Reducing Life Safety Risks to the Kashechewan First Nation Community

Canadian Consulting Engineering Awards

HATCH

Project objectives, solutions, and achievements

The Kashechewan First Nation is located on the Lower Albany River Delta and is home to a community of over 2,000 persons. Each year an ice "dam" forms at the near the mouth of the river at James Bay causing the river levels to rise rapidly.

Given the correct combination of temperature and flow, the rise in river levels can be significant. To reduce the impacts of flooding to the community, a Ring Dyke was constructed that surrounds the town. However, while this reduced the frequency of flooding, it created another problem. In the spring of 2006 the Ring Dyke was almost overtopped which would have released a wall of water engulfing the entire community in a matter of minutes.

In addition to the potential for overtopping, the dyke exhibited other less quantifiable dam safety hazards including the potential for piping failure and slope instability because of issues associated with the design and construction of the dyke.

Project Objectives

Following the near miss in 2006, Kashechewan Chief and Council concluded that proactive action was needed to ensure the safety of the community. The only mechanism available was evacuation of over 2,000 people, a matter complicated by the fact that;

- the only means of evacuation during the flood season was by air during a period in which weather conditions often precluded landing at the community,
- community members resisted evacuation due to the significant strain it placed on family life,
- the costs to evacuate are very significant such that decision makers often resisted ordering the evacuation.

It was clear that there were many pressing needs to ensure the safety of the community.

- Identification of the risks associated with this ageing and deteriorating dyke.
- Determination of what rehabilitation measures were needed to upgrade the dam to meet modern dam safety standards.
- Establishment of a means of forecasting the potential for flooding with at least ten days warning.

The problem in meeting these expectations was the fact that the required engineering tools did not exist. The community turned to Hatch to meet this challenging mandate.

Solutions

Hatch responded to the challenge using two innovative tools developed in-house.

A first of its kind quantitative dam safety risk assessment tool designed to provide a scientifically defendable assessment of the likelihood of dam failure combined with,

a unique flood forecast system, developed by Hatch specifically for the community that, in combination with traditional knowledge, provides a ten-day forecast of the potential for ice jam flooding as well as whether the flood would pose a material risk to the community.

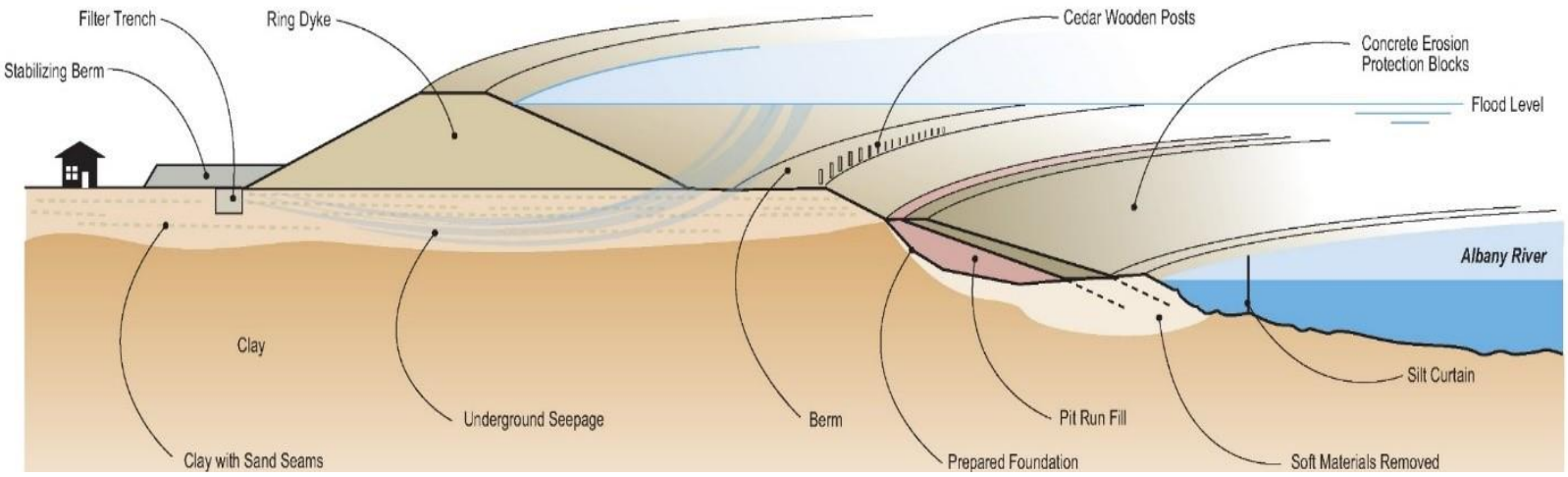
The results have led to a clear understanding of the risks that the community faces and a means to reduce the risks to tolerable levels.

Achievements

In 1957, the Government of Canada moved the Kashechewan First Nation to the Lower Albany River Delta, an area prone to frequent flooding. Since that time the community has been faced with ongoing hardships including flooding, associated health issues and, since the completion of the Dyke, the possibility of a dam breach.

The work performed by Hatch, using two innovative engineering tools, has in the short term, reduced life safety risks to the community and, in part, led to a landmark agreement between Kashechewan and the governments of Ontario and Canada. This “Agreement of Hope” is intended to determine a final solution that will eliminate the six decades of hardships and risks that the community has endured since it was obliged to occupy this remote location.

This project is an example of how the emerging science of risk informed decision-making, innovation and practical engineering can serve to provide real long-term benefits to the public and the community.



Innovation

The Kashechewan First Nation is located on the Lower Albany River Delta and is home to a community of over 2,000 persons. Each year an ice "dam" is formed at the near the mouth of the river at James Bay causing the river levels to rise rapidly.

To reduce the impacts of flooding to the community, a Ring Dyke was constructed that surround the town. However, while this reduced the frequency of flooding, it created another problem. In the spring of 2006 the Ring Dyke was almost overtopped which would have released a wall of water engulfing the entire community in a matter of minutes. In addition to the potential for overtopping, the dyke exhibited other less quantifiable dam safety hazards including the potential for piping failure and slope instability because of issues associated with the design and construction of the dyke.

The challenge was therefore to quantify the risks and provide a means of warning the community if they should evacuate. To meet the challenge made use of two new engineering tools. The Quantitative Dam Safety Risk Assessment tool provided the information decision makers needed to fully understand the intolerable dam safety risks that this community was being subjected to. The unique Flood Forecast Tool provided the information the Chief and council needed to ensure a safe and orderly evacuation in advance of a dam safety emergency.

The Dam Safety Risk Assessment Tool

While the dam safety industry embraces the concepts of risk informed decision-making, no methods for quantifying the likelihood of the key failure modes at this site had previously been available. A clear, quantitative, presentation of risk was needed to convince decision makers that the time for action was now, and the need for a method to achieve this was clear.

The Hatch team, using all the available date on the Ring Dyke gathered from over 10 years of working with the First Nation Community, used a newly developed dam safety risk assessment tool to define the likelihood of Ring Dyke failure. These quantitative estimates, combined with an estimate of the consequences should a breach occur, provided the community the ammunition it needed to make positive change.

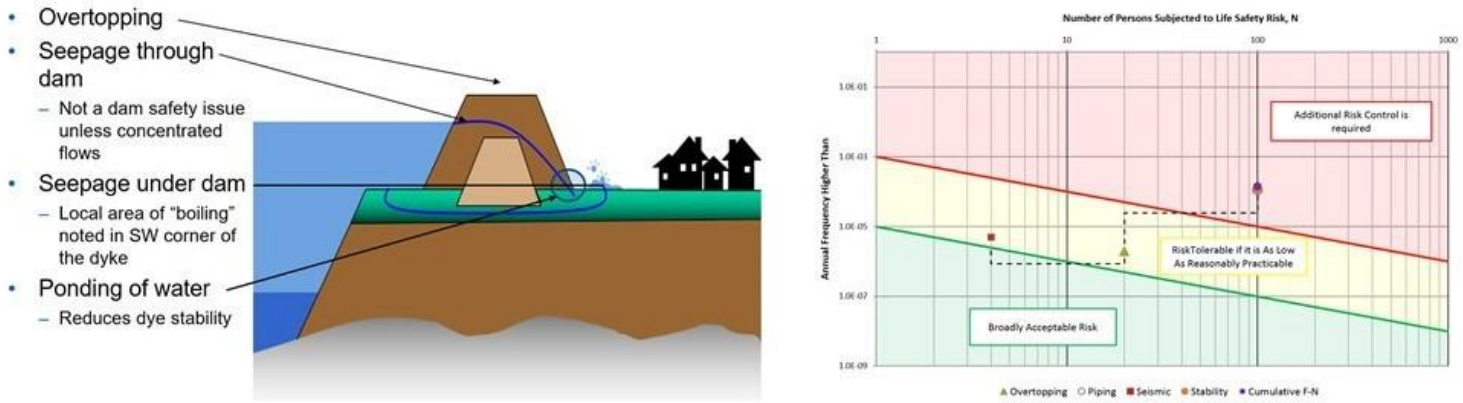


Figure 1: Dam Safety Risk Assessment Tool

The Flood Forecast Tool

Given the logistics of trying to evacuate over 2,000 people by air during a period of typically adverse weather in Canada's far north, one of the key development criteria of a new flood forecasting tool was that it needed to provide an indication of a substantial risk of flooding at least 10 days in advance of the potential event.

To achieve this, a systematic approach would normally be used that would include the installation of an extensive and costly hydro-meteorological station network within the river basin combined with the collection and analysis of data from this network over at least a 25-year period to acquire enough information to produce flood forecasts. Unfortunately, these data were not available for the Lower Albany River and the time required to gather it would clearly not meet the community's immediate need for assistance.

With only historical flow records collected from a site over 200 km upstream of the community available, Hatch took on the challenge. To obtain a reasonable data set, we collected and reviewed the available hydro-meteorological data outside the river basin and identified correlative relationships based upon physical processes to produce a working algorithm for predicting snow melt and consequential ice jam flood risk based on meteorological forecasts of temperature and rainfall.

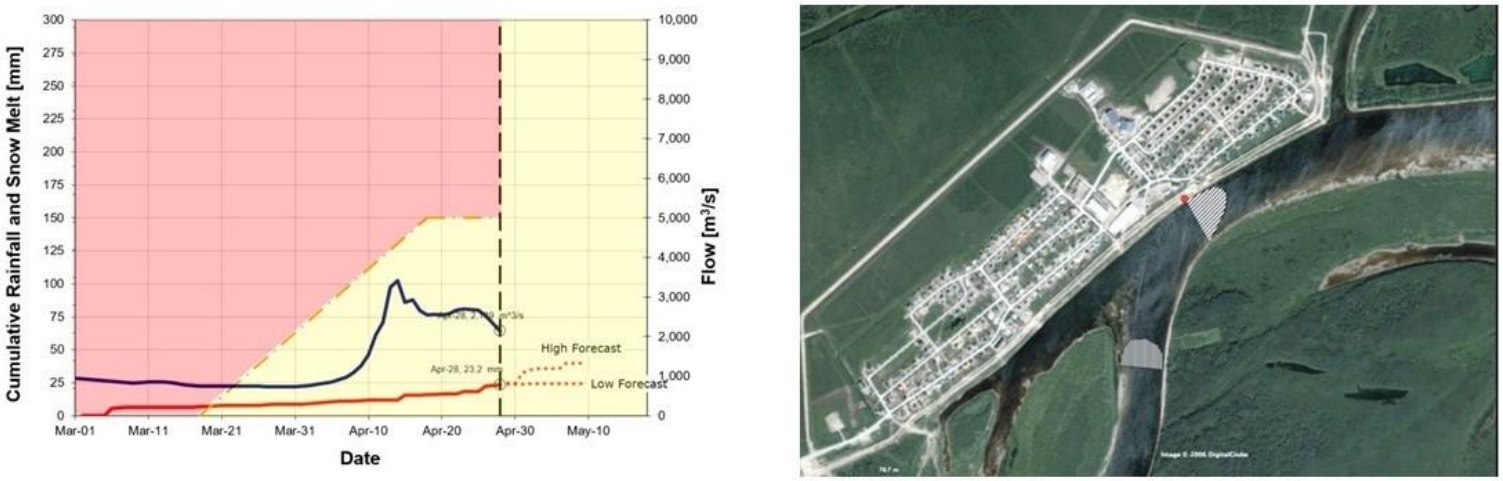


Figure 2: Flood Forecast Tool

Over a period of six years the tool, has proven to provide a reliable method for assembling, manipulating and summarizing readily available date to support a rational an assessment of the potential for ice jam flooding and the need for evacuation.

The success of the tool is evidenced by the fact that Ontario's Ministry of Natural Resources and Forestry want to take ownership of it for the Kashechewan and commission Hatch to develop similar tools for other sites.

Contribution to Social and Economic Quality of Life

Flooding at Kashechewan has been occurring since the community was relocated there in 1957. Since 1997, the entire Kashechewan community has been evacuated more than eight times due to concerns about the safety of the ageing Ring Dyke. This represents a significant social cost, displacing families to unfamiliar surroundings, often in small motel rooms, for a period of weeks to months. In some cases, community members have been displaced for over a year due to flooding of their homes and concerns about mold.

Enhance Safety

The positive results of Hatch's efforts are significant. Today, decisions with respect to the need for an extent of evacuation have significantly improved making use of traditional knowledge and the new flood forecast tool. The newly developed dam safety risk tool has provided decision makers with the scientific evidence needed to show that the risks this small community are subjected to are intolerable.

Overall the project has resulted in enhanced safety, potentially reduced evacuation requirements and, most importantly, the landmark "Agreement of Hope" that will result in a permanent solution to one of Ontario's most distressing problems.

Elsewhere, news of the Hatch flood forecast tool has garnered interest from Emergency Management Ontario and the Moosonee office of the Ontario Ministry of Natural Resources who see its value for Kashechewan and other northern communities. The dam safety tool provides Hatch with a unique approach which has recently been used to expand dam safety practices in countries such as Nepal, Indonesia, South Africa and Uganda.

This project is an example of how the emerging science of risk informed decision-making, innovation and practical engineering can serve to provide real long-term benefits to the public and the community.

Complexity

Assessing the likelihood of a breach of the Kashechewan Ring Dyke is complicated by factors that are difficult, if not impossible, to assess using traditional methods. What is clear is that a dam breach would occur suddenly and catastrophically, placing a community of over 2000 people at risk. Hatch's challenge was to demonstrate to government officials and other decision makers that the potential for failure was unacceptable.

First Major Challenge

One of the major challenges was to develop a Flood Forecast Tool that would provide the information needed to make risk-informed decisions on the need for evacuation. Normally, this would require the installation of an extensive and costly hydro-meteorological station network combined with the collection and analysis of data from at least 25-year period to acquire enough information to produce reliable forecasts. Unfortunately, these data were not available and the time required to gather it would clearly not meet the community's immediate need for assistance. With only historical flow records collected from a site over 200 km upstream of the community available, Hatch took on the challenge. To obtain a reasonable data set, we collected and reviewed the available hydro-meteorological data outside the river basin and identified corrective relationships based upon physical processes to produce a working algorithm for predicting snow melt and consequential ice jam flood risk based on meteorological forecasts of temperature and rainfall.

Second Major Challenge

The second challenge was to clearly and transparently quantify all the risks that the community faced; including overtopping and the potential for slope instability and piping. Hatch's unique dam safety risk screening tool was up to the challenge providing transparent and scientifically defendable quantitative values for the probability of occurrence of each of the dam failure modes.

Environmental Benefits

The residents of Kashechewan are surrounded by an earth dyke that was poorly constructed and does not meet current dam safety needs that was very nearly overtopped in 2006. They live in fear each spring as ice jams form in James Bay at the mouth of Upper Albany River and water levels rise.

Flooding at the community also has a significant environmental toll, affecting homes with mold, creating the potential for the release of sewage into the community and health risks, both within the community and to community members who are evacuated. For example, the incidence of asthma in the community is alarmingly high. The understanding of the issues by decision makers have led to enhanced efforts over the past four years to ensure that the community is adequately drained to help to reduce some of these ongoing hardships.

Meeting Client's need

The goals of the Kashechewan community were clear. The residents were presented with unquantified risks every spring with ad-hoc decisions being made with respect to the safety of a ring dyke and the need to evacuate if a major flood were to occur. The Chief and council needed to know how much risk the members of the community were exposed to and how to maintain the safety of the community members.

Hatch's work met and exceeded these requirements. Today, the community is better informed as to what the risks are and decision makers understand that these risks are well above tolerability limits as defined by the Canadian Dam Association.

The community now has a system that includes scientific evidence and traditional knowledge to make the best possible risk informed decisions on the need for, and extent of, evacuations. Risks have been quantitated and solutions to reduce those risks to manageable levels developed. What seemed impossible tasks at the start of this challenging project has been solved, making use of the best that engineering can offer. Most importantly, this project has shown the governments of Ontario and Canada that it is time to develop permanent solutions to this decade's old problem leads to the historic "Agreement of Hope".

> "What we're signing today [the Agreement of Hope] is the hope for the better of our children. We mark March 31 [2017] as the first step to sustainability for our community."
>
> - Leo Friday
> Kashechewan Chief

This project is an excellent example of how engineering, coupled with judgement and community involvement, can result in the betterment of society.

De :	Lamirande-Gauvin, Gabrielle
A :	Ducharme, Sophie
Objet :	FW: Canadian Consulting Engineer Awards - your entry
Date :	Friday, April 20, 2018 2:25:39 PM

FYI

Gabrielle Lamirande-Gauvin
Global Marketing Manager, Energy
Marketing Lead, Eastern North America

From: Canadian Consulting Engineer [mailto:info@ccemag.com]
Sent: April 20, 2018 2:24 PM
To: Lamirande-Gauvin, Gabrielle <g.lamirande-gauvin@hatch.com>
Subject: Canadian Consulting Engineer Awards - your entry

DO NOT REPLY

Project Information

Project Name

Reducing Life Safety Risks to the Kashechewan First Nation Community

Location of Project

Not applicable
Kashechewan First Nation, Ontario
Canada
Map It

Completed by

2017

To be entered in Category

C. Water Resources

Entering Firms

Firm Name(s)

Hatch/FHR Inc.

Firm Address

2800 Speakman Drive
Mississauga, Ontario L5K 2R7
Canada
Map It

Role in the Project

Research and Studies to quantify the flooding risks associated with an ageing dam to a remote First Nations Community and develop solutions to reduce these risks.

Member of the Association of Consulting Engineering Companies of Canada (ACEC)?

Yes

Contact #1 (Communications/Marketing/Public Relations)

Gabrielle Lamirande-Gauvin

Phone for Contact #1

(514) 864-5500

Email for Contact #1

gabrielle.lamirande-gauvin@hatch.com

Contact #2 (Management/Administration)

Gabrielle Lamirande-Gauvin

Phone for Contact #2

(514) 864-5500

Email for Contact #2

gabrielle.lamirande-gauvin@hatch.com

Contact #3 (Project Engineer)

C. Richard Donnelly

Phone for Contact #3

(905) 357-6970

Email for Contact #3

richard.donnelly@hatch.com

P.Eng?

Yes

Project Outline

Project Summary

The Kashechewan Ring Dyke protects over 2000 residents of a remote community from flooding that occurs during spring break up. The dyke is ageing and, in the spring of 2006, was almost overtopped. With increasing concerns about life safety risks, the Chief and Council turned to Hatch to quantify the risks and develop solutions to reduce these risks making use of two innovative Hatch tools. The results have led to a historic Agreement of Hope designed to rectify decades of hardship.

Q. 1 Innovation (40%)

The Kashechewan First Nation is located on the Lower Albany River Delta and is home to a community of over 2,000 persons. Each year an ice “dam” is formed at the near the mouth of the river at James Bay causing the river levels to rise rapidly. To reduce the impacts of flooding to the community, a Ring Dyke was constructed that surround the town.

However, while this reduced the frequency of flooding, it created another problem. In the spring of 2006 the Ring Dyke was almost overtopped which would have released a wall of water engulfing the entire community in a matter of minutes. In addition to the potential for overtopping, the dyke exhibited other less quantifiable dam safety hazards including the potential for piping failure and slope instability because of issues associated with the design and construction of the dyke.

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Over a period of six years the tool, has proven to provide a reliable method for assembling, manipulating and summarizing readily available date to support a rational an assessment of the potential for ice jam flooding and the need for evacuation. The success of the tool is evidenced by the fact that Ontario's Ministry of Natural Resources and Forestry want to take ownership of it for the Kashechewan and commission Hatch to develop similar tools for other sites.

Q. 2 Complexity (20%)

Assessing the likelihood of a breach of the Kashechewan Ring Dyke is complicated by factors that are difficult, if not impossible, to assess using traditional methods. What is clear is that a dam breach would occur suddenly and catastrophically, placing a community of over 2000 people at risk. Hatch's challenge was to demonstrate to government officials and other decision makers that the potential for failure was unacceptable.

One of the major challenges was to develop a Flood Forecast Tool that would provide the information needed to make risk-informed decisions on the need for evacuation. Normally, this would require the installation of an extensive and costly hydro-meteorological station network combined with the collection and analysis of data from at least 25-year period to acquire enough information to produce reliable forecasts. Unfortunately, these data were not available and the time required to gather it would clearly not meet the community's immediate need for assistance. With only historical flow records collected from a site over 200 km upstream of the community available, Hatch took on the challenge. To obtain a reasonable data set, we collected and reviewed the available hydro-meteorological data outside the river basin and identified corrective relationships based upon physical processes to produce a working algorithm for predicting snow melt and consequential ice jam flood risk based on meteorological forecasts of temperature and rainfall.

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Q. 3 Social and/or Economic Benefits (15%)

Flooding at Kashechewan has been occurring since the community was relocated there in 1957. Since 1997, the entire Kashechewan community has been evacuated more than eight times due to concerns about the safety of the ageing Ring Dyke. This represents a significant social cost, displacing families to unfamiliar surroundings, often in small motel rooms, for a period of weeks to months. In some cases, community members have been displaced for over a year due to flooding of their homes and concerns about mold.

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Q. 4 Environmental Benefits (15%)

The residents of Kashechewan are surrounded by an earth dyke that was poorly constructed and does not meet current dam safety needs that was very nearly overtopped in 2006. They live in fear each spring as ice jams form in James Bay at the mouth of Upper Albany River and water levels rise.

Today, the risks still exist to the safety of the community but the constant fear has reduced to some degree. Community members have been educated in what the risks are and how they can be reduced. In addition, there is now at least some warning of an impending flood such that the community members can be evacuated by air during a period of the year when weather conditions often prevent so allows for reduced numbers of people being evacuated and a shorter time in which they must remain away from their homes.

Flooding at the community also has a significant environmental toll, affecting homes with mold, creating the potential for the release of sewage into the community and health risks, both within the community and to community members who are evacuated. For example, the incidence of asthma in the community is alarmingly high. The understanding of the issues by decision makers have led to enhanced efforts over the past four years to ensure that the community is adequately drained to help to reduce some of these ongoing hardships.

Q. 5 Meeting Client's Needs (10%)

The goals of the Kashechewan community were clear. The residents were presented with unquantified risks every spring with ad-hoc decisions being made with respect to the safety of a ring dyke and the need to evacuate if a major flood were to occur. The Chief and council needed to know how much risk the members of the community were exposed to and how to maintain the safety of the community members.

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