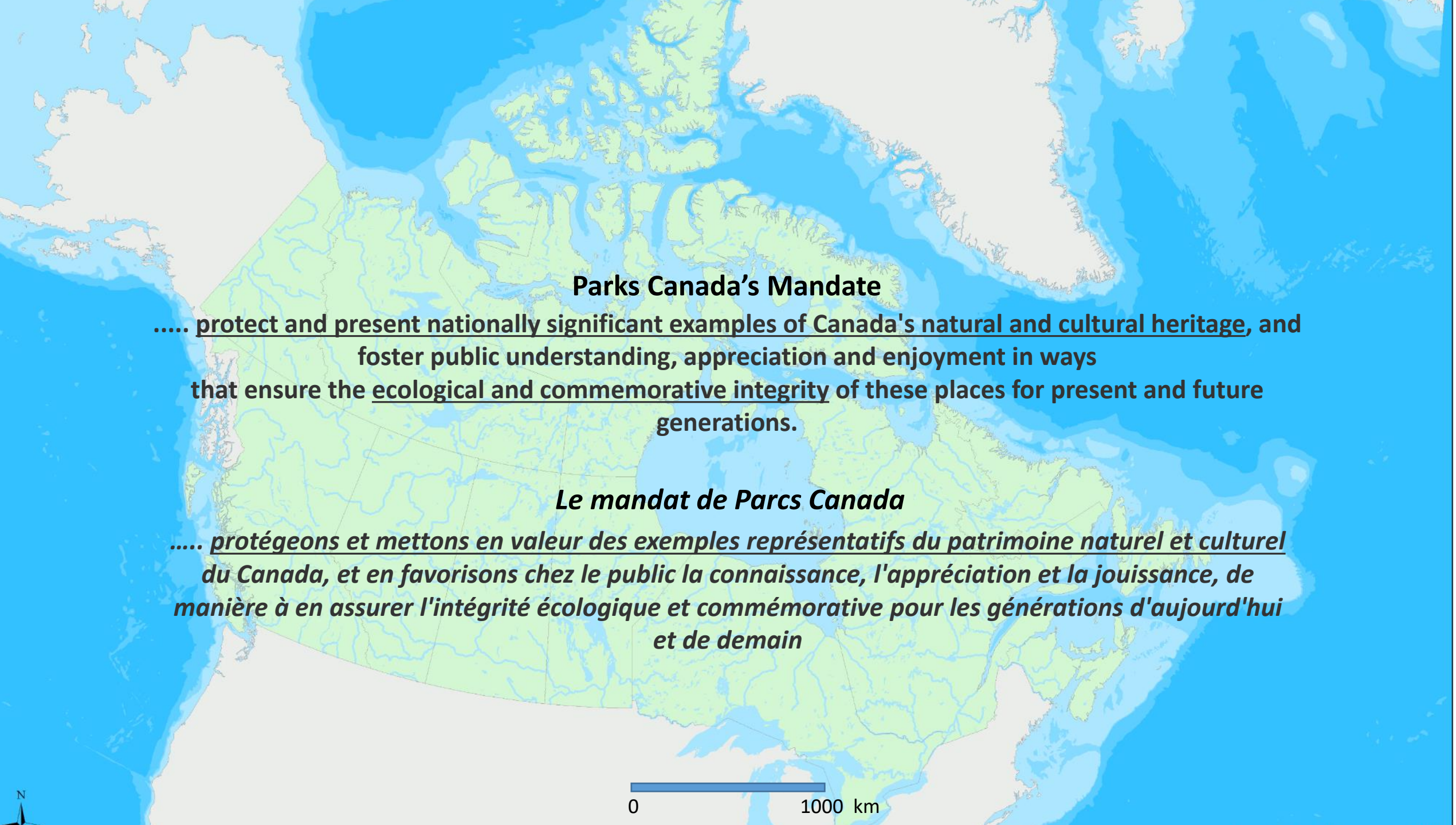
Finding feasible and effective climate change adaptation measures for national historic sites managed by Parks Canada

David Scarlett, Chief Architect (Built Heritage), Parks Canada
June 21-22, 2019
CCICH, Athens, Greece

Trouver des mesures d'adaptation réalistes et efficaces aux changements climatiques pour les lieux historiques nationaux gérés par Parcs Canada

David Scarlett, architecte en chef (patrimoine bâti), Parcs Canada
Le 21-22 juin 2019
CCICH, Athènes, Grèce

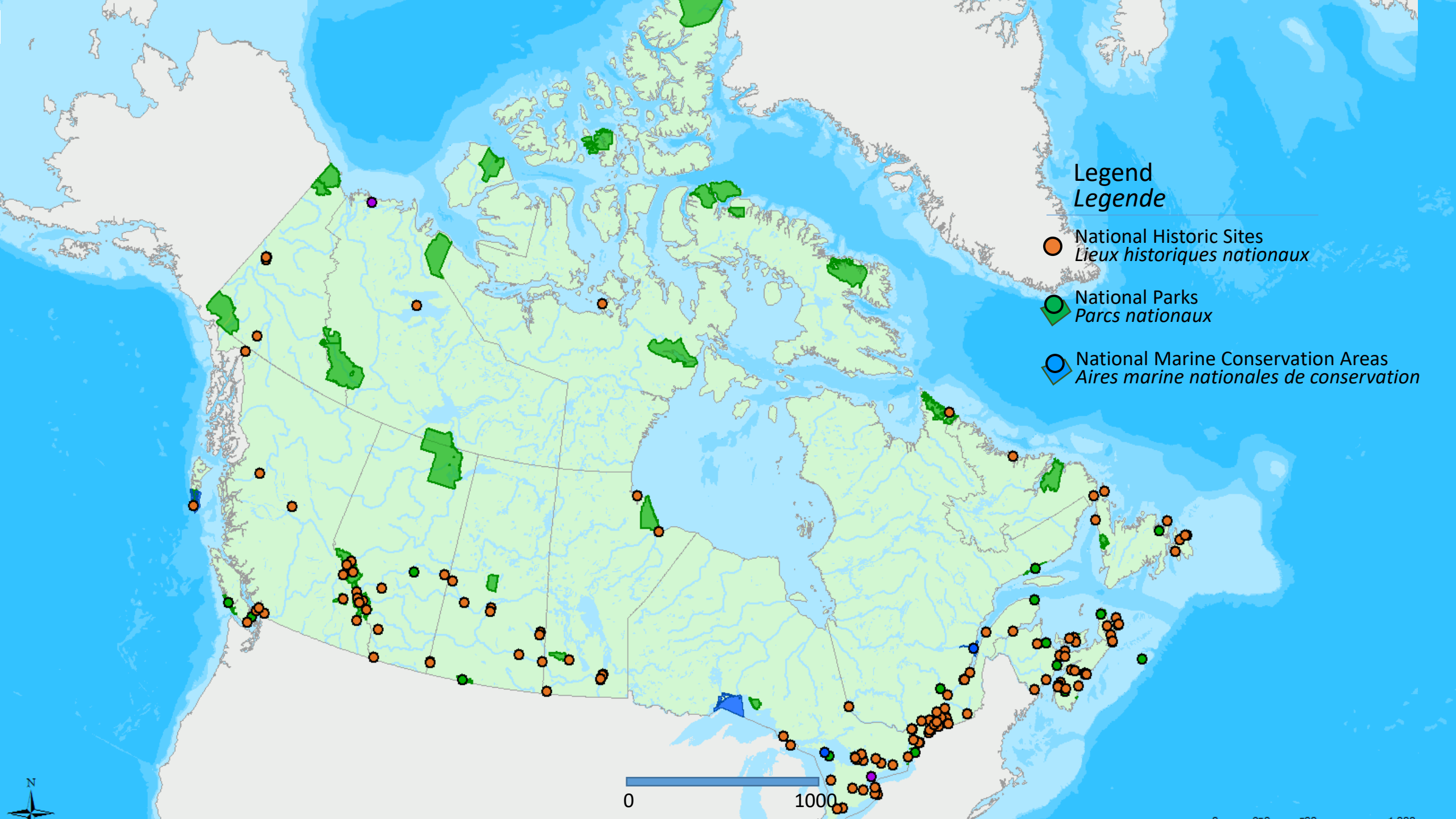

Parks Canada's Mandate
..... protect and present nationally significant examples of Canada's natural and cultural heritage, and foster public understanding, appreciation and enjoyment in ways that ensure the ecological and commemorative integrity of these places for present and future generations.
Le mandat de Parcs Canada
..... protégeons et mettons en valeur des exemples représentatifs du patrimoine naturel et culturel du Canada, et en favorisons chez le public la connaissance, l'appréciation et la jouissance, de manière à en assurer l'intégrité écologique et commémorative pour les générations d'aujourd'hui et de demain
N
0
1000 km

Kootenay National Park, British Columbia
Parc national Kootenai, Colombie-Britannique

Forillon National Park, Quebec
Parc nationale Forillon, Québec

Bar U Ranch National Historic Site
Lieu historique national du Canada du Ranch-Bar U

Cape Spear Lighthouse National Historic Site, Newfoundland
Lieu historique national du Canada du Phare-de-Cap-Spear, Terre-Neuve


Legend
Legende
National Historic Sites
Lieux historiques nationaux
National Parks
Parcs nationaux
National Marine Conservation Areas
Aires marine nationales de conservation
N
0
1000

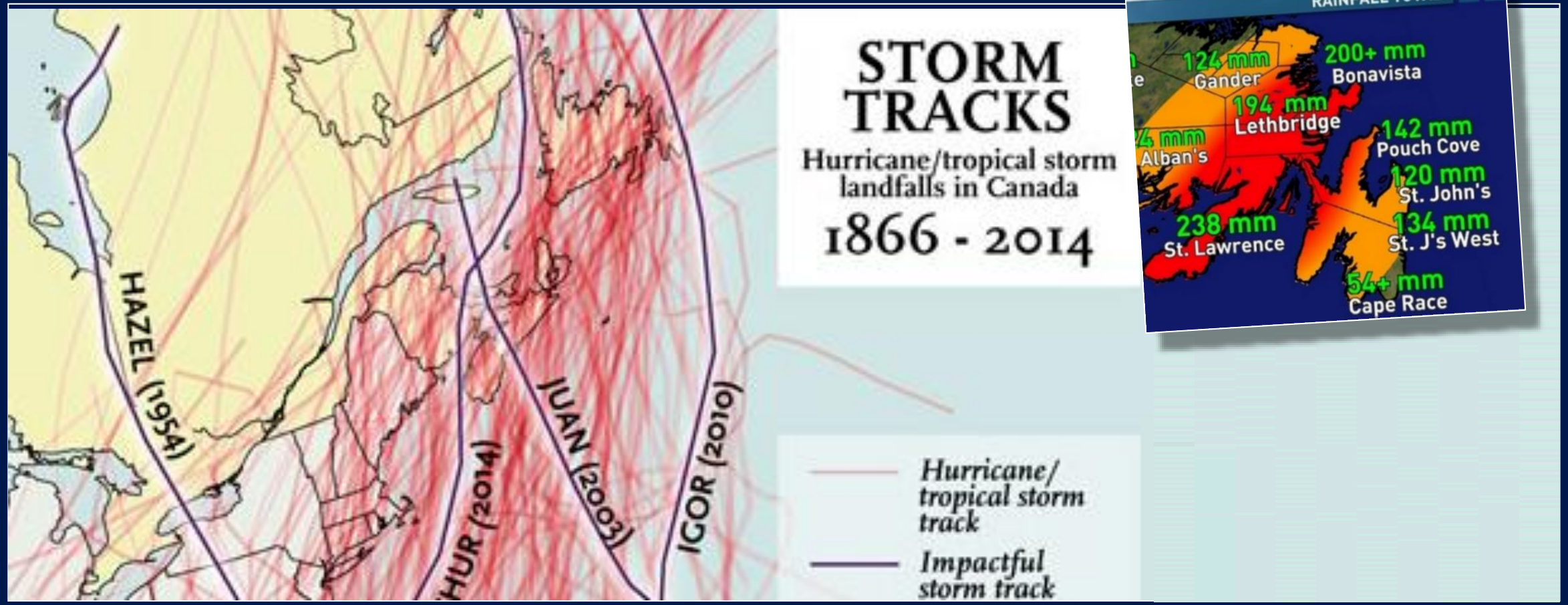
Banff National Park, Alberta
Parc nationale Banff, Alberta

Having four seasons is an integral part of Canadian society
Le fait d'avoir quatre saisons fait partie intégrante de la société canadienne.

Louisbourg, Nova Scotia

Increased awareness and commitment

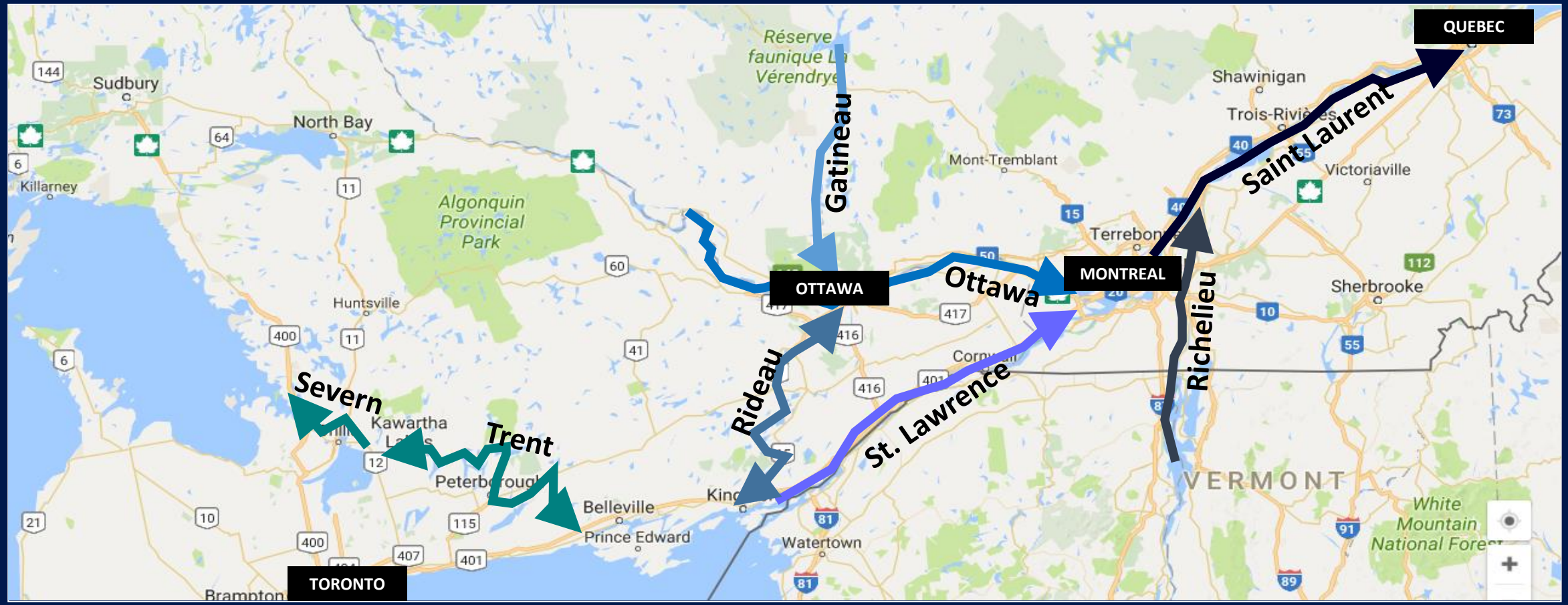
Une sensibilisation et un engagement accrus



Map: Chris Brackley/Canadian Geographic

Hurricanes and tropical storms, some with record-setting winds and rain

Les ouragans et tempêtes tropicales, parfois avec des records de vents et des pluies



In central Canada, floods due to snowmelt and prolonged heavy rains combined

Au centre du pays, les inondations dues à la fonte des neiges et aux fortes pluies prolongées combinées

Photo: Parks Canada

Fort Lennox, Québec

Floods due to snowmelt and prolonged heavy rains combined

Inondations dues à la fonte des neiges et aux fortes pluies prolongées combinées

Photo: Parks Canada

Carillon, Québec

Floods due to snowmelt and prolonged heavy rains combined

Inondations dues à la fonte des neiges et aux fortes pluies prolongées combinées

Photo: Parks Canada

Kootenay, B.C.

Forest fires
Les feux de forêt

Photo: Parks Canada

Waterton Lakes, Alberta

Forest fires
Les feux de forêt

Longview, Alberta

Wildfires, combined with high winds

Les feux aggravés par les vents violents

Dawson City, Yukon

Permafrost thaw
Dégel du pergélisol

Photo: Parks Canada

Above tree line, at sites such as Abbot Pass Refuge, near Lake Louise
Au-delà de la limite forestière, à des sites comme le refuge du Col Abbot, près du Lac Louise

Permafrost thaw at high altitudes
Dégel du pergélisol à haute altitude

Photo: Parks Canada

Above tree line, at sites such as Abbot Pass Refuge, near Lake Louise

Au-delà de la limite forestière, à des sites comme le refuge du Col Abbot, près du Lac Louise

Permafrost thaw at high altitudes

Dégel du pergélisol à haute altitude

1

The “Cultural Resources and Climate Change” discussion group

Le groupe de discussion “Le changement climatique et les ressources culturelles”

2

“Climate Change Mitigation at Heritage Places”

"Atténuation du changement climatique dans les lieux patrimoniaux"

3

“Climate Change Adaptation Workshops for Heritage Places”

"Ateliers sur l'adaptation aux changements climatiques pour les lieux patrimoniaux"

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"Ateliers sur l'adaptation aux changements climatiques pour les lieux patrimoniaux"

In 2016, in the spirit of “let’s get started”, we proposed an expedited programme of climate change adaptation workshops where we’d ask participants to:

- help us find feasible and effective adaptation measures for climate scenarios that could play out within the next 25 years
- acknowledge a certain « logical incrementalism »
- understand that it is only a “first cycle” to achieve quick gains

En 2016, dans l'esprit de « allons-y donc sans plus tarder », nous avons proposé un programme d'ateliers sur l'adaptation aux changements climatiques ou nous avons demandé aux participants:

- *nous aider à trouver des mesures d'adaptation réalistes et efficaces aux scénarios climatiques qui pourraient se concrétiser au cours des 25 prochaines années*
- *de reconnaître une certain « logique progressive»*
- *de comprendre que ceci n’est qu’un « premier cycle », afin d’obtenir des gains rapides*

“Time is of the essence”
« Le temps est un facteur essentiel »

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“Time is of the essence”
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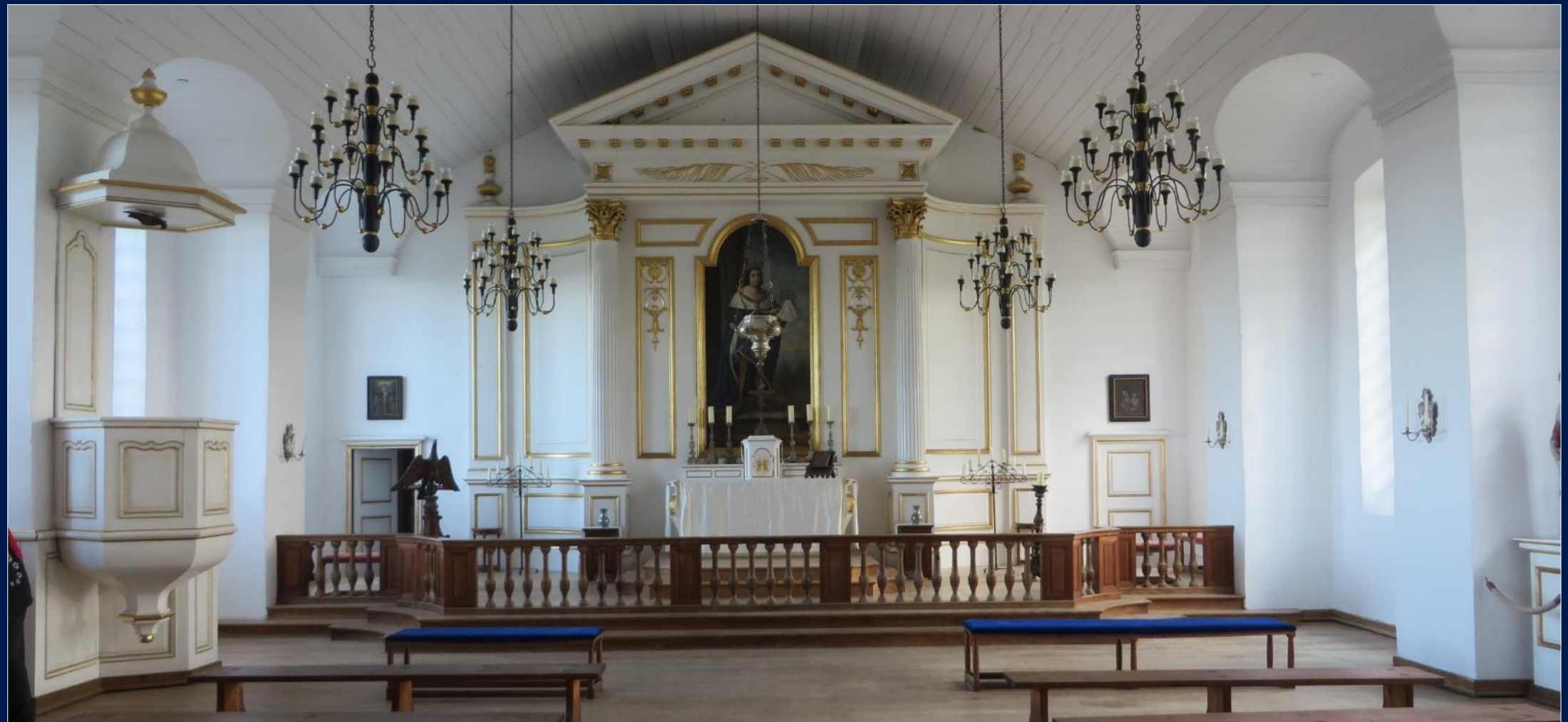
Buildings
Bâtiments

Fortress of Louisbourg NHS

Interiors, including art and fursnishing
Intérieurs, y compris les objets d’art et l'ameublement

Fortress of Louisbourg NHS



Archaeological resources, both terrestrial and underwater
Les ressources archéologiques terrestre et sous-marine

Artifacts, the collection, and the archives.
Les artefacts, la collectionet les archives.

Fortress of Louisbourg NHS

Engineering works
Travaux d'ingénierie

Fortress of Louisbourg NHS

Linear systems / infrastructure (roads, electrical service, drainage systems etc.).
Systèmes linéaires / infrastructure (routes, service électrique, systèmes de drainage etc.)

Visitor Experience and programming
Expérience des visiteurs et programmation

Fortress of Louisbourg NHS

And because each heritage place has a setting, the « associated landscape » is included…
Et puisque chaque aire patrimoniale a un cadre, le « paysage associé » est inclus...

… essentially, the « cultural landscape ».
... essentiellement, le " paysage culturel ".

Fortress of Louisbourg NHS

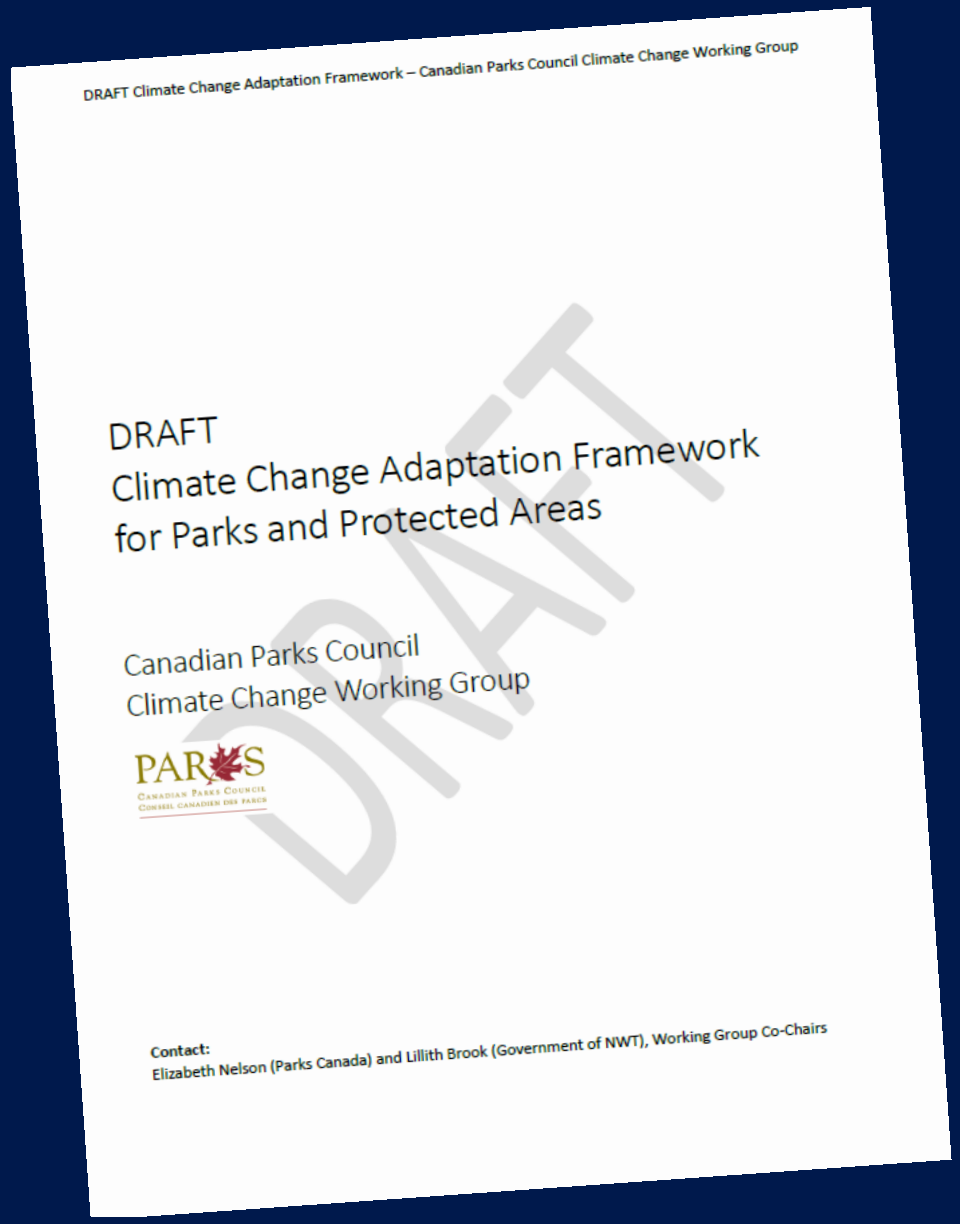
- ✓ Climate scientists and specialists
- ✓ Asset managers
- ✓ Project managers
- ✓ Maintenance staff
- ✓ Visitor experience specialists
- ✓ Collections and curatorial specialists
- ✓ Conservation architects
- ✓ Cultural resource managers / advisors
- ✓ Archaeologists
- ✓ Ecologists and other natural resource conservation specialists

- ✓ Professional writer

- ✓ Scientifiques et spécialistes du climat
- ✓ Gestionnaires des biens
- ✓ Gestionnaires de projets
- ✓ Personnel d'entretien
- ✓ Spécialistes de l'expérience du visiteur
- ✓ Spécialistes des collections et de la conservation
- ✓ Architectes en conservation.
- ✓ Gestionnaires et conseillers(ères) en ressources culturelles
- ✓ Archéologues
- ✓ Écologistes et autres spécialistes de la conservation des ressources naturelles

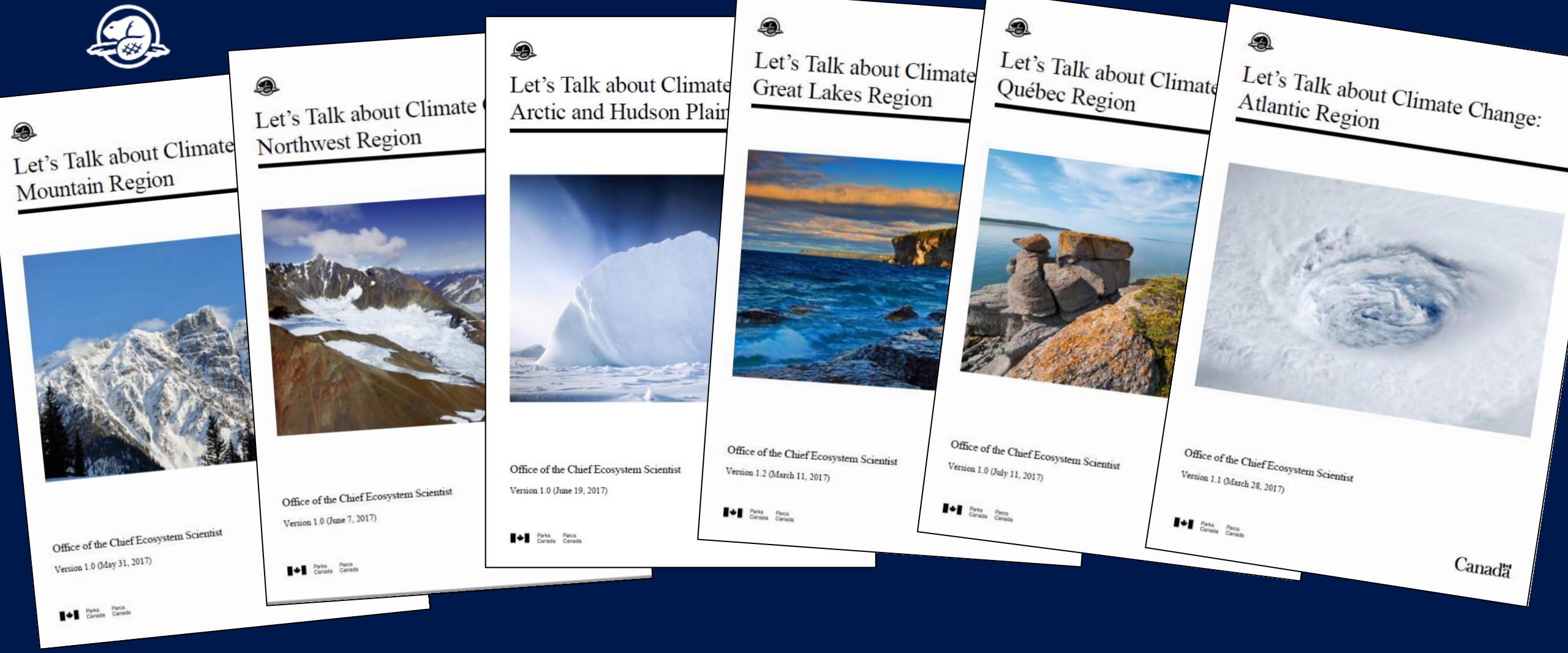
- ✓ Écrivain professionnel

A multi-disciplinary approach
Une approche multidisciplinaire



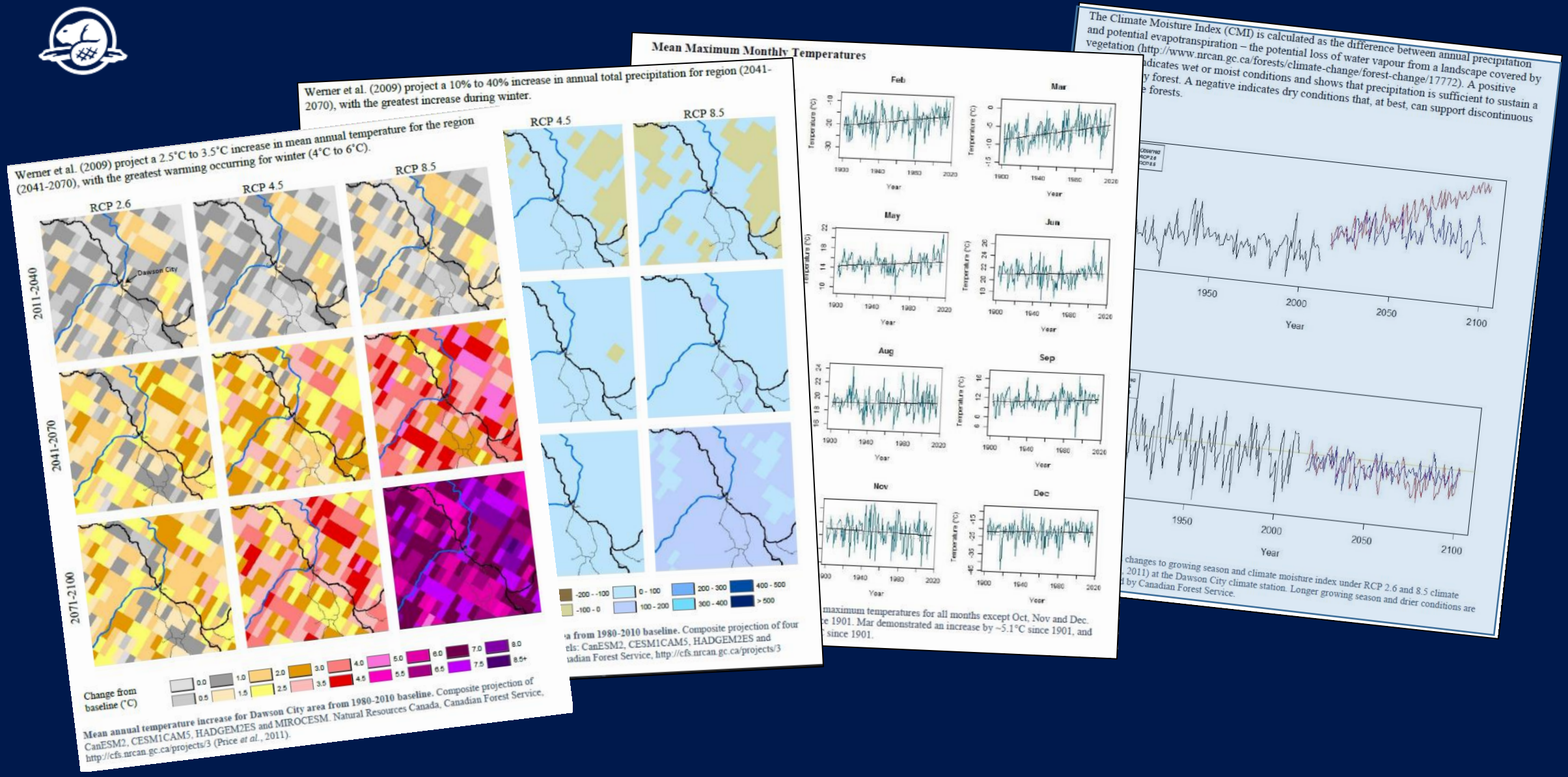
We use a Framework developed by Parks Canada & the Canadian Parks Council

Nous utilisons un cadre développé par l'Agence Parcs Canada et le Conseil canadien des parcs



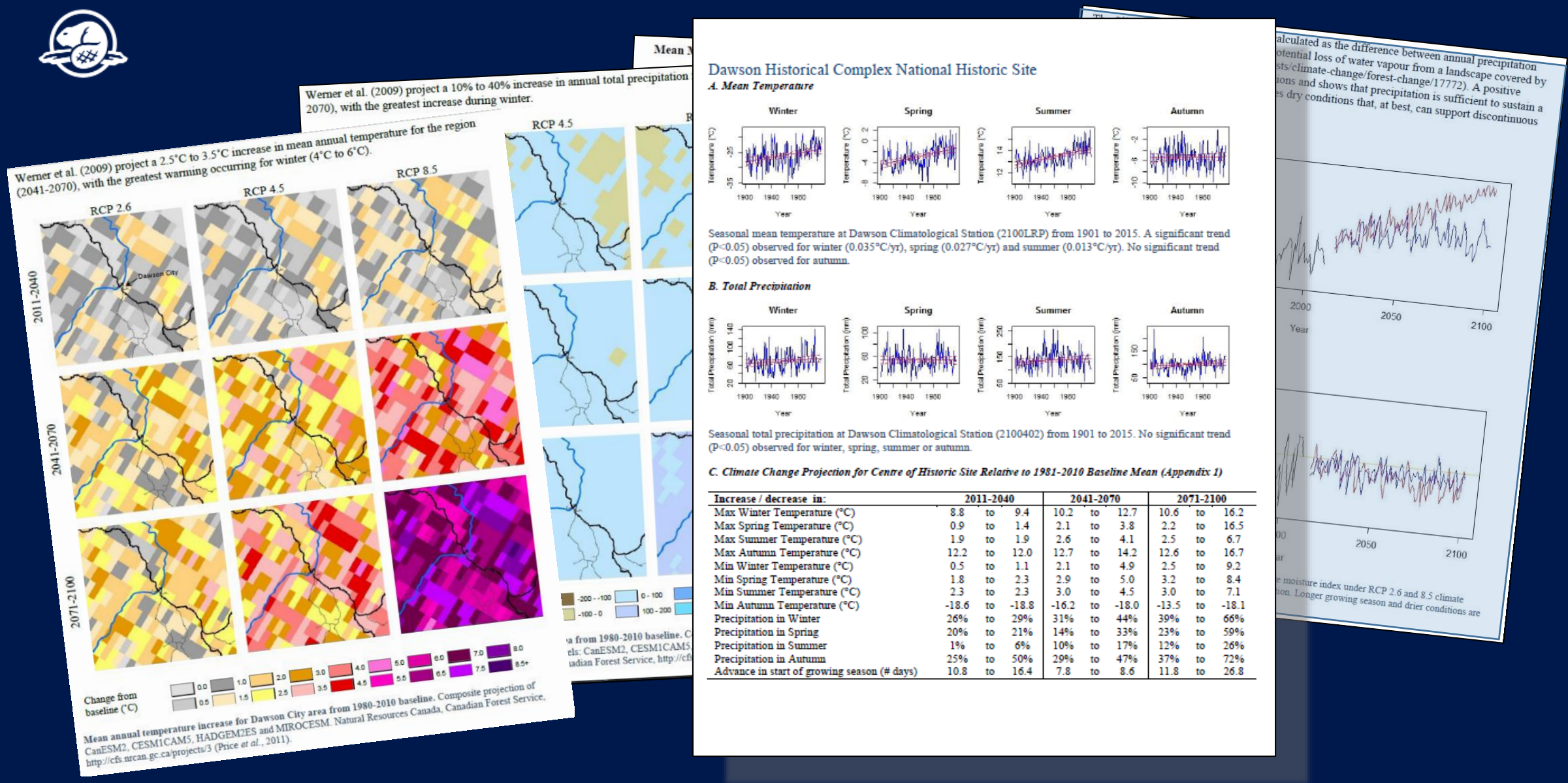
Before workshop: The compilation of relevant scientific information

Avant l'atelier: La compilation d'informations scientifiques pertinentes



Before workshop: The compilation of relevant scientific information (Regional)

Avant l'atelier: La compilation d'informations scientifiques pertinentes (Régionale)



Before workshop: The compilation of relevant scientific information (Site by site)

Avant l'atelier: La compilation d'informations scientifiques pertinentes (Site par site)

“Heritage place” workshops completed

Des ateliers sur les " lieux patrimoniaux " complétés

Before workshop: We define a “area of study”

Avant l’atelier: Nous définissons une "zone d'étude"

Climate science backgrounders.

Heritage reports, and other documents and studies

Site photos and orientation material

Fiches d'information sur les sciences du climat

Rapports sur le patrimoine et autres documents et étud

Photos du site et matériel d'orientation

Before workshop: We load-up a site on our shared network with reading material

Avant l'atelier: Nous chargeons un site sur notre réseau commun avec du matériel de lecture

Cape Spear Lighthouse National Historic Site, Newfoundland
Lieu historique national du Canada du Phare-de-Cap-Spear, Terre-Neuve

Before workshop: Information-sharing and ‘orientation’ visits etc.
Avant l’atelier: Partage de l'information et visites d'orientation, etc.

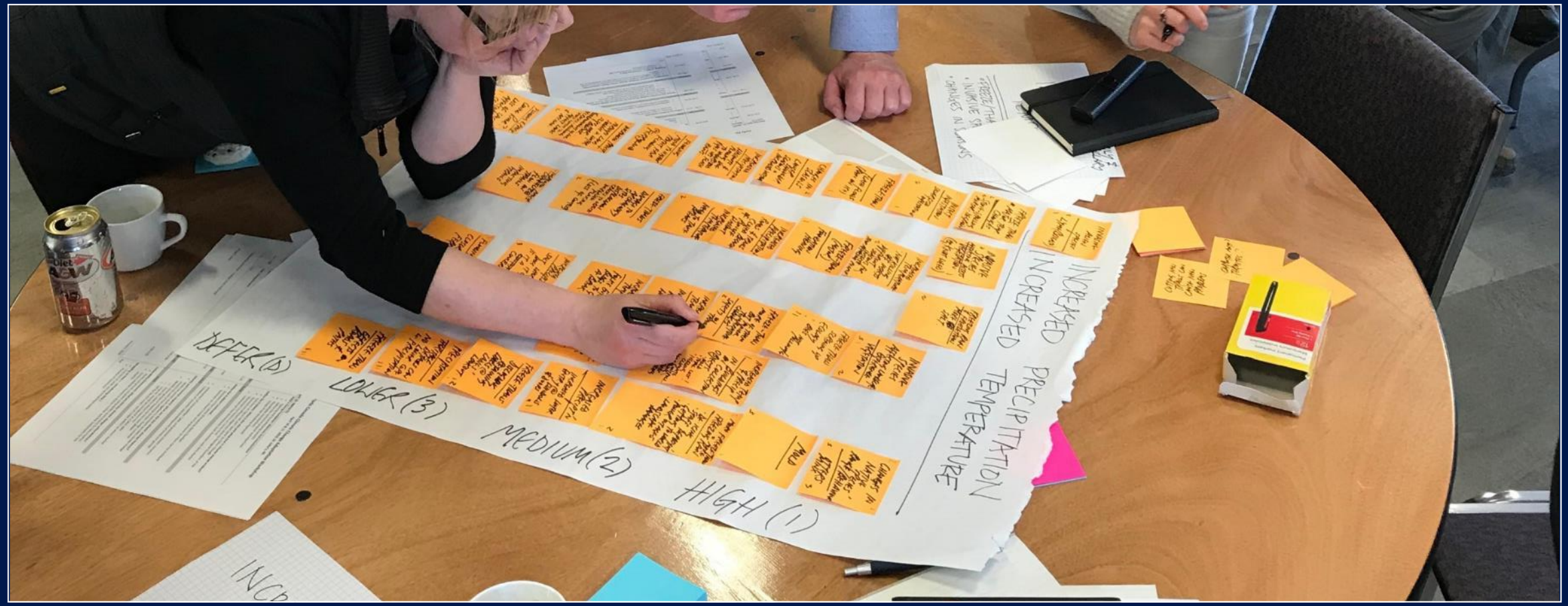
Day #1 morning:
Jour 1, matin:

Introductions.
Des introductions.

An overview of the process.
Une vue d'ensemble du processus.

Learning about site’s issues from the Field Unit staff and other local experts.
Les enjeux du site auprès du personnel de l'Unité de gestion et d'autres experts locaux.

Scientists present the site’s historical and projected climate change trends.
Les scientifiques présentent les tendances historiques et projetées en matière de changements climatiques.



Day #1 afternoon: Brain-storming to list impacts.

Jour 1, après-midi : Remue-méninges des impacts

Day #1 afternoon: Checking with our cards to make sure we haven`t forgotten impacts.

Jour 1, après-midi : Vérifier avec nos cartes pour s'assurer que nous n'avons pas oublié les impacts

Overall risk table:

Determine the level of risk by combing the likelihood and consequence level assigned to each climate impact

Tableau de risque global

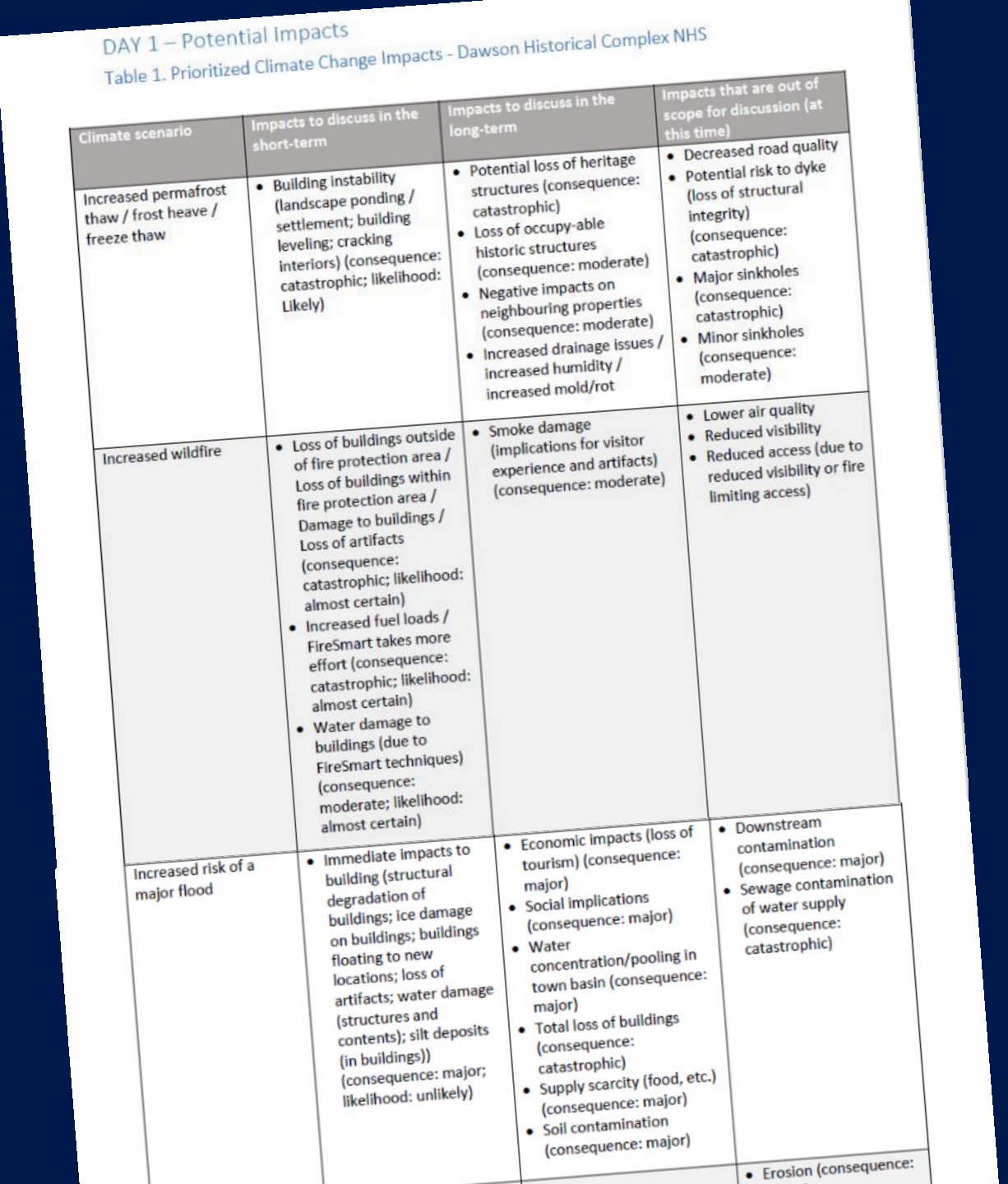
Déterminer le niveau de risque en combinant le niveau de probabilité et de conséquence attribué à chaque impact climatique

Consequences / *Conséquences*

Likelihood / Probabilité	**Negligible** ***Négligeable***	**Minor** ***Mineur***	**Moderate** ***Moderate***	**Major** ***Majeur***	**Catastrophic** ***Catastrophique***
Rare ***Rare***	Low *Bas*	Low *Bas*	Low *Bas*	Low *Bas*	Low *Bas*
Unlikely ***Peu probable***	Low *Bas*	Low *Bas*	Moderate *Modéré*	Moderate *Modéré*	Moderate *Modéré*
Possible ***Possible***	Low *Bas*	Moderate *Modéré*	Moderate *Modéré*	High *Haut*	High *Haut*
Likely ***Probable***	Low *Bas*	Moderate *Modéré*	High *Haut*	High *Haut*	Extreme *Extrème*
Almost certain ***Presque certain***	Low *Bas*	Moderate *Modéré*	High *Haut*	Extreme *Extrème*	Extreme *Extrème*

Determining the level of risk associated with climate impacts

Déterminer le niveau de risque associé aux impacts climatiques



DAY 1 – Potential Impacts

Table 1. Prioritized Climate Change Impacts - Dawson Historical Complex NHS

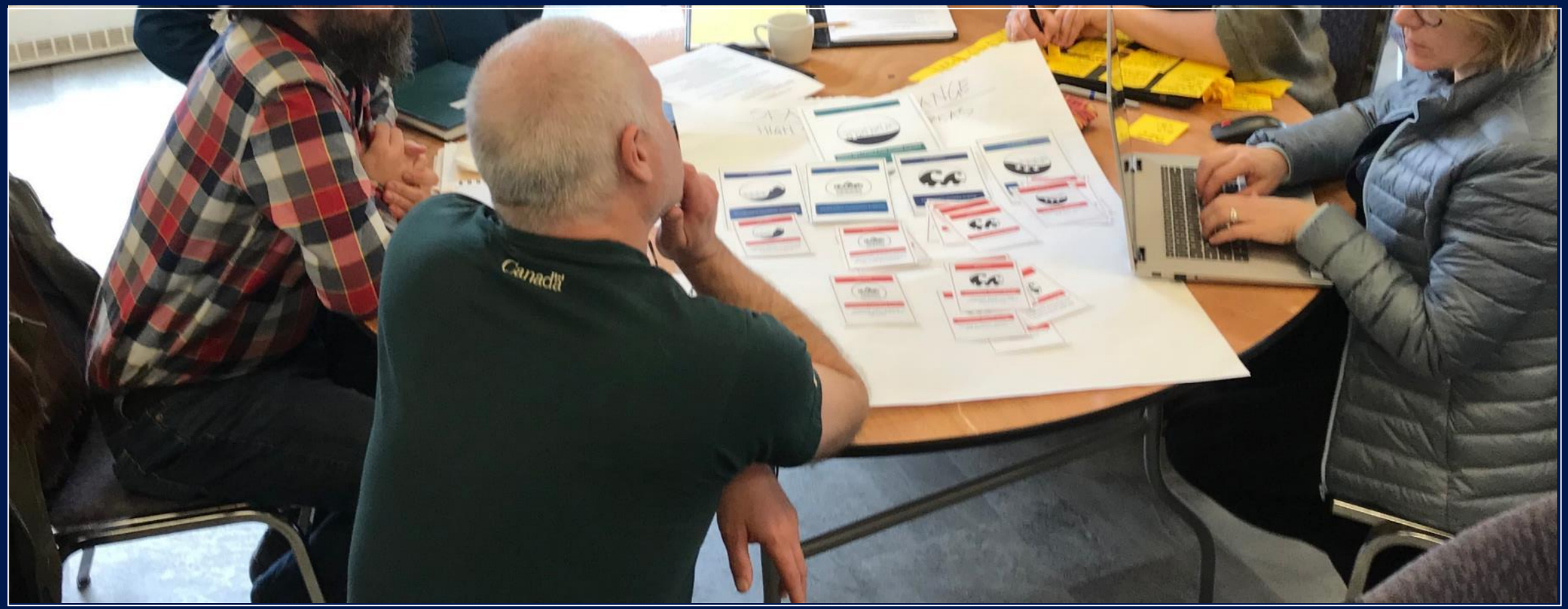
Climate scenario	Impacts to discuss in the short-term	Impacts to discuss in the long-term	Impacts that are out of scope for discussion (at this time)
Increased permafrost thaw / frost heave / freeze thaw	• Building instability (landscape ponding / settlement; building leveling; cracking interiors) (consequence: catastrophic; likelihood: Likely)	• Potential loss of heritage structures (consequence: catastrophic) • Loss of occupy-able historic structures (consequence: moderate) • Negative impacts on neighbouring properties (consequence: moderate) • Increased drainage issues / increased humidity / increased mold/rot	• Decreased road quality • Potential risk to dyke (loss of structural integrity) (consequence: catastrophic) • Major sinkholes (consequence: catastrophic) • Minor sinkholes (consequence: moderate)
Increased wildfire	• Loss of buildings outside of fire protection area / Loss of buildings within fire protection area / Damage to buildings / Loss of artifacts (consequence: catastrophic; likelihood: almost certain) • Increased fuel loads / FireSmart takes more effort (consequence: catastrophic; likelihood: almost certain) • Water damage to buildings (due to FireSmart techniques) (consequence: moderate; likelihood: almost certain)	• Smoke damage (implications for visitor experience and artifacts) (consequence: moderate)	• Lower air quality • Reduced visibility • Reduced access (due to reduced visibility or fire limiting access)
Increased risk of a major flood	• Immediate impacts to building (structural degradation of buildings; ice damage on buildings; buildings floating to new locations; loss of artifacts; water damage (structures and contents); silt deposits (in buildings)) (consequence: major; likelihood: unlikely)	• Economic impacts (loss of tourism) (consequence: major) • Social implications (consequence: major) • Water concentration/pooling in town basin (consequence: major) • Total loss of buildings (consequence: catastrophic) • Supply scarcity (food, etc.) (consequence: major) • Soil contamination (consequence: major)	• Downstream contamination (consequence: major) • Sewage contamination of water supply (consequence: catastrophic)
			• Erosion (consequence:

Preliminary categorization and analysis of climate change impacts, including:

- Impacts for priority attention
- Impacts worthy of longer-term consideration
- Impacts to be put aside for now

Catégorisation et analyse préliminaires des impacts du changement climatique, notamment :

- *Impacts pour une attention prioritaire*
- *Impacts dignes d'un examen à plus long terme*
- *Impacts à mettre de côté pour l'instant*



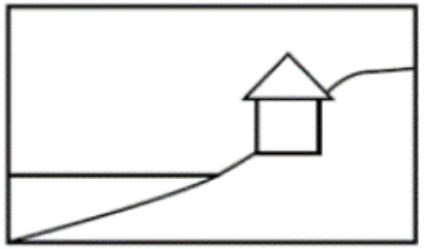
Day #2 morning: Development of adaptation options

Jour 2, matin : Élaboration d'options d'adaptation

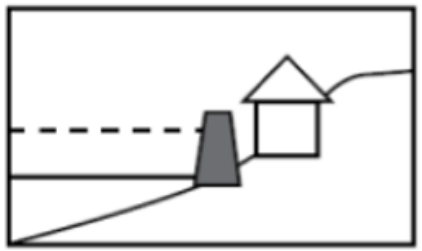
Using the coastal erosion example to show a typical range of options
Utiliser l'érosion des côtes comme exemple pour démontrer une gamme d'options

Source : Mercer Clarke/Manuel/Warren dans Canada's Changing Coasts, citant Linham et Nichols 2010, basé sur le GIEC 1990

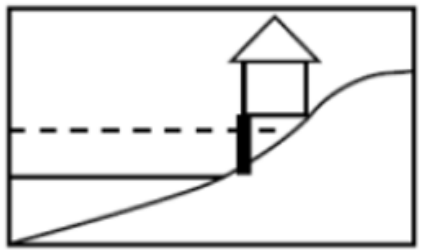
No intervention
Aucune intervention



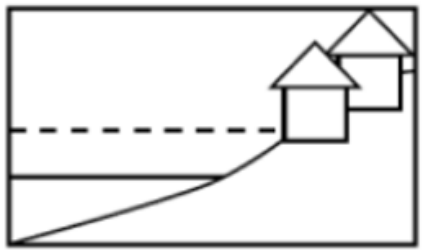
Protect
Protéger

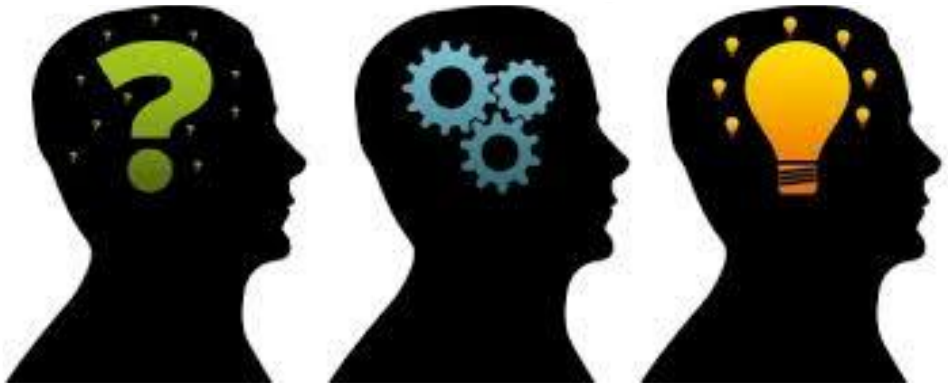


Accommodate
Accommoder

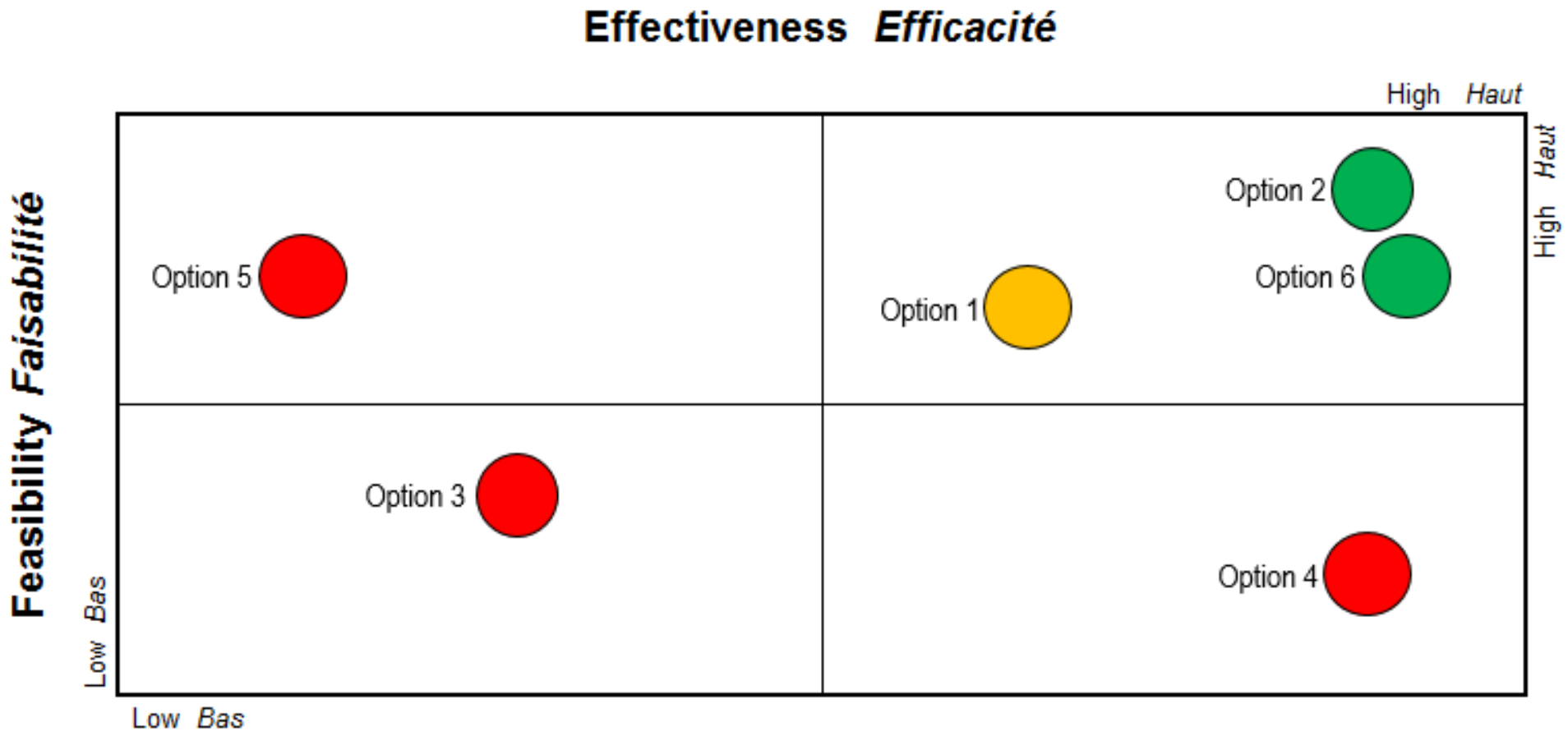


Retreat
Reculer





Development of adaptation options
Développement d'options d'adaptation



Determining the effectiveness and feasibility of adaptation options
Déterminer l'efficacité et la faisabilité des options d'adaptation

Day 2: Identify Adaptation Options

Impact: Drainage

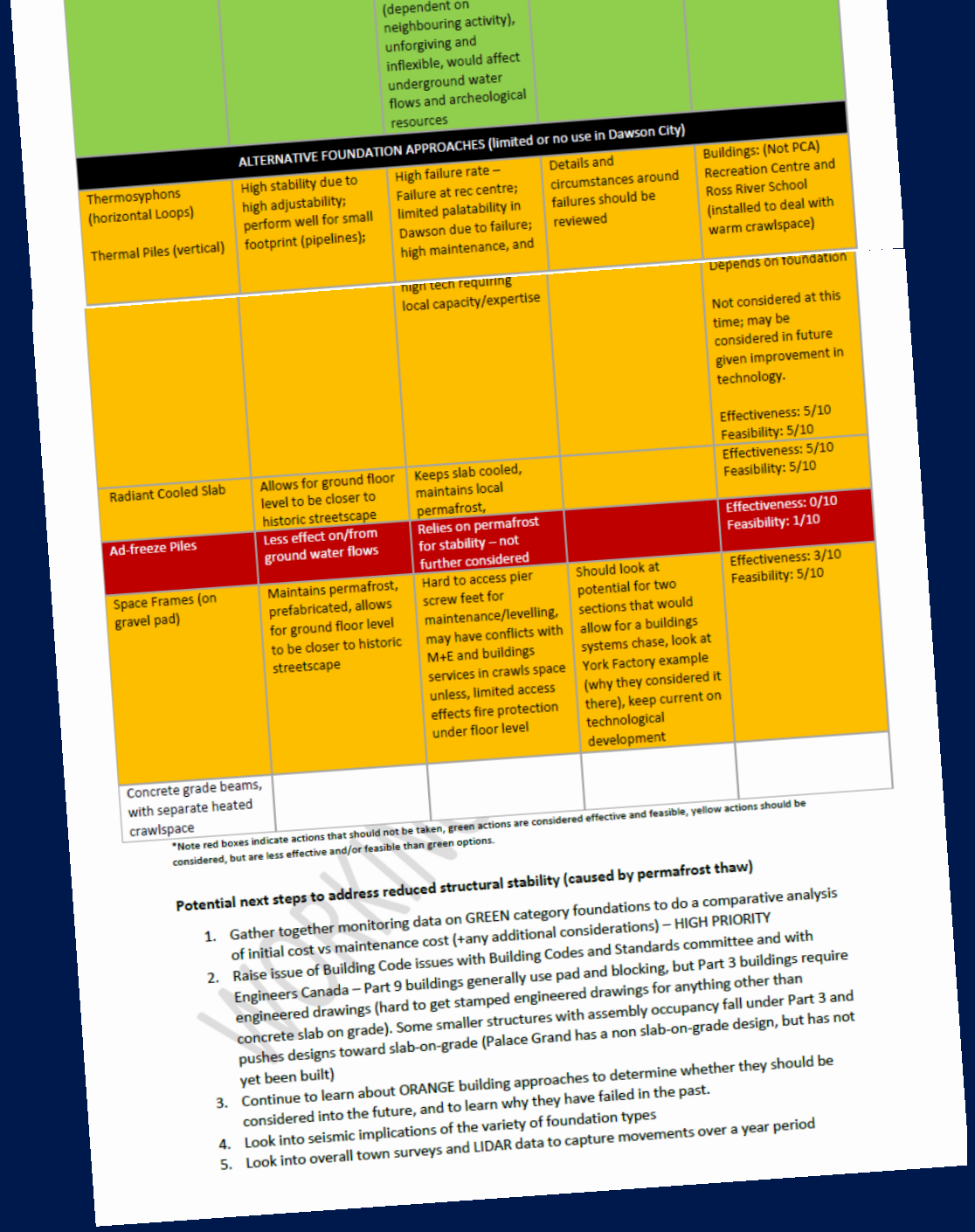
Approach to manage impact	Advantages of current approach	Disadvantages of current approach	Revised approach (if needed)	Additional thoughts & Next steps
Current Approaches				
Installing our own surface box drains to move water away		• Water seems to want to cut around the drain or under the drain, have proven to ineffective (creates a drain, but not in the box), become decayed and not usable		• Should not be considered
Attempted to re-use deeper historic box drains (by opening them up – but encountered ice)		• Mostly plugged by ice, also been impacted by heave, requires a lot of maintenance/manual operation		• Not feasible at all, need to clear all of the water before winter season
Re-using drainage ditches (south and north side) – clearing vegetation to keep water moving	• Not changing landscape from historic use, • No need for extra installations, taking advantage of existing structures; • Tried and true, not highly technical; less use of heavy equipment	• But drains may be eroded beyond depth of original ditch; using drain is accelerating lateral erosion (impact on cultural resources)	• We could go deeper to move water faster • Could clear ditches of vegetation (done once already); should look for ways to reduce erosion (both along length but mostly at discharge point at shoreline) • Could limit erosion if the ditches were lined somehow	Now deeper than original ditches Effectiveness: High Feasibility: High
New and Revised Approaches				
Create a new drain/ditch (by staff house, etc.) to bring pooling water to riverbank	• It is draining water!	• Creating a new path for water to run – impact on cultural resources, increasing in depth/width; • Outflow is upstream of site • Not many places for new drains that won't affect one or another cultural resources • Current drain in front of the staff house is impacting cultural resources	• Could we move outflow to downstream? • But impacts First Nations cultural landscape; • Need to PLAN these ditches (last one was not planned) to limit impacts to cultural resources (but may have to accept some loss)	**NEXT STEP: Explore potential areas where new ditches could be created that limit impacts on cultural resources (but needs to be effective at drainage, and not accelerating other impacts)** Effectiveness: High Feasibility: High
Changing the drain outflow to downstream from site (currently upstream)	• would reduce drainage erosion	• Creates impacts to indigenous partners (downstream)		
Ensuring ditches have correct grade	• Lower gradients or slope reduces erosion	• Having to cut into ground to adjust grade affects soil stability, could make this less	• Need another method simultaneously to stabilize the slope to reduce channel	But ensure grade is appropriate, don't want it to move to fast; **NEXT STEP: assessing the grade of all the ditches on site;**

We build a list of adaptation measures sorted by "Impact Type", including:

- Description of adaptation measure;
- Advantages of current approach;
- Disadvantages of current approach;
- Revised approach (if necessary);
- Additional thoughts.

Nous bâtissons une liste des mesures d'adaptation triées par « type d'impact", y compris :

- *Description de la mesure d'adaptation ;*
- *Avantages de l'approche actuelle ;*
- *Inconvénients de l'approche actuelle ;*
- *Approche révisée (si nécessaire) ;*
- *Réflexions supplémentaires.*



		(dependent on neighbouring activity), unforgiving and inflexible, would affect underground water flows and archeological resources		
ALTERNATIVE FOUNDATION APPROACHES (limited or no use in Dawson City)				
Thermosyphons (horizontal Loops) Thermal Piles (vertical)	High stability due to high adjustability; perform well for small footprint (pipelines);	High failure rate – Failure at rec centre; limited palatability in Dawson due to failure; high maintenance, and	Details and circumstances around failures should be reviewed	Buildings: (Not PCA) Recreation Centre and Ross River School (installed to deal with warm crawlspace)
		high tech requiring local capacity/expertise		Depends on foundation Not considered at this time; may be considered in future given improvement in technology. Effectiveness: 5/10 Feasibility: 5/10
Radiant Cooled Slab	Allows for ground floor level to be closer to historic streetscape	Keeps slab cooled, maintains local permafrost,		Effectiveness: 5/10 Feasibility: 5/10
Ad-freeze Piles	**Less effect on/from ground water flows**	**Relies on permafrost for stability – not further considered**		**Effectiveness: 0/10 Feasibility: 1/10**
Space Frames (on gravel pad)	Maintains permafrost, prefabricated, allows for ground floor level to be closer to historic streetscape	Hard to access pier screw feet for maintenance/levelling, may have conflicts with M+E and buildings services in crawls space unless, limited access effects fire protection under floor level	Should look at potential for two sections that would allow for a buildings systems chase, look at York Factory example (why they considered it there), keep current on technological development	Effectiveness: 3/10 Feasibility: 5/10
Concrete grade beams, with separate heated crawlspace				

*Note red boxes indicate actions that should not be taken, green actions are considered effective and feasible, yellow actions should be considered, but are less effective and/or feasible than green options.

Potential next steps to address reduced structural stability (caused by permafrost thaw)

1. Gather together monitoring data on GREEN category foundations to do a comparative analysis of initial cost vs maintenance cost (+any additional considerations) – HIGH PRIORITY
2. Raise issue of Building Code issues with Building Codes and Standards committee and with Engineers Canada – Part 9 buildings generally use pad and blocking, but Part 3 buildings require engineered drawings (hard to get stamped engineered drawings for anything other than concrete slab on grade). Some smaller structures with assembly occupancy fall under Part 3 and pushes designs toward slab-on-grade (Palace Grand has a non slab-on-grade design, but has not yet been built)
3. Continue to learn about ORANGE building approaches to determine whether they should be considered into the future, and to learn why they have failed in the past.
4. Look into seismic implications of the variety of foundation types
5. Look into overall town surveys and LIDAR data to capture movements over a year period

- Red = Not recommendable
- Yellow = Needs further study
- Green = Recommendable

and at the bottom, we have “Next Steps”.

- *Rouge = Non recommandé*
- *Jaune = Nécessite une étude plus approfondie*
- *Vert = Recommandé*

et en bas, nous avons les “Prochaines Étapes".

Government of Alberta

British Columbia

Canada

Manitoba

New Nouveau Brunswick

Newfoundland Labrador

Northwest Territories

Nova Scotia

Nunavut

Ontario

Prince Edward Island
Canada

Québec

Government of Saskatchewan

Yukon Government

Write-up and sharing of findings
Rédaction et partage des résultats

A Federal Provincial and Territorial Collaboration
Une collaboration fédérale-provinciale-territoriale

1

The “Cultural Resources and Climate Change” discussion group

Le groupe de discussion “Le changement climatique et les ressources culturelles”

2

“Climate Change Mitigation at Heritage Places”

"Atténuation du changement climatique dans les lieux patrimoniaux"

3

“Climate Change Adaptation Workshops for Heritage Places”

"Ateliers sur l'adaptation aux changements climatiques pour les lieux patrimoniaux"

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