Nancy E.
Please Return

IMPROVING NORTH SLOPE GAS MARKETING THROUGH ADVANCEMENTS IN PIPELINE TECHNOLOGY

MARCH 1997

Foothills Pipe Lines Ltd.

PRESENTATION OVERVIEW

- Background
- Pipeline Technology Advancements
- North Slope Gas Economics

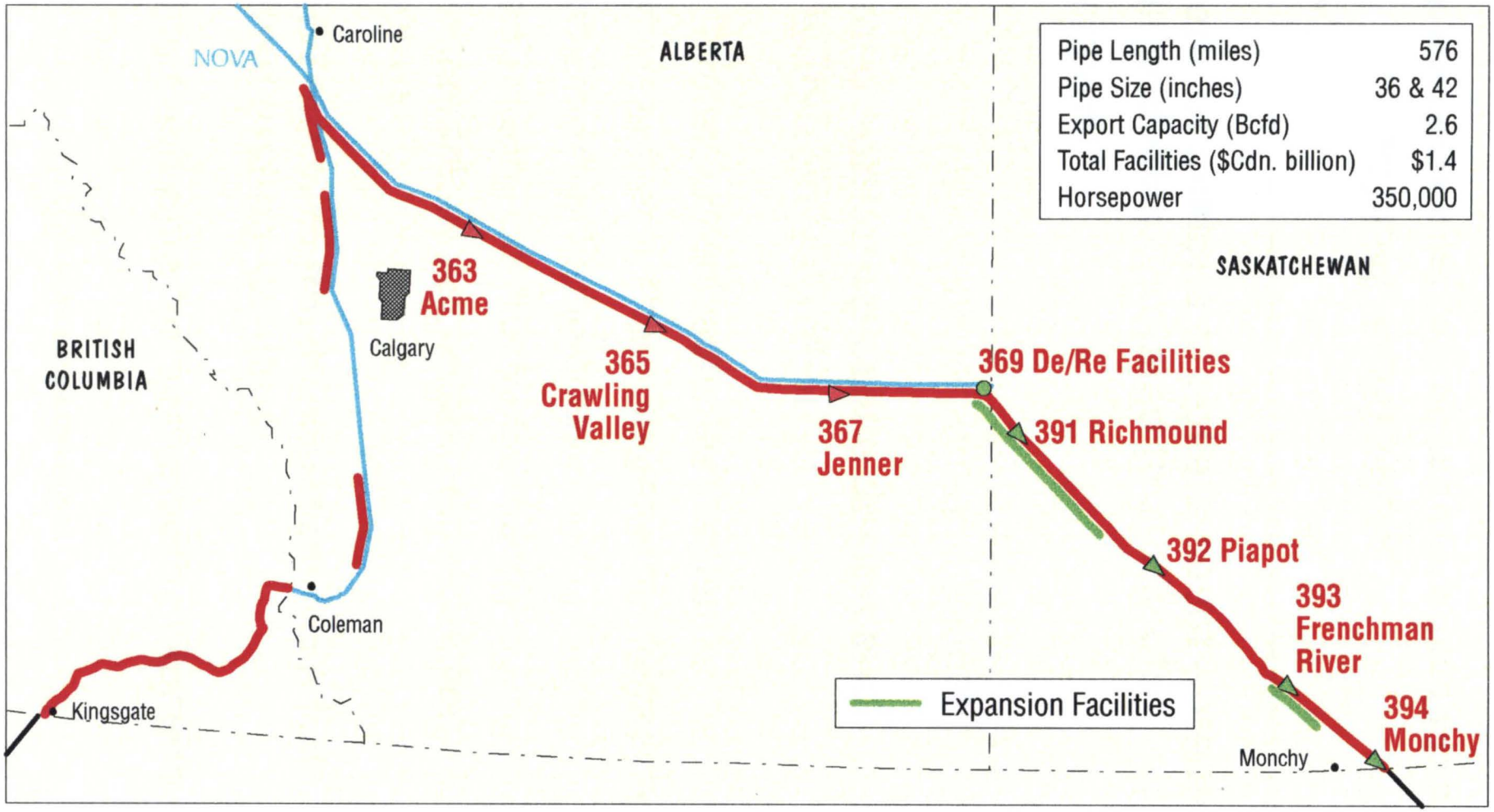
BACKGROUND

FOOTHILLS PIPE LINES LTD.

- **Privately held Canadian Company**
- **Owned equally by NOVA Corporation and Westcoast Energy Inc.**
  - Total combined investment $US 17 Billion
- **Created to pursue Northern Pipeline Project Development and has actively done so since its inception in the 1970's**
- **Canadian sponsor of the Alaska Natural Gas Transportation System (ANGTS)**
- **Ownership interest in and joint operator of the Alaskan Segment of the ANGTS (ANNGTC)**
- **Has done extensive work with respect to all aspects of Northern Pipeline Development**
- **Owns and operates the Prebuild Canadian section of ANGTS**
  - In 1996 transported 922 Bcf, 1/3 of the total Canadian gas exported to the U.S.
- **Total investment $US 1.0 Billion**

Foothills Pipe Lines Ltd.

FOOTHILLS EXISTING FACILITIES



ANGTS PROJECT PIPELINE RESEARCH COMPLETED

TOTAL PROJECT

- **Hundreds of millions of dollars spent both in Canada and Alaska related to study of:**
  - Permafrost
  - Soil Stabilization
  - Environmental Management and Mitigation
- **Confirmed northern pipeline design and construction techniques,**
  e.g.:
  - Soil Thermal Prediction Techniques
  - Frost Heave and Thaw Settlement Mitigation
  - Arctic Ditching Techniques
  - Pipe Fracture Control Methodology
  - Environmentally Acceptable Construction Windows
- **Obtained much of the information from full scale field testing facilities**
- **Provides base data for site specific pipeline design**

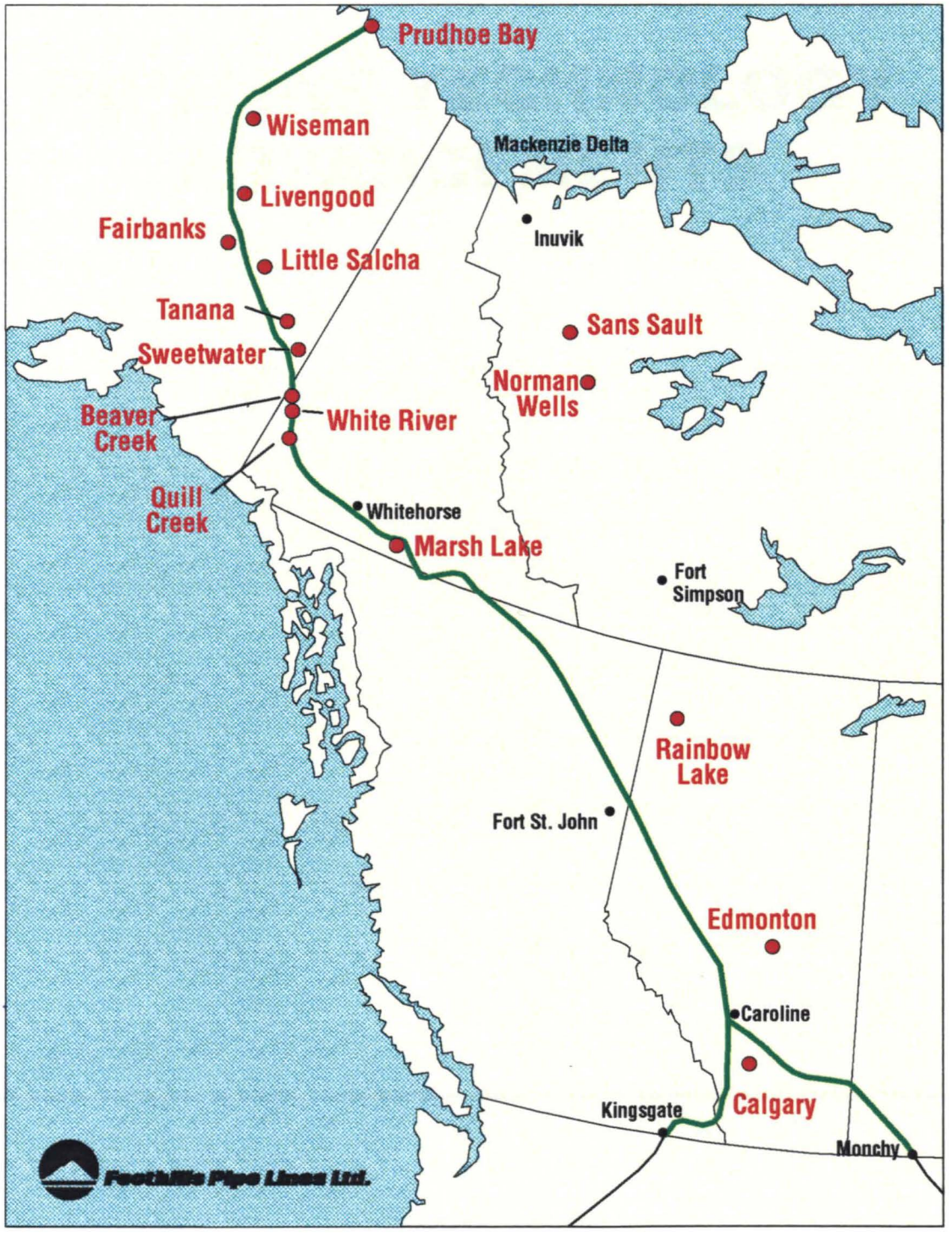
ANGTS PROJECT PIPELINE RESEARCH COMPLETED

SPECIFIC TO ALASKA

- **Approximately $450 million spent on research and gathering of field data**
  - Seven Field Research Test Sites
  - Extensive Geotechnical Data Obtained and Documented, eg.:
    - Borehole Drilling — 3650 holes
    - Hydrologic Surveys and Aufeis Studies — 130 stream crossings
    - Soil Temperature Measurements — 20,000 thermistors
    - Seismic and Fault Crossing Studies
    - Majority of data specific to the Prudhoe Bay to Delta Junction section of pipeline alignment
  - Comprehensive Environmental Studies
- **Resulted in approval of engineering and environmental design criteria by both OFI and FERC**
- **Knowledge applicable to other northern projects**

Foothills Pipe Lines Ltd.

ARCTIC PIPELINE
TEST SITE LOCATIONS



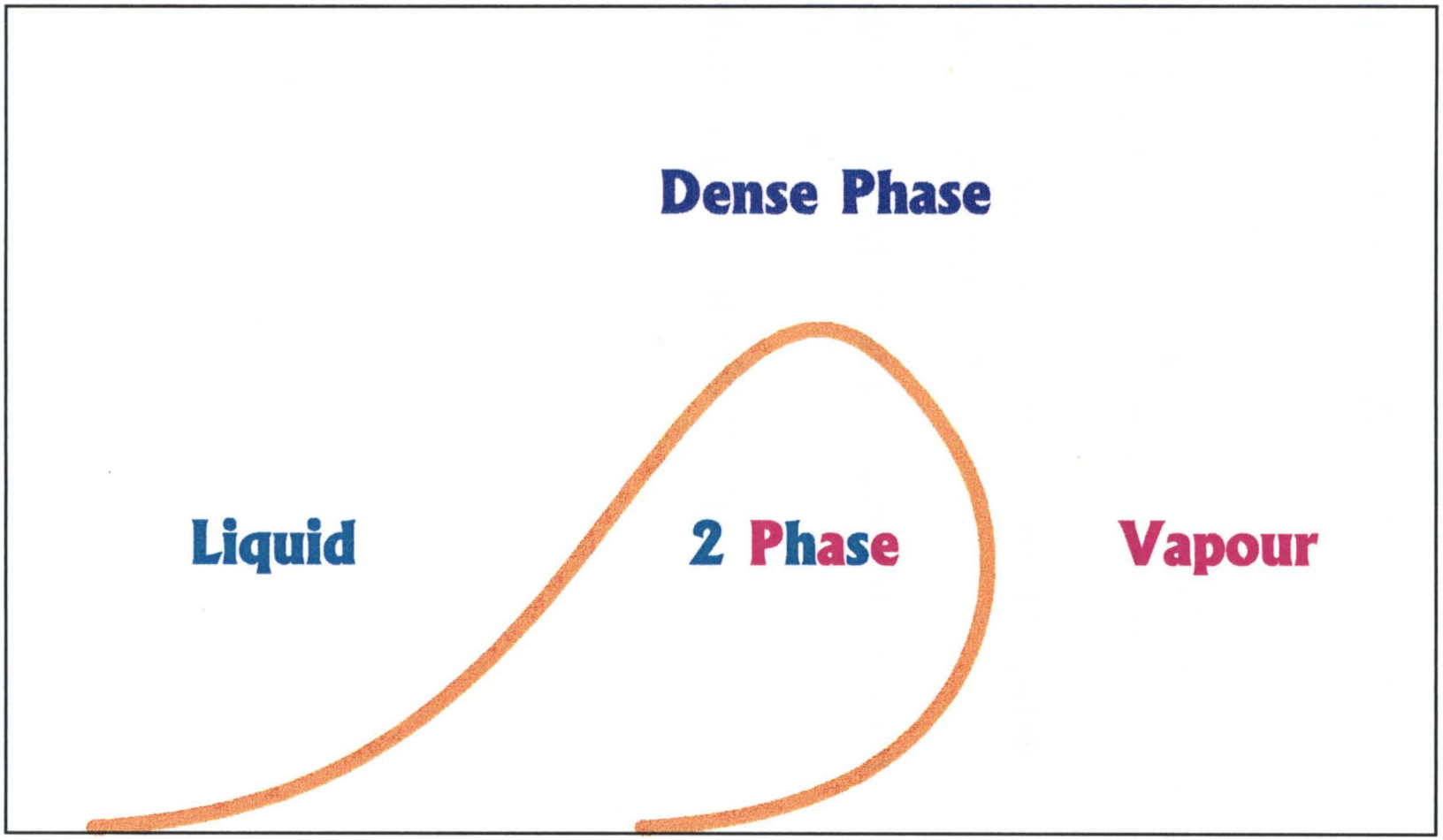
PIPELINE TECHNOLOGY ADVANCEMENTS

PIPELINE TECHNOLOGY ADVANCEMENTS OVERVIEW

- Dense Phase Flow
- Higher Operating Pressures
- Ultra High Strength Steel/Composite Materials
- High Speed Automatic Welding Systems
- Geometric Inspection Tools
- Advanced Ditcher Technology
- Enhanced Modular Construction Techniques
- Satellite/Fibre Optic Communication Systems
- High Efficiency Gas Turbines
- Real Time Transient Modelling

Foothills Pipe Lines Ltd.

THE PHASE ENVELOPE



Foothills Pipe Lines Ltd.

DENSE PHASE ADVANTAGES

- Transports up to 50% higher Btu stream, reducing unit transportation cost
- Smaller diameter, high strength pipe reduces pipeline cost
- Reduces frost heave/thaw settlement concerns
- Reduces gas conditioning

RECENTLY COMPLETED STUDIES

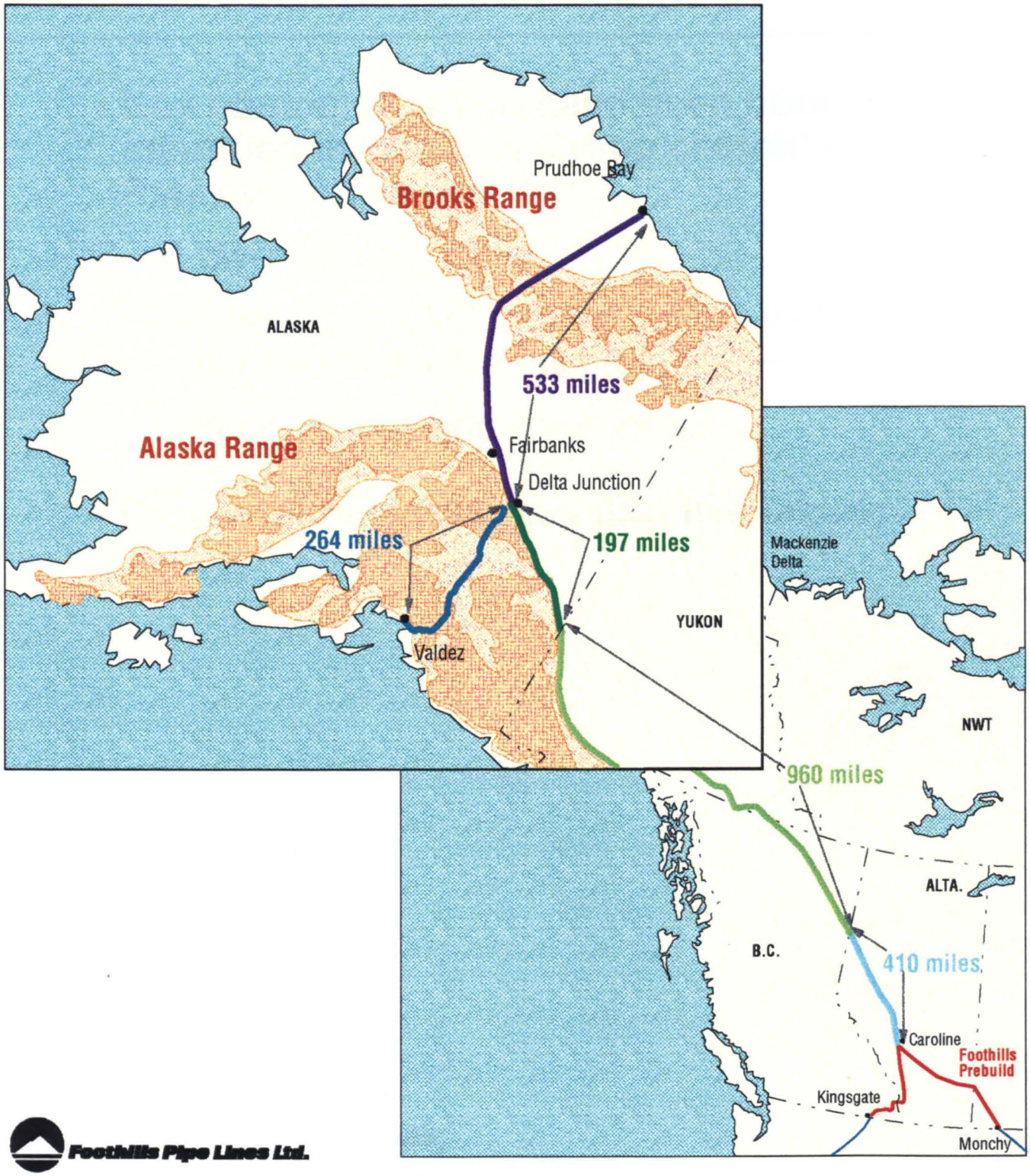
- Preliminary Design and Cost of Prudhoe Bay Gas Conditioning Facility
- Modelling Dense Phase Fluid properties and behaviour - Statoil independent analysis
- Preliminary Design and Cost of Dense Phase Compressor Station
- Study of Technical Capability and Availability of X100 Steels
- Frost Heave Study for X-100 Steel Pipeline
- Hydraulic Design of Pipeline Facilities
- Preliminary Fracture Control Design
- Plume Dispersion Study

STUDIES IN PROGRESS

- Cost Estimate of Pipeline Facilities
- Composite Materials Design
- High Strength Component Availability
- Evaluation of High Pressure Pipeline Compressors
- Pipe/Ground Heat Flow Simulations
- Environmental Assessment of Dense Phase Design
- Laboratory Evaluation of Dense Phase Fluid Properties
- University of Alaska collaboration

NORTH SLOPE GAS PROJECT

ROUTINGS - ALASKAN GAS PROJECTS

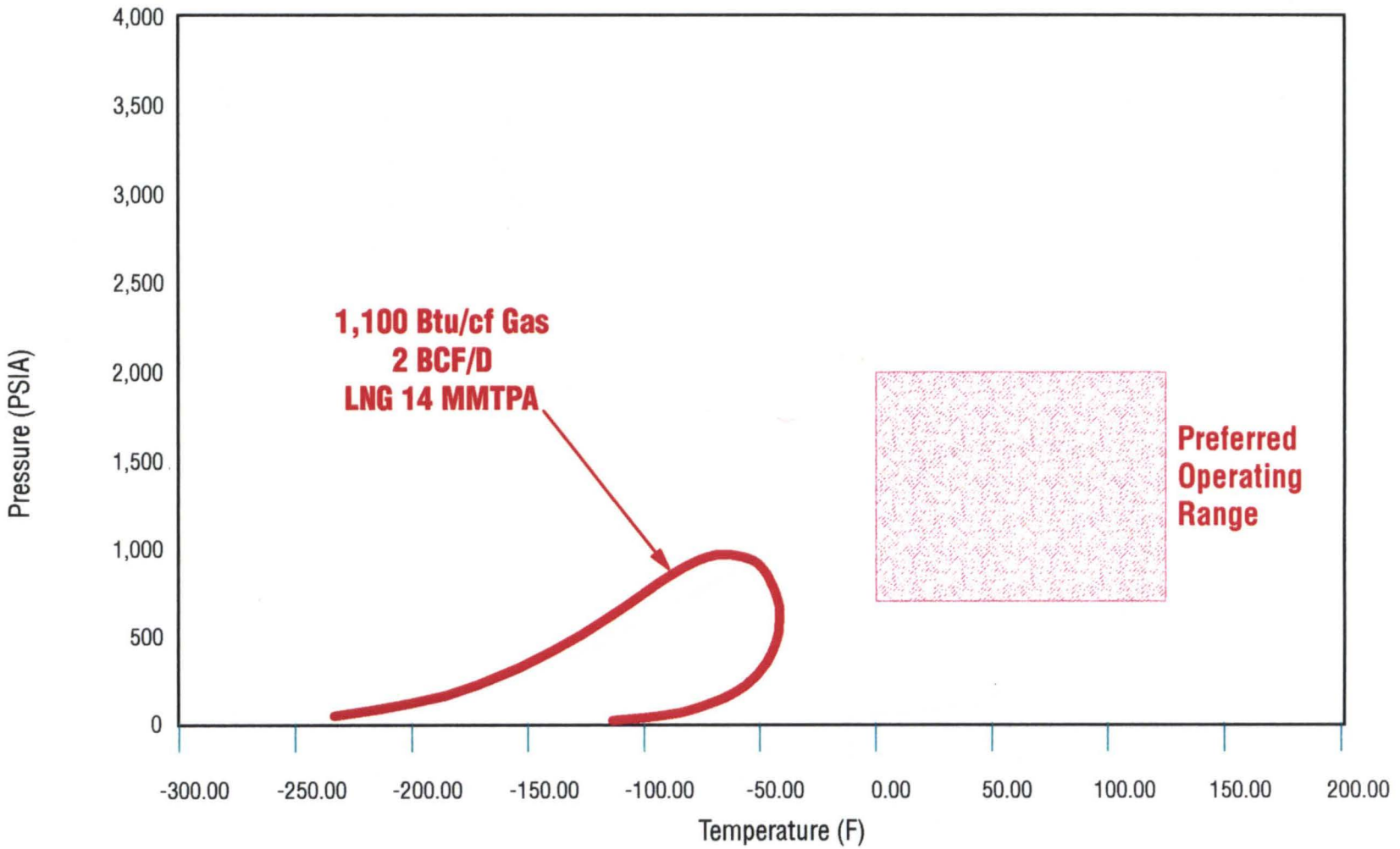


Foothills Pipe Lines Ltd.

PROJECT ISSUES

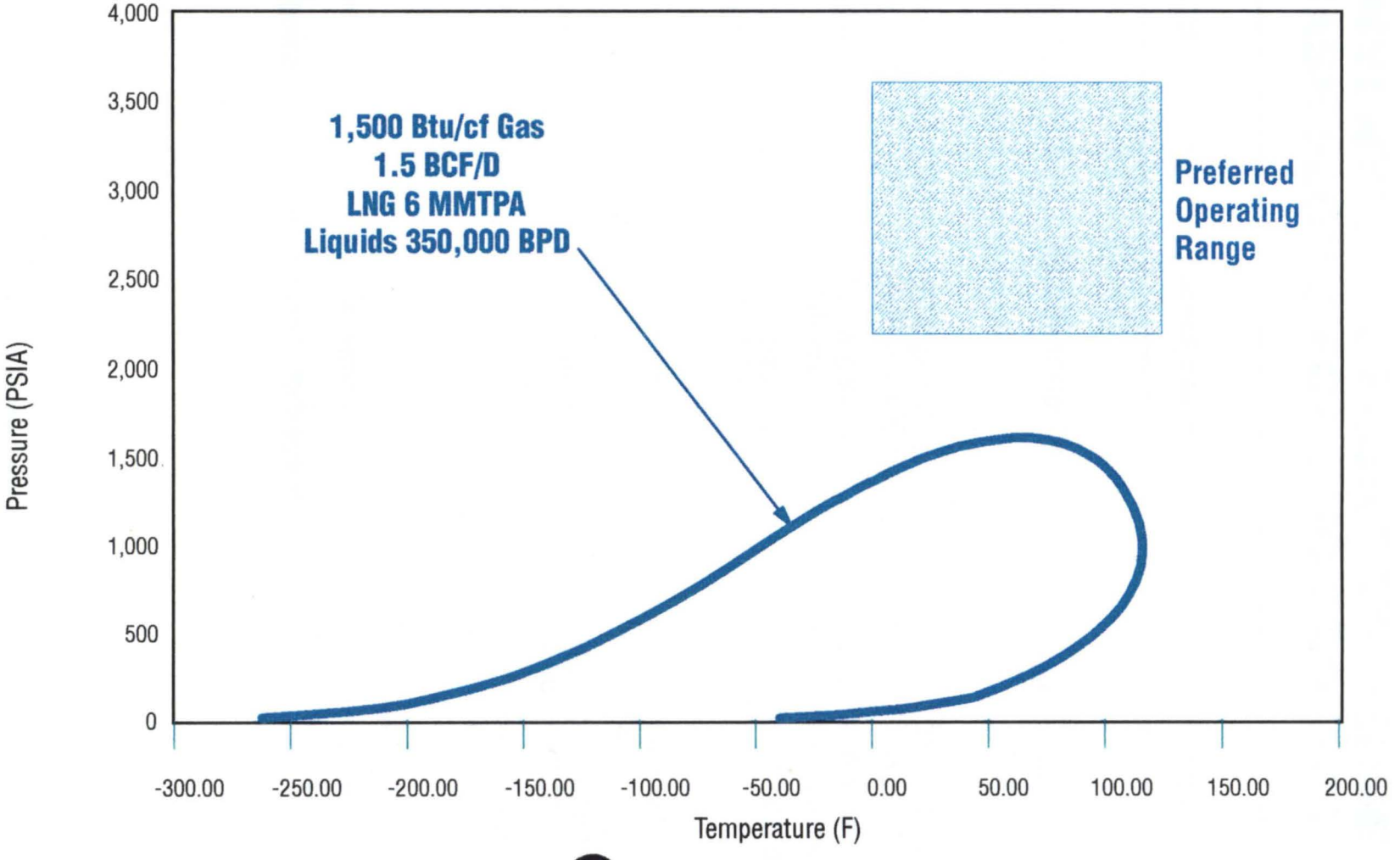
- **Key obstacles which have been publicly identified in Working Group chaired by Representative Barnes:**
  - Lower capital costs
  - Penetrating LNG market quickly with large volumes to realize full project revenues
  - Suitable financing environment
- **Presentation addresses first two issues**

COMPARISON OF THROUGHPUTS AND PRODUCTS
FOR EQUAL ENERGY (2.2 TRILLION BTU/D) LEAN AND ENRICHED GAS STREAMS

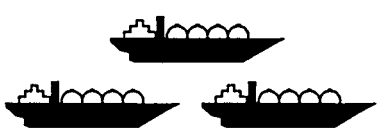
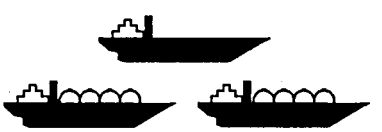


Foothills Pipe Lines Ltd.

COMPARISON OF THROUGHPUTS AND PRODUCTS
FOR EQUAL ENERGY (2.2 TRILLION BTU/D) LEAN AND ENRICHED GAS STREAMS



CONVENTIONAL FLOWS VS DENSE PHASE FLOWS FOR LNG PROJECT

Conventional	Dense Phase	Advantages
Gas Conditioning	Gas Conditioning	▸ Reduces volume of gas to be processed
42" Pipeline MOP = 2 200 psi 3 Compressor Stations Lean Gas (1 100 Btu/scf)	30" Pipeline MOP = 3 400 psi 4 Compressor Stations Rich Gas (eg. 1 500 Btu/scf)	▸ Greater flexibility in product mix ▸ Frost heave/thaw settlement reduced ▸ Reduction in cost of service
1 300 psi inlet Liquefaction Facilities	2 100 psi inlet Liquefaction Facilities	▸ Light condensates will liquefy easily ▸ Larger pressure drop will aid liquefaction ▸ Likely reduces cost per unit of energy
		▸ Less costly tanker fleet ▸ Larger market area (light condensates)

Foothills Pipe Lines Ltd.

PIPELINE COST REDUCTION

- **Smaller diameter pipe**
  - 30 inch diameter pipe at 3 400 psi
- **Automatic welding**
  - higher production rates
  - 120 welds/day
- **High strength steel**
  - X-100
- **Advanced ditcher technology**
- **Reduced frost heave concerns**
- **Year round construction**
- **Shortened construction period (2 years)**

NORTH SLOPE CONDITIONING PLANT COST REDUCTION

- **Maximize use of existing infrastructure**
  - Central compression facility
  - Central processing facility
- **Lower initial gas volumes minimize CO_2 and H_2O removal and gas refrigeration**
  - (1.5 Bcfd versus 2 Bcfd)

LIQUEFACTION PLANT COST REDUCTION

- **Initially 6 MM tons/year versus 14 MM tons/year LNG**
- **Higher inlet pressure reduces capital and operating costs**
- **Light condensates liquefy more easily than methane**
  - New revenue stream

TANKER COST REDUCTION

- 6 MM tons/year versus 14 MM tons/year LNG
- Large light condensate component
- Lower cost condensate tanker construction (-60°F design versus -260°F LNG design)

PRELIMINARY CAPITAL COST COMPARISON OF NORTH SLOPE GAS PROJECTS PRUDHOE BAY - VALDEZ

Component	Capital Cost (1996 $US Billions)	
	Conventional[1] 1 100 Btu/cf, 14 MMT/yr. LNG	Dense Phase 1,500 Btu/cf, 6 MMT/yr. LNG 350,000 Bpd Liquids
Prudhoe Bay Conditioning Plant	**1.5**	**1**
Pipeline	**6**	**4**
Valdez Liquefaction Plant	**3.75**	**2 - 3**
Tankers	**3.75**	**2 - 3**
TOTAL	**15.0**	**9 - 11**

[1] State of Alaska Revenue Department

Foothills Pipe Lines Ltd.

SUMMARY

- Foothills has extensive northern pipeline expertise
- Technology advancements reduce project cost
- Modest initial LNG volumes sized to penetrate market
- Significant expansion capability
- Highly marketable light condensates
- Revenue equivalent of 14 million tons of LNG per year with smaller start-up project