THE CONSTRUCTION OF ADDITIONAL CAPACITY TO AIRSTRIPS AT TEN REMOTE COMMUNITIES IN NORTHERN MANITOBA - A BENEFIT COST ANALYSIS

A Practicum Presented to
The Natural Resource Institute
The University of Manitoba

In Partial Fullfilment
of the Requirements for the Degree
of Master of Natural Resource Management

---

by
Kenneth Andrew Jonas Davidson
May 1976

THE CONSTRUCTION OF ADDITIONAL CAPACITY TO AIRSTRIPS AT TEN REMOTE COMMUNITIES IN NORTHERN MANITOBA - A BENEFIT COST ANALYSIS

by

KENNETH ANDREW JONAS DAVIDSON

A dissertation submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

MASTER OF NATURAL RESOURCE MANAGEMENT

ABSTRACT

This practicum puts forward the operational cost saving criterion as one method which may be used to help allocate economic resources between ten remote communities in Northern Manitoba, for the purpose of upgrading airstrip landing facilities.

All of the costs, both public and private, which are associated with the delivery air transport needs on a Ministry of Transport designated Class 2, regular specific point commercial air service, are calculated for a five year planning period. These costs, infrastructural, operations and maintenance and passenger and freight delivery via each of three types of aircraft, the de Havilland Twin Otter, the Douglas DC-3 and the de Havilland Dash 7, are discounted at an appropriate rate of discount for each year in which they occur in order to derive the cumulative net present value of each alternative. A given pattern of air transport demand along a route serving the ten communities is assumed. The cumulative net present values of the alternatives are then compared first for the delivery of all of the communities' freight requirement by each alternative aircraft and then similarly for the passenger requirement. Operational cost savings occur when the additional costs of airport infrastructure necessary to accomodate larger more cost efficient aircraft

are positively offset by the operating economies offered by larger capacity aircraft. Communities are then priorized for the purpose of additional airstrip construction according to the percentage cost saving generated by one alternative over another. Communities where higher costs savings may be generated by the building of additional airstrip capacity are given order of preference for airport upgrading.

ACKNOWLEDGMENTS

In recognition of the assistance provided in the preparation of this practicum, I wish to thank the members of my committee, Dr. Gregory Mason (Chairman), Professor of Economics, the University of Manitoba; Mr. David O'Brien, Manager, Regulatory Affairs, Transair Ltd., Winnipeg and Mr. John Reader, Head, Engineering & Construction Services, The Manitoba Department of Northern Affairs, Thompson, Manitoba.

I wish to express my gratitude to Dr. Paul Nickel and Mr. Thomas Henley of the Natural Resource Institute, the University of Manitoba for suggestions and advice offered regarding this practicum during its preparation. I also wish to thank Mr. Frank Duval, Superintendant of Airport Operations & Maintenance, The Manitoba Department of Northern Affairs, for his generous offering of information and time. I am grateful to Mr. Terry Partridge of the Manitoba Government Planning Secretariat for helping to put this study into the proper perspective with respect to the development of a northern transportation policy for Manitoba.

This practicum was made possible by a fellowship granted by the Transportation Development Agency, Ministry of Transport, Montreal. I am deeply grateful for the opportunity to do research that was provided by the fellowship.

Finally, I owe a special thank you to Mrs. Marjorie McBride for taking the time and responsibility for typing this report.

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

FIGURES

CHAPTER I

Introduction

THE IMPORTANCE OF THE STUDY

The physical geography of much of Northern Manitoba makes the development of transportation infrastructure difficult and often extremely expensive. Large areas of muskeg and rock outcroppings create difficulties in the location and construction of airstrips at remote communities.

Under these circumstances, the high costs of upgrading airstrips at the communities in this proposed study, dictate that any new investments undertaken to increase airstrip capacity be evaluated thoroughly.

Airstrip upgrading decisions are of critcal importance to the future of the concerned communities as they relate to the more economical delivery of necessary goods and improved passenger service. The resolution of upgrading issues is vital in the interests of safe, fast and economical air service to these communities. For these reasons it is believed this proposed study can make a valuable contribution to the public decision-making process in this area.

An Historical Review of Manitoba Government Policy

The Airport Development Program for remote northern communities in Manitoba was launched in 1966-67. The policy of the Commission of Northern Affairs was to proceed on requests to build airstrips at remote communities with a population of 100 people or more. The purpose of the policy was to provide year-round VFR air transportation access to those communities not connected to southern Manitoba or larger service centres by a surface mode of transportation on a permanent basis.

The program did not exclude Indian Reserves, but as funds were limited, work proceeded with assistance from Winter Works and Fisherman's Compensation programs and the Federal Department of Indian Affairs.

By 1970, thirty-one airstrips were under construction and some degree of operation and maintenance activity was in progress.

The original purpose of the Airport Development Program placed emphasis on the provision of very basic landing facilities which could provide access during the winter freeze-up and spring break-up periods and meet the needs of emergency medical situations. However, many of

the airstrips have outgrown their original functions. Usage has grown tremendously in the past few years and the need for more expensive, sophisticated and reliable facilities has increased. The two busiest remote airstrips in the province, Garden Hill and Norway House, recorded total aircraft movements of 10,784 and 10,108 respectively in the 1975-76 period.[1]

For these airstrips, this represents an increase of 21 percent at Garden Hill and nearly 9 percent at Norway House over the previous one year period.

As the role of many remote airstrips has evolved to include the requirement of higher quality landing and support facilities, an increased strain has been placed on the economic resources of the province. While the further development of criteria to govern the initial investment in remote airstrips remains a concern, the need for economic criteria to aid in decisions relating to the upgrading or re-classification of already existing facilities has become increasingly apparent.

1 Province of Manitoba, Department of Northern Affairs Local Services Division, Airport Activity Summary 1975-76.

Note: For additional information concerning the historical development of Manitoba Government Air Transportation Policy for remote communities, please see Appendix A, Air Transportation Policy and Strategy for Remote Communities in Manitoba, J.D. Collinson, 1971.

A REVIEW OF RECENT STUDIES

Studies done prior to, and including 1974, in the area of northern transportation to remote communities in Manitoba, were directed at synthesizing information from a wide variety of sources in order to gain a better understanding of the behaviour of transportation in Northern Manitoba.[1] These studies contributed to our knowledge of the subject by describing the level of demand for goods and services at remote communities and by examining the degree of modal split occurring in the delivery of passengers and goods between the various transportation alternatives.

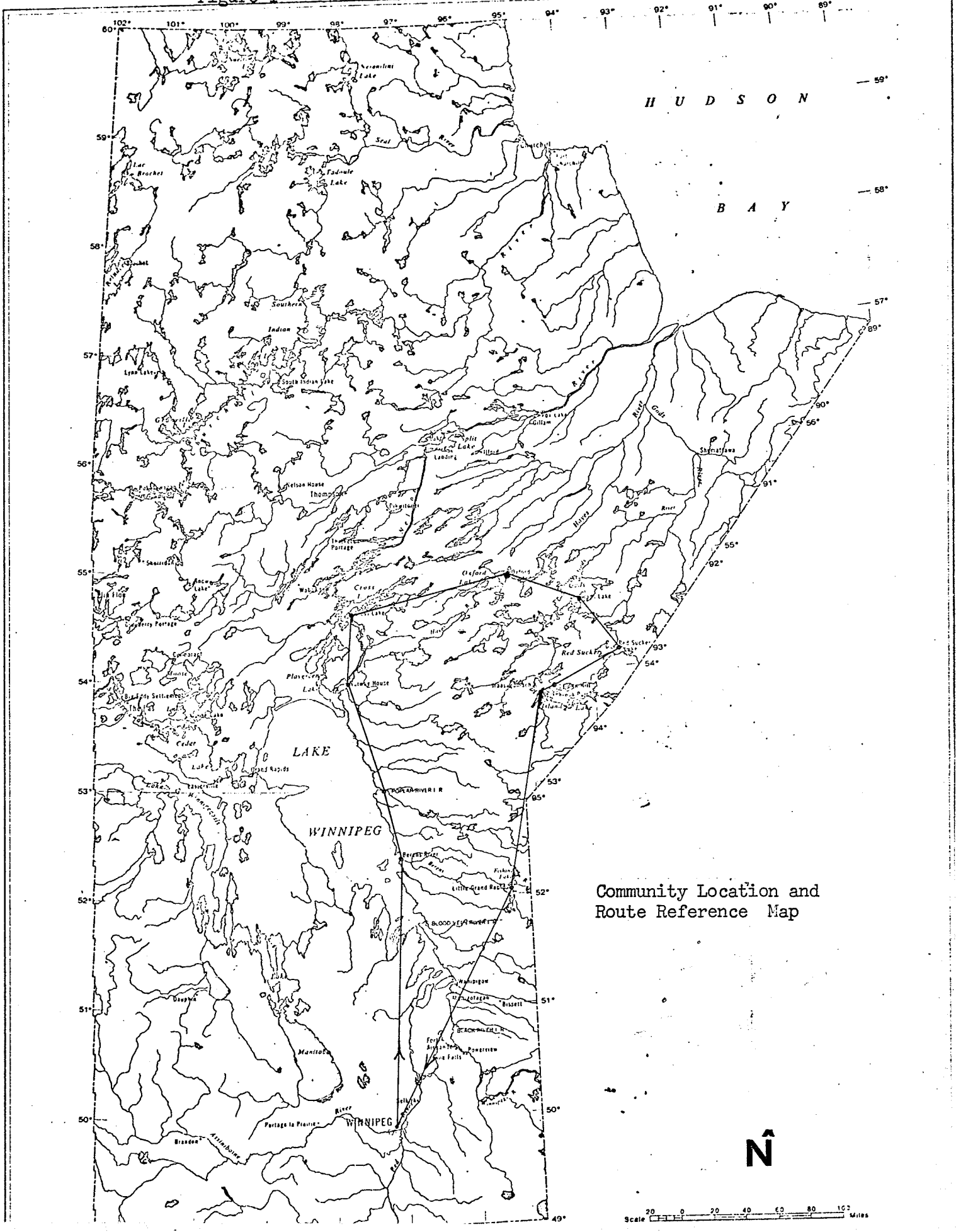
The most recent comprehensive study of transportation in Northern Manitoba, evaluates the economic efficiency of a large number of possible transportation alternatives.[2] The measure of economic efficiecy used is the operational cost saving criterion. The air transportation section of the study evaluates alternatives on

1. Materials for the Development of Remote Airstrips in Manitoba, K.A.J. Davidson, Winnipeg, Manitoba. The Department of Northern Affairs, 1974 and A Study of Freight Transportation to Remote Northern Communities Mackenzie, Ruhr, Simpson Main Report, Winnipeg, Manitoba, 1973.

2. Manitoba Northlands Transportation Study, an Economic Evaluation of Transport System Alternatives, Hickling Johnston Ltd., Toronto, Ontario, 1975.

a point to point basis. This introduces some distortion into the way in which the air transport system actually operates. Like the Hickling Johnston report, this practicum expresses the economic benefits or disbenefits of alternatives in terms of operational cost savings. A major difference is that the alternatives evaluated are compared along a route and thus the costs of delivery of goods and passengers more closely represent actual costs. The other significant difference between the Hickling Johnston study and this practicum is that the analysis undertaken here considers additional investments made at each airstrip to be a separate project rather than part of a combined air transportation package.

Figure 1


HUDSON
BAY
LAKE
WINNIPEG
WINNIPEG
Community Location and
Route Reference Map
N
Scale
Miles

CHAPTER II

THE PROBLEM AND ITS SETTING

The Statement of the Problem

The purpose of this practicum is to develop a practical model which may be used to evaluate decisions relating to the construction of additional capacity to airstrips at selected remote communities in Northern Manitoba.

The Subproblems

The first subproblem. The first subproblem will be to determine the total private and public cost of servicing the communities' current air transport needs, using the existing landing facilities and operating equipment.

The second subproblem. The second subproblem will be to derive an estimate of the growth in demand for goods and passenger movement, by air, to the communities considered.

The third subproblem. The third subproblem is to estimate the probable costs of additional airstrip capacity, at each community, that would be necessary in order to handle more cost efficient aircraft. Also, the probable direct operating costs of such aircraft will be determined.

The fourth subproblem. The fourth subproblem will be to compare the direct monetary benefits of servicing these communities' future air transport needs using the existing delivery system or by using upgraded ground facilities and more cost efficient aircraft.

The Hypothesis

There is at present no commonly accepted method that is applied to the issues involved in deciding whether or not to upgrade the landing facilities at remote airstrips in Northern Manitoba. On the basis of operational cost savings, the direct benefits and costs of additional airstrip investment at the selected communities can be evaluated. Upgrading decisions are critical to the economic future of these remote communities. To the extent that the results of the analysis can be interpreted, the effect of upgrading decisions will be discussed as they relate to lower delivery costs of goods and faster more frequent passenger service.

The Delimitations

There are certain social goals that the provision of air access to remote communities can help to fulfill. One important consideration is the need to provide remote settle-

ment with access to medical relief during times of emergency, especially during periods of spring break-up or winter freeze-up when many communities are cut off from surface modes of transportation. The criteria that may be used, in such circumstances to govern the initial investment in basic airstrip facilities will not be discussed.

Modes of transportation, other than air, may be discussed only in so far as they affect the immediate objectives of this study.

The role of the Ministry of Transport and the Canadian Transport Commission in the provision of air service to the communities in this study, is of a regulatory nature. Their authority in the areas of aircraft safety, airstrip construction standards, the licensing of carriers and the approval of routes, schedules and tariffs, will only be discussed in so far as they affect the main purpose of this study.

The role of air transportation as an instrument of economic and social development is beyond the scope of this study.

The analysis of the communities as a network with regular routes and schedules, precludes the inclusion of information about goods and passengers moved on a charter

basis.

This study does not address itself to the problem of 'rationalizing' northern air service.

The Definition of Terms

Practical model. The term 'practical model' in the context of this study refers to the attempt to view a group of selected communities as a subsystem of the northern air transportation network. The total costs of serving the communities by air will then be determined. These costs will be analyzed using the benefit - cost method. The benefits of additional investments to airstrips can then be evaluated in terms of any operational cost savings to be obtained by serving the transport needs of the communities by more cost efficient aircraft, compared to the continued use of present landing facilities and operating equipment.

Additional capacity cost. Additional capacity cost is the marginal investment necessary to make each airstrip capable of accomodating more cost efficient aircraft than are presently being utilized.

Remote community. Remote communities for the purposes of this study, are, those communities which are not served by

a surface mode of transportation on a permanent basis.

Selected communities. The communities that have been selected for this study are remote communities in Northeast and the East side of Lake Winnipeg, North of the Winnipeg River. They are currently served by Midwest Airlines Ltd. of Winnipeg on a regular scheduled basis from Winnipeg. They are:

	Berens River		Gods Lake Narrows
*	Poplar River	*	Red Sucker Lake
	Norway House		Garden Hill
	Cross Lake	*	Ste. Therese Point
*	Oxford House	*	Little Grand Rapids

Public costs. Public costs are those expenditures made by the Manitoba Department of Northern Affairs, which are directly associated with the construction and operation and maintenance of air service infrastructure at the remote communities outlined in this proposal.

* Service to these points was suspended by the Ministry of Transport on June 30, 1975. Nevertheless, these communities have been included as part of the route system because it has been assumed that the suspension of Class 2 air service to these points, is of a temporary nature.

Private costs. Private costs refer to the direct operating costs of equipment incurred by a private air carrier in providing air service to the communities outlined in this proposal. Direct operating costs include, crew costs, fuels and oil, hull insurance, hull maintenance labour, engine maintenance labour, hull maintenance materials, engine maintenance materials, depreciation, and loan or rental charges.

Air transport needs. The air transport needs of the outlined communities are the current and forecast consumption of goods shipped by air to the communities and the current and forecast demand for passenger movement by air to the communities.

Existing landing facilities. Existing landing facilities in this study, are the current air infrastructure in place at the communities before new investments are made to provide additional capacity.

Existing operating equipment. The existing operating equipment refers to the aircraft currently being used on the specified route that serves the outlined communities on a scheduled basis. At present the operator, Midwest Airlines

Ltd. of Winnipeg, uses the De Havilland DHC-6, Twin Otter. Thus, this aircraft is considered representative of those used to currently service the air transport needs of these communities.

Growth in demand. The term, growth in demand, is used in the general sense to refer to the estimated probable requirement of each of the communities for goods and passenger services provided by the air mode. The forecast of growth in demand will be made for a five year period, from 1976 to 1981. The forecast projected air freight and passenger demands will be made on the basis of population growth at constant per capita levels of consumption.

Critical aircraft. The critical aircraft for an airstrip is the airplane with the largest cargo and/or passenger seating capacity that can legally be used to provide a unit-toll air service.

Cost efficient aircraft. Cost efficient aircraft are those aircraft which reputedly have lower direct operating costs per unit of output than the existing operating equipment. In this study the direct operating costs of the De Havilland Dash 7 and the Douglas DC-3 will be analyzed and

compared with those of the Twin Otter operating on the same route.

Monetary benefit. A monetary benefit is a reduction in the total cost of servicing the air transport needs of the group of communities outlined which comes about as the result of cost savings achieved by operating more cost efficient aircraft on the specified route joining the communities. The monetary net benefit is equal to the total cost of servicing the communities' projected air transport needs using existing landing facilities and existing operating equipment minus the total cost of servicing the communities' projected air transport needs using upgraded landing facilities and more cost efficient aircraft, plus the costs of upgrading.

Assumptions

The first assumption. The first assumption is that the data on freight volumes and passenger movements at each community are normal and representative of the community's air transport requirements.

The second assumption. The second assumption is that the growth in the demand for goods and passenger transport to each community, is constant.

The third assumption. The third assumption is that the rate of population growth is constant.

The fourth assumption. The fourth assumption is that patterns of consumption of the services offered by air transport do not change over the five year period.

The fifth assumption. The fifth assumption is that the level of consumption of air transport services at the communities is a function of population growth.

The sixth assumption. The decision to make additional investments to increase airstrip capacities is made purely on the grounds of economic efficiency.

The seventh assumption. The seventh assumption is that all of the air transport needs of each community are met from Winnipeg using the aircraft that is considered to be the critical aircraft for each community's airstrip or using an aircraft which promises to offer operating cost savings over those aircraft presently in service.

The eighth assumption is that any cost savings realized by the private air carrier because of a public investment in additional airport infrastructure, can be fully passed on to the consumers of air services.

THE DATA AND THE TREATMENT OF THE DATA

The Data Needed

The data necessary for the study may be discussed under three categories.

The first category of data are those which physically describe the physical and operational characteristics of the current air transport delivery system serving the communities outlined in this proposal. These data include the distances between the various communities, travel time between communities, present population of the communities, the volume of passengers and freight transported by air, the costs of operating and maintaining the airstrips at these communities, and the direct operating costs of the kind of aircraft presently serving the communities on a scheduled basis.

The second category of data are estimates of population growth rates at the communities under study, for a five year period, from 1976 to 1981. These data will be estimated on the basis of historical patterns and current population growth trends. Forecasts of air passenger and freight transportation demand will be based on population growth.

The third category of data is necessary to describe the physical and operating characteristics of an air transport

delivery system used to service the study communities, modified to accomodate more cost efficient aircraft than are currently being used. These data include (in addition to the type of information outlined in category number one) the costs of the additional investments required to increase the airstrip capacity at each community, and the direct operating costs of the proposed more cost efficient aircraft.

The Sources of the Data.

Physical & Operational Data. Mileage, distance and travel time information has been obtained from the Manitoba Flight Information Map Supplement[1] and the Transair System Timetable. Population data has been gathered from secondary sources. One of the most recent sources is from the Manitoba Northlands Transportation Study - An Economic Evaluation of Transport System Alternatives.[2] The current operating and maintenance costs for the various airstrips has been obtained directly from the Airport Operations & Maintenance Division of the Department of Northern Affairs. Freight and passenger volume data have been obtained directly from airport activity

[1] The Manitoba Flight Information Map Supplement. The Department of Northern Affairs.

[2] Manitoba Northlands Transportation Study - An Economic Evaluation of Transport System Alternatives. Hickling Johnston Ltd., Toronto, Ontario, 1975. (unpublished report).

summaries compiled by the Airport Operations and Maintenance Division.

The direct operating costs of the Twin Otter (DTO) and the Dash 7 were obtained from Transair Ltd. of Winnipeg. The DOC's for the latter aircraft are the figures presented in a route study done by de Havilland Aircraft of Canada Ltd.[1] Direct operating costs of the DC-3 have been adapted from the Aviation Statistics Centre Service Bulletin (Vol. 7 No. 53, Sept. 1975)

Population Growth Data. Population growth estimates will be based on the information supplied by the Hickling Johnston Study.

Modified System Data. These data will be obtained from the same sources as data in the first category of data mentioned. The additional information regarding the costs of upgrading airstrips has been obtained from the Department of Northern Affairs, Engineering and Construction Services Branch.

[1] Dash 7/Transair; Route Performance & Operating Cost Analysis, prepared by the de Havilland Aircraft of Canada, Limited, Downsview, Ontario, January, 1976

The Research Methodology.

The research methodology employed to analyze the problems presented at the outset of this proposal, is the Benefit-Cost method of analysis.[1] The treatment of all of the relevant data will be done within this framework.

The procedure involves the comparison of the total costs of operating alternative air transport delivery systems to the remote communities outlined in this proposal. Net benefits result when the operational costs of one system are less than those of another.

All benefits and costs will be discounted, for the five year planning horizon used in this study, at a discount rate equal to the cost of capital used in any additional investments to airstrip capacity. The cost of capital used in this study will be 10 per cent.

[1] This study is not a benefit-cost analysis in the broad sense of the term. That is to say, benefit/cost ratios are not determined. Benefits and costs are implied in the computation of the cumulative net present value of cost outlays.

CHAPTER III

THE RESULTS OF THE ANALYSIS

A RE-STATEMENT OF THE METHODOLOGY

The first stage of the analysis involved the projection of air passenger and goods transportation demand for the period 1976 to 1981. The average growth rate in air cargo demand for the area corresponds closely with the population growth rate which is 3.5 per cent per annum. The population projections in this study are based on actual 1971 figures from the census of Canada. The growth rate in passenger traffic along this route has been observed to be approximately 7 per cent per annum.[1.] [2.]

The second stage of the analysis required the determination of all costs associated with the construction of additional capacity at the airstrips, the operation and maintenance of them and the delivery of passengers and goods.[3.]

1. From conversations with David O'Brien, Transair Ltd. W innipeg and Frank DuVal, The Department of Northern Affairs, Thompson, Manitoba, April, 1976.

2. Please see Tables 1, 2 and 3.

3. For the costs of upgrading and operations and maintenance, please refer to Tables 4 and 5.

TABLE 1.

POPULATION PROJECTION AT A GROWTH RATE OF 3.5% PER ANNUM [1]

Community	1976	1977	1978	1979	1980	1981
Berens	1,042	1,079	1,116	1,155	1,196	1,237
Poplar	510	528	546	565	585	606
Norway	3,060	3,167	3,278	3,393	3,511	3,634
Cross	2,123	2,198	2,274	2,354	2,436	2,521
Oxford	976	1,010	1,045	1,082	1,120	1,159
God's Narrows	1,269	1,314	1,360	1,407	1,457	1,508
Red Sucker	310	321	332	344	356	369
Garden Hill	1,430	1,480	1,532	1,586	1,641	1,699
Ste. Theresa	1,053	1,090	1,128	1,168	1,209	1,251
Little Grand	798	826	855	885	916	948

[1] Based on the method used in Population Projections for Manitoba by Region & Town Size - Some Alternatives, 1971 - 1990, by W.R. Maki, C.F. Framingham, D. J. Sandell, The University of Manitoba, Department of Agricultural Economics, Research Bulletin No. 73-2, September, 1973.

TABLE 2.

PROJECTED PASSENGER TRAFFIC, based on Airport Activity for 1975-76, at 7 per cent per annum passenger per year.
by destination

COMMUNITY	1976	1977	1978	1979	1980	1981
BERENS	5,801	6,207	6,642	7,106	7,604	8,136
POPLAR	286	306	327	350	375	401
NORWAY	31,404	33,602	35,954	38,471	41,164	44,045
CROSS	9,677	10,354	11,079	11,855	12,684	13,572
OXFORD	6,969	7,457	7,979	8,537	9,135	9,774
GODS NARROWS	6,278	6,717	7,188	7,691	8,229	8,805
RED SUCKER	1,996	2,136	2,285	2,445	2,616	2,799
GARDEN HILL	28,654	30,660	32,806	35,102	37,559	40,188
STE. THERESA	3,443*	3,684	3,942	4,218	4,513	4,829
LITTLE GRAND	545	583	624	668	714	764
	95,053	101,707	108,826	116,444	124,595	133,317

* This is the figure for 1974-75.
No figure is available for 1975-76.

TABLE 3.

PROJECTED FREIGHT TRAFFIC, based on Airport Activity for 1975-76 at 3.5 per cent per annum (pounds per annum)

COMMUNITY	1976	1977	1978	1979	1980	1981
BERENS	176,200	182,367	188,750	195,356	202,193	209,270
POPLAR	250,000*	258,750	267,806	277,179	286,881	296,922
NORWAY	2,355,400	2,437,839	2,523,163	2,611,474	2,702,875	2,797,476
CROSS	706,000	730,710	756,285	782,755	810,151	838,506
OXFORD	1,757,400	1,818,909	1,882,571	1,948,461	2,016,657	2,087,240
GODS NARROWS	1,204,200	1,246,347	1,289,969	1,335,118	1,381,847	1,430,212
RED SUCKER	169,400	175,329	181,465	187,817	194,390	201,194
GARDEN HILL	3,709,600	3,839,436	3,973,816	4,112,899	4,256,851	4,405,841
STE. THERESA	546,000*	565,110	584,889	605,360	626,548	648,477
LITTLE GRAND	223,600	231,426	239,526	247,909	256,586	265,567
	11,097,800	11,486,223	11,888,240	12,304,328	12,734,979	13,180,703

* This is the figure for 1974-75.
No figure is available for 1975-76.

TABLE 4.

Operations and Maintenance Costs at Airstrips

COMMUNITY	Facility	Salaries	Equipment	Head Office Applied Admin.	TOTAL
ISLAND	78,340	67,621	15,382	14,902	176,245
NORWAY	42,181	55,830	14,218	14,902	127,131
POPLAR	6,248	2,320	-	14,902	23,470
STE. THERESA	11,060	4,265	96	14,902	30,323
LITTLE GRAND	20,062	1,434	5,878	14,902	42,276
CROSS	28,689	34,584	10,849	14,902	89,024
OXFORD HOUSE	34,549	17,457	3,617	14,902	70,525
GODS LAKE NARROWS	31,955	27,188	8,314	14,902	82,359
RED SUCKER	10,381	2,215	1,352	14,902	28,850
BERENS	14,781	5,821	4,252	14,902	39,756
				GRAND TOTAL	709,959

Note: Does not include equipment costs or equipment rental charges.

Source: The Province of Manitoba, Department of Northern Affairs, Airport Operations and Maintenance Section, the 1975-76 fiscal year accounts.

TABLE 5.

THE COSTS OF UPGRADING THE AIRSTRIPS

COMMUNITY	CLASS/LENGTH	ESTIMATED TOTAL COST $M's	BALANCE TO COMPLETE $M	CLASS/LENGTH	ADDITIONAL COST $M
*1 BERENS RIVER	D 2999'	394.00	136.00	C 4000'	899.00 Relocation is necessary
*2 CROSS LAKE	D 2999'	706.00	3.00	C 4000'	500.00
*3 GARDEN HILL (Island Lake)	C 4000'	1,721.00	70.00		
*4 GOD'S LAKE NARROWS	D 2999'	1,252.00	449.00	C 4000'	1,109.00
*5 LITTLE GRAND RAPIDS	D 2999'	982.00	619.00	No information.	
*6 NORWAY HOUSE	C 4000'	2,066.00	834.00	Includes $330,000 for base course which could be excluded	
*7 OXFORD HOUSE	D 2999'	626.00	435.00	C 3500'	837.00
*8 POPLAR RIVER	D 2600'	559.00	357.00	Water to water, impractical to extend	
*9 RED SUCKER LAKE	D 2999'	831.00	655.00	Relocation required, no cost information.	
*10 ST. THERESA	D 2999'	572.00	449.00	Water to water, impractical to extend.	

* Cost of NDB and lighting is included in the estimates.
To exclude these costs subtract $50,000 to get the cost for Day VFR.

Note: Construction could be completed within two years.

Source: Province of Manitoba, Department of Northern Affairs, Engineering Services & Construction Services Division, B.E. Seppala, April 12, 1976.

The determination of the delivery costs of passengers and goods for the alternatives considered, involved a number of steps. The first step entailed the calculation of the number of trips that would be required to satisfy each community's annual air transportation needs.

Three aircraft with different freight and passenger capacities, the Twin Otter (DTO), the DC-3 and the Dash 7, were compared - first assuming all the required cargo was delivered by one kind of aircraft and similarly, assuming all passengers to be delivered by each of the aircraft. The percentage of cargo or passengers delivered to a community on each circuit of the route has been assumed to be the same as each community's annual percentage share of the total amount of freight or passenger movement to communities on the route. Each plane commences from Winnipeg with the maximum possible passenger or freight payload (allowing for fuel and enough reserve fuel to fly to the designated alternate airport, in this case, Norway House). Weather conditions are assumed to be ideal with a zero wind factor. The next step in the determination of the cost

of delivery of both goods and passengers involved the calculation of the direct operating costs for each section of the route. This calculation involved the calculation of the total block time required to complete each section. Block time is a function of the air speed of the aircraft plus an allowance of approximately ten minutes for landing and takeoff maneuvres. Turn around or ground time was not considered a cost because the air carrier usually does not include this time in the determination of direct operating costs of an aircraft. The direct operating cost per section, then, is equal to the block time used multiplied by the direct operating cost per hour. For the Twin Otter the D.O.C. per block hour is 265 dollars.[1] A figure of 540 dollars per block hour was used for the Dash 7[2] and 295 dollars per block hour was used for the D.C-3[3]. The total cost of delivery for

1 Transair Ltd., Aircraft costing by Block Hour 1976, from the 1976 budget.

2 Dash 7/Transair, Route Performance and Operating Cost Analysis, prepared by: The deHavilland Aircraft of Canada Ltd., Downsview, Ontario, January, 1976.

3 Statistics Canada, Aviation Statistics Centre, Service Bulletin; Vol. 7 No. 53, September, 1975

passengers and goods is equal to the cost per section multiplied by the number of trips necessary to reach the required output for any year during the 1976 to 1981 time period.[1]

The final stage of the analysis required the determination of the cumulative net present value of all airstrip and delivery costs for each of the alternatives. The total cost for each year of the 5 year planning period are added together. Each community is done separately but in the same fashion. All costs are discounted at 10% per annum.[2] The rate is approximately the same as the Provincial Government's long term cost of capital. The cumulative net present value of all costs for each alternative, first for freight and then for passengers is presented in detail in tables C1 to C6 in Appendix C.[3] A summary of the result is presented in Chapter IV.

1 Please see tables B1 to B12 in Appendix B.

2 Province of Manitoba, Planning Secretariat, conversation May, 1976.

3 Please note that the operations and maintenance costs of Norway House ($127,131) have been used as a model of probable operating and maintenance costs at a Class "C" strip. Norway House was considered to be representative of the costs of a fully equipped "C" class strip of Northern Affairs Airport O. & M.

CHAPTER IV
THE DISCUSSION OF THE RESULTS

Operational Cost Savings & Disavings of Alternatives 1, 2 and 3 for Freight Output

Of the six communities for which complete construction cost estimates were available, four show that under the conditions set out in Chapter I, positive cost savings can be generated by upgrading existing facilities from Ministry of Transport Class "D" airstrips to Class "C" airstrips. This means that if all of the freight requirement of each of these communities was delivered using either a DC-3 or a Dash 7, the additional expense of greater airstrip capacity would be more than offset by the lower total cost of freight delivery in the five year period. At two communities, Norway House and God's Lake Narrows, the high cost of additional airstrip capacity would not be positively offset within the period 1976 to 1981. For these communities the analysis indicates that it would be more economical to use existing facilities than to upgrade. The disaving at Norway House would be greater if the $330,000 necessary for a base course had been included in the additional construction costs.[1 & 2]

[1] The finding of a disaving at Norway House is somewhat academic as the airstrip there already is a Class "C" licensed to M.O.T. standards. However, it should be that the Norway House airstrip is not a full Class "C" airstrip because zoning restrictions are in effect.

[2] A summary of these results appears in Table 6.

TABLE 6.

SUMMARY, OPERATIONAL COST SAVINGS/DISAVINGS BY ALTERNATIVE FOR FREIGHT OUTPUT[1]

Cumulative Net Present Value of all Costs (in Dollars)	Berens	Poplar	Norway	Cross	Oxford	God's Lake	Red Sucker	Garden Hill	Ste. Therese	Little Grand
Alternative 1 (DTO)	5,324,215	2,281,631	3,070,636	2,242,532	4,041,865	2,527,297	2,533,980	2,808,465	1,426,911	4,716,589
Alternative 2 (DC-3)	4,274,361		3,098,154	2,096,353	3,250,741	2,623,418		1,752,406		
Alternative 3 (Dash 7)	3,609,927		2,734,713	1,988,183	2,928,694	2,530,923		1,630,773		
2 over 1	1,049,854		(27,518)	146,179	791,124	(96,121)		1,056,059		
Percent Saving/disaving	19.71		(.90)	6.51	19.57	(3.80)		37.60		
3 over 2	664,434		363,441	108,170	322,047	(92,495)		121,633		
Percent Saving/disaving	15.54		11.73	5.15	9.90	(3.52)		6.94		
3 over 1	1,714,288		335,923	254,349	1,113,171	(3626)		1,177,692		
Percent Saving/disaving	32.19		10.93	11.34	27.54	(.14)		41.93		

[1] These results are true within the context of the assumptions made in Chap. II and at a 10 per cent discount rate for the period 1976-81. Some disavings could be reduced or eliminated by extending the pay-back period. The base data used in these calculations may be obtained in Appendices B & C.

Note: Bracketed numbers indicate disavings.

Operational Cost Savings & Disavings of Alternatives 1A, 2A and 3A for Passenger Output

All but one of the communities evaluated show that cost savings are associated with the construction of additional capacity at the airstrips. Again Norway House results appear to indicate that the economies of the larger more cost efficient aircraft would not be realized in the first five years of a construction program.[1]

Priorization of Communities for the Purpose of Construction of Additional Airstrip Capacity

The six communities for which complete construction cost estimates were available, were priorized for the purpose of additional airstrip construction, according to percentage cost savings. This was done separately for passenger and freight output. The communities that may generate the highest cost savings over the given time period are given a higher order of preference so that they might be the first to receive additional airstrip capacity. The order of preference is similar for both the freight and passenger alternatives with the exception that God's Lake Narrows and Norway House appear in reverse order.[2]

1 A summary of the results of the passenger output alternatives appears in Table 7.

2 Please see Table 8.

TABLE 7.

SUMMARY, OPERATIONAL COST SAVINGS/DISAVINGS BY ALTERNATIVE FOR PASSENGER OUTPUT [1]

Cumulative Net Present Value of all Costs(in dollars)	Berens	Poplar	Norway	Cross	Oxford	God's Lake	Red Sucker	Garden Hill	Ste. Therese	Little Grand
Alternative 1A (DT⌀)	10,645,860	4,300,743	5,692,422	4,160,910	7,503,147	4,341,876	4,439,587	4,890,789	2,348,119	8,553,047
Alternative 2A (DC-3)	8,508,088		6,121,798	3,612,979	6,022,722	4,058,327		3,374,990		
Alternative 3A (Dash 7)	6,475,412		4,425,770	3,129,382	4,483,611	3,467,819		2,663,689		
2 over 1	2,137,772		(429,376)	547,931	1,480,425	283,549		1,515,799		
percent saving/disaving	20.08		(7.50)	13.16	19.73	6.53		30.99		
3 over 2	2,032,676		1,696,028	483,597	1,539,111	590,508		711,301		
percent saving/disaving	23,89		27.70	13.38	25.55	14.55		21.07		
3 over 1	4,170,448		1,266,652	1,103,152	3,019,536	874,057		2,227,100		
percent saving/disaving	39.17		22.25	24.79	40.24	20.13		45.53		

[1] At a discount rate of 10% for the five year period 1976-81. The base data used in these calculations may be obtained in Appendices B & C.

Note: Bracketed numbers indicate disavings.

TABLE 8.

PRIORIZATION OF COMMUNITIES FOR ADDITIONAL AIRSTRIP CONSTRUCTION ACCORDING TO PERCENTAGE COST SAVINGS [1]

FOR PASSENGER OUTPUT		FOR FREIGHT OUTPUT	
Community	Per Cent Cost Saving (Disaving)	Community	Per Cent Cost Saving (Disaving)
1. GARDEN HILL	30.99[2]	1. GARDEN HILL	37.60[2]
2. BERENS RIVER	20.08	2. BERENS RIVER	19.71
3. OXFORD HOUSE	19.73	3. OXFORD HOUSE	19.57
4. CROSS LAKE	13.16	4. CROSS LAKE	6.51
5. GOD'S NARROWS	6.53	5. NORWAY HOUSE	(.90)[2]
6. NORWAY HOUSE	(7.50)[2]	6. GOD'S NARROWS	(3.80)

1 Percentage cost savings refers to the operational cost savings realizable by the upgrading of a "D" class airstrip to a "C" class airstrip in order to accomodate Class 2 regularly scheduled air service via DC-3 rather than DTO.

2 Norway House and Garden Hill are already Class "C" airstrips except that there are some zoning restrictions in effect.

OTHER CONSIDERATIONS

The Frequency of Service and Economic Efficiency

There is a trade off between the generation of cost savings in the delivery of passengers and goods and the frequency of air service offered to a community. The benefits associated with the construction of additional airstrip capacity are derived entirely from the fact that larger capacity planes are able to deliver the entire compliment of community air services in less time and in fewer trips. It is probable that there are economies to be gained in the shipment of some types of freight because they can be marshalled and held over. This is less true of mail and perishable goods. The demand for air passenger movement obviously must be met when it occurs. The rationale, in the pursuit of economic efficiency, becomes not a question of more service but of less at a lower price. It is uncertain, particularly in the case of passenger service, to what degree the clients of a service would be willing to give up some convenience offered by the freedom of movement in favour of lower priced service.

From the point of view of the carrier, there is the awareness that in spite of their investment in a larger capacity more cost efficient aircraft, they run the risk of losing a portion of a market to operators with smaller aircraft that offer more frequent service.

The Distribution of Benefits

The operational cost saving criterion does provide the Province with a rational method for deciding how to allocate resources to existing communities within the airstrip development program. It does offer a way of priorizing communities for further airstrip development within the confines of a limited budget, but there are two significant impediments which make the free operation of such a criterion difficult. The first impediment is that the benefits or operational cost savings which may occur as the result of airstrip upgrading, accrue first to the air carrier and not to the community or to the Province. The second impediment is that once additional airstrip capacity is built, the Province has no assurance that it will be fully utilized.

These problems arise because the Province and the air carriers are partners in an enterprise who each have differing objectives. The Province's concern in the delivery of air service to a community is to facilitate the desired level of service through the investment in infrastructure. The carrier while not providing the infrastructure must judge the market accordingly and invest in operating equipment which will return a reasonable profit.

The resolution of this latter problem may lie outside the scope of this practicum - in the procedure engaged in by the Canadian Transportation Commission and the air carriers with respect to the granting of operating licenses. Perhaps upgrading should not take place at an airstrip until both the Province and the prospective applicant are reasonably assured that a proposed service can be viable. Such assurance would come in part from more detailed information about the level of demand and the type of demand for air services at communities than is often available.

There are several mechanisms which might serve to help pass on the benefits of reduced operating expenses to the local community and/or the province. The authority

of the Canadian Transport Commission to approve or disapprove passenger fares and freight rates is one way. The entry of new competition into a route is another. The use of landing fees by the airstrip operator, in this case the Province is still another possible way of transfering some of the operational cost savings on to shippers and consumers.

Patterns of Demand

The purpose of this practicum is to offer a rational economic criterion to be of assistance in the making of decisions relating to the upgrading of remote airstrips. It is not intended as a route study and as such it can not realistically be concluded categorically that the DC-3 or Dash 7 are the best aircraft to service the route.

It was assumed that the pattern of demand for passenger and freight services by air is no different from day to day than it is on an annual basis. This is true on average. The simplification was made because airport activity summaries do not record the origin of passenger and cargo flights. So for the purpose of uniform comparison, Winnipeg was assumed to be the origin of all flights and consequently all the air transport needs of each community would be satisfied

from Winnipeg.

In actual fact the air transport demand along the route on a scheduled basis probably fluctuates considerably from day to day and between seasons. In order to choose the optimum plane for the route, the same methodology used in this study could be applied but more detailed information concerning the market share of each carrier, the freight to passenger ratio on trips and variations in the quantities of cargo and passengers transported over time would have to be known.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The Practicality of the Model

The use of the benefit-cost method of analysis and the application of the operational cost saving criterion, within the benefit-cost framework, does fulfill the major objectives of this practicum as stated in Chapter one.[1] The approach has merit in the solution of the managment problem outlined - ie; the upgrading of remote airstrips within a limited budget. Where other considerations do not take precedence over economic efficiency, the approach is a rational and administratively feasible way of allocating economic resources.

The extent to which this application of the benefit-cost method is actually used in airstrip upgrading decisions by the Department of Northern Affairs is subject to at least three reservations; the realization

[1] Chapter I, The Statement of the Problem - P. 4 and The Definition of terms, practical model - P. 7

of a transfer of the benefits of larger capacity airstrips from the air carrier(s) to the clients of an air service or the Province, the willingness of clients of an air service to sacrifice some frequency of service for some cost reductions in the transportation of passengers and goods and the assurance that upgraded strips can be fully utilized by the introduction or expansion of improved air services.

The two former concerns are matters of judgment on the part of the government manager for they have political implications that go beyond the upgrading issue. With regard to the latter concern, the advent of more detailed airport activity reports and greater liason between the provincial government and air carriers proposing to offer improved air services to communities in Northern Manitoba can do much to reduce the risk of constructing airstrips which may prove to be over capacity.

The Limitations of the Study

One major objective of this study has been to illustrate that the upgrading issue (in relation to remote

airstrips in Manitoba) is capable of being reduced to a management problem - one from which realistic solutions can be derived through systematic examination. In order to do this it should be pointed out that simplifications were necessarily made. Obviously some constraints were placed on the number of possible alternatives investigated and some issues which have a bearing on the provision of northern air servicesbut which were peripheral to the immediate problem under study, had to be ommited.

The choice of aircraft to be evaulated was arbitrarily limited. There are no doubt, several other types of operating equipment that could be compared. A five year payback period was chosen for two reasons - first a shorter period reflects the need for early, tangible returns on new public investments and secondly, because the realiability of predictions decreases the further they are removed from the present. A market rate of discount as opposed to a social rate of discount was used. The evaluation of a wider range of alternatives under a variety of different assumptions concerning the rate of growth in demand for certain types of air services, the length of the planning period, the magnitude of the discount rate etc. certainly would be useful.

In this study, population is used as the sole determinant of passenger and freight demand by air. However, changes in the volume of air traffic between communities may also be a function of economic development, personal incomes, the degree of community self-sufficiencyin terms of reliance on the natural resource base for the provision of needs and the existence of other transportation modal linkages. Where these kinds of data are available they should be used in order to improve the predictive qualities of the model for forecasting future air traffic demands at communities under study.

There are a number of important issues which would require an entirely different methodological framework than the one used in this study, in order to be evaluated. They are political or legal and regulatory in nature. For example, the development of criteria to govern initial public investment in airport infrastructure and the definition of minimum construction standards for airstrips are questions where the opinions of the responsible parties are at variance. It became apparent during the course of this study that there is a train of airport support services that follows in the "wake" of the issuing of a license to provide particular classes of air service. There is confusion and disagreement about what services are to be offered with each class of air service, which support services are essential, and what agency (or agencies) is legally and financially responsible for the provision of these support services.

RECOMMENDATIONS

The first recommendation is that the possible merits of greater provincial involvement in the approval of improved levels of commercial air service at remote communities be investigated further. This recommendation does not come about as the direct result of the analysis

done in this study but arises from the belief that because the responsibility for the provision of air services to remote communities is so divided that co-operation between the different concerned parties (The Ministry of Transport, The Department of Northern Affairs and the private air carriers) that a greater degree of co-operation is both desirable and essential.[1]

The second recommendation relates to the collection of date for The Department of Northern Affairs airport activity reports. It would be extremely valuable in future studies of the air transportation system in Northern Manitoba if the reports recorded the origin of flights as well as the destination, the name of the commercial operator and type of airplane, according to manufacturer and model. Such measures would simplify the conduct of future studies by facilitating the analysis of the actual economic feasibility of offering improved air services over specified routes using various types of aircraft to carry out service.

[1]It should be emphasized that this is a recommendation for further study.

BIBLIOGRAPHY

1. References Cited

Reports - Published

Good, W.S., The Direct Operating Costs of a S.T.O.L. Aircraft in Northern Manitoba, Research Report No. 15, Winnipeg, The Centre for Transportation Studies, The University of Manitoba, 1974.

Unpublished Material

Collinson, J.D. Air Transportation and Strategy for Remote Communities in Northern Manitoba, Winnipeg, 1971.

Davidson, K.A.J. Materials for the Development of Remote Airstrips in Manitoba, Winnipeg, The Department of Northern Affairs, 1974.

Davidson, K.A.J. Cost Criteria for Investment in Airstrips at Remote Communities in Northern Manitoba, Winnipeg, 1974.

de Havilland Aircraft of Canada Limited, Dash 7/Transair; Route Performance & Operating Cost Analysis, Downsview, Ontario, January, 1976.

The Department of Northern Affairs, Airport Operations and Maintenance Division,

1) Airport Activity Summaries, 1975-76

2) Budget Estimates 1975-76

3) Operations & Maintenance Records, 1975-76

Hickling Johnston Ltd., Manitoba Northlands Transportation Study. (Volume 2) An Economic Evaluation of Transport System Alternatives; (Volume 3) General Appendix, Toronto, 1975.

Mackenzie, Ruhr, Simpson, A Study of Freight Transportation to Remote Northern Communities, Main Report, Winnipeg, 1973.

2. Other References

Books

Adler, Hans A., Economic Appraisal of Transport Projects, a Manual with Case Studies, Bloomington, Indiana University Press, 1971.

Unpublished Materials

Schreyer, The Honourable Edward, Prospective Transportation Innovations in Northern Manitoba, Winnipeg, 1973.

J.D. Collinson
1971

APPENDIX "A"

AIR TRANSPORTATION POLICY AND STRATEGY FOR REMOTE COMMUNITIES IN NORTHERN MANITOBA

I. POLICY - to provide facilities for 12 months air transportation (VFR) in all northern communities of 100 or more persons without access by road.[1]

II. STRATEGY

1) To provide key potential regional centres with airports capable of handling scheduled passenger and freight aircraft on a 24-hour basis during all seasons.

Facilities provided would include:

- graded, gravel runways
- beacon and runway lights
- radio equipment
- terminal building with weather facilities
- warehouse facilities
- snowplowing, dragging and fire-fighting equipment.

[1] Wherever possible, airstrips and associated facilities would be located in close proximity to float-plane bases in order to serve both types of aircraft and to permit easy transfer of both passengers and freight from one to the other.

Upon completion, passenger fares would be considerably lowered, scheduled service more dependable and air freight costs could become more competitive with tractor, train or truck hauling over winter roads along with greater frequency (and therefore less storage) and less damage to cargo.

Priority centres for airsrips are:

- Norway House
- Garden Hill.

This would link the central and eastern, northern Manitoba communities with both Winnipeg and Thompson on a scheduled and lower cost basis.

2) To provide centres without road access with 500 or more population with airstrips having the following facilities:

- graded, gravel runway, small terminal building and warehouse;
- radio equipment available through Department of Mines, Resources and Environmental Management field office;
- snowplowing, dragging and general maintenance arrangements with local authorities.

These airstrips would be operational at all times of the year during daylight hours for visual flying.

They would facilitate scheduled passenger and freight operations hereby reducing access costs and general costs of living without abnormally high per capita sunk capital costs. Access would be more available, in particular to either the regional airports or to the mainline airports of Thompson, Flin Flon, The Pas, Lynn Lake, Churchill and Gillam.

Priority airstrip locations are:

- Beren's River
- Cross Lake
- God's Narrows
- Oxford House
- Nelson House
- Leaf Rapids
- Brochet
- Moose Lake
- Little Grand Rapids
- Pukatawagan
- Ste. Therese Point

3) To provide centres without road access with 100 or more population with a graded sand or clay landing strip with light gravel. Existing landing strips of this quality have been in fairly regular use in 23 northern communities over the past year. While not as dependable as graded gravel in all weather conditions, they provide for economical and quite dependable service by lighter aircraft[1] at relatively low capital cost. As well, many are located on or

[1] Twin Otter type or smaller

near scheduled routes of larger aircraft and would serve as emergency landing sites.

Priority locations for landing strips are:

- Poplar River
- Shamattawa
- Split Lake
- South Indian Lake
- York Landing
- Bloodvein
- Thicket Portage
- Pikwitonei
- Ilford
- Red Sucker
- Sherridon

4) Access to and from other communities (many are under 100 population), including those nearby locations served by the above (e.g. Wasagomach - population 204) will continue, at least until the priority projects are completed, to be served by water, over ice in winter, by float or ski-equipped aircraft, or by helicopters strategically located during freeze-up and thaw for emergency purposes.

5) To make provision for airstrips for exploration and development purposes in northern Manitoba. These airstrips would be authorized by the provincial government but financed by the exploration or development company involved. They would be available to the general public on an emergency basis only and upon completion of

the exploration or development project the control could revert to the provincial government.

III. JUSTIFICATION

- residents have the same right of access to opportunities and services (particularly those publicly sponsored) as all other citizens.
- road access to these communities is extremely expensive.
- capital costs of high quality airports at all locations is expensive.
- the level and frequency or intensity of service varies by community size and role.
- Wheel equipped aircraft are faster and more efficient than those equipped with floats or skies.
- tractor trains for freight hauling are slow, unpredictable, relatively inefficient and suited only to certain types of cargo.
- scheduled passenger service would reduce transportation costs to residents, and also to the public generally when compared to the present cost of charter float or ski service.
- access to health and medical facilities would be greatly improved, particularly during periods of freeze-up and thaw.

- improved real physical access, along with, improved communications, would provide a basic foundation for greater understanding of the larger society; opportunity horizons could be broadened; and a major physical constraint to mobility (either of a permanent or of a temporary "testing" nature) would be removed.
- considerable employment would be created during the construction stage with some continuing employment during operations: not only would this provide job and income opportunities; it would provide an environment for training or orientation (along the lines of the Manpower Corps Program) that would further enhance long term employability of those involved.

TABLE B 1 APPENDIX B.

THE CALCULATION OF ROUND TRIPS TO FREIGHT OUTPUT USING THE DTO

	Berens	Poplar	Norway	Cross	Oxford	God's	Red	Garden Hill	Ste. Therese	Little Grand
Percent of total cargo	1.58	2.25	21.26	6.36	15.83	10.85	1.52	33.44	5.0	2.0
Percent of total passengers max. available payload (lbs.)	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775	3,775
Amount of cargo dropped per trip (in lbs.)	60	85	803	240	598	410	57	1,262	189	75
No. of trips to output										
1976	2,936	2,941	2,933	2,941	2,939	2,937	2,972	2,939	2,889	2,981
1977	3,039	3,044	3,036	3,044	3,042	3,040	3,076	3,042	2,990	3,086
1978	3,146	3,151	3,142	3,151	3,148	3,146	3,184	3,148	3,095	3,194
1979	3,255	3,261	3,252	3,261	3,259	3,257	3,295	3,259	3,203	3,306
1980	3,369	3,375	3,366	3,375	3,373	3,371	3,410	3,373	3,315	3,422
1981	3,487	3,494	3,484	3,494	3,491	3,488	3,530	3,491	3,431	3,541

TABLE B 2

THE CALCULATION OF THE COST OF CARGO DELIVERY FOR THE DTO, 1976-1981

	Berens	Poplar	Norway	Cross	Oxford	God's Narrows	Red Sucker	Garden Hill	Ste. Therese	Little Grand
Stage length (S.M.)	172	46	71	45	104	41	43	51	8	127
Distance from Wpg. (S.M.)	172	214	283	327	359	343	335	296	292	168
Block time at 160 MPH + 10 mins. stop & maneuvers (in mins.)	74.50	27.25	36.62	26.87	49.00	25.38	26.12	29.12	13.00	57.62
Cost per section ($)	329.00	120.00	162.00	119.00	216.00	112.00	115.00	129.00	57.00	254.00
Round tripsto output, 1976	2,936	2,941	2,933	2,941	2,939	2,937	2,972	2,939	2,889	2,981
Total cost of delivery via DTO										
1976	965,944	352,920	475,146	349,979	634,824	328,944	341,780	379,131	164,673	757,174
1977	999,831	365,280	491,832	362,236	657,072	340,480	353,740	392,418	170,430	783,844
1978	1,035,034	378,120	509,004	374,969	679,968	352,352	366,160	406,092	176,415	811,276
1979	1,070,895	391,320	526,824	388,059	703,944	364,784	378,925	420,411	182,571	839,724
1980	1,108,401	405,000	545,292	401,625	728,568	377,552	392,150	435,117	188,955	869,188
1981	1,147,223	419,280	564,408	415,786	754,056	390,656	405,950	450,339	195,567	899,414

TABLE B3

THE CALCULATION OF ROUND TRIPS TO PASSENGER OUTPUT VIA DTO, 1976-1981

	Berens	Poplar	Norway	Cross	Oxford	God's Lake	Red Sucker	Garden	Ste. Therese	Little Grand
Percent of total passengers	6.10	.30	33.03	10.18	7.33	6.60	2.09	30.14	3.62	.57
Max. available payload (persons) NOT including crew	17									
No. of persons dropped per trip	1.04	.05	5.61	1.73	1.25	1.12	.35	5.12	.62	.10
No. of trips to output										
1976	5,578	5,720	5,598	5,594	5,575	5,605	5,703	5,596	5,553	5,450
1977	5,968	6,120	5,990	5,986	5,965	5,997	6,102	5,988	5,942	5,832
1978	6,386	6,549	6,409	6,405	6,383	6,417	6,529	6,407	6,358	6,240
1979	6,833	7,007	6,858	6,853	6,830	6,866	6,986	6,855	6,803	6,676
1980	7,311	7,498	7,338	7,333	7,308	7,347	7,475	7,335	7,279	7,144
1981	7,823	8,023	7,851	7,846	7,819	7,861	7,999	7,849	7,788	7,644

TABLE B 4

THE CALCULATION OF THE COST OF PASSENGER DELIVERY FOR THE DTO, 1976-1981

	Berens	Poplar	Norway	Cross	Oxford	God's Lake	Red Sucker	Garden	Ste. Therese	Little Grand
Stage length (S.M.)	172	46	71	45	104	41	43	51	8	127
Distance from Wpg. (S.M.)	172	214	283	327	359	343	335	296	292	168
Block time including stop & maneuvres (mins.)	74.50	27.25	36.62	26.87	49.00	25.38	26.12	29.12	13.00	57.62
Cost per section ($)	329.00	120.00	162.00	119.00	216.00	112.00	115.00	129.00	57.00	254.00
Total cost of delivery ($)										
1976	1,835,162	686,400	906,876	665,686	1,204,200	627,760	655,845	721,884	316,521	1,384,300
1977	1,963,472	734,400	970,380	712,334	1,288,440	671,664	701,730	772,452	338,694	1,481,328
1978	2,100,994	785,880	1,038,258	762,195	1,378,728	718,704	750,835	826,503	362,406	1,584,960
1979	2,248,057	840,840	1,110,996	815,507	1,475,280	768,992	803,390	884,295	387,771	1,695,704
1980	2,404,319	899,760	1,188,756	872,627	1,578,528	822,864	859,625	946,215	414,903	1,814,576
1981	2,573,767	962,760	1,271,862	933,674	1,688,904	880,432	919,885	1,012,521	443,916	1,941,576

TABLE B 5

THE CALCULATION OF ROUND TRIPS TO PASSENGER OUTPUT VIA DC-3, 1976-1981

	Berens	Norway	Cross	Oxford	God's	Garden
Percent of total passengers	6.53	35.37	10.89	7.84	7.07	32.27
Max. available payload (persons) not including crew	26	26	26	26	26	26
No. of persons dropped per trip	1.69	9.20	2.83	2.04	1.84	8.39
No. of trips to output						
1976	3,432	3,413	3,419	3,416	3,412	3,415
1977	3,672	3,652	3,659	3,655	3,651	3,654
1978	3,929	3,908	3,914	3,911	3,906	3,910
1979	4,204	4,181	4,188	4,185	4,180	4,184
1980	4,499	4,474	4,482	4,478	4,472	4,476
1981	4,814	4,787	4,795	4,791	4,786	4,790

TABLE B 6

THE CALCULATION OF THE COST OF PASSENGER DELIVERY FOR THE DC-3, 1976-1981

	Berens	Norway	Cross	Oxford	God's	Garden
Stage length(S.M.)	172	116	45	104	41	50
Distance from Winnipeg (S.M.)	172	283	327	359	343	296
Block Time (min)	74.50	53.50	26.87	49.00	25.38	28.75
Cost per section ($)	366.00	263.00	132.00	241.00	125.00	141.00
Total cost of delivery via DC-3 ($)						
1976	1,256,112	897,619	451,308	823,256	426,500	481,515
1977	1,343,952	960,476	482,856	880,855	456,375	515,214
1978	1,438,014	1,027,804	516,648	942,551	488,250	551,310
1979	1,538,664	1,099,603	548,856	1,008,585	522,500	589,944
1980	1,646,634	1,176,662	591,624	1,079,198	559,000	631,116
1981	1,761,924	1,258,981	632,940	1,154,631	598,250	675,390

TABLE B 7.

THE CALCULATION OF ROUND TRIPS TO FREIGHT OUTPUT USING THE DC-3

	Berens	Norway	Cross	Oxford	God's	Garden
Percent of total cargo	1,77	23.78	7.12	17.73	12.15	37.44
Maximum available payload (lbs.)	6,720	6,720	6,720	6,720	6,720	6,720
Amount of cargo dropped per trip (lbs.)	119	1,598	478	1,191	816	2,516
No. of trips to output						
1976	1,481	1,474	1,477	1,476	1,476	1,474
1977	1,532	1,525	1,529	1,528	1,528	1,525
1978	1,586	1,579	1,582	1,581	1,581	1,579
1979	1,641	1,634	1,638	1,636	1,636	1,634
1980	1,699	1,691	1,695	1,694	1,694	1,691
1981	1,759	1,751	1,754	1,753	1,753	1,751

TABLE B 8

THE CALCULATION OF THE COST OF CARGO DELIVERY FOR THE DC-3, 1976 - 1981

	Berens	Norway	Cross	Oxford	God's Narrows	Garden Hill
Stage length (in S.M.)	172	116	45	104	41	50
Distance from Winnipeg (S.M.)	172	283	327	359	343	296
Block time at 160 MPH including stop over and maneuvers (in mins.)	74.50	53.50	26.87	49.00	25.38	28.75
Cost per trip @ $295.00 blk. hr.	366.00	263.00	132.00	241.00	125.00	141.00
Round trips to output total DOC via DC-3						
1976	542,046	387,662	194,964	355,716	184,500	207,834
1977	560,712	401,075	201,828	368,248	191,000	215,025
1978	580,476	415,277	208,824	381,021	197,625	222,639
1979	600,606	429,742	216,216	394,276	204,500	230,394
1980	621,834	444,733	223,740	408,254	211,750	238,431
1981	643,794	460,513	231,528	422,473	219,125	246,891

TABLE B 9.

THE CALCULATION OF ROUND TRIPS TO FREIGHT OUTPUT USING THE DASH 7

	Berens	Norway	Cross	Oxford	God's Narrows	Garden Hill
Percent of total cargo	1.77	23.78	7.12	17.73	12.15	37.44
Maximum available payload (lbs.)	10,640					
Amount of cargo dropped per trip (lbs.)	188	2,530	758	1,886	1,293	3,984
No. of trips to output						
1976	937	931	931	932	931	931
1977	970	964	964	965	964	964
1978	1,004	997	997	998	997	997
1979	1,039	1,032	1,032	1,033	1,032	1,032
1980	1,075	1,068	1,068	1,069	1,068	1,068
1981	1,113	1,106	1,106	1,107	1,106	1,106

TABLE B 10.

THE CALCULATION OF THE COST OF CARGO DELIVERY FOR THE DASH 7, 1976 - 1981

	Berens	Norway	Cross	Oxford	God's Narrows	Garden Hill
Stage length (S.M.)	172	116	45	104	41	50
Distance from Wpg. (S.M.)	172	283	327	359	343	296
Block time (mins.)	51.28	37.84	20.8	34.96	19.84	22.00
Cost per section @ $540.00 blk. hr.	462.00	341.00	187.00	315.00	179.00	198.00
Total DOC via Dash 7 ($)						
1976	432,894	317,471	174,097	293,580	166,649	184,338
1977	448,140	328,724	180,268	303,975	172,556	190,872
1978	463,848	339,977	186,439	314,370	178,463	197,406
1979	480,018	351,912	192,984	325,395	184,728	204,336
1980	496,650	364,188	199,716	336,735	191,172	211,464
1981	514,206	377,146	206,822	348,705	197,974	218,988

TABLE B 11.

THE CALCULATION OF ROUND TRIPS TO PASSENGER OUTPUT
VIA DASH 7 - 1976-1981

	Berens	Norway	Cross	Oxford	God's Narrows	Garden Hill
Percent of total passengers	6.53	35.37	10.89	7.84	7.07	32.27
Max. available payload (persons) not including crew	50	50	50	50	50	50
No. of persons dropped per trip	3	18	5	4	3.5	16
No. of trips to output						
1976	1,934	1,745	1,935	1,742	1,794	1,791
1977	2,069	1,867	2,070	1,864	1,920	1,916
1978	2,214	1,999	2,215	1,994	2,054	2,051
1979	2,369	2,138	2,370	2,134	2,198	2,194
1980	2,535	2,287	2,536	2,283	2,352	2,348
1981	2,713	2,447	2,714	2,443	2,516	2,512

TABLE B 12.

THE CALCULATION OF THE COST OF PASSENGER DELIVERY FOR THE DASH 7, 1976-1981

	Berens	Norway	Cross	Oxford	God's Narrows	Garden Hill
Stage length (S.M.)	172	116	45	104	41	50
Distance from Winnipeg (S.M.)	172	283	327	359	343	296
Block time (mins.)	51.28	37.84	20.80	34.96	19.84	22.00
Cost per section ($)	462	341	187	315	179	198
Total cost of delivery via Dash 7 ($)						
1976	893,508	595,045	361,845	548,730	321,126	354,618
1977	955,878	636,647	387,090	587,160	343,680	379,368
1978	1,022,868	681,659	414,205	628,110	367,666	406,098
1979	1,094,478	729,058	443,190	672,210	393,442	434,412
1980	1,171,170	779,867	474,232	719,145	421,008	464,904
1981	1,253,406	834,427	507,518	769,545	450,364	497,376

TABLE C 1

ALTERNATIVE 1, DELIVERY OF ALL GOODS BY DTO FROM 1976 to 1981

1976	Berens	Poplar	Norway	Cross	Oxford	God's Narrows	Red Sucker	Garden Hill	Ste. Theresa	Little Grand
Cost of add. airstrip construction *	68,000	178,500	0	1,500	217,500	224,500	327,500	0	224,500	309,500
Airstrip operations & maintenance costs	39,756	23,470	127,131	89,024	70,525	82,359	28,850	176,245	30,323	42,276
Delivery cost of goods	965,944	352,920	475,146	349,979	634,824	328,944	341,780	379,131	164,673	757,174
Total cost	1,073,700	554,890	602,277	440,503	922,849	635,803	698,130	555,376	419,496	1,108,950
Discount factor @ 10%	1.00									
Net present value of costs	1,073,700	554,890	602,277	440,503	922,849	635,803	698,130	555,376	419,496	1,108,950
1977										
Cost of add. airstrip construction	68,000	178,500	0	1,500	217,500	224,500	327,500	0	224,500	309,500
Airstrip operations & maintenance costs	39,756	23,470	127,131	89,024	70,525	82,359	28,850	176,245	30,323	42,276
Delivery cost of goods	999,831	365,280	491,832	362,236	657,072	340,480	353,740	392,418	170,430	783,844
Total cost	1,107,587	567,250	618,963	452,760	945,097	647,339	710,090	568,663	425,253	1,135,620
Discount factor @ 10%	.9091									
Net present value of costs	1,006,691	515,687	562,699	411,604	859,188	588,496	645,543	516,972	386,598	1,032,392

* All costs are expressed in 1976 dollars

TABLE C 1 Continued

1978	Berens	Poplar	Norway	Cross	Oxford	God's Narrows	Red Sucker	Garden Hill	Ste. Theresa	Little Grand
Cost of add. airstrip construction	0	0	0	0	0	0	0	0	0	0
Airstrip operations & maintenance costs	39,756	23,470	127,131	89,024	70,525	82,359	28,850	176,245	30,323	42,276
Delivery cost of goods	1,035,034	378,120	509,004	374,969	679,968	352,352	366,160	406,092	176,415	811,276
Total cost	1,074,790	401,590	636,135	463,993	750,493	434,711	395,010	582,337	206,738	853,552
Discount factor @ 10%	.8264									
Net present value of costs	888,206	331,874	525,702	383,444	620,207	359,245	326,436	481,243	170,848	705,375
1979										
Cost of add. airstrip construction	0	0	0	0	0	0	0	0	0	0
Airstrip operations & maintenance costs	39,756	23,470	127,131	89,024	70,525	82,359	28,850	176,245	30,323	42,276
Delivery cost of goods	1,070,895	391,320	526,824	388,059	703,944	364,784	378,925	420,411	182,571	839,724
Total cost	1,110,651	414,790	653,955	477,083	774,469	447,143	407,775	596,656	212,894	882,000
Discount factor @ 10%	.7513									
Net present value of costs	834,432	311,632	491,316	358,422	581,859	335,939	306,361	448,268	159,947	662,647

TABLE C 1 Continued

1980	Berens	Poplar	Norway	Cross	Oxford	God's Narrows	Red Sucker	Garden Hill	Ste. Theresa	Little Grand
Cost of add. airstrip construction	0	0	0	0	0	0	0	0	0	0
Airstrip operations & maintenance costs	39,756	23,470	127,131	89,024	70,525	82,359	28,850	176,245	30,323	42,276
Delivery cost of goods	1,108,401	405,000	545,292	401,625	728,568	377,552	392,150	435,117	188,955	869,188
Total cost	1,148,157	428,470	672,423	490,649	799,093	459,911	421,000	611,362	219,278	911,464
Discount factor @ 10%	.6830									
Net present value of costs	784,191	292,645	459,265	335,113	545,780	314,119	287,543	417,560	149,767	622,530
1981										
Cost of add. airstrip construction	0	0	0	0	0	0	0	0	0	0
Airstrip operations & maintenance costs	39,756	23,470	127,131	89,024	70,525	82,359	28,850	176,245	30,323	42,276
Delivery cost of goods	1,147,223	419,280	564,408	415,786	754,056	390,656	405,950	450,339	195,567	899,414
Total cost	1,186,979	442,750	691,539	504,810	824,581	473,015	434,800	626,584	225,890	941,690
Discount factor @ 10%	.6209									
Net present value of costs	736,995	274,903	429,377	313,436	511,982	293,695	269,967	389,046	140,255	584,695
Cumulative net present value of costs	5,324,215	2,281,631	3,070,636	2,242,532	4,041,865	2,527,297	2,533,980	2,808,465	1,426,911	4,716,589

TABLE C 2.

ALTERNATIVE 2. DELIVERY OF ALL GOODS BY DC-3. 1976-1981

1976	Berens	Norway	Cross	Oxford	God's Narrows	Garden Hill
Cost of add. airstrip construction	449,500	252,000	250,000	418,500	554,500	35,000
Airstrip operations & maintenance	127,131	127,131	127,131	127,131	127,131	127,131
The delivery cost of goods	542,046	387,662	194,964	355,716	184,500	207,834
Total cost	1,118,677	766,793	572,095	901,347	866,131	369,965
Discount factor @ 10%	1.00					
Net present value of costs	1,118,677	766,793	572,095	901,347	866,131	369,965
1977						
Cost of add. airstrip construction	449,500	252,000	250,000	418,500	554,500	35,000
Airstrip operations & maintenance cost	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of goods	566,712	401,075	201,828	368,248	191,000	215,025
Total cost	1,137,343	780,206	578,959	913,879	872,631	377,156
Discount factor @ 10%	.9091					
Net present value of costs.	1,033,959	709,285	526,332	830,807	793,309	342,873

TABLE C 2 Continued

1978	Berens	Norway	Cross	Oxford	God's Narrows	Garden Hill
Cost of add. airstrip construction	0	0	0	0	0	0
Airstrip operations & maintenance cost	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of goods	580,476	415,277	208,824	381,021	197,625	222,639
Total cost	707,607	542,408	335,955	508,152	324,756	349,770
Discount factor @ 10%	.8264					
Net present value of costs	584,766	448,246	277,633	419,937	268,378	289,050
1979						
Cost of add. airstrip construction	0	0	0	0	0	0
Airstrip operations & maintenance cost	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of goods	600,606	429,742	216,216	394,276	204,500	230,394
Total cost	727,737	556,873	343,347	521,407	331,631	357,525
Discount factor @ 10%	.7513					
Net present value of costs	546,749	418,379	257,957	391,733	249,154	268,609

TABLE C 2 Continued

1980	Berens	Norway	Cross	Oxford	God's Narrows	Garden Hill
Cost of add. airstrip construction	0	0	0	0	0	0
Airstrip operations & maintenance cost	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of goods	621,834	444,733	223,740	408,254	211,750	238,431
Total cost	748,965	571,864	350,871	535,385	338,881	365,562
Discount factor @ 10%	.6830					
Net present value of costs	511,543	390,583	239,645	365,668	231,456	249,679
1981						
Cost of add. airstrip construction	0	0	0	0	0	0
Airstrip operations & maintenance costs	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of goods	643,794	460,513	231,528	422,473	219,125	246,891
Total cost	770,925	587,644	358,659	549,604	346,256	374,022
Discount factor @ 10%	.6209					
Net present value of costs	478,667	364,868	222,691	341,249	214,990	232,230
Cumulative net present value of costs	4,274,361	3,098,154	2,096,353	3,250,741	2,623,418	1,752,406

TABLE C 3.

ALTERNATIVE 3, DELIVERY OF ALL GOODS BY DASH 7 FROM 1976 to 1981

1976	Berens	Norway	Cross	Oxford	God's Narrows	Garden Hill
Cost of add. airstrip construction	449,500	252,000	250,000	418,500	554,500	35,000
Airstrip operation & maintenance costs	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of goods	432,894	317,471	174,097	293,580	166,649	184,338
Total cost	1,009,525	696,602	551,228	839,211	848,280	346,469
Discount factor @ 10%	1.00					
Net present value of cost	1,009,525	696,602	551,228	839,211	848,280	346,469
1977						
Cost of add. airstrip construction	449,500	252,000	250,000	418,500	554,500	35,000
Airstrip operations & maintenance costs	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of goods	448,140	328,724	180,268	303,975	172,556	190,872
Total cost	914,771	707,855	557,399	849,606	854,187	353,003
Discount factor @ 10%	.9091					
Net present value of costs	831,618	643,511	506,731	772,377	776,541	320,915

TABLE C3 Continued

1978	Berens	Norway	Cross	Oxford	God's Narrows	Garden Hill
Cost of add. air-strip construction	0	0	0	0	0	0
Airstrip operations & maintenance costs	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of goods	463,848	339,977	186,439	314,370	178,463	197,406
Total cost	590,979	467,108	313,570	441,501	305,594	324,537
Discount factor @ 10%	.8264					
Net present value of costs	488,385	386,018	259,134	364,856	252,543	268,197
1979						
Cost of add. air-strip construction	0	0	0	0	0	0
Airstrip operations & maintenance costs	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of goods	480,018	351,912	192,984	325,395	184,728	204,336
Total cost	607,149	479,043	320,115	452,526	311,859	331,461
Discount factor @ 10%	.7513					
Net present value of costs	456,151	359,905	240,502	339,983	234,300	249,027

TABLE C3 Continued

1980	Berens	Norway	Cross	Oxford	God's Narrows	Garden Hill
Cost of add. air-strip construction	0	0	0	0	0	0
Airstrip operations & maintenance costs	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of goods	496,650	364,188	199,716	336,735	191,172	211,464
Total cost	623,781	491,319	326,847	463,866	318,303	338,595
Discount factor @ 10%	.6830					
Net present value of costs	426,042	335,571	223,237	316,820	217,401	231,260
1981						
Cost of add. air-strip construction	0	0	0	0	0	0
Airstrip operations & maintenance costs	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of goods	514,206	377,146	205,822	348,705	197,974	218,988
Total cost	641,337	504,277	333,953	475,836	325,105	346,119
Discount factor @ 10%	.6209					
Net present value of costs	398,206	313,106	207,351	295,447	201,858	214,905
Cumulative net present value of costs	3,609,927	2,734,713	1,988,183	2,928,694	2,530,923	1,630,773

TABLE C 4

ALTERNATIVE 1A, THE DELIVERY OF ALL PASSENGERS BY DTO FROM 1976 - 1981

	Berens	Poplar	Norway	Cross	Oxford	God's Narrows	Red Sucker	Garden Hill	Ste. Theresa	Little Grand
1976										
Cost of add. airstrip construction	58,000	178,500	0	1,500	217,500	224,500	327,500	0	224,500	309,500
Airstrip operation & maintenance costs	39,756	23,470	127,131	89,024	70,525	82,359	28,850	176,245	30,323	42,276
Delivery cost of passengers	1,835,162	686,400	906,876	665,686	1,204,200	627,760	655,845	721,884	316,521	1,384,300
Total cost	1,942,918	888,370	1,034,007	756,210	1,492,225	934,619	1,012,195	898,129	571,344	1,736,076
Discount factor @ 10%	1.00									
Net present value of costs	1,942,918	888,370	1,034,007	756,210	1,492,225	934,619	1,012,195	898,129	571,344	1,736,076
1977										
Cost of add. airstrip construction	68,000	178,500	0	1,500	217,500	224,500	327,500	0	224,500	309,500
Airstrip operation & maintenance costs	39,756	23,470	127,131	89,024	70,525	82,359	28,850	176,245	30,323	42,276
Delivery cost of passengers	1,963,472	734,400	970,380	712,334	1,288,440	671,664	701,730	772,452	338,694	1,481,328
Total cost	2,071,228	936,370	1,097,511	802,858	1,576,465	978,523	1,058,080	948,697	593,517	1,833,104
Discount factor @ 10%	.9091									
Net present value of costs	1,882,953	851,254	997,747	729,878	1,433,164	889,575	961,900	862,460	539,566	1,666,475

TABLE C 4.

ALTERNATIVE 1A, THE DELIVERY OF ALL PASSENGERS BY DTO FROM 1976 - 1981

1978	Berens	Poplar	Norway	Cross	Oxford	God's Narrows	Red Sucker	Garden Hill	Ste. Theresa	Little Grand
Cost of add. airstrip construction	0	0	0	0	0	0	0	0	0	0
Airstrip operations & maintenance costs	39,756	23,470	127,131	89,024	70,525	82,359	28,850	176,245	30,323	42,276
Delivery cost of passengers	2,100,994	785,880	1,038,258	762,195	1,378,728	718,704	750,835	826,503	362,406	1,584,960
Total cost	2,140,750	809,350	1,165,389	851,219	1,449,253	801,063	779,685	1,002,748	392,729	1,627,236
Discount factor @ 10%	.8264									
Net present value of costs	1,769,116	668,847	963,077	703,447	1,197,663	661,998	644,332	828,671	324,551	1,344,748
1979										
Cost of add. airstrip construction	0	0	0	0	0	0	0	0	0	0
Airstrip operations & maintenance costs	39,756	23,470	127,131	89,024	70,525	82,359	28,850	176,245	30,323	42,276
Delivery cost of passengers	2,248,057	840,840	1,110,996	815,507	1,475,280	768,992	803,390	884,295	387,771	1,695,704
Total cost	2,287,813	864,310	1,238,127	904,531	1,545,805	851,351	832,240	1,060,540	418,094	1,737,980
Discount factor @ 10%	.7513									
Net present value of costs	1,718,834	649,356	930,205	679,574	1,161,363	639 620	625,262	796,784	314,114	1,305,744

TABLE C 4. Continued

1980	Berens	Poplar	Norway	Cross	Oxford	God's Narrows	Red Sucker	Garden Hill	Ste. Theresa	Little Grand
Cost of add. airstrip construction	0	0	0	0	0	0	0	0	0	0
Airstrip operations & maintenance costs	39,756	23,470	127,131	89,024	70,525	82,359	28,850	176,245	30,323	42,276
Delivery cost of passengers	2,404,319	899,760	1,188,756	872,627	1,578,528	822,864	859,625	946,215	414,903	1,814,576
Total cost	2,444,075	923,230	1,315,887	961,651	1,649,053	905,223	888,475	1,122,460	445,226	1,856,852
Discount factor @ 10%	.6830									
Net present value of costs	1,669,303	630,566	898,751	656,808	1,126,303	618,267	606,828	766,640	304,089	1,268,230
1981										
Cost of add. airstrip construction	0	0	0	0	0	0	0	0	0	0
Airstrip operations & maintenance costs	39,756	23,470	127,131	89,024	70,525	82,359	28,850	176,245	30,323	42,276
Delivery cost of passengers	2,573,767	962,760	1,271,862	933,674	1,688,904	880,432	919,885	1,012,521	443,916	1,941,576
Total cost	2,613,523	986,230	1,398,993	1,022,698	1,759,429	962,791	948,735	1,188,766	474,239	1,983,852
Discount factor @10%	.6209									
Net present value of costs	1,622,736	612,350	868,635	634,993	1,092,429	597,797	589,070	738,105	294,455	1,231,774
Cumulative net present value of Costs.	10,645,860	4,300,743	5,692,422	4,160,910	7,503,147	4,341,876	4,439,587	4,890,789	2,348,119	8,553,047

TABLE C 5

ALTERNATIVE 2A, THE DELIVERY OF ALL PASSENGERS BY DC - 3
1976 - 1981

1976	Berens,	Norway	Cross	Oxford	God's Narrows	Garden Hill
Cost of add. air-strip construction	449,500	252,000	250,000	418,500	554,500	34,000
Airstrip operations & maintenance costs	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of passengers	1,256,112	897,619	451,308	823,256	426,500	481,515
Total cost	1,832,743	1,276,750	828,439	1,368,887	1,108,131	643,646
Discount factor @ 10%	1.00					
Net present value of costs	1,832,743	1,276,750	828,439	1,368,887	1,108,131	643,646
1977						
Cost of add. air-strip construction	449,500	252,000	250,000	418,500	554,500	35,000
Airstrip operations & maintenance costs	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of passengers	1,343,952	960,476	482,856	880,855	456,375	515,214
Total cost	1,920,583	1,339,607	859,987	1,426,486	1,138,006	677,345
Discount factor @ 10%	.9091					
Net present value of costs	1,746,002	1,217,8[illegible]	781,814	1,296,818	1,034,561	[illegible]15,774

TABLE C 5 Continued

1978	Berens	Norway	Cross	Oxford	God's Narrows	Garden Hill
Cost of add. air-strip construction	0	0	0	0	0	0
Airstrip operations & maintenance costs	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of passengers	1,438,014	1,027,804	516,648	942,551	488,250	551,310
Total cost	1,565,145	1,154,935	643,779	1,069,682	615,381	678,441
Discount factor @ 10%	.8264					
Net present value of costs	1,293,436	954,438	532,019	883,985	508,551	560,664
1979						
Cost of add. air-strip construction	0	0	0	0	0	0
Airstrip operations & maintenance costs	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of passengers	1,538,664	1,099,603	548,856	1,008,585	522,500	589,944
Total cost	1,665,795	1,226,734	675,987	1,135,716	649,631	717,075
Discount factor @ 10%	.7513					
Net present value of costs	1,251,512	921,645	507,869	853,263	488,068	538,738

TABLE C 5 Continued

1980	Berens	Norway	Cross	Oxford	God's Narrows	Garden Hill
Cost of add. air-strip construction	0	0	0	0	0	0
Airstrip operations & maintenance costs	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of passengers	1,646,634	1,176,662	591,624	1,079,198	559,000	631,116
Total cost	1,773,765	1,303,793	718,755	1,206,329	686,131	758,247
Discount factor @ 10%	.6830					
Net present value of costs	1,211,481	890,491	490,910	823,923	468,627	517,883
1981						
Cost of add. air-strip construction	0	0	0	0	0	0
Airstrip operations & maintenance costs	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of passengers	1,761,924	1,258,981	632,940	1,154,631	598,250	675,390
Total cost	1,889,055	1,386,112	760,071	1,281,762	725,381	802,521
Discount factor @ 10%	.6209					
Net present value of costs	1,172,914	860,637	471,928	795,846	450,389	498,285
Cumulative net present value of costs	8,508,088	6,121,7[illegible]	3,612,979	6,022,722	4,058,327	[illegible]374,990

TABLE C 6

ALTERNATIVE 3A, THE DELIVERY OF ALL PASSENGERS BY DASH 7, 1976 - 1981

	Berens	Norway	Cross	Oxford	God's Narrows	Garden Hill
1976						
Cost of add. air-strip construction	449,500	252,000	250,000	418,500	554,500	35,000
Airstrip operations & maintenance costs	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of passengers	893,508	595,045	361,845	548,730	321,126	354,618
Total cost	1,470,139	974,176	738,976	1,094,361	1,002,757	516,749
Discount factor @ 10%	1.00					
Net present value of costs	1,470,139	974,176	738,976	1,094,361	1,002,757	516,749
1977						
Cost of add. air-strip construction	449,500	252,000	250,000	418,500	554,500	35,000
Airstrip operations & maintenance costs	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of passengers	955,878	636,647	387,090	587,160	343,680	379,368
Total cost	1,532,509	1,015,778	764,221	1,132,791	1,025,311	541,499
Discount factor @ 10%	.9091					
Net present value of costs	1,393,204	923,444	694,753	1,029,820	932,110	492,277

TABLE C 6 Continued

1978	Berens	Norway	Cross	Oxford	God's Narrows	Garden Hill
Cost of add. air-strip construction	0	0	0	0	0	0
Airstrip operations & maintenance costs	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of passengers	1,022,868	681,659	414,205	628,110	367,666	406,098
Total cost	1,149,999	808,790	541,336	755,241	494,797	533,229
Discount factor @ 10%	.8264					
Net present value of costs	950,359	668,384	447,360	624,131	408,900	440,660
1979						
Cost of add. air-strip construction	0	0	0	0	0	0
Airstrip operations & maintenance costs	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of passengers	1,094,478	729,058	443,190	672,210	393,442	434,412
Total cost	1,221,609	856,189	590,321	799,341	520,573	561,543
Discount ractor @ 10%	.7513					
Net present value of costs	917,795	643,255	443,508	600,545	391,106	421,887

TABLE C 6 Continued

1980	Berens	Norway	Cross	Oxford	God's Narrows	Garden Hill
Cost of add. air-strip construction	0	0	0	0	0	0
Airstrip operations & maintenance costs	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of passengers	1,171,170	779,867	474,232	719,145	421,008	464,904
Total cost	1,298,301	906,998	601,363	846,276	548,139	592,035
Discount factor @ 10%	.6830					
Net present value of costs	886,740	619,480	410,731	578,007	374,379	404,360
1981						
Cost of add. air-strip construction	0	0	0	0	0	0
Airstrip operations & maintenance costs	127,131	127,131	127,131	127,131	127,131	127,131
Delivery cost of passengers	1,253,406	834,427	507,518	769,545	450,364	497,376
Total cost	1,380,537	961,558	634,649	896,676	577,495	624,507
Discount factor @ 10%	.6209					
Net present value of costs	857,175	597,031	394,054	556,747	358,567	387,756
Accumulative net present value of costs	6,475,412	4,425,770	3,129,382	4,483,611	3,467,819	2,663,689