.A Pipe-in-Pipe	**a.** Trench Length (ft)	8,000	24,400	150	2,376	19,900	205	11,616	17,524	205
	b. Trench Width (ft)	53'-115'	53'-115'	25	53'-115'	53'-115'	25	53'-115'	53'-115'	25
	c. Trench Excavation (yd^3)	(137,600)	(419,700)	(1,875)	(40,900)	(342,300)	(2,570)	(200,000)	(301,500)	(2,570)
	d. Select Backfill (yd^3)	none	none	2,160	none	none	2,950	none	none	2,950
	e. Native Backfill (yd^3)	137,600	419,700	345	40,900	342,300	470	200,000	301,500	470
	f. Total Trench Backfill (yd^3)	137,600	419,700	2,505	40,900	342,300	3,420	200,000	301,500	3,420
	g. Trench Fill Area (acres)	15.4	47.1	0.3	4.6	38.4	0.36	22.4	33.8	0.36
	h. Trench Depth (ft)	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Alternative III.B Pipe-in-HDPE	**a.** Trench Length (ft)	8,000	24,400	150	2,376	19,900	205	11,616	17,524	205
	b. Trench Width (ft)	59'-126'	59'-126'	25	59'-126'	59'-126'	25	59'-126'	59'-126'	25
	c. Trench Excavation yd^3	(166,400)	(507,520)	(2,090)	(49,420)	(413,920)	(2,850)	(241,615)	(364,500)	(2,850)
	d. Select Backfill (yd^3)	17,000	50,000	2,400	5,800	40,800	3,275	24,250	36,050	3,275
	e. Native Backfill (yd^3)	149,400	457,520	385	43,620	373,120	525	217,365	328,450	525
	f. Total Trench Backfill (yd^3)	166,400	507,520	2,785	49,420	413,920	3,800	241,615	364,500	3,800
	g. Trench Fill Area (acres)	17.0	51.8	0.3	5.1	42.3	0.39	24.7	37.2	0.39
	h. Trench Depth (ft)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Alternative III.C Flexible Pipe	**a.** Trench Length (ft)	8,000	24,400	150	2,376	19,900	205	11,616	17,524	205
	b. Trench Width (ft)	50'-110'	50'-110'	25	50'-110'	50'-110'	25	50'-110'	50'-110'	25
	c. Trench Excavation (yd^3)	(123,200)	(375,760)	(1,770)	(36,590)	(306,460)	(2,425)	(178,890)	(269,870)	(2,425)
	d. Select Backfill (yd^3)	17,000	50,000	2,035	5,800	40,800	2,790	24,250	36,050	2,790
	e. Native Backfill (yd^3)	106,200	325,760	325	30,790	265,660	445	154,640	233,820	445
	f. Total Trench Backfill (yd^3)	123,200	375,760	2,360	36,590	306,460	3,235	178,890	269,890	3,235
	g. Trench Fill Area (acres)	14.7	44.9	0.24	4.4	36.6	0.33	21.4	32.3	0.33
	h. Trench Depth (ft)	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
Alternative VII Bury the Pipe Deeper	**a.** Trench Length (ft)	8,000	24,400	150	2,376	19,900	205	11,616	17,524	205
	b. Trench Width (ft)	120'-152'	120'-152'	25	120'-152'	120'-152'	25	120'-152'	120'-152'	25
	c. Trench Excavation (yd^3)	(355,200)	(1,083,360)	(3,125)	(105,500)	(883,560)	(4,275)	(515,750)	(778,070)	(4,275)
	d. Select Backfill (yd^3)	17,000	50,000	3,590	5,800	40,800	4,920	24,250	36,050	4,920
	e. Native Backfill (yd^3)	338,200	1,033,360	575	99,700	842,760	785	491,500	742,020	785
	f. Total Trench Backfill (yd^3)	355,200	1,083,360	4,165	105,500	883,560	5,705	515,750	778,070	5,705
	g. Trench Fill Area (acres)	24.9	76.1	0.4	60.6	62.0	0.59	36.2	54.6	0.59
	h. Trench Depth (ft)	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0

Source: BPXA (2000a)

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Table II.C-4 Pipeline Corrosion and Leakage into the Annulus

Alternative IV.A Pipe-in-Pipe System	Alternative IV.B Pipe-in-HDPE System	Alternative IV.C Flexible Pipe
Corrosion of either the inner or outer pipeline is the most probable cause of this type of damage. If only the inner pipe corrodes, oil would be released into the annulus area between the pipes. If only the outer pipe corrodes, then seawater could enter the annulus between the pipes. If both pipes corrode, oil could be releases into the environment. The table in Section II.A.1.e.(4) provides the engineering failure rate for each of the above failure states.	Corrosion of the inner pipeline is the most likely cause for this type of damage. The outer pipe cannot corrode, so a release of oil to the environment would not occur. The table in Section II.A.1.e.(4) provides the engineering failure rate for this pipeline to release oil into the environment.	This type of damage, although theoretically possible, is extremely unlikely to occur. Because the pipeline is made of layers of plastic and stainless steel, it is very unlikely that the pipeline would be damaged by corrosion. The exception would be at the connectors between the sections of flexible pipe; however, at this location the pipeline would not be able to provide secondary containment. The flexible pipe acts much more like a single pipe than either of the other multiwall pipeline systems. Because of this, it is highly unlikely for either the inner or outer fluid-containment barrier to fail by itself. The table in Section II.A.1.e.(4) provides the engineering failure rate for each pipeline design to release oil into the environment.

Source: INTEC (1999a). **Note:** The single-wall pipe in the Proposal is not included in this table, because it does not have an annulus.

Table II.C-5 Pipeline Failure Rate and Expected Spill Volume

	Alternative I Single-Wall Steel Pipe	Alternative IV.A Pipe-In-Pipe System	Alternative IV.B Pipe-In-HDPE System	Alternative IV.C Flexible Pipe	INTEC's 7-Foot Burial Depth Pipe-In-Pipe System
Damage Category	**Pipeline Failure Probability by Pipeline Design [1]**				
1–Pipeline displacement but no leak	0.031	0.02	0.03	0.04	0.022
2–Pipeline buckle but no leak	0.0012	0.001	0.002	0.006	0.00012
3–Small/medium leak into the environment	0.000013	0.0001	0.0001	0.001	0.00000028
3–Oil leaks into the annulus	NA	0.0001	0.001	NA	0.0001
3–Water leaks into the annulus	NA	0.0001	NA	NA	0.0001
4–Large leak/rupture	0.0000003	0.0001	0.000001	0.00001	0.00000021
	"Expected" Spill Volume—Life of the Pipeline [1]				
	0.0021 bbl (0.088 gal)	0.028 bbl (1.18 gal)	0.014 bbl (0.59 gal)	0.14 bbl (5.88 gal)	0.00034 bbl (0.014 gal)
	"Expected" Spill Volume—Life of the Pipeline [2]				
	28 bbl (1176 gal)	8 bbl (336 gal)	24 bbl (1008 gal)	29 bbl (1218 gal)	13 bbl (546 gal)
	Probability of Spill Larger Than 1000 bbls Occurring During Project Life [2]				
	0.0138	0.00158	0.0138	0.0138	0.00234

[1] Summary information from INTEC pipeline alternatives report (INTEC, 2000).
[2] Summary information from Fleet risk evaluation report (Fleet, 2000).

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Table II.C-6 Pipeline Repair Techniques: Overview

	Season	Applicable Zone	Diving Requirements	Level of Excavation	Temporary or Permanent	Comments
Welded Repair with Cofferdam	***winter***	0-6 feet	Not Required	Moderate	Permanent	The advantage is that this repair is performed in a dry environment.
		7-22 feet	Minimal			
	open water	0-22 feet	Minimal			
Hyperbaric Weld Repair	***winter***	7-22 feet	Extensive	Moderate	Permanent	This is for repairs of minor damage.
	open water	0-22 feet	Extensive			
Surface Tie-In Repair	***winter***	0-6 feet	Not Required	High	Permanent	
		7-22 feet	Moderate			
	open water	0-22 feet	Moderate			
Tow Out of Replacement String	***winter***	0-6 feet	Not Required	High	Temporary	This is a permanent repair if a spool piece is welded. Temporary repair if mechanical connectors are used.
		7-22 feet	Extensive			
	open water	0-22 feet	Extensive			
Rigid Spool Piece with Mechanical Connectors	***winter***	0-6 feet	Not Required	Moderate	Temporary	This is used only if there is insufficient time to carry out permanent repair.
		7-22 feet	Extensive			
	open water	0-22 feet	Extensive			
Split Sleeve Repair Method	***winter***	0-6 feet	Not Required	Low	Temporary	This is used for stopping leaks and for lowering the potential for rupture when external dents or bulges have been detected in the pipeline.
		7-22 feet	Moderate			
	open water	0-22 feet	Moderate			

Source: INTEC (1999a).

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Table II.C-7 Pipeline Repair Techniques: Excavation, Repair Time, Integrity

	Alternative I Single-Wall Steel System	Alternative IV.A Pipe-In-Pipe System	Alternative IV.B Pipe-In-HDPE System	Alternative IV.C Flexible Pipe
WELDED REPAIR WITH COFFERDAM				
Sediment Excavated	**1,150 yd^3**	**1,034 yd^3**	**1,150 yd^3**	**1,150 yd^3**
Repair Time	**35 days**	**41 days**	**37 days**	**37 days**
Integrity	Once completed, this repair would return the pipeline to its original integrity.	Once completed, this repair would return the inner pipe to its original integrity but would require sleeves to repair the outer pipe and, therefore, would reduce the integrity of the outer pipe.	Once completed, this repair would return the inner pipe to its original integrity but would require sleeves to repair the outer pipe and, therefore, would reduce the integrity of the outer pipe.	Once completed, this repair would return the pipeline to its original integrity.
HYPERBARIC WELD REPAIR				
Sediment Excavated	**1,150 yd^3**	**1,034 yd^3**	**NA**	**1,150 yd^3**
Repair Time	**35 days**	**42 days**	**NA**	**37 days**
Integrity	Once completed, this repair would return the pipeline to its original integrity.	Once completed, this repair would return the inner pipe to its original integrity but would require sleeves to repair the outer pipe and, therefore, would reduce the integrity of the outer pipe.	**NA**	Once completed, this repair would return the pipeline to its original integrity.
SURFACE TIE-IN REPAIR				
Sediment Excavated	**6.490 yd^3**	**8,500 yd^3**	**6.490 yd^3**	**2,926 yd^3**
Layover Area	**3,150 yd^3**	**4,000 yd^3**	**3,150 yd^3**	**1,528 yd^3**
Excavation Time	**10 - 15 days**	**15 - 20 days**	**10 - 15 days**	**5 - 10 days**
Total Repair Time	**35 days**	**47 days**	**39 days**	**42 days**
Integrity	Once completed, this repair would return the pipeline to its original integrity and a zero-stress condition.	Once completed, this repair would return the inner pipe to its original integrity but would require sleeves to repair the outer pipe and, therefore, would reduce the integrity of the outer pipe.	Once completed, this repair would return the inner pipe to its original integrity and, although it would require sleeves to repair the outer pipe, this would not reduce the integrity of the outer pipe.	Once completed, this repair would return the pipeline to its original integrity.
TOW-OUT OF REPLACEMENT STRING				
Sediment Excavated	**6,480 yd^3**	**6,480 yd^3**	**6,480 yd^3**	**6,480 yd^3**
Total Repair Time	**40 days**	**46 days**	**42 days**	**46 days**
Integrity	Once completed, this repair would return the pipeline to its original integrity, if the end connections were welded.	Once completed, this repair would return the inner pipe to its original integrity but would require sleeves to repair the outer pipe and, therefore, would reduce the integrity of the outer pipe.	Once completed, this repair would return the inner pipe to its original integrity and, although it would require sleeves to repair the outer pipe, this would not reduce the integrity of the outer pipe.	Once completed, this repair would return the pipeline to its original integrity.

Source: INTEC (1999a:Appendix E).

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Table III.B-1 Environmental Studies Sponsored by MMS Applicable to the Beaufort Sea Area

Program Type	Status	Title	Year (x = Fiscal Year of Funding) 1998	1999	2000	2001
Physical Oceanography						
Cooperative Agreement with CMI	Cont.	Circulation, Thermohaline Structure, and Cross Shelf Transport in Alaskan Beaufort Sea	x			
Contract with Watson Co.	Cont.	Evaluation of Sub-Sea Physical Environmental Data for Beaufort Sea OCS and Incorporation into a Geographic Information System (GIS) Database		x	x	
Competitive Contract TBA	New	Synthesis and Collection of Meteorological Data in the Nearshore Beaufort Sea			x	
Cooperative Agreement with CMI	Cont.	Beaufort Sea Nearshore Under-Ice Currents: Science, Analysis and Logistics		x		
Cooperative Agreement with CMI	Cont.	Beaufort and Chukchi Sea Seasonal Variability for Two Arctic Climate States			x	
Fate and Effects						
Contract with Sintef	Cont.	Revision of the OCS Oil Weathering Model: Implementation		x	x	
Competitive Contract TBA	New	Update of Circulation and Oil-Spill-Trajectory Model for Beaufort Sea Nearshore Development Areas			x	
Competitive Contract TBA	New	Environmental Sensitivity Index Shoreline Classification in the Beaufort Sea			x	
Cooperative Agreement with CMI	Cont.	Kinetics and Mechanisms of Slow PAH Desorption From Lower Cook Inlet and Beaufort Sea Sediments		x		
Cooperative Agreement with CMI	Cont.	Petroleum Hydrocarbon Degrading Microbial Communities in Beaufort Sea Sediments		x	x	x
Cooperative Agreement with CMI	Cont.	The Role of Zooplankton in the Distribution of Hydrocarbons			x	
	Cont.	Historical Changes in Trace Metals and Hydrocarbons, Beaufort Sea Inner Shelf	x			
Biological						
Cooperative Agreement with CMI	Cont.	Seabird Samples as Resources for Marine Environmental Assessment		x		
Protected Species						
USGS/BRD	Cont.	Monitoring Beaufort Sea Waterfowl and Marine Birds		x	x	
MMS/Interagency	Cont.	Monitoring the Distribution of Arctic Whales	x	x		
USGS/BRD	Cont.	Alaska Marine Mammal Tissues Archival Project	x	x	x	
Cooperative Agreement with CMI	Cont.	The Alaska Frozen -Tissue Collection and Electronic Database: A Resource for Marine Biotechnology	x			
Cooperative Agreement with ADF&G	Cont.	Monitoring Key Marine Mammals, Arctic: Arctic	x			
Contract with LGL, Ltd	Cont.	Bowhead Whale Feeding in the Eastern Alaskan Beaufort Sea: Update of Scientific and Traditional Knowledge	x	x	x	
Cooperative Agreement with CMI	Cont.	Correction Factor for Ringed Seal Surveys in Northern Alaska	x			
USGS/BRD	Cont.	Polar Bear Den Surveys: Workshop		x		x
USGS/BRD	Cont.	Simulation Modeling of Effects of Oil Spills on Polar Bear Population Dynamics		x		

Source: USDOI, MMS, Alaska OCS Region

Acronyms and abbreviations: **ADF&G**, Alaska Department of Fish and Game; **CMI**, Coastal Marine Institute; **USGS/BRD**, U.S. Geological Survey/Biological Resources Division; **TBA**, To be Awarded; **Cont.**, Continuing.

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Table III.B-1 Environmental Studies Sponsored by MMS Applicable to the Beaufort Sea Area (continued)

Program Type	Status	Title	Year (x = Fiscal Year of Funding) 1998	1999	2000	2001
Social and Economic						
Contract with Impact Assessment, Inc	Cont.	Exxon Valdez Oil Spill Cleanup and Litigation: A Synthesis of Community-Based Social Impacts Information and Analysis, 1989-1996		x		
Contract with Ukpeagvik Inupiat Corp.	Cont.	Collection of Traditional Knowledge of the Alaskan North Slope	x	x		
Contract with Stephen R. Braund & Assoc.	Cont.	Publication of a Synthesis/Book of Information on the Socioeconomic Effects of Oil and Gas Industry Activity on the Alaska OCS	x	x		
Contract with Jack Faucett & Assoc.	Cont.	Update Oil Industry Labor Factors for Manpower Model	x			
Cooperative Agreement with CMI	Cont.	Regional Economic Impact Analysis of Bowhead Whaling: Accounting for Non-Market Activities on Alaska's North Slope			x	x
Cooperative Agreement with CMI	Cont.	Subsistence Economics and Oil Development: Case Studies from Nuiqsut and Kaktovik	x	x		
Other						
Contract with LGL. Ltd	Cont.	Reference Manual and GIS Overlays, Oil Industry and Other Human Activity (1970-1995) Beaufort Sea		x		
Competitive Arthur D. Little	Cont.	ANIMIDA - Arctic Nearshore Impact Monitoring in Development Area		x	x	x
Contract with Hart Crowser	Cont.	Estimation of Oil Spill Risk from the Alaska North Slope, Trans-Alaska Pipeline, and Canadian Spill Data Sets		x		
Competitive Contract TBA	New	Alternative Oil Spill Occurrence Estimators for Beaufort/Chukchi Sea OCS			x	
Contract with MBC Applied Environmental Sciences	Cont.	Conference Management and Reports on MMS Results	x	x	x	

Source: USDOI, MMS, Alaska OCS Region

Acronyms and abbreviations: **ADF&G**, Alaska Department of Fish and Game; **CMI**, Coastal Marine Institute: **USGS/BRD**, U.S. Geological Survey/Biological Resources Division; **TBA**, To be Awarded; **Cont.**, Continuing.

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Table III.C-1 Derated Skimmer Capacity

Description and Model	Quantity	Name Plate Capacity (gal/min)	Derating Factor*	Total Recovery (gal/20 hr day)
Disc				
MI-11/24	7	28	0.2	47,040
12KMkII	9	52	0.2	112,320
MI-2*	1	4	0.2	960
MI-30*	6	7	420 g/h	50,400
30k	9	7	420 g/h	75,600
Mini	1	77	0.2	18,480
Seaskimmer 50	1	132	0.2	31,680
Ocean	1	220	0.2	52,800
T-54	3	238	0.2	171,360
Drum				
Drum/Brush	3	97	0.2	69,840
TDS-118	4	50	0.2	48,000
TDS-136	1	90	0.2	21,600
Brush				
Lori	4	152	0.8	729,600
TransVac				
Diesel	3	350	0.2	252,000
Rope Mop				
Foxtail	1	174	0.3	62,640
MW62	2	20	0.2	9,600
Z14-E	37	10	0.2	88,800
Weir				
Desmi 250 Ocean	1	440	0.2	105,600
Desmi 250 Harbor	3	308	0.2	221,760
Destroil	2	110	0.2	52,800
Fasflow	2	440	0.2	211,200
Mini-Fasflow	4	100	0.2	96,000
Manta Ray rigid	12	24	0.2	69,120
Manta Ray flexible	73	38	0.2	665,760
Slurp	10	44	0.2	105,600
Alum	1	100	0.2	24,000
Seavac	1	656	0.2	157,440
Walosep W-1	1	175	0.2	42,000
Walosep W-4	1	396	0.2	95,040
Totals	**204**			**3,689,040**

Source: Alaska Clean Seas (1998:Vol. I, Tactic L-6, 3/1/99).
*Derating factor from Guidance for Preparing Marine Response Scenarios, Alaska Clean Seas (1998:Vo.. I, Assumptions).

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Table III.C-2 Comparison of Relative Island Design Parameters

	Liberty	Tern	Mukluk	Endicott Main Production Island	Northstar
Water depth	22 feet	21.5 feet	48 feet	6 feet	39 feet
Elevation of the working surface	12-15 feet	12 feet	21 feet	12 feet	
Height of gravel bag berm around perimeter of the working surface	5 feet	7 feet	4 feet	4 foot concrete splash wall on northwest side	N/A
Slope armor	Concrete mat and 4 cubic yard gravel bags	2 and 4 cubic yard gravel bags	2 and 4 cubic yard gravel bags	Concrete Mat and 4 cubic yard gravel bags	Steel sheetpile and concrete mat
Slope angle	1:3	1:3		1:3	1:3

Source: USDOI, MMS, Alaska OCS Region

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Table III.C-3a Exposure Variables and Location of Oil Spill Data Used to Estimate the Chance of an Oil Spill Occurring from Historical Data

Source	MMS OCS	Alaska North Slope	CONCAWE	S.L. Ross
Exposure variable	Volume produced in barrels	Volume produced in barrels	Pipeline miles in mile/years	Pipeline miles in mile/years and wells in well/years
Location of data on crude oil spills	Gulf of Mexico and Pacific OCS	Alaska North Slope	European onshore pipelines and estuary crossings	Gulf of Mexico and Pacific OCS

Table III.C-3b MMS OCS Spill Rates ≥1,000 Barrels for Offshore Pipelines and Gravel Island Based on Volume

Source	Oil Reserve Volume Barrels	Spills per Barrels	Mean Number of Spills	Probability of No Spills	Probability of One or More Spills
Gravel Island	0.12	0.32	0.04	0.95	0.04
Pipeline	0.12	1.33	0.16	0.85	0.15

Table III.C-3c Alaska North Slope Spill Rates ≥500 Barrels for Pipelines and Gravel Island Based on Volume

Source	Oil Reserve Volume Barrels	Spills per Barrels	Mean Number of Spills	Probability of No Spills	Probability of One or More Spills
Gravel Island	0.12	0.48	0.06	0.94	0.06
Pipeline	0.12	0.12	0.01	0.99	0.01

Table III.C-3d CONCAWE Spill Rates ≥1,000 Barrels for Pipelines Based on Mile Year

Alternative		Miles of Pipeline	Mile Years	Spills Per Mile Year	Mean Number of Spills	Probability of No Spills	Probability of One or More Spills
I	**Offshore Pipeline**	6.1	91.5	0.00018	0.016	0.984	0.016
	Onshore Pipeline	1.5	22.5	0.00018	0.004	0.996	0.004
	System	7.6	114	0.00018	0.021	0.980	0.020
II	**No Action**	0	0	0.00018	0	100	0
III.A	**Offshore Pipeline**	4.2	63	0.00018	0.011	0.989	0.011
	Onshore Pipeline	3.1	46.5	0.00018	0.008	0.992	0.008
	System	7.3	109.5	0.00018	0.020	0.980	0.020
III.B	**Offshore Pipeline**	5.5	82.5	0.00018	0.015	0.985	0.015
	Onshore Pipeline	3.1	46.5	0.00018	0.008	0.992	0.008
	System	8.6	129	0.00018	0.023	0.977	0.023
IV, V, VI, VII	**Offshore Pipeline**	6.1	91.5	0.00018	0.016	0.984	0.016
	Onshore Pipeline	1.5	22.5	0.00018	0.004	0.996	0.004
	System	7.6	114	0.00018	0.021	0.980	0.020

Table III.C-3e S.L. Ross Spill Rates ≥1,000 Barrels for Offshore Pipelines and Gravel Island Based on Mile Year and Well Year

Alternative		Miles of Pipeline	Mile Years	Spills Per Mile Year	Mean Number of Spills	Probability of No Spills	Probability of One or More Spills
I	**Offshore Pipeline**	6.10	91.50	0.00025	0.02	0.977	0.023
	Onshore Pipeline	1.50	22.50	0.00025	0.01	0.994	0.006
	System	7.60	114.00	0.00025	0.03	0.972	0.028
II	**No Action**	0	0	0.00018	0	100	0
III.A	**Offshore Pipeline**	4.20	63.00	0.00025	0.02	0.984	0.016
	Onshore Pipeline	3.10	46.50	0.00025	0.01	0.988	0.012
	System	7.30	109.50	0.00025	0.03	0.973	0.027
III.B	**Offshore Pipeline**	5.50	82.50	0.00025	0.02	0.980	0.020
	Onshore Pipeline	3.10	46.50	0.00025	0.01	0.988	0.012
	System	8.60	129.00	0.00025	0.03	0.968	0.032
IV, V, VI, VII	**Offshore Pipeline**	6.10	91.50	0.00025	0.02	0.977	0.023
	Onshore Pipeline	1.50	22.50	0.00025	0.01	0.994	0.006
	System	7.60	114.00	0.00025	0.03	0.972	0.028
		Well	Well Year	Spills per Well-Year			
	Platform	14.00	210.00	0.000036	0.008	0.992	0.008

Source for all tables: USDOI, MMS, Alaska OCS Region

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Table III.C-4 Large and Small Spill Sizes We Assume for Analysis in this EIS by Alternative

	ASSUMED VOLUME FOR SPILLS							
	CRUDE OIL							DIESEL OIL
	GRAVEL ISLAND	OFFSHORE PIPELINE					ONSHORE PIPELINE	GRAVEL ISLAND (Diesel Tank)
		Leak Detection and Location System		Pressure-Point Analysis And Mass-Balance Line Pack-Compensation				
		Leak	Rupture	Summer Leak	Winter Leak	Rupture		
Alternative I BPXA Proposal	925	125	1,580	715	2,956	1,580	720–1,142	1,283
Alternative II, No Action	0	0	0	0	0	0	0	0
Alternative III, Use Alternative Island Locations and Pipeline Routes	925	125	1,580	715	2,956	1,580	720–1,142	1,283
Alternative IV, Use Different Pipeline Designs								
Assumption 1, Neither Outer nor Inner Pipe Leaks								
Alternative IVA Use Pipe in Pipe System	925	0		0			720–1,142	1,283
Alternative IVB Use Pipe in HDPE System	925	0		0			720–1,142	1,283
Alternative IVC Use Flexible Pipe System	925	0		0			720–1,142	1,283
Alternative I Single Wall (for comparison)	925	0		0			720–1,142	1,283
Assumption 2, Both Outer and Inner Pipes Leak								
Alternative IVA Use Steel Pipe in Pipe System	925	125	1,580	715	2,956	1,580	720–1,142	1,283
Alternative IVB Use Pipe in HDPE System	925	125	1,580	715	2,956	1,580	720–1,142	1,283
Alternative IVC Use Flexible Pipe System	925	125	1,580	715	2,956	1,580	720–1,142	1,283
Alternative I Single Wall (for comparison)	925	125	1,580	715	2,956	1,580	720–1,142	1,283
Assumption 3, Only the Inner Pipe Leaks								
Alternative IVA Use Pipe in Pipe System	925	0		0			720–1,142	1,283
Alternative IVB Use Pipe in HDPE System	925	0		0			720–1,142	1,283
Alternative IVC Use Flexible Pipe System	925	125	1,580	715	2,956	1,580	720–1,142	1,283
Alternative I Single Wall (for comparison)	925	125	1,580	715	2,956	1,580	720–1,142	1,283
Assumption 4, Only the Outer Pipe Leaks								
Alternative IVA Use Pipe in Pipe System	925	0		0			720–1,142	1,283
Alternative IVB Use Pipe in HDPE System	925	0		0			720–1,142	1,283
Alternative IVC Use Flexible Pipe System	925	Na	Na	Na	Na	Na	720–1,142	1,283
Alternative I Single Wall (for comparison)	925	Na	Na	Na	Na	Na	720–1,142	1,283
Alternative V, Use Steel Sheetpile	925	125	1,580	715	2,956	1,580	720–1,142	1,283
Alternative VI, Use Duck Island Mine	925	125	1,580	715	2,956	1,580	720–1,142	1,283
Alternative VII, Use a 15-Foot Trench Depth	925	125	1,580	715	2,956	1,580	720–1,142	1,283

Source**:** USDOI, MMS Alaska OCS Region.

Table III.C-5 Concentration of Dispersed Oil Remaining in the Water Column After 1, 3, 10, and 30 Days From Possible Pipeline and Facility Crude-Oil Spills

Area and Assumed Dispersal Depth	Dispersed[1] Oil Concentration in Parts per Million After				*Area* and Assumed Dispersal Depth	Dispersed Oil Concentration in Parts per Million After			
	1 Day	3 Days	10 Days	30 Days		1 Day	3 Days	10 Days	30 Days
PIPELINE SPILLS INTO OPEN WATER									
125 Barrels									
Foggy Island Bay					*Beaufort Sea*				
5 feet (1.5 meters)	0.510	–	–	–	33 feet (10 meters)	–	0.038	0.019	–
10 feet (3.0 meters)	–	0.124	–	–	49 feet (15 meters)	–	–	0.013	0.007
20 feet (6.1 meters)	–	–	0.030	0.015					
715 Barrels[2]									
Foggy Island Bay					*Beaufort Sea*				
5 feet (1.5 meters)	0.510	–	–	–	33 feet (10 meters)	–	0.038–0.089	0.019–0.044	–
10 feet (3.0 meters)	–	0.124–0.294	–	–	49 feet (15 meters)	–	–	0.013–0.031	0.015
20 feet (6.1 meters)	–	–	0.030–0.070	0.035					
1,580 Barrels									
Foggy Island Bay					*Beaufort Sea*				
5 feet (1.5 meters)	0.194	–	–	–	33 feet (10 meters)	–	0.019	0.015	–
10 feet (3.0 meters)	–	0.063	–	–	49 feet (15 meters)	–	–	0.010	0.008
20 feet (6.1 meters)	–	–	0.024	0.017					
PIPELINE SPILLS IN BROKEN ICE/MELTOUT CONDITIONS									
125 Barrels									
Foggy Island Bay					*Beaufort Sea*				
5 feet (1.5 meters)	0	–	–	–	33 feet (10 meters)	–	–	0.001	–
10 feet (3.0 meters)	–	0.004	–	–	49 feet (15 meters)	–	–	–	0.001
20 feet (6.1 meters)	–	–	0.002	0.001					
715 Barrels[2]									
Foggy Island Bay					*Beaufort Sea*				
5 feet (1.5 meters)	0	–	–	–	33 feet (10 meters)	–	–	0.001	–
10 feet (3.0 meters)	–	0.004–0.009	–	–	49 feet (15 meters)	–	–	–	0.001
20 feet (6.1 meters)	–	–	0.002	0.002					
2,956 Barrels									
Foggy Island Bay					*Beaufort Sea*				
5 feet (1.5 meters)	0.0	–	–	–	33 feet (10 meters)	–	–	0.001	–
10 feet (3.0 meters)	–	0.0	–	–	49 feet (15 meters)	–	–	–	0.001
20 feet (6.1 meters)	–	–	0.002	0.002					
FACILITY SPILL INTO OPEN WATER									
925 Barrels									
Foggy Island Bay					*Beaufort Sea*				
5 feet (1.5 meters)	0.153	–	–	–	33 feet (10 meters)	–	0.018	0.029	–
10 feet (3.0 meters)	–	0.060	–	–	49 feet (15 meters)	–	–	0.020	0.008
20 feet (6.1 meters)	–	–	0.046	0.018					
FACILITY SPILL UNDER BROKEN ICE/MELTOUT CONDITIONS									
925 Barrels									
Foggy Island Bay					*Beaufort Sea*				
5 feet (1.5 meters)	0.0	–	–	–	33 feet (10 meters)	–	–	0.002	–
10 feet (3.0 meters)	–	0.008	–	–	49 feet (15 meters)	–	–	–	0.0
20 feet (6.1 meters)	–	–	0.003	0.002					

Source: USDOI, MMS, Alaska OCS Region

[1] The analysis assumes uniform distribution of the dispersed hydrocarbons throughout the part of the water column defined by the discontinuous areas shown in Appendix A, Table A-6g and the water depths shown in this table.

[2] The 715-barrel oil spill is assumed to take place during a 7-day period and the daily spill rates are the same. The concentration of dispersed oil in the water after the first day would be about the same as the concentration estimated for the 125-barrel spill, which is the result of a small leak over a 24-hour period. The concentration of dispersed oil in the water after 3 and 10 days is assumed to range between the concentration for the 125-barrel spill and the concentration for a 715-barrel spill in which the entire 715 barrels leaked into the water in less than one day. After 30 days the concentration of dispersed oil from the 715-barrel spill is assumed to be uniformly distributed in the water.

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Table III.C-6 Concentration of Dispersed Oil Remaining in the Water Column After 1 to 30 Days From a Possible Diesel-Oil Spill

Spill / Assumed Dispersal Depth	Dispersed[1] Oil Concentration in Parts per Million After			
	1 Day	**3 Days**	***7 Days* / 10 Days**	**30 Days**
Facility Spill Into Open Water				
1,283 Barrels				
5 feet (1.5 meters)	43.557	–	–	–
10 feet (3.0 meters)	–	5.603	–	–
20 feet (6.1 meters)	–	–	*1.219*	–
Facility Spill Under Broken Ice/Meltout Conditions				
1,283 Barrels				
5 feet (1.5 meters)	1.728	–	–	–
10 feet (3.0 meters)	–	0.519	–	–
20 feet (6.1 meters)	–	–	0.153	0.091

[1] The analysis assumes uniform distribution of the dispersed hydrocarbons throughout the part of the water column defined by the discontinuous areas shown in Appendix A, Table A-6g and the water depths shown in this table.

Table III.C-7 Distances from Liberty Island to Channels Between the Barrier Islands

Channel	Distance from Liberty Island (nautical miles)	Travel Time Between Liberty Island and the Channel Assuming a 0.3-Knot Surface Current	
		Hours	Days
West of Cross Island	16	53	2.2
Between Cross and Narwhal Islands	9.5	32	1.3
Newport Entrance (between Karluk and Stockton Islands)	7	23	1
East of Stockton Island	17	56	2.3

Source for both tables: USDOI, MMS, Alaska OCS Region

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Table III.C-8 Nearshore Waves: Heights and Periods

	Wind Velocity (miles per hour)								
	20			30			40		
	Fetch (miles)								
	5	10	15	5	10	15	5	10	15
Water Depth (feet)	**Wave Height (feet)**								
5	0.9	1.1	1.2	1.3	1.4	1.4	1.5	1.6	1.6
10	1.2	1.5	1.7	1.6	2.0	2.1	2.0	2.4	2.5
	Period (seconds)								
5	2.0	2.4	2.5	2.4	2.6	2.8	2.6	2.9	3.1
10	2.2	2.6	2.8	2.5	3.0	3.2	2.8	3.3	3.5

Source**:** U.S. Army Corps of Engineers (1984b:Figs. 3-27 and 3-28).

Table III.C-9 Annual Maximum Sustained Winds: Oliktok Point and Barter Island

	Return period (years)			
	2	5	25	100
	Wind Speed (knots)			
Oliktok Point	39.1	46.9	59.2	76.8
Barter Island	52.1	61.7	76.8	97.9

Source: Brower et al. (1988).

Table III.C-10 Rates of Infilling of Seafloor Scours and Gouges in the Vicinity of Liberty

Study	In-Filling Rate (ft/year) Yearly Average	Comments
Egg Island	4 - 7	Reimnitz and Kempema (1982, 1983)* Island sheltered from currents.
Sagavanirktok Delta	5 - 8	Reimnitz and Kempema (1982, 1983)* Exposed areas. From currents.
Depth of deposit immediately after an event	1.6	Reimnitz and Kempema (1982, 1983)* From suspended particle immediately after event. Initial in-filling will depend on the soil type, and could be nearly negligible for cohesive soil or flat-sided craters.
Endicott Strudel	0.3 - 1	Adjacent to the causeway; attributed to the settlement of suspended particles.
Duck Island/Sagavanirktok Delta	5	Harding Lawson (1981)* and McClelland (1982)*.
Liberty Pipeline Route	8.1 (maximum)	Coastal Frontiers Corporation (1999)*.
Off Resolution Island in the Sagavanirktok Delta	1.8	Coastal Frontiers Corporation (1999)*.
Northstar Test Trench	2 - 4	Coastal Frontiers Corporation (1999)*.
Liberty area (before 1997 survey)	0.2 - 0.7	Based on an analysis of winds ≥ 20 knots.

Source: *as cited in Blanchet et al. (2000)

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Table III.C-11 Potential Sources of Selected Polycyclic Aromatic Hydrocarbons

	Potential Sources — May be found in
Phenanthrene	the atmosphere as a product of incomplete combustion coal[1] petroleum[1]
2-Methylnaphthalene	coal tar petroleum
Benzo(a)pyrene	the atmosphere as a product of incomplete combustion[3] coal[1] petroleum[1]
Phenol	coal tar[3] various plant materials as a minor constituent[3] petroleum
4-methylphenol (p-cresol)	the atmosphere as a product of incomplete combustion[2] plant volatile[4] petroleum[5]

Notes: [1] Neff, 1985. [2] Sax and Lewis, 1987. [3] McGraw Hill, 1997. [4] Howard, 1990.

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Table III.D-1 Air-Quality Impact-Analysis Summary—Liberty Project (PSD Class II Increment Analysis)

Pollutant	Averaging Period	Maximum Concentration[1] ($\mu g/m^3$)	PSD Class II Increment Level ($\mu g/m^3$)	% of Class II Increment
NO_2	annual	24.0[2,3]	25	96.0
SO_2	3-hour	183.0[4]	512	35.7
	24-hour	88.2[4]	91	96.9
	annual	5.1[3]	20	25.5
PM_{10}	24-hour	22.0[4]	30	73.3
	annual	1.8[4]	17	10.6

Source: BPXA (1998e:Table 3-2).

[1] All maximum concentrations occur within 200 meters of facility boundary. [2] NO_2 concentration includes contribution of 1.9 micrograms per cubic meter from other PSD sources. [3] Maximum concentrations occur during the pre-2001 sealift operations (initial drilling phase). [4] Maximum concentrations occur during long-term operations (production phase).

Table III.D-2 National Ambient-Air-Quality Standard Analysis

Pollutant	Averaging Period	Maximum Conc.[1]	Background Concentration[2]	Total Conc.	NAAQS*	% of NAAQS
Initial Drilling/Commissioning Period						
NO_2	Annual	22.1	7.8	29.9	100	29.9
SO_2	3-hour	168.7	6.8	175.5	1,300	13.5
	24-hour	81.4	4.8	86.2	365	23.6
	annual	5.1	0.1	5.2	80	6.5
PM_{10}	24-hour	21.4	7.0	28.4	150	18.9
	annual	1.3	0.1	1.4	50	2.8
CO	1-hour	804.0	--	804.0	40,000	2.0
	8-hour	245.6	--	245.6	10,000	2.5
Long-Term Operations						
NO_2	Annual	19.2	7.8	27.0	100	27.0
SO_2	3-hour	183.0	6.8	189.8	1,300	14.6
	24-hour	88.2	4.8	93.0	365	25.5
	annual	2.7	0.1	2.8	80	3.5
PM_{10}	24-hour	22.0	7.0	29.0	150	19.3
	annual	1.8	0.1	1.9	50	3.8
CO	1-hour	804.0	--	804.0	40,000	2.0
	8-hour	270.4	--	270.4	10,000	2.7

Source: BPXA (1998e:Table 3-3).

[1] All maximum concentrations occur within 200 meters of facility boundary.

2 Background concentrations include global background and contributions from existing emission sources.

*National Ambient Air Quality Standards

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Table III.D-3 Estimated Alaska Employment from Liberty Project Design and Construction

Material/Service	Average Number of Personnel (Monthly)	Start of Project	Estimated Duration (months)	Primary Contractor	Location of Workforce	Estimated Direct Labor Hours	Estimated Wages (total $)
Engineering	17	0	41	VEI	Anchorage	140,000	$10,000,000
Anchorage Fabrication	119	0 + 14 mos.	22	APC	Anchorage	653,000	$35,900,000
Island Construction	65	0 + 22 mos.	14	AIC	North Slope	265,000	$14,600,000
Pipeline Construction	49	0 + 28 mos.	7	HCC	North Slope	98,000	$5,400,000
Facilities Installation	98	0 + 36 mos.	5	VCI	North Slope	143,000	$7,800,000
Drilling	55	0 + 38 mos.	15	BPXA	North Slope	240,000	$10,857,000
Anchorage Support Staff	29	0	41	BPXA	Anchorage	203,000	$15,200,000
TOTAL						**1,742,000**	**$99,757,000**

Source: Table courtesy of BPXA. VEI = Veco Engineering, Inc.; APC = Alaska Petroleum Contractors; AIC = Alaska Interstate Construction; HCC = Houston Contracting; VCI = Veco Construction, Inc.

Table III.D-4 Estimated Alaska Employment from Liberty Project Operations

Material/Service	Average Number of Personnel (Monthly)	Start of Project*	Estimated Duration (months)	Primary Contractor	Location of Workforce	Annual Direct Labor Hours	Annual Estimated Wages ($)
Operations Personnel	20	0 + 37 mos.	ongoing	BPXA/contractor tbd	North Slope	60,000	$1,800,000
Support Personnel	5	0 + 37 mos.	ongoing	tbd	North Slope	10,000	$200,000
Anchorage Staff	25	0 + 34 mos.	ongoing	BPXA/contractor tbd	Anchorage	50,000	$2,000,000
Annual Maintenance	50	0 + 47 mos.	2 weeks per year	tbd	North Slope	8,400	$168,000
TOTAL						**128,400**	**$4,168,000**

Source: Table courtesy of BPXA.   *0 = 0 in Table III.D-3.   tbd = to be determined.

Table III.D-5 Estimated Production and Federal, State and North Slope Borough Revenue from the Liberty Project by Year.
In millions of dollars, except estimated production (thousand barrels per day).

	Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	TOTAL	PERCENT
Estimated Production (thousand barrels per day)	**4.1**	**58.5**	**58.5**	**46.7**	**39.0**	**30.0**	**22.0**	**15.0**	**10.6**	**9.0**	**7.6**	**6.9**	**6.2**	**5.6**	**5.2**	**3.8**		
Projected Gross Revenue*	18	256	256	205	171	131	96	66	46	39	33	30	27	25	23	17	1440	
Annual Revenue Net of Royalty	16	224	224	179	149	115	84	57	41	34	29	26	24	21	20	15	1260	
Capital Expense	6	85	85	68	57	44	32	22	15	13	11	10	9	8	8	6	480	
Operating Expenses	3	43	43	34	28	22	16	11	8	7	6	5	5	4	4	3	240	
Total Expenses	9	128	128	102	85	66	48	33	23	20	17	15	14	12	11	8	720	**50**
Taxable Income	7	96	96	77	64	49	36	25	17	15	12	11	10	9	9	6	540	
Federal Royalty	2	23	23	19	16	12	9	6	4	4	3	3	2	2	2	2	131	
Federal Income Tax	2	33	33	27	22	17	12	8	6	5	4	4	3	3	3	2	185	
Total Federal Revenue	4	55	55	44	37	28	21	14	10	9	7	7	6	5	5	4	311	**22**
State Share of Federal Royalty	1	9	9	7	6	4	3	2	2	1	1	1	1	1	1	1	49	
State Income Tax	0	2	2	2	1.5	1	0.5	0.5	0.5	0.5	0	0	0	0	0	0	11	
State Spill and Conservation Tax	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	4	
Total State Revenue	1	13	13	11	9	7	5	3	2	2	2	2	1	1	1	1	63	**5**
Ad Valorem Tax	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	5	
	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	5	**0.3**

Source: Table courtesy of BPXA (BPXA, 1998a:5-10).
* Nominal (as spent) dollars.
The assumptions used for this Table are as follows:

- North Slope wellhead: $12 per barrel
- Transportation tariffs: $4.00
- Oil price (wellhead plus transportation tariffs): $16.00 per barrel
- Reserves: 120 million barrels
- Royalty rate: 12.5%
- State share of royalty: 27%
- Federal income tax rate: 35%
- State income tax rate: 4%
- State spill and conservation tax: $0.034 per barrel
- Ad valorem tax rate: 2%

Projections of capital expense, operating expenses, Federal tax, and royalty and ad valorem tax in this table are different than those in Appendix D-1. The MMS recognizes these differences. The MMS prepared Appendix D-1 as an independent analysis to determine technically and economically feasible development options.

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Table III.D-6 Kadleroshilik River Mine Site Land Areal Coverage by Land Cover Type (Class)

Class	Land Cover Description	Wetland	Phase 1 Mine Cell		Phase 2 Mine Cell		Reserve Area		Total Mine Site	
			Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area
Ia	Water	No	0.15	0.8%	0.01	0.1%	0.06	0.3%	0.21	0.4%
IIIa	Wet Sedge Tundra	Yes	0.15	0.8%	0.00	0.0%	0.00	0.0%	0.15	0.3%
Va	Moist Sedge, Dwarf Shrub Tundra	Yes	0.02	0.1%	1.02	8.2%	0.22	1.0%	1.26	2.4%
Vc	Dry Dwarf Shrub, Crustose Lichen	Yes	7.26	38.1%	4.83	38.8%	3.23	15.1%	15.32	29.0%
IXb	Dry Barren/Dwarf Shrub, Forb Grass Complex	Yes	2.00	10.5%	3.41	27.4%	3.85	18.0%	9.26	17.5%
IXc	Dry Barren/Forb Complex	Yes	1.44	7.6%	2.11	17.0%	9.47	44.2%	13.02	24.6%
IXf	Dry Barren/Dwarf Shrub, Grass Complex	Yes	1.90	10.0%	0.16	1.3%	0.00	0.0%	2.06	3.9%
Xa	River Gravel	No	6.12	32.2%	0.89	7.1%	4.59	21.4%	11.6	21.9%
	Total Land Cover Area		19.03	100.0%	12.43	100.0%	21.42	100.0%	52.87	100.0%
	Total Wetland Area		12.77	67.1%	11.53	92.7%	16.77	78.3%	41.06	77.6%

Source: Noel and McKendrick (2000).
Total Wetland Area is defined by the U.S. Army Corp of Engineers as Land Cover Types (Class) III.a, Va,Vc, IXb, IXc, and IXf.

Contents

Table IV.A-1 List of Alternatives and their Location in the EIS

	Alternative Number and Name	EIS Section That Provides: Description of Alternative	EIS Section That Provides: Environmental Effects of Alternative
I	**Liberty Development and Production Plan – (The BPXA Proposal)**	II.A	III
II	**No Action – (Alternative II)**	II.B	IV.B
	Alternative Drilling Locations and Pipeline Route	II.C.1.a	IV.C.1
I	Use Liberty Island Location and Pipeline Route (Liberty DPP)	II.C.1.d	IV.C.1.c
III.A	Use Southern Island Location and Eastern Pipeline Route	II.C.1.b	IV.C.1.d
III.B	Use Tern Island Location and Pipeline Route	II.C.1.c	IV.C.1.e
	Alternative Pipeline Designs	II.C.2	IV.C.2
I	Use Single Steel Wall Pipeline System (Liberty DPP)	II.C.2.e	IV.C.2.h
IV.A	Use Pipe-in-Pipe Pipeline System	II.C.2.b	IV.C.2.i
IV.B	Use Pipe-in-HDPE Pipeline System	II.C.2.c	IV.C.2.j
IV.C	Use Flexible Pipeline System	II.C.2.d	IV.C.2.k
	Alternative Upper Island Slope Protection Systems	II.C.3	IV.C.3
I	Use Gravel Bags (Liberty DPP)	II.C.3.c	IV.C.3.a
V	Use Steel Sheet Pile	II.C.3.b	IV.C.3.b
	Alternative Gravel Mine Sites	II.C.4	IV.C.4
I	Use Kadleroshilik River Mine Site (Liberty DPP)	II.C.4.c	IV.C.4.a
VI	Use Duck Island Gravel Mine	II.C.4.b	IV.C.4.b
	Alternative Pipeline Burial Depths	II.C.5	IV.C.5
I	Use a 7-Foot Burial Depth	II.C.5.d	IV.C.5.a
VII	Use a 15-Foot Pipeline Trench Depth	II.C.5.c	IV.C.5.b
	Combination Alternatives	II.D	IV.D
A	Combination Alternative A	II.D.2.a	IV.D.5
B	Combination Alternative B	II.D.2.b	IV.D.6
C	Combination Alternative C	II.D.2.c	IV.D.7
I	Liberty DPP	II.D.2.d	IV.D.4

Source: USDOI, MMS, Alaska OCS Region (2000)

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Table IV.A-2 Location in the EIS of the General Effects Analyses that are the Same for All Alternatives.

	EIS Section that Discusses the Effects Of …					
Resource	**A Large Oil Spill**	**Disturbances**	**Discharges**	**Small Oil Spills**	**Seawater Intake**	**Abandonment**
Threatened & Endangered bowhead Whales	III.C.2.a.(1)(b)1)	III.C.3.a.(1)(b)1)	III.D.1.a.(1)	III.D.3.a.(1)		III.D.6.a.(1)
Threatened and Endangered Eiders	III.C.2.a.(2)(b)1)	III.C.3.a.(2)(b)1)	III.D.1.a.(2)	III.D.3.a.(2)		III.D.6.a.(2)
Seals and Polar Bears	III.C.2.b.(2)(a)	III.C.3.b.(2)(a)	III.D.1.b	III.D.3.b		III.D.6.b
Marine and Coastal Birds	III.C.2.c.(2)(a)	III.C.3.c.(2)(a)	III.D.1.c	III.D.3.c		III.D.6.c
Terrestrial Mammals	III.C.2.d.(2)(a)	III.C.3.d.(2)(a)	III.D.1.d	III.D.3.d		III.D.6.d
Lower Trophic-Level Organisms	III.C.2.e.(2)(a)	III.C.3.e.(2)(a)	III.D.1.e	III.D.3.e		III.D.6.e
Fishes	III.C.2.f.(1)(b)1)	III.C.3.f.(1)(b)1)	III.D.1.f.(1)	III.D.3.f.(1)	III.D.4.a.	III.D.6.f.(1)
Essential Fish Habitat	III.C.2.f.(2)	III.C.3.f.(2)	III.D.1.f.(2)	III.D.3.f.(2)	III.D.4.b.	III.D.6.f.(2)
Vegetation-Wetlands Habitats	III.C.2.g.(2)(a)	III.C.3.g.(2)(a)	III.D.1.g	III.D.3.g		III.D.6.g
Subsistence-Harvest Patterns	III.C.2.h.(2)	III.C.3.h.(2)(a)	III.D.1.h.	III.D.3.h.		III.D.6.h.
Sociocultural Systems	III.C.2.i.(2)	III.C.3.i.(2)(a)	III.D.1.I	III.D.3.I		III.D.6.I
Archaeology Resources	III.C.2.j.(2)	III.C.3.j.(2)	III.D.1.j	III.D.3.j		III.D.6.j
Economy	III.C.2.k.	III.C.3.k.	III.D.1.k	III.D.3.k		III.D.6.k
Water Quality	III.C.2.l.(2)(a)	III.C.3.l.(2)(a)	III.D.1.l	III.D.3.l.(2)(a)		III.D.6.l.(2)(a)
Air Quality	III.C.2.m.(2)	III.C.3.m.(2)	III.D.1.m	III.D.3.m		III.D.6.m

Source: USDOI, MMS, Alaska OCS Region (2000)

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Table IV.A-3

Summary Comparisons of Impacts Among Alternatives for the Liberty Development Project Environmental Impact Statement

Bowhead Whales
Eiders
Seals and Polar Bears
Marine and Coastal Birds
Terrestrial Mammals
Lower-Trophic Level Organisms
Fishes
Essential Fish Habitat
Vegetation-Wetlands
Subsistence-Harvest Patterns
Sociocultural Systems
Archaeological Resources
Economy
Water Quality
Air Quality

Note to the Reader: Please keep the following information in mind as you read the summaries in this table.

This EIS will use the comparative term "the same as" to indicate an impact essentially is identical or as similar as can be determined to that noted for another alternative. Within the EIS analysis, we use the phrase "the same as" to indicate to the reader that two impacts are considered to be equal. We do not intend this in the pure or mathematical sense. We are not saying two impacts are exactly the same or identical. Rather, we use the phrase to indicate that two impacts are so close that finding a difference between them is beyond our analytical ability to measure or analyze.

The effects associated with potential oil spills are based on the assumptions that a spill occurs and no spill response activities were conducted that could reduce the amount of oil in the environment or prevent oil from reaching critical areas.

The summaries presented in this table are based on the comprehensive analysis in Sections III.C and D and Section IV.C.

<table>
<tr><th colspan="2">Bowhead Whales</th></tr>
<tr><th>Alternative I – Proposed Action</th><th>Alternative III</th></tr>
<tr><td rowspan="4">
Effects of Oil Spills:
The effects of a large oil spill (greater than or equal to 500 barrels) would have on bowhead whales is unknown, but some conclusions can be drawn from studies of the effects of oil spills on other cetaceans. If a large spill occurred and contacted bowhead habitat during the fall whale migration, it is likely that some whales would be contacted by oil and temporarily experience one or more of the following nonlethal effects:
•oiling of their skin, causing irritation
•inhaling hydrocarbon vapors
•ingesting oil-contaminated prey
•fouling of their baleen
•losing their food source
•moving temporarily from some feeding areas
Some whales could die as a result of contact with spilled oil. Studies on the physiologic and toxic effects of oil on whales and concluded there was no evidence that oil contamination had been responsible for the death of a cetacean. Nevertheless, the effects of oil exposure to the bowhead whale population are uncertain, speculative, and controversial. The effects would depend on how many whales contacted oil, the duration of contact, and the age/degree of weathering of the spilled oil. If oil got into leads or ice-free areas frequented by migrating bowheads, a significant portion of the population could be exposed to spilled oil. Prolonged exposure to freshly spilled oil could kill some whales, but we expect that number to be very small with such a low chance of contact.
The chance of a large oil spill from the offshore production island and the buried pipeline occurring and entering the offshore waters is estimated to be on the order of 1%. A large spill could contact areas outside the barrier islands when bowhead whales may be present during eastward migration in the spring lead system or during the fall westward migration . The chance of oil from a large spill reaching these migration areas, 30 days after a spill, is estimated to be 15% or less.
Effects of Disturbances:
Noise sources that may affect bowhead whales are drilling and other noise associated with production operations, vessel traffic, aircraft traffic, construction, and oil-spill cleanup. Underwater industrial noise, including drilling noise measured from artificial gravel islands, has not been audible in the water more than a few kilometers away. Because the main bowhead whale’s migration corridor is 10 kilometers or more seaward of the barrier islands, drilling and production noise from Liberty Island is not likely to reach many migrating whales. Noise also is unlikely to affect the few whales that may be in lagoon entrances or inside the barrier islands due to the rapid attenuation of industrial sounds in a shallow-water environment. Subsistence whalers have stated that noise from some drilling activities displaces whales farther offshore away from their traditional hunting areas.
Marine-vessel traffic outside the barrier islands probably would include only seagoing barges transporting modules and other equipment and supplies from Southcentral Alaska to the Liberty location, most likely between mid-August and mid- to late September in Year 2 and Year 3. Barge traffic continuing into September could disturb some bowheads. Whales may avoid being within 1 to 4 kilometers of barges. Fleeing behavior usually stops within minutes after a vessel has passed but may last longer. Vessels and aircraft inside the barrier islands should not affect bowhead whales.
Because island and pipeline construction would occur during the winter and be well inside the barrier islands, it is not likely to affect bowhead whales. Reshaping of the island and placement of slope-protection material should be completed by mid-August, before the bowhead whales start their migration. Whales should not be affected by these activities, even during the migration, because the island is well shoreward of the barrier islands, and whales infrequently go there. Bowhead whales are not likely to be affected by sediment or turbidity from placing fill for island construction, island reshaping before placing slope-protection material, or pipeline trenching or backfilling.
</td>
<th>Alternative III.A
Southern I./Eastern Pipeline</th></tr>
<tr><td> Effects of Oil Spills:
Same as Alternative I. Effects of Disturbances:
Same as Alternative I. </td></tr>
<tr><th>Alternative III.B
Tern I. and Pipeline</th></tr>
<tr><td> Effects of Oil Spills:
Same as Alternative I. Effects of Disturbances:
Same as Alternative I </td></tr>
</table>

Contents

<table>
<tr><th colspan="4">Bowhead Whales</th></tr>
<tr><th>Alternative IV</th><th rowspan="2">Alternative V
Use Sheetpile</th><th rowspan="2">Alternative VI
Use Duck I Mine Gravel Site</th><th rowspan="2">Alternative VII
Use a 15-Foot Trench Depth</th></tr>
<tr><th>Alternative IV.A
Pipe-in-Pipe</th></tr>
<tr><td>Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I</td><td rowspan="5">Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I</td><td rowspan="5">Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I</td><td rowspan="5">Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I</td></tr>
<tr><td>Alternative IV.B
Pipe-in-HDPE</td></tr>
<tr><td>Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I.</td></tr>
<tr><td>Alternative IV.C
Flexible Pipe</td></tr>
<tr><td>Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I</td></tr>
</table>

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Eiders

Alternative I – Proposed Action

Effects of Oil Spills:

Mortality resulting from the Liberty Project would be additive to natural mortality and would interfere significantly with recovery from any declines of the coastal plain spectacled eider population, and would be considered a take under the Endangered Species Act. An oil spill from Liberty Island or associated marine pipeline would have the highest probability of contacting nearshore and offshore areas of Foggy Island Bay and the eastern Sagavanirktok River Delta where spectacled eiders may be staging before migration. Oil could contact these eiders from early June to September. Mortality from a spill that moves offshore would be difficult to estimate. Aerial surveys conducted by the Fish and Wildlife Service located few spectacled eiders offshore in all but two subareas, thus a model developed by the Fish and Wildlife Service estimates very low mortality from an oil spill for this species. The estimated population for the Arctic Coastal Plain is about 9,500 individuals. A spill that enters open water off river deltas in spring could contact any migrant eiders present. Recovery of this population from even small losses is not likely to occur quickly. Any substantial spill-related losses would have significant adverse effects on this population.

Small oil spills are expected to cause few deaths among nesting, broodrearing, or staging eiders. Potentially one or two spectacled eiders and their productivity could be lost as a result of an onshore spill.

Reduction of prey populations from an oil or diesel fuel spill could have a negative effect on foraging success of eiders in the local area, especially in spring when there is limited open water. However, substantial foraging habitat is expected to be available following the breeding season, although the amount of high quality habitat in the Beaufort Sea area remains unknown, as are details of eider foraging habits.

Although Fish and Wildlife Service survey data do not show a significant decline in the coastal plain spectacled eider population, the potential exists for a significant adverse effect from an oil spill on this population, particularly that segment nesting in the eastern portion of the range. Steller's eiders are not expected to occur in the Liberty Project area.

Effects of Disturbances:

Helicopter flights to Liberty Island during pack-ice breakup may disturb some spectacled eiders feeding in open water off the Sagavanirktok River Delta. If they relocate to other areas, competition for food available during this period following migration may result in decreased breeding success in some individuals. Likewise, summer flights to the island may displace some eiders from preferred marine foraging areas or juveniles from coastal habitats occupied after they fledge. The extra energy and time used in responding to such disturbance and finding alternate habitat may result in decreased survival of some juvenile eiders. Using boats instead of helicopters to supply Liberty Island during the open-water season would minimize airborne disturbance but would increase the possible disturbance from boats.

Onshore, frequent flights over nesting or broodrearing eiders may cause them to relocate in less favorable habitat; eiders that abandon a nest probably will not renest. Females temporarily displaced from a nest by occasional onshore pipeline inspection flights may expose eggs to predation. Either situation may result in fewer young produced. Most onshore activities in the Liberty area are likely to affect at most only a few individuals, and careful selection of aircraft routes could eliminate most disturbance of nesting eiders. Displacement of eiders from the vicinity of disturbing activities would eliminate them from only a small proportion of available similar habitat, although the amount of high quality habitat in the Beaufort Sea area remains unknown, as are details of eider foraging habits. This likely would be a minor effect.. Development of the Liberty Prospect is expected to result in only a small amount of habitat loss involving displacement of few eiders to alternate sites. Spill-cleanup activities may disturb nesting, broodrearing, or staging eiders or juveniles occupying coastal habitats, resulting in decreased survival. Spectacled eider mortality from collisions with Liberty Island structures is estimated to be 2 or less per year. Collisions with the onshore pipeline are considered unlikely.

The small losses and displacements likely to result from the above activities may cause population effects that would be difficult to separate from natural variation in population numbers. However, any decline in productivity or survival resulting from the Liberty Project would be additive to natural mortality and could interfere with the recovery from any decline the coastal plain spectacled eider population may experience. Disturbance of spectacled eiders by Liberty Project activities could result in a take under the Endangered Species Act. Steller's eiders are not expected to be found in the Liberty Project area.

Alternative III

Alternative III.A Southern I./Eastern Pipeline

Effects of Oil Spills:

The probability of oil-spill contact and potential effects in most environmental resource areas or land segments from Alternative I and Alternative III.A island sites and offshore pipeline spill points are essentially the same, including the probability of contact in the western Simpson Lagoon area, where spectacled eider use is documented. There is a difference in probability of contact in the southern Foggy Island Bay area due to island location, which suggests that there is a somewhat greater potential for oil-spill contact with eiders from this Alternative than from Alternative I. However, we conclude that effects, though different, would not be significantly different, because the difference between this Alternative and Alternative I in probability of oil contacting any spectacled eiders that may occur in southern Foggy Island Bay is not substantial, and the extent of eider use of this area is uncertain.

Effects of Disturbances:

Disturbance effects from Alternative III.A and Alternative I are expected to be the same except those resulting from aerial inspection of the onshore portion of the pipeline. Such traffic potentially would disturb more eiders along the greater onshore length of the Alternative III.A pipeline than along the Alternative I pipeline. This is not viewed as a significant difference.

Alternative III.B Tern I. and Pipeline

Effects of Oil Spills:

The chance of a spill from the Alternative III.B Tern Island location and offshore portion of the pipeline route contacting environmental resource areas or land segments is essentially the same as from the Alternative I Liberty Island location. Alternative III.B would result in lower adverse effects because of a somewhat lower probability for contacts from a nearshore pipeline leak.

Effects of Disturbances:

Disturbance under Alternative III.B is expected to be the same as for Alternative I, with no significant adverse population effects likely to occur.

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<table>
<tr><th colspan="4">Eiders</th></tr>
<tr><th>Alternative IV</th><th rowspan="2">Alternative V
Use Sheetpile</th><th rowspan="2">Alternative VI
Use Duck I Mine Gravel Site</th><th rowspan="2">Alternative VII
Use a 15-Foot Trench Depth</th></tr>
<tr><th>Alternative IV.A
Pipe-in-Pipe</th></tr>
<tr><td>Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I</td>
<td rowspan="5">Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I</td>
<td rowspan="5">Effects of Oil Spills:
Effects of an oil spill on spectacled eiders under Alternative VI is expected to be essentially the same as for Alternative I.

Effects of Disturbances:
The potential for occurrence of resting, foraging, or nesting eiders is likely to be lower at the Duck Island quarry site than at the proposed Kadleroshilik site due to the undisturbed character and vegetative cover of the latter. Although this represents a substantial difference in habitat availability between the two sites, spectacled eiders are not actually expected to be nesting at either site, so no significant difference in effects of habitat disturbance on the spectacled eider is expected between this Alternative and Alternative I.</td>
<td rowspan="5">Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I</td></tr>
<tr><th>Alternative IV.B
Pipe-in-HDPE</th></tr>
<tr><td>Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I.</td></tr>
<tr><th>Alternative IV.C
Flexible Pipe</th></tr>
<tr><td>Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I</td></tr>
</table>

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Seals and Polar Bears	
Alternative I – Proposed Action	**Alternative III**
Effects of Oil Spills: Seals and polar bears most likely would contact the spill in the Foggy Island Bay, and Mikkelsen Bay areas. An estimated 60-150 ringed seals (out of a resident population of 40,000) fewer than 50 bearded seals (based on their sparse distribution in the project area) out of a population of several thousand) could be affected by the large spill. An estimated 5 to 30 bears could be lost if the spill contacted Cross Island when and where that many polar bears may be concentrated during the whale harvest. This represents a severe event. The more likely loss from Liberty development would be no more than three to six bears. The seal and polar bear populations are expected to recover individuals killed by the spill within 1 year, and there would be no effect on the population. A study on the effects of a 5,912 barrel spill estimated oil could contact 0 to 25 polar bears in open water conditions and 0 to 61 polar bears in autumn mixed ice conditions. The oil spill trajectories contacted small numbers of bears far more often than they contacted large numbers of bears. In October 75% of the trajectories oiled 12 or fewer bears while in September 75% of the trajectories oiled 7 or fewer polar bears. The median of polar bears that could be affected by a 5,912 barrel spill in October was 4.2. Barring environmental degradation after such a loss, survival of young born in the year of the spill should prevent net changes in population size. These results are comparable to the estimate of 5-30 bears. A spill from Liberty is likely to affect 12 or fewer polar bears. The polar bear population is expected to recover this likely loss within one year. Secondary effects could come from oil contaminating food sources. A spill might affect the abundance of some prey species in local, coastal areas of Foggy Island Bay where epibenthic food such as amphipods (small shrimp) concentrate, but a spill should not greatly decrease abundant food, such as arctic cod. Local changes in the abundance of some food sources would not affect the seal populations or, in turn, affect the polar bear population in the Beaufort Sea. **Effects of Disturbances:** Construction activity would displace some ringed seals within perhaps 1 kilometer of the island and along the pipeline route in Foggy Island Bay. Seals and polar bears would be exposed to noise and disturbance from pipeline dredging and burial activities in Foggy Island Bay. This disturbance of seals and polar bears would be local, within about 1 mile along the pipeline route, and would persist for one season. Food smells coming from the camp on the island may attract a few bears to the production-island. This attraction could require deliberate hazing of these polar bears, but this effect would not be significant to bear abundance or distribution. Low-flying helicopters or boats would cause some ringed and bearded seals to dive into the water, and a few females may be temporarily separated from their pups. This displacement is expected to be brief (a few minutes to less than 1 hour). Low flying helicopters moving to and from the Liberty Project area could briefly disturb a few polar bears. These disturbances would not affect overall seal or bear abundance and distribution in Foggy Island Bay. Vehicle traffic on the ice roads from the Endicott causeway directly to the production island and along the coast to Foggy Island Bay/Kadleroshilik River could disturb and displace a few denning polar bears and a small number of denning ringed seals. The number of bears and seals potentially displaced is expected to be low and would not affect the populations of ringed seals and polar bears.	**Alternative III.A** **Southern I./Eastern Pipeline** **Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I. **Alternative III.B** **Tern I. and Pipeline** **Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I.

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Seals and Polar Bears			
Alternative IV	**Alternative V** **Use Sheetpile**	**Alternative VI** **Use Duck I Mine Gravel Site**	**Alternative VII** **Use a 15-Foot Trench Depth**
Alternative IV.A **Pipe-in-Pipe** **Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I. **Alternative IV.B** **Pipe-in-HDPE** **Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I. **Alternative IV.C** **Flexible Pipe** **Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I.	**Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I.	**Effects of Oil Spills:** Effects of a large oil spill on seals and polar bear under Alternative VI are expected to be the same as under Alternative I. **Effects of Disturbances:** Using the Duck Island Gravel Mine rather than the Kadleroshilik River mine site would avoid potential noise and disturbance of denning polar bears in the Kadleroshilik River area during winter. Using this gravel mine site probably would involve an increase in ice-road traffic to and from the Sagavanirktok River to Liberty Island, which could present a potential increase in disturbance of polar bears and seals in this area. The potential effect on polar bears from mining and other development activities could be reduced along the coast of the Kadleroshilik River.	**Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Burying the offshore pipeline deeper would double the amount of benthic habitat altered by pipeline installation. This alternative would increase the amount of time that seals and polar bears would be exposed to noise and disturbance from pipeline dredging and burial activities in Foggy Island Bay. The disturbance of seals and polar bears would be local, within about 1 mile along the pipeline route, and would persist for one season.

Contents

Marine and Coastal Birds

Alternative I – Proposed Action

Effects of Oil Spills:

A large oil spill would have the highest probability of contacting nearshore and offshore areas of Foggy Island Bay and the eastern Sagavanirktok River Delta, where waterfowl and other aquatic birds may be staging before migration. Mortality from a spill contacting long-tailed ducks in lagoons or other protected nearshore areas is estimated to exceed 1,200 individuals (equivalent to about 1% of the average coastal plain population) at average bird densities. Total kill potentially could approach or exceed 10 times this number, if oil were to contact areas of high bird density. A model developed by the Fish and Wildlife Service estimates mortality exceeding 1,400 individuals at average bird densities in the Harrison Bay to Brownlow Point area, where these ducks concentrate during the molt period. Total kill estimate from a 5,912 barrel spill used in the Fish and Wildlife Service model (twice the spill size estimated by MMS) ranged up to 35% of this central Beaufort Sea population. The maximum estimate would result in a significant adverse effect on population numbers and productivity (out of an estimated Arctic Coastal Plain population of about 115,500 individuals), especially if many of those molting in this area come from declining subpopulations. Should long-tailed ducks be contacted by a spill outside the barrier islands, mortality is likely to be considerably lower than this number due to the lower bird density

Flocks of staging eiders could contact oil in nearshore and/or offshore areas. Oil could contact flocks of king and common eiders offshore from early June to September, although mortality from a spill that moves offshore would be difficult to estimate. King and common eider populations have declined 50% in the past 20 years and substantial oil-spill mortality would aggravate this effect. For most species, the relatively small losses likely to result from a spill may be difficult to separate from the natural variation in population numbers, but their populations are not expected to require lengthy recovery periods. Because much of the information needed to determine the recovery rate of bird populations from incidents causing mortality is only superficially known for most species (for example, accurate values for population size, breeding rate and success, age- and sex-specific survival), the long-term effect (i.e., rate of recovery) of oil-spill mortality on such populations is uncertain. Species that are declining in numbers, such as king and common eiders and red-throated loon, or have limited capacity for population growth, such as (loons and seaducks in general), are expected to recover from oil spill mortality slowly. In particular, because of historic or current declines in common eiders and long-tailed ducks and the estimated mortalities of an assume oil spill, a large offshore spill could result in impacts to these species.

A spill that enters open water off river deltas in spring could contact migrant loons, swans, long-tailed ducks, eiders, and glaucous gulls. Some of the several hundred broodrearing, molting, or staging brant and snow geese could contact oil in coastal habitats. Also, several thousand shorebirds could encounter oil in shoreline habitats, and the rapid turnover of migrants during the migration period suggests that many more could be exposed. Effects are expected to be similar to those outlined above.

An onshore pipeline spill in summer probably would affect only a few nests even considering all species. If the oil spread to streams or lakes, long-tailed ducks, brant, and greater white-fronted geese that gather on large lakes to molt could be adversely affected in larger numbers. Losses of oiled birds in this case could range up to a few hundred individuals, a minor effect for species whose populations are relatively abundant and stable or increasing (for example, northern pintail, geese, glaucous gull, most shorebirds, songbirds).

Reduction of prey populations from an oil or diesel fuel spill may reduce foraging success of shorebirds and sea ducks that depend on this local energy source for molt or migration. Substantial areas of at least superficially similar foraging habitat apparently is available onshore and offshore following the breeding period, although the amount of high quality foraging habitat in the Beaufort Sea area for particular species remains unknown, as are details of foraging habits for most species.

Effects of Disturbances:

Helicopter flights to Liberty Island during the pack-ice breakup may disturb some loons and king or common eiders feeding in open water off the Sagavanirktok River Delta. If they relocate to other areas, competition for food available during this period following migration may result in lowered survival. During the summer, flights to the island may displace some long-tailed ducks and eiders from preferred marine foraging areas and snow goose and brant family groups from coastal broodrearing areas. These flights are not likely to directly cause bird mortality, but extra energy and time used in response to disturbance and to find alternate areas may result in decreased fitness and, potentially, survival to breeding age in some individuals. Substantial areas of at least superficially similar foraging habitat apparently are available onshore and offshore following the breeding period, although the amount of high quality foraging habitat in the Beaufort Sea area for particular species remains unknown, as are details of foraging habits for most species. Using vessels instead of helicopters would minimize airborne disturbance while increasing surface disturbance. The latter generally would result in negligible effects to bird populations.

Frequent flights over nesting or broodrearing waterfowl and shorebirds on the mainland may cause birds to relocate in less favorable habitat. Birds that abandon a nest may not renest, or may be delayed to a less favorable period. Adults temporarily displaced from nests by occasional onshore pipeline inspection flights may expose eggs or nestlings to predation. Any of these situations may result in fewer young produced.

Most onshore activities in the Liberty area are likely to disturb relatively few birds. Construction and vehicle traffic in winter may displace a few ptarmigan from near the activity. Spill-cleanup activities may displace some nesting, broodrearing, juvenile, or staging waterfowl and shorebirds from preferred habitats, resulting in lower survival. Development of the Liberty Prospect is expected to result in a small amount of habitat loss involving displacement of a few birds to alternate sites. This is likely to be a minor effect, unless it results in decreased survival either by itself or in combination with other factors. Mortality from collisions with onshore structures is expected to be negligible.

The small losses and displacements likely to result from the above activities are expected to cause minor changes in numbers that may be difficult to separate from natural variation in population numbers for any species (Eppley, 1992). Such changes are not expected to require lengthy recovery periods. However, any mortality resulting from development of the Liberty Prospect would be additive to natural mortality, requiring some time for recovery from such losses, and may interfere with the recovery of Arctic Slope populations should declines in these species (for example, king and common eiders) take place.

Contents

Marine and Coastal Birds

Alternative III

Alternative III.A
Southern I./Eastern Pipeline

Effects of Oil Spills:

The probability of oil-spill contact and potential effects on loons, waterfowl, shorebirds, and seabirds in most environmental resource areas or land segments from Alternative I and Alternative III.A island sites and offshore pipeline spill points is essentially the same. There is a difference in probability of contact in the southern Foggy Island Bay area due to island location, which suggests that there is a somewhat greater potential for an oil spill to contact waterbirds from this Alternative than from Alternative I. However, we conclude that effects, though different, would not be significantly different, because the difference between this Alternative and Alternative I in probability of oil contacting any waterbirds that may occur in southern Foggy Island Bay is not substantial, and the extent of waterbird use of this area is uncertain. Also, Alternative III.A slightly increases risk to waterbirds in eastern Foggy Island Bay and Alternative I increases risk in the western bay and Sagavanirktok River Delta due to relative pipeline positions.

Effects of Disturbances:

Disturbance effects from Alternative III.A and Alternative I are expected to be the same except those resulting from aerial inspection of the onshore portion of the pipeline. Such traffic potentially would disturb approximately twice as many nesting or broodrearing loons, waterfowl or shorebirds along the greater onshore length of the Alternative III.A pipeline than along the Alternative I pipeline. Because of the population size and status of species most likely to be involved, this is not viewed as a significant difference.

Alternative III.B
Tern I. and Pipeline

Effects of Oil Spills:

Although the chance of a spill from the Alternative IIIB Tern Island location and offshore portion of the pipeline route contacting Environmental Resource Areas or Land Segments is essentially the same as from the Alternative I Liberty Island location, Alternative IIIB would result in lower adverse effects on waterbirds because of a somewhat lower probability for contacts from a nearshore pipeline leak.

Effects of Disturbances:

Disturbance of waterbirds under Alternative IIIB is expected to be the same as for Alternative I, with no significant adverse population effects likely to occur

Alternative IV

Alternative IV.A
Pipe-in-Pipe

Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I

Alternative IV.B
Pipe-in-HDPE

Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative

Alternative IV.C
Flexible Pipe

Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I

Alternative V
Use Sheetpile

Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I

Alternative VI
Use Duck I Gravel Mine Site

Effects of Oil Spills:

Effects of an oil spill on marine and coastal birds under Alternative VI is expected to be essentially the same as for Alternative I.

Effects of Disturbances:

The potential for occurrence of resting, foraging, or nesting birds, and probably ptarmigan in winter, is likely to be considerably lower at the Duck Island quarry site than at the proposed Kadleroshilik site due to the undisturbed character and vegetative cover of the latter. Thus a potentially significant difference in effect of habitat disturbance on marine and coastal bird species is expected between this Alternative and Alternative I.

Alternative VII
Use a 15-Foot Trench Depth

Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I

Terrestrial Mammals

Alternative I – Proposed Action	Alternative III	
	Alternative III.A **Southern I./Eastern Pipeline**	**Alternative III.B** **Tern I. and Pipeline**
Effects of Oil Spills: Crude oil or diesel fuel is most likely to contact some coastal areas from Prudhoe Bay, the Sagavanirktok River Delta east to Mikkelsen Bay. Caribou may use some of these areas for relief from insects. The main potential effect on terrestrial mammals that contact spilled oil could be the loss of fewer than 100 caribou and a few muskoxen, grizzly bears, and arctic foxes. These losses are expected to be replaced by normal reproduction within about 1 year. A large onshore pipeline spill could occur and oil less than 5 acres of vegetation along the pipeline landfall to the Badami tie-in. Such a spill is not expected to directly affect caribou or other terrestrial mammals and would cause very minor ecological harm. Secondary effects could come from disturbance associated with spill-cleanup activities and temporary local displacement of some caribou, muskoxen, grizzly bears, and foxes. These activities, however, would not affect the terrestrial mammals' movements or overall use of habitat.	**Effects of Oil Spills:** Under this alternative, caribou, muskoxen, grizzly bears, and arctic foxes may be more likely to encounter an oil spill from the south production island, should it occur, because the island would be located closer to shore. Crude oil or diesel fuel is most likely to contact some coastal areas from the Sagavanirktok River Delta east to Mikkelsen Bay. Caribou may use some of these areas for relief from insects. The main potential effect on terrestrial mammals that contact spilled oil could be the loss of fewer than 100 caribou and a few muskoxen, grizzly bears, and arctic foxes. These losses are expected to be replaced by normal reproduction within about 1 year. A 1,500-barrel onshore pipeline spill could occur and oil less than 5 acres of vegetation along the pipeline landfall to the Badami tie-in. Such a spill is not expected to directly affect caribou or other terrestrial mammals and would cause very minor ecological harm.	**Effects of Oil Spills:** Under this alternative, caribou, muskoxen, grizzly bears, and arctic foxes are as likely to encounter an oil spill from the Tern Island production island, should it occur, as from the Liberty Island location because the island is located about the same distance from shore. The effect of potential oil spills, is likely to be about the same as described under the Alternative I. Crude oil or diesel fuel is most likely to contact some coastal areas from the Sagavanirktok River Delta east to Mikkelsen Bay. Caribou may use some of these areas for relief from insects. The main potential effect on terrestrial mammals that contact spilled oil could be the loss of fewer than 100 caribou and a few muskoxen, grizzly bears, and arctic foxes. These losses are expected to be replaced by normal reproduction within about 1 year. A 1,500-barrel onshore pipeline spill could occur and oil less than 5 acres of vegetation along the pipeline landfall to the Badami tie-in. Such a spill is not expected to directly affect caribou or other terrestrial mammals and would cause very minor ecological harm.
Effects of Disturbances: Helicopter and ice-road traffic, encounters with people, and mining and construction operations could disturb individual or small groups of these mammals for a few minutes to a few days or no more than about 6 months within about 1 mile of these activities. These disturbances would not affect populations. This traffic could briefly disturb some caribou, muskoxen, and grizzly bears, when the aircraft pass overhead or nearby, but would not affect terrestrial mammal populations. Traffic for constructing the ice roads, production island, pipeline, and gravel pads and to haul gravel and supplies could disturb some caribou and muskoxen along the ice roads during the 2 years of development and during other winters, when further work on the project is needed. This traffic would occur during December though early May, with more ice-road construction and traffic occurring during the 2 years of development. Some continued ice-road activity would occur during the 15 years of production to support project operations. These disturbances would have short-term effects on individual animals and would not affect populations. Encounters between grizzly bears and oil workers or with facilities could lead to the removal of problem bears. However, the amount of onshore activity associated with Liberty (1.4 miles of onshore pipeline with no onshore camp facilities) is not likely to result in the loss of any bears. Arctic fox numbers could increase in the project area because of the possible availability of food and shelter on the production island. However, the amount of onshore activity associated with Liberty (1.4 miles of onshore pipeline with no onshore camp facilities) would not result in a significant increase in fox abundance. BPXA's wildlife interaction plan and treatment of galley wastes should help to reduce the availability of food to foxes.	**Effects of Disturbances:** Effects of disturbances on terrestrial mammals under Alternative III.A are expected to be the same as for Alternative I.	**Effects of Disturbances:** The general effects of disturbance on terrestrial mammals for this alternative are expected to be the same as analyzed for Alternative I.

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<table>
<tr><th colspan="4">Terrestrial Mammals</th></tr>
<tr><th>Alternative IV</th><th rowspan="2">Alternative V
Use Sheetpile</th><th rowspan="2">Alternative VI
Use Duck I Gravel Mine Site</th><th rowspan="2">Alternative VII
Use a 15-Foot Trench Depth</th></tr>
<tr><th>Alternative IV.A
Pipe-in-Pipe</th></tr>
<tr><td>Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I.

Alternative IV.B
Pipe-in-HDPE

Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I.

Alternative IV.C
Flexible Pipe

Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I</td><td>Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I.</td><td>Effects of Oil Spills:
Effects of a large oil spill on terrestrial mammals under Alternative VI are expected to be the same as under Alternative I.

Effects of Disturbances:
Using the Duck Island Gravel Mine site rather than the Kadleroshilik River mine site would avoid potential noise and disturbance to muskoxen from ice-road traffic and mining activities in the Kadleroshilik River area during winter.</td><td>Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I.</td></tr>
</table>

Lower Trophic-Level Organisms		
Alternative I – Proposed Action	**Alternative III**	
	Alternative III.A **Southern I./Eastern Pipeline**	**Alternative III.B** **Tern I. and Pipeline**
Effects of Oil Spills: A large oil spill would have only short-term effects on plankton, but long-term effects on the fouled coastlines. Up to 15% of the sound's coastline would be affected by a large spill. While the ice-gouged coastline is inhabited by mobile, seasonal invertebrate species that would recover within a year, fractions of the oil would persist in the sediments for about 5 years in most areas, and could persist up to 10 years in areas where water circulation is reduced. Liberty crude is highly viscous and particularly resistant to natural dispersion, so very little would be dispersed down in the water column and affect benthic communities such as the Boulder Patch kelp habitat. However, diesel oil, which would be used on the island for startup and emergency fuel, could be dispersed down to the seafloor. If 1,500 barrels of diesel were spilled from a fuel-delivery barge at the island during the open-water season, the concentration would be toxic within an area of about 18 square kilometers (7 square miles). Such toxicity would probably stunt the seasonal growth of kelp plants and reduce the population size of associated invertebrates for several years. Oil-spill responses in general would have both minor beneficial and adverse effects on these organisms. **Effects of Disturbances:** Island construction for Alternative 1 would bury about 23 acres of typical benthic organisms. Pipeline trenching would disturb additional benthos, burying up to 14 acres with very low (1%) coverage of kelp, boulders, and suitable substrate. Sediment plumes from pipeline and island construction would reduce Boulder Patch kelp production by up to 6% during 1 year. The buried 14 acres would equal less than 0.1% of the Boulder Patch kelp habitat. The density of the kelp, boulders and suitable substrate in the pipeline corridor is very low, averaging about 1% coverage; therefore, the lost kelp biomass and production probably would be less than .01% of the Boulder Patch totals, but the effect (kelp substrate burial) would last forever. Some of the suspended sediment from pipeline trenching and island construction would drift over other parts of the Boulder Patch, reducing light penetration and kelp production during 1 year. This reduction is estimated to be less than 6%, about one-third of which would be due to the proximity between the Boulder Patch to the Zone 1 disposal area for excess sediments. However, in relation to the large range of natural variability, these suspended sediment effects would be barely detectable. The island's concrete slopes from 6 feet deep to the seafloor would be colonized by kelp and other organisms that grow on hard substrates. This portion of the concrete slope would become a home for colonies of species similar to those of the Boulder Patch area. Upon abandonment, the concrete mats probably would become buried naturally or would be removed, cutting back on the new kelp habitat. BPXA could also mitigate some trenching effects, if excess quarry boulders were placed on the backfill in the outer portion of the trench. The quarry boulders probably would reduce the longevity of trenching effects from permanent ones to decade-long ones, because a Boulder Patch study showed that bare rocks were colonized by kelp within a decade.	**Effects of Oil Spills:** Diesel-fuel spills: There might be specific differences in the effects of diesel-fuel spills because of the longer distance between the alternative island site and the Boulder Patch kelp habitat. In the unlikely event of a diesel spill, the longer distance would reduce slightly the risk of diesel effects to the kelp community. **Effects of Disturbances:** There would be specific differences in disturbance effects. The disturbance effects under this alternative would be lower than for Alternative I for two reasons. (1) There is no kelp in the Eastern Pipeline Route; therefore, trenching would not eliminate kelp habitat, causing only minor, short-term effects only to the silty/sandy sediments. This conclusion would be the same regardless of pipeline burial depth in the alternative pipeline route; however, fewer survey data are available for the alternative route, so we are less certain about these conclusions than for Alternative I. (2) The shorter pipeline length and the shallower water depth for the island would reduce the footprint of the project and the amount of turbidity caused by construction activity. A smaller sediment plume still would drift northwest over the Boulder Patch, reducing light levels and kelp production by an estimated 5% during construction. However, in relation to the large range of natural variability, the disturbance effects on lower trophic-level organisms would be barely detectable.	**Effects of Oil Spills:** Diesel-fuel spills: There might be specific differences in the effects of diesel-fuel spills. The longer distance between the island and the Boulder Patch would allow greater dispersion of any spilled diesel fuel, reducing the toxicity to the kelp community. **Effects of Disturbances:** There would be specific differences in disturbance effects also. The disturbance effects would be lower than for Alternative I but similar to the effects of the plan with a Southern Island and Eastern Pipeline Route (Alternative III.A). The differences in island footprints and pipeline lengths means that the Tern alternative would effect about 35 fewer acres of typical benthos than Alternative I.

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<table>
<tr><th colspan="5">Lower Trophic-Level Organisms</th></tr>
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<tr><th>Alternative IV.A
Pipe-in-Pipe</th><th>Alternative IV.B
Pipe-in-HDPE</th><th>Alternative IV.C
Flexible Pipe</th><th>Use Sheetpile</th><th>Use a 15-Foot Trench</th></tr>
<tr>
<td rowspan="3">Effects of Oil Spills:
The general oil-spill risk to these organisms would be about the same for Alternative 1 and pipe-in-pipe because the main risk in both cases would come from spills of diesel rather than Liberty crude

Effects of Disturbances:
There would be specific differences in the disturbance effects. The pipe-in-pipe would require less burial depth, causing fewer effects than Alternative 1 in two important ways. (1) Shallower burial in the Alternative 1 pipeline route would permanently eliminate 2 less acres of very diffuse kelp, boulder and suitable substrate than would the Alternative 1 burial depth. (2) The amount of turbidity generated by shallower burial would be only two-thirds of that for Alternative 1, probably causing less reduction in annual kelp production during the construction phase. There is no kelp or solid substrate in the Eastern or Tern pipeline corridors, so shallower burial there would not save any kelp habitat, however, the reduced suspended sediments probably would cause less reduction in annual kelp production during the construction phase.</td>
<td rowspan="3">Effects of Oil Spills:
The general oil-spill risk to these organisms would be about the same for Alternative 1 and pipe-in-HDPE because the main risk in both cases would come from spills of diesel rather than Liberty crude.

Effects of Disturbances:
There would be specific differences in the disturbance effects. The pipe-in-HDPE would require less burial depth, causing fewer effects than Alternative 1 in two important ways. (1) Shallower burial in the Alternative 1 pipeline route would permanently eliminate 2 less acres of very diffuse kelp, boulder and suitable substrate than would the Alternative 1 burial depth. (2) The amount of turbidity generated by shallower burial would be only two-thirds of that for Alternative 1, probably causing less reduction in annual kelp production during the construction phase. There is no kelp or solid substrate in the Eastern or Tern pipeline corridors, so shallower burial there would not save any kelp habitat, however, the reduced suspended sediments probably would cause less reduction in annual kelp production during the construction phase.</td>
<td rowspan="3">Effects of Oil Spills:
The general oil-spill risk to these organisms would be about the same for Alternative 1 and flexible pipe because the main risk in both cases would come from spills of diesel rather than Liberty crude.

Effects of Disturbances:
There would be specific differences in the disturbance effects. The flexible pipe would require less burial depth, causing fewer effects than Alternative 1 in two important ways. (1) Shallower burial in the Alternative 1 pipeline route would permanently eliminate 2 less acres of very diffuse kelp, boulder and suitable substrate than would the Alternative 1 pipeline design. (2) The amount of turbidity generated by shallower burial would be only two-thirds of that for Alternative 1, probably causing less reduction in annual kelp production during the construction phase. These effects of shallower burial would be the same for the alternate island design (steel sheetpile). There is no kelp or solid substrate in the Eastern or Tern pipeline corridors, so shallower burial there would not save any kelp habitat, however, the reduced suspended sediments probably would cause less reduction in annual kelp production during the construction phase.</td>
<td>Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I.</td>
<td rowspan="3">Effects of Oil Spills:
The general oil-spill risk to these organisms would be about the same with deeper pipeline burial and with the Alternative 1 pipeline-burial depth because the main risk in both cases would come from spills of diesel fuel rather than Liberty crude.

Effects of Disturbances:
There would be specific differences in the disturbance effects. The disturbance effects of deeper pipeline burial would be greater than the effects of Alternative 1 in two important ways. (1) Deeper burial in the Alternative 1 pipeline route would permanently eliminate 3 additional acres of very diffuse kelp, boulder and suitable substrate. (2) The amount of turbidity generated by deeper burial would be about two times greater than for Alternative 1, possibly causing additional reduction in annual kelp production during the construction phase. These effects of deeper burial would be the same for the alternate island design (steel sheetpile). There is no kelp or solid substrate in the Eastern or Tern pipeline corridors, so deeper burial there would not eliminate additional kelp habitat, however, the additional suspended sediments possibly would cause additional reduction in annual kelp production during the construction phase.</td>
</tr>
<tr><th>Alternative VI
Use Duck I. Gravel Mine</th></tr>
<tr><td>Effects of Oil Spills:
The general oil-spill risk to these organisms would be the same for the project with the Duck Island mine and for the Alternative 1mine site.

Effects of Disturbances:
There would be specific differences in the disturbance effects because gravel from the Duck Island mine might be hauled along an ice road over the Boulder Patch.</td></tr>
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<table>
<tr><th colspan="2">Fishes</th></tr>
<tr><th>Alternative I – Proposed Action</th><th>Alternative III</th></tr>
<tr><td rowspan="4">Effects of Oil Spills:

The likely effects on arctic fishes (including incidental anadromous species) from a large oil or diesel fuel spill assumed to occur at Liberty Island or from the buried pipeline and enter offshore waters would depend primarily on the season and location of the spill, the lifestage of the fishes (adult, juvenile, larval, or egg), and the duration of the oil contact. Due to their very low numbers in the spill area, no measurable effects are expected on fishes in winter. Effects would be more likely to occur from an offshore oil spill moving into nearshore waters during summer, where fishes concentrate to feed and migrate. . The probability of an offshore oil spill contacting nearshore waters in summer ranges from less than 1 to 26%. If an offshore spill did occur and contact the nearshore area, some marine and migratory fish may be harmed or killed. However, it would not be expected to have a measurable effect on fish populations and recovery would be expected within 5 years. In general, the effects of fuel spills on fish are expected to be less than those of crude-oil spills.

If a pipeline oil spill did occur onshore, and contacted a small waterbody supporting fish (for example, ninespine stickleback, arctic grayling, and Dolly Varden char) with restricted water exchange, it would be expected to kill or harm most of the fish within the affected area. Recovery would be expected in 5-7 years. However, because of the small amount of oil or diesel fuel likely to enter freshwater habitat, the low diversity and abundance of fish in most of the onshore area, and the unlikelihood of spills blocking fish migrations or occurring in overwintering areas or small waterbodies (containing many fish or fish eggs), an onshore spill of this kind is not expected to have a measurable effect on fish populations on the Arctic Coastal Plain.

Effects of Disturbances:

Noise and discharges from dredging, gravel mining, island construction, island reshaping, and pipeline trenching associated with Liberty are expected to have no measurable effect on fish populations (including incidental anadromous species). While a few fish could be harmed or killed, most in the immediate area would avoid these activities and would be otherwise unaffected. Effects on most overwintering fish are expected to be short term and sublethal, with no measurable effect on overwintering fish populations. Placement of the concrete mat would create additional food resources for fishes and, thereby, would have a beneficial effect on nearshore fish populations in the Beaufort Sea.</td>
<th>Alternative III.A
Southern I./Eastern Pipeline</th></tr>
<tr><td>Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I.</td></tr>
<tr><th>Alternative III.B
Tern I. and Pipeline</th></tr>
<tr><td>Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I.</td></tr>
</table>

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Fishes			
Alternative IV	**Alternative V** **Use Sheetpile**	**Alternative VI** **Use Duck I Gravel Mine Site**	**Alternative VII** **Use a 15-Foot Trench Depth**
Alternative IV.A **Pipe-in-Pipe** **Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I. **Alternative IV.B** **Pipe-in-HDPE** **Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I. **Alternative IV.C** **Flexible Pipe** **Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I	**Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I.	**Effects of Oil Spills:** Oil-spill related effects would remain unchanged from that of Alternative I. **Effects of Disturbances:** Alternative VI is expected to have similar effects on fishes as Alternative I. While the Duck Island mine site would eliminate any possibility of disturbing fish, it also would eliminate the possibility of creating overwintering habitat on the Kadleroshilik River, as discussed for Alternative I. Otherwise, Alternative VI is not expected to result in measurable differences in effects on fishes.	**Effects of Oil Spills:** Oil-spill effects would remain unchanged from those of Alternative I. **Effects of Disturbances:** Alternative VII would be expected to have a slightly greater effect on fishes than Alternative I, due to more trenching and disturbance. Overall, this would not be expected to result in measurable differences in effects on fishes over that of Alternative I.

<table>
<tr><th colspan="2">Essential Fish Habitat</th></tr>
<tr><th>Alternative I – Proposed Action</th><th>Alternative III</th></tr>
<tr><td rowspan="4">Effects of Oil Spills:

In the event of a large, offshore oil spill, the most likely potential threat to individual salmon would occur if spilled oil came in contact with spawning areas or migratory pathways. However, salmon are not believed to spawn in the intertidal areas or the mouths of streams or rivers of the Beaufort Sea. Therefore, contact between spilled oil and spawning areas is very unlikely. If spilled oil concentrated along the coastline at the mouths of streams or rivers, the potential movements of a small number of salmon could be disrupted during migrations.

Zooplankton and fish form most of the potential diet for salmon in the Beaufort Sea Zooplankton populations could be subjected to short-term, localized, negative effects from oil spilled as a result of Liberty development. Nearshore coastal lagoons support seasonal concentrations of zooplankton, which are potential prey for juvenile and adult salmon during summer. Crude or diesel oil spilled between May and September could cause the death of limited numbers of fish of a variety of species that are potential prey for salmon in the Beaufort Sea. Mortality rates would be expected to be low, with the most likely effects on fish being sublethal, including changes in growth, feeding, fecundity and temporary displacement. Although measurable effects on prey populations would not be expected, any mortality of fish potentially would have an adverse effect on essential fish habitat.

Marine plants provide habitat for potential prey. Juvenile lifestages of salmon inhabit fresh or estuarine waters and generally feed on insects. Oil spilled in wetland habitat could kill vegetation and associated insect species and, thus, have an adverse effect on essential fish habitat lasting from less than 10 years to several decades.

Salmon and their prey require relatively clean water in which to live and perform their basic life functions. Essential fish habitat would be adversely affected over a fairly large area for a period of from days to months, if a large spill of crude or diesel oil occurred.

Effects of Disturbances:

None of the lifestages of Pacific salmon have been documented to use or inhabit the areas expected to be disturbed directly by Liberty construction and operations. Nonetheless, the waters surrounding the development have been included in the area designated Essential Fish Habitat for Alaskan salmon. Thus, Essential Fish Habitat would be adversely affected by disturbances to potential prey, to prey habitat, to potential substrate, and to marine and fresh waters. As a result of disturbances caused by Liberty Island construction and operation, fish and zooplankton might experience short-term, localized but unmeasurable effects. This would include potential adverse effects from noise during construction and operations and from increased turbidity and sedimentation as a result of dredging, gravel mining, island construction, and pipeline trenching. Marine plants could be subjected to short-term, localized, negative effects due to mechanical removals of individuals and from sedimentation resulting from pipeline trenching and island construction. Pipeline construction is expected to bury up to 14 acres of kelp and solid substrate, and sediment plumes are expected to reduce kelp production by 6% during 1 year. Water quality would be primarily affected by increased turbidity that would result from gravel island and pipeline construction, Liberty Island abandonment, and gravel mine reclamation. Turbidity and salinity of seawater discharged from the Liberty Island production facility are expected to be slightly higher than water in surrounding Foggy Island Bay. All of these disturbances are expected to be fairly localized and short term.</td>
<td>Alternative III.A
Southern I./Eastern Pipeline</td></tr>
<tr><td>The potential adverse effects of this alternative on essential fish habitat could be reduced slightly, because the size of the island footprint and amount of offshore trenching would be reduced. Otherwise, the effects from possible oil spills or from other activities would be similar to the Proposal.</td></tr>
<tr><td>Alternative III.B
Tern I. and Pipeline</td></tr>
<tr><td>The potential adverse effects of this alternative on essential fish habitat could be slightly reduced primarily because of expected smaller effects on fish and algae at the Boulder Patch. The longer distance between Tern Island and the Boulder Patch would reduce the risk of diesel fuel spills to the kelp and associate fish communities. The disturbance effects would be slightly lower for the alternative, because pipeline trenching would not eliminate kelp. Less material would be used to construct Tern Island than would be used for Liberty, and the total amount of particulate matter suspended would be less. The turbidity plume would be expected to have a shorter duration than the plume associated with Liberty.</td></tr>
</table>

<table>
<tr><th colspan="4">Essential Fish Habitat</th></tr>
<tr><th>Alternative IV</th><th rowspan="2">Alternative V
Use Sheetpile</th><th rowspan="2">Alternative VI
Use Duck I Gravel Mine Site</th><th rowspan="2">Alternative VII
Use a 15-Foot Trench Depth</th></tr>
<tr><th>Alternative IV.A
Pipe-in-Pipe</th></tr>
<tr><td>The effects of Alternative IV.A are expected to be essentially the same on potential salmon prey and associated vegetation for all Alternatives. Water quality is expected to be improve, because the total amount of suspended-particulate matter would be less than under the Alternative I.</td><td rowspan="5">The effects of Alternative V are expected to be the same as Alternative I.</td><td rowspan="5">The potential net effect of this alternative on essential fish habitat is expected to be similar to Alternative I. However, using the Duck Island mine site as a source for gravel would eliminate any possibility of disturbance of fish or algae from increased turbidity and sedimentation downstream of the mine site. It also would eliminate the potential countervailing effect of creating overwintering habitat on the Kadleroshilik River for fish that potentially would serve as prey for salmon.</td><td rowspan="5">The potential adverse effects of this alternative on essential fish habitat could be slightly increased compared to Alternative I. The risk of oil spills to essential fish habitat would be unchanged. However, deeper burial in the proposed pipeline route would permanently eliminate about 3 more acres of diffuse kelp and solid substrate. Moreover, the amount of suspended sediments from deeper burial would be about two times greater than for Alternative I, possibly causing additional reduction in annual kelp production during the construction phase.</td></tr>
<tr><th>Alternative IV.B
Pipe-in-HDPE</th></tr>
<tr><td>The effects of Alternative IV.B are expected to be essentially the same on potential salmon prey and associated vegetation as Alternative I. Water quality is expected to be improved slightly, because the total amount of suspended-particulate matter would be slightly less than under the Alternative I.</td></tr>
<tr><th>Alternative IV.C
Flexible Pipe</th></tr>
<tr><td>The effects of Alternative IV.C are expected to be essentially the same on potential salmon prey and associated vegetation for all alternatives. Water quality is expected to be improved, because the total amount of suspended-particulate matter would be less than under the Alternative I.</td></tr>
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<table>
<tr><th colspan="3">Vegetation-Wetland Habitats</th></tr>
<tr><th>Alternative I – Proposed Action</th><th colspan="2">Alternative III</th></tr>
<tr><td rowspan="2">Effects of Oil Spills:

The main potential effects of a large offshore spill on vegetation and wetland include oil-fouling, smothering, asphyxiation, and poisoning of plants and associated insects and other small animals. In this case, complete recovery of moderately oiled wetlands of the Sagavanirktok River east to Mikkelsen Bay would take perhaps 10 years or longer. A second main effect is the disturbance of wetlands from cleanup activities. Complete recovery of heavily oiled coastal wetlands from these disturbances and oil could take several decades.

A large onshore spill along the pipeline route from the landfall to the Badami tie-in would oil no more than 5 acres of vegetation and cause very minor ecological harm. Oiled vegetation should recover within a few years but may take more than 10 years to fully recover.

Effects of Disturbances:

Disturbances mainly come from constructing gravel pads and ice roads and installing the onshore pipeline and tie-in with the Badami pipeline. Gravel pads, pipeline trench, and the 1.4-mile-long onshore pipeline would destroy only 0.8 acres of vegetation and affect a few acres of nearby vegetation and have only local effects on the tundra ecosystem. Ice roads would have local effects (compression of tundra under the ice roads) on vegetation, with recovery expected within a few years, and no vegetation would be killed. The construction and installation of the onshore pipeline and gravel pad on State land will be required to have a Section 404/10 permit and approval by the Corps of Engineers, as stated in the Liberty Development Project Development and Production Plan. The permit and approval process is expected to minimize adverse effects on wetlands.</td><th>Alternative III.A
Southern I./Eastern Pipeline</th><th>Alternative III.B
Tern I. and Pipeline</th></tr>
<tr><td>Effects of Oil Spills:

Under this alternative, coastal vegetation and wetlands in the Foggy Island Bay area probably are more likely to be oiled by an assumed production-island spill with the island located closer to shore (4.1 miles [6.6 kilometers] compared to 6.1 miles [9.8 kilometers] under Alternative I). The main potential effects of a large offshore spill on vegetation and wetland include oil-fouling, smothering, asphyxiation, and poisoning of plants and associated insects and other small animals. In this case, complete recovery of moderately oiled wetlands of the Sagavanirktok River east to Mikkelsen Bay would take perhaps 10 years or longer. A second main effect is the disturbance of wetlands from cleanup activities. Complete recovery of heavily oiled coastal wetlands from these disturbances and oil could take several decades.

A large onshore spill would oil no more than 5 acres of vegetation along the pipeline landfall to the Badami tie-in would cause very minor ecological harm. Oiled vegetation should recover within a few years but may take more than 10 years to fully recover.

Effects of Disturbances:

Effects of disturbances on vegetation-wetlands under Alternative IIIA are expected to be the same as for Alternative I. Moving the production-island a little closer to shore is not expected to increase the amount vegetation-wetlands altered under Alternative I.</td><td>Effects of Oil Spills:

Under this alternative, coastal vegetation and wetlands in the Foggy Island Bay area probably are as likely to be oiled by an assumed production-island spill at Tern Island location as at the proposed Liberty location because both locations are about equal distance to shore. The main potential effects of a large offshore spill on vegetation and wetland include oil-fouling, smothering, asphyxiation, and poisoning of plants and associated insects and other small animals. In this case, complete recovery of moderately oiled wetlands of the Sagavanirktok River east to Mikkelsen Bay would take perhaps 10 years or longer.

A large onshore spill would oil no more than 5 acres of vegetation along the pipeline landfall to the Badami tie-in would cause very minor ecological harm. Oiled vegetation should recover within a few years but may take more than 10 years to fully recover.

Effects of Disturbances:
The effects of disturbance on vegetation and wetlands for this alternative are expected to be the same as analyzed for Alternative I.</td></tr>
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Vegetation-Wetland Habitats			
Alternative IV	**Alternative V** **Use Sheetpile**	**Alternative VI** **Use Duck I Gravel Mine Site**	**Alternative VII** **Use a 15-Foot Trench Depth**
Alternative IV.A **Pipe-in-Pipe** **Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I. **Alternative IV.B** **Pipe-in-HDPE** **Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I. **Alternative IV.C** **Flexible Pipe** **Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I.	**Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I.	**Effects of Oil Spills:** The effects of a large spill on vegetation-wetlands for this alternative are expected to be the same as analyzed for Alternative I. **Effects of Disturbances:** Using Duck Island-Sagavanirktok River gravel mines rather than the Kadleroshilik River mine site would avoid disturbance of the sparsely vegetated gravel bar on the Kadleroshilik River. Consequently, the disturbance effect on vegetation and wetlands from mining activities would be avoided. Disturbance of vegetation and wetlands from the Liberty Project would still occur at the pipeline land-fall site and along the on shore pipeline route. Effects would be local and have very little effect on overall the vegetation and wetlands habitats.	**Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I.

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<table>
<tr><th colspan="2">Subsistence-Harvest Patterns</th></tr>
<tr><th>Alternative I – Proposed Action</th><th>Alternative III</th></tr>
<tr><td rowspan="4">

Effects of Oil Spills:

The chance of an oil spill greater than or equal to 500 barrels occurring from the offshore production island and the buried pipeline and entering the offshore waters is estimated to be low. Based on the assumption that a spill has occurred, the chance of an oil spill during summer from either Liberty Island or the pipeline contacting important traditional bowhead whale and seal harvest areas of Cross and McClure Islands over a 360-day period would be 16% or less. A spill also could affect other subsistence resources and harvest areas used by the communities of Nuiqsut and Kaktovik. For crude oil or diesel fuel spills, conditional probabilities have been used to determine the likelihood of oil contact with subsistence-resources areas.

Overall, oil spills could affect subsistence *resources* periodically in the communities of Nuiqsut and Kaktovik. If an oil spill occurred and affected any part of the bowhead whale's migration route, it could taint this culturally important resource. In fact, even if whales were available for the spring and fall seasons, traditional cultural concerns of tainting could make bowheads less desirable and alter or stop the subsistence harvest. Tainting concerns also would apply to polar bears and seals. Additionally, a large oil spill could cause potential short-term but serious adverse effects to oldsquaw and king and common eider populations. A potential loss of one or two polar bears could reduce their availability locally to subsistence users, although they are seldom hunted by Nuiqsut hunters except opportunistically while in pursuit of more preferred subsistence resources.

No harvest areas would become unavailable for use and all resources, except possibly bowhead whales, would remain available for use. Some resource populations could suffer losses and, as a result of tainting, bowhead whales could be rendered culturally unavailable for use. Tainting concerns in communities nearest a spill event could seriously curtail traditional practices for harvesting, sharing, and processing bowhead whales and threaten a pivotal underpinning of Inupiat culture. Whaling communities unaffected by potential spill effects are likely to share bowhead whale products with impacted villages. Harvesting, sharing, and processing of other subsistence resources should continue.

Effects of Disturbances:

For the communities of Nuiqsut and Kaktovik, disturbances periodically could affect subsistence resources, but no resource or harvest area would become unavailable and no resource population would experience an overall decrease. Disturbance and noise could affect subsistence species that include bowhead whales, seals, polar bears, caribou, fish, and birds. Oil-spill cleanup would increase these effects. Disturbances could displace subsistence species, alter or reduce subsistence hunter access to these species, and therefore alter or extend the normal subsistence hunt, but potential disruptions to subsistence resources should not displace traditional practices for harvesting, sharing, and processing those resources. Beluga whales rarely appear in the Liberty Project area. We do not expect them to be affected by noise or other project activities, nor do we expect changes in Kaktovik's subsistence harvest of beluga whales.

</td><td>Alternative III.A
Southern I./Eastern Pipeline</td></tr>
<tr><td>Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I.</td></tr>
<tr><td>Alternative III.B
Tern I. and Pipeline</td></tr>
<tr><td>Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I.</td></tr>
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Subsistence-Harvest Patterns

Alternative IV	Alternative V Use Sheetpile	Alternative VI Use Duck I Gravel Mine Site	Alternative VII Use a 15-Foot Trench Depth
Alternative IV.A **Pipe-in-Pipe** **Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I.	**Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I.	**Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I.	**Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I.
Alternative IV.B **Pipe-in-HDPE** **Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I.			
Alternative IV.C **Flexible Pipe** **Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I			

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<table>
<tr><th colspan="2">Sociocultural Systems</th></tr>
<tr><th>Alternative I – Proposed Action</th><th>Alternative III</th></tr>
<tr><td rowspan="4">Effects of Oil Spills:

Effects on the sociocultural systems of communities of Nuiqsut and Kaktovik could come from disturbance from small changes in population and employment and periodic interference with subsistence-harvest patterns from oil spills and oil-spill cleanup. Effects from these sources are not expected to displace ongoing sociocultural systems, but community activities, and traditional practices for harvesting, sharing, and processing subsistence resources could be seriously curtailed in the short term, if there are concerns over the tainting of bowhead whales from an oil spill.

Effects of Disturbances:

Effects on the sociocultural systems of communities near the Liberty Project area could occur as a result of disturbance from industrial activities; changes in population and employment; and effects on subsistence-harvest patterns. These effects could affect the social organization, cultural values, and social health of the communities. Together, effects may periodically disrupt but not displace ongoing social systems, community activities, and traditional practices for harvesting, sharing, and processing subsistence resources.</td><th>Alternative III.A
Southern I./Eastern Pipeline</th></tr>
<tr><td>Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I.</td></tr>
<tr><th>Alternative III.B
Tern I. and Pipeline</th></tr>
<tr><td>Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I.</td></tr>
</table>

Sociocultural Systems			
Alternative IV	**Alternative V** **Use Sheetpile**	**Alternative VI** **Use Duck I Gravel Mine Site**	**Alternative VII** **Use a 15-Foot Trench Depth**
Alternative IV.A **Pipe-in-Pipe** **Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I. **Alternative IV.B** **Pipe-in-HDPE** **Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I. **Alternative IV.C** **Flexible Pipe** **Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I.	**Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Using steel sheetpile in island construction would relieve ongoing concerns of local subsistence hunters about gravel bags from past gravel island developments contaminating the environment and creating navigation hazards for whaling boats. Using steel sheetpile would serve to reduce overall stress in the local Inupiat population, particularly Nuiqsut, over the development of Liberty Island in the Beaufort Sea offshore environment. This reduction in stress of local Inupiat could be considered a slight reduction in effect to sociocultural systems and also could be construed as taking into account local knowledge and concern for the offshore environment and its resources. General oil-spill effects on sociocultural systems would be the same as for Alternative I.	**Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I.	**Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances:** Same as Alternative I.

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<tr><th colspan="2">Archaeological Resources</th></tr>
<tr><th>Alternative I – Proposed Action</th><th>Alternative III</th></tr>
<tr><td rowspan="4">Effects of Oil Spills:

The geography, prehistory and history of the Liberty Project area is very different from that of Prince William Sound, where the effects of the Exxon Valdez oil spill were concentrated; therefore, direct analogies cannot be drawn regarding the numbers and types of sites that may be affected should such a spill occur in the Liberty Project area. However, general findings and conclusions regarding the types and severity of impacts to archaeological sites present within the Exxon Valdez oil spill area are applicable to the Liberty Project area. The most important understanding that came from the Exxon Valdez oil spill was that the greatest effects to archaeological sites were not from the oil itself, but from the cleanup activities. The effects from cleanup activities were due both to physical disturbance of sites from cleanup equipment and due to vandalism by cleanup workers. Regardless, researchers concluded that less than 3% of the archaeological resources within the spill area suffered any significant effects and that level of effect would be expected in the unlikely event that an oil spill would occur from the Liberty development.

Effects of Disturbances:

Any bottom- or surface-disturbing activity, such as pipeline construction, island installation, anchoring of vessels, or oil-spill-cleanup activities could damage previously unidentified archaeological sites. Physical disturbance of sites could cause destruction of artifacts, disturbance or complete loss of site context, and resulting loss of data. Archaeological sites are a nonrenewable resource and could not be replaced.

Archaeological surveys are required both onshore and offshore in areas where there is the potential for archaeological resources to occur. Therefore, potential impacts to archaeological resources from physical disturbance would be mitigated. If a previously unknown archaeological site is discovered during construction, MMS and the State Historic Preservation Officer will be immediately contacted.</td><th>Alternative III.A
Southern I./Eastern Pipeline</th></tr>
<tr><td>Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I.</td></tr>
<tr><th>Alternative III.B
Tern I. and Pipeline</th></tr>
<tr><td>Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I.</td></tr>
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<table>
<tr><th colspan="4">Archaeological Resources</th></tr>
<tr><th>Alternative IV</th><th rowspan="2">Alternative V
Use Sheetpile</th><th rowspan="2">Alternative VI
Use Duck I Gravel Mine Site</th><th rowspan="2">Alternative VII
Use a 15-Foot Trench Depth</th></tr>
<tr><th>Alternative IV.A
Pipe-in-Pipe</th></tr>
<tr><td>Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I.</td><td rowspan="5">Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I.</td><td rowspan="5">Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I.</td><td rowspan="5">Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I.</td></tr>
<tr><th>Alternative IV.B
Pipe-in-HDPE</th></tr>
<tr><td>Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I.</td></tr>
<tr><th>Alternative IV.C
Flexible Pipe</th></tr>
<tr><td>Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances:
Same as Alternative I.</td></tr>
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<table>
<tr><th colspan="2">Economy</th></tr>
<tr><th>Alternative I – Proposed Action</th><th>Alternative III</th></tr>
<tr><td rowspan="4">
Economic Effects of the Proposed Action

The Liberty Project would generate approximately the following economic benefits:
• $100 million in wages and 870 full-time equivalent construction jobs for 1 year in Alaska during 14-18 months of construction
• $4.2 million in wages and 50 jobs annually for operations for 16 years in Alaska
• 1,248 indirect full-time equivalent jobs during the 14-18 months of construction
• 78 indirect full-time equivalent jobs each year for 16 years of operations
• $480 million capital expenditure, $240 million operating expenditures
• $344 million total Federal revenue
• $63 million total State revenue $5 million ad valorem tax to the North Slope Borough
• $114 million net present value of receipts to Federal and State governments

Effects of Oil Spills:

Employment generated to clean up possible large oil spills of 715-2,956-barrel oil spills is estimated to be 30-125 cleanup workers for 6 months in the first year, declining to zero by the third year following the spill.

Effects of Disturbances:

We do not expect disturbances to affect the cash economy. The economic effects on the Alaska economy would be caused by construction activities.
</td><th>Alternative III.A
Southern I./Eastern Pipeline</th></tr>
<tr><td>Economic Effects of Alternative III.A

Alternative III.A generates fewer jobs, less wages and less revenue to the government than for the Proposal. This alternative would result in a decrease of approximately $1.7 million in wages for 12 months, 9 direct jobs in Alaska for 12 months, 14 indirect jobs in Alaska for 12 months, and $10 million in net present value to the company. The net present value to the government is estimated to be $107, or $7 million less than the Proposal.</td></tr>
<tr><th>Alternative III.B
Tern I. and Pipeline</th></tr>
<tr><td>Economic Effects of Alternative III.B

Alternative III.B generates fewer jobs, less wages, and less revenue to the government than for the Proposal. This alternative would result in a decrease of approximately $1.7 million in wages for 12 months, 9 direct jobs in Alaska for 12 months. 14 indirect jobs in Alaska for 12 months, and $10 million in net present value to the company. The net present value to the government is estimated to be $107, or $7 million less than the Proposal.</td></tr>
</table>

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Economy				
Alternative IV			**Alternative V**	**Alternative VII**
Alternative IV.A	**Alternative IV.B**	**Alternative IV.C**	**Use Sheetpile**	**Use a 15-Foot Trench**
Pipe-in-Pipe	**Pipe-in-HDPE**	**Flexible Pipe**		
Economic Effects of Alternative IV.A Alternative IV.A generates more jobs, greater wages, and greater capital expenditure than for the Alternative I. This alternative would result in an increase of $4 million in wages for 7 months; 34 direct jobs in pipeline construction in Alaska for 7 months; 50 indirect jobs in Alaska for 7 months; and $20 million in capital expenditures. The increased cost of this alternative is based primarily on additional, labor, welding and material costs.	**Economic Effects of Alternative IV.B** Alternative IV.B, which is a pipe-in-HDPE system, generates more jobs, greater wages and greater capital expenditures than for the Proposal. This alternative would result in an increase of $2.4 million in wages for 7 months; 22 direct jobs in pipeline construction in Alaska for 7 months; 33 indirect jobs in Alaska for 7 months; and $12.6 million in capital expenditures. The increased cost of this alternative is based primarily on additional labor and material costs.	**Economic Effects of Alternative IV.C** Alternative IV.C generates more jobs, greater wages and greater capital expenditures than for the Proposal. This alternative would result in increases of $0.9 million in wages for 7 months; 8 direct jobs in pipeline construction in Alaska for 7 months; 12 indirect jobs in Alaska for 7 months; and $5.1 million in capital expenditures. The increased cost of this alternative is based primarily on increased material cost. Due to the increased cost of the pipeline, the pipeline tariff would be higher. Higher pipeline tariffs mean higher allowable transportation costs and reduced royalty revenue to the government from the project and reduced Section 8(g) payments to the State	**Economic Effects of Alternative VII** Same as Alternative I. **Alternative VI** **Use Duck I. Gravel Mine** Alternative VI generates more jobs, greater wages, and greater costs than Alternative I. This alternative would result in an increase of approximately $4.4 million in wages for 14 months; 20 direct jobs in Alaska for 14 months; 30 indirect jobs in Alaska for 14 months; approximately $15 million in cost for gravel island construction; and additional costs associated for gravel mining and hauling for pipeline construction. The increased costs are based on three factors. Dewatering the Duck Island site would cost about $2.4 million. The distance from the Duck Island mine to the island is about 17.3 miles or about 2.7 times farther from the Kadleroshilik mine, causing increased costs of hauling. The Duck Island haul route would include preparation of a longer floating ice segment than the route to the island in Alternative 1.	**Economic Effects of Alternative VII** Alternative VII generate more jobs and greater wages than for the Proposal. Assuming labor costs for construction of the deeper pipeline would increase by as much as two times over those of the Proposal, this alternative would result in increases of $10.8 million in wages; 100 direct jobs in pipeline construction for 7 months in Alaska; and 150 indirect jobs in Alaska. This twofold factor is about in proportion to the volume of additional material to be handled in this alternative as compared to Alternative I. Higher pipeline construction costs result in higher pipeline tariffs. Higher pipeline tariffs reduce royalty revenue to the Federal Government from the project and likewise reduce Section 8(g) payments to the State.

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Water Quality		
Alternative I – Proposed Action	**Alternative III**	
	Alternative III.A **Southern I./Eastern Pipeline**	**Alternative III.B** **Tern I. and Pipeline**
Effects of Oil Spills: During open water, hydrocarbons dispersed in the water column from a large (greater than or equal to 500 barrels) crude oil spill could exceed the 0.015-parts per million chronic criterion for 10-30 days in an area that ranges from 30-45 square kilometers (11.6-17.4 square miles) to 51-186 square kilometers (19.7-71.8 square miles). Hydrocarbons in the water could exceed the 1.5-parts per million acute (toxic) criterion during the first day in the immediate vicinity of the spill. A large crude oil spill in broken sea ice or when the sea ice melts could exceed the chronic criterion for several days in an area of about 7.6 square kilometers (2.9 square miles). Hydrocarbons from a 1,283-barrel diesel oil spill during open water could exceed the acute (toxic) criterion for about 7 days in an area of about 18 square kilometers (7 square miles). During broken sea ice or melting ice conditions, a 1,283-barrel diesel spill could exceed the acute (toxic) criterion for about 1 day in an area of about 1 square kilometers (0.4 square miles) and the chronic criterion for more than 30 days in an area of about 103 square kilometers (39.8 square miles). The effects from a spill occurring under the ice would be similar to those described for broken ice or melting conditions; the oil would be trapped and essentially remain unchanged until breakup occurred and the ice began to melt. A large crude or refined oil spill (greater than or equal to 500 barrels) would significantly affect water quality by increasing the concentration of hydrocarbons in the water column to levels that greatly exceed background concentrations; however, the chance of a large spill occurring and oil entering the offshore waters is estimated to be about 1%. Also, regional (more than 1,000 square kilometers [386 square miles]), long-term (more than 1 year) degradation of water quality to levels above State and Federal criteria because of hydrocarbon contamination is very unlikely **Effects of Disturbances:** The greatest effect on water quality from gravel island and pipeline construction would be additional turbidity caused by increases in suspended particles in the water column. Increases in turbidity generally are expected to be considerably less than the 7,500 parts per million suspended solids used in the analysis as an acute (toxic) criterion for water quality; exceptions may occur within the immediate vicinity of the construction activity. Turbidity increases from construction activities generally are temporary and expected to occur during the winter and end within a few days after construction stops. Material excavated from the pipeline trench but not used for backfill most likely would be left in an area where active erosion of sediment particles could occur during breakup and open water. This material would be similar in composition to seafloor sediments in the trenching and disposal areas, and its contribution to future turbidity from waves and currents is expected to be about the same as the sediments existing at the seafloor surface before pipeline construction. Construction activities are not expected to introduce or add any chemical pollutants. **Effects of Discharges on Water Quality** Treated seawater would be the primary discharge from the Liberty Island production facility. The discharged waters would be a few degrees warmer and contain higher concentrations of suspended sediments and dissolved salts when compared to the water in Foggy Island Bay. Increases in turbidity generally are expected to be considerably less than the 7,500 parts per million suspended solids used in the analysis as an acute (toxic) criterion for water quality. The water also would contain some chemicals that have been added to prevent biofouling, scaling, and corrosion. Mixing in the receiving waters of the bay is estimated to dilute the effluent waters by a 50:1 ratio within about 6 meters (20 feet) of the island. Additional mixing would continue, as waters are carried away from the island by the currents.	**Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances and Discharges:** The greatest effect on water quality from gravel island and pipeline construction would be additional turbidity caused by increases in suspended particles in the water column. Increases in turbidity generally are expected to be considerably less than the 7,500 parts per million suspended solids used in the analysis as an acute (toxic) criterion for water quality; exceptions may occur within the immediate vicinity of the construction activity. Turbidity increases from construction activities generally are temporary and expected to occur during the winter and end within a few days after construction stops. The duration of turbidity from Southern Island and eastern pipeline trenching is expected to be less by 3-5 and 15days, respectively, compared to Liberty Island (45-60 days) and pipeline (49 days). The overall effects of turbidity are expected to be about 14% less during the construction of the Southern Island and 32% less for the eastern pipeline compared to the construction of Liberty Island and pipeline, respectively. Material excavated from the pipeline trench but not used for backfill most likely would be left in an area where active erosion of sediment particles could occur during breakup and open water. This material would be similar in composition to seafloor sediments in the trenching and disposal areas, and its contribution to future turbidity from waves and currents is expected to be about the same as the sediments existing at the seafloor surface before pipeline construction. Construction activities are not expected to introduce or add any chemical pollutants. The effects of discharges are expected to be the same as Alternative I.	**Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances and Discharges:** The greatest effect on water quality from gravel island and pipeline construction would be additional turbidity caused by increases in suspended particles in the water column. Increases in turbidity generally are expected to be considerably less than the 7,500 parts per million suspended solids used in the analysis as an acute (toxic) criterion for water quality; exceptions may occur within the immediate vicinity of the construction activity. Turbidity increases from construction activities generally are temporary and expected to occur during the winter and end within a few days after construction stops. The duration of turbidity from Tern Island is expected to be less by about 15 days compared to Liberty Island (45-60 days) and pipeline trenching is expected to be less by 5 days compared to Liberty pipeline (49 days). The overall effects of turbidity are expected to be about 25% less during the construction of the Southern Island and 10% less for the eastern pipeline compared to the construction of Liberty Island and pipeline, respectively. Material excavated from the pipeline trench but not used for backfill most likely would be left in an area where active erosion of sediment particles could occur during breakup and open water. This material would be similar in composition to seafloor sediments in the trenching and disposal areas, and its contribution to future turbidity from waves and currents is expected to be about the same as the sediments existing at the seafloor surface before pipeline construction. Construction activities are not expected to introduce or add any chemical pollutants. The effects of discharges are expected to be the same as Alternative I.

Contents

Water Quality				
Alternative IV			Alternative V	Alternative VII
Alternative IV.A Pipe-in-Pipe	Alternative IV.B Pipe-in-HDPE	Alternative IV.C Flexible Pipe	Use Sheetpile	Use a 15-Foot Trench
Effects of Oil Spills: Same as Alternative I. **Effects of Disturbances and Discharges:** The greatest effect on water quality from gravel island and pipeline construction would be additional turbidity caused by increases in suspended particles in the water column. Increases in turbidity generally are expected to be considerably less than the 7,500 parts per million suspended solids used in the analysis as an acute (toxic) criterion for water quality; exceptions may occur within the immediate vicinity of the construction activity. Turbidity increases from construction activities generally are temporary and expected to occur during the winter and end within a few days after construction stops. The duration of turbidity from pipe-in-pipe pipeline trenching is expected to be 11 days less compared to Liberty Pipeline (49 days). The overall effects of turbidity are expected to be about 23% less for the pipe-in-pipe pipeline construction compared to the Liberty pipeline construction. Material excavated from the pipeline trench but not used for backfill most likely would be left in an area where active erosion of sediment particles could occur during breakup and open water. This material would be similar in composition to seafloor sediments in the trenching and disposal areas, and its contribution to the future turbidity from waves and currents is expected to be about the same as the sediments existing at the seafloor surface prior to pipeline construction. Construction activities are not expected to introduce or add any chemical pollutants. The effects of discharges are expected to be the same as Alternative I.	**Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances and Discharges:** The greatest effect on water quality from gravel island and pipeline construction would be additional turbidity caused by increases in suspended particles in the water column. Increases in turbidity generally are expected to be considerably less than the 7,500 parts per million suspended solids used in the analysis as an acute (toxic) criterion for water quality; exceptions may occur within the immediate vicinity of the construction activity. Turbidity increases from construction activities generally are temporary and expected to occur during the winter and end within a few days after construction stops. The duration of turbidity from pipe-in-HDPE pipeline trenching is expected to be 4 days less compared to Liberty Pipeline (49 days). The overall effects of turbidity are expected to be about 7% less for the pipe-in-pipe pipeline construction compared to the Liberty Pipeline construction. Material excavated from the pipeline trench but not used for backfill most likely would be left in an area where active erosion of sediment particles could occur during breakup and open water. This material would be similar in composition to seafloor sediments in the trenching and disposal areas, and its contribution to future turbidity from waves and currents is expected to be about the same as the sediments existing at the seafloor surface before pipeline construction. Construction activities are not expected to introduce or add any chemical pollutants. The effects of discharges are expected to be the same as Alternative I.	**Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances and Discharges:** The greatest effect on water quality from gravel island and pipeline construction would be additional turbidity caused by increases in suspended particles in the water column. Increases in turbidity generally are expected to be considerably less than the 7,500 parts per million suspended solids used in the analysis as an acute (toxic) criterion for water quality; exceptions may occur within the immediate vicinity of the construction activity. Turbidity increases from construction activities generally are temporary and expected to occur during the winter and end within a few days after construction stops. The duration of turbidity from trenching of the flexible pipeline is expected to be about 15 days less compared to the Liberty pipeline (49 days). The overall effects of turbidity are expected to be about 31% less for the pipe-in-pipe pipeline construction compared to the Liberty pipeline construction. Material excavated from the pipeline trench but not used for backfill most likely would be left in an area where active erosion of sediment particles could occur during breakup and open water. This material would be similar in composition to seafloor sediments in the trenching and disposal areas, and its contribution to the future turbidity from waves and currents is expected to be about the same as the sediments existing at the seafloor surface before pipeline construction. Construction activities are not expected to introduce or add any chemical pollutants. The effects of discharges are expected to be the same as Alternative I.	**Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances and Discharges:** Same as Alternative I. **Alternative VI** **Use Duck I. Gravel Mine** **Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances and Discharges:** Same as Alternative I. If the Duck Island gravel mine is used as a source of gravel for Liberty Island 600 million gallons of water would have to be pumped from the site before mining could be done. Presently, gravel pit dewatering is authorized in accordance with the Environmental Protection Agency's General National Pollution Discharge Elimination System Permit AKG-31-0000 covering Alaska's North Slope Borough; the permit authorizes the removal of up to 1.5 million gallons per day. If the removal rate were increased, to decrease dewatering time, the permit or Best Management Practices Plan may have to be modified. Water from the mine site is used to construct ice roads. Increasing the mine dewatering rate from 1.5 to 5 million gallons per day most likely would have little, if any, measurable effect on the quality of the receiving waters.	**Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances and Discharges:** The greatest effect on water quality from gravel island and pipeline construction would be additional turbidity caused by increases in suspended particles in the water column. Increases in turbidity generally are expected to be considerably less than the 7,500 parts per million suspended solids used in the analysis as an acute (toxic) criterion for water quality; exceptions may occur within the immediate vicinity of the construction activity. Turbidity increases from construction activities generally are temporary and expected to occur during the winter and end within a few days after construction stops. Pipeline trenching and backfilling would take longer and/or use more equipment than estimated for the Liberty Pipeline buried at a minimum depth of 7 feet. The overall effects of turbidity are expected to be about 98% greater for the 15-foot trench compared to the 10-foot trench. Material excavated from the pipeline trench but not used for backfill most likely would be left in an area where active erosion of sediment particles could occur during breakup and open water. This material would be similar in composition to seafloor sediments in the trenching and disposal areas, and its contribution to the future turbidity from waves and currents is expected to be about the same as the sediments existing at the seafloor surface before pipeline construction. Construction activities are not expected to introduce or add any chemical pollutants. The effects of discharges are expected to be the same as Alternative I.

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<table>
<tr><th colspan="2">Air Quality</th></tr>
<tr><th>Alternative I – Proposed Action</th><th>Alternative III</th></tr>
<tr><td rowspan="4">

Effects of Oil Spills:

Oil spills from the offshore gravel island and the buried pipeline could cause a small, local increase in the concentrations of gaseous hydrocarbons (volatile organic compounds) due to evaporation from the spill. The concentrations of volatile organic compounds would be very low and normally be limited to only 1 or 2 square kilometers (0.4-0.8 square miles). During open-water conditions, spreading of the spilled oil and action by winds, waves, and currents would disperse the Volatile organic compounds so that they would be at extremely low levels (although over a relatively larger area). During broken-ice or melting ice conditions, because of limited dispersion of the oil, the concentrations could reach hazardous levels for several hours, possibly up to 1 day. The effects from a spill occurring under the ice would be similar to but less than those described for broken ice or melting conditions; the oil would be trapped and essentially remain unchanged until the ice began to melt and breakup occurred. Some of the volatile organic compounds, however, would be released from the oil and dispersed, even under the ice. In any of these situations, moderate or greater winds would further reduce the concentrations of volatile organic compounds in the air. Concentrations of criteria pollutants would remain well below Federal air-quality standards. The overall effects on air quality would be minimal.

Effects of Disturbances:

No effects from disturbances to air quality are expected. Impacts to air quality would result from discharges (air emissions).

Effects of Discharges (Air Emissions) on Air Quality

The Liberty Proposal would cause a small, local increase in the concentrations of criteria pollutants. Concentrations would be within the Prevention of Significant Deterioration Class II limits and National Ambient Air Quality Standards. Therefore, the effects would be low. The air-quality analysis is based on the specific emission controls and emission limitations that BPXA would apply to meet the appropriate Environmental Protection Agency regulations. This will include the requirement to use dry, low nitrogen oxide technology for the turbines to reduce emissions further. These controls become part of the proposed project and are written into the permit and, thus, are binding. The use of best available control technology and compliance with the Environmental Protection Agency emission standards is the primary factor in reducing emissions of criteria pollutants (such as nitrogen oxides and sulfur dioxide). BPXA also plans voluntary reduction of greenhouse gases (notably carbon dioxide); this also would result in a slight additional reduction in emissions of other pollutants. These voluntary measures, however, will not be part of the permit and, therefore, are not enforceable. BPXA's Development and Production Plan (BPXA, 2000a), especially Sections 12.3 (p.104) and 6.2.1 (pp. 45-47) have some additional information; their *Part 55 Permit Application for the BP Exploration (Alaska) Inc. Liberty Development Project*, includes a thorough discussion of control measures.

</td><td>Alternative III.A
Southern I./Eastern Pipeline</td></tr>
<tr><td>

Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances and Discharges (Air Emissions):
Same as Alternative I.

</td></tr>
<tr><td>Alternative III.B
Tern I. and Pipeline</td></tr>
<tr><td>

Effects of Oil Spills:
Same as Alternative I.

Effects of Disturbances and Discharges (Air Emissions):
Same as Alternative I.

</td></tr>
</table>

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Air Quality			
Alternative IV	**Alternative V** **Use Sheetpile**	**Alternative VI** **Use Duck I Gravel Mine Site**	**Alternative VII** **Use a 15-Foot Trench Depth**
Alternative IV.A **Pipe-in-Pipe** **Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances and Discharges (Air Emissions):** Same as Alternative I. **Alternative IV.B** **Pipe-in-HDPE** **Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances and Discharges (Air Emissions):** Same as Alternative I. **Alternative IV.C** **Flexible Pipe** **Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances and Discharges (Air Emissions):** Same as Alternative I.	**Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances and Discharges (Air Emissions):** Same as Alternative I.	**Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances and Discharges (Air Emissions):** If the Duck Island gravel mine is used as a source of gravel for Liberty Island, the gravel would need to be hauled about 17.4 miles (28 kilometers), or about 2.7 times farther from the Liberty Island construction sites than the proposed Kadleroshilik mine. The differences in air-quality effects from hauling the gravel from the Duck Island mine site a greater distance than from BPXA's proposed Kadleroshilik mine site would be a slight increase in the fugitive dust from trucks traveling a greater distance and in the air emissions from truck engines operating for a longer period of time. These air emissions would remain at negligible levels and should have no significant effect on regional air quality	**Effects of Oil Spills:** Same as Alternative I. **Effects of Disturbances and Discharges (Air Emissions):** Same as Alternative I.

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Table IV.C-1 Potential Reduction in Boulder Patch Kelp Production due to Suspended-Sediment Plumes from Liberty Construction

	Alternative		
	I Proposal	**III.A Southern Island**	**III.B Tern Island**
Winter Island Construction	0.13%	0.00%	0.00%
Winter Pipeline Construction	4.10%	1.40%	3.90%
Zone 1 or Zone 3 Disposal	2.10%	3.70%	3.70%
Total	6.33%	5.10%	7.60%

Notes: The reductions were estimated with the same process that was used by Ban et. al., (1999), in the report entitled *Liberty Development: Construction Effects on Boulder Patch Kelp Production*. The estimates for the proposal are listed also in Table 3-1 of the report. The estimates for the Southern and Tern alternatives were calculated with the same procedure. The estimates are for percent reductions in kelp production over the entire Boulder Patch during 1 year.

Table IV.C-2 A Comparison of Construction Time by Pipeline Design and Construction Activity

Construction Activity	Construction Time (days)			
	Single-Wall Steel Pipe Alt I	Pipe-in-Pipe Alt IV.A	Pipe-in-HDPE Alt IV.B	Flexible Pipe Alt IV.C
Mobilize Equipment, Material and Workforce	3	3	3	3
Construct Ice Roads	47	56	47	47
Slot Ice for Trench	11	14	11	11
Trenching	49	38	45	34
Preparing Pipeline Makeup Site	37	47	47	37
Welding Pipe Strings	17	48	34	—
Transporting Pipe String	8	10	10	8
Welding Tie-in	10	33	22	9
Installing Offshore Pipeline	35	29	37	30
Backfilling Trench	36	30	44	38
Hydrostatic Testing	5	5	5	5
Demobilizing Equipment	2	2	2	2

Source: INTEC (2000).

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Table IV.D-1 Key Project Element Summary for the Combination Alternatives

	Combination Alternative A	Combination Alternative B	Combination Alternative C	BPXA Proposal (Liberty DPP)
GRAVEL ISLAND				
a. Location	Liberty Island	Southern Island	Tern Island	Liberty Island
b. Upper Slope Protection	Steel Sheetpile	Gravel Bags	Gravel Bags	Gravel Bags
c. Lower Slope Protection – Cement Mats	22,500	16,000	23,500	17,000
d. Amount of Gravel	855,000 cu yd	684,800 cu yd	659,000 cu yd	797,600 cu yd
e. Maximum Footprint Dimension	905' * 1240'	800' * 1110'	925' * 1,260'	835' * 1170'
f. Maximum Footprint Size	25,8 acres	21.9 acres	26.8 acres	22.4 acres
g. Working Surface	345' * 680'	345' * 680'	345' * 680'	345' * 680'
h. Water Depth at Island	22 feet	18 feet	23 feet	22 feet
PIPELINE				
a. Pipe Design	1 Steel pipe in a Steel Pipe	1Steel pipe in HDPE	1 Steel pipe in a Steel Pipe	1 Steel pipe
b. Route	Liberty Route	Eastern Route	Tern Route	Liberty Route
c. Engineering Calculation of Probability of a Spill Larger than 1,000 bbl during project life	0.234%	1.38%	0.234%	1.38%
d. Average Trench Depth /Range in (Feet)	10.5 / (8 -12)	10 / (7.5 - 11.5)	15 feet	10.5 / (8 -12)
e. Quantity of Trench Dredge/ Excavation Material	724,000 cu yd	466,190 cu yd	1,298,095 cu yd	724,000 cu yd
f. Quantity of Trench Backfill Material	724,000 cu yd	466,190 cu yd	1,298,100 cu yd	724,000 cu yd
g. Minimum Burial Depth	7 feet	6 feet	11 feet	7 feet
h. Trench Width	61' X 132'	59' X 126'	120'-152'	61' X 132'
i. Surface Area Disturbed by Trench	59 acres	49 acres	91 acres	59 acres
j. Offshore Length	6.1 miles	4.2 miles	5.5 miles	6.1 miles
k. Onshore Length	1.5 miles	3.1 miles	3.1 miles	1.5 miles
GRAVEL MINE SITE				
a. Location	Duck Island	Kadleroshilik River	Duck Island	Kadleroshilik River
b. Number of Haul Days	90 -120 or use more equipment	40-57	60 -90 or use more equipment	45-60
c. Distance from Island	20 miles	5 miles	21 miles	6 miles

Source: USDOI, MMS, Alaska OCS Region (2000)

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Table IV.D-2 Comparison of Selected Features of the Combination Alternatives

Selected Alternative Attributes	**Combination A** Liberty Island Rte, Pipe in Pipe, Steel sheetpile, Duck Island Gravel, 7-Foot burial Depth	**Combination B** South Island/Eastern Rte, Pipe in HDPE, Gravel Bags, Kadleroshilik River Gravel, 6-Foot burial depth	**Combination C** Tern Island/Tern Rte, Pipe in Pipe, Steel Sheetpile, Duck Is Gravel, 11-Foot Burial Depth	**BPXA Proposal** Liberty Island Rte, Singled walled pipe, Gravel Bags, Kadleroshilik River Mine, 7-Foot burial depth
Distance from bowhead migration	**closest**	**furthest**	**second furthest**	**closest**
Likelihood of disturbance of bowhead whales and subsistence hunting	**low**	**lowest**	**lower**	**low**
Gravel requirement	**855,000 cu yd** (most)	**684,800 cu yd** (3rd most)	**659,000 cu yd** (least)	**797,600 cu yd** (2nd most)
Gravel haul distance	**20 miles** (2nd most)	**5 miles** (least)	**21 miles** (most)	**6 miles** (3rd most)
Use of existing offshore gravel	**None**	**none**	**most**	**none**
Mine wetland habitat destroyed	**Least**	**most**	**least**	**most**
Impacts from gravel bags	**None**	**low**	**none**	**low**
Newly buried ocean bottom (island)	**25.8 acres** (most)	**21.9 acres** (3rd most)	(least)	**22.4 acres** (2nd most)
Temporarily disturbed habitat from pipeline trench	**59 acres** (2nd most)	**49 acres** (least)	**91 acres** (most)	**59 acres** (2nd most)
Length of offshore pipeline deeper than 8-foot water depth	**Least**	**least**	**most**	**least**
Average depth of pipeline trench	**10.5 ft**	**10 ft**	**15 ft**	**10.5 ft**
Distance from Boulder Patch	**1 mile** (closest)	**2.5 miles** (furthest)	**1.5 miles** (2nd furthest)	**1 mile** (closest)
Likelihood of impacts to the Boulder Patch	**Low**	**lowest**	**lower**	**low**
Length offshore pipeline	**6.1 miles** (most)	**4.2 miles** (least)	**5.5 miles** (2nd most)	**6.1 miles** (most)
Length onshore pipeline	**1.5 miles** (least)	**3.1 miles** (most)	**3.1 miles** (most)	**1.5 miles** (least)
Secondary pipeline spill containment	**Yes**	**yes**	**yes**	**no**
Likelihood of pipeline leak offshore	**Lower**	**lowest**	**lowest**	**low**
Likelihood of pipeline leak onshore	**Lower**	**low**	**low**	**lower**
Directional drilling	**Least**	**most**	**most**	**least**
Risk to maximum recovery of oil	**Least**	**most**	**most**	**least**
Costs over the BPXA Proposal	**$51.5 million** (3rd most)	**$24.5 million** (2nd most)	**$59 million** (most)	same
Economic return to BPXA	**second highest**	**third highest**	**least**	**highest**
Economic benefits to Federal and State government	**second highest**	**third highest**	**least**	**highest**

Source: USDOI, MMS, Alaska OCS Region (2000)

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Table IV.D-3 Additional Costs For Component And Combination Alternatives

Task	BPXA Proposal	III.A Southern Island [1]	III.B Tern Island [1]	IV.A Pipe-in-Pipe [2]	IV.B Pipe-in-HDPE [2]	IV.C Flexible Pipe [2]	V Steel Sheetpile	VI Duck Island Gravel Mine	VII Bury Deeper	
	Cost of Component Alternative ($ Millions)									
a. Directional Drilling	76			76	76	76	76	76	76	
b. Pipeline	20			40	34	28	20	20	20	
c. Pipeline Trenching	7			9	8	5	7	7	21	
d. Pipeline Ice Road	4			6	4	4	4	4	6.5	
e. Gravel Transportation	13			13	13	13	13	28	13	
g. Slope Protection/ Island Foundation	29			29	29	29	35	29	29	
h. Mine Site Dewatering	0			0	0	0	0	2.5	0	
i. Mine Site Rehabilitation	0			0	0	0	0	0	0	
j. Other [3]	215			215	215	215	215	215	215	
Total Cost	**364**			**388**	**379**	**370**	**370**	**381.5**	**380.5**	
Total Additional Cost Over BPXA Proposal	**0**	**9.5** [1]	**10** [1]	**24**	**15**	**6**	**6**	**17.5**	**16.5**	
	Additional Cost of Combination Alternative ($ Millions) [4]									*Total Additional Cost Over BPXA Proposal*
A				28 [5]			6	17.5		**51.5** [5]
B		9.5 [1]			15					**24.5** [1]
C			10 [1]	9 [6]			6	17.5	16.5	**59.0** [1,6]
Liberty DPP										**0**

Source: BPXA (2000a), INTEC (2000), Appendix D-1

1 Columns III.A and III.B, and the corresponding totals, reflect the Net Present Value difference for all the costs associated with Island Location and Pipeline Route as calculated by MMS in Table D.1-3, Appendix D-1, Economic Analysis of Alternatives for Net Present Value of Additional Directional Drilling Costs.

2 Columns IV.A, IV.B, and IV.C are from the Pipeline System Alternatives as prepared by INTEC (2000).

3 Other costs include expenditures for Facility Construction, Infrastructure, BPXA Management Overhead, Permitting and Studies, Operating Capital, and Contingency, as provided by BPXA, which do not vary between alternatives.

4 Additional cost over the cost of the BPXA Proposal.

5 This number is adjusted to includes costs ($4 million) associated with the 7-foot burial depth for the Pipe-in-Pipe Design for single season construction as per Table A4-1, INTEC (2000).

6 The $24 million cost for pipe-in-pipe has been adjusted to $9 million for this combination alternative, because the deeper trench depth already includes $16.5 million for additional trenching and ice road maintenance. Therefore, this combination alternative would cost about $59 million.

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Table V.B-1a Alaska North Slope Oil and Gas Discoveries as of August 1, 2000

	Name	Location of Field or Pool	Production Oil, Gas	Location of Production Facility	Discovery	Production Began	Category	Ranking Criteria
				PAST DEVELOPMENT AND PRODUCTION				
1	**South Barrow**	Onshore	Gas	Onshore	1949	1950	Field	
2	**Prudhoe Bay**	Onshore	Oil	Onshore	1967	1977	Field	
3	**Lisburne**	Onshore	Oil	Onshore	1967	1981	Field	
4	**Kuparuk**	Onshore	Oil	Onshore	1969	1981	Field	
5	**East Barrow**	Onshore	Gas	Onshore	1974	1981	Field	
6	**Milne Point**	Onshore	Oil	Onshore	1969	1985	Field	
7	**Endicott**	Offshore	Oil	Offshore	1978	1986	Field	
8	**Sag Delta**	Offshore	Oil	Onshore	1976	1989	Field	
9	**Sag Delta North**	Offshore	Oil	Offshore	1982	1989	Satellite[1]	
10	**Schrader Bluff**	Onshore	Oil	Onshore	1969	1991	Satellite[2]	**When Production Began**
11	**Walakpa**	Onshore	Gas	Onshore	1980	1992	Field	
12	**Pt McIntyre**	Offshore	Oil	Onshore	1988	1993	Field	
13	**N. Prudhoe Bay**	Onshore	Oil	Onshore	1970	1993	Field	
14	**Niakuk**	Offshore	Oil	Onshore	1985	1994	Field	
15	**Sag River**	Onshore	Oil	Onshore	1969	1994	Satellite[3]	
16	**West Beach**	Onshore	Oil	Onshore	1976	1994	Field	
17	**Cascade**	Onshore	Oil	Onshore	1993	1996	Field	
18	**West Sak**	Onshore	Oil	Onshore	1969	1998	Satellite[2]	
19	**Badami**	Offshore	Oil	Onshore	1990	1998	Field	
20	**Eider**	Offshore	Oil	Offshore	1998	1998	Satellite[1]	
21	**Tarn**	Onshore	Oil	Onshore	1991	1999	Field	
22	**Tabasco**	Onshore	Oil	Onshore	1992	1999	Satellite[2]	
23	**Midnight Sun/Sambucca**	Onshore	Oil	Onshore	1998	1999	Satellite[4]	
24	**Alpine**	Onshore	Oil	Onshore	1994	(2000)	Field	
				PRESENT DEVELOPMENT				
25	**Northstar**	Offshore	Oil	Offshore	1984	(2001)	Pool	**When Production Is Expected**
26	**Liberty**	Offshore	Oil	Offshore	1983	(2003)	Pool	
27	**Fiord**	Onshore	Oil	Onshore	1992	(2004)	Pool	
				REASONABLY FORESEEABLE FUTURE DEVELOPMENT AND PRODUCTION				
28	**Meltwater**	Onshore	Oil	Onshore	2000		Prospect	
29	**Nanuk**	Onshore	Oil	Onshore	1996		Prospect	
30	**Kalubik**	Offshore	Oil	Onshore	1992		Prospect	
31	**Pete's Wicked**	Onshore	Oil	Onshore	1997		Prospect	
32	**Sikulik**	Onshore	Gas	Onshore	1988		Pool	
33	**Thetis Island**	Offshore	Oil	Offshore	1993		Prospect	**When we Estimate Chance and Timing of Development (highest/first to lowest/last)**
34	**Gwydyr Bay**	Offshore	Oil	Onshore	1969		Pool	
35	**Mikkelson**	Onshore	Oil	Onshore	1978		Prospect	
36	**Sandpiper**	Offshore	Gas & Oil	Offshore	1986		Pool	
37	**Point Thomson**	Onshore	Gas & Oil	Onshore	1977		Pools	
38	**Sourdough**	Onshore	Oil	Onshore	1994		Pool	
39	**Yukon Gold**	Onshore	Oil	Onshore	1994		Prospect	
40	**Flaxman Island**	Offshore	Oil	Offshore	1975		Prospect	
41	**Stinson**	Offshore	Oil	Offshore	1990		Prospect	
42	**Hammerhead**	Offshore	Oil	Offshore	1985		Pool	
43	**Kuvlum**	Offshore	Oil	Offshore	1987		Prospect	
				SPECULATIVE FUTURE DEVELOPMENT				
44	**Hemi Springs**	Onshore	Oil	Onshore	1984		Prospect	
45	**Ugnu**	Onshore	Oil	Onshore	1984		Pool	
46	**Umiat**	Onshore	Oil	Onshore	1946		Pool	
47	**Fish Creek**	Onshore	Oil	Onshore	1949		Prospect	
48	**Simpson**	Onshore	Oil	Onshore	1950		Pool	
49	**East Kurupa**	Onshore	Gas	Onshore	1976		Show	**Insufficient Information to Estimate Chance of Development**
50	**Meade**	Onshore	Gas	Onshore	1950		Show	
51	**Wolf Creek**	Onshore	Gas	Onshore	1951		Show	
52	**Gubik**	Onshore	Gas	Onshore	1951		Pool	
53	**Square Lake**	Onshore	Gas	Onshore	1952		Show	
54	**E. Umiat**	Onshore	Gas	Onshore	1964		Prospect	
55	**Kavik**	Onshore	Gas	Onshore	1969		Show	
56	**Kemik**	Onshore	Gas	Onshore	1972		Show	

Notes: Field information is taken from State of Alaska, Dept. of Natural Resources (2000a).
Footnotes for Satellites identify the associated production unit: [1]Duck Island Unit; [2]Kuparuk River Unit; [3]Milne Point Unit; [4]Prudhoe Bay Unit.
Parentheses indicate when production startup is expected. **Definitions:** Field—infrastructure (pads/wells/facilities) installed to produce one or more pools. Satellite—a pool developed from an existing pad. Pool—petroleum accumulation with defined limits. Prospect—a discovery tested by several wells. Show—a one-well discovery with poorly defined limits and production capacity.

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Table V.B-1b Trans-Alaska Pipeline System and Future Natural Gas Projects

Name	Estimated Pipeline Length (miles)	Project Description and Route
Active Project		
Trans-Alaska Pipeline (TAPS)	800	TAPS is the key transportation link for all North Slope oil fields. It has been in operation since 1977 and to-date has carried nearly 13 billion barrels of oil. Approximately 16.3 square miles are contained in the pipeline corridor that runs between Prudhoe Bay and Valdez. The Dalton Highway (or Haul Road) was constructed parallel to the pipeline between Prudhoe Bay and Fairbanks. The pipeline design capacity is 2 million barrels per day, and it reached near peak capacity in 1988. Presently, TAPS is running at about 1.0 million barrels per day. The lower operational limit is generally thought to be between 200,000 and 400,000 barrels per day. If oil production from northern Alaska cannot be sustained above this minimum rate, the TAPS system will become nonoperational and all oil production will be shut in.
Future Natural Gas Projects		
Trans-Alaska Gas System (TAGS)	800	The TAGS plan consists of a gas-conditioning plant on the North Slope; an 800 mile, 42 inch, pipeline; a liquefied natural gas (LNG) plant and marine terminal at Valdez; and a fleet of new LNG carriers. LNG would be transported to Japan and other Pacific Rim countries. The Yukon Pacific Corporation has obtained permits for construction of TAGS and export of Alaska North Slope gas to Asia. The LNG facility and marine terminal in Valdez has received the Final EIS prepared by the Federal Energy Regulatory Commission. Yukon Pacific believes the large scale of the project (2.05 billion cubic feet per day to yield 14 million metric tons of LNG annually) will make this project competitive with other new LNG projects. The project is currently stalled by the lack of commitments from the North Slope gas producers, delivery contracts to Asian buyers, and high construction costs ($12-$15 billion).
Alaska Natural Gas Transportation System (ANGTS)[1]	2,102	The ANGTS plan is a pipeline system connecting Alaska North Slope gas production through Canada to the lower 48. The new pipeline would run parallel to TAPS from the North Slope to interior Alaska and then cross the Yukon Territory to connect to existing pipelines in Caroline, Alberta. The primary market would be consumers in the U.S. Numerous permits, rights-of-way, and approvals have been obtained for the proposed pipeline route through Alaska and Canada. The cost of delivery of the gas to market was estimated in the late-1970's to range from $2.82-$4.17 million cubic feet at a total project cost of $16.7 billion. Since then, gas prices in the U.S. have averaged about $2.00 million cubic feet, thus rendering the original project uneconomic. However, downward revisions to construction costs and the recent increase in gas prices into the $3-$4-million-cubic-foot range make this project more appealing today. Currently, several variations to routes are being considered for the overland gas pipeline system.
Arctic Resources, Northern Gas Pipeline Project	326 offshore 874 onshore	The ARC project involves a 42 inch, high pressure gas pipeline running offshore from Prudhoe Bay in Alaska to the Mackenzie delta in the Northwest Territory and then south through the Mackenzie River Valley to the existing gas pipeline network in northern Alberta. The 326 mile offshore portion would be trenched in 30-60 feet of water. The 874 mile onshore portion would also be buried. The estimated project cost is $5.3 MM. It is expected to deliver 2.5 billion cubic feet per day to markets primarily in the U.S. If optimistic construction schedules and costs can be met, the project could provide wellhead net backs to North Slope producers ranging from $1.75 to $1.95 million cubic feet at a gas sales price of $3.00 million cubic feet. The project would involve a consortium of gas producers, pipeline companies, and native corporations in both Alaska and Canada. Commitments of gas producers and gas buyers have not yet been obtained nor have right-of-way permits been issued.
Natural Gas to Liquids Conversion[2]	Will use existing TAPS Pipeline	Atlantic Richfield Co. (ARCO) and Syntroleum Corp constructed a pilot-scale, natural gas to liquids conversion facility in Puget Sound, Washington. More recently, BP-Amoco has begun design work on a GTL pilot project on the Kenai Peninsula in Alaska. As a result of the BP-Amoco-ARCO merger, BP-Amoco now holds an equal interest in the gas reserves in the Prudhoe Bay field. All of the major North Slope gas owners (BP-Amoco, Exxon-Mobil, and Phillips-Alaska) are studying the feasibility of various gas commercialization projects. GTL is an attractive option because it will use the existing TAPS pipeline (extending its life and lowering future tariffs) and produce clean-burning fuels to meet more stringent Environmental Protection Agency emission standards for vehicles. At the present time, the overall cost of a full-scale gas to liquids project is comparable to a similar sized LNG project, both of which are uneconomic under present conditions. As an emerging technology, new cost-reduction breakthroughs are expected for gas to liquids processing, improving the economic potential for future gas to liquids projects .

[1] Thomas et al. (1996). [2] Alaska Report (1997).

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Table V.B-1c Future Lease Sales

Sale	Sale Date(s)	Area/Description	Resources or *Hydrocarbon Potential*
FEDERAL OCS			
176	2000	To Be Determined (TBD)	TBD
5-Year Program	TBD	TBD	TBD
Northeast NPR-A	TBD	As much as 18.6 million acres west of the Northeast NPR-A Planning Area.	0.50-2.2 Bbbl Oil (Estimated)
STATE OF ALASKA			
North Slope Areawide	Oct 2001, Oct 2002, Oct 2003	As much as 5,100,000 acres of State-owned lands between the Canning and Colville Rivers and north of the Umiat Base Line (about 69 20' N).	*Moderate to High*
Beaufort Sea Areawide	Nov 2000, Oct 2001, Oct 2002, Oct 2003	Unleased State-owned tide and submerged lands between the Canadian border and Point Barrow and some coastal uplands acreage located along the Beaufort Sea between the Staines and Colville rivers. The gross proposed sale area is in excess of 2,000,000 acres. The State of Alaska was scheduled to hold its first areawide sale in the Beaufort Sea on October 13, 1999. This sale was delayed pending the outcome of the BP Amoco and ARCO merger and related uncertainties in future lease holdings.	*Moderate to High*
North Slope Foothills Areawide	May 2001	State-owned lands lying between the NPR-A and the Arctic National Wildlife Refuge south of the Umiat Baseline and north of the Gates of the Arctic National Park and Preserve. The gross proposed sale area is in excess of 7,000,000 acres.	*Moderate*

Source: USDOI, MMS, Alaska OCS Region (2000)

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Table V.B-2 Past Development: Production and Reserve Data

Unit or *Area*	Field	Type (Oil or Gas)	Discovery	Production: Began	Production: Gas (BCF)	Production: 1999 Oil (MMbbl)	Production: 1999 Oil Daily Rate (bbl)	Production to	Reserves: Oil (MMbbl)[1]	Reserves: Gas (BCF)
Duck Island	Endicott	O	1973	1987	–	15.009	–	Endicott	201[3]	–
	Sag Delta North[2]	O	1989	1989	–	–[2]	–	Endicott	-	–
	Sag Delta[2]	O	1976	1989	–	–[2]	–	Endicott	-	–
	Eider[2]	O	1998	1998	–	–[2]	–	Endicott	5	–
	Ivishak[2]	O			–	0.216[2]		Endicott		
Prudhoe Bay	Prudhoe Bay	O	1967	1977	–	223.761	–	Prudhoe	2,865	–
	P Bay Satellites	O	–	–	–	–	–	Prudhoe	311	–
	Lisburne	O	1968	1981	–	2.529	–	Lisburne	40	–
	Niakuk	O	1985	1994	–	9.968	–	Lisburne	63	–
	West Beach	O	1976	1994	–	0.670	–	Lisburne	6	–
	N. Prudhoe Bay	O	1970	1993	–	–	–	Lisburne	1	–
	Pt McIntyre	O	1988	1993	–	34.256	–	Lisburne	251	–
Kuparuk River	Kuparuk River	O	1969	1981	–	82.394	–	Kuparuk	960	–
	Tabasco	O	1992	1998	–		–	Kuparuk	27	–
	Tarn	O	1992	1998	–		–	Kuparuk	63	–
	West Sak	O	1969	1998	–		–	Kuparuk	103	–
Milne Point	Milne Point	O	1969	1985	–	17.408	–	Milne Pt.	292[4]	–
	Cascade	O	1993	1996	–	–	–	Milne Pt.	-[4]	–
	Schrader Bluff	O	1969	1991	–	2.178	–	Milne Pt.	105	–
	Sag River	O	1968	1994	–	–	–	Milne Pt.	7	–
Badami	Badami	O&G	1990	1998	–	1.15	–	TAPS	9	–
Colville River	Alpine	O	1994	2000	–	0	0	Kuparuk	429[5]	–
NPR-A[1]	East Barrow	G	1974	1981	0.123	–		Barrow	–	5
	South Barrow	G	1949	1950	0.055	–		Barrow	–	4
	Walakpa	G	1980	1993	1.281	–		Barrow	–	25
All Units or Areas Total									**5,738**	**34**

[1] Unless otherwise indicated, information is from State of Alaska, Dept. of Natural Resources (2000b), [2] AOGCC combined 1999 production volumes for Sag Delta, Sag Delta North and Eider and reported these data in the "Ivishak Pool".
[3] Endicott include Endicott, Sag Delta and Sag Delta North. [4] Case is included in Milne Point. [5] ArRCO (1999) (www.arco.com/news/1999/al0826.html).

Table V.B-3 Past Development: Infrastructure and Facilities

UNIT OR *AREA* Field	Gravel Roads, Pads, & Airstrips (acres)	Pipelines: Gathering, Common Carrier, Unspecified (miles) G	C	U	Gravel Mines Num.	Gravel Mines Acres	Wells[5]	Pads	Reserve Pits Num.	Reserve Pits Acres	Facilities: Prod. Centers	Facilities: Camps Base & Const.	Facilities: Plants: Power Topping Gas Seawater	Facilities: Docks & Cause-ways	Facilities: Airports & Airstrips	Roads (miles)	River Cross-ings
DUCK ISLAND																	
Endicott	392	3	26		1	179	129	2[1]	0	0	0	0[1]	3[1]	2[1]	0[1]	15[1]	1[1]
PRUDHOE BAY																	
Prudhoe Bay	–			145	6	726	1,764	38	106	560	6[1]	4[1]	4[1]	2[1]	2[1]	200[1]	3[1]
Lisburne	213	50	–	–	0	0	80	5[1]	10	16	1[1]	1[1]	1[1]	0[1]	0[1]	18[1]	–
Niakuk	22	5		–	0	0	19		0	0	–	–	–	–	–	–	–
West Beach	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–
N. Prudhoe Bay	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–
Pt. McIntyre	33	12	–	–	0	0	84	–	0	0	–	–	–	–	–	–	–
KUPARUK RIV.																	
Kuparuk River	1,435	97	37		5	564	996	34[1]	126	161	3[1]	2[1]	4[1]	1[1]	1[1]	94[1]	5
West Sak	–	–	–	–	0	0	17		0	0	0	0	0	0	0		0
MILNE POINT																	
Milne Point	205	30	10		1	43	182	4[1]	20	19	1[1]	0[1]	2[1]	0[1]	0[1]	19[1]	1[1]
Cascade	31	–	–	–	0	0	–	–	0	0	–	–	–	–	–	–	–
Schrader Bluff	–	–	–	–	–	–	52	–	–	–	–	–	–	–	–	–	–
Sag River	–	–	–	–	–	–	4	–	–	–	–	–	–	–	–	–	–
BADAMI[2]	85		26	35	1	89	10	2	0	0	1	1	0	1	1	4.5	5
ALPINE	97			34	0	0	150	2	0	0	1	2	–	0	1	3	5
West of Kuparuk																	
Tarn[3]	72.8			10	0-1[4]		16	2	0	0	0	0	0	0	0	10	2
Totals	**7,126**	**197**	**99**	**224**	**14-15**	**1,601**	**3,537**	**89**	**262**	**756**	**13**	**110**	**14**	**6**	**5**	**364**	**22**
NPR-A																	
East Barrow							4										
South Barrow							19										
Walakpa							9										

[1] Eg&G Idaho, Inc. (1991). [2] BPXA (1996). [3] U.S. Army Corps of Engineers, Public Notice of Application for Permit Reference Number 4-970705. [4] The gravel would come from Mine Site F and should be sufficient. However, a future aliquot to the north has already been permitted for expansion necessary, this aliquot may need to be opened to support the project. [5] Alaska Oil and Gas Conservation Commission 1998 Annual Report.

Table V.B-4 Present Development: Estimated Reserve Data

Unit or Area	Field	Type (Oil, Gas)	Discovery	Status	Oil Reserves (MMbbl)
Northstar	Northstar	Oil	1984	Present Development	158 [b]
Colville River	Fiord	Oil	1992	Present Development	50
Liberty	Liberty	Oil	1993	Present Development	120
Total for All Units or Areas					328

[a]ARCO (1999) http:\www.arco.com.news/1999/a10826.htm1. Arco, Anadarko increases reserve production estimates for Alpine Oil Field on Alaska's North Slope. August 26, 1999.
[b] U.S. Army Corps of Engineers (1999).

Table V.B-5 Present Development: Proposed Infrastructure and Facilities

Unit or Area/Field	Gravel Roads, Pads, & Airstrips (acres)	Pipelines (miles)	Gravel Mines		Wells	Pads	Reserve Pits		Facilities					Roads (miles)	River Cross-ings
			Num.	Acres			Num.	Acres	Prod. Centers	Camps Base & Const.	Plants: Power Topping Gas Seawater	Docks & Cause-ways	Airports And Airstrips		
Northstar/Northstar	18+	28	1	36	23	1	0	0	1	1	1	0	0	0	0
Colville River	40	7	1	45	22	1	0	0	0	0	0	0	0	7	0
Liberty/Liberty [a]	16	6.1	1	45	23	1	0	0	1	1	1	0	0	0	0

[a]BPXA (2000a).

Table V.B-6a Reasonably Foreseeable Future Development: Estimated Resources for Purposes of Analysis

Area/Group	Pool	Type (Oil, Gas)	Discovery	Facility Location	Oil Resource (MMbbl)
Western Group	Nanuk	O	1996	Onshore	
	Kalubik	O	1992	Offshore	
	Thetis Island	O	1993	Offshore	250
Central Group (Northstar)	Gwyder Bay	O	1969	Offshore	
	Pete's Wicked	O	1997	Onshore	
	Sandpiper	G&O	1986	Offshore	200
Eastern Group (Badami)	Mikkelson	O	1978	Onshore	
	Sourdough	O	1994	Onshore	
	Yukon Gold		1994	Onshore	
	Pt. Thompson	G&O	1975	Onshore	
	Flaxman Island	O	1975	Offshore	
	Stinson	O	1990	Offshore	
	Hammerhead	O	1985	Offshore	
	Kuvlum	O	1987	Offshore	1,000
Southern Group (KRU)	Meltwater	O	2000	Onshore	50
Total					1,500

Source: USDOI, MMS, Alaska OCS Region

Resource estimates are assumed for purposes of cumulative-effects analysis only. Accurate oil volumes for individual fields generally are unavailable, as these discoveries have not been adequately delineated or studied for their development potential. Most of these discoveries are noncommercial at the present time and will require new technology or higher oil prices to be economic. It is possible that many of these pools will remain undeveloped. Future development likely would occur in conjunction with the infrastructure for the fields shown in parentheses.

Resource estimates for Hemi Springs and Ugnu are not included in the above table, but they are included in the 2.0 billion barrels expected to be produced from satellites, pools, and enhanced recovery in existing fields. Gas resources are not listed because commercial production from the North Slope will require a new gas transportation system to reach outside markets.

The oil volume including the Point Thompson pool is largely condensate recovered with associated gas production wells. We assume that produced gas will be used for field operations (fuel) or be reinjected into reservoirs in nearby oil fields to optimize oil production. Reinjected gas could be recovered at some later date, when a transportation system for North Slope gas is constructed.

Table V.B-6b Reasonably Foreseeable Future Development: Estimated New Infrastructure for Purposes of Analysis

Area/Group	Pads	Footprint (Acres)	Wells	Production Facilities	Base Camps	Docks	Airstrips	Roads	Pipeline (Miles)
Western	4	120	131	1	1	1	0	0	38
Central	3	60	87	0	0	0	0	0	22
Eastern	9	300	320	5	3	2	3	12	125
Southern	1	25	20	0	0	0	0	12	12

Source: USDOI, MMS, Alaska OCS Region

Development Assumptions: (1) Industry will minimize permanent (gravel) roads by using ice roads; (2) new pipelines from satellite fields will tie into pipelines from main fields (Alpine, Northstar, Badami, Kuparuk River); (3) number of pads and wells are estimated from resource volumes; (4) production pad footprints are estimated from pad number, connecting roads, landfall/docks, and airstrips. Hemi Springs and Ugnu are considered to be examples of satellites and enhanced oil recovery, respectively, and will be developed using existing infrastructure of the Prudhoe Bay and Kuparuk River fields.

Table V.B-7a Oil and Gas Production to Date on the North Slope of Alaska

Production To Date	Oil (billions of barrels)	Gas (billions of cubic feet)	Reference
Onshore	12.521	37.23[1,2]	State of Alaska, DNR, 2000b , Historical Oil Production and Historical Gas Production
Offshore	0.403	0	
Total	**12.924**	**37.23**[1.2]	

Source: USDOI, MMS, Alaska OCS Region.

Table V.B-7b Summary of Reserve and Resource Estimates We Use for Analytical Purposes in the Cumulative Analysis

Production Activity	Oil (billions of barrels)	Contribution of Liberty by Volume of Oil (%)	Reference Table
Low End of the Range (Past and Present)	6	2.0	Table III.E-7c
Middle Portion (Past, Present, and Reasonably Foreseeable)	10	1.2	Table III.E-7c
High End (Past, Present, Reasonably Foreseeable, and Speculative)	14	0.8	Table III.E-7c

Source: USDOI, MMS, Alaska OCS Region

For purposes of analysis, oil volumes are rounded to the nearest billion barrels.

Table V.B-7c Detailed Reserve and Resource Estimates We Use for Analytical Purposes in the Cumulative Analysis

Activity	Oil (billions of barrels)	Gas (billions of cubic feet)	Reference Table
Past and Present Production (total)	6.066	34[1]	Table III.E-2
onshore–past (Prudhoe Bay, Kuparuk River, Milne Point, Badami, & Colville River)	5.532	34[1]	Table III.E-4
offshore–past (Duck Island Unit)	0.206		
onshore–present (Fiord)	0.050		
offshore–present (Northstar)	0.158		
Liberty–present	0.120		
Reasonably Foreseeable Future Production (total)	4.156[1]	–[2]	Table III.E-6a
Discovered Onshore	0.550		
Discovered Offshore	0.950		
Undiscovered Onshore	2.300[4]		
Undiscovered Offshore	0.356[4a]		
Speculative Production (total)	3.724	32,800[3]	See Notes Below
Onshore	2.300[5]		
Offshore	1.424[5]		
Total	**13.947**	**32,834**	Tables III.E-1 to 7b

Source: USDOI, MMS, Alaska OCS Region.
Notes: Data as of August 1999.
[1]Gas production to date is from Barrow gas fields supplied for local use to the village of Barrow. [2]Currently, all gas production from existing oilfields is consumed by facilities or reinjected for reservoir pressure maintenance. No gas production is transported and marketed outside of the North Slope. [3]Future production of natural gas assumes that a transportation system eventually will be constructed to move North Slope gas resources to outside markets. All proposed systems are uneconomic under current conditions. [4]Includes 2.0 billion barrels in unnamed satellite fields and from enhanced oil recovery from existing oil fields. Also, 0.300 billion barrels estimated for NPR-A multiple sales under the Preferred Alternative (RDC, 1997). [4a] Includes 20% of the undiscovered resources, from the base case ($18.00) of MMS's 2000 Assessment of Beaufort Sea (totaling 1.780 billion barrels). [5]Includes the remaining portion of the undiscovered offshore resources recoverable at $18.00.

Table V.B-7d Estimates for Speculative Oil and Gas Resources

Area	Oil (billions of barrels)	Gas (trillions of cubic feet)	Study/Source
Beaufort Shelf	1.8–3.2		MMS (2000)–*1*
Northern Alaska	0.6–3.3	—	USGS (1995)–*2*
Beaufort-MacKenzie River Delta	1.0	9.0	NEB (1998)–*3*
Northeast NPR-A	0.5–2.2	—	MMS/BLM (1997)–*4*
Arctic National Wildlife Refuge	2.4–6.3	—	USGS (1998)–*5*
North Slope-State lands	4.0	32.8	Industry–*6*; MMS–*7*
Chukchi Shelf	1.0–6.1	—	MMS (2000)–*1*

Sources: *1*, MMS Update Assessment for 2002-2007 OCS Program. *2*, USGS Circular 1145. *3*, National Energy Board, Canada, Probabilistic Estimates of Hydrocarbon Volumes in the MacKenzie Delta and Beaufort Sea Discoveries. *4*, USDOI, BLM and MMS, 1998. *6*, Informal industry estimates of oil recoverable from enhanced recovery technology and from new small satellite fields near existing North Slope infrastructure. *7*, Discovered but undeveloped gas reserves, mainly associated with existing oil fields (Sherwood and Craig, 2000).

Notes: The resource estimates for the Beaufort Shelf (USDOI, MMS, Alaska OCS Region, 2000) and Northern Alaska (U.S. Geological Survey, 1995) are mean undiscovered volumes that are economically recoverable at oil prices between $18 and $30 per barrel. Economic resources represent a small fraction of the total recoverable petroleum endowment, much of which is in pools too small or too remote to be economic under modeling assumptions. It is impossible to accurately predict the timing of commercial discoveries or future production volumes for speculative resources.   Resource estimates often change with new information or modeling assumptions. For example, a new Geological Survey assessment (1998) reports that more economic oil may occur in the small coastal plain of the Arctic National Wildlife Refuge than previously estimated (U.S. Geological Survey, 1995) for all of Northern Alaska. The economic analysis in Section III.D.5 including Table III.D-5 uses $16 per barrel price for the proposal. The estimates shown above use $18 to $30 as reference prices. Assuming different price ranges is reasonable given the volatility of oil prices. A more optimistic assumption, that is a higher price, is reasonable for the cumulative case.

For the Liberty Proposal, exploration/appraisal is completed and the field is ready for development. For the cumulative case, regional exploration in Arctic Alaska is not complete and development may be delayed long into the undetermined future. The hope for giant oil fields will continue to draw leasing and exploration activities in the future. However, it is unreasonable to speculate on the timing and infrastructure needed to produce resources that have not been discovered. More than 30 trillion cubic feet of gas has been discovered on the North Slope and remains undeveloped due to the lack of a regional transportation infrastructure and market. This huge proven resource base will undoubtedly be produced before major exploration efforts are focused on undiscovered gas resources in other onshore areas or the Beaufort Sea off Alaska.

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Table V.B-8 Seasonal Transportation Access for Projects off the Road System

	Construction Period			Operation/Production Period		
Project	**Summer**	**Breakup**	**Winter**	**Summer**	**Breakup**	**Winter**
LIBERTY [1]						
Aircraft [2]	10-20 daily[3]	10-20 daily	10-20 daily	3 trips weekly [4]	1 trip daily	3 trips weekly [4]
Surface	None	None	400 daily[5]	None	None	100 per season[6]
Marine	150 local round trips + sealift	None	None	4-5 trips per season[7]	None	None
ALPINE[8]						
Aircraft [9]	4-7 trips monthly	N/A	3-6 trips monthly	4 trips monthly or as needed	N/A	4 trips monthly or as needed
Surface	Frequent	N/A	Frequent	Daily	N/A	Daily
Marine	N/A	N/A	N/A	N/A	N/A	N/A
NORTHSTAR[10]						
Aircraft [11]	See footnote [11]	N/A	2,480	See footnote [11]	N/A	7 per month
Surface	See footnote [12]	N/A	35,013 [12]	See footnote [12]	N/A	190 Yearly
Marine	132 trips	N/A	None	5-6 Yearly	N/A	None
BADAMI [13]						
Aircraft	See footnote [13]	See footnote [13]	See footnote [13]	36 weekly during drilling[14]	40 weekly during drilling[14]	2 weekly during drilling [14]
Surface	See footnote [13]	See footnote [13]	See footnote [13]	1 yearly[15]	N/A	30 daily during drilling [16]
Marine	See footnote [13]	See footnote [13]	See footnote [13]	10[17]	N/A	N/A

[1]Liberty construction phase December 1999 through the 4th quarter of 2001; production phase 4th quarter of 2001 until around 2015. [2]All Liberty-related aircraft traffic is calculated as helicopter trips. [3]A maximum figure for summer movement. Transport movements to be shared with work boats. [4]Does not include one helicopter flight per week to inspect the pipeline corridor. [5]Indicates a "worst case" situation. [6]100 per season post drilling, 400 per season during drilling. [7]4-5 trips per month during drilling; 4-5 trips per season post-drilling. [8]For the Alpine Project, summer is defined as April 20 to November 30; the rest of the year is winter. Alpine construction and development drilling phase may last from present to approximately 2005, with the field life estimated at another 15 to 20 years. [9]Aircraft operations calculated for the Alpine project, by Arco contractors, were made on the basis of an amalgamation of three aircraft type: Hercules cargo planes, Twin Otter's and Boeing 737's. [10]The Northstar project should be completed (island construction and development drilling) within 4 years of initiation. The life of the field is projected at 15 years. The transportation requirements indicated here are the construction of the Northstar island in a single season. [11]Data presented in the Northstar Final EIS (US Army Corps of Engineers, 1999) for helicopter transport is not separated out by season. [12]Data presented in the Northstar Final EIS for surface transport is not separated out by season. However, of the presented figure of 35,013 surface transport, 2,775 trips are composed of bus trips and would be primarily involved with the movement of personnel to construction sites. The balance of the surface transport trips are truck traffic. [13]The Badami project has proceeded beyond the construction phase and is now in developmental drilling. [14]For all three periods, 6 aircraft operations will occur weekly after drilling. [15]Planned pipeline inspection via rolligon; emergency use of rolligons not estimated. [16]After drilling, 3 yearly trips planned for pipeline inspection via rolligons; emergency use not estimated. [17]An additional 10 trips are planned in summer of 1998 to support drilling operations.

Table V.B-9 Summary of Cumulative Effects

Resources	Summary of Effects
a. Endangered Species: **Bowhead Whale** **Eiders** **Other Species**	Bowhead whales temporarily may avoid noise-producing activities, and contact with spilled oil could cause temporary, nonlethal effects, and a few could die from prolonged exposure to freshly spilled oil. The Liberty Project's contribution to cumulative effects is expected to be limited to temporary avoidance behavior by a few bowhead whales in response to vessel traffic. If an unlikely large oil spill (greater than or equal to 500 barrels) occurred significant adverse effect would occur to spectacled eiders. Disturbance may cause short-term energy loss when displaced from preferred habitat and a large oil spill could result in significant losses in offshore and nearshore areas. Liberty would be additive to effects from all projects in this cumulative analysis, but only in the case of a large offshore oil spill would Liberty be expected to increase adverse cumulative effects to potentially significant population levels. Oil transportation from Liberty to ports along the U.S. west coast likely would contribute little to cumulative effects on species along transportation routes.
b. Seals and Polar Bears	Ongoing activities that may effect polar bears and seals include disturbance, habitat alteration, and spilled oil. Overall effects (mainly from oil) should last no more than one generation (about 5-6 years) for seals and about 7-10 years for polar bears. Liberty should only briefly and locally disturb or displace a few seals and polar bears. A few polar bears could be temporarily attracted to the production island with no significant effects on the population's distribution and abundance.
c. Marine and Coastal Birds	If an unlikely large oil spill occurred, significant adverse effects would occur to long-tailed ducks and common eiders. Losses could be substantial from a large oil spill contacting offshore staging areas, in lagoons or along beaches during the brief period of exposure. Disturbance from support activities could cause displacement to less favorable foraging areas. Effects of Liberty would be additive to effects observed or anticipated for cumulative projects and, in the case of a large oil spill, could measurably increase adverse effects at the population level in several species.
d. Terrestrial Mammals	About half the Central Arctic Caribou Herd uses coastal habitat adjacent to the Liberty area during summer. Oil development in the Prudhoe Bay area is likely to continue to displace some caribou during the calving season within about 4 kilometers of roads with vehicle traffic. Liberty is expected to contribute less than 1% of the local short-term disturbance of caribou. Liberty should only briefly and locally disturb or displace a few muskoxen and grizzly bears.
e. Lower Trophic Organisms	Effects of additional drilling discharges, construction-related activities and oil spills are not expected to substantially affect organisms near Liberty island or elsewhere. Liberty is not expected to make a measurable contribution to the cumulative effects on these organisms.
f. Fishes	Small numbers of fish in the immediate area of an offshore or onshore oil spill may be killed or harmed, but this would not have a measurable effect on fish populations. Marine and migratory fishes are widely distributed in the Beaufort Sea and are not likely to be affected by the Liberty Project. Oil is not expected to contact overwintering areas during winter. Hence, the Liberty Project is not expected to contribute measurably to the overall cumulative effect on fishes.

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Table V.B-9 Summary of Cumulative Effects (continued)

Resources	Summary of Effects
g. Vegetation-Wetland Habitats	Construction causes more than 99% of the effects, with spills having a very minor role. Rehabilitation of gravel pads can result in the growth of grasses-sedges within 2 years after abandonment of the pads. Natural growth of plant cover would be very slow. Liberty would contribute less than 1% of the cumulative disturbance effects on 9,000 acres now affected by oil development.
h. Subsistence-Harvest Patterns	In the past, drilling and seismic activity near the bowhead whale migration route has made subsistence whaling more difficult, and if a large oil spill occurred, subsistence harvests in Nuiqsut and Kaktovik could be affected with one or more important subsistence resources becoming unavailable or undesirable for use for 1-2 years, a significant adverse effect. Liberty is expected to have periodic effects on subsistence resources, but no harvest areas would become unavailable for use and no resource population would experience an overall decrease.
i. Sociocultural Systems	Past and present development of oil and gas and other projects have had negative effects on North Slope communities by producing conflicts to traditional lifestyles and straining social and health service providers. At the same time, tax revenues from past oil and gas development have also produced positive effects that include increased funding for infrastructure, higher incomes (that can be used to purchase better tools for subsistence), better health care, and improved educational facilities. Liberty development could produce periodic disturbance effects to communities near the Liberty Project but would not displace any sociocultural systems, community activities, or traditional practices.
j. Archaeological Resources	Liberty's contribution to cumulative effects and the cumulative effects overall are expected to be minimal for archaeological resources, because any surface-disturbing activities that could damage archaeological sites would be mitigated by current State and Federal procedures.
k. Economy	This cumulative analysis projects employment increases as follows: 2,400 direct oil industry jobs at peak, declining to 1,300; about 3,400 indirect jobs at peak, declining to 2,000; about 150 jobs for North Slope Borough residents at peak, declining to 50; about 5-125 jobs for 6 months for cleanup of an oil spill in the Beaufort Sea; and about 10,000 jobs and 25% price inflation for 6 months for cleanup of a tanker oil spill in the Gulf of Alaska. This cumulative analysis projects annual revenues as follows: $125 million Federal, $77 million State, and $28 million for the State and North Slope Borough. Liberty's contribution to the cumulative effects above is between 3% and 36%.
l. Water Quality	A large crude or refined oil spill (greater than or equal to 500 barrels) would have a significant effect on water quality by increasing the concentration of hydrocarbons in the water column to levels that greatly exceed background concentrations; however, the chance of a large spill occurring is low. Also, regional (more than 1,000 square kilometers – 386 square miles), long-term (more than 1 year) degradation of water quality to levels above State and Federal criteria because of hydrocarbon contamination is very unlikely. Resuspended sediments from construction activities are not expected to exceed acute water-quality criteria and permitted discharges will be designed to ensure rapid mixing and dilution of the discharge. The effects from the Liberty Project from construction activities are expected to be short term, lasting as long as the individual activity, and have the greatest impact in the immediate vicinity of the activity.
m. Air Quality	Projects in the past and present now have caused essentially no deterioration in air quality or contribute measurably to global climate change. Air emissions from the Liberty Project essentially would have no effects on air quality.

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Table VI.A-1 Breeding Season Nest and Bird Densities for Selected Species in the Kadleroshilik River Area in 1994

Species	Breeding Season (Nests) [2]	Breeding Season [3]	Brood-Rearing Season [3]	Post-Breeding Season [3]	9-13 June [4]	11-18 July [4]	17-23 August [4]
Red-Throated Loon	0.0	0.5	0.4	0.2	0.3	1.0	0.0
King Eider	0.7	1.8	0.3	1.0	0.7	1.7	1.7
Oldsquaw	1.3	8.1	1.2	---	10.7	5.0	0.0
Lesser Golden-Plover	1.7	3.8	4.1	3.8	7.3	2.0	3.7
Semi-Palmated Sandpiper	9.0	19.9	6.7	0.2	27.3	8.0	0.0
Pectoral Sandpiper	12.0	28.3	20.0	41.0	42.0	23.3	29.0
Dunlin	4.0	9.2	5.9	5.8	10.0	9.0	7.0
Stilt Sandpiper	1.3	4.7	1.1	0.0	5.7	4.0	0.0
Red-Necked Phalarope	3.3	14.0	4.8	1.2	19.0	8.3	1.0
Red Phalarope	7.7	12.5	3.6	0.7	19.7	4.0	0.7
Lapland Longspur	25.0	65.3	35.6	52.7	82.0	34.0	50.3

[1] Source: TERA (1995b) [2] Density, nests/km^2 [3] Average density, birds/km^2 [4] Density, birds/km^2

Table VI.B-1 Resources Used in Barrow, Kaktovik, and Nuiqsut

Species	Inupiaq Name	Scientific Name	Location B[1]	K[2]	N[3]
Marine Mammals					
Bearded seal	*Ugruk*	Erignathus barbatus	√	√	√
Ringed seal	*Natchiq*	Phoca hispida	√	√	√
Spotted seal	*Qasigiaq*	Phoca largha	√	√	√
Ribbon seal	*Qaigulik*	Phoca fasciata	√		
Beluga whale	*Quilalugaq*	Delphinapterus leucas	√	√	
Bowhead whale	*Agviq*	Balaena mysticetus	√	√	√
Polar bear	*Nanuq*	Ursus maritimus	√	√	√
Walrus	*Aiviq*	Odobenus rosmarus	√	√	
Terrestrial Mammals					
Caribou	*Tuttu*	Rangifer tarandus	√	√	√
Moose	*Tuttuvak*	Alces alces	√	√	√
Brown bear	*Aklaq*	Ursus arctos	√	√	√
Dall sheep	*Imnaiq*	Ovis dalli	√	√	√
Musk ox	*Uminmaq*	Ovibus moschatus		√	√
Arctic fox (Blue)	*Tigiganniaq*	Alopex lagopus	√	√	√
Red fox [4]	*Kayuqtuq*	Vulpes fulva	√	√	√
Porcupine	*Qinagluk*	Erethizon dorsatum	√		
Ground squirrel	*Siksrik*	Spermophilus parryii	√	√	√
Wolverine	*Qavvik*	Gulo gulo	√	√	√
Weasel	*Itigiaq*	Mustela erminea		√	√
Wolf	*Amaguk*	Canis lupus	√	√	√
Marmot	*Siksrikpak*	Marmota broweri		√	√
Fish					
Salmon (ns)			√	√	√
Chum	*Iqalugruaq*	Oncorhynchus keta	√		√
Pink (humpback)	*Amaqtuuq*	Oncorhynchus gorbuscha	√	√	√
Silver (coho)	*Iqalugruaq*	Oncorhynchus kisutch		[5]	
King (chinook)		O. tshawytscha			
Sockeye (red)		Oncorhynchus nerka			
Whitefish (ns)	*Aanaakliq*	Coregonus sp.	√	√	
Round w.f.	*Aanaakliq*	Prosopium cylindraceum	√		
Broad w.f.	*Aanaakliq*	Coregonus nasus	√	√	√
Humpback w.f.	*Pikuktuuq*	Coregonus clupeaformis	√		√
Least cisco	*Iqalusaaq*	Coregonus sardinella	√	√	√
Bering,Arctic cisco	*Qaaktaq*	Coregonus autumnalis	√	√	√
Other f.w. fish					
Arctic grayling	*Sulukpaugaq*	Thymallus arcticus	√	√	√
Arctic char	*Iqalukpik*	Salvelinus alpinus	√	√	√
Burbot (Ling cod)	*Tittaaliq*	Lota lota	√	√	√
Lake trout	*Iqaluaqpak*	Salvelinus narnaycush	√	√	√
Northern pike	*Siulik*	Esox lucius	√		
Fish (continued)					
Other coast. fish					
Capelin	*Pagmaksraq*	Mallotus villosus	√		
Rainbow smelt	*Ilhuagniq*	Osmerus mordax	√		√
Arctic cod	*Iqalugaq*	Boreogadus saida	√	√	√
Tomcod	*Uugaq*	Eleginus gracilis	√	√	
Flounder (ns)	*Nataagnaq*	Liopsetta glacialis		√	
Birds					
Snowy owl	*Ukpik*	Nyctea scandiaca			√
Red-throated loon	*Qaqsraupiagruk*	Gavia stellata	√		
Tundra swan	*Qugruk*	Cygnus columbianus		√	√
Eider					
Common eider	*Amauligruaq*	Somateria mollissima	√	√	√
King eider	*Qinalik*	Somateria spectabilis	√	√	√
Spectacled eider	*Tuutalluk*	Somateria fischeri	√		
Steller's eider	*Igniqauqtuq*	Polysticta stelleri	√		
Other ducks (ns)	*Qaugak*		√	√	
Pintail	*Kurugaq*	Anas acuta		√	
Oldsquaw	*Aaqhaaliq*	Clangula hyemalis	√	√	
Surf scoter	*Aviluktuq*	Melanitta perspicillata	√		
Goose					
Brant	*Niglingaq*	Branta bernicla n.	√	√	√
White-fronted g.	*Niglivialuk*	Anser albifrons	√	√	√
Snow goose	*Kanuq*	Chen caerulescens	√	√	√
Canada goose	*Iqsragutilik*	Branta canadensis	√	√	√
Ptarmigan (ns)	*Aqargiq*	Lagopus sp.	√	√	√
Willow ptarmigan	*Nasaullik*	Lagopus lagopus	√		
Other resources					
Berries (ns)			√	√	√
Blueberry	*Asiaq*	Vaccinium uliginosum	√		
Cranberry	*Kimminnaq*	Vaccinium vitis-idaea	√		
Salmonberry	*Aqpik*	Rubus spectabilis	√		
Bird eggs (ns)	*Mannik*		√	√	
Gull eggs				√	
Geese eggs				√	
Eider eggs			√	√	
Greens/roots (ns)			√	√	√
Wild rhubarb	*Qunulliq*	Oxyric digyna	√		
Wild chives	*Quagaq*	Allium schoenoprasum	√		
Clams	*Imaniq*		√		
Wood				√	√
Fresh water	*Imiq*		√		
Fresh water ice	*Sikutaq*		√		
Sea ice	*Siku*		√		

Sources: Stephen R. Braund and Assocs. and University of Alaska, Anchorage, Institute of Social and Economic Research (1993); Pedersen (1995a,b); Stephen R. Braund and Assocs. (1996).

Footnotes: [1] B, Barrow, resources used 1987–1990. [2]K, Kaktovik, resources used 1992–1993. [3]N, Nuiqsut, resources used 1993. [4]Red fox (Cross, Silver) [5]Harvest of silver, king, and sockeye salmon is rare.

Note: An unchecked box may mean a resource was not used or, especially in the case of "Other Resources," the resource might have been used but use was reported as "berries" rather than "blueberries," for example.

Abbreviations: ns, nonspecified; w.f., whitefish; f.w., freshwater; coast., coastal.

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Table VI.B-2 Proportion of Inupiat Household Food Obtained from Subsistence Activities, 1977, 1988, and 1993 (proportion is measured in percent)

	All Communities of the North Slope Borough		
Proportion	**1977**	**1988**	**1993**
None	13	20	18
Less Than Half	42	31	25
Half	15	14	15
More Than Half	30	35	42

Source: Harcharek (1995).

Table VI.B-3 Participation in Successful Harvests of Selected Resources (percentage of households per resource)

	Barrow[1]	Nuiqsut[2]	Kaktovik[3]
Total	87 %	90 %	89 %
Marine mammals	76	37	40
Terrestrial mammals	77	76	68
Fish	60	81	81
Birds	65	76	64
Marine mammals			
Bowhead whale	75 %	5 %	6 %
Walrus	29	0	2
Bearded seals	46	7	28
Ringed seals	19	31	26
Spotted seals	1	2	4
Polar bear	7	2	4
Terrestrial mammals			
Caribou	77 %	74 %	55 %
Moose	7	10	6
Brown bear	0	8	0
Dall sheep	3	0	28
Wolverine	1	16	13
Arctic Fox	5	13	15
Red Fox	*	23	11
Fish			
Whitefish (all species)	54 %	74 %	70 %
Grayling	21	65	15
Arctic Char	5	31	79
Salmon (all species)	16	36	9
Burbot	10	57	0
Birds			
Geese	40 %	73 %	47 %
Eiders	52	36	38
Ptarmigan	26	45	57

All numbers are percentages.
Sources: Stephen R. Braund and Assocs. and University of Alaska, Anchorage, Institute of Social and Economic Research (1993); Pedersen (1995a,b); Stephen R. Braund and Assocs. (1996).
Notes: Dates resources used: [1]1987–1990. [2]1993. [3]1992–1993.
*Represents less than 0.1%.

Table VI.B-4 Percent of Total Subsistence Resources Consumed and Total/Per Capita Harvests

	Barrow (%)		Nuiqsut (%)		Kaktovik (%)	
Resource	**1962-82[1]**	**1989**	**1993**	**1994-95**	**1962-82**	**1992**
Bowhead Whale	21.3	38.7	28.7	0	27.5	63.2
Caribou	58.2	22.2	30.6	58	16.2	11.1
Walrus	4.6	8.9	0	—	3.2	— *
Bearded Seal	2.9	2.1	0.3	—	7.4	2.4
Hair Seals	4.3	1.6	2.7	2 [2]	4.1	1.0
Beluga Whales	0.5	0.	0	—	6.2	0.
Polar Bears	0.3	2.2	0.	—	2.8	0.7
Moose	0.3	2.2	1.6	5	3.5	1.1
Dall Sheep	0	0.1	0	—	3.8	2.5
Muskox	—	—	0	—	—	
Small Land Mammals	0.1	— *	— [3]	— [3]	0.4	— *
Birds[4]	0.9	3.3	1.5	5	0.4	1.9
Fishes	6.6	7.8	33.7	30	21.7	13.4
Vegetation	—	0.1	1.4	— *	—	0.1
Total Harvest (lb)	**928,205**	**872,092**	**160,035**	**267,818**	**32,408**	**170,939**
Per Capita Harvest (lb)	**540**	**289.16**	**399.19**	**741.75**	**219**	**885.60**

Source: Stoker, 1983, as cited by ACI/Braund (1984); Stephen R. Braund & Associates (1989b); State of Alaska, Dept. of Fish and Game (1995a).

Notes: [1] Averaged for the period.
[2] Represents all marine mammals harvested in 1994-95: 1 polar bear and 35 ringed seals.
[3] Not harvested for food. [4] Birds and eggs. [5] Not calculated in report. *Represents less than 0.1 percent.

Table VI.B-5 Nuiqsut 1993 Subsistence-Harvest Summary for Marine Mammals, Terrestrial Mammals, Fish, and Birds

		Edible Pounds Harvested		
	Total Number Harvested	Total	Household Harvest Mean	Per capita
Marine Mammals				
Total Marine Mammals	113	85,216	936.44	236.01
Bowhead Whale	3	76,906	845.12	213.00
Polar Bear	1 *	0	0.00	0.00
Bearded Seal	6	1,033	11.35	2.86
Ringed Seal	98	7,277	79.96	20.15
Spotted Seal	4 *	0	0.00	0.00
Terrestrial Mammals				
Large Land Mammals	691	87,306	959.40	241.80
Brown Bear	10 *	734	8.06	2.03
Caribou	672	82,169	902.95	227.57
Moose	9	4,403	48.38	12.19
Muskox	0	0	0.00	0.00
Dall Sheep	0	0	0.00	0.00
Small Land Mammals/Furbearers	599 §	84	0.92	0.23
Arctic Fox	203	0	0.00	0.00
Red Fox	63	0	0.00	0.00
Marmot	0	0	0.00	0.00
Mink	0	0	0.00	0.00
Parka Squirrel	336	84	0.92	0.23
Weasel	10	0	0.00	0.00
Wolf	31	0	0.00	0.00
Wolverine	19	0	0.00	0.00
Fishes				
Total Fish	71,897	90,490	994.39	250.62
Total Salmon	272	1,009	11.08	2.79
Total Nonsalmon	71,626	89,481	983.30	247.83
Smelt	304	42	0.46	0.12
Cod	62	7	0.07	0.02
Burbot	1,416	5,949	65.37	16.48
Char	618	1,748	19.20	4.84
Grayling	4,515	4,063	44.65	11.25
Total Whitefish	64,711	77,671	853.53	215.12
Cisco	51,791	34,943	383.98	96.78
Arctic Cisco	45,237	31,666	347.97	87.70
Least Cisco	6,553	3,277	36.00	9.08
Birds				
Total Birds and Eggs	3,558	4,325	47.53	11.98
Migratory Birds	2,238	3,540	38.90	9.80
Ducks	772	1,152	12.66	3.19
Eider	662	1,059	11.63	2.93
Geese	1,459	2,314	25.43	6.41
Brant	296	356	3.91	0.99
Canada Geese	691	830	9.11	2.30
White Fronted	455	1,092	12.00	3.02
Swan	7	73	0.80	0.20
Ptarmigan	973	681	7.48	1.89

Number of households in the sample = 62; number of households in the community = 91.
Source: ADF&G, Community Profile Database (1995b).
Footnotes: *Not eaten. §Some not eaten.

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Table VI.B-6 Subsistence Harvest by Month for Nuiqsut, July 1, 1994, to June 30, 1995

	1994						1995						Total	Est.Total
Item	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**71 HH's**	**83 HH's**
Arctic Char	0	8	0	0	0	0	0	0	0	0	0	0	8	8
Arctic Cisco[1]	0	0	37	5,737	2,400	1,050	262	0	0	0	0	0	9,486	9,842
Broad Whitefish	1,535	25	75	855	500	0	0	0	0	0	0	130	3,120	3,237
Burbot	0	0	0	9	76	3	0	0	0	0	0	0	88	91
Fish Unidentified	0	0	0	0	0	0	0	0	0	0	0	75	75	78
Grayling	0	24	225	110	84	0	0	0	0	0	0	2	445	462
Humpback Salmon	10	0	0	0	0	0	0	0	0	0	0	0	10	10
Humpback Whitefish[1]	0	0	0	150	25	0	0	0	0	0	0	0	175	182
Least Cisco	0	0	0	0	0	750	0	0	0	0	0	0	750	778
Northern Pike	0	0	0	0	0	0	0	0	0	0	0	18	18	19
Whitefish Unidentified	0	0	0	50	425	0	0	0	0	0	0	0	475	493
Caribou	63	32	6	80	13	4	9	5	13	7	2	15	249	258
Moose	1	1	1	1	0	0	1	0	0	0	0	0	5	5
Wolf	0	0	0	0	1	1	3	0	12	1	0	0	18	19
Wolverine	0	0	0	0	1	1	2	1	1	2	0	0	8	8
Arctic Fox	0	0	0	0	0	1	1	1	3	0	0	0	6	6
Fox Unidentified	0	0	0	0	4	0	0	0	0	0	0	0	4	4
Red Fox	0	0	0	0	0	1	1	1	1	1	0	0	5	5
Polar Bear	0	0	0	0	1	0	0	0	0	0	0	0	1	1
Tundra Swan	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Geese Unidentified	0	0	0	0	0	0	0	0	0	0	409	48	457	474
Eider Unidentified	0	0	0	0	0	0	0	0	0	0	50	40	90	93
Ptarmigan	0	0	0	0	0	0	0	0	0	33	23	0	56	58
Sandhill Crane	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Ringed Seal	2	10	0	0	0	0	0	0	0	6	0	5	23	24
Salmonberries (gal)	0	9	0	0	0	0	0	0	0	0	0	0	9	9
Cranberries (gal)	0	0.5		0	0	0	0	0	0	0	0	0	0.5	1
Blueberries (gal)	0	2.5		0	0	0	0	0	0	0	0	0	2.5	3
Blackberries (gal)	0	0.5		0	0	0	0	0	0	0	0	0	0.5	1

Source: Brower and Opie (1997); Brower and Hepa (1998).
Notes: HH=Households. [1]The harvest of arctic cisco and humpback whitefish is under represented: one household provided evidence of a significant but unquantifiable harvest by saying that "sled loads" were harvested "every couple of days during October and November."

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Table VI.B-7 North Slope Borough Employment by Industry 1990-1998

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Total Industries	9,185	9,208	8,400	8,823	9,570	9,114	9,149	9,102	9,404
Mining	5,126	5,018	4,411	4,213	4,617	4,436	4,431	4,158	4,753
Construction	373	484	387	361	623	415	344	354	371
Manufacturing	0	0	0	0	0	2	3	7	8
Trans.,Comm., & Util.	362	364	241	238	378	403	428	440	435
Wholesale Trade	0	0	0	0	0	0	0	0	0
Retail Trade	252	205	213	487	522	481	524	540	567
Finance, Ins., R.E.	183	177	167	166	166	145	143	175	177
Services	976	1,031	1,008	1,308	949	804	890	1,046	1,035
Government	1,901	1,929	1,964	2,040	2,315	2,428	2,385	2,293	2,068
Federal	107	98	78	57	70	78	43	38	28
State	32	64	60	59	58	58	57	52	56
Local	1,762	1,767	1,827	1,925	2,187	2,293	2,286	2,204	1,983
Miscellaneous	0	0	5	0	0	0	1	1	1
Total Less Mining	4,059	4,190	3,989	4,610	4,953	4,678	4,718	4,854	4,651

Source: Alaska Department of Labor and Workforce Development, Research and Analysis Section.

Table VI.B-8 Employment Estimates (in Thousands)

	1995	1996	1997	1998	1999
Anchorage – Matsu Region	131	132	135	141	144
Kenai Peninsula Borough	16	16	16	17	17
Fairbanks North Star Borough	31	31	32	33	33
Total	178	179	183	191	194

Source: Alaska Department of Labor and Workforce Development, Research and Analysis Section.

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Table VI.C-1 Quaternary Marine Transgressions

Transgression	Shoreline	Age	Correlation	
			North America	Europe
Krusensternian	Within 2 m of present	Approx 5,000 years	Late Wisconsin Retreat/Late Flandrian	Late Würm and Recent
Woronzofian	2-5 m below present	25,000 to 48,000 years	Middle Wisconsin interstade	Middle Würm interstade
Pelukian	7-10 m above present	Ca. 100,000 years	Sangamon Interglacial	Broerup Interstade (?) and Riss Würm Interglaciation
Wainwrightian	20-25 m above present	158,000-540,000 years	Pre-Illinoian interglacial	Mindel-Riss Interglaciation
Fishcreekian	25-35 m above present	1,500,000-2,480,000 years	Late Pliocene-Early Pleistocene	
Bigbendian	35-60 m above present	>2,400,000 years	Late Pliocene	Early Pleistocene
Colvillian	40-60 m above	<3,500,000 years	Late Pliocene	

Source: After Hopkins (1967) and Dinter et al. (1990).

Table VI.C-2 Late Pleistocene Regressive Events

Age	Shoreline	Correlation
13,000 yrs before present	approximately 50 m below present	Beginning of Krusensterian Transgression
18,000 yrs before present	approximately 90 m below present	Beginning of Flandrian Transgression

Source: From Hopkins (1967).

Table VI.C-3 Trace Metal Concentrations in Beaufort Sea Sediments and Waters

Area	Arsenic (As)	Chromium (Cr)	Mercury (Hg)	Lead (Pb)	Zinc (Zn)	Cadmium (Cd)	Barium (Ba)	Copper (Cu)	Nickel (Ni)	Vanadium (V)
			Sediments (ppm)							
Nearshore, Lagoons, and Bays[1]	—[2]	17–19	0.02–0.09[3]	3.9–20	19–116	0.04–0.31	185–745	4.9–37	334	33–153
Nearshore, Lagoons, and Bays[19]	—	67–219 96±23	—	3.9–23.2 11±4	77–134 109±13	0.06–0.29 0.16±0.06	309–1,112 651±117	14.3–38.1 23±4	—	80–229 115±30
Shelf[5]	16–23[6]	85[4]	0.03–0.16[7]	3[8]	98	0.2[7]	—	57	47	140[4]
Slope and Abyssal[8]	55[6] 2[9]	99[9]	0.07–0.17[7]	—	82	—	—	59	56	19
Northstar[20]	7.1	16.6	—	—	—	—	63	—	—	—
Average Liberty Pipeline Routes[12]	5.5	18.5	—	10.1	—	—	67.5	—	—	—
	5.5	12.2	0.035	5.36	—	—	44.8	—	—	—
Foggy Island Bay[19]	—	87±9.70	—	9.11±2.91	110±12	0.14±0.03	620±47	23±2.20		160±20
Suspended Sediments (ppm of dry weight)[13]	—	21–140	—	—	8–232	—	—	5–83	10–100	2–307
Average World Coastal Ocean[8]	—	10–100	0.01–0.07[10]	2–20	5–200	0.2–3.0	60–1,500[11]	5–40	16–47[11]	130[9]
			Effects Range[21] (ppm)							
Effects Range — Low*	33.0	80.0	0.15	35.0	120	5.0	—	70.0	30.0	—
Effects Range — Median*	85.0	145.0	1.3	110.0	270	9.0	—	390.0	50.0	—
			Water (ppb)							
Total[13]	—	0.1–2.1	0.005–0.57[7]	—	0.4–3.7[14]	—	—	0.4–2.1	—	—
Dissolved[8]	—	0.02–0.3	0.008–0.032[15]	0.02–1.7	0.2–3.4	0.02–0.11	—	0.3–1.8	—	—
Typical Worldwide Marine Total[16]	1.35–2.5[17]	0.3	0.001[18]	0.01	1	0.04	—	0.3	0.3	—

Source: Minerals Management Service, 1996.
Notes: *The Effects Range-Low (ERL) is defined as the concentration of a substance in the sediment that results in an adverse biological effect in about 10 percent of the test organisms, and the Effects Range-Median (ERM) is defined as the concentration of a substance that affects 50% of the test organisms.

1 Boehm et al. (1987).
2 No data.
3 Northern Technical Services (1981b), Weiss et al. (1974).
4 Naidu, 1982, cited in USDOI, MMS (1996a).
5 Naidu (1974).
6 Robertson and Abel (1979).
7 Weiss et al. (1974).
8 Thomas (1988).
9 Naidu et al. (1980).
10 Nelson et al. (1975) (for central Bering Shelf and Chukchi Sea).
11 Chester (1965).
12 Upper row—Montgomery Watson (1997). Lower row–Montgomery Watson (1998).
13 OCSEAP data, NODC/NOAA data bank.
14 Burrell et al. (1970).
15 Guttman, Weiss and Burrell (1978) (for Chukchi and Beaufort Seas).
16 Berhard and Andreae (1984).
17 Burton and Statham (1982) in Langston (1990).
18 Gill and Fitzgerald 1(985).
19 Boehm et al.(1990).
20 Montgomery Watson (1996).
21 Long and Morgan (1990).

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Table VI.C-4 Ambient-Air-Quality Standards Relevant to the Liberty Project
(Measured in $\mu g/m^3$; an asterisk [*] indicates that no standards have been established.)

Pollutant[1]	Annual	24 hr	8 hr	3 hr	1 hr	30 min
	Averaging Time Criteria					
Total Suspended Particulates [2]	60 [3]	150	*	*	*	*
Class II [4]	19 [3]	37	*	*	*	*
Carbon Monoxide	*	*	10,000	*	40,000	*
Ozone [5]	*	*	*	*	235 [6]	*
Nitrogen Dioxide	100 [7]	*	*	*	*	*
Class II [4]	25 [7]	*	*	*	*	*
Inhalable Particulate Matter (PM10) [8]	50 [9]	150 [10]	*	*	*	*
Class II [4]	17	30	*	*	*	*
Lead	1.5[11]	*	*	*	*	*
Sulfur Dioxide	80 [7]	365	*	1,300	*	*
Class II [4]	20 [7]	91	*	512	*	*
Reduced Sulfur Compounds [2]	*	*	*	*	*	50

Source: State of Alaska, Dept. of Environmental Conservation(1982), 80, 18, AAC, 50.010, 18 AAC 50.020; 40 CFR 52.21 (43 FR 26388); 40 CFR 50.6 (52 FR 24663); 40 CFR 51.166 (53 FR 40671).
Footnotes: [1]All-year averaging times not to be exceeded more than once each year, except that annual means may not be exceeded. [2]State of Alaska air-quality standard (not national standard). [3]Annual geometric mean. [4]Class II standards refer to the PSD Program. The standards are the maximum increments in pollutants allowable above previously established baseline concentrations. [5]The State ozone standard compares with national standards for photochemical oxidants, which are measured as ozone. [6]The 1-hour standard for ozone is based on a statistical, rather than a deterministic, allowance for an "expected exceedance during a year." [7]Annual arithmetic mean. [8]PM10 is the particulate matter less than 10 micrometers in aerodynamic diameter. [9]Attained when the expected annual arithmetic mean concentration, as determined in accordance with 40 CFR 50 subpart K, is equal to or less than 50 $\mu g/m^3$. [10]Attained when the expected number of days per calendar year with a 24-hour average concentration above 150 $\mu g/m^3$, as determined in accordance with 40 CFR 50, subpart K, is equal to or less than 1. [11]Maximum arithmetic mean averaged over a calendar quarter.

Table VI.C-5 Measured-Air-Pollutant Concentrations at Prudhoe Bay, Alaska 1986-1996
(Measured in $\mu g/m^3$; absence of data is indicated by asterisks [**].)

Pollutant[1]	A[2]	B[3]	C[4]	D[5]	National Standards[6]	Class II Increments[7]
	Monitor Sites					
Ozone						
Annual Max. 1 hr	115.8	180.3	115.6	100.0	235	**
Nitrogen Dioxide						
Annual	26.3	11.9	16.0	4.9	100	25
Inhalable Particulate Matter (PM10)						
Annual	**	**	10.5	**	50	17
Annual Max. 24 hr	29.3	**	25.0 [8]	**	150	30
Sulfur Dioxide						
Annual	2.6	**	5.2	2.6	80	20
Annual Max. 24 hr	10.5	**	26.2[8]	13.1	365	91
Annual Max. 3 hr	13.1	**	44.5	55.0	1,300	512
Carbon Monoxide						
Annual Max. 8 hr	**	**	1,400	**	10,000	**
Annual Max. 1 hr	**	**	2,500 [8]	**	40,000	**

Sources: ERT (1987), Environmental Science and Engineering (1987), and ENSR, 1996, as cited in U.S. Army Corps of Engineers (1999).
Footnotes: [1]Lead was not monitored. [2]Site CCP (Central Compressor Plant), Prudhoe Bay monitoring program, selected for maximum pollutant concentrations. All data are for years 1992-1996. [3]Site Pad A (Drill Pad A), Prudhoe Bay monitoring program, site of previous monitoring, selected to be more representative of the general area or neighborhood. All data are for years 1992-1996. [4]Site CPF-1 (Central Processing Facility), Kuparuk monitoring program, selected for maximum pollutant concentrations. Ozone, nitrogen dioxide, and sulfur dioxide are for years 1990-1992; PM_{10} and carbon monoxide data are for 1986-1987. [5]Site DS-1F, Kuparuk monitoring program site selected to be representative of the general area or neighborhood. All data are for years 1990-1992. [6]Applicable National Ambient Air Quality Standards. Please refer to Table V.C-4 for more specific definitions of air-quality standards. [7]Class II PSD Standard Increments. [8]Second highest observed value (in accordance with approved procedures for determining ambient-air quality).

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Table VI.C-6 Climatic Conditions Onshore Adjacent to the Liberty Project

	Arctic Coast
Distance to the ocean (km)	<20
Elevation (m)	<50
Air Temperature (°C)	
Mean diurnal amplitude	4 to 8
Range (extreme low-high)	–50 to + 26
Mean annual	–12.4 ± 0.4
Annual amplitude	17.5 ± 1.2
Degree-Day (°C-day)	
Freeze	4930 ± 150
Thaw	420 ± 120
Precipitation (mm)[1]	
Snow	113
Rain	85
Annual total	198
Seasonal Snow Cover	
Average starting date	27 Sep.
Range	4 Sep. to 14 Oct.
Average duration (days)	259
Range (extreme)	212 to 288
Average maximum thickness (cm)	32
Range (extreme)	10 to 83
Thaw Season	
Average starting time	6 Jun.
Range (extreme)	26 May to 19 Jun.
Average length (days)	106
Range (extreme)	77 to 153

Source: Zang, Osterkamp and Stamnes (1996).
[1] From Natural Resources Conservation Service (1994).

Table VI.C-7 Wind Speed and Air Temperature at Tern Island from February to May 1987

Month	Average Wind Speed		Median Wind Speed		Average Air Temperature		Median Air Temperature	
	kts	m/s	kts	m/s	°F	°C	°F	°C
February	9.0	4.6	7.5	3.9	-21.6	-29.8	-21.5	-29.7
March	9.4	4.8	6.0	3.1	-17.6	-27.6	-14.0	-25.6
April	9.1	4.7	9.0	4.6	-4.5	-20.3	-6.0	-21.1
May	12.4	6.4	12.0	6.2	17.0	-8.3	13.0	-10.6

Source: USDOI, MMS (1998). Calculated from meteorological data collected at Tern Island in 1987.

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Table VI.C-8 Current Speeds in Foggy Island Bay

Month	Current (cm/s) Maximum	Mean	Location	Source
November	9.6	1.4		Matthews (1981)
December	9.3	1.3		Matthews (1981)
January		0.7		Matthews (1981)
February		<2		Montgomery and Watson (1997, 1998)
	Range	*Range*		
July–September	20–68	4–16	70 17.60 N 147 43.00 W	Hachmeister et al. (1987); Short et al. (1990, 1991); Morehead et al. (1992a;b); and Morehead, Dewey, and Horgan (1993).

Table VI.C-9 River Discharge

River	Approximate Length (miles)	Discharge (cf/s)	Drainage (sq miles)	Drains From
Shaviovik	100	800	1,700	Arctic Foothills
Kadleroshilik	75	325	650	Arctic Coastal Plain
Sagavanirktok	260	2,770	4231	Arctic Foothills
Sagavanirktok (East Channel)		83		Arctic Foothills

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Table IX-1 Discharge Conditions for a Well Blowout to Open Water

Discharge Category	Volume of Oil (Barrels) Day 1	Day 2	Day 3	Day 15	15 Day Totals
Well's Discharge Volume	15,000	15,000	15,000	15,000	225,000
Evaporation (20%)	-3,000	-3,000	-3,000	-3,000	-45,000
Fall out to Gravel Island	6000	6,000	6,000	6,000	90,000
Oil Remaining on Gravel Island	-3,400	0 [1]	0 [1]	0 [1]	-3,400
Oil Draining to the Sea from Gravel Island	0	6000	6,000	6,000	86,600
Oil Falling to the Sea	6,000	6,000	6,000	6,000	90,000
Total Oil to the Sea	8,600	12,000	12,000	12,000	176,600

Source: S.L. Ross Environmental Research Ltd., D.F. Dickins and Associates, and Vaudrey and Associates, (1998) and BPXA (2000b).
Notes: Assumes Alaska North Slope crude; constant wind speed of 20 knots; winds change from WSW to ENE; current speed of 0.6 knots; wave height of 1-5 feet; and air temperature of 45 °F.
1 After hour 14, the gravel island is saturated with oil. All oil falling on the gravel island drains to the sea.

Table IX-2 Discharge Conditions for a Well Blowout to Broken Ice

Discharge Category	Volume of Oil (Barrels) Day 1	Day 2	Day 3	Day 15	15 Day Totals
Well's Discharge Volume	15,000	15,000	15,000	15,000	225,000
Evaporation (20%)	-3,000	-3,000	-3,000	-3,000	-45,000
Fall out to Gravel Island	6000	6,000	6,000	6,000	90,000
Oil Remaining on Gravel Island	-3,400	0 [1]	0 [1]	0 [1]	-3,4000
Oil Draining to the Sea from Gravel Island	4800	6,000	6,000	6,000	86,600
Oil Falling to the Open Water	3,000	3,000	3,000	3,000	45,000
Oil Falling to Ice Floes	3,000	3,000	3,000	3,000	45,000
Total Oil to the Environment	8,600	12,000	12,000	12,000	176,600
Oil Thickness on Floe	0.0004 to 0.9 mm				

Source: S.L. Ross Environmental Research Ltd., D.F. Dickins and Associates, and Vaudrey and Associates, (1998) and BPXA (2000b).
Notes: Assumes Alaska North Slope crude; wind speed averages 19 knots; air temperature 8–18 °F; 5/10ths icefloes; ice is 0.6-0.8 feet thick and covered by 2-4 inches of snow; floes are hundreds of thousands of feet in size; 50% of the oil spray lands on the ice, 50% lands on the water.
1 After 14 hours, the gravel island is saturated with oil. All oil falling on the gravel island drains to the sea.

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Table IX-3a General Mass Balance of Oil from a 180,000-Barrel Winter Meltout Spill

Day[1]	Oil Remaining (bbl)	Evaporated (bbl)	Dispersed (bbl)	Sedimented (bbl)	Onshore (bbl)
0	156,000	22,000 [2]	—	—	—
3	111,000	24,000	13,000	1,100	29,000
10	96,000	27,000	19,000	1,600	34,000
30	87,000	28,000	25,000	2,100	36,000
60	63,000	32,000	40,000	3,400	39,000

Source: USDOI, MMS, Alaska OCS Region 1998; based on ocean-ice weathering model of Kirstein and Redding (1987).
Notes: Based on a 177,900-barrel spill size with values rounded to the nearest 1,000 and 100. Assumes oil pools on ice to 2 millimeters at 32 °F for 0-10 days, depending on when it was spilled, and melts out into 50% broken ice at 32 °F, with 11-knot winds.
Footnotes: [1]Days after meltout of winter spilled oil (97% of total spillage) or summer spillage (3% of total spillage). [2]Evaporation on day 0 attributable to evaporation during oil pooling on the ice surface prior to oil release to the water (= meltout).

Table IX-3b Areas of Discontinuous and Thick Slicks from a 180,000-Barrel Winter Meltout Spill

	Discontinuous Slick Area (km^2)[1]	Area of Thick Slick (km^2)[2]
Initial Spill Area	—	125
Area During Oil Pooling on Ice Surface	—	12
Days after Spill Reaches Water Surface[1]		—
3	160	5
10	770	8
30	3,200	16
60	7,900	22

Source: USDOI, MMS, Alaska OCS Region, 1998.
Footnotes: [1]Calculated from Ford (1985) and Kirstein and Redding (1987). [2] Based on ocean-ice weathering model of Kirstein and Redding (1987).

Table IX-4 Length of Coastline a 180,000-Barrel Spill May Contact Without any Oil-Spill Response

	Amount of coastline contacted in miles and kilometers[1]	
Days	**Winter Ice Conditions**	**Summer Open Water**
3	48 (77.23)	65 (104.5)
10	48 (77.23)	130 (209.17)
30	48 (77.23)	200 (321.8)
60	48 (77.23)	220 (353.98)
90	48 (77.23)	—
180	55 (88.50)	—

Source: USDOI, MMS, Alaska OCS Region 1998.
[1]Calculated from oil-spill-risk analysis conditional probabilities. We add the length of land segments with chance of contact >0.5% to estimate the amount of coastline contacted. This calculation assumes no oil spill response and includes land segments that have a very small chances of contact.

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Table IX-5a General Mass Balance of Oil from a Spill of 180,000 Barrels in Open Water

Day[1]	Oil Remaining in Slick (bbl)	Evaporated (bbl)	Dispersed (bbl)	Sedimented (bbl)	Onshore (bbl)
0	180,000	0	—	—	—
3	122,000	20,000	11,000	1,000	22,000
10	93,000	26,000	29,000	2,600	26,000
30	60,000	31,000	49,000	4,100	36,000
60	39,000	34,000	58,000	5,100	39,000

Source: USDOI, MMS, Alaska OCS Region (1998);
based on ocean-ice weathering model of Kirstein and Redding (1987).
Notes: Based on a 177,900-barrel spill size with values rounded to the nearest 1,000 and 100.
Assumes Alaska North Slope crude, constant wind speed of 20 knots, and air temperature of 45 °F.
Footnotes: [1] We assume day 0 is 15 days after the start of the spill, when all the oil is in the water.

Table IX-5b Areas of Discontinuous and Thick Oil Slicks from a Spill of 180,000 Barrels in Open Water

Days After Spill Reaches Water Surface	Discontinuous Slick Area (km^2)[1]	Area of Thick Slick (km^2)[2]
3	290	7
10	1,370	12
30	5,700	19
60	14,000	24

Source: USDOI, MMS, Alaska OCS Region, 1995.
[1] Calculated from Ford (1985) and Kirstein and Redding (1987).
[2] Based on ocean-ice weathering model of Kirstein and Redding (1987).

Table IX-6 Summary of the Conditional Probabilities (expressed as percent chance) That an Oil Spill Starting During Summer or Winter at the Liberty Gravel Island (L1) will Contact a Certain Environmental Resource Area Within 1, 3, 10, 30, or 360 Days

Environmental Resource Area	Summer Spill From Liberty Gravel Island Time in Days					Winter Spill from Liberty Gravel Island Time in Days				
	1	3	10	30	360	1	3	10	30	360
All Land Segments	27	54	74	87	94	1	4	8	13	98
Spring Lead 1	n	n	n	n	n	n	n	n	n	n
Spring Lead 2	n	n	n	n	n	n	n	n	n	n
Spring Lead 3	n	n	n	n	n	n	n	n	n	n
Spring Lead 4	n	n	n	n	n	n	n	n	n	n
Spring Lead 5	n	n	n	n	n	n	n	n	n	n
Ice/Sea Segment 6	n	n	n	n	1	n	n	n	n	1
Ice/Sea Segment 7	n	n	1	3	3	n	n	n	n	1
Ice/Sea Segment 8	n	n	1	1	2	n	n	n	1	1
Ice/Sea Segment 9	n	n	3	3	4	n	n	1	1	4
Ice/Sea Segment 10	n	1	3	4	5	n	n	1	2	5
Ice/Sea Segment 11	n	1	5	8	8	n	n	1	1	5
Ice/Sea Segment 12	n	n	1	3	3	n	n	n	n	1
Ice/Sea Segment 13	n	n	1	3	3	n	n	n	n	n
ERA 14	n	n	n	n	n	n	n	n	n	n
ERA 15	n	n	n	n	n	n	n	n	n	1
ERA 16	n	n	n	n	1	n	n	n	n	2
ERA 17	n	n	1	1	1	n	n	n	n	4
ERA 18	n	n	n	1	2	n	n	n	n	4
ERA 19	n	n	n	2	2	n	n	n	n	2
ERA 20	n	n	2	4	4	n	n	n	n	4
ERA 21	n	n	2	6	7	n	n	n	n	7
Simpson Lagoon	n	2	5	8	10	n	n	n	n	14
Gwyder Bay	n	2	5	6	6	n	n	n	n	2
ERA 24	n	1	4	7	8	n	n	n	1	8
Prudhoe Bay	1	4	6	6	7	n	n	1	1	5
ERA 26	3	10	12	13	14	n	n	1	1	8
ERA 27	9	15	17	18	18	n	1	1	2	12
ERA 28	2	7	11	11	12	n	1	1	3	20
ERA 29	n	3	7	10	11	n	n	1	1	11
ERA 30	n	6	11	13	14	n	1	1	2	11
ERA 31	n	4	7	9	9	n	n	1	1	11
Boulder Patch 1	10	18	21	21	21	1	1	3	4	25
Boulder Patch 2	52	59	60	60	61	5	6	7	11	59
ERA 34	10	15	16	17	17	1	1	1	2	9
ERA 35	29	33	34	34	34	4	5	6	10	46
ERA 36	12	14	16	17	17	1	2	2	3	16
ERA 37	6	12	13	14	15	1	2	3	4	23
ERA 38	4	10	12	12	13	n	1	2	3	15
ERA 39	1	6	13	15	16	n	1	2	3	15
ERA 40	n	4	10	13	14	n	n	1	2	16
ERA 41	n	1	6	9	9	n	n	1	1	7
Canning River	n	n	2	3	3	n	n	n	n	4
ERA43	n	n	3	7	7	n	n	n	1	4
Simpson Cove	n	n	1	2	2	n	n	n	n	2
ERA45	n	n	3	5	5	n	n	n	n	2
Arey Lagoon, Hula Hula River	n	n	1	1	2	n	n	n	n	1
Whaling Area/Kaktovik	n	n	1	3	3	n	n	n	n	1
Thetis Island	n	n	1	2	2	n	n	n	n	5
Spy Island	n	n	1	2	3	n	n	n	n	5
Leavitt and Pingok Islands	n	n	3	4	4	n	n	n	n	8
Bertoncini, Bodfish, and Cottle	n	2	6	8	10	n	n	n	1	15
Long Island	n	3	8	9	9	n	n	n	1	8
Egg and Stump Islands	n	6	9	10	10	n	n	1	2	12
West Dock	1	7	9	10	10	n	n	1	2	11
Reindeer and Argo Islands	n	4	7	8	8	n	n	1	1	10
Cross and No Name Islands	n	2	6	7	8	n	n	1	1	11
Endicott Causeway	14	19	21	22	22	1	1	2	3	15
Narwhal, Jeanette and Karluk	6	11	13	15	15	1	2	3	4	21
Tigvariak Island	10	14	16	17	17	1	2	2	3	13
Pole and Belvedere Islands	1	6	8	10	10	n	1	2	3	16
Challenge, Alaska, Dutchess a	1	2	5	6	7	n	n	1	2	13
Flaxman Island	n	1	3	4	5	n	n	n	1	7

Land Segment	Summer Spill From Liberty Gravel Island Time in Days					Winter Spill from Liberty Gravel Island Time in Days				
	1	3	10	30	360	1	3	10	30	360
16	n	n	n	n	1	n	n	n	n	3
17	n	n	n	n	n	n	n	n	n	2
18	n	n	n	n	n	n	n	n	n	1
19	n	n	n	1	2	n	n	n	n	1
20	n	n	n	1	1	n	n	n	n	1
21	n	1	2	3	4	n	n	n	n	7
22	n	1	4	5	6	n	n	n	n	4
23	n	4	6	7	7	n	n	1	2	11
24	n	1	2	3	3	n	n	n	n	1
25	4	9	12	12	13	1	1	1	2	7
26	17	22	25	26	26	1	2	3	5	27
27	5	9	10	11	11	n	1	1	2	13
28	1	4	6	7	7	n	n	1	1	7
29	n	1	3	3	4	n	n	n	n	5
30	n	1	1	2	2	n	n	n	n	3
31	n	n	n	1	1	n	n	n	n	1
32	n	n	1	2	2	n	n	n	n	2
33	n	n	1	2	2	n	n	n	n	1
34	n	n	n	1	2	n	n	n	n	n

Source: Johnson, Marshall and Lear, 2000. n = less than 0.5%.
Note: For Environmental Resource Areas See Maps A-2 and A-3, Land Segments See Map A-1 and Liberty Gravel Island See Map A-6

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Table IX-7 Hypothetical 200,000-Barrel Tanker-Spill-Size Examples

	200,000-barrel spill[1]					
Time After Spill in Days	**1**	**3**	**10**	**30**	**45**	**60**
Oil Remaining (%)	79	70	53	37	33	31
Oil Dispersed (%)	2	7	19	32	35	37
Oil Evaporated (%)	16	21	26	29	30	30
Thickness (mm)	5.1	2.9	1.4	0.7	0.5	0.4
Area of Thick Slick (km^2)[2]	4.7	7.3	12	17	19	21
Discontinuous Area (km^2)[3]	88.0	365.2	1,737.5	7,210.9	12,192.6	17,698.7

Source: USDOI, MMS, Alaska OCS Region, 1995. **Notes:** Calculated with the SAI oil-weathering model of Kirstein, Payne, and Redding (1983). **Footnotes:** [1]Summer 11.7-knot-windspeed, 9.9-°C, 1.0-meter-wave height. Average Weather Marine Area C (Brower et al., 1988). [2]This is the area of oiled surface. [3]Calculated from Equation 6 of Table 2 in Ford (1985): The discontinuous area of a continuing spill or the area swept by an instantaneous spill of a given volume.

Table IX-8 Mass Balance of Oil Through Time of a Hypothetical 200,000-Barrel Oil Spill Along Tanker Segment T6

Days	**1**	**3**	**10**	**30**	**45**	**60**
Oil Evaporated[1]	30,000 [2]	40,000	48,000	56,000	58,000	58,000
Oil Disbursed[1,3]	4,000	9,000	31,000	55,000	57,000	60,000
Oil Sedimented[1,3]	0	5,000	9,000	11,000	13,000	16,000
Oil Onshore[1,3]	0	17,000	30,000	40,000	45,000	55,000
Oil Remaining[1,3]	162,000	125,000	78,000	36,000	23,000	7,000

Source: MMS, Alaska OCS Region, 1993. **Footnotes:** [1]Calculated with the SAI oil-weathering model of Kirstein, Payne, and Redding (1983). The examples are for a Cook Inlet crude type in Summer 9.9-°C sea-surface temperature and 11.7-knot winds. [2]Barrels. [3]Modified to fit fate calculations of Gundlach et al. (1983) and Wolfe et al. (1993).

Table IX-9 200,000-Barrel Spill Dispersed-Oil Characteristics

Time after Spill in Days[1]	**Oil Dispersed[1] (%)**	**Discontinuous Area[1] (km^2)**	**Assumed Dispersion Depth (m)**	**Dispersed-Oil Concentration (µg/l)**
1	2	88.0	1	6,477
3	7	365.2	2	2,731
10	19	1,737.5	7.5	416
30	32	7,210.9	15	84
45	35	12,192.6	17.5	47
60	37	17,698.7	20	30

Source: USDOI, MMS, Alaska OCS Region, 1993. [1]Table IX-7.

FIGURES

Contents

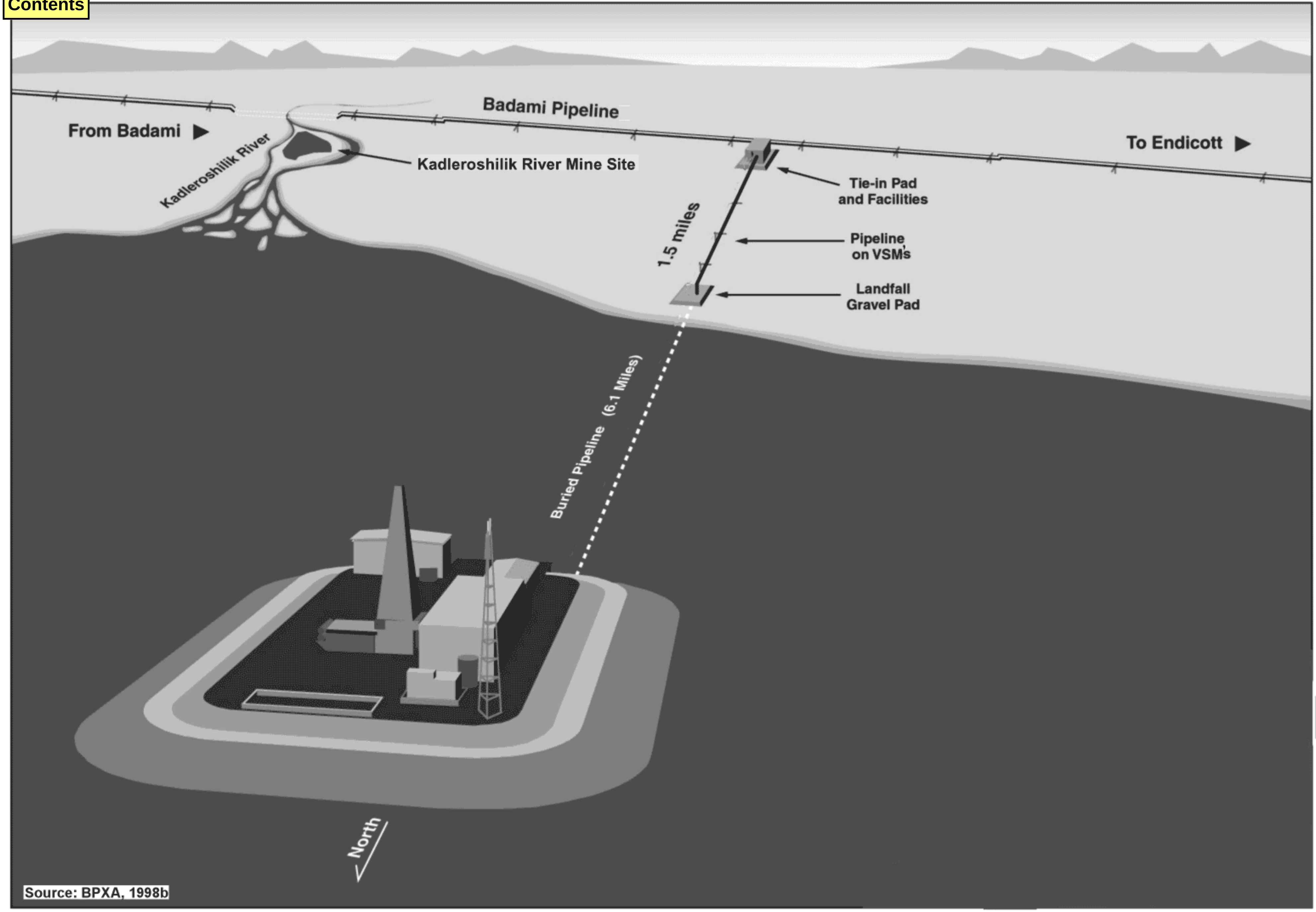

Figure II.A-1 Liberty Development Project: Conceptual 3-D Rendering of the Proposed Liberty Island and Pipeline

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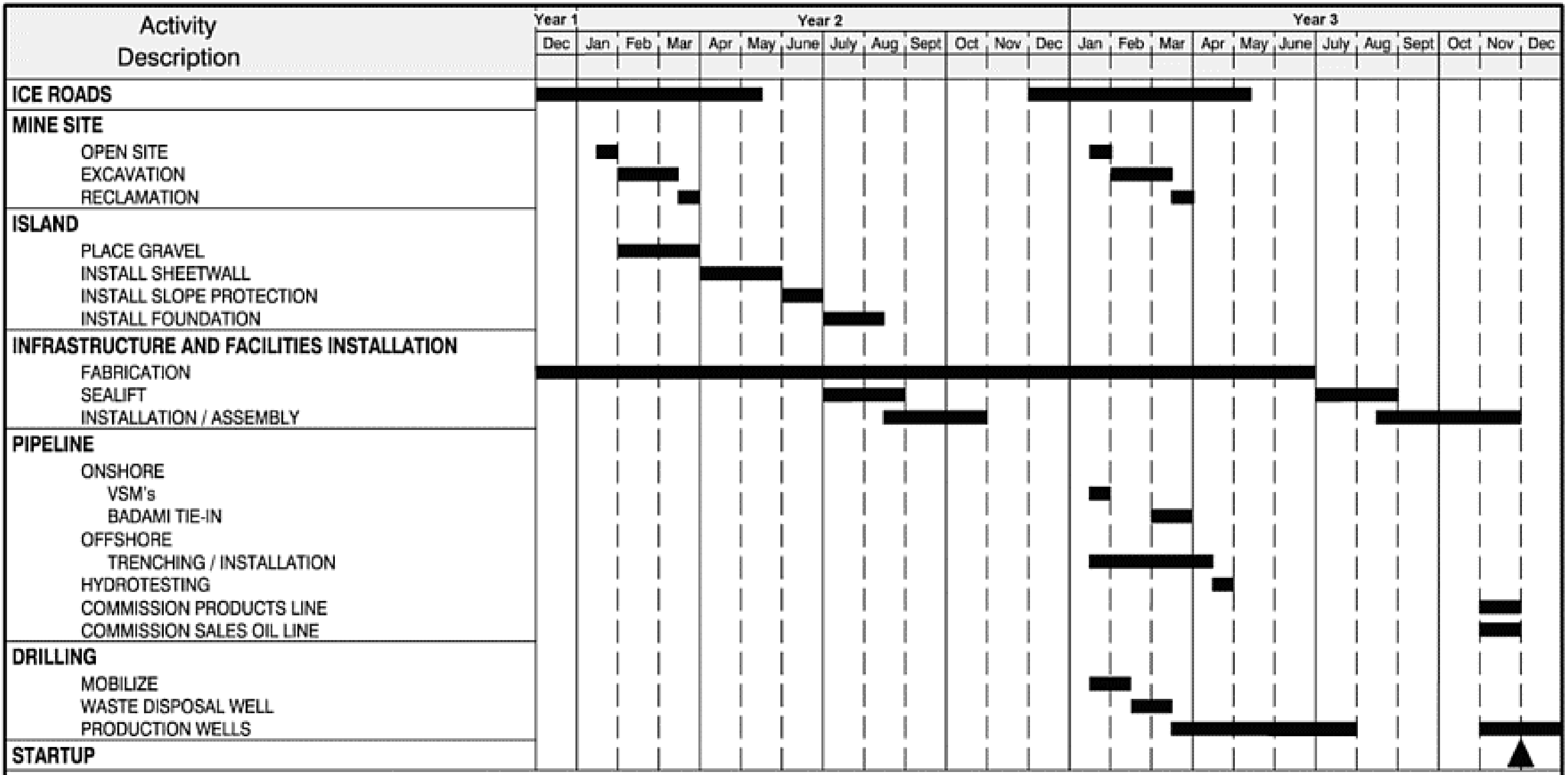

Source: BPXA, 2000

Figure II.A-2 Liberty Construction Schedule- Year 1 to Year 3

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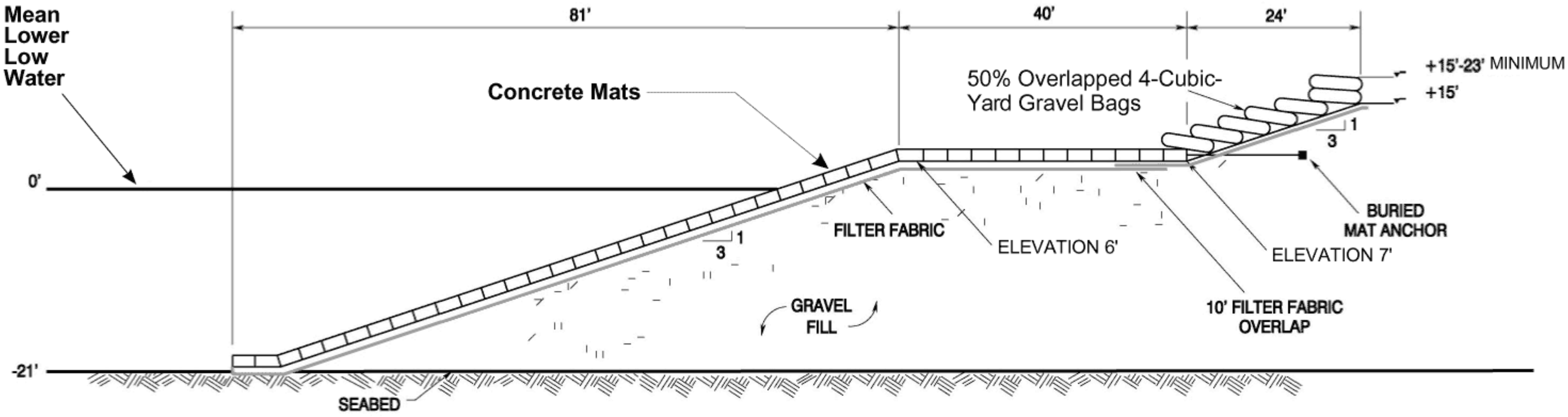

Source: BPAX, 1998a

ALL DIMENSIONS ARE APPROXIMATE

Figure II.A-3 Liberty Development Project: Island Slope Protection, Cross-Section and Details

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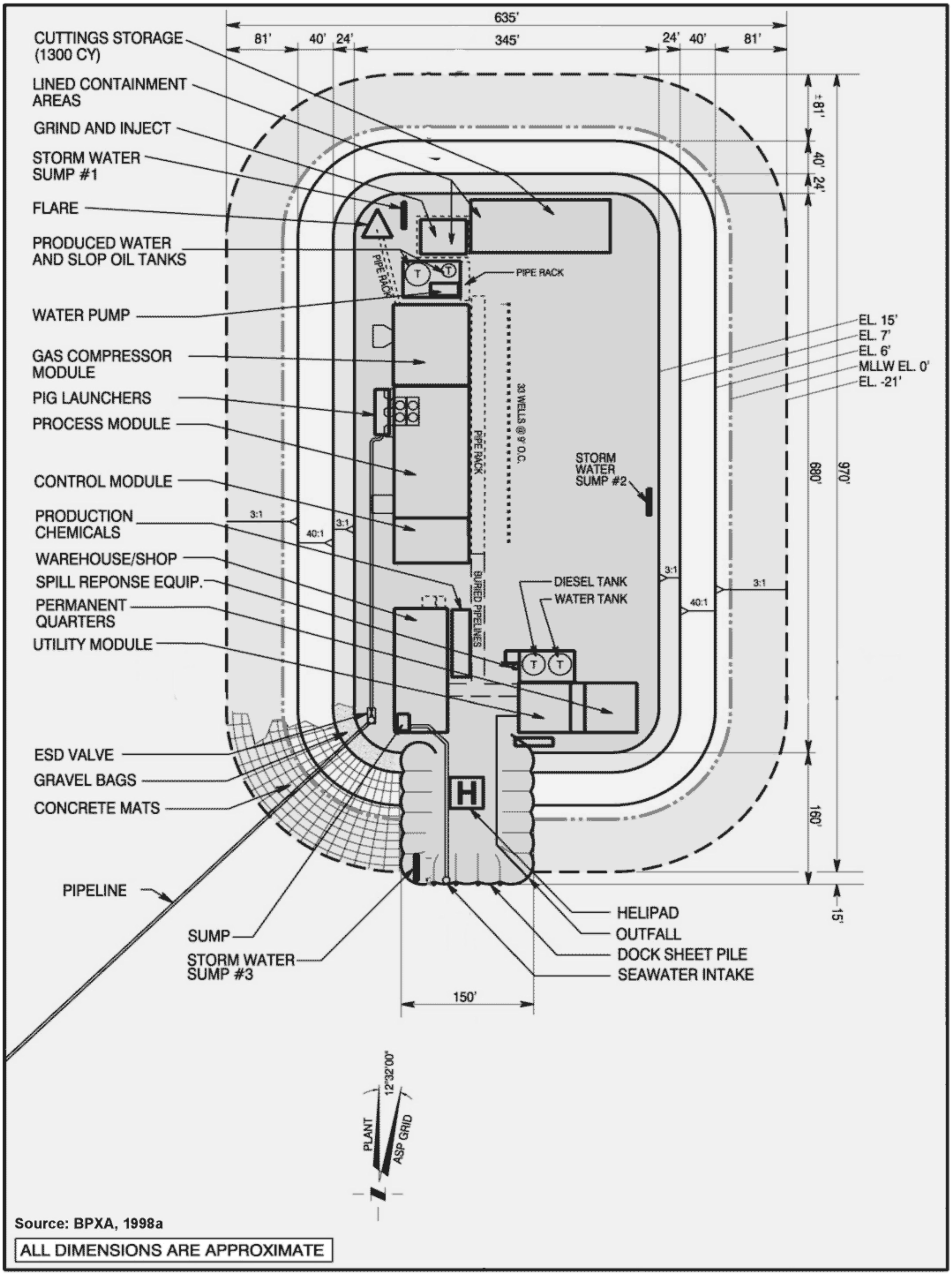

Figure II.A-4 Liberty Development Project: Island Layout

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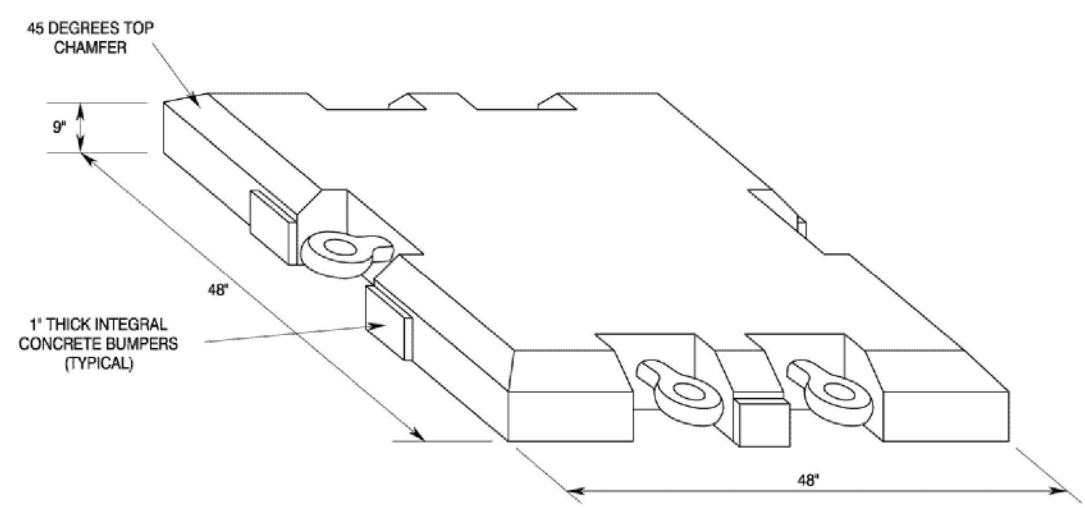
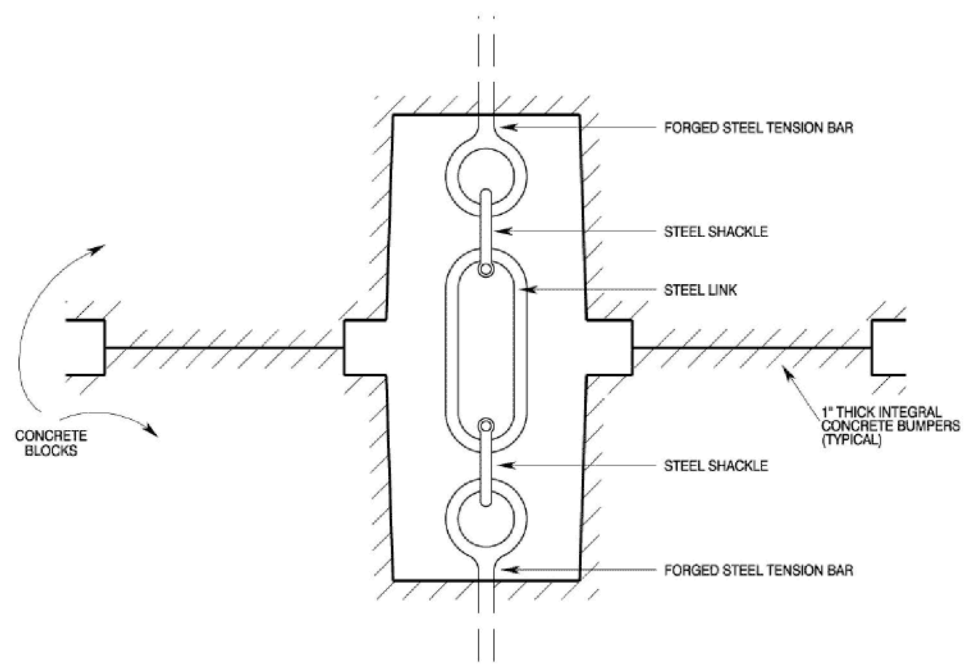


Source: BPXA, 1998a

Figure II.A-5 Liberty Development Project: Island Slope Protection, Concrete Block



Source: BPXA, 1998a

Figure II.A-6 Liberty Development Project: Island Slope Protection, Concrete Mat Linkage Detail

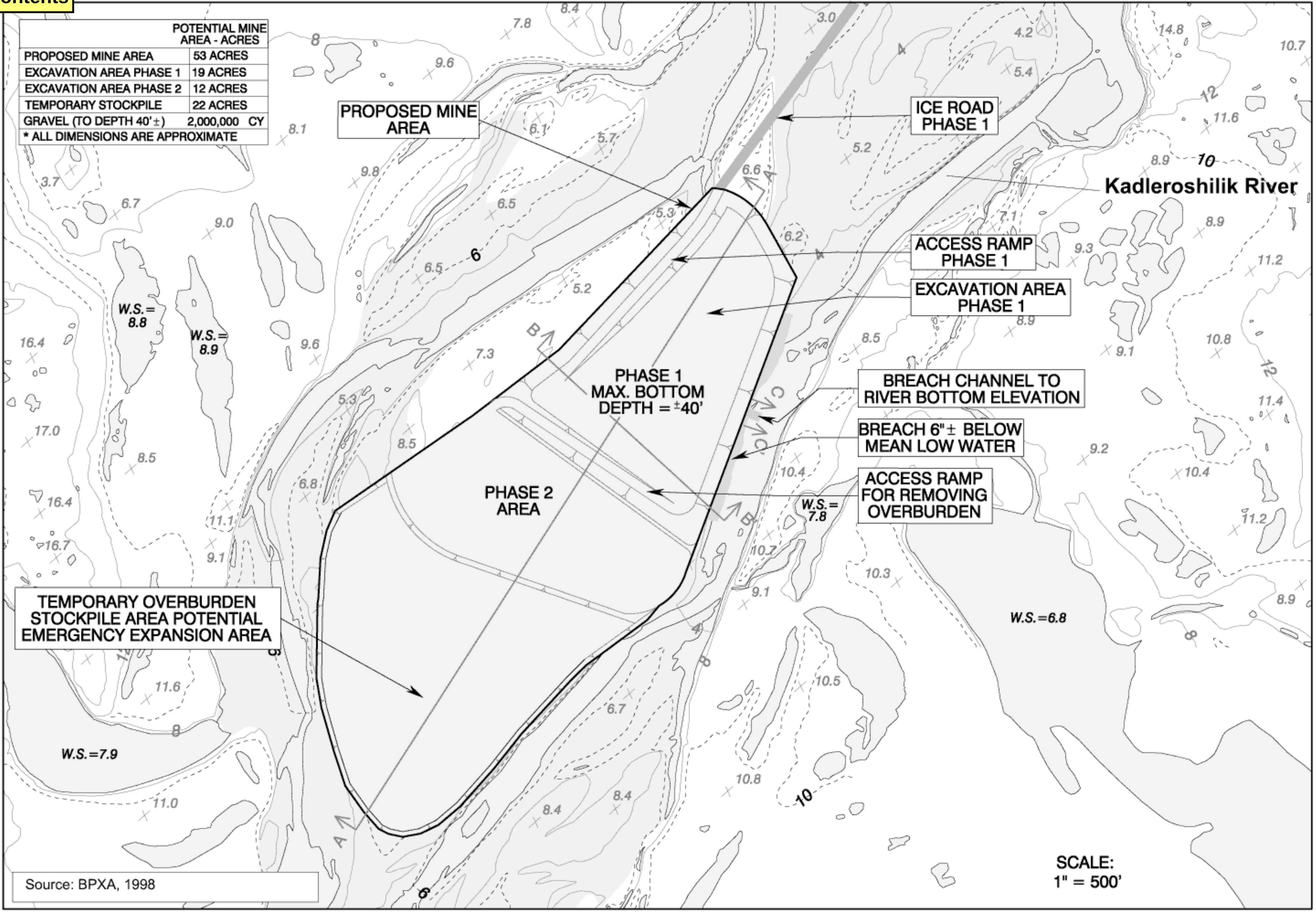


Figure II.A-7a Proposed Kadleroshilik River Mine Site - Phase I - Plan View

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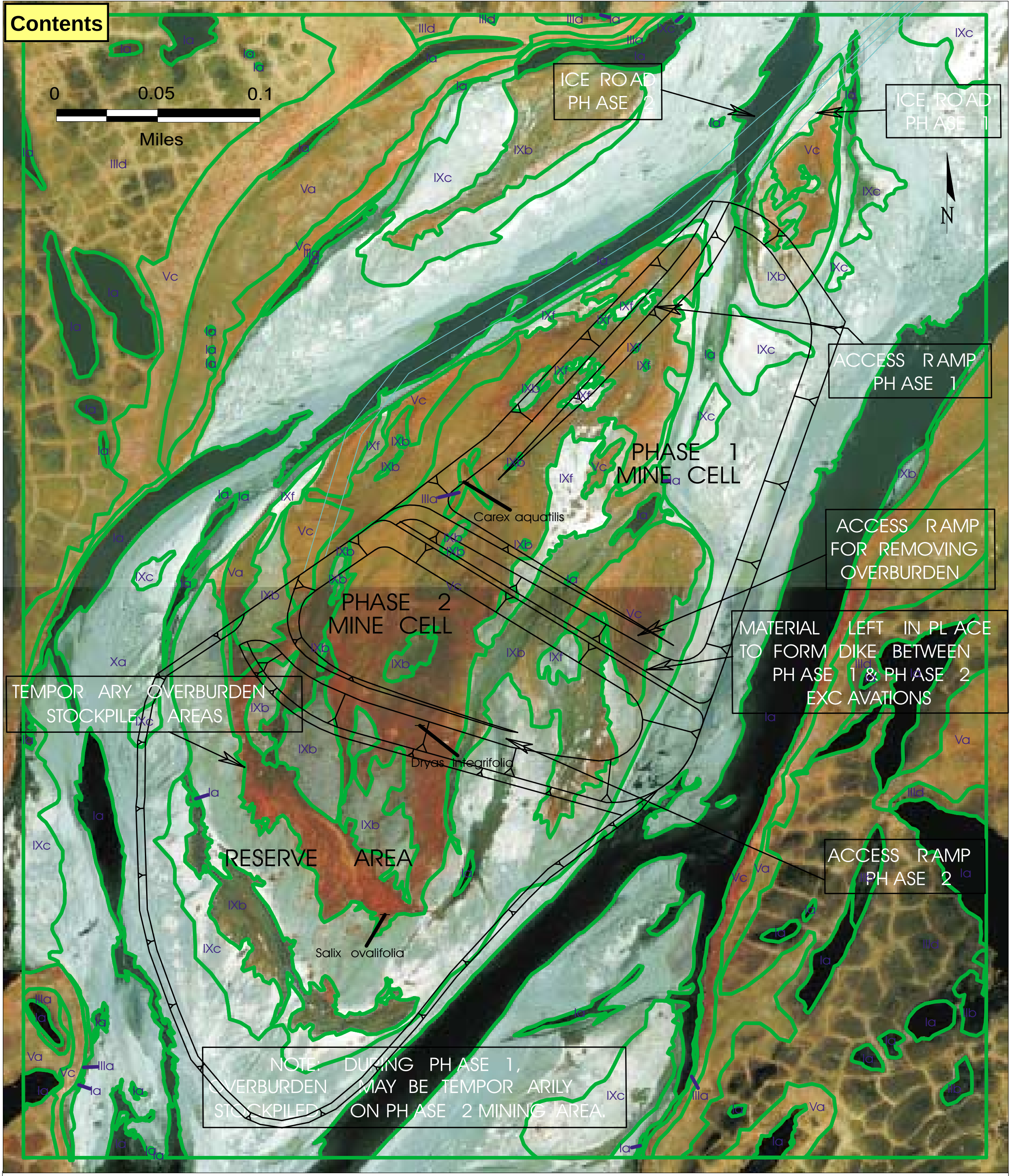

Area (acres)	Class	Land Cover Description
23.97	Ia	Water
0.65	IIb	Aquatic Graminoid Tundra
0.82	IIIa	Wet Sedge Tundra
26.08	IIId	Wet Sedge/Moist Sedge, Dwarf Shrub Tundra Complex
14.17	Va	Moist Sedge, Dwarf Shrub Tundra
27.97	Vc	Dry Dwarf Shrub, Crustose Lichen Tundra
13.16	IXb	Dry Barren/Dwarf Shrub, Forb Grass Complex
20.45	IXc	Dry Barren/Forb Complex
2.92	IXf	Dry Barren/Dwarf Shrub, Grass Complex
49.35	Xa	River Gravels

Ground Data Site
Vegetation Community
Vegetation Polygon
IXc — Vegetation Polygon Label

Map Projection: US State Plane, AK Zone 3
Datum: NAD 27
View Scale: 1:3,000
Map Scale: 1:6,000
Photo Date: 2 July 1994
Photo Scale: 1:6,000
Photo Resolution: 0.5 ft/pixel (by AeroMap U.S.)
Prepared by: LGL Alaska Research Associates, Inc.

Figure II.A-07b Proposed Liberty Mine Footprint and Vegetation Types, Kadleroshilik River, Alaska's North Slope

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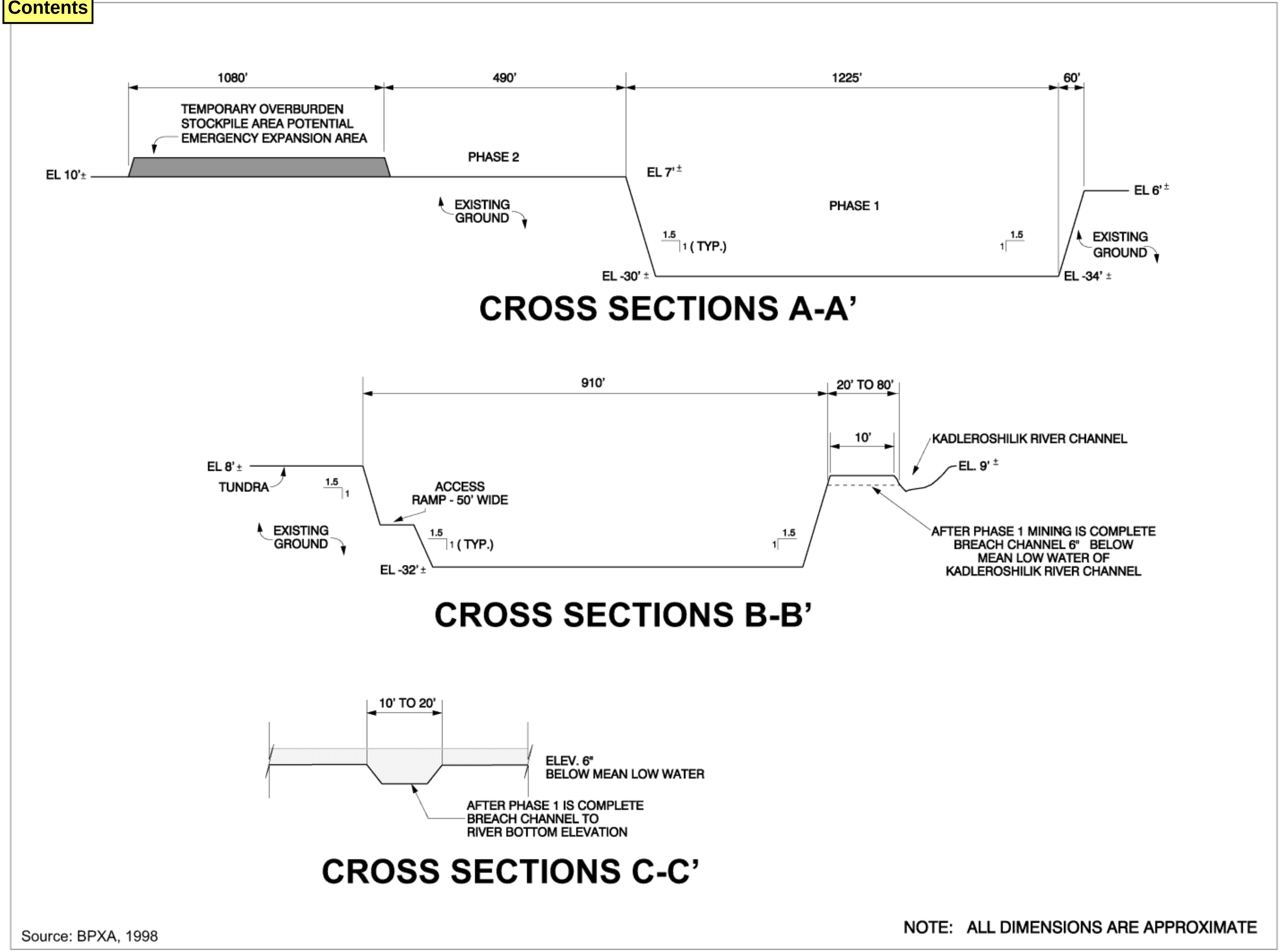

Figure II.A-8 Proposed Kadleroshilik River Mine Site - Phase I - Cross Sections

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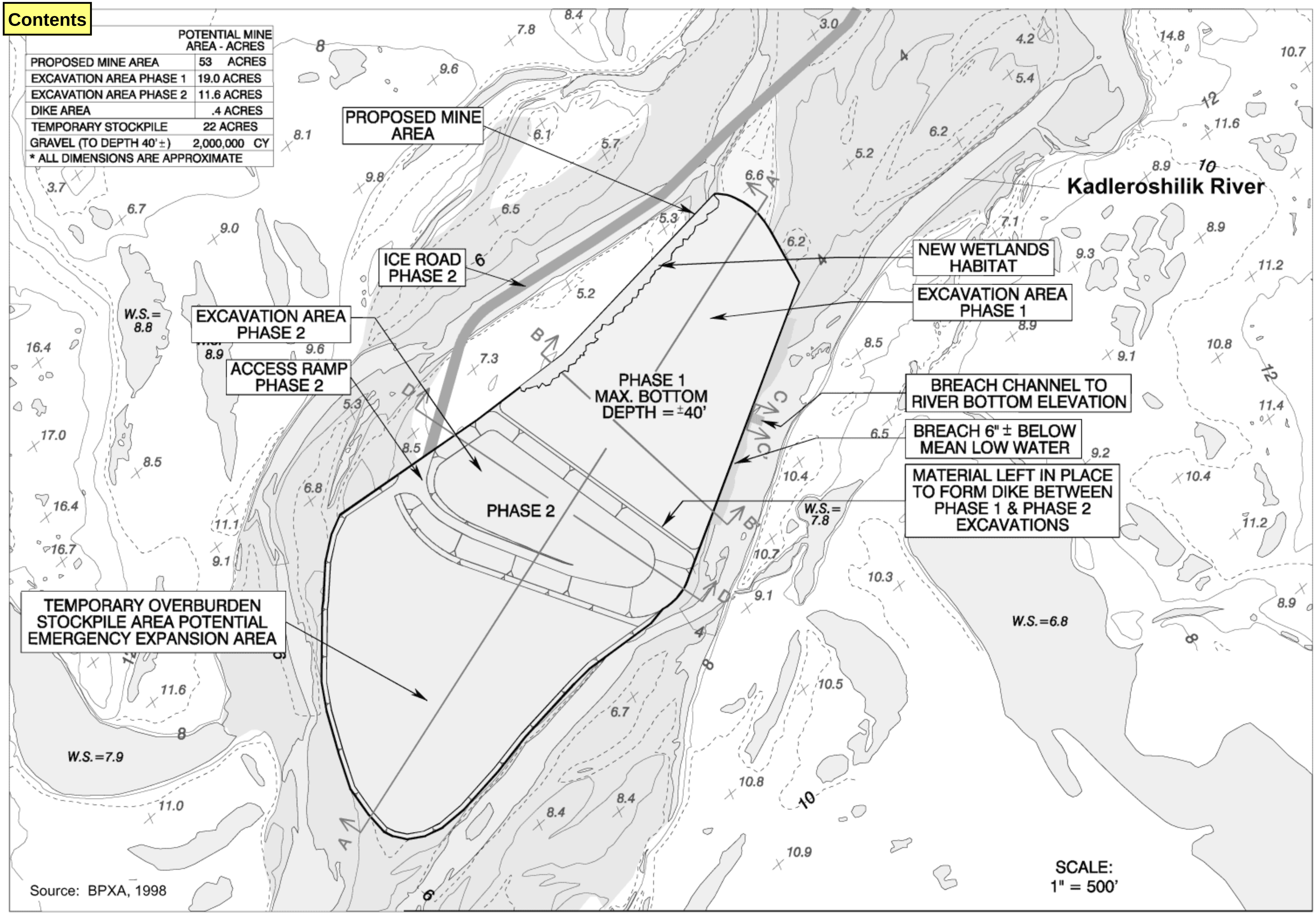

Figure II.A-9 Proposed Kadleroshilik River Mine Site - Phase II - Plan View

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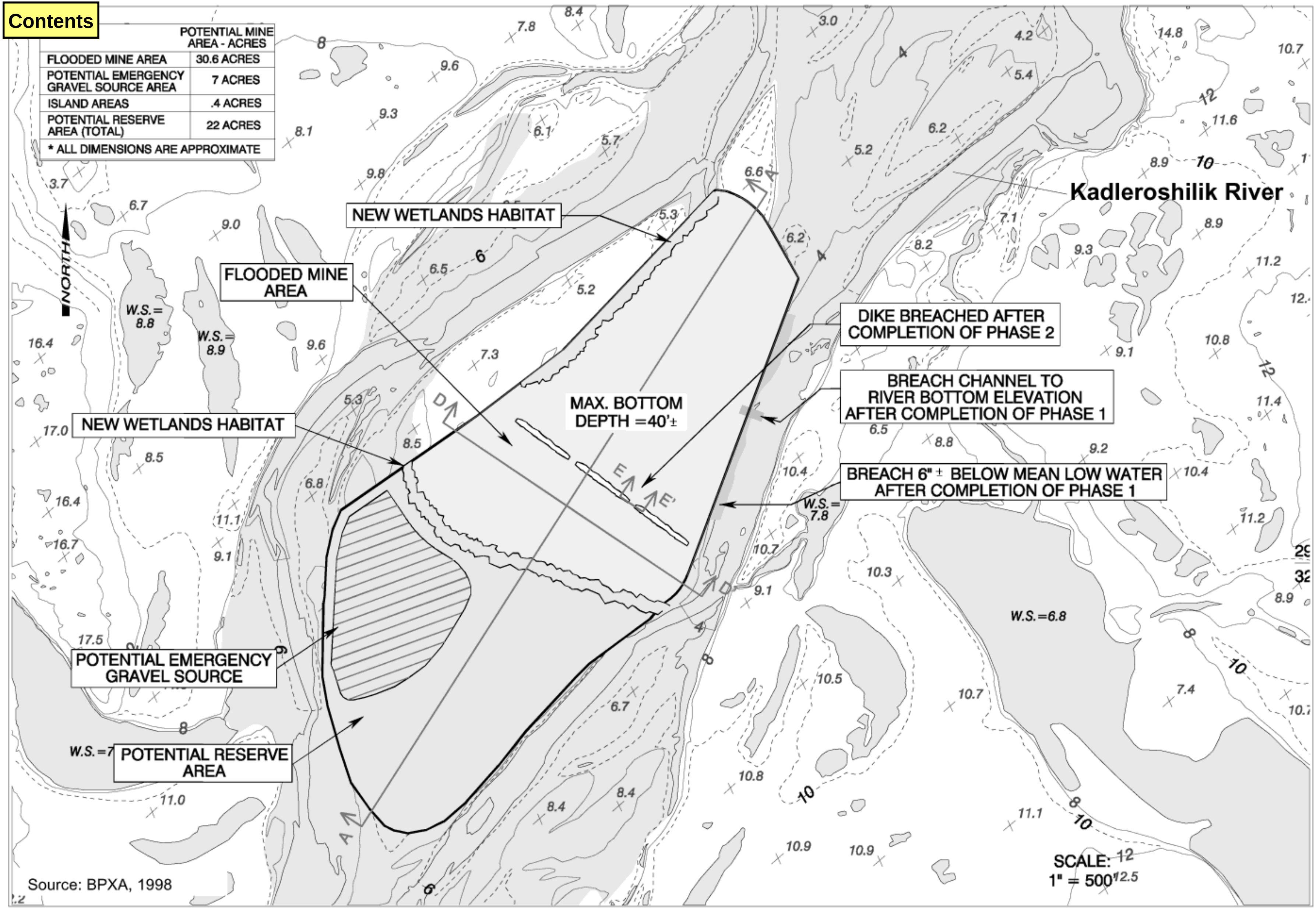

Figure II.A-10 Proposed Kadleroshilik River Mine Site - Rehabilitation Plan - Plan View

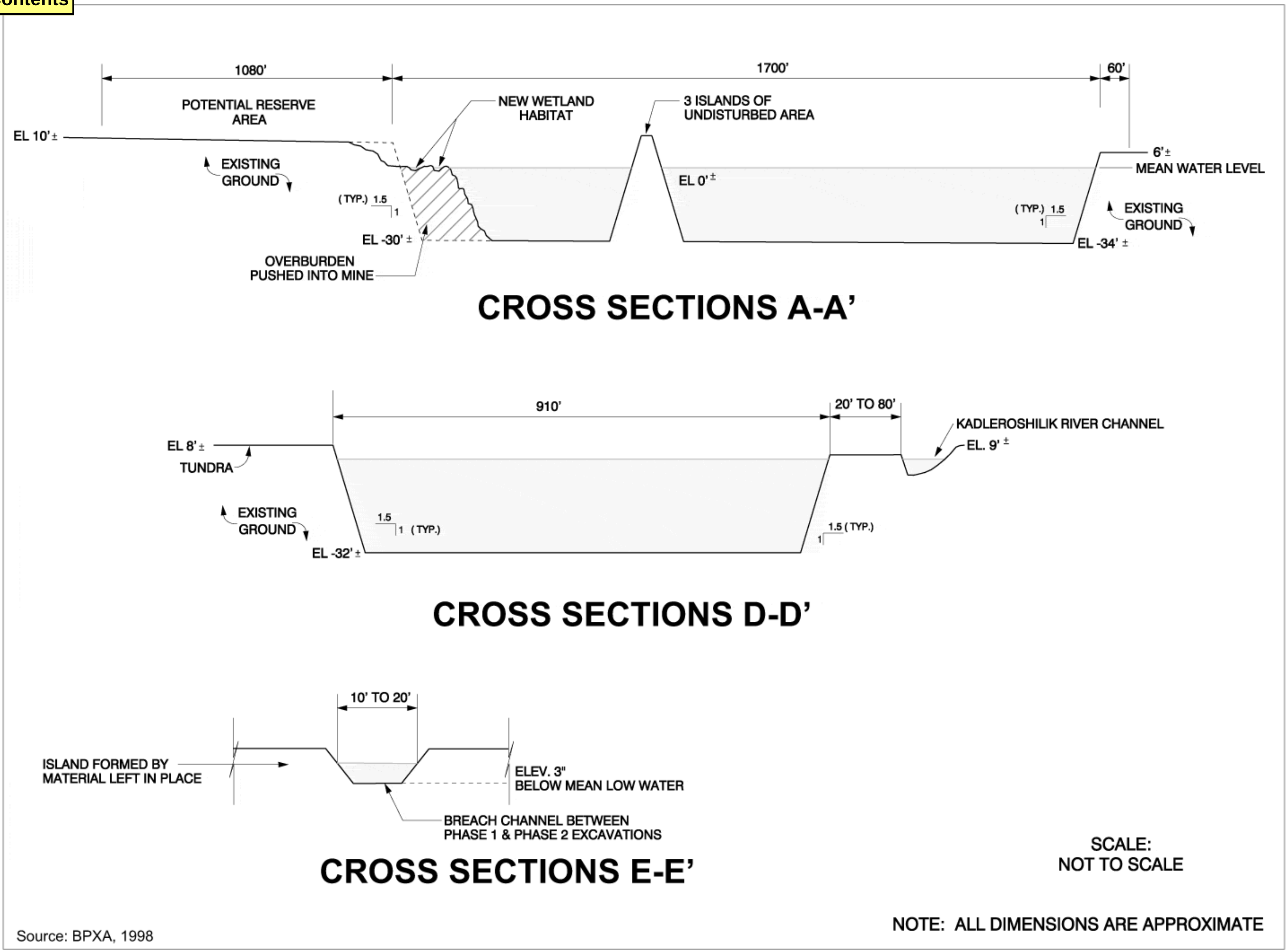

Figure II.A-11 Proposed Kadleroshilik River Mine Site - Rehabilitation Plan - Cross Sections

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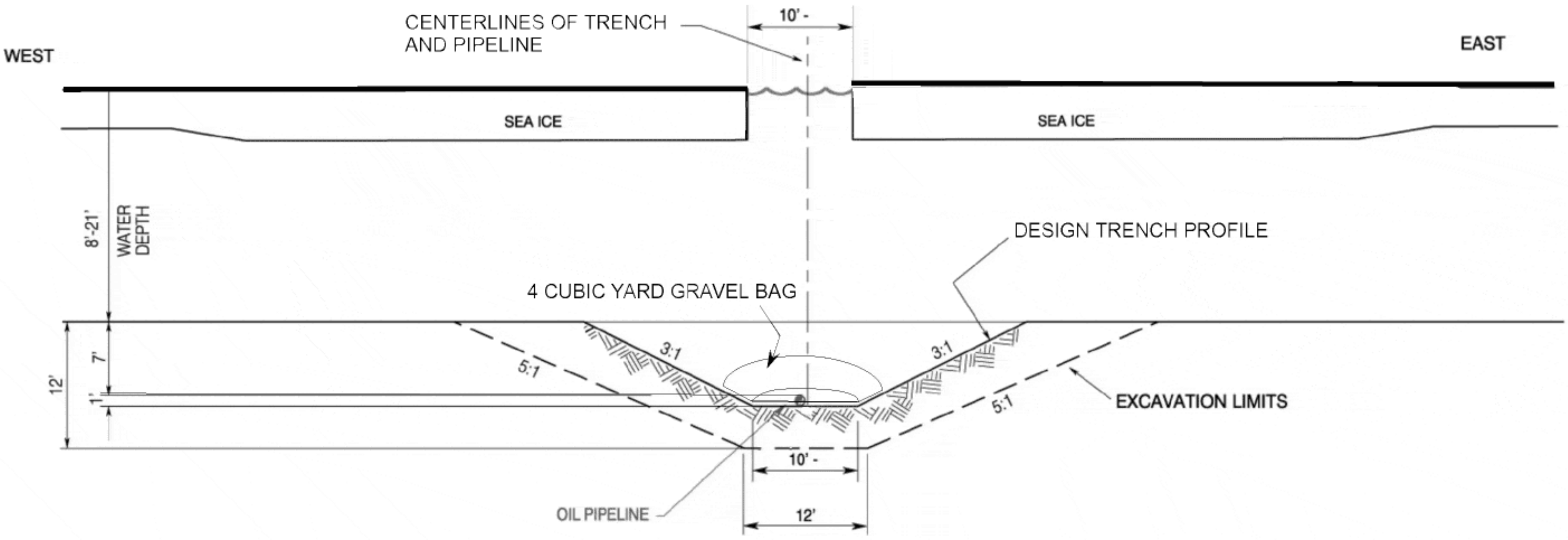

NOTES:

1. PIPELINE DEPTH OF COVER IS 7 FEET MINIMUM.
2. TRENCH SIDE SLOPES ARE VARIABLE, DEPENDING ON SOIL CONDITIONS.
3. TRENCH WILL BE BACK FILLED WITH A COMBINATION OF EXCAVATED MATERIAL, SELECT BACK FILL (GRAVEL) AND GRAVEL BAGS.

ALL DIMENSIONS ARE APPROXIMATE

Source: BPXA, 1998a

Figure II.A-12 Liberty Development Project: Pipeline Trench Section, Intermediate/Deep (8 to 21 feet) Water Depths

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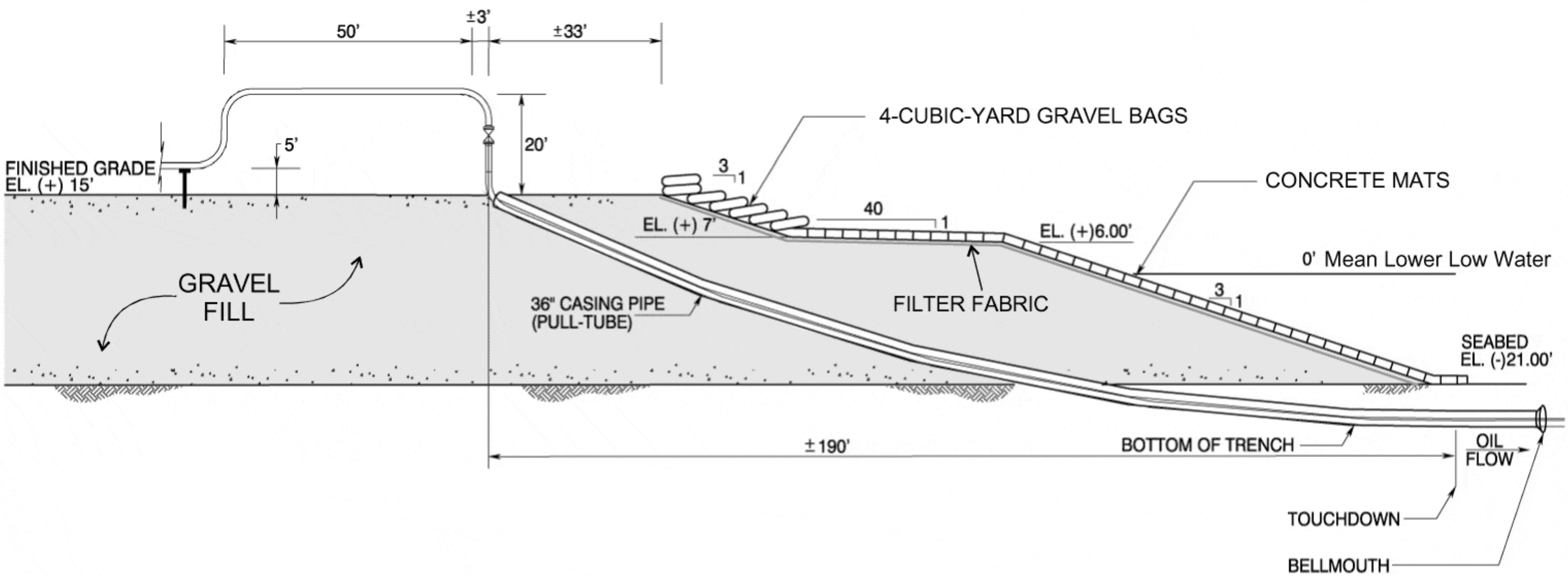

Source: BPXA, 1998b

ALL DIMENSIONS ARE APPROXIMATE

Figure II.A-13 Liberty Development Project: Pipeline Island Approach, Cross-Section

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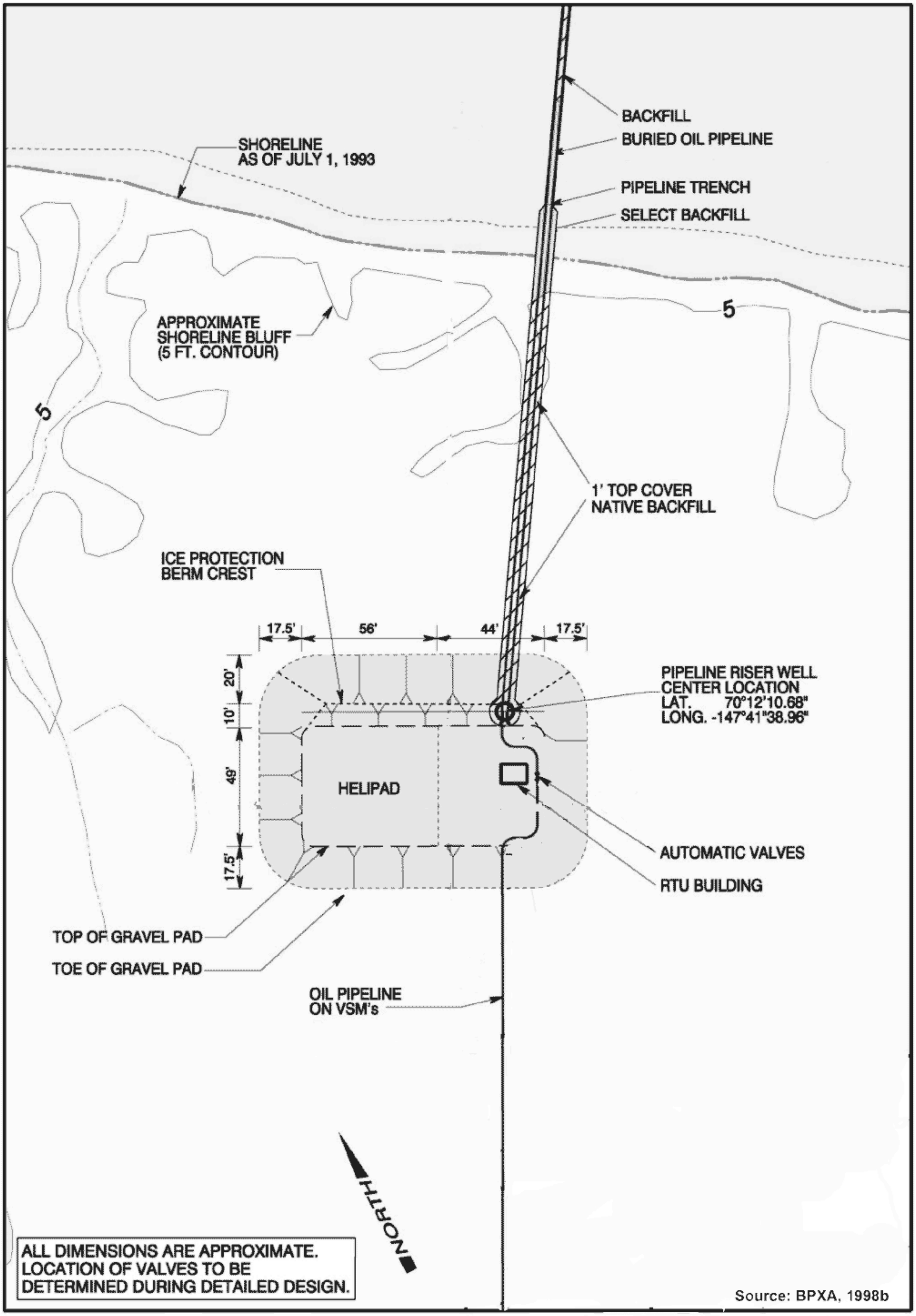

Figure II.A-14 Liberty Development Project: Shore Cross Pad

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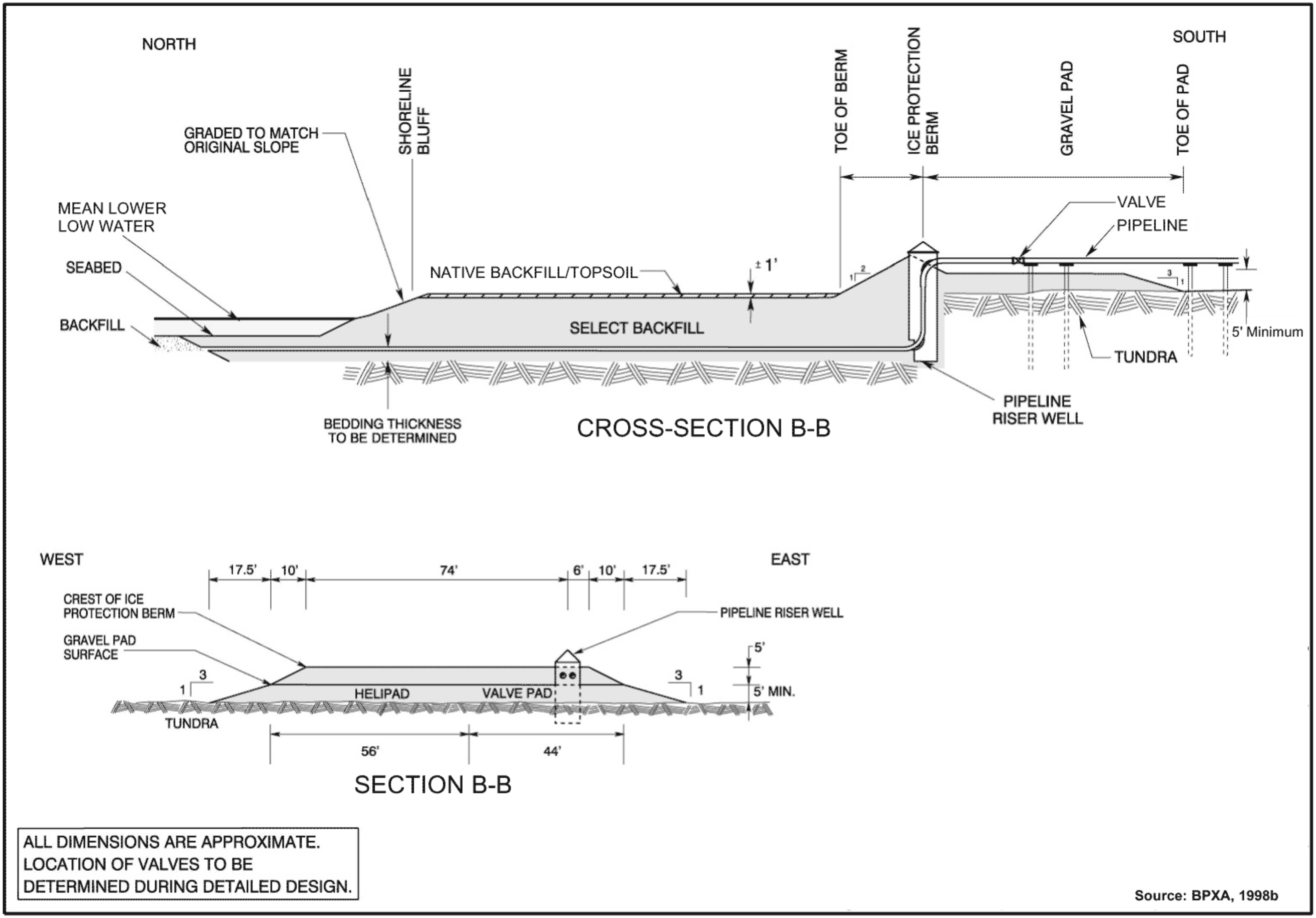

Figure II.A-15 Liberty Development Project: Pipeline Landfall Valve Pad, Cross-Sections

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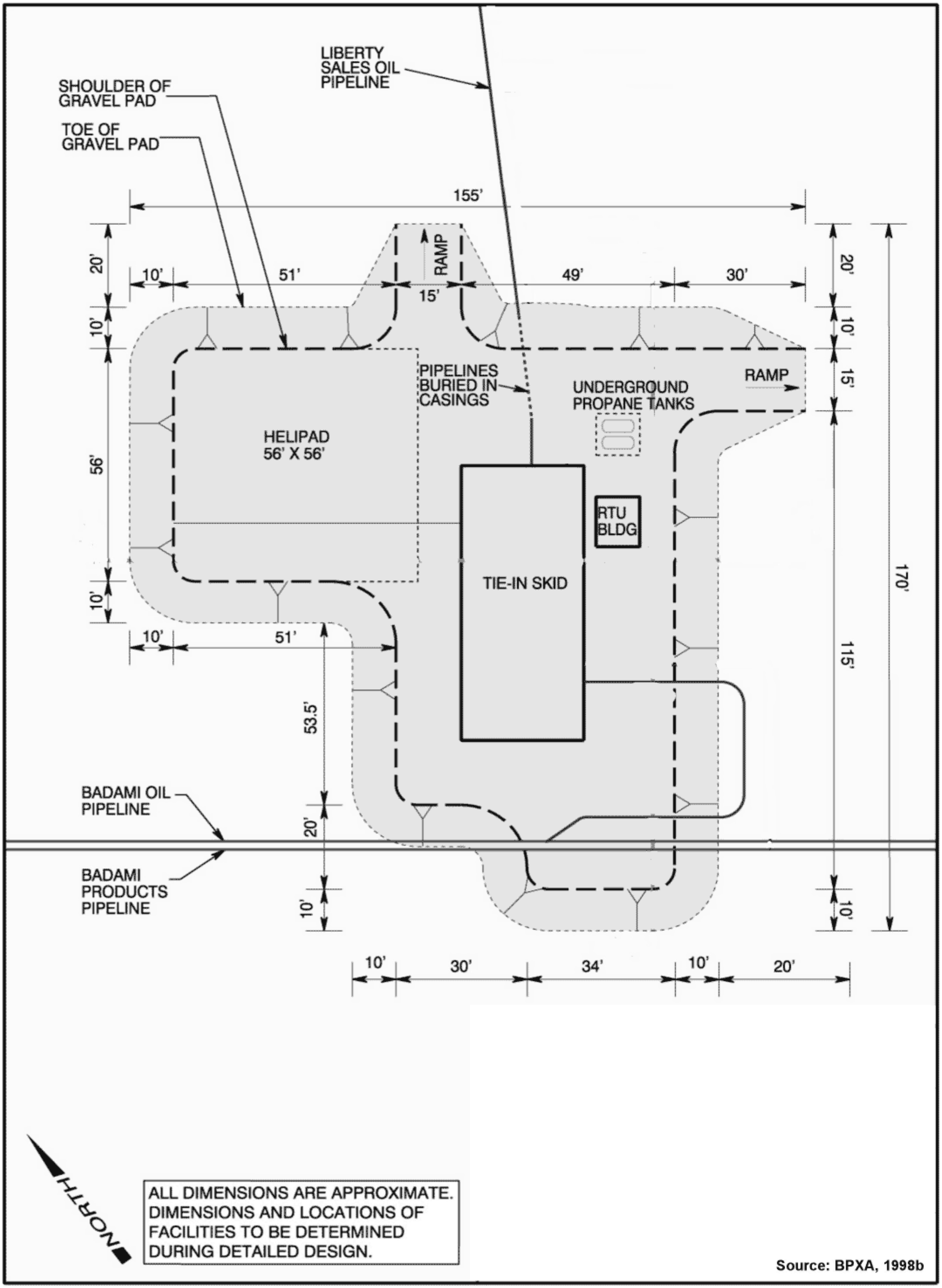

Figure II.A-16 Liberty Devolopment Project: Pad at Badami Pipeline Tie-In, Plan View

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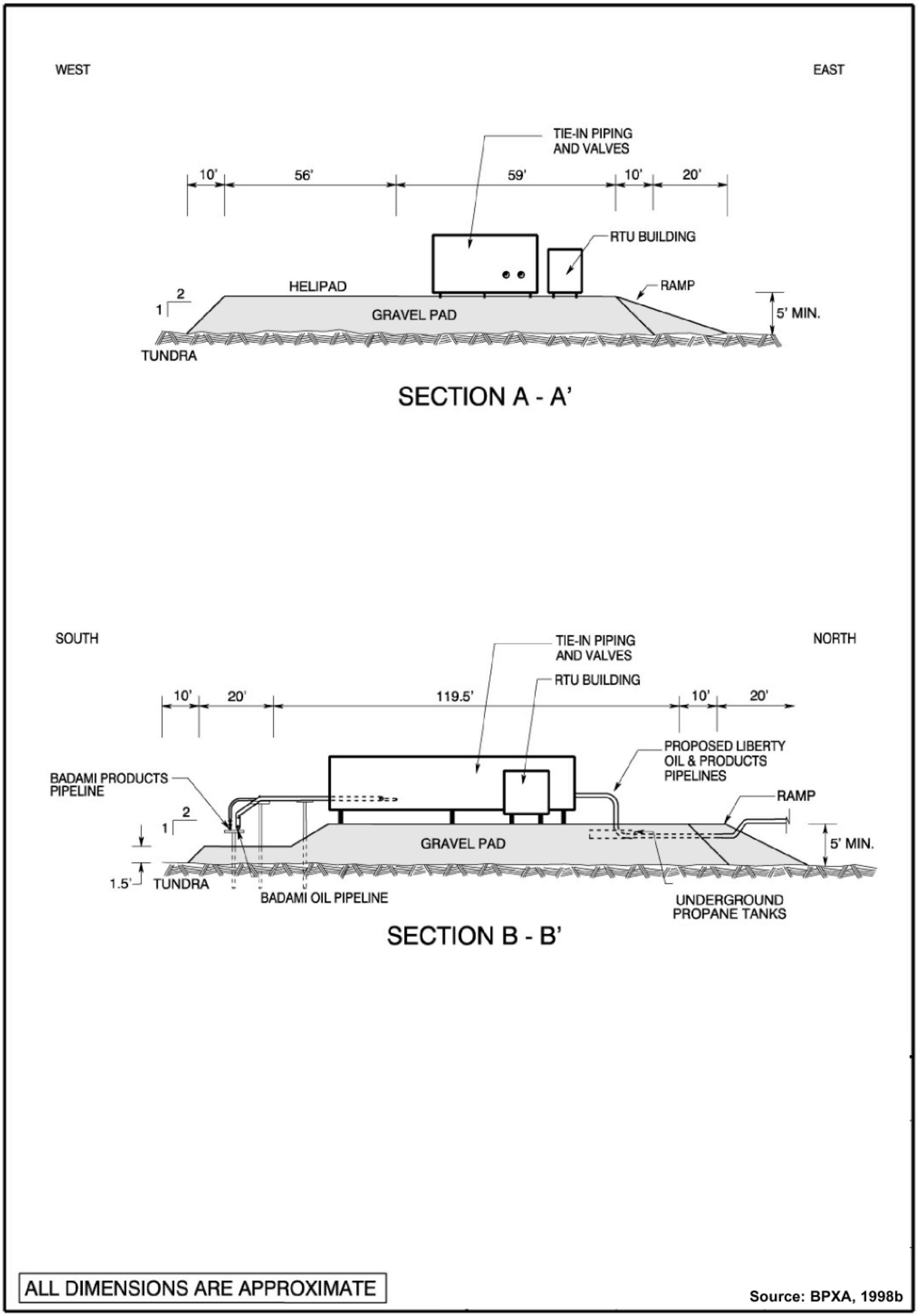

Figure II.A-17 Liberty Development Project: Tie-In Pad - Cross Sections

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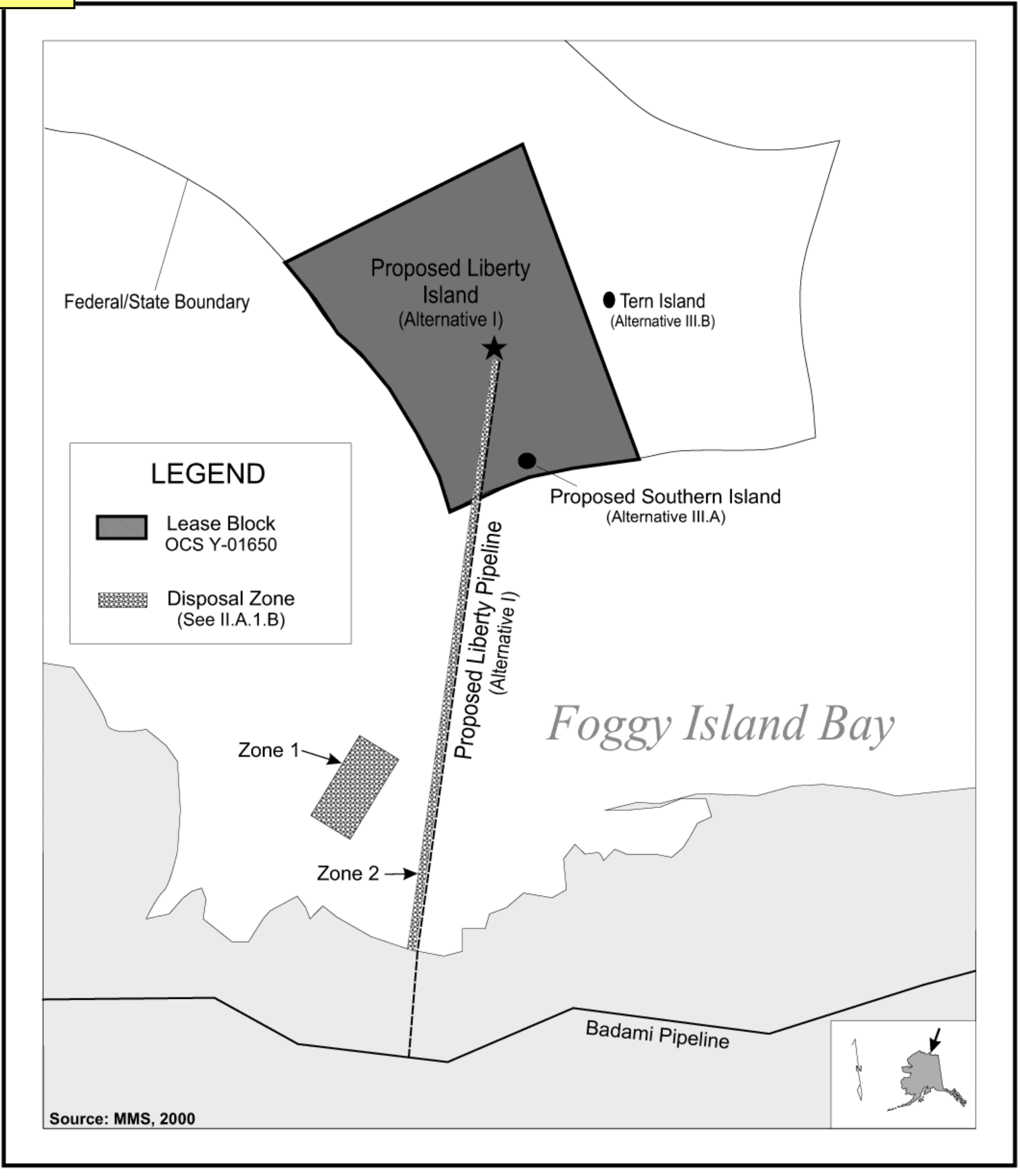

Figure II.A-18 Liberty Development Project: Alternative I Proposed Liberty Island and Pipeline and Dredged Material Disposal Zones

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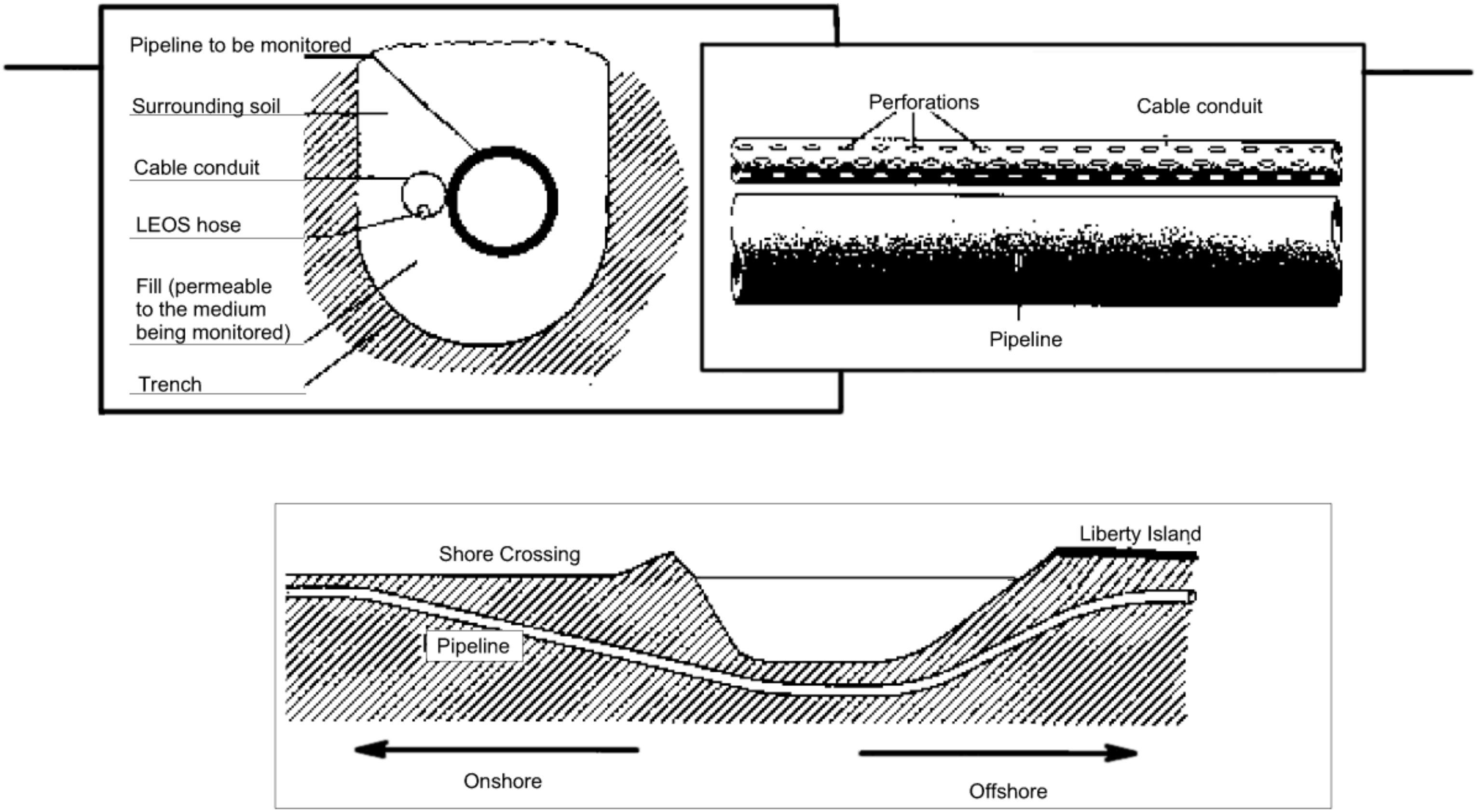

Source: Seimens, 2000

Figure II.A-19 Offshore Pipeline with LEOS Installed (Leak Detection and Location System)

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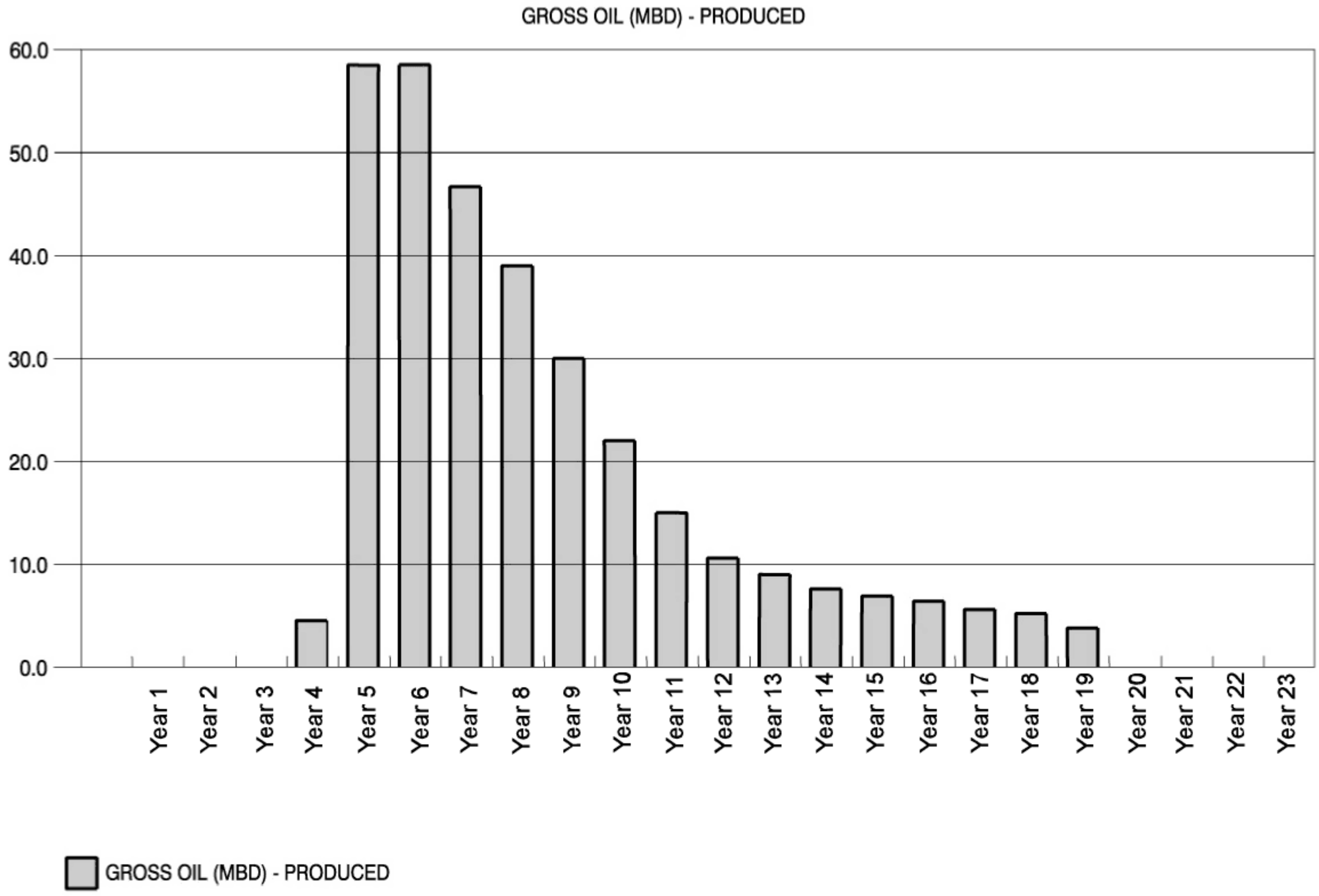

Figure II.A-20 Liberty Development Project: Projected Oil Production Schedule Years 4 through 19

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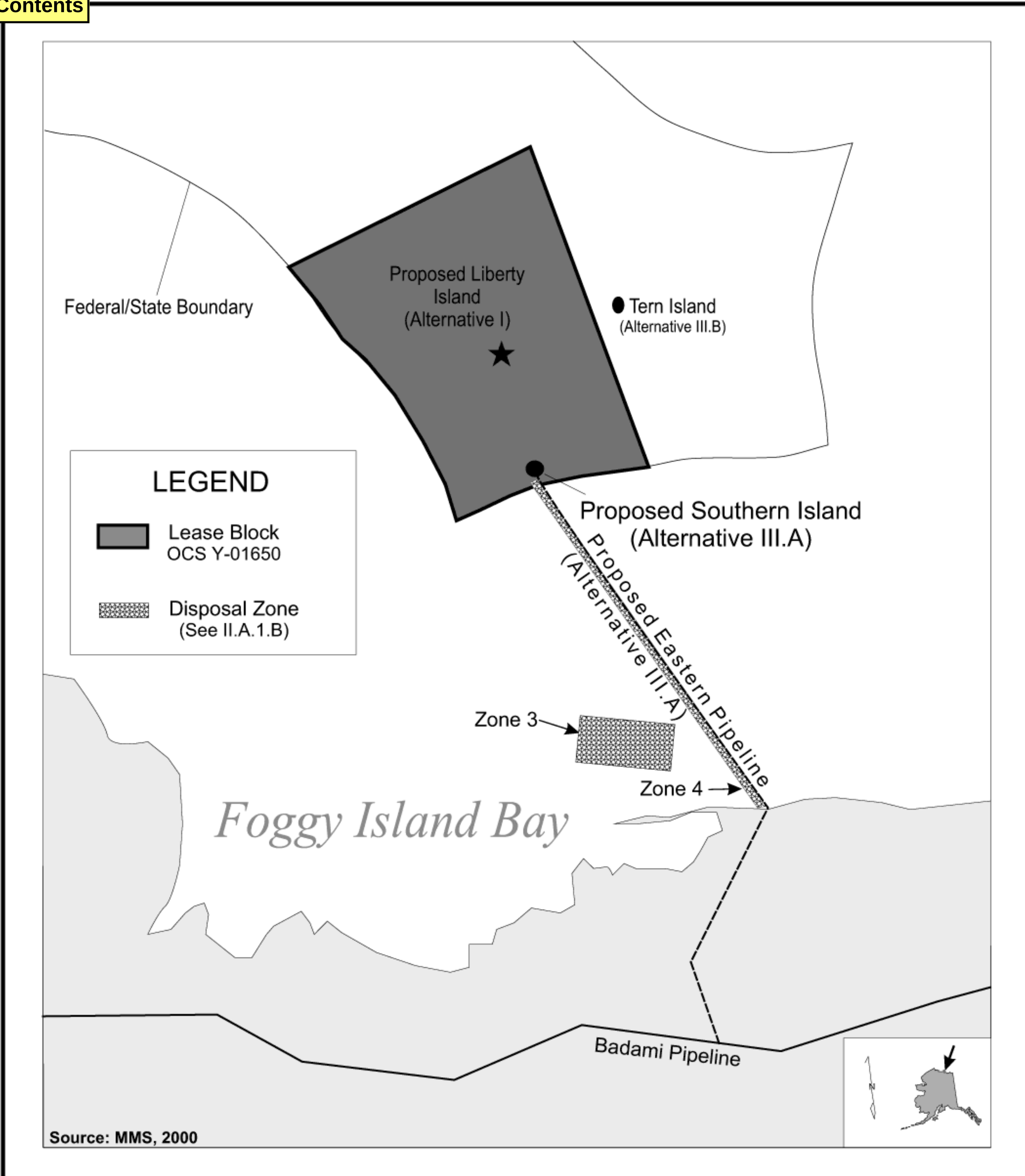

Figure II.C-1 Liberty Development Project: Alternative III.A Proposed Southern Island, Proposed Eastern Pipeline and Dredged Material Disposal Zones

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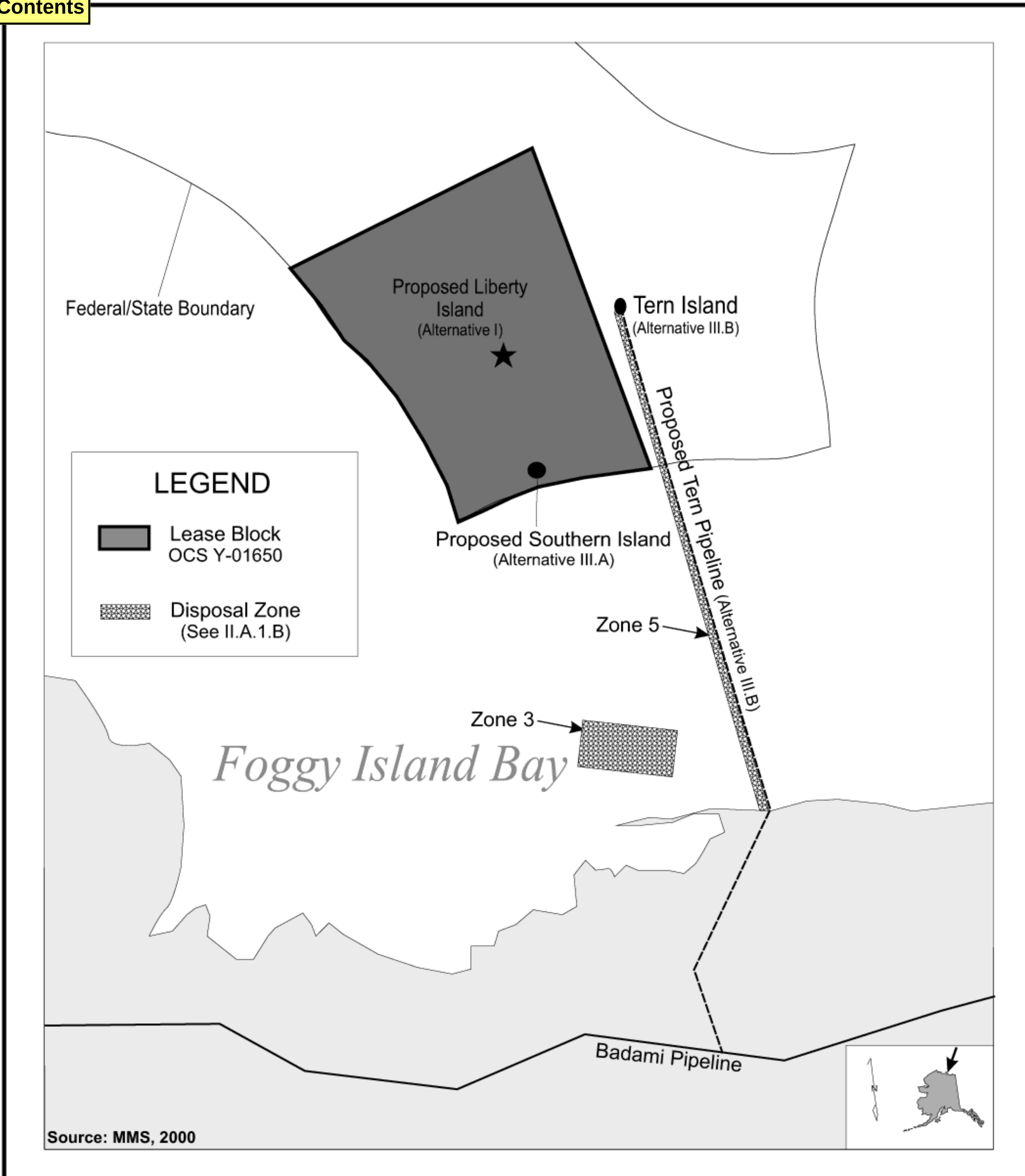

Figure II.C-2 Liberty Development Project: Alternative III.B Tern Island and Proposed Tern Pipeline and Dredged Material Disposal Zones

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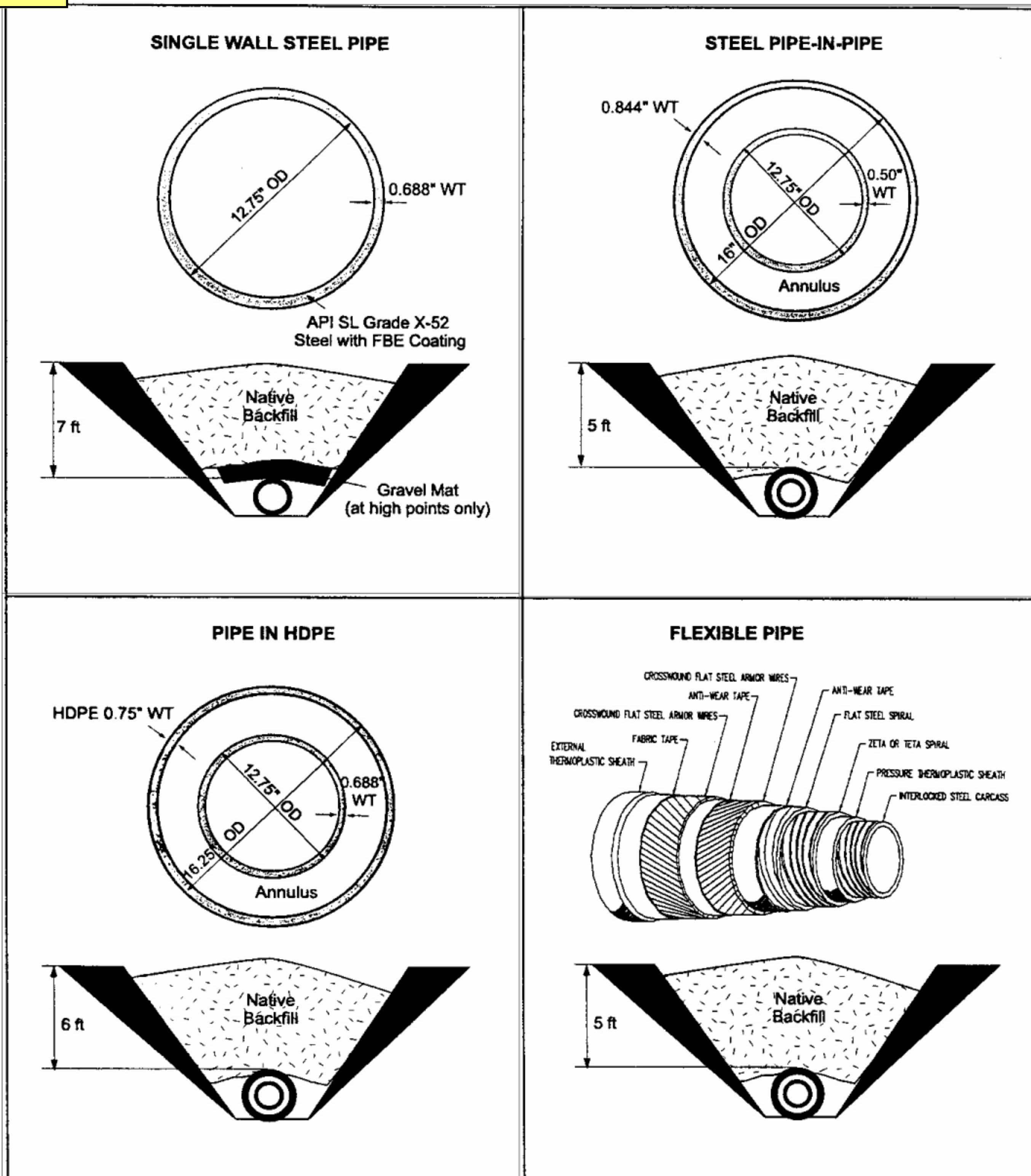

Figure II.C-3 Liberty Pipeline Design Comparison - Cross Sections

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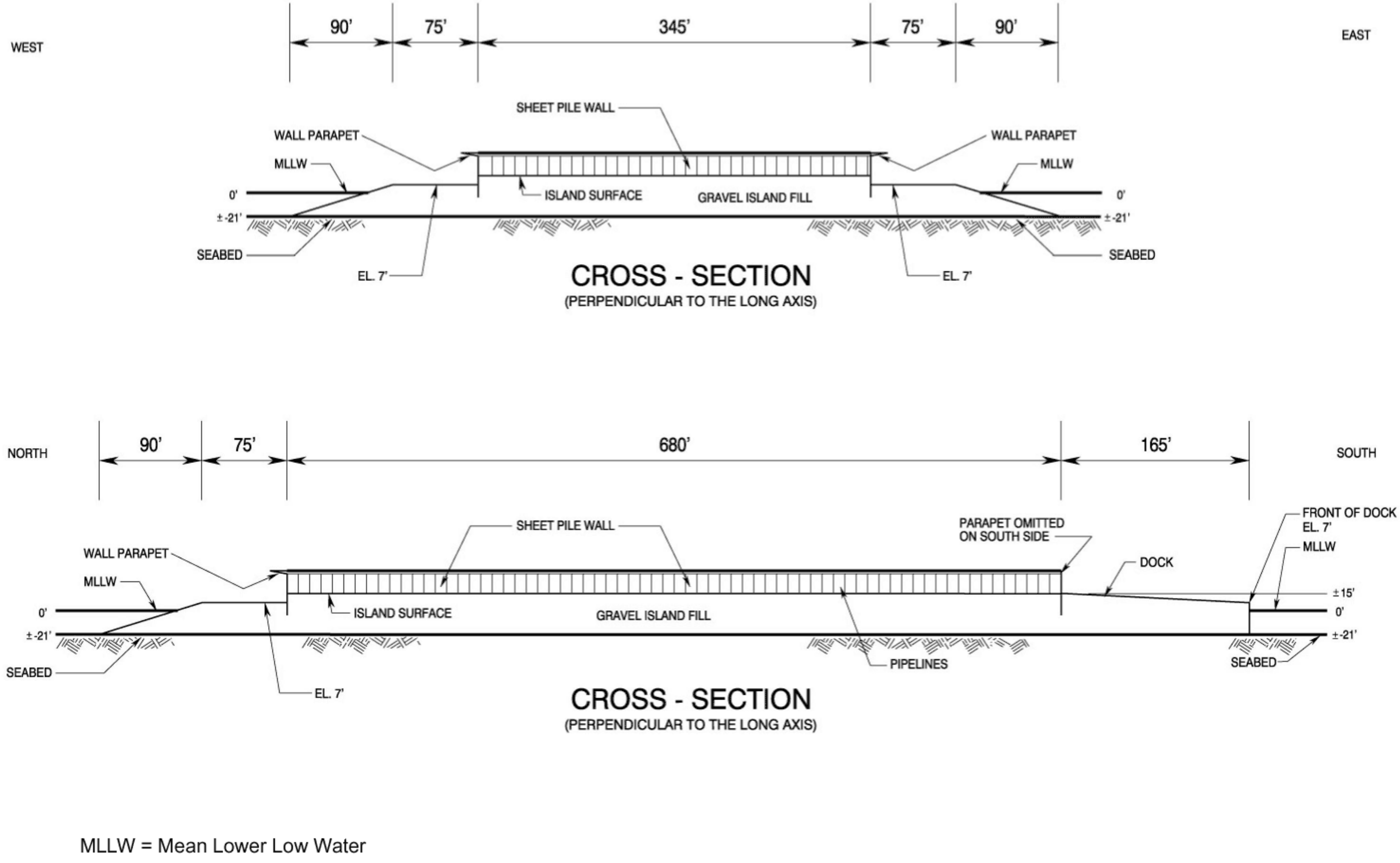

Source: BPXA, 1998b

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Figure II.C-4 Liberty Development Project: Sheet Pile Island (Alternative IV), Cross Sections

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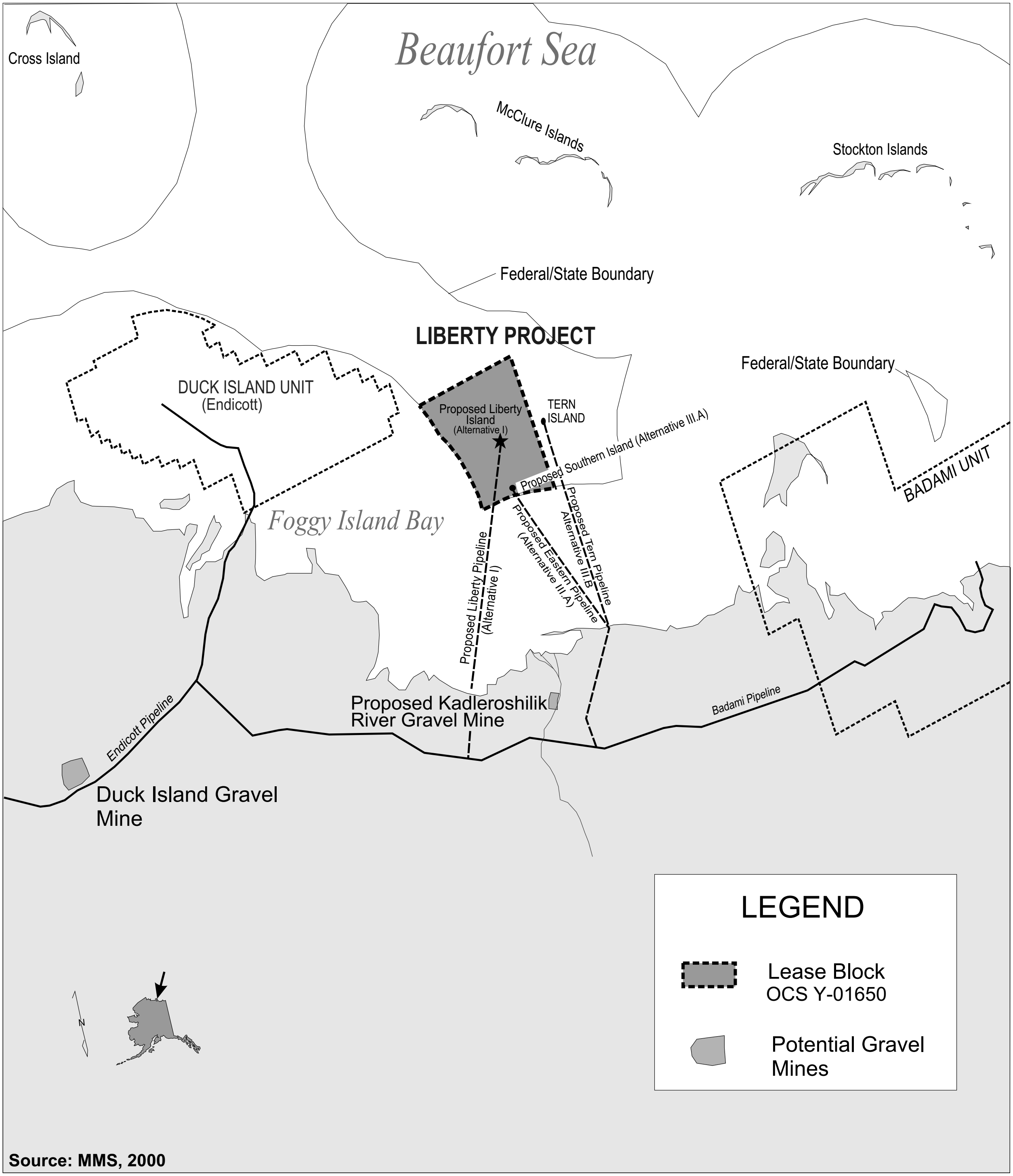

Figure II.C-5 Potential Gravel Mine Sites

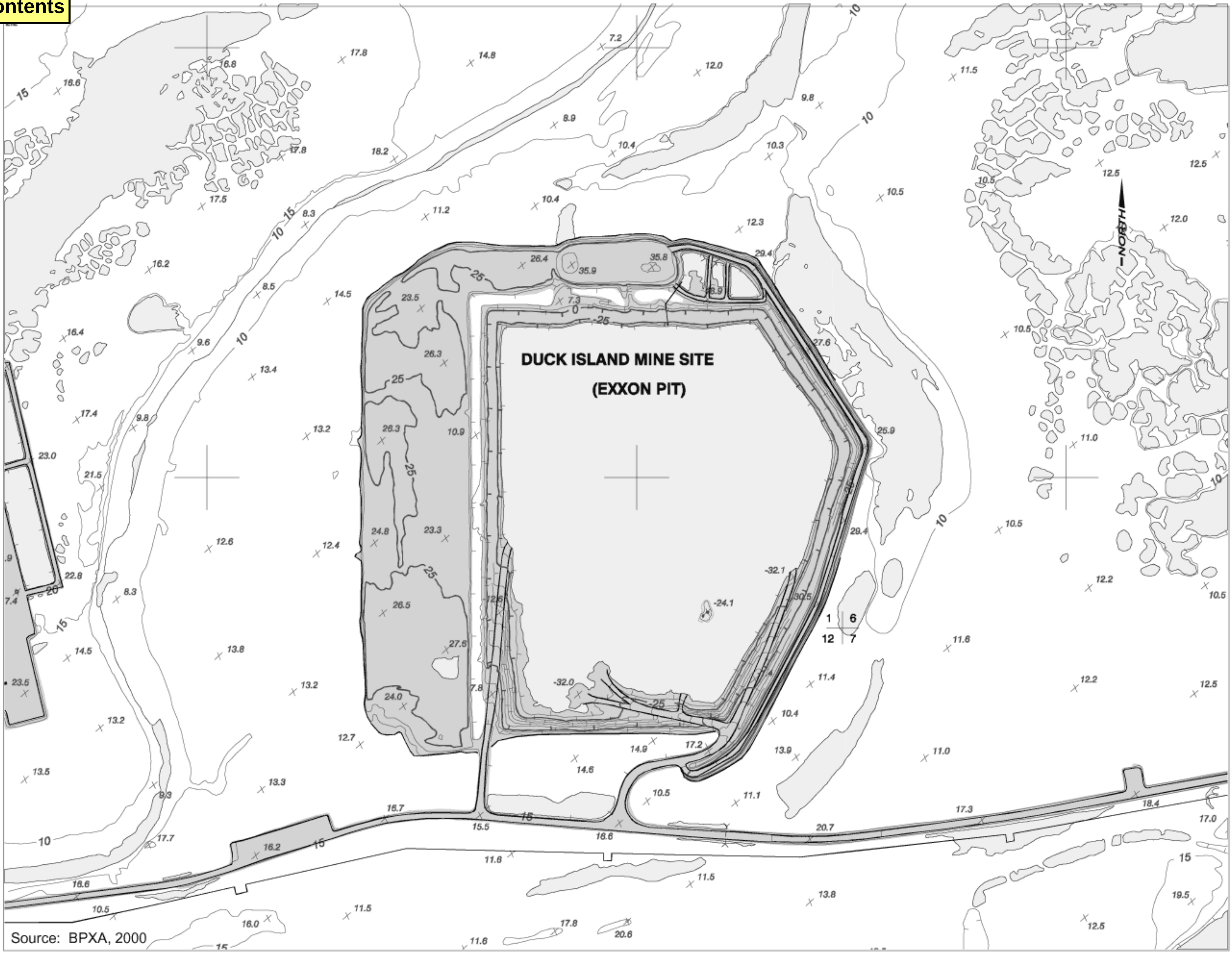

Figure II.C-6 Duck Island Mine Site - Existing Facility - Plan View

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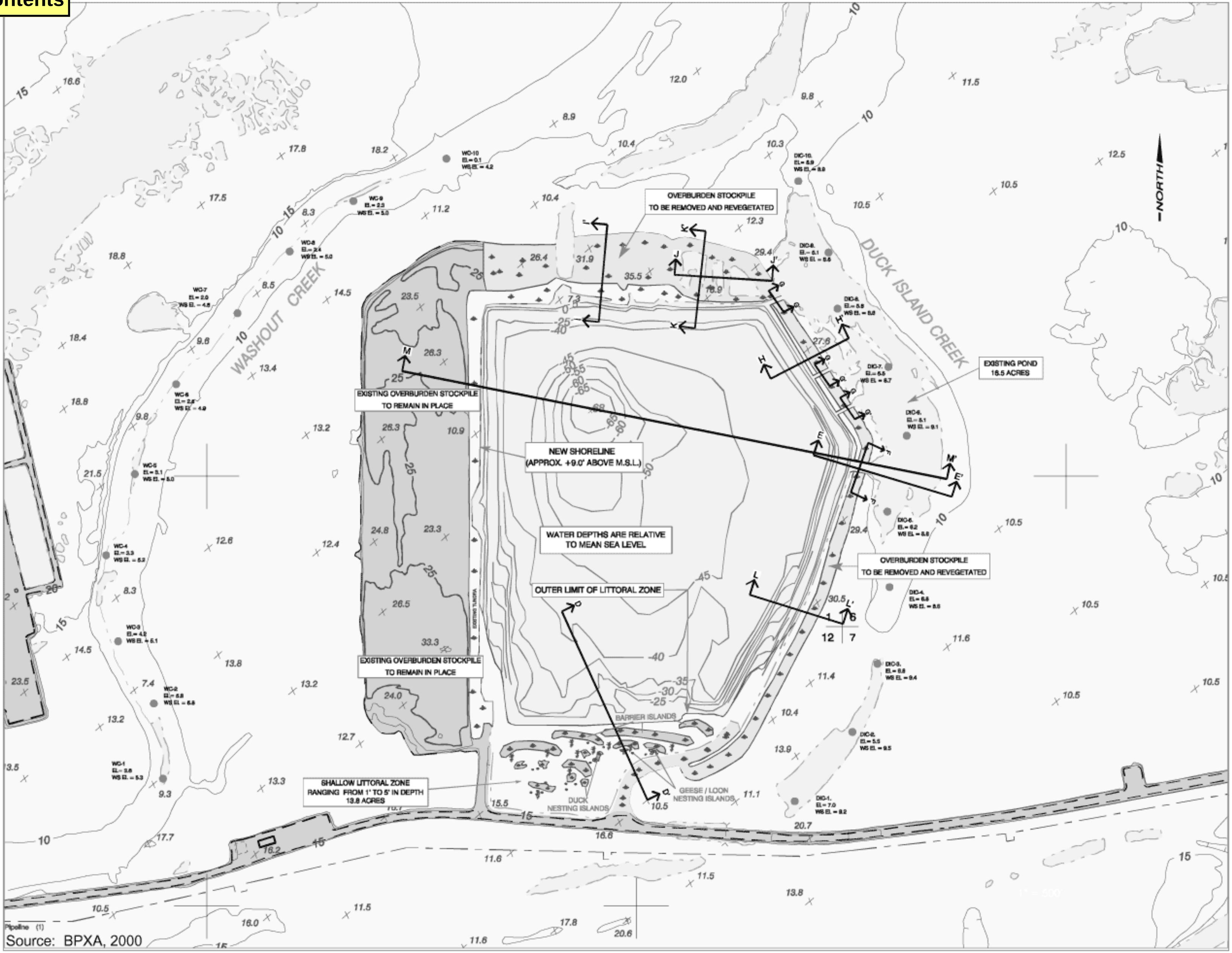

Figure II.C-7 Duck Island Mine Site - Proposed Restoration - Plan View

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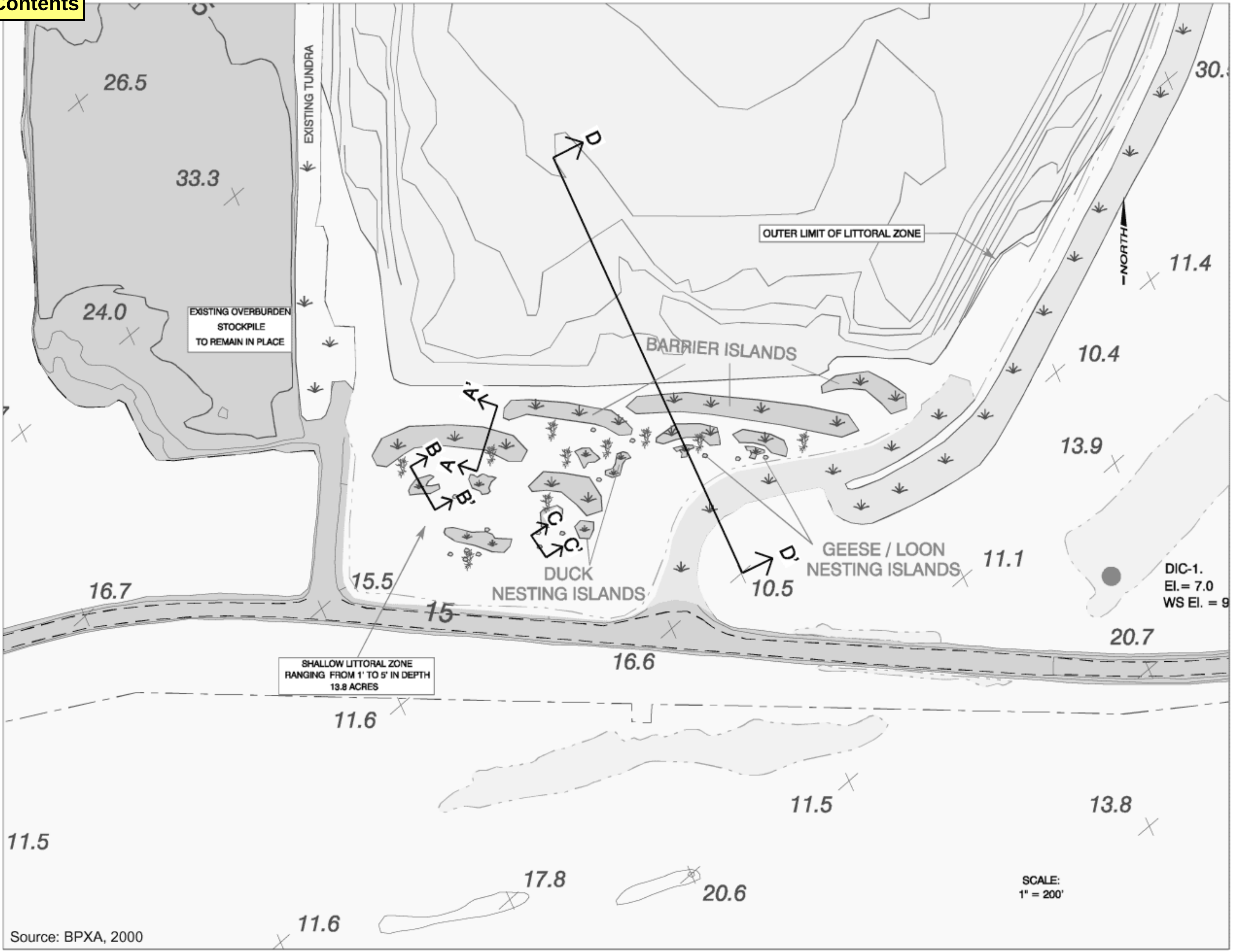
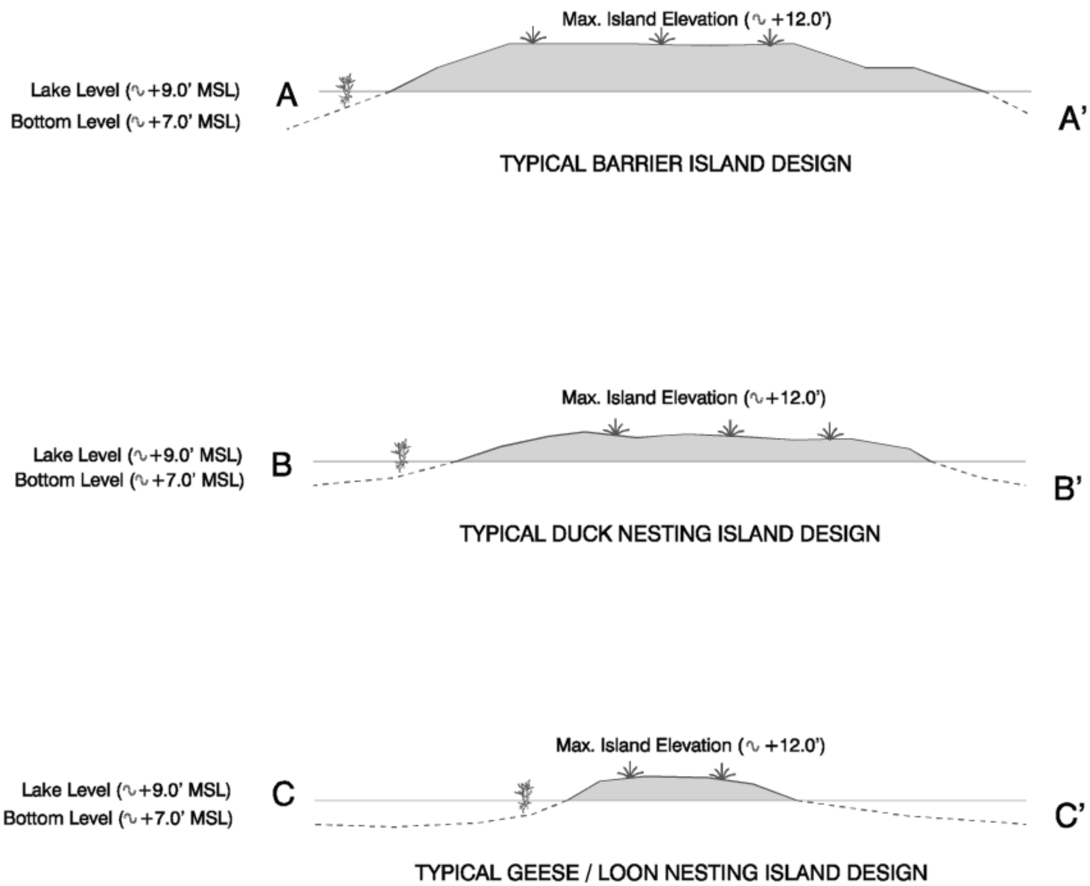


Figure II.C-8 Duck Island Mine Site - Proposed Restoration Littoral Zone - Plan View



Source: BPXA, 2000

Figure II.C-9 Duck Island Mine Site - Proposed Restoration - Typical Cross-Sections

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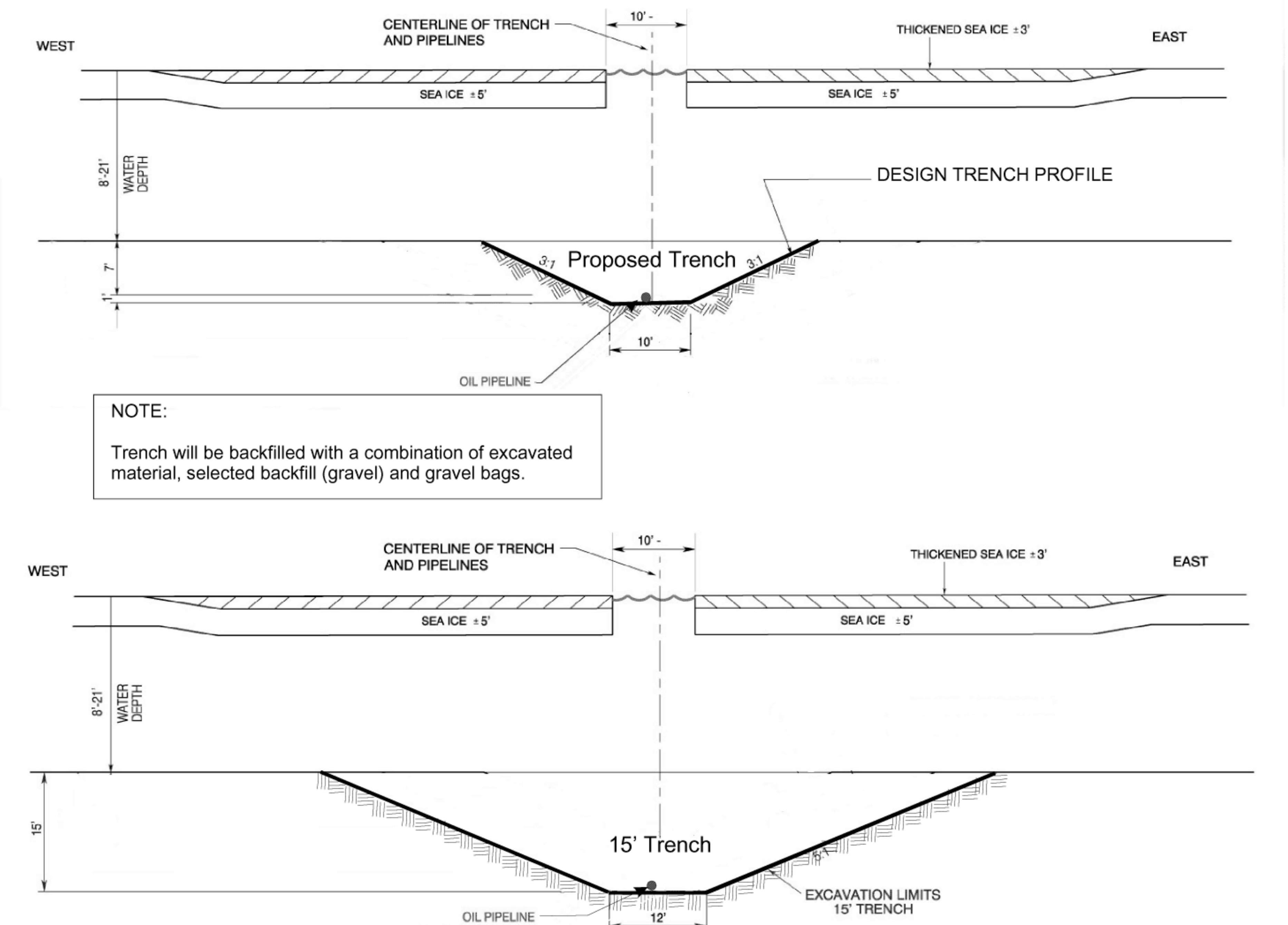

Source: BPXA, 1998b

Figure II.C-10 Liberty Development Project: Comparison of Proposed Trench (Alternative I) and 15-Foot Deep Trench (Alternative VII)

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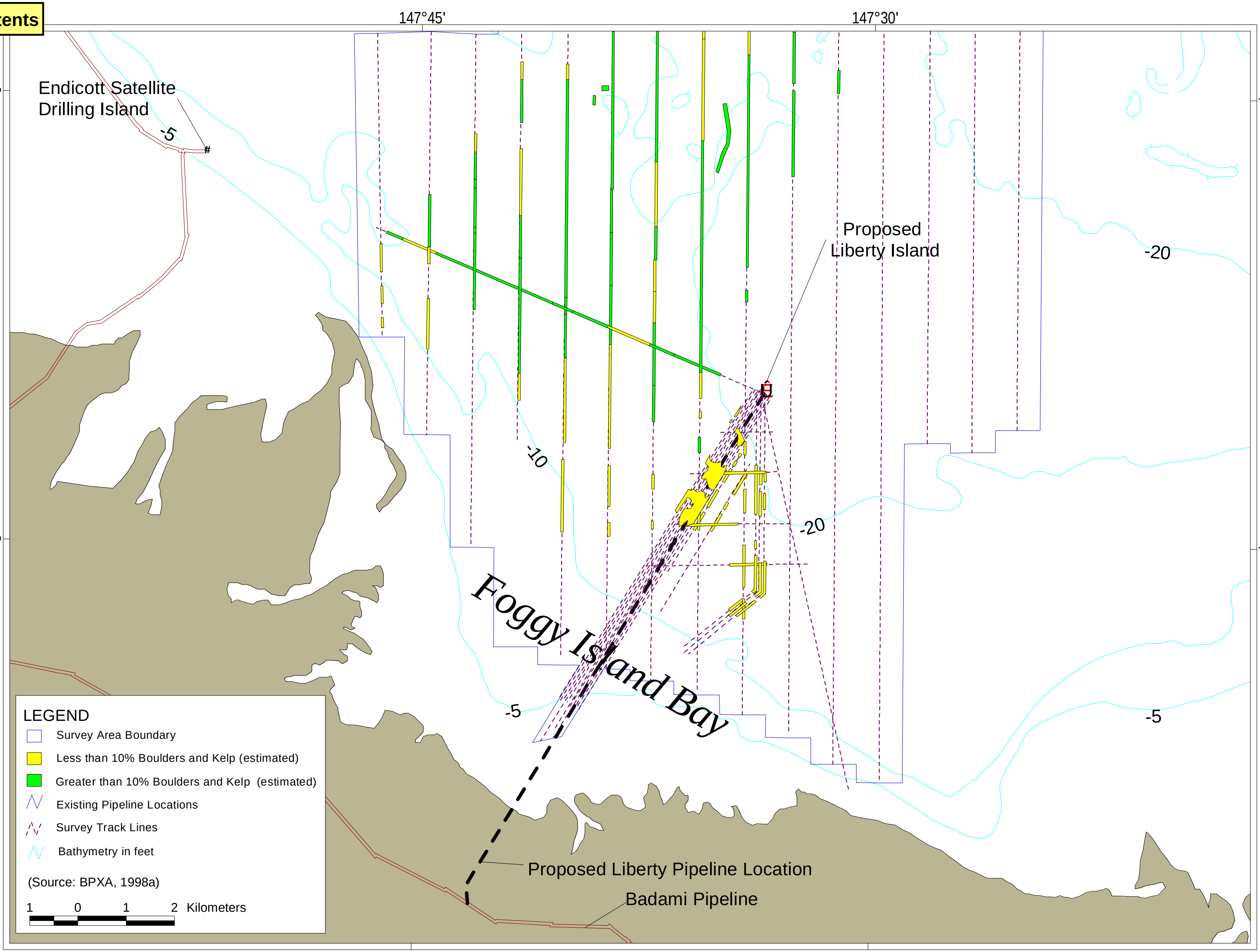

Figure III. C-1 Surveys of Boulder Patch Kelp Habitat

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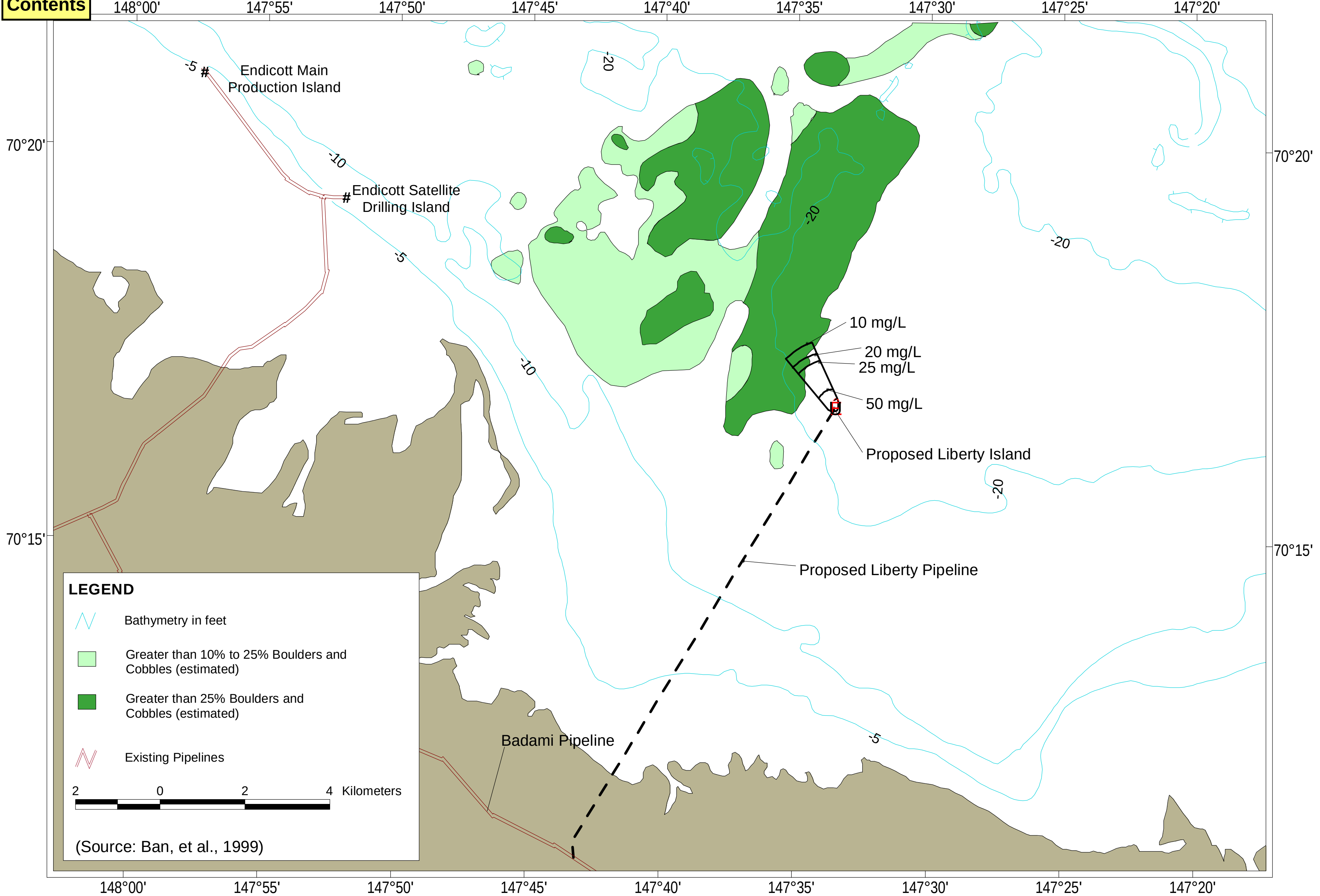


Figure III.C-2 Maximum Area of Boulder Patch Kelp Habitat that would be Exposed to Suspended Solids from Liberty Island Construction, Winter Conditions, Concentrations in Milligrams per Liter (mg/L).

Contents

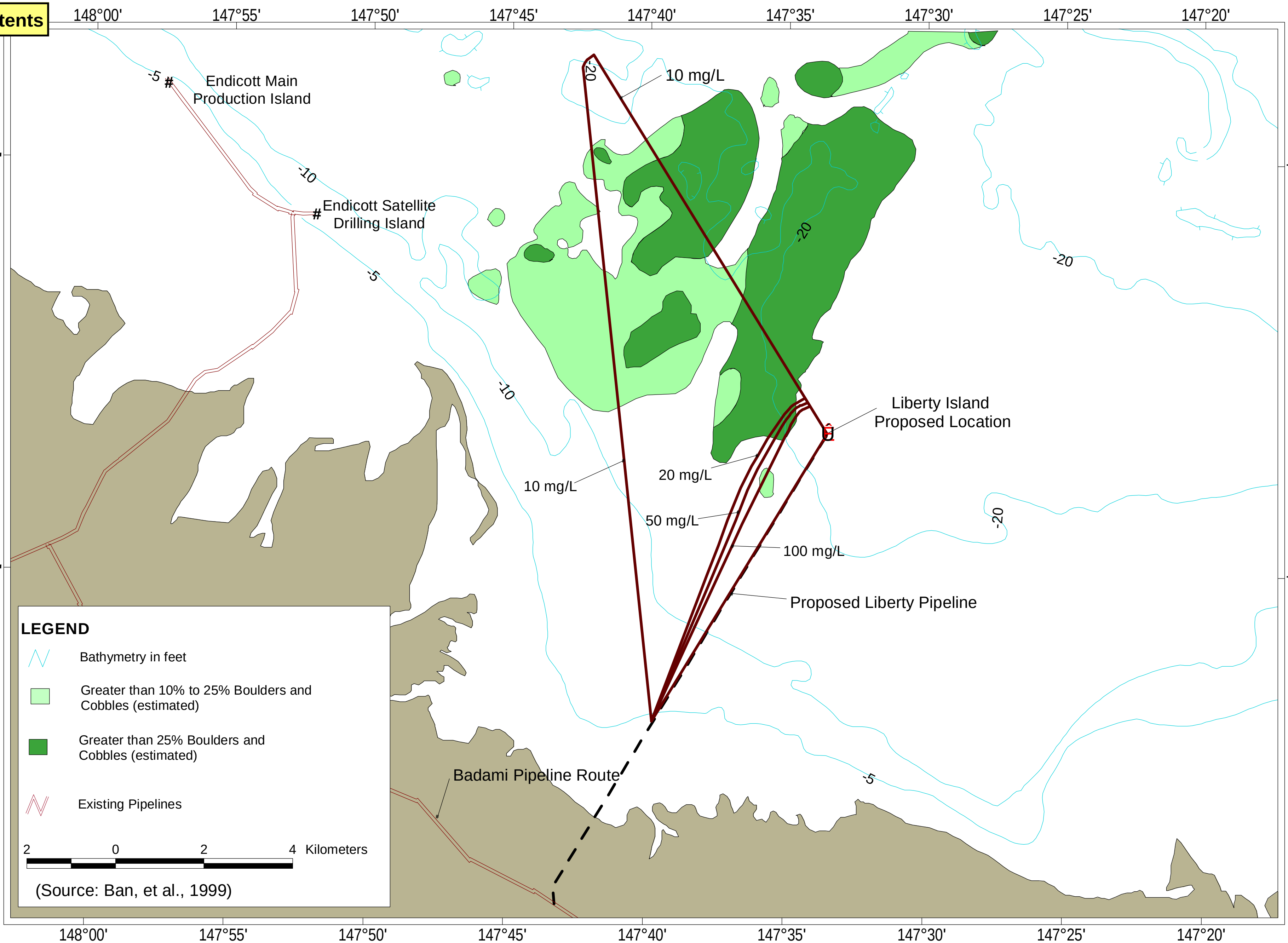


Figure III.C-3 Maximum Area of Boulder Patch Kelp Habitat Exposure to Suspended Solids from Liberty Pipeline Construction, Winter Conditions, Concentrations in Miligrams/per Liter (mg/L).

Contents

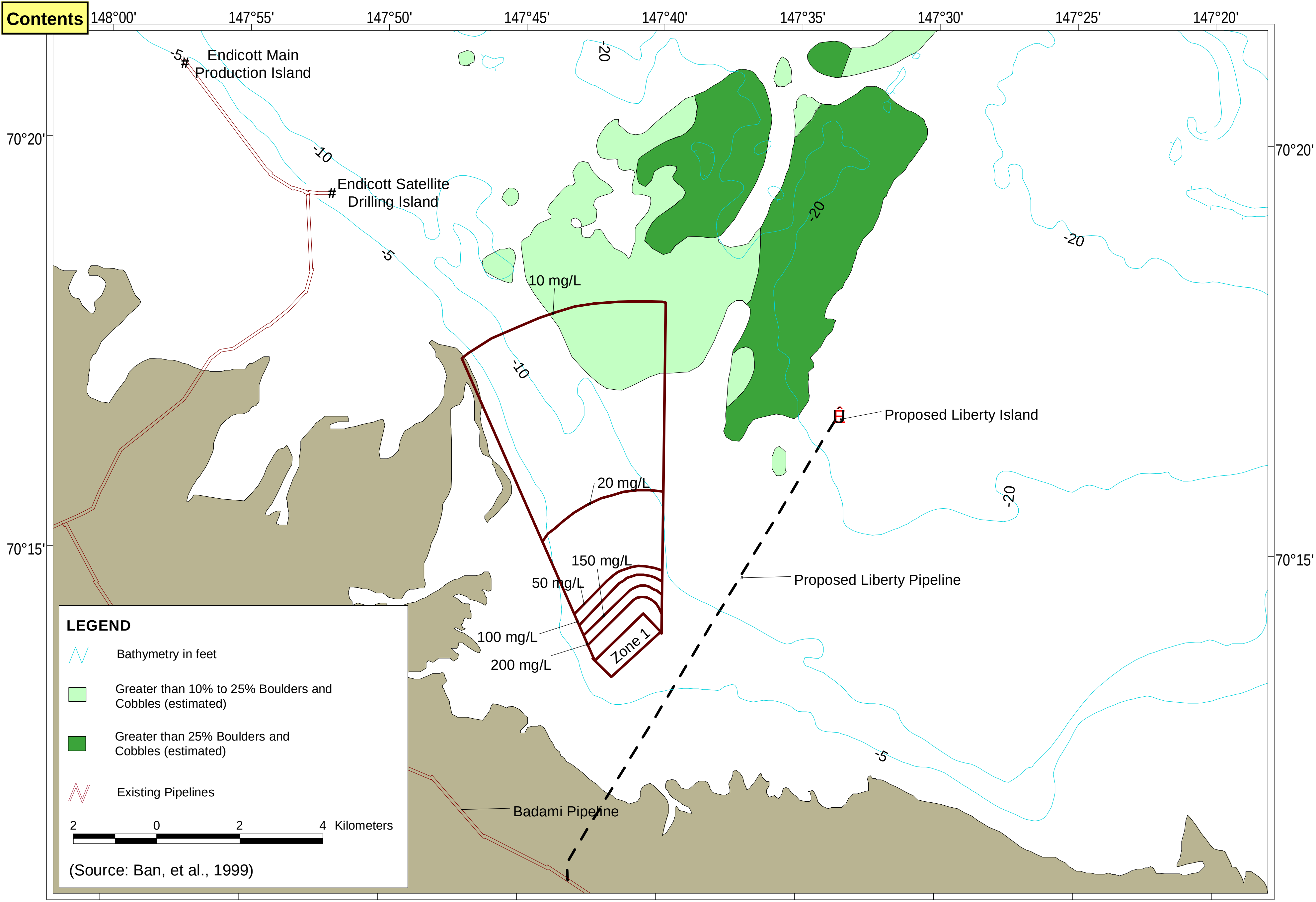
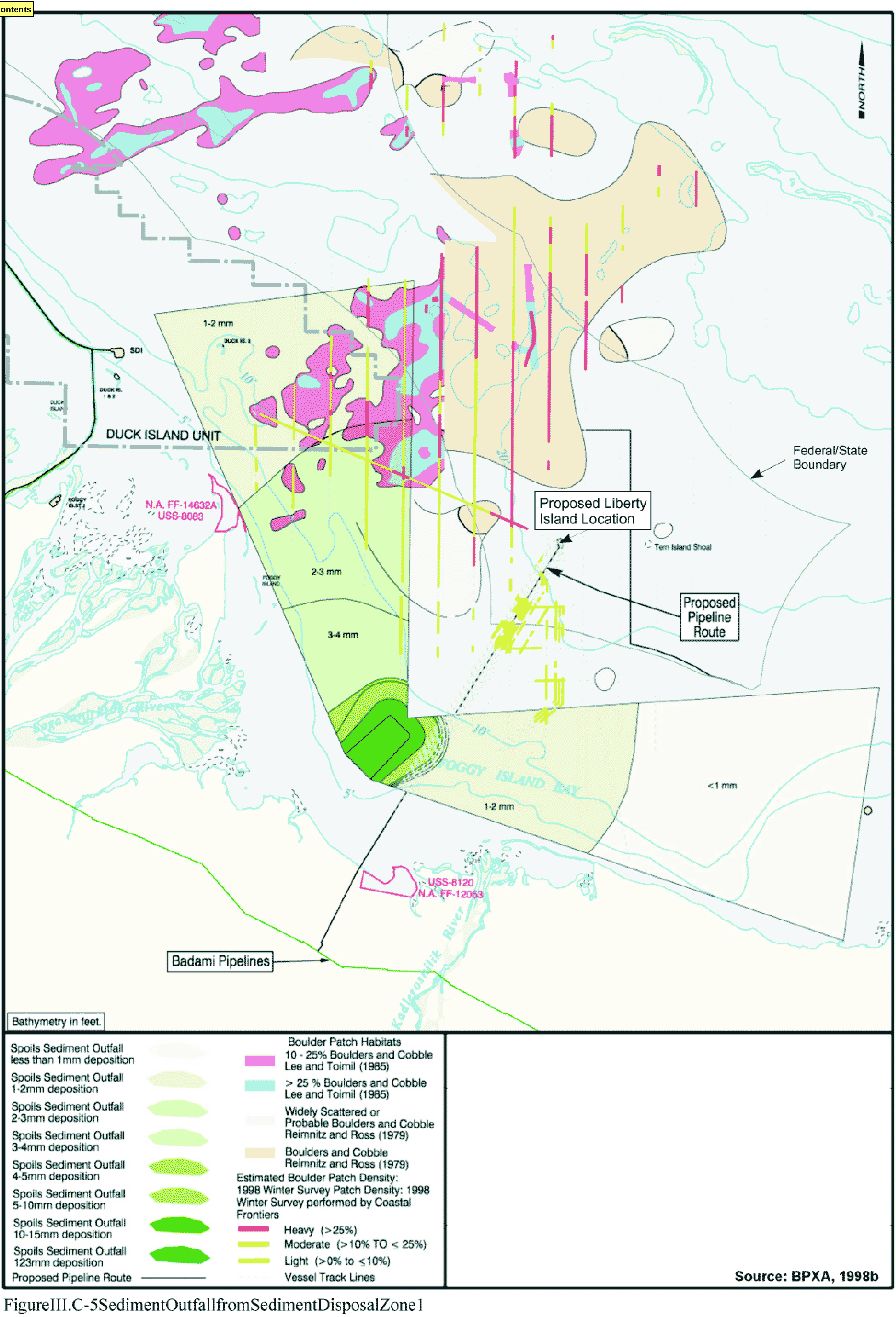


Figure III.C-4 Maximum Area of Boulder Patch Kelp Habitat Exposure to Suspended Solids from Alternative I Dredged Material Disposal Zone 1, Breakup Conditions, Concentrations in Miligrams per Liter (mg/L).



FigureIII.C-5SedimentOutfallfromSedimentDisposalZone1

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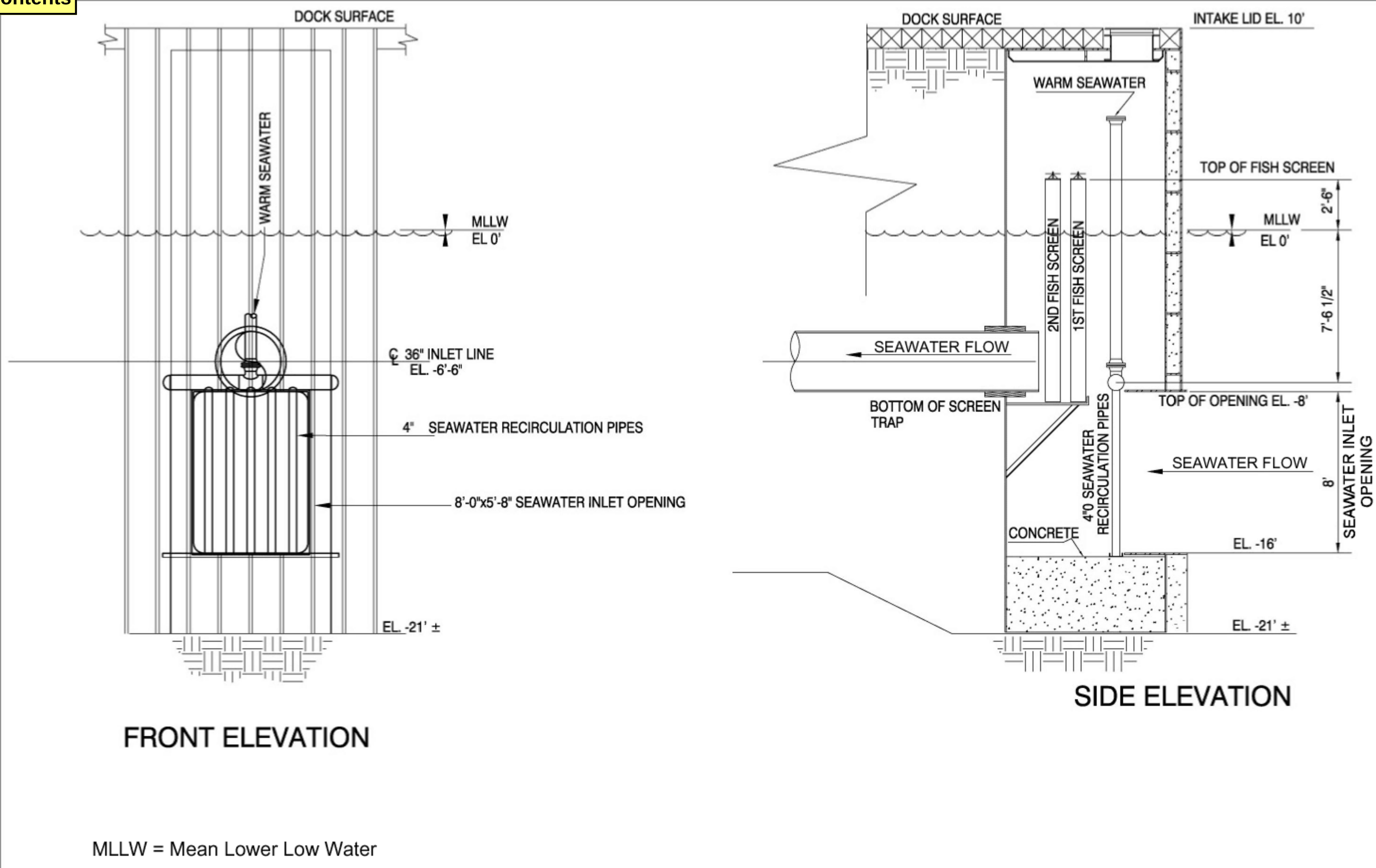

Source: BPXA, 1998b

ALL DIMENSIONS ARE APPROXIMATE

Figure III.D-1 Liberty Development Project: Seawater Intake Detail

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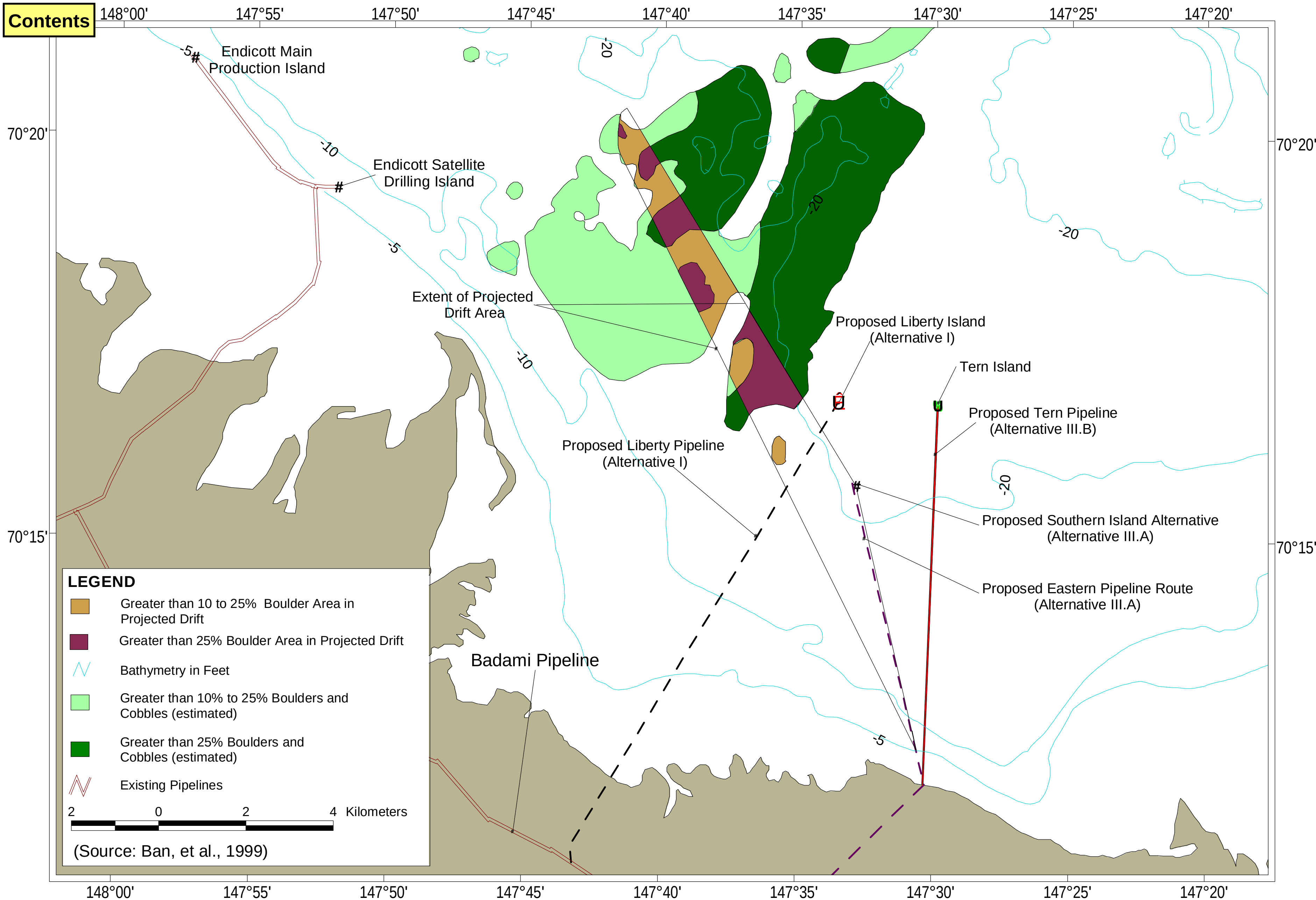

Figure IV.C-1 Maximum Area of Boulder Patch Kelp Habitat Exposure to Suspended Solids from the Proposed Eastern Pipeline Trench Excavation.

Contents

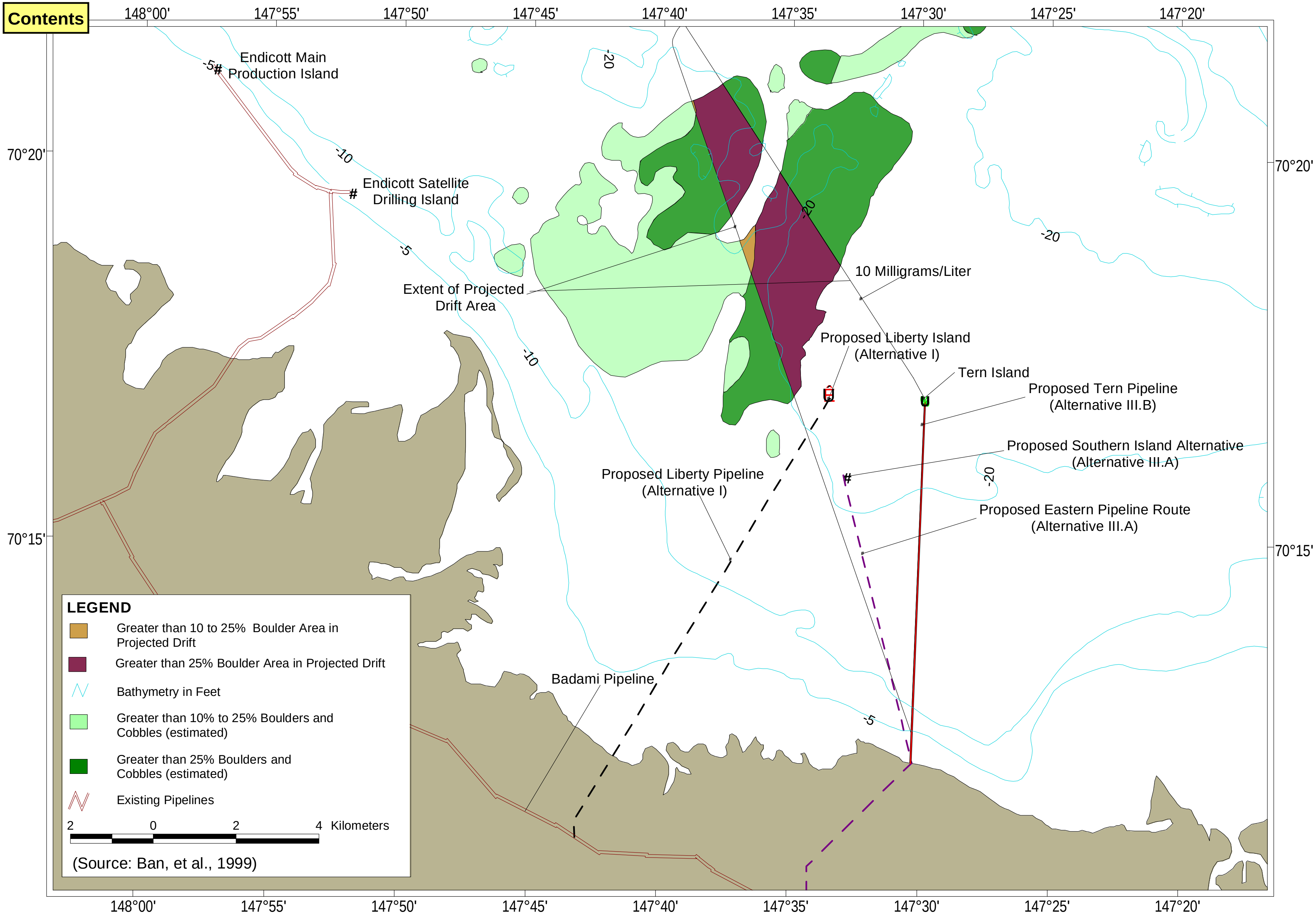

Figure IV.C-2 Maximum Area of Boulder Patch Kelp Habitat Exposure to Suspended Solids from the Proposed Tern Pipeline Trench Excavation.

Contents

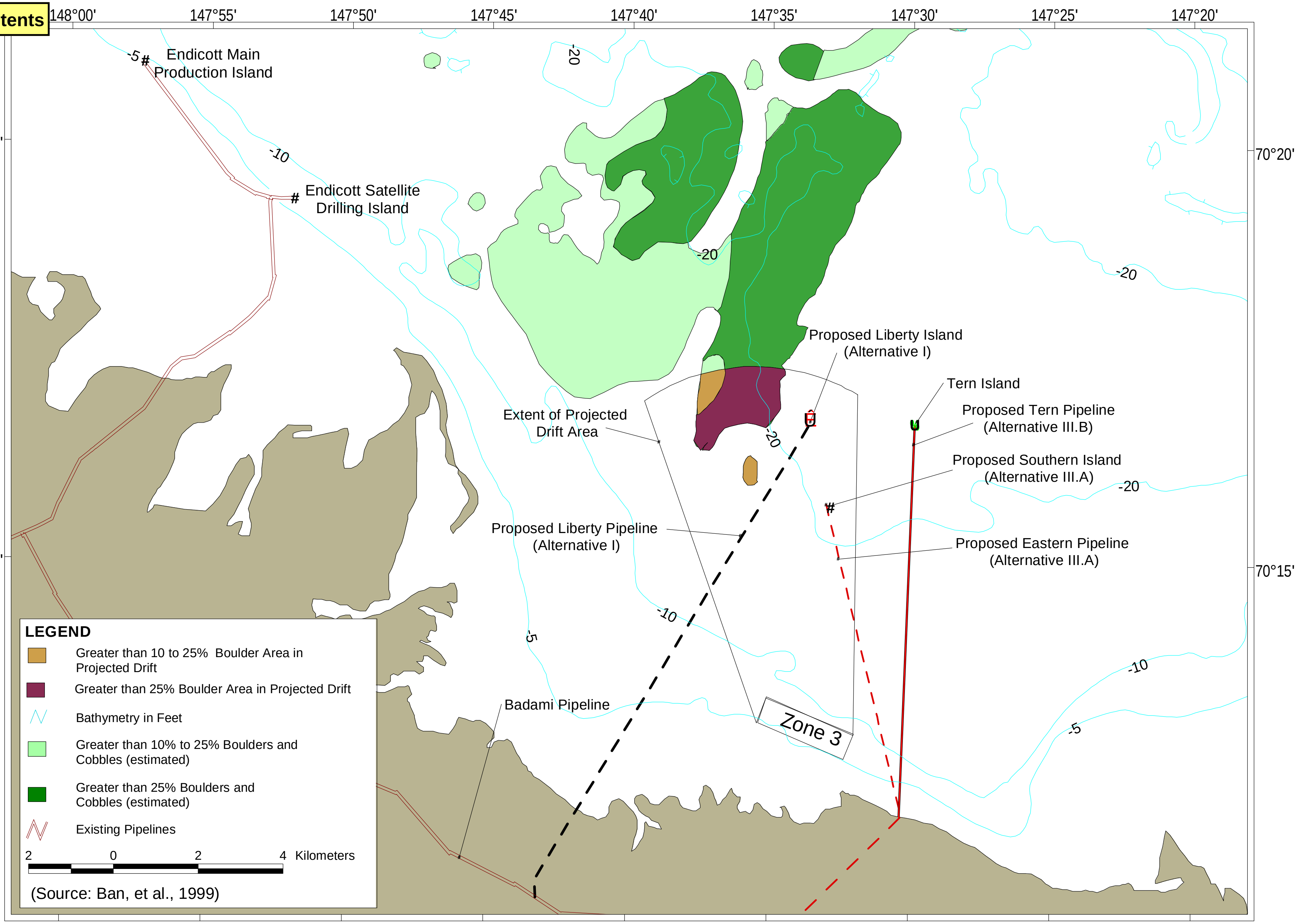

Figure IV.C-3 Maximum Area of Boulder Patch Kelp Habitat Exposure to Suspended Solids from the Disposal of Excavated Trench Materials in Zone 3 .

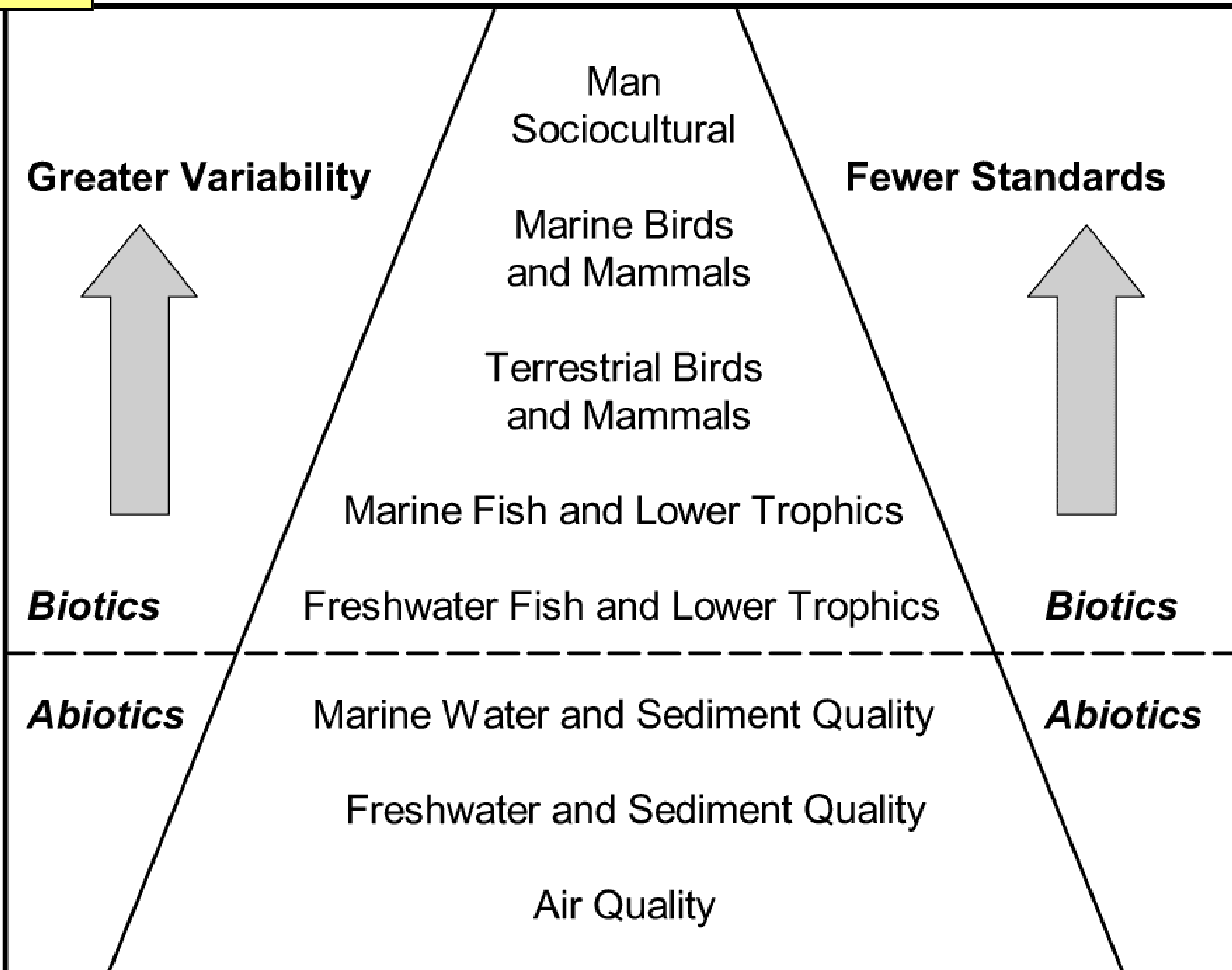

Figure V-1 Relationship Among Resources, Standards, and Degree of Variability

Contents

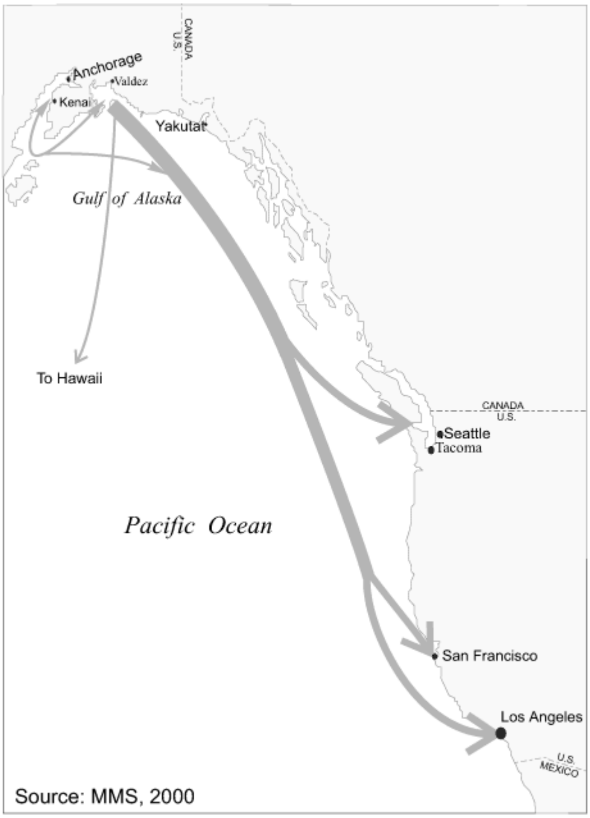

Figure V-2 General Tanker Routes and Ports of Entry

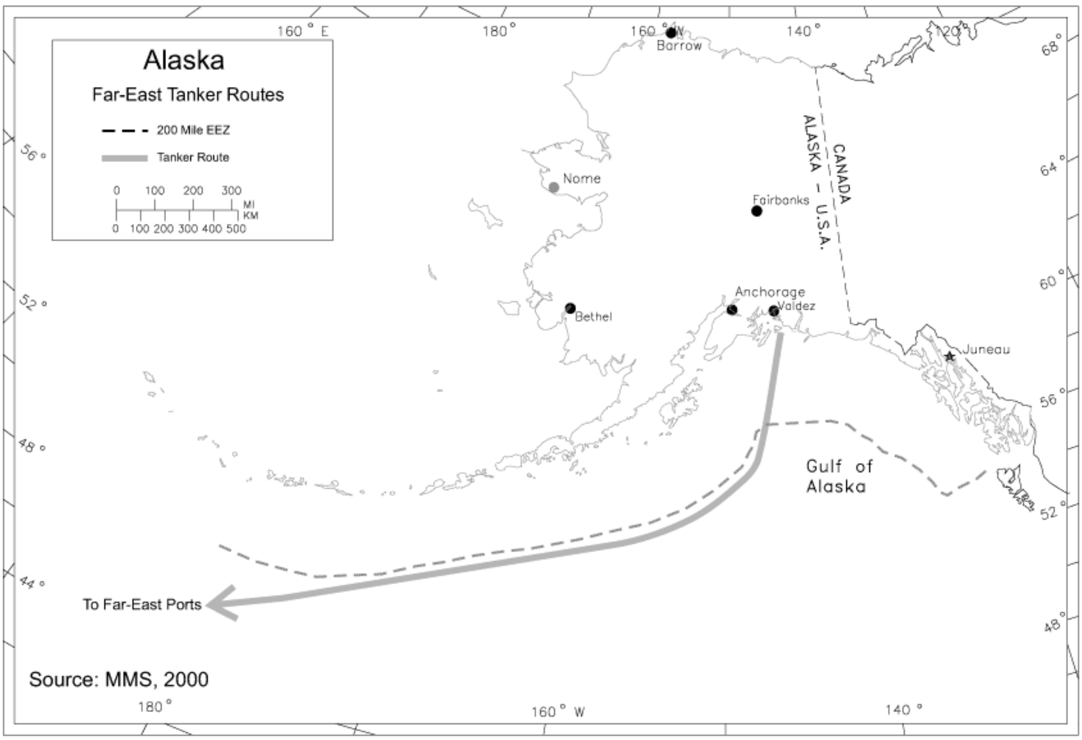

Figure V-3 Potential Valdez to Far East Tanker Route

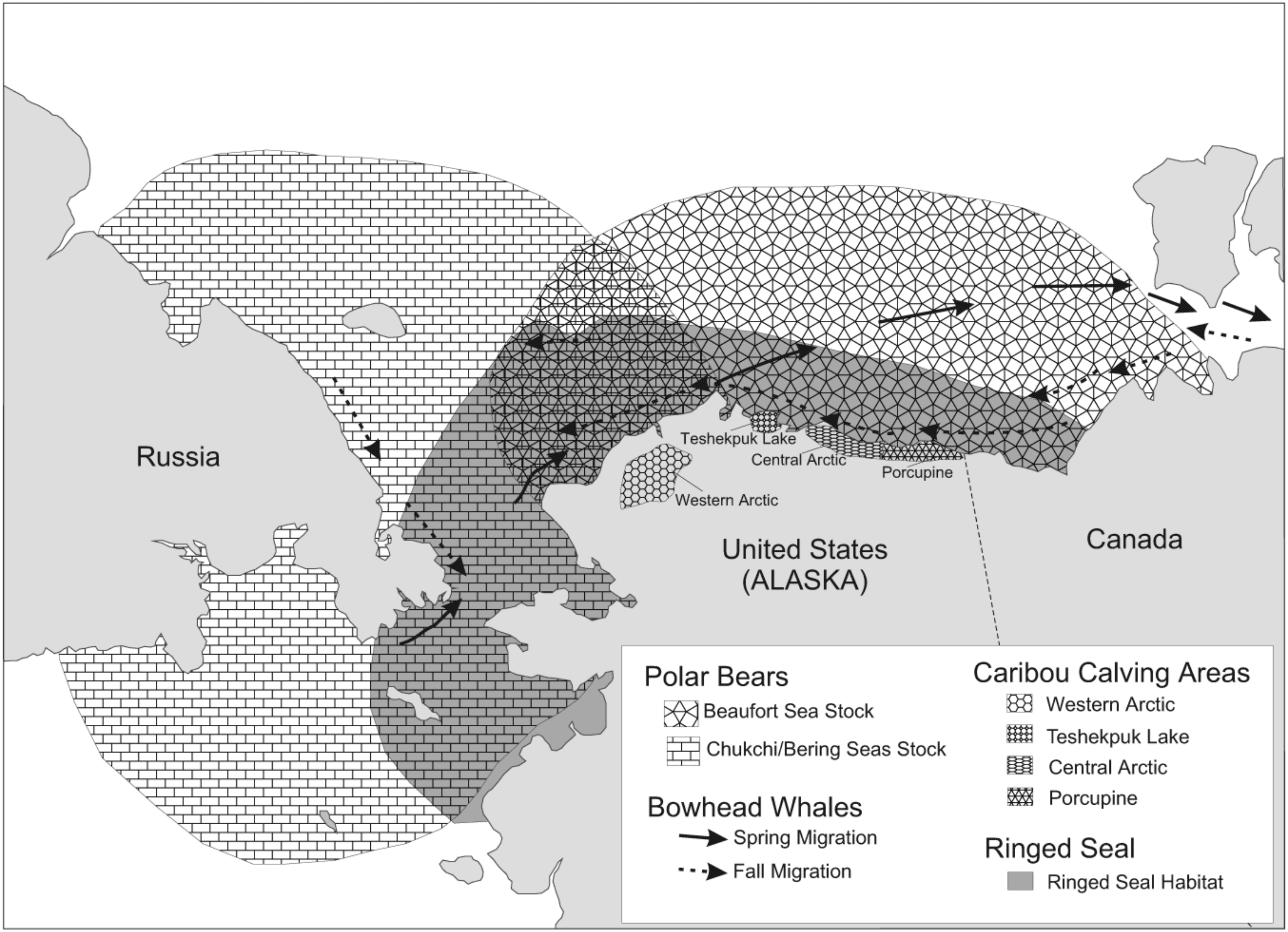

Figure V-4 Polar Bear Stocks, Ringed Seal Habitat, Bowhead Whale Migration Routes, and Caribou Calving Areas.

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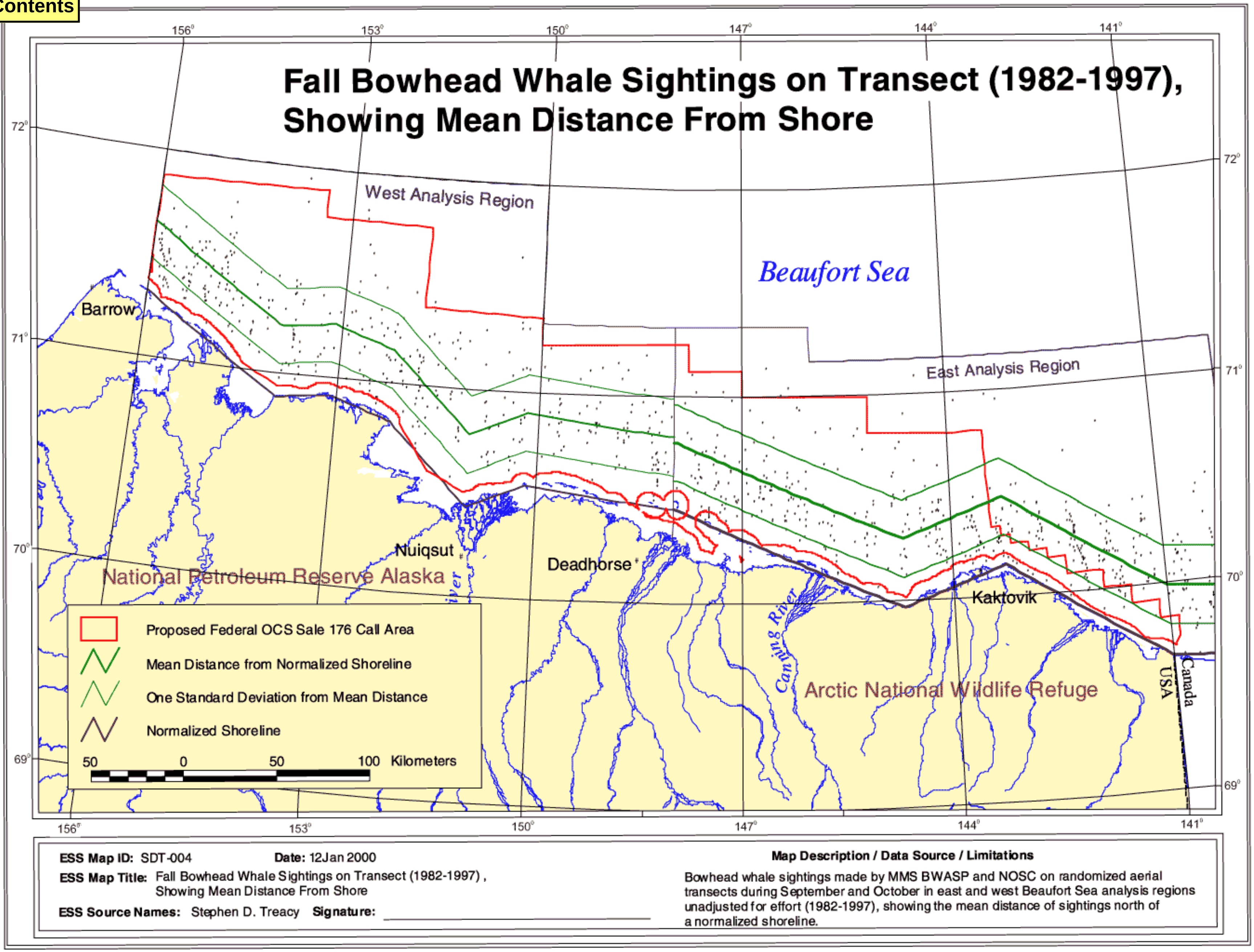

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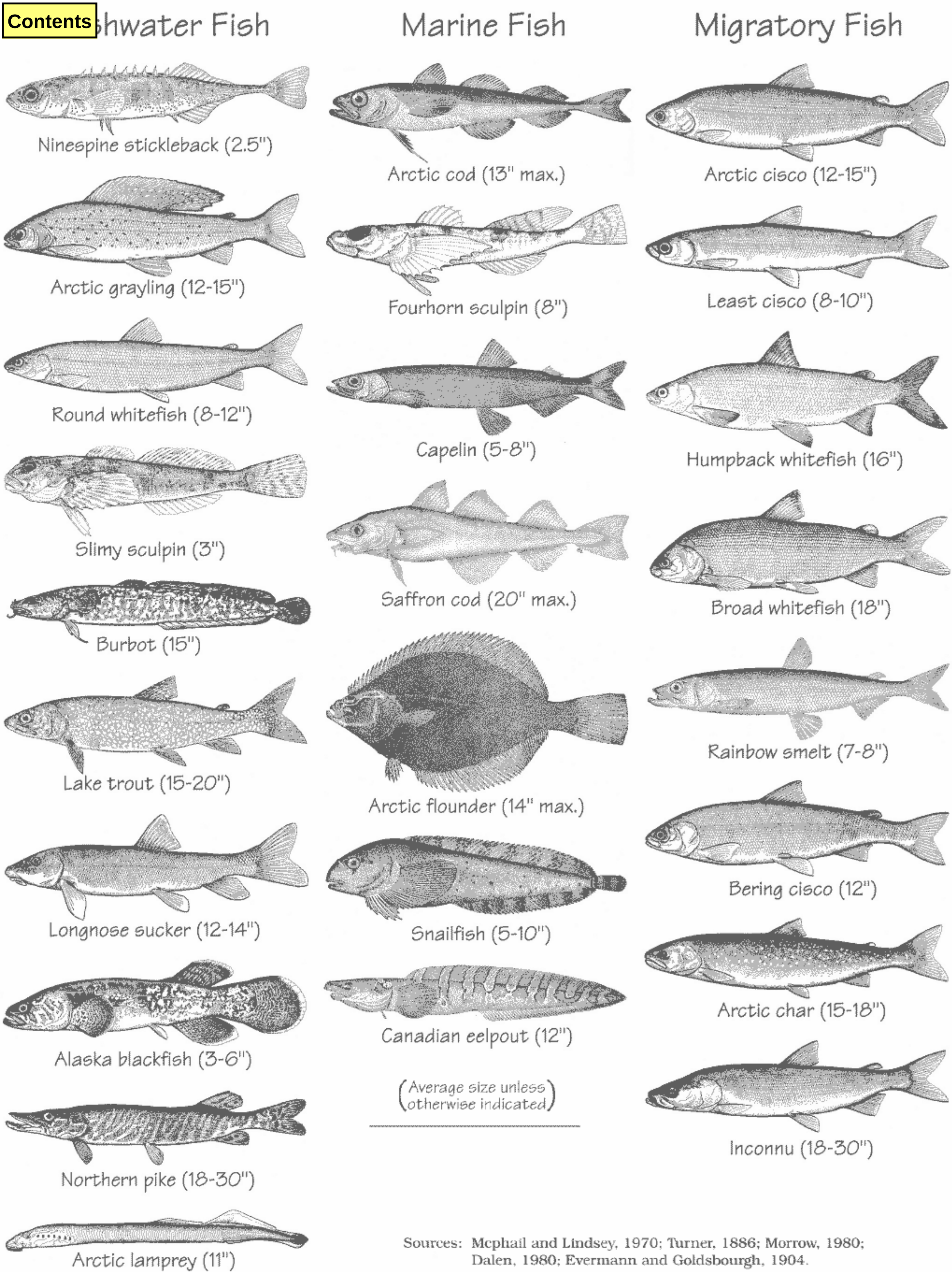

Sources: Mcphail and Lindsey, 1970; Turner, 1886; Morrow, 1980; Dalen, 1980; Evermann and Goldsbourgh, 1904.

Figure VI.A-2 Fish of the Arctic Environment

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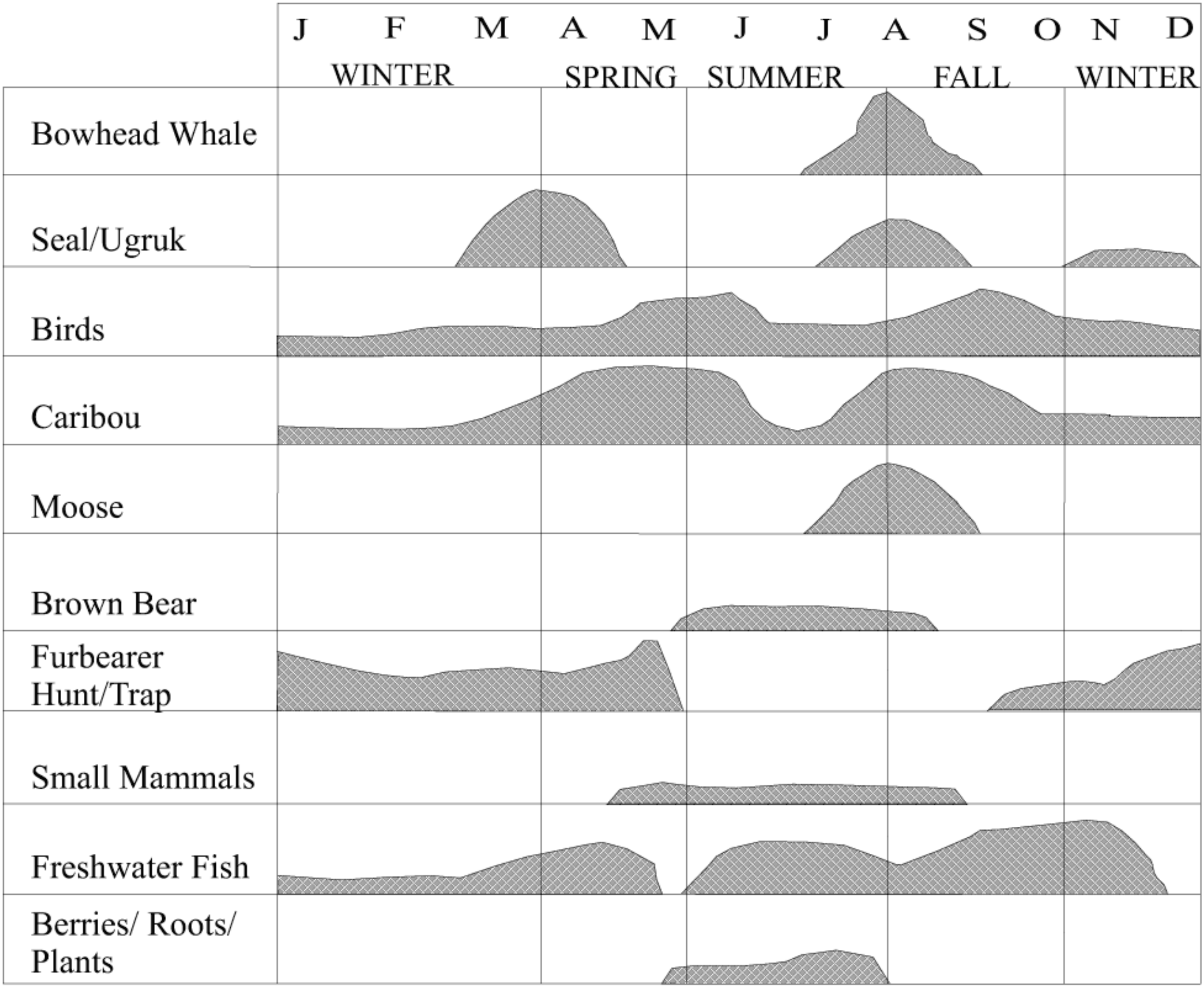

Figure VI.B-1 Nuiqsut Annual Subsistence Cycle. Patterns indicate desired periods for pursuit of each species based upon the relationship of abundance, hunter access, seasonal needs, and desirability. Peaks represent optimal periods of pursuit of subsistence resources. (Data for invertebrates, sheep, and ocean fish are unavailable.)
Source: North Slope Borough Contract Staff, 1979; Impact Assistance, Inc., 1990.

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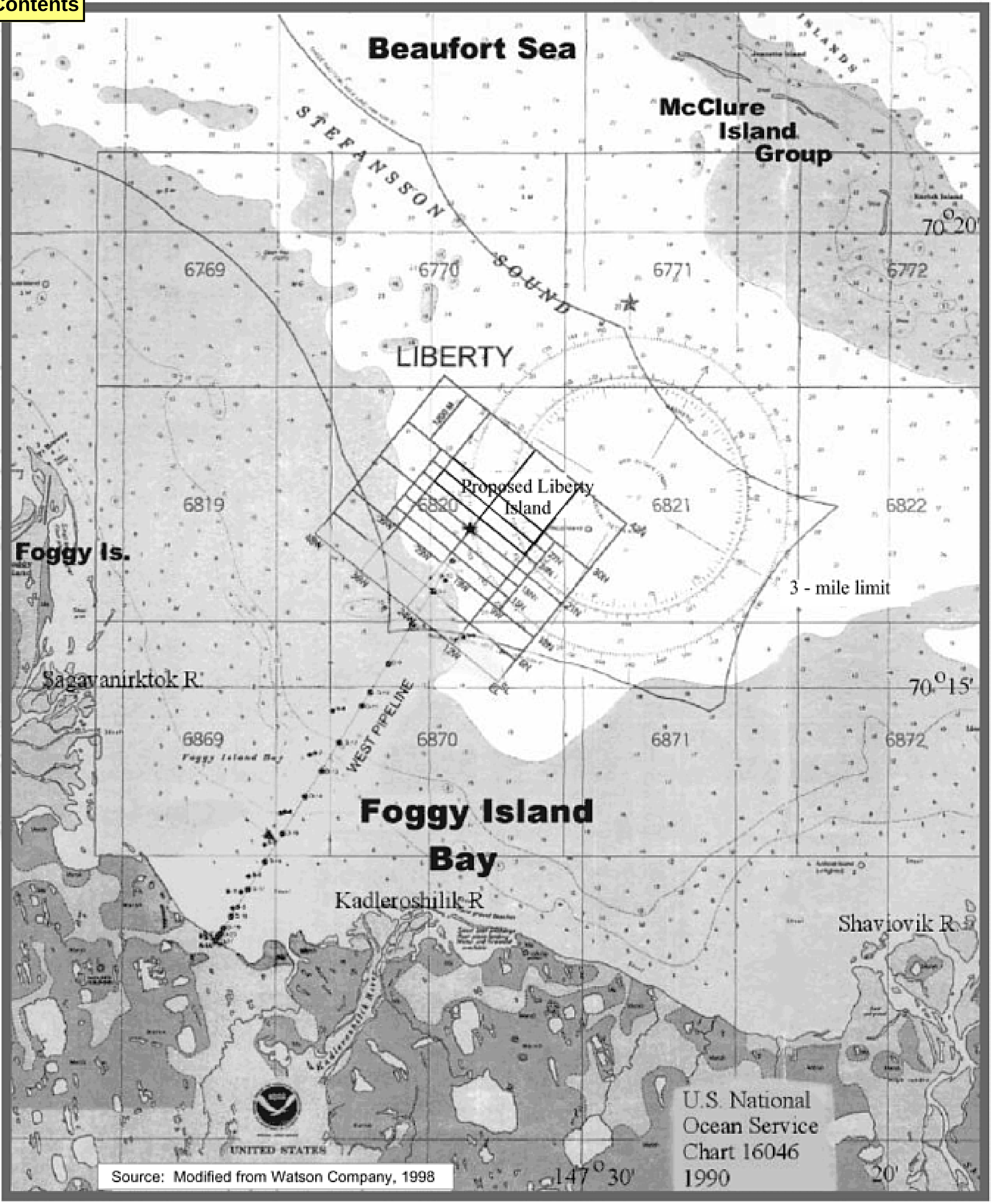

Figure VI.C-1 Index map showing the proposed Liberty Island site.

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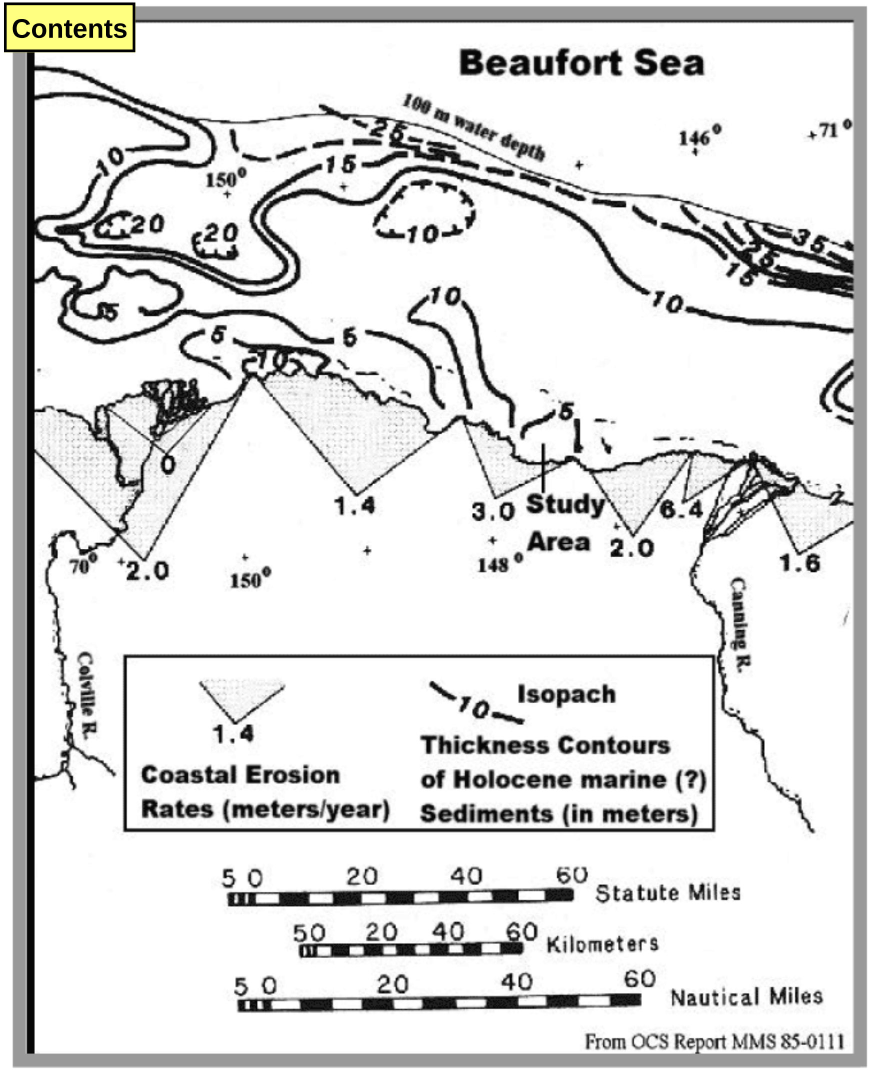

Figure VI.C-2 Isopach map showing thickness of the shallow Holocene, seismically transparent, unit that is interpreted as being composed of marine sediments (modified from Dinter, 1982). Erosion rates for shoreline segments are shown in meters per year and were measured in 20- and 30-year intervals (after Hopkins and Hartz, 1978). This figure is reproduced from the Beaufort Sea Geologic Report (OCS Report MMS 85-0111).

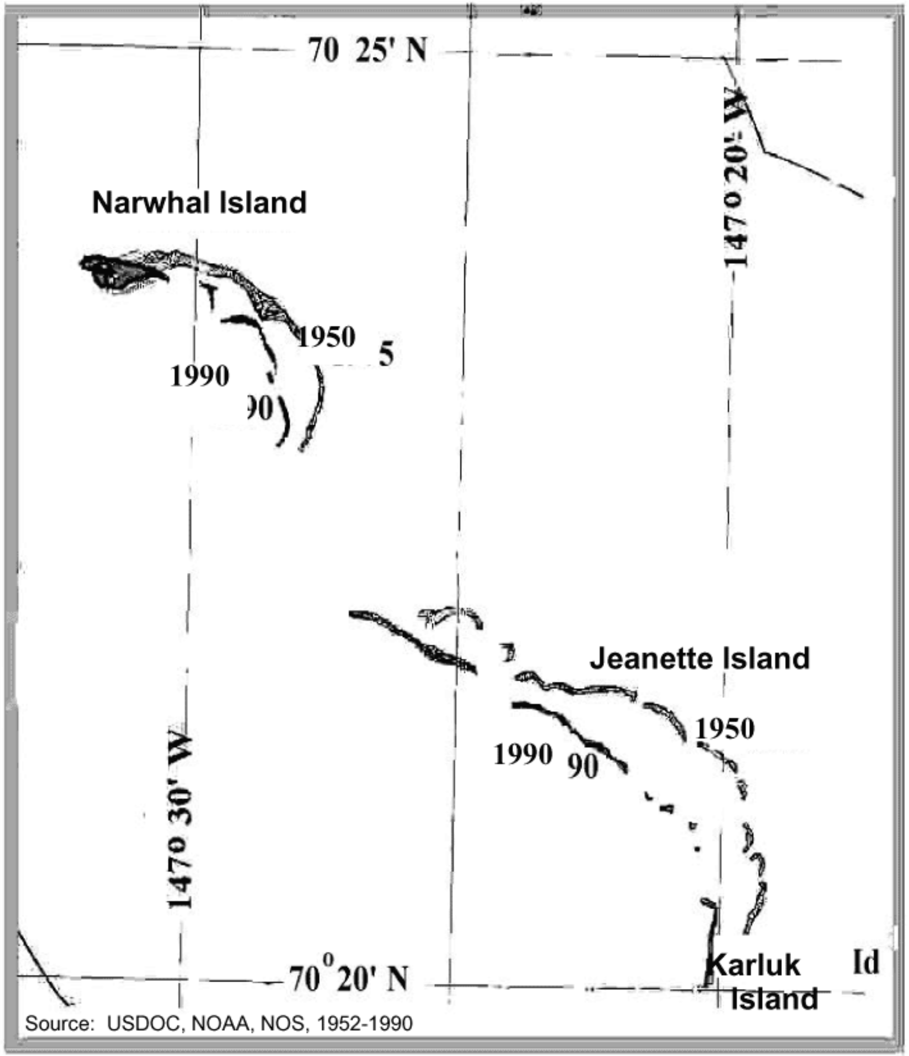

Figure VI.C-3 McClure Island Group. Comparison of island locations from approximately 1950 to approximately1990 showing net migration to the southwest.

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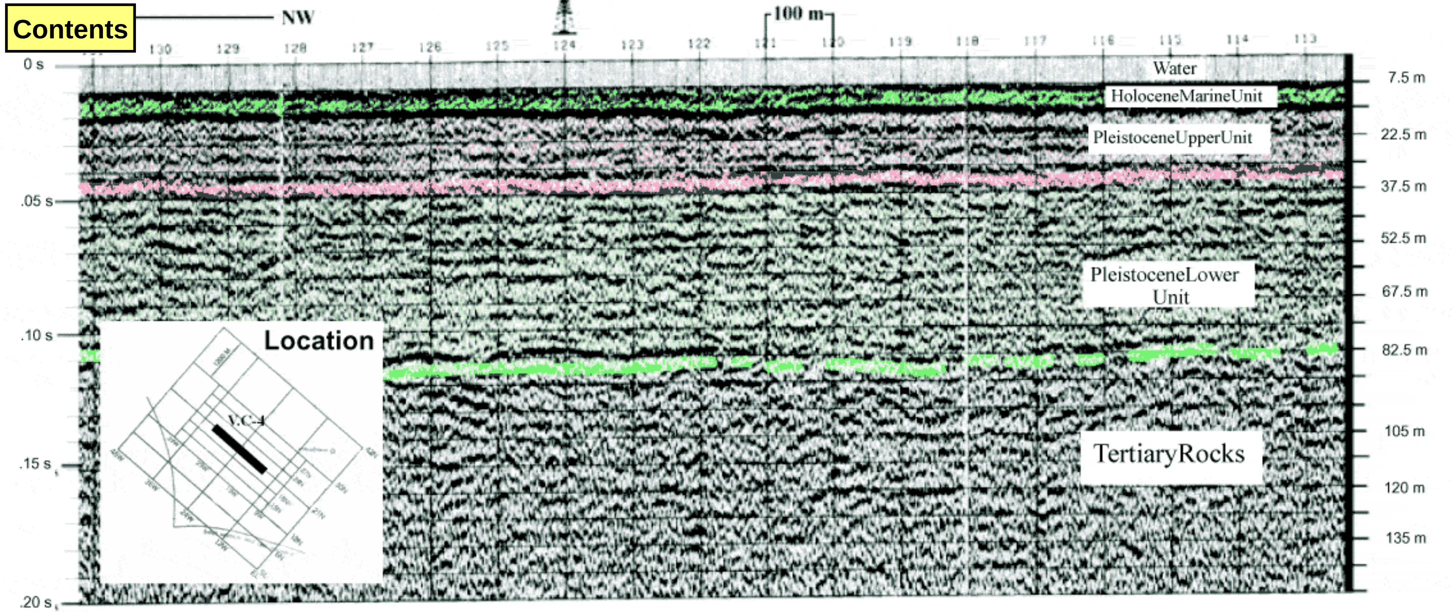

Figure VI.C-4 Minisparker profile record passing through the island site, showing Pleistocene and Holocene stratigraphic units overlying strata of Tertiary age. The uppermost unit, interpreted as Holocene marine sediments, is mapped on a regional scale in Figure VI.C-2. The seismic stratigraphic horizon between the Pleistocene upper and lower units is correlative to "Seismic Horizon 3" of Dinter et. al (1990) shown in Figure V.C-5. Minisparker record from Watson Company Liberty Site Survey.

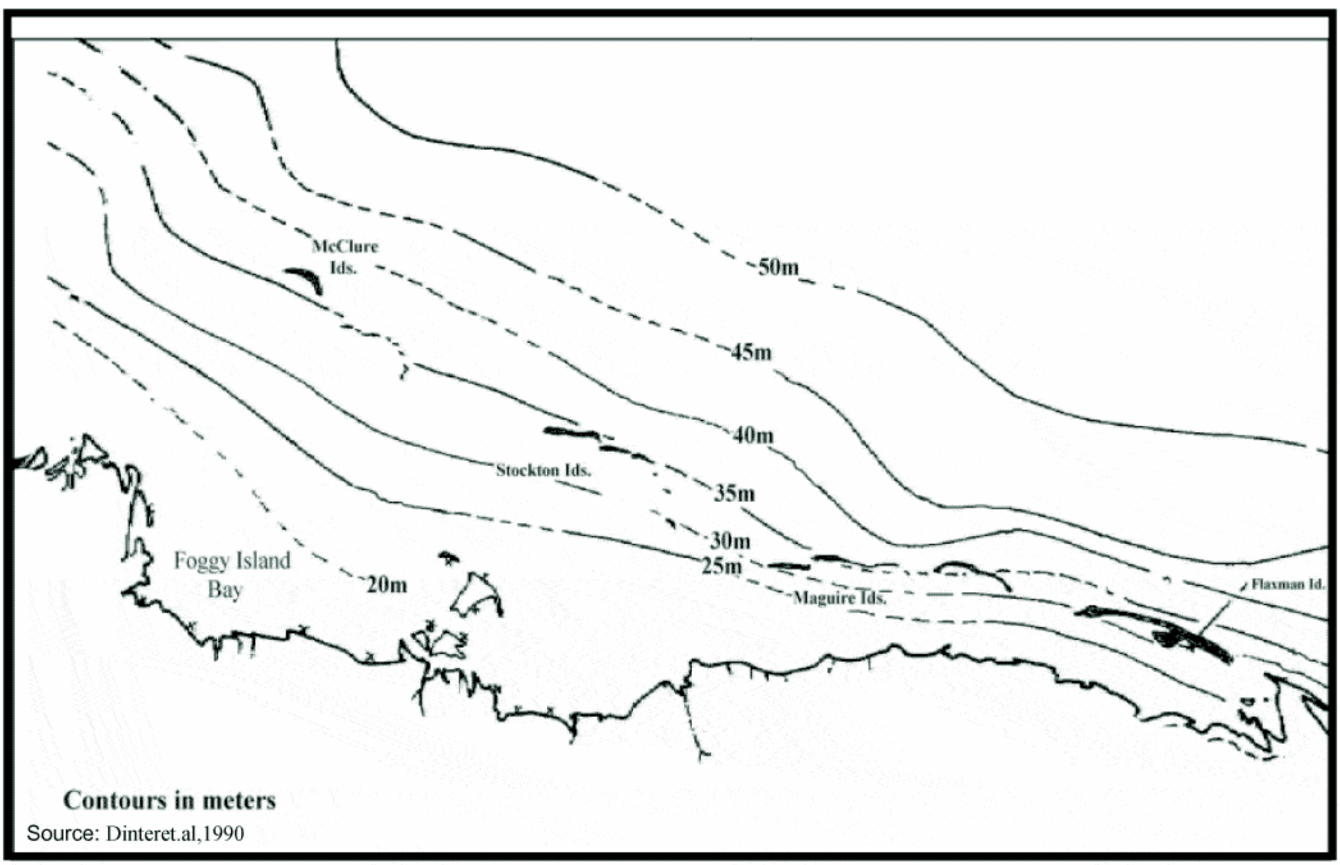

Figure VI.C-5 Generalized contour map on the surface of "Seismic Horizon 3", which separates upper and lower Pleistocene sedimentary units

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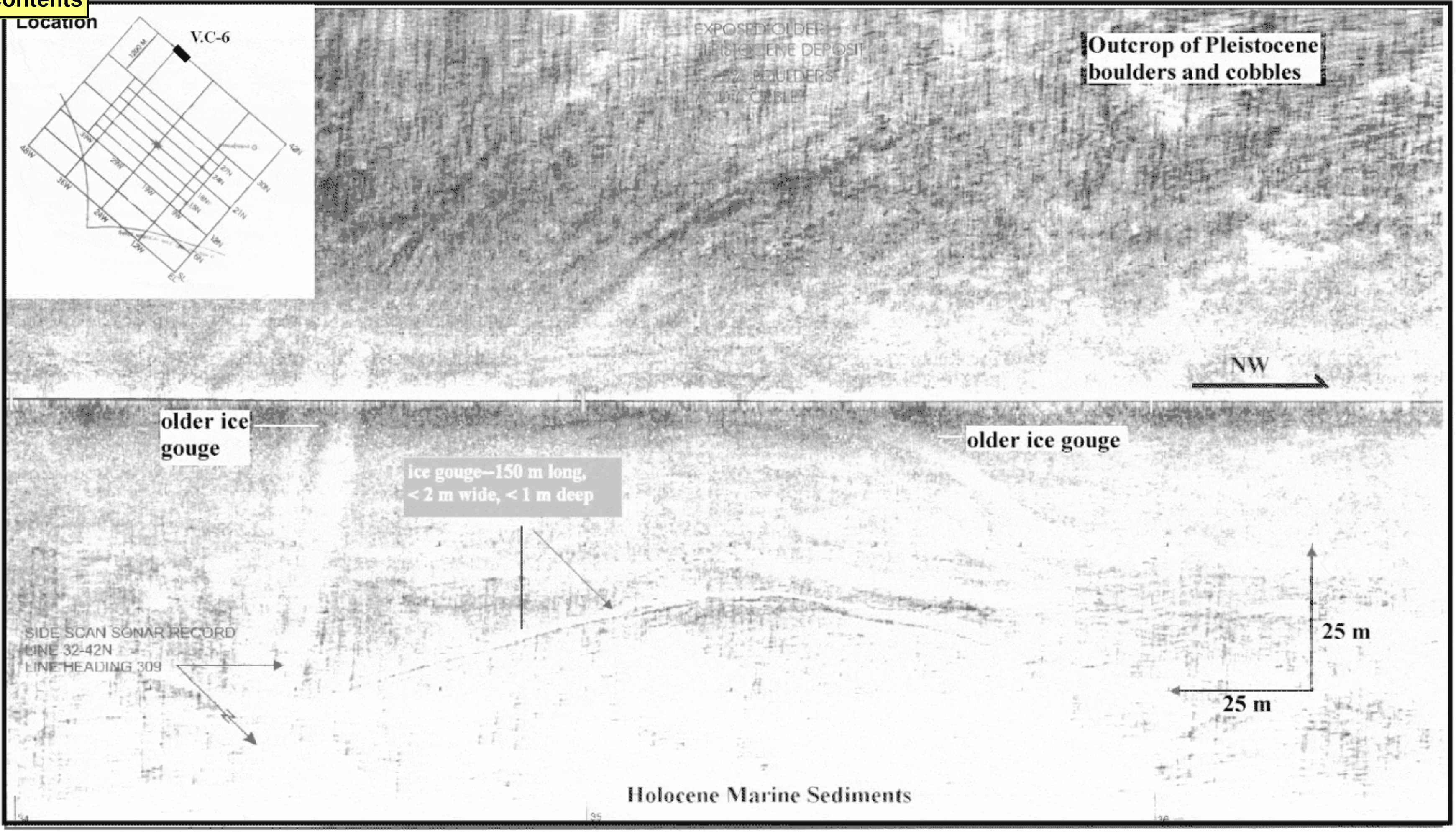

Figure VI.C-6 Side-scan sonar record showing area of boulder and cobbles and adjacent Holocene marine sediments. Older and wide relict ice gouges and young narrow ice gouges can be seen in the sediments. Side-scan sonar record from Watson Company Liberty Site survey.

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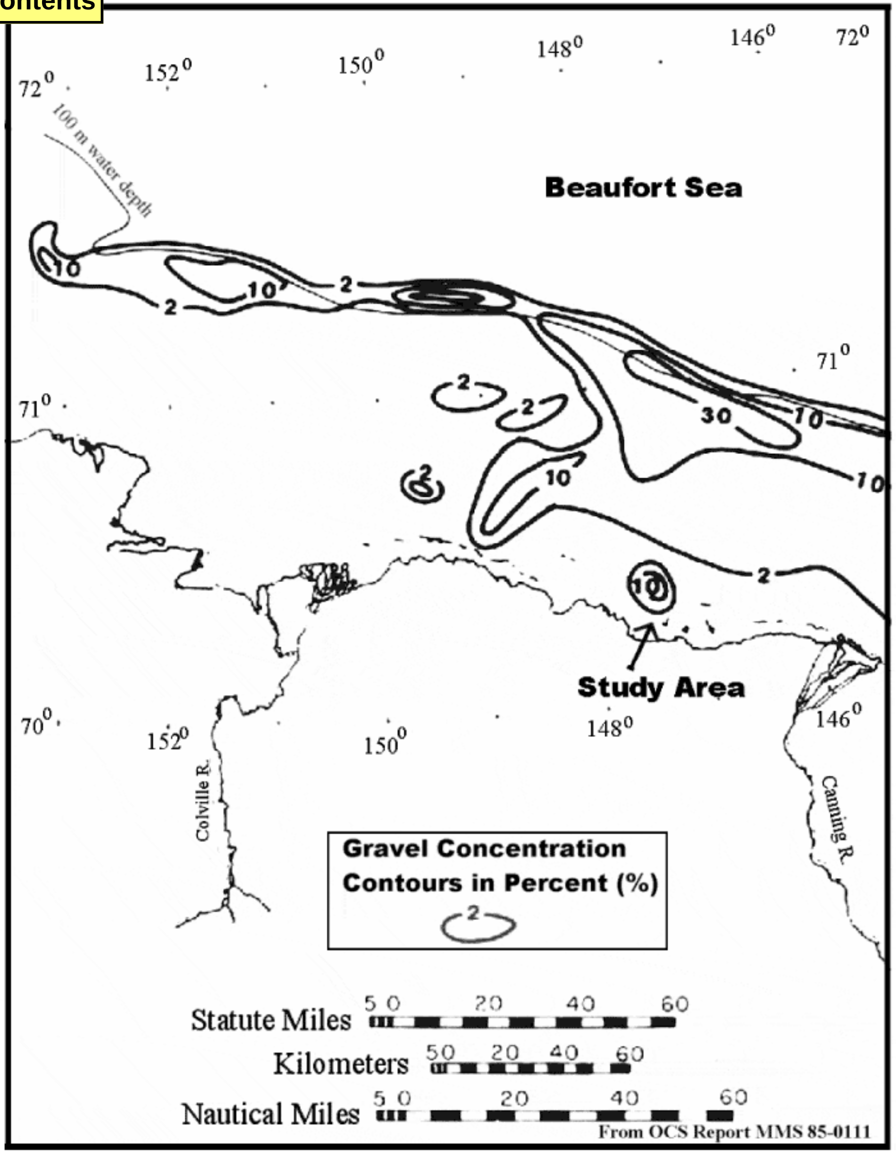

Figure VI.C-7 Regional Distribution of Gravel (>2mm) in the Central Beaufort Sea

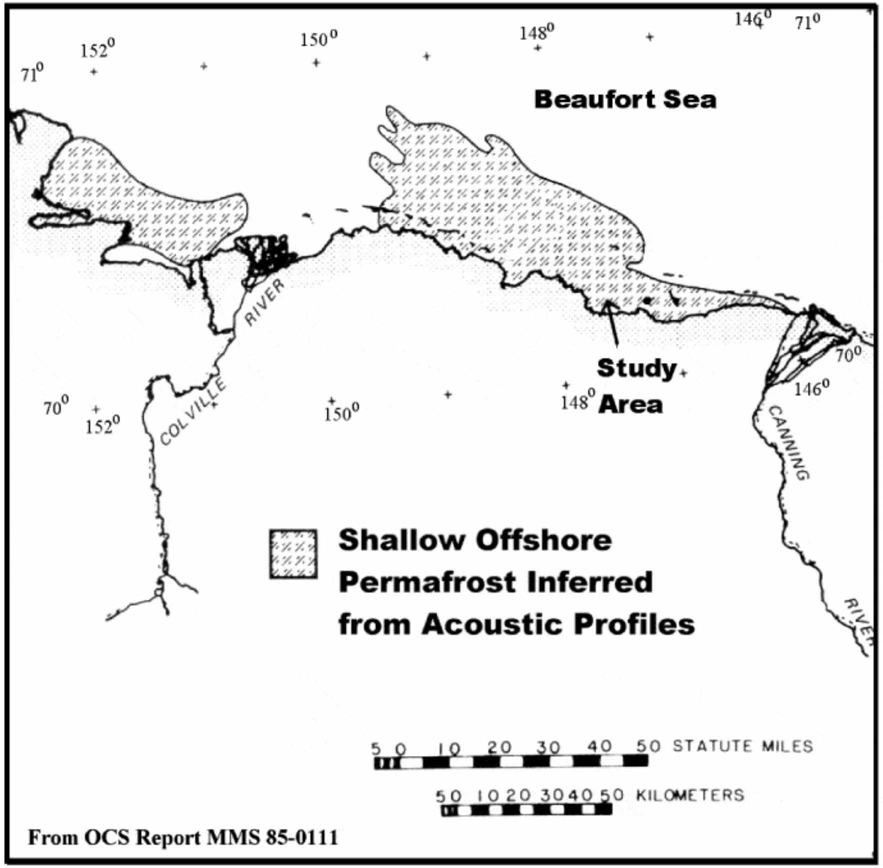

Figure VI.C-8 Regional Inferred Shallow Permafrost

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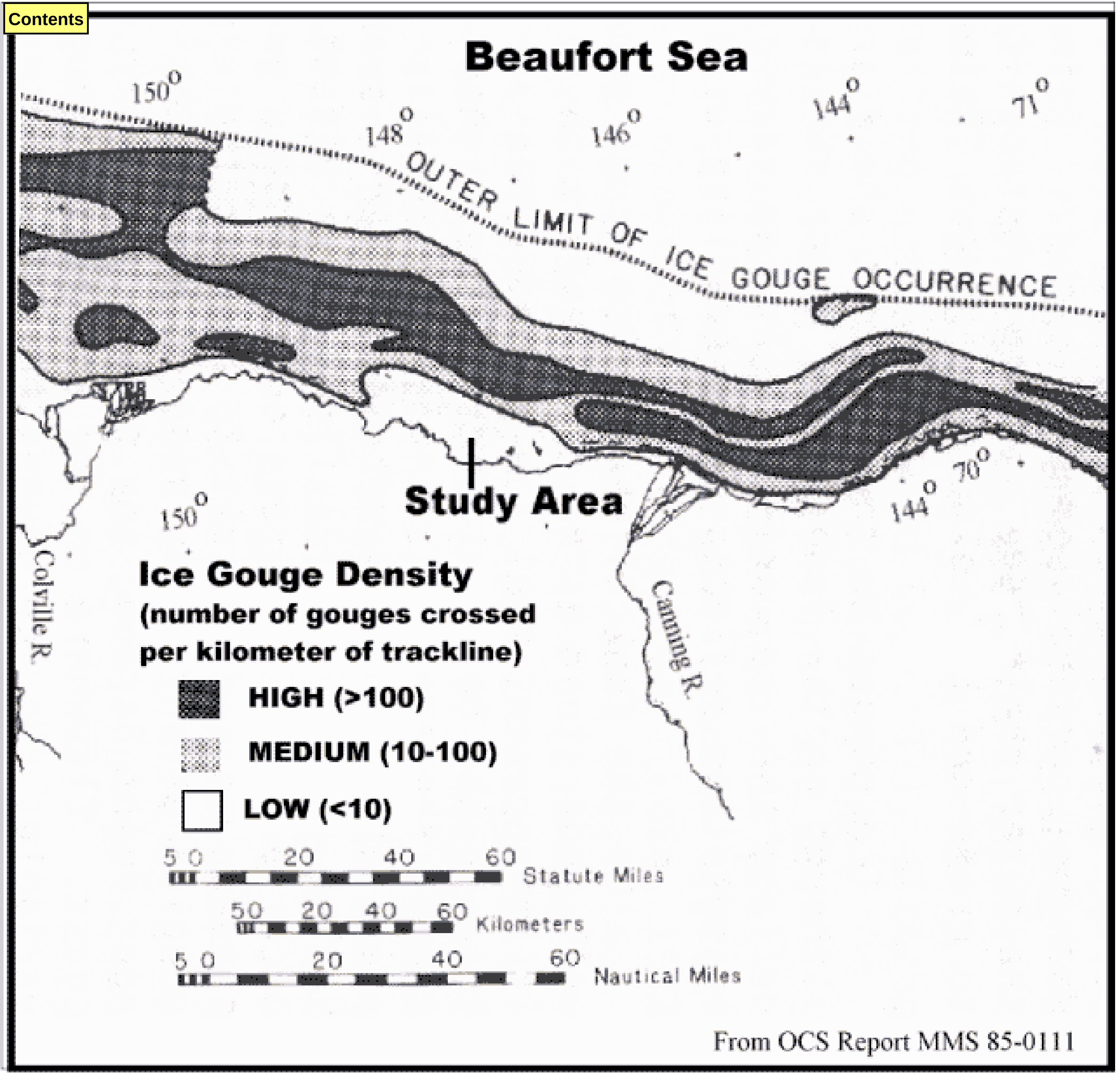
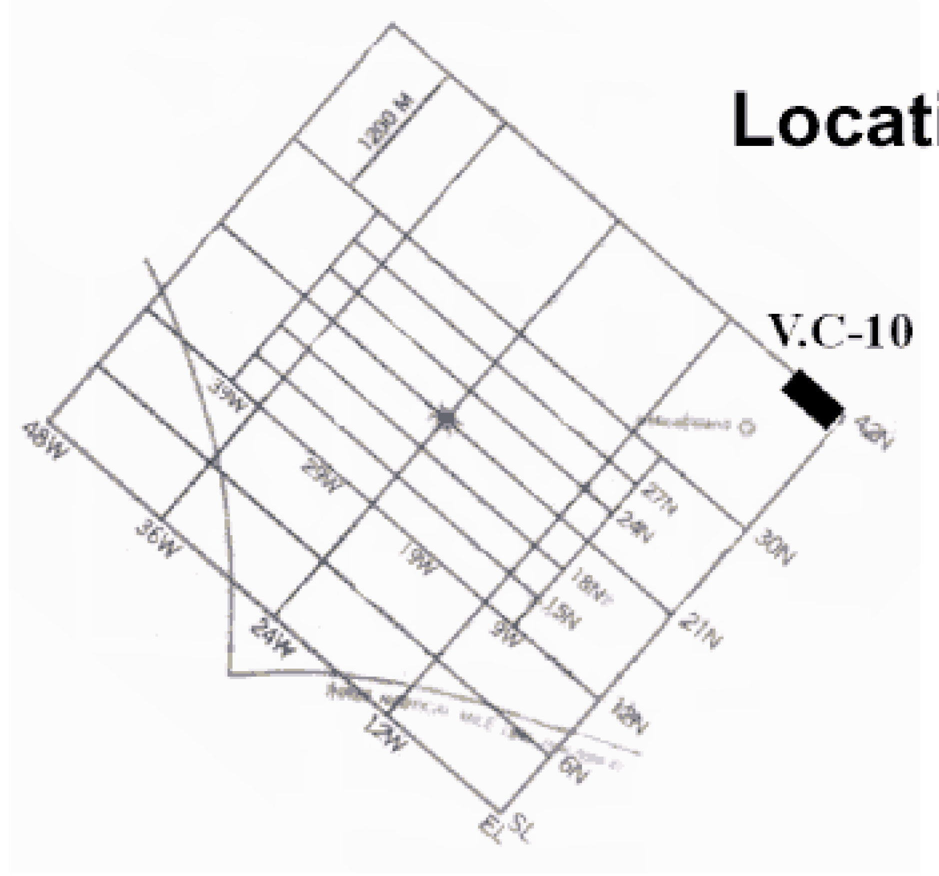


Figure VI.C-9 General distribution of ice gouge density based on the number of ice gouge crossings on acoustic data during USGS marine survey (Barnes, 1981). Modified figure from the Beaufort Sea Geologic Report (OCS Report MMS 85-01 11)



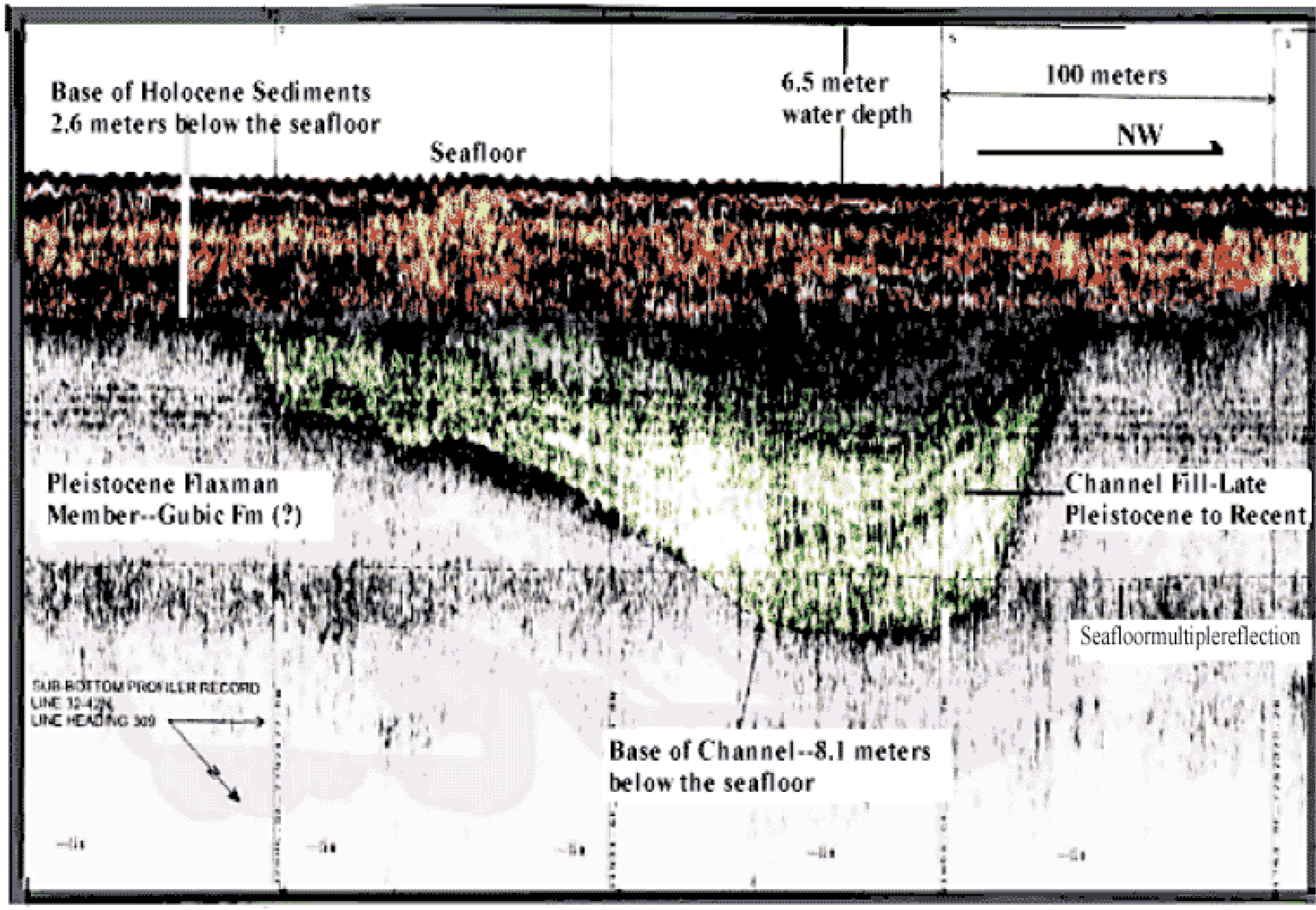


Figure VI.C-10 "Chirp" high-resolution seismic profile records showing a submerged buried Pleistocene or Holocene channel. At a lower sea level, the channel cut into Pleistocene sedients approximately 5.5 meters. After sea level rose, it was drowned and subsequently covered by 2.6 meters of Holocene marine sediments. Record from Watson Company Liberty Site survey.

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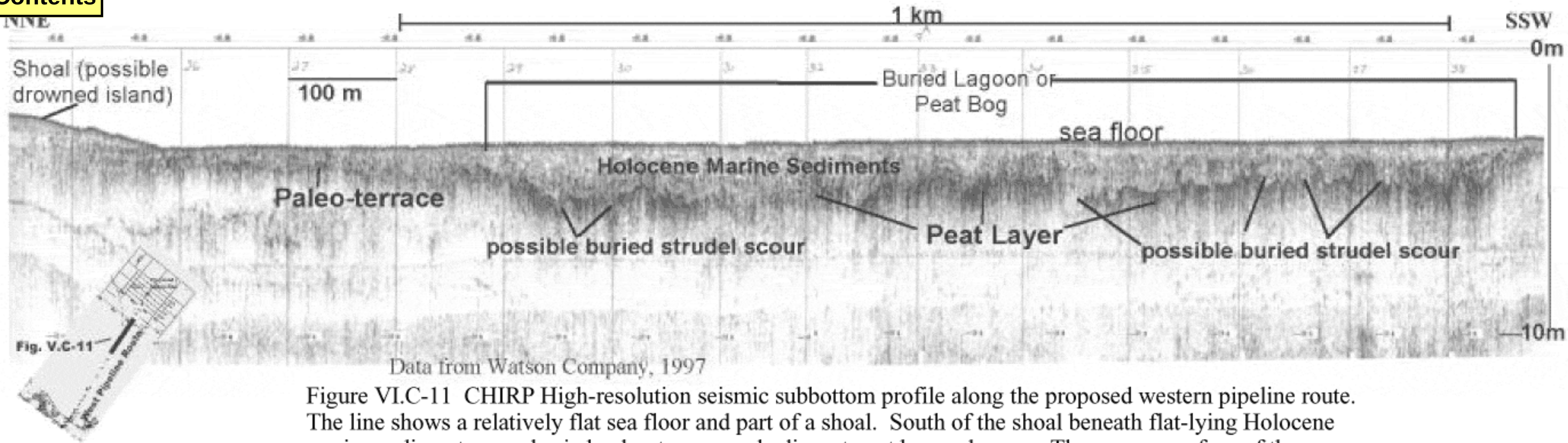

Figure VI.C-11 CHIRP High-resolution seismic subbottom profile along the proposed western pipeline route. The line shows a relatively flat sea floor and part of a shoal. South of the shoal beneath flat-lying Holocene marine sediments are a buried paleo-terrace and adjacent peat bog or lagoon. The uneven surface of the peat layer may be due to repeated downward excavation by strudel scouring. Water depths range from about 19 feet (5.8 meters) at the center of the record to 15 feet (4.5 meters) over the shoal. Vertical exaggeration is approximately 2.5 to 1.

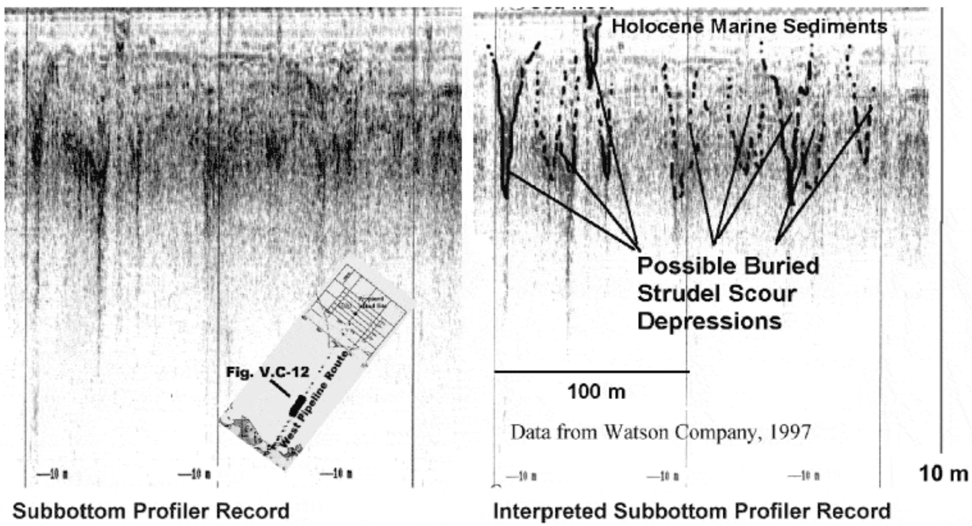

Figure VI.C-12 Comparison of an uninterpreted and an interpreted CHIRP high-resolution subbottom profile record along the southern end of the proposed western pipeline route. The interpretation at right outlines anomalies that may be filled-in strudel scour depressions. Water depth is 7.5 feet (2.3 meters). Vertical exaggeration is approximately 2.5 to 1.

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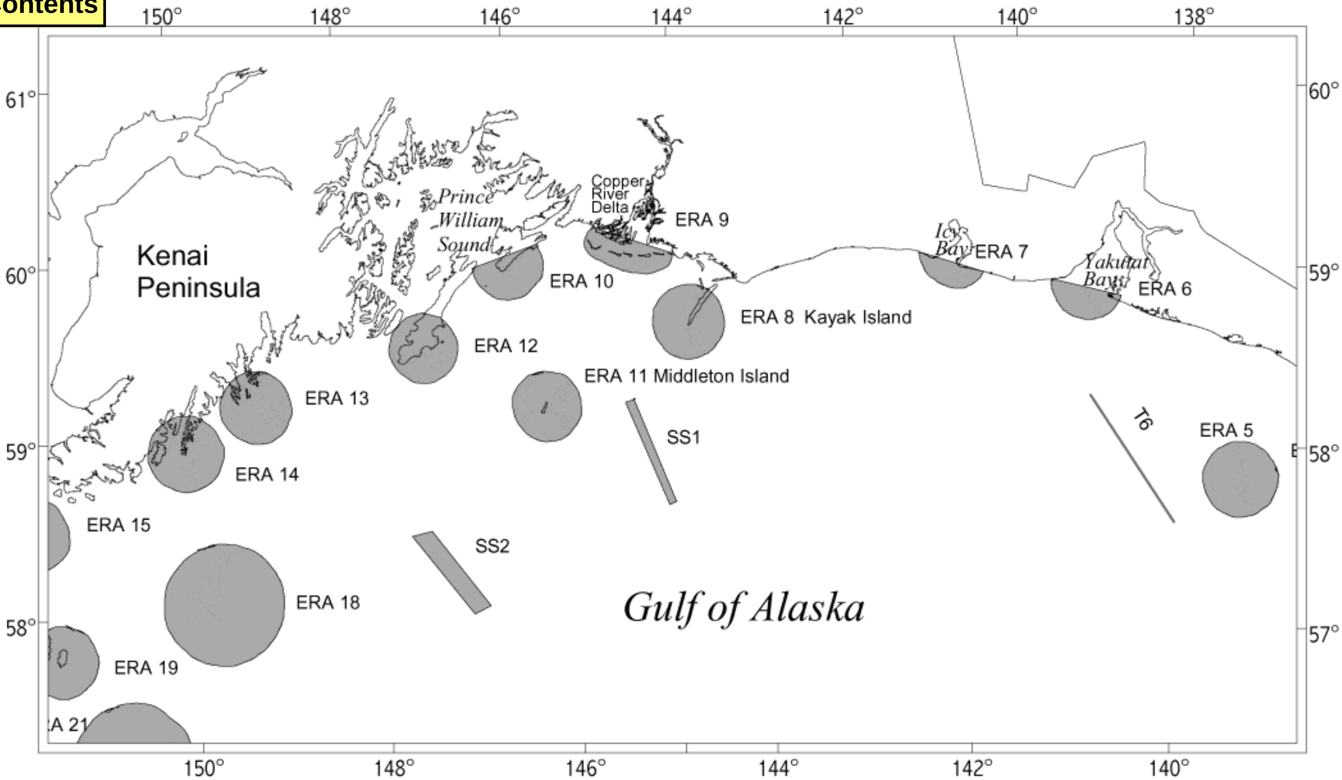


Figure IX-1a. Environmental Resource Areas, Sea Segments and Tanker Segment T6 Used in the Analysis of a Tanker Spill in the Gulf of Alaska

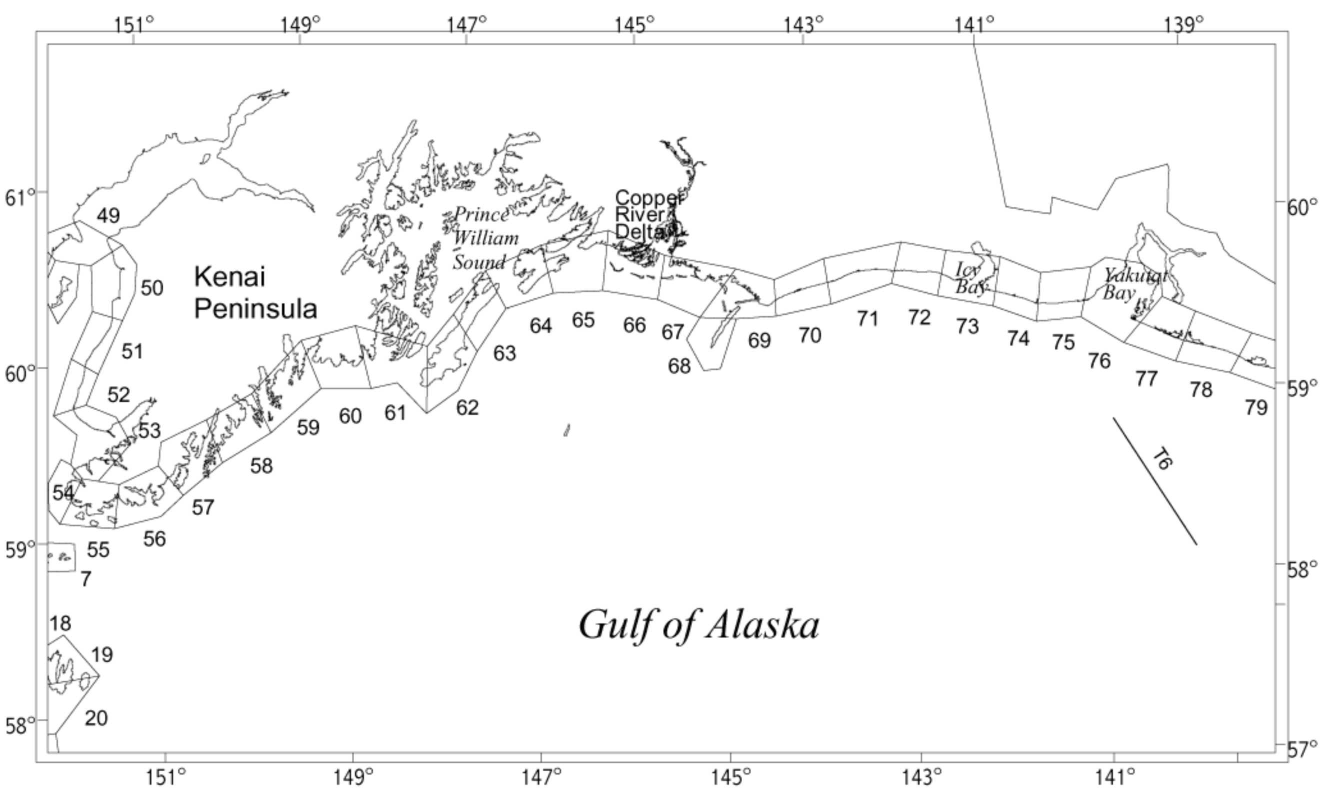
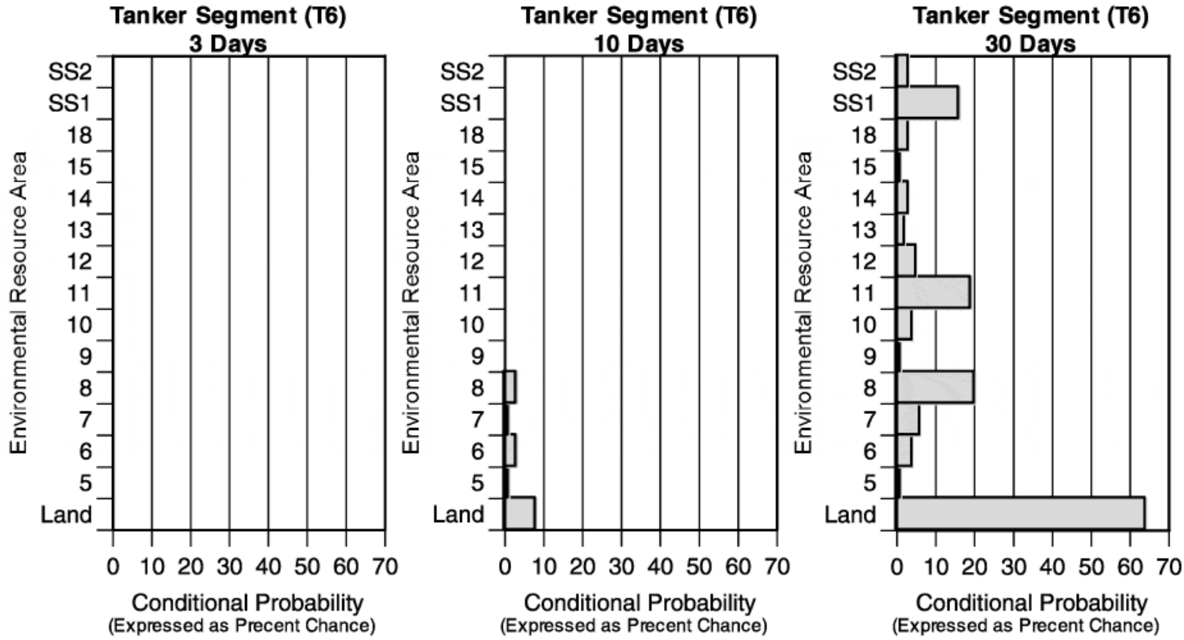
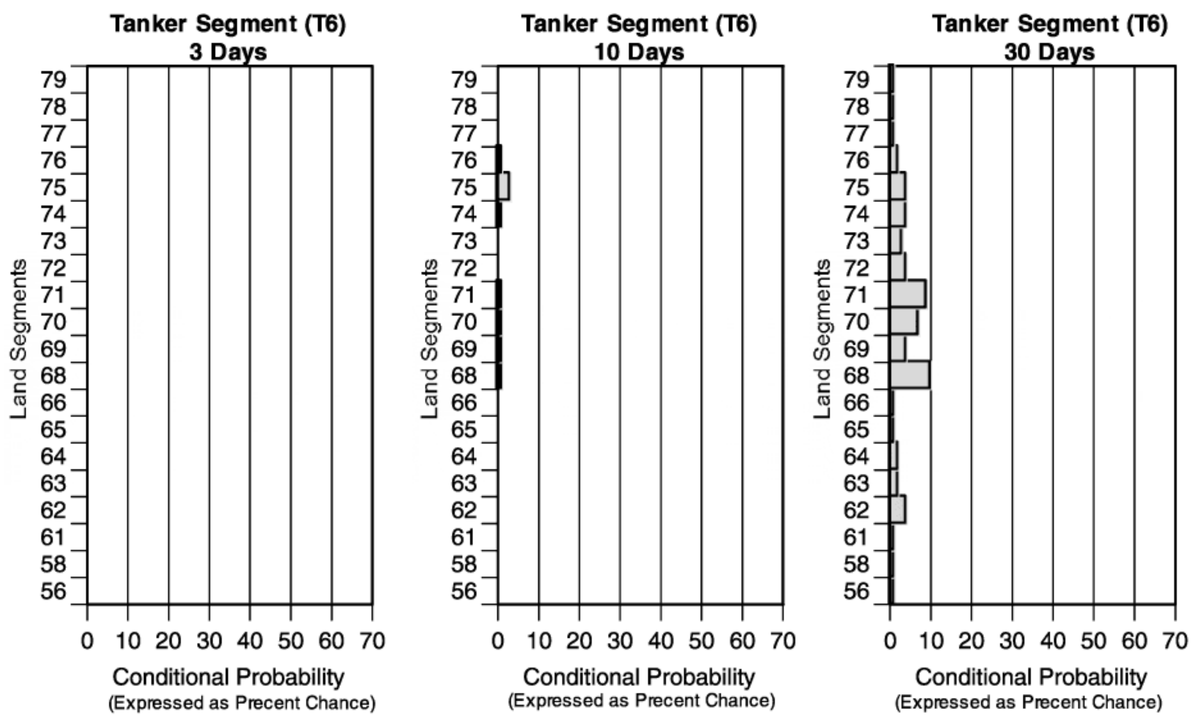


Figure IX-1b. Land Segments and Tanker Segment T6 Used in the Analysis of a Tanker Spill in the Gulf of Alaska



Note: Only ERA's with >0.5 percent chance of contact are shown on the graph.

Figure IX-2a. Estimated Conditional Probabilities (expressed as percent chance) Than an Oil Spill Greater Than or Equal to 1,000 Barrels Starting at Tanker Segment T6 in the Summer Season Will Contact Certain Environmental Resource Areas (ERA), Sea Segments (SS) and Land within 3, 10 or 30 Days



Note: Only Land Segment's with >0.5 percent chance of contact are shown on the graph.

Figure IX-2b. Estimated Conditional Probabilities (expressed as percent chance) Than an Oil Spill Greater Than or Equal to 1,000 Barrels Starting at Tanker Segment T6 in the Summer Season Will Contact Certain Land Segments within 3, 10 or 30 Days

MAPS

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Sources: BPXA 1998a; Ban et al, 1999.

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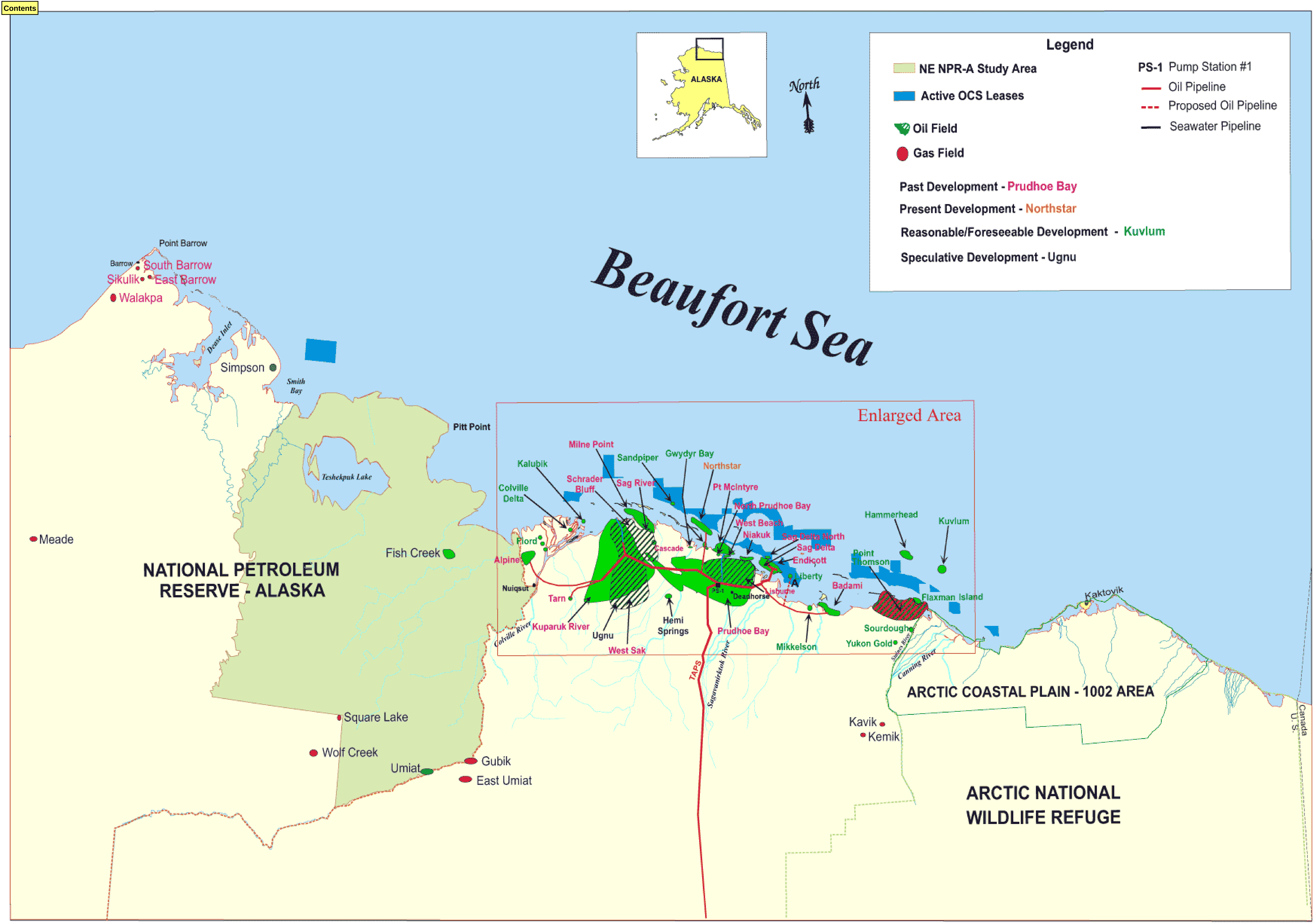
Map 2B Terrestrial Mammals, Gravel Islands, Gravel and Ice Roads, and Pipelines.

Sources: USDOI, MMS 1998 (Sale 170 FEIS); BP Exploration, 1995; LGL, Woodward-Clyde Consultants, and Applied Sociocultural Research 1998.



Map 3a Location of Oil and Gas Discoveries on the North Slope of Alaska and Federal Leases on the Outer Continental Shelf

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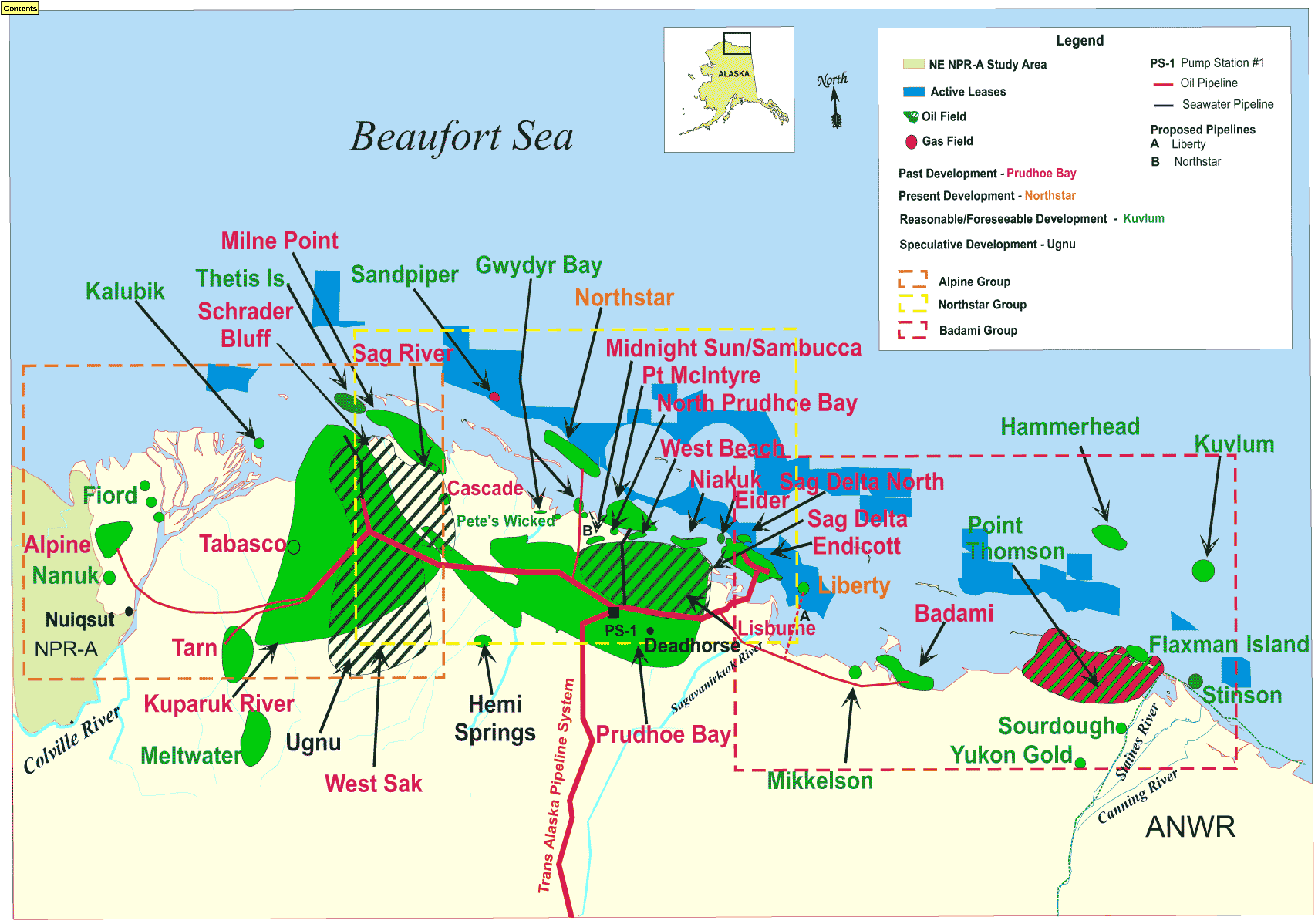

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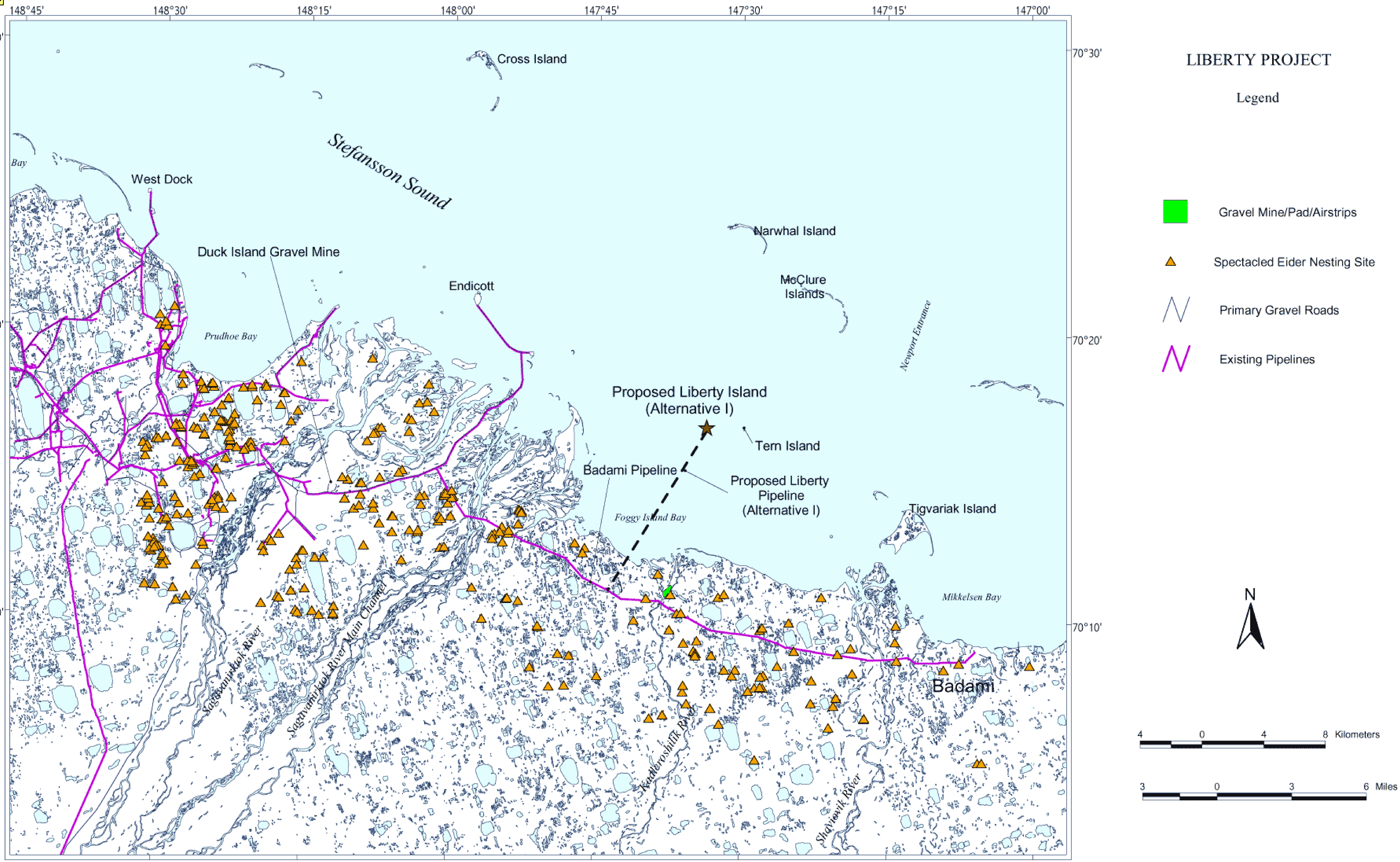

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Source: USDOI, FWS, Personal Communication 1999.

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Source: Pedersen, In Prep.

The Department of the Interior Mission
As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission
As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Royalty Management Program** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.