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PIPELINE AND LNG TRANSPORTATION SYSTEMS

FOR

COOK INLET GAS

Pacific Gas and Electric C
Southern California Gas Cc
February 14, 1978

CONTENTS

I. SUMMARY

The recent selection of the Alcan Highway Route for transportation of Alaskan North Slope gas has raised questions concerning the feasibility of moving Cook Inlet gas to the lower 48 states via pipeline across Central Alaska to the Alcan system. From this connection, Cook Inlet gas would flow south to Kingsgate, B.C. where connection would be made to the Pacific Gas Transmission Company (P.G.T.) portion of the Western Leg for transport to Malin, Oregon and then through Pacific Gas and Electric Company's system to Antioch, California. Several routes from the Cook Inlet area to a point of connection with this system were investigated in September, 1977, and cost estimates were prepared. A pipeline from Cook Inlet to Tok, on the Alcan Route, proved to be the most promising alternative.

On October 28, 1977, the FERC requested Pacific Alaska LNG Associates to provide a supplement to the "Alternatives to the Proposed Action" section of their environmental report. Specifically, FERC asked for information on possible pipeline route alternatives from Cook Inlet to the proposed Alcan Highway pipeline at Tok or Fairbanks.

This report summarizes estimated capital costs of these two alternatives and includes construction schedules and cost of service projections. All estimates are based on a 24" main line with an initial capacity of 431.4 million cubic feet per day. This volume is identical to that of the Pacific Alaska

filing. All costs are in July, 1977 dollars.

Energy balances for both alternatives have been estimated and are compared with the energy balance for the Pac Alaska LNG project. The following are the points of comparison:

	Pac Alaska	Pipeline via Tok	Pipeline via Fairbanks
Efficiency (%)	88.1	82.1	81.3
Capital ($ MM)	1269	1154	1233
Cost of Delivered Gas ($/MMBtu)			
Incremental:			
1st Year	3.63	4.03	4.29
Level Annual	3.42	3.45	3.66
Average:			
1st Year	4.06	4.64	5.06
Level Annual	3.72	3.85	4.16

II. DESCRIPTION OF ALTERNATES

Two cases are considered in this study (See Map - Exhibit A). Common to both are the Cook Inlet gathering systems, compressor stations at Beluga and Soldotna, 20" transmission lines from these stations to Palmer, and the Palmer compression station. From Palmer, Case I transports the gas in a 24" main line along Highway No.1 to a compressor station at Glennallen and then to Tok with a fifth station at Tok for delivery to the Alcan system. Case II provides for a 24" main line from Palmer generally following Highway No.3 with compressor stations at Curry, Lignite, and Fairbanks where connection to the Alcan line would be made.

Several assumptions have been necessary which undoubtedly will be changed by actual gas discoveries. These changes should have little effect on the capital cost and cost of service figures, however. For this initial study, the 431.4 million cubic feet per day capacity of the Pacific Alaska LNG project has been used as the basis for line and compressor sizing and cost of service calculations. Pacific Alaska's layout and cost estimates for gathering systems on both sides of Cook Inlet were also used with the exception that this pipeline plan provides for laterals on each side of the Inlet and eliminates the need for the 23-mile long underwater crossing required by the LNG project. Lacking firm data on location and deliverability of actual gas sources, it was further assumed that the two laterals would carry equal volumes of gas and that final design

changes in pipeline sizes and compression requirements would balance out in the final cost estimate.

Flow calculations for the two cases are detailed in Exhibits E-1 and E-2.

III. ENERGY BALANCES

Gas balances have been estimated for both pipeline alternatives as well as for the LNG project. Fuel usage from Cook Inlet to the points of delivery, Gosford, California for Pac Alaska and Antioch, California for the pipeline alternatives have been calculated and are detailed in Exhibits B-1, B-2, and B-3. The overall efficiency of the LNG project is about 6-7% higher than the pipeline alternatives' incremental efficiencies presented in the Exhibits. The pipeline alternatives' efficiencies are based on the incremental fuel necessary to transport the Cook Inlet gas when it is transported on top of Prudhoe Bay and Mackenzie Delta Gas.

IV. CAPITAL COSTS

Capital cost figures have been developed for Cook Inlet to Alcan and Western Leg segments of the proposed system using, wherever possible, firm quotations from suppliers and contractors. In this phase of the study, however, it has been necessary to make assumptions on construction methods and unit costs on some portions of the work. Where this has been done, the effort has been made to estimate costs on the conservative side. For example, total costs include refrigeration of the gas to 30°F and insulation of the entire pipeline. In final design, it may well be that this will prove redundant. Bases for the major cost items are:

Construction - Hood Corporation was retained to inspect and determine the feasibility of the proposed routes, and to prepare installation estimates and construction schedules. Exhibit F is a statement of their assessment of the project.

Pipeline Materials - Price quotations were obtained by Southern California Gas Company's purchasing department from domestic suppliers for pipe, valves, and insulation. All pipe was quoted as double-jointed and wrapped, F.O.B., Seattle. Transportation to the job sites is included in the Hood estimate. Ten mile spacing of main line valves was used with three main valves at compressor stations and valves at both sides of the Turnagain Arm underwater crossing.

Gathering Systems - Costs developed by Pacific Alaska LNG Associates (Docket No. CP75-140, et al, Exhibit No. _____ MEF-12) were amended to eliminate the 23-mile Cook Inlet crossing. Pipeline systems on both sides of the inlet were retained with connection assumed to be made at compressor stations located at Beluga and Soldotna.

Capital cost estimates are itemized in Exhibits C-1 through C-5.

V. COST OF SERVICE

Cost of service figures have been developed for delivery of Cook Inlet gas to California using the following data:

- Cook Inlet to Alcan: Southern California Gas Company capital cost extimates, Exhibits C-1 and C-2.

- Alcan System: to Kingsgate, B.C. Southern California Gas Company estimates based on Alcan Pipeline Company, March, 1977 FPC filing. Average cost of service for Prudhoe gas was used prorated on a mileage basis. Incremental cost of service for Prudhoe plus Cook Inlet gas based on PGandE estimates.

- P.G.T. System: Kingsgate-Malin, Ore. P.G.T. estimates for 592 miles of 42" - 911 psig pipeline looping with 4-14100 HP compression units. Incremental cost for Prudhoe plus Cook Inlet gas.

- PG&E System: Malin-Antioch, CA. PG&E estimate for 281.6 miles of 42" - 911 psig pipeline looping with 2-14100 HP compression units. Incremental cost for Prudhoe plus Cook Inlet gas.

Other assumptions used in the calculations were:

	Debt/Equity	Return on Equity	Debt Interest
Pac Alaska	75/25	16%	10%
Cook Inlet to Alcan Pipelines	75/25	16%	10%
P.G.T.-Kingsgate to Malin	75/25	16%	10%
PGandE-Malin to Antioch	75/25	16%	10%

Cost of Services Estimates for both the first year of full delivery and on a level annual cost basis over the project life are tabulated in Exhibits D-1 through D-6.

VI. CONSTRUCTION

Project completion date is assumed to be first quarter 1983 to agree with estimated completion of the Alcan System. Actual construction time for either the Tok or Fairbanks alternate is estimated to be 18 months. Soil conditions are expected to limit construction of the gathering systems and Beluga and Soldotna laterals to the winter months. Work on the main lines from Palmer to Alcan is expected to be possible year-round. Thus, construction would start in the fall of 1981, and be completed in spring 1983 with two winter construction periods available for the Cook Inlet work. Hood Corporation has estimated that the work would be organized in the following manner:

	Miles	Crew Size	# of Spreads	Pipeline Inst. Time	Project Duration
East Side Cook Inlet					
Soldotna-Turnagain Arm	60	190	1	5 mo.	7 mo.
Turnagain Arm Crossing	5	160	1	2 mo.	4 mo.
Turnagain Arm-Palmer	43	190	1	4 mo.	6 mo.
West Side Cook Inlet					
Beluga-Palmer	84	260	2	4 mo.	6 mo.
Main Line					
Palmer-Tok	267	750	3	6 mo.	8 mo.
or					
Palmer-Fairbanks	314	750	3	7 mo.	9 mo.
Gathering Systems					
Indefinite but based on previous estimates of laterals extending to Anchor Point and Drift River on the order of:					
East Side Cook Inlet	--	190	1	5 mo.	7 mo.
West Side Cook Inlet	--	260	1	7 mo.	9 mo.

Other conditions considered in the study are 100% x-ray of all welds and the use of existing power line and/or highway rights-of-way.

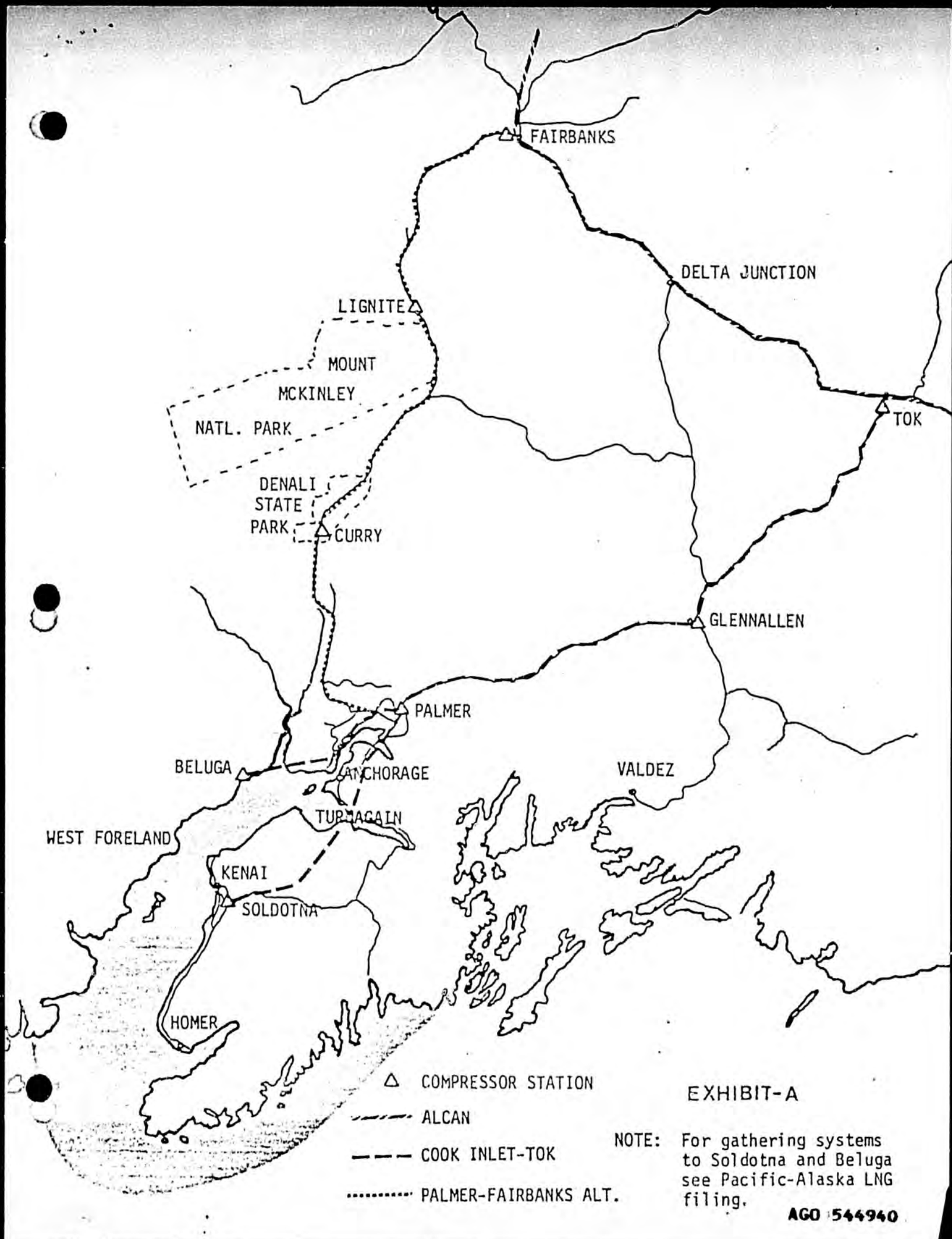


EXHIBIT-A

NOTE: For gathering systems to Soldotna and Beluga see Pacific-Alaska LNG filing.

AGO 544940

PAC ALASKA

GAS BALANCE
(Millions of cubic feet per day) (1)

Cook Inlet Input		442.8
Fuel		
LNG Plant	39.3	
LNG Shipping (2)	3.3	
LNG Terminal	0.2	
Total Fuel	42.8	
Delivery to Gosford		400
Pac Alaska Efficiency (2)		90.3%

(1) All gas volumes adjusted to 1014 Btu/cf heating value.
(2) If Bunker "c" fuel oil consumption of 10.1 mmcf/d gas equivalent is included, efficiency is reduced to 88.1%.

Exhibit B-1

PIPELINE ALTERNATIVE VIA TOK

GAS BALANCE

(Million cubic feet per day) (1)

Cook Inlet Input		431.4
Fuel (2)		
Cook Inlet to Tok	9.0	
Tok to Caroline	50.7	
Caroline to Kingsgate	2.5	
Kingsgate to Malin	10.8	
Malin to Antioch	4.2	
Total Fuel	77.2	
Delivery to Antioch		354.2
Pipeline Efficiency		82.1%

(1) All gas volumes adjusted to 1014 Btu/cf heating value.
(2) Incremental fuel to transport Cook Inlet gas in addition to Prudhoe (2.4 Bcf/d) and Delta (1.2 Bcf/d) gas.

Exhibit B-2

PIPELINE ALTERNATIVE VIA FAIRBANKS
GAS BALANCE
(million cubic feet per day) (1)

Cook Inlet Input		431.4
Fuel (2)		
Cook Inlet to Fairbanks	8.9	
Fairbanks to Tok	3.4	
Tok to Caroline	50.7	
Caroline to Kingsgate	2.5	
Kingsgate to Malin	10.8	
Malin to Antioch	4.2	
Total Fuel	80.5	
Delivery to Antioch		350.9
Pipeline Efficiency		81.3%

(1) All gas volumes adjusted to 1014 Btu/cf heating value.

(2) Incremental fuel to transport Cook Inlet gas in addition to Prudhoe (2.4 Bcf/d) and Delta (1.2 Bcf/d) gas.

Exhibit B-3

COOK INLET TO TOK PIPELINE

CAPITAL COST ESTIMATE - 1977 $

(Thousands of Dollars)

	Materials	Construction	Total
Pipeline	$ 79,690	$247,494	$327,184
Valves, Fittings, Misc.	8,679	4,575	13,254
Insulation	39,816	19,340	59,156
Compression	28,000	12,750	40,750
Refrigeration	12,280	5,590	17,870
Anchors	820	1,640	2,460
Controls	6,515	13,030	19,545
X-Ray	--	8,845	8,845
	$175,800	$313,264	$489,064
Sales Taxes	10,080	--	10,080
Total Pipeline Direct	$185,880	$313,264	$499,144
Right-of-Way			$ 11,641
R/W Restoration			9,300
E.I.R			2,815
Engineering			26,310
Contingency			71,497
Working Capital			588
AFUDC			64,073
Financing Fee			2,522
Materials & Supplies			6,210
Total Project			$694,100

AGO 544944

Exhibit C-1

COOK INLET TO FAIRBANKS PIPELINE

CAPITAL COST ESTIMATE - 1977 $

(Thousands of Dollars)

	Materials	Construction	Total
Pipeline	$ 86,130	$267,474	$353,604
Valves, Fittings, Misc.	8,914	4,581	13,495
Insulation	44,331	21,274	65,605
Compression	28,000	12,750	40,750
Refrigeration	12,280	5,590	17,870
Anchors	820	1,640	2,460
Controls	6,515	14,350	20,865
X-Ray	--	9,832	9,832
	$186,990	$337,491	$524,481
Sales Taxes	10,751	--	10,751
Total Pipeline Direct	$197,741	$337,491	$535,232

Right-of-Way	$ 12,192
R/W Restoration	10,220
E.I.R.	3,061
Engineering	28,115
Contingency	76,910
Working Capital	588
AFUDC	68,721
Financing Fee	2,704
Materials & Supplies	6,657
Total Project	$744,400

Exhibit C-2

PAC ALASKA LNG

CAPITAL INVESTMENT SUMMARY - 1977$
(Millions of Dollars)

Pac Alaska LNG	Phase I	Phase II	Total
Gas Gathering	168	32	200
Liquefaction Plant	496	154	650
Ships	197	197	394
Terminal	25	-	25
Total	886	383	1269

Exhibit C-3

PIPELINE ALTERNATIVE VIA TOK

CAPITAL INVESTMENT SUMMARY - 1977 $

(MILLIONS OF DOLLARS)

	Base[1] Design	Base Plus Cook	Cook Incremental
Cook to Tok	0	694	694
Tok to Kingsgate	-	-	150
Kingsgate to Malin	367	590	223
Malin to Antioch	205	292	87
TOTAL[2]	-	-	1154

(1) Base Design is for a system to transport Prudhoe plus Mackenzie Delta Gas.

(2) Modifications to existing natural gas system will be needed south of Antioch. Such modifications may add as much as an additional $126 million (1977 $) investment to the Cook Incremental.

PIPELINE ALTERNATIVE VIA FAIRBANKS

CAPITAL INVESTMENT SUMMARY - 1977 $

(MILLIONS OF DOLLARS)

	Base[1] Design	Base Plus Cook	Cook Incrementa
Cook to Fairbanks	0	744	744
Fairbanks to Kingsgate	-	-	179
Kingsgate to Malin	367	590	223
Malin to Antioch	205	292	87
TOTAL[2]	-	-	1233

(1) Base Design is for a system to transport Prudhoe plus Mackenzie Delta Gas.

(2) Modifications to existing natural gas system will be needed south of Antioch. Such modifications may add as much as an additional $126 million (1977 $) investment to the Cook Incremental.

Exhibit C-5

PAC ALASKA

INCREMENTAL COST OF GAS SUMMARY

(1977 $/MMBTU)

Pac Alaska	1982 Phase I	1983 Phase I & II	Level Annual
Purchased Natural Gas	1.64	1.64	1.64
Gathering & Liquefaction Plant	2.25	1.29	1.18
Shipping	.61	.62	.52
Terminal (Incremental)	.16	.08	.08
Delivered Price of Gas (Incremental)	4.66	3.63	3.42
Price of Pac Indonesia at Incremental Cost	4.72	3.74	3.45

Exhibit D-1

PAC ALASKA

COST OF GAS SUMMARY SUBSTITUTING AVERAGE TERMINAL AND TERMINAL PIPELINE COSTS

(1977 $/MMBTU)

Pac Alaska	1982 Phase I	1983 Phase I & II	Level Annual
Purchased Natural Gas (Incremental)	1.64	1.64	1.64
Gathering & Liquefaction Plant (Incremental)	2.25	1.29	1.18
Shipping (Incremental)	.61	.62	.52
Terminal (Average)	.93	.46	.34
Terminal Pipeline (Average)	.08	.05	.04
Delivered Price of Gas at Average Cost of California Facilities	5.51	4.06	3.72
Price of Pac Indonesia at Average Terminal Cost	4.04	3.36	3.25

PIPELINE ALTERNATIVE VIA TOK

INCREMENTAL COST OF GAS SUMMARY

(1977 $/MMBTU)

	1983	Level Annual
Purchase of Natural Gas	1.80	1.80
Pipeline Segments		
Cook to Tok	1.28	.92
Tok to Kingsgate	.41	.33
Kingsgate to Malin	.39	.29
Malin to Antioch	.15	.11
TOTAL DELIVERED TO ANTIOCH(1)	4.03	3.45

(1) Modification to existing natural gas system will be needed south of Antioch. Such modification may add as much as an additional 20¢ to 30¢ per million Btu (1977 $).

PIPELINE ALTERNATIVE VIA TOK

COST OF GAS SUMMARY
SUBSTITUTING AVERAGE COST FOR
INCREMENTAL COST FOR TOK TO KINGSGATE

(1977 $/MMBTU)

	1983	Level Annual
Purchase of Natural Gas	1.80	1.80
Pipeline Segments		
Cook to Tok	1.28	.92
Tok to Kingsgate[1]	1.02	.73
Kingsgate to Malin	.39	.29
Malin to Antioch	.15	.11
TOTAL DELIVERED TO ANTIOCH[2]	4.64	3.85

(1) Based on Alcan Pipeline Company, March, 1977 FPC filing. Redesign of Alcan system may reduce this average cost slightly.

(2) Modification to existing natural gas system will be needed south of Antioch. Such modification may add as much as an additional 20¢ to 30¢ per million Btu (1977 $).

PIPELINE ALTERNATIVE VIA FAIRBANKS

INCREMENTAL COST OF GAS SUMMARY

(1977 $/MMBTU)

	1983	Level Annual
Purchase of Natural Gas	1.84	1.84
Pipeline Segments		
Cook to Fairbanks	1.41	1.01
Fairbanks to Kingsgate	.48	.39
Kingsgate to Malin	.40	.30
Malin to Antioch	.16	.12
TOTAL DELIVERED TO ANTIOCH(1)	4.29	3.66

(1) Modification to existing natural gas system will be needed south of Antioch. Such modification may add as much as an additional 20¢ to 30¢ per million Btu (1977 $).

PIPELINE ALTERNATIVE VIA FAIRBANKS

COST OF GAS SUMMARY
SUBSTITUTING AVERAGE COST FOR INCREMENTAL COST FOR FAIRBANKS TO KINGSGATE
(1977 $/MMBTU)

	1983	Level Annual
Purchase of Natural Gas	1.84	1.84
Pipeline Segments		
Cook to Fairbanks	1.41	1.01
Fairbanks to Kingsgate[1]	1.25	.89
Kingsgate to Malin	.40	.30
Malin to Antioch	.16	.12
TOTAL DELIVERED TO ANTIOCH[2]	5.06	4.16

(1) Based on Alcan Pipeline Company, March, 1977 FPC filing. Redesign of Alcan system may reduce this average cost slightly.

(2) Modification to existing natural gas system will be needed south of Antioch. Such modification may add as much as an additional 20¢ to 30¢ per million Btu (1977 $).

Exhibit D-6

ASSUMPTIONS USED IN COST OF SERVICE AND CAPITAL COST COMPARISONS

Cook Inlet to Tok
Cook Inlet to Fairbanks

1. Construction costs, fuel usage, operating and maintenance estimated by Southern California Gas Company. AFUDC cost computed.
2. 75% debt at 10% interest and 25% equity at 16% return.
3. 20-year project life.
4. 2% property tax rate.
5. 52.89% composite federal and state income taxes.
6. Fuel included in cost of purchased gas.
7. Annual Btu volume based on delivered volume as shown in energy balance.
8. Used normalized method to compute cost of service.

Tok to Kingsgate
Fairbanks to Kingsgate

1. Based on cost of service figures from Exhibit 7-1, page 1 of 2 of Alcan's filing of March 1977 for 48" alternative.
2. Used 10% of Alcan's Alaskan cost of service for Tok alternate since distance from Tok to Yukon is approximately 75 miles or 10% of a total of 731 miles from Prudhoe to Yukon. Used 38% for Fairbanks costs since distance from Fairbanks is approximately 280 miles or 38% of a total distance of 731 miles.
3. Used 100% of the remaining cost of service figures excluding PGT and PG&E.
4. Increased cost of service figures by 30% for probable cost overruns per President Carter's Message to Congress.
5. Inflated cost of service derived above by an additional 8% compounded annually to obtain 1977 $ from 1975 $.
6. Fuel cost left at $1.00/MMBTU per the Alcan Pipeline Company filing of March 1977 for 48" alternative.

(Continued)

Kingsgate to Malin

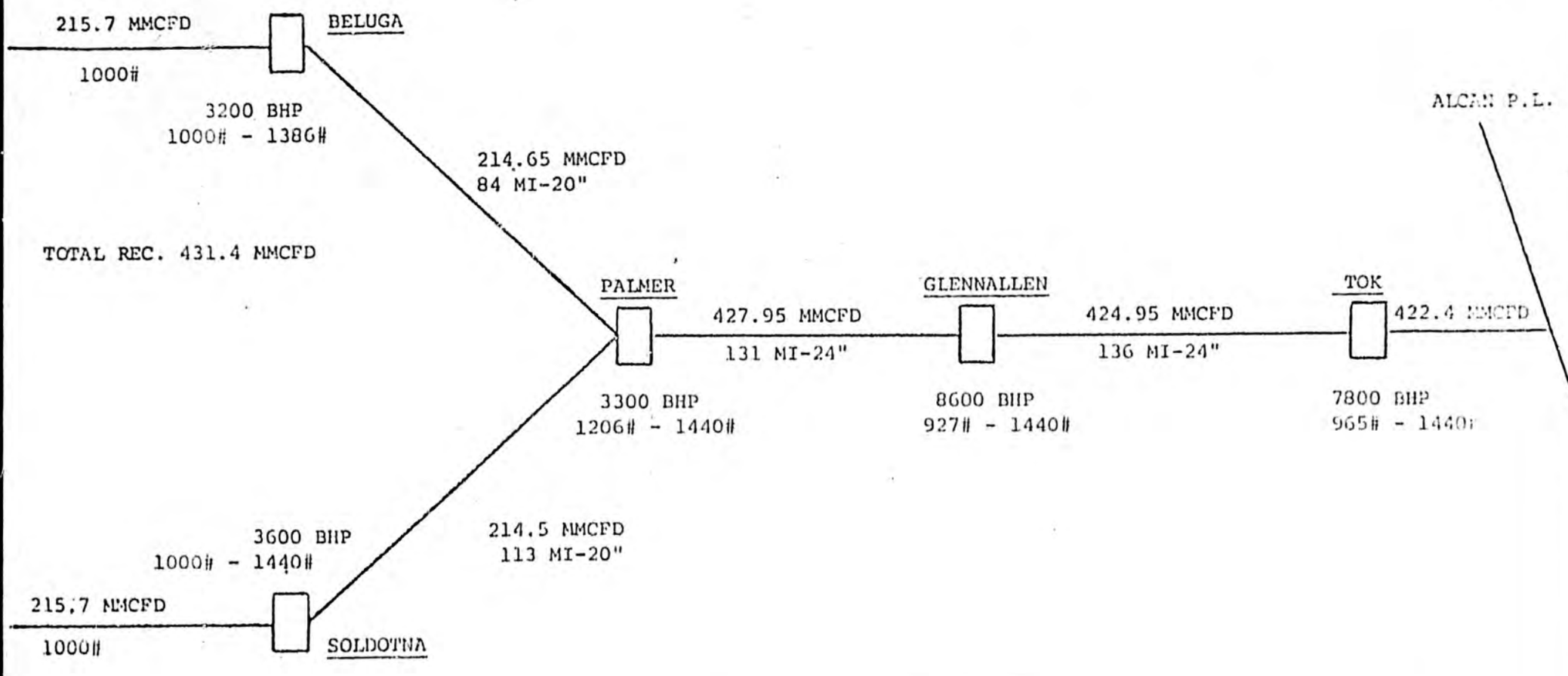
1. Construction costs, fuel usage, operating and maintenance and AFUDC from P.G.T.
2. 75% debt at 10% interest and 25% equity at 16% return.
3. 20-year project life.
4. 1.5% property tax rate.
5. 52% composite federal and state income taxes.
6. Fuel included in cost of purchased gas.
7. Annual BTU volume based on delivered volume as shown in energy balance.
8. Used normalized method to compute cost of service.

Malin to Antioch

1. Construction costs, fuel usage, operating and maintenance and AFUDC from PG&E.
2. 75% debt at 10% interest, 25% common equity at 16% return.
3. 20-year project life.
4. 1.75% property tax rate.
5. 52.68% composite federal and state income taxes.
6. Fuel included in cost of purchased gas.
7. Annual BTU volume based on delivered volume as shown in energy balance.

Purchase Natural Gas Costs

Purchase Natural Gas costs for both the LNG and Pipeline alternatives reflect the $1.46/MMBtu field price assumed for both projects adjusted to reflect the respective overall system gas balance efficiency of each project.

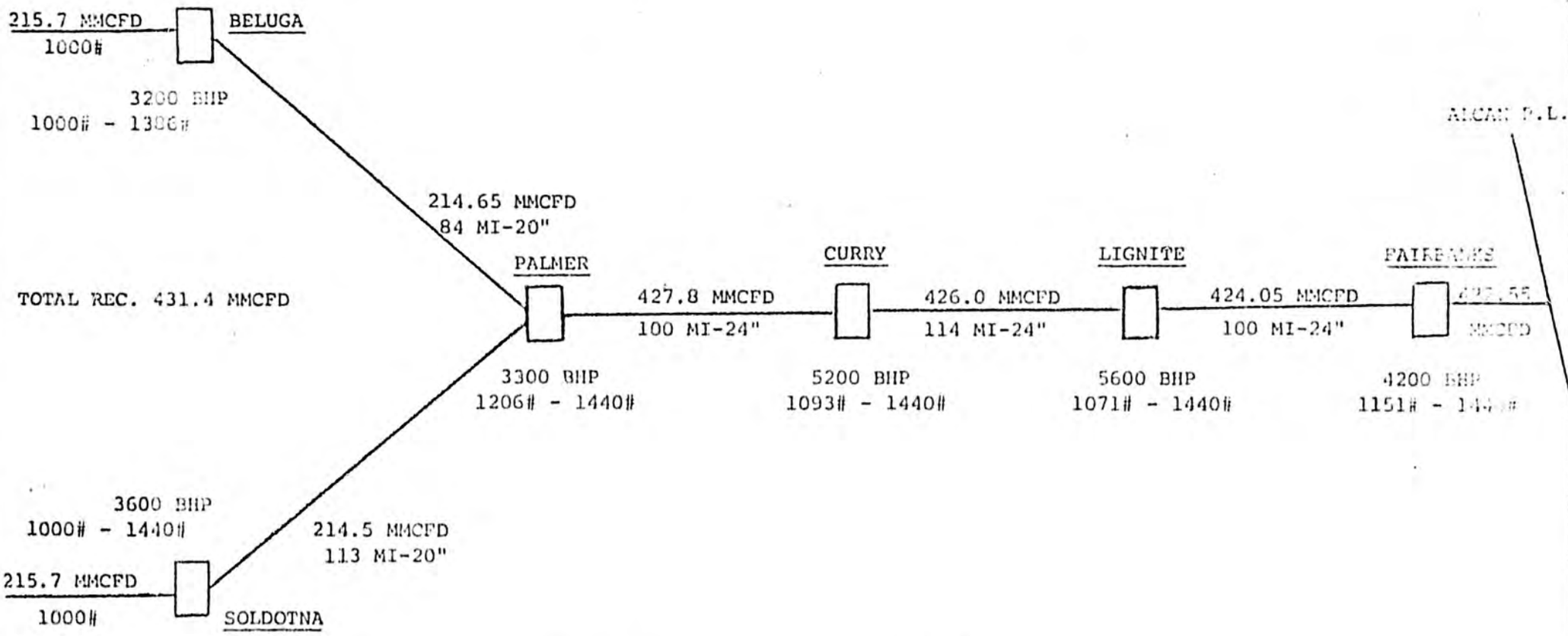


PIPELINE: X-65 t = 30°F
1440# MAOP S.G. = 0.60
CLASS I EFF. = 85%

EXHIBIT E-1

FLOW CALCULATIONS-COOK INLET TO TOK

AGO 544957



PIPELINE: X-65 t = 30°F
1440 MAOP S. G. = 0.60
CLASS I EFF. = 85%

EXHIBIT E-2

FLOW CALCULATIONS-COOK INLET TO FAIRBANKS

AGO 544958

Southern California Gas Company
Alaska Gas Pipeline Study
Possible Route Selection and Description

In November of 1977, Hood Corporation was engaged by the Southern California Gas Company to examine possible gas pipeline routes from Anchor Point, Alaska on the east side of Cook Inlet and Drift River on the west side of Cook Inlet, north to Palmer and then on northerly to a possible tie-in point on the proposed Alcan Natural Gas Pipeline at either Fairbanks, Delta Junction or Tok Junction.

Six different cost of field construction alternates were prepared and submitted to the Gas Company utilizing various pipeline sizes and final tie-in points to the Alcan line. The proposed right-of-way for all cases studied was identical from Drift River and Anchor Point to Palmer. At Palmer the Fairbanks alternate would follow north along Highway 3 to Fairbanks while the Delta Junction and Tok Junction alternates would be routed easterly to Glennallen along Highway #1 and either follow Highway 4 northerly to Delta Junction or continue along Highway 1 to Tok Junction.

Route determination was accomplished by utilizing topographic maps of the Alaska topographic series prepared by the United States Department of the Interior Geological Survey. Topographic or physical features not shown or noted on the U.S.G.S. maps were confirmed by visual inspection while flying the proposed pipeline routes in a Bell Jet Ranger Helicopter.

A generalized description of the terrain to be encountered and existing rights-of-way on each leg of the proposed right-of-way is described below.

Drift River to Beluga (63 Miles)
(Kenai and Tyonek topographic sheets)

Beginning at the Drift River Marine Terminal follow existing Drift River pipeline right-of-way north to West Foreland and Beluga. This terrain is essentially flat, marshy ground and can only be worked as a winter time operation off of snow pads - all materials must be barged in from the east side of Cook Inlet and temporary construction camps set up along the right-of-way. Camp site facilities are available at Drift River, Trading Bay and Standard Oils' Beluga installation. Air strip facilities exist at Drift River, Trading Bay and Beluga. Due to existing pipeline right-of-way, minimal negative environmental effect anticipated from additional pipeline construction operations.

Beluga to Palmer (84 Miles)
(Tyonek and Anchorage topographic sheets)

From Beluga to Point McKinzie follow Chugach Electric transmission line right-of-way across the mouth of the Big Suisitna River Delta. Terrain flat, swampy marsh lands suitable only for winter construction operations. Existing electrical transmission line right-of-way suitable for pipeline construction purposes. All material must be barged across from east side of Cook Inlet, however, there appears to be an abundance of local trails and roads suitable for pipe and equipment hauling.

From Point McKenzie area follow transmission line right-of-way north of Knik Arm up the Matanuska River Valley to Palmer. The existing road system from Goose Lake to Wasilla to Palmer should minimize pipe hauling and stringing operations. Utilization of existing right-of-way should minimize environmental problems. Terrain is high elevation and contains less lakes and swamp conditions.

Anchor Point to Soldatna (57 Miles)
(Seldovia and Kenai topographic sheets)

From Anchor Point follow the existing power line rights-of-way

north along the Sterling Highway to Soldatna. Ample right-of-way for pipeline construction appears to be available with minimal environmental impact anticipated if existing right-of-way is utilized. Right-of-way terrain is cleared of timber with scattered brushy areas.

Kenai River crossing south of Soldatna should be scheduled to avoid Salmon run season.

Between Soldatna and Sterling go north to pick up the existing Anchorage Natural Gas Company right-of-way. This existing cleared pipeline right-of-way is an excellent route across the moose range and should have a very minimal environmental impact. This route avoids most of the major swampy areas and could be constructed in either summer or winter. This route continues to Burnt Island on the south side of Turnagain Arm.

Turnagain Arm Crossing (5 Miles)
(Seward and Anchorage topographic sheets)
This proposed crossing of the Turnagain Arm parallels the dual line crossing installed by Anchorage Natural Gas Company. The recommended crossing point is approximately 500' west of the existing lines from Burnt Island across to Potter on the Anchorage side of the arm. No environmental problems are anticipated in installing a parallel system to the existing lines. Lines should be buried across tidal mud flats.

Turnagain Arm to Palmer (48 Miles)
(Anchorage topographic sheets)
From Potter on the north side of Turnagain Arm it is recommended to follow the existing Anchorage Natural Gas line right-of-way along the foothills east of Anchorage, east of Campbell Air Strip and north to Fort Richardson and Eagle River. From Eagle River north to Palmer follow existing power line right-of-ways along the Glenn Highway across the Knik River, Matanuska River and on into Palmer.

Palmer to Fairbanks (314 Miles)
(Anchorage, Tyonek, Talkeetna, Talkeetna Mts., Healy and Fairbanks topographic sheets)

For the Palmer to Fairbanks alternate route follow Highway 3 west out of Palmer to Willow. Workable right-of-way exists between the highway and the Alaska Railroad right-of-way. From Willow continue to follow Highway 3 and the R.R. right-of-way northerly along the Chulitna River Valley. Terrain is low rolling and swampy with available space for a pipeline adjacent to Highway 3. Continue up the Chulitna Valley through Broad Pass to Cantwell. Highway 3 continues north along the east side of Mount McKinley National Park through the narrow Nenana River Valley. Pipeline right-of-way through this stretch of terrain is narrow and rocky from McKinley Park to Garner. From Lignite north along Highway 3 fair to good right-of-way exists across the Early Warning Missile Range and on up to Nenana. From Nenana to Fairbanks, Highway 3 runs through broken foothills with limited space for a pipeline right-of-way along the highway to Fairbanks.

Palmer to Delta Junction (279 Miles)
(Anchorage, Valdez, Gulkana, Mount Hayes topographic sheets)

From Palmer the proposed right-of-way runs north easterly along Highway 1 (the Glenn Highway) ample cleared space is available on either side of the highway along and under existing power lines to afford an adequate pipeline construction route. Terrain along the Matanuska River Valley is primarily valley glacial moraine deposits which could be easily worked for pipeline construction. Good existing right-of-way exists all along Highway 1 up to Glennallen. From Glennallen the proposed pipeline route travels north along Highway 1 and 4 to Gakona Junction. From Gakona Junction fair to good existing cleared right-of-way is available along the Richardson Highway, #4, north to Delta Junction. A possible alternate for this section of pipeline could be to lay the gas line along the existing Alyeska pipeline right-of-way from Glennallen to Delta Junction.

Palmer to Tok Junction (267 Miles)
(Anchorage, Valdez, Gulkana, Nabesna and Tanacross topographic sheets)

The Palmer to Tok Junction follows the same Highway 1 route from Palmer to Glennallen as previously described and also Highway 1 and 4 from Glennallen to Gakona. At Gakona this proposed route continues north easterly along the continuation of Highway 1 (the Glenn Highway). North of the Cupper River, fair to good existing right-of-way is available for pipeline construction. This Glenn Highway route continues north easterly to cross the Chistochina River at Sinona Lodge up and over Mentasta Pass and on north to Tok Junction.

This alternate from Palmer north to the proposed Alcan gas line appears to have the best existing available right-of-way of all the routes observed.