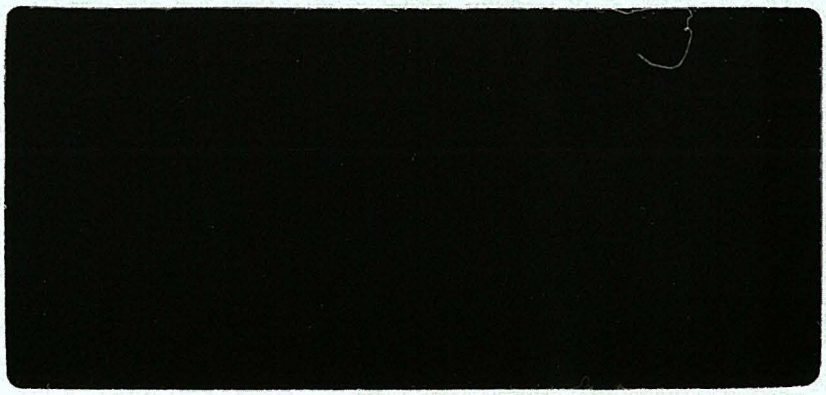
ENVIRONMENTAL SERVICES



Foothills Pipe Lines (South Yukon) Ltd.

DESIGN CONCEPTS
FOR DEALING WITH
STREAM FLOW

SUBMISSION 4-4

SEPTEMBER, 1981

ADDENDUM
TO
THE ENVIRONMENTAL IMPACT STATEMENT
FOR
THE YUKON SECTION
OF
THE ALASKA HIGHWAY GAS PIPELINE

THE ALASKA HIGHWAY GAS PIPELINE PROJECT

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This document is one of a series of addenda prepared to meet information requirements placed on Foothills Pipe Lines (South Yukon) Ltd. by the Federal Environmental Assessment and Review Office. Addenda within the series are divided into seven sets of submissions dealing with separate subject areas:

1. Introduction to Addenda Submissions.

2. Project Description and Update for Addenda Submissions.

3. Alternative Routes.

4. Geotechnical, Hydrological, Design Mode and Revegetation Issues.

5. Fisheries, Wildlife and Scheduling Issues.

6. Issues Related to Pipeline Facilities.

7. Other Issues.

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PART 1

INTRODUCTION

In its 1979 report, the Environmental Assessment and Review (EAR) Panel requested detailed information on the methods used by Foothills Pipe Lines (South Yukon) Ltd. (the Project) in determining Project design flows for streams to be crossed by the pipeline and access roads, together with an analysis of the risks of exceeding design flows for a 30- and a 50-year service life. In addition, the Panel requested information on the determination of design flows for small drainage basins and for right-of-way drainage where run-off data are inadequate. It was suggested that the type of data required, as well as an identification of data gaps and methods of collecting additional data, be outlined. These requests were subsequently clarified to include "the rationale for the criteria for project design flows" together with "design flows... for typical streams along the project route".

This submission reviews pertinent information supplied to the Panel previously and outlines the Project's position with respect to methods and approaches in the matter of design flows.

PART 2

INFORMATION PREVIOUSLY SUBMITTED

In the 1979 Environmental Impact Statement (EIS), the Project provided information on hydrological features and conditions along the pipeline route and described plans for dealing with these during construction of the pipeline. Further information was supplied to the Panel in the following reports which were annexed to the EIS:

1) Northwest Hydraulic Consultants Ltd. 1978.
Yukon stream survey data-Foothills Pipe Lines (South Yukon) Ltd. pipeline route. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. (Annex No. 09).

This report presented channel cross-sections, profiles, bed and bank sample analyses, field photographs, high water mark elevations and a channel regime commentary for eleven selected crossing sites on nine river and stream crossings along the pipeline route in southern Yukon Territory.

2) Northwest Hydraulic Consultants Ltd. 1978.
Multi-discipline stream characteristics along Foothills (South Yukon) Ltd. pipeline route. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. (Annex No. 11).

The results of an evaluation of design and construction considerations at watercrossings along the pipeline route in Yukon are presented in this report. Hydrological and morphological characteristics as well as fisheries concerns are tabulated for each major watercrossing.

3) Northwest Hydraulic Consultants Ltd. 1978.
1978 spring break-up observations along the proposed South Yukon pipeline route. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. (Annex No. 12).

This report summarized the results of a field program undertaken to determine the nature of break-up on rivers and streams and how this might affect construction and operation of the pipeline. In addition to break-up information, an analysis of ice surveys and aerial photography conducted by Foothills in late winter was presented.

4) Northwest Hydraulic Consultants Ltd. 1978. Assessment of South Yukon flood hydrology. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. (Annex No. 14).

The criteria and methods were established in this document for determining design floods for construction of the pipeline in southern Yukon Territory. The report also presented preliminary design flood estimates for representative river and creek crossings.

5) Northwest Hydraulic Consultants Ltd. and R.M. Hardy & Associates Ltd. 1978. Design documentation for eleven selected South Yukon stream crossings. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. (Annex No. 13).

This report presented watercrossing designs for eleven representative streams. A description of design considerations for watercrossings introduced the design data in the report.

In addition to filing the above information, the Project prepared responses to deficiency questions posed by the EAR Panel prior to and during the Yukon Public Hearings held in the spring of 1979. The following responses to questions relevant to the topic under consideration are taken from a compilation of these responses entitled Response to EAR Panel Deficiency Requests dated March and April 1979 prepared by Foothills Pipe Lines (South Yukon) Ltd., August, 1979.

With respect to: small stream hydrology

1) What project design flow will be adopted for temporary access roads?
Temporary road culverts and bridges may be designed for floods having a much lower return period than 100 years. Selection of what level of flood to use will be made during the final design process and will depend on what life the installation is expected to have, and to what extent fish passage is important.

2) What project design flow will be adopted for permanent access roads and other small hydraulic structures designed to handle surface run- off?
For streams crossed by permanent access roads, a 100-year return period (instantaneous) flood peak will be used for design of culverts, bridges and associated erosion protection works (see Annex Number 14 attached to the EIS, Section 2.2 and exceptions noted therein).

3) What flood frequency curve will be adopted for basins smaller than 100 km^2? . . . and . . .

4) What formula will be used to estimate project design flows for those basins?
Some general procedures for arriving at 100-year flood peak estimates for "small" basins have been outlined in Annex Number 14, made available with the EIS. These procedures are based on a form of regionalized frequency analysis, with the added comment that for small basins (like those along the west side of Kluane Lake) where few data are available, estimates will be compared with estimates made from the use of channel geometry and regime methods, or from the "rational" and related methods.

PART 3

PROJECT POSITION ON DESIGN FLOWS

The Project has provided a report documenting the criteria and methods used for determination of Project design flows, which was annexed to the 1979 EIS entitled Assessment of South Yukon Flood Hydrology. In addition to identifying the 100-year return Project design flood as the appropriate flood frequency for design, preliminary design flood estimates for a selected set of watercourse crossings were presented, based on that recommended frequency. The recommendations of that report, which have been adopted by the Project, are:

> "that design floods for computation of river-bed scour and high water levels at pipeline river crossings be based generally on frequency criteria. This is in accord with normal engineering practice for facilities whose failure is unlikely to entail life risk to the public, where the design frequency (or return period) can be related to the expected economic life of the facility.
>
> In deciding upon an appropriate design frequency, various considerations, including the length of the hydrologic data base and its geographical coverage, restrict attention to return periods in the order of 50 to 100 years. Given the relatively slight difference between 50-year and 100-year flood estimates at most gauged sites, in relation to statistically possible differences between estimates and true values, it is recommended that 100-year flood estimates be adopted generally as pipeline design floods. This criterion should be supplemented by other considerations in certain special cases: (i) where glacier outburst floods are foreseeable; (ii) where, because of the nature of the soil, crossing sites are especially susceptible to river-bed scour; and (iii) where worst scour may occur at less than maximum flood conditions."

A summary of the rationale for the methods used in determining design flood values, as previously submitted in the above-mentioned report, is as follows:

> "Consideration was given to the following hydrologic methods for developing flood discharge figures:
>
> 1. Regional frequency analysis.
> 2. Hydrograph analysis and synthesis.
> 3. Watershed modelling by computer simulation.
> 4. Channel hydraulics and regime.
> 5. Rational and related methods.
>
> The primary method recommended is a form of regional frequency analysis based on mapping of flood coefficients. For ungauged basins, coefficients are selected from the map by judgement, having regard to local physiographic characteristics and geographical location. More sophisticated approaches were found to be inappropriate due to the limited data base and the extremely non-homogeneous nature of physiography and runoff in the South Yukon.
>
> For glacial rivers in the Kluane area, consideration is given to potential for glacial outburst floods as identified by government reports. For small steep basins, independent estimates are made by considerations of runoff from short-duration high-intensity rainfall.
>
> Hydrologic estimates of flood discharges are to be checked against hydraulic estimates derived from field survey data at river crossings."

Rather than reproducing the entire report in this document, it is suggested that the report be consulted for the detailed information requested by the Panel.

Table 1 of the above mentioned report presents the risk of experiencing a flood of given return period within a given period of years. For example, the risk of experiencing a 100-year flood during a 30-year service life is 0.26, while the risk of experiencing the same flood during a 50-year service life is 0.39.

The method recommended to and adopted by the Project received extensive scrutiny by Panel advisors and intervenors (Dr. R. Kellerhals, Mr. P. Strilaeff and Dr. V. Schilder) (Proceedings of the Yukon Public Hearings, April 25 and 26, 1979, pages 1815-1900). Following clarification that the identified Project design flows referred to watercourse crossings by the pipeline and permanent access roads, and not to runoff processes on the pipeline right-of-way as they pertain to accelerated erosion or drainage control, the issue of the Project's design standards was reduced to differences in professional opinion.

The Panel has also requested information on the determination of design flows for small drainage basins and for right-of-way drainage, where runoff data are inadequate. These design flows are only determined for instances of permanent culvert facilities either in access roads or in segments of above-grade pipeline construction mode. Preliminary flow estimates for small basins are based on the "rational" method, for which the following formula, which utilizes available meterological data and an assumed expression for time of concentration, was judged to be adequate:

$$Q = 5.0\ C(A)^{0.75}$$

where Q = (100 yr) peak discharge, m^3/s
C = runoff coefficient, range 0 to 1.0
A = contributing drainage area, km^2

These hydrologic estimates for small basins are to be checked against hydraulic estimates based on field inspections of channel geometry.

Design flows for right-of-way drainage are not required for below-grade installation as conventional erosion control measures (e.g., channel restoration, mound breaks, diversion dikes) are expected to be effective. This expectation is based on pipeline operations experience throughout Canada.

For a further discussion of this topic reviewers are referred to Submission 4-1, entitled "Engineering, Construction and Environmental Aspects Of Alternative Design Modes", and in particular Appendix I of the submission which contains the report "Basis of the Permafrost and Earthquake Pipeline Design For Warm Flow".