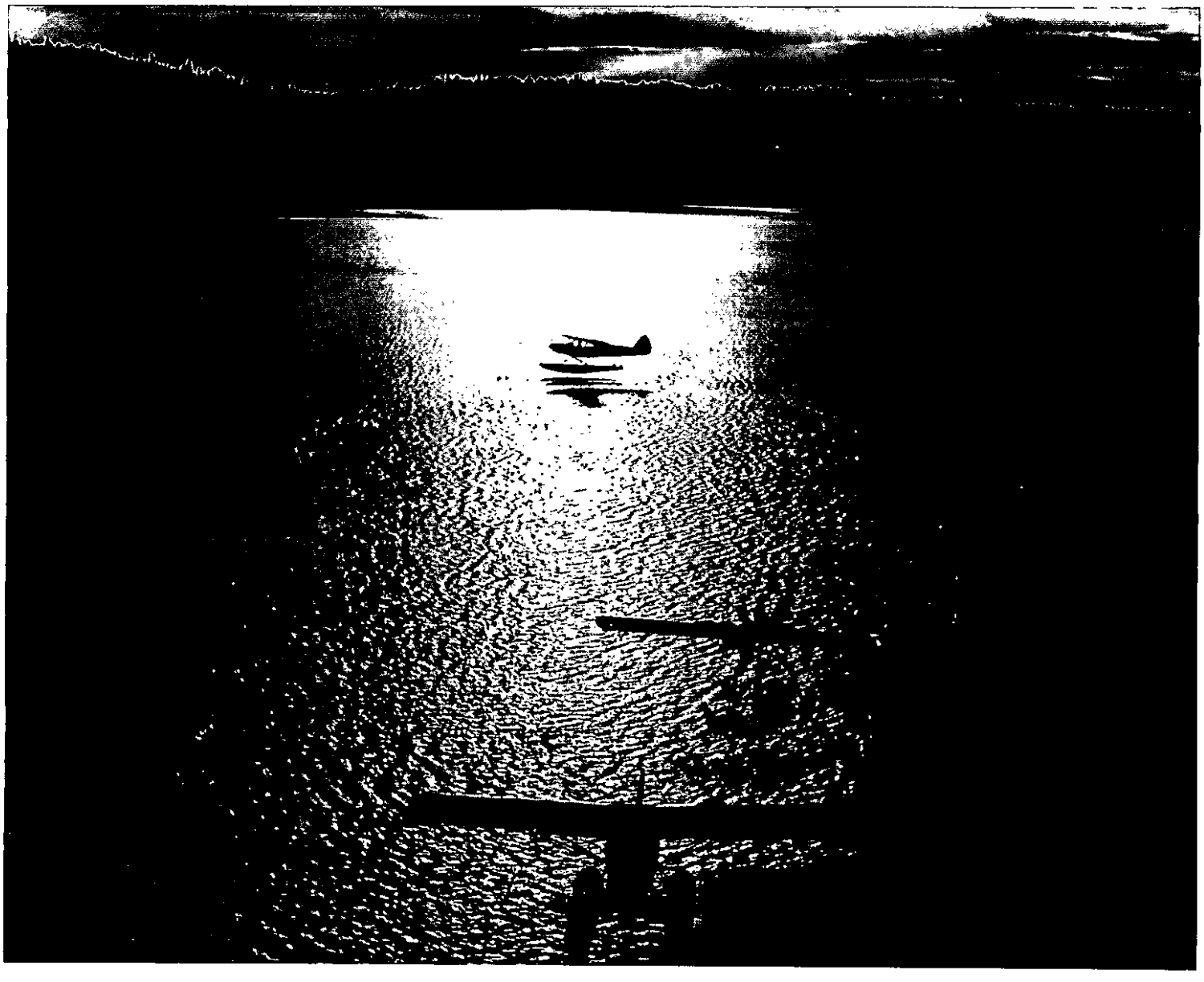
PART TWO

Environment and Land



7 The Physical Environment

Many people assume that the vastness of the North and the sparseness of its human population preclude the possibility that its land, water and air could ever become polluted. This assumption, I believe, is false. Although large areas of the North still remain relatively pristine, there is ample evidence to suggest that they may not always remain unpolluted. Over the years, and especially during recent years, human activity has progressively extended disturbance from small, isolated centres to much larger areas. We can now see a marked contrast between the untouched wilderness on the one hand and, on the other hand, the lands and waters that surround the settlements and the extensive areas in the Mackenzie Valley and Mackenzie Delta that have been subjected to intensive exploration and development.

There is a tendency to underestimate the dimensional and cumulative aspects of human impacts on the northern landscape and to overestimate the capacity of the environment to absorb them. The concentration of polluting activities that follows projects of a linear nature, such as seismic lines, the proposed pipeline, highways, and transportation corridors in general, means that such impacts are not only becoming more extensive but also that they are becoming interlocking and interdependent. People and their polluting activities are generally found together, and the overlap and cumulative build-up of successive environmental changes they create tend to be longer lasting in the North than they are in more temperate regions. Our technological needs and capabilities are leading us to undertake very large-scale projects in the North, and these projects necessarily involve very large-scale environmental impacts and risks.

For these reasons, I do not believe that the vastness of the North and the relative sparseness of its population will be any protection from serious degradation of environmental quality. Furthermore, northern ecosystems are vulnerable because certain important species within them have critical habitats and critical life stages; thus, some human activities and some areas of wilderness will have to be excluded from industrial development, if we are sincere in our commitment to protect the northern environment. Some kinds of environmental damage that are self-healing in the South, or are at least capable of rehabilitation, are, in the North, virtually permanent, and they therefore tend to be cumulative. It is this kind of cumulative effect, however slowly it may develop, that I see as the most serious threat to the northern environment in the long run.

Environmental Priorities

The evidence of hundreds of witnesses at the community hearings makes it quite clear that cumulative environmental impacts in the Mackenzie Valley and Mackenzie Delta have already reached a level that disturbs the people who live there. It is impossible for me to compare analytically past and probable future rates of accumulation of environmental impact. In the past, the rate was no doubt hastened by a general insensitivity to environmental concerns, and our ability to mitigate these effects was less advanced than it is today. In the future, the rate may be slowed by a greater corporate, governmental, and personal concern for the environment, but it might equally be intensified by our now greater technological ability to advance massive industrial developments.

Subject to the recommendations in this volume, I am convinced that a pipeline can be built in the Mackenzie Valley with an acceptable level of environmental impact. But we must bear in mind that any individual "acceptable" level of impact may be the beginning of a significant impact that will result from insignificant increments. How often and in how many locations can "acceptable" levels be tolerated before cumulative impact has produced an "unacceptable" level? This question is important. It seems to me that an "unacceptable" level is determined by, among other factors, both the absolute extent of the change involved and the public's perception of the environmental quality base that is being changed. It may be that undamaged areas are likely to be regarded as worthy of protection from even minimal or "acceptable" damage. On the other hand, areas that have already been changed and that need protection to preserve

their remaining environmental qualities may not be considered worthy of such protection. Often a crisis situation has to develop before action in the form of ameliorative measures is thought necessary.

Environmental protection cannot be viewed in isolation from man's perception of what is right and proper. It involves decisions on which elements of the environment warrant protection for their own sake, which elements should be protected to meet man's needs for renewable resources or his desire for aesthetic enjoyment, sport or recreation, and how far protection should be relaxed to meet his priorities for industrial development. Thus, priorities for environmental protection depend upon individual attitudes, and they will differ among the various segments of any society.

1. *Priorities for environmental protection must reflect not only those of government and of the Company, but also those of native people and of other residents of the North, together with those of citizens of other parts of Canada. Of necessity, standards and measures for environmental protection must be developed and implemented. In practice, public officials will carry out this function, but interested segments of society must be permitted to have a voice in the formulation and the means of implementing controls. This is in recognition of the fact that, in the North, regulation of land use and protection of the environment are closely related. Environmental impact of an industrial development project will involve not only the project itself but it will also lead to changes in the renewable resources and lands and will therefore affect their ongoing use by others.*

I am aware that there are many codes, standards, and regulations that apply generally to the environmental questions raised here, and that there are guidelines and standards specifically designed to apply to pipelines in the North. It is not my intention, in this report, to supersede such existing standards and regulations; rather, my purpose is to place on record some of the insights gained during the Inquiry process. I hope that my comments will supplement and complement existing measures and that they will be useful in the drafting of an environmental code and guidelines for the pipeline. (*See* Project Regulation and Review.)

Environmental Atlas

The interrelationships among the elements of an ecosystem are complex. Once one of the primary elements, such as land, water, vegetation, air or wildlife, is badly abused, it is difficult to prevent that damage from spreading to the other elements. Also, effects within an ecosystem are often felt in time and space far from the point of initial impact. For these reasons, damage to a highly visible element in the environment cannot be ignored or used as an excuse to avoid taking action that would prevent further degradation of that element. The northern environment must be viewed as an integrated entity.

Except in a very few localized situations, development in the North has not yet greatly abused the environment. Nevertheless, few large areas apart from the Northern Yukon can justify absolute protection measures solely on the basis of their wilderness condition. Most of the Mackenzie Valley and Western Arctic environment is in a state of early development and of sporadic impairment, a state that unfortunately evokes a somewhat apathetic response in any consideration of its environmental values. This apathy facilitates and serves to condone incremental damages that can, in the areas of critical habitat and life stages, quickly surmount the threshold of acceptability.

As an aid to understanding the wide range of environmental issues, I have been impressed with the usefulness of the environmental and wildlife maps prepared by the two pipeline companies and, in particular, by the atlas prepared by the Environment Protection Board and subsequently revised by Carson Templeton (Exhibits F135, F834 and F835). These documents present the various elements of the northern ecosystems, of present and projected land use, and related subjects in a visual format that is easily understood.

2. *I recommend that a large-scale, detailed, environmental atlas be prepared jointly by the Agency and the Company to show environmental sensitivity and land use priority for the use of all interested parties during design review, construction surveillance and project monitoring.*

Environmental Quality Index

How much "acceptable" damage can be tolerated before the situation becomes "unacceptable"? This question could be answered if we understood both the nature and extent of the accumulated damage and the public's perception of that total. I heard much evidence on the need for and the means of project and environmental monitoring, often of a subject-specific, species-specific or site-specific nature. However, I heard very little about how this valuable information could be used to appraise in a general way changes of broad environmental quality or changes over broad geographic areas.

Statistics bearing on changes in environmental quality already exist but they are frequently inaccessible, irregular in coverage and in time, or isolated from other related data. We need some measure of overall and cumulative environmental change to which the expert and layman alike can refer. In final argument, such a measure was proposed by Commission Counsel in his recommendation for environmental quality indices along the lines developed by Inhaber (1974) in Canada and by the Council on Environmental Quality in the United States (Thomas, 1972). Properly developed environmental quality indices would permit trends to be easily seen, would not hide assumptions, would be easily understood, and would be meaningful indicators of changes in, for example, air, water, land, and in biological and total environmental quality.

Air quality indices already exist for some metropolitan areas, for example Toronto, and the principle is firmly entrenched in our everyday lives by such well-known, continuously updated measurements as the gross national product (GNP) and the consumer price index.

Research by government and industry in the Mackenzie Valley has provided adequate environmental data to begin establishing indices for water, air quality, land and various biological components. Many measurements upon which such indices would be based are purely scientific. They are free from the cultural bias that the Committee on Original Peoples Entitlement stated, in its response to Commission Counsel's recommendations, would result from the imposition of non-native values on an index. Indices relating to things such as renewable resources could possibly be established that would take into account both the values of native people and their interaction with the environment.

Arctic Gas criticized severely the idea of indices, saying that it is "nothing but a futile attempt to portray in simple, meaningful ecological terms the complexity of ecosystems" (*Responses of Canadian Arctic Gas Pipeline Limited to Commission Counsel Submissions*, Vol. I, p. 11-91). I think that response misses the point. An index is not an attempt to provide a model of a system; rather, it is designed to give a general overview of a complex situation without an immense volume of reports, studies or detailed statistics. It is one means, admittedly a general means, for experts to communicate with both their peers and the layman.

3. *The government should establish a system of environmental indices for the Mackenzie Valley and Western Arctic so that there will be a readily available and easily understood measure of the state of the regional environment and a baseline against which short- and long-term changes can be assessed.*

The Northern Landscape

During pipeline construction and operation, large and widely distributed parts of the landscape will be subject to major disturbance. Compressor station sites will be the foci of activity, with associated wharves, gravel pits, landing strips, roads and other facilities affecting large areas around them. Permanent disturbance and sources of pollution will be introduced for the first time into areas where land, water and air are now virtually unimpaired. Large blocks of land, still in their natural state, will be split by the pipeline and held open by permanent access routes and sources of pollution.

We have been assured by the pipeline companies that deleterious environmental effects associated with short- and long-term disturbances of land and waterbodies, degradation of landscape values, and increases in air and noise pollution levels will be held to "minimal" or "acceptable" levels. Nonetheless, I believe these effects will be significant.

Of course, some environmental damage is acceptable and some is unavoidable. However, this fact does not negate the need for protective measures; rather, it emphasizes such a need if we are not to foreclose other uses of the environment during the selection of land for a pipeline and the pipeline's use of it. Similarly, conflicts over land use can be exacerbated by environmentally inappropriate selection and use of land. Clearly there is a need for broad measures that will help mitigate these kinds of problems.

4. *As a general principle of environmental conservation, the areas of land and water used by any part of the project or physically disturbed by it should be kept to a minimum. Furthermore, the right-of-way, roads and sites for facilities should be selected so that their geographic distribution ensures minimal infringement upon other existing or potential uses of land. This principle of minimal pre-emption and disturbance applies to the routing, siting, design, construction, operation and, ultimately, the abandonment phases of the project.*

Sensitive Terrain

In Volume One, I described the characteristics of northern terrain that make the Mackenzie Valley much more sensitive to engineering ventures than topography alone would suggest. The Valley was formerly flooded by extensive postglacial lakes, which means that much of the region is now underlain by silts and clays. These soils cause engineering problems that are made yet more difficult by the presence of permafrost, which increases northward in the Valley. Under permafrost conditions, fine-grained soils frequently contain excess ice. When such areas are disturbed, the thermal regime can be altered so that the ice melts and the soil loses its strength and stability, leading to subsidence, slope failure and erosion.

5. *For environmental as well as for purely technical reasons, the pipeline route and facilities should avoid, wherever practicable, areas of sensitive terrain and particularly areas in which terrain disturbance could adversely affect nearby waterbodies or lands important to wildlife.*

The importance of the insulating properties of the organic mat that overlies permafrost is well-known. Irreversible and progressive environmental damage is often the inevitable result of disturbance of this mat.

6. *In permafrost terrain, and particularly in areas of sensitive fine-grained soils, disturbance of the organic mat and the vegetation that protects it should be minimized to avoid or reduce a wide range of environmental and engineering problems that could develop from permafrost degradation.* (See Terrain Considerations: Ground Surface Preparation.)

7. *Any organic mat and surface vegetation that has been disturbed should be restored, rehabilitated and stabilized. In*

permafrost terrain with fine-grained soils, the progressive nature of thermokarst degradation, slope failure and erosion requires quick and efficient remedial measures.

Importance of Valleys

In Volume One, I noted the special importance of valleys in the landscape:

> Although the valleys crossed by the corridor may constitute only a small proportion of the total landscape, they are the locations of disproportionately high land use and are of particular environmental, aesthetic and recreational values. They define essential fish and mammal habitat and the vegetation along them is more varied and abundant than elsewhere. Valleys have always been and still are the preferred areas for many native people. ... Valleys ... are the foci of the regional ecosystem. [pp. 78-79]

One of the most important elements of any valley, in environmental terms, is the bank of the river or stream. Here, the "edge effect" brings together for many species, including stream dwellers, their complex requirements of food, cover and water; it is a zone of very high biological productivity and diversity. The setting – the collective land-water contrast – is also a vital element of the scenery. From this perspective, shorelines can be considered to be environmentally sensitive areas that, if damaged by construction, will tend to broadcast the effect far out of proportion to the immediate and local circumstance.

8. *The potential for the pipeline project to cause land use conflicts, unacceptable damage to aesthetic values, or degradation of wilderness or areas important for recreation is particularly great in valleys and around waterbodies. The project should be adjusted to avoid or minimize impacts of this nature. Careful consideration must be given to the location of pipeline crossings, roads, water intakes, sewage and waste disposal sites, wharves, stockpile sites, work pads, camps, compressor stations and borrow areas where such facilities may impinge on valleys and waterbodies. Wherever possible, facilities (particularly groups of facilities) should be kept out of valleys and away from waterbodies and buffer strips should be left undisturbed. The land-water interface should be accorded special attention because of the special environmental values and geotechnical sensitivity associated with them. Water crossings should be kept to a minimum, and the pipeline route and roads should avoid closely paralleling watercourses.*

Wetlands

Swamps, marshes and wetlands constitute a unique natural landscape. Although they are recognized by some as vital habitat with high values for wildlife and water conservation, they are more often treated as wastelands or nuisances – something to be drained or filled in.

Wetlands must not be regarded simply as wastelands. In this regard, I cite the following statement made by President Carter to Congress on May 23, 1977, in a message about the environment:

> The important ecological function of coastal and inland wetlands is well-known to natural scientists. The lasting benefits that society derives from these areas often far exceed the immediate advantage their owners might get from draining or filling them. Their destruction shifts economic and environmental costs to other citizens ... who have had no voice in the decision to alter them. ... We must now protect against the cumulative effects of reducing our total wetlands acreage. [p. 13]

9. *To protect the hydrologic and biologic values of wetlands, they should be accorded the same level of protection as other elements in the landscape and environment.*

Aesthetic Values

In relation to the amount of direct evidence presented on aesthetic impacts of the project, the Inquiry heard a disproportionately large amount of cross-examination and discussion. This reflects the difficulty of coming to grips with such an abstract concept. The cross-examination was unsuccessful in demonstrating the existence of clear ameliorative measures, but it was useful in highlighting gaps in our knowledge and in delineating various aspects of the problem.

Arctic Gas stressed the subjective nature of aesthetic judgments, saying that perceptions vary so much from individual to individual that contradictory assessments can be made of the same situation. This extreme view tends to down play the importance of aesthetics. I agree that aesthetic judgment has a strong subjective component and that, as appeared in cross-examination, we know little of the influence of culture on aesthetics, particularly with regard to native people. However, whatever subjectivity and cultural influence there may be in aesthetic judgment, I believe there is a general consensus on what is pleasing and displeasing, on what is good practice, and on unacceptable aesthetic design. Although difficult to quantify or to protect, aesthetic values are an important component of environmental quality, and they must be viewed in this way in all aspects of the project.

10. *All aspects of the pipeline project should be designed and the right-of-way and facilities should be located to protect the natural aesthetic attributes of landscapes and waterbodies. All installations (and not simply those in areas of high sensitivity or visibility) should be constructed so that, as far as possible, the surrounding area is left in its natural state.*

Cumulative Effects of Development

Although the Mackenzie Valley covers a vast area, it will not be long before conflicts over land use within it intensify. The wildlife of the region has certain requirements. The native people will continue to need extensive lands for their own purposes. Industrial developers will need land, and still other areas may be designated for conservation and recreation. Each

designated use will diminish the availability of uncommitted land, and competition for such land will increase.

The environmental effect of industrial development will often preclude or inhibit the ongoing use of the land by others. This problem is exacerbated by a tendency to view and assess each industrial development as a single and exclusive event. In considering the effect of a project like the pipeline, not only its direct and immediate impact but also the effect of all ancillary and spin-off activities, and the effect of other developments that can be reasonably anticipated over the life of the project, must be taken into account.

11. *The pipeline project should be designed and located so that its effects on the ongoing use of the region by others, such as the native people, are kept to a minimum. In so doing, the cumulative effects of all construction, operation and abandonment activities shall be considered, along with the effects of other developments that can be reasonably anticipated in the region over the life of the project.*

Two particular aspects of the pipeline project that are related to cumulative environmental impact warrant special mention. The first deals with the operation of the project after construction. It is established engineering practice to minimize long-term costs by judicious allocation of costs between initial capital construction costs and annual maintenance and repair costs. An essentially maintenance-free project is generally not feasible. In many locations, however, environmental considerations may render maintenance and repair activities too unacceptable to allow standard economic trade-offs to be employed. If the environmental protection of sensitive areas is to be taken seriously, there must be a shift in the ratio that normally exists between capital costs and annual maintenance costs to reflect more firmly the impact of maintenance activities on the environment.

Let me cite one example. Pipeline maintenance and repair, particularly in summer when the active layer is unfrozen and the ground surface is soft and when waterfowl or fish may be concentrated nearby, could be much more damaging and disturbing than the original construction activity.

12. *The Company should locate, design and construct the pipeline and related facilities so that maintenance and repair activities that could damage the landscape and disturb wildlife over the life of the project are kept to a minimum. In permafrost and other sensitive terrain, the Company's designs may, as a result, have to be significantly more conservative than is usual in established pipeline engineering practice.*

The second aspect related to cumulative environmental impact is of broader concern. It refers to both the current use of local resources by others and the possible future demand on those resources by further development. It is likely that there will be sections along any route where water, gravel and other resources that are essential to virtually all developments will be in short supply, or where they will be regionally depleted before there is a comprehensive plan to share a scarce resource among present and future users.

13. *The use of resources such as gravel and water by the pipeline project shall be compatible with the demand made on such resources by local activities and by developments that can be reasonably anticipated in the future. In particular, the pipeline Company shall employ designs and construction practices that minimize the use of limited local natural resources so far as practicable.*

Water

Water, as an element of the physical environment, has innumerable domestic, commercial and industrial uses; as an element of the landscape, it is the essential element of marshes, ponds, lakes, streams, rivers and springs. In both of these functions, the quality of water is a prime consideration and it is this aspect that I develop in this section.

Much of what I have to say about other aspects of water is contained in other parts of this report. In the chapters on Fish and Wildlife, I deal with the biological aspects of waterbodies. Elsewhere I recommend measures to protect the land-water interface — the shorelines, the river banks and the stream edges — measures that would indirectly protect the waterbodies themselves.

Just as I recommend that the pipeline should avoid wilderness areas and specific, important natural areas to protect their intrinsic values, I also recommend that:

14. *Wherever possible, lakes should be avoided, and the crossings of watercourses should be minimized to protect water resources. For example, the pipeline route should be adjusted where practicable so that meandering rivers are crossed only once.*

Fluctuations in flow and water levels are natural, and certain plants and animals find their habitat in intertidal zones, floodplains, intermittent stream channels or sloughs that result from such changes. On the other hand, drastic changes in water levels, either natural or man-induced can cause destructive environmental changes. Although aquatic vegetation, furbearers, waterfowl and fish can tolerate a certain range of natural or seasonal fluctuations in water level, untimely changes may cause effects ranging from significant to severe. After a severe disruption, populations depending on such an environment may take generations to attain previous stable levels. It would be prudent, therefore, to eliminate or to minimize large-scale, man-induced effects of this kind. Such man-induced changes could occur if streams were overused as water sources, particularly in winter when flow is low, or if surface and subsurface drainage were impeded by the construction and operation of a chilled gas pipeline.

15. Site-specific review of water withdrawal proposals shall be required to ensure that any drawdown of water that exposes shorelines, shrinks channel flow or depletes stream pools does not cause unacceptable vegetative or faunal changes. (See Water Withdrawals.) *Similarly, designs or construction activities that result in ponding or flooding shall be deemed unacceptable practice, and they shall require modification to mitigate these adverse impacts.* (See Terrain Considerations: Drainage and Erosion.)

It is the pristine quality of water in the North that gives the waterbodies their great value. To the extent that southern Canadians have some idea of an undefiled northern landscape, it is probably based on their impression of pure lakes and streams rather than on unspoiled tracts of land. But the waterbodies in the North are highly susceptible to industrial pollutants. Permafrost restricts downward filtration so that spilled contaminants move laterally into surface waters rather than into deep soils and bedrock, where self-cleansing might take place. Permafrost also restricts groundwater movement so that many waterbodies are separate and isolated, rather than forming parts of a connected system, as they would in a region lacking permafrost. The cold temperatures also greatly inhibit biodegradation of pollutants, so they persist longer and often have a more devastating effect in northern waters than they would in the South.

Our experience with water pollution, competing demands, and conflicting interests over water resources in southern Canada should provide the motivation necessary to avoid these problems in the North. In southern Canada, we are now learning the great environmental, social and economic cost of water pollution and the difficulty of trying to restore the surface water to an acceptable quality. In the North, except for a few isolated localities, the surface waters have not yet been badly polluted. In allowing development to proceed, we have an obligation to maintain the high quality of water where it now exists. We must emphasize that here we would be maintaining the relative purity of northern water, a contrast with the current emphasis on water pollution control programs in southern Canada. Such a maintenance program must have two parts. The first is to control what goes into the water. My recommendations in this regard are found under Waste Management and, to a lesser extent, in other chapters such as Management of Fuels and Hazardous Substances. The second involves monitoring the quality of the receiving waters.

Following waste management procedures and adhering to effluent standards will not in themselves guarantee that the quality of receiving waters will be maintained. The treatment of effluent is limited by current technology, and it relies to some extent on the natural assimilative capacity of the receiving waters. Effluent standards are only one part of the administrative mechanisms directed at environmental (and public health) protection. They are not an end in themselves.

Each waterbody in its natural state has its own unique chemistry – its own unique quality. The development and use of effluent standards require judgment to determine how effluent can be released without adverse impact. Watercourse and effluent volume, flow or exchange rate, method and timing of effluent discharge, downstream water use and, of course, receiving water quality must all be considered.

I have not found a fully satisfactory compilation of the limits within which receiving water quality parameters must be kept, but Commission Counsel has examined a number of sources and combined the findings of three excellent and authoritative works: *Water Quality Criteria, 1972*, U.S. National Academy of Sciences and National Academy of Engineering; *Surface Water Quality Criteria, Province of Alberta*, Government of Alberta; and *Standards Methods for the Examination of Water and Wastewater*, American Public Health Association. Commission Counsel's compilation is included below as standards for the Agency and the Company.

Many of the streams and waterbodies that will be selected to receive effluent discharges are likely to be used for this purpose far into the future. There is no reason to believe that either the period of pipeline construction or the life of the project itself will terminate effluent discharges into them. Only by long-term monitoring will it be possible to make rational decisions that will maintain ambient water quality.

16. To ensure that receiving waters maintain the water quality standards imposed by the Agency, a program to monitor the streams and waterbodies into which effluents are discharged shall be established. Both the Company and the Agency should take into account the information made available by the Department of the Environment's Water Resources Document Reference Centre (WATDOC) and the National Water Quality Data Bank (NAQUADAT). These two computerized services shall be supplied with all relevant new information that is assembled during the design, construction and operation of the pipeline project.

Water Quality Standards

17. Unless otherwise specifically approved by the Agency, wherever effluent is released into a waterbody the Company shall adhere to the following limits for water quality:

a) Bacteria: at least 90 percent of the samples (not less than five samples in any consecutive 30-day period) shall have a total coliform density of less than 5000/100 ml and a fecal coliform density of less than 1000/100 ml. These standards are the upper limits; in certain cases, they may have to be substantially altered to guarantee that public health is protected. (See Waste Management.)

b) Dissolved oxygen: shall not go below 6.0 mg/1. If natural conditions are below 6.0 mg/1, effluent shall not be released into the waterbody unless the Company can demonstrate that discharge will not adversely deplete the oxygen level.

c) pH: shall not be altered by more than 0.5 and shall be maintained in the 6.5-8.5 range.

d) Temperature: shall not be altered by more than 3°C.

e) Odour: shall not exceed the threshold odour number 8 at 20°C (see American Public Health Association, op. cit., p. 252).

f) Colour: shall not be increased more than 30 colour units above background.

g) Turbidity: see Fish.

h) Phenolics: shall not exceed 0.005 parts per million. Fish flesh shall not have any detectable change in taste or odour as determined by a government agency taste panel.

i) Oils and greases: no visible iridescent sheen shall be present.

j) Inorganic chemicals: shall not exceed the following levels expressed in mg/l:

Boron	*0.5*	*Nitrogen*	*1.0*
Copper	*0.02*	*Phosphorus*	*0.15*
Fluoride	*1.5*	*Sodium*	*30-75*
Iron	*0.3*	*Sulphide*	*0.05*
Manganese	*0.05*	*Zinc*	*0.05*

k) Pesticides: only air-fogging pesticides shall be permitted. No persistent chemicals shall be used.

l) Toxic chemicals: shall not exceed the following levels expressed in mg/l:

Arsenic	*0.01*	*Lead*	*0.015*
Barium	*1.0*	*Mercury*	*0.001*
Cadmium	*0.01*	*Selenium*	*0.01*
Chromium	*0.05*	*Silver*	*0.05*
Cyanide	*0.01*		

18. *Samples for the water quality criteria shall be taken at points determined by the method outlined in Fish. Dissolved oxygen shall be measured in stream pools and locations in lakes where depleted oxygen levels could be expected because of organic loading.*

19. *Testing for the parameters listed above shall be carried out according to the methods outlined in* Standard Methods for the Examination of Water and Wastewater, *American Public Health Association, 1974.*

Air

There can be little doubt that, from a global perspective, there is little man-made air pollution in the North. However, the contrast between localized areas of human activity and the large intervening wilderness areas illustrates the high potential that exists for problems related to air quality, even with limited human activity. These problems range from the emissions of certain industries, to ice fog in communities and dust problems along the gravel highways. While the pipeline project would cause many problems that would have to be dealt with by the Agency, my principal concern here is the environmental effect of major sources of pollution at given points, such as compressor stations. Unless we formulate comprehensive standards for such permanent emissions now, we will be faced in the future, after successive industrial developments, with the problems and costs of trying to clean up these emissions.

Most of us do not think about problems of air quality when we have clean air, but quickly become obsessed by the sight and smell of pollution when, apparently from nowhere, the reward of our negligence is inflicted upon us. It is not surprising, therefore, that pure air is taken for granted throughout most of the Mackenzie Valley, whereas the residents of Toronto keep an anxious eye on their air quality index, and the citizens of Fairbanks and Inuvik suffer through the inconvenience and hazards of ice fog.

We can sometimes conceal or walk away from lands and waters that have been degraded, but we cannot walk away from air pollution. It envelops and pervades all aspects of our lives. No doubt that is one reason why, during the growth of environmental awareness in the 1960s, air quality was among the first aspects of the physical environment to receive widespread attention. Air quality is an issue that is personal, regional, national and international in scope.

Air Quality Objectives

The Department of the Environment has established National Ambient Air Quality Objectives for a number of common air contaminants. These objectives are divided into three levels – maximum tolerable, maximum acceptable and maximum desirable – with standards applicable for various periods of discharge. The most stringent standard, the maximum desirable level, is meant to "define the long term goal for air quality and provide a basis for an anti-degradation policy for the unpolluted parts of the country and for the continuing development of control technology" (*The Canada Gazette*, Part I, August 7, 1976, p. 3898).

In uninhabited areas, where there is no foreseeable threat of air quality degradation, an anti-degradation policy means little. If an anti-degradation policy is to be implemented anywhere, it should, I think, be applicable in the Mackenzie Valley and Western Arctic where the present air quality is high but is threatened by industrial development. The following recommendation therefore seems to me to be in keeping with stated government policy.

20. *Emissions from pipeline development shall be controlled in the Mackenzie Valley so that ambient air quality figures do not exceed "maximum desirable levels" as defined in the* Clean Air Act: Ambient Air Quality Objectives *(The Canada Gazette, Part II, Vol. 108, No. 11, and Vol. 109, No. 3).*

But is this control practicable under normal conditions? Temperature inversions must be regarded as normal, for this condition prevails from one-half to two-thirds of the time in winter in the Mackenzie Valley. During a temperature inversion, pollutants are discharged into the air as though into a closed container, the lid of which is removed only when the weather changes. As a result, under inversion conditions, emissions often accumulate for days at a time, and ice fog forms spontaneously if the temperature drops below -40°C.

21. *Constraints placed on the pipeline project to maintain air quality must reflect northern conditions, such as temperature inversions, which inhibit dilution and dispersal of atmospheric pollutants.* (See Facilities Complexes and Equipment Operations.)

Noise

The control of noise is as much a part of environmental conservation as the maintenance of water quality and of natural landscapes. The only redeeming features of noise pollution are that it is often of short duration, and that it usually leaves no visible scars when it stops. Nevertheless, intermittent or sustained noise has an overwhelming influence on overall environmental values from both a human and a wildlife perspective. Noise cannot be ignored because its effects, although not necessarily the sound itself, can and do linger on in the form of abandoned wildlife ranges, staging areas and nesting sites, and a general lessening of the usefulness of the region. In yet another sense, and one that I do not discuss here because it is adequately dealt with in existing codes, noise can be an occupational hazard for health and safety reasons.

Environmental Aspects of Noise

Noise is measured in decibels (dBA) on a scale that is not linear, but is based on doubling the apparent loudness of noise to the human ear with every additional seven to 10 dBA. Zero dBA, the lower end of the scale, is at the threshold of hearing. The level of conversation is about 65 dBA, and 120-140 dBA is at the threshold of pain. To place environmental noise levels in context, in a tundra environment under calm conditions, natural noise levels are less than 15 dBA (Dr. George Thiessen, National Research Council, Ottawa, personal communication, August 1977); in an open alpine meadow, with the rustling of grasses and brush and the distant sound of tree movement, Dailey and Redman reported the background level to be about 30 dBA under low wind conditions of three to five miles per hour, but to increase to about 35 dBA in a mature coniferous forest under the same conditions (*Guidelines for Roadless Area Campsite Spacing to Minimize Impact of Human-Related Noises*, 1973, p. 12). They also pointed out that noise must be reduced to 15 dBA *less* than the background level of the setting before it is muffled by background noise (p. 16). Generally, noise levels decrease by six dBA for each doubling of the distance from its source. This figure may be increased or decreased by topography, vegetation and meteorological conditions.

In recent years, environmental noise pollution has received increased attention from the public and law-makers, a fact attested by the proliferation of arcticles and studies on the subject and by noise control legislation at all levels of government. The sound emission standards for construction equipment recently passed by the Province of Ontario, (Ontario Ministry of the Environment, Publication NPC-115 in Schedule 1 of *Model Municipal Noise Control By-Law*, Revised May 1976), are a good example of an approach that aims at maintaining environmental, and not simply occupational, quality. This trend toward noise abatement as part of the maintenance of overall environmental quality is directly applicable in the North and to the pipeline project in particular. Despite the present use of planes, trucks, snowmobiles, outboard motors and diesel motors in many communities, the North is still a relatively quiet place. This silence is a vital aspect of the habitat for many species of wildlife and is also one of its main attractions for both residents and visitors.

I shall not discuss here the complexities of the production, propagation, attenuation and measurement of sound and the enforcement of its control. But central to all these problems is the fact that sound is both a physical phenomenon and a perceived sensation. The first is objective, scientific, measurable; the latter is highly subjective and personal.

The recommendations I make, here and elsewhere in this report, require compliance with certain standards — in this case, with noise levels measured in decibels. It is a quantitative approach, such as regulatory agencies have traditionally felt bound to use for public health. The approach is not as satisfactory as a protection of environmental quality, but I nevertheless advocate its continued use for that purpose.

This approach, however useful it may be to quantify the problem, is quite inadequate to solve it. It seems to me that the crucial difference is the perceived difference between sound and noise. The distinction should not be made on the basis of intensity or of a decibel reading on a sound meter. The distinction should be made on the basis of acceptability or non-acceptability — on the basis of pleasantness or disagreeableness, of annoyance or disturbance — however difficult it may be to assess these qualities.

Low intensity sounds — lower than noise standards are ever likely to be set — can still be perceived as noise, and they can therefore be considered a disturbance. Disturbance to wildlife need not be manifested in fright or flight reactions to be real and harmful.

Subjective judgment must therefore be added to the quantitative approach to noise control. In attempting this change, we shall have to follow the advice of wildlife experts and to accommodate the feelings of the public. A solely

quantitative approach to noise is limited in its application by the very fact that response to it is subjective according to species.

The Environment and Project Noise

It is clear that pipeline construction and operation in the Mackenzie Valley, which will have noise levels in the range of 90 to 140 dBA, will often produce noise that may be considered environmental pollution over an area several miles from its source. Noise will pervade a greater area than any other form of pollution generated by the project. The commonly held impression that transportation by pipeline is quiet is no doubt based on the public's experience with gas mains, water mains and sewage systems in urban areas. But such an analogy is wrong. The pipeline will be a noisy business, both in its construction and in its operation.

Of course, I cannot recommend that pipeline construction and operations should be silent: that is patently impossible. No technology exists (and it may never exist) that would eliminate the variety of noises associated with the construction and operation of industrial developments. But technologies do exist to reduce noise levels. Although noise is increasingly attenuated in the interests of public health and worker safety, we must begin to consider the importance of attenuating noise as a means of mitigating environmental pollution.

When compressor stations are operating, the gas turbine engines, which are comparable to jet aircraft engines, will emit constant noise of very high intensity. Maintenance blowdown (depressurizing the pipeline), with its intermittent but startlingly loud noise, will be confined mainly to compressor station sites, but similar noises will be generated elsewhere along the line, for example during purging. My recommendations on pipeline operations noise are dealt with more fully in the chapter Facilities Complexes and Equipment Operations. As a general principle however:

22. *The pipeline project should be designed in accordance with good noise abatement practice to minimize environmental disturbance, particularly at times and at locations that are critical to wildlife populations and to traditional land use by local people.*

Pipeline construction will employ thousands of pieces of heavy equipment, machinery and vehicles that have the potential for environmental disturbance by making noise. Crawler-type tractors, earth-moving and ditching equipment, air compressors and drills, to name only the most familiar machines, generate noise in the 85-115 dBA range. These noise levels will be generated at wharf sites on the Mackenzie River, at borrow pits, which are scattered over a wide area, and along the right-of-way. Only slightly lower intensities will be generated by road construction and haulage activities.

There seems to be no justification to diminish environmental quality through noise pollution because noise reduction technology is available. Sound emission standards for construction equipment are common in the South, and new standards have been developed for 1980 (Ontario Ministry of the Environment, op. cit.), so there is ample and practicable precedent for standards of noise attentuation in construction activities.

23. *Environmental standards for noise associated with the operation of construction equipment should be developed by the Agency in keeping with the best practicable technology. Special noise abatement practices should be developed for activities in sensitive areas for wildlife.* (See Wildlife.)

Construction noise will be accompanied by noise from associated transportation activities. The movement of supplies and personnel will increase barge, vehicular, helicopter and fixed-wing aircraft traffic, and commercial air traffic will also increase greatly. These sources of noise are discussed further under Facilities Complexes and Equipment Operations and under Wildlife. Blasting, another construction-related noise, is separately discussed under Terrain Considerations: Blasting.

Monitoring and maintenance activities, which will be carried out mainly by aircraft, will produce most of the transportation noise during the post-construction period. The major concerns about this form of continued disturbance are discussed at some length in the chapters entitled Wildlife and Aircraft Control.

Archaeological Sites

Archaeological sites are one aspect of the physical environment that we often overlook. In Volume One, I referred to the prehistory of the North as it is known through archaeological discoveries that have so far been made in, for example, the Old Crow Flats, but I said nothing about the impact of the pipeline upon the part of our national heritage that is represented by as yet undiscovered sites.

Archaeological sites constitute not only an irreplaceable element of our national heritage, they are also an integral part of the history of northern native peoples. The little that we know of the prehistory of the Mackenzie Valley and the Western Arctic suggests that sites there may be rare and small. Their smallness makes them hard to find and particularly susceptible to destruction. As J.V. Wright wrote in his article, "The Destruction of Canada's Prehistory," "Any human or natural force that alters, buries, or floods the earth can be regarded as being potentially destructive to archaeological data" (p. 5). Obviously, such forces include pipeline construction and associated activity. Preliminary studies in the Mackenzie Valley and elsewhere have shown that some disturbance and destruction of archaeological sites is inevitable in a project the size of the proposed pipeline.

Paradoxically, the very process of disturbing the northern

landscape is often the means of finding an archaeological site. The numerous borrow pits, the ditch excavation, and the excavations for other facilities involved in the pipeline project will provide unprecedented opportunities for archaeological and paleoecological studies that would further our knowledge as much as, if not more than, the disturbances would hinder it. This is an opportunity not to be taken lightly. Sites are difficult to find in the boreal forest and logistics are often complex and expensive. Moreover, the density of human population may always have been quite low so that archaeological sites may, in fact, be relatively scarce. We must, therefore, take advantage of any opportunity to provide future generations with a more complete record of past human occupation and environmental evolution in the North.

Existing legislation clearly stipulates that archaeological sites should be protected from both wilful and negligent destruction. The Territorial Land Use Regulations prohibit industrial excavations or other land use operations within 100 feet of a known archaeological site, and whenever an operation encounters a previously unknown site, the operator is instructed to suspend his work and notify the engineer or an inspector of the location and nature of the occurrence. Embodied in the Yukon Act and the Northwest Territories Act are Archaeological Sites Regulations that stipulate that all archaeological investigations must be conducted under permission of the Minister of Indian Affairs and Northern Development.

It appears that existing law provides a legal framework for the protection of archaeological resources from construction projects, but on a large-scale venture such as the pipeline only the organization of an adequate archaeological project can ensure that this will be done. It is certainly in keeping with this position that the pipeline companies have proposed archaeological work as a complement to the pipeline project.

25. *An archaeological program shall be established to identify, protect, excavate and investigate archaeological sites and associated paleoecological materials on or adjacent to lands used by or for the pipeline project. This archaeological program should be funded by the Company and organized under an arrangement between the Company and the Agency with the especial involvement of the Archaeological Survey of Canada, National Museum of Man. The program should be in operation from the time field operations of the Company begin until the pipeline is commissioned and all archaeological field studies and reports are completed.*