

A DISCUSSION OF THE FLOOD PROBLEMS
AFFECTING THE NEW TOWN OF FORT McMURRAY

GENERAL PLAN POSITION PAPER

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INTRODUCTION

The purpose of this Paper is to bring together the relevant factors of the investigations into the problem of ice-jam flooding in Fort McMurray, in relation to a consideration of the future development of the Town. The technical evidence referred to in the text prepared by T. Blench & Associates and Ripley, Kohn & Leonoff International Ltd. is available if more detailed information is required.

It is anticipated that a review of this Paper will lead to the formulation of a policy for flood protection in the Town. Indeed, it is imperative that decisions be made in order that the General Plan, now being prepared, can be completed.

It is proposed that this Paper should have a limited circulation in the first instance, to Cohos, Evamy & Partners and associated consultants; The Department of the Environment; the Office of Program Coordination; Alberta Housing Corporation, and the Minister of Municipal Affairs.

THE BLENCH REPORT

This Report, to investigate the flood problems from ice jams in Fort McMurray, was authorized by the Provincial Planning Board, March 19, 1974. The terms of reference required T. Blench and Associates, Consulting Hydraulic Engineers, to investigate:

1. Direct action of any kind against ice jams.
2. Protective dyking.
3. Flood control on the Clearwater or combinations of these alternatives.

The Report is the most comprehensive collection of data available on the Fort McMurray flood problem; some of the historical facts were collected from local knowledge and Hudsons Bay Company's records. The causes of ice jams are detailed, graphs of flood return periods in relation to flood levels and flood damage probability factors for structures are plotted. A dyke across the Snye recommended in the Report was implemented. The effectiveness of dykes to protect the Town and alternate means of protection such as power dams on the Athbasca were all discussed in the Report.

Specifically, the Report describes three locations for Town dykes, in addition to the Snye dyke. In each case, elevations of 819 and 824, stated as corresponding to flood return periods of 50 and 100 years respectively, were examined and cost benefits of the alternatives were projected. The engineering feasibility of two of these locations is questioned, due to anticipated unsatisfactory subsoil conditions. The third location, where subsoil conditions appear to be "adequate", excludes a substantial amount of the Lower Townsite. Because of the possibility of loss of life with a dyke, in the event of a sudden flood and the doubt cast on engineering feasibility, the Report concludes that deferring the construction of a dyke until a conclusion is reached on the construction of a power dam on the Athabasca could have merit.

Since Cohos, Evamy & Partners are now preparing the General Plan for the Town, it was considered necessary to review this Report and obtain a current opinion on the implications in regard to the development of the Town.

THE GENERAL PLAN

The amendments to the General Plan, now being prepared, include the proposal for a peripheral road along the bank of the Clearwater River, with connections to Highway 63 at each end of the Town. From the peripheral road, it is intended to make access into Area 4, should this area prove feasible for development, by means of a bridge (or bridges) across the Clearwater. In view of the flooding problem in the Lower Townsite, it was initially assumed that a dyke could conveniently be incorporated with the peripheral road and that the flooding would be alleviated.

In order to test the viability of the initial concept, further geotechnical and transportation analyses were initiated. Ripley, Klohn & Leonoff International Ltd. were requested December 17th to provide support information for the location of bridges and the alignment of the peripheral road in conjunction with Cohos, Evamy & Partners and TES Research & Consulting Ltd. Since the location of a dyke would have to be considered in relation to the alignment of the peripheral road, and other existing and future land uses, the first part of the analysis was established as "to determine the need, location, cost and effectiveness of a dyke."

THE CAUSE OF FLOODING

The principle cause of flooding in the Town of Fort McMurray is due to the formation of ice jams on the Athabasca River during spring breakup, when the flow of water downstream obstructed by the ice jam, drains into the Clearwater River and backs up into the low areas of the Town. Since the source of the Athabasca is in the south and breakup occurs from the south, there is a tendency for the ice mixture in the water to accumulate as it flows north. In the 80 mile section of the river immediately south of Fort McMurray, the slope of the river and the rapids which occur in this section can induce flood wave conditions. When the flood wave, consisting of a water-ice mixture enters the broader channel of the Athabasca opposite the Snye, it slows down. The ice in the mixture then sticks on the river bed and causes the jam to form. The ice jam will remain until the water level builds up sufficiently to move the ice on. Ice jams can rise to a height of 40 feet above river level.

Prior to the construction of the dam on the Snye, built after the report from T. Blench and Associates in 1964, the ice jams formed immediately downstream from the Snye. The dam has had the effect of moving the ice jam location further down, close to the confluence of the Clearwater River with the Athabasca, as predicted in the report. The report further indicated that the construction of the dyke would reduce the potential flood level by slightly more than three feet.

The ice jam flood conditions are described in detail in Chapter 3 of the Blench Report.

REPORT OF REVIEW ON FORT McMURRAY POTENTIAL FLOODING - Ripley, Klohn & Leonoff
International Ltd.

Ripley, Klohn & Leonoff International Ltd. reviewed the 1964 Report prepared by T. Blench and Associates. Subsequently, they met with Professor Blench to ascertain if information on water level records, or further advances in ice research, since 1964 would materially affect his previous findings. An interim report, prepared by Mr. C. H. Maartman, P. Eng., (Hydrologist) and Mr. E. W. Speer, P. Eng., of Ripley, Klohn & Leonoff International Ltd., was submitted to Cohos, Evamy & Partners on January 11, 1974. This Report confirmed Professor Blench's original findings, and his recommendations regarding further study of upstream dams, groin construction on the Athabasca River, and the need for further analysis of ice jam water level probability factors, particularly as they might affect the flood return period evaluation. The Report then discussed the related problems of determining the height of a dyke in relation to its effectiveness in protecting the Town, and the physical requirements of such a dyke, using alternative flood return period factors of a 100-year, 25-year, and 10-year life expectancy, based on 'risk to life' and 'no risk to life'. This indicated that design water levels in excess of elevation 840 would need to be used, on the basis of the information in the Blench Report, if dykes were to be seriously considered. Elevation 840 was determined, with 'risk to life', based on an expectancy period of 10 years, on the assumption that a power dam would be built on the Athabasca River within this period. On a 25-year life expectancy, for a permanent dyke, the design water level would be in excess of elevation 850. Because of the difficulty of predicting water levels due to ice jam conditions, it was suggested by Ripley, Klohn & Leonoff International Ltd. that a further opinion be sought on this matter. Accordingly, Professor J. B. Nuttal of the University of Alberta, who worked with Professor Blench on the original Report, was consulted.

Professor Nuttal reaffirmed his confidence in the Blench Report, strongly recommending the effectiveness of an upstream dam for flood control, if properly located, designed, and operated. It was his opinion that the results of more study on water levels might not justify the expense and, further, that additional works, including dykes and alteration to the Athabasca River channel, "would be of doubtful value".

Ripley, Klohn & Leonoff International Ltd. presented the final review of the problem with a report on February 14, 1974, summarizing their own findings and the opinions of Professor Blench and Professor Nuttal. The uncertainties of predicting water levels are discussed again, and a graph is plotted which includes additional information from the past 10 years, including the 1972 ice-jam flood data. The graph gives a range of ice-jam water elevations related to flood return periods, rather than a straight line projection, as in the Blench Report. Whilst this is considered to be a more reasonable way to present the information statistically, it is concluded that the steepness of the curve in the graph creates such wide confidence limits, that an unreasonably high dyke would be required to satisfy the conditions, since the highest elevations would have to be used for design purposes. To provide closer confidence limits, with a flatter curve, would require monitoring of further ice-jam situations. In view of the time period over which this would be required, it is considered impractical.

Ripley, Klohn & Leonoff International Ltd.'s conclusions are stated as follows:

- (a) The best possible protection will be obtained from the construction of power storage dams on the Athabasca River in the rapids section upstream of the Town. With sufficient storage and with reasonable operation, the chances of flooding above elevation 800 should become negligible.

- (b) From the data available, it is not considered possible to determine a crest level for dykes that would provide complete and reliable protection against flooding due to ice jams. If attempted, such dykes would be very high and would create a false sense of security for those sleeping behind. The construction of high dykes is not recommended.
- (c) Low dykes, not higher than Elevation 820, would provide a measure of protection to commercial facilities in the low areas, and to the lower-lying residential properties, provided such low dykes are economic. They should not be considered as protection against all flooding, and the present system of alerts during ice break-up period must be continued. Residential construction below Elevation 815 should also not be permitted.

ALBERTA DEPARTMENT OF THE ENVIRONMENT

During the course of this review, the Alberta Department of the Environment had expressed interest in taking part in any study on flooding problems in Fort McMurray. Consequently, a meeting was arranged at the Department with Mr. W. Solodzuk, Assistant Deputy Minister, and Mr. R. Deeprose, P. Eng., Director of Technical Services, on February 20, 1974. Messrs. Speer, Wightman and Maartman, from Ripley, Klohn & Leonoff International Ltd., and B. Cooper from Cohos, Evamy & Partners attended a summary of the meeting.

Mr. Solodzuk indicated that the Department of the Environment had been looking at the situation for about ten years and had all the information available. The review of information undertaken by Ripley, Klohn & Leonoff International Ltd. was presented and in discussion it was concluded that all parties were in agreement with the quality of information available and the recommendations which had been made.

Specific points discussed:

1. Construction work on the north side of the Athabasca River to form groins to assist in moving ice jams - it was felt that it was unlikely this would prove very effective. Groins would need to be constructed to the design elevations of the dykes and the cost would not justify the results.
2. Probability plots for flood return period and water levels - some doubts were expressed as to the statistical validity of treating high water levels caused by the jams in the same manner as peak flows. It was agreed, however, that the historical evidence lent credence to this method and that the theoretical alternative, an analysis of the physical make-up and limits of ice jams and concomitant high waters that could form, was out of the question.

3. Upstream power dams - this was discussed at length and it was agreed that it would be the most effective means of flood control for Fort McMurray. Mr. Solodzuk indicated that the Government has been looking into the possibility of a hydro dam on the Athabasca for some time but that it was a long-term project, which might be ten to twenty-five years away.
4. Probability of flooding in relation to protection of life - it was felt that even a five hundred-year return period was not reliable enough as a design factor for dykes. Construction of dykes creates a false sense of security and, therefore, endangers life. It was felt that dykes could not effectively protect people, but might be useful to give some measure of protection to property.
5. Residential development - Mr. Solodzuk indicated that the criteria in flood areas determined by the Department would prevent residential development within the one hundred-year flood area. In Fort McMurray, this minimum would be at Elevation 825. In discussion, it was suggested that an elevation of between 815 and 820 would be reasonable for protection of property.
6. Involvement of residents - it was agreed that people living in the flood plain area should be made aware of the risk to life factors in determining where residential development should be permitted.
7. Flood plain management - the implementation of controls following from Items 5. and 6. was discussed. It was felt that a system of controls should be established which should include limitation on type of development as well as conditional development.
8. Flood warning - it was felt that a flood warning system should be implemented. The Alberta Disaster Services should have the capacity to put this into operation. Any system would involve the Town, Alberta Department of the Environment and the Alberta Disaster Services.

9. The Bow River Study (Calgary) - the implications of this Study, particularly in regard to public reaction, was discussed. Mr. Solodzuk presented copies of the Calgary Bow River Study Committee Report, which contains the recommendations of the Committee after receiving briefs from residents in the flood plain. The following are some of the principle items which may be specifically relevant to further consideration of the Fort McMurray situation:

(a) Flood plain management:

The recommendations made by Montreal Engineering in their study were rejected by residents. One of the main concerns in this respect appears to be the possible effect of development controls on the depreciation of property values. At the same time, it was agreed that a floodway should be defined to be controlled and protected by the Province under the Water Resources Act.

(b) Undeveloped lands:

All undeveloped land in the flood plain area should be designated as parkland. Throughout the Report, concern for protection of the natural environment was significant. This was specific in the recommendation of a 200 foot strip adjacent to the River to be preserved and protected.

(c) Upstream controls:

The feasibility of utilizing existing or new structures should be further examined.

(d) Flood forecasting and warning:

It was recommended that this be established immediately.

(e) Insurance:

It was recommended that the Province look further into this matter.

At the conclusion of the meeting, Mr. Solodzuk expressed the view that the Department of the Environment considered the flood situation in Fort McMurray to be one of the most critical in Alberta. The following three-point summary of the discussion was then made:

1. A flood plain management area for Fort McMurray should be delineated; a flood warning system and development controls should be implemented. All undeveloped lands in the flood plain should be restricted from development. No further residential development should be allowed in the 1/100 year flood area, except if some other method of flood protection can be implemented.
2. Several studies indicate that whilst there is no physical engineering problem to the construction of dykes which cannot be overcome, there are limitations in the cost/height factors which would make the cost of construction prohibitive. A dyke built to Elevation 817, may be reasonable but would be effective for the protection of PROPERTY ONLY.
3. Other engineering works may be possible upstream on the Athabasca River. Power dams, which are a long-range possibility, would alleviate ice jam problems.

It was agreed that Cohos, Evamy & Partners should consolidate available information and review the possible effects of flood problems on the General Plan now being prepared. The Department of the Environment expressed their interest in assisting further and with implementation of future recommendations. The question of public participation was considered to be an important factor in determining a course of action. The means of communicating with the public was left open, to be established when further discussions with Government Departments and consultants had identified clearly the nature and implications of possible alternate policies.

CONCLUSION

From the discussion, it is clear that the construction of a power dam on the Athabasca River would provide the most effective protection against flooding. There is every indication that such a dam would eliminate the problem in Fort McMurray. In view of the possible dangers from flooding, the Government should be fully aware of the flood protection benefits of a dam, in considering the power requirements which would lead to the construction of a dam. At the same time, the possible effects of a dam on the environment and the potential influence on existing ecological systems should be clearly identified. As a power dam would be a very long-range possibility, the need, effectiveness, and practicability of flood management controls should be considered on a short and long-term basis.

It is recognized from the discussion, that for the protection of life, it would be theoretically desirable to limit or restrict residential development within the 1/100-year flood return area, which coincides with Elevation 825-830. All of the developed area of the Lower Townsite is within the 1/100 year flood area and almost entirely above the 815 contour. The major areas of undeveloped or under-utilized land are below the 815 contour, which represents the 1/30 year flood area. The area below elevation 815 is potentially developable and represents the major area of privately held land in the whole of the Town. Furthermore, this is the only land available for future development if the objective of increasing the residential component in the Lower Townsite is to be met. With these circumstances, consideration has to be given to both the protection of existing development above and below the 815 contour, and possible future development below the 815 contour. This is particularly significant in regard to residential development.

It appears that construction of dikes, whilst feasible from an engineering point of view, would be hardly reasonable in terms of height and cost to be effective, particularly if there is any possibility a dam will be constructed in the foreseeable future. It follows, therefore, that protection of existing development would need to be achieved by alternative methods. The practical alternative would be an improved warning system of flood danger, incorporating a comprehensive monitoring system of ice jam conditions. The Emergency Measures Organization and the Alberta Disaster Services, together with the Alberta Department of the Environment, would be the appropriate authorities to work with the Town in this endeavour.

With regard to land below the 815 contour presently undeveloped, the opportunity exists for several alternate uses, which need not be conditional on the total elimination of the flood problem.

1. Recreation open space use.
2. Non-residential use.
3. Conditional residential use.

In any consideration of future development the recreation potential of the river bank for both active and passive use should be recognized, including the improvement of visual quality. However, the full extent of land available may be in excess of what would be practically usable. Furthermore, it is questionable if this would represent either the highest or the best use of the land. Some parts of the area are already committed to light industrial service commercial use. From a land use planning point of view, it would be reasonable to consolidate such uses in a limited area, where development has already occurred. To over extend this use would be detrimental to the amenity of the area. Other non-residential uses, such as office or retail use, if located in relation to other compatible uses may be acceptable.

In both of these cases, the "loss of life" factor is not a significant element, since their major use would occur during daylight hours, when flood danger may be more easily observed. Further residential development below 815 elevation is therefore the most important element to be considered. To prohibit all further residential development may cause anxiety or a sense of insecurity to those people already living below the 830 contour and may in addition affect both property values and insurance risk factors. Inasmuch as the probability of a dam in the near future is unlikely, to prevent residential development totally until a decision is made when there are already people living below the 830 contour may be considered an unreasonable restriction.

To allow conditional development of the area for residential use, where living accommodation is situated above elevation 815, would enable consolidation of the Lower Townsite to take place. This would provide some degree of protection to future residents and at the same time would not be prejudicial to existing development. Implementation of the conditions could be achieved either by fill or by structural means as may be appropriate in each case.

RECOMMENDATIONS

1. The warning system of ice jam flooding danger now in operation, should be continued. The appropriate Government Departments should be requested to review the system and make recommendations, if necessary, for improvement or additional management assistance. Additional funding for the service, if required, should be made available to the Town.

2. The appropriate Government Department should look into the feasibility and implementation of special insurance in flood areas.
3. The Government should accelerate consideration of the construction of a dam upstream from Fort McMurray.
4. The area of river bank adjacent to the Clearwater and the Snyc should be reserved for future recreation use.
5. There should be consolidation of industrial service-commercial use to a defined area, which should not intrude further into the river bank recreation area.
6. Further residential development in the area, should be conditioned by Development Control Guidelines which would exclude the provision of living accommodation below elevation 815.