

DYNAMIC LANDSCAPE SETTING : RIVERBANK EROSION AND EFFECT OF GLOBAL WARMING ON PERMAFROST THREATEN YORK FACTORY NATIONAL HISTORIC SITE OF CANADA

Lunn, Kevin / Canada

archaeologist and management planner , Western and Northern Canada Service Centre of Parks Canada

Fontaine ,Lyne / Canada

senior conservation engineer , Heritage Conservation Directorate at Public Works and Government Services in Ottawa

Elliott, Cam / Canada

Introduction

York Factory, or Kihci-wâskâhikan (“the Great House” in the Cree language), is a place of great importance to all of Canada. But, it is a far-away and largely inaccessible place for most people. And it is threatened by a changing landscape and environment. A new site management plan is being updated to guide future protection and telling of York Factory’s history.

This paper presents a brief historical background of the site and its historical significance, a description of current conservation activities, and some strategies being considered to understand and respond to threats and a dynamic, changing landscape.

Three Centuries of History on the Shore of Hudson Bay

The Hudson’s Bay Company (HBC) first established York Factory in 1684 on the Hayes River, several kilometres upriver from Hudson Bay in northern Canada (Figure 1). As one of the oldest and longest operated HBC posts in North America (1684-1957), York Factory played a significant role in Canada’s fur trade history. It was the scene of French – English struggle on the Hudson Bay for control of the fur trade and northern North America. It was an important trading post and entrepôt for more than 2 ½ centuries (supplying European and country-made trade goods to inland trading posts within a 3.9 square kilometre region), and was the principal base for the expansion of the fur trade into the interior of Canada (Figure 2). For most of the 19th century, York Factory was the political, economic and social hub of western Canadian fur trade society. At the same time York Factory was a vibrant community, home to many Cree

people of western Hudson Bay, and Orkneymen and others from Europe.

To give you an idea as to the magnitude of York Factory, by the mid 19th century there were more than fifty buildings comprising the main complex, including the 32 metre by 30 metre 3-storey Depot with its 1672 square meters of floor space. Surrounding these were cabins of servants and Home Guard Cree. The permanent workforce included 51 officers of the HBC, artisans, clerks and labourers and a resident population of Aboriginal (Cree) servants and hunters and their families. Letitia Hargrave, wife of Chief Factor James Hargrave proclaimed York Factory “The most respectable place in the territory”.

York Factory was named a Canadian national historic site in 1936. The Hudson’s Bay Company closed the post in 1957. Families moved from York Factory to York Landing, Shammattawa, Fox Lake and elsewhere. Parks Canada acquired York Factory (250 hectares) from the HBC in 1968 and since then has operated it as a national historic site. The site includes the Depot, archaeological remains of more than 70 buildings and large features, more than 300,000 artifacts, and the cemetery of possibly 600 graves. York Factory can be difficult and expensive to get to and to work at. It is accessible by boat or aircraft in the summer and over snow vehicle in the winter. About 100 people visit York Factory every year. Unpredictable weather, polar bears, black flies and mosquitoes make up part of the site experience.

York Factory is Threatened: The Need for a Management Plan

The Parks Canada Agency Act sets out the principal objective for Parks Canada National Historic Sites – to ensure their commemorative integrity for the benefit,

Section II: Vulnerabilities within the settings of monuments and sites:
understanding the threats and defining appropriate responses

Section II : Identifier la vulnérabilité du cadre des monuments et des sites – Menaces et outils de prévention

education and enjoyment of this and future generations.

Commemorative Integrity means:

- York Factory NHSC and the resources representative of its national significance are protected from damage and threat;
- The reasons for York Factory's national significance are effectively told to the public; and
- Decisions and actions affecting the site are respectful of its heritage values.

The Parks Canada Agency Act also requires that national historic sites operated by Parks Canada must have a management plan approved by the Minister of Environment and tabled in Parliament. The plan must give direction for ensuring commemorative integrity and appropriate visitor use of the site. The current management plan for York Factory, approved in 1988, no longer provides adequate direction for site protection and presentation. Among the goals established from that plan were to stabilize and secure the surviving historic structures, and address the very serious stabilization problems associated with the Hayes riverbank and the associated site drainage. While work was done on one of the buildings – the Depot, York Factory continues to be threatened and impaired.

Parks Canada is in the initial stages of analysis and planning. Staff have reviewed the current conditions and issues affecting York Factory commemorative integrity and visitor experience. Discussions have begun with members of First Nation communities associated with York Factory to learn more of their values and concerns for York Factory. Tour operators, lodges and outfitters have been interviewed regarding visitor services. Professional expertise in areas of geotechnical engineering, permafrost and cold climate heritage management has and is being sought to assist research and planning.

The main issue for management planning is vulnerability and ultimate loss of commemorative integrity of York Factory National Historic Site of Canada (NHSC). York Factory faces a situation where:

- Unyielding riverbank erosion along the Hayes River is destroying archaeological resources and, in an estimated 100 years, the Depot, cemetery and the entire historic place.
- More immediate threats to the Depot, cemetery, and archaeological features may be coming from other environmental conditions including permafrost sensitive to climate warming, ground and surface water, and willow growth. These complex conditions and their effect on the site's cultural resources are not adequately understood.

- Funding necessary to adequately mitigate these threats and impacts cannot be secured in the short term.

The current conservation activities and some of the strategies being considered in the course of planning to address these cultural resource threats follow.

Riverbank Erosion

Understanding the Threat

Riverbank erosion along the Hayes River has been happening at York Factory since its beginnings. York Factory I (1684 to 1715) and York Factory II (1715 to 1788) were lost as long ago as 1900. Today, we estimate that York Factory III that dates from 1788 to 1957 may be lost within 100 years (Figure 3).

A comprehensive study of solutions to riverbank erosion was done in 1983. It reported that:

- Hydrology studies indicated that wave action is mainly responsible for riverbank erosion. Wave action washes away the toe of the slope, exposes permafrost to the sun and warm air, eventually promoting fresh slope failures. Channel migration, surface and groundwater drainage, ice scour and seasonal flooding can also contribute to the erosion.
- Any engineering works designed to stabilize the riverbank, including extensive use of riprap or rock mounds are best regarded as "holding actions" only and, with proper maintenance, would extend the life of the site by 25 to 100 years.

Responses to Date

No stabilization of the bank has been attempted largely because of uncertainties, costs and logistical challenges of working in a remote northern location. (For example, more than 10,000 cubic metres of rock would need to be barged from the closest source more than 100km away, to riprap the bank). Instead, archaeologists have conducted test excavations, recorded and salvaged archaeological features near the riverbank, and have been monitoring the encroachment of the riverbank. Some features have been lost in the last 25 years and numerous artifacts can be found along the tidal flats at the toe of the bank. The erosion is now approaching unexamined features and the question again is can erosion be stopped or is salvage archaeology the only recourse?

Section II: Vulnerabilities within the settings of monuments and sites:
understanding the threats and defining appropriate responses

Section II : Identifier la vulnérabilité du cadre des monuments et des sites – Menaces et outils de prévention

Defining Future Responses

This year three geotechnical engineers interested in the erosion issues facing York Factory, volunteered to review past riverbank erosion studies and current conditions at the site. Their overall observation is that the riverbank continues to have extreme slope failure. Permafrost thaw is a factor, but ice scouring appears to be a significant event trigger for major slope failure (and damage or loss to bank armouring). Wave and tidal actions on the toe of the slope and the predominantly marine clays and silts exasperate the situation. While intrusive measures have been considered, including a combination of armouring and regrading slope to remove slip load and pressure on the bank, less intrusive treatments are being looked at, such as those once done by the HBC. Historic photographs show some armouring of the bank toe and possibly placement of rocks that could be like jetties (groining). Former residents of York Factory have recounted memories of cutting back the willows at York Factory, bundling them and packing them along the riverbank, along with stones, to slow down erosion. This was done every year. While the approach had some success, as demonstrated by the historic photographs, it was labour intensive and had to be repaired each year, otherwise the erosion processes would take over.

Engineering alternatives to stopping or drastically slowing down erosion are being looked into, but may not be possible because of the remoteness of the site and limited means of access. Documenting the site before it is lost may be the only viable choice to site protection.

Permafrost and Drainage

Understanding the Threat

Permafrost and drainage are interrelated issues. Managing both has been a challenge throughout York Factory's history. The following quote, from Colin Robertson's Diary September 9th, 1816, serves as an example:

"York Fort is built in the Hay's River, about six miles from the entrance [to Hudson Bay], altho the land is nearly twenty feet above the level of the River, the land round the Fort is in general covered water, drains have been tried to take away the water, but have proved ineffectual, on account of the ground being froze within three feet of the surface." (Hudson's Bay Company Archives, E. 10/1, vol IV, Colin Robertson's Diary J. 260d, 9 Sept 1817 [1816])

As cultural resource managers, we need to better understand the permafrost and hydrology at York Factory. York Factory is near the southernmost extent of the continuous / discontinuous permafrost zone limit in Canada. This area is predicted to experience significant changes to permafrost with climate warming. Approximately 50% of the Canadian landmass is underlain by permafrost and a significant portion has an average temperature above -2° C. Under climate warming scenarios this warmer permafrost, within the discontinuous zone, may ultimately disappear. Thawing of ice-rich permafrost may result in ground thawing and displacement. At York Factory the soil profile is generally 0.6metre of peat over 2.74 to 3.65 metre of silt, clay and sand with marine clays underneath. Permafrost is generally encountered at a depth ranging from 0.3 to 0.9 metre below the surface. Once thawed the soil loses considerable mechanical strength and bearing capacity. While our past concern with site threats have focused on riverbank erosion, York Factory may be facing permafrost instability from warming surface air, effects of surface and ground water drainage at the site, and the unconsolidated nature of the marine clay and silts of the site. This instability could accelerate instability and erosion along the river as well as elsewhere on the site.

The Depot is a case in point. The Depot was built in 1832-38 as the center of supply operations at York Factory. It is both architecturally and historically significant and is designated a Classified Federal Heritage Building. The original construction used shallow wooden foundations. It had a complex drainage system. It featured adjustable beam/column connections that permitted adjustment to deal with seasonal frost heaving or permafrost active layer movement, an important building engineering innovation for the time. However, by the 1980s the heavy wood frame resting on a sleeper foundation had decayed considerably, particularly in the lower level in contact with the soil, and to a lesser extent the superstructure. The building suffered significant differential movements over the years. Some of the columns had punched through the ground floor. The lack of connection between the sills, and the wall structure resulted in the exterior walls moving outward, off the sills.

Responses to Date

In the early 1990's a major stabilization project was undertaken to reduce movement in the foundation, improve strength of the wall structure, create a new insulated floor, and protect the numerous artefacts and an earlier building located under building. Insulation was used around the building as well to reduce the active layer in the permafrost, i.e., stabilize the year-round permafrost layer (Figure 4). A

Section II: Vulnerabilities within the settings of monuments and sites:

understanding the threats and defining appropriate responses

Section II : Identifier la vulnérabilité du cadre des monuments et des sites – Menaces et outils de prévention

temperature monitoring program was set up to evaluate the rate at where the active layer stabilized above and below the insulation. Additional work was carried out on the building envelope, windows and roof, and on the drainage in the courtyard and around the building. A system of sump pits and drains were incorporated into the work on the foundation and landscaping. Within the last two years a sinkhole has appeared in the courtyard of the Depot that may be signalling a problem in the drain system (Figure 5). Water is filling the hole, warming it and accelerating soil loss around the hole.

Elsewhere at York Factory a drain, modelled after historic drains used at the site, was installed north and east of the cemetery to redirect groundwater away from the cemetery, to dry the area and to decrease the potential for erosion along the bank of nearby Sloop Creek. Another building, the Library now faces collapse from ice upheaval, which will need to be addressed.

Defining Future Responses

Readings from monitoring equipment and inspections of the Depot indicate that while there is some significant heaving in the building's main level floors and there are drainage problems, notably evident by the start of the large sink hole in the courtyard, overall indications are that the superstructure is in good condition. Monitoring air temperature beneath the Depot and the water table will continue along with routine maintenance and repair of sump pits, drainage and eaves troughs.

A permafrost monitoring program is being explored for York Factory. Combining permafrost readings with archaeological survey using Ground Penetrating Radar (GPR) is one possibility. Preliminary discussion has begun to consider York Factory as part of a nation-wide permafrost monitoring system (under the direction of the Geological Survey of Canada). It is a suitable candidate for such a network because of its unique location on the edge of discontinuous permafrost along western Hudson Bay, its status as a protected and managed area, and the historical information available about the site that is relevant to environmental studies (including, for example, daily temperature readings as far back as 1772).

Ultimately, as permafrost conditions change, we will not be able to stabilize ground thawing across the site. However, we should have in hand baseline data and measurements of any change to ground conditions that may signal warnings of erosion from permafrost thaw and ground instability. This

will then contribute to planning and prioritizing the mitigation and documenting needs for the site.

Vegetation Encroachment

Understanding the Threat

One of the long-standing concerns regarding willow growth has been the effect of the encroaching willows on the cultural landscape. In areas where the willows have been allowed to grow, they can reach heights of 12 feet and get very dense in a short time. The vegetation pushes major root systems into the archaeological features, disrupts the stratigraphy, impacts larger artifacts, and destroys the impression of the overall scale of the site. Willows can be a threat to York Factory as a fuel load for natural fires. Until 1957, the HBC maintained York Factory as an open landscape, kept clear of willows and trees, which were no doubt used for fuel, but also helped keep the site dry.

Responses to Date

Since the 1970s staff and people from nearby communities have resumed the practice of keeping the site clear. The purposes of vegetation management at York Factory are:

- to make the surface evidence of archaeological and landscape features visible to the visitor;
- to improve the protection and presentation of the cemetery;
- to protect the cultural resources from fires and root damage; and
- to enable sighting of polar bears for public safety.

Annual clearing is necessary, time consuming and costly as it must be done with hand tools. Historically and today, willow cuttings were dumped over the edge of the riverbank and in small ravines in an effort to maintain permafrost and retard erosion.

Defining Future Responses

Interestingly, we do not know if or how vegetation management may relate to permafrost conditions and drainage. This question needs to be explored. Because York Factory practices vegetation management that is not done elsewhere in this region, there is an opportunity here to study changing vegetation patterns and their affect on permafrost as part of a broader framework of permafrost studies in the western Hudson Bay region. The results of these studies would be considered in modifying the

Section II: Vulnerabilities within the settings of monuments and sites:
understanding the threats and defining appropriate responses

Section II : Identifier la vulnérabilité du cadre des monuments et des sites – Menaces et outils de prévention

objectives and practices for managing vegetation at York Factory.

Abstract

Listed in the 2001-2002 Heritage at Risk ICOMOS World Report, York Factory is one of the oldest and longest operated fur trade posts in North America. Located at the confluence of Hudson Bay and the Hayes River, and in operation between 1684 and 1957, York Factory played a pivotal role in history as the political, economic and social hub of western Canadian fur trade society. This cultural setting, once the repeated scene of conflict between England and France in the 17th and 18th century, is now facing the loss of its commemorative integrity. The first two York Factories, I and II, were lost to shore erosion in previous centuries. York Factory III is loosing in some locations up to one meter a year. Archaeological resources and built heritage have been lost or are at threat. Moreover, York Factory is in a permafrost region extremely sensitive to climate warming. Although we do not have a good understanding of permafrost condition at York Factory, there is growing concern that the unconsolidated and ice-rich soil could loose its strength and undermine the foundation of an historic three-storey building. This paper outlines the strategies set in place to understand the threats and to define the appropriate responses to address change and possibly loss of this cultural heritage in the face of a dynamic landscape setting.

Conclusions

York Factory may not be unique as a site vulnerable from a changing landscape; it is for example one of a number of sites in Canada reported in the ICOMOS World Report 2001-2002 Heritage at Risk because of shoreline erosion. However, it does stand out as a site under threat not only because of the array and degree of interrelated environmental concerns affecting its cultural resources, including riverbank erosion, surface and groundwater drainage, permafrost, and vegetation encroachment, but because of the dramatic consequences of the potential total loss of these important cultural resources and the site overall. Compounding the challenges facing York Factory is the remoteness of the site, which makes working at the site costly and can limit the mitigation responses that are appropriate, yet practical.

The 1988 management plan focused attention on erosion along the Hayes River, the cultural resources immediately along the riverbank and stabilization of the Depot. Parks Canada has completed the long-term stabilization of the Depot and maintains a program to monitor the riverbank erosion and impacts on cultural resources, and to record and salvage them where and when possible. Increasingly, more of the site will be under this threat and it is time to revisit what might be done to slow erosion, perhaps using softer, less intrusive methods similar to those used by the HBC and the Cree people of York Factory, instead of larger, more intrusive engineering feats. However, attention must be also turned to the site as a whole to gain a better understanding of other complex environmental conditions that make York Factory vulnerable – permafrost, drainage and vegetation. Each of their structure and process affects the other, the riverbank erosion, and the cultural resources of the site. Because these environmental dynamics are not adequately understood at York Factory, management planning envisions a program of research, monitoring and evaluation that will help guide appropriate and adaptive responses to threats and the managing of cultural resources. To do so we see numerous opportunities to incorporate site-specific research needs into broader programs of study of environmental change in Canada's North. Likewise, we welcome international interest and advise in cold climate heritage management, such as through the International Polar Heritage Committee of ICOMOS.

References

1. Carroll, Patrick. Cumulative Effects and Impacts Analysis, York Factory National Historic Site of Canada. Parks Canada
 2. I.D. Engineering Company. Investigations of Biophysical Resources and Riverbank Stabilization at York Factory National Historic Site
 3. Parks Canada. York Factory National Historic Site Management Plan.
 4. Smith, Sharon and Burgess, Margo. n. d. The Sensitivity of Canadian Permafrost to Climate Warming. Natural Resources Canada (<http://sts.gsc.nrcan.gc.ca/permafrost/Wkshpsensitivityposter2.cdr-CoreIDRAW.pdf>)
-

Section II: Vulnerabilities within the settings of monuments and sites:
understanding the threats and defining appropriate responses

Section II : Identifier la vulnérabilité du cadre des monuments et des sites – Menaces et outils de prévention

DYNAMIC LANDSCAPE SETTING: RIVERBANK EROSION AND EFFECT OF GLOBAL WARMING ON PERMAFROST THREATEN YORK FACTORY NATIONAL HISTORIC SITE OF CANADA

Lunn, Kevin / Canada

archaeologist and management planner , Western and Northern Canada Service Centre of Parks Canada

Fontaine ,Lyne / Canada

senior conservation engineer , Heritage Conservation Directorate at Public Works and Government Services in Ottawa

Elliott, Cam / Canada



Figure1. York Factory National Historic Site of Canada, Manitoba, Canada. York Factory was at the heart of Rupert's Land—lands that drained to Hudson Bay, which the Hudson's Bay Company held title.



Figure 2. York Factory in 1923 (top) and in 2005. The Depot (centre of bottom photograph) and library (to right) are the only historic buildings left. Only part of the historic site, with more than seventy archaeological features, is kept clear of willows (Photos from National Archives of Canada, K.Skafffeld)



Figure 3. Bank slump, Hayes River at high tide.(photo from K.Skafffeld)

Section II: Vulnerabilities within the settings of monuments and sites:
understanding the threats and defining appropriate responses

Section II : Identifier la vulnérabilité du cadre des monuments et des sites – Menaces et outils de prévention



Figure 4. Conservation work on the Depot in the 1990s. Elements of the foundation were repaired and replaced, insulation was placed beneath the floor to stabilize the permafrost, and drainage was improved. (photo from Parks Canada)



Figure 5. Sinkhole that has formed in the last couple of years within the courtyard of the Depot. The hole fills with groundwater that is warmed by exposure to surface air and then warms surrounding frozen ground. Drainage appears to be the issue. (Photos from Parks Canada and K. Skaffeld)