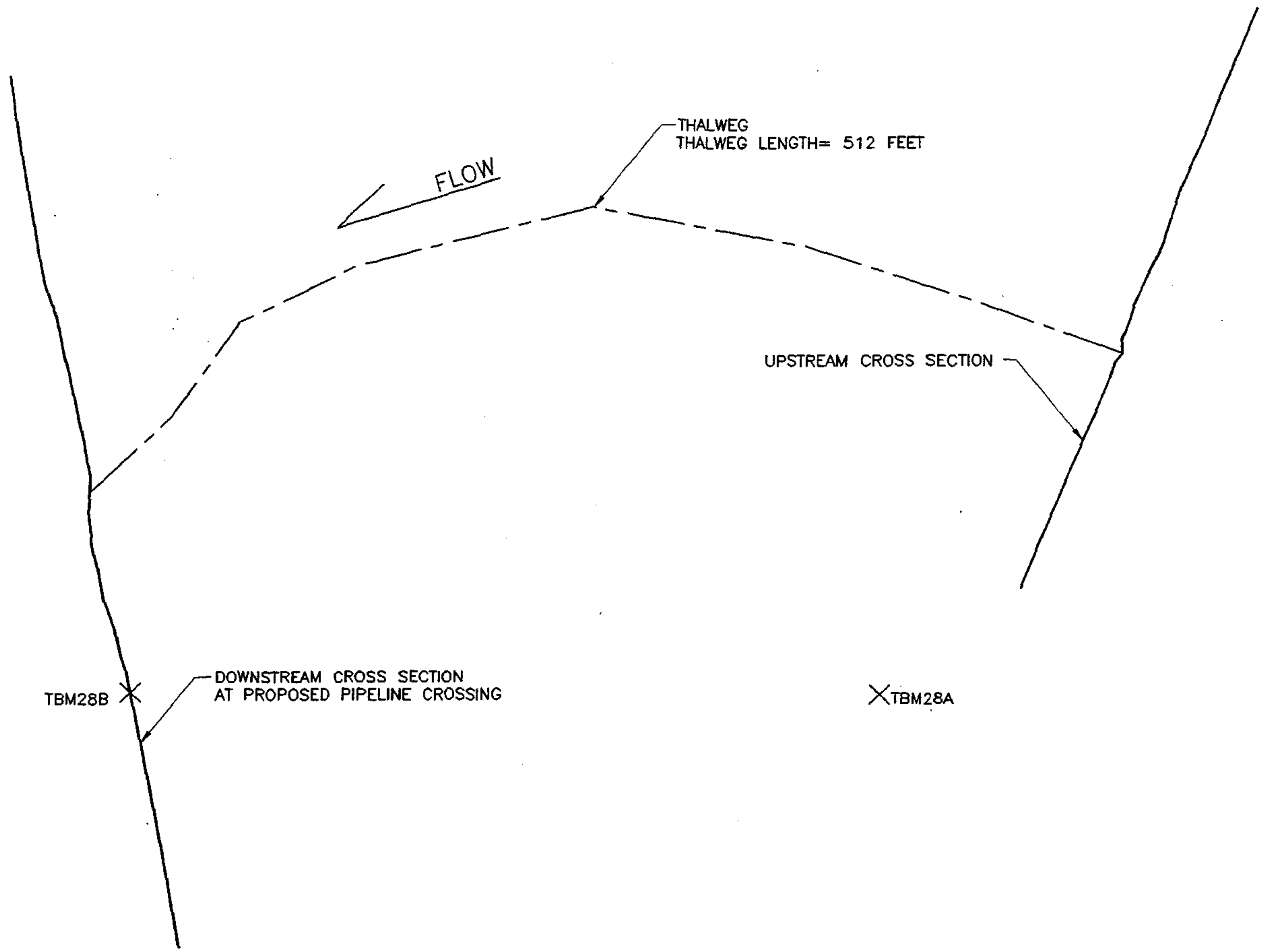
APPENDIX DD: PLX 28

TABLE OF CONTENTS



NOTES:

1. THE PRIMARY TEMPORARY BENCH MARK WAS ASSUMED TO HAVE: (1) AN ELEVATION OF 100.00 FEET, (2) A NORTHING OF 5000 FEET, AND (3) AN EASTING OF 5000 FEET. THE PRIMARY TEMPORARY BENCH MARK AT EACH STREAM PROVIDED THE VERTICAL AND HORIZONTAL CONTROL.
2. THE PRIMARY TEMPORARY BENCH MARK ON THIS STREAM IS TBM28A.

REVISION			
NO.:	DATE:		BY:

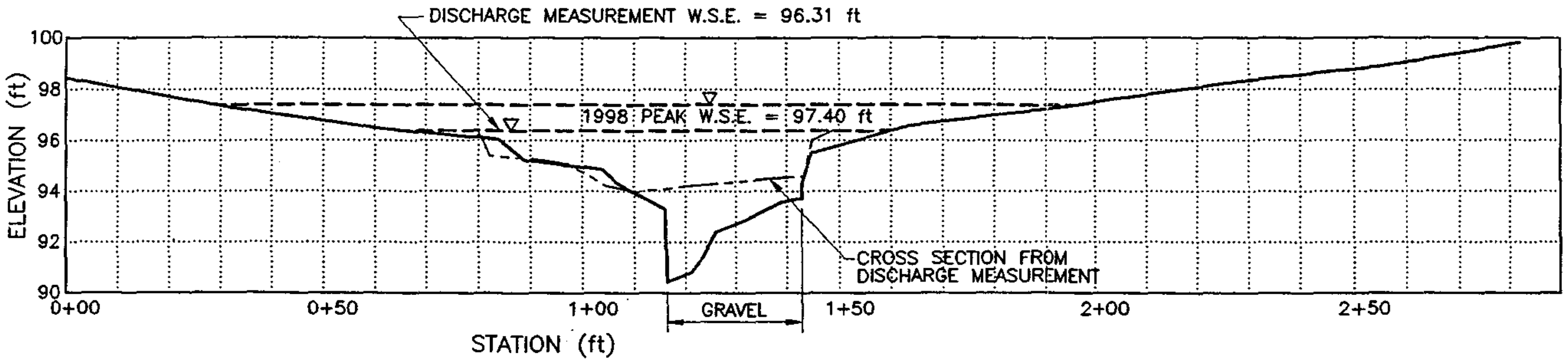
STREAM PLX28
PLAN

SOURDOUGH AREA DEVELOPMENT PROJECT
NORTH SLOPE, ALASKA

Baker Michael Baker Jr., Inc.

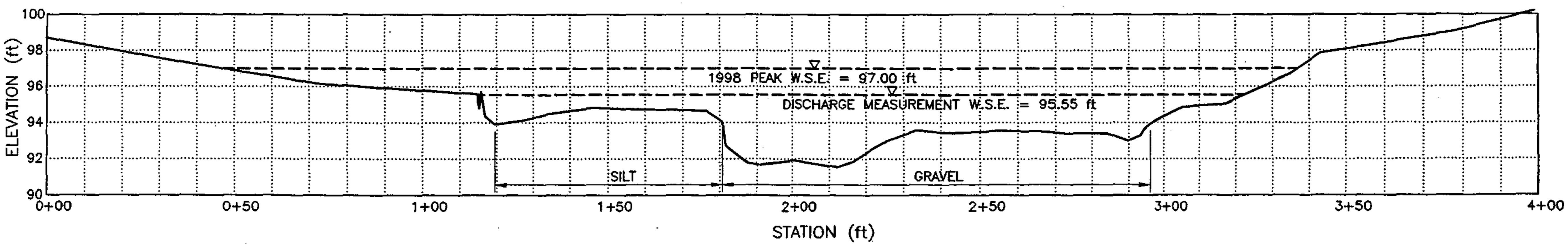
DATE:	8/3/98	PROJECT:	SADP
DRAWN:	BC	FILE:	SADP-X28
CHECKED:	JWA	SCALE:	1"= 60'

FIGURE:
PLX 28-1



PROFILE: PLX28 UPSTREAM CROSS SECTION

SCALE: H 1"= 30'
V 1"= 6'



PROFILE: PLX28 DOWNSTREAM CROSS SECTION AT PROPOSED PIPELINE CROSSING

SCALE: H 1"= 30'
V 1"= 6'

NOTES:
1. THE ELEVATIONS SHOWN ARE BASED ON AN ASSUMED ELEVATION OF 100.00 AT TBM28A.
2. W.S.E.= WATER SURFACE ELEVATION
3. DISCHARGE MEASUREMENT CROSS SECTION AFFECTED BY ICE IN CHANNEL.

REVISION			
NO.:	DATE:		BY:

STREAM PLX28
PROFILES
SOURDOUGH AREA DEVELOPMENT PROJECT
NORTH SLOPE, ALASKA

Baker Michael Baker Jr., Inc.

DATE:	8/3/98	PROJECT:	SADP
DRAWN:	BC	FILE:	SADP-X28
CHECKED:	JWA	SCALE:	VARIES

FIGURE: PLX 28-2

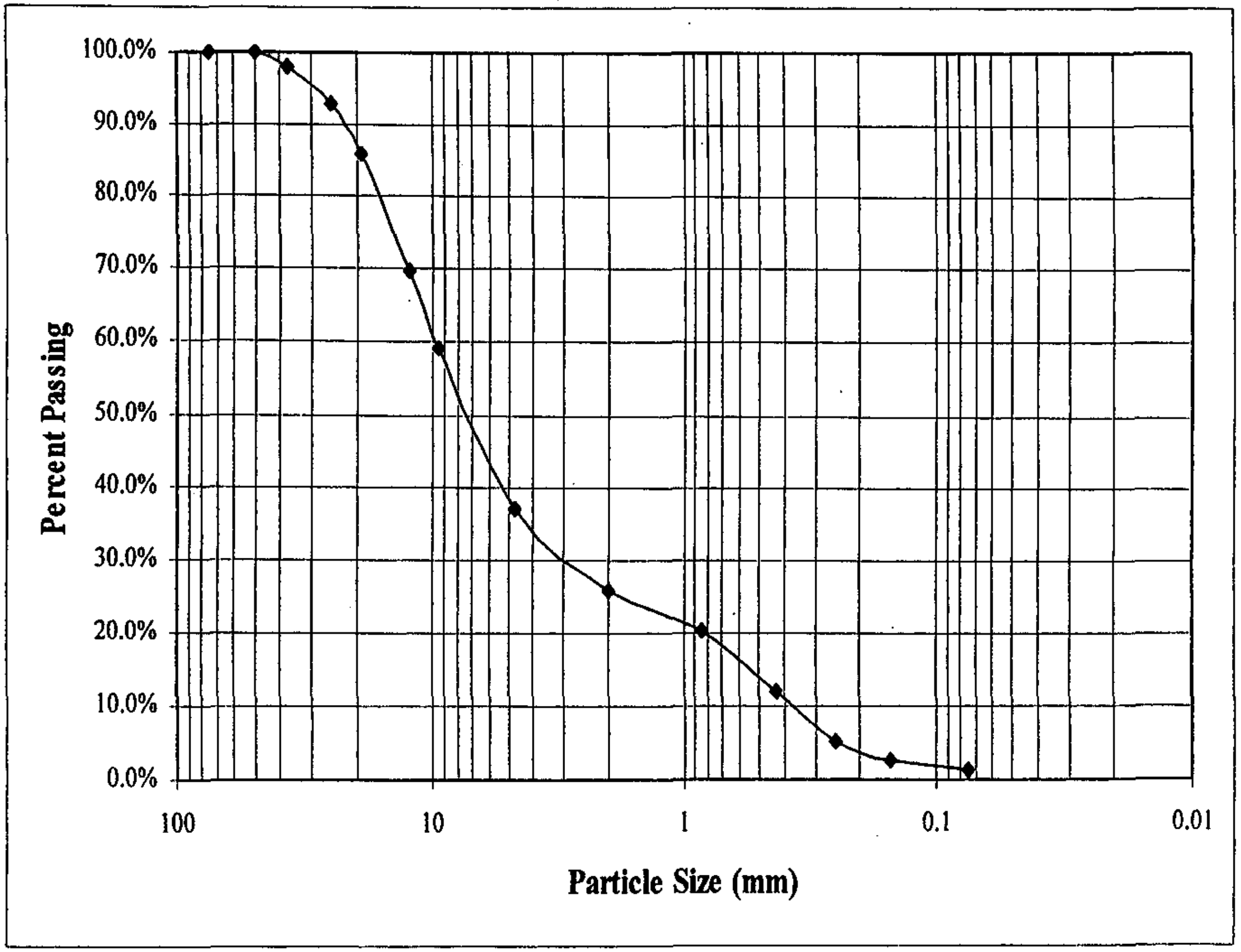


Figure Number: PLX 28-3

Baker Michael Baker Jr., Inc.

Date: 8/6/98	Project: 23247
Drawn: JDA	File: gradations.ppt
Checked: JWA	Scale: N/A

STREAM PLX 28
BED MATERIAL GRADATION

SOURDOUGH AREA DEVELOPMENT PROJECT
NORTH SLOPE, ALASKA

REVISION:

NO:	DATE:		BY:

Photo PLX 28-1: Looking north at the proposed pipeline crossing (6/11/98).

Photo PLX 28-2: Looking north at the proposed pipeline crossing (6/2/98).

STREAM PLX 28 PHOTOGRAPHS	Michael Baker Jr., Inc.		Photo Number:
SOURDOUGH AREA DEVELOPMENT PROJECT NORTH SLOPE, ALASKA	Date: 6/7/98	Project: 23247	PLX 28-1
	Drawn: JDA	File: photo28	
	Checked: JWA	Scale:	

DISCHARGE MEASUREMENT NOTES

LOCATION: PLX 28, 500 feet upstream from the upstream cross section

Date: 5/31 ,1998 **Party:** J. Meckel, P. McGranahan

Width: 74.4 **Area:** 118 **Vel:** 3.31 **G.H.:** **Disch.:** 391 cfs

No Secs. 10 **G.H. change:** **in.:** **hrs.:** **Susp.:**

Method coef.: **Hor. Angle coef.** **Sus. Coef.:** **Meter No.**

Gage Readings

Time	Recorder	Inside	Outside
	upstream x-sec	WSE=	96.31
	downstream x-sec	WSE=	95.55
Weighted M.G.H.			
G.H. corrections			
Correct M.G.H.			

Type of meter: Price AA

Date rated: Std No 1

Meter: **ft. above bottom of weight.**

Spin before meas. ok **after** ok

Method: Wading 500 feet above the upstream cross section.

Proposed pipeline crossing is at the downstream cross section.

Levels obtained

Measurement rated: Poor (over 8%). Uniform short grass - some ice. **based on following conditions:**

Cross section:

Flow: **Weather:** **Air °F@:**

Gage: **Water °F@:**

Other:

Record Removed: **Intake flushed:**

Observer

Control Channel expanding - mostly clear of snow and ice. Grass 4-8" high, cobbles 2-4", and sand.

Remarks s= .76/512=.0015 ft/ft.

G.H. of zero flow: ft.

DISCHARGE MEASUREMENT NOTES (PLX 28 Continued)

Angle coef.	Dist. From Initial point (ft)	Width (ft)	Depth (ft)	Observ. depth	Revo-lutions	Time In seconds	VELOCITY At Point (fps)	VELOCITY Mean in-vertical (fps)	Area (s.f.)	Discharge (cfs)	Description
	44.6	3.9							0.0	0.0	Left Edge Water (14:30)
	52.4	7.7	1.0	0.6	10	48		0.47	7.7	3.6	
	60.0	7.6	1.1	0.6	40	46		1.92	8.3	15.9	
	67.5	7.5	1.3	0.6	80	50		3.50	9.8	34.1	
	75.0	6.8	2.2	0.6	80	42		4.16	14.9	61.8	
	81.0	16.0	2.4	0.6	100	43		5.08	38.4	195.1	Grounded ice
	107.0	16.3	1.9	0.6	50	43		2.55	30.9	78.7	Grounded ice
	113.5	4.0	1.8	0.7	5	47		0.25	7.2	1.8	Grounded ice
	115.0	2.8	0.4	5.0	3	70	0.11	0.10	1.1	0.1	
	119.0	2.0							0.0	0.0	Right Edge Water (15:00)
Total	74.4	74.4							118.2	391.2	

file: disch_P28.xls

Table PLX 28-1: Survey Data

Survey Point Number	Easting (ft)	Northing (ft)	Elevation (ft)	Description
1	5000	5000	100	TBM-P28 (TBM28A)
2	5000	5330.1548	95.701	P28/CL/CG (TBM28B)
3	4886.240296	5309.004891	98.71	T
4	4918.212999	5314.579028	97.483	T
5	4957.363927	5321.983234	96.177	T
6	4999.032089	5329.992282	95.59	T
7	4999.552019	5330.009673	94.806	LEW
8	5001.065161	5330.382622	94.369	G
9	5003.764304	5331.091684	93.925	MUD
10	5010.794669	5332.205554	94.108	MUD
11	5018.135136	5334.705444	94.49	M/G
12	5029.68953	5337.000554	94.827	REW
13	5043.345402	5341.847908	94.718	T
14	5058.902276	5344.693128	94.657	T
15	5063.22772	5345.727833	94.048	T-C/B
16	5064.056329	5346.225891	92.741	C
17	5069.849718	5347.197801	91.795	C
18	5073.375418	5347.065364	91.672	C/POSS.TH
19	5082.921059	5348.21594	91.936	C
20	5094.896117	5347.444261	91.544	C
21	5099.623745	5347.52467	91.867	C
22	5104.797132	5348.416968	92.616	C
23	5108.762111	5349.045925	93.038	C
24	5115.843075	5350.362566	93.574	C
25	5125.409781	5352.299674	93.431	C
26	5136.809807	5354.730108	93.552	C
27	5147.675056	5356.984076	93.532	C
28	5154.372257	5358.687683	93.398	C
29	5165.778297	5361.096303	93.399	C
30	5171.208539	5361.808492	93.009	C
31	5174.457765	5363.194659	93.312	C
32	5175.737009	5363.372096	93.704	C/G
33	5176.987731	5363.975252	93.974	REW
34	5186.318905	5367.144329	94.868	T
35	5197.557331	5369.216171	95.043	T
36	5215.129313	5372.073144	96.703	T
37	5223.237999	5373.517018	97.868	T
38	5235.973278	5375.546433	98.279	T
39	5257.885894	5378.973346	99.081	T
40	5278.686639	5381.863581	100.211	T
41	5309.293216	4829.016334	99.829	T
42	5285.000269	4839.747208	98.894	T
43	5257.980409	4850.896474	98.263	T
44	5229.014727	4863.915864	97.346	T

Table PLX 28-1: Survey Data (continued)

Survey Point Number	Easting (ft)	Northing (ft)	Elevation (ft)	Description
45	5199.949395	4874.308411	96.586	T
46	5182.525471	4882.107177	95.472	T/TB
47	5181.091548	4883.070669	94.281	REW
48	5180.969665	4883.043671	93.719	M
49	5177.826834	4884.573053	93.586	M/C
50	5171.239418	4886.700883	92.896	C
51	5165.307495	4888.941238	92.394	C
52	5162.874015	4890.111365	91.389	C
53	5160.77338	4890.681542	90.825	C
54	5155.423544	4890.467921	90.449	C/TH
55	5155.08353	4890.538661	93.282	G
56	5150.980891	4893.565936	93.795	G
57	5146.893094	4894.861801	94.302	LEW/G
58	5144.239005	4896.099059	94.858	T
59	5130.470109	4902.045217	95.211	T
60	5126.011113	4904.212664	96.034	T
61	5105.349386	4913.512073	96.451	T
62	5078.60395	4925.095587	97.278	T/IPP28/HWM
63	5048.880233	4937.367335	98.452	T
64	5203.249738	5030.557231	92.585	TH
65	5220.79868	5125.332013	91.23	TH
66	5194.510369	5230.115359	91.901	TH
67	5169.156343	5281.987735	92.732	TH
68	5126.413197	5312.186207	92.746	TH
69	5095.168215	5344.169602	92.057	TH

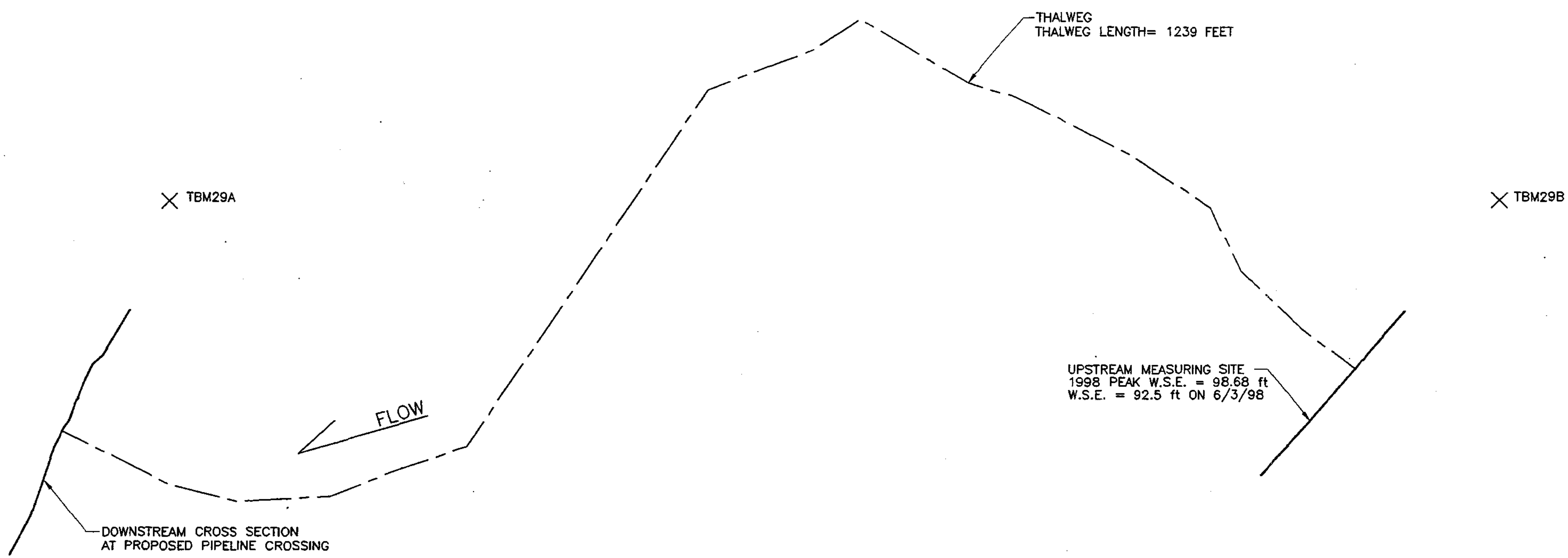
Legend:

G = grass	REW = right edge of water	DS = downstream	CL = center line
T = tundra	TH = thalweg	US = upstream	PK = "pk" nail
C = cobbles	CG = crest gage	TWET = wet tundra	
LEW = left edge of water	GB = ground break	M = mud	
	SH = shoulder	SB = sand bags	

file:plx28.xls

APPENDIX EE: PLX 29

TABLE OF CONTENTS



NOTES:
1. THE PRIMARY TEMPORARY BENCH MARK WAS ASSUMED TO HAVE: (1) AN ELEVATION OF 100.00 FEET, (2) A NORTHING OF 5000 FEET, AND (3) AN EASTING OF 5000 FEET. THE PRIMARY TEMPORARY BENCH MARK AT EACH STREAM PROVIDED THE VERTICAL AND HORIZONTAL CONTROL.
2. THE PRIMARY TEMPORARY BENCH MARK ON THIS STREAM IS TBM29A.

NO.:	DATE:	REVISION	BY:

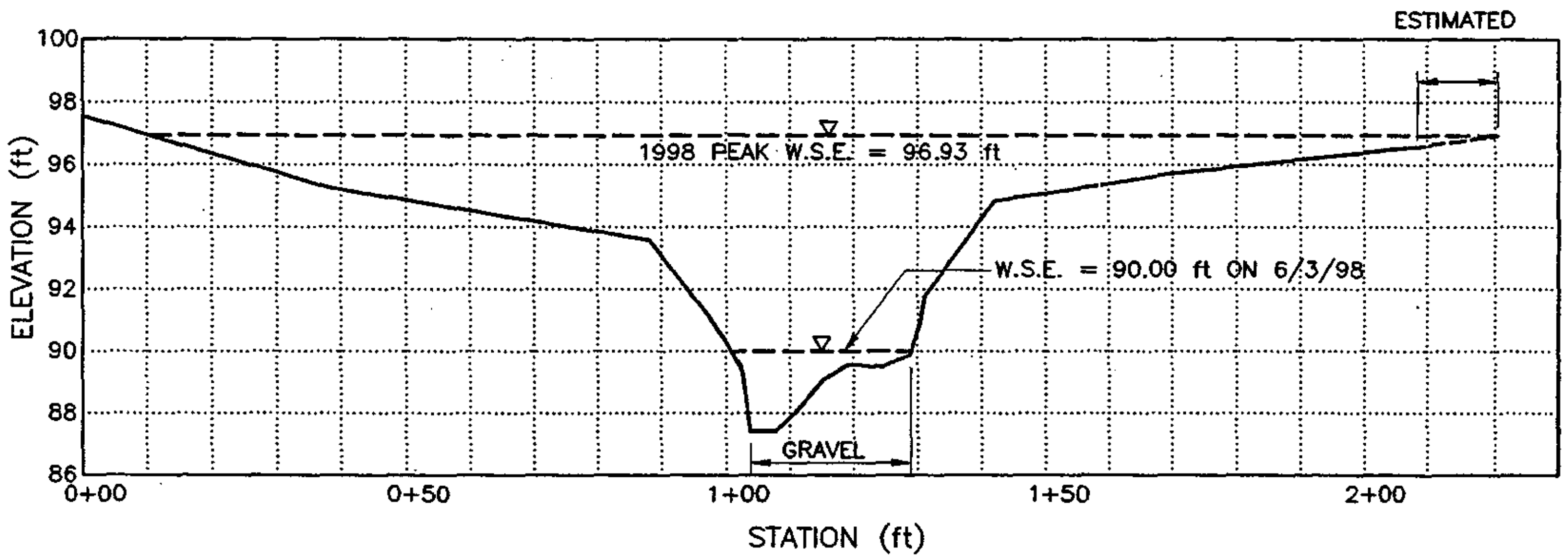
STREAM PLX29
PLAN

SOURDOUGH AREA DEVELOPMENT PROJECT
NORTH SLOPE, ALASKA

Baker — Michael Baker Jr., Inc.

DATE:	8/3/98	PROJECT:	SADP
DRAWN:	BC	FILE:	SADP-X29
CHECKED:	JWA	SCALE:	1"= 80'

FIGURE: PLX 29-1



PROFILE: PLX29 DOWNSTREAM CROSS SECTION AT PROPOSED PIPELINE CROSSING

SCALE: H 1"= 30'
V 1"= 6'

NOTES:
1. THE ELEVATIONS SHOWN ARE BASED ON AN ASSUMED ELEVATION OF 100.00 AT TBM29A.
2. W.S.E.= WATER SURFACE ELEVATION

REVISION			
NO.:	DATE:		BY:

STREAM PLX29
PROFILE

SOURDOUGH AREA DEVELOPMENT PROJECT
NORTH SLOPE, ALASKA

Baker Michael Baker Jr., Inc.

DATE:	8/3/98	PROJECT:	SADP
DRAWN:	BC	FILE:	SADP-X29
CHECKED:	JWA	SCALE:	VARIES

FIGURE: PLX 29-2

Photo PLX 29-1: Looking northeast at the proposed pipeline crossing (6/2/98).

Photo PLX 29-2: Looking northeast at the proposed pipeline crossing (6/11/98).

STREAM PLX 29 PHOTOGRAPHS	Baker Michael Baker Jr., Inc.	Photo Number:
SOURDOUGH AREA DEVELOPMENT PROJECT NORTH SLOPE, ALASKA	Date: 6/7/98 Project: 23247 Drawn: JDA File: photo29 Checked: JWA Scale:	PLX 29-1

Photo PLX 29-3: Looking north at the proposed pipeline crossing (6/3/98).

STREAM PLX 29 PHOTOGRAPHS	Baker — Michael Baker Jr., Inc.	Photo Number:
SOURDOUGH AREA DEVELOPMENT PROJECT NORTH SLOPE, ALASKA	Date: 6/7/98 / Project: 23247 Drawn: JDA / File: photo29 Checked: JWA / Scale:	PLX 29-2

Table PLX 29-1: Survey Data

Survey Point Number	Easting (ft)	Northing (ft)	Elevation (ft)	Description
1	5000	5000	100	TBM/CL/P29 (TBM29A)
2	4008.94	5000	100.33	TBM/UPS/P29 (TBM29B)
101	4097.470492	5109.573261	96.562	SG
102	4076.634779	5084.506776	97.816	T
103	4103.692388	5117.183395	96.16	T
104	4107.055037	5121.480383	92.468	REW
105	4107.903538	5121.783456	91.227	C
106	4111.713693	5126.575648	90.915	C
107	4113.744168	5128.610657	87.852	TH
108	4154.537493	5098.155668	89.677	TH
109	4199.886019	5053.474696	90.256	TH
110	4222.738848	5005.558291	89.225	TH
111	4284.724441	4965.277888	88.542	TH
112	4371.642871	4920.712882	89.665	TH
113	4405.20552	4910.665113	90.533	TH
114	4485.420652	4863.401537	90.297	TH
115	4518.821434	4885.132875	88.974	TH
116	4598.861575	4916.319589	89.509	TH
117	4664.306012	5014.110506	89.856	TH
118	4779.536391	5187.896635	90.583	TH
119	4829.133696	5205.282398	89.826	TH
120	4881.193047	5226.413903	89.428	TH
121	4948.297513	5230.359172	88.632	TH
122	4998.041966	5218.304124	87.452	TH
123	5114.226815	5151.324452	88.083	TH/FL
124	5057.399231	5124.484746	95.354	SG
125	5029.455533	5083.083838	96.572	T
126	5050.056649	5117.77523	95.688	T
127	5064.49989	5139.911077	94.831	T
128	5068.63488	5150.296435	91.676	T
129	5068.151327	5151.143555	90.945	REW
130	5069.227427	5152.228312	89.884	C
131	5071.493922	5156.086288	89.503	C
132	5073.032468	5160.936959	89.583	C
133	5074.423144	5165.052964	89.066	C
134	5075.939922	5169.017819	88.035	C
135	5078.257975	5171.380051	87.415	C
136	5080.224302	5174.76596	87.414	C
137	5080.867497	5176.00957	89.547	G
138	5082.671129	5180.754594	91.129	LEW

(continued on next page)

Table PLX 29-1: Survey Data (continued)

Survey Point Number	Easting (ft)	Northing (ft)	Elevation (ft)	Description
139	5086.684095	5189.019646	93.575	T
140	5102.263454	5236.962766	95.263	T
141	5119.678209	5270.990923	97.565	T

Legend:

G = grass
T = tundra
C = cobbles
LEW = left edge of water
REW = right edge of water
TH = thalweg
CG = crest gage
GB = ground break
SH = shoulder
DS = downstream
US = upstream
TWET = wet tundra
M = mud
SB = sand bags
CL = center line
PK = "pk" nail

file:plx29.xls

PROJECT REPORT

TEXT AND FINAL ADJUSTED VALUES

SOURDOUGH PHOTO CONTROL PROJECT

JULY 1997

FOR

AeroMap U.S., Inc.
2014 MERRILL FIELD DRIVE
ANCHORAGE, ALASKA 99501-4116

BY

C.A. HERSCHBACH, R.L.S.
SURVEYING CONSULTANT
P.O. BOX 521084
BIG LAKE, ALASKA 99652
PHONE: (907) 892-7839

I. INTRODUCTION

AeroMap U.S. had a requirement for horizontal and vertical control for photogrammetric mapping of the Sourdough Project area situated between Bullen Point and the Staines River and extending seven to thirteen miles inland from the Beaufort Sea coastline on the North Slope, Alaska. After preliminary discussions and the submission of several written and verbal proposals by the survey consultant, a contract was executed 26 June, 1997.

The contract required the determination of X, Y, and Z coordinates and postmarking of a total of 93 HV points, 48 being entirely new locations in the southerly portions of the project area and 41 to coincide, where possible, with HV points set under the consultant's direction some fourteen years ago in the northerly portions of the project area. Also, four were to be set on existing NGS monumentation, also in the northerly portions of the project area. The survey was to be accomplished by a combination of conventional spirit differential leveling and utilization of GPS technology, as the consultant had proposed.

The vertical datum was to be Mean Sea Level, East Dock, Prudhoe Bay, to be established by extending vertical control from the Badami mapping project immediately to the west and adjoining this project. The consultant emphasized he could not vouch for the accuracy of the vertical tie from the Badami project to East Dock itself, as this had been done previously by others.

Horizontal control was to be based on NGS monumentation within or adjacent to the project area, taking care to assure consistency of the horizontal datum between the Badami and Sourdough projects. Final submission of the horizontal data to AeroMap would be in Alaska State Plane Coordinates, NAD 1927, Zone 3.

BPX would provide helicopter support with a ERA Bell 206 Long Ranger helicopter based in Deadhorse. The helicopter would be available for night time use by the consultant's team from the night of 10 July, 1997 to the night of 6 August, 1997, if the project so required.

A project control map with numbered photo control points, a listing of coordinates of new points digitized from USGS 1" = 1 mile maps and the approximate coordinates of the old points was furnished the consultant by AeroMap. AeroMap also provided a 70mm camera with sufficient film to accomplish the postmarking requirement.

It was expected all field work would be completed by 6 August, 1997 and all required elevations, coordinates and postmark data furnished AeroMap during August 1997.

The consultant provided all personnel, equipment, software, vehicle, room and board for field personnel and miscellaneous supplies as required on this project. This report details that logistical support and describes in detail the techniques utilized to accomplish the project. A primary control diagram, project point plot, final elevations and coordinate values are included in the attached appendices. Also included are photographs of recovered NGS monumentation in the project area and photographs of primary equipment utilized.

II. QUALIFICATIONS OF CONSULTANT

The lead consultant and project manager was Clarence A. "Bud" Herschbach, registered land surveyor and certified inshore and offshore hydrographic surveyor. Mr. Herschbach is a 43 year Alaska resident and registered as a professional surveyor in Alaska and 12 other States. His experience as a surveyor on the North Slope, Alaska began during Dewline construction in the 1950s, extended through nearly all phases of oil exploration and production and, though now retired, continues on occasional specific projects.

The primary assistant consultant was Thomas C. Herschbach. Thomas Herschbach is also registered as a professional land surveyor in Alaska. He was born and raised in Alaska and has been involved on major survey projects throughout the State for the past 17 years. He is especially well experienced in GPS surveys and survey related computer operations. Thomas was in charge of those aspects of the Sourdough project.

III. PREMOBILIZATION AND PLANNING PRIOR TO FIELD ACTIVITIES

This activity was completed between June 26 and July 9, 1997. The consultant and AeroMap professionals met in detailed planning sessions to determine a project plan that would meet the analytical triangulation requirements, while at the same time be feasible from a survey and site access point of view. A project planning map indicating the old and new point positions was developed.

The planning map was carefully studied to determine the suitability of various survey approaches to accomplish the desired result. Control recovery requirements were determined and field logistics were planned. Several additional copies of USGS 1" = 1 mile maps of the project area were acquired and the proposed photo control layout plotted thereon. Latitude and longitudes were digitized by AeroMap of all new postmark positions. State Plane coordinate values of the old points were converted to Latitudes and Longitudes and all Latitudes and Longitudes converted to NAD 83 datum as this is the datum the ERA helicopter GPS utilizes. All available NGS control data was acquired, thoroughly reviewed so the data could be coordinated in the field, and control that was deemed desirable to recover was highlighted.

Supplies such as mosquito repellent, field books, computer paper, computer disks, and monumentation material were purchased. All equipment was packaged to protect it during shipment to the field. Lease of four Trimble 4000 SSI Geodetic GPS receivers was arranged from Accupoint Incorporated in Anchorage. Airline reservations were made and tickets purchased. Availability of room and board, vehicles and other supplies at Deadhorse was determined by telephone communications, and reservations made where required.

A portable postmarking panel of highly reflective 10" wide material was fabricated. Each leg was six foot in length except one which was eight foot in length, this to always be aligned to the North. A grommet was placed in the center to fit over the rebar planned to be used to mark each postmark location. The ends of each panel leg had weights sewn within to facilitate placement and positioning in windy conditions, natural or helicopter induced.

A Hasselblad 70mm camera was acquired from AeroMap and tested to assure it was working properly. A bull's eye leveling bubble was glued on the film magazine to facilitate the perpendicular positioning of the camera, since it was to be hand held during postmarking photography due to the model helicopter to be utilized.

Planning was completed and mobilization to the field was possible on the preplanned date. The survey crew and all equipment was in place ready to begin field work on the night of July 10. Room and board and field office space was obtained from The Arctic Caribou Inn as The Prudhoe Bay Hotel, the consultant's first choice, was filled to capacity by other oil field contractors. A four wheel drive crew cab vehicle was leased for the length of field activity from Nana Oil Field Services. The living arrangements, field office arrangements and vehicle proved to be entirely satisfactory.

IV. CHRONOLOGY OF FIELD OPERATIONS

Mobilization:

Two consultant personnel with basic equipment as baggage traveled to Deadhorse on the afternoon of 10 July, 1997 via Alaska Airlines Flight 55. The remaining equipment and supplies had been airfreighted to Deadhorse on the 8th and was already at the air cargo terminal in Deadhorse upon personnel arrival. A lease truck, as had been arranged by telephone, was picked up at Nana Oil Field Services and the equipment and supplies picked up. Rooms were secured at The Arctic Caribou Inn and a field office was set up. Field work began on the night of July 10th. A third crew man, who would serve as rodman and survey helper, arrived on Alaska Airlines Flight 55 on July 14th, the flight having been delayed by one day due to fog at the Deadhorse Airport.

Personnel:

C. A. "Bud" Herschbach, R.L.S., Project Manager and Principal Consultant
Thomas C. Herschbach, R.L.S., GPS Manager and Data Reduction Manager
Douglas Herschbach, Rodman and Survey Helper

Equipment:

The consultant supplied all equipment, except the camera. This included:

4	Trimble 4000 SSI Geodetic GPS receivers with antennas, tripods and software.
1	Hasselblad Model 500 EL/M camera with Distagon 40mm F4 lense with yellow filter. Battery powered and equipped with detachable handle and bull's eye leveling bubble.
1	Sokkisha automatic level with tripod and 16 foot rod.
1	Topcon DL-102 electronic digital level with 3 meter rod, tripod and software.
4	FM Hand-held radios.

1	Four-wheel drive crew cab pickup truck.
2	Magellan hand-held GPS navigation receivers.
1	Trimble hand-held GPS navigation receiver.
1	Pentium based computer with printer.
	Miscellaneous small survey tools and equipment.
	A variety of appropriate surveying software packages.

Supplies:

Various supplies were carried with the survey team, which included:

1	Collapsible postmarking panel.
8	70-exposure rolls of 70 millimeter Kodak Tri-X film.
	Monumentation, lath and flagging materials.
	Miscellaneous maps, computer disks, printer paper, field books, etc.

Field Operations:

With the availability of the helicopter, field operations began on the night of July 10, 1997. The scheduled work day was from 7:00 p.m. in the evening until 7:00 a.m. in the morning. This varied significantly in practice due to the non-availability of the helicopter and prevailing dense fog in the early morning hours. The earliest the crew ever departed Deadhorse was 7:30 p.m. and the latest 12:30 a.m. in the morning. The average was 8:00 to 8:30 p.m. The crew sometimes returned early due to dense fog which not only hampered helicopter flight but prevented leveling by curtailing visibility directly and coating the instrument lenses with water droplets. One night was not worked as fog totally prevented the helicopter from flying. In addition, two nights were not worked due to non-availability of the helicopter because of required maintenance. The survey team took advantage of these shutdowns by catching up on data reduction and computations. A flight log is attached detailing helicopter usage. Although the extensive amount of helicopter non-availability was frustrating, the pilot, Ron Adair, was exceptional in both capability and interest. Without his expertise and cooperation this project would have taken considerably longer to complete and many more hours of flight time expended. GPS observations were completed on the night of July 27/28 and all remaining field work completed on the night of July 29/30. The GPS receivers were shipped via Alaska Airlines on July 28th and the personnel and remaining equipment departed by Alaska Airlines late afternoon on July 30th, 6 days ahead of the original estimated completion date.

Unpacking of equipment and final computations were begun the following day. Final elevations, coordinates and this project report were delivered to AeroMap on August 29, 1997.

V. FIELD PROCEDURES

Field procedures on the Sourdough Project consisted of four primary functions: recovery of NGS control and existing photo control points in northern project area and setting of rebar and lath on new photo control points in southern project area, collapsible panel emplacement and low level photography, GPS procedures, and differential leveling procedures. All, of course, required various levels of logistical support and other sub-functions fell within these four primary functions. Following, this report details how each of the primary functions was accomplished.

A. Recovery:

Eight NGS control monuments were to be searched for in the project area. Only five were located and all were in poor condition. A summary of the results of this investigation is as follows:

Station	Comments
SAVAK	Recovered. Monument 2.38 feet above ground and leaning slightly. Curiously, the NGS CD-ROM based data files does not list this station but a phone call to NGS secured positional data.
GORDON	Destroyed or covered by beach gravel.
HOBSON	Recovered. Monument 4.09 feet above ground and leaning.
NORA	Destroyed or covered by beach gravel.
TUNDRA	Recovered. Monument 4.35 feet above ground and leaning. Rebar found at base set by F. Robert Bell and Associates in 1993.
RODA	Recovered. Monument 4.05 feet above ground and leaning.
NYGREN	Recovered. Monument has been hit by vehicle and bent dramatically. Cap missing. Found rebar at base of monument.
LILY	Monument destroyed. Has relatively recently fallen over eroding bluff.

Note: Photographs of all recovered monuments in the project area are provided in Appendices to this project report.

Due to the weakness of the control stations directly within the project area the search and recovery was extended to stations immediately outside the project area. These consisted of "TIGVARIAK EAST BASE", "IOVIK" and "ELIZA" in the Badami area as these had been previously recovered during the survey of photo control for that mapping project. These stations were again recovered. The helicopter was also landed west of the Staines River and a foot search made for "FINISH" in ANWR. It was recovered in good condition. Also recovered were photo control points 537 and 538 of the Badami Survey Project. These were later to be utilized as beginning bench marks for the differential leveling for the Sourdough Project. Also points 304, 311, 313, 314, and 315, recently set by Mike Schoder of AeroMap and included in his GPS static survey were recovered for inclusion in the Sourdough mapping control net. To prevent duplicate and/or confusion these were given new numerical identification numbers as follows: 304=1304, 311=1311, 313=634, 314=637 and 315=636.

Of the 41 old photo control points in the northerly project area 38 were found, generally in good condition although all of the mechanically driven aluminum rods were jacked one to three feet due to frost action. New points were set in the general area of the three missing points.

In addition, two control rebar set by F. Robert Bell and Associates in 1993 in the Yukon Gold area were recovered in good condition.

B. Monumentation:

Following recovery work all new postmark locations were marked with 30" x 1/2" rebar, lath and hi-vis flagging. These were set by navigating to the previously digitized latitudes and longitudes by use of the helicopter GPS unit and the points set at the desired locations as indicated by this instrument. In all cases a flat area was selected of a relatively dark color so as to attain high contrast with the white panel to be later utilized. By chance, this procedure was accomplished in dense fog conditions and no visual reference to surrounding land marks was possible. The later accurate survey, however, indicated all were very close to preselected desired locations.

Postmark locations were similarly monumented at the three northerly locations where the old panel points were not found and also near the locations of unrecovered NGS stations "LILY" and "GORDON". These last two were given identification names "LILY OFFSET" and "GORDON OFFSET".

C. Postmarking and low level photography:

The low level postmarking photography was accomplished during four separate sessions when weather and light conditions permitted. The postmarking was accomplished utilizing a 10" x 12' (6 foot legs) retrievable panel which was placed at each panel location, photographed, and then removed. One leg was two foot longer (8') than the other three, and, using a hand compass, this leg was always aligned in a northerly direction to assist the photogrammetrist in later alignment of the low level photography with the high level photograph. The panel was made of impregnated canvas material of a high white gloss color. A weight of approximately one pound was sewn into each end so as to hold it down in windy conditions. A grommet was placed in the center as an aid to centering the panel on the rebar that was emplaced in the ground.

The postmarking was accomplished by a two man survey team, plus pilot. The helicopter normally landed slightly to one side of the premarked panel location. After one individual with the panel, hand held radio and compass embarked, the helicopter would ascend to the predetermined height over the panel. During this time the individual on the ground would lay out the panel, properly orienting the long leg in a northerly direction. After the photo runs were achieved, the pilot notified the individual on the ground by use of the VHF radio that suitable photography had been attained. At this signal the individual on the ground refolded the panel and put it in an accompanying laundry-type bag to prevent it from being blown around by the rotor blast during the subsequent helicopter reboarding operation. The helicopter would then land, pick up the individual on the ground and proceed to the next postmark point. Approximately ten points per flight hour could be postmarked in this fashion.

The right rear door was removed from the helicopter prior to all postmarking photo missions. All loose items were removed from the back seat area of the helicopter to avoid their being blown about. Photography was accomplished using a Hasselblad, Model 500 EL/M, 70mm camera hand-held outside the rear doorway from which the door had been removed. A bull's eye bubble was glued to the back of the camera to facilitate pointing the camera perpendicularly downward. By holding the camera at door sill level and just outside the door, the skid was outside the photo image and an unobscured view was attained.

70 millimeter Kodak Tri-X film was used in oversized magazines which allowed approximately 70 exposures per roll of film. Three or more photographs were taken of each panel as the helicopter made runs at approximately 60 miles per hour across the panel location. One photograph was normally taken when the panel was approximately one-third into the frame from the direction of flight, one was taken when directly over the panel and one was taken approximately one-third of a frame past the panel point. Where possible, all runs were made from south to north, toward the long leg of the panel.

Where the photographer or pilot felt the run was not suitably aligned over the target, or that a camera tilt exceeding 5 degrees existed at the time the exposures were made, the helicopter would make a 180 degree teardrop turn and make a return run in a North-South direction to attain more photos while holding flight time to a minimum.

The pre-planned photo height was ideally 1,000 feet above ground level. The height above ground was determined by the helicopter pilot utilizing his radar altimeter. All photos were taken at, or very near, the pre-determined height.

The first photos were taken the night of July 14 and some trial and error was required to properly coordinate the actions of the pilot, photographer and ground crewman. The field party had concern some photo runs were sufficiently to one side or the other that the panel was not suitably in the frame. AeroMap did not have a problem in this respect, however, and no reflights were required. In all cases exposed film was shipped to Anchorage by Alaska Airlines counter to counter service the day after exposure so its suitability could be determined and adjustments made in the photo process if the developed film indicated this was desirable. This proved very successful as a quality control procedure. No reflights were required, however, on this project.

In all case, except as mentioned in the following paragraph, a shutter speed of 1:250 or 1:500 of a second was utilized with the lens openings varied to meet the existing light conditions. Light availability was determined intermittedly with a hand held light meter. Camera lenses were taped in position so as to prevent them inadvertently rotating due to vibrations in the helicopter. The photographer had a light meter available at all times to check the light conditions as he felt necessary. Kodak Tri-X film proved to be versatile under poor light conditions at high shutter speeds and would be highly recommended for any future photography of the type taken.

On the final postmark panel photographed a series of frames were exposed at 1:125 of a second shutter speed as it was near midnight and light conditions very poor. This shutter speed was thought to be undesirable due to the speed of the helicopter over the panel target and the unavoidable vibrations in the Bell Long Ranger type helicopter. Later analysis by AeroMap, however, indicated this photography was suitable for its desired purpose if light conditions did not allow a faster shutter speed. If this relatively slow shutter speed is used in the future, however, care must be taken by the photographer not to rest his camera or arms on the doorsill so as to isolate the camera from the rotor induced vibrations.

The only difficulty in the postmarking photography occurred on the second photo mission on the night of 20 July. On the third panel the camera lens suddenly jammed and all efforts by the photographer failed to remedy the problem so photography was suspended and leveling undertaken instead. Consultation by phone with AeroMap the following day could not identify the problem so the camera was sent by one day air service to AeroMap in Anchorage. They were able to identify and remedy the problem and returned the camera to Deadhorse one day later. The camera performed satisfactory during the rest of the project. On any future project the photographer should discuss the potential and solution for camera lens jamming with Steve Sparks of AeroMap in Anchorage.

D. GPS Survey:

A total of 107 points were surveyed on this project utilizing GPS, 14 by static GPS methods for inclusion in the primary control network and 93 by rapid static methods to fill in the intermediate points. One NGS station "LEFFINGWELL" was not actually occupied during this project survey but the long static GPS observations taken by Mike Schoder of AeroMap utilizing Trimble 4000 SSI Geodetic GPS receivers the first week of July, 1997, were utilized.

Equipment:

GPS equipment was leased by the consultant from Accupoint, Incorporated of Anchorage, Alaska. This equipment included four Trimble 4000 SSI, nine channel, dual frequency geodetic receivers and associated L1/L2 geodetic antennas, cables, tribrachs, tripods, batteries and chargers. Trimble's GPSurvey post-processing software package, Version 2.20, was used for GPS data computations.

The Trimble 4000 SSI dual frequency geodetic receivers utilized are small in size, packaged in compact units well-suited to helicopter operations, and are supplemented by flexible, comprehensive software. The Geodetic Surveyor SSI offers the highest productivity and accuracy available in a dual frequency GPS receiver for post-processed land surveying and mapping applications. Utilizing Trimble's Super-Trak technology for robust satellite tracking, even in difficult locations, these receivers maintain a firm lock on signals once acquired, and are capable of very short occupation times in fast static mode with a published accuracy of 5 mm horizontally, 1 cm vertically, and 1 arc second of azimuth.

All primary control stations on this project were observed for a minimum of 60 minutes, and in most cases several hours, with the receiver operating in static mode. Many of these control vectors were observed multiple times on different occasions, thus giving many redundant baselines for verification purposes. All panel points were observed a length of time wherein the receivers indicated an accurate position had been attained. Generally three base stations were operated in static mode and one rover unit operated in fast static mode. A network of multiple, interconnecting vectors was thus established. By utilizing the 7 recovered horizontal control stations and 37 vertical bench marks surveyed by differential levels (33 surveyed on this project and four from the Badami Survey Project), the network was subsequently rotated and scaled to the existing control and tipped and tilted to agree with the local geoid (leveling datum).

Field Computations:

Field computations were done on a daily basis and included the routine downloading and backup of the GPS data, running satellite predictions for the following day, as well as baseline computations. A Pentium based computer was available in the field for the duration of the project for these tasks. The GPS data would be downloaded from the receiver into a subdirectory of the hard drive. Station ID's, session number and HI's were then verified. All discrepancies were resolved before archiving the data to 3-1/2" floppy disks.

After data backup, satellite predictions for the following night were performed to ascertain the ideal times for observing and to avoid any windows of poor satellite availability and/or high PDOP. Once these predictions were done and plots made for the next nights use, baseline computations were performed. This processing consisted of using the Trimble WAVE baseline processor, version 2.20, to compute the delta X, delta Y, and delta Z vector components for each baseline. Each baseline consisted of four separate solutions:

- L1 code
- Iono free triple
- P/C1 Lw Ln float
- L1 fixed (or Iono free fixed)

After the vectors were processed, the various statistical indicators were examined and in most cases the high ratios and low reference variances obtained indicated acceptable results. These statistics also gave confidence to which solution should be used. The vector components were then loaded into a database and various combinations of Cartesian loop closures were computed. These loop closures gave an additional indication of the quality of the data.

After loop closures were computed, the vectors were further analyzed through least squares methods. This was done through Trimble's Network Adjustment Module. The approximate coordinates, observed vectors and estimated weights were input into the adjustment program. The preliminary adjustment was executed and the statistics in the form of the standard error of unit weight and the normalized residuals were analyzed. These "daily" adjustments are of a minimally constrained type, i.e., one arbitrary station is held fixed.

Once all the field observations were completed, the daily adjustments were combined into one large adjustment for the entire project area. This adjustment insured the internal integrity of the observed network and any weak vectors were located through this process and reobserved prior to project demobilization. The final minimally constrained adjustment for the project area produced a standard error of unit weight of 0.98 and includes 336 vectors. All vectors used in the adjustment were based on the double difference solution. The average coordinate precisions were in the 5 mm range, with the majority of vector accuracies meeting or exceeded the 1.0 ppm (1:1,000,000) range. Based on this minimally constrained adjustment, a decision was made to demobilize the GPS field operation for this project.

E. Differential Leveling:

Care must be taken when acquiring elevations by GPS methods, as GPS heights are referenced to a surface called the ellipsoid, whereas real world elevations as normally utilized are referenced to a surface called the geoid. The ellipsoid and geoid are of differing heights and are tilted a small amount about both North-South and East-West axis. The latest available geoidal separation computer program (Geoid 96) provides only an approximate correction for any given local area. Bench marks determined by differential levels are thus mandatory every five to ten miles if elevations determined by GPS are to be properly correlated to the local datum. In this case, 33 new bench marks were determined by differential levels throughout the project area, a considerable over kill.

Top of rebar of Point 537 of the Badami Project was utilized as the origin bench mark for this project. It's elevation was first verified by leveling to existing Badami Point 538. The two points agreed with record values by 0.01 of a foot.

Over 43 miles of levels (actual distance traveled was actually much more due to water bodies to be detoured) were carried out on this project. All runs were double-rodded so as to provide a check closure without returning in the opposite direction. The level was pegged to verify it was in adjustment, foresights and backsights were balanced and all shots were held to 200 foot or less in length. The night work minimized heat waves and the resulting refraction. Third order standards were attained or the segment in question was rerun. Three segments, totaling approximately three miles, had to be rerun to meet this requirement. Approximately five miles forward progress per shift was attained, although fog terminated most shifts early. A two man leveling crew remained on site all one day to make up for the numerous shortened night shifts. Bench marks were established at all geographical limits of the project. In addition, elevations were set by differential levels on a considerable number of interior points. All GPS derived elevations were computer-adjusted to match the spirit level derived datum.

The hand-held Magellan GPS units proved themselves of great value during the leveling process. Few visible landmarks exist at ground eye level in the project area and guidance from point to point was entirely by these units, especially in foggy conditions.

The water surface of the Beaufort Sea was shot from 14 HV points near the shoreline. The night was windy and water quite rough making accurate readings difficult. These shots, however, serve as an excellent quality control procedure, especially on the East-West vertical component of the project. These readings indicate a possible maximum 0.20 foot vertical deviation from the westerly to easterly limits of the project area, a distance of approximately 20 miles. These readings do indicate, however, the entire project datum to be from 0.60 foot to 1.20 foot low, relative to mean sea level. The exact amount is uncertain due to the scarcity of tidal information in this area and the impact environmental conditions can have on coastal water levels at any particular point in time.

Visual observations indicated a low tide stage at the time the water readings were taken. Assuming a tide range of 0.65 to 0.70 foot in this area a datum error of approximately 0.60 foot is indicated. GPS observations taken by Mike Schoder of AeroMap from this project's point 637 (Mike's 314) to NGS station "Leffingwell" on Flaxman Island, when reduced by this consultant, however, would indicate a datum error of nearer 1.20 foot. Station "Leffingwell" has an elevation leveled from a bench mark established by three days of tidal observations in 1981. See conclusions for more thoughts on this issue.

VI. POST FIELD COMPUTATIONS

Following return from the field, a meeting was held with AeroMap to review preliminary data. An intense period of computations followed. All field notes were double checked and variously weighted adjustments were run by computer and the results analyzed. Various plots were made to facilitate use of the data by the client.

Post field GPS computations consisted of completing a constrained adjustment, in NAD 1927, for the entire project area. This adjustment, performed with the Trimble Network Adjustment Module software, is where known horizontal and vertical stations were held fixed to their published values. The adjustment output consists of the final adjusted coordinates and the associated statistics. Many iterations were attempted with this final adjustment to ascertain which horizontal control stations to hold fixed. The final constrained adjustment held the following stations fixed:

Horizontal: "TIGVARIAK EAST BASE", "IOVIK", "SAVAK", "FINISH", "YUKON GOLD GPS CONTROL POINT E", "LEFFINGWELL", "YUKON GOLD GPS CONTROL POINT YG-1"

Vertical: H.V. control points 306, 325, 395 (Nora Offset), 418, 423, 603, 607, 611, 612, 613, 614, 615, 616, 618, 619, 628, 635, 637, 638, 640, 641, 642, 643, 644, 645, 646, 647, 648, TUNDRA_REBAR, 1311(AeroMap's 311), 1304 (AeroMap's 304), and Badami H.V. Points 383, 537, 538, and "ELIZA".

Note: Elevations determined by differential leveling procedures based upon given height for rebars at panel points 537 and 538, Badami Mapping Project.

There are 108 stations and 336 vectors in the final adjustment. The final adjustment for this project produced the following statistics:

Standard Error:	1.02
Deflection in Latitude:	0.6801"
Deflection in Longitude:	-0.4888"
Azimuth Rotation:	-14.0481"
Network Scale:	1.000021487118

Due to distortions in the network control (incorrect shapes of geometric figures defined by the fixed network) the highly accurate GPS network was artificially degraded to conform to the existing NGS control stations. The majority of horizontal control stations used in the final adjustment are second order (1:20,000) stations and the final positions derived in this GPS survey can therefore not be said to exceed that accuracy.

Final adjusted X, Y, and Z values were delivered to AeroMap on August 29, 1997.

VII. SUMMARY AND CONCLUSIONS

The techniques and procedures utilized followed the pre-work plan very closely and proved to be an efficient time and cost-effective method to accomplish the goals of the field program. Only minor modifications were necessary in the field work plan to meet localized conditions.

A close review and analysis of the data herein leads the consultant to believe all goals of the contract were achieved. Stations TIGVARIAK EAST BASE, IOVIK, ELIZA, LEFFINGWELL and FINISH were incorporated outside the scope of the contract to offset the poor conditions of the control stations within the project area. Bell's rebars, "Yukon Gold GPS Control Point E" and "Yukon Gold GPS Control Point YG-1" were also incorporated into the survey in order to bring all survey points in the project area into a single, consistent net.

The consultant believes all desired accuracy specifications were achieved and, in fact, exceeded. The horizontal accuracy achieved by GPS far exceeded that of the existing control net, and was artificially degraded to conform to existing NGS control monuments, whose published values will undoubtedly be used by others in the future in the project area. The vertical values, within this and the Badami Project area, within themselves, appear to be excellent and to meet all specifications required for accurate mapping of the area. The mapping tie to the Badami area mapping should be seamless. As noted previously, however, the entire vertical datum may vary from true mean sea level by up to 1.20 foot. Many questions remain on this issue. The most obvious include:

1. Is the East Dock bench mark truly representative of mean sea level for the area as it originally involved only a very short period of tidal observations?

2. Is the vertical tie from East Dock to Badami accurate?

3. Are single water surface shots in this area meaningful considering potential environmental impact on coastal water levels and minimal tidal data in this project area?

4. Is the "Leffingwell" vertical data meaningful considering the short duration observations and 16 year potential movement of bench marks?

Several steps could be taken to shed further light on this issue.

1. A long static GPS observation from the Badami or Sourdough project datum could be made back to East Dock to confirm their relationship.

2. A long static GPS observation could then be made from East Dock to the NGS tidal bench mark on West Dock to determine East Dock's relationship to true mean sea level. The West Dock NGS bench mark was established by long and on going observations.

3. A long term tide gauge could be established in the Sourdough or Badami Project area and an accurate tidal bench mark established. NGS may be agreeable to establish a tidal bench mark on the newly constructed Badami dock.

4. As long as the Badami and Sourdough vertical datums are good within themselves their accurate relationship to mean sea level may not be meaningful and nothing further may need to be done.

Senior project managers should further consider this issue.

Weather conditions were very difficult during the field operations, especially for night operations, but about what one must expect and be prepared for on the North Slope of Alaska. An earlier start of each night's operation would be very beneficial as the nightly fog usually does not envelope the area until after midnight. Time of use of the helicopter needs to be more clearly defined in future such operations as much survey crew time was wasted awaiting transportation in the ERA hanger. Use of a helicopter totally dedicated to the survey effort possibly would be cost effective even if a helicopter need be mobilized specifically for this effort. A Bell 206 (not Long Ranger) with range extender would be satisfactory for this type survey program and an ASTAR ideal due to its unique suitability for aerial photography (i.e. low rotor vibrations and port suitable for hard mounting of camera).

The helicopter operation, after ERA became familiar with the unique requirements of this project, proceeded reasonably well but only through outstanding cooperation and effort by the assigned pilot. As always, pilot technique and attitude is an all important factor in a helicopter supported survey operation. The helicopter was equipped with a GPS receiver which was extremely useful in navigating to specific operational areas and in recovery of existing points and locating ground crews. The ongoing fog would have proven much more of a hampering factor without the GPS unit.

Likewise, the consultant-supplied, hand-held GPS navigation receiver were of great value in finding one's way around in poor visibility conditions on the ground and should be a required item on any survey program on the North Slope occurring away from the immediate Deadhorse area.

Few changes would be made in any similar survey effort in the future. The procedures and techniques utilized were deemed to be time and cost-effective and to meet all desired accuracy parameters.

Helicopter Flight Log
Sourdough Survey Project (AeroMap Photo Control)

DATE	FLIGHT HOURS	COMMENTS
7/10/97	2.8	Terminated work at 1:30 AM due to fog.
7/11/97	4.0	Terminated work at 4:45 AM due to fog.
7/12/97	4.7	
7/13/97	0.0	No field work or flight due to bad weather.
7/14/97	8.0	
7/15/97	0.0	No flight due to helicopter maintenance.
7/16/97	6.6	
7/17/97	7.7	
7/18/97	4.0	Terminated work at 3:30 AM due to fog.
7/19/97	7.0	Work & flight hampered by fog.
7/20/97	2.1	Terminated work at 3:36 AM due to fog.
7/21/97	1.8	Flew to project area but no work due to fog.
7/22/97	3.7	Terminated work at 3:00 AM due to fog.
7/23/97	6.5	Two men ran levels during the day to avoid fog, in addition to night work.
7/24/97	3.4	Helicopter was not available until 12:30 AM due to maintenance.
7/25/97	4.6	Light rain but relatively good weather.
7/26/97	7.1	
7/27/97	0.0	No field work or flight due to helicopter maintenance.
7/28/97	2.4	
7/29/97	2.2	

78.6 Hours total helicopter flight hours on project.

Note: Total days 2nd pilot required for survey support - 20.

FINAL ADJUSTED VALUES - SOURDOUGH PHOTO CONTROL PROJECT - 8/29/97

Ellipsoid: NAD27
Output: State Plane Zone 3, Pt #, Northing, Easting, Elevations(Feet)
Notes: * = Indicates elevation derived by differential levels.
Elevations based off rebar height for pt 537, 1994 Badami Survey
Points labeled with 1994 are from the 1994 Badami Survey

PT#	Northing	Easting	Elevation (Top Rebar, Alum. Rod or Monument)	Elev. (Panel)	Comments
302	5893997.739	468910.167	50.76	50.42	
304	5895695.816	484664.517	24.55	24.28	
305	5895200.442	490287.912	21.70	21.21	
306	5894906.800	491937.148	18.61	18.29	*
310	5897360.242	469503.333	40.23	39.93	
316	5899457.050	491550.672	13.96	13.60	
317	5900794.416	484617.929	13.08	12.71	
322	5901547.619	458320.178	38.41	37.81	
324	5901442.161	448174.795	42.37	42.17	
325	5901633.952	443140.149	42.13	41.99	*
326	5901402.695	437167.633	41.94	41.72	
328	5901299.913	426592.097	36.88	36.53	
329	5901290.634	420913.566	41.19	40.87	
336	5903854.279	469384.863	20.48	20.09	
337	5903782.513	487029.035	8.80	8.48	
342	5906183.562	468918.117	12.94	12.51	
344	5906288.415	458278.703	24.83	24.58	
346	5905487.637	448114.520	29.55	29.31	
348	5906336.263	437075.459	29.21	28.99	
350	5906832.312	427143.792	21.40	21.08	
351	5906926.737	421765.039	22.85	22.74	
359	5910216.807	426408.487	14.66	14.55	
361	5908904.007	469352.579	7.58	6.86	
362	5908856.218	479288.910	9.42	9.02	
364	5910420.987	474530.688	4.94	4.54	
367	5912970.377	458138.970	3.62	3.32	
371	5911640.937	437447.989	14.67	14.45	
375	5911432.446	417800.597	14.86	14.65	
377	5912353.017	406700.308	10.91	10.58	
383	5915131.723	398233.694	5.19	4.40	* 1994 Survey
385	5915477.987	405989.327	7.11	6.66	
387	5914390.349	426703.422	2.86	2.60	
391	5914773.941	458431.438	3.20	3.05	
395	5917277.973	446793.025	2.73	2.56	* NORA_OFFSET
398	5917438.548	433195.869	3.56	3.32	
413	5904664.798	407512.047	22.30	22.05	
414	5910257.220	407725.889	10.97	10.74	
418	5909624.234	446567.560	18.56	18.31	*
419	5910081.447	458280.426	12.67	12.43	
422	5913319.051	467967.561	3.24	2.65	

23	5914464.888	447288.230	7.27	6.89	*	
9	5919126.073	435937.547	4.76	4.13		
37	5891346.116	395679.154	51.175	49.995	*	1994 Survey
38	5896953.082	393018.176	38.875	37.775	*	1994 Survey
39	5901966.098	395595.499	34.050	32.540	*	1994 Survey
01	5900438.012	410747.644	39.99	39.87		
02	5897340.581	406924.415	43.79	43.71		
03	5892160.449	410710.078	57.89	57.76	*	
04	5887485.535	409066.917	71.68	71.46		
05	5883279.225	409787.570	85.58	85.45		
06	5897669.104	423336.213	42.83	42.62		
07	5892336.620	426374.810	65.15	65.03	*	
08	5886894.476	424878.122	80.91	80.74		
09	5882812.788	426679.876	94.57	94.39		
10	5896931.800	439770.211	55.81	55.69		
11	5892109.642	442729.824	69.05	68.90	*	
12	5886956.676	440835.037	85.01	84.90	*	
13	5882589.131	443968.495	98.02	97.92	*	
14	5877693.002	446806.816	114.65	114.49	*	
15	5873153.556	444461.926	130.93	130.80	*	
16	5891872.730	451449.423	68.64	68.54	*	
17	5896403.660	461951.473	48.94	48.68		
18	5892128.591	458616.329	63.22	63.07	*	
19	5886907.746	463204.652	73.63	73.49	*	
20	5882223.329	458500.002	92.83	92.69		
21	5877287.453	459417.463	107.51	107.37		
22	5872043.880	458487.383	125.70	125.57		
23	5868172.839	457182.172	140.82	140.64		
24	5863540.637	458606.183	151.59	151.44		
25	5859652.103	460412.780	161.00	160.84		
26	5854369.419	458364.295	182.62	182.47		
27	5891731.913	474732.975	49.08	49.00		
28	5886271.528	478860.044	55.98	55.82	*	
29	5882277.371	475522.641	71.09	70.96		
30	5877475.728	474324.962	86.57	86.46		
31	5872090.284	475003.291	99.61	99.50		
32	5868549.222	469652.997	119.56	119.49		
33	5863154.805	469602.799	133.88	133.73		
34	5858207.934	468517.657	153.04	152.25		AeroMap's 313
35	5854378.978	471312.786	151.91	151.86	*	
36	5903827.366	493522.550	2.63	2.20		AeroMap's 315
37	5900795.145	498669.298	1.81	1.33	*	AeroMap's 314
38	5899030.551	495628.990	5.65	5.51	*	
39	5890864.829	485960.166	38.15	38.04		
40	5891090.927	491866.222	20.89	20.72	*	
41	5886876.950	489954.118	35.46	35.26	*	
42	5881733.259	486365.010	53.99	53.85	*	
43	5876747.172	486993.330	61.68	61.59	*	
44	5872516.026	485408.482	74.33	74.24	*	
45	5870540.494	483036.095	82.04	81.84	*	
46	5868747.301	480313.616	92.02	91.91	*	
47	5863941.656	477322.394	109.28	109.20	*	
8	5859923.885	475893.008	123.98	123.87	*	
002	5914299.163	417021.631	16.56	16.40		GORDON_OFFSET

1003	5914194.916	434704.362	16.90	12.81		HOBSON
006	5907663.907	481832.158	8.77	8.49		LILY_OFFSET
1012	5910503.721	455113.967	15.29	14.69	*	TUNDRA_REBAR
1304	5880245.283	485736.172	55.32	54.73	*	AeroMap's 304
1311	5851169.293	468716.748	173.54	173.05	*	AeroMap's 311
1359	5909770.816	398210.375	14.07	13.57	*	Badami359(1994)

FINAL ADJUSTED VALUES - SOURDOUGH PHOTO CONTROL PROJECT - 8/29/97

Ellipsoid: NAD27
Output: Point #, Latitude, Longitude, Elevations (Feet)
Notes: * = Indicates elevation derived by differential levels.
Elevations based off rebar height for pt 537, 1994 Badami Survey
Points labeled with 1994 are from the 1994 Badami Survey

PT#	Latitude	Longitude	Elevation (Top Rebar, Alum. Rod or Monument)	Comments
302	70 07 17.182416	146 14 58.643084	50.76	
304	70 07 34.358913	146 07 23.369146	24.55	
305	70 07 29.577671	146 04 40.771240	21.70	
306	70 07 26.708380	146 03 53.083733	18.61	*
310	70 07 50.279783	146 14 41.888772	40.23	
316	70 08 11.461004	146 04 04.402702	13.96	
317	70 08 24.508274	146 07 25.015170	13.08	
322	70 08 30.943176	146 20 05.937989	38.41	
324	70 08 29.290396	146 24 59.448517	42.37	
325	70 08 30.821778	146 27 25.151034	42.13	*
326	70 08 28.083369	146 30 17.892952	41.94	
328	70 08 26.137635	146 35 23.821179	36.88	
329	70 08 25.484547	146 38 08.096133	41.19	
336	70 08 54.150534	146 14 46.073334	20.48	
337	70 08 53.943801	146 06 15.408159	8.80	
342	70 09 17.042676	146 14 59.858519	12.94	
344	70 09 17.571062	146 20 07.893484	24.83	
346	70 09 09.076981	146 25 01.994043	29.55	
348	70 09 16.601006	146 30 21.745388	29.21	
350	70 09 20.604347	146 35 09.400298	21.40	
351	70 09 21.005371	146 37 45.147772	22.85	
359	70 09 53.822828	146 35 31.640645	14.66	
361	70 09 43.818364	146 14 47.599251	7.58	
362	70 09 43.679790	146 09 59.825033	9.42	
364	70 09 58.928156	146 12 17.781941	4.94	
367	70 10 23.286650	146 20 13.009041	3.62	
371	70 10 08.806553	146 30 12.229918	14.67	
375	70 10 04.907943	146 39 41.338109	14.86	
377	70 10 12.696179	146 45 03.212510	10.91	
383	70 10 38.951690	146 49 09.572140	5.19	* (1994 Survey)
385	70 10 43.344373	146 45 24.934978	7.11	
387	70 10 34.900056	146 35 24.269338	2.86	
391	70 10 41.042182	146 20 04.821521	3.20	
395	70 11 04.954193	146 25 42.648915	2.73	* NORA_OFFSET
398	70 11 05.472293	146 32 16.897634	3.56	
413	70 08 57.178595	146 44 36.976901	22.30	
414	70 09 52.207170	146 44 32.760918	10.97	
418	70 09 49.657991	146 25 47.619391	18.56	*
419	70 09 54.879094	146 20 08.448794	12.67	
422	70 10 27.188238	146 15 28.252456	3.24	

423	70 10 37.319394	146 25 27.723467	7.27	*	
429	70 11 22.303554	146 30 57.825053	4.76		
537	70 06 44.676890	146 50 14.127890	51.175	*	(1994 Survey)
538	70 07 39.457290	146 51 33.284990	38.875	*	(1994 Survey)
539	70 08 29.113810	146 50 20.770450	34.050	*	(1994 Survey)
601	70 08 15.988449	146 43 01.894701	39.99		
602	70 07 45.072173	146 44 51.382068	43.79		
603	70 06 54.571368	146 43 00.164489	57.89	*	
604	70 06 08.400114	146 43 46.024104	71.68		
605	70 05 27.114018	146 43 23.772971	85.58		
606	70 07 50.109645	146 36 56.951176	42.83		
607	70 06 57.957584	146 35 27.591725	65.15	*	
608	70 06 04.286598	146 36 09.284214	80.91		
609	70 05 24.313748	146 35 16.121746	94.57		
610	70 07 44.316517	146 29 01.570329	55.81		
611	70 06 57.112169	146 27 34.943318	69.05	*	
612	70 06 06.285667	146 28 28.535095	85.01	*	
613	70 05 23.560835	146 26 57.122583	98.02	*	
614	70 04 35.603594	146 25 34.220675	114.65	*	
615	70 03 50.789274	146 26 40.895200	130.93	*	
616	70 06 55.379782	146 23 22.936185	68.64	*	
617	70 07 40.535199	146 18 20.127769	48.94		
618	70 06 58.314033	146 19 55.883584	63.22	*	
619	70 06 07.194172	146 17 42.564144	73.63	*	
620	70 05 20.879808	146 19 57.682257	92.83		
621	70 04 32.379193	146 19 30.445074	107.51		
622	70 03 40.753935	146 19 56.444377	125.70		
623	70 03 02.607174	146 20 33.434188	140.82		
624	70 02 17.122038	146 19 51.689580	151.59		
625	70 01 38.968512	146 18 59.099286	161.00		
626	70 00 46.900351	146 19 57.212864	182.62		
627	70 06 55.108285	146 12 10.119886	49.08		
628	70 06 01.523483	146 10 10.425079	55.98	*	
629	70 05 22.138004	146 11 46.421941	71.09		
630	70 04 34.869666	146 12 20.519194	86.57		
631	70 03 41.919990	146 12 00.444966	99.61		
632	70 03 06.898421	146 14 34.240735	119.56		
633	70 02 13.836296	146 14 35.067144	133.88		
634	70 01 25.134885	146 15 05.717825	153.04		AeroMap's 313
635	70 00 47.581077	146 13 44.891415	151.91	*	
636	70 08 54.466956	146 03 07.472861	2.63		AeroMap's 315
637	70 08 24.667807	146 00 38.498281	1.81	*	AeroMap's 314
638	70 08 07.299821	146 02 06.427449	5.65	*	
639	70 06 46.865466	146 06 45.652008	38.15		
640	70 06 49.174235	146 03 55.015899	20.89	*	
641	70 06 07.702482	146 04 50.102795	35.46	*	
642	70 05 17.053402	146 06 33.481637	53.99	*	
643	70 04 28.020298	146 06 15.103450	61.68	*	
644	70 03 46.373776	146 07 00.575378	74.33	*	
645	70 03 26.893738	146 08 08.828242	82.04	*	
646	70 03 09.191161	146 09 27.144738	92.02	*	
647	70 02 21.840229	146 10 52.906354	109.28	*	
648	70 01 42.277604	146 11 33.693603	123.98	*	
1000	70 09 20.984905	147 08 14.389498	21.15	*	ELIZA (1994)

C. A. " Bud " Herschbach
Surveying Consultant
Registered Land Surveyor Certified Hydrographer

August 29, 1997

AeroMap U.S.
2014 Merrill Field Drive
Anchorage, Alaska 99501-4116

RECEIVED
AUG 29 1997
AEROMAP U.S.

ATTN: Steve St. Peter

RE: Sourdough Survey - Letter of Transmittal

Dear Steve:

Transmitted herewith are final vertical and horizontal values for the photo control points established during the recently completed field work. Also included are three copies of the final project report and an invoice for the final 25% of the project contract amount.

We appreciate the opportunity to work with you on this project. Give me a call if any questions arise.

Very truly yours,

C. A. Herschbach

C. A. "Bud" Herschbach, R.L.S.

P.O. Box 521084 • Big Lake, AK 99652 • Tel. (907) 892-7839

NAL ADJUSTED VALUES - SOURDOUGH PHOTO CONTROL PROJECT - 8/29/97

llipsoid: NAD27
utput: State Plane Zone 3, Pt #, Northing, Easting, Elevations(Feet)
otes: * = Indicates elevation derived by differential levels.
Elevations based off rebar height for pt 537, 1994 Badami Survey
Points labeled with 1994 are from the 1994 Badami Survey

T#	Northing	Easting	Elevation (Top Rebar, Alum. Rod or Monument)	Elev. (Panel)	Comments
02	5893997.739	468910.167	50.76	50.42	
04	5895695.816	484664.517	24.55	24.28	
05	5895200.442	490287.912	21.70	21.21	
06	5894906.800	491937.148	18.61	18.29	*
10	5897360.242	469503.333	40.23	39.93	
16	5899457.050	491550.672	13.96	13.60	
17	5900794.416	484617.929	13.08	12.71	
22	5901547.619	458320.178	38.41	37.81	
24	5901442.161	448174.795	42.37	42.17	
25	5901633.952	443140.149	42.13	41.99	*
26	5901402.695	437167.633	41.94	41.72	
28	5901299.913	426592.097	36.88	36.53	
29	5901290.634	420913.566	41.19	40.87	
36	5903854.279	469384.863	20.48	20.09	
37	5903782.513	487029.035	8.80	8.48	
342	5906183.562	468918.117	12.94	12.51	
344	5906288.415	458278.703	24.83	24.58	
346	5905487.637	448114.520	29.55	29.31	
348	5906336.263	437075.459	29.21	28.99	
350	5906832.312	427143.792	21.40	21.08	
351	5906926.737	421765.039	22.85	22.74	
359	5910216.807	426408.487	14.66	14.55	
361	5908904.007	469352.579	7.58	6.86	
362	5908856.218	479288.910	9.42	9.02	
364	5910420.987	474530.688	4.94	4.54	
367	5912970.377	458138.970	3.62	3.32	
371	5911640.937	437447.989	14.67	14.45	
375	5911432.446	417800.597	14.86	14.65	
377	5912353.017	406700.308	10.91	10.58	
383	5915131.723	398233.694	5.19	4.40	* 1994 Survey
385	5915477.987	405989.327	7.11	6.66	
387	5914390.349	426703.422	2.86	2.60	
391	5914773.941	458431.438	3.20	3.05	
395	5917277.973	446793.025	2.73	2.56	* NORA_OFFSET
398	5917438.548	433195.869	3.56	3.32	
413	5904664.798	407512.047	22.30	22.05	
414	5910257.220	407725.889	10.97	10.74	
418	5909624.234	446567.560	18.56	18.31	*
19	5910081.447	458280.426	12.67	12.43	
22	5913319.051	467967.561	3.24	2.65	

3	5914464.888	447288.230	7.27	6.89	*	
9	5919126.073	435937.547	4.76	4.13		
37	5891346.116	395679.154	51.175	49.995	*	1994 Survey
38	5896953.082	393018.176	38.875	37.775	*	1994 Survey
39	5901966.098	395595.499	34.050	32.540	*	1994 Survey
01	5900438.012	410747.644	39.99	39.87		
02	5897340.581	406924.415	43.79	43.71		
03	5892160.449	410710.078	57.89	57.76	*	
04	5887485.535	409066.917	71.68	71.46		
05	5883279.225	409787.570	85.58	85.45		
06	5897669.104	423336.213	42.83	42.62		
07	5892336.620	426374.810	65.15	65.03	*	
08	5886894.476	424878.122	80.91	80.74		
09	5882812.788	426679.876	94.57	94.39		
10	5896931.800	439770.211	55.81	55.69		
11	5892109.642	442729.824	69.05	68.90	*	
12	5886956.676	440835.037	85.01	84.90	*	
13	5882589.131	443968.495	98.02	97.92	*	
14	5877693.002	446806.816	114.65	114.49	*	
15	5873153.556	444461.926	130.93	130.80	*	
16	5891872.730	451449.423	68.64	68.54	*	
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31	5872090.284	475003.291	99.61	99.50		
32	5868549.222	469652.997	119.56	119.49		
33	5863154.805	469602.799	133.88	133.73		
34	5858207.934	468517.657	153.04	152.25		AeroMap's 313
35	5854378.978	471312.786	151.91	151.86	*	
36	5903827.366	493522.550	2.63	2.20		AeroMap's 315
37	5900795.145	498669.298	1.81	1.33	*	AeroMap's 314
38	5899030.551	495628.990	5.65	5.51	*	
39	5890864.829	485960.166	38.15	38.04		
40	5891090.927	491866.222	20.89	20.72	*	
41	5886876.950	489954.118	35.46	35.26	*	
42	5881733.259	486365.010	53.99	53.85	*	
43	5876747.172	486993.330	61.68	61.59	*	
44	5872516.026	485408.482	74.33	74.24	*	
45	5870540.494	483036.095	82.04	81.84	*	
46	5868747.301	480313.616	92.02	91.91	*	
47	5863941.656	477322.394	109.28	109.20	*	
8	5859923.885	475893.008	123.98	123.87	*	

02	5914299.163	417021.631	16.56	16.40		GORDON_OFFSET
03	5914194.916	434704.362	16.90	12.81		HOBSON
006	5907663.907	481832.158	8.77	8.49		LILY_OFFSET
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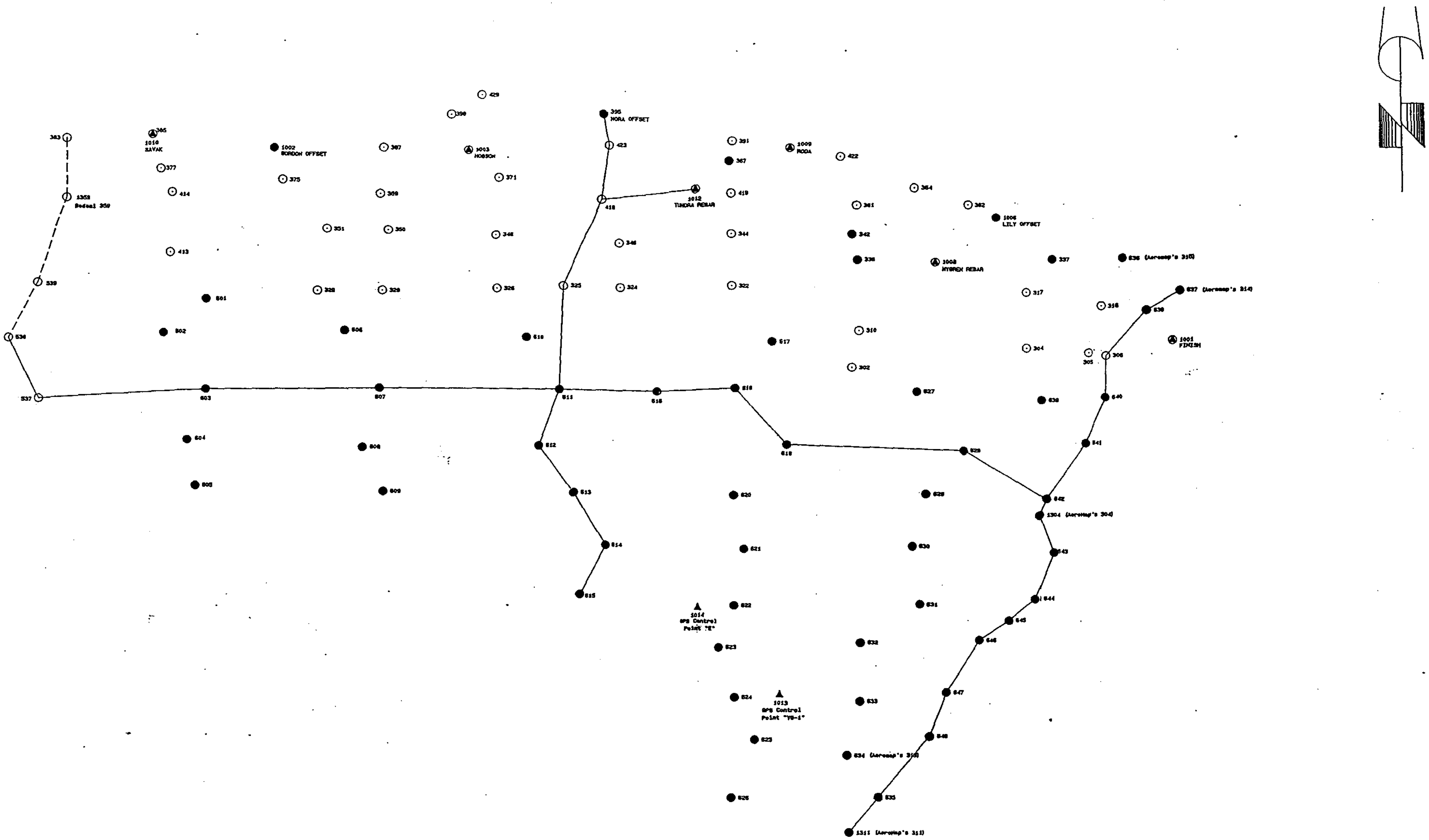
359	5909770.816	398210.375	14.07	13.57	*	Badami359(1994)

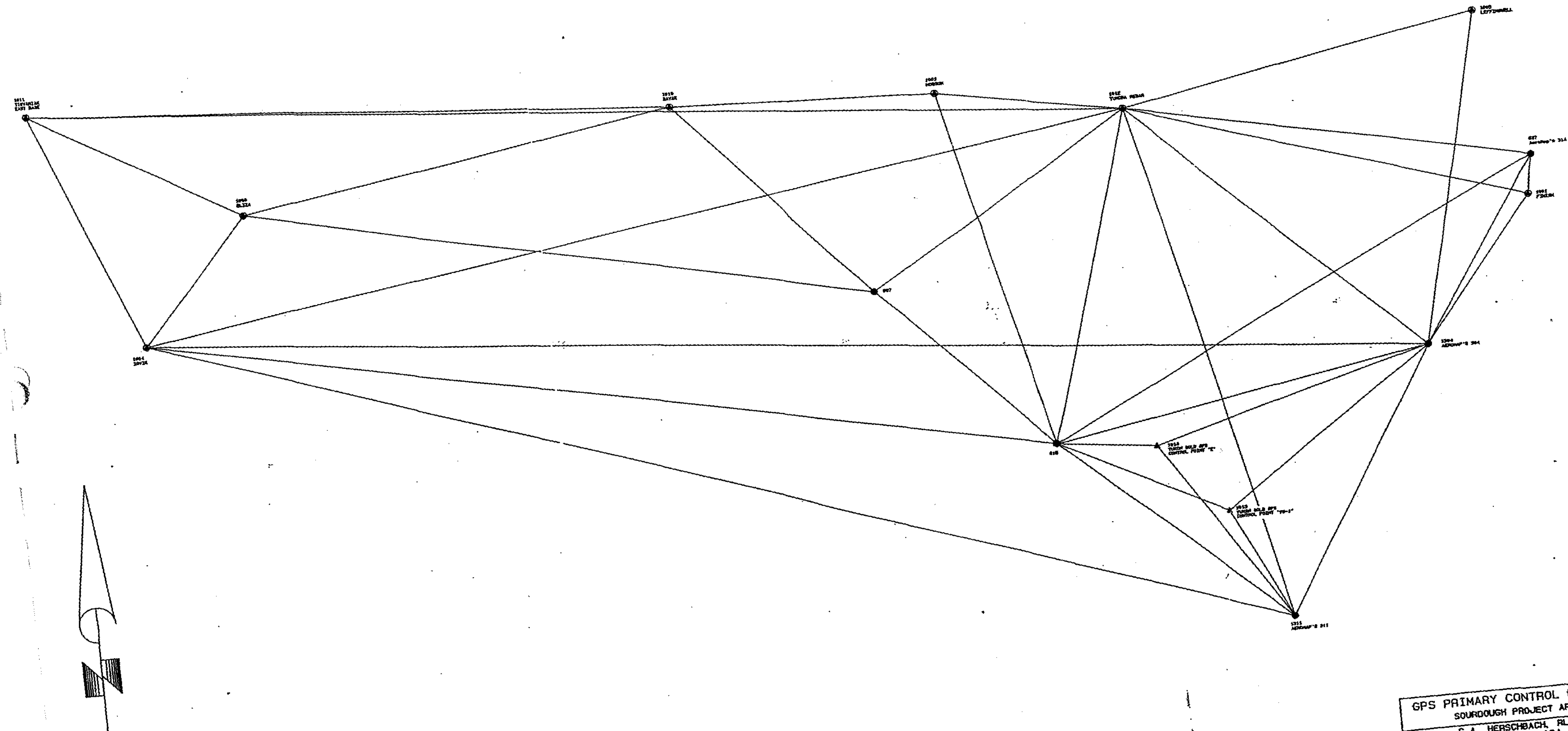


LEGEND

OL POINT, BRASS CAP MONUMENT
N GOLD GPS CONTROL POINT
PHOTO CONTROL POINT
TING PHOTO CONTROL POINT FROM
IOUS MAPPING PROJECTS
L RUNS BADAMI PROJECT
FERENTIAL LEVEL RUNS

PHOTO CONTROL POINT PLOT
SOURDOUGH PROJECT AREA

C.A. HERSCHBACH, RLS
P.O. BOX 521084
BIG LAKE, ALASKA, 99652
Phone: 907-892-7839



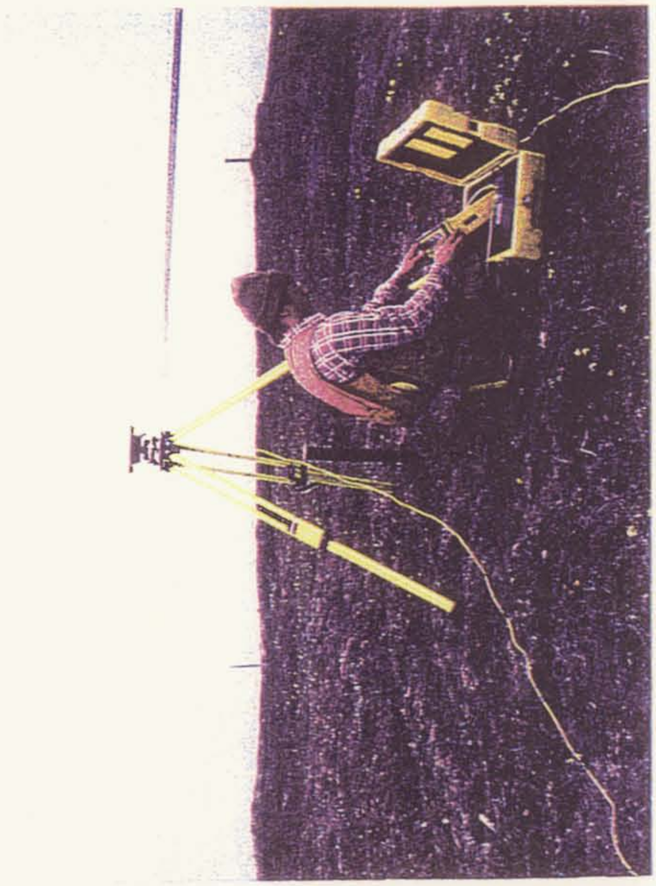
GPS PRIMARY CONTROL DIAGRAM
SOURDOUGH PROJECT AREA

C.A. HERSCHBACH, RLS
P.O. BOX 521084

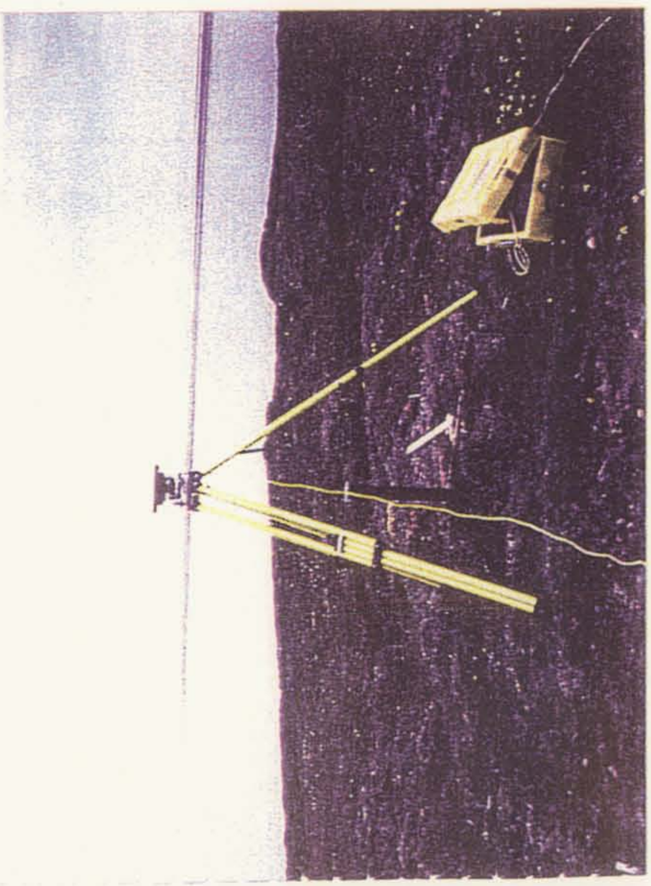
LEGEND

- EXISTING NGS CONTROL MONUMENT
- NEW PHOTO CONTROL POINT
- ▲ YUKON GOLD CONTROL POINT

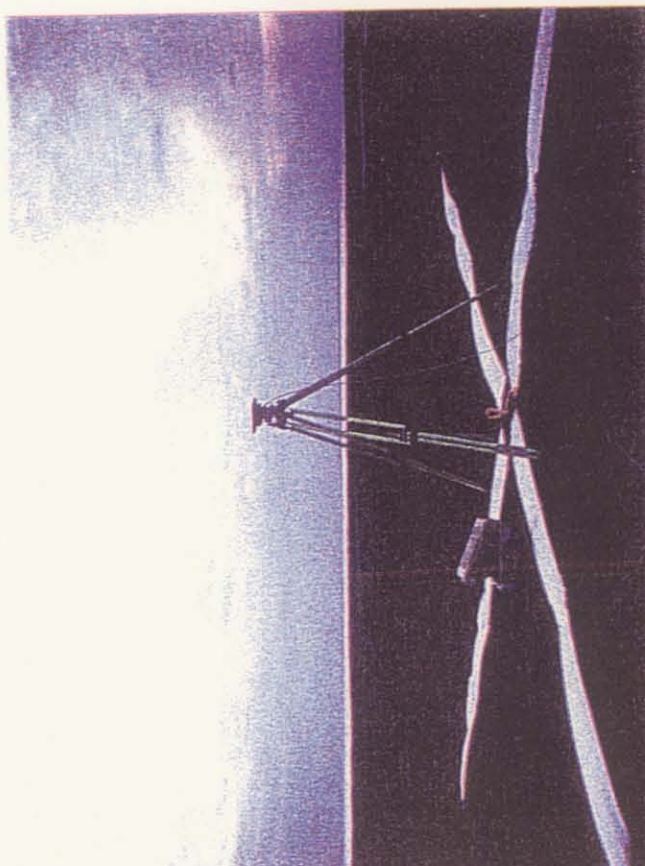
Trimble 4000SSi GPS



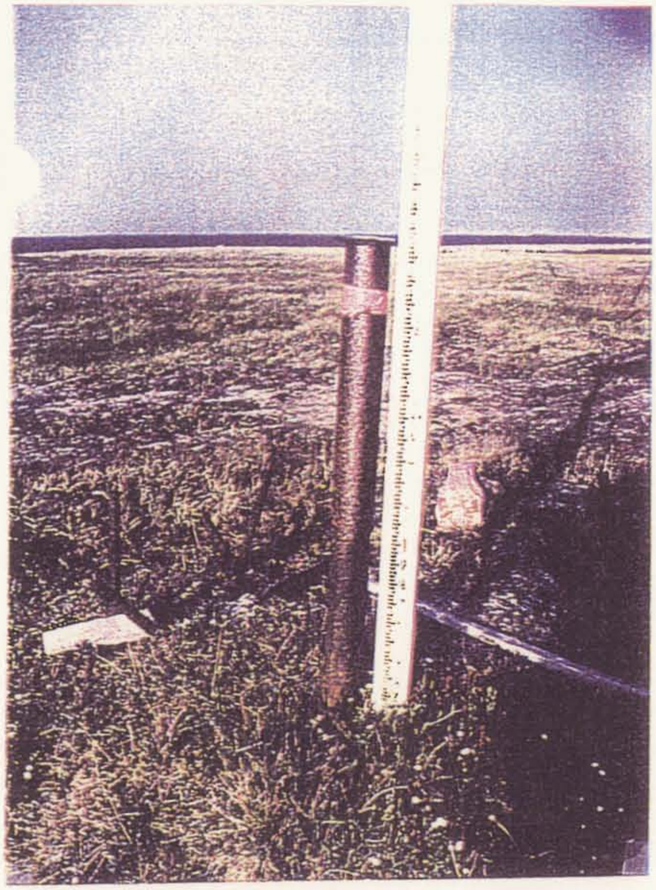
GPS operation



GPS operation

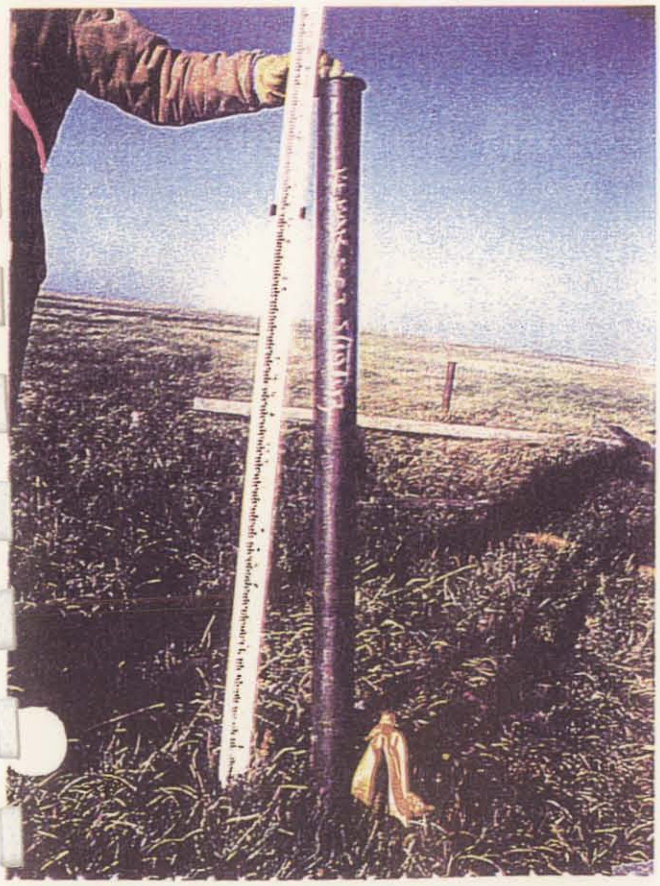


GPS operation



NGS Station "SAVAK"

NGS Station "Hopson"



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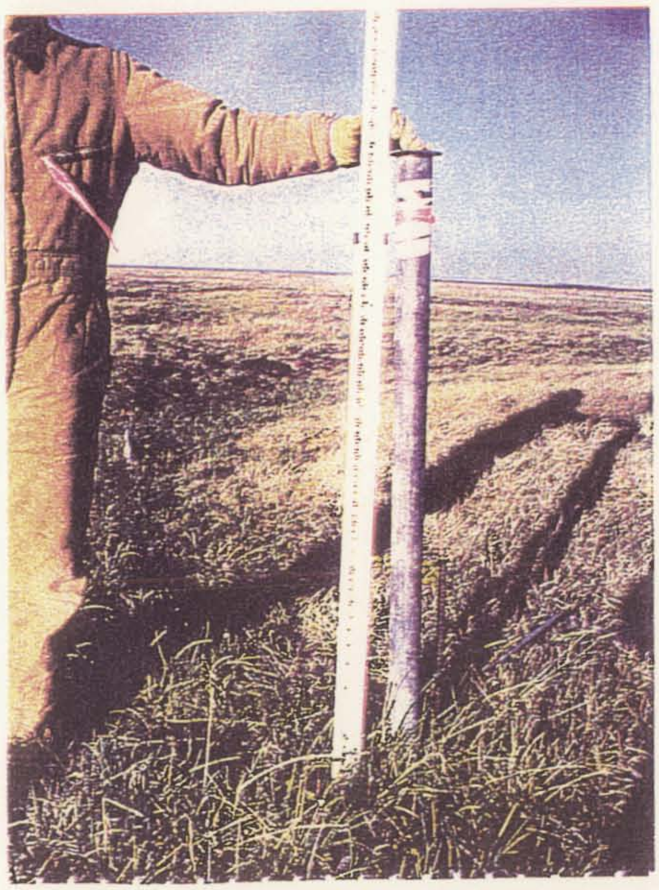
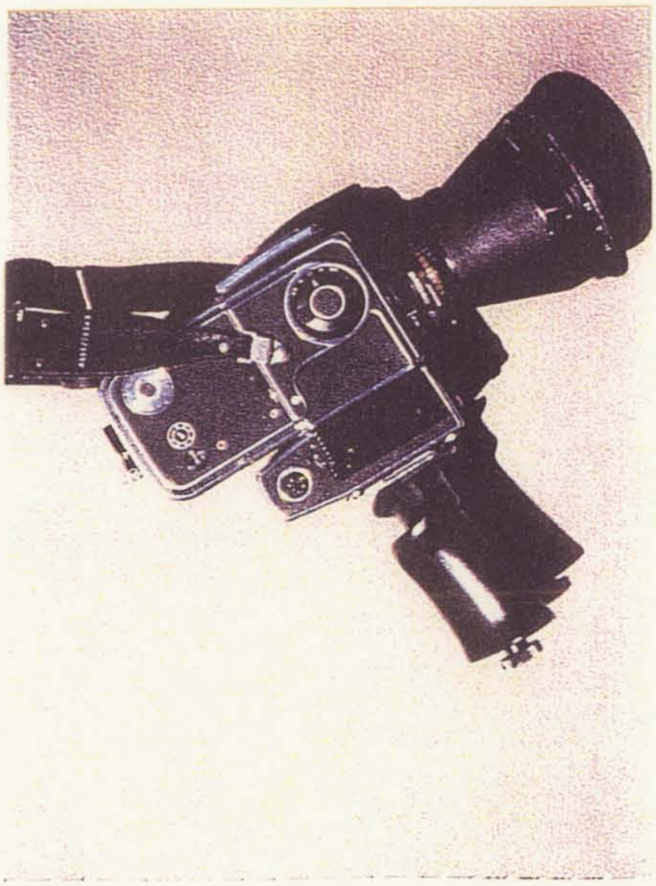


NGS Station "RODA"

NGS station "NYGREN"

Bell 206 Long Ranger



Hasselblad model 500 EL/M

Differential Leveling

CONFIDENTIAL
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Sourdough Area Development Project Economic Screening Study February 1998

TABLE OF CONTENTS

APPENDICES

Executive Summary

BPXA is evaluating the opportunity to develop the Sourdough Area prospects, which include both the condensate from the Point Thomson gas field as well as neighboring oil reservoirs. The development prospects are linked in that the condensate by itself does not offer favorable economics, and the oil fields are difficult to produce. The BPXA concept is to tap the gas reserves, and produce the condensate from that gas, resulting in a rich and favorable export product. In addition, a portion of the gas stream would then be processed into miscible injectant (MI) to be injected into the oil reservoirs to improve the well yields for those Brookian deposits. The separate products would then be mixed into a single export stream for transmission back to Pump Station #1 of the Trans Alaska Pipeline System (TAPS) for delivery to Valdez and final export destination.

This document reports the outcome of an economic evaluation of a number of possible development options. An estimating strategy was developed for the Sourdough Area Development Project, and applied uniformly to the various development options using cost indices benchmarked to existing and developing North Slope projects. Although drilling costs are not included, the project drilling group supplied their initial estimates of optimal pad locations and processing requirements to aid the evaluation.

The recommended option based on this screening study is a scenario which co-locates the processing facility to an onshore single drill pad used to develop both the Point Thomson gas field and near shore Flaxman reserves. A significant processing component is involved to handle the gas and production of MI, and is included in a main facility located close to this drill pad. The transmission pipeline would also originate at this point, travel in an aboveground mode to the Badami unit, and then follow the Badami and Endicott pipelines to PS#1 of TAPS. The current economics are based on a new pipeline, although concurrent studies are underway which focus on the use of existing horsepower and pipeline segments along this route to improve the project economics.

Additionally, two scenarios which are expansions of this first option are introduced which allow further development of Point Thomson prospects as well as the Flaxman reserves

further offshore. These scenarios can be viewed as incremental to the base option, thus improving the project cash flow during startup of the development project. In addition, the base option is seen to be compatible with further developments of neighboring prospects, if and when those reservoirs are further proved.

The options #7, #8 and #9 are the recommended options, with option #7 as a base option and #8 and/or #9 viewed as expansions to that base option. More detailed design definition and cost estimating will focus on this development scenario.

1.0 INTRODUCTION

British Petroleum Exploration (Alaska), Inc. (BPXA) is evaluating the opportunity to develop the Point Thomson condensate reserves and neighboring Sourdough Area prospects. The project development area is located approximately 25 miles east of the Badami Development Project or approximately 60 miles east of the Prudhoe Bay Unit (Figure 1).

The development prospects of the Point Thomson gas field and neighboring Brookian oil fields are linked in that the condensate by itself does not offer favorable economics, and the oil fields are difficult to produce. The BPXA concept is to tap the gas reserves, and produce the condensate from that gas, resulting in a rich and favorable export product. In addition, a portion of the gas stream would then be processed into miscible injectant (MI) to be injected into the oil reservoirs to improve the well yields for those Brookian deposits. The separate products would then be mixed into a single export stream for transmission back to Pump Station #1 of the Trans Alaska Pipeline System (TAPS) for delivery to Valdez and final export destination.

The proposed Sourdough Area Development Project (SADP) involves a central processing facility, an approximately 63.5 mile pipeline transmission to PS#1, both well and injection lines to well pads, an airfield, an infield road system, a gravel source, and associated drilling pads.

As part of the conceptual engineering effort numerous infrastructure layout scenarios were investigated. A large part of this investigation was cost estimates for various scenarios to facilitate finding the most cost effective, "fit for purpose" layout. The infrastructure layouts evaluated took into account drilling considerations, environmental issues, and commercial viability. The next section, Chapter 2, explains the approach to the estimation process, while Chapter 3 defines the cost items included in the estimate. Chapter 4 defines the options evaluated in the screening process, and presents the results of the cost estimation.

2.0 COST ESTIMATION ACCURACY

2.1 General

The principal difference between project estimates is the design and plan information available and the accuracy required of the estimate. The accuracy of the estimate will change depending on the level of design definition. The terminology used for this estimate process is contained in Appendix A.

In the conceptual stage of design, the project is typically defined in terms of major components, e.g. linepipe, stations, major facilities. At this level, estimates can only be made using broad industry and experience based guidelines, such as the concept of "dollars per in-diameter mile" used in pipeline estimating. Broad factors are then applied to express perceived variations such as geographical factors. As design progresses, more definition of the components of the major elements are better known and can thus be separately costed using specific vendor and contractor quotes or recent analogous project experience. Thus, accuracy of the cost estimation increases with design.

Contingency is the additional amount that is added to the estimate to account for the uncertainties in the estimated amounts. Uncertainty in estimation for hardware items can be attributed to a large number of factors such as lack of detail in the item being estimated, lack of basic information about unit costs, uncertainty in supply/demand factors at the time of bid, etc. In most cases, the uncertainty is greatest for those items that require an estimation of labor. Labor estimation has all of the uncertainty factors associated with hardware estimation, but in addition can include productivity, weather, contracting, permitting and a number of other unknowns. Note, in particular, that contingency is not intended to address cost changes associated with scope change, but is rather intended to address the uncertainty range in the estimate for the project as described to the estimator.

The level of contingency should take the increase in accuracy into account. In the early stages of a project, a 90% level would not be expected to be close to the mean estimate (the "P50" estimate value). As the project progresses, the confidence in the design and estimation should increase, i.e. the 90% level is "closer" to the mean value. Thus, for the same level of uncertainty, say 90%, the estimate value should be closer to P50.

For example, say that at the original phase of design the P50 estimate is $1000, and that through a risk analysis it is ascertained that the actual bid would come in at $2000 90% of the time. Later in design, the estimate indicates that the P50 value is still $1000, but that increased information allows us to say that the actual bid would come in at $1500 90% of the time. The estimate P50 value has not changed, but the accuracy increase allows us to decrease the money for contingency and retain the same confidence in the estimate. It follows that it is not necessary to change the project view of the acceptable level of risk of a project as the project progresses, but that increased design definition and estimating unit costs would lead to a lowered required funding of the project for the same desired confidence level. Again, note that this process is distinct from savings due to changes in the design scope and/or improved technology to accomplish the scope.

2.2 Project Specific

For this project, estimates are to be made using the best available information referenced, and all assumptions listed. The estimate values are to be the "P50" values, i.e. if the item went for bid a large number of times and/or to a large number of contractors, the estimated value would equal the average of all the bids. In other words, the estimated values are expected to be the "mean" actual cost for the service or equipment being estimated.

The contingency level that is acceptable to the project can only be decided by the project management, and is an expression of the risk that they are willing to undertake. To aid in this decision process, it is worthwhile to show how the estimate would vary depending on the full range of contingency. This is done through a formal estimate risk analysis which assigns the range of uncertainty for each element in the estimate, and then combines the individual range estimates through a numerical process to find the range of uncertainty of the combined total of all estimated elements.

At this conceptual stage of the project, the estimates are considered Level 0. This is considered adequate for economic screening of alternative options. With the scant information available during this early stage of conceptual design, a formal risk analysis provides little additional information. The screening evaluation benchmarked, to the degree possible, major cost items against similar experience on developed or developing North

Slope projects. Based on these benchmarks and experience, it is our judgement that an additional amount of 40% of the mean estimates provided for the screening options should provide about a 90% confidence level that the actual costs will be at or below the mean estimates contained in this report, e.g. if the mean estimate quoted is $100 million, then 90% of the time the actual costs would be $140 million or below.

3.0 COST ESTIMATION PROCEDURE

3.1 Methodology

The initial screening studies were done using the FAST-EST computer software developed by OPC Engineering, Inc. of Houston, Texas. FAST-EST is a system of computer programs designed for performing field development planning, feasibility studies and cost estimates for onshore oil and gas field developments. The software used in this study was licensed to BP Exploration (Alaska), Inc. (BPXA) and was used with their permission. Basic cost indices input into the FAST-EST model are presented in Appendix B.

The software was used to model the BPXA Liberty Project and the results were compared to a detailed estimate to determine accuracy and to validate the cost indices used by the program. This comparison was done by BPXA "in-house" and was not part of the conceptual engineering effort. The results of this comparison indicate that, while on a line by line basis that results are not always comparable to other project estimates, the overall results are comparable. This is considered reasonable since estimation techniques and individual estimators will often allocate individual cost factors to different cost items at this level of analysis. An adjustment of a few of the default values increased the accuracy of the line by line comparison, but did not affect the overall accuracy. For example, increasing the erection productivity and the erection cost per hour to more reasonable values resulted in a more reasonable number of manhours while not significantly altering the cost.

A number of minor problems with the software were identified during the screening efforts, none of which seriously impaired the screening process.

3.2 Project Cost Items

A checklist of the major items used for cost estimating at this level of project development is shown in Table 3-1.

Table 3-1

Project Cost Item Checklist

Project Cost Item	Included in this Cost Analysis?
Central Processing Facility – Civil (Pad, Buildings…)	Yes
Major Drivers (Pumps, Compressors)	Yes
Well Pads	Yes
Well Pad equipment (manifolds…)	Yes
Infield Gathering Lines	Yes
Infield Injection Lines	Yes
Infield Pipeline Support System	Yes
Infield Roads	Yes
Transmission Pipeline	Yes
Transmission Support System	Yes
Dock	Yes
Airstrip	Yes
Construction Indirects (Camps, Catering,…)	Yes
Drilling – Labor and Material	**No**
Freight	Yes
Finance Costs	**No**
Engineering Costs	Yes
Contingency	**No**
Operating and Maintenance	**No**
Permitting Costs	**No**

From the above list, the most significant item that is not included in this cost analysis is an estimate of the drilling costs. However, the estimation group worked as closely as possible with the drilling group to select pad locations and scenarios that reflect the current reservoir and drilling scenarios of interest.

The specifics of the individual major cost items used in this study are explained in the following sections.

3.2.1 Central Processing Facility

The CPF estimate includes costs for gravel pad, permanent camp, communication system, and all process facilities (equipment and structures). The size of the gravel pad is assumed to be 1750-feet long by 850-feet wide by 5-feet thick.

3.2.2 Export Pipeline

The export pipeline is a 16-inch diameter elevated line extending about 63.5 miles from the CPF to Pump Station 1. The actual length is dependant on the location of the facilities for each option. Crossings of East Badami Creek, No Name River, Shaviovik River, Kadleroshilik River and the Sagavinirktok River are all to be accomplished using conventional open-ditching techniques. Additional costs associated with these river crossings were not included in the economic screening studies since they are the same for all options. These costs will be included in the detailed estimate.

3.2.3 Dock

The gravel dock will extend approximately 1500-feet offshore and will have a 15-foot freeboard. The maximum water depth is 10-feet. A 50-foot wide drive lane will extend from shore 1100-feet to a 400-foot by 400-foot lay-down area. The seaward end will have a vertical sheet-pile face, while all other sides will be dressed to a 7 horizontal to 1 vertical (7:1) slope. A 50-foot wide module road from the dock to the CPF is included in this estimate. The gravel road will be 5 feet thick and have 2:1 sideslopes.

3.2.4 Airstrip

The gravel airstrip is 5500-feet long by 150-feet wide by 5-feet thick. The last 300-feet at each end will be widened an additional 50-feet, for a total width of 200-feet and the sideslopes will be 2:1. Runway lights will be installed as well as fueling facilities and minimal maintenance/emergency/passenger facilities. An access road from the airstrip to the CPF is included in this estimate. The gravel access road will be 32-feet wide and will be 5-feet thick with 2:1 sideslopes.

3.2.5 Construction Camp

The estimate for the temporary construction camp includes housing and catering costs to handle up to 500 workers, depending on the option.

3.2.6 Drill Pads

The estimate for the main drill pads includes costs for the gravel pad, well houses, manifolds, gathering lines and re-injection lines. There will be two manifolds on some pads, one for the Point Thomson gas and the other for the Brookian oil. The length of all lines is estimated based upon the mapping for that option. All line sizes are estimated using the piping requirements of API 5LX grade X65. The size of drill pads, for civil quantity estimates, are 800-feet long by 500-feet wide by a uniform 5-feet thick.

4.0 INITIAL SCREENING STUDIES

A number of possible alternatives were considered as viable options for further consideration and economic evaluation. An economic evaluation was undertaken for each option using the FAST-EST program, after review of the unit cost indices used by the program to estimate cost for the major equipment and labor items. The same program and unit cost indices were used for the evaluation of all alternatives. This is considered a Level 0 estimate study, suitable for evaluating the relative cost indices of project development alternatives.

4.1 Description of Options

Following are the descriptions of the alternatives investigated in this screening study :

Case 1 was the initial scenario considered and consisted of a centrally located process facility, with a nearby airstrip, and six drill pads: Callaway, Chilkoot, Flaxman, Point Thomson East, Point Thomson West, and Sourdough. Callaway was co-located with Point Thomson West, while Flaxman was co-located with Point Thomson East. This scenario also had a dock located approximately 1-mile east of the existing Point Thomson Unit #3 pad. Case 1 is presented on Figure 2.

Case 2 differed from Case 1 only in the location of the CPF and airstrip. The CPF was located nearer the shore, very close to the Point Thomson West pad. The airstrip was also located nearer the shore. While this scenario actually required a longer export pipeline, it reduced the length of the high-pressure injection lines considerably. Case 2 is presented on Figure 3.

Case 3 is the same as Case 1 with the addition of a drill pad at Lynx. Case 3 is presented on Figure 4.

Case 4 is the same as Case 2 with a Lynx Pad. Case 4 is presented on Figure 5.

Case 5 differed from the others in CPF location, airstrip location, dock location, and the addition of another drill pad located at Point Hopson, significantly further west than the remainder of the drill pads. A cursory analysis showed that the added cost was not warranted due to the significant distance from the actual penetrated hydrocarbon reserves central to this development.

Case 6 was aimed at identifying possible cost savings through consolidation of the Sourdough and Chilkoot Pads. After cursory evaluation; Cases 7, 8 and 9 were found to be superior.

Cases 5 and 6 were dropped from further evaluation.

Case 7 evaluated the scenario that Point Thomson and Flaxman would be developed, if possible, from a single drill pad located adjacent to the existing North Staines River #1 pad. The Central Process Facility would be located nearby with an airstrip approximately 1 mile to the southwest. A dock would be located on the point immediately west of the CPF. Case 7 is presented in Figure 6.

Case 8 is the same as Case 7 with an additional drill pad located at the existing Point Thomson Unit #3 pad. This would allow development of additional Point Thomson reserves as well as the potential Callaway reserves and, to a lesser extent, Lynx. Case 8 is presented in Figure 7.

Case 9 further builds on Case 8 with an additional drill pad being located on Flaxman Island to allow further development of the Flaxman formation. In addition to the drill pad, a small landing pier, and minimal maintenance/camp facilities would be required. Case 9 is presented in Figure 8.

4.2 Results

Cost breakdowns for Cases 1, 2, 3, 4, 7, 8 and 9 are presented in Table 4-1. Summary output for these cases from the FAST-EST models is presented in Appendix C. (The FAST-EST output report contains a known error in computing the freight costs on the gathering/support lines, this error has been hand corrected on the copies contained in this report.)

The results indicate a preference for the last three options investigated, Options #7, 8 and 9. Although the co-location of the main drill pad and facilities further east involves higher export pipeline costs, the cost of the associated development infrastructure (well lines, injection lines, etc) more than make up for this loss in these options. In addition, there are other savings not immediately evident in this cost analysis due to expected lower operational and maintenance costs that should be realized with the operating personnel closely located to the main facilities and drilling location. Further examination of these favorable options prompted renewed interest in the co-location of a dock near the central facilities location. Using the available bathymetry data, a dock location near the facilities is possible and will be further examined in planned field studies.

The favorable cost outcome coincides with the project preference to focus initially on only those areas containing known hydrocarbon deposits, i.e., Point Thomson, Flaxman and Sourdough.

Table 4-1

Initial Cost Estimate Comparison (in $1000's)

	CPF	Export Pipeline	Well Lines	Injection Lines	Civil Infrastructure	Drill Sites	Total
Case 1	$372,365	$140,258	$17,446	$25,173	$28,353	$39,145	***$622,740***
Case 2	$372,365	$141,436	$17,542	$21,231	$26,333	$39,145	***$618,052***
Case 3	$376,242	$140,258	$19,437	$26,404	$30,299	$45,856	***$638,496***
Case 4	$376,242	$141,436	$19,793	$22,101	$28,533	$45,856	***$633,961***
Case 7	$368,259	$149,687	$3,793	$2,859	$20,621	$21,733	***$566,952***
Case 8	$370,457	$149,687	$7,926	$15,703	$23,980	$27,532	***$595,285***
Case 9	$372,655	$149,687	$22,746	$26,883	$24,330	$33,038	***$629,339***

5.0 CONCLUSIONS

The outcome of the economic screening study shows favorable economics for the development of a single well pad that would develop the reserves and condensates from Flaxman and Point Thomson. In addition, a pad would be located at the Sourdough prospect with a direct connecting road to the central processing facilities located near the main drill pad. This is Case #7 in the screening options described. The economics coincide with the project preference to focus on only those areas containing known hydrocarbon deposits, i.e. Point Thomson, Flaxman and Sourdough. A dock location near this facility appears feasible, based on the available bathymetry data. In addition, this option utilizes an existing abandoned pad at the main facility location which serves to minimize the new footprint required for the project.

The Cases #8 and #9 build on this case to develop additional Point Thomson reserves to the west of the main facilities, and additional Flaxman reserves further offshore. The economics of these options are also favorable when considered on a cost per barrel basis. Moreover, the three alternatives are not mutually exclusive, i.e. either Case #8 and/or Case #9 can be treated as expansions of the base case (Case #7). This leads to additional favorable economics by treating the three options as phased development scenarios, wherein Case #7 is developed first and then expanded to include additional Point Thomson and Flaxman reserves. A suboption of Case #7 would be to develop only the main drill pad first, and then phase in the Sourdough field thereafter, but still within the same construction plan. (The development of only the Point Thomson/Flaxman main site without Sourdough leads to a reduced, and probably unfavorable, return when measured in Capex cost/barrel/day.)

As reservoirs are proved, additional prospects from currently unproved reservoirs, e.g. Lynx, Callaway, can be further included in the total project development scenario.

Further project definition and detailed cost estimating is planned to explore further the Case #7 Development Scenario, with and without phasing, for inclusion of the Point Thomson Unit #3 drill pad, and the Flaxman Island pad.

FIGURES

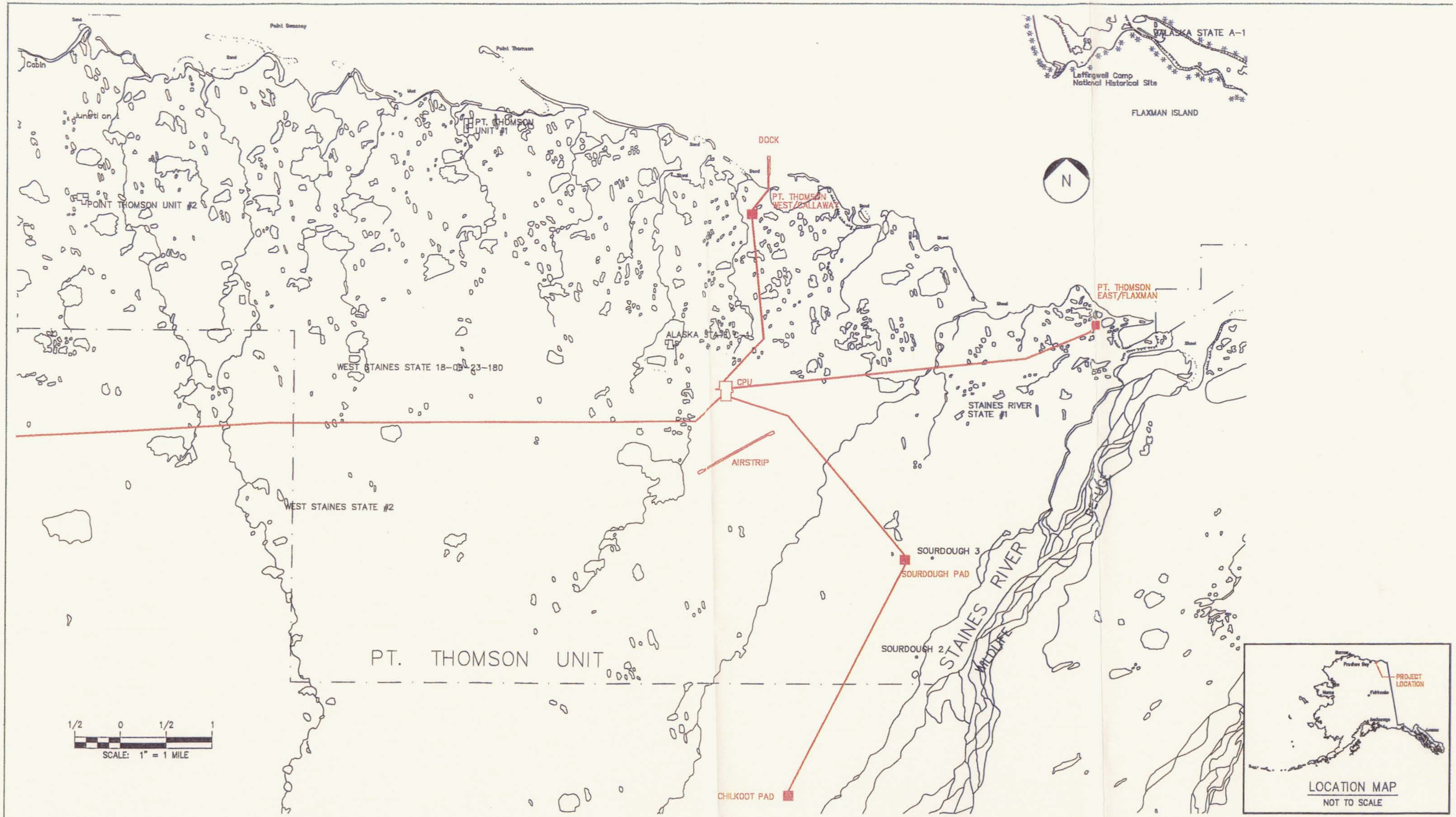

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FIGURE 2

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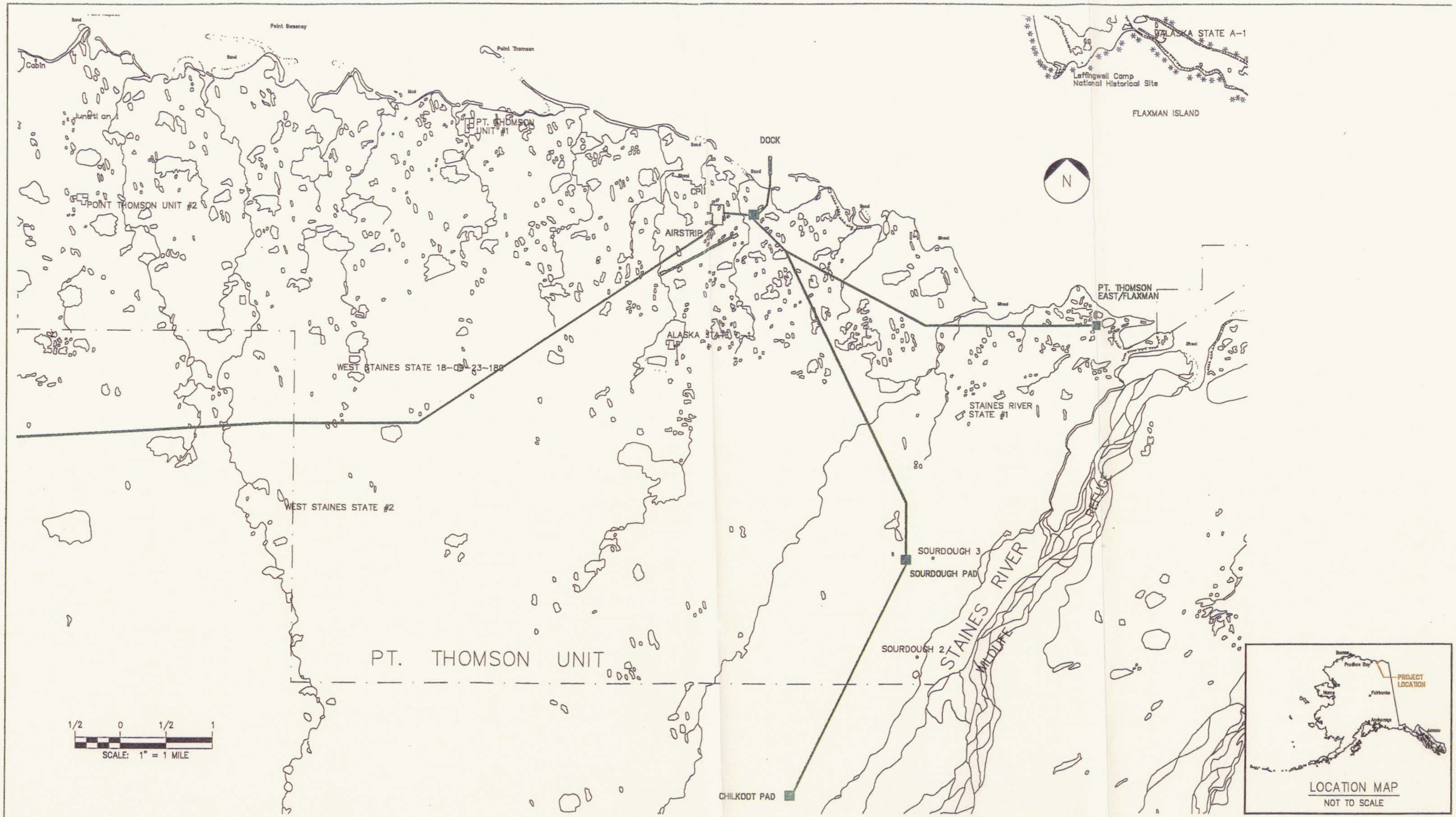

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FIGURE 3

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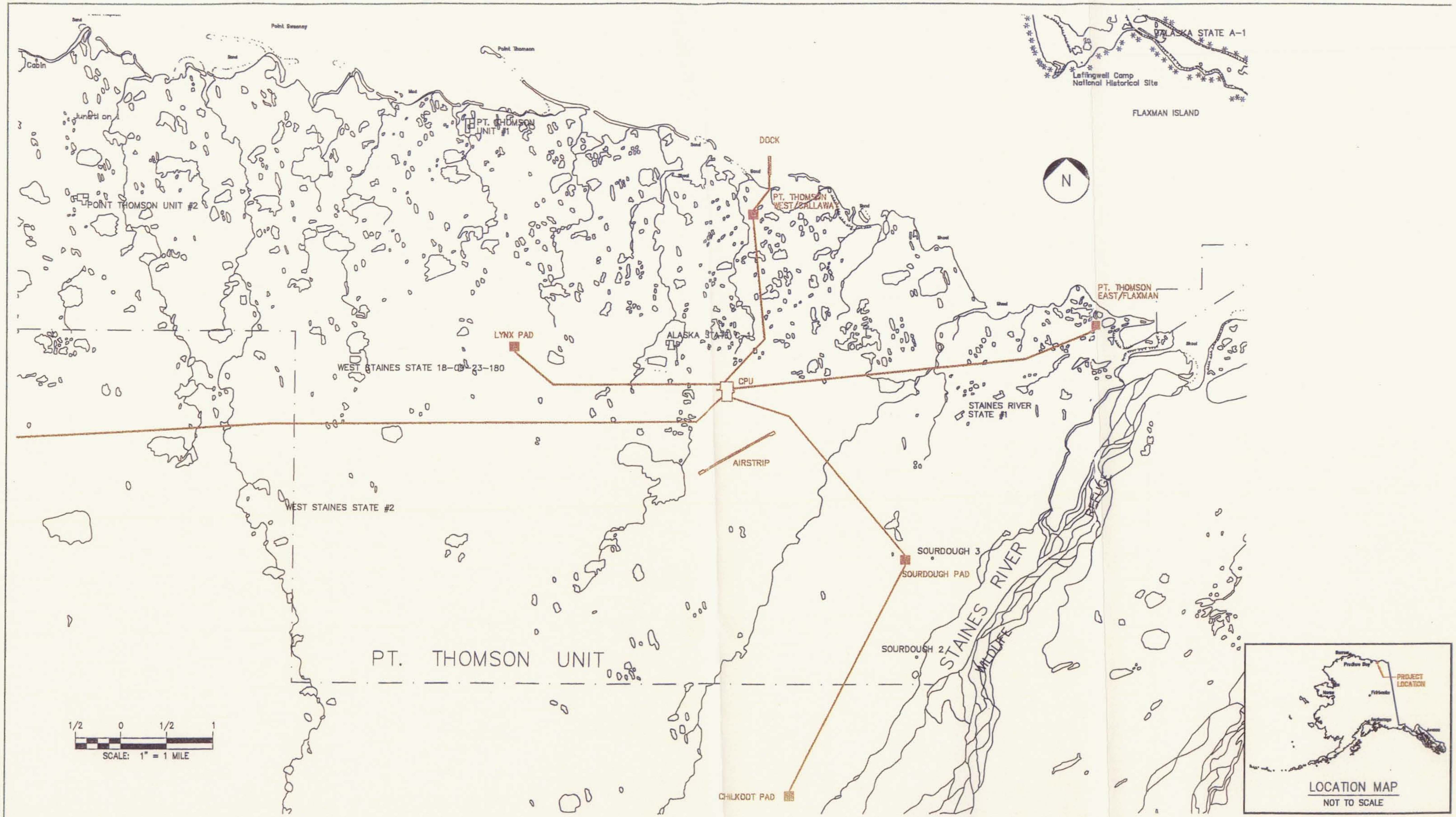

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FIGURE 4

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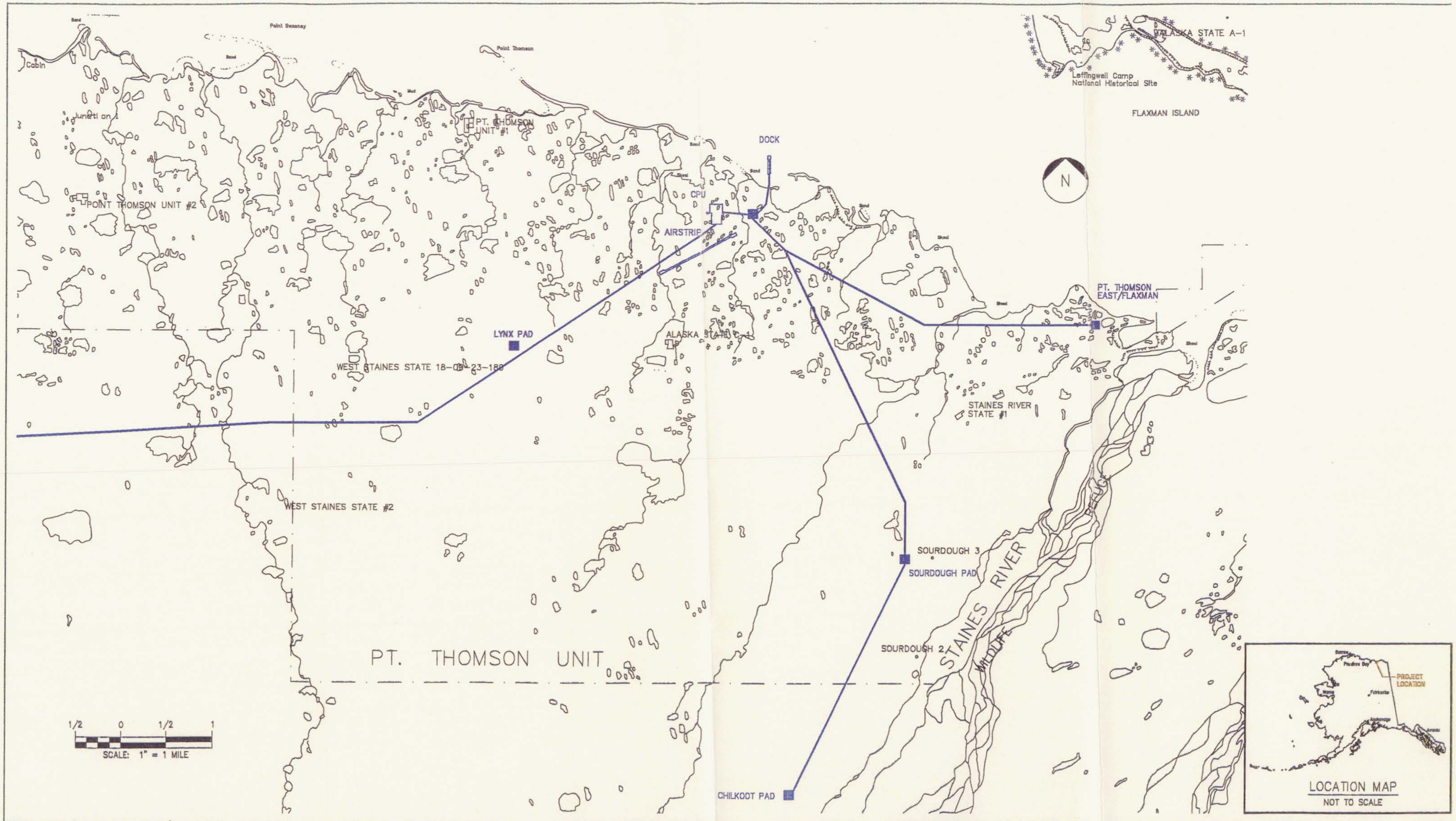

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FIGURE 5

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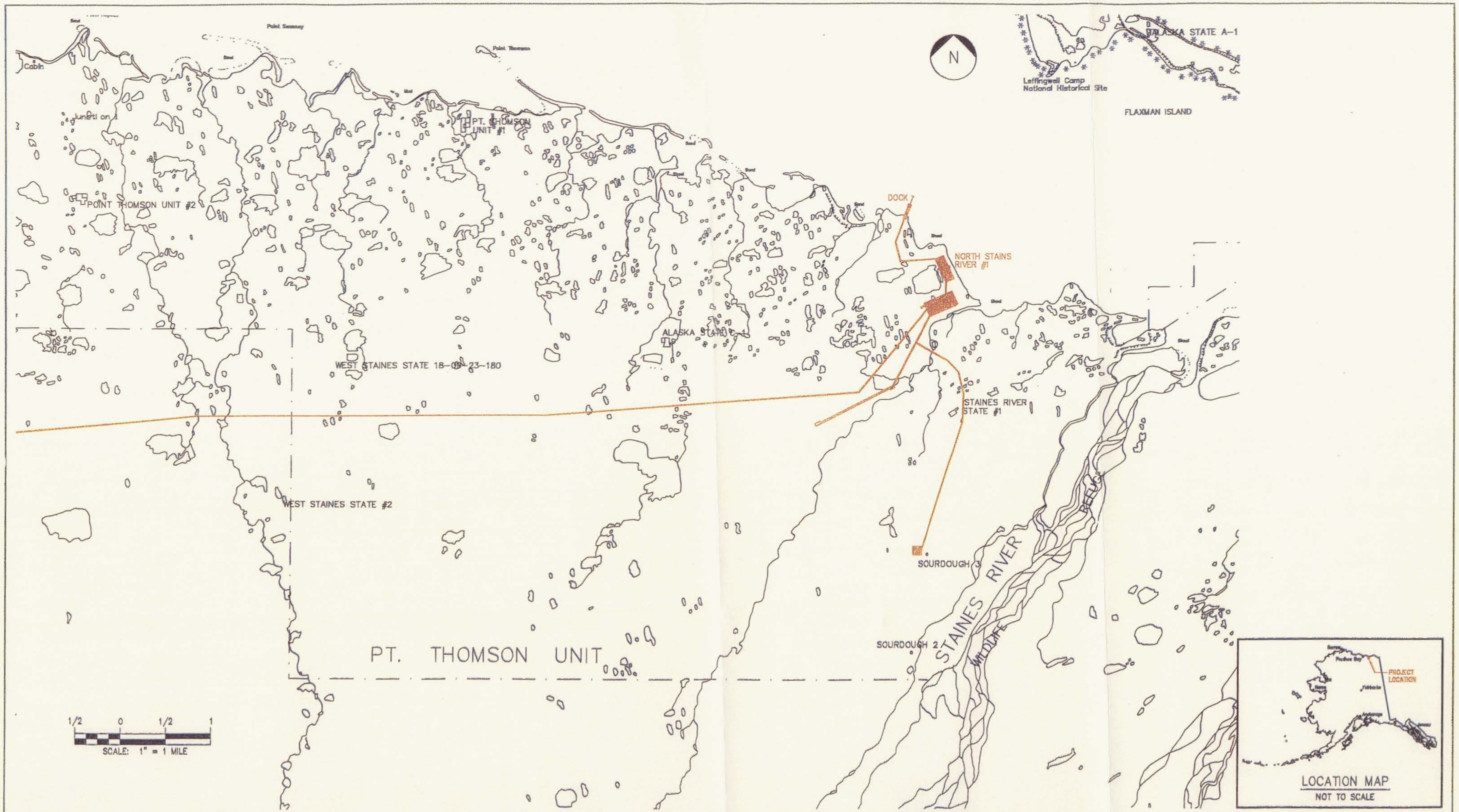

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FIGURE 6

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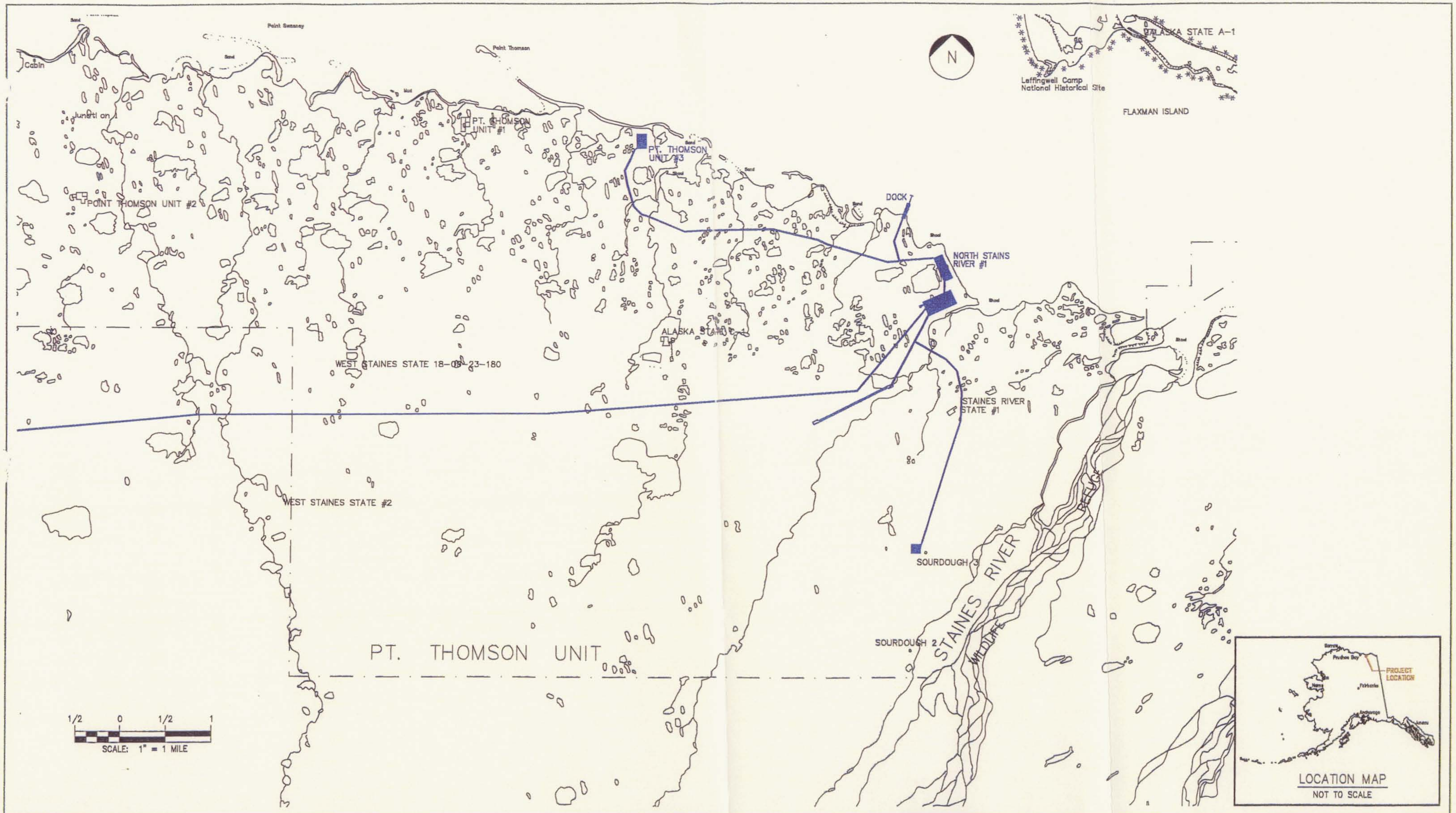

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FIGURE 7

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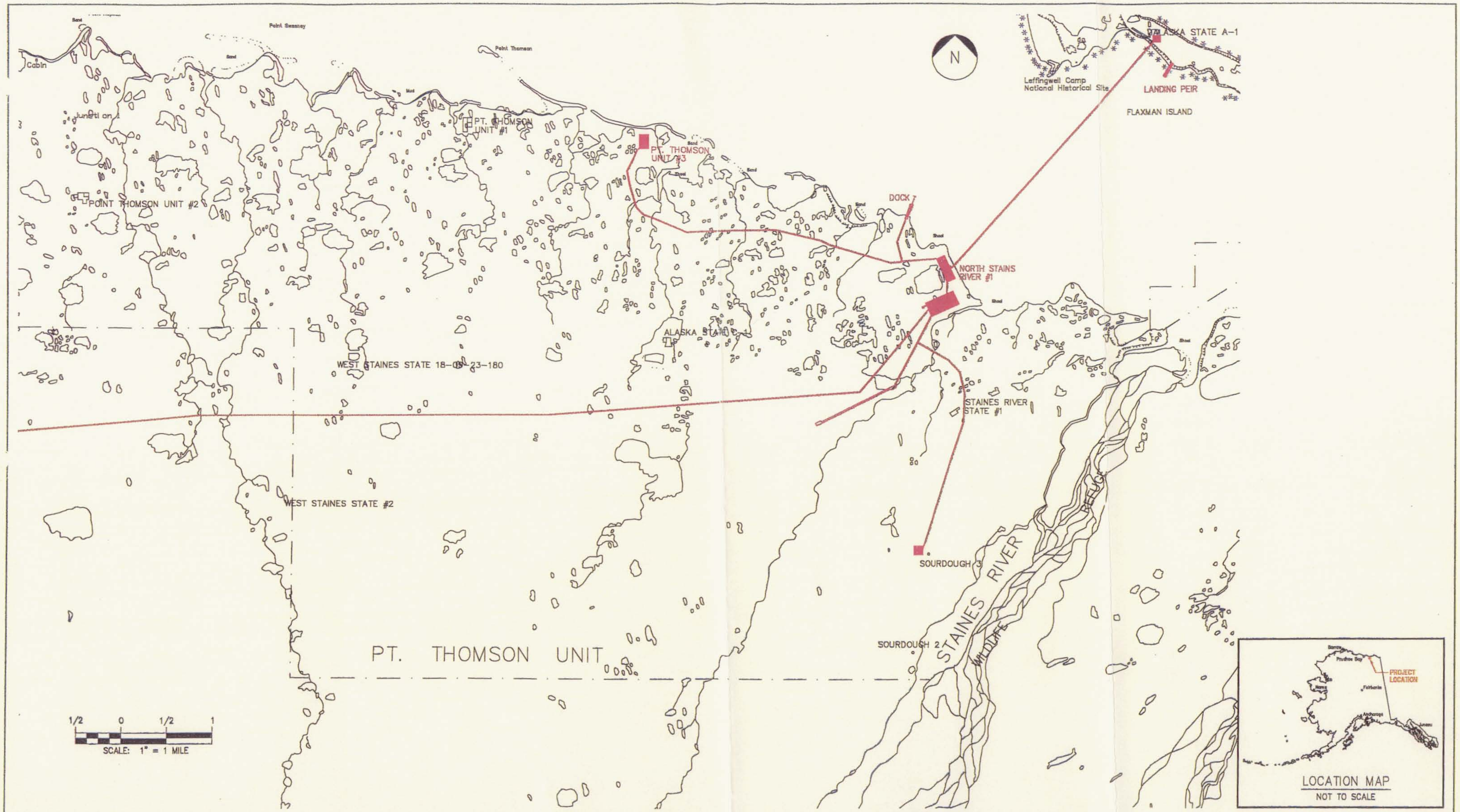

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FIGURE 8

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Appendix A
Estimate Accuracy Definition

Budget Estimate (Level 0)

The budget estimate evaluates the approximate cost of a project early in the proposal stage. If the cost is greater than the expected benefits or if the job will not bring an adequate return on investment required, the project is dropped as impractical. Normally the budget estimate is made from known costs of similar projects already completed. Contingency and escalation factors are usually projected and included. Budget estimates are identified as "Level 0 in the "Detailed Cost Estimate Procedures."

Conceptual Estimates (Level 1)

Conceptual estimates can be made at several stages during the conceptual design stage. The accuracy of the estimates can range from 20 to 30 percent of the actual costs depending upon the plan information available. The conceptual estimate will be utilized in comparing and evaluating various designs and construction techniques. Constructability will be defined and evaluated at this level. Conceptual estimates are identified as "Level 1" in the "Detailed Cost Estimate Procedures".

Preliminary Design Estimates (Level 2)

The preliminary design estimate, or order of magnitude estimates, is made by the construction estimator and the design engineers. The estimate is based on the conceptual drawings, the equipment requirements and the flow sheets when the final design is between 30 and 60 percent complete. This estimate serves as a check against the final conceptual estimate and should be within 15 to 25 percent of the final construction costs. The preliminary design estimate is identified as "Level 2" in the "Detailed Estimate Procedures" There may be several estimates in the "Level 2" category.

Final Design Estimate (Level 3)

The final design estimate is the construction estimator and design engineers' last estimate and will be compared with the contractor's bid estimate. This estimate shall be a detailed estimate made from completed drawings and specification. It does not include any allowances for later change orders. This estimate will also become a model of information in preparation for the "Bid Proposal Documents" of (RFP). The estimator will assist in the preparation and critique the final "Bid Proposal Documents." The final design estimate is identified as "Level 3" in the "Detailed Estimate Procedures." This estimated should be within 5 to 10 percent of the average cost of bids received from the bidders.

Contractor's Bid Estimate

This should be the most complete, detailed estimate of all costs of labor, equipment and material to construct the project shown on the drawings and described in the specifications. The drawings, specifications, site conditions, weather data, instruction to bidders, etc. should be as detailed and complete as possible. All work should be identified and quantified. If not quantifiable, unit prices should be identified and made as complete as possible. The more complete the RFP, the more accurate the Contractor's cost estimate will be and the less likely that change-orders will be required.

Change Order Estimates (Level 4)

The change order estimate is a bid estimate made on a change required after the contract is awarded. It is made in a manner similar to the contractors bid estimate. Note, contractors bid documents are usually specific about what is a change order or a changed condition. Usually labor rates, equipment rates, payroll burdens, small tools, material markup, subcontractor markup, etc., overhead and profit is fixed by the contract documents. In some cases, items such as small tools may be excluded from a change order. The final change order estimate is identified as "Level 4" in the "Detailed Estimate Procedures."

Appendix B
Base Cost Indices

Description	FAST-EST Variable	Unit	Cost
COSTS:			
Infield roads, 32' x 5', 2:1 sideslope	Gravel road	mile	$ 761,500
Module road, 50' x 5', 2;1 sideslope	Paved Road	mile	$1,087,500
Well pads, 500' x 800' x 5', 2:1 sideslope	Well site preparation	each	$1,412,000
Airstrip, 5000' x 150' x 5', 2:1 sideslope	Airstrip	each	$3,609,000
Dock, 1500' x 50' plus 400' x 400'	Added to site prep.	each	$7,600,000
Fabrication labor rate	Fabrication labor rate	hour	$ 78
Erection labor rate	Erection labor rate	hour	$ 90
Erection management labor rate	Erection management labor rate	hour	$ 95
CPF pad, 1300' x 650' x 5', 2:1 sideslope	CPF site preparation	each	$4,000,000
Infield pipeline material	Well line & support line material	kip	$ 405
Infield pipeline installation	Well line & support line installation	dia.-in. mile	$ 34,000
Infield pipeline coating and insulation	Well line & support line coating/insulation	dia.-in. mile	$ 12,000
Mainline pipeline material	Export pipeline material	kip	$ 390
Mainline pipeline installation	Base export pipeline installation	dia.-in. mile	$ 32,900
Mainline pipeline coating and insulation	Export pipeline material insulation	dia.-in. mile	$ 11,000
Marine freight	Marine freight	kip	$ 225
Engineering labor rate	Engineering labor rate	hour	$ 75
Construction camp	Construction camp	person	$ 26,700
Communications	Communications	each	$3,000,000
Aerial powerline	Powerline	mile	$ 84,700
OTHER FACTORS:			
Aboveground pipeline factor	Pipeline installation factors, stilts	1.5	
Design maximum ambient air temp.	Design maximum ambient air temp.	40	degrees F

Appendix C
Estimate Model Output
Screening Study

Case 1 - CPU Option .

SYSTEM COST SUMMARY

SYSTEM	EQUIPMENT MATERIAL USD(000)	BULK MATERIAL USD(000)	FABRICATION COST USD(000)	ERECTION COST USD(000)	FREIGHT COST USD(000)	ENGINEERING COST USD(000)	PROJECT MANAGEMENT USD(000)	OTHER COST USD(000)	SUBTOTAL COST USD(000)	CONTINGENCY USD(000)	TOTAL COST USD(000)
WELLSITE: Chilkoot											
MANIFOLD	192.2	131.0	402.3	1642.5	10.1	236.8	355.2	0.0	2970.1	0.0	2970.1
POWER DISTRIBUTION	22.2	451.0	1672.6	273.6	40.7	241.9	362.9	0.0	3065.0	0.0	3065.0
TOTAL	214.4	582.0	2074.9	1916.1	50.8	478.7	718.1	0.0	6035.1	0.0	6035.1
WELLSITE: Sourdoug											
MANIFOLD	559.9	267.5	844.7	1732.1	22.6	340.4	510.6	0.0	4278.0	0.0	4278.0
POWER DISTRIBUTION	22.2	451.0	1672.6	273.6	40.7	241.9	362.9	0.0	3065.0	0.0	3065.0
TOTAL	582.1	718.4	2517.4	2005.7	63.3	582.4	873.6	0.0	7342.9	0.0	7342.9
WELLSITE: PTWest											
MANIFOLD	310.8	340.5	964.8	9378.1	25.5	1099.4	1649.1	0.0	13768.3	0.0	13768.3
POWER DISTRIBUTION	44.4	600.5	2189.7	373.3	49.4	320.8	481.2	0.0	4059.3	0.0	4059.3
TOTAL	355.3	941.0	3154.4	9751.4	74.9	1420.2	2130.3	0.0	17827.6	0.0	17827.6
WELLSITE: PTEast											
MANIFOLD	229.8	243.9	691.4	920.5	17.1	208.6	312.9	0.0	2624.2	0.0	2624.2
POWER DISTRIBUTION	44.4	600.5	2189.7	373.3	49.4	320.8	481.2	0.0	4059.3	0.0	4059.3
TOTAL	274.3	844.4	2881.1	1293.8	66.4	529.4	794.0	0.0	6683.5	0.0	6683.5
WELLSITE: Flaxman											
MANIFOLD	367.7	205.5	640.0	910.1	16.4	212.3	318.5	0.0	2670.5	0.0	2670.5
POWER DISTRIBUTION	0.0	267.9	954.6	170.6	18.0	139.3	209.0	0.0	1759.3	0.0	1759.3
TOTAL	367.7	473.4	1594.6	1080.7	34.3	351.6	527.5	0.0	4429.8	0.0	4429.8

Case 1 - CPU Option ...

SYSTEM COST SUMMARY

SYSTEM	EQUIPMENT MATERIAL USD(000)	BULK MATERIAL USD(000)	FABRICATION COST USD(000)	ERECTION COST USD(000)	FREIGHT COST USD(000)	ENGINEERING COST USD(000)	PROJECT MANAGEMENT USD(000)	OTHER COST USD(000)	SUBTOTAL COST USD(000)	CONTINGENCY USD(000)	TOTAL COST USD(000)
WELLSITE: Callaway											
MANIFOLD	367.7	205.5	640.0	910.1	16.4	212.3	318.5	0.0	2670.5	0.0	2670.5
POWER DISTRIBUTION	0.0	267.9	954.6	170.6	18.0	139.3	209.0	0.0	1759.3	0.0	1759.3
TOTAL	367.7	473.4	1594.6	1080.7	34.3	351.6	527.5	0.0	4429.8	0.0	4429.8
CENTRAL PROCESSING FACILITY: PTAC CPF											
MANIFOLD	404.1	298.3	936.9	142.8	38.9	267.3	356.4	0.0	2444.8	0.0	2444.8
SEPARATION	2245.4	2653.3	8493.5	1445.6	452.7	2225.7	2967.6	0.0	20483.8	0.0	20483.8
CRUDE METERING	462.4	166.3	505.1	74.8	25.4	181.3	241.7	0.0	1656.9	0.0	1656.9
LOW PRES. GAS COMPR.	2685.4	1514.9	5065.1	842.1	238.9	1516.1	2021.5	0.0	13884.0	0.0	13884.0
REINJ. GAS COMPR.	57336.5	21821.1	67414.7	12007.0	3120.4	23786.9	31715.9	0.0	217202.4	0.0	217202.4
REINJ. GAS DEHYD.	2751.4	2028.9	6401.0	1162.7	338.1	1851.6	2468.8	0.0	17002.5	0.0	17002.5
PIG/SPHERE LAUNCHER	47.1	291.3	836.7	164.1	18.6	200.9	267.8	0.0	1826.5	0.0	1826.5
PRODUCED WATER	299.9	122.4	405.2	57.4	20.9	132.7	177.0	0.0	1215.4	0.0	1215.4
RELIEF	20.1	127.6	396.6	76.0	10.1	93.1	124.1	0.0	847.7	0.0	847.7
POWER GENERATION	8854.7	983.7	1801.9	225.1	183.7	1779.8	2373.1	0.0	16202.0	0.0	16202.0
POWER DISTRIBUTION	4127.0	4090.2	14568.7	2488.5	397.2	3791.2	5054.9	0.0	34517.6	0.0	34517.6
FIRED HEATERS	3147.9	1569.4	6815.6	443.6	488.3	1796.5	2395.3	0.0	16656.6	0.0	16656.6
HEATING MEDIUM	31.4	88.9	313.9	44.8	10.5	71.9	95.8	0.0	657.2	0.0	657.2
EFFLUENT WATER	51.2	569.8	1824.8	317.1	48.6	414.4	552.6	0.0	3778.6	0.0	3778.6
INSTRUMENT AIR	123.9	130.3	597.8	38.6	38.1	133.6	178.1	0.0	1240.4	0.0	1240.4
UTILITY AIR	0.0	45.2	136.3	27.6	2.5	31.4	41.8	0.0	284.7	0.0	284.7
FUEL GAS	53.0	68.2	207.1	41.3	5.8	55.4	73.9	0.0	504.7	0.0	504.7
DIESEL FUEL	806.2	181.5	832.5	140.5	100.0	294.1	392.1	0.0	2746.9	0.0	2746.9
INERT GAS	118.3	39.6	111.7	21.8	4.5	43.7	58.3	0.0	398.0	0.0	398.0
CHEMICAL INJECTION	20.1	30.5	41.5	8.3	1.2	15.0	20.1	0.0	136.6	0.0	136.6
FIRE PROTECTION	284.8	187.4	596.4	93.6	21.5	174.3	232.4	0.0	1590.4	0.0	1590.4
CONTROL CENTER	468.0	50.3	103.4	20.0	4.2	96.2	128.3	0.0	870.5	0.0	870.5
BUILDINGS	1256.8	0.0	716.4	145.1	127.6	317.7	423.6	0.0	2987.2	0.0	2987.2
TANKAGE	158.2	620.6	1994.5	403.9	118.6	476.6	635.4	0.0	4407.8	0.0	4407.8
FLARE	1191.4	225.6	951.3	104.8	84.1	371.0	494.6	0.0	3422.7	0.0	3422.7
SITE PREPARATION	0.0	0.0	0.0	4000.0	0.0	600.0	800.0	0.0	5400.0	0.0	5400.0
TOTAL	86945.4	37905.1	122068.4	24537.1	5900.2	40718.4	54291.2	0.0	372365.8	0.0	372365.8

Case 1 - CPU Option .

SYSTEM COST SUMMARY

SYSTEM	EQUIPMENT MATERIAL USD(000)	BULK MATERIAL USD(000)	FABRICATION COST USD(000)	ERECTION COST USD(000)	FREIGHT COST USD(000)	ENGINEERING COST USD(000)	PROJECT MANAGEMENT USD(000)	OTHER COST USD(000)	SUBTOTAL COST USD(000)	CONTINGENCY USD(000)	TOTAL COST USD(000)
WELL LINES	0.0	1877.2	0.0	8489.0	1042.9	1336.2	1704.7	2996.1	17446.0	0.0	17446.1
GATHERING LINES	0.0	7700.2	0.0	7224.4	~~35336.1~~ 4218	1747.4	1673.2	2549.8	~~56231.0~~ 25173	0.0	~~56231.0~~ 25173
EXPORT LINES	0.0	5891.0	0.0	93962.4	3398.7	11032.5	15501.6	10472.0	140258.3	0.0	140258.3
INFRASTRUCTURE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20753.5	20753.5	0.0	20753.5
DRILLING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GRAND TOTAL	89107.0	57406.2	135885.4	151341.2	~~46062.0~~ 14943	58548.6	78741.6	36771.4	~~653009.5~~ 622745	0.0	~~653803.1~~ 622745

Case 2 - CPF Option .

SYSTEM COST SUMMARY

SYSTEM	EQUIPMENT MATERIAL USD(000)	BULK MATERIAL USD(000)	FABRICATION COST USD(000)	ERECTION COST USD(000)	FREIGHT COST USD(000)	ENGINEERING COST USD(000)	PROJECT MANAGEMENT USD(000)	OTHER COST USD(000)	SUBTOTAL COST USD(000)	CONTINGENCY USD(000)	TOTAL COST USD(000)
WELLSITE: Chilkoot											
MANIFOLD	192.2	131.0	402.3	1642.5	10.1	236.8	355.2	0.0	2970.1	0.0	2970.1
POWER DISTRIBUTION	22.2	451.0	1672.6	273.6	40.7	241.9	362.9	0.0	3065.0	0.0	3065.0
TOTAL	214.4	582.0	2074.9	1916.1	50.8	478.7	718.1	0.0	6035.1	0.0	6035.1
WELLSITE: Sourdoug											
MANIFOLD	559.9	267.5	844.7	1732.1	22.6	340.4	510.6	0.0	4278.0	0.0	4278.0
POWER DISTRIBUTION	22.2	451.0	1672.6	273.6	40.7	241.9	362.9	0.0	3065.0	0.0	3065.0
TOTAL	582.1	718.4	2517.4	2005.7	63.3	582.4	873.6	0.0	7342.9	0.0	7342.9
WELLSITE: PTWest											
MANIFOLD	310.8	340.5	964.8	9378.1	25.5	1099.4	1649.1	0.0	13768.3	0.0	13768.3
POWER DISTRIBUTION	44.4	600.5	2189.7	373.3	49.4	320.8	481.2	0.0	4059.3	0.0	4059.3
TOTAL	355.3	941.0	3154.4	9751.4	74.9	1420.2	2130.3	0.0	17827.6	0.0	17827.6
WELLSITE: PTEast											
MANIFOLD	229.8	243.9	691.4	920.5	17.1	208.6	312.9	0.0	2624.2	0.0	2624.2
POWER DISTRIBUTION	44.4	600.5	2189.7	373.3	49.4	320.8	481.2	0.0	4059.3	0.0	4059.3
TOTAL	274.3	844.4	2881.1	1293.8	66.4	529.4	794.0	0.0	6683.5	0.0	6683.5
WELLSITE: Flaxman											
MANIFOLD	367.7	205.5	640.0	910.1	16.4	212.3	318.5	0.0	2670.5	0.0	2670.5
POWER DISTRIBUTION	0.0	267.9	954.6	170.6	18.0	139.3	209.0	0.0	1759.3	0.0	1759.3
TOTAL	367.7	473.4	1594.6	1080.7	34.3	351.6	527.5	0.0	4429.8	0.0	4429.8

Case 2 - CPF Option :

SYSTEM COST SUMMARY

SYSTEM	EQUIPMENT MATERIAL USD(000)	BULK MATERIAL USD(000)	FABRICATION COST USD(000)	ERECTION COST USD(000)	FREIGHT COST USD(000)	ENGINEERING COST USD(000)	PROJECT MANAGEMENT USD(000)	OTHER COST USD(000)	SUBTOTAL COST USD(000)	CONTINGENCY USD(000)	TOTAL COST USD(000)
WELLSITE: Callaway											
MANIFOLD	367.7	205.5	640.0	910.1	16.4	212.3	318.5	0.0	2670.5	0.0	2670.5
POWER DISTRIBUTION	0.0	267.9	954.6	170.6	18.0	139.3	209.0	0.0	1759.3	0.0	1759.3
TOTAL	367.7	473.4	1594.6	1080.7	34.3	351.6	527.5	0.0	4429.8	0.0	4429.8
CENTRAL PROCESSING FACILITY: PTAC CPF											
MANIFOLD	404.1	298.3	936.9	142.8	38.9	267.3	356.4	0.0	2444.8	0.0	2444.8
SEPARATION	2245.4	2653.3	8493.5	1445.6	452.7	2225.7	2967.6	0.0	20483.8	0.0	20483.8
CRUDE METERING	462.4	166.3	505.1	74.8	25.4	181.3	241.7	0.0	1656.9	0.0	1656.9
LOW PRES. GAS COMPR.	2685.4	1514.9	5065.1	842.1	238.9	1516.1	2021.5	0.0	13884.1	0.0	13884.1
REINJ. GAS COMPR.	57336.5	21821.1	67414.6	12007.0	3120.4	23786.9	31715.9	0.0	217202.4	0.0	217202.4
REINJ. GAS DEHYD.	2751.4	2028.9	6401.0	1162.7	338.1	1851.6	2468.8	0.0	17002.5	0.0	17002.5
PIG/SPHERE LAUNCHER	47.1	291.3	836.7	164.1	18.6	200.9	267.8	0.0	1826.5	0.0	1826.5
PRODUCED WATER	299.9	122.4	405.2	57.4	20.9	132.7	177.0	0.0	1215.4	0.0	1215.4
RELIEF	20.1	127.6	396.6	76.0	10.1	93.1	124.1	0.0	847.7	0.0	847.7
POWER GENERATION	8854.7	983.7	1801.9	225.1	183.7	1779.8	2373.1	0.0	16202.0	0.0	16202.0
POWER DISTRIBUTION	4127.0	4090.2	14568.6	2488.5	397.2	3791.1	5054.9	0.0	34517.5	0.0	34517.5
FIRED HEATERS	3147.9	1569.4	6815.6	443.6	488.3	1796.5	2395.3	0.0	16656.6	0.0	16656.6
HEATING MEDIUM	31.4	88.9	313.9	44.8	10.5	71.9	95.8	0.0	657.2	0.0	657.2
EFFLUENT WATER	51.2	569.8	1824.8	317.1	48.6	414.4	552.6	0.0	3778.6	0.0	3778.6
INSTRUMENT AIR	123.9	130.3	597.8	38.6	38.1	133.6	178.1	0.0	1240.4	0.0	1240.4
UTILITY AIR	0.0	45.2	136.3	27.6	2.5	31.4	41.8	0.0	284.7	0.0	284.7
FUEL GAS	53.0	68.2	207.1	41.3	5.8	55.4	73.9	0.0	504.7	0.0	504.7
DIESEL FUEL	806.2	181.5	832.5	140.5	100.0	294.1	392.1	0.0	2746.9	0.0	2746.9
INERT GAS	118.3	39.6	111.7	21.8	4.5	43.7	58.3	0.0	398.0	0.0	398.0
CHEMICAL INJECTION	20.1	30.5	41.5	8.3	1.2	15.0	20.1	0.0	136.6	0.0	136.6
FIRE PROTECTION	284.8	187.4	596.4	93.6	21.5	174.3	232.4	0.0	1590.4	0.0	1590.4
CONTROL CENTER	468.0	50.3	103.4	20.0	4.2	96.2	128.3	0.0	870.5	0.0	870.5
BUILDINGS	1256.8	0.0	716.4	145.1	127.6	317.7	423.6	0.0	2987.2	0.0	2987.2
TANKAGE	158.2	620.6	1994.5	403.9	118.6	476.6	635.4	0.0	4407.8	0.0	4407.8
FLARE	1191.4	225.6	951.3	104.8	84.1	371.0	494.6	0.0	3422.7	0.0	3422.7
SITE PREPARATION	0.0	0.0	0.0	4000.0	0.0	600.0	800.0	0.0	5400.0	0.0	5400.0
TOTAL	86945.4	37905.1	122068.3	24537.1	5900.2	40718.4	54291.2	0.0	372365.7	0.0	372365.7

Case 2 - CPF Option …

SYSTEM COST SUMMARY

SYSTEM	EQUIPMENT MATERIAL USD(000)	BULK MATERIAL USD(000)	FABRICATION COST USD(000)	ERECTION COST USD(000)	FREIGHT COST USD(000)	ENGINEERING COST USD(000)	PROJECT MANAGEMENT USD(000)	OTHER COST USD(000)	SUBTOTAL COST USD(000)	CONTINGENCY USD(000)	TOTAL COST USD(000)
WELL LINES	0.0	1753.0	0.0	8682.8	973.9	1350.0	1718.6	3064.5	17542.7	0.0	17542.7
GATHERING LINES	0.0	6183.0	0.0	6415.8	~~[illegible]~~ 3435	1486.3	1446.6	2264.4	~~30150.9~~ 21231	0.0	~~30150.9~~ 21231
EXPORT LINES	0.0	5940.5	0.0	94752.0	3427.2	11125.3	15631.9	10560.0	141436.9	0.0	141436.9
INFRASTRUCTURE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18733.3	18733.3	0.0	18733.3
DRILLING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GRAND TOTAL	89107.0	55814.3	135885.4	151516.0	~~42980.2~~ 14061	58394.0	78659.2	34622.2	~~646978.3~~ 618059	0.0	~~646978.3~~ 618059

Case 3 - CPU Option 1 with [illegible]x

SYSTEM COST SUMMARY

SYSTEM	EQUIPMENT MATERIAL USD(000)	BULK MATERIAL USD(000)	FABRICATION COST USD(000)	ERECTION COST USD(000)	FREIGHT COST USD(000)	ENGINEERING COST USD(000)	PROJECT MANAGEMENT USD(000)	OTHER COST USD(000)	SUBTOTAL COST USD(000)	CONTINGENCY USD(000)	TOTAL COST USD(000)
WELLSITE: Chilkoot											
MANIFOLD	192.2	131.0	402.3	1642.5	10.1	236.8	355.2	0.0	2970.1	0.0	2970.1
POWER DISTRIBUTION	22.2	451.0	1672.6	273.6	40.7	241.9	362.9	0.0	3065.0	0.0	3065.0
TOTAL	214.4	582.0	2074.9	1916.1	50.8	478.7	718.1	0.0	6035.1	0.0	6035.1
WELLSITE: Sourdoug											
MANIFOLD	559.9	267.5	844.7	1732.1	22.6	340.4	510.6	0.0	4278.0	0.0	4278.0
POWER DISTRIBUTION	22.2	451.0	1672.6	273.6	40.7	241.9	362.9	0.0	3065.0	0.0	3065.0
TOTAL	582.1	718.4	2517.4	2005.7	63.3	582.4	873.6	0.0	7342.9	0.0	7342.9
WELLSITE: PTWest											
MANIFOLD	310.8	340.5	964.8	9378.1	25.5	1099.4	1649.1	0.0	13768.3	0.0	13768.3
POWER DISTRIBUTION	44.4	600.5	2189.7	373.3	49.4	320.8	481.2	0.0	4059.3	0.0	4059.3
TOTAL	355.3	941.0	3154.4	9751.4	74.9	1420.2	2130.3	0.0	17827.6	0.0	17827.6
WELLSITE: PTEast											
MANIFOLD	229.8	243.9	691.4	920.5	17.1	208.6	312.9	0.0	2624.2	0.0	2624.2
POWER DISTRIBUTION	44.4	600.5	2189.7	373.3	49.4	320.8	481.2	0.0	4059.3	0.0	4059.3
TOTAL	274.3	844.4	2881.1	1293.8	66.4	529.4	794.0	0.0	6683.5	0.0	6683.5
WELLSITE: Flaxman											
MANIFOLD	367.7	205.5	640.0	910.1	16.4	212.3	318.5	0.0	2670.5	0.0	2670.5
POWER DISTRIBUTION	0.0	267.9	954.6	170.6	18.0	139.3	209.0	0.0	1759.3	0.0	1759.3
TOTAL	367.7	473.4	1594.6	1080.7	34.3	351.6	527.5	0.0	4429.8	0.0	4429.8

Case 3 - CPU Option 1 witl x

SYSTEM COST SUMMARY

SYSTEM	EQUIPMENT MATERIAL USD(000)	BULK MATERIAL USD(000)	FABRICATION COST USD(000)	ERECTION COST USD(000)	FREIGHT COST USD(000)	ENGINEERING COST USD(000)	PROJECT MANAGEMENT USD(000)	OTHER COST USD(000)	SUBTOTAL COST USD(000)	CONTINGENCY USD(000)	TOTAL COST USD(000)
WELLSITE: Callaway											
MANIFOLD	367.7	205.5	640.0	910.1	16.4	212.3	318.5	0.0	2670.5	0.0	2670.5
POWER DISTRIBUTION	0.0	267.9	954.6	170.6	18.0	139.3	209.0	0.0	1759.3	0.0	1759.3
TOTAL	367.7	473.4	1594.6	1080.7	34.3	351.6	527.5	0.0	4429.8	0.0	4429.8
WELLSITE: Lynx											
MANIFOLD	367.7	205.5	640.0	1690.6	16.4	290.4	435.6	0.0	3646.2	0.0	3646.2
POWER DISTRIBUTION	22.2	451.0	1672.6	273.6	40.7	241.9	362.9	0.0	3065.0	0.0	3065.0
TOTAL	390.0	656.4	2312.6	1964.2	57.1	532.3	798.5	0.0	6711.1	0.0	6711.1
CENTRAL PROCESSING FACILITY: PTAC CPF											
MANIFOLD	449.2	307.6	983.3	145.3	43.0	282.8	377.1	0.0	2588.3	0.0	2588.3
SEPARATION	2272.4	2687.1	8606.5	1463.0	458.8	2254.4	3005.8	0.0	20748.0	0.0	20748.0
CRUDE METERING	462.4	166.3	505.1	74.8	25.4	181.3	241.7	0.0	1656.9	0.0	1656.9
LOW PRES. GAS COMPR.	2727.4	1528.0	5104.6	849.0	240.7	1531.3	2041.8	0.0	14022.7	0.0	14022.7
REINJ. GAS COMPR.	57364.0	21842.2	67483.3	12020.3	3123.5	23806.5	31742.0	0.0	217381.8	0.0	217381.8
REINJ. GAS DEHYD.	2751.8	2029.3	6402.1	1162.9	338.2	1851.9	2469.2	0.0	17005.2	0.0	17005.2
PIG/SPHERE LAUNCHER	47.1	291.3	836.7	164.1	18.6	200.9	267.8	0.0	1826.5	0.0	1826.5
PRODUCED WATER	302.3	125.4	416.9	58.6	21.5	135.5	180.7	0.0	1240.9	0.0	1240.9
RELIEF	20.1	128.5	399.2	76.6	10.2	93.7	124.9	0.0	853.2	0.0	853.2
POWER GENERATION	8854.7	983.7	1801.9	225.1	183.7	1779.8	2373.1	0.0	16202.0	0.0	16202.0
POWER DISTRIBUTION	4573.9	4391.4	15632.2	2665.9	428.7	4089.5	5452.7	0.0	37234.3	0.0	37234.3
FIRED HEATERS	3164.1	1578.1	6855.0	445.7	491.0	1806.4	2408.6	0.0	16749.0	0.0	16749.0
HEATING MEDIUM	31.4	89.4	315.4	45.1	10.5	72.2	96.3	0.0	660.4	0.0	660.4
EFFLUENT WATER	51.2	577.4	1847.2	321.7	49.0	419.6	559.5	0.0	3825.6	0.0	3825.6
INSTRUMENT AIR	123.9	130.8	599.0	38.9	38.1	133.9	178.5	0.0	1243.0	0.0	1243.0
UTILITY AIR	0.0	45.5	137.3	27.8	2.5	31.6	42.1	0.0	286.8	0.0	286.8
FUEL GAS	53.0	68.6	208.5	41.5	5.9	55.7	74.3	0.0	507.6	0.0	507.6
DIESEL FUEL	806.2	181.8	833.5	140.8	100.0	294.3	392.4	0.0	2749.0	0.0	2749.0
INERT GAS	118.3	39.8	112.4	22.0	4.5	43.9	58.5	0.0	399.4	0.0	399.4
CHEMICAL INJECTION	20.1	30.7	41.8	8.3	1.2	15.1	20.2	0.0	137.3	0.0	137.3
FIRE PROTECTION	285.9	188.9	601.7	94.3	21.7	175.6	234.2	0.0	1602.3	0.0	1602.3
CONTROL CENTER	468.0	50.3	103.4	20.0	4.2	96.2	128.3	0.0	870.5	0.0	870.5
BUILDINGS	1351.9	0.0	770.6	156.0	137.2	341.8	455.7	0.0	3213.3	0.0	3213.3
TANKAGE	158.2	620.6	1994.5	403.9	118.6	476.6	635.4	0.0	4407.8	0.0	4407.8
FLARE	1193.6	226.3	953.6	105.2	84.2	371.8	495.8	0.0	3430.5	0.0	3430.5
SITE PREPARATION	0.0	0.0	0.0	4000.0	0.0	600.0	800.0	0.0	5400.0	0.0	5400.0
TOTAL	87651.3	38308.9	123545.6	24776.7	5960.9	41142.4	54856.5	0.0	376242.3	0.0	376242.3

Case 3 - CPU Option 1 with x

SYSTEM COST SUMMARY

SYSTEM	EQUIPMENT MATERIAL USD(000)	BULK MATERIAL USD(000)	FABRICATION COST USD(000)	ERECTION COST USD(000)	FREIGHT COST USD(000)	ENGINEERING COST USD(000)	PROJECT MANAGEMENT USD(000)	OTHER COST USD(000)	SUBTOTAL COST USD(000)	CONTINGENCY USD(000)	TOTAL COST USD(000)
WELL LINES	0.0	2065.6	0.0	9486.0	1147.6	1490.0	1900.1	3348.0	19437.3	0.0	19437.3
GATHERING LINES	0.0	7917.8	0.0	7742.4	~~43133.5~~ 4379	1839.3	1773.1	2732.6	~~65130.8~~ 26404	0.0	~~65130.8~~ 26404
EXPORT LINES	0.0	5891.0	0.0	93962.4	3398.7	11032.5	15501.6	10472.0	140258.3	0.0	140258.3
INFRASTRUCTURE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22699.7	22699.7	0.0	22699.7
DRILLING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GRAND TOTAL	90202.8	58872.5	139675.3	155060.2	~~54021.6~~ 15267	59750.5	80400.8	39252.4	~~677236.1~~ 638502	0.0	~~677236.1~~ 638502

Case 4 - CPF Option 2 witl x

SYSTEM COST SUMMARY

SYSTEM	EQUIPMENT MATERIAL USD(000)	BULK MATERIAL USD(000)	FABRICATION COST USD(000)	ERECTION COST USD(000)	FREIGHT COST USD(000)	ENGINEERING COST USD(000)	PROJECT MANAGEMENT USD(000)	OTHER COST USD(000)	SUBTOTAL COST USD(000)	CONTINGENCY USD(000)	TOTAL COST USD(000)
WELLSITE: Chilkoot											
MANIFOLD	192.2	131.0	402.3	1642.5	10.1	236.8	355.2	0.0	2970.1	0.0	2970.1
POWER DISTRIBUTION	22.2	451.0	1672.6	273.6	40.7	241.9	362.9	0.0	3065.0	0.0	3065.0
TOTAL	214.4	582.0	2074.9	1916.1	50.8	478.7	718.1	0.0	6035.1	0.0	6035.1
WELLSITE: Sourdoug											
MANIFOLD	559.9	267.5	844.7	1732.1	22.6	340.4	510.6	0.0	4278.0	0.0	4278.0
POWER DISTRIBUTION	22.2	451.0	1672.6	273.6	40.7	241.9	362.9	0.0	3065.0	0.0	3065.0
TOTAL	582.1	718.4	2517.4	2005.7	63.3	582.4	873.6	0.0	7342.9	0.0	7342.9
WELLSITE: PTWest											
MANIFOLD	310.8	340.5	964.8	9378.1	25.5	1099.4	1649.1	0.0	13768.3	0.0	13768.3
POWER DISTRIBUTION	44.4	600.5	2189.7	373.3	49.4	320.8	481.2	0.0	4059.3	0.0	4059.3
TOTAL	355.3	941.0	3154.4	9751.4	74.9	1420.2	2130.3	0.0	17827.6	0.0	17827.6
WELLSITE: PTEast											
MANIFOLD	229.8	243.9	691.4	920.5	17.1	208.6	312.9	0.0	2624.2	0.0	2624.2
POWER DISTRIBUTION	44.4	600.5	2189.7	373.3	49.4	320.8	481.2	0.0	4059.3	0.0	4059.3
TOTAL	274.3	844.4	2881.1	1293.8	66.4	529.4	794.0	0.0	6683.5	0.0	6683.5
WELLSITE: Flaxman											
MANIFOLD	367.7	205.5	640.0	910.1	16.4	212.3	318.5	0.0	2670.5	0.0	2670.5
POWER DISTRIBUTION	0.0	267.9	954.6	170.6	18.0	139.3	209.0	0.0	1759.3	0.0	1759.3
TOTAL	367.7	473.4	1594.6	1080.7	34.3	351.6	527.5	0.0	4429.8	0.0	4429.8

Case 4 - CPF Option 2 with x

SYSTEM COST SUMMARY

SYSTEM	EQUIPMENT MATERIAL USD(000)	BULK MATERIAL USD(000)	FABRICATION COST USD(000)	ERECTION COST USD(000)	FREIGHT COST USD(000)	ENGINEERING COST USD(000)	PROJECT MANAGEMENT USD(000)	OTHER COST USD(000)	SUBTOTAL COST USD(000)	CONTINGENCY USD(000)	TOTAL COST USD(000)
WELLSITE: Callaway											
MANIFOLD	367.7	205.5	640.0	910.1	16.4	212.3	318.5	0.0	2670.5	0.0	2670.5
POWER DISTRIBUTION	0.0	267.9	954.6	170.6	18.0	139.3	209.0	0.0	1759.3	0.0	1759.3
TOTAL	367.7	473.4	1594.6	1080.7	34.3	351.6	527.5	0.0	4429.8	0.0	4429.8
WELLSITE: Lynx											
MANIFOLD	367.7	205.5	640.0	1690.6	16.4	290.4	435.6	0.0	3646.2	0.0	3646.2
POWER DISTRIBUTION	22.2	451.0	1672.6	273.6	40.7	241.9	362.9	0.0	3065.0	0.0	3065.0
TOTAL	390.0	656.4	2312.6	1964.2	57.1	532.3	798.5	0.0	6711.1	0.0	6711.1
CENTRAL PROCESSING FACILITY: PTAC CPF											
MANIFOLD	449.2	307.6	983.3	145.3	43.0	282.8	377.1	0.0	2588.3	0.0	2588.3
SEPARATION	2272.4	2687.1	8606.5	1463.0	458.8	2254.4	3005.8	0.0	20748.0	0.0	20748.0
CRUDE METERING	462.4	166.3	505.1	74.8	25.4	181.3	241.7	0.0	1656.9	0.0	1656.9
LOW PRES. GAS COMPR.	2727.4	1528.0	5104.6	849.0	240.7	1531.3	2041.8	0.0	14022.8	0.0	14022.8
REINJ. GAS COMPR.	57364.0	21842.2	67483.4	12020.3	3123.5	23806.5	31742.0	0.0	217381.8	0.0	217381.8
REINJ. GAS DEHYD.	2751.8	2029.3	6402.1	1162.9	338.2	1851.9	2469.2	0.0	17005.2	0.0	17005.2
PIG/SPHERE LAUNCHER	47.1	291.3	836.7	164.1	18.6	200.9	267.8	0.0	1826.5	0.0	1826.5
PRODUCED WATER	302.3	125.4	416.9	58.6	21.5	135.5	180.7	0.0	1240.9	0.0	1240.9
RELIEF	20.1	128.5	399.2	76.6	10.2	93.7	124.9	0.0	853.2	0.0	853.2
POWER GENERATION	8854.7	983.7	1801.9	225.1	183.7	1779.8	2373.1	0.0	16202.0	0.0	16202.0
POWER DISTRIBUTION	4573.9	4391.4	15632.2	2665.9	428.7	4089.5	5452.7	0.0	37234.3	0.0	37234.3
FIRED HEATERS	3164.1	1578.1	6855.0	445.7	491.0	1806.4	2408.6	0.0	16749.0	0.0	16749.0
HEATING MEDIUM	31.4	89.4	315.4	45.1	10.5	72.2	96.3	0.0	660.4	0.0	660.4
EFFLUENT WATER	51.2	577.4	1847.2	321.7	49.0	419.6	559.5	0.0	3825.6	0.0	3825.6
INSTRUMENT AIR	123.9	130.8	599.0	38.9	38.1	133.9	178.5	0.0	1243.0	0.0	1243.0
UTILITY AIR	0.0	45.5	137.3	27.8	2.5	31.6	42.1	0.0	286.8	0.0	286.8
FUEL GAS	53.0	68.6	208.5	41.5	5.9	55.7	74.3	0.0	507.6	0.0	507.6
DIESEL FUEL	806.2	181.8	833.5	140.8	100.0	294.3	392.4	0.0	2749.0	0.0	2749.0
INERT GAS	118.3	39.8	112.4	22.0	4.5	43.9	58.5	0.0	399.4	0.0	399.4
CHEMICAL INJECTION	20.1	30.7	41.8	8.3	1.2	15.1	20.2	0.0	137.3	0.0	137.3
FIRE PROTECTION	285.9	188.9	601.7	94.3	21.7	175.6	234.2	0.0	1602.3	0.0	1602.3
CONTROL CENTER	468.0	50.3	103.4	20.0	4.2	96.2	128.3	0.0	870.5	0.0	870.5
BUILDINGS	1351.9	0.0	770.6	156.0	137.2	341.8	455.7	0.0	3213.3	0.0	3213.3
TANKAGE	158.2	620.6	1994.5	403.9	118.6	476.6	635.4	0.0	4407.8	0.0	4407.8
FLARE	1193.6	226.3	953.6	105.2	84.2	371.8	495.8	0.0	3430.5	0.0	3430.5
SITE PREPARATION	0.0	0.0	0.0	4000.0	0.0	600.0	800.0	0.0	5400.0	0.0	5400.0
TOTAL	87651.3	38309.0	123545.6	24776.7	5960.9	41142.4	54856.5	0.0	376242.3	0.0	376242.3

Case 4 - CPF Option 2 with .ux

SYSTEM COST SUMMARY

SYSTEM	EQUIPMENT MATERIAL USD(000)	BULK MATERIAL USD(000)	FABRICATION COST USD(000)	ERECTION COST USD(000)	FREIGHT COST USD(000)	ENGINEERING COST USD(000)	PROJECT MANAGEMENT USD(000)	OTHER COST USD(000)	SUBTOTAL COST USD(000)	CONTINGENCY USD(000)	TOTAL COST USD(000)
WELL LINES	0.0	1966.0	0.0	9809.9	1092.2	1523.8	1939.5	3462.3	19793.7	0.0	19793.7
GATHERING LINES	0.0	6308.3	0.0	6813.6	~~10286.7~~ 3504	1552.7	1520.8	2404.8	~~57886.0~~ 22401	0.0	~~57886.0~~ 22101
EXPORT LINES	0.0	5940.5	0.0	94752.0	3427.2	11125.3	15631.9	10560.0	141436.9	0.0	141436.9
INFRASTRUCTURE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20933.4	20933.4	0.0	20933.4
DRILLING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GRAND TOTAL	90202.8	57212.9	139675.3	155244.8	~~50148.2~~ 14364	59590.4	80318.1	37360.5	~~660753.0~~ 633965	0.0	~~660752.9~~ 633965

Alternate 1 - Minimal Faci. s (CASE 7)

SYSTEM COST SUMMARY

SYSTEM	EQUIPMENT MATERIAL USD(000)	BULK MATERIAL USD(000)	FABRICATION COST USD(000)	ERECTION COST USD(000)	FREIGHT COST USD(000)	ENGINEERING COST USD(000)	PROJECT MANAGEMENT USD(000)	OTHER COST USD(000)	SUBTOTAL COST USD(000)	CONTINGENCY USD(000)	TOTAL COST USD(000)
WELLSITE: Sourdoug											
MANIFOLD	559.9	267.5	844.7	1732.1	22.6	340.4	510.6	0.0	4278.0	0.0	4278.0
POWER DISTRIBUTION	22.2	451.0	1672.6	273.6	40.7	241.9	362.9	0.0	3065.0	0.0	3065.0
TOTAL	582.1	718.4	2517.4	2005.7	63.3	582.4	873.6	0.0	7342.9	0.0	7342.9
WELLSITE: PtThom											
MANIFOLD	569.2	393.0	1156.9	1795.3	34.2	391.4	587.2	0.0	4927.1	0.0	4927.1
POWER DISTRIBUTION	44.4	600.5	2189.7	373.3	49.4	320.8	481.2	0.0	4059.3	0.0	4059.3
TOTAL	613.6	993.5	3346.5	2168.6	83.5	712.2	1068.3	0.0	8986.4	0.0	8986.4
WELLSITE: Flaxman											
MANIFOLD	367.7	205.5	640.0	1690.6	16.4	290.4	435.6	0.0	3646.2	0.0	3646.2
POWER DISTRIBUTION	0.0	267.9	954.6	170.6	18.0	139.3	209.0	0.0	1759.3	0.0	1759.3
TOTAL	367.7	473.4	1594.6	1861.2	34.3	429.7	644.5	0.0	5405.5	0.0	5405.5
CENTRAL PROCESSING FACILITY: PTAC CPF											
MANIFOLD	269.0	270.3	797.7	135.4	26.6	220.9	294.5	0.0	2014.3	0.0	2014.3
SEPARATION	2245.4	2653.3	8493.5	1445.6	452.7	2225.7	2967.6	0.0	20483.8	0.0	20483.8
CRUDE METERING	462.4	166.3	505.1	74.8	25.4	181.3	241.7	0.0	1656.9	0.0	1656.9
LOW PRES. GAS COMPR.	2685.5	1514.9	5065.2	842.1	238.9	1516.2	2021.5	0.0	13884.3	0.0	13884.3
REINJ. GAS COMPR.	57338.5	21822.6	67419.6	12008.0	3120.6	23788.3	31717.7	0.0	217215.2	0.0	217215.2
REINJ. GAS DEHYD.	2751.4	2028.9	6401.0	1162.7	338.1	1851.6	2468.8	0.0	17002.5	0.0	17002.5
PIG/SPHERE LAUNCHER	47.1	291.3	836.7	164.1	18.6	200.9	267.8	0.0	1826.5	0.0	1826.5
PRODUCED WATER	299.9	122.4	405.2	57.4	20.9	132.7	177.0	0.0	1215.4	0.0	1215.4
RELIEF	20.1	126.0	391.8	75.1	10.1	91.9	122.6	0.0	837.5	0.0	837.5
POWER GENERATION	8854.7	983.7	1801.9	225.1	183.7	1779.8	2373.1	0.0	16202.0	0.0	16202.0
POWER DISTRIBUTION	3091.4	3480.5	12408.3	2137.5	328.9	3167.7	4223.5	0.0	28837.8	0.0	28837.8
FIRED HEATERS	3147.9	1569.4	6815.6	443.6	488.3	1796.5	2395.3	0.0	16656.6	0.0	16656.6
HEATING MEDIUM	31.4	88.0	311.0	44.2	10.4	71.2	94.9	0.0	651.2	0.0	651.2
EFFLUENT WATER	51.2	556.0	1783.4	308.8	47.8	404.9	539.9	0.0	3691.9	0.0	3691.9
INSTRUMENT AIR	123.9	129.4	595.6	38.2	38.0	133.1	177.4	0.0	1235.5	0.0	1235.5
UTILITY AIR	0.0	44.6	134.4	27.2	2.4	30.9	41.2	0.0	280.9	0.0	280.9
FUEL GAS	50.9	67.0	202.9	40.5	5.6	54.2	72.2	0.0	493.1	0.0	493.1
DIESEL FUEL	806.2	180.8	830.6	140.2	99.9	293.7	391.6	0.0	2742.9	0.0	2742.9
INERT GAS	118.3	39.2	110.5	21.6	4.4	43.4	57.9	0.0	395.4	0.0	395.4
CHEMICAL INJECTION	20.1	30.1	41.0	8.2	1.2	14.9	19.9	0.0	135.2	0.0	135.2

SYSTEM COST SUMMARY

SYSTEM	EQUIPMENT MATERIAL USD(000)	BULK MATERIAL USD(000)	FABRICATION COST USD(000)	ERECTION COST USD(000)	FREIGHT COST USD(000)	ENGINEERING COST USD(000)	PROJECT MANAGEMENT USD(000)	OTHER COST USD(000)	SUBTOTAL COST USD(000)	CONTINGENCY USD(000)	TOTAL COST USD(000)
FIRE PROTECTION	283.6	185.1	588.4	92.4	21.2	172.4	229.9	0.0	1573.0	0.0	1573.0
CONTROL CENTER	468.0	50.3	103.4	20.0	4.2	96.2	128.3	0.0	870.5	0.0	870.5
BUILDINGS	1040.3	0.0	593.0	120.1	105.6	263.0	350.7	0.0	2472.7	0.0	2472.7
TANKAGE	158.2	620.6	1994.5	403.9	118.6	476.6	635.4	0.0	4407.8	0.0	4407.8
FLARE	1191.4	224.6	948.4	104.2	84.0	370.3	493.7	0.0	3416.7	0.0	3416.7
SITE PREPARATION	0.0	0.0	0.0	11600.0	0.0	1740.0	2320.0	0.0	15660.0	0.0	15660.0
TOTAL	85557.0	37245.0	119578.3	31740.6	5796.1	41118.1	54824.2	0.0	375859.4	0.0	375859.4
WELL LINES	0.0	387.4	0.0	1868.3	215.2	291.5	371.3	659.4	3793.1	0.0	3793.1
GATHERING LINES	0.0	656.1	0.0	1047.2	~~11066.0~~ [364]	207.3	214.9	369.6	~~14361.8~~ [2859]	0.0	~~14361.0~~ [2859]
EXPORT LINES	0.0	6287.1	0.0	100279.2	3627.2	11774.2	16543.7	11176.0	149687.4	0.0	149687.4
INFRASTRUCTURE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13021.4	13021.4	0.0	13021.4
DRILLING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GRAND TOTAL	87120.6	46760.8	127036.9	140970.8	~~31686.5~~ [10184]	55115.5	74540.6	25226.4	~~578458.0~~ [566756]	0.0	~~578458.0~~ [566756]

Alternate 2 - Minimal Facilities w 2 PT Pads (CASE 8)

SYSTEM COST SUMMARY

SYSTEM	EQUIPMENT MATERIAL USD(000)	BULK MATERIAL USD(000)	FABRICATION COST USD(000)	ERECTION COST USD(000)	FREIGHT COST USD(000)	ENGINEERING COST USD(000)	PROJECT MANAGEMENT USD(000)	OTHER COST USD(000)	SUBTOTAL COST USD(000)	CONTINGENCY USD(000)	TOTAL COST USD(000)
WELLSITE: Sourdoug											
MANIFOLD	559.9	267.5	844.7	1732.1	22.6	340.4	510.6	0.0	4278.0	0.0	4278.0
POWER DISTRIBUTION	22.2	451.0	1672.6	273.6	40.7	241.9	362.9	0.0	3065.0	0.0	3065.0
TOTAL	582.1	718.4	2517.4	2005.7	63.3	582.4	873.6	0.0	7342.9	0.0	7342.9
WELLSITE: PtThom											
MANIFOLD	363.3	349.7	1004.9	1764.5	28.4	348.2	522.4	0.0	4381.5	0.0	4381.5
POWER DISTRIBUTION	44.4	600.5	2189.7	373.3	49.4	320.8	481.2	0.0	4059.3	0.0	4059.3
TOTAL	407.8	950.2	3194.6	2137.8	77.8	669.0	1003.6	0.0	8440.8	0.0	8440.8
WELLSITE: Flaxman											
MANIFOLD	367.7	205.5	640.0	1690.6	16.4	290.4	435.6	0.0	3646.2	0.0	3646.2
POWER DISTRIBUTION	0.0	267.9	954.6	170.6	18.0	139.3	209.0	0.0	1759.3	0.0	1759.3
TOTAL	367.7	473.4	1594.6	1861.2	34.3	429.7	644.5	0.0	5405.5	0.0	5405.5
WELLSITE: PT#3											
MANIFOLD	183.9	201.6	555.3	1673.5	12.5	261.4	392.1	0.0	3280.4	0.0	3280.4
POWER DISTRIBUTION	22.2	451.0	1672.6	273.6	40.7	241.9	362.9	0.0	3065.0	0.0	3065.0
TOTAL	206.2	652.5	2227.9	1947.1	53.2	503.4	755.1	0.0	6345.4	0.0	6345.4
CENTRAL PROCESSING FACILITY: PTAC CPF											
MANIFOLD	314.0	279.6	844.1	137.9	30.7	236.3	315.1	0.0	2157.8	0.0	2157.8
SEPARATION	2245.4	2653.3	8493.5	1445.6	452.7	2225.7	2967.6	0.0	20483.8	0.0	20483.8
CRUDE METERING	462.4	166.3	505.1	74.8	25.4	181.3	241.7	0.0	1656.9	0.0	1656.9
LOW PRES. GAS COMPR.	2685.4	1514.9	5065.2	842.1	238.9	1516.1	2021.5	0.0	13884.2	0.0	13884.2
REINJ. GAS COMPR.	57337.8	21822.1	67417.9	12007.7	3120.5	23787.8	31717.1	0.0	217210.9	0.0	217210.9
REINJ. GAS DEHYD.	2751.4	2028.9	6401.0	1162.7	338.1	1851.6	2468.8	0.0	17002.5	0.0	17002.5
PIG/SPHERE LAUNCHER	47.1	291.3	836.7	164.1	18.6	200.9	267.8	0.0	1826.5	0.0	1826.5
PRODUCED WATER	299.9	122.4	405.2	57.4	20.9	132.7	177.0	0.0	1215.4	0.0	1215.4
RELIEF	20.1	126.5	393.3	75.4	10.1	92.3	123.1	0.0	840.8	0.0	840.8
POWER GENERATION	8854.7	983.7	1801.9	225.1	183.7	1779.8	2373.1	0.0	16202.0	0.0	16202.0
POWER DISTRIBUTION	3417.5	3681.4	13119.4	2254.1	350.9	3370.9	4494.5	0.0	30688.7	0.0	30688.7
FIRED HEATERS	3147.9	1569.4	6815.6	443.6	488.3	1796.5	2395.3	0.0	16656.6	0.0	16656.6
HEATING MEDIUM	31.4	88.3	311.9	44.4	10.4	71.4	95.2	0.0	653.1	0.0	653.1
EFFLUENT WATER	51.2	560.4	1796.7	311.4	48.0	408.0	543.9	0.0	3719.7	0.0	3719.7

Alternate 2 - Minimal Facilities w... 2 PT Pads (CASE 8)

SYSTEM COST SUMMARY

SYSTEM	EQUIPMENT MATERIAL USD(000)	BULK MATERIAL USD(000)	FABRICATION COST USD(000)	ERECTION COST USD(000)	FREIGHT COST USD(000)	ENGINEERING COST USD(000)	PROJECT MANAGEMENT USD(000)	OTHER COST USD(000)	SUBTOTAL COST USD(000)	CONTINGENCY USD(000)	TOTAL COST USD(000)
INSTRUMENT AIR	123.9	129.7	596.3	38.3	38.1	133.2	177.6	0.0	1237.1	0.0	1237.1
UTILITY AIR	0.0	44.8	135.0	27.3	2.4	31.1	41.4	0.0	282.1	0.0	282.1
FUEL GAS	50.9	67.2	203.7	40.6	5.6	54.4	72.5	0.0	494.8	0.0	494.8
DIESEL FUEL	806.2	181.0	831.2	140.3	99.9	293.8	391.7	0.0	2744.2	0.0	2744.2
INERT GAS	118.3	39.3	110.9	21.7	4.5	43.5	58.0	0.0	396.2	0.0	396.2
CHEMICAL INJECTION	20.1	30.2	41.1	8.2	1.2	14.9	19.9	0.0	135.7	0.0	135.7
FIRE PROTECTION	283.6	185.7	590.3	92.8	21.2	172.8	230.5	0.0	1576.8	0.0	1576.8
CONTROL CENTER	468.0	50.3	103.4	20.0	4.2	96.2	128.3	0.0	870.5	0.0	870.5
BUILDINGS	1108.8	0.0	632.0	128.0	112.5	280.3	373.8	0.0	2635.4	0.0	2635.4
TANKAGE	158.2	620.6	1994.5	403.9	118.6	476.6	635.4	0.0	4407.8	0.0	4407.8
FLARE	1191.4	224.9	949.4	104.4	84.0	370.5	494.0	0.0	3418.6	0.0	3418.6
SITE PREPARATION	0.0	0.0	0.0	11600.0	0.0	1740.0	2320.0	0.0	15660.0	0.0	15660.0
TOTAL	85995.9	37462.1	120395.1	31871.7	5829.6	41358.7	55144.9	0.0	378058.0	0.0	378058.0
WELL LINES	0.0	848.0	0.0	3862.4	471.1	607.4	774.7	1363.2	7926.8	0.0	7926.8
GATHERING LINES	0.0	5122.9	0.0	4175.2	2844 ~~[illegible]~~	1077.2	1007.3	1473.6	15703 ~~31196.9~~	0.0	15703 ~~31196.8~~
EXPORT LINES	0.0	6287.1	0.0	100279.2	3627.2	11774.2	16543.7	11176.0	149687.4	0.0	149687.4
INFRASTRUCTURE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16380.9	16380.9	0.0	16380.9
DRILLING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GRAND TOTAL	87559.7	52514.6	129929.6	148140.3	~~28496.5~~ 13003	57001.9	76747.5	30393.7	~~610783.8~~ 595290	0.0	~~610783.7~~ 595290