POSITION PAPER: USE OF SNOW/ICE ROADS, SNOW/ICE WORK PADS, AND WINTER CONSTRUCTION PROGRAMS

prepared by
Northwest Alaskan Pipeline Company

June 20, 1980

Magnificently padded report!

Exhibits

Note: Exhibits are placed at the end of each chapter in order of their exhibit number

Introduction

In accordance with the President's Decision[1] of September 1977 and subsequent Congressional action, Northwest Alaskan Pipeline Company (Northwest Alaskan) has assumed responsibility for financing, designing, constructing, and operating a transportation system to deliver natural gas from Prudhoe bay to lower-48 markets in a cost-effective and judicious manner. To help ensure that this objective is achieved, the President's Decision mandates the use of fixed-price contracts in the execution of the project, with any exceptions requiring special approval from the Office of the Federal Inspector (OFI). In addition, the Federal Energy Regulatory Commission (FERC) has established an Incentive Rate of Return (IROR) mechanism to ensure that the natural gas is provided to consumers in the most cost-effective manner possible.

---

1. Executive Office of the President, Energy Policy and Planning, Decision and Report to Congress on the Alaskan Natural Gas Transportation System (September 1977), hereinafter cited as the President's Decision.

The Department of Interior (DOI) has indicated that it may mandate that Northwest Alaskan made extensive use of winter construction techniques, particularly in the pipeline segment north of Atigun Pass in the Brooks Range (Section I)[2]. DOI's announced intentions differ in a fundamental respect with a basic premise upon which the entire Northwest Alaskan project was conceived, justified, and defended before the Federal Power Commission (FPC), selected by the President, and approved by Congress.

Since the Alaskan Natural Gas Transportation System (ANGTS) was originally proposed in 1976, Northwest Alaskan has planned to use only proven construction techniques. The fundamental construction philosophy for the project is of general summer and shoulder-month construction of a buried gas pipeline, using conventional construction techniques, from a full-width, all-purpose, all-weather gravel work pad in all locations where such a pad is required to provide year-round, all-weather access to the pipeline by tracked vehicles for construction, operation, maintenance, or repair.

History of this?

---

2. Letter of June 13, 1979, from Honorable Guy R. Martin, Assistant Secretary for Land and Water Resources, Department of Interior to Edwin A. Kuhn, Director, Government and Environmental Affairs, Northwest Alaskan Pipeline Company.

Specifically, in its original submission to FPC, Northwest Alaskan stated that "a gravel work pad concept, proven in the construction of the Alyeska system, is included in Alcan's plan to allow pipeline construction from March through November. Such a construction season facilitates operating within the 'time windows' established to protect sensitive species and locations; it also includes periods when streams and rivers are frozen. Productivity is enhanced by avoiding construction during the winter period of low efficiency caused by the harsh climate and darkness."[3]

Fbx, Jan 16, 1981, +50°!

It has always been Northwest Alaskan's position that the use of snow/ice roads, snow/ice work pads, and winter construction programs are unproven construction practices for a large-diameter pipeline of the magnitude of the proposed project. Consequently, these techniques were not planned for any segment of the pipeline as a primary method of construction.

---

3. Alcan Pipeline Project, 48-Inch Alternative Proposal, Submittal of Alcan Pipeline Company at Docket No. RM77-6 before the Federal Pipeline Commission, March 1977, page 5.

It was never closed.

Northwest Alaskan questions the government's rationale for reopening this fundamental issue, which was explored exhaustively in the events preceding the President's Decision and resolved with the participation of all relevant federal agenies, including DOI. Nonetheless, in response to DOI's letter, and to facilitate timely preconstruction planning and subsequent execution, we have reexamined our position on this important issue. Based on this reexamination, Northwest Alaskan's position is unchanged: we cannot accept a mandate to make use of snow/ice roads and construction work pads.

baloney.

alternative?

The adoption of the winter construction concepts proposed by DOI would constitute an imprudent and unsound management decision. The required use of winter construction techniques, particularly snow/ice work pads for pipeline construction will increase the risk of delay or noncompletion to the point where the project cannot be financed or constructed because of the inability to forecast the final cost. Timely completion and

Not unusual for NWA.

Same old paper tiger — delay, risk etc Hah!

project cost control are the major areas of concern to potential debt lenders. Therefore, a decision by DOI to mandate the use of snow/ice roads, snow/ice work pads, and winter construction programs will shift the responsibility for project schedule and cost control from Northwest Alaskan to the government.

Not if NWA accepts the DOI grants

The Northwest Alaskan position is based on review and analysis of three areas:

- Construction costs
- Environmental impacts
- Construction contracting, efficiency, and safety.

Based on our analysis in each of these areas, Northwest Alaskan concludes that the use of snow/ice work pads, snow/ice roads, and winter construction programs is not cost-effective, will not minimize environmental impacts, and is impractical from a construction contracting, efficiency, and safety points of view.

Never proven!

The analysis supporting this conclusion is presented in the following three chapters.

1 CONSTRUCTION COSTS

The use of snow/ice work pads for pipeline construction will cost more than three times as much as the use of conventional gravel work pads. Specifically, using a snow/ice work pad, each mile of the pipeline will cost $5,818,015, compared to $1,639,263 when using a gravel pad. For example, if snow/ice pads are used for all 132 miles of Section I of the pipeline, project costs will increase by at least $551,595,264, or $4,178,752 per mile (see Exhibit 1.a and 1.c). The incremental cost to the consumer during the first year of pipeline operations will be at least $108,112,620 for the 132 miles of snow/ice work pads (see Exhibit 1.b).

Proof!??

The increase in project costs results from the following four factors:

- Incremental costs of snow/ice work pad construction
- Incremental costs of snow/ice work pad maintenance
- Incremental costs of pipeline construction from snow/ice work pads
- Impacts on overall system cost of construction schedule slippage.

The "construction schedule" is only a paper tiger @ this time. 1-81,

Incremental Costs of Snow/Ice Work Pad Construction

Construction of snow/ice work pads will cost approximately $840,451 more per mile than construction of conventional gravel pads (see Exhibit 1.c). Although construction of a gravel pad requires more volume of material than a snow/ice work pad, the cost of each volume unit for a snow/ice pad is approximately 5.3 times greater than for a gravel pad.

Based on an analysis of two projects that used snow/ice work pads on roads (NPR-4 and TAPS), we estimate that the cost of constructing a snow/ice work pad capable of withstanding heavy tracked-vehicle traffic averages $2.77 per cubic foot, or $1,128,914 per mile. (We converted the costs of these two snow/ice pads to dollars per cubic foot to eliminate the effects of different pad dimensions.) In 1979, contractors building ice roads in NPR-4 incurred an costs of $0.95 per cubic foot (direct labor and equipment cost). Assuming that total cost for work pad construction in Section I is 2.36 times direct costs,* the equivalent cost would have been $2.24. Adjusted for inflation at 8 percent per year, the 1980 cost would be $2.42 per cubic foot. In November 1975, Alyeska built a snow/ice work pad near Globe

Whose Costs? TAPS? Ha!

* The 2.36 multiplier consists of: indirect costs (construction support activities, e.g., camp operations, catering, supervision, etc.) equaled 100 percent of direct costs. In addition contractor's profit and overhead of 18 percent applied to both direct and indirect costs.

Creek on the TAPS right-of-way. Job accounting reports indicate that the snow pad (which was 2,500 feet long, 65 feet wide, and an average of 3 feet deep) would cost a total of $437,353 (direct labor and equipment costs). Again, assuming that total cost is 2.36 times direct costs, the result is a 1975 cost of $2.12 per cubic foot, and a 1980 cost of $3.12 per cubic foot (at an annual inflation rate of 8 percent).

Balance

Interesting comparison!

The average of these costs is $2.77 per cubic foot for snow pad construction in 1980.* We used this value to develop a cost per mile for using snow/ice work pads. Because such pads are most likely to be considered in Section I, we used this section for our analyses.

The average dimensions of snow/ice work pad in Section I would be 61.75 feet wide and 1.25 feet thick. The average width was determined assuming a combination of two construction techniques. Specifically, when ditch excavation is not used for backfill, and instead hauled away to a spoil disposal area (i.e., 85 percent of the length of

---

* The Arctic Gas Project estimated the costs of using snow pads and roads for construction activities. However, because those estimates include the cost of 955 miles of snow pads and 536 miles of snow roads of unspecified dimensions, we did not believe that they were comparable with this project.

Why not?

Why not? Alyeska's steep hillside 2,500' of snow pad was comparable.

Section I), the work pad surface is assumed to be 55 feet wide. For approximately 15 percent of Section I, the soil can be used for backfill and can be piled adjacent to the ditch on a wider work pad until the backfill activity takes place. This technique results in a snow/ice pad 100 feet wide. The weighted average width for Section I is thus 61.75 feet.

Assuming average work pad dimensions of 61.75 feet by 1.25 feet at $2.77 per cubic foot, a snow/ice work pad will cost approximately $1,128,914 per mile in 1980.

Current estimates of the cost of constructing a gravel work pad of average dimension (37.125 feet by 2.83 feet)* in Section I are $0.52 per cubic foot. These figures were derived from a detailed analysis of the direct labor costs and equipment expenses, indirect costs, and contractors' overhead and profit. The cost of a gravel work pad is therefore estimated to be $288,463 per mile. This is approximately one-fourth the cost of constructing a snow/ice work pad.

---

* 37.125 feet average width is the weighted-average of 36.5 miles of Section I 25 feet wide, 78.7 miles 40 feet wide and 16.8 miles 50 feet wide. 2.83 feet is the thickness required to support construction operations during anticipated shoulder-month construction periods.

Is a 2.83' (34") gravel pad scheduled for anywhere?

Incremental Costs of Snow/Ice
Work Pad Maintenance

The use of heavy tracked vehicles in pipeline construction will require substantial snow/ice pad maintenance. It is estimated that the top 2 inches of the snow pad will be bladed and rebuilt four times during pipeline construction.*

Using the previously developed costs, we estimate the costs of snow pad maintenance to be $605,098 per mile (61.75 feet x 0.67 feet x 5,280 feet x $2.77). These costs are 23.7 times greater than current estimates for combined gravel pad and road maintenance for Section I ($2,556,000 for 132 miles of pipeline).

Cut

Incremental Costs of Pipeline
Construction from Snow/Ice Work Pads

Pipeline construction progress can be severely limited by winter temperatures. In fact, Northwest Alaskan estimates that no more than 24 miles of continuous pipe could be laid per section during any winter construction season (see

* Repairs will be made after passage of major track equipment following pipebending, welding, bedding, and lowering-in activities.

Appendix A). It is estimated that construction costs will be 3.07 times higher ($4,084,003 per mile) if construction takes place in the winter instead of the summer and shoulder months, as currently planned (see Exhibit 1.c)*. This construction estimate incorporates the following assumptions: another inflation factor..

- A progress rate of 3,200 feet per day (384,000 feet for four months) will be achieved in the summer and shoulder months**

---

* These figures do not include the impact of wind chill on construction productivity. If wind chill is included, the costs per mile could increase to over $8,069,00 per mile constructed from a snow/ice work pad.

** Assuming an average pipe lay rate of 3,200 feet per day per section.

- The average cost per mile for pipeline construction will be $1,331,436 during the summer and shoulder months*
- Additional construction spreads including support must be used to maintain a lay rate of 3,200 feet per spread per day during winter construction from snow/ice work pads.

Using these assumptions and considering ambient air temperature data without wind chill effects, we calculated that pipeline construction costs from a snow/ice pad will be $4,084,003 per mile. This is $2,757,567 per mile more than the estimated cost of construction from a conventional gravel work pad during the shoulder and summer months (see Exhibit 1.c).

Impacts on Overall System Cost of Construction Schedule Slippage

Even if additional spreads were added during the winter to maintain scheduled construction completion, the effects of abnormal temperature and wind chill could delay the project

---

* Including both direct costs (survey, ditching, haul and stringing, bend, line up and weld, weld repair, field joints, lower-in, tie-in crews, ditch insulation, bedding, padding, backfill, clean-up, testing, road crossing, and test support) and indirect costs (field supervision, camp maintenance, equipment service, general haul maintenance of vehicles for others, indirect consumables, catering, and 18 percent for contractors' overhead and profit).

for an entire construction season. If the schedule slipped an entire season, the following types of costs would be incurred:

- Execution contractor mobilization for the next season
- Camp utilization costs for an additional season
- Additional season of project management costs
- Costs of delaying overall system completion.

The last cost, delay of overall system completion, is critical. Under the Incentive Rate of Return (IROR) procedure established in the President's Decision, costs incurred by the project will earn a 12 percent return for each year they are invested prior to project completion.

This return (total project costs x 0.12) is added to the rate base. Assuming that the project were completed at estimated costs,* the consumer would be charged the following amount as a result of the schedule slippage (in addition to the incremental costs incurred as a result of construction from snow/ice work pads):

$$\text{INCREASED TARIFF DUE TO DELAY} = \begin{bmatrix}\text{Total}\\ \text{Project}\\ \text{Costs}\end{bmatrix} \times (0.12) \times (0.175).$$

---

* An overrun due to schedule slippage as a result of snow/ice work pad construction will be allowed as a design change by the Office of the Federal Inspector (OFI). Therefore, the overrun would be added to the original Certification Cost Estimate filed with the Federal Energy Regulatory Commission (FERC).

Exhibit 1.d demonstrates the impact on the consumer of project delays due to snow/ice work pad construction for different levels of project cost.

Using the same approach, the incremental cost to the consumer resulting from the increased construction costs can be calculated as follows:

$$\text{INCREASED TARIFF DUE TO SNOW /ICE PAD CONSTRUCTION} = \left[\begin{array}{l}\text{Incremental Cost}\\ \text{Snow/Ice Work Pad}\end{array}\right] \times (1.12) \times (0.175)$$

In the first year of pipeline operations, these costs will total $819,035 for each mile of snow/ice pads. Exhibit 1.b demonstrates the increased cost to the consumer for each mile of snow/ice pad constuction. These costs should be considered low because they include direct construction costs only and do not include all costs resulting from schedule delays (e.g., no allocation for project management or taxes and insurance).

Exhibit 1.a

INCREMENTAL COST OF
SNOW/ICE WORK PAD

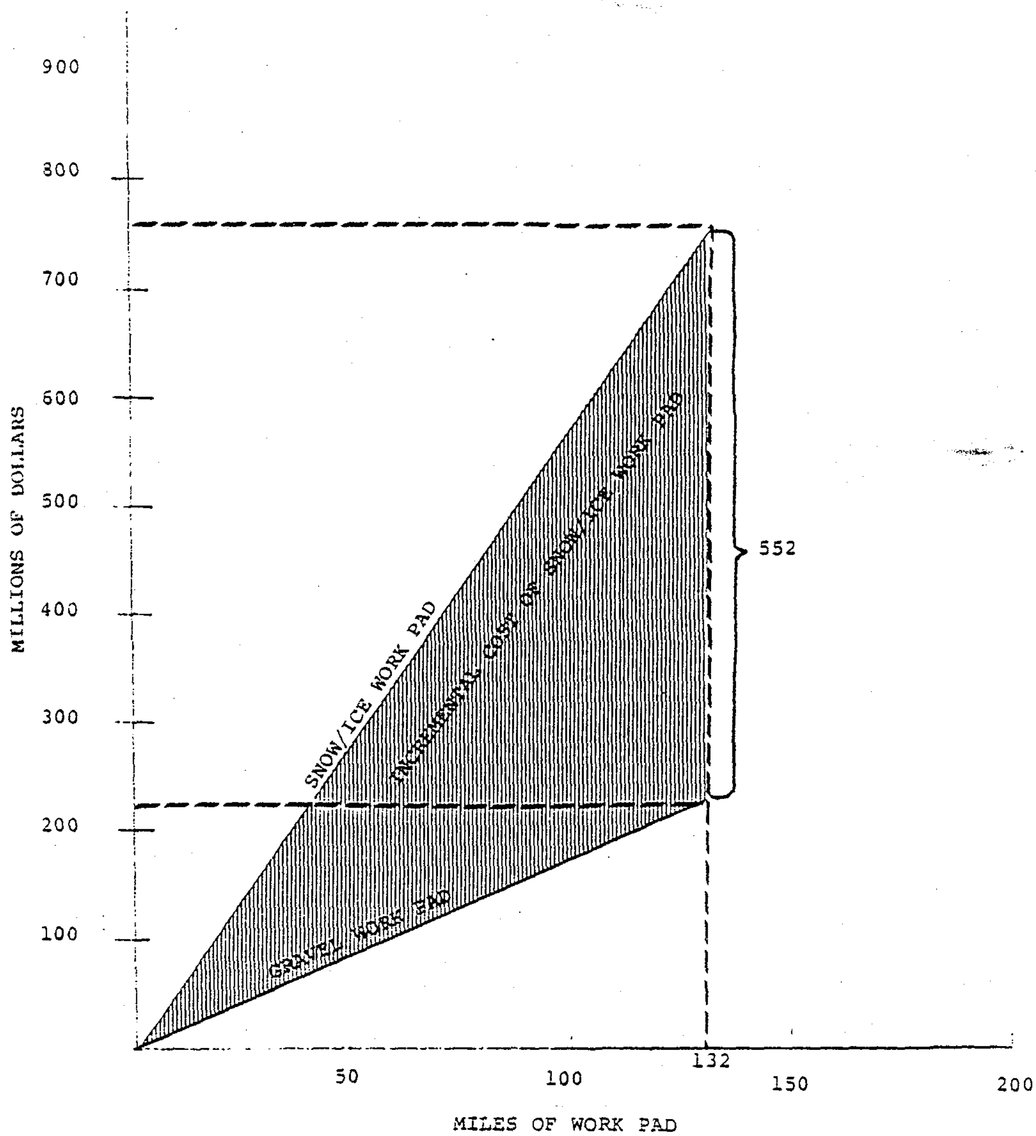
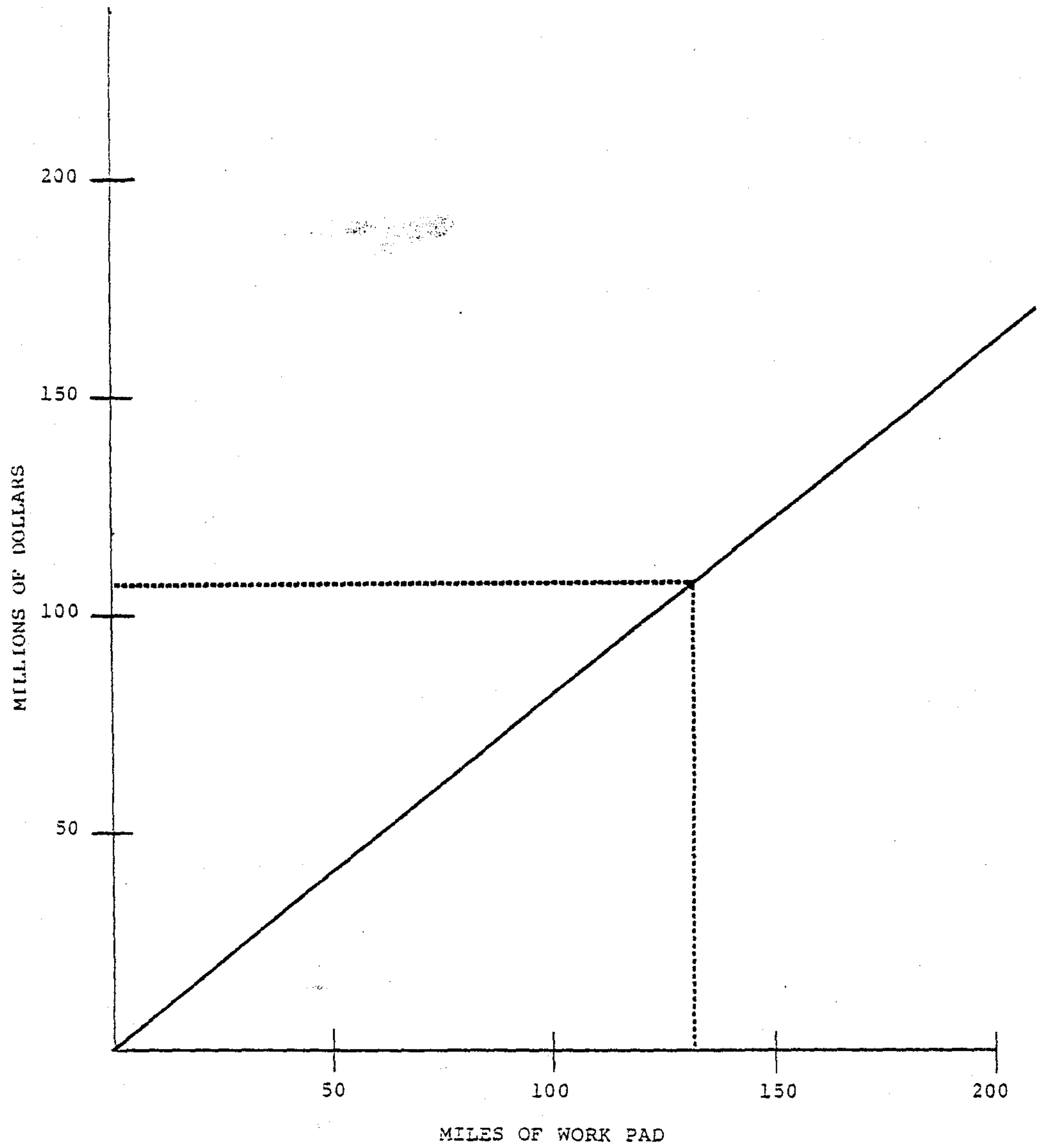


Exhibit 1.b

INCREMENTAL COST TO CONSUMER
OF SNOW/ICE WORK PAD CONSTRUCTION



* First year of pipeline operations

Exhibit 1.c

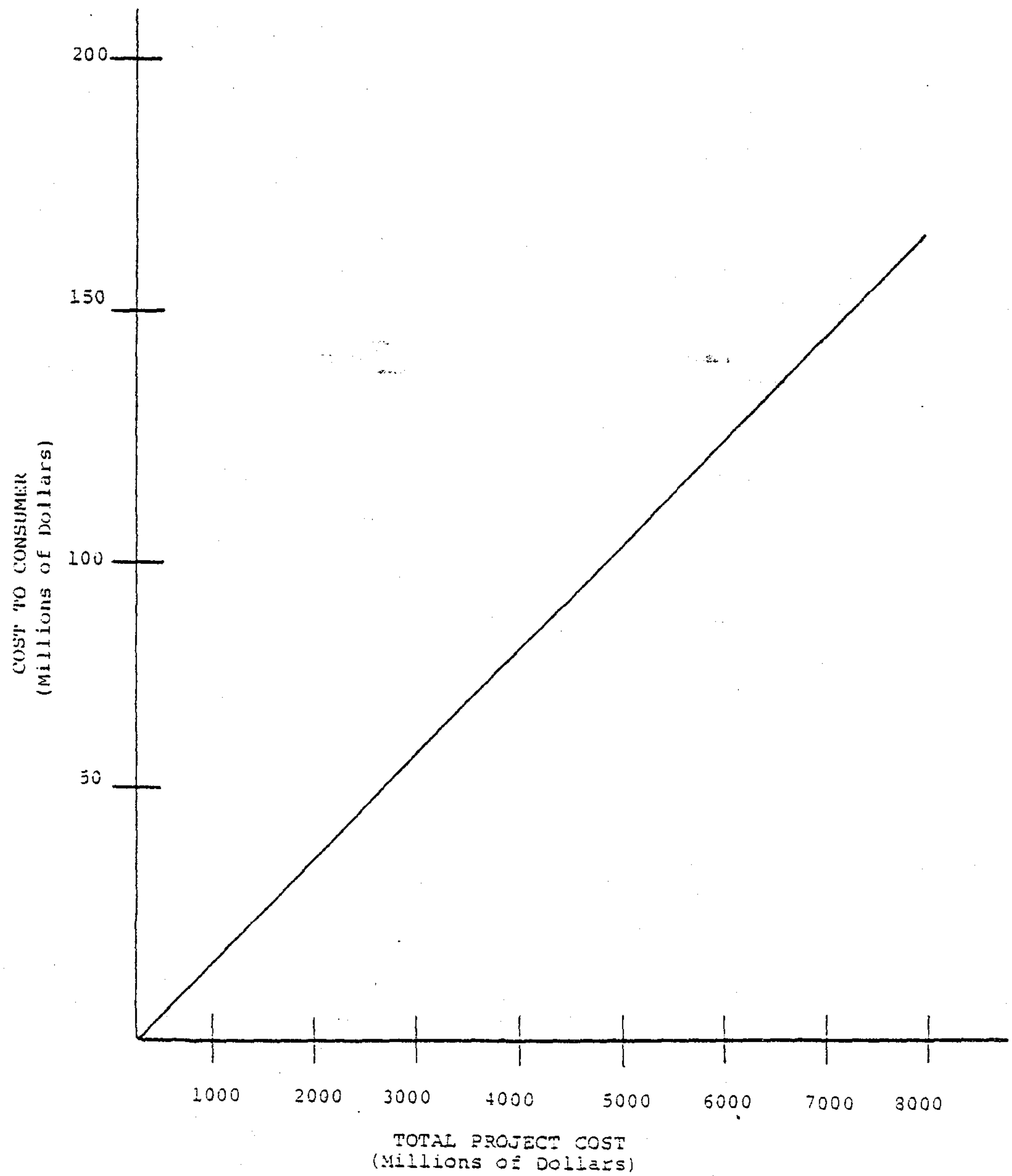
INCREMENTAL COST OF SNOW/ICE WORK PAD CONSTRUCTION

	Construction Cost Per Mile	Maintenance Cost Per Mile	Pipeline Construction Cost Per Mile	Total Cost Per Mile
Snow/Ice Work Pad	1,128,914	605,098	4,084,003	5,818,015
Gravel Work Pad	288,463	19,364	1,331,436	1,639,263
Incremental Cost of Snow/Ice Work Pad	840,451	585,734	2,752,567	4,178,752

6/1/80

Exhibit 1.d

INCREMENTAL COST TO CONSUMER DUE TO SLIPPAGE FROM SNOW PAD CONSTRUCTION*



* First year of operations only.

2 ENVIRONMENTAL IMPACTS

The concept of construction from snow/ice work pads and roads has been advocated from an environmental viewpoint. However, our analysis indicates that winter construction of a large-diameter buried pipeline from a snow/ice work pad will not mitigate critical environmental concerns. In addition, the provisions of the grant of right-of-way stipulations cannot be met when constructing a pipeline from a snow/ice work pad.[1]. Environmental advantages are offset by corresponding environmental disadvantages.

The use of snow/ice work pads or roads does not minimize overall environmental impacts. This conclusion is based on a review of three important environmental aspects of employing such a construction concept:

- Tundra and terrain degradation
- Natural snow and water requirements.
- Impacts of wildlife and fish

---

1. Draft Department of Interior Right-of-Way Stipulations.

Tundra and Terrain Degradation

Although it is theoretically possible to keep tundra and terrain degradation within acceptable limits while constructing a large-diameter, buried pipeline from a snow/ice work pad, practical considerations prevent such accomplishment under full-scale field operations (see Appendix B). Restoration of the pipeline right-of-way where the pipeline trench has been excavated and backfilled in a frozen condition has not been tested under field conditons, much less executed successfully after the installation of a pipeline. Furthermore, servicing of a large-diameter buried pipeline and maintenance of the right-of-way without a gravel pad is not practical and would lead to additional tundra and terrain disturbances (see Appendix B).

In theory, winter construction from a snow/ice work pad appears to offer two important advantages over construction from a gravel work pad:

- After melt-off, the ground underneath a snow/ice pad would require little or no restoration because little or no disturbance has taken place.*

---

* This advantage is only true where little nonretreivable contamination of the snow/ice pad occurs.

- The absence of a remnant gravel work pad avoids the interception of natural sheet flow which is important to flat terrain ecology, and avoids the need for longitudinal-drainage structures to concentrate the sheet flow into cross-drainage structures.

However, each of these apparent advantages has a corresponding disadvantage.

Regarding the lack of impact on the tundra under a snow/ice pad, the preliminary surf cial results of the TAPS experiments are impressive. However, with a large-diameter, buried pipeline, the need for stabilization and restoration of the pipe ditch is more important a concern than the need for restoration of the pad area. In the event that immediate post-construction restoration and grading efforts (e.g. backfill with frozen material) were not successful, summer vehicular access would be mandatory. Without a permanent traffic surface adjacent to the buried pipeline, restoration activities would be limited to workers on foot (supported by helicopter) using hand tools to establish proper grading and to control thaw settlement or possibly major longitudinal hydraulic/thermal erosion problems. Any subsequent major restoration of the ditch area would require the construction of a new snow/ice work pad for access during the winter months.

With respect to avoiding interception of natural sheet flow, it is doubtful that winter restoration practices will successfully eliminate ponding along the ditch and work pad areas. Without summer access to the ditch area to ensure proper final grading of the ditch it is likely that the sheet flow will pond. Any longitudinal-drainage control required after construction would negate the advantage of using snow/ice work pad.

Overall, winter construction of a large-scale, buried pipeline is impractical when restoration and erosion control schemes are considered. Current plans require access to all sections of the pipeline in each of at least the four summers seasons following the pipeline construction season for certain maintenance activities, including terrain rehabilitation and restoration. In addition (see Appendix C), some activities performed in the summer will require direct access to the pipeline ditch from a gravel pad (e.g., hydrotest, erosion control and revegetation).

What are the "current plans" for 4 years of maintenance & terrain rehabilitation & restoration? I'll bet there aren't any at all.

The successful use of snow pads would reduce the quantity of granular materials required and incrementally reduce the adverse impacts of mining on aquatic and terrestrial habitats as well as associated fish and wildlife. Substituting water removal for granular material under winter conditions has potential adverse environmental consequences as described in the following section.

Natural Snow and Water Requirements

Major pipeline construction during the winter from snow/ice work pads capable of withstanding the weight and abuse of heavy equipment will require vast quantities of natural snow and water. Although the exact volumes of snow, water, and crushed-ice aggregate needed will depend on the densities required and site-specific pad specifications for load-bearing capabilities, it has been clearly established from historical weather records that sufficient supplies of natural snow will not be available anywhere along the pipeline route (see Appendix C) to meet even minimal demands. In some areas, particularly the North Slope, water for snowmaking or direct water layering will be in extremely short supply, if available at all. Moreover, in some areas, water use will adversely affect fish overwintering.

Based on discussions with Arctic construction experts, it appears unlikely that sufficient snow, will be available to begin construction of a snow/ice work pad in November (see Appendixes B and C). In fact, in some years, accumulations may not be adequate to start pad construction until January. Exhibit 2.a represents the amount of snow that can be expected to be on the ground from October through May in the North Slope basin.

To compensate for the lack of sufficient supplies of natural snow in the early winter season months, it will be necessary to manufacture snow. This need, combined with the usual water requirements of forming a layered snow/ice pad, will place tremendous demands on winter water supplies. These supplies will decrease rapidly in the early winter as the ice on lakes thicken and streams stop flowing. In addition, water supplies will be restricted where water removal from lakes and rivers will jeopardize fish overwintering. As a result water probably will have to be hauled long distances via large fleets of insulated trucks.

Assuming an average snow/ice work pad volume for Section I of 407,550 cubic feet (61.75 feet wide by 1.25 feet thick by 5,280 feet long), the water requirements are greater than 3 million gallons per mile. Water requirements of this magnitude will be difficult to meet, particularly on the North Slope. For example, the current total winter reservoir volume for the Prudhoe Bay Development Area on the North Slope is 274 million gallons. The current winter demand is 208 million gallons.[2]

---

2. "Prudhoe Bay Water Problems," <u>Alaska Construction and Oil</u>, Parts I and II, April and May 1980.

Water is in critically short supply on the North Slope, especially in the winter. Several plans are being developed to bolster supplies; for example, the Prudhoe Bay Development Area is planning to add about 3 billion gallons of winter storage capacity over the next several years.[3] However, it is unclear whether the plans to ensure supply can be carried out, given limits on total water availability and the increasing difficulty of obtaining permits for water use on the North Slope.

about as unclear as NWA's financing!

Impacts on Wildlife and Fish

The use of snow/ice work pads, snow/ice roads, and winter programs for pipeline construction is theoretically less disturbing to animals and birds than construction during the shoulder months from conventional gravel work pads. The direct impacts of pipeline construction during the fragile winter months on fish and local ecosystems will, however, be more severe (see Appendix B) and such a construction approach will be incompatible with the grant of right-of-way stipulations.

NWA set summer construction too!

Big lie!!

No backfill!

---

3. "Prudhoe Bay Water Problems," Alaska Construction and Oil, Parts I and II, April and May 1980.

The absence of remnant gravel work pads or roads may possibly limit the disruption of mammal and avian movement and migration. However, the dynamics of animal and bird avoidance of or attraction to foreign structures of this nature cannot be impirically proven. In fact, there is no apparent mammal avoidance of the gravel work pad adjacent to the buried oil line or the haul road per se. With either a snow/ice or gravel work pad the pipe ditch area will continue to act as a possible modifier of lateral or longitudinal animal and bird movements regardless of construction method.

Winter construction using a snow/ice work pad could have serious negative impacts on fish and other fresh-water life along the pipeline corridor. The critical areas are fish stream crossings and fish overwintering areas from which water might be withdrawn.

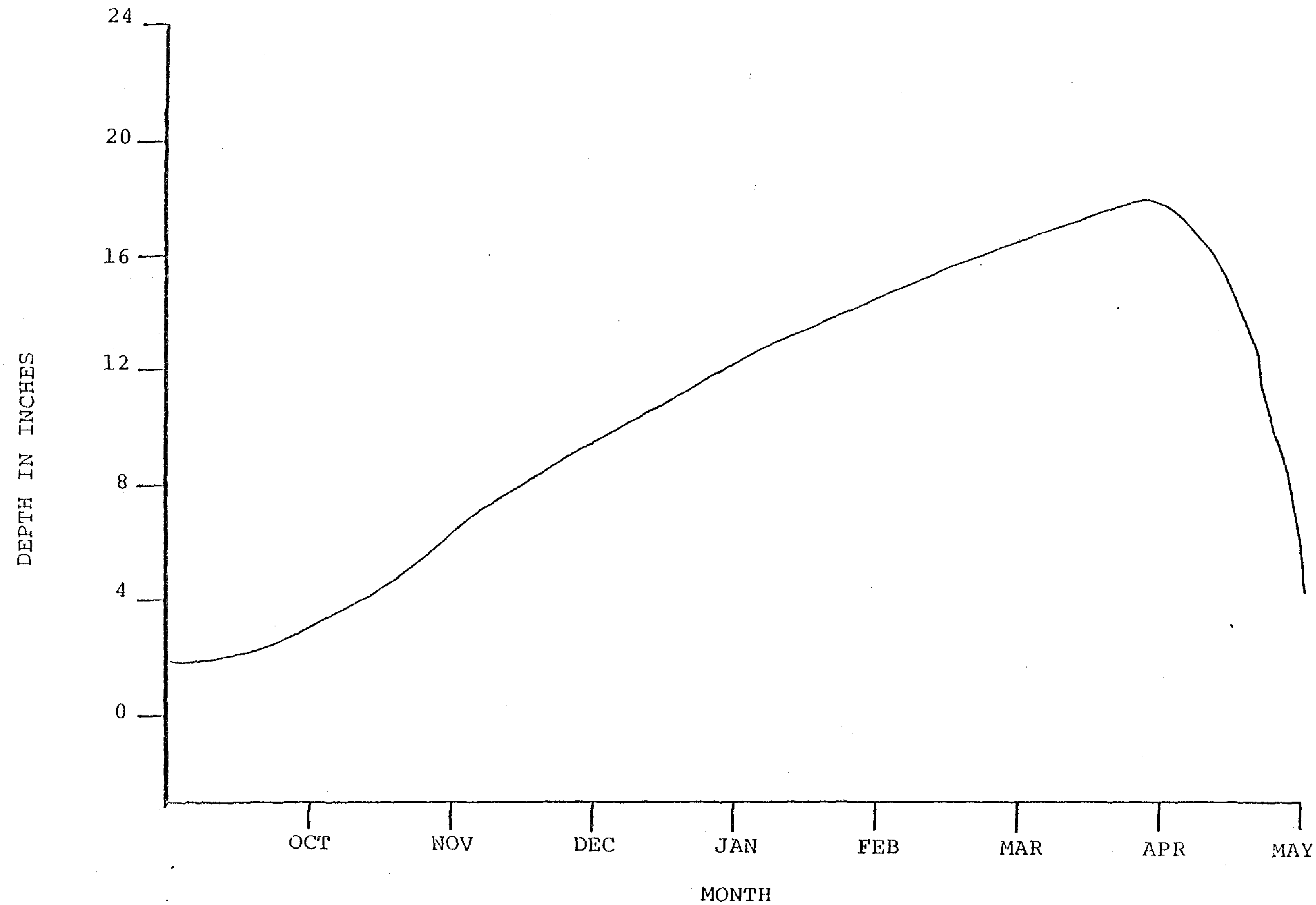
For many fish streams, winter construction would avoid most of the significant biologically sensitive periods. While this is generally true for most mammal and avian species it is not always the case for fish. In fact, winter construction crossings of many streams will not be permitted because of sensitive winter fish habitat conditions. In other cases, where winter crossings may be preferable, the early winter shoulder months may be unavailable due to inadequate snow or depth of freeze down for the establishment of snow/ice pads.

Whether a gravel or snow/ice work pad is used approaching stream crossings, the pipeline ditch will definitely disturb the stream bed and banks. Furthermore, summer access to streambed crossings for tracked equipment for bank stabilization and erosion control would be virtually impossible without a gravel approach. Also access limited to the winter months would require that initial construction of fish passage or habitat protection structures be accomplished in the winter; the results of constructing such structures in the winter has often proved unsatisfactory.

In summary, the general use of snow pads for below ground construction will result in greater adverse impacts to the ecosystems involved. Snow pad utilization will present compliance with right of way stipulations designed to assure environmental protection.

Exhibit 2.a

AVERAGE CUMMULATIVE MONTHLY SNOW DEPTH IN THE NORTH SLOPE BASIN



6/1/80

3 CONSTRUCTION CONTRACTING, EFFICIENCY, AND SAFETY

The concept of a snow/ice work pad, snow/ice roads, and winter construction programs for a buried, large-diameter pipeline is totally impractical from construction contracting, efficiency, and safety points of view. It is not planned that any part of the pipeline will be built using unproven construction techniques.

Construction Contracting

Northwest Alaskan intends to match the specific type of contract with the degree of risk in contract performance. However, under the terms of the President's Decision, Northwest Alaskan will be required to use fixed-price contracts unless the Federal Inspector determines that special conditions justify cost-plus contracts.

Because uncontrollable risks associated with snow/ice work pads, snow/ice roads and winter construction programs are so great, Northwest Alaskan is certain that no execution contractor with Arctic experience will submit a bid for this work under the terms of a fixed-price contract (see Appendix C).

CONSTRUCTION CONTRACTING, EFFICIENCY, AND SAFETY 3.2

In the event that snow/ice work pads or roads become mandatory, Northwest Alaskan would prepare a cost estimate for the change in design and schedule. This estimate will be submitted to the OFI for approval by the Federal Inspector. Once approved, it will be added to the base estimate as required by the Incentive Rate of Return (IROR) mechanism. Using the philosophy consistent with the President's Decision, it is unlikely that the Federal Inspector will accept a cost estimate with contingencies. However, any experienced contractor who must submit a fixed-price bid for pipeline construction from a snow/ice work pad will include a significant contingency, possibly 100 percent or more. This contingency will compensate for the risks inherent in this type of construction. As a result of this contingency, the competitive bids received will greatly exceed Northwest Alaskan's estimate. In effect the adoption of a winter construction concept is contrary to the President's Decision from a contracting point of view, inconsistent with the objective of the IROR procedure, and the project equity participants would be unfairly penalized.

Construction Efficiency

Pipeline construction is a highly mobile, labor-intensive, assembly-line production effort. Rather than the product moving through the assembly point, the assembly progresses over the product. Enclosing a mobile construction operation to provide a temperature-controlled environment will be virtually impossible to accomplish in a manner that will permit both efficient construction operations and the adherence to high standards of quality control (see Appendix C).

Severe cold temperatures places constraints on activities such as welding, coating, and backfilling and causes a significant reduction in the efficiency of all operations exposed to the cold temperatures. Also, equipment breakdown is more frequent, lubrication imparied, and maintenance and repairs will be difficult and costly (see Appendix C).

In addition, worker efficiency in cold weather drops significantly, with an estimated productivity ranging from 25 to 75 percent of that experienced during a normal moderate month. Operations such as welding and coating must normally be shut down when ambient temperatures drop to -20^0F to -30^0F, and all operations will generally cease below -35^0F.

Another important construction and logistics consideration would be the limited amount of natural light during winter months. Although artificial lighting has been provided successfully for fixed construction sites in the Arctic (e.g., Prudhoe Bay facilities), the actual concept of providing such construction support for a large-diameter pipelaying operations is untested. The maintenance and logistics requirements of a major, mobile artificial lighting operation are expected to be prohibitive (see Appendix B).

Another untested aspect of snow/ice work pad and road construction is the building of an extensive layered snow/ice work areas of nonuniform thickness on side slopes. It is unknown whether it is possible to contain the fluid snow/ice mixture on a side slope to maintain a uniform density for strength. For any large-scale operations, it would be necessary to develop and test new water application methods and equipment prior to any significant amount of winter construction scheduling. Even then, there is some risk that the thick sides of snow/ice work pads and roads will collapse under concentrated traffic loads of heavy sideboom tractors (see Appendixes B and C).

The majority of snow/ice pads and roads constructed in the Arctic to date have been to accommodate rubber-tired vehicles for the purpose of transporting bulk materials to isolated gravel drilling pads. There is very little experience with the use of snow/ice structures to support large-scale, heavy construction using tracked equipment. However, all experience available indicates that abrasion and surface deterioration will be severe. In fact, tracked equipment are ordinarily prohibited on snow/ice roads. Pad maintenance is expected to be costly* (more than gravel work pad maintenance), eliminates the possibility of a two-shift operation, and is distruptive to the normal cadence of pipeline construction operation (see Appendix C).

Construction Safety

The use of heavy construction equipment to lay large-diameter pipe from a snow/ice work pad is a dangerous construction practice. It creates an unreasonable safety hazard for workers.

Heavy equipment, even with snow grousers, has little traction and limited control. The snow/ice compacts between the grousers resulting in loss of traction. This is particularly true when under load on an incline or on uneven surfaces (see Appendix C).

---

* See Chapter 1 for a comparison of maintenance costs.

Any construction or monitoring personnel required to work on the snow/ice pad surface around the heavy equipment would be subjected to an unreasonable level of danger on the construction site (see Appendix C).

Appendix A

ESTIMATE OF PIPELAYING PRODUCTIVITY DURING A WINTER CONSTRUCTION SEASON

Northwest Alaskan estimates that there is a high probability that no more than 24 miles of continuous pipe could be laid per section during any winter construction season using snow/ice work pads. This estimate is based on an analysis of winter construction uncertainties associated with a decision to construct from a snow/ice work pad and is, fundamentally, an analysis of weather patterns and the effect of ambient air temperature on construction productivity. Unlike construction from a conventional, all-season gravel work pad, construction from a snow/ice work pad is dependent on temperatures conducive to snow/ice work pad construction and maintenance. Efficient project scheduling is, therefore, subject to the vagaries of weather and the pipelaying production limits due to weather-related delays, worker efficiency under adverse climate conditions, and traditional holiday periods. These factors must be examined in detail.

ESTIMATE OF PIPELAYING PRODUCTIVITY A.2

We followed a three-step analytical approach in developing the 24-mile estimate:

Step 1: Estimate the number of expected construction days available based on weather records and seasonal constraints

Step 2: Refine the estimate of available pipeline construction days to a higher level of statistical probability

Step 3: Estimate pipelaying productivity during available construction days taking account of operations sequence and efficiency.

Each of these steps is discussed below.

Step 1: Estimate the Number of Expected Construction Days Available

The average number of construction days expected to be available between October 1 and April 30, working from a snow/ice work pad, is estimated to be 106 days (1.8 days in October, 13.3 in November, 20.4 in December, 17.8 in January, 20.1 in February, 23.9 in March, and 8.7 in April). The primary factors considered in estimating the number of days available are:

- Temperature constraints
- Time period required for mobilization and pre-construction of snow/ice work pad
- Time period required for final backfill and demobilization
- Time period allotted for traditional holiday season.

Temperature Constraints

The number of construction days available working from snow/ice work pads or roads is limited by several temperature constraints:

1) Initial construction of snow pads requires ambient air temperatures <0°F. Construction of the initial work pad foundation depends on rapid freezing of large volumes of water to a thickness and a snow/water density that can support heavy construction loads. The experience of Bearfoot, Inc. gained from extensive Arctic work (for the Arctic Gas project, NPR-4, etc) along with that of Alyeska and others, indicates that temperatures less than 0°F are necessary for this freezing when laying a snow/ice work pad.

2) Snow/ice work pad maintenance operations require temperatures <20°F. Once a snow/ice work pad is laid, maintenance operations (e.g., repairing pot holes, reblading, adding make-up snow or water) can be accomplished at higher temperatures than those required for initial construction. The volumes of water that must be frozen rapidly and the ability to control snow/water densities on an existing snow pad foundation do not require the

subzero temperatures needed for initial construction. Nonetheless, the maintenance of snow/ice work pads that will be exposed to the high wheel loads of heavy construction equipment and degrading action of tracked equipment requires substantially colder temperatures regimes than are required for manufacturing snow (at near thawing temperatures) for recreational sking purposes.

3) Pipeline construction operations cease at temperatures below -35°F. At extremely low temperatures, labor and equipment efficiency rates decline to a level where construction efforts are no longer cost-effective, regardless of whether pipeline operations are being conducted from a snow/ice work pad or a conventional gravel pad, a "no-work" condition is assumed to exist at temperatures below -35°F.

4) Pipeline construction operations from a snow pad must cease at temperatures above 20°F. When snow/ice work pad maintenance ceases to be effective at temperatures above 20°F, then pipeline construction operations must also terminate to prevent destruction of the pad. Therefore, a "no-work" condition also exists for temperatures of 20°F and higher

Since the development of the Prudhoe Bay area and the construction of the Trans-Alaskan Pipeline System (TAPS), a substantial amount of North Slope weather data has been collected.* To identify the months in which winter construction from a snow/ice work pad is possible, Northwest Alaskan used detailed records of hourly weather readings, covering the 10 year period from 1969 through 1979, to compute the average daily high and average daily low for each month (see Exhibit A.1).

Using the raw weather data from AEIDC, we categorized hourly temperature readings into six temperature ranges compatible with our construction assumptions:

Temperature Range	Work Conditions
>32°F	No work; snow/ice work pad thawing
20°F to 31°F	No work; snow/ice work pad remains frozen but can not withstand construction activity loads
0°F to 19°F	Snow/ice work pad maintenance and pipeline construction are possible
-20°F to -1°F	Snow/ice work pad and pipeline construction are possible
-34°F to -21°F	Snow/ice work pad and pipeline construction are possible at reduced productivity
<-35°F	No work; too cold.

* The primary source for the data is the Arctic Environmental Information and Data Center (AEIDC), located in Anchorage, Alaska.

The number of days in each month were then sorted into the six temperature ranges in each of the 10 years for which data were available, and computed the average number of days in each month falling within each range (see Exhibit A.2).

Using the construction assumptions and temperature data, the average or expected work days available per month were estimated for the months of October through April (see Exhibit A.3). Because of mobilization, work pad pre-building, and the traditional holiday season, no pipeline construction can be scheduled during the months of October, November, December and the first week of January. Similarly, because of the pre-breakup demobilization, no pipeline construction can be scheduled during May.

Mobilization and Work Pad Pre-Building

If winter construction follows a summer and fall construction season, the time required for mobilizing construction equipment and crews can be reduced by enabling prepositioning of major equipment prior to freeze-up. Work can then begin almost immediately upon governmental issuance of an on-tundra permit. The remaining mobilization task, then, is the necessity of starting each season by pre-building snow/ice work pads of sufficient length to support the transient nature of pipeline operations.

Because the temperatures required for initial snow/ice work pad construction are lower than the temperatures required for pipeline construction, days that would otherwise be acceptable for pipeline construction from a weather standpoint are unusable until a sufficient length of work pad is pre-built. For construction scheduling, all of the available work days in October (1.8 days), November (13.3 days) and December (20.4 days) will be used for mobilization of major equipment and pre-building the snow/ice working surface. Therefore, no pipeline construction would occur during this period.

Time Required for Demobilization

In a manner similar to mobilization, the end of each winter construction season requires that time be scheduled for demobilization prior to break-up. Furthermore, pipeline welding operations must often be terminated before demobilization begins to ensure that all welded pipe can be lowered in and backfilled before the equipment is demobilized. For schedule purposes, demobilization will require all available working days in May, and all pipe welding and pipelaying activities will have to terminate at the end of April.

Time Allocated for Holiday Season

It is customary in the pipeline industry to cease major construction activity during the Christmas and New Year's holiday season. Therefore, the last week of December and the first week of January are treated as a "no-work" period.

Step 2:
Refine the Estimate of Available Pipeline Construction Days

In this step of the analysis, the estimate of the available number of work days for pipeline construction is refined to establish higher levels of statistical confidence for predicted weather patterns.

The use of mathematical averages, or more precisely the arithmetic mean, in calculating the number of winter days likely to be available during a typical winter season in Step 1, assumes a probability of occurrence of 50 percent. (P = 0.5). The extremely large capital investment necessary for the Northwest Alaskan project cannot logically be attracted on such a 50-50 chance basis.

Accordingly, we used historical data to more accurately predict the number of work days available per month (see Exhibit A.4). For example, the historical data may show that the average number of days within a certain temperature range is 5, with a standard deviation of 1. While the use of a mathematical average implies only that there is a 50 percent chance of at least 5 available work days, the distribution implies that there is an 84 percent chance of at least 4, or more available working days. This approach, based on one standard deviation of the normal distribution, can be used to predict the minimum number of available work days in each month with greater certaintly.

Using this methodology, the estimate of the probable work days available per month was refined as follows (see Exhibit A.5):

Work Days Available (P = 0.84)

Temperature Range	Month Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
$-35^{\circ}F$ to $20^{\circ}F$	6.8	21.5	22.0	21.0	21.6	27.2	22.2
$-35^{\circ}F$ to $0^{\circ}F$	0	4.9	15.4	13.0	17.7	15.6	2.4

However, for the purposes of construction scheduling, it is important to note that the number of work days available in any month may not be consecutive or even in reasonably close sequence. For example, a day or two of cold weather at the beginning of the month may be followed by a series of warm days. Consequently, the month of November, with only 4.9 probable work days available is unusable for mobilization and pre-building. Similarly, the month of December with only 15.4 work days (i.e., 50 percent of the total days in the month) is only marginally dependable for mobilization and initial snow/ice work pad construction. The months of January, February and March contain 46.3 expected work days for snow pad construction (52 percent of the total season) and 69.8 expected work days for pipeline construction (78 percent of the total season). The month of April offers no opportunity for further construction of snow/ice work pads and must be dedicated to final wrap-up of the winter pipeline construction season (i.e., backfilling, cleanup, and the beginning of equipment and labor demobilization).

Step 3:
Estimate Pipelaying Productivity

Northwest Alaskan has estimated and scheduled the construction rate for installing buried gas pipeline in Alaska, operating from a gravel work pad during the summer months, to be 3,200 feet in pipe per day per section. This planning figure can be modified for use in estimating winter construction by considering the special constraints encountered when laying pipe from a snow/ice pad. The results provide a model of a typical season for a single construction spread that, allowing for weather and variations in available working days and worker efficiency, estimates the total length of pipe that can be laid.

The factor controlling the length of pipe that can be laid in any period of time is pipeline welding operations. In the case of construction from a snow/ice work pad, sufficient time must be scheduled at the start of the season to pre-build the pad, shoot and excavate a ditch, and string and bend pipe far enough in advance of the welders to ensure continuity of operations. Based on the expected number of work days available in a typical season on Alaska's North Slope, it is not feasible to mobilize an entire construction crew until some of these preliminary activities are well under way.

The period with the highest risk of schedule delays due to temperature constraints are the months of November and December. No snow/ice work pad construction can be scheduled during November because of limited cold temperatures, and only skeleton crews can be expected to be available during December due to the holiday season interruption. Consequently, the following assumptions must be incorporated into our construction model:

1) Construction camps and support facilities can be activated and (upon receipt of on-tundra permits) snow/ice work pad construciton can commence in December.

2) Skeleton crews can continue to work through the holiday season building snow/ice work pads whenever the temperatures are low enough, i.e., less than 0°F. These crews could pre-build the work pad at the average rate of one-third mile per day. During the 15 days likely to be available in December, the resulting 5 miles of snow/ice work pad will require approximately 1,013,800 gallons of water per day. During the 40 working days available in January, February, and March, snow/ice work pad construction rates must increase to one-half mile per day with corresponding water requirements of 1,520,700 gallons per day.

3) Blasting and ditching crews can mobilize on the first of January, followed closely by the stringing and bending crews. Production must initially average one-third mile per day, increasing in later months.

4) Welding can commence the second week of January and continue to mid-April, when it must terminate to ensure the lowering-in and backfilling of all welded pipe before spring break-up. Work days scheduled for welding are, therefore, reduced to 75 percent of the time available in January and 67 percent of the time available in April, for a seasonal total of 78 days in which temperature ranges are expected to be satisfactory (with an 84 percent probability).

5) Northwest Alaskan has adopted the following worker efficiency rate for pipeline welding operations under adverse temperature conditions:*

Temperature Range	Work Efficiency**
0° to 20°F	75 percent
-20° to -1°F	50 percent
-35° to -21°F	20 percent
below -35°F	Nil

* This estimate is based on advise from consultants with extensive Arctic construction experience.

** Precentage of estimated summer or moderate month rates.

Using welding operations as the basis for reductions in worker efficiency (down from an optimum of 3,200 feet per day), Northwest Alaskan estimates that no more than 24 miles of continuous pipeline construction could be scheduled during a winter construction season. This estimate is based primarily on an analysis of ambient temperatures. This optimistic estimate of 24 miles per construction season is the sum of estimated pipeline construction during three different temperature ranges for each of the four months when pipe construction could take place (see Exhibit A.6).

Other factors such as the effects of wind and blowing snow will further reduce the estimated pipelaying productivity. For example, considering wind chill effects and assuming that no pipeline construction operations will take place when wind chill falls below -35°F, the available work day would be reduced by 44 percent. This, in turn, will reduce the pipelaying productivity to approximately 12 miles per section for an entire season.

Exhibit A.1

AVERAGE MONTHLY AMBIENT TEMPERATURES
(^{o}F) OCTOBER THROUGH APRIL

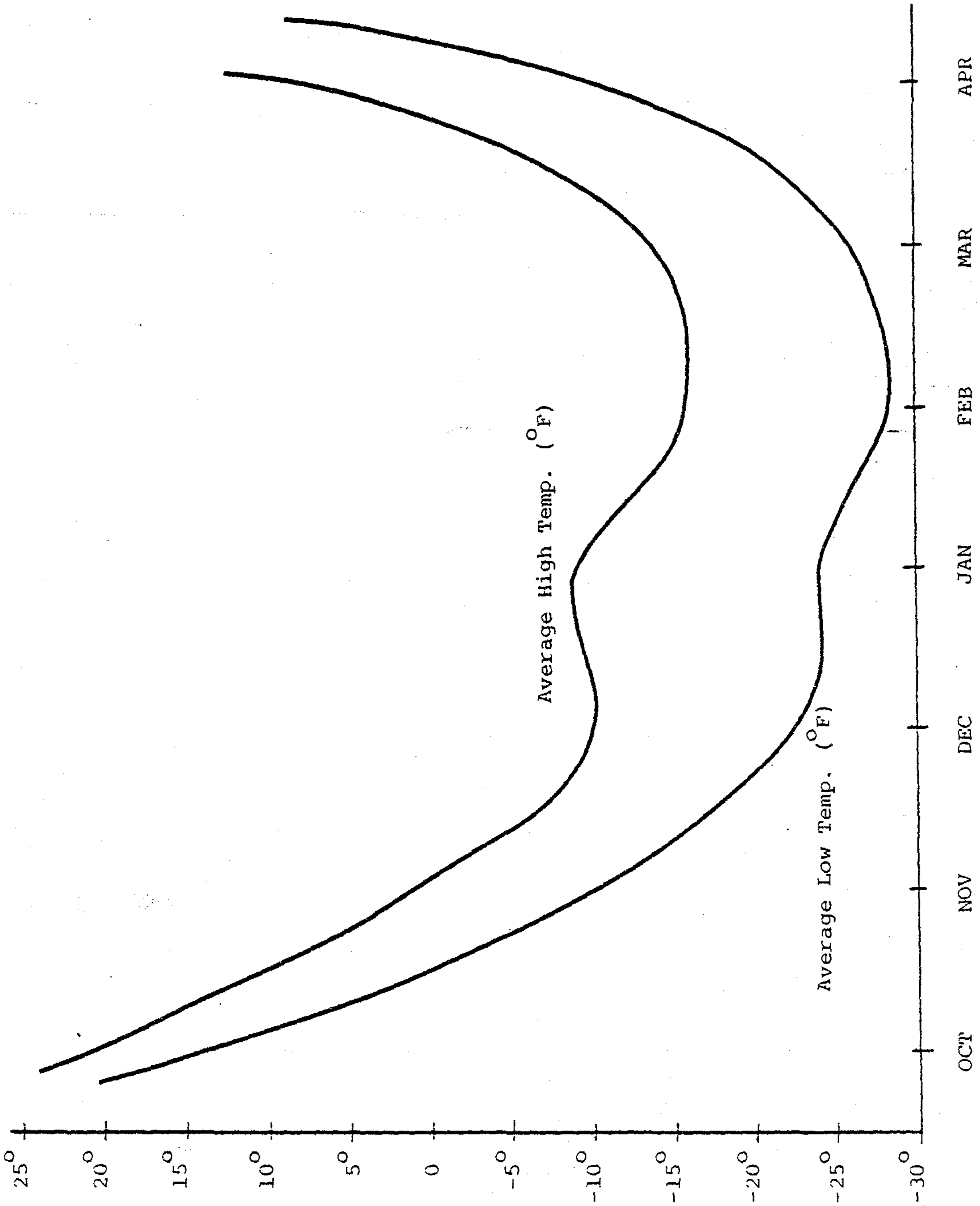


Exhibit A.2

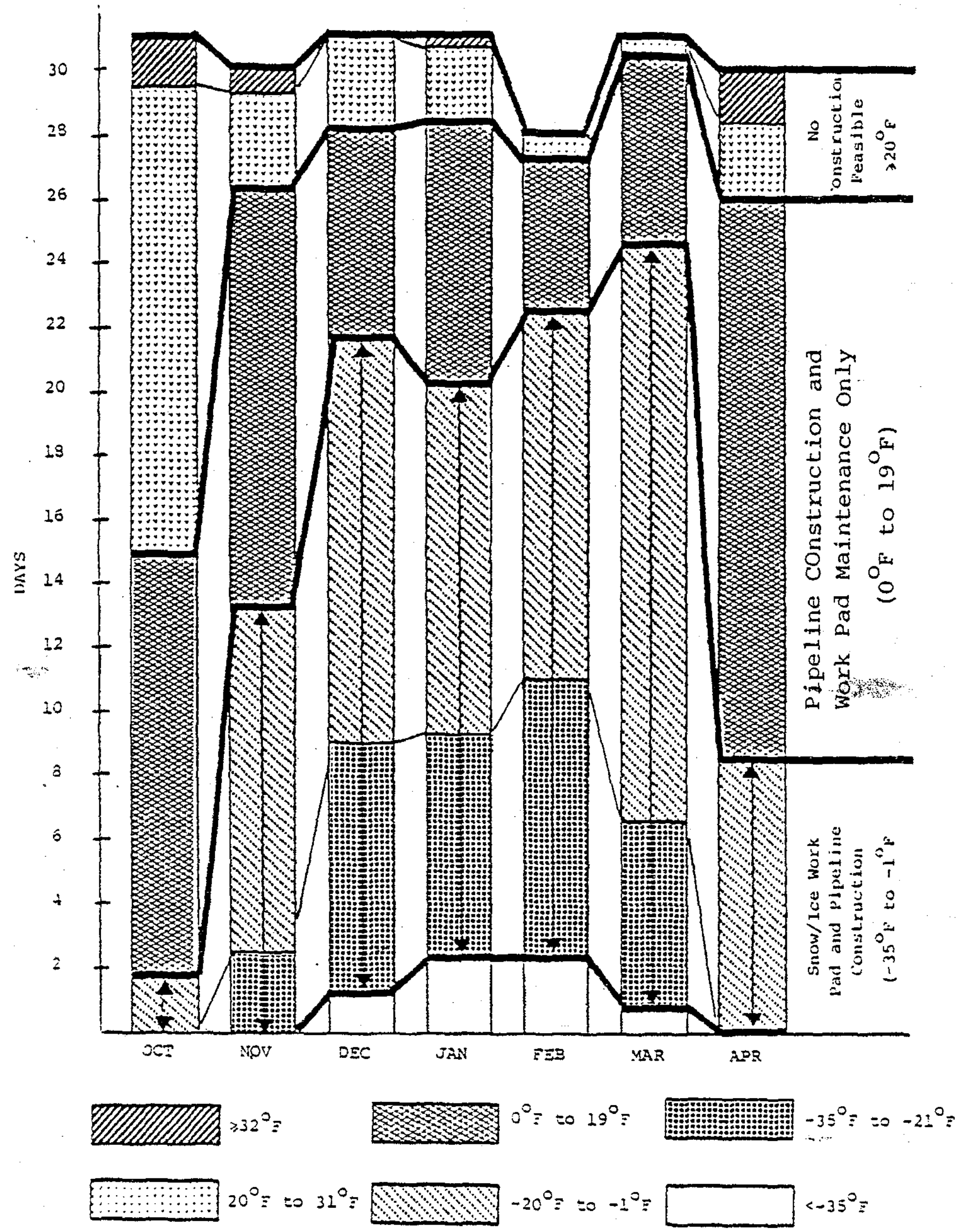
DISTRIBUTION OF NORTH SLOPE TEMPERATURE DATA*
(Average days per month within selected temperature ranges)

TEMP. RANGE (°F)	OCT		NOV		DEC		JAN		FEB		MAR		APR	
	HI	LOW	HI	LOW	HI	LOW	HI	LOW	HI	LOW	HI	LOW	HI	LOW
≥32°	1.5	0.2	0.7	–	–	–	0.2	–	–	–	–	–	1.6	–
20° to 31°	14.4	7.0	2.9	0.7	2.8	–	2.3	0.1	0.7	–	0.6	–	2.3	0.8
0° to 19°	13.3	14.5	13.1	7.3	6.4	3.3	8.2	3.5	4.6	0.9	5.6	1.3	17.4	7.2
-20° to -1°	1.8	8.7	10.7	15.9	12.8	10.4	11.0	9.3	11.6	6.6	18.1	7.9	8.7	15.4
-35° to -21°	–	0.6	2.6	5.8	7.6	10.2	6.8	8.3	8.5	10.9	5.8	14.6	–	6.4
<-35°	–	–	–	0.3	1.4	7.1	2.5	9.8	2.6	9.6	0.9	7.2	–	0.2
	31 DAYS		30 DAYS		31 DAYS		31 DAYS		28 DAYS		31 DAYS		30 DAYS	
AVERAGE MONTHLY TEMPERATURE (°F)	20.8	14.7	2.5	-10.8	-10.3	-22.6	-8.9	-23.6	-16.3	-18.9	-13.8	-26.3	9.6	-10.8

* DATA SOURCE: Arctic Environmental Information and Data Center, University of Alaska, Anchorage (for 10 year period, 1969-1979)

Exhibit A.3

AVERAGE MONTHLY WORK DAYS AVAILABLE
FOR SNOW/ICE WORK PAD CONSTRUCTION*



* Assumes that an ambient air temperature of 0°F or less is required for snow/ice work pad construction.

Exhibit A.4

SAMPLE DISTRIBUTION OF
AVAILABLE WORK DAYS

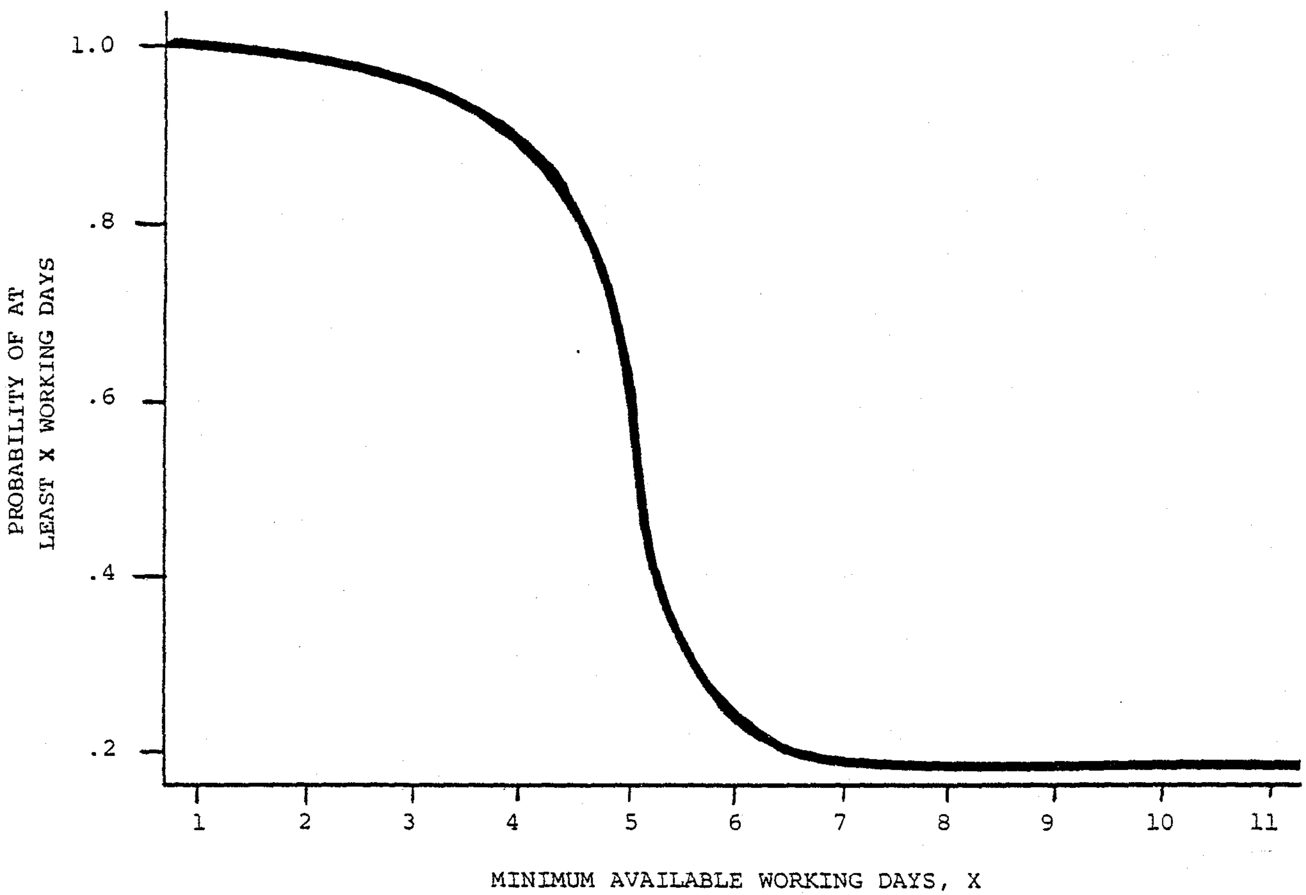
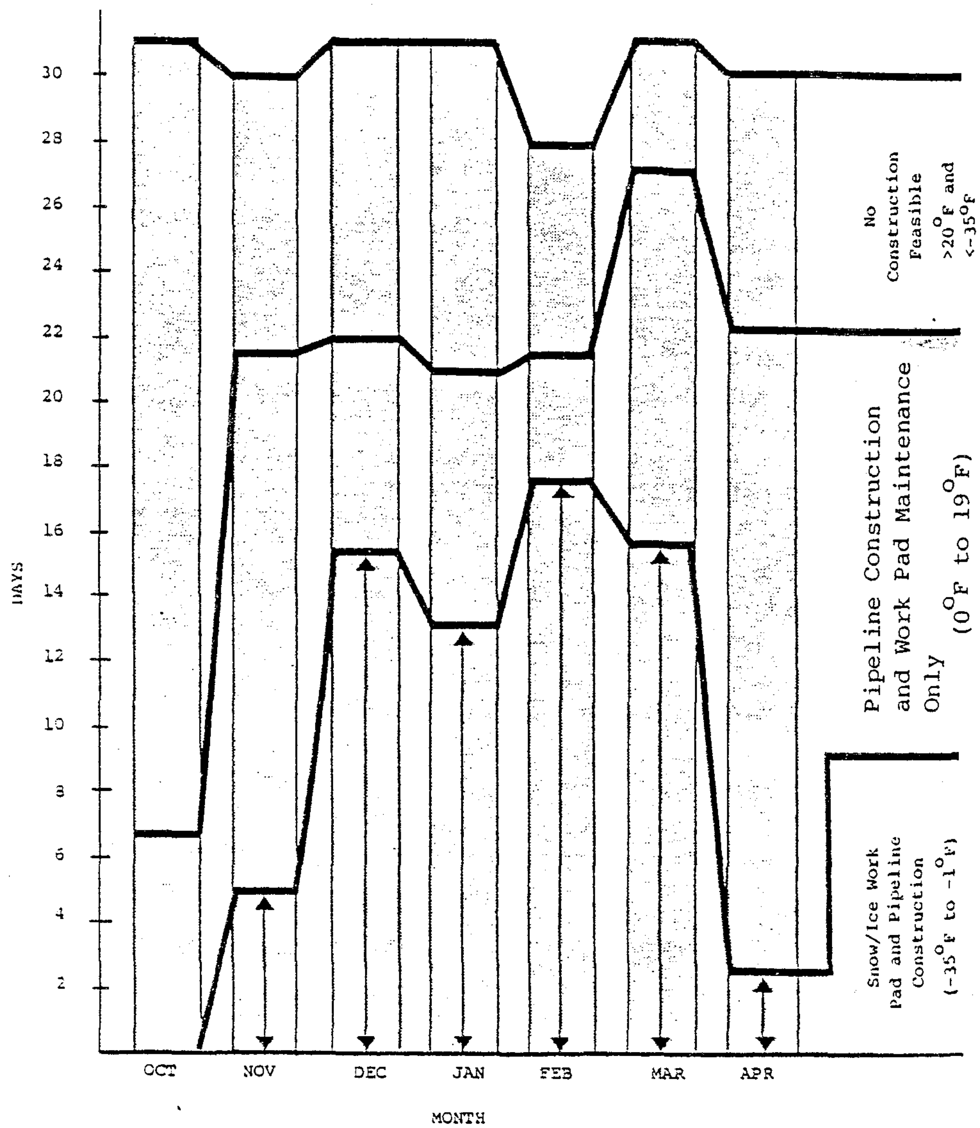


Exhibit A.5

MONTHLY WORK DAYS AVAILABLE
WITH PROBABILITY OF 0.84*



* Assumes that an ambient air temperature of 0°F or less is required for snow/ice work pad construction.

Exhibit A.6

ESTIMATE OF PIPELAYING PRODUCTIVITY
(Work Days Per Month and Production of Welded Pipeline)

TEMPERATURE AND LAY RATE	MONTH: JANUARY	FEBRUARY	MARCH	APRIL	WINTER CONSTRUCTION SEASON
0°F to 20°F 2400 Feet Per Day[1]	5 Days 2.27 Miles	4 Days 1.82 Miles	4 Days 1.82 Miles	9 Days 4.09 Miles	22 Days 10.00 Miles
-20°F to -1°F 1600 Feet Per Day[2]	6 Days 1.82 Miles	10 Days 3.03 Miles	17 Days 5.15 Miles	5 Days 1.52 Miles	38 Days 11.52 Miles
-35°F to -21°F 640 Feet Per Day[3]	5 Days 0.61 Miles	7 Days 0.85 Miles	6 Days 0.73 Miles	0 Days 0.00 Miles	18 Days 2.19 Miles
-35°F to 20°F TOTALS	16 Days 4.70 Miles	21 Days 5.70 Miles	27 Days 7.70 Miles	14 Days 5.61 Miles	78 Days 23.71 Miles

1 Assumes 0.75 labor efficiency factor.

2 Assumes 0.50 labor efficiency factor.

3 Assumes 0.20 labor efficiency factor.

6/1/80

Appendix B

EXTRACT FROM TERMINUS LIMITED REPORT

SECTION 10

WINTER CONSTRUCTION

ALASKA PIPELINE OFFICE
OF
U.S. DEPARTMENT OF INTERIOR

TRANS-ALASKA PIPELINE - SPECIAL STUDY

AN OVERVIEW STUDY WITH RESPECT TO EFFECTIVENESS OF THE STIPULATIONS DURING THE CONSTRUCTION PHASE AND AN ANALYSIS OF EXPERIENCE GAINED WHICH MAY BE OF USE FOR GRANT OF ROW FOR FUTURE PIPELINE PROJECTS

INTERIM REPORT

JUNE 1977

UPDATED AUGUST, 1977

PREPARED FOR MECHANICS RESEARCH, INC.

BY TERMINUS LIMITED
TORONTO, CANADA

ITEM 10 - WINTER CONSTRUCTION AND SNOW ROADS

10.1 PREAMBLE

The construction plan for the Trans-Alaska pipeline called for extensive logistics operations during the winter, including the transportation of materials and equipment, in order to meet the construction schedule. The plan did not call for the construction of any sections of the main pipeline during the winter months. During the winter season of 1975-76, however, an attempt was made to construct a section of the main pipeline in the elevated mode, using a snow pad. During the same winter season, approximately 147 miles of fuel gas line, running from Prudhoe Bay to the pump stations on the North Slope, were scheduled to be constructed using a snow pad.

One of the proposals for transporting Alaskan natural gas from Prudhoe Bay to the lower 48 states contemplates a winter construction scheme (i.e., construction activities on the ROW limited to the winter season) on the North Slope of Alaska and on the northern sections of the pipeline route through Canada (herein collectively referred to as "The North Slope"). It would therefore appear that an analysis of the Trans-Alaska winter pipeline construction experience would be useful in evaluating the relative viability and the potential environmental impact of any future pipelines on the North Slope. Moreover, such an analysis would facilitate the setting of terms and conditions for grant of ROW across federal public land for such pipelines.

10.2 "PHILOSOPHY" OF WINTER CONSTRUCTION

The proposed scheme to limit pipeline construction on the North Slope to the winter season apparently developed from the premise that winter construction virtually eliminates adverse environmental impacts. Winter construction is thought to protect the tundra from construction impact through the use of snow roads and snow construction pads, in lieu of gravel roads and construction pads. It is thought to limit the field activities on the ROW to a season when there is minimal presence of wildlife and no fish migrations in the streams and rivers. And, with its reduced requirements for gravel for roads and construction support facilities, it is thought to reduce disturbance of streams and rivers and to minimize the adverse visual impacts of construction.

10.3 THE WINTER CONSTRUCTION SCHEME

The season for the winter construction scheme theoretically commences with sufficient freeze-up in the fall to permit travel on the tundra and lasts until the break-up of snow roads and snow construction pads in the spring.

The viability of a winter construction scheme for a big-inch pipeline in the north is based on the following assumptions:

that snow roads can be built to handle all transport of materials, equipment, and supplies required for the construction of a big-inch pipeline;

- that such snow roads, if constructed and used in accordance with certain specifications, will not cause degradation of the tundra;
- that the installation and use of the snow construction pad will not cause degradation of the tundra;
- that all the pipeline spread construction activities can be carried out from a snow pad designed to handle the construction traffic;
- that the complete pipeline ROW can be restored from the snow pad, including erosion control measures;
- that all activities for a big-inch pipeline spread on the North Slope can be carried out at a reliable production rate throughout the winter construction season, allowing for certain reductions in the productivity of men and equipment;
- that all pipeline maintenance can be carried out using LGP vehicles or helicopters, without permanent roads along the ROW.

10.4 CONCLUSIONS

Environmental Aspects:

The winter construction concept is not a panacea for the environmental problems connected with the construction of a big-inch pipeline in the north. In the terms of its direct impact on animals and birds during construction, the winter scheme is theoretically the least disturbing. Regarding direct impact on fish and local ecosystems, however, the winter scheme may not be the best solution. Experience on the Trans-Alaska pipeline shows that direct impact on wildlife, fish, and local ecosystems can be kept within acceptable limits using the moderate weather season for the principal construction activities in the north, provided the work is properly planned and scheduled with a view to minimizing such direct impact. An extension of the moderate weather season scheme to an all-year schedule will further reduce direct impact on the environment, an alternative which also has substantial economic and social advantages.

In terms of terrain degradation, the winter construction scheme theoretically appears to be an ideal solution. In practice, however, the near-perfect performance required to minimize terrain degradation from construction and use of snow roads and snow construction pads will be difficult to achieve. Practical experience in Alaska and northern Canada indicates a very high probability of deficiencies in the execution of an all-winter scheme. The winter construction concept is based on the assumption that the pipeline trench can be backfilled and the ROW restored with frozen material in the winter, thus preventing thermal degradation and controlling erosion. From even a theoretical point of view, this assumption is highly questionable; from a constructability point of view, such a restoration and erosion control scheme must be classed as impractical.

The winter construction concept also makes the assumption -- as yet untested -- that the operation and maintenance of a pipeline system can be carried out without permanent road access to either the compressor or pump stations.

Construction Aspects:

The success of cold weather construction, as developed in Alaska and Canada, has been based on creating an artificial climate for the work. By constructing enclosures, such artificial climates can be created economically for both large industrial installations and commercial building. In northern Canada, entire hydro-electric powerhouse sites have been enclosed, thus facilitating the placing of mass concrete during the winter months. The experience in Alaska and Canada clearly shows that enclosure of the work site is the most practical and economic way to assure productivity and quality construction in sub-zero weather. Individual shelters for specific activities are not practical on a production basis, because the necessary concurrent logistics activities involved in keeping such enclosures operative and heated are subject to full exposure to the climatic elements, rendering unpredictable the performance of both workers and equipment. If the enclosure for a single pipeline activity becomes non-operational, the whole spread may be brought to a halt.

There is no record of the successful artificial lighting of a complete buried mode big-inch pipeline spread, which stretches between 4 to 10 miles and is required to move at rates of up to 1 mile per day. The additional technical and logistics requirements to keep such an artificial lighting installation in operation under the climatic conditions in the north during December and January would further reduce the overall efficiency of a big-inch pipeline spread. In terms of constructability, such a scheme appears impractical.

Assuming the foregoing is correct, the practical daylight season for winter construction in the north is limited to 85 to 95 calendar days. In order to meet the objectives of environmental protection, this season is unyielding in terms of scheduling work, because it is controlled by the climate. The latest potential freeze-up for practical purposes eliminates pipeline construction prior to the Christmas - New Year holidays, due to the lack of daylight hours; the earliest break-up in the spring fixes the end of the winter season.

This study has revealed no facts indicating that the plan to limit the construction of a buried mode big-inch pipeline to the winter season serves any objectives other than environmental protection. No technical or cost advantages have been claimed for the winter construction concept, although experience in Canada (mainly south of 60° latitude) has shown that a buried pipeline in muskeg and similar wet terrain may be easier to construct when the ground is frozen and no special ground protection is required.

A construction scheme based on an annual 85-95 calendar day schedule in the winter, at a time of year when the productivity of men and equipment will be at best 50% of that for an extended moderate season schedule, is totally uneconomical. Direct construction cost for workers, equipment, logistics, and supplies is likely to run 4 to 6 times the cost of an all-year construction scheme, exclusive of the cost of schedule slippage. Moreover, the winter construction concept does not meet any test for "balancing environmental amenities and values with economic and technical capabilities, so as to be consistent with applicable national policies."

10.5 ANALYSIS AND EVALUATION OF RELATED EXPERIENCES

Preamble

The following analysis and evaluation deals with the various issues raised in the general discussions of winter construction of a big-inch pipeline in the north, and supports the foregoing conclusions. The related experience is based on records from the construction of the Trans-Alaska pipeline, submissions before the Federal Power Commission in the United States and the National Energy Board and the Mackenzie Valley Pipeline Inquiry (Berger Commission) in Canada, regarding gas transportation systems from Prudhoe Bay to the lower 48 states. In addition, background information was collected through interviews with persons having expertise or experience pertinent to these issues.

The basic intent of the agreement and grant of right-of-way for the Trans-Alaska pipeline was that "the parties shall balance environmental amenities and values with economic practicalities and technical capabilities, so as to be consistent with applicable national policies." It seems proper to test the "philosophy" of winter construction in terms of its effectiveness in satisfying this basic objective, as it may apply to any future pipelines using federal public land. For the purposes of these discussions, the terms "environment" and "environmental" have a limited connotation; for clarity, "socio-economic aspects" which are proper environmental concerns have been labelled separately. Further, the term "The North Slope" refers to the geographical area of the North Slope of Alaska and the Yukon (and the lower Mackenzie Valley north of the Arctic Circle.)

Environmental Aspects

The potential environmental impact during the construction of a big-inch pipeline in the north takes two main forms. The first is terrain disturbance, which results in visual impact, thermal degradation, and erosion (erosion may have a secondary impact on fish populations). The second is damage to wildlife, fish, and local ecosystems through the direct disturbance of construction activities, such as noise, harassment, water pollution, and air pollution.

In terms of terrain disturbance, both all-year construction (using gravel roads and gravel construction pads) and winter construction (using snow roads and snow construction pads) can theoretically keep damage to the terrain within acceptable limits. Experience in Alaska and the Canadian North demonstrates conclusively that gravel roads and construction pads, when properly constructed, keep terrain disturbance to a minimum. Further, the existence of roads and gravel construction pads facilitates terrain rehabilitation and maintenance within the pipeline right-of-way without further terrain disturbance.

On the other hand, experience in both Alaska and northern Canada shows that under operational conditions in the field it is extremely difficult to comply with the specifications for the construction and use of snow roads as required in order to prevent terrain degradation. Although there is no actual experience in Alaska or Canada of snow construction pads on a big-inch buried pipeline, there is limited experience available from the Alyeska installation of 4.5 miles of above-ground mode of the main line Trans-Alaska pipeline. There is also related experience from the Alyeska 8- and 10-inch gas fuel line on the North Slope. The Alyeska fuel gas line experience indicates that where blasting for the trench is required, it will be very difficult to prevent terrain degradation if the construction is carried out from a snow pad (Ref.10.7). The Alyeska fuel line experience does indicate that, where trenching machines can be used and where excavated material can be removed from the ROW and replaced with processed backfill material which is not susceptible to frost, terrain degradation may be within acceptable limits (Ref.10.7). However, while it is theoretically possible to keep terrain degradation within acceptable limits while constructing a big-inch pipeline from a snow pad, analysis of related experience in Alaska indicates that it is very doubtful if it can be done under full-scale field operation. The restoration of the pipeline right-of-way where the pipeline trench is excavated and backfilled in frozen condition has not been tested under field conditions, much less executed successfully after the installation of a pipeline. Furthermore, on a production basis.the servicing of a big-inch buried pipeline and the maintenance of the right-of-way without a gravel service road appear totally impractical, in fact virtually impossible, without causing additional terrain disturbance.

The Alyeska experience does show that a big-inch pipeline in the elevated mode can be constructed from a snow pad without causing unacceptable terrain disturbance (Ref. 10.8).

Regarding the second form of potential environmental impact from the construction of a big-inch pipeline, namely the direct disturbance of wildlife, fish, and other ecosystems, a schedule limited to the winter months should have the least impact. This does not mean, however, that there will be no impact during winter construction nor that the potential impact for any other construction schedule, whether an extended summer season or an all-year schedule, will be unacceptable. The experience with the Trans-Alaska pipeline shows clearly that, by proper planning and scheduling of the construction operations, direct disturbance to wildlife and aquatic animals can be kept within acceptable limits for an extended summer season schedule. Further, if such a schedule is extended to an all-year schedule with selected winter activities, additional "windows" with minimal direct impact of the construction operations on wildlife, fish, and local ecosystems will become available.

With regard to potential conflicts with mammals, a winter construction scheme involves about the same conflicts as an all-year scheme. As for fish populations, experience in Alaska shows that smaller streams may be as important as large rivers, and uncontrolled winter crossing by the pipeline installation may have quite severe secondary impact.

If a rigid winter construction schedule is compared with a flexible or all-year construction schedule, in terms of the desired balancing of "environmental amenities and values with economic practicalities and technical capabilities," this study shows that there are serious doubts as to whether this balance can be achieved if a restricted to winter operation construction scheme is implemented.

Regarding the socio-economic impacts of a major pipeline construction schedule limited to less than 100 days a year, it is unquestionably the least desirable scheme for the local people and communities affected by the construction operations. This question is of less concern on the Alaskan North Slope, where there are few individuals or communities, but it is of major concern for the people in the lower Mackenzie Valley of Canada. Taking into account both regional and national socio-economic effects, it is much more desirable to spread employment within physical and cost limits over the longest practical construction season. A year-round schedule designed to level employment peaks would be the most preferable scheme, in terms of both the local socio-economic impact and the regional economic benefits.

Constructability and Cost Aspects

The success of a winter construction scheme in the North, as has been proposed for a Prudhoe Bay-Lower 48 gas pipeline, is totally dependent upon the following untested assumptions:

- that a big-inch buried pipeline can be constructed during the winter months, using a snow construction pad only, at a production rate in excess of 50% of the rate which has been recorded in Alaska for summer construction;
- that snow roads can handle all transportation of equipment, materials, supplies, and logistics along the pipeline ROW;
- that a big-inch pipeline spread can be lighted artificially, to permit work during December and January;
- that sufficient workers and supervisors will be available for a full-scale pipeline operation during December and January.

Experience in Alaska and Canada shows clearly that reliable production during winter construction in the North (or in any sub-zero or inclement weather condition) can only be achieved by creating an artificial climate at the work site. The enclosure of individual work activities has not proved successful on a production basis; nor is it economical. Experience and independent studies both show a tremendous impact of sub-zero and inclement weather on construction activities which are not fully protected. The required time to carry out work varies from a slightly reduced performance rate for straight manual work which is not hindered by protective clothing, to a rate ten times as long for complex mechanical tasks requiring exposure of the hands. It is therefore very doubtful that an average production rate in excess of 50% of the actual summer production in Alaska could be accomplished during the winter in the North. Related Alyeska experience shows poor production rates, with virtually no buried pipeline completed during the months of December and January (Ref. 10.7, 10.8 and 10.9).

There is no actual experience in Alaska or Canada of snow roads being used for "production transport" for the sorts of tonnages during a limited season that are involved in a big-inch buried pipeline (Ref. Green Report). Nor is there any experience in either Alaska or Canada of the artificial lighting of a big-inch buried pipeline spread. The experts before the F.P.C. and the N.E.B. "totally" disagree as to the feasibility of such a scheme. Extrapolation from other construction experience indicates that, even if it is feasible to light satisfactorily each of the pipeline spread activities, this will constitute one more concurrent and dependent operation which will reduce the average production rate.

Both past experience and the current trend in Alaska and Canada is towards a shut-down of all but essential functions in the North for an extended Christmas-New Year holiday, lasting as long as 3 to 4 weeks. Alyeska's experience on the fuel gas line and on the elevated mode mainline section confirms this fact. It is very doubtful if sufficient workers and supervisors can be induced to forego their traditional holiday reunion with family and friends, when they have been working in remote areas and particularly the North.

Moreover, the first two potential winter construction months in the North, namely December and January, have more adverse conditions for outside construction activities than the last 3 to 4 months from February to May. The weather during this period is generally more stormy, there are fewer hours of daylight, and inadequate freeze-up can limit traffic and make the crossing of rivers and streams more time-consuming and dangerous. These problems, coupled with low morale among both workers and supervisors due to the curtailment of traditional holidays, support the conclusion derived from practical experience in the North that outdoor activities on a large construction job during the months of December and January are almost counter-productive.

One further point requires mention. The safety of workers who are scattered over a long distance, as is the case in a big-inch pipeline spread, when they are exposed to sub-zero weather, high wind-chill factors, and "white-outs," has not been properly considered in the winter construction scheme.

Weighing the foregoing factors, it must be concluded that full-scale pipeline installation in the buried mode, or in any other mode, during December and January borders on the impractical. The additional cost due to potential premature mobilizations and additional holiday premiums for workers and supervisors, together with the cost and the production impact of artificial lighting, make it impossible to predict with any degree of accuracy either the cost or the rate of progress of the construction. If one assumes that construction in the North during December and January is not practical, the winter construction "window" becomes 85-95 calendar days. By comparison, an extended summer season schedule should yield 180-200 calendar days, and an all-year schedule 250-280 calendar days. If one takes the average production rate for winter work at 50% of an extended summer season production rate, which has roughly twice the number of days per schedule season, the direct field cost for the winter construction scheme (comprising labour costs, equipment capital cost, logistics facilities, etc.) will be four times as great. This figure does not include the significant impact of learning curves for twice the number of workers and supervisors for a limited season, and their inevitably lower average skill. Moreover, the Alyeska experience fully supports the DOE risk analysis evaluation of schedule slippage during the winter construction of a gas pipeline. Both the short section of the mainline in the elevated mode and the fuel gas pipeline "slipped a season."

Considering the massive negative factors of the projected cost increase and the high probability of schedule slippage, with little or no potential reduction in direct environmental impact, there appears to be valid reason to reassess the merits of a winter construction scheme. Furthermore, from a socio-economic point of view, a winter construction scheme is most undesirable. The inevitable vastly increased demand for equipment is certainly not in the national interest;

nor is the potential delay of a year in a planned schedule. The high seasonal business and employment is not desirable from any regional economic point of view.

10.6 THE ALYESKA FUEL GAS LINE

The Alyeska fuel gas line is designed to supply gas to pump stations 1 through 4. It runs from Prudhoe Bay to pump station no. 4 south of Galbraith Lake, for a total length of 146.6 miles. The size is norminally 8 inches in diameter. The pipeline is located partially adjacent to the state highway, and partially adjacent to the gravel construction pad for the main pipeline.

Alyeska proposed the use of a snow pad adjacent to the highway or the gravel pad for winter construction during the 1975-76 season for this pipeline. The scheme was approved by APO, and construction commenced in December 1975. By mid-February 1976, approximately 8 miles had been completed, and by April 30, 1976 a total of 35 miles. From April 30 to the end of the season (about mid-June), another 35 miles was completed, giving a season total of approximately 70 miles. The work was rescheduled for the 1976-77 season. By February 13, 1977, some 27 miles of snowpad had been constructed and approximately 26 miles of ditch excavated, but no pipe lowered into the ditch. Completion was scheduled for May 1, 1977.

The figures indicate that during the 1975-76 winter season very little work was accomplished before mid-February. Production after April 30 to breakup equalled the total for the season prior to that date. During the 1976-77 season, no pipe lowering-in or backfill had been started by February 1977. Moreover, pictures taken during summer

1976 show that considerable disturbance of the tundra had taken place (Appendix 10-A2).

Conclusions

Snow pads can be constructed to the various classifications outlined in the Alyeska snow-ice road manual.

When a ditcher can be used and excavated material is removed from the ROW and backfill is done with processed non-frost material, minimal terrain disturbance takes place. However, when blasting for the ditch is required, the ground adjacent to the ditch gets disturbed, the snow pad gets contaminated, and the terrain disturbance along the ROW is considerable.

It is impractical to schedule production work in December and January because workers in the north, who have been away from their families for extended periods of time, want to go home for the holiday period. Furthermore, darkness and severe weather severely limit outdoor activities and affect the morale of the workers during this period.

Experience on the fuel gas line clearly shows that winter construction is no panacea for environmental protection, as far as terrain disturbance is concerned. In fact, if the highway and the gravel pad had not been adjacent to the snow construction pad to handle the transport traffic during construction and to facilitate the remedial work during the summer, the terrain would have been even more damaged than it was.

10.7 ALYESKA WINTER CONSTRUCTION OF MAIN PIPELINE - ELEVATED MODE

Field Data

On March 27, 1975, APO issued a NTP for the construction of an elevated mode section of the main pipeline on A.S. 117-118, a distance of approximately 5 miles. Snow for the construction pad was collected, with snow fences installed during December 1975. The pad was graded and compacted during January 1976. The installation of VSM's cross-members and pipe was carried out from February through April, 1976.

The snow pad served the intended purposes during the construction activities. Although the work on the section did not get completed before spring break-up, the schedule slippage was not related to the utility of the snow pad. Reports by APO/TSC and CRREL concur that the terrain disturbance by the construction activities was minimal, and aerial photos taken in late summer 1976 show little impact on the tundra along this section of pipeline.

The pipeline on this section parallels the main Yukon-Prudhoe Bay road, which was used for all supply and logistics traffic. Thus the snow pad was used for construction purposes only.

It should also be noted that grades both transverse and longitudinal were slight to moderate for this section of the pipeline.

Conclusions

A snow pad is practical for the installation of a large-diameter pipeline in the elevated mode.

A snow pad adequately protects the tundra if it is constructed according to Alyeska design standards after there is sufficient freeze-up and if use is discontinued before break-up in the spring (see pictures, Appendix 10-A3).

Except for activities connected with the snow pad construction, no activities of the VSM-Pipe installation took place during December and January.

10.8 NOTES FROM MEETING WITH DR. TERRY MCFADDEN AND PHILIP JOHNSON OF CRREL, FORT WAINWRIGHT, ALASKA, MARCH 16, 1977

The Cold Regions Research and Engineering Laboratory (CRREL) of the U.S. Corps of Engineers is conducting an ongoing operation of "spot" observations for various types of work, covering the performance of both equipment and workers. CRREL's final reports will be prepared in Hanover, N.H. Their observations have led them to the following preliminary conclusions:

Productivity

- factors ranging from 1 to 10 have been recorded for the time required for workers to perform tasks in cold weather, as compared to the summer season, depending on the type of work and the chill factor;
- the worst impact is on any activities requiring exposure of hands, such as equipment repair; the least impact is on simple manual work;
- equipment is affected as much as workers. It almost seems to acquire human idiosyncrasies when it gets cold, and a lot of small things go wrong;
- in general on Alyeska work, a factor of 3 may be a good average for winter vs. summer;
- the months of December and January have for practical purposes been non-productive, due to bad weather, darkness, and the fact that workers want to go home;
- most types of work can be accomplished in the winter, but at "a cost";
- the answer is to create your own climate.

Artificial Lighting

- no full-scale operations were observed, but considerable work in fixed locations was carried out under artificial light;

- the operation and maintenance of lighting equipment falls in the most affected class, in terms of productivity.

Fuel Gas Line

- all observations were taken during the 1975-76 season;

- construction of the snow pad is no particular problem. The standards set in the Alyeska Manual are sound and can be accomplished in the field;

- works well for most construction equipment, but there were traction problems and consequent breakdown of the surface for trucks and truck trailers, particularly on the slopes - used dozer for assistance (Note: Exactly the same as Green report);

- ditching in silts, etc., was fine, but the ditchers did not perform in frozen gravel;

- there was considerable disturbance to the ground where the ditch needed to be blasted, as well as contamination of the snow pad.

- in the spring, rock dust was put on top of the snow pad to complete the work. The cleanup and restoration work afterwards did disturb the tundra; and would have been impossible without the adjacent highway or gravel pad.

- no follow-up observation on terrain degradation was conducted by CRREL during Summer 1976.

Regarding Winter Construction

- environmental impact evaluations were not part of CRREL's Alyeska programs;

- in general, they cannot see that environmental protection is "automatic" with winter construction;

- this season (i.e., 1976-77) the drilling at Naval Petroleum Reserve No. 4 was much delayed due to lack of snow. The plan had been to work from central camp with snow roads to each drill site, but little was accomplished before January;

- from the point of productivity, don't do anything in the early winter which can be done in the moderate seasons;

- there are lots of problems with stream crossings during early winter.

WINTER CONSTRUCTION-FUEL GAS LINE

Total Length	774,036 ft.
	146.6 Miles

1975-76 SEASON AS PER ALYESKA AND APO REPORTS

PROGRESS ANALYSIS:	April 30, 1976	June, 1976 End Season
Snow Pad	435,397	
Ditch	287,012	365,407 (AL)
String	398,138	578,326 (MRI)
Weld	371,512	508,407 (AL)
Lower-In	230,519	375,397 (MRI)
Back-Fill	186,386	365,407 (AL)

1976-77 SEASON AS PER ALYESKA PROGRESS REPORT

	February 13, 1977	Plan May 1, 1977
Snow Pad	145,000	405,000
Ditching	138,699	405,000
String	45,061	206,000
Weld	14,470	272,000
Lower-In	Nil	405,000
Back-Fill	Nil	405,000

WINTER CONSTRUCTION

ALYESKA BELOW-GROUND PRODUCTION RATES

NORTH SLOPE - SPRING, FALL AND "BORDER LINE" WINTER

Week Ending	Production Rate (miles per day)	Week Ending	Production Rate (miles per day)
Oct. 5, 1975	0.36	April 25, 1976	0.11
Oct. 12, 1975	0.10	May 2, 1976	0.16
Oct. 19, 1975	0.40	Oct. 3, 1976	0.043
Oct. 24, 1975	0.41	Oct. 10, 1976	0.014
Nov. 2, 1975	0.07	Oct. 17, 1976	0.043
Nov. 9, 1975	0.13	Oct. 24, 1976	0.57
Nov. 16, 1975	0.14	Oct. 31, 1976	0.014
Nov. 24, 1975*	0.014	Nov. 7, 1976	0.028
Nov. 30, 1975	0.03	Nov. 14, 1976	0.10
April 11, 1976	0.44	Nov. 21, 1976	0.13
April 18, 1976	0.20	Nov. 28, 1976	0.10

* Begin winter shutdown.

Source: Alaska State Pipeline Coordinator Office.

Appendix C

LETTERS FROM ARCTIC CONSTRUCTION EXPERTS

Bearfoot, Inc.

H. C. Price of Canada Ltd.

Majestic Wiley Contractors Limited

Travis E. Smith

Frank Moolin and Associates, Inc.

Curran Houston, Inc.

:ARFOOT INC.

130 West International Airport Road · Suite M · Anchorage, Alaska 99502 · (907) 279-6823

July 9, 1979

Mr. R. N. Hauser
Northwest Alaskan Pipeline Corporation
P. O. Box 1526
Salt Lake City, Utah 84110

Dear Mr. Hauser: Re: Contract A79-152

Transmitted under cover of this letter is our analysis of the current state of the art of snow road and snow pad construction as practiced on the North Slope of Alaska and its relation to a winter big-inch pipeline construction.

We are prepared to do further work on this or related subjects as you may require.

BEARFOOT, INC.

Robert E. Hiukka

Robert E. Hiukka, President

James K. Trimble

James K. Trimble, P.E.

REH/km

Enc.

INTRODUCTION

Snow roads as used on the North Slope of Alaska, particularily in the Prudhoe Bay area and vicinity have been constructed with water saturated snow, built up thin layer by thin layer to a thickness of 6 to 12 inches. These roads have served primarily for rubber-tired traffic in the winter haul of gravel for the construction of permanent gravel roads, drilling pads and production facilities. These roads for these specific uses have been employed to minimize damage to the tundra and effects on wildlife. They were used for construction of the high voltage overhead electric distribution system at Prudhoe Bay and in conjunction with the gravel road network for the relatively short oil and gas gathering lines. Other uses have included access roads to winter test sites and infrequent or low density rubber-tired heavy load transport accesses.

The owner of Bearfoot, Inc., Robert Hiukka has built many snow roads on the Arctic Slope. First as Superintendent for Rivers Construction Company from 1969-1974, he was in charge of all civil works for Rivers Const. in the Prudhoe Bay oil field. He built snow roads to haul large amounts of gravel at Prudhoe Bay for B.P.-Sohio and Atlantic Richfield Company. These were successful operations with minimum damage to the tundra. Later with Arctic Constructors for the Alyeska Pipeline Construction as a construction super-intendent, he built snow roads for access and gravel hauling for the pipeline pad in the Franklin Bluff's section of the pipeline just south of Prudhoe Bay. While with River's Construction, he built a snow airstrip for Hercules Aircraft specification 150' wide by 5,000' long, at Happy Valley Camp about 100 miles south of Prudhoe Bay.

Another principal, James K. Trimble was involved in the snow road construction as chief site engineer and assistant construction manager for Brown and Root. He was in charge of construction for the B.P.-Sohio portion of Prudhoe Bay. As Director of Engineering, he was in charge of Arctic Gas experimentation for snow roads and construction pads in Alaska.

The principals of Bearfoot, Inc. have been actively engaged in Arctic planning and testing of snow road construction.

The unsuccessful Arctic Gas proposal involved several hundred miles of snow road and snow construction pad area across Northern Alaska and Canada and down the Mackenzie River Valley. Bearfoot also made several trips to northern Canada and the Mackenzie River Valley in regard to snow road construction for both the Alaskan and Canadian portion. In addition Bearfoot directed ice aggregate experiments for both Alaskan Arctic Gas and Atlantic Richfield Company.

For the last two winter construction seasons, Bearfoot, Inc. has furnished construction management assistance to Husky Oil Co. in the National Petroleum Reserve on the Alaskan North Slope, on civil works which included snow roads, snow landing fields and winter cat trails.

IMPACT FACTORS

There is no significant accumulation of snow on the North Slope until November and some of the years much later. In at least two years since 1969 there has not been enough snow to construct snow roads until January or February unless supplemented by other materials or hauling from natural snow traps.

The North Slope is characterized by frequent winds which are often high enough to blow snow and increase the chill factor making work at times not only difficult but often impossible. The wind is also an important factor in the accumulation of snow either by natural or man made traps, thus affecting availability for snow road construction.

Construction of snow roads is temperature dependent. Either too high or too low temperatures increases the difficulty of construction. Although the overall average temperature is fairly constant from year to year, there is often significant variation on a weekly or monthly basis.

Permits are required from State and Federal Government to get on the tundra in the fall and they are subject normally to cancellation on 72 hour notice during the approach of breakup time in the spring. The time of issuance of permits is heavily dependent on the freezing of the unfrozen layer of tundra, the active layer between the top of the ground and the top of the underlying permafrost layer, and also the presence of sufficient snow cover to protect the surface vegetation.

In our experience, the tundra has been completely frozen sometime in November, often by the middle of November. It can be said with reasonable certainty that the tundra is frozen, in most years by mid November. Snow cover is another question and it is doubtful that in most years there will be sufficient snow naturally available to start in November. It has been our experience that there may in some years be a deficiency into January.

CONSTRUCTION PROCEDURES

The construction procedures used in the 70's at Prudhoe Bay evolved from experience and basic methods used earlier in the 60's and results are similar. The roads are essentially snow saturated with water and built up in thin layers of 2 or 3 inches at a time with densities in the order of 0.8 in comparison with ice at 0.9.

Although these snow roads are approaching the density of ice, their behavior is different than a road constructed by freezing water poured out on the ground, being tougher and more resistant to cracking and chipping. Not only does the snow serve as a sponge to contain the water until it freezes, it also promotes a mat of ice crystals which interlock and are stronger than the ice structure of standing water which is frozen and has the ice crystal all oriented in one direction.

Snow road construction starts with stripping the existing snow layer down to the tundra, leaving just enough snow that the dozer operator doesn't scar the existing vegetation or cut off the natural ridges of the tundra.

It is necessary to remove the snow from depressions, as all of the road has to be built up in thin layers to avoid bridging over snow pockets. These pockets would be weak and the surface would soon break through under any traffic necessitating continuing repair.

After the snow is removed from the tundra, the tundra is flooded with water and allowed to freeze.

Then a layer of snow about 2 to 4 inches deep is applied and dragged or bladed over the route, leveled and then sprayed with water to saturate the snow. This surface is compacted and smoothed with the special drag and then allowed to freeze. This is repeated in several layers until 6" to 12" of dense, hard, durable road surface is built up.

Repairs are accomplished in the same way as construction, with pot holes and other areas being filled in with snow, saturated and allowed to freeze before being subjected to traffic. Most snow roads are made wide enough to allow traffic to bypass areas being repaired.

Our own experience has been with snow roads used primarily by heavy hauling equipment mounted on rubber tires such as scrapers, dump trucks and front end loaders. There was occassional traffic with tracked dozers and other equipment but it was avoided when possible, as the tracked vehicles would require the necessity for repair on a frequent basis.

There was considerable tracked equipment used on the construction of the 10 inch gas line south from Prudhoe Bay to the Brooks Range. Most if not all of this snow pad was directly off the shoulder of the gravel haul road and was not used for logistic traffic, which used the main gravel road. Thus there was much less traffic on the snow pad than would have been the case if it had been the only surface utilized. Furthermore this pad was, to the best of our knowledge, not constructed by the layered snow and water method previously described.

We do not believe that there have been any examples of snow road construction which would demonstrate those wearing and maintenance qualities required for a full big-inch pipeline spread working solely from snow roads.

REQUIREMENTS FOR EARLY START OF CONSTRUCTION

The worst period for construction during the winter is January and February with the extreme cold and long hours of darkness.

Due to inadequacy of snow in the early winter in November and December, prime winter construction months, it may be necessary to supplement the natural snow with other materials and methods.

We participated in some research in the winter of 1976-1977 on the use of snow fences to entrap snow during the early part of the winter. These experiments were encouraging, however, only a preliminary beginning was made with much work remaining to be done before it could be even considered for a major construction project.

Snow making has been tried but to date without a great deal of success. It is a slow, costly method involving handling very large volumes of water at a time of the year when water supplies are low or non-existant requiring long hauls and vast numbers of water trucks to cover long distances. Research had been projected for large scale experiments on very large scale equipment but was not accomplished.

We have been involved in experiments in using crushed ice in lieu of snow for making ice aggregate roads in Fairbanks in February 1977 which was successful on a very small scale. However, the surface of this type of road was severely abraded with the introduction of track vehicle traffic.

More recently we were involved in an ice aggregat. experiment under entirely different conditions in the field on the North Slope but they were inconclusive and the data so far obtained is the proprietary information of the client.

It would appear that this method has some promise for an early start in construction but a great deal of work and experimentation remains to be done before the method could be perfected or shown to be applicable as a pipeline work pad.

We do not believe that there has been any Alaskan North Slope experience with construction and use of snow pads built on side slopes requiring a snow pad of non-uniform thickness. These roads and pads present additional problems in construction and maintenance. Such construction at a minimum would require considerably more snow which may be short supply. It is unknown if it is possible to contain the necessary water on the side slope to maintain a uniform density for strength. The development of highly sophisticated and specialized water application methods and equipment would of necessity need to occur for this type of large scale application. Even then it cannot be guaranteed that the thick side of the snow road will stand up under the concentrated traffic loads of sideboom tractors.

INHERENT RISKS

Present techniques of snow road construction as practiced on the North Slope are highly dependent on weather conditions of temperature, wind, snow fall and snow accumulation on the ground. Variations in weather has shown by experience the inability to predict when it can be reliably stated that a full scale snow road could be constructed. This ability to predict is a basic requirement for any contractor to bid fixed price on a definite starting date and on a known construction schedule.

It may be possible that sufficient snow has accumulated in November sometime to permit construction of a snow road or working pad. However, in our experience, there have been years when even as late as January and February there has been a severe shortage of accumulated snow. Under these conditions, using presently developed techniques, a work pad could not be completed in time for large scale pipeline construction. As another weather dependent variable, temperatures should ideally be about -20°F. When the temperature is substantially above or below, snow pad construction would be greatly slowed down.

It is very difficult to make any progress at temperatures much above 0°F as freeze back times are greatly increased. At temperatures much below -20°F water penetration into the snow is poor and water handling problems are great. At this temperature construction becomes difficult and slow.

Construction may require hauling snow in from catchment areas which is slow, costly and inefficient due in part to the light weight of snow and other gathering and handling problems.

The winter construction period means construction during the period of the year when temperatures are usually very low, when high winds are common, greatly increasing the effect of cold by wind chill and producing white-out (a reduction or complete loss of visibility due to blowing snow.) In addition, the periods of daylight varies from a few hours to virtually none. For nearly two months the sun does not rise at all and there is only a mid-day twilight, resulting in the great inefficiency of having to do everything in the dark under the difficulty of trying to keep adequate portable lighting systems running under arctic conditions. Operating under the conditions of poor lighting and intense cold results in very poor working conditions and a low level of workmen efficiencies. In many operations where the worker is exposed to the weather the efficiency may be 25% or less. Equipment breakdown is more frequent, lubrication impaired and maintenance and repairs are difficult and costly.

The construction of the saturated snow road requires large quantities of water. In the winter time supplies of water are very limited. The quantity decreases rapidly in the early winter as ice thickness increases. The constraint is added to severe restrictions on water removal from fish bearing lakes and rivers. As a consequence, water probably would have to be hauled long distances requiring a large fleet of water trucks.

Access to an area during a second winter season will require the construction of an entirely new set of roads and work pads which is a duplication of previous work, as of course, the structure is lost at the melting at breakup. This creates the potential for delay in the construction schedule and the associated cost over-runs.

As influenced by the conditions of weather, construction rates would be unpredictable for any designated period making scheduling difficult.

In our experience there has been little use of snow roads for tracked vehicle use. Those used have been for gravel hauling with rubber-tired equipment for road and drilling pad construction and drilling rig moves. Tracked vehicles abrade the surface and for such reasons are ordinarily kept off the snow roads. There has been no large scale experience to our knowledge in handling large pipe over the ditch on a snow pad. It is expected that abrasion and pad deterioration will be severe. Due to the congestion of the working area, maintenance will be difficult and disruptive as it requires wetting and refreezing of the surface. Traffic must be halted in this area and cannot resume until refreezing occures.

We have directed our remarks to the proven methods of snow road construction. There are possibilities of being able to develop means for collecting early snow, for manufacturing snow on a grand scale and in using new techniques and materials such as ice aggregate. These developments are either in the conceptual stage or are in the early experimental stage and not yet are ready for a project of this type. A large scale testing and Research and Development program would be required and positive results obtained to justify utilization on a large scale "fixed price" project.

As a conclusion, we do not believe that the present use of snow road construction is predictable enough to permit a contractor to present a reasonable fixed price bid for pipeline construction from a snow pad on the Arctic Slope. It would be extremely difficult to get fixed price bids due to the following reasons:

- Not complete control over natural events
- Confined working schedule
- Simultaneous construction tasks
- Limited schedule flexibility
- Snow pad not known to be resistant to severe deterioration by pipeline equipment and concentrated work areas.
- Requires additional equipment
- Severe weather problems encountered
- Low workmen productivity
- Increased maintenance problems
- Reduced daylight work time

In summary, the unpredictable nature of the entire snow road concept contributes to the inability of any contractor or company to assess potential final cost with any degree of accuracy.

H. C. PRICE OF CANADA LTD.

214 - Chinook Centre, P.O. Box 5038, Postal Station "A",
Calgary, Alberta T2H 1X1

Telephone (403) 253-2815

Telex 038-24696

August 22, 1979

Northwest Alaskan Pipeline Company
P.O. Box 1526
Salt Lake City, Utah 84110

Attention: R. N. Hauser
Director of Construction

Gentlemen:

Subject: Contract No. 179-158, Report on Winter Construction and use of Snow Roads

Pursuant to your request we are pleased to enclose herewith our summation of our views concerning winter construction of a large diameter pipeline under arctic conditions.

We are pleased to assist you in your efforts and should you need any further assistance or have any questions please feel free to contact me.

Yours very truly,

J. G. Beddome
President

DRB/dh

encl.

H. C. PRICE OF CANADA LTD.
214 · Chinook Centre, P.O Box 5038, Postal Station "A",
Calgary, Alberta T2H 1X1
Telephone (403) 253-2815 Telex 038-24696

A COMPARISON OF WINTER PIPELINE CONSTRUCTION TECHNICS

Pipeline Construction Technics in Northern Regions vary depending upon the many variables affected by the design and construction of major pipeline projects in different locations. Some of the parameters affecting pipeline construction methods are as follows:

A. Terrain
B. Soil Conditions - Muskeg, permafrost
C. Weather - Temperature and Precipitation i.e., rainfall and snowfall
D. Daylight working hours per day
E. Construction time frame and related progress
F. Vegetation - heavy timber, sparce growth

Primarily, pipelining in northern regions must be broken down into summer or winter construction based on the preceding parameters. By assessing the impact of each variable, a viable construction sequence must be evaluated to determine the best practical way to approach a particular project obtaining a construction procedure which will be both environmentally sound and effective to the extent of project completion within the construction time frame alloted in an efficient, safe and cost affective effort of the owner companies, state and federal agencies and the contractor.

From a construction point of view, the most important aspect is the related progress that must be achieved to complete the project both on schedule and under budget. However, overcoming the terrain and weather conditions in northern regions can become the foremost obstacle in achieving these goals.

In Northern Canada and Alaska how to approach building a large diameter pipeline with the existing ground conditions such as permafrost and muskeg along with the extremely harsh weather conditions and their effects that plague construction efforts becomes a major concern. Looking at pipeline practices in Northern Canada and Alaska there are two methods of construction which are used to proceed with the work in an effective manner. They are as follows:

1. Build the pipeline in the winter utilizing winter construction practices to overcome the inherent soil problems. Canadian construction practices dictate that

H. C. PRICE OF CANADA LTD.
214 - Chinook Centre, P.O. Box 5038, Postal Station "A",
Calgary, Alberta T2H 1X1
elephone (403) 253-2815 Telex 03^c-24696

where stable soil conditions exist these areas are con-constructed in the summer while areas which have muskeg and ice rich soil are constructed during winter months.

2. For Alaskan pipeline projects, working from a work pad placed on the right-of-way to protect the ice rich layers of soil provides a workable surface to support heavy equipment.

In the past, a method of construction in Northern Canada has been devised and is working extremely well in areas where there is a combination of both heavily timbered areas with intermixed areas of low lying muskeg and small bush.

In this instance, to move the pipeline spread across these areas of muskeg it is more economical to use the winter construction technics rather than summer construction practices.

One of the advantages in Canadian winter pipeline construction seasons compared to Alaska is the approximate eight working hours of daylight. Also, the time frame for winter construction in Canada is generally from November 10 thru December 15 at which time pipeline operations would normally be shut down with work resuming on approximately January 5 thru March 25 of the following year. During this time one could expect to have at least one to two weeks of extremely cold weather in January along with extremely harsh conditions in which to achieve any suitable production.

Assuming the type of terrain in Canada as previously mentioned, the typical construction sequence would be as follows:

> The initial construction crews beginning on the pipeline right-of-way would be the clearing and grading crews. As the timber and brush are being cleared the grading crew is immediately following this operation. Snow and loose debris from clearing and grade operations would be pushed into a berm over the ditch line to heights of up to ten feet with an approximate width of fifteen feet to create an insulation barrier over the ditch line thereby protecting the soil over the ditch from the extremely low temperatures.

H. C. PRICE OF CANADA LTD.
214 - Chinook Centre, P.O. Box 5038, Postal Station "A",
Calgary, Alberta T2H 1X1
Telephone (403) 253-2815 Telex 038 24696

The winter construction method previously mentioned may appear to be desirable to construct pipelines in areas such as Alaska, however the concept differs due to some of the same parameters previously listed.

For instance, the severe weather conditions along with reduced daylight working hours are good examples. The long summer construction season available in Alaska negates the use of conventional Northern Canadian pipeline practices as previously discussed or the use of snow pad construction for winter pipelaying.

An alternate previously used to construct pipelines in potential ice rich areas is one of building a gravel work pad along the right-of-way in order to prevent vegetative growth of permafrost areas from being damaged to a point that degradation of ice lenses occurs prompting settlement and permanent soil instability. In doing so, this alternate has many other advantages over building of a snow pad in winter months as a working surface.

By using the gravel work pad for pipeline construction in Alaska, the contractor is able to take advantage of the eight months of workable temperatures along with sufficient daylight hours.

Also, during the actual pipelaying activities, working from a level gravel work pad on steep terrain can be a vital advantage for standard pipelaying. In section III (North and South of Fairbanks) of the Alyeska Project H.C. Price Co. experienced one section of constructing the 48" pipeline where snow pad construction was mandated due to sensitive soil conditions. When laying pipe in choppy terrain with sidehill slopes it is very difficult for the equipment to maintain the traction needed. Once the pipe is skidded up, it has a tendency to slide downhill creating a very dangerous situation to workers. On this particular location H.C. Price Co. had a near fatal accident resulting from just this kind of a problem.

In addition the extensive heavy equipment traffic requires a constant repair and maintenance program for the snow pad. The turning of tracked equipment and the heavy weights particularly with sidebooms shifting weight on only one of the tracks causes immeasurable damage to the snow pad and makes the snow pad maintenance non existant in a short time.

H. C. PRICE OF CANADA LTD.

214 - Chinook Centre, P.O. Box 5038, Postal Station "A",
Calgary, Alberta T2H 1X1

Telephone (403) 253-2815

Telex 038-24696

In relying on a snow pad for means of construction, all operations are more dependent on the weather, for example having delayed winter temperatures or an early spring break-up can disrupt all planning and co-ordination of intricate construction schedules to meet environmental deadlines. In conclusion, H.C. Price Co. having worked both Alaskan and Canadian pipeline projects during both summer and winter schedules have concluded that even though winter pipeline technics such as those used effectively in Canada, may not be desirable for other areas.

Contractors recognize certain environmentally critical areas must be constructed during winter months and in our opinion the gravel work pad enables the contractor to perform his duties in these areas in the winter and complete the non sensitive areas during the summer construction period.

James G. B[illegible]

MAJESTIC WILEY CONTRACTORS LIMITED

George M. Oswald
Vice-President, Construction

September 18, 1979

Northwest Alaska Pipeline Company
P.O. Box 1526
Salt Lake City, Utah
84110

Attention: R. N. Houser
Director of Construction

Subject: Contract No. A79-159 Report on Winter Construction and use of Snow Roads

Gentlemen;

We herewith submit our opinions to the best of our knowledge on the construction of large diameter pipelines under Artic Conditions.

We appreciate the opportunity to assist you on this subject and any further assistance you may require please feel free to contact us.

Yours truly,

MAJESTIC WILEY CONTRACTORS LTD.

G. M. Oswald
Vice-President, Construction

GMO/ce

Encls.

10123 - 118 STREET, EDMONTON, ALBERTA T5K 1Y4 — TEL: (403) 482-5921, TELEX: 037-2713

MAJESTIC WILEY CONTRACTORS LIMITED

A Comparison of Winter Pipeline Construction Methods

Winter pipeline construction in Northern Canada has been determined by the following:

A) Access

B) Ground conditions   Muskeg - Permafrost

C) Weather conditions

D) Time frame

E) Environmental restraints

F) Fish - Wild life

A construction plan must be prepared taking into consideratin all of the above mentioned items to ensure that the project meets all environmental requirements, completion dates, and to ensure a safe but cost effective pipeline is constructed which will satisfy the requirements of the Owner, Governmental Agencies and the Contractors.

Looking at winter pipeline construction in Northern Canada and Alaska, where there is a considerable amount of Permafrost and muskeg to contend with, there are only two methods to follow which we believe will satisfy all concerned.

The current approved winter construction method used in Northern Canada, could be used on the southern portion of the proposed Alaskan Gas Pipe Line.

The time frame for winter construction in Northern Canada is generally from November 10th through the end of March.

.../2

10120 - 118 STREET, EDMONTON, ALBERTA T5K 1Y4 — TEL: (403) 482-3921, TELEX: 037-2713

Time between November 10th and the month of January is the time usually set aside for Clearing, Grading and obtaining the proper frost penetration. The months of February and March are basicly for completing all the pipe related activities.

The initial construction crews on the pipeline right-of-way would be the clearing and grading crews. As the timber and brush are being cleared the grading crew is immediately following this operation. Snow and loose debris from clearing and grade operations would be pushed into a berm over the ditch line to heights of up to ten feet with an approximate width of fifteen feet to create an insulation barrier over the ditch line thereby protecting the soil over the ditch from the extremely low temperatures.

By utilizing this technique, the soil is prevented from freezing enabling the ditching equipment to excavate under almost normal summer conditions. In addition the equipment should stay off the ditch line as much as possible to prevent driving the frost down. In the low lying areas (muskeg and wet areas), wide pads would be used to remove the snow to obtain the opposite effect of the insulation barrier. By using low ground pressure equipment, the snow can be removed without the equipment breaking through these soft areas. Also, the same pieces of equipment would "walk down" the frost to a desirable depth from two feet or more under normal winter temperatures. In effect, an ice bridge is created across an area which before would have prevented passage of heavy equipment.

As ditching commences, the removal of berm to spoil side of ditch would be immediately in front of the ditching crew and removed only to anticipated length to be ditched in a single day.

.../3

To facilitate this method of winter construction, the sequence of operations would be changed somewhat from normal cross-country pipelining practices. Instead of bending and laying pipe (welding) behind the ditch, the pipe is bent, welded and placed on skids in front of the ditch operation. This procedure prevents the backfill from freezing in place on the right-of-way and provides the contractor with near summer backfilling conditions.

The previous mentioned methods of pipeline construction can not be used on the northern portion of this anticipated project. We would propose an alternate previously used to construct pipelines in potential ice rich areas of building a gravel work pad along the right-of-way in order to prevent vegetative growth of Permafrost areas from being damaged to a point that degradation of ice lenses occurs propting settlement and permanent soil instability. In doing so, this alternate has many other advantages over building of a snow pad in winter months as a working surface.

By using the gravel work pad for pipeline construction in Alaska, the contractor is able to take advantage of the eight months of workable temperatures along with sufficient daylight hours and to be able to ensure the anticipated progress to meet the completion dates and to come within budget.

Furthermore, once this gravel pad is in place it will be an asset to the Owning Company for their maintenance program to enable them to comply with all Governmental requirements.

The question arises: Can the use of a Snow Pad accomplish the same end results as a Gravel Work Pad?

We are not aware of any pipeline being constructed from a Snow Work Pad

.../4

in Northern Canada, although being Assistant Project Manager on Section II of the Alyeska Pipeline Project we know of the problems that H. C. Price had on the short section that was installed off of a Snow Pad just out of Fairbanks, Alaska.

We wish to bring your attention to some of the problems that occured:

A) All operations are more dependent on the weather.

B) Additional Right-way Maintenance people are required for constant repairs due to the extensive heavy equipment traffic.

C) In order to hold the snow on the work pad, it has to be watered down thereby forming a "skating rink" for equipment and hands to work on, contributing to a higher accident rate.

D) Inability to maintain the same progress as working from a Gravel Work Pad.

E) No access for maintenance purposes.

F) Due to the rigid time schedule, the project would not be economically feasible to be constructed off of a Snow Pad.

Majestic Wiley Contractors LImited, having played a major role in the construction of the Alyeska Pipeline Project and being one of the major pipeline contractors who have pioneered winter construction pipeline proedures, highly recommend the use of a Gravel Work Pad.

TRAVIS E. SMITH
850 CHERRY LANE
BARTLESVILLE, OKLA. 74003

September 28, 1979

Mr. R. N. Hauser
Northwest Alaskan Pipeline Co.
P. O. Box 1526
Salt Lake City, Utah 84110

Dear Bob:

In accordance with your request, the following are my comments on the use of snow pads and snow roads for construction of the Alaska portion of the Alaska Natural Gas Transportation System:

1. Snow roads are only suitable for light vehicular traffic if extensive use is required. They can handle infrequent heavy wheel loads, but the thickness must be increased. Maintenance becomes a serious and costly problem when tracked construction equipment is used on snow roads or pads as the road/pad deteriorates rapidly under use. The pad must be maintained daily and the surface watered down each night so that it will harden prior to the next day's activities.

2. Generally there is insufficient snowfall during the winter from Fairbanks to Prudhoe to provide the quantity of snow needed for significant pad construction (e.g., there was only enough for infrequent 3-to-4 mile maximum segments on TAPS), and much of the snow has to be manufactured to meet the total requirements.

3. Snow fences North of the Brooks Range generally have been ineffective in collecting snow for snow pad requirements, because of the limited snowfall and the frequent shifting winds.

4. Manufactured snow is the only reliable means of providing your snow requirements. It is mandatory if snow pad construction is to commence in October and November. If snow is to be manufactured, the following must be borne in mind:

   (a) Making snow requires that a large volume water source be available during the full duration of the winter months. Such large sources are very limited in number and generally they are remote from the work site.

   (b) Snow or water normally must be transported significant distances from the water source to the work site.

   (c) Manufacturing of snow cannot begin until ambient temperatures are consistently below freezing.

(d) Snow normally must be manufactured 24 hours/day to meet placing requirements.

(e) The production rate from one snow machine is generally insufficient, so that numerous units will be required for extensive pad construction requirements. As an example, two machines operated 24 hours/day for three weeks to construct 2500 feet of snow pad in Section 3 of the TAPS line.

5. Use of ice aggregate for pad construction cannot commence until the thickness of ice on the lakes is sufficient to support mining equipment. Furthermore, large bodies of water will be needed to provide adequate quantities of material for significant pad construction. This will usually necessitate long haul distances from the source of supply to the work site.

6. The progress rate for snow pad construction is significantly less than for gravel pad construction unless large quantities of hauling equipment (either snow or water) are used.

7. You must allow a minimum of one month advance start for snow pad construction before subsequent activities can commence. Otherwise, critical construction activities will be delayed by the pad construction effort. Thus, a minimum of one month will be lost during the critical Fall-Winter shoulder months for pipeline construction.

8. A snow pad deteriorates rapidly during the Winter-Spring shoulder months. Use of snow pads will result in loss of a minimum of one month during this period for pipeline construction when compared with the use of a gravel work pad.

9. Use of snow pad is extremely sensitive to winter temperatures. An abnormally warm winter will make the use of snow pads impractical. When this becomes apparent, it will be too late to build a gravel pad. Should this occur, the critical Winter construction scheduled for that season will have to be delayed until the following year. There will be no assurance that the same situation will not occur again the following season.

10. Construction from a snow pad in hilly terrain is extremely hazardous since even tracked equipment with snow grousers tend to slide under load when on an incline.

11. Based upon my TAPS experience, the cost of work pad construction using snow will be at least ten times, if not greater, the cost of a gravel work pad.

Frank Moolin &
Associates, Inc.

July 27, 1979

AIC/FAI-0651

Mr. Edwin (Al) Kuhn
Director of Government &
Environmental Affairs
Northwest Alaskan Pipeline Co.
1301 "K" Street
Washington, D.C. 20006

Subject: Location of Gas Line

Dear Al:

Your letter of June 28, 1979 transmitted additional information and requested comments regarding the concept of the gas line "hugging" the haul road for substantial lengths of line, instead of being placed alongside an extended Alyeska work pad. Also, when I was in Washington, D. C., you related to me some of the discussions going on about locating the gas line along the Haines line right-of-way from the Salcha River area south of Fairbanks to Delta Junction, instead of paralleling the crude line. This letter will address these two issues.

Firstly, regarding proximity to the haul road I strongly disagree with and am bothered by the paragraph contained on page 2 of the June 13, 1979 letter from the DOI that says, "where the gas line is routed along the Yukon River to Prudhoe Bay State Highway, the minimum separation distance between the gas pipeline center line and the highway center line shall be nominally 44 feet...". The 44' distance from the center line of haul road to the gas line is much too close and is obviously predicated on statements included in Jack Turner's June 7, 1979 memo to the Assistant Secretary where he says, "...preferably such construction should be done in <u>winter when snow pads can be used</u> both for equipment support and storage". (emphasis added)

I can summarize my opinion regarding "hugging" the haul road by saying that it is practical to locate a buried gas line 55-60' from the center line of the haul road. This is somewhat less then the 70' proposed by Northwest in previous submissions to the DOI. However, the fact that it is practical does not necessarily mean that such a location would be the least costly.

The 55-60' spacing (haul road to gas line) is based on the following:

1). A gravel work pad would be built between the shoulder of the haul road and the edge of the ditch for stringing, line-up, welding, side boom cradling of the pipe, lowering into the ditch and backfill.

2). One lane of the haul road would be used as a part of the work pad for the movement of equipment and personnel along the line.

3). The other lane of the haul road will be kept open for one-way controlled, non-pipeline construction traffic.

4). No snow pads will be used. As I have indicated in earlier correspondence (my letter dated July 10, 1979 containing a draft copy of prepared testimony to the Dingell Committee), Northwest must not agree to build significant lengths of snow pad or snow road. This statement applies regardless of whether the gas line "hugs" the haul road, is built adjacent to the Alyeska work pad or is built at any other location. An all-weather, full width gravel work pad is absolutely essential to your project, and locating the gas line alongside the haul road does not change this situation.

I do not share many of Northwest's concerns about using one lane of the haul road as a part of the work pad. The haul road lane used as a part of the work pad would primarily be for passing of equipment. All work relating to stringing, line-up and clamping, welding, cradling, lowering-in and backfilling would be done off the gravel work pad, which would be built alongside of the shoulder of the haul road. I have included a rough sketch of this concept as an attachment to this letter.

Dust would be controlled by watering the haul road. One-way, non-gas line traffic could be safely controlled on the other lane of the haul road. I don't believe that the volume of traffic will be so significant that safety problems or bunching up of haul road traffic would develop. After completion of gas line construction, the haul road would have to be dressed and recontoured to repair the damage done moving heavy equipment over the haul road shoulder. Again, I don't believe this is extraordinarily difficult or costly to accomplish.

I believe the basic criteria for the location of the gas line, whether it is to hug the Alyeska gravel work pad, hug the haul road or be built from a totally separate and distinct work pad, should be cost and schedule effectiveness. In other words, Northwest should locate the gas line at that location where the total cost of the project would be the least.

At these locations where the Alyeska line is buried soil conditions are favorable to buried pipeline construction...in other words the ground is thaw stable. When possible, the gas line should also be buried at such locations, "hugging" the Alyeska work pad as close as possible, so that the advantages of the favorable soil conditions can be realized. Exceptions to this basic rule should be made only to reduce the number of river crossings or where another alignment is clearly more cost and schedule effective. Northwest people have rightfully pointed out that, to the extent that the gas line deviates from the crude line, changes due to unexpected subsurface conditions increases dramatically. One only has to look at the negative geotechnical surprises that Alyeska endured to support this statement.

To summarize the "hugging the haul road" situation, I do not have a basic concern about locating the gas line 55-60' away from the haul road, as long as there is a gravel work pad between the shoulder of the haul road and the edge of the ditch. I believe that one lane of the haul road can be used as a part of the work pad and therefore the width of gravel work pad that has to be constructed for the gas line can be correspondingly reduced. Of course, the cost effectiveness of this solution is directly related to whether or not a heavy wall pipe is going to be required by regulatory agencies. Intuitively, I believe that heavy wall pipe should not be required, but the number of dollars at stake is so significant that formal approval must be obtained from the regulatory agencies.

I will leave this issue by again expressing my concern about the number of times I see comments being made about building extensive lengths of the gas line from a snow pad, with the gas line as close as 44' to the center line of the haul road. Any attempt to do this would result in tremendous additional costs and schedule slippages.

By the way, several miles (perhaps as many as four) of the crude line were built immediately adjacent to the haul road in the Finger Mountain area south of Old Man Camp. I refreshed my recollection about building this length of the crude line by talking with some of the field people involved with its construction. There were no significant problems with building the crude line adjacent to the haul road, although the crude line was 75' from the center of the haul road. Of course, a full width gravel work pad was built between the haul road and the edge of ditch.

Now I will get into the subject of the re-rou·· proposed by the regulatory agencies in the Salcha River area south of Fairbanks and north of Delta Junction. I indicated to you that Alyeska also studied this re-route and did not resolve the final location of the pipeline until mid 1974. The so-called Salcha River re-route, similar to what is being proposed by the agencies in much of the correspondence that I reviewed, was rejected by Alyeska for the following reasons:

1). The re-route alignment traversed very rugged and choppy terrain.

2). There was no definitive data available about soil conditions on the re-route location.

3). Because of the side slope construction, a slope stability problem could exist.

4). Access roads, although short, would have to be numerous and contain exaggerated looping to maintain reasonable grades.

5). Considerable use of terraced, shoofly roads could be anticipated due to the rugged nature of the terrain.

6). There were numerous parcels of private patented land and a number of old and new mining claims on the re-route.

7). Although material for the work pad would be available, it would have to be hauled up very steep access roads.

8). The proposed re-route was about 8 miles longer than the Alyeska alignment.

9). Following the ridge lines and close to the Haines right-of-way and the Richardson Highway would mean the crude line would pass through high use recreational areas, and the visual impact would be significant.

10). There would be any where from 6 to 15 miles of steep side slope construction required.

11). Substantial through cuts would be required at as many as three locations.

The conclusion of the Alyeska study was that the cost of the re-route would be considerably greater than the cost of the present crude line alignment. Also, the uncertainties associated with the unknown soil conditions were such that the risks were just too great to change the alignment to a location closer to the Richardson Highway. I don't believe that the situations that exist today are any different than they were for the crude line so my recommendation to you is to stick with your proposed alignment.

As requested by John McMillian and John Mason, I am in the process of reviewing the construction communication requirements and should have something to you in 2 weeks. Also, I have again reviewed all of the documents given me, primarily the exchange of letters between DOI/Northwest and DOI/Alyeska, and my comments and recommendations regarding these will be in your hands shortly.

If there are any questions, please do not hesitate to get in touch with me. I am also available to meet with you at any time.

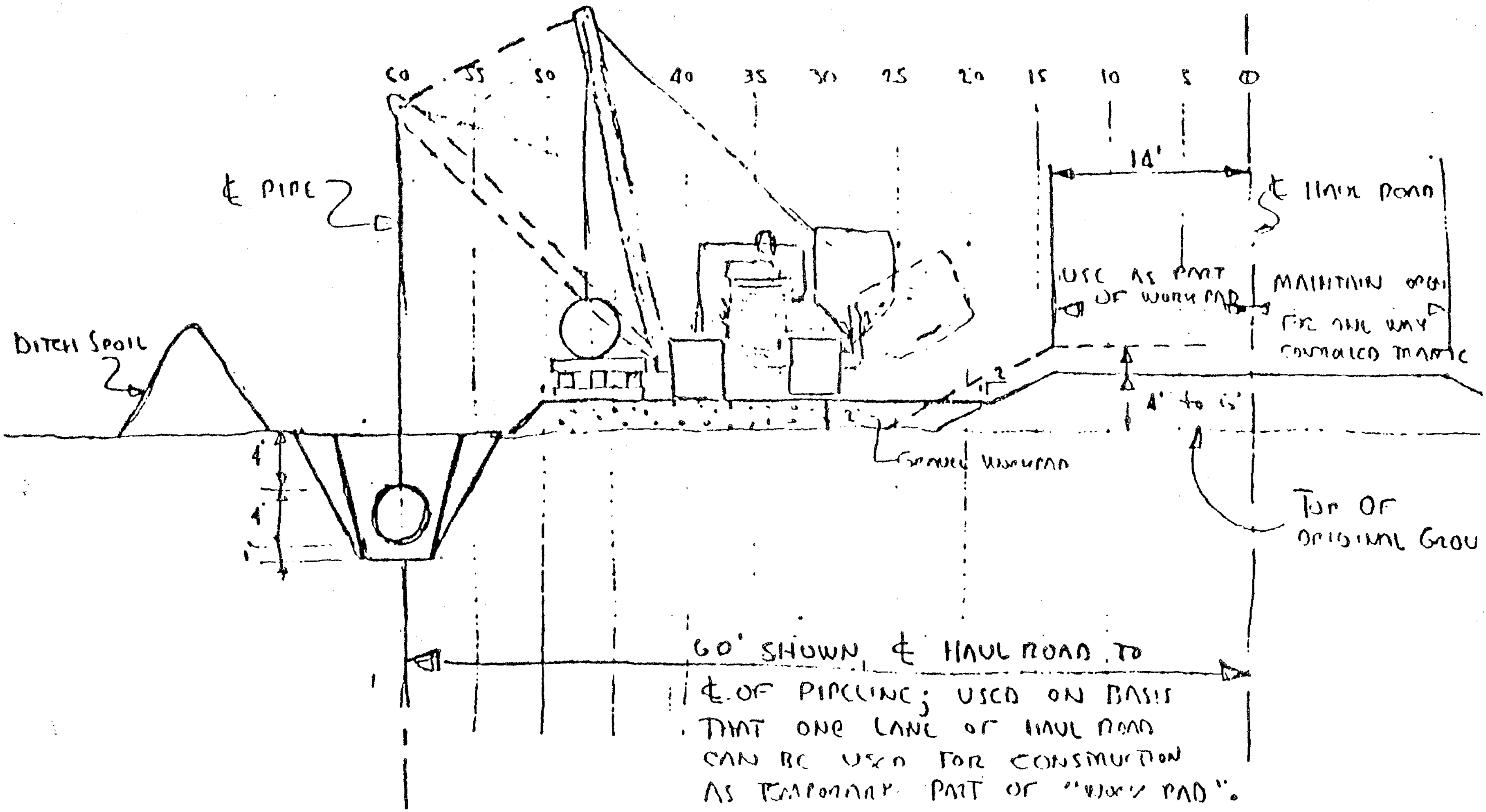
Sincerely,

Frank P. Moolin /Bj

Frank P. Moolin, Jr.

FPM:bjm

cc: John Mason/NWP/SLC
Darrell Mackay/NWP



60' SHOWN, ℄ HAUL ROAD TO ℄ OF PIPELINE; USED ON BASIS THAT ONE LANE OF HAUL ROAD CAN BE USED FOR CONSTRUCTION AS TEMPORARY PART OF "WORK PAD".

TRAFFIC TO BE CONTROLLED ON OTHER LANE OF HAUL ROAD.

POSSIBLE TO REDUCE TO 55' WHEN HAUL ROAD THICKNESS IS 4'.

JMcJ July 15, 1979

cc: NWAPL
TES
SHG

CURRAN HOUSTON, INC.
PIPE LINE CONTRACTORS
1770 YORKTOWN, HOUSTON, TEXAS 77056

713-961-4200
TELEX-77-5262

April 7, 1980

Mr. Robert N. Hauser,
Vice President
Northwest Alaskan Pipeline Co.
3333 Michelson Drive
Irvine, California 92730

Dear Mr. Hauser:

Subsequent to our conversation relative to our firms experiences in winter pipeline construction north of the Alaska Brooks Range and more specifically the utilization of snow work pads, I submit to you our comments which are based on our construction activities spanning a period of six years. During this period we have constructed over 300 miles of various size pipelines (6" thru 38") using the following construction modes.

1) Pipeline Construction Activities Performed in Winter and Summer

   A) Ditch excavation

   B) Hauling, stringing, fabrication, pipe laying, lowering-in, and tie-ins

   C) Drilling and vertical pipe support (VSM) installation

   D) Thermal insulation

   E) Hydrotesting (using water and water/antifreeze test medium)

2) Pipelines Constructed in Both the Above and Below Ground Modes

3) Pipelines Constructed Utilizing Both Snow and Gravel Work Pads

Approximately 76 miles of the work accomplished by our firm was installed utilizing a snow work pad. This 76 miles was the portion of the Alyeska Fuel Gas Line that was constructed during the 1976-77 winter season.

The construction plan for the Trans-Alaska Pipeline called for the system to go on stream in early summer of 1977. To that end, completion of the fuel gas line before break-up was of the utmost importance. To accomplish this task, our crews were mobilized in mid-November, 1976 to start snow pad construction. This proved to be a slow, costly operation since there was no significant accumulation of snow until mid-January and in some areas mid-February. To augment the amount of natural snow accumulated in November, December, and January, we resorted to several methods of entrapment. More specifically these methods were:

1) Erecting snow fences

2) Constructing a snow berm along the R.O.W. on the off-side to the prevailing winds

3) Utilizing natural traps and transporting snow to needed areas

The area from Franklin Bluffs to Prudhoe Bay is characterized by frequent winds high enough to move large quantities of snow. In this area, we were able to trap snow with an acceptable degree of success. However, our production in this area was very erratic and was controlled by the frequent shifting winds. Trapping of snow in all other areas proved to be very ineffective.

The costly and slow method of layering snow and water was not used. This method was considered, but was ruled out based on the following:

1) Schedule - Construction of a pad using materials other than natural snow could not be accomplished at a rate that would allow completion of the fuel gas line before break-up.

2) Cost - Due to the logistics involved in getting water to the work site and the large quantity of equipment that would be required, it was agreed that the cost of this type construction would be unacceptable. It was estimated that the cost associated with this method would be in excess of $100.00 per linear foot.

3) Pad Utilization - Since the snow pad was to be located immediately adjacent to the haul road or Alyeska work pad, traffic could be reduced to a minimum on the snow pad. Only the tracked equipment essential to pipe handling was allowed on the snow pad. All support equipment would traverse the haul road or gravel work pad. As a result of our ability to keep snow pad traffic to a minimum, combined with the fact that all the equipment needed for small diameter pipe laying is relatively light, the need for a high density pad such as the snow/water layered pad was not necessary.

4) Safety - It is our opinion that the use of conventional tracked crawler equipment on a snow/water layered pad would be very dangerous. The build up of ice on the track pads would build to a point where the track grousers would not contact, the pad surface reducing traction to near zero.

   Additionally, all employees that are required to work on the pad surface would be subjected to unreasonable dangers due to working on ice and also would be in danger due to the possible movement of skids supporting sections of welded pipe.

After ruling out the use of the snow/water layered method, we elected to build a pad of natural snow using the following procedures.

1) The first passes over the pad surface were made using a low ground pressure Rologon. This process was continued until the pad thickness and density was great enough to protect the tundra from damage by light tracted vehicles.

2) After the base layer was completed, additional pad depth was obtained by rolling in additional snow from natural snow fall, snow entrapment and snow transported from natural traps. Motor graders and dozers pulling compacting and leveling equipment was used for leveling and compaction. This process was continued until the optimum depth was obtained.

By mid-January we had completed only 10 miles of snow pad, and on February 6, 1977, with 22 miles of snow pad, we started our pipe laying operations. In mid April, we were experiencing temperatures forty degrees above zero and pad degradation was considerable. The impact of this unseasonable phenomenon was minimized due to our ability to divert all equipment not essential to pipe handling or ditching to gravel pad. The snow pad was constructed adjacent to either the haul road or the oil line pad throughout the project.

The risk of schedule disruption due to the unpredictable nature of snow pad construction was great and both owner and contractor were faced with the ever present possibility that the schedule would slip into the next construction season delaying project completion for one year. Due to this unpredictable nature (i.e., warmer than normal temperatures in early winter, the lack of natural snow fall in November, December, and January, periodic high temperatures throughout the winter resulting in pad degradation) a delay of the project would have been inevitable had completion of the project been dependent on snow pad utilization. The last 16 miles of the gas line was constructed from the oil line gravel pad and not a snow pad.

Reference has been made to Alyeska's Fuel Gas Line as evidence that the use of snow pads is a viable and proven mode of construction and should be used on portions of the Alaskan Natural Gas Transportation System. Based on our experience in Arctic construction and the use of snow pads, we strongly recommend that Northwest vigorously oppose the snow pad concept. Further, it is our opinion that two monumental facts were learned from the fuel gas line construction.

1) The snow pad, as constructed, would be totally and completely unacceptable for your project.

2) Development and execution of a coherent schedule would be next to impossible due to the unpredictable nature of the entire snow pad concept.

Additionally, due consideration should be given to the following:

1) Construction of large diameter pipelines utilizing a snow work pad is an "unproven" construction technique.

2) Construction would be restricted primarily to the winter months and would have a very significant impact on the cost effectiveness of the project. This would be primarily due to:

   A) Worker effectiveness and losses in productivity due to extremely cold temperatures, wind and artificial lighting. To compensate for some of this loss of productivity per worker, additional manpower would be needed. This would impact camp facilities and transportation. From our experience, we calculate productivity losses for winter construction to be:

      From +10°F to -5°F a 5% loss in productivity
      From -5°F to -20°F a 10% loss in productivity
      From -20°F to -30°F a 17% loss in productivity
      From -30°F to -40°F a 30% loss in productivity

3) Equipment down-time and maintenance becomes more of a problem and cost factor during the extreme winter months than the human element. Operating costs could increase by as much as 40% during this period due to the following:

   A) Equipment maintenance and service personnel would double during this period

   B) Fuel requirements would increase by approximately 50% due to the fact that all equipment would be running 24 hours a day

   C) Spare equipment and parts inventory would be increased by 10%

   D) Overall equipment life would be much shorter

4) There are certain construction activities that must be performed during the summer months, e.g., hydrotest, backfill armor and erosion control, sand-blasting and painting above ground facilities, revegetation, etc., all of which would be very difficult to carry out without the benefit of free access. In the area where construction utilizing a snow pad is advocated, there could be as many as 20 test sections and 20 test manifolds where access with heavy equipment would be essential.

   Additionally, since water will be the test medium for hydrotesting, access to the water sources and transporting by truck or pipeline will be next to impossible without gravel access roads.

5) Maintenance after construction would become a very expensive and difficult operation without the benefit of year-long access. As maintenance contractor for Alyeska Pipeline Service Company, we encountered many maintenance problems in our 250 mile area of responsibility which I would consider as almost impossible to correct without free access. Our area of responsibility was from

Pump Station 1 to south of Atigun Pass and would cover the entire area where snow pad construction is advocated.

Much of the area in question is subjected to flooding during breakup and erosion and settlement of backfill is significant. In some flooded areas of the fuel gas line, large amounts of backfill was washed away allowing the ditch insulation board to float out. Replacement of this material was very difficult due to the fact that all equipment was restricted to either the haul road or oil line work pads.

In conclusion, we wish to reiterate our concern as to the inherent risks and problems that would be associated with constructing large diameter pipelines using the snow pad concept.

Very truly yours,

CURRAN HOUSTON, INC.

V. E. Seale
Vice President

VES:me