ALBERTA WILDERNESS ASSOCIATION
*"Defending Wild Alberta through Awareness and Action"*

June 9, 2023

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**Re: Alberta Wilderness Association Request for Reconsideration No. 1942728**

Dear Aimée Hockenhull,

This letter and the documents attached thereto constitute the reply submissions of Alberta Wilderness Association ("AWA") in respect of AWA's Request for Reconsideration No. 1942728 pursuant to section 42 of the Responsible Energy Development Act ("REDA").

**Overview**

The purpose of these reply submissions is to continue to assist the Alberta Energy Regulator (the Regulator) in making its determination with respect to AWA's Request for Reconsideration in accordance with the Regulator's public-interest mandate. To this end, the below submissions and attached appendices explain why the response submissions of Suncor Energy Operating Inc. ("Suncor") are deficient and should have little bearing on the Regulator's reconsideration. Namely, Suncor's submissions fail to provide any meaningful counter to AWA's central point that the evidence included in AWA's initial submissions is new and may cause the Regulator to change its decision upon reconsideration.

These reply submissions will address each of the six argument sections of Suncor's response in their respective order.

**1 – Suncor's emphasis on AWA's decision not to participate in the Sustainability Committee ("SC") does not detract from the significance of the new submitted information**

To reiterate our initial submissions, AWA's information is new because it was not reasonably available prior to the Regulator's decision to approve the Operational Plan. Suncor's argument that AWA should have made the information available through participation in the SC ignores AWA's clear explanation in our initial submissions and throughout the history of AWA's correspondence with Suncor that such participation would conflict with our public-interest mandate, and was therefore not reasonable.

First, Suncor's claim that AWA had a meaningful opportunity to participate in the SC is incorrect and misleading because it ignores the public-interest rationale at the core of both AWA's approach towards the SC and the purpose of this reconsideration request. AWA's mandate is to serve the public interest by advocating for the protection of ecological systems, including the McClelland Lake Wetland Complex ("MLWC"). A critical part of this mandate is to maintain our ability to publicly advocate and maintain our independence from processes which would conflict with our public-interest mandate by legitimizing the destruction of ecological systems we aim to protect. AWA has clearly articulated this mandate in discussions with Suncor, including during a meeting on February 23, 2010.[1] In the case of the MLWC, AWA takes the well-documented and strongly-founded position that mining in part of the MLWC will inevitably lead to the destruction of the unmined portion of the MLWC.[2] The SC's sole purpose is to facilitate the regulatory implementation of the Fort Hills project.[3] The sole purpose of the SC, to facilitate something which in AWA's view will destroy the unmined portion of the MLWC, is in direct conflict with AWA's mandate, and is therefore not a process in which AWA could reasonably have participated. Given the Regulator's mandate to act in the public interest, including in these reconsideration proceedings, AWA's decision to uphold its own public-interest mandate should not count against AWA's submission of new information in this case.

Suncor's claim that AWA "determined strategically that it would not support the Operational Plan before it ever existed" is also incorrect and misleading. AWA has made no such strategic determination and Suncor provides no evidence of such a strategic determination. Instead, Suncor's claim simply restates AWA's rationale for upholding its public-interest mandate, which is not evidence of a strategic determination against the Operational Plan, but which is instead evidence of AWA's good-faith adherence to its own mandate. If Suncor's suggestion is that the Operational Plan could never align with AWA's mandate, meaning that the Operational Plan would not guarantee the protection of the unmined portion of the MLWC, then Suncor is simply indicating that the Operational Plan will not satisfy the project's Water Act Approvals.[4]

Suncor's response also fails to refute AWA's characterization of the SC's purpose. Suncor claims vaguely that "years of collaboration" sufficiently demonstrates that "it is clearly not the case" that the purpose of the SC is not to facilitate mining in a portion of the MLWC, which would in AWA's view likely lead to the destruction of the unmined portion of the wetland. "Years of collaboration" says nothing about the purpose of the SC and does nothing to refute AWA's view that the project will destroy the unmined

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[1] "Meeting Notes: McClelland Watershed Overview with Suncor" (February 23, 2010), attached as Appendix A to the reply submissions; see pp 1-2.

[2] See Attachment 4 to Suncor's Response Submissions at pp 56-57; see also "Presentation to the Oil Sands Multi-stakeholder Panel" (September 27, 2006) attached as Appendix B to these reply submissions; see also Letter to Victor Choy and Sheila Chernys (September 2, 2008), attached as Appendix C to these reply submissions; see also "Memorable McClelland Lake Wetlands" (June 2016) by Carolyn Campbell, attached as Appendix D to these reply submissions.

[3] "McClelland Lake Wetland Complex Sustainability Committee Terms of Reference" (July 6, 2010), attached as Appendix E to these reply submissions; see p 2.

[4] Attachment 1 to Suncor's Response Submissions.

portion of the MLWC. Rather, Suncor's claim is simply a general description of the SC process, not a clear demonstration that the SC is meant to do anything other than facilitate mining in the MLWC.

Suncor's response also raises an imagined concern that this reconsideration request would incentivize members of the public to provide input when they "could have provided it earlier". Again, this claim that AWA could have reasonably participated in the SC is incorrect as explained above. Furthermore, proceeding with this reconsideration does not provide an incentive or create a "troubling precedent". What is truly troubling is that AWA's request is only necessary as a result of Suncor's choice to instigate a process in which AWA was forced to choose between participating or upholding its public-interest mandate. Suncor has created the conditions incentivizing a reconsideration request by failing to produce an Operational Plan that meets the conditions of its Water Act Approval and Suncor should be held accountable accordingly.

**2 – Suncor's assertion that AWA has not used the available appeal mechanisms is self-contradictory, and entirely misses the point of this request for reconsideration on the basis of new information**

First, Suncor's claim that there is no mechanism for members of the public to request reconsideration is incorrect and contradicts other statements in their response. Being at the sole discretion of the Regulator is not the same as having no mechanism to consider requests for reconsideration. As the Regulator noted in Reconsideration No. 194149, although the Regulator's discretionary power to reconsider does not give rise to an "appeal" mechanism per se, the discretion does give rise to a mechanism for the Regulator to reconsider a decision where there is new information to warrant such a reconsideration.[5] As was the case in Reconsideration No. 194149, and as Suncor notes in section 4 of its response, members of the public and other parties clearly have requested reconsideration in the past. In fact, requests are the primary process by which reconsideration is initiated. Also, given that the Regulator acts in the public interest in the exercise of its sole discretion, it would not make sense for that discretion to preclude a request from the very public the discretion is intended to serve, especially where the request by the public is also made in accordance with the public interest, as is the case here.

Second, Suncor's claim that AWA has failed to use available appeal mechanisms is incorrect. The appeal routes Suncor describes under sections 38 and 45 of the REDA apply to parties who would be directly and adversely affected by the decision. AWA does not purport to be directly and adversely affected by the decision. Indeed, as Suncor notes elsewhere in its response, AWA is not directly and adversely affected. It is precisely because AWA is not directly and adversely affected that the appeal mechanisms under sections 38 and 45 of the REDA were not available to AWA in this context. AWA therefore did not fail to use available appeal mechanisms, as none were available. As the Regulator notes in the 2014 decision regarding Beaver Lake Cree Nation's reconsideration request which Suncor's response cites, the Regulator may exercise its discretion to reconsider "where it is satisfied there are exceptional and compelling grounds to do so, <u>and no other review process exists</u>" [emphasis added]. When new

[5] Alberta Energy Regulator Reconsideration No.: 1941491 at pp 5-6, online: https://static.aer.ca/prd/documents/decisions/regulatory-appeal-decisions/1941491_20230222.pdf.

information becomes available that may cause the Regulator to make a different decision upon reconsideration, and no other review process is available, reconsideration is the proper procedure to make that new information available to the AER.

Third, Suncor's claim in this section and the following section of their response that AWA's reconsideration request is "time barred" is incorrect because it fails to grasp the main basis of this reconsideration request, namely the presence of new information. New information is new precisely because it arises after the decision is made. Rather than creating uncertainty as Suncor argues, the discretion to reconsider based on new information exists to provide the Regulator with a tool to address evolving circumstances. Otherwise the Regulator would not be able to provide certainty when new circumstances arise. As Suncor notes, the Regulator's discretion under section 42 of the REDA has no time limit. A time limit would not make sense for a discretionary power meant to enable the Regulator to respond to evolving circumstances after the decision was made. In this case, the new information arose after both the authorization decision on September 9, 2022 and the expiry of the section 38 and 45 appeal period on October 9, 2022, and could not have arisen earlier because AWA only received notice of the authorization decision in November 2022. The basis of this reconsideration request is thus new information, for which the notion of a time limit is irrelevant.

**<u>3 – Suncor's arguments fail to show that there are no exceptional and compelling grounds to warrant a reconsideration</u>**

To reiterate our initial submissions, the central issue in this reconsideration proceeding is whether the evidence in AWA's submissions was not previously available to or considered by the Regulator and may cause the Regulator to change its decision if considered during a reconsideration, thereby giving rise to exceptional and compelling grounds for a reconsideration under the Regulator's discretionary power. Suncor's claim that AWA "unreasonably delayed its engagement of consultants and has failed to file or provide any relevant information with the AER which would explain its reasons for this delay" is simply incorrect and cannot therefore refute AWA's position that the information in AWA's submission was not available to or considered by the Regulator.

As indicated in our initial submissions, the time AWA took to retain experts and the timing of AWA's request for reconsideration were entirely reasonable, and indeed necessary. As explained above, AWA could not have reasonably participated in the SC prior to the decision being made. Suncor's claim that "AWA had ample opportunity to make information available prior to the time of the decision" and that "AWA could have and should have taken advantage of the opportunities to provide input and potentially influence the contents" misses the point that although AWA could have provided "information" at any time, the information at issue in this case, namely a report based on independent expert reviews of the final Operational Plan, by its very nature could not have existed prior to the Regulator's decision. Also, to be clear, AWA is a non-profit organization with a small staff of six full-time and two part-time employees with a small operating budget and limited capacity to engage with projects of this scale and complexity. AWA engaged with numerous experts over the seven months after the decision, and AWA could not have moved any faster within our limited means to find relevant experts without conflicts of interest. The experts also took a reasonable amount of time to conduct their reviews, considering the many thousands of pages of technical documents they reviewed and their own capacity constraints.

Suncor's claim that AWA "appears to be in vehement disagreement" with the authorization decision and the 2002 EUB Decision is also irrelevant to the central question in this reconsideration proceeding, namely whether AWA has submitted new information not available at the time of the decision which could lead the Regulator to come to a different conclusion upon reconsideration. AWA's position on the authorization decision or the 2002 EUB Decision are not the basis for this reconsideration request. Rather, as discussed in detail in our initial submissions, the new information contained within AWA's submitted report reveal significant uncertainties about the Operational Plan's ability to satisfy the conditions of the 2002 EUB Decision and the 2002/2015 Water Act Approvals. This new information could therefore lead the Regulator to come to a different conclusion upon reconsideration, and is thus sufficiently compelling and exceptional grounds for reconsideration.

**4 – Suncor places undue emphasis on the irrelevant "directly and adversely affected" standing test**

Suncor's assertion that AWA is not directly and adversely affected has no bearing on AWA's basis for requesting reconsideration. As discussed above, AWA made this reconsideration precisely because AWA is not directly and adversely affected and could not participate in the regulatory appeals process to provide the new information contained in our submissions. The Regulator has not actually applied the standing test to reconsiderations. Indeed, it would not make sense to apply a standing test from one type of proceeding in another type of proceeding which results specifically because that standing test does not apply.

Furthermore, Suncor's argument provides no proof that reconsideration proceedings are only requested by parties who would meet the directly and adversely affected test, as the test was not actually applied in those cases and no determination was made as to whether the parties satisfied the test. Also, even if all reconsideration requests happened to have been made by parties who would meet the test, it would only show a correlation and would not explain the correlation or show that those parties had to satisfy the test for the request to succeed.

**5 – Suncor's assertion that AWA did not demonstrate an error in the decision is irrelevant because AWA did not need to demonstrate such an error to warrant a reconsideration**

Reconsiderations do not require a demonstration of an error in the decision. Instead, as discussed in AWA's initial submissions, the central issue in this reconsideration proceeding is whether the evidence in AWA's submissions was not previously available to or considered by the Regulator and may cause the Regulator to change its decision if considered during a reconsideration. The question is therefore not whether the decision contained an error based on the information it had at the time of the decision, but rather whether the decision may turn out differently if the new information is taken into consideration. As explained in our initial submissions, the uncertainties within the Operational Plan highlighted by our report demonstrate that the Operational Plan cannot guarantee protection of the unmined portion of the MLWC in violation of the conditions set out by the 2002/2015 Water Act approvals and 2002 EUB

Decision. These uncertainties highlighted in our report could therefore lead the Regulator to make a different decision upon reconsideration.

**6 – Suncor's response fails to show that AWA's submissions contain no new information**

As discussed above, Suncor's assertion that AWA "had ample opportunity to submit the information previously" and that the information is therefore not new is incorrect for two reasons. First, AWA could not have reasonably participated in the SC process, and therefore had no such opportunity to provide the information before the Operational Plan was submitted and approved. Second, the information is a report based on independent expert review of the finalized Operational Plan, which by its very nature could not have arisen until after the Operational Plan was submitted and approved. Suncor's argument thus fails to show that the information presented in AWA's report is not new.

Also, Suncor's claim that AWA's report is not compelling, significant, or extraordinary fails on all four grounds on which Suncor relies, namely that the Operational Plan addresses the seven concerns highlighted in the report, that the report is based on incorrect or misleading assumptions, that the report is speculative, and/or that the report demonstrates a lack of knowledge about the technical expertise that went into the development of the Operational Plan. We address these four grounds as applied in Suncor's response to each of AWA's seven highlighted concerns in the following sections and show that Suncor has failed to show that AWA's concerns could not lead the Regulator to a different conclusion upon reconsideration.

1. Unaddressed potential saline contamination of freshwater (wetlands and groundwater)

Suncor's claim that AWA does not provide relevant evidence and that for AWA's concern to have merit, "it would have to be demonstrated that elevated salinity levels were observed at the MLWC" is incorrect. As Suncor's argument notes, AWA's report includes evidence of elevated salinity from mining activity elsewhere in the mineable oil sands region. Suncor's claim fails to provide any evidence or reason for why this evidence would not be relevant, beyond noting that conditions at each site are unique. Conditions at each site may be unique, but regional trends from similar activities in similar circumstances are still useful indicators of potential risk and cannot simply be ignored, especially where it would be impossible to provide evidence of increased salinity from mining in the MLWC itself because no such mining has actually taken place to date. Instead, the Operational Plan admits that the salinity issue is unresolved and relies on a conjecture that a solution might be found, thereby failing to provide any guarantee that such a solution emerges or would sufficiently protect the unmined portion of the MLWC.[6]

2. Lack of modelling for potential impacts to groundwater quality

Suncor's assertion that "AWA ignores that a roadmap for future work required on water quality modelling was provided in Figure 4.3-3 of the Operational Plan" fails to refute the concern raised in

[6] "Comments to Alberta Wilderness Association on Suncor's Response Submission Letter of May 31, 2023" (June 2, 2023) by Richard Lindsay, attached as Appendix F to these reply submissions; see p 1.

AWA's report that the Operational Plan is insufficient. A roadmap for future work on water quality modeling is not enough to guarantee the diversity and function of the unmined portion of the MLWC as required by the Water Act Approvals and the 2002 EUB Decision.[7] Therefore, the roadmap cannot be considered sufficient for ensuring the Operational Plan meets the requirements of the Water Act Approvals and 2002 EUB Decision.

3. Insufficient observational data for hydrological model calibration

Despite Suncor's unproven claims that "AWA lacks expertise" and/or "did not review or misinterpreted Appendix D of the Operational Plan", AWA's concern that the hydrological model calibration relies on insufficient data still stands. As stated by Richard Lindsay, Head of Environmental and Conservation Research at the Sustainability Research Institute of the University of East London with regards to the Operational Plan and in response to AWA's report:

> …while a huge amount of data has been gathered, collated and assessed, the data are **only interpreted with confidence and adequate quality assurance for the *current* set of conditions**. There are so many acknowledged (and un-acknowledged) unknowns in the practical implementation of the Operational Plan that it is not possible to generate an interpretation of what will happen in the future with any degree of confidence. It may be argued that the modelling provides this interpretation, but, as has often been said: "A model is not reality. It is a means of producing a hypothesis which is then tested against reality." **In this case, however, no real testing of the model output can take place until the Operational Plan has been implemented, by which time it is too late to undo the engineered construction works**.
>
> Furthermore, the various reports provide long lists of assumptions and generalisations which have been used to generate the models – assumptions and generalisations which are in at least some cases not supported by existing evidence. For example, it is stated that the derived model assumes peat to be a homogeneous material, but a huge archive of published evidence shows repeatedly that this is very far from the case (e.g. Godwin and Conway, 1939; Conway, 1954; Charman, 1994; Kutenkov and Philippov, 2019). Even the paper by Vitt and House (2023) for this site reveals a **substantial degree of variation in the composition of the peat** throughout the length of the various cores obtained. Indeed, their longest core, Core 1, while showing a considerable degree of uniformity along much of its length also contains areas where no sample was obtained – which from my own experience suggests that there are extremely liquid lenses or even what are termed 'peat pipes' contained within this otherwise uniform core. Such layers and features can have a major impact on the behaviour of water within the peat, and more will be said about this in the section on 'Potential for catastrophic change'.
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> The Interpretation stage also fails adequately to address the fact that peatland systems, particularly patterned peatlands, are **highly responsive, self-organising systems** because, unlike a mineral soil surface which is largely shaped by mechanical forces, the 'soil' surface of a

[7] Appendix F at p 1.

peatland is continually generated, shaped and renewed by the living layer of vegetation. Changes to the vegetation inevitably result in changes to the shape of the peat surface, the processes of peat formation and ultimately the hydro-ecological behaviour of the peatland ecosystem. Barber (1981) established a clear link between climate and changing surface patterns over time, and many authors since then have explored the mechanisms of self-organisation and feedback that control the surface patterns of peatlands (e.g. Belyea and Malmer, 2004; Couwenberg and Joosten, 2005). The current reports linked to the Operational Plan do not adequately address the dynamic nature of a peatland system and the fact that effects may extend out from areas of impact, resulting in changes to the vegetation, the microtopography and therefore the hydro-ecological behaviour of the peatland system. It is not enough simply to state that there is little evidence of dynamic change within an aerial-photo sequence spanning a period of 65 years when in fact there is little reason to suspect that environmental conditions have changed significantly during this period, given the relatively undisturbed nature of the site. However, by the time any changes due to construction of the Suncor mine are noticed, it will be too late to do much about them. Perhaps this is why there is no adequate description given of actions to be taken should such changes be observed over time.

This lack of appropriate consideration in terms of potentially key factors is part of a broader pattern whereby such factors are simply excluded from consideration in somewhat Nelsonian fashion – if the existence of something is simply not acknowledged it is not then necessary to take into account any potential impact of that feature on the proposed course of action. Thus, for example, Table 3.4-5 in Objective 2 lists a number of 'excluded parameters', in many cases such exclusion being justified on the basis that they are "*difficult to measure effectively*". These excluded parameters include such critical features as seepage rates from springs and several aspects of vegetation response. However, in terms of significance and evidence of impact, **absence of evidence is not evidence of absence**, particularly if those sources of evidence are simply excluded from consideration.

[Emphasis in original][8]

AWA's concern is therefore that the hydrogeological model as a whole, given the above flaws and limitations, is simply unable to provide any meaningful guarantee of protection for the unmined portion of the MLWC.

4. <u>Uncertainty and risk with the proposed "conceptual stage" water management plan</u>

Suncor also fails to justify its claims that "AWA provides no evidence or data" and that "it does not appear that either consultants retained by AWA are experience in engineering, design, or construction."

[8] "A Report to Alberta Wilderness Association - Suncor Operational Plan for McClelland Lake Wetland Complex" (May 29, 2023), attached as Appendix G to these reply submissions; see pp 5-6.

Firstly, Suncor's claims make no reference to any fact, and are simply bald statements. Secondly, AWA's report does in fact rely on plentiful evidence about the uncertainties inherent in the proposed mitigation strategy. As Richard Lindsay notes with respect to Suncor's response:

> The Suncor Operational Plan itself is, however, 'highly speculative' in the sense that *no* testing has been undertaken of the whole OP approach as an integrated system while the practical implementation of this approach is explicitly described by Suncor *itself* as 'conceptual' rather than practical.
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> Also, no information is provided about how the Operational Plan systems will be maintained at cessation and restoration of the mining nor who will bear the responsibility for this. Given that peatland systems demonstrably operate over timescales of centuries and even millennia (as evidenced by the preserved peat archive), the timescales for responsibility approach those of a nuclear power plant rather than a short-rotation conifer plantation, which is the timescale explicitly addressed by Suncor's Operational Plan. As such, Suncor's OP mitigation measures proposal is not merely 'highly speculative', it is more accurately described as conjectural and presumptive.
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> …
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> Given the conditions of planning consent, however, the onus lies with Suncor to demonstrate conclusively that its conceptual designs can be converted into functionally effective reality - something which Suncor has patently failed to do through its own admission that it is only able to provide 'conceptual' designs for what is the most crucial part of the whole Operational Plan. If the practical implementation of the mitigation measures fails, then all the hydrological modelling and baseline measurements become completely irrelevant. Suncor are the applicants here, with the resources to undertake such practical testing as well as being under obligation to do so, but they have demonstrably failed to do so as they themselves admit.
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> "*SEOI will monitor the performance of the design features through various instruments and field observations as part of ongoing operations and has a robust response framework as per Objective 6 of the Operational Plan*". If failure occurs at a single weak point during heavy rains or following a dry period when the peat shrinks and cracks, as has been observed with other catastrophic failures, such monitoring has been shown to be of little practical help and practical response times utterly inadequate. See, for example, the Irish or Australian examples noted in my May 29, 2023 report, but other peat failures have been reported from around the world (https://www.youtube.com/watch?v=k6UMUW4IIrc - this is the site where the Irish Government has had to close and remove the windfarm). It provides what is in effect a fig-leaf of perceived security by being able to state that monitoring is in place, but when the monitoring devices are themselves swept away by a catastrophic event (as has been the case) their main function is to show just how far the catastrophe has extended.

[Emphasis in original][9]

And as Richard Lindsay further notes in response to AWA's report:

> There is **no evident attempt to undertake small-scale experimental trials** of the proposed construction works and mitigation measures elsewhere within the land holdings of Suncor in order to test the proposed approach and thereby obtain data which could be used to verify the models. Indeed, as proposed, the Operational Plan *is* the experimental trial, meaning that the Interpretation phase can only be undertaken in any meaningful way *post-hoc*, after irreversible actions have been taken. Although the Operational Plan includes 'Reference Sites' which will be used to compare *background* changes with those observed at the MLWC, **no similar reference sites are employed where similar construction and mitigation works are already in place** and can thus provide direct evidence with which to inform the Interpretation phase of the MLWC Operational Plan.
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> Furthermore, the construction and mitigation measures **currently exist only as conceptual designs**. The whole of Operational Plan Objective 4 section describing the designed features consists only of such conceptual designs with explicit acknowledgement that further investigations will be required in order "*to confirm the resulting flow pattern in the fen areas will be similar to pre-mining conditions*". No adequate description is provided of actions to be taken should it prove that the flow patterns prove *not* to be similar to pre-mining conditions, nor a critical assessment provided of the possible complexity of such actions. The approach is instead based on the neat, clean designs set out on a drawing board instead of acknowledging the complexity and thus unpredictability of natural materials and processes. At least some trial testing would highlight the differences between these design concepts and the reality of manipulating such natural systems.
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> The potential for reality to diverge from the conceptual designs is summarised in the listing of caveats which it is acknowledged must be applied to the modelled proposals. In addition to issues already raised above, these caveats include:
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> - **Numerical uncertainty in the values applied to model flow equations** – values which can only be based on current and predicted conditions rather than actual tested post-construction conditions, and furthermore it is acknowledged that, in relation to future flow conditions, "*Laboratory or field-measured hydrogeological properties of tailings and backfill material were not available and were parameterized based on best available estimates*";
> - **Mesh resolution of the model**, with a minimum mesh size of 100 m applied, which significantly exceeds the fine-scale structures of strings and flarks that provide the self-organising mechanism underpinning and maintaining the stability of the patterned fen system;

[9] Appendix F at pp 1-2; see also Appendix G at p 9.

- **Geological heterogeneity** – acknowledged thus: "*there are currently no efficient tools/methodologies available to systematically mitigate structural uncertainty when using complex physics-based hydrologic models*";
- **Parametric uncertainty** – described thus: "*subsurface data is inherently uncertain. A formal parametric uncertainty quantification has not been performed with the 2020 MLWC HGS model. The complexity of the model, the long model runtimes, the requirement for a large numbers of runs (in the hundreds to thousands for uncertainty quantification methods like Latin Hypercube), precluded its use*";
- **Role of climate data**, described as having "*biggest relative effect on the modelled levels and flows as it is both the largest water source (precipitation) and water sink (evapotranspiration) in the Fort Hills Lease*", though this may no longer be the case following mine construction, as discussed below;
- **Data available for model calibration** – which, though based on actual field data, in practice only describe *current* conditions rather than field data obtained from actual examples of the proposed construction works on similar site conditions. No effort appears to have been devoted to seeking out calibration data from existing similar sites which have been subject to the proposed construction methods to be employed as part of the Suncor Operational Plan;
- **Mine plan evolution** – highlighting the difficulties of making meaningful predictions about likely future hydro-ecological behaviour given the uncertainties of construction phases, evolution of construction methods and properties of materials used – issues explored further below.

[Emphasis in original][10]

These significant uncertainties support AWA's concern that the Operational Plan is fundamentally unable to guarantee the protection of the MLWC and is likely to violate the conditions imposed by the Water Act Approvals and the 2002 EUB Decision. As such, the information in AWA's report could result in a significantly different outcome if considered by the Regulator upon reconsideration.

5. Assumption of negligible impacts from predicted water level changes

Suncor's dismissal of AWA's concern with the Operational Plan's assumption that there will be negligible impacts from predicted water flow changes is also unconvincing. Suncor's argument again hinges on unproven conjectures that AWA's concerns allegedly "appear" to be founded on incorrect assumptions and a misunderstanding of the issue. Suncor's claim in this regard simply fails to explain what assumptions of AWA's are incorrect or what is incorrect about AWA's understanding of the issues. Such an argument based on these unproven statements is without any relevance or merit.

Furthermore, Suncor's argument fails to provide any explanation as to how the Operational Plan's assumption of negligible impacts from predicted water level changes can guarantee the protection of the unmined portion of the MLWC. Suncor's argument refers to the discussion of potential changes to vegetation communities and wetland function, which we address in detail in the below section. Suncor's claim falls short by failing to recognize that an assumption of negligible impacts is inappropriate in the

[10] Appendix G at pp 6-7.

context of a complex wetland system such as the MLWC. As Dr. David Locky, Associate Professor of the Biological Sciences Department at MacEwan University notes in response to AWA's report:

> If there are changes to water levels or base cation concentrations, it is very likely that shifts in plant dominance or even loss of peat-forming species could occur, ultimately affecting organic matter accumulation (i.e., carbon) on the site (Vitt et al. 2022). Thus, any subsequent interruption to the source waters that the MLWC are dependent on would very likely be detrimental to the fen.[11]

The assumption of negligible impacts therefore gives AWA great concern that the Operational Plan cannot guarantee the protection of the unmined portion of the MLWC. This concern should therefore also lead the Regulator to come to a different conclusion about the Operational Plan upon reconsideration.

6. Unrecognized impacts to the ecological integrity and functionality of the patterned fen

Contrary to Suncor's response, the Operational Plan also does not sufficiently address AWA's concerns about unrecognized impacts to the fen. The integrity and functionality of the MLWC as a patterned fen is complex and multi-faceted, as are the risks which mining can pose to that integrity and functionality.[12] Such complex and multi-faceted risks can be difficult to monitor and it is similarly difficult to determine the full range of impacts.[13] The regional risk includes the factors of uniqueness, biodiversity, age and stability, hydrology and biogeochemistry, fire, carbon, and reclamation challenges.[14]

One such complexity inherent to the MLWC as a patterned fen is its string and flark patterning. Section 2.4 of the Operational Plan contains one paragraph under Section 2.4.1.2.2 describing Surface Water Flows as it Relates to Strings and Flarks, but does not adequately describe the complex, small scale feedback mechanisms that produce and maintain the string and flark formations within the fen. Though the Operational Plan discusses potential changes to peat vegetation in Section 4.3.2.4 of Objective 3, the Operational Plan only makes cursory reference to a potential shift in wetland type and does not relate the potential vegetation shifts sufficiently to the maintenance of the string and flark formation. The Operational Plan therefore fails to provide sufficient certainty that it guarantees the protection of the unmined portion of the MLWC.

The Operational Plan does however state that surface hydrology has not changed significantly between dataset years (2008 and 2019) which only reinforces the risk that the Operational Plan proposes by disrupting that hydrology. Furthermore, as the newly released study by Dale Vitt and Melissa House illustrates, the MLWC is a uniquely ancient peatland with a unique resiliency based on persistent long-

[11] "A Case for Preserving the McClelland Lake Patterned Fen" (May 31, 2023), attached as Appendix H to these reply submissions; see p 4.
[12] See generally Appendix H.
[13] Appendix H at pp 4-5; also see generally "Report to Alberta Wilderness Association" (May 24, 2023) by Dr. R. Kelman Wieder, attached as Appendix I to these reply submissions.
[14] See generally Appendix H.

term groundwater inflows, which suggests that surrounding watersheds are an important part of long-term survival of patterned rich fens.[15] The Operational Plan's proposed disruption of the surrounding watershed and the unique hydrology of the MLWC therefore poses an even more profound risk to the survival of the MLWC.

<u>7. Unrecognized impacts to peatland carbon stores and the resulting increase in greenhouse gas emissions</u>

Suncor claims that because greenhouse gas ("GHG") emissions were assessed in the 2002 EUB Decision, considerations of peatland carbon stores and increases in GHG emissions are beyond the scope of the Operational Plan. As Suncor's response notes, the Operational Plan's intent was to identify appropriate mitigation measures. Contrary to Suncor's suggestion that considerations of peatland carbon stores and GHG emissions would "revisit whether a portion of the MLWC should be mined, which was already decided in 2002", these considerations are directly relevant to the identification of appropriate mitigation measures.

In particular, the impacts of climate change and the protection of the MLWC are directly and mutually related to the MLWC's ecosystem functions including buffering fire risk in the oil sands region. As Dr. Locky notes:

> The fire severity and risk have significantly increased in Alberta's boreal region. This is primarily due to the area becoming significantly warmer and drier over the past 50 years (Whitman et al. 2022). During this period there have been increases in the annual number of large wildfires, area burned, and fire sizes. Additionally, the likelihood, area and number of extreme short-interval reburns (≤15 years between fires; 1985–2019) have also significantly increased, with the portion of forested unburned islands within fire perimeters declining, but fire severity increasing in open conifer and mixedwood forests.
>
> But parts of the boreal region have built-in resistance to fire (Kuntzeman et al. 2023). Because peatlands are a dominant component in the oilsands region (Foote and Krogman 2016), their reliable water sources and saturated nature provide fire resilience compared to adjacent ecosystem types (Kuntzeman et al. 2023). The authors' study of fire in Alberta's boreal region (1985-2018) investigated the role of hydrological, ecological, and topographic heterogeneity, and climate moisture patterns, on the presence of fire refugia in forested upland and peatland ecosystems. Predictive maps developed highlighted the probability of refugia from fire with forested fens have 64% higher probability of provided refugia than upland forests. In peatlands in general, [neither] regional climate moisture conditions nor the interannual deviations affected refugia, demonstrating [the critical importance] of large areas of intact peatlands. In fact, intact peatland areas have a high probability of providing fire refugia, slowing climate-driven, fire-mediated vegetation transitions in surrounding forest ecosystems.

[15] "An 11,000 year record of plant community stability and paludification in a patterned rich fen in northeastern Alberta, Canada" (April 25, 2023), attached as Appendix J to these reply submissions; see pp 10-11.

> Peatlands that have been compromised hydrologically do not fare as well. Sites decoupled from their hydrological regime present a severe positive feedback loop, in that, those peatlands that succumb to fire are even more susceptible to increased post-fire drying (Kettridge et al. 2019). This adds to future fire risk. A significant resilient ecosystem on the greater landscape in its current form, a compromised McClelland fen would fall into this category of fire susceptibility. An uncompromised MLWC is critical to helping buffer fire risk in the region, given the increased the unprecedented fire risk Alberta currently faces (Whitman et al. 2022).[16]

This negative feedback loop of fire risk associated with climate change also relates to peatland carbon store impacts. As Dr. Locky highlights:

> When modelled, a moderate drop in water table position predicted for most northern regions will trigger vegetation shifts previously observed within only severely disturbed tropical peatlands. Non wetland or compromised wetlands, i.e., non-carbon accumulating ecosystems, are more likely to experience low intensity, high frequency wildfires, further depleting stored peat carbon. There is a good case for maintain contiguous, well-functioning wetlands like MLWC to reduce fire risk and preserve carbon stores.[17]

The Operational Plan fails to account for these negative feedback loops associated with climate change, GHG emissions, and peatland carbon stores, and therefore is insufficient for guaranteeing the protection of the unmined portion of the MLWC.

Summary

In total, Suncor's responses to each of AWA's seven highlighted concerns fall short of showing that AWA's concerns are sufficiently addressed in the Operational Plan, that AWA's report is based on incorrect or misleading assumptions, that AWA's report is speculative, and/or that the report demonstrates a lack of knowledge. Suncor's response therefore does not refute AWA's assertion in our initial submissions that the new information in AWA's report could lead the Regulator to a different conclusion upon reconsideration, namely that the Operational Plan does not guarantee protection of the unmined portion of the MLWC, and therefore does not satisfy the conditions of the Water Act Approvals and 2002 EUB Decision.

**Conclusion – Suncor overall has not produced any reasons, individually or in total, which ought to dissuade the AER from exercising its discretion to conduct a reconsideration**

Contrary to Suncor's conclusion, Suncor's response fails on all points to refute AWA's submissions.

[16] Appendix H at pp 5-6.
[17] Appendix H at p 6.

In arguing that (1) AWA should have participated in the SC which it could not reasonably have done, (2) that AWA should have used inapplicable appeal routes, (3) that AWA's request is "time barred" based on an inapplicable appeal framework, (4) that AWA failed to show an error in the initial decision which AWA was not required to show, and (5) that AWA failed to meet an inapplicable standing test, Suncor's response misses the central point of this reconsideration request.

Namely, Suncor's response fails to refute AWA's assertion that AWA's submissions contain new information not reasonably available to the Regulator at the time of the decision which could lead the Regulator to come to a different decision upon reconsideration. AWA has provided the compelling and exceptional grounds necessary for an exercise of the Regulator's discretion to reconsider its approval of the Operational Plan for the Fort Hills Oils Sands Project.

Suncor's arguments therefore have little merit and carry little weight.

Sincerely,
ALBERTA WILDERNESS ASSOCIATION

Phillip Meintzer
Conservation Specialist

cc: Bola Talabi, Vice President Regulatory Applications, Alberta Energy Regulator, Bola.Talabi@aer.ca
cc: Blair Penner, Director Approvals, Suncor Energy Inc., bjpenner@suncor.com

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Appendix A
to the Reply Submission of
Alberta Wilderness Association
dated June 9, 2023

# ALBERTA WILDERNESS ASSOCIATION

**McClelland Watershed Overview with Suncor**

**Date: February 23, 2010** **Time: 1-2 pm**

**Location: Suncor Energy, SunLife Plaza North Tower, 4th floor, 144 – 4 Ave SW, Calgary**

**Participants: Chris Fordham, Senior Sustainability Manager, Suncor Energy Inc., Carolyn Campbell, AWA Regrets: Helene Walsh, CPAWS N AB – these notes sent to Helene**

(These points on Athabasca River Water Management Framework Phase 2 included as part of Suncor-AWA overall relationship)

- regarding Athabasca Phase 2 latest developments: Carolyn stressed she did not know how the P2FC final report leak happened early February 2010, but was disappointed because it's a matter of trust, and also prevented organizations getting out messages about the value of the overall process
- Chris apologized for CEMA spokespeople misrepresenting the P2FC conclusion, that it was plain wrong to call it consensus. CEMA Communications person Corey went way overboard in trying to portray a positive spin on CEMA, and it was wrong. Chris said although Suncor funds CEMA he doesn't control what the staff say or do and he feels the episode didn't send an encouraging message to ENGOs like AWA about why anyone would join CEMA

On McClelland Lake:

- Chris has flown over the wetland complex; Carolyn noted she'd been in flyover, canoed on lake and hiked at edge of fen
- Carolyn went through 3-page Background handout – ecological significance, resource management history. Chris lived in Fort McMurray during True North hearings and sat in on much of them. He hadn't recalled that part of True North's EIA had been set aside. Carolyn gave Chris the 'McClelland Lake wetland complex' hard copy section from EUB's 2002 decision outlining that
- Carolyn finished overview with Opportunities part of handout. Explained Conservation Directive in a bit more detail as tied in with LUF tools, but emphasized our key issue is not the particular form of protection, but that there is long-term protection from mining or industrial logging in the watershed
- Carolyn: emphasize we recognize there's a valuable economic resource there too. We've consistently advocated for compensation in lease swapping (which, as so many leases were sold by 2007, became unrealistic), or monetary compensation, or technology advance in, say, horizontal drilling to enable recovering the resource without surface mining.
- Chris: to his knowledge, currently conditions for mining or In Situ are mutually exclusive – need capping layer and certain depth for In Situ. Carolyn

acknowledged this is the current state; point is, we're not saying whole Fort Hills project should not go, or that bitumen in McClelland watershed should never be taken out, only that the watershed should be left intact.

- Chris: with Fort Hills, still no decision by Suncor, as Firebag was put back on the 'active' list. They also have on their potential mine projects the Voyageur South mine, which isn't as far along in terms of approval as is Fort Hills.
- Chris: encouraged AWA and CPAWS N AB to get involved in Sustainability Committee (SC), that he'd heard from SC we would still be welcome, and it would help to get the best results if SC could factor in our concerns. Also, SC decided to only make agendas available to non-members, not minutes or other documents.
- Carolyn: on membership, I will take this back –: speaking for AWA, we considered carefully at outset whether to join SC, and also in 2008 whether we'd get involved in Jones & Stokes functionality study. In each case, we decided we didn't want to be supporting or enabling a process that we felt would end in disaster for the watershed
- Chris: why not get involved to help prevent what you don't want to happen?
- Carolyn: as AWA sees it, the regulators have stated clearly what has to be done, in terms of producing a science-based plan for how to preserve the unmined part of the watershed from the effects of mining. And we will be watching carefully to see that those conditions are met in any proposal. As a small organization with limited capacity, we do not see the value in being part of a long journey to conclude that mining will damage the rest of the wetland complex, or else pressure to massage the results.
- Carolyn: regarding receiving SC minutes and documents: last in-person contact AWA had with Petro-Canada was after writing letter of objection to AUC to Fort Hills power proposal. Followed that letter up with Carolyn meeting with Sheila Chernys and others at Petro-Canada in Sept 2008, at Sheila's suggestion, and in that meeting Sheila provided us with more SC documentation – minutes up to April 2008 and several 2007 reports - and agreed to keep us informed with future minutes and reports. Carolyn followed up with October 2008 letter to AUC confirming that understanding. Next correspondence was Aug 2009 when Sheila in a 'form e-mail' informed AWA of Suncor purchase; Carolyn immediately followed up with e-mail asking for SC documentation.
- Chris asked if Carolyn had anything in writing directly from Sheila agreeing to provide SC documentation and Carolyn said no. Chris took hard copies of the October 2008 letter and August 2009 e-mails.
- Chris wasn't sure, but thought SC met only once in the past year, in fall 2009
- Back to participation question: Chris asked whether AWA and CPAWS N AB would each need to make the same decision on SC participation. Carolyn said

not necessarily - we collaborate, but we also take different actions. For example, CPAWS N AB is a CEMA member and AWA respects that.

- Chris: would talk to committee more about providing AWA with documents. Would AWA like to have presentation by a member of the Sustainability Committee on the status of the Sustainability Committee? Carolyn said yes. Chris said it could happen at AWA offices. Carolyn said in that case, possibly our E-D would attend. Chris said he would try to make that meeting happen by end of March 2009.
- Carolyn: hopefully this meeting is useful to Suncor to know that we ENGOs have had these longstanding concerns and are not going to go away in terms of advocating for the watershed. Chris said he understands, and yet to an outsider it looks like on the one hand we're saying we're going to stay involved, but on the other hand we're saying we don't want to be involved. Carolyn said involved in terms of public awareness about the importance of protecting the watershed. Chris said, but not being part of working on a solution via the SC. Carolyn said we have a solution, which is not to mine in the watershed. Chris said he understood our position
- Chris: sees that EUB decision says SC will be Fort McKay IRC and True North. Carolyn: from SC minutes we've received, that's expanded to other aboriginal communities, for example, Jumbo Fraser from Fort Chipewyan Metis is on, also a Fort McMurray environmental group.
- Chris: complexity with compensating for lease is, it's not just lease payment, but valuation of the holding. Carolyn agreed. Chris: also, for some companies, that lease is the whole company, so being bought out is not what they want. Carolyn: That may be so for UTS, but joked that one solution is for Suncor to buy UTS, as had been speculated in the papers. Chris laughed and observed that some juniors do indeed have a business case to just be bought out at a certain point.

On Suncor's work on peat reclamation:

- CEMA sub-group's work tends to be about issuing guidelines, not scientific research
- Research happens through CONRAD – Cdn Oilsands Network for Research and Development – Chris chairs the Environmental research group, but there are several working groups – one is with all the mining companies doing reclamation research
- For peatlands, CONRAD has several site projects – one with Syncrude (Carolyn said yes, that one had been mentioned somewhat in the press) and one with Suncor on one of its leases
- Chris brought a thick report to meeting on Suncor fen re-creation project (author was Christine Daly) but wasn't sure if it could be released, outlining steps towards re-creation of a fen

- Chris: conventional thinking was that a fen couldn't be recreated, and then someone had asked, Why not? So they're trying. He knew that this was a simple fen, and that a patterned fen was another order of magnitude complexity. He also thought it was still early stages, and thought it involved setting down some plants and seeing if they would grow. He will check if/when this can be released.
- Chris: CONRAD outputs are public. There's an annual two day workshop where findings are presented. A lot of CONRAD's work is through universities.
- [Carolyn checked CONRAD website that afternoon – found no reports posted, only announcement of 2 day Water Use workshop – seemed restricted to oilsands companies and R&D providers]

Appendix B
to the Reply Submission of
Alberta Wilderness Association
dated June 9, 2023

ALBERTA WILDERNESS ASSOCIATION

# Presentation to the Oil Sands Multi-stakeholder Panel

***Calgary, September 27, 2006***
**Joyce Hildebrand, Conservation Specialist**
**Alberta Wilderness Association**

Good afternoon members of the panel. I speak today both as a concerned Albertan and as a representative of the Alberta Wilderness Association, a provincial conservation group dedicated to the completion of a protected areas network and the conservation of wilderness throughout the province.

***The point I wish to make today is that oil sands development must take place only after identifying and legally protecting irreplaceable watersheds in our boreal forests.*** While the government of Alberta has recently produced two documents on water that emphasize the critical importance of watersheds and wetlands to Albertans, these fine words must be followed up with action. To this point, there has been a yawning chasm between rhetoric and action.

The document *Water for Life: Alberta's Strategy for Sustainability* was produced by Alberta Environment and adopted as government policy in 2004. Two of the principles articulated in this document are these: (1) "Alberta's water resources must be managed within the capacity of individual watersheds" and (2) "Healthy aquatic ecosystems are vital to a high quality of life for Albertans and must be preserved." Throughout the *Water for Life* strategy, the importance of healthy watersheds and aquatic ecosystems is stressed over and over, and the government makes the following commitment to us: "Albertans will be assured that the province's aquatic ecosystems are maintained and protected."

At the same time that the *Water for Life* strategy was being developed, another story was unfolding: the story of one of those aquatic ecosystems and what became of its promised protection when oil was found underneath it.

The McClelland Lake watershed, about 90 km north of Fort McMurray, is less than one-third the size of Calgary's landbase. It contains 3 ESAs, Environmentally Significant Areas, as defined by the Alberta government: (1) McClelland Lake itself, (2) an unusually large and intricate patterned fen connected to the lake, and (3) 12 sinkhole lakes, formed as part of the provincially rare karst topography of the area. This watershed has been identified by a number of scientific studies as an area of extraordinary significance, a critical aquatic ecosystem that contains a number of rare plant species, a nursery for birds such as bald eagles and sandhill cranes, and a stopover for endangered whooping cranes on their migration to their nesting areas further north.

So important was this watershed deemed to be that in 1995 it was nominated for protection through the Special Places 2000 program. The following year, the Integrated Resource Plan (IRP) for the Fort McMurray-Athabasca region – which took 4 years to thrash out – was finally approved by cabinet. The IRP placed the large McClelland Lake fen and the surrounding area off-limits to oil sands mining because of its uniqueness. Indeed, peatlands expert Dr. Diana Horton describes it as the most extraordinary patterned fen she has seen in the world. Albertans were assured that there was no need for legal protection because the IRP protected it. Being well aware of the difference between policy and law, AWA was skeptical, to say the least.

In 1998, a report by Alberta Environmental Protection stated that the fen and the lake was "worthy of a strenuous protection effort." The following year, in 1999, the Special Places Provincial Coordinating Committee recommended that the area be legally protected. The government subsequently placed the wetland complex under protective notation.


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Those who were concerned that the McClelland Lake watershed be preserved breathed a tentative sigh of relief.

And then True North Energy discovered a billion barrels of oil under the fen.

One might ask, why did the government allow exploration in an area under protective notation? Did the right hand not know what the left hand was doing? Or was there never any intention to follow through with protection of an area that was almost certainly underlain by oil sands reserves?

Whatever the answer, there was never any doubt as to oil trumping protection in a government "run by elites for elites," as journalist Frank Dabbs wrote recently (*Alberta Views*, September 2006, p. 25).

What followed can only be described as by-passing democracy, buying off supposedly objective scientists, and promoting yet another sham public consultation process.

At True North's request, the government promptly removed the protective notation from the fen and rushed an IRP amendment through, violating its own amendment guidelines. Only two open houses were held, both in the immediate area. The first of these was advertised only 4 days in advance with a single ad that did not specify the time, date or location. The amendment process was supposedly independent of True North's interests, and yet True North had a display at the open houses. The government circulated a 2-page survey opposing wetland protection and economic growth, a dishonest and manipulative representation of the issue. And the public had a mere 23 days to respond. Not surprisingly, the IRP was changed to allow oil sands strip mining in the upper half of the McClelland Lake fen.

The next few nails in the coffin of McClelland Lake fen and watershed were pounded in during the lengthy EUB hearing for the approval of True North's application. Despite extensive testimony of scientific experts showing that mining part of the fen would almost certainly destroy the entire aquatic ecosystem and negatively affect the whole watershed, both the EUB and Alberta Environment approved the application. So much for the importance of protecting watersheds and wetlands.

Most astounding of all was the quiet shelving of the most critical portion of True North's legally required Environmental Impact Assessment. The EUB granted True North's request that they be allowed to withdraw the portion of the EIA that applied to the fen and its surrounding area and replace it with something they called a Sustainability Plan. This plan consisted simply of a proposal to put together a Sustainability Committee to develop a management strategy to sustain the unmined portion of the wetland. The completed EIA had been compiled by a group of qualified scientists, was required by law, and strongly indicated the impossibility of mining half of the fen without affecting the other half. But instead of considering this as part of their decision, the EUB accepted in exchange the promise of a committee yet to be convened, deeming this to be in the public interest.

Perhaps the most sordid chapter in this narrative is the one involving the role of supposedly objective scientists. To ensure the amendment of the IRP, True North commissioned a group of 4 University of Alberta scientists to study the fen. These same scientists were subsequently awarded a $1 million research grant by True North. Not surprisingly, the study concluded that this particular patterned fen was not unique after all, but only "representative," implying that it was not worthy of protection. The study contradicted the conclusions of a number of previous studies and was found by peer scientists to be based on seriously flawed methodology. Despite this, it was this study that constituted the primary basis used by the government to amend the IRP and by the EUB and Alberta Environment to approve True North's application.

And so the 8,000-year-old fen will soon be replaced by a grey, toxic wasteland.


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The McClelland Lake story shows us that when an extraordinary ecosystem set aside for protection on sound scientific grounds stands in the way of oil sands development, industry wins, cheered on by government. Concerns for wildlife, wilderness and watersheds are shrugged aside and ignored.

In their *Draft Wetlands Policy*, released this year, Alberta Environment stresses the importance of wetlands for Albertans. “It is the policy of the Government of Alberta,” it says, “to protect and conserve wetlands for the ecological, social and economic benefits they provide, thereby helping to ensure a safe and secure drinking water supply, healthy aquatic ecosystems, and reliable quality water supplies for a sustainable economy.” Given the McClelland Lake story, it would be no surprise if Albertans responded to this statement with the utmost cynicism.

The horses are out of the McClelland Lake barn, but the doors are not yet closed. The government of Alberta ***can*** revoke the EUB approval of the Fort Hills Project, restore the protective notation, and legally protect this watershed. They ***can*** identify other watersheds and wetlands in the boreal forest and move forward with their legislated protection. They ***can*** show Albertans that words result in appropriate action.

This past summer, I saw the Athabasca oil sands mines, both from the air and from the ground. I was utterly shocked by what I saw and smelled: a vast grey landscape dotted with piles of oily waste and saturated with highly toxic tailings ponds within meters of the Athabasca River. Every few seconds airguns boomed to discourage waterfowl from landing on these deadly lakes. Dust and haze filled the air from the flayed landscape. A rich, biodiverse boreal forest filled with life has been replaced by a wasteland. While the word “reclamation” is used with abandon, implying that all of this can be restored to its original state, this entire scenario represents a huge, irreversible experiment.

The public lands of this province belong to the people of Alberta. Yes, we need a healthy economy for good quality of life, but we also need healthy watersheds and forests. We cannot wait any longer to set aside watersheds and wetlands as out-of-bounds to oil sands extraction, whether mining or in-situ. ***Oil sands development must take place only after identifying and legally protecting irreplaceable watersheds in our boreal forests.***

Thank you for your attention this afternoon and for the opportunity to express AWA’s concerns. I wish you all the best in fulfilling your mandate.


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Appendix C
to the Reply Submission of
Alberta Wilderness Association
dated June 9, 2023

ALBERTA WILDERNESS ASSOCIATION
*"Defending Wild Alberta through Awareness and Action"*

September 2, 2008

Victor Choy
Alberta Utilities Commission, Utilities Division
Fifth Avenue Place, 4th floor, 425 – 1 Street SW
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Sheila Chernys
Environmental and Regulatory Affairs Manager
Petro-Canada Oilsands Inc.
P.O. Box 2844
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**Re: Application No. 1571279, PCOSI and Fort Hills Energy Corp – Substations, Transmission Line, Industrial System Designation for FHOSP**

Dear Mr. Choy and Ms. Chernys,

This is a formal intervention letter by Alberta Wilderness Association (AWA) to object to the Application by Petro-Canada Oil Sands Inc. (PCOSI) on behalf of Fort Hills Energy Corporation to construct and operate an intertie substation, a central plant substation and a transmission line, and receive industrial system designation associated with the Fort Hills Oil Sands Project (FHOSP).

Our comments concern the authorized destruction of the McClelland Lake Wetland Complex inherent in approving this application for the power infrastructure of FHOSP.

We request that the Commission delay approval of the power infrastructure of the Fort Hills Oil Sands Project until surface mining of the McClelland Lake watershed is removed from this project.

In this letter, we comment directly on several inaccurate statements in the ISD application. Then we outline our concerns about McClelland Lake Wetland Complex that the authorization of this power infrastructure will make possible. AWA's interest, including our directly affected status, is described in the last section of this letter.

<u>Concerns with Industrial System Designation application statements</u>

ISD22) *List all stakeholders that you contacted…*
There is an error in the submitted list of organizations and stakeholders. Number 25 should be Alberta Wilderness Association rather than Alberta Wildrose Association as stated. Alberta Wilderness

Association is listed in the PCOSI Attachment 7 – Public Consultation Summary in Tables 5-1 and 5-3, while there is no mention of Alberta Wildrose Association.

ISD25) *Summarize discussion held with potentially directly and adversely affected parties*.
PCOSI states "Please see Attachment 7 – Public Consultation Summary. PCOSI has had numerous discussions with parties and submits that there are no significant outstanding issues yet to be resolved."

This is incorrect. A significant outstanding issue remains the planned destruction by surface mining of the upper McClelland watershed, including half of the rare, ecologically rich wetland fen. There is no known way to reclaim destroyed peat wetlands. This activity will very likely destroy the hydrologically connected remaining half of the wetlands, and lake, in the lower part of the watershed. Indeed, in Attachment 7 – Public Consultation Summary, Table 5-3, (p. 11) PCOSI does state that "AWA remains opposed to mining in the Fen." AWA actually opposes mining in entire McClelland watershed, but that clarification aside, the Attachment's own wording suggests there remains a significant outstanding issue.

ISD26*) If potentially directly and adversely affected parties raised any concerns, describe how you dealt with or will deal with them.*

PCOSI states "All concerns were discussed with parties during meetings and any follow-up actions were documented and completed, or are in the process of being completed. PCOSI views stakeholder discussions as an ongoing activity."

This is essentially incorrect. Attachment 7 – Public Consultation Summary, Table 5-3, Alberta Wilderness Association stakeholder – Response column (p. 11), states "PCOSI to provide AWA with updates on the Sustainability Committee (MLWCSC) and the transplanting program." AWA did receive the September 2007 Closure, Conservation and Reclamation Plan, which it appreciates. In October 2007 AWA received MLWCSC meeting notes 2-6, from February 28, 2006 to April 18, 2007, and four technical reports dated as recently as March 2006. It has not received any MLWCSC meeting notes or reports since that time. AWA and PCOSI agree that AWA was invited to join the MLWCSC but chose not to participate in it. AWA is aware of no scientific evidence that mining half of a peat wetlands complex can be deemed sustainable of that ecosystem. It has not been presented with any evidence to that effect by any documentation generated by the MLWCSC and forwarded to AWA up to April 2007. Statements by PCOSI of its commitment to the fen do not constitute in any sense 'completion' of addressing a concern that mining half the peat wetlands will destroy it.

*ISD27) For those potentially directly and adversely affected parties identified above, include a confirmation of resolution of the concerns, if applicable.*

For reasons outlined above, PCOSI has not been able to resolve AWA's concerns on this project.

<u>AWA's Position on the Effect of the FHOSP Power Infrastructure</u>

Alberta Wilderness Association opposes Application No. 1571279 because it will enable mining in the McClelland Lake watershed, which includes the McClelland Lake Wetland Complex and patterned fen. AWA requests that the portion of the FHOSP mining project that overlaps the McClelland Lake watershed be withdrawn from the mining application, and until that time, requests that Application 1571279 regarding power infrastructure to the project should be deferred.

The McClelland Lake watershed includes a unique system of wetlands, the heart of which is the McClelland patterned fen. Only 1% of Alberta's land base comprises patterned fens, and the McClelland fen is larger than 91% of patterned fens in the province. It is home to more than 100 species of birds, numerous rare plants including the carnivorous pitcher plant, amphibians such as the red-listed Canadian toad, and even the endangered whooping crane, which has been seen on the fen.

The McClelland fen was nominated for protection under the province's Special Places program in the 1990s and was designated as off-limits for oil sands mining under the Integrated Resource Plan for the area. When oil was found under the fen, the IRP was quickly changed at the request of True North, and True North's mining application, which included mining 45% of the fen, was approved despite overwhelming evidence that this would threaten the ecological integrity of the entire fen and Wetland Complex.

The approved mining of the 'upper' portion of the watershed will almost certainly lead to prolonged water table disruption in the lower part of the watershed which contains the patterned fen and lake. This will produce severe effects on vegetation and organic soils of the peat wetlands and lake. As noted above, no evidence exists that a patterned fen can be reclaimed. The patterned fen took approximately 8,000 years to develop. There have never been attempts to construct peat wetlands on a large scale. The ecological effects of replacing peatlands with other types of wetlands are unknown.

Reclamation will require re-engineering of the whole upper watershed. The September 2007 Reclamation and Closure FHOSP plan states that for the entire project site, "Class 5 wetland areas will see a decrease of 2,785 hectares." The construction of uplands and wetlands on the disturbed site will result in a profoundly different hydrological, soil and vegetation regime in the upper part of the watershed. It is not credible to expect that the McClelland Lake Wetland Complex can be sustained when subjected to this disturbance.

Moreover, the McClelland Lake watershed drains into the Firebag River, an ecological sensitive area itself, and ultimately into the Athabasca River, a river about which both scientists and other Albertans currently have serious concerns because of the intensity of oil sands operations in the area. To sustain the water quality, water quantity and biodiversity of this landscape, regulators have a responsibility to ensure we retain the most ecologically significant functioning natural watersheds in the larger Athabasca watershed.

AWA supports compensating FHOSP project owners for the withdrawal of mining access to the McClelland Lake watershed. Alternatively, emerging technology in subsequent decades may well offer other approaches to extract some of the bitumen resource without strip mining.

<u>AWA's Directly Affected Status</u>
Alberta Wilderness Association, founded in 1965, is a province-wide conservation group with 7,000 members and supporters in Alberta and around the world. In carrying out our mandate, "to defend

Wild Alberta through awareness and action," we speak for those who cannot speak for themselves – the wildlife, rivers, and ecosystems of our province. We focus on protecting areas of special ecological significance in Alberta. McClelland Lake watershed is one such place.

AWA has had a long-standing interest in the Fort Hills and McClelland Lake Wetland Complex area covered by the Application. In 1994 the Northeast Wild Alberta Coalition, of which Alberta Wilderness Association was a member, met to discuss potential new protected areas in northeast Alberta (NEWAC was a Fort-McMurray-based coalition of environmental, recreational, and wildlife user groups and individuals). The Fort Hills area was identified as a top priority area in need of protection. NEWAC concluded that the most appropriate protection would be a combination of Provincial Park designation in the south west Fort Hills area, and Ecological Reserve designation for McClelland Lake, the patterned fens and the sinkhole lakes.

Since that time, AWA's commitment to securing protection for this ecological treasure has not wavered. AWA publicized and lauded the 1996 Fort McMurray-Athabasca Oil Sands Subregional Integrated Resource Plan (IRP) Guidelines prohibiting oil sands surface-mining and in situ techniques within McClelland Lake wetlands, and protested the flawed process that accompanied the removal of this protection in 2002.

AWA's long-term interest in the McClelland watershed was recognized by the AUC's predecessor, the EUB. Represented by AWA member Dr. Richard Thomas, AWA testified in the EUB hearings on True North Energy's application from July 2-10, 2002. Dr. Thomas presented, posed questions to True North Energy's panel, and provided closing arguments.

AWA members are concerned about the future of this area. Some, including Dr. Richard Thomas and Dr. Diana Horton, have conducted research on site. Canoe trips on the Lake by AWA members have been profiled in our *Wild Lands Advocate* magazine, and in August 2008 AWA led a three day canoe and hiking trip to McClelland Lake Wetland Complex.

The AUC's mandate is to give consideration of whether the project is in the public interest, having regard to its social, economic and environmental effects. AWA respectfully maintains that the Commission has the discretion to determine "directly affected" status beyond a narrow financial or property-owning definition, particularly in weighing environmental effects in a wilderness area. As in the 2002 True North EUB hearings, inclusion of AWA's decades-long environmental interest and expertise relating to McClelland Wetlands will assist the AUC in fulfilling its legislated mandate.

Thank you for considering our concerns.

Sincerely,
ALBERTA WILDERNESS ASSOCIATION

Carolyn Campbell

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Conservation Specialist

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Appendix D
to the Reply Submission of
Alberta Wilderness Association
dated June 9, 2023

# Memorable McClelland Lake Wetlands

**By Carolyn Campbell,** ***AWA Conservation Specialist***

Growing up in Calgary, my sense of Alberta was mountains, foothills, and prairie. I knew there was a northern boreal area somewhere beyond Edmonton. Once, in Grade 10, I briefly visited northern Alberta in winter thanks to the good people from Chevron's Calgary office who had mentored me and other teens in a Junior Achievement company. That was during the boom-time era of the late 1970s when, as high school students, we were flown up on a company plane on a grey snowy day and shown an oil well drilling facility. It was eye-opening to see that side of the energy industry but I still hadn't any sense of northern forests, wetlands, wildlife, or long-term indigenous residents. As a third-generation Albertan, I had no concept of the two-thirds of Alberta that is boreal forest.

That soon changed when I began working for Alberta Wilderness Association on our northeast Alberta areas of concern. As I think now of all my memorable AWA boreal trips, a standout was in the late summer of 2008 when I went paddling and hiking with three other people in and around the magnificent McClelland Lake wetland complex.

McClelland Lake is situated just east of the Athabasca River, about 90 kilometres north of Fort McMurray. The Lake is an integral part of a unique system of wetlands, the McClelland Lake Wetland Complex. The area's ecological significance is due both to its important wildlife habitat and its biophysical features, which include rare sinkhole lakes and a large, spectacular 'patterned fen' that makes up part of the wetland complex (a fen is a peat wetland fed by groundwater). Then, as now, the biggest threat to the McClelland Lake Wetland Complex is from the Fort Hills oil sands mine. The key difference though is what was a proposal then is a reality now. I needed to get to know this area.

Three of us, Chris, George, and I arrived in Fort McMurray in late August 2008. The forecast was for rain, and Saturday morning was indeed quite rainy, but we headed off optimistically. Our guide was a paddler from Fort McMurray who had previously explored the McClelland area. He provided transport, two canoes, skillful navigation on land and water, and camp gear to supplement our own. I will be forever grateful to him for so generously sharing his time and resources with us.

We drove north on the highway following the route of the Athabasca River valley, past the mine pits and tailing ponds of the oldest tar sands operations. I hadn't realized how near the surface the bitumen could be. We stopped at an exposed deposit by the roadside, where I easily picked up a chunk of bitumen sands; it has since been inspected by a Texas climate change conference audience and Calgary elemen-

*We set up camp beside one of the 12 lovely, rare circular sinkhole lakes in the McClelland watershed.*
PHOTO: © C. CAMPBELL

*We paddled into the edge of the McClelland patterned fen. Groundwater flows over the 8,000 years since the last glaciation created upland 'flark' ridges that support small trees, separated by 'string' pools rich in aquatic vegetation.* PHOTO: © C. WEARMOUTH

tary school kids. The roads exposed fine sands beneath a fairly thin layer of vegetation and shallow soil. We continued north beyond the pavement on the sandy road that is the winter road to Fort Chipewyan. Each winter this road is traditionally iced to make a solid surface for vehicle travel. Then we turned off that road and headed through a myriad of exploration and forestry roads.

As the rain continued to fall, our guide jokingly told us he realized he had forgotten to bring "quadder currency." This was six packs of beer: very helpful if we got stuck on any trails in the rainy weather and needed help getting out. We actually met very few quadders on our way in or out. No currency was needed in any case since the rain soon stopped and the rest of our trip only saw occasional light showers.

We set up our tents and tarp at a site by a lovely sinkhole lake in the McClelland watershed, west of McClelland Lake itself. These circular sinkhole lakes are formed from 'karst' erosion: over time, surface water and groundwater wears into the Devonian-era limestone formation at or below ground level, causing collapses in the limestone which are termed karst topography or geology. Karst lakes are rare in Alberta's boreal mixedwood forest, and the string of 12 karst lakes in the McClelland watershed earned these lakes a provincial Environmentally Significant Area (ESA) designation in both 1997 and 2009. In more recent years, karst and other erosion processes affecting the Devonian formation in the wider oilsands region have greatly interested the Alberta Geological Survey. Uneven erosion processes influence the thickness of the bitumen-bearing McMurray formation below the Devonian; they also affect the connectivity of saline and freshwater aquifers and the integrity of caprock overlying oil sands deposits that are subjected to high pressure steaming in the in-situ oilsands area.

After setting up camp we were ready for our first exploratory paddle on McClelland Lake and drove a short distance to the launch site our guide had scouted. On an overcast afternoon, we put our canoes into the Lake. Almost immediately, we passed near some tall aquatic grasses, which to my astonishment appeared to be bearing wild rice. I loosened the grains from a strand or two to taste the crunchy grains. Later I read that wild rice was introduced into northern Saskatchewan lakes from water bodies in eastern Canada, initially to boost muskrat populations, then for commercial harvest. I do not know the source of these aquatic grasses in McClelland Lake, whether native or introduced, but I do know that, at the moment we discovered them, it seemed the lake was offering a most generous autumn greeting.

Paddling west along the lakeshore we saw abundant floating lily pads and grassy aquatic vegetation. McClelland is relatively shallow and fed by shallow groundwater and surface water that flows northeast through its large wetland complex. It doesn't support fish populations, but is rich in bird life. Its 1997 provincial ESA designation noted it as a hydrologically important lake, an important waterfowl staging area, and an important bald eagle nesting area.

The lake is the largest natural water body between Fort McMurray and the Athabasca River delta. It is strategically located on the Athabasca River Valley migratory bird flyway about 100 kilometres upstream

*The jack pine forest is carpeted with reindeer lichen.* PHOTO: © C. CAMPBELL

of the Peace Athabasca Delta, one of the world's largest inland freshwater deltas. Two hundred and five bird species have been recorded within or in the vicinity of McClelland Lake, of which about 115 stay to breed. That late August day we surprised several immature greater white-fronted geese into flight, paddled past a pair of cormorants, and encountered a group of ring-billed gulls, several of which were curious enough to briefly escort our canoes.

We paddled to the lake's western edge. Our goal was to enter as far as possible into the patterned fen known as the McClelland fen. Patterned fens form on gently sloped landscapes fed by groundwater: over thousands of years, complex water and possibly ice actions push up narrow ridges of peaty soil at right angles to the water flow. These ridges, called strings, can eventually support small trees. They are separated by long, narrow, shallow pools of water, called flarks.

The McClelland Lake fen has built up over 8,000 years since the last glacial retreat. In some areas its peat layers are five metres deep. It is intricately and beautifully patterned, with hundreds of flarks and strings. The 1997 ESA called the McClelland fen one of the most significant and largest patterned fens in Alberta, citing its rare and significant plant species and a sandhill crane nesting area. Since then, endangered whooping cranes have been documented landing there on several occasions. The fen is also home to other species of concern, including the Canadian toad, yellow rail, black tern, and short-eared owl.

Leaving the lake's open water, we paddled into narrow water fingers but it wasn't long before the fen's dense aquatic vegetation blocked our way. We retreated back to open water and found an access point where we could stand on a string ridge. We walked a short distance, uncertain how much farther our weight could be supported on the delicate structure. We looked across what appeared to be a deceptively solid ground meadow, knowing it was all floating plants. We retreated again and paddled back to our launch site, satisfied with our exploration of this unusual water-land transition zone.

After our meal that evening, we walked in the beautiful jack pine forest near our camp and discovered a patch of ripe blueberries. Soon we were tasting the excellent vintage of the year. In amongst the blueberries was the odd bog cranberry, deliciously tart. As we made plans for the next day back at camp, the tree trunks glowed reddish brown in the setting sun.

The next morning we set off for an exploratory hike farther south at an edge of the fen. We wondered how far we could walk from the solid upland forests towards the aquatic fen. We also wanted to see if we could find pitcher plants. The pitcher plant *(Sarracenia purpurea)* is a vulnerable species according to the Alberta Conservation Information and Management System. Pitcher plants are fascinating insectivorous plants that thrive in some nutrient-poor wetland areas by attracting insects into their bright red-veined pitcher-shaped leaves. The insects are trapped by the downward pointing hairs and slippery surface of the leaves and drown in the water that collects at the base of the leaves.

We saw what were likely wolf prints in the sandy road, and enjoyed the graceful shapes of the jack pine forest. The understory in this forest was sparser than what I was used to. Sometimes there was shrubby ground cover, sometimes low green mosses, but most striking was the forest floor of white reindeer lichen, which resembled an early season snowfall from a distance. The drier jack pine areas gave way to black spruce, which tolerate much wetter soils. Closer to water-logged ground, we began picking our way carefully, letting the taller vegetation guide us to more solid footing. We could still stand for a time on the open moss-carpeted ground, but water would gradually penetrate into the area compressed by our bootprints, so we shifted weight, keeping our eyes on the ground. Suddenly Chris yelled out, "Pitcher plants!" We found several photogenic clusters. A few more steps, and the ground took on a wavy water mattress character, so we again retreated.

The next morning we went for a final exploratory paddle eastward along the lake. McClelland Lake is on the northern edge of the mineable oil sands area and for now it remains a safe stopover for birds, in contrast to nearby projects' growing tailings ponds. The area is within an aboriginal trap line area and indigenous communities' traditional land use territories. This extraordinarily beautiful, ecologically valuable and sensitive place should be protected for future generations to marvel at, rather than be destroyed by the Fort Hills mine (see Inset).

*We found these colourful insectivorous pitcher plants near the edge of the McClelland fen.* PHOTO: © C. WEARMOUTH

We drove out of that beautiful forest with a small water bottle full of wild blueberries to share with the others in our Calgary office and the chunk of roadside bitumen. Those two souvenirs sum up the paradox and challenge of our industrial society – to learn to live within ecological limits so that all species can thrive. Alberta's northeast boreal forest reveals itself in many ways through the seasons, but I will always cherish my first trip to the McClelland wetlands.

*Blueberry picking.* PHOTO: © C. WEARMOUTH

## Fort Hills oilsands mine and McClelland Wetland Complex

AWA took part in a four-year sub-regional planning process that in 1994 resulted in protection of the McClelland wetland complex from oil sands surface access. However, in 2002 the sub-regional plan rules changed suddenly at the request of Koch Industries' subsidiary True North Energy, which had acquired the leases in 1998, after the plan rules were clearly in place. The amended plan allowed mining in about half of the wetland complex, provided that "surface mining ... shall maintain the water table, water chemistry and water flow within limits as indicated by natural fluctuations to maintain ecosystem diversity and function of the McClelland Lake wetland complex where surface mining is not allowed." A few months later during Fort Hills project application hearing, Alberta's Energy Utilities Board accepted True North Energy's request to withdraw the portion of its EIA describing impacts to the wetland complex. This EIA had stated that water table disruptions from mine dewatering and other lease disturbances would likely kill peat-forming mosses, ending peat production on the fen. Instead, the EUB granted True North Energy its request to develop a plan prepared by a company-led committee of regulators and stakeholders to mitigate the mine's effects on the unmined portion of the wetland complex. AWA has not joined this committee, which we regard as a means to legitimize the wetland complex's destruction. As of June 2016, with Suncor Energy now the lead operator at Fort Hills, there is still no approved plan to mine in the McClelland watershed.

Appendix E
to the Reply Submission of
Alberta Wilderness Association
dated June 9, 2023

FORT HILLS

Updated July 6th, 2010
at the 16th meeting of the

# McClelland Lake Wetland Complex Sustainability Committee

# Terms of Reference

## *Background:*

Petro-Canada Oil Sands Inc. (PCOSI), a wholly-owned subsidiary of Suncor Energy Inc. (Suncor), is the operating partner of the Fort Hills Oil Sands Processing Plant and Mine whose owners are composed of: UTS Energy Corporation; Teck Resources Limited; and, Fort Hills Energy Corporation. The Project, located approximately 90 km north of the town of Fort McMurray, received initial approval from the Alberta Energy and Utilities Board (EUB) and Alberta Environment (AENV) in October 2002 following submission by True North Energy L.P., (True North) then owner of the Project, of an EIA and a subsequent public hearing. Since that time, ownership of the project has changed twice: first in April 2005, Petro-Canada purchased a majority interest in Fort Hills Energy L.P. (FHELP) holder of the Project Oil Sands Leases and regulatory approvals, and established PCOSI as Project operator, and again in August 2009 when Petro-Canada merged its assets and operations with those of Suncor.

## *Purpose:*

As noted in the EUB Decision Report 2002-089 – Section 10.1, the McClelland Lake Wetland Complex (MLWC) Sustainability Plan, as proposed by TrueNorth Energy, called for the creation of a committee of regulators and stakeholders to assist TrueNorth to develop a management strategy to sustain the un-mined eastern portion of the wetland. The proposed committee would agree on a set of indicators and objectives that would then be used to design baseline monitoring, assess potential mitigation activity, and monitor success. The proposed MLWC Sustainability Plan had the support of the Fort MacKay First Nation, the Mikisew Cree First Nation and the Athabasca Chipewyan First Nation.

The ERCB recommended in Section 10.3 of its Decision Report that TrueNorth convene a committee of stakeholders and regulators, as proposed in the MLWC Sustainability Plan, to oversee collection of baseline monitoring data, establish the natural variability of the wetland, establish criteria to protect the biotic diversity and function of the no-surface-access zone, critically evaluate the proposed mitigation plans in relation to the protection criteria, and evaluate post-construction monitoring data and adaptive management. This recommendation was subsequently incorporated into the ERCB Approval 9241 and its covering letter. The minimum requirements of the required MLWC Operational Plan are described Water Act Approval #00151636-00-00 and noted below.

## *Mandate:*

The Committee will assist Petro-Canada Oil Sands Inc. (PCOSI), as operator for FHEC, to prepare the Operational Plan, in accordance with the *ERCB Approval* and the *Water Act* approval. The Committee will provide advice on mitigation options, monitoring, and adaptive management approaches. The MLWC SC has been established in advance of any development activities within the watershed of the MLWC to ensure an acceptable multi-year baseline is established.

The Committee recognizes the importance of working closely with engineering, hydrologists, and ecologists to ensure that a meaningful proposal is prepared.

## *Tasks:*

The Committee will assist PCOSI with the following tasks:

- Clarify the definitions of key terms used in the Fort Hills regulatory commitments. Such terms include functionality, sustainability and natural variability as they relate to the non-mined portion of the MLWC patterned fen.
- Determination of the factors affecting the functionality and sustainability of the fen, and associated indicators and criteria.
- Preparation of detailed work plans.
- Preparation of the Operational Plan
- Preparation of reports and other progress documents as required.
- Identification of key management objectives for the MLWC.

## *Operational Plan:*

As noted in Clause 14 of the *Water Act* Approval # 00151636-00-00, the Operational Plan will contain, at a minimum,

1) Physical and biological baseline conditions in the MLWC:

2) Design features or measures as required for the protection of the non-mined portions of the MLWC;
3) A wetlands monitoring program containing as a minimum a yearly survey of vegetation species distribution, abundance, health, and string and flark configuration as compared to baseline studies;
4) A monitoring program to study groundwater and surface water levels and water quality in overburden and muskeg; flow measurements of polishing ponds, and level monitoring in McClelland Lake;
5) Proposed investigation and monitoring necessary to verify the model prediction that the MLWC will not drain towards the dewatered area through the groundwater flow system:
6) Indicators to evaluate the tolerance of the MLWC to project effects;
7) The necessary contingency mitigation measures to maintain the water table, water chemistry and water flow within limits as indicated by natural fluctuations to maintain ecosystem diversity and function of the non-mined portions of the MLWC during operation and reclamation of the project; and
8) A detailed schedule for the implementation of each component of the plan

## *Membership:*

Committee membership will be comprised of representatives of the regulators, regional aboriginal stakeholders and environmental organizations with interest and expertise in environmental management pertinent to the Committee's mandate. The Committee will be chaired by a representative from the FHEC Partnership who will act as one of the Committee members.

Members that represent specific stakeholders may nominate alternates as required. Regular attendance is expected. Members will be responsible, with the assistance of PCOSI and/or the Committee, for communications with the constituents they represent. PCOSI will provide assistance, as required, to allow members to participate (specifics of which are outlined in the funding section).

While additional individuals may observe the MLWC SC meetings, below is a list of members that can vote on decisions and/or receive assistance to attend.

The Members are as follows:

- 4 aboriginal representatives or their alternates (one appointed by each of the Fort McKay IRC, ACFN IRC, MCFN IRC, and Ft. Chipewyan Métis Local 125).
- 1 representative from the FHEC partnership acting as chair
- 1 representative from the FHEC Environmental Group
- 1 representative from the FHEC Project Engineering Team

- 1 representative from the FHEC Stakeholder Affairs Group
- 3 representatives from the provincial government (one from each of the following agencies: AENV, EUB, ASRD)
- 2 representatives from a Environmental Non-Government Organizations (ENGO)

As the MLWC SC is actively pursuing the engagement of additional ENGOs, additional membership may be allocated upon those groups' commitment to the committee.

Observing individuals typically include:

- Support members from the FHEC Environmental Group
- Other elders from participating aboriginal groups
- Scientific advisors to aboriginal representatives

## *Decision Making:*

The Committee will make decisions based, to the extent possible, on consensus using an open and transparent process. When one or more members do not agree, and there are external or project time and/or budget constraints, it will be deemed that consensus cannot be reached. If this occurs then PCOSI will make the final decision. The reasons for the decision and lack of consensus will be tabled with the Committee. As required, decisions may also need regulatory review.

## *Scientific and Technical Support (Task Groups):*

When a requirement for a high degree of technical and/or scientific expertise is required the MLWC SC may establish one or more Task Group(s) to address these issues. Task Groups have the following attributes:

- Are created when necessary, as agreed upon by the MLWC SC
- Populated by experts who can contribute and provide information on scientific, technical, or traditional knowledge issues.
- The MLWC SC understands that directed mandates exist within particular member-groups. The MLWC SC encourages discussions germane to these overriding mandates to be discussed at the MLWC SC; task groups are directed to limit their discussions to technical, scientific, or direct traditional experiences only.
- Task groups are encouraged to engage the experts in the subjects they are mandated to investigate; this may include university researchers, traditional use experts, and/or consultants.
- Task group shall develop terms of reference, for approval by the MLWC SC, for their particular tasks.

## *Accountability:*

The Committee is expected to assist PCOSI in meeting the requirements of the ERCB approval and preparing the Operational Plan required under the Water Act Approval through provision of thoughtful and constructive advice PCOSI recognizes that individual members of the SC are also accountable to their sponsor organization for ensuring that their sponsors views and concerns are considered by the Committee. Members will also act as the conduit back to their community or related organizations to address questions, issues, concerns and sharing of how the Sustainability Committee is progressing.

## *Administration:*

The administration required to support activities of the Committee, including logistics; minute taking and coordination will be the responsibility of PCOSI.

At least two meetings will be convened annually, or as required by the membership, with more frequent meetings initially for the development of the Committee and its programs.

The MLWC SC will revisit Terms of Reference (ToRs) every 3 years.

## *Funding:*

The cost of the program, including the monitoring programs, hiring and/or stipends to Science Advisors, costs for participation by aboriginal elders, and logistical costs for Committee meetings will be funded by the FHEC.

Per Diems (honorariums) will be paid at a rate of $350 per day ($150 for meetings lasting less than 3 hours) for aboriginal representatives' participation. Similarly, travel expenses will be reimbursed, at cost, for those voting members other than representatives of government regulators. Travel expenses include hotel, airfare, meals, and transportation to/from meetings.

If aboriginal representatives require the attendance of a technical (science) advisor, Suncor will pay for the flights, accommodation, and the advisor's hourly rate during the meeting only. Suncor will cover these costs for one technical advisor per aboriginal group per meeting.

Appendix F
to the Reply Submission of
Alberta Wilderness Association
dated June 9, 2023

## Comments to Alberta Wilderness Association on Suncor's Response Submission Letter of May 31, 2023

**Suncor's Response Submission Re: Request for Reconsideration of Suncor's McClelland Lake Wetland Complex (MLWC) Operational Plan for the Fort Hills Oil Sands Project by Alberta Wilderness Association; Suncor Energy Inc. (Suncor)/ Fort Hills Energy Corporation (Fort Hills) Request for Reconsideration No.: 1942728**

Richard Lindsay
Head of Environmental and Conservation Research
Sustainability Research Institute
University of East London
UK

2nd June 2023

I have reviewed the Suncor letter referenced above and provide these further comments to Alberta Wilderness Association (AWA), in addition to my May 29, 2023 report to Alberta Wilderness Association on Suncor's McClelland Lake Wetland Complex (MLWC) Operational Plan.

In Suncor-Fort Hills' 2015 *Water Act* approval permission, the onus is clearly on Suncor to demonstrate that its proposals will not harm the MLWC. The Suncor letter states that: "AWA's seven concerns either: i) are addressed in the Operational Plan; ii) are based on incorrect or misleading assumptions; iii) are highly speculative and not supported by relevant evidence". The Suncor Operational Plan itself is, however, 'highly speculative' in the sense that *no* testing has been undertaken of the whole OP approach as an integrated system while the practical implementation of this approach is explicitly described by Suncor *itself* as 'conceptual' rather than practical.

Also, no information is provided about how the Operational Plan systems will be maintained at cessation and restoration of the mining nor who will bear the responsibility for this. Given that peatland systems demonstrably operate over timescales of centuries and even millennia (as evidenced by the preserved peat archive), the timescales for responsibility approach those of a nuclear power plant rather than a short-rotation conifer plantation, which is the timescale explicitly addressed by Suncor's Operational Plan. As such, Suncor's OP mitigation measures proposal is not merely 'highly speculative', it is more accurately described as conjectural and presumptive.

The Suncor document openly admits that the salinity issue is not resolved - which is a crucial admission. Suncor states: *"SEOI acknowledges that groundwater quality modelling is continuing to be progressed- section 4.3 of the Operational Plan is clear in this regard. However, AWA ignores that a roadmap for future work required on water quality modelling was provided in Figure 4.3-3 of the Operational Plan. Further, refinements to the MLWC water quality model are ongoing and this work will continue to be shared with the Sustainability Committee and its advisory groups, as well as with the AER, for feedback."* In this statement, Suncor admits that its only way of addressing the issue is to continue developing and refining the existing model *in the hope* that a solution will be found, but with no guarantee that such a solution with practical possibilities of implementation will in fact emerge from such work.

With regard to the practical application of mitigation measures, the Suncor document states: *"AWA expresses concern regarding uncertainty and risk with the conceptual stage water management plan and* *states: "There is a high risk that the construction and operation of all the necessary mitigation infrastructure (called "Design Features" within the OP) will result in significant damage to the downstream non-mined fen and connected wetlands, watercourses, and lake.''42 Again, AWA provides no evidence or data to back up this statement."* Given the conditions of planning consent, however, the onus lies with Suncor to demonstrate conclusively that its conceptual designs can be converted into functionally effective reality - something which Suncor has patently failed to do through its own admission that it is only able to provide 'conceptual' designs for what is the most crucial part of the whole Operational Plan. If the *practical* implementation of the mitigation measures fails, then all the hydrological modelling and baseline measurements become completely irrelevant. Suncor are the applicants here, with the resources to undertake such practical testing as well as being under obligation to do so, but they have demonstrably failed to do so as they themselves admit.

"*SEOI will monitor the performance of the design features through various instruments and field observations as part of ongoing operations and has a robust response framework as per Objective 6 of the Operational Plan*". If failure occurs at a single weak point during heavy rains or following a dry period when the peat shrinks and cracks, as has been observed with other catastrophic failures, such monitoring has been shown to be of little practical help and practical response times utterly inadequate. See, for example, the Irish or Australian examples noted in my May 29, 2023 report, but other peat failures have been reported from around the world (https://www.youtube.com/watch?v=k6UMUW4IIrc - this is the site where the Irish Government has had to close and remove the windfarm). It provides what is in effect a fig-leaf of perceived security by being able to state that monitoring is in place, but when the monitoring devices are themselves swept away by a catastrophic event (as has been the case) their main function is to show just how far the catastrophe has extended.

Appendix G
to the Reply Submission of
Alberta Wilderness Association
dated June 9, 2023

## A Report to Alberta Wilderness Association - Suncor Operational Plan for McClelland Lake Wetland Complex.

Richard Lindsay
Head of Environmental and Conservation Research
Sustainability Research Institute
University of East London
UK

29TH May 2023

### 1. Introduction

On the basis of my experience and expertise in peatland ecosystems I have been asked by the Alberta Wilderness Association to comment on Suncor's Operational Plan for the McClelland Lake peat wetland complex. I have worked in peatland ecology and conservation for almost 50 years, and for 20 years was the Senior Peatland Specialist to the Chief Scientist Team of the UK Government's statutory agency the Nature Conservancy Council and its successor bodies. I was a founding member of the International Mire Conservation Group, which is the international network of researchers and advisors to their respective governments on peatland ecology, conservation and wise-use matters, and for 11 years was its Chair. I have advised the European Commission on a variety of high-profile cases, have represented peatland conservation cases on behalf of statutory agencies, non-governmental organisations and local groups in public inquiries and legal cases. I have been Visiting Researcher at Chuo University, Tokyo, and Visiting Professor at the University of Tokyo. I am a member of the UK Government's Lowland Agricultural Peat Task Force, and am Senior Research Advisor to the IUCN UK Peatland Programme. For more than a decade I have been Head of Environmental and Conservation Research at the University of East London, UK.

I have not been paid by the Alberta Wilderness Association to undertake this review, but do so because I believe this to be an important issue worthy of international concern. I have reviewed the multiple parts of the Suncor Operational Plan for the McClelland Lake peatland complex (MLWC) and also studied additional associated material. I have also considered other material which I believe to be relevant to this case.

The key issues of the case are:

- direct loss of peatland habitat and biodiversity;
- changes to peatland hydro-ecology;
- on-the-ground implementation of the Operational Plan;
- potential for catastrophic change;
- peat carbon emissions to the atmosphere.

### 2. Direct loss of peatland habitat and biodiversity

The McClelland Lake peatland complex (MLWC) has now been identified as one of the oldest and earliest-forming peatland ecosystems in continental western Canada. Indeed Vitt and House (2023) describe the site thus: "*McClelland Wetland: A unique early peatland*".

It is a well-established fact that ecosystems which have persisted for long periods of time possess levels of characteristic biodiversity, ecosystem structure and function which are significantly greater than those ecosystems which are younger and still in states of formation and transition. While this alone renders the MLWC particularly valuable in terms of habitat and biodiversity conservation, being a peatland system adds yet another level of value which cannot be matched by almost any other ecosystem – nor can it be recreated if lost.

This additional feature is the archive of information stored within the peat itself. Few, if any, opportunities exist to determine the record of local or regional changes which have occurred within the landscape during the past 11,000 years, whether this be through shifts in climate since the Ice Age or the impact of animal or human activity. Peatlands provide an unrivalled record of such changes, and the MLWC represents one of the best, if not the best, source of such information within the region. Once lost, this aspect of the peatland ecosystem is one that can never be restored no matter how technically advanced restoration techniques may become in the future. There is no way to recapture the past.

This palaeo-ecological archive is often overlooked when considering issue of ecosystem services and ecosystem biodiversity, but the archive contains a wealth of biodiversity, albeit much now not living, while the ecosystem service provided by the picture obtainable from the archive can be extraordinarily useful in helping to understand the present, given that the present is often shaped by the past.

And in the past it has sometimes mistakenly been believed that taking a few peat cores for preservation and subsequent analysis will suffice, but advances in sampling, preservation and analysis have shown how flawed this approach to be. Furthermore, it is increasingly understood that location of sampling can be crucial, rendering it impossible to predict today where key sampling locations may be required tomorrow. This is why it is particularly important that good examples of peatland systems be maintained in as complete a state as possible – not merely for their present biodiversity but also for their past archive and the future needs of society.

The Government of Canada is signatory to a number of legally binding international treaties which have particular relevance to the proposals for the MLWC, not least of which is the UN Framework Convention on Climate Change (UNFCCC) although I will reserve discussion about this particular treaty until later in my report.

Canada has been a ratified signatory to the **Convention on Biological Diversity (CBD)** since December 1993. Under this Convention, Canada's stated Aichi Targets in 2020 were as follows:

> **Goal A**: By 2020, Canada's lands and waters are planned and managed using an ecosystem approach to support biodiversity conservation outcomes at local, regional and national scales.
>
>> **Target 1:** By 2020, at least 17 percent of terrestrial areas and inland water, and 10 percent of coastal and marine areas, are conserved through networks of protected areas and other effective area-based conservation measures.
>>
>> **Target 3**: By 2020, Canada's wetlands are conserved or enhanced to sustain their ecosystem services through retention, restoration and management activities.
>>
>> **Target 4:** By 2020, biodiversity considerations are integrated into municipal planning and activities of major municipalities across Canada.

**Goal B**: By 2020, direct and indirect pressures as well as cumulative effects on biodiversity are reduced, and production and consumption of Canada's biological resources are more sustainable.

**Target 12:** By 2020, customary use by Aboriginal peoples of biological resources is maintained, compatible with their conservation and sustainable use.

**Target 13:** By 2020, innovative mechanisms for fostering the conservation and sustainable use of biodiversity are developed and applied.

The development proposed by Suncor for the MLWC breaches each of these commitments. Until oil tar sands were found beneath the wetland, this complex wetland/peatland ecosystem enjoyed formal protection using an ecosystem approach in that the whole watershed was afforded protection. Removal of that protection in order to grant mining consent quite clearly breaches Targets 1, 2 and 4 of Goal A of the Aichi Targets by reducing the wetland system itself by 63% (never mind the larger watershed on which, to a greater or lesser extent, the wetland relies).

Furthermore, on 19th December 2022, in Montreal, the 15th CBD Conference of Parties agreed on a historic package of measures deemed critical to addressing the dangerous loss of biodiversity and restoring natural ecosystems. In particular, two of the four over-arching Kunming-Montreal Global Biodiversity Framework Global Goals and three of the 23 Targets are directly relevant to the case of the MLWC and the Suncor Operational Plan:

**GOAL A:** The integrity, connectivity and resilience of all ecosystems are maintained, enhanced, or restored, substantially increasing the area of natural ecosystems by 2050;

**Goal B:** Biodiversity is sustainably used and managed and nature's contributions to people, including ecosystem functions and services, are valued, maintained and enhanced, with those currently in decline being restored, supporting the achievement of sustainable development, for the benefit of present and future generations by 2050;

**Target 1:** Ensure that all areas are under participatory integrated biodiversity inclusive spatial planning and/or effective management processes addressing land and sea use change, to bring the loss of areas of high biodiversity importance, including ecosystems of high ecological integrity, close to zero by 2030, while respecting the rights of indigenous peoples and local communities.

**Target 2:** Ensure that by 2030 at least 30 per cent of areas of degraded terrestrial, inland water, and coastal and marine ecosystems are under effective restoration, in order to enhance biodiversity and ecosystem functions and services, ecological integrity and connectivity.

**Target 3:** Ensure and enable that by 2030 at least 30 per cent of terrestrial, inland water, and of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem functions and services, are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas and other effective area-based conservation measures, recognizing indigenous and traditional territories, where applicable, and integrated into wider landscapes, seascapes and the ocean, while ensuring that any sustainable use, where appropriate in such areas, is fully consistent with conservation outcomes, recognizing and respecting the rights of indigenous peoples and local communities including over their traditional territories.

Removing the conservation status from a designated conservation wetland area and then permitting the destruction of 63% of that wetland area runs directly counter to both the practice and the spirit these international commitments.  Attempting to maintain a mere 37% of a currently near-natural peatland/wetland system cannot in any way or form be described as:

- maintaining “the integrity, connectivity and resilience” of this ecosystem complex;
- nor does it aid in bringing the loss of areas of high biodiversity importance, including ecosystems of high ecological integrity, close to zero by 2030;
- and cannot by any stretch of the imagination be described as “sustainable use”.
- Such loss as will occur also stands as a *debit sum* in terms of the commitment to restore 30% of *existing* degraded terrestrial and inland water ecosystems.

Canada’s international commitments under the CBD are not the only relevant obligation here. Canada is also a signatory to the **Ramsar Convention**.  This was “*the first of the modern global nature conservation conventions and, today, is a highly regarded and active multilateral environmental agreement.  The mission of the Ramsar Convention is the wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world. Canada joined the Convention in 1981 and has a long reputation of making constructive inputs to the programs of the Convention, such as policy development, program assessment, peatlands and carbon conservation, grasslands wetland restoration, economic valuation, mitigation issues and other topics.* (Government of Canada website).

The Convention’s Objective is:  “…*the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world.*” (Government of Canada website).

The Key Elements are:  “Contracting Parties are required to:

- designate at least one Ramsar site and ensure their effective management;
- work towards the wise use of all their wetlands through national land-use planning, appropriate policies and legislation, management actions, and public education (my emphasis); and,
- cooperate internationally concerning transboundary wetlands, shared wetland systems, shared species, and development projects that may affect wetlands.

In the case of the Suncor development and the planning process, both the removal of protected status for the wetland and the granting of consent for mining very clearly contravene this commitment to the wise use of wetlands through land-use planning, appropriate policies and legislation – indeed it represents a significant retrograde step.

## 3. Changes to peatland hydro-ecology

The several reports associated with the Suncor Operational Plan undoubtedly provide an abundance of data.  For the most part this consists of hydrological or hydrochemical data, although some botanical data are also provided.  These data are then used to model various scenarios and provide a certain amount of validation for the models.  There are, however, various significant weaknesses in the approach presented.

It may seem odd to introduce practices employed by the Intelligence community at this point, but there is good reason to do so. The Intelligence community operates through a system known as the Intelligence Cycle. This is displayed in Figure 1.

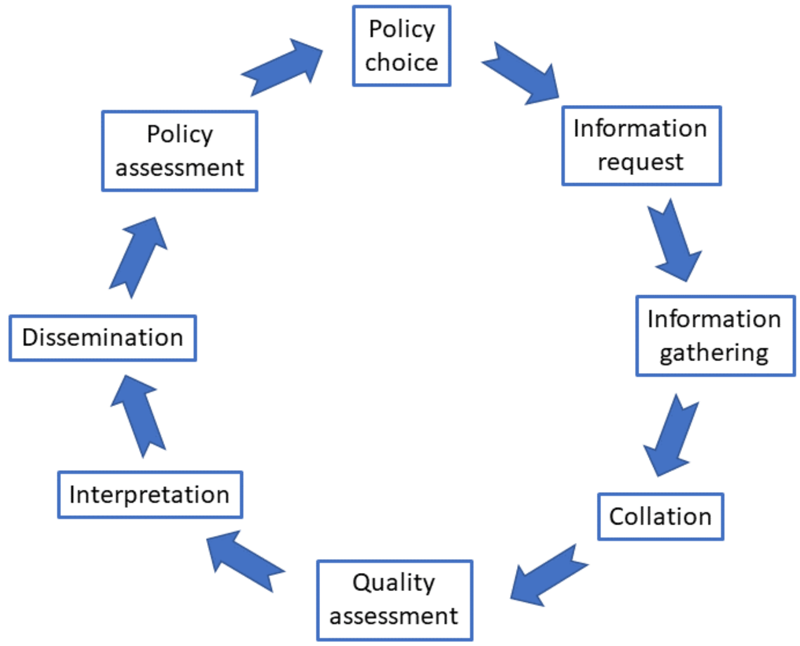


**Figure 1.** The 'Intelligence Cycle' as employed by the Intelligence community. It begins with a Policy choice which leads to a request for information. The information gathered proceeds through the various steps until a Policy Assessment either enables a Policy choice to be made, or it is decided that further information is required in which case the cycle is repeated until a Policy choice can be made.

The various reports of the Operational Plan fulfill the first two steps in the Intelligence Cycle following an Information request, and to some undertake a degree of Quality assessment, but the **reports become particularly weak at the Interpretation stage** and instead skip on to the Dissemination stage without adequate Interpretation. This weak link arises for several reasons.

Firstly, while a huge amount of data has been gathered, collated and assessed, the data are **only interpreted with confidence and adequate quality assurance for the *current* set of conditions**. There are so many acknowledged (and un-acknowledged) unknowns in the practical implementation of the Operational Plan that it is not possible to generate an interpretation of what will happen in the future with any degree of confidence. It may be argued that the modelling provides this interpretation, but, as has often been said: "A model is not reality. It is a means of producing a hypothesis which is then tested against reality." **In this case, however, no real testing of the model output can take place until the Operational Plan has been implemented, by which time it is too late to undo the engineered construction works**.

Furthermore, the various reports provide long lists of assumptions and generalisations which have been used to generate the models – assumptions and generalisations which are in at least some cases not supported by existing evidence. For example, it is stated that the derived model assumes peat to be a homogeneous material, but a huge archive of published evidence shows repeatedly that this is very far from the case (e.g. Godwin and Conway, 1939; Conway, 1954; Charman, 1994; Kutenkov and Philippov, 2019). Even the paper by Vitt and House (2023) for this site reveals a **substantial degree of variation in the composition of the peat** throughout the length of the various cores obtained. Indeed, their longest core, Core 1, while showing a considerable degree of uniformity along much of its length also contains areas where no sample was obtained – which from my own experience suggests that there are extremely liquid lenses or even what are termed 'peat pipes' contained within this otherwise uniform core. Such layers and features can have a major impact on the behaviour of water within the peat, and more will be said about this in the section on 'Potential for catastrophic change'.

The Interpretation stage also fails adequately to address the fact that peatland systems, particularly patterned peatlands, are **highly responsive, self-organising systems** because, unlike a mineral soil surface which is largely shaped by mechanical forces, the 'soil' surface of a peatland is continually generated, shaped and renewed by the living layer of vegetation. Changes to the vegetation inevitably result in changes to the shape of the peat surface, the processes of peat formation and ultimately the hydro-ecological behaviour of the peatland ecosystem. Barber (1981) established a clear link between climate and changing surface patterns over time, and many authors since then have explored the mechanisms of self-organisation and feedback that control the surface patterns of peatlands (e.g. Belyea and Malmer, 2004; Couwenberg and Joosten, 2005). The current reports linked to the Operational Plan do not adequately address the dynamic nature of a peatland system and the fact that effects may extend out from areas of impact, resulting in changes to the vegetation, the microtopography and therefore the hydro-ecological behaviour of the peatland system. It is not enough simply to state that there is little evidence of dynamic change within an aerial-photo sequence spanning a period of 65 years when in fact there is little reason to suspect that environmental conditions have changed significantly during this period, given the relatively undisturbed nature of the site. However, by the time any changes due to construction of the Suncor mine are noticed, it will be too late to do much about them. Perhaps this is why there is no adequate description given of actions to be taken should such changes be observed over time.

This lack of appropriate consideration in terms of potentially key factors is part of a broader pattern whereby such factors are simply excluded from consideration in somewhat Nelsonian fashion – if the existence of something is simply not acknowledged it is not then necessary to take into account any potential impact of that feature on the proposed course of action. Thus, for example, Table 3.4-5 in Objective 2 lists a number of 'excluded parameters', in many cases such exclusion being justified on the basis that they are "*difficult to measure effectively*". These excluded parameters include such critical features as seepage rates from springs and several aspects of vegetation response. However, in terms of significance and evidence of impact, **absence of evidence is not evidence of absence**, particularly if those sources of evidence are simply excluded from consideration.

There is **no evident attempt to undertake small-scale experimental trials** of the proposed construction works and mitigation measures elsewhere within the land holdings of Suncor in order to test the proposed approach and thereby obtain data which could be used to verify the models. Indeed, as proposed, the Operational Plan *is* the experimental trial, meaning that the Interpretation phase can only be undertaken in any meaningful way *post-hoc*, after irreversible actions have been taken. Although the Operational Plan includes 'Reference Sites' which will be used to compare *background* changes with those observed at the MLWC, **no similar reference sites are employed where similar construction and mitigation works are already in place** and can thus provide direct evidence with which to inform the Interpretation phase of the MLWC Operational Plan.

Furthermore, the construction and mitigation measures **currently exist only as conceptual designs**. The whole of Operational Plan Objective 4 section describing the designed features consists only of such conceptual designs with explicit acknowledgement that further investigations will be required in order "*to confirm the resulting flow pattern in the fen areas will be similar to pre-mining conditions*". No adequate description is provided of actions to be taken should it prove that the flow patterns prove *not* to be similar to pre-mining conditions, nor a critical assessment provided of the possible complexity of such actions. The approach is instead based on the neat, clean designs set out on a drawing board instead of acknowledging the complexity and thus unpredictability of natural materials and processes. At least some trial testing would highlight the differences between these design concepts and the reality of manipulating such natural systems.

The potential for reality to diverge from the conceptual designs is summarised in the listing of caveats which it is acknowledged must be applied to the modelled proposals. In addition to issues already raised above, these caveats include:

- **Numerical uncertainty in the values applied to model flow equations** – values which can only be based on current and predicted conditions rather than actual tested post-construction conditions, and furthermore it is acknowledged that, in relation to future flow conditions, "*Laboratory or field-measured hydrogeological properties of tailings and backfill material were not available and were parameterized based on best available estimates*";
- **Mesh resolution of the model**, with a minimum mesh size of 100 m applied, which significantly exceeds the fine-scale structures of strings and flarks that provide the self-organising mechanism underpinning and maintaining the stability of the patterned fen system;
- **Geological heterogeneity** – acknowledged thus: "*there are currently no efficient tools/methodologies available to systematically mitigate structural uncertainty when using complex physics-based hydrologic models*";
- **Parametric uncertainty** – described thus: "*subsurface data is inherently uncertain. A formal parametric uncertainty quantification has not been performed with the 2020 MLWC HGS model. The complexity of the model, the long model runtimes, the requirement for a large numbers of runs (in the hundreds to thousands for uncertainty quantification methods like Latin Hypercube), precluded its use*";
- **Role of climate data**, described as having "*biggest relative effect on the modelled levels and flows as it is both the largest water source (precipitation) and water sink (evapotranspiration) in the Fort Hills Lease*", though this may no longer be the case following mine construction, as discussed below;
- **Data available for model calibration** – which, though based on actual field data, in practice only describe *current* conditions rather than field data obtained from actual examples of the proposed construction works on similar site conditions. No effort appears to have been devoted to seeking out calibration data from existing similar sites which have been subject to the proposed construction methods to be employed as part of the Suncor Operational Plan;
- **Mine plan evolution** – highlighting the difficulties of making meaningful predictions about likely future hydro-ecological behaviour given the uncertainties of construction phases, evolution of construction methods and properties of materials used – issues explored further below.

## 4. On-the-ground implementation of the Operational Plan

*No plan of operations extends with certainty beyond the first encounter with the enemy's main strength.* (Moltke the Elder)

All the modelling and mitigation processes outlined in the Operational Plan and associated reports are based on the premise that actual implementation of the proposed measures can be achieved to the specifications used in the models and operational plans. No evidence is presented, however, to show that this will in fact be the case or is indeed even possible.

It is not at all clear, for example, that the challenges are recognised of attempting to engineer structures within a peat body that, at the junction between the mined area and the non-mined area, possesses a peat depth of more than seven metres. A few comments are made to the effect that should difficulties arise then certain measures would be put in place. Such potential challenges are, however, rendered apparently harmless by the simple act of presenting everything as a simple graphic design which contains none of the real-world difficulties of dealing with a mass of semi-liquid peat at considerable depth.

The fact that *all* the construction and mitigation methods presented in Objective 4 are 'conceptual' rather than actual means that no real-world details are provided for precisely how various aspects of the Operation Plan will be implemented – and **thus it is impossible to offer any degree of assurance in terms of the planning condition that the MLWC will remain unchanged following mine construction and restoration**.

So many of the proposed construction and mitigation measures remain untested and are provided with such little *operational* detail that their contribution to maintaining the long-term stability of the MLWC cannot be judged. Taking just two interlinked issues, the dewatering of peat that is as much as 7 m deep and potentially extremely liquid is proposed as the source of replacement water for the fen between 2025 and 2059, while also associated with removal of peat and construction of a retaining berm:

- Experience of such peat removal in Scotland has proved to be more challenging than anticipated, with examples of peat collapse and peat flow into mine workings, as shown in Figure 2. The peat has collapsed in a series of concentric half-circles and at initiation there was considerable flow of liquid peat into the mining operation. The fen peat of the MLWC is likely to be significantly more liquid than was the case for this raised bog. Little information is provided in the Operational Plan for engineering solutions to the challenges of removing part of the huge depth of peat occurring at the boundary to the mining site.
- Other than stating that the water obtained from dewatering of the peat will be provided to the MWLC as a spray in order to avoid creating erosion channels, no details are provided about the way in which this delivery is to mimic the combination of diffuse and channelled water inputs that currently supply the MLWC. Furthermore, it is stated that water pumped from the Athabasca River would form a main supply for the period 2060-2075, but no solution is provided beyond this date.

**Figure 2.** Mining of fire clay from beneath a raised bog in the Central Belt of Scotland. The peat face has collapsed in a series of concentric half-circles, leading to significant impact into the main peat body.

## 5. Potential for catastrophic change

The MLWC Operational Plan is predicated on any impacts being incremental. There is no acknowledgement, nor therefore provision for the fact, that events can occur which bring about catastrophic change through a single incident. A single point-source failure of peat within a construction site in Ireland has led the Irish Government to be found guilty in the European Court of Justice for granting, on the basis of an inadequate environmental assessment, planning consent for Ireland's largest windfarm (https://www.oireachtas.ie/en/debates/question/2021-11-09/313/). Failure of a single section of constructed track next to a turbine base led to 2 km of peat covered hillside collapsing downslope and travelling 20 km along the local river system (Lindsay and Bragg, 2004). After a multi-million Euro fine and ongoing failure to restitute and stabilise the area, the Irish Government has now decreed that the windfarm must be dismantled.

This incident is not an isolated case. There have been several peatslope failures associated with construction developments in Ireland in recent years (Long, Trafford and Donohue, 2013; and https://www.youtube.com/watch?v=Whuo69ZXG3A)

A fen system not unlike that of the MLWC, Wingecarribee Swamp in Australia sat within the watershed supplying much of Sydney with its drinking water. Peat extraction operations within the site contributed to sudden and catastrophic collapse of this system as a result of failure at a single point, rendering the drinking-water supply for Sydney unusable for an extended period (http://www.herinst.org/wingecarribee/story/story.html).

Given that the Suncor mine will lie upslope from the MLWC, catastrophic failure of a single point associated with the mining operation would inevitably flow into the MLWC – not a point explored by the Operational Plan.

## 6. Carbon emissions

Figure 3 illustrates the challenges in terms of the peat depths facing those attempting to implement the Operational Plan - surprising omission from the Operational Plan, which refers occasionally to peat depths but at no point provides such a whole-site assessment of the peat within the area to be mined.

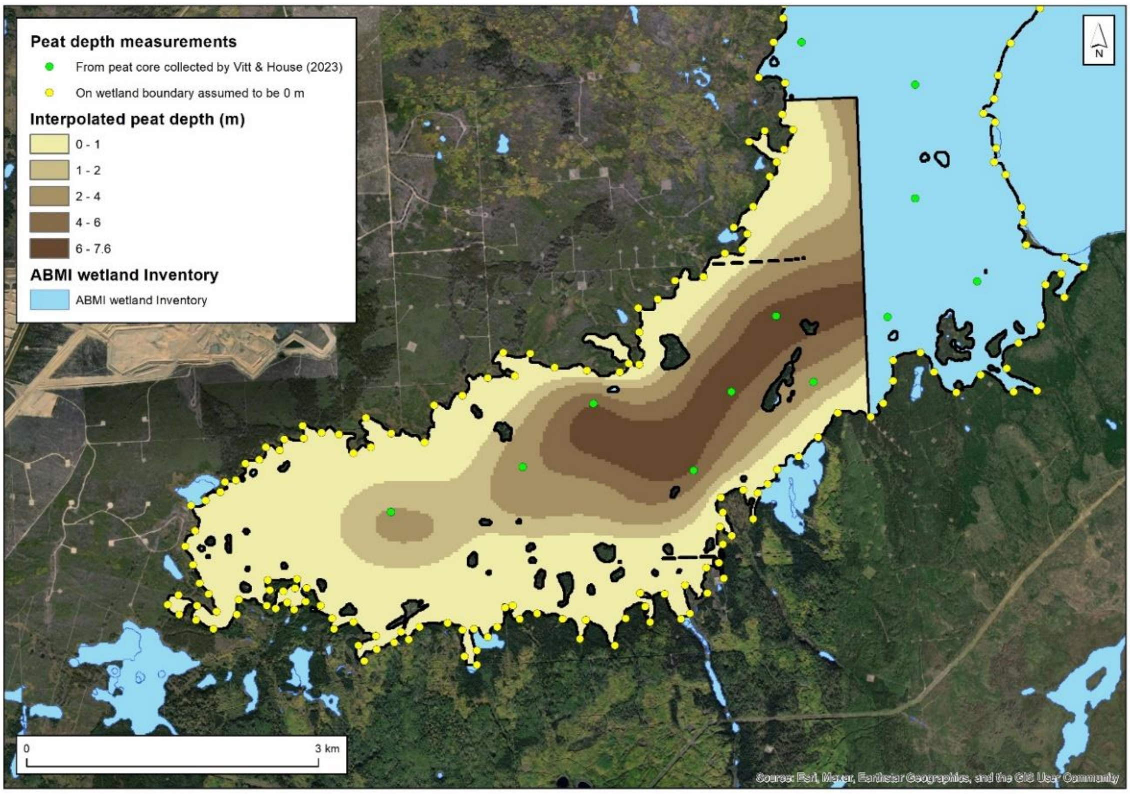


**Figure 3.** Interpolated peat depths within the consented area of the MLWC, based on depth of peat cores recorded by Vitt and House (2023). Generated for this report by Dr Ben Clutterbuck, Nottingham Trent University, UK.

The peat volumes which must be extracted can be estimated from the model used to generate Figure 3, assuming that the edge of the ABMI boundary represents the edge of the peat – which may in fact not be the case. This amounts to 31.6 million $m^3$. The fate of this huge volume is not addressed in the Operational Plan, but it can be assumed that the majority will ultimately be oxidised and lost to the atmosphere as carbon dioxide.

Notwithstanding the fact that extraction of oil from tar sands itself runs counter to Canada's commitments under the UN Framework Convention on Climate Change, this loss of peat-derived carbon to the atmosphere represents somewhere between 7 million and 11 million tonnes of $CO_2$ to the atmosphere depending on the dry bulk density of the peat, in yet further direct conflict with the Government of Canada's commitment to its current NDC target "*to reduce its economy-wide greenhouse gas emissions by 40-45% below 2005 levels by 2030.*

*Canada is also committed to reducing its emissions to net-zero by 2050, as enshrined in the Canadian Net-Zero Emissions Accountability Act. The Act, which became law on June 29, 2021, establishes a legally binding process to set five-year national emissions-reduction targets as well as develop credible, science-based emissions-reduction plans.*" (Government of Canada website).

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Appendix H
to the Reply Submission of
Alberta Wilderness Association
dated June 9, 2023

# A Case for Preserving the McClelland Lake Patterned Fen

Report to Alberta Wilderness Association

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May 31, 2023

## Introduction

The McClelland Lake Wetland Complex (MLWC) has been described by scientists who have worked in the region as one of the largest and most spectacular patterned fens in the province with a plethora of unique attributes. One has even gone as far as noting if rivals the natural beauty of the Canadian Rockies (Horton 2002). True North Energy's request to the AEUB to withdraw the portion of its EIA describing impacts to the wetland complex was a mistake that has led to the current crisis of the fen's destruction. The Alberta Wilderness Association's (AWA) report on this long-standing issue outlines how Suncor's mitigation strategy poses a significant risk with severe and irreversible damage to the unmined portion of the MLWC (AWA 2023[a]); the mine extension into the wetland simply should not have been approved by the AER. The amended plan to allow mining in half of the wetland complex is flawed given the significant uncertainties associated with surface mining and reclamation (AWA 2023[a]). To be able to maintain the water table, water chemistry, and water flow within limits as indicated by natural fluctuations to maintain ecosystem diversity and function of the McClelland Lake wetland complex where surface mining is not allowed cannot be viewed as reasonably feasible. It is highly improbable that the remaining section of the McClelland Lake patterned fen will retain its ecological integrity. The building of a 14 km wall 20 – 70 m deep with peat 2 – 8 m deep to sustain an 8,000+ year wetland and the associated habitats has not been clearly developed. The slightest changes in hydrology can instigate irreparable community change. There is much at stake here. Coupled with the complete loss of the lower half of the wetland, the risk is regional in scope if one includes the factors of uniqueness, biodiversity, age and stability, hydrology and biogeochemistry, fire, carbon, and reclamation challenges.

## Uniqueness

Patterned fens represent only 4.5% of the peatlands in Alberta (Vitt et al. 1996). It has been long suspected that the MLWC was unique before a highly flawed report by Halsey et al. (2001) used to support mining of the fen was revealed. Since then, various research, including by some of the authors of Halsey (2001), have been conducted to a much higher standard with different results. Dr. Diana Horton, now deceased, was a peatland ecologist and intimately familiar with McClelland fen (Horton 2002). She testified at the 2002 EUB Hearings in Ft. McMurray, outlining the significant deficiencies of Halsey et al. (2001). The simple misrepresentation of numbers was corrected by Horton, including numbingly poor statistical analyses, and ultimately that, when Halsey's figures are converted more correctly to percentages, the McClelland fen is larger than 91% of peatland complexes/patterned fens in Alberta. Additionally, while Thickwood fen, a site given as a better example close to McClelland fen to preserve, was recorded as the 203rd largest peatland complex and the 511th largest patterned fen and larger than 95% of peatland complexes, it is only larger than 36% of patterned fens in Alberta, less than McClellend fen (Horton 2002).

The significance of the fen is well known in the ecological community. Special Places Alberta recommended protected status over 20 years ago. The uniqueness alone should be rationale enough for full preservation. Additionally, given its location near current transportation infrastructure, the MLWC will provide the legacy of a unique ecosystem that will be accessible to future generations of Albertans and others should it remain intact.

***The McClellend Lake Fen is an incredibly unique example of a patterned fen in Alberta and a strong candidate as a legacy ecosystem for Albertans and others.***

**Biodiversity Loss**

Peatlands in general provide essential habitat for a plethora of organisms, from microbes to moose (Locky 2003, 2004). The larger the wetland, particularly based on its location, the more critical habitat it can provide. The MLWC is an important stopover point and breeding grounds for many bird species along one of North America's major migratory flyways, including the critically endangered whooping crane, and breeding rusty blackbirds and yellow rails (AWA 2023). For the whooping crane, MLWC lies just south of its two most important breeding areas, which are protected. The protection MLWC once had needs to be reinstated in an even more robust form to complete habitat linkages.

Peatlands are also inordinately important in the boreal region to terrestrial ecosystems and their organisms because they may cover 40 – 60% or the region (Foote and Krogman (2016). We also know that various biological, biogeochemical, and hydrological aspects interconnect theses ecosystems. The larger wetlands are particularly important during environmental perturbations like drought and fire when terrestrial organisms find respite in peatlands. The diversity of McClelland Fen is well known with locally, regionally, and nationally rare plants (Vitt et al. 2003, Vitt and House 2020, Vitt and House 2021).

It is important to point out the ongoing risk to wildlife with associated ponds in the oilsands region, particularly migrating water birds (Foote and Krogman 2016). There is also vast documentation demonstrating that tailings ponds waters with contaminants have seeped into groundwater and pose a risk to migratory birds that land on them.

Additionally, while we know something of the plant communities associated with the site, almost nothing of most of the vertebrates and invertebrate communities; research is required before we know the extent of potential losses in those groups.

***McClellend Lake Wetland Complex is a large unique example of a wetland habitat that is not only home to plethora of rare and native and migrating wetland species, but also provides a buffer of critical habitat for terrestrial organisms.***

**Age and Stability**

The first dating of wetlands in the oilsands region occurred in the 1980s, with number suggesting sites were up to 8,000 years old (Zoltai and Vitt 1990). The McClelland Fen was first thought to have initiated 4,000 – 6,000 years before present (AWA 2023[b]). We now know that the McClellend fen first began accruing organic matter some 11,457 years before present (Vitt and House 2023). While tropical forests and coral reefs are considered the oldest ecosystems on earth, in Canada it is incredibly rare to have an ecosystem that has not changed floristically for such a long time such as the McClelland fen.

The dominant central portion the fen has remained incredibly resistant to change, with the same two dominant mosses, varnished hook moss (*Hamatocaulis vernicosus*) and sausage moss (*Scorpidium scorpioides*), functionally present for up to 8,000 years. These foundational species have been drivers of maintaining the community composition along with a few other species, including golden fuzzy fen moss (*Tomenthypnum nitens*). This is due to dependence on a persistent long-term ground water source. If there are changes to water levels or base cation concentrations, it is very likely that shifts in plant dominance or even loss of peat-forming species could occur, ultimately affecting organic matter accumulation (i.e., carbon) on the site (Vitt et al. 2022). Thus, any subsequent interruption to the source waters that the MLWC are dependent on would very likely be detrimental to the fen.

***The McClelland Lake Fen is one of the oldest ecosystem types in Alberta, but whose stability is based on two or three main species through maintenance of the hydrology that has persisted for over 10,000 years.***

**Hydrology and Biogeochemistry**

Patterned fens are unique and complex ecosystems, given their string and flark patterning. There are several theories based geomorphic, biological, and climatic variables, but none is without criticism (Glaser et al. 1981). While an integration of those and other factors is required for further understanding, it is safe to say the hydrology plays a key role, with the reticulating patterns generally perpendicular to water flow.

Vitt et al. (2022) have revealed five spatial areas within the McClelland fen based on surface water chemistry and water flow. The wetland is quite heterogeneous, with water chemistry in the northern area containing about one-half of the cation concentrations than that of the south. This is likely related to the differing stoichiometry of the water between these regions of the fen, as the water is coming from different sources. What follows is the vegetation; distributions of the dominant plant species are different in both north and south sections, with a narrow transitionary zone in between.

Challenges to peatland integrity in the oil sands region is already well stated (Volik et al. 2020). Coupled with climate changes, the issues are heightened. Whittington and Price

(2006) have demonstrated how patterned fens react to water draw downs. The resulting lawn peat becoming more rigid forces water to fluctuate relative to the surface and further enhances peat decay and densification; the resulting positive feedback loop may intensify further peat degradation, changing carbon cycling dynamics, i.e., the loss of peat. That Suncor's Fort Hills mine already butts up against the McClelland Lake wetland could likely already be causing unknown issues.

***The McClelland Fen is quite heterogeneous from north to south based on differing source waters, biogeochemistry, and ultimately the plant communities, and loss of the southern portion will mean loss of those unique plant communities.***

**Climate Change and Fire**

Fire activity in Canada has doubled since 1970 (Public Safety Canada 2023). Alberta has been at the epicenter of natural disasters in Canada in recent memory, including fires in Ft. McMurray in 2016, Waterton Lakes areas in 2017, and the unprecedented fires in central Alberta in spring 2023. Most of the current fires and fire risk reside in Alberta's boreal region, with an area greater than the size of Cape Breton burned by May 31, 2023.

The fire severity and risk have significantly increased in Alberta's boreal region. This is primarily due to the area becoming significantly warmer and drier over the past 50 years (Whitman et al. 2022). During this period there have been increases in the annual number of large wildfires, area burned, and fire sizes. Additionally, the likelihood, area and number of extreme short-interval reburns (≤15 years between fires; 1985–2019) have also significantly increased, with the portion of forested unburned islands within fire perimeters declining, but fire severity increasing in open conifer and mixedwood forests.

But parts of the boreal region have built-in resistance to fire (Kuntzeman et al. 2023). Because peatlands are a dominant component in the oilsands region (Foote and Krogman 2016), their reliable water sources and saturated nature provide fire resilience compared to adjacent ecosystem types (Kuntzeman et al. 2023). The authors' study of fire in Alberta's boreal region (1985-2018) investigated the role of hydrological, ecological, and topographic heterogeneity, and climate moisture patterns, on the presence of fire refugia in forested upland and peatland ecosystems. Predictive maps developed highlighted the probability of refugia from fire with forested fens have 64% higher probability of provided refugia than upland forests. In peatlands in general, regional climate moisture conditions nor the interannual deviations affected refugia, demonstrating a critical the importance of large areas of intact peatlands. In fact, intact peatland areas have a high probability of providing fire refugia, slowing climate-driven, fire-mediated vegetation transitions in surrounding forest ecosystems.

Peatlands that have been compromised hydrologically do not fare as well. Sites decoupled from their hydrological regime present a severe positive feedback loop, in that, those peatlands that succumb to fire are even more susceptible to increased post-fire drying (Kettridge et al. 2019). This adds to future fire risk. A significant resilient ecosystem on the greater landscape in its current form, a compromised McClelland fen would fall into this category of fire susceptibility. An uncompromised MLWC is critical to helping buffer fire risk in the region, given the increased the unprecedented fire risk Alberta currently faces (Whitman et al. 2022).

***An intact McClelland Lake Wetland Complex will provide a significant buffer and refuge for organisms to climate change and to the ever-increasing fires on the region.***

**Carbon Loss**

The Geological Survey of Canada reports that the peat in Canada's wetlands stores almost 60 percent of all the carbon stored in soils across the country (As reported in DUC 2017). Most of these wetlands are peatlands, and the 147-billion tonnes of carbon stored in Canadian wetlands is over 900 times the annual $CO_2$ emissions from all industrial activity in Canada.

The loss of the carbon sequestered in the fen by removal for bitumen extraction itself is problematic, given the large proportion that has been stored for close to 10,000 years in the greater region (Zoltai and Vitt 1990), and for up to 11,000 years at MLWC (Vitt and House 2023). The risk is heightened when coupled with the threat of fire (Kettridge et al. 2015, 2019). When modelled, a moderate drop in water table position predicted for most northern regions will trigger vegetation shifts previously observed within only severely disturbed tropical peatlands. Non wetland or compromised wetlands, i.e., non-carbon accumulating ecosystems, are more likely to experience low intensity, high frequency wildfires, further depleting stored peat carbon. There is a good case for maintain contiguous, well-functioning wetlands like MLWC to reduce fire risk and preserve carbon stores.

***An intact McClelland Lake Wetland Complex will help to maintain significant amount of sequestered carbon in the region.***

**Operational and Reclamation Challenges**

The amended plan to allow mining in half of the wetland complex is flawed given the significant uncertainties associated with surface mining (Suncor-Ft. Hills 2021). To be able to maintain the water table, water chemistry, and water flow within limits as indicated by natural fluctuations to maintain ecosystem diversity and function of the McClelland Lake wetland complex where surface mining is not allowed cannot be viewed as reasonably feasible (AWA 2023[a]). It is highly improbable that the remaining section of the McClelland Lake patterned fen will retain its ecological integrity. The building of a 14 km wall 20 – 70 m deep with peat 2 – 8 m deep to sustain an 8,000+ year wetland and the associated habitats has its own challenges outlined in AWA (2023[a]). That it has been informally referred to as a water management experiment more than a mitigation plan has more truth in this than we know.

As noted in Vitt and House (2023), differences in source waters and the associated biogeochemistry can illicit community change. Based on the historic record through the Holocene, the resistance to vegetation change for rich fens across the region is likely associated with the persistence of long-established, reliable groundwater inflows. More importantly, maintaining the integrity of the surrounding watersheds is critically important to the long-term survival of patterned rich fens.

Bryophytes have very specific habitat requirements. Experiments with bryophyte establishment at experimental peatlands like Sandhill Fen have demonstrated negative results to bryophyte communities over time due to a wide variety of difficult to control factors (Vitt et al. 2023). While a number of peatland bryophytes initially established in numerous areas across Sandhill Fen, in subsequent years these populations have been compromised by: 1) increasing water tables with expanding Typha-dominating areas, 2) high sedge productivity and fluctuating water tables, 3) increasing vascular plant cover, and 4) increasing sodicity. These factors have reduced the number of bryophyte microhabitats, resulting in a much-diminished community of peatland bryophyte species.

Reclamation designs for fens should include microhabitats for bryophytes as they are foundational species and integral to fen development. (Vitt et al. 2023). However, even the risk to the unmined MLWC is very high, with the mitigation strategy put forth my Suncor, deeply flawed (AWA 2023[b]). Drs. Biagi and Harris have been outlined succinctly the uncertainties and deficiencies posed to the unmined MLWC, including, 1) unaddressed potential saline contamination of the wetlands and groundwater, 2) lack of modelling for potential impacts to groundwater quality, 3) insufficient observational data for hydrological model calibration, 3) uncertainty and risk with proposed “conceptual stage” water management plan, 4) the assumption of negligible impacts from predicted water level changes, 5) unrecognized impacts to the ecological integrity and functionality of the patterned fen, 6) and unrecognized impacts to peatland carbon stores and, 7) the resulting increase in greenhouse gas emissions.

One only must look at the great cost and lack of efficacy of the Suncor and Syncrude constructed fens to understand the monumental financial and operative challenges with developing and maintaining constructed peatlands. Realistically, there will never a peatland to be restored or reclaimed on the site that is mined and maintenance of the remaining north section of the fen unlikely. Potential effects to McClelland Lake could also potentially occur.

Oil sands companies and the Alberta Energy Regulator have a poor track record of functional and government response to the public of associated environmental issues, with the Imperial Oil tailings pond leak at Kearl being the most recent and poignant example. Several million litres of contaminated water in ground and surface waters continues to be an issue. That anyone can guarantee the McClellend Fen mine wall, a much more complex venture, could fail needs to be deeply questioned. The complicated and complex realities associated with massive scale bitumen mining development, operation, and closure are becoming increasingly placed under the microscope at all scales.

Should the project even be successful, the massive current and future liabilities of cleanup and reclamation are the elephant in the room. There are 160 billion barrels of oil sequestered beneath 142,200 square kilometres in northern Alberta. While just over 1,000 square kilometres has been excavated to date (AWA 2023[a]) not a single reclamation ticket has been yet issued to cleanup a tailings pond. The reason is that companies are struggling to find means for dealing with the landscape scale disturbances they left behind. The MLWC mine will just be one more, and one potentially more difficult to address.

Alberta needs a stronger mandate to protect all peatlands in the oil sands region; it should quality as a wetland of highest value for the long-term benefit of Albertans. It is a vitally important, irreplaceable, and irrecoverable wetland complex. The downgrade in protection using the ‘abundance’ of patterned fens is very unfortunate given several other associated factors.

***The operation and reclamation of a mined McClelland Lake Fen will be exceedingly difficult with a high probability of failure and high cost.***

**Summary**

***The McClellend Lake Fen is an incredibly unique example of a patterned fen in Alberta and a strong candidate as a legacy ecosystem for Albertans and others.***

***McClellend Lake Wetland Complex is a large unique example of a wetland habitat that is not only home to plethora of rare and native and migrating wetland species, but also provides a buffer of critical habitat for terrestrial organisms.***

***The McClelland fen is one of the oldest ecosystem types in Alberta, but whose stability is based on two or three main species through maintenance of the hydrology that has persisted for over 10,000 years.***

***The McClelland Fen is quite heterogeneous from north to south based on differing source waters, biogeochemistry, and ultimately the plant communities.***

***An intact McClellend Lake Wetland Complex may provide a significant buffer and refuge for organisms to climate change, and to the ever-increasing fires on the region.***

***An intact McClellend Lake Wetland Complex helps to maintain significant amounts of sequestered carbon in the region.***

***The operation and reclamation of a mined McClellend Lake Fen will be exceedingly difficult with a high probability of failure and high cost.***

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Appendix I
to the Reply Submission of
Alberta Wilderness Association
dated June 9, 2023

**Report to Alberta Wilderness Association**

I am a Peatland Ecologist/Biogeochemist who has been conducting research on bogs and fens in North America for over 30 years. I have read the *Fort Hills Oil Sands Project - McClelland Lake Wetland Complex Operational Plan*, December 2021. I also have read the Alberta Wilderness Association's Report: *A Review of Suncor's McClelland Lake Wetland Complex Operational Plan for the Fort Hills Oil Sands Project*, April 2023, which listed and described seven major concerns. I am in agreement with all of these concerns. Here, I offer some additional comments, focusing on vegetation, water quality, and normal ranges.

*Vegetation*

I have several concerns about the McClelland Lake Fen vegetation monitoring. Although vegetation monitoring has been carried out almost every year since 2008, the number of plots in the fen (six sites, two plots per site) is low, given the overall area of the fen. The Operational Plan (page 2-124) notes concerns with changing species identification and inter-annual variation in percent cover values, that apparently persisted over this pre-mining vegetation monitoring effort. Although the Operational Plan acknowledges that these issues must be resolved (page 2-126), the quality and value of the pre-mining vegetation data may have been diminished. If the goal is to be able to detect changes in vegetation composition over time during and after mining, it is critical that identifications be made to the species level. Identifying sedges as *Carex* sp. and then removing those observations from the pre-mining data set (page 2-126) also has compromised the vegetation monitoring effort. I provide comment on using the normal range approach below, but the Tables in Section 2.5 have large normal ranges, which may be a result, at least in part, of small sample sizes, issues in species identification, not identifying all groups to the species level, and inter-surveyor variability in expertise and experience. Given these large ranges in normal ranges, it is very unlikely that the proposed vegetation monitoring would be able to detect change that would be attributed to mine operations even if such changes indeed exist. These comments may be moot, as the normal ranges for vegetation metrics in Objective 1 appear to have been calculated by identifying all plants to the species (or genus) level, yet the metrics proposed for triggers and limits in Objective 6 would be based on only the nine indicator species identified in Objective 1. If my reading of these sections is correct, the natural range values reported in Objective 1 do not have bearing on the trigger and limit criteria in Section 6.

Indicator species are indicators of a particular wetland type or landform in that they reflect water quantity and quality typical of these features. Therefore, the vegetation monitoring effort described in the Operational Plan is designed as a tool to indirectly assess water quality and quantity, not vegetation change. Further, none of the nine indicator species (page 2-128) is rare. However, several studies have reported that there are many plant species in McClelland Lake Fen that are considered rare, and some of these are culturally important. Under the proposed vegetation monitoring structure, all of the rare species could be extirpated from McClelland Lake Fen without a trigger or limit being reached.

If the goal of vegetation monitoring is to be able to detect changes relative to baseline conditions, sampling should be performed annually.

*Water Quality*

The Operational Plan correctly states that "… key drivers predicted to affect wetland plant community composition and function in the MLWC are changes in surface water levels (Section 4.3.2.1.3) and surface water quality" (Section 4.3.2.4). I have concerns about the McClelland Lake Fen water quality aspects of the Operational Plan. In my view, insufficient information is provided about the shallow peat wells from which water will be collected for water quality analyses. How deep into the peat are these wells inserted?

Are the well walls slotted throughout the entire depth of the well? If so, it is not clear what the water that fills a well after purging represents. Hydraulic conductivity of peat generally decreases with depth, so if water from all depths refills a well, the mixed water in the well would likely be overrepresented by water from shallower depths. For some parameters, peat porewater chemistry changes with depth, which could also confound understanding what refilled water in a well represents. Our research group has used stacked segmented wells in 10-cm depth intervals in bogs so that when we purge and refill each segment prior to sampling, we are reasonably certain which depth interval each sample represents (Wieder et al. 2021). Being able to detect changes in water quality could be strongly affected by the type of well used. If fen porewater quality is affected by surface water inputs, including resupply water associated with the proposed wall, changes are likely to be manifested in surface water. If fen porewater quality is affected by mining-altered groundwater inputs, changes are likely to be manifested in deep fen porewater. While it may be that the well design is fine, it is not possible to evaluate the design from the Operational Plan document.

Detecting changes in water quality in the unmined portion of the fen will be a challenge for several reasons. Water quality may vary temporally. Vitt and Chee (1990) concluded that across sites in Alberta, moderate-rich fen water quality is much more variable seasonally than extreme-rich or poor fen water quality. With this in mind, it might be prudent to collect peatland water samples at dates (or weeks) that are consistent from year to year, and consistently with respect to time since most recent rain event. The large standard deviations for fen water quality parameters (Appendix C) necessarily result in large calculated normal ranges (Table 2.5-16). As a result, for example, in zone EHZ2, mean $K^+$ concentrations would have to rise from a baseline concentration of 1.6 mg/L to being consistently over 4.9 mg/L to cause a limit or trigger - a 3-fold increase. For other water quality parameters, in EHZ1 and EHZ2, concentrations/values would have to rise to being more than 50 % above baseline to cause a limit or trigger. Thus, a very large magnitude of change in a water quality parameter, which could have implications for vegetation, would be considered acceptable. The normal ranges appear to have been calculated using data across all seasons. If there are clear seasonal patterns, using seasonal normal ranges might be considered (although sample sizes would be smaller, or even zero). To some extent, the small sample size for EHZ1 data ($n$=15, across all seasons) also could contribute to large standard deviations and therefore calculated normal ranges. A total sample size of 15 for EHZ1 seems small vis-à-vis establishing baseline pre-mining water quality.

*Normal Range Approach*

Kilgore et al. (2015) discuss the traditional normal range approach, the approach to be used for detecting change in water quality and other data in the McClelland Lake Operational Plan. Of note, Kilgore et al. report that when the normal range approach is applied, there is a ~50 % probability of committing a Type I error (falsely claiming a measured value is outside of the normal range) and a ~50 % probability of committing a Type II error (falsely claiming a measured value is within the normal range). Neither of these errors is desirable. Although often used, the normal range approach for detecting change in environmental parameters is not very robust. Kilgore et al. (2015) describe two novel noncentral alternative approaches to detecting change in environmental monitoring efforts that reduce Type I and Type II errors to 5 %. Adoption of one of these noncentral alternatives to detecting change in McClelland Lake Fen water quality, and other parameters, should be considered.

*Commentary*

As an academic researcher, I feel a responsibility to speak out from time to time, especially on issues where I have a modicum of experience and expertise. I find it difficult to reconcile declaring McClelland Lake Fen to be an Environmentally Significant Area of Alberta (Sweetgrass Consultants Ltd. 1997) with the

McClelland Lake Operational Plan. The fen is a simply spectacular peatland situated in a largely undisturbed watershed. A truly beautiful place on Earth. Comments from Indigenous People in the Operational Plan clearly and deeply reveal the close connection between people who have lived in the region for hundreds of generations in coexistence with McClelland Lake Fen, McClelland Lake, and the surrounding region. The Operational Plan comes across to this reader as yes, we hear you, Indigenous Peoples, but here's what we are going to do. We are going to move forward to completely obliterate over half of McClelland Lake Fen and use a completely untested approach (installing an impermeable "wall," the composition of which has not yet determined, over 13 km long to the bottom of the fen, along with a series of ponds, pipes, wells, and pumps) to preserve water quantity, water quality, and vegetation composition in the remaining parts of the fen. Not to worry, this complex, untested approach will work flawlessly, 24 hours per day, 365 days per year, for the next 50 years or so. This seems overly optimistic. I support preserving all of McClelland Lake Fen.

Respectfully,

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Appendix J
to the Reply Submission of
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Research Paper

# An 11,000 year record of plant community stability and paludification in a patterned rich fen in northeastern Alberta, Canada

The Holocene
1–12

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**Dale H Vitt and Melissa House**

**Abstract**

Patterned rich fens have a diverse flora and are maintained by unidirectional inflowing water with high concentrations of base cations, along with high pH and limited nutrients. Rich fens are among the most threatened ecosystems in Europe, but are not uncommon across the western boreal forest zone of Canada. Utilizing 10 radiocarbon dated cores extracted from the wetland, we investigated the Holocene developmental history of a large patterned rich fen in northeastern Alberta (McClelland Wetland). Organic matter accumulation began around 11,457 cal yr BP as primary peat formation on recently deglaciated substrates. Over the 10,000+ years history of McClelland Wetland, the central portions of the wetland have been remarkably resistant to change, with little alteration in dominant species. The resistance to change is set against a background of fluctuations in regional Holocene climate and local varying water balance. The dominant bryophyte species (*Hamatocaulis vernicosus* and *Scorpidium scorpioides*) continued to play a foundational role on site for the duration of the Holocene, dependent on a persistent long-term ground water source. Accumulation rates of organic matter have remained steady once the dominant bryophyte layer was established, but with accumulation rates at paludifying marginal sites lower than those of the central moss-graminoid-dominated areas.

**Keywords**

Alberta, boreal, *Hamatocaulis vernicosus*, Holocene, macrofossil, moss, organic matter accumulation, paludification, peatland development, rich fen, *Scorpidium scorpioides*

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## Introduction

Hydrological inputs from precipitation and inflowing surface and ground waters regulate the mineral composition of peatland surface water, including pH, base cations, alkalinity, and inorganic nutrients, and provide the basis for differing peatland site-types. Peatlands are hydrologically divided into ombrogenous bogs and minerogenous fens. In bogs, the surface water and that of the upper peat column are derived only from precipitation, while fens receive additional inputs from surrounding mineral soils or water bodies. Based on direction of inflowing water, fens can be divided into soligenous peatlands, those that receive unidirectional inputs and usually have a patterning of raised strings and elongated pools (flarks – Andersson and Hesselmann, 1907), or those that are located in topogenous basins with inputs from the surrounding landscape, and have no patterning.

DuReitz (1949) recognized differences in plants occurring among various fen sites in Scandinavia, with some sites having a rich and unique flora, while others had fewer species (a poor flora), but with high fidelity. Witting (1947, 1949) was the first to recognize differences in pH and cation concentrations between the rich and poor categories, and Sjörs (1950) related the poor–rich floristic gradient to the pH and electrical conductivity of surface water (see also Sjors and Gunnarsson, 2002; Økland et al., 2001). The water chemistry of the poor–rich floristic gradient has been examined in numerous studies (reviewed by Gorham et al., 1987; Horton et al., 1979; Malmer, 1986). In addition to the differences in species diversity between poor and rich fens, poor fens are typically dominated by *Sphagnum* and ericaceous dwarf shrubs, while rich fens have abundant herbaceous and graminoid vascular plants and true mosses (Bryopsida). The partition between *Sphagnum* and true mosses represents the most distinct floristic gradient along the poor-rich continuum (Gorham and Janssens, 1992).

Rich fens, especially extreme-rich fens, are of specific interest as they harbor high species richness (Vitt et al., 1995), contain unique species assemblages (Janssen et al., 2016), and are important habitats for many rare and threatened species, for example, land snails and calcium-tolerant brown mosses (Horsáková et al., 2018; Jiménez-Alfaro et al., 2012). Rich fens are restricted to areas having base-rich groundwater that maintains basic pH and relatively poor availability of nutrients (phosphorus and nitrogen). In Europe, polluted areas with high land-use intensity, rich fens have lost many of their specialized plant species (Bergamini et al., 2009; Hájek et al., 2015; Kooijman, 2012) and are among the most threatened habitat types (Janssen et al., 2016).

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Extreme-rich fens are dependent on a long-term constant ground water source with high cation content (especially $Ca^{2+}$) and high alkalinity. In cases where these conditions remain constant over millennia, rich fens have undergone little internal change, with a high degree of species resilience; however, these situations are uncommon across the boreal realm (Kubiw et al., 1989; Yu et al., 2003, 2014; Zoltai and Johnson, 1985). In areas with topogenic fen basins or ground water with less alkalinity, autogenic changes within the peatlands provide conditions for succession to other fen site-types (Kuhry et al., 1993). Other paleorecords from boreal peatlands have shown recent increases of *Sphagnum* mosses and shifts toward ombrotrophic conditions during the 20th century, coinciding with warming and lengthening of the growing season (Loisel and Yu, 2013; Primeau and Garneau, 2021; Robitaille et al., 2021; van Bellen et al., 2018). The change from rich fen to *Sphagnum*-dominated poor fen and bog vegetation includes an ecosystem-scale shift, with the potential increase of carbon accumulation (Loisel and Bunsen, 2020).

Peatlands are abundant across the boreal plain of western Canada with approximately 23% of the area covered by fens and bogs (Halsey et al., 1998). Approximately two-thirds of these are fens and one-third are bogs. The distribution and composition of vegetation of fens are related to the pH, base cation contents, and alkalinity of surrounding hydrological inflows. Acidic poor fens are associated with low electrolyte concentrations in waters of areas with poorly weathered bedrock, a situation common on the siliceous Canadian and Fennoscandian shields (Tahvanainen et al., 2002; Vitt and Bayley, 1984). In western boreal Canada, an area largely of sedimentary limestones and shales, poor fens are restricted to topographic highs – for example, Swan Hills (Vitt et al., 1975), and Caribou Mountains (Horton et al., 1979), or to sandy outwash substrates – for example, Mariana Lakes area (Graham et al., 2016). Circumneutral (moderate-rich fens) and alkaline rich fens (extreme-rich fens) are abundant along the eastern foothills of the Rocky Mountains (Slack et al., 1980), and extreme-rich fens become less frequent eastward, except in local areas influenced by calcareous ground water discharge systems also high in base cation content and alkalinity (Vitt et al., 2022).

Peatlands across boreal western Canada have gradually increased in abundance on the landscape over the past 7000–8000 years (Halsey et al., 1998), and have accumulated organic matter to depths of between 200 and 250 cm, with less than 5% of these having depths greater than 450 cm (based on review of 371 sites – Vitt and Wieder, 2008). In general, over the course of the Holocene, peatlands of the region have undergone one of four developmental pathways. Firstly, at higher elevations and on drainage divides, peatlands initiated as *Sphagnum*-dominated poor fens and in the Late-Holocene diversified into bog-poor fen complexes (Nicholson and Vitt, 1990). Secondly, initiating as either marshes or shallow pools and early on developing into true moss-dominated rich fens (Bauer et al., 2003), sites expanded rapidly paludifying the surrounding uplands, and in some cases with consequent isolation from mineral waters and *Sphagnum* invasion, sites developed into bogs (Kuhry et al., 1992, 1993). Thirdly, situated on short-lived, Late Glacial lakes that dried in the Early Holocene, bogs developed and maintained ombrotrophy throughout the Late-Holocene (Bloise, 2007). Fourthly, in the foothills of the Canadian Rocky Mountains and at lower elevations farther east, peatlands initiated as true moss-dominated rich fens with high alkalinity and base cations. These rich fens, with a constant supply of calcareous water, have remained unchanged as wet, moss-graminoid rich fens paludifying surrounding landscapes as wooded or shrub-dominated rich fen site-types (Kubiw et al., 1989).

Patterned fens (or northern ribbed fens) are "very common in the Mid Boreal and High Boreal Regions" (Zoltai et al., 1988); however, few studies have investigated the developmental histories of these unique peatlands. Zoltai et al. (1988) presented an overview of one patterned fen located in north-central Alberta wherein they described rich fen species (*Scorpidium scorpioides)* continually present for the 175 cm length of a core 210 cm long and dated at ca. 7700 cal yr BP. They reported the long-term accumulation rate of 0.31 mm $yr^{-1}$. This developmental pattern compares well with historical studies of non-patterned rich fens in other parts of Alberta (e.g. Bauer et al., 2003; Kubiw et al., 1989; Yu et al., 2003). From the limited studies available across the western boreal region of Canada, these unique peatlands appear to have remained largely unchanged for much of their Holocene development, in contrast to autogenic successional changes that have occurred in other peatlands.

Here, we examine the Holocene development of a large patterned fen, with the following objectives: (1) Utilizing a set of radiocarbon-dated cores extracted throughout the peatland, determine the developmental history of the fen, (2) place the early history of the peatland into the post glacial chronology and peatland development, as presently known, of the area, (3) examine the rates of long-term organic matter accumulation and relate these to spatial development of the fen, and (4) explore whether changes in dominant species and overall vegetation have changed or remained constant over the life of the peatland.

## Study area

The McClelland Wetland Complex is located at 57°27′01.81″N, 111°25′35.90″W, 83 km north of Fort McMurray, Alberta. The complex is approximately 10 km long and 5.0 km wide at its widest point, with an area of 3835 ha (Figure 1). The patterned area contained within the wetland is 6.6 km long, 2.5 km wide, and 720 ha in extent, with an elevational gradient from 300.4 to 292.8 m.

Located on the northern slopes of the Fort Hills and associated with a fluvial-aeolian sand plain to the north, the McClelland watershed is 330 $km^2$ in extent and consists of (1) McClelland Lake, (2) the McClelland Wetland complex located west of the lake (studied here), (3) a mosaic of upland forests of *Picea glauca, Pinus banksiana*, and *Populus tremuloides*, and (4) a number of large wetlands along the northeastern and southern margins of McClelland Lake. The Fort Hills Upland Complex is a thrust moraine of displaced blocks of pre-exiting sediments and bedrock that forms a prominent physiological feature rising about 50 m about the surrounding glacial till plain and provides calcareous groundwater discharge to the watershed. The McClelland Wetland complex is comprised of a number of wetland site-types. These various site-types are organized into complex patterns on the wetland landscape and together occur as areas that exhibit specific ecological and hydrological characteristics. These site-types can be described as follows.

## Modern wetland vegetation

*Northern patterned fen* (136 ha – N in Figure 1). This area is characterized by moderate-rich fen chemistry and vegetation indicators (see Vitt and House (2021) for terminology and peatland classification), with well-organized strings and flarks. Water flows into the area from the northwest, flows eastward, and exits the wetland through one northern outlet (east of arrow at "1") to McClelland Lake. This site-type grades sharply in chemistry and vegetation into the southern patterned fen to the south through a low water divide characterized by poorly organized strings and flarks (Vitt et al., 2022).

*Southern patterned fen* (576 ha – S in Figure 1). The area is a moss-dominated extreme-rich fen occupying the central portion of the complex. Characterized by large flarks to the east, with these becoming smaller in width and well-organized to the west

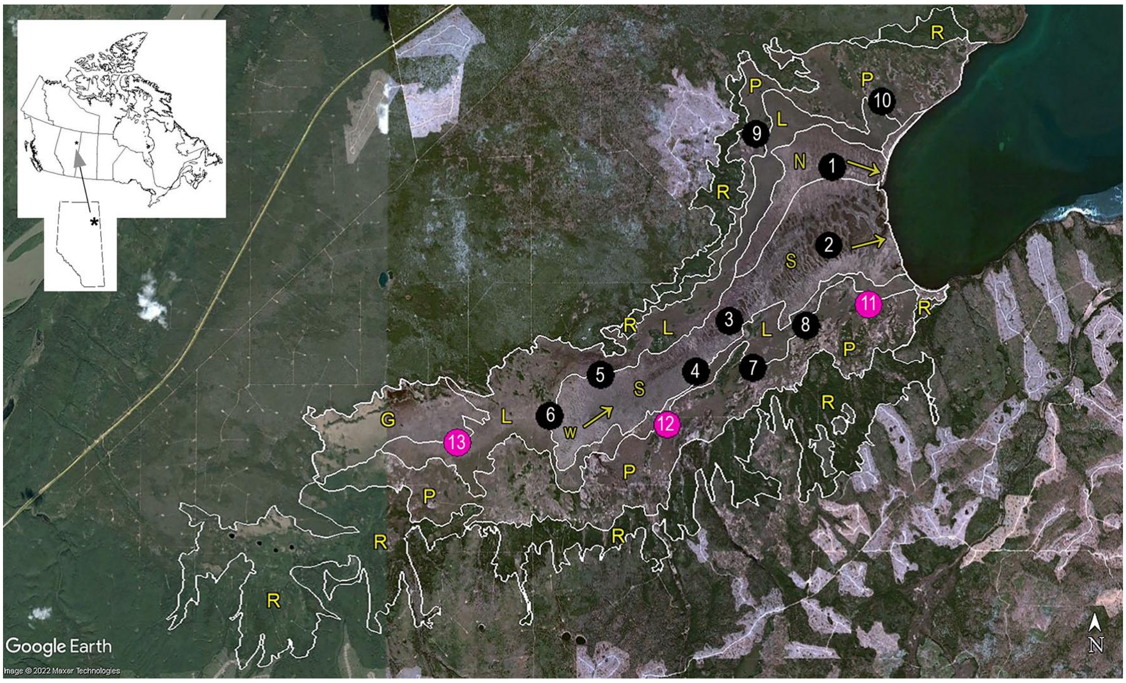


**Figure 1.** Google image of McClelland Lake Wetland (2005). Outline of vegetation zones surrounding the patterned fen and location of cores 1–10 (Black) and cores 11–13 (not used analyzed for macrofossils-Pink). L = *Larix*-dominated rich fens; P = areas of permafrrost/bog/fen swamp complexes, with permafrost-dominated peat plateaus that are actively thawing; *G* = moss/graminoid fens; and R = riparian swamp forests dominated by *Picea mariana*. N = area influenced by northern water sources (=northern patterned fen), S = area influenced by southern water sources (southern patterned fen), arrows denote direction of water flow. Core 1 from the patterned area of the northern patterned fen, Cores 2–6 from the southern patterned fen, Cores 7 to 8 and 11–12 from areas surrounding the southern basin, Cores 9–10 from surrounding areas of the northern fen, and Core 13 from the western moss-graminoid area. McClelland Lake on right of image, Athabasca River present beneath insets flowing to the NNE, Fort Hills Upland Complex adjoins the Wetland to the south with clear-cut upland forest evident to the SE of the Wetland. Inset map of Canada and Alberta * = location of study area.

along an elevational increase. At the western end of the patterned area, the flark/string pattern becomes oriented east/west indicating water flow from the southern boundary of the wetland complex (w in Figure 1) and directed along the main water track. Additionally, water flows eastward from a second source located to the south of the main water track (just NW of "8" in Figure 1). Strings are dominated by larch (*Larix laricina*) in the eastern portion of the area and by shrub birch (*Betula glandulifera*) to the west. Water exits the area to McClelland Lake mostly through one southeastern outlet (east of arrow at "2").

*Moss/graminoid* fen (213 ha – G in Figure 1) with high water levels, no patterning, and relatively shallow peat depth (<1.5–2.0 m), occurs as a large homogenous region in the northwest portion of the wetland where it grades into a shrubby rich fen to the south. The northwestern moss/graminoid area is dominated by the moss, *Scorpidium scorpioides* and the graminoid, *Carex lasiocarpa*. The northwestern area is dissected by a sigmoid, linear, upland sand ridge. Water levels are highest along the southern edge of the ridge and drier along the northern side, suggesting water flow from the south and blockage along the ridge (pers. observation, D. Vitt).

*Larix-dominated rich fens* (662 ha – L in Figure 1) consist of areas of the wetland complex bordering the patterned fens to the west, north, and south and dominated by uniform open forest, grading to shrubby fen to the northwest. Mineral islands are present in the northern portion.

*Permafrost/bog/fen/swamp complexes* (1084 ha – P in Figure 1) Three extensive areas are located along the southern boundary of the wetland and also present to the northeast of the northern patterned area. Areas in this zone are a complex of bogs with and without permafrost, most of which has recently thawed and are currently regenerating with a variety of woody vegetation components. Peat plateaus are present to the southeast interspersed with *Larix* fen and extensive thaw in some areas. Graminoid-dominated areas, some with pooled water, indicate water movement through saturated peat.

*Riparian swamp forests* (1161 ha – R in Figure 1). Areas of wooded swamp dominate the southern margin of the wetland complex and extend southward along tributary streams to the wetland, becoming less abundant along the northern boundary. These riparian, wooded areas have large *Picea mariana* (with some *Larix laricina* and *Picea glauca*) on shallow organic soils.

## Climate

The climate of the region is subhumid and continental (Little-Devito et al., 2019), with warm, short summers and long, cold winters. The annual mean monthly temperature 0.2;°C[a], ranging from −19.6°C[a] in January to 16.8°C[a] in July; annual precipitation is 429 mm[a], with 56% falling during the May-August growing season. Potential evaporation is 529 mm[b] and relative humidity 70%[b] ([a] 1919–1943 data from the Fort McMurray climate station, and 1944–2019 data Fort McMurray Airport and [b] from the Fort McMurray airport, 1953 to 2019).

## Methods

### Core extraction and analyses

We investigated development of McClelland Wetland through macrofossil profiles from 10 long cores (Figure 1, Table 1). In 2017, one long core was extracted using a 4 cm diameter MacCaulay peat corer 0.5 m in length (Core 5, Figure 1). Core material was carefully moved to 4 cm diameter, longitudinally split, PVC pipe and wrapped with plastic wrap. During the winter of 2017 three cores were extracted using a Sonic corer; however,

**Table 1.** Elevations, peat depth, and locations for the 13 long cores extracted from the wetland in 2017 to 2020.

| Core no. | Mineral contact elev (masl) | Surface elevation (masl) | Depth (cm) | Age (cal yr BP) | Location (Latitude, Longitude) |
|---|---|---|---|---|---|
| 1 | 287.8 | 295.0 | 722 | 11,457 | 57.468111° −111.405417° |
| 2 | 291.8 | 295.1 | 360 | 9131 | 57.457611° −111.406444° |
| 3 | 289.9 | 296.7 | 690 | 11,425 | 57.447450° −111.431299° |
| 4 | 291.1 | 297.7 | 657 | 11,280 | 57.440694° −111.439639° |
| 5 | 293.5 | 299.4 | 590 | 11,310 | 57.440242° −111.463356° |
| 6 | 296.4 | 299.9 | 316 | 6863 | 57.434761° −111.476028° |
| 7 | 294.3 | 297.0 | 279 | 10,421 | 57.441183° −111.425525° |
| 8 | 297.7 | 303.1 | 538 | 11,179 | 57.446822° −111.412250° |
| 9 | 293.4 | 295.6 | 223 | 5517 | 57.472581° −111.424522° |
| 10 | 291.1 | 295.1 | 404 | 5596 | 57.476961° −111.392872° |
| 11 | 288.4 | 295.3 | 690 | - | 57.449650° −111.396642° |
| 12 | 293.0 | 298.9 | 590 | - | 57.433605° −111.446842° |
| 13 | 297.9 | 300.0 | 210 | - | 57.431220° −111.498947° |

Cores 1–10 were used in macrofossil analysis.

these were allowed to dry out and were not useable for macrofossil analyses. Core logs from these three cores (Cores 11 to 13) were used to assist in elevational and depth profiles (Figure 1). In 2018, 2019, and 2020, nine 15 cm diameter cores were extracted using a sonic corer and shipped to Southern Illinois University (SIU) where they were stored at 2°C until analysis. These nine cores plus core 5 taken in 2017 were used for the macrofossil analyses and radiocarbon dates.

Cores were sampled in 4 cm intervals by removing small (ca. 1–2 $cm^3$) samples, placed in plastic bags, and all material identified in a three-step process. (1) Samples were removed by forceps, placed in a petri dish, and an estimate (to 5%) made of quantity of material identifiable by structure and unidentifiable material (debris); (2) samples were gently rinsed through a 0.5 mm sieve (tea strainer) and structural components estimated, (3) after structural percentages were estimated, percent of all bryophyte species were identified as percent of total bryophytes. Abundances of individual bryophyte species were quantified by multiplying % bryophytes found in step 2 by % in step 3. A list of all structural components and bryophyte macrofossils identified is given in Supplemental Table 1, available online and abundances of all macrofossils in each of the 10 cores are provided in Supplemental Figure 1, available online. Samples of bryophytes or wood were extracted for 37 AMS radiocarbon dates (Table 2) from points along the cores having structural changes and from the basal organic matter, and calibrated for calendar years BP (cal yr BP – Reimer et al., 2009).

### *Long-term organic matter accumulation (LTAR)*

We regressed peat depth against age using calibrated radiocarbon dates from 10 cores extracted from both the patterned areas and the surrounding wooded areas spanning the entire date range of 11,457 cal yr BP. Additionally, we assessed long-term accumulation rates for individual cores using calibrated radiocarbon dates and core depth profiles. Long-term accumulation rates were calculated for the entire length of each core, given as "depth."

## Results

### *Core 1-Northern patterned fen (Figure 2)*

Basal date 11,457 cal yr BP, depth 722 cm, mineral contact at 287.8 m elev.

LTAR (long-term accumulation rate) = 0.63 mm $yr^{-1}$

This core came from a flark located in the center of the northern patterned area (Figure 1). The organic material at 730 cm depth (dated at 11,457 cal yr BP) contained abundant woody twigs with lesser amounts of graminoids, and no bryophytes. Just above this organic stratum, a 24 cm wide zone (with a duration of 231 years) of sandy mineral sediments occurred. These zones suggest a moist post-glacial landscape with at first shrubs, succeeding to a wet meadow. The first peat-forming community (at 11,226 cal yr BP) was dominated by graminoids with shrubs and few bryophytes, suggesting a wet meadow environment formed on wet sand. High percentages of debris suggest relatively high rates of decomposition and limited peat accumulation. About 1000 year later, eutrophic bryophytes became dominant (*Calliergon giganteum* and *Drepanocladus aduncus*) indicating a marsh or young rich fen community. At about 10,000 years, *Hamatocaulis vernicosus* became dominant, but with some remaining shrub presence. This species is a key indicator of moderate-rich fen conditions as found at the site today and indicates succession to rich fen habitats. At about 8500 years cal yr BP shrubs decrease and *Scorpidium scorpioides* is abundant for a short period, along with *H. vernicosus.* This latter species remains dominant throughout the core until the present time. The continued abundance of *H. vernicosus* indicates a stable water regime with little variation and little change for the past 9000–10,000 years (Figure 2).

### *Core 2-Southern patterned fen (Figure 2)*

Basal date 9131 cal yr BP, depth 352 cm, mineral contact at 291.8 m elevation, LTAR = 0.39 mm $yr^{-1}$

**Table 2.** Radiocarbon dates (as calibrated (or calendar) years before AD 1950 – cal yr BP) from McClelland Wetland.

| Lab code | Core | Depth (cm) | $^{14}$C date ±1σ error (yr BP) | Fraction of modern | | Median age (cal yr BP) |
|---|---|---|---|---|---|---|
| | | | | pMC | 1σ error | |
| D-AMS034262 | 1 | 228 | 3749 ± 31 | 62.71 | 0.24 | 4118 |
| D-AMS034263 | 1 | 390 | 4968 ± 37 | 53.88 | 0.25 | 5693 |
| D-AMS034274 | 1 | 699 | 9820 ± 44 | 29.45 | 0.16 | 11,226 |
| D-AMS034264 | 1 | 722 | 9999 ± 42 | 28.80 | 0.15 | 11,457 |
| D-AMS034265 | 2 | 100 | 1073 ± 26 | 87.50 | 0.28 | 960 |
| D-AMS034266 | 2 | 273 | 5859 ± 40 | 48.22 | 0.24 | 6687 |
| D-AMS038120 | 2 | 352 | 8158 ± 35 | 36.22 | 0.16 | 9130 |
| D-AMS038121 | 3 | 681 | 9949 ± 44 | 28.98 | 0.16 | 11,425 |
| D-AMS038122 | 3 | 340 | 3269 ± 30 | 66.57 | 0.25 | 3490 |
| D-AMS038123 | 3 | 478 | 4039 ± 36 | 60.48 | 0.27 | 4602 |
| D-AMS038124 | 3 | 578 | 9203 ± 38 | 31.80 | 0.15 | 10,371 |
| D-AMS034270 | 4 | 138 | 1714 ± 27 | 80.79 | 0.27 | 1596 |
| D-AMS034271 | 4 | 338 | 5376 ± 33 | 51.21 | 0.21 | 6226 |
| D-AMS034272 | 4 | 528 | 7550 ± 37 | 39.07 | 0.18 | 8372 |
| D-AMS034273 | 4 | 657 | 9869 ± 41 | 29.27 | 0.15 | 11,280 |
| D-AMS027127 | 5 | 179 | 1929 ± 42 | 78.65 | 0.41 | 1865 |
| D-AMS027128 | 5 | 313 | 5083 ± 32 | 53.11 | 0.21 | 5828 |
| D-AMS027129 | 5 | 339 | 5899 ± 28 | 47.98 | 0.17 | 6785 |
| D-AMS027130 | 5 | 445 | 7158 ± 31 | 41.02 | 0.16 | 7978 |
| D-AMS027131 | 5 | 549 | 9900 ± 39 | 29.16 | 0.14 | 11,310 |
| D-AMS034255 | 6 | 98 | 2175 ± 27 | 76.28 | 0.26 | 2273 |
| D-AMS034256 | 6 | 178 | 2513 ± 40 | 73.14 | 0.36 | 2604 |
| D-AMS034257 | 6 | 316 | 6016 ± 34 | 47.29 | 0.20 | 6863 |
| D-AMS034260 | 7 | 243 | 6793 ± 36 | 42.93 | 0.19 | 7632 |
| D-AMS034261 | 7 | 279 | 9257 ± 43 | 31.59 | 0.17 | 10,421 |
| D-AMS034267 | 8 | 142 | 1599 ± 37 | 81.95 | 0.38 | 1482 |
| D-AMS034268 | 8 | 400 | 4091 ± 32 | 60.09 | 0.24 | 4574 |
| D-AMS034269 | 8 | 538 | 9731 ± 46 | 29.78 | 0.17 | 11,179 |
| D-AMS034248 | 9 | 106 | Modern | 104.63 | 0.32 | Modern |
| D-AMS034249 | 9 | 142 | 315 ± 25 | 96.15 | 0.30 | 400 |
| D-AMS034250 | 9 | 189 | 1991 ± 27 | 78.05 | 0.26 | 1940 |
| D-AMS034251 | 9 | 223 | 4741 ± 33 | 55.42 | 0.23 | 5517 |
| D-AMS034252 | 10 | 214 | 292 ± 28 | 96.43 | 0.34 | 402 |
| D-AMS034253 | 10 | 270 | 2212 ± 28 | 75.93 | 0.26 | 2233 |
| D-AMS034254 | 10 | 404 | 4843 ± 34 | 54.72 | 0.23 | 5596 |

AMS=DirectAMS, 11822 North Creek Parkway North, Suite 107, Bothell, WA 98011, USA. All calibrations were based on intCal109 calibration dataset (Reimer et al., 2009).

This core was extracted from a medium-sized flark located in the southern portion of the southern patterned area, and just west of the very large flarks bordering McClelland Lake (Figure 1). The core is 360 cm long, with an additional 90 cm of sand mixed with small amounts of wood. At 430–440 cm and 342–368 cm and at the peat-mineral interface (360 cm) several charcoal layers are present. Just above the peat-mineral interface, ectomycorrhizal roots and wood are present. No bryophytes occur in the core until 300 cm (but note that there was no recovery between 304 and 338 cm). The peat/mineral interface is at 291.8 m elevation, 4 m above the surrounding mineral surface of the basin. Peat initiation began at 9131 cal yr BP, 2326 years later than at Core 1. These data indicate the presence of a mineral rise (4 m) above the surrounding basin that for 2000 years contained upland woody vegetation. At the peat/mineral interface, the lack of bryophytes and very few graminoids, coupled with wood and ectomycorrhizal roots indicate a wooded landscape. At about 7500 cal yr BP *Hamatocaulis vernicosus* along with graminoids increase. Wood and twigs continue to be abundant in the core until about 500 cal yr BP. At about 5000 cal yr BP, *Scorpidium scorpioides* and *Pseudocalliergon trifarium* increased in abundance, decreasing a short time afterward, replaced by *Hamatocaulis vernicosus*. At 960 cal yr BP, *S. scorpioides* becomes dominant and woody materials decrease to the surface (Figure 2). Organic matter accumulation rates were relatively low for the first 8000 years at 0.30 mm yr$^{-1}$, increasing to 1.04 mm yr$^{-1}$ in the last 960 years correlating to the increase in *S. scorpioides.*

### *Core 3-Southern patterned fen (Figure 2)*

Basal date 11,425 cal yr BP, depth 718 cm, mineral contact at 289.5 m elevation, LTAR = 0.60 mm yr$^{-1}$

This site is situated near the middle of the southern patterned area, about 1.9 km west of Core 2 (with the mineral contact 2 m lower in elevation) and 0.9 km east of Core 4 (with the mineral contact 1.2 m lower in elevation) in an area of medium-sized flarks (Figure 2). Initiation of organic matter accumulation began at 686 cm depth and 11,425 cal yr BP on wet sand. Woody vegetation and graminoids were present just before and after initiation of peat with continued presence until 610 cm depth. At 674 cm, both *Scorpidium scorpioides* and *Hamatocaulis vernicosus* are present and remain frequent until 606 cm. At 610 cm, continuing until 586 cm, sand dominates the core with no organic matter present until at 582 cm and dated at 10,372 cal yr BP. *Calliergon giganteum* with ectomycorrhizal roots dominate this transition, indicating a zone with woody vegetation. Evidence of shrubs and woody

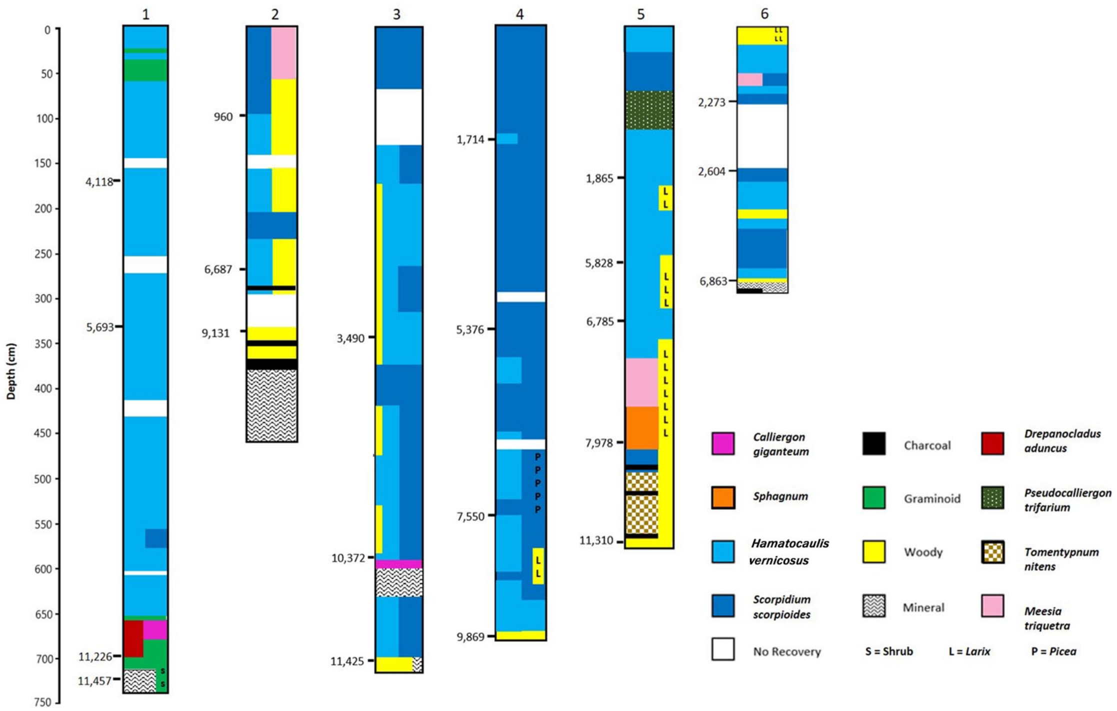


**Figure 2.** Summarized profiles of core lithologies for Cores 1–6. Dominant macrofossil components color coded. Radiocarbon dates shown on left of profiles (cal yr BP). Profiles based on data in Supplemental Figure 1, available online.

vegetation remain present until 180 cm. At about 86 cm (but with no recovery between 86 and 152 cm), *S. scorpioides* becomes dominant with no evidence of woody vegetation. Between 560 and 150 cm, *H. vernicosus* and *S. scorpioides* are variably dominant with *S. scorpioides* dominant for a period between 416 and 368 cm depth (at about 4000 cal yr BP for 500 years). Organic matter accumulation during the first 5700 years was relatively slow at 0.17 mm $yr^{-1}$, and relatively fast in the last 4600 years (at 1.04 mm $yr^{-1}$). Overall, this site developed from a shrub-dominated (perhaps with scattered trees) area to an open, moss-dominated, wet flark. The 20 cm mineral band at 586–610 cm depth is worth noting as a unique mineral incursion (Figure 2).

### *Core 4-Southern patterned fen (Figure 2)*

Basal date 11,280 cal yr BP, depth 657 cm, mineral contact at 291.1 m elevation, LTAR = 0.58 mm $yr^{-1}$

The site of this core is 0.9 km SW of Core 3 (with the mineral contact 1.6 m higher in elevation) and 1.1 km east of Core 5 (with the mineral contact 2.4 m lower in elevation), in a flark on the south side of the patterned area (Figure 1). Organic matter initiation began at 11,280 cal yr. BP and 657 cm depth. *Picea* needles, wood, and abundant twigs are present in the core at this depth, with bryophytes (*Hamatocaulis vernicosus* and *Scorpidium scorpioides*) evident at 648 cm. *Hamatocaulis vernicosus* and then together with *S. scorpioides* dominate the core until 528 cm (and 8372 cal yr BP), with brief evidence of *Picea* (at 576–580 cm) and *Larix* (at 568–572 cm). At 8372 cal yr BP an abrupt shift occurs with bryophytes decreasing and *Picea* and woody components increasing, remaining conspicuous in the core until 468 cm (about 7400 cal yr BP). From this depth until the present, *S. scorpioides* is the dominant component in the core, with several occurrences of co-dominance with *H. vernicosus* (Figure 2). The rate of peat accumulation in the first 5054 years was 0.63 mm $yr^{-1}$, compared to a slightly lower rate of 0.54 mm $yr^{-1}$ for the last 6226 years. In summary, this site paludified quickly at 11,280 cal yr BP to a moderate-rich fen, underwent a dry treed phase beginning at 8372 cal yr BP lasting until about 7400 cal yr BP, after which moss-dominated wet conditions prevail until the surface.

### *Core 5-Southern patterned fen (Figure 2)*

Basal date 11,310 cal yr BP, depth 590 cm, mineral contact at 293.5 m elevation, LTAR = 0.52 mm $yr^{-1}$

This core came from the northern edge of the patterned area, 1.1 km northwest, with the mineral contact 2.4 m higher in elevation than Core 4 and 1.24 km east, with the mineral contact 2.5 m lower in elevation than Core 6 (Figure 1). Peat formation began at 11,310 cal yr BP (at 549 cm depth) associated with abundant macrofossils of *Tomentypnum nitens*, *Picea*, wood, and charcoal, indicating a paludifying black spruce wooded fen with a hummocky ground layer. Charcoal is abundant in the samples from 543 to 429 cm, with wood abundant from initiation to 339 cm – dated at 6750 cal yr BP. Transitions in the early core were from *Tomentypnum nitens*, to *Scorpidium scorpioides*, to *Sphagnum warnstorfii* at 7978 cal yr BP, indicating at first treed conditions, then open conditions, and back to treed habitats. *Larix* is present from 446 cm to 354, 299–263, and 191–171 cm in low abundance. At about 400 cm depth, *Sphagnum* species abruptly decrease and species of open flark conditions increase, notably *Meesia triquetra*, followed by *Hamatocaulis vernicosus* and *Pseudocalliergon trifarium* at 339 cm and 6750 cal yr BP. Wood is abundant in the core until 339 cm and decreases upward, and after from 425 cm to the surface *H. vernicosus* and herbaceous macrofossils dominate the core (Figure 2). Organic matter accumulated at a rate of 0.31 mm $yr^{-1}$ for the first 3332 years, then increased to 0.86 mm $yr^{-1}$ during the period of *Sphagnum* presence and transition to wet conditions, followed a rate of 0.50 mm $yr^{-1}$ for the last 6750 years. In summary, organic matter began accumulating in a paludifying forest at 11,320 cal yr BP and continued until approximately 7460 cal yr BP when trees decreased and rich fen bryophyte species became more abundant. From about 5800 cal yr BP until the present, species characteristic of very wet rich fens (including flarks) are variously abundant.

### *Core 6-Western edge of southern patterned fen (Figure 2)*

Basal date 6863 cal yr BP, depth 316 cm, mineral contact at 296.4 m elevation, LTAR = 0.46 mm $yr^{-1}$

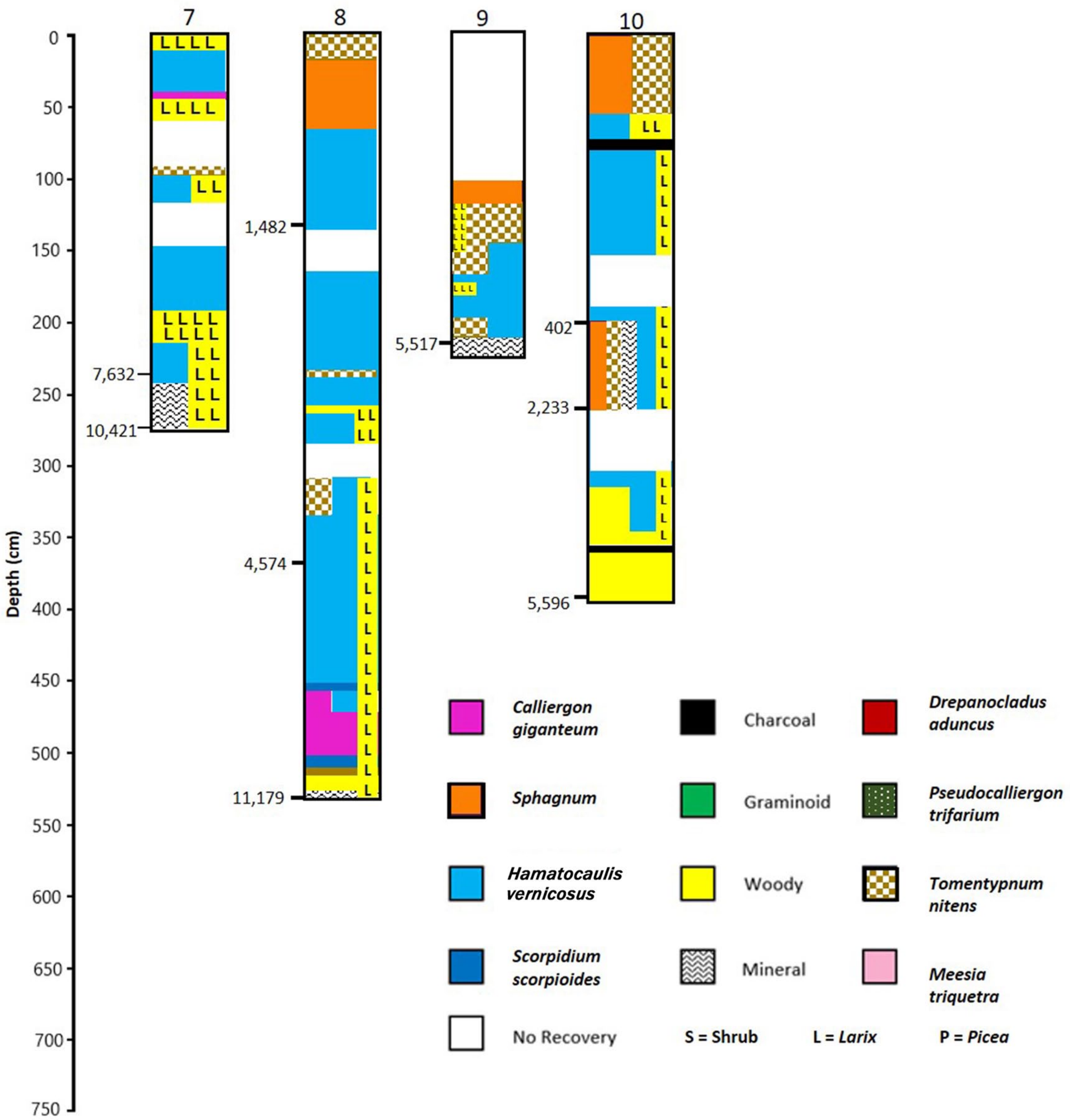


**Figure 3.** Summarized profiles of core lithologies for Cores 7–10. Dominant macrofossil components color coded. Radiocarbon dates shown on left of profiles (cal yr BP). Profiles based on data in Supplemental Figure 1, available online.

The site of this core is 1.24 km west of core 5 with the mineral contact 2.9 m higher than the elevation of core 5. The site is located just west of the north/south patterned area, in an area of indistinct flark/string patterning (Figure 1). The surface elevation of 300 m is slightly higher or the same as areas to the west and east, suggesting a shallow drainage divide. Peatland initiation occurred at 6863 cal yr BP at a depth of 316 cm. At 318 cm depth charcoal macrofossils are present within a matrix of sand. Wood is present at 318 cm and *Larix* needles at 314–310 cm, and twigs are abundant from 318 to 314 cm, all suggesting an area of scattered shrubs and *Larix* trees. Bryophytes are present at 318 cm and again at 314 cm continuing upward to the present. *Hamatocaulis vernicosus* is abundant from 310 to 298 cm, replaced by *Scorpidium scorpioides* from 294 to 254 cm. At 246 through 190 cm depth a drier period is indicated by increases in shrub and root components. From 190 to 72 cm, *H. vernicosus* and *S. scorpioides* occur in alternating bands, and from 38 cm to the surface *Larix* was present on the site with drier conditions. The large portion of the core with no recovery makes detailed accumulation rates uncertain, but the rate of 0.46 mm $yr^{-1}$ (based on the depth of 316 cm) is just below the overall fen average. This site initiated on an upland landscape with woody vegetation with an increase in *Larix* abundance, and quickly paludified to rich fen conditions. The site maintained wet, rich fen habitats varying in dryness and chemistry over the past 6000 cal yr BP, becoming drier with increases in *Larix* over the past 900 years.

### *Core 7-Southern marginal treed fen (Figure 3)*

Basal date 10,421 cal yr BP, depth 279 cm, mineral contact at 294.3 m elevation, LTAR = 0.27 mm $yr^{-1}$

The core site is a wet area within forest dominated by *Larix laricina*, south of the main patterned area. The area surrounding the site appears to be a part of inflow through the upper peat column from a north-flowing stream and separated from the patterned fen by an area of wooded fen. Peat initiated about 1000 years after earliest initiation occurred in the central patterned area. From the mineral contact at 279 to 243 cm depth (dated at 7632 cal yr BP), the core contains sandy mineral material mixed with wood and *Larix* needles indicating a *Larix*-dominated swamp. During this 2789 year period, bryophytes were scarce and the rate of organic matter accumulation was very low (at 0.13 mm $yr^{-1}$, accumulating only 36 cm of peat). From 243 cm to the surface, the core contains numerous *Larix* needles, abundant wood, and periodic bryophyte indicators of wooded conditions (*Calliergon richardsonii*, *Tomentypnum nitens*). Periodic wetter conditions (indicated by increases in *Hamatocaulis vernicosus)* occur at 203–112 cm and at 50–30 cm depth. The relatively high peat/mineral contact elevation – 3.2 m higher than core 4, and 4.5 m higher than core 3, both within the patterned area, coupled with the early basal date (10,421 cal yr BP), and very low rates of organic matter accumulation all indicate a marginal (ecotonal) site influenced by seepage water from inflowing streams, with wooded conditions continually present at the site for the entire Holocene.

### *Core 8 Southern marginal treed fen (Figure 3)*

Basal date 11,179 cal yr BP, depth 538 cm, mineral contact at 297.7 m elevation, LTAR = 0.48 mm $yr^{-1}$

The core was extracted from the edge of the western-most bog island on the southeastern side of the patterned area. No permafrost thaw is seen on Google images at the coring site. The mineral/peat contact is between 3.4 and 9.3 m higher than the two nearest coring sites. The current surface elevation is likewise between 6.1 and 7.8 m higher than the surrounding coring sites. Peat accumulation rates at the site have gradually increased, with an accumulation rate of 0.21 mm $yr^{-1}$ during the first 6600 years, followed by a rate of 0.83 mm $yr^{-1}$ for the next 3000 years and the past 1500 years had a rate of 0.96 mm $yr^{-1}$. Earliest organic matter accumulation developed in a wooded habitat with both *Picea* and *Larix* needles present, along with the mosses *Calliergon giganteum* and *Tomentypnum nitens. Larix* macrofossils and wood were continually present throughout most of the core. *Picea* macrofossils appear abundantly in the core at 274 cm depth (about 3000 cal yr BP) and remain frequent in the core until 198 cm, and then become dominant in the core at 82 cm. About 750 cal yr BP, *Sphagnum fuscum* becomes dominant. This site began as a wet swampy *Larix*-dominated forest that accumulated peat at a low rate for the first 5000 years or so. With gradual peat accumulation the site developed into a wooded (*Larix*) rich fen. The presence of *Picea* macrofossils at about 3000 years indicates development of a wooded poor fen or bog. The recent occurrences of *Sphagnum fuscum* indicates ombrotrophy, either the result of permafrost development in the past ~800 years or dry raised peat surfaces. An ash layer at 26 cm and the change from *S. fuscum* to *S. teres* in the subsequent samples indicates a wildfire on site with increases in wetness and minerotrophy.

### *Core 9 Northern marginal treed fen (Figure 3)*

Basal date 5517 cal yr BP, depth 223 cm, mineral contact at 293.4 m elevation, LTAR = 0.40 mm $yr^{-1}$

This location of this core is just west of a bog island, with the peat/mineral contact at 293.4 m elevation, 5.6 m above the central portion of the northern patterned area (core 1) and near the source of the surface water flow into the northern fen area. The top 100 cm of the extracted core is missing. The site paludified at 5517 cal yr BP with abundant *Larix*. At 189 cm, *Larix* presence is reduced and *Hamatocaulis vernicosus* abundance increases suggesting wetter conditions. At 161 cm, the hummock-forming moss, *Tomentypnum nitens*, is co-dominant with *H. vernicosus*, and at 150–118 cm, *Larix* abundance increases and *T. nitens* becomes the dominant moss indicating drier conditions. At 114–106 cm, *Sphagnum fuscum* is dominant. *Picea*, although sporadically present throughout the core, is never abundant and probably never was present at the site, but occurred nearby. This site has remained a moderate-rich fen dominated by *Larix* for its duration; however, a pronounced wet period was present between 185–153 cm depth (approximately 1900 and 800 cal yr BP).

### *Core 10 Northern marginal treed fen (Figure 3)*

Basal date 5596 cal yr BP, depth 404 cm, mineral contact at 291.1 m elevation, LTAR = 0.72 mm $yr^{-1}$

This site is 0.76 km NNE of the edge of the northern patterned area in a *Larix*-dominated moderate-rich fen. The peat/mineral boundary is 3.3 m elevation above that of core 1 in the patterned area and 2.1 m lower than core 9 at the western edge of the northern patterned area. Two broad areas of no recovery in this core prohibit determining accumulation rates within the core, but the mean accumulation rate is among the highest recorded in the fen (0.72 mm $yr^{-1}$). Organic matter accumulation began at 5596 cal yr BP (at 404 cm depth) with abundant wood and *Larix* needles. Bryophytes become abundant at 376 cm (mostly *Hamatocaulis vernicosus*). *Larix* remained abundant throughout the core, with sporadic occurrences of *Picea*. Charcoal occurs in most samples up to 60 cm depth, with large pieces especially noticeable at 384, 336, 104, 76, and 68 cm depth, indicative of local site wildfires. *Tomentypnum nitens* and *Sphagnum* are present in some abundance beginning at 270 cm, continuing to 210 cm, associated with sand grains, then with *H. vernicosus* until 68 cm, and at 60–12 cm, both species dominate the bryophyte fraction. From 270 to 210 mineral materials are present (1–20%). This site paludified in Mid-Holocene and remained a wet, wooded, rich fen until 60 cm depth when drier, more oligotrophic conditions prevailed.

### *Long term apparent organic matter accumulation rates (LTAR)*

When 30 radiocarbon dates obtained from 10 cores are regressed against peat depth, there is an overall significant positive correlation between age and depth of organic matter (linear model $R^2 = 0.793$ and polynomial model $R^2 = 0.806$ (Figure 4). The linear model provides a mean long term accumulation rate of 0.557 mm $yr^{-1}$), varying from 0.27 to 0.72 mm $yr^{-1}$. This rate agrees well with that reported by Bauer et al. (2003) for a fen complex near Calling Lake AB, wherein they reported a range of accumulation rates from 0.29 to 0.94 mm $yr^{-1}$ and a mean of 0.529 mm $yr^{-1}$ (from 16 cores dated between 1560 to 7440 cal yr BP).

Cores 1, 3, and 4, all located in the patterned fen areas with high moss abundance and early basal dates, have high accumulation rates. Cores 2, 6, 7, and 9, all with abundant woody materials indicating paludified, wooded sites, have lower accumulation rates. Except core 2, located on a mineral rise in the patterned fen, all of the other cores with woody materials are in located in present day wooded fens. Core 7, with the lowest accumulation rate (0.27 mm $yr^{-1}$), stands out and is unique in its marginal landscape position with almost the entire core length containing abundant macrofossils of *Larix.* In contrast, core 10 had the highest accumulation rate (0.72 mm $yr^{-1}$). This is true even if a zone with a mineral intrusion is subtracted from the total core length. Comparing mean accumulation rates for cores 1–6 and 13 along the central patterned axis (Figure 5) reveals higher accumulation rates eastward at sites at lower elevations (except core 2 located on a mineral rise). As a result, the 10.1 m initial mineral substrate gradient between core 13 and core one (over the 7.75 km) has been reduced by half, to a gradient of 5.0 m, over the 6800–11,000-plus years of organic matter accumulation.

## Discussion

### *Developmental history of McClelland Wetland*

The first evidence of organic matter accumulation at McClelland wetland is present at 11,200–11,400 cal yr BP, nearly synchronous with deglaciation, the opening of the Athabasca River northward drainage, and the Lake Agassiz Clearwater River flood. Soon after deglaciation, the lower portions of the McClelland fen basin (at elevations from 287.8 to 293.5 m) appear to have been a wet sandy landscape with shrubs and graminoids – seemingly a wet meadow with organic matter accumulation commencing from primary peat formation. At somewhat higher elevations, larch (*Larix laricina*) and black spruce (*Picea mariana*) were present. At a minimum,

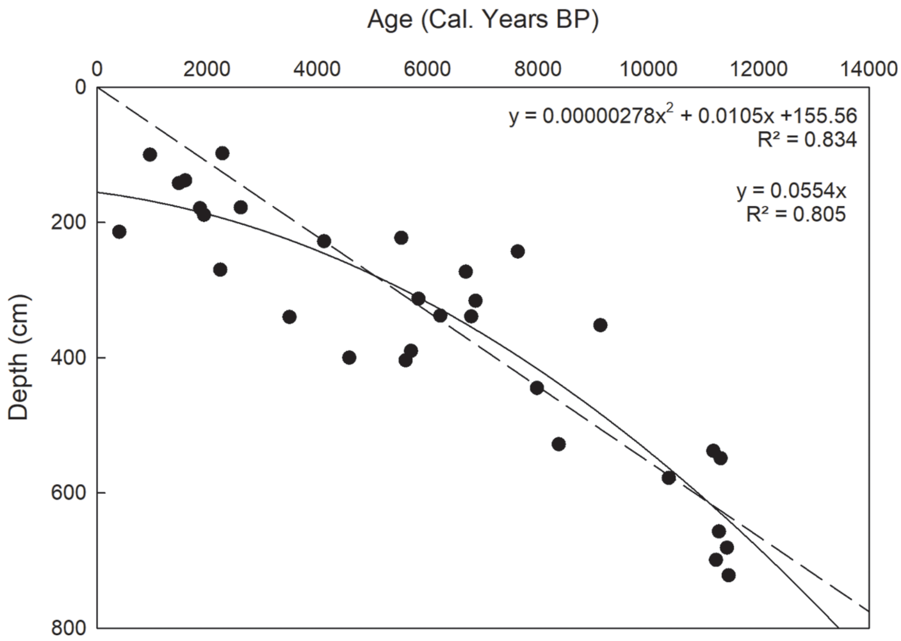


**Figure 4.** Peat depth (cm) as a function of age (cal yr BP) from 30 radiocarbon dates from 10 cores from McClelland Lake wetland Linear model $R^2 = 0.793$, $y = 0.0557x$; polynomial model $R^2 = 0.806$, $y = 130.06e^{0.0001x}$.

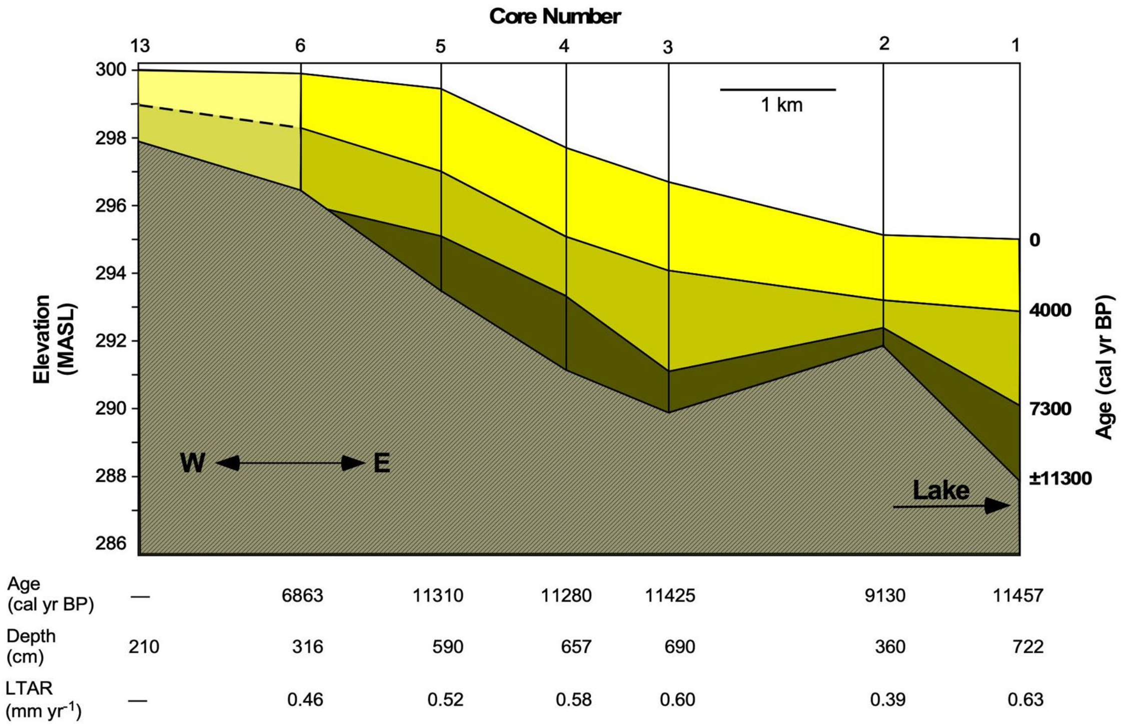


**Figure 5.** Longitudinal section for McClelland patterned fen through Cores 1–6, and 13 along the elevational gradient from west (on the left) to east (on the right). Total distance is 7.75 km. Age, Depth, and LTAR (long term apparent rate of organic matter accumulation) shown at bottom. Approximate organic matter accumulated by depth shown by colors for three interpolated ages (4000; 7300; and 11,300 cal yr BP). McClelland Lake is located to the right (east) of the profile.

4.5 km of the fen westward from the lake began organic matter accumulation before 11,000 cal yr BP, with all sites except that at Core 1 developing from and having woody vegetation on site, most sites with abundant larch. By 10,000 cal yr BP, these wooded sites had developed to moss-dominated moderate-rich fens. Paludification of the surrounding landscape continued until at around 6000 cal yr BP and sites to the west, north, and south of the peatland were accumulating peat at low rates from swampy larch woodlands. After 6000 years, these marginal sites maintained tree cover and today are either black spruce or more commonly larch-dominated rich fens. By 10,000 cal yr BP the dominant bryophyte species present today were present on site, with sites to the north dominated by *Hamatocaulis vernicosus* and those influenced by the south-western water inflows dominated by *Scorpidium scorpioides*. These two species have continued to dominate to the present time.

### *Regional development of peatlands in the Early Holocene*

In general, deglaciation of the northeastern part of Alberta took place around 11,000 cal yr BP (Dyke et al., 2003); however, large scale peatland initiation from paludified landscapes did not occur until after 7000–7500 cal yr BP (Campbell et al., 1998). Fisher et al. (2009) studied the stratigraphy of lakes associated with moraines in the Fort McMurray area. The Firebag moraine lies on the Fort Hills (adjacent to McClelland Wetland) continuing westward across the present-day Athabasca River channel. North flowing waters were blocked by ice until deglaciation of the moraine and opening of the drainage northward to the Arctic Ocean via the Mackenzie River that Fisher et al. (2009) determined took place 11,250 cal yr BP. Glacial Lake Agassiz discharged meltwater eastward (into the St Lawrence River) until 11,450 cal yr BP when this outlet closed. Subsequently, at 11,275 cal yr BP an earthen drainage divide was overtopped and incised, lowering the lake by 52 m (Smith and Fisher, 1993), creating a massive discharge event with maximum volume of 22,000 $km^3$ that was discharged over a 1.5–3.0 year period and followed by continued flow until 10,750 cal yr BP.

First recognized as early as 1896 in Sweden by Gunnar Andersson, and well-documented cold climatic anomaly, the Younger Dryas, occurred from 12,900 to 11,600 cal yr BP, with abruptly warmer temperatures afterward (Carlson, 2013). Following the Younger Dryas, at 11,300 cal yr BP a brief (150–350 years) cooling event (the Preboreal Oscillation [PBO]) has been widely recognized. Fisher et al. (2002) argued that the close association of Lake Agassiz flood dates and opening of the northward drainage to the Arctic Ocean with the beginning of the PBO provide compelling arguments for the cause of this short cooling event. This cooling event is synchronous with the initiation of organic matter accumulation and the presence of peatland vegetation at McClelland Wetland.

The Early Holocene climate in northern and central Alberta was warmer with summer solar radiation reaching a maximum about 11,000 cal yr BP (Pisaric et al., 2003) and drier, with lowered lake levels suggested by diatom assemblages from 9200 to 8100 cal yr BP recorded at Otasan Lake (66 km WNW of McClelland Wetland – Prather and Hickman, 2000).

Following deglaciation at Mariana Lake (178 km south of McClelland Wetland at 55°57′N), Hutton et al. (1994) described early vegetation as dominated by *Artemisia* and Gramineae, with limited abundance of arboreal species, and recorded abundant *Sphagnum* spores in their lake core, with these spores suggesting the presence of peat-forming wetlands in local area between ca. 11,200 and 10,200 cal yr BP.

Between ca. 11,400 and 8500 cal. yr BP, spruce forest, including both *Picea mariana* and *P. glauca*, began to dominate the MacKenzie Basin (MacDonald, 1987) and *Larix* pollen first appears at Mariana Lake between ca. 8400 and 10,200 cal yr BP.

At about 10,000 cal yr BP, *Sphagnum* disappears, reappearing in the core at ca. 6900 cal yr BP, increasing in abundance to the present. At 8300–6200 cal yr BP, *Populus* reached its maximum Holocene occurrence. Beginning around 7300–6800 cal yr BP, peatlands increased, with extensive paludification after 5700 cal yr BP (Hutton et al., 1994). In concordance, at an associated large complex peatland at Mariana Lake, early peatland formation from lake infilling was present at 9100 cal yr BP, and continued until 8000 yr BP, with portions of the landscape paludifying by 7300 cal yr BP. By 4800 cal yr BP, organic terrain had extended to one-third of the present-day peatland. Extensive paludification began around 5700 cal yr BP (Nicholson and Vitt, 1990). Differentiation of bog islands interspersed with fen water tracks were evident at about 5000–5700 cal yr BP. Basal dates from a large poor fen near to the Mariana Lakes site studied by Nicholson and Vitt (1990) have basal dates ranging from 5910 to 7260 cal yr BP (5150–6310 RC yr BP – Yu et al. (2014)). These vegetation changes occurred simultaneously with increased aridity between ca. 10,000 and 5700 cal yr BP (Ritchie, 1976; Viau and Gajewski, 2009).

### *Peatland initiation and development in boreal western Canada*

A global postglacial ~1450-year climatic periodicity has been recognized (Bond et al., 1997). In continental western Canada, the ~1450-year periodicity has been identified as wet and dry cycles in Late-Holocene sediments (Campbell et al., 1998). Additionally, Campbell et al. (1998, 2000) proposed for southern Alberta a paleoclimatic model with 19 wet/warm periods at ~1450 year intervals over the past 15,000 years, including wet periods at about approximately 8500, 10,000, and 11,500 years (cal yr BP). Periodicity in peat accumulation rates and ash-free bulk densities were found to be associated with wet periods of 1400–1600 year duration at 6900, 5500, and 4000 cal yr BP at a rich fen in western Alberta (Yu et al., 2003), and other fens in other parts of the province (Yu et al., 2014). The wet events were contemporary with warm periods in the North Atlantic (Bond et al., 1997), probably in response to solar activity (Yu et al., 2003). Associated with these functional changes, basal dates (71) from paludified peatlands across continental western Canada show the same regularity at a millennial time scale (Campbell et al., 2000). Most peatlands initiated during wet periods, especially at 7000, 5200, and 3800 cal yr BP with a 400–500 year time lag from the beginning of wet events at 7500, 5600, and 4200 cal yr BP. This lag may be due to sampling bias by incorporating younger peat into compacted basal samples for dating. Somewhat fewer initiation events are also present at 8500 cal yr BP.

### *Summary – McClelland Wetland: A unique early peatland*

In summary, it appears that at around 11,000 cal yr BP peatlands, including *Sphagnum*-dominated ones, were present, but uncommon across the northern boreal areas of western Canada (Halsey et al., 2000). These decreased or were eliminated between 8300 and 6200 cal yr BP, with peatlands restricted to small areas surrounding bodies of water, and only after 7000 cal yr BP did extensive paludification occur. Differentiation of peatland landforms (bog islands, water tracks) were secondary features developing only after 5000–5700 cal yr BP.

Few peatland initiation events have been recorded before 8500 cal yr BP, with basal dates (71) from paludified peatlands across continental western Canada exhibiting a regularity at a millennial time scale (Campbell et al., 2000). Most peatlands initiated during wet periods, especially at 7000, 5200, and 3800 cal yr BP apparently corresponding to warm events in the North Atlantic (Yu et al., 2003).

A few initiation events prior to 10,000 cal. yr BP are known from northern Alberta, including at Rainbow Lake in northwestern Alberta (10,230 cal yr BP) where peat accumulated in depressions (Bauer and Vitt, 2011); however, widespread peatland expansion in the area occurred only after 8000 cal yr BP (Bauer and Vitt, 2011). This early peatland initiation is in contrast to sites farther south where Bauer et al. (2003) reported the earliest dates for peat accumulation in the Athabasca area of the province were at around 7000 cal yr BP.

### *McClelland wetland – A wetland resistant to allogenic change*

Over the 10,000 year history of McClelland Wetland, the central portions of the wetland have been remarkably resistant to change, with little alteration in dominant species. The resistance to change is set against a background of fluctuations in regional Holocene climate and local varying water balance (reconstructed from $^{18}O$ preserved in moss cellulose - Gibson et al., 2022). These dominant bryophyte species continued to play a foundational role on site for the duration of the Holocene responding to persistent long-term ground water sources. Accumulation rates have remained steady (or decreased somewhat using a polynomial model) once a dominant bryophyte layer was established, but with accumulation rates at paludifying marginal sites lower than those of the central moss-graminoid-dominated areas. The greater organic matter accumulation present in the central portion of the wetland (nearest the lake) compared to areas farther westward has decreased the elevational gradient by half, increasing the occurrence of ponding in the largest flarks. The resistance to changing Holocene events, together with stabile ecosystem functions, provide a case study for how species in rich fens may resist change against future climate-related and anthopogenic disturbances to the surrounding boreal forest regime. This resistance to vegetation change for rich fens across the region appears to be associated with persistent long-term groundwater inflows, and suggests that surrounding watersheds are an important part of long-term survival of patterned rich fens.


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## Supplemental material

Supplemental material for this article is available online.

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