APPENDIX A: SUMMARY OF INTERVIEWS

The responses to the interview questions are provided below. The responses are not attributed to individuals or organizations but have been organized into blocks of related comments/subjects.

The following context was provided for the interviews:

In the context of this project, the term 'site' is defined as a legacy upstream oil and gas wellsite and the associated facilities requiring reclamation per Alberta's reclamation criteria for peatland and/or forested sites. The specific sites in question are those that were constructed using imported mineral soil pads in peatlands and/or upland sites that have had vegetation encroachment which present one or more reclamation deficiencies to meet current regulatory criteria. This project was established to evaluate the benefits and drawbacks of removing mineral soil pads in peatlands, and disturbing established vegetation to modify soil and landscape features required to meet reclamation criteria. The objective of the project is to provide regulators, practitioners and industry stakeholders with management options supported by case studies, and a literature review to assist in making decisions around appropriate management and certification. The goal is to ensure that functioning ecosystems can be restored with an appropriate level of activity, and that sites will be eligible for reclamation certificate application.

In the context of this project, a peatland is defined as in the "Reclamation Criteria for Wellsites and Associated Facilities for Peatlands" (AEP, 2017) to be lands covered by peat to a minimal depth of 40 cm. Other wetlands, such as those defined in the Alberta Wetland Classification System as a marsh, shallow open water or swamp (ESRD, 2015) with less than 40 cm of accumulated peat may also be included in the assessment.

A total of 41 people provided feedback either in writing or through phone interviews. The distribution of responses between government, industry and consulting is provided in Figure 8.

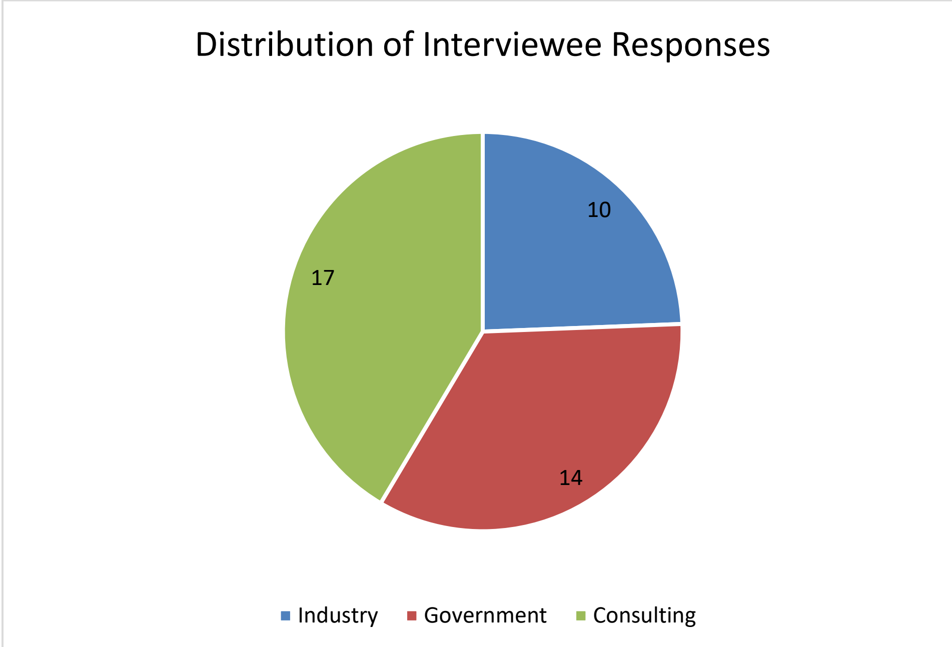

Figure 8. Distribution of interviewee responses.

The responses to the interview questions are provided below. The responses are not attributed to individuals or organizations but have been organized into blocks of related comments/subjects.

1. What site/local/regional characteristics and/or conditions would lead you to apply for / approve leaving a mineral soil pad in place in a peatlands?

General Comments

- If they can be creative with the fill and utilize it with upland materials/sites – that is one thing, but the challenge is really in the true peatland sites.
- From a regulator perspective, an application from a specific company may be deemed stronger, where they have shown that some of their higher risk sites (sites likely or are having an impact to surrounding vegetation) have been pulled/or mitigated.
- Not in the department's best interest to leave a pad in place. In general it creates a negative impact on the environment.
- Do not encourage it and seldom entertain it
- Prefers not to leave pads in place because pads do not produce the same type of forest that reclaimed upland forests produce.
- Site by site (look at landscape holistically)
- One-off single site (i.e., no potential for an area based program)
- Access roads – would not allow it to be left unless it is servicing other sites. Transference of LOC may be required. Or do a partial reclamation if access is no longer required.

- Considerations for the wetland policy may be required
  - If you want to create a change in land use you would be required to make a wetland elsewhere (need to ensure that the request equates with the policy or PAY a penalty)
  - The borrow pit could be used as a replacement for the pad left in place if it met the functional equivalent in terms of the wetland definition.
- Need to ensure "forests" are not being considered ecologically more valuable than "wetlands".
- From a "change in land use perspective" not as interested in sites that have not had reclamation occur at this time.
  - Could be looking towards doing this when planning reclamation prior to conducting any "dirt work", but don't always control reclamation activates form the beginning. Inherit many sites that have had partial reclamation activities already initiated.
- Tried to approach reclamation approvers for leaving some things in place – have been able to leave some of the older more remote sites
- BC experience
  - From current perspective not having to do this. In BC there isn't a mechanism (or need) to do this because there aren't as many legacy sites that are relevant.
  - In BC, the First Nations stakeholders are driving the end land use
  - They are tying restoration to development for all new development therefore companies have to have a "restoration" plan to get approval for development.
  - There is currently a lawsuit in BC that will likely impact activities across all provinces in traditional lands. Foresee that Alberta will be following suit with B.C. [Important consideration because there may be changes in the future that influence how activities are conducted within traditional lands].
  - Consider doing a post-abandonment but pre-reclamation assessment with stakeholder involvement and then deciding what the appropriate revegetation plan would be (if pad removal wasn't an option, then work with the stakeholder/OGC to develop an appropriate revegetation plan).
- Old sites – Need to break it down and discuss the access roads and wellsites separately.

Original Plan / Commitment

- What the company agreed to do when the disposition was granted/renewed
- Companies need to consider what was agreed to in the original agreement. Particularly if the sites is still owned by the original owner. Sometimes companies just want to not complete.
- NOTE – do not want to condone bad behavior (i.e., if it was agreed upon when a disposition was granted that the company would return the site to equivalent capability as existed prior to disturbance (with no change in land use), then that is the expectation).
  - Not reasonable to have left a site unattended for years and vegetation re-grew which led to the assumption that it would be justified to request a change in end land use.
  - The change in end-land use needs to be justified by more than just the vegetation established on a mineral soil pad.
  - Other considerations need to be made for the regional implications, the borrow material, the borrow pit, the surrounding landscape (whether it blends with the surrounding topography), etc.

- Consider how long the site has been in place for and the requirements under which it (and the borrow pit) were constructed and the expectations for reclamation.
- Need to consider what was in the original agreement (only if provided by the company; it is not AEPs role to dig up site information on behalf of the company)

Documentation / Rationale

- Companies provide reasoning with background and explanation for why they feel the sites requires a change in end land use.
- Only have what is available/provided to enable a decision (i.e., aerial photos; description of site on DSA, etc.)
    - Limitations are explicitly outlined in the application and why they should be allowed to remain
- AEP response for OSE pad left in place (vegetation criteria passes – improvement left in place) – not change in land use.
    - Justifications were provided that the DSA and photos show that the vegetation and criteria are growing well.

Current Impacts / Uses / Status

- If it can be demonstrated that there is no adverse environmental impact. This can be assessed through vegetation, hydrology, pooling water, etc. Vegetation is the best indicator of negative impacts. Offsite trees will appear unhealthy, vegetation surrounding the site will be unhealthy, etc.
- There is no refuse/debris.
- No major slumping occurring.
- Under unique circumstances:
- First consideration: What is the benefit to having left the pad in place? Example – high traffic area that is used by the public and without the pad the recreational trails would have an adverse effect on the environment.
- Within a peatland the site may not always been disturbed (many are minimal disturbance sites and thus there isn't a pad) – reclamation activities are thus minimal.
- Current site conditions are playing a major role in terms of the decision (rather than thinking about where the site may end up (even with minimal additional activity)).
- Passes detailed site assessment
- Abiotic and Biotic properties of the site resemble or are on a trajectory of an upland ecosystem
- Was the whole wellsite padded, how thick was it padded, what was used, where did it come from (it might actually need to be put back)
- Where is it located (in sensitive areas – caribou areas)
- Size – wellhead (4'x4' area that is still padded) – not really impacting the function of the system, not restricting water movement, vegetation growing.
- If it is deemed feasible to switch to the upland forested criteria and meet equivalent land capability with that criteria (landscape may not be homogeneous, however the small area is functional).

Reclamation Methods / Soils

- There are two considerations when thinking about partial pad removal:
  - Skim the top off and try to reclaim to the appropriate peatland; or
  - Skim the sides off and re-contour so that it is more representative in the environment (lower the elevation around the perimeter and re-contour the top (could place material in the middle and create a hill).
  - Relative relationship to the surrounding area (species may not be the same, but the "hill" is representative of similar landforms in the area).
  - Sustainable, self-perpetuating isolated ecosystem.
  - Consider things like: nutrient cycling, litter development, etc.
- Partial pad removal (removing fill so that it is level with surrounding wetland) or recontouring of the pad (creating swales, reducing the overall footprint of the pad by creating a small, dune-like hills) in my opinion is probably the best option, so that conditions that appear natural are created, as well conditions that could support the initiation of a swamp or fen are created. Also, recontouring could reduce impacts to off-site drainage.
- If the pad is left in place – would want to see the mineral material de-compacted with an appropriate growth medium and recontouring.
- Just submitted a conservation and reclamation plan: Anything that was over 40 cm of peat – leave the pad in place.
  - Take off surface infrastructure, gravel, decompacting the clay, cover with minimal organic/suitable growing media
  - Shape pad to surrounding topography
  - Restore any drainage that's needed.
- For anything less than 40 cm of peat – field level call for construction but likely removed and filled with clay and left as an upland.
- Only consider sites where partial pad removal has occurred to generate an appropriate growing medium that would support a change in land use to an upland forest community. Thus, the site should have been recontoured to blend with the surrounding landscape as much as possible, deep-ripped to ensure there are no rooting restrictions and appropriate nutrients are available to support plant growth.
- A site where partial decompaction has been completed. Some rooting medium has been established.
- Partial pad removal – a full pad in place doesn't have any topsoil, therefore an appropriate growing medium needs to be established to ensure ELC in the long term; deep rip it, blend it in to the surrounding system.
- Assumption is that the filter cloth under the pad is preventing root development/penetration. The material has no organic matter so it doesn't hold the trees up as they age (i.e., it is not a good rooting medium to provide good structure in the long term).
- Did the application/request for a change in lands use, show any of the following (none of these things are currently policy requirements, just items that strengthen a request)
  - That the forested eco-site selection was both locally common and suitable to the pad soil characteristics.

  - Any investigation that the pad was chemically suitable to the forested site proposed (eg. Naturally occurring sulphates brought to surface).

Borrow / Disposal Site

- Within a large network of pads one of the biggest challenges is borrows. Old sites – built in 80s and the borrow site has been reclaimed/restored – thus nowhere to put the mineral material. Refusal form AEP for temporary work space to go back
- The wetland destroyed when returning the fill to a borrow pit could be close to equivalent to the wetland created in the former location of the pad.
- 6. Condition of borrow pit – The pad material has to go somewhere, so if the borrow pit is revegetated and functioning as a wetland that would be additional cause to seek approval. Also, there are significant logistical issues to filling in a borrow pit, especially in winter (e.g., pumping/squeezing water, saturated soil)
- 2) in-situ area (end of life area would require a real consideration for what to do with the mineral material – borrows (landscape borrows are just recontoured; pit borrow) are typically reclaimed within 2 years of creating the borrow site. Toward end of life the material could not be put back thus that drives end of life closure plan (islands of uplands in the area).
- Consideration for where the borrow material came from – if the borrow is now a functioning wetland with wildlife use then there is a stronger argument for leaving the mineral material in place for the pad.
- No place to return the pad to
- Overgrown borrow pit – fully revegetated and established as a marsh
- Is there a borrow pit that the mineral material could be put back to, or if the material needs to find a new “home”.
  - Is there a net environmental benefit to removing the mineral soil material.
- Remote access to haul pad material back to the borrow pit
- Source of the material (borrow)
  - Example, landscape borrow that doesn’t have a place to put the material back
  - If the unreclaimed borrow is taking away from productive forest land then there is a stronger desire to have the material returned and the borrow pit reclaimed.
  - If the borrow that was created and is now a productive wetland and the water is serving a purpose (fire control, wildlife and waterfowl) consideration may be given to leaving the material in place.
- Not wanting a borrow filled that has been created and is providing functioning wetland
- Consider leaving a mineral soil pad in a peatland if there is nowhere to remove the material.
- If the in situ company has paid the “in lieu fee” they have effectively purchased the right to leave the pad in place

Site Access / Remoteness / Cost / Reclamation Impacts

- Remoteness of site is a consideration due to the effort to reclaim.

- Remote access is not as much of a factor for leaving a mineral soil pad in place (or the associated borrow pit and access road) for peatlands. The size of the project warrants the amount of effort required to go in and do the reclamation (as opposed to remote upland sites).
- Excessively long, costly or difficult winter access
- 4 – Site by sit characteristics come into play such as length of access road and remoteness and growth of existing vegetation
- Sensitive Wildlife Habitat and Vegetation Area impact concerns to reconstruct an access road (frozen or non-frozen) in order to remove the pad and haul back to the borrow pit. Keeping in mind the question: what are we gaining from a holistic perspective if we implement disturbances to gain a certain reclamation in one area?
- I would consider leaving a pad in place in most conditions - pad removal is costly and there is no guarantee that a functioning peatland can be reclaimed. The diesel required to remove a pad would create a huge carbon footprint.
- Cost is not an appropriate justification for leaving a pad in place.
- "Doing more harm in going in there and removing than if the site is left in place"
    - Need to confirm that this is actually true. It isn't necessarily about money, but they do want to consider the environmental impacts and consider the distance and access.
    - Is it a "routine" request from a company or is it more a unique request – weighs into the decision.
    - Need to determine if it is a justifiable request.
- In their experience, the driving factor to leave a pad in place is based on costs and remoteness of sites.
- Access issues going into the sites
- Remote site – fully forested
- Preface – sometimes the cure (or it's side effects) is not better than the problem itself
    - Net gain to the site or the environment to reclaiming
- Net cost to the environment to "fix" the problem needs to be taken into consideration.
- Need to ask the question: Can we actually go in and do improvements to the site that will result in a net environmental benefit? Now, or in the long term.
- Need to consider the advantage to fixing something and whether or not the level of disturbance required is warranted to alleviate the "issue"
- Need to discuss HOW you would go about fixing it and equate that to what the environmental effect would be for reclaiming it or not
- If the net impact to the environment currently outweighs the benefit to completing the reclamation.
    - Bringing in equipment requires a significant disturbance.
    - What is actually gained by conducting work?
- Concerns that disturbing the pad and hauling material out would increase the spread of any invasive species of concern in a sensitive habitat area.
- Need to think about implications about the impact of removal of a small feature such as the wellhead) – information and justification needs to be provided.
- If some topsoil was re-distributed on the site, but it is lacking in some areas.

Vegetation Status

- Needs to meet upland vegetation criteria or a combination of upland/peatland
- Change in land use (forested criteria) – type of vegetation and how long the site has been there.
- Is the site growing trees and shrubs, etc.
- Established site with vegetation growing
- Volunteer agronomic grasses
    - When a site hasn't been planted and these agronomics are not in the surrounding landscape, it difficult to justify their existence.
- Already has a forest established on it (already indicates that soil was conducive to growth) (self-established forest)
- If there was nothing growing on it already then he would recommend it be removed
- 7. Vegetation – This is lower on the list because it is possible to revegetate the pad accordingly, but significant natural recovery on the pad would lead me to seek approval (in the same manner as I would for upland).
- Regeneration is occurring, ideally on trajectory to surrounding ecosystem.
- Pad supporting productive tree growth and desirable vegetation
- What is the current situation on the site (resembling conditions offsite) encroachment of woody species (shrubs and trees) vs grass that has been seeded
- Does the on-site vegetation resemble similar vegetation off-site
- Natural Ingression of suitable species to the area.
- Of the mineral soil pads within peatlands that have vegetation established on them, they are often revegetated with grass and willows, but have very limited ability to grow forest species.
- Species composition
- The site would need to be re-vegetated with species that are common to the surrounding upland ecosystem.
- Fully vegetated sites with mature trees – vegetation override – if vegetation meets criteria
- Determining that is feasible to establish vegetation species on the pad that will meet land use criteria (i.e., establish *Salix* sp. and understorey similar to a boreal setting to meet wildlife use criteria)
- What vegetation is growing. Is it similar to what is growing around there. Non-native species were often planted on a site and are not desirable in the area
- 2 – Plant community growing on-site
- 3 – Plant community needs to represent what's growing up their off-site (e.g., should be trajectory to a forest)
- Did the application/request for a change in lands use, show any of the following (none of these things are currently policy requirements, just items that strengthen a request)
    - Any discussion on how the risks of pad forested reclamation success will be managed. (e.g., Additional monitoring of planted trees).

Hydrology / Drainage / Elevation

- Current or potential adverse effect to the surrounding wetland. I would look at the below risk factors:
    - Fen vs Bog (fen being perceived as more likely to have drainage impacts)

  - Linear vs non-linear (linear being considered more likely to cause drainage impacts)
  - Existing (occurred post disturbance but before applying for RC) presence of vegetation death or changes in community in the surrounding wetland.
- Natural drainage/hydrology not impeded.
- 1. Hydrology – is the pad having significant adverse effect on water movement and vegetation? Example: flooded area upstream up the pad and dryer downstream. This can be worse with a padded access road than the well pad itself.
- 1 – Hydrology, ensuring hydrology isn't being impacted off and on-site. More of a visual assessment, but also wants to see historical air photos to prove no hydrology issues overtime
- If the pad doesn't interfere with hydrologic flow.
- No evidence of long term impacts to hydrology
- Additionally, they see displacement of water as the biggest issue with pads.
- Does it disrupt the hydrology; if it is impacting hydrology, it would be important to remediate it, but not necessarily remove the material.
- Noting that the regional hydrology hasn't been impacted overall.
- Hydrological function
- If the mineral soil pad has sunken below natural grade and has peat forming species growing at the site
- Sunken pads (low reveal; maybe <20 cm)
- Determining that is feasible to complete contouring on the existing pad to ensure regional and site-specific water flow is maintained
- In some instances, it might be beneficial to remove a pad when it causes excessive off-site impacts to drainage.

Cumulative Effects / Regional Context

- Regionally, where there are higher densities padded infrastructure remaining in a watershed (e.g., HUC 8 mapping), decreases the likelihood of getting a pad approved in place. Footprint management is a regional consideration.
- Regional conditions, I would think, should be considered in the pre-construction planning stages and. Having a high number of pads in a single peatland should be prevented before it gets to the reclamation stage.
- Geographic location in proximity to other infrastructure (for example – if it is the first pad in a series of pads in an area that will continue to be accessed for multiple years, it may be considered to leave in place).
- 2. Cumulative effect – are there other nearby pads that are have a cumulative adverse effect on function of the wetland?
- Did the application/request for a change in lands use, show any of the following (none of these things are currently policy requirements, just items that strengthen a request)
  - Indication that the proposed end land use of the remaining pad was locally common in the natural subregion?

Local Context / Wetland / Upland Transition

- If it is a forest in the middle of a fen/bog and there is no upland forest nearby, then less likely to give consideration.
- What does the site look like in terms of the matrix for the entire surrounding area (if the area is a mix of both upland and lowland then it fits better).
- If there is a lot of bog/fen in the area, would consider landscape diversification if it can provide value.
- Proximity to other upland characteristics (similar landscape with respect to topography) in the general area (so that the site can blend into the landscape and not be an upland feature in the middle of a wetland/peatland)
- 3. Location – is the pad on the fringes of a wetland and ties into upland area, or completely surrounded by wetland?
- 4. Landform – Could the pad be reclaimed to be representative of other upland features within the wetland, or is it a large, uninterrupted wetland?
- 5. Land use – Green Area or White Area? Remote or not? What is the proximity to land use other than forested/wetland and potential for future development? Example: Edson area where agriculture encroaches into natural areas.
- Sites that have an established and functioning upland vegetation system and can fit in with the regional landscape.
    - Upland terrestrial plants and shrubs (meeting equivalent land capability from an upland island scenario)
    - Lack of erosion
- If the site is in close proximity to natural upland topography and the mineral soil pad has similar vegetation to the natural upland topography
- Creating transitional sites between peatland and upland sites.
- Clay pad on the edge of a bog or fen that is not blocking the overall flow and hydrology of the area
- Adjoining upland or close to upland areas
- Under unique circumstances:
    - First consideration: What is the benefit to having left the pad in place? Example – If the site is on the fringe; transitional area where there is upland/peatland within immediate proximity of the site to ensure it is more compatible with the surroundings.
- In some instances, it might be beneficial to remove a pad when it is located in a transitional area where the pad material can easily be moved to the upland portion of the wellsite.
- Did the application/request for a change in lands use, show any of the following. None of these things are currently policy requirements, just items that strengthen a request.
    - That the pad would be contoured into the existing landscape?

Wetland Type

- If a pad has been left in place and it is in a fen then it is unlikely to be successful even as an upland.
    - JACOS site is a good example.
- Wetland type influences the decision
    - Fen – take the mineral down to the surrounding elevation and try to establish fen peatland species.

- Bog is more amenable to pulling the clay out. Likely good success to pull all the clay material out, particularly in scenarios where the clay material was not placed more than 1 to 1.5 m thick.

- In his experience, both fen and bog peatlands have had successful pad removal (i.e., not peatland dependant). Although a fen is easier to get things to grow afterwards.

Summary

- The type of peatland is a factor: pad removal can be successful for both fens and bogs, but fens may recover more quickly.
- Pads that have been recontoured to blend into the landscape, have been deep ripped to reduce compaction, or have had partial removal already are more likely to get application/approval.
- When it can be shown that the pads is not impacting offsite drainage, approval is more likely.
- The condition of the borrow pit is a factor. If the borrow pit is already revegetating into a wetland system, it may be more feasible to keep the pad in place as the clay material would likely be placed back in the borrow pit.
- If natural recovery or revegetation success is proven successful, an application may be made and/or approved to keep a pad in place.
  - However, regulators do not consider vegetation alone to be a high priority or appropriate justification to keep a pad in place.
- An application or approval may be sought where a change in land use to upland forest could result in landscape diversification, or an upland forest is representative of other landscape features.
- However, change in land use is low priority of the AEP, and it is important to ensure forests are not being considered more important than wetlands.
- Cumulative effects can result in non-approval or non-application. Where pad density is high, networks of pads are present, or the pad is in close proximity to other infrastructure, approval is less likely.
- The original agreement between the company and land manager should be considered.
- There is a need to evaluate the idea that going in and removing the pad could be more harmful than keeping it in place.
- It seems that industry and consultants are more likely to consider vegetation re-establishment as a condition that would merit leaving a pad in place, whereas regulators consider the landscape and soil as factors more likely to merit leaving a pad in place.

2: What vegetation characteristics and/or conditions would lead you to apply for / approve a criteria variance (i.e., how do you determine if the site is appropriately revegetating):

General

- BC experience
  - My work has predominantly been in BC; therefore, the criteria is subject to professional justification. The key goal in BC is to demonstrate that the site is on the trajectory to adjacent land use or similar land use capabilities and at a minimum 80% ground cover of a

mix of agronomic and native plants. In my experience, most pads are left in place; therefore, essentially you have change the micro landscape onsite to that resembling boreal forest vs. muskeg as the borrow pit material is typically clay based. To determine if the site is revegetating properly, considerations would include:

        - Are short lived agronomics feasible to help outcompete aggressive invasive species until a canopy of suitable grasses, shrubs, forbs, trees establish? If yes than I would apply even with the use of agronomics if it is evident that the site vegetation trajectory is towards boreal/muskeg.
        - In the case of a partial pad reclamation including native seeding and/or planting of native species plugs, I would apply if the vegetation cover or stems/ha were not at a suitable rate if it were clear that ingression would occur over time without the concern of invasive species.
    - In BC, it is not a formal process. They would have to meet with the oil and gas regulator to discuss the site.
- Need to take each site and asses the specific limitations associated with a variance request and evaluate the long-term impacts of making a decision.
- Site specific – mineral on mineral; established forest community
- Woody debris concentration – is there a fire risk?

Criteria / Policy

- Not in the role of approving criteria variance, however in general default to criteria for the respective land uses.
- Variance is a new thing (there is no policy or guidance around what the requirement is).
- Note: variance is very poorly defined
- Not clear how AEP needs to play a role in this.
- Meets reclamation criteria
- Follow the criteria as per vegetation override.
- If a site passes the forested criteria in terms of the vegetation component then it is simple to provide justification for other soil and landscape factors. Site must be able to meet the vegetation component of the forested criteria, then an override can be considered. Wouldn't consider applying for a variance if the vegetation didn't meet criteria. [He was primarily focussed on trees, but looking at it from a "forest" perspective – thus the layers of the vegetation would be present].
- What did they apply for – forested criteria, peatland criteria, tame pasture criteria [thus there needs to be proper justification for the land use change and the appropriate vegetation growing for the criteria].
- Generally, I use the stem density requirement of the current forested criteria to gauge whether a variance request is appropriate or not. If it meets or exceeds the required stem density at most (e.g., 85%) of the assessment points and the vegetation appears healthy, then I will pursue a variance. The only exception is if there is a landscape issue that poses a safety risk (e.g., unstable slope). This includes if the recovered species are shrubs only (e.g., willows and roses) that some people interpret as 'less valuable' than conifers, because they still represent an early seral stage and are still valuable to ecosystem function and recovery.

- In regards to herbaceous vegetation, I will still seek a variance if the woody stem count is high but desirable herbaceous cover (native forbs and grasses) does not meet criteria, because I believe that woody vegetation drives the succession of the vegetation and that native forbs will return as the forest floor (LFH) recovers and the canopy closes.
- Criteria variance – vegetation overrides are considered when the vegetation meets the forested criteria.
- What is threshold government will accept? What guidance is available to practitioners.
- General comment – timeline to get variance in well program, better to define practitioner leeway

Objective / Land Use

- Overall – really looking for getting back to ELC. Could end up taking longer if a disturbance is required, but the driver has to be ELC.
- If equivalent capability is met
- Government and Practitioners all have a common GOAL, which is to create a forest, thus it doesn't necessarily make sense to start at ground zero twice. If a site has a functioning forest that meets the vegetation criteria within the forested criteria then it is difficult to justify failure of a site for other conditions which may be deficient.
- First Consideration: What is the benefit of the variance in terms of the intended land use?
    - Example, if the variance can be shown to be creating additional/different habitat, etc.
- Reforestation needs to be emphasized as part of certification
    - Significant benefit to progressive reclamation to reforest areas that interim reclamation can completed on.
    - Security in the fact that it was the "requirement of the day" – as long as it is not causing severe limitations, then requests would not be made to disturb areas that had been previously reclaimed and planted.
        - Forest cover is highly variable and dynamic and some variation is not a bad thing so as long as it is compatible it would be acceptable.
- Do a pre-disturbance site assessment (for all new activities). [on public lands this will become a requirement].
    - It should be considered an investment so that you know what your end goal is
    - You know what species were there, what limitations and/or pests were there (example, Clubroot in the white area).
    - You don't know where you are going unless you know where you've been
- Often get stuck on "what the site is now" (which is what the criteria demands) – but need to consider what the site will be with and without additional activity
- Can't just look at the vegetation, bust look at the soil and landscape factors as well. AEP needs to require the long-term impacts for the decisions they are making (20, 50, 100, 200 years into the future) and the current and potential future land users.
    - Things like timber value (does the site have the ability to meet ELC in the long term).
    - All stakeholders need to be taken into consideration when making a decision.

Documentation / Rationale

- In general:
  - Listening to the justification of the proponents and considering the integrity of the company (is it in the best interest of the environment or is the company just trying to save money)
  - Case by case and go by the strength of the justification provided by the proponent.
  - Not a black and white decision.
  - Pictures, documents and history (location (lat report); with respect to the regional perspective – caribou zone, etc.); access, history and vegetation that is there presently vs. what was there previously. If one was to go and do reclamation what would be done.
- Ideally multiple years of data (pictures) should show the trajectory is moving towards a forest.

Communication / Responsibility

- Need to communicate with land owner (i.e., AEP) EARLY in the process if there is going to be consideration for land use change.
- Talk to AEP (land owner) at the initial planning phase. Lessee is not the land owner. Even if the lease user wants to use the access road – BUT AEP needs to consider the long term implications for culverts, Texas gates, bridges, etc. Some improvements may be approved, but AEP needs to be involved in that decision.
- There is confusion [even within the government] as to variances and whether AEP has anything to do with these requests.
  - Currently AEP – does not do variance
  - Land use changes require AEP

Examples of Past Decisions

- Typical variances I have reviewed in my SRD days, prior to AER, on Forested lands include variances for, topsoil replacement depth, regulated weeds, and third party impacts. Each scenario would require different professional rationale. Most of what I provide below is strictly from a policy perspective on how the criteria was intended to work and how I perceive it to have been operationalized.
  - Topsoil replacement depth failed. Where there was no topsoil resource available. A "vegetation override was applied". All vegetation parameters within the applicable criteria would pass to provide this justification. Also, typically I would expect to see a bit more time (greater than the typical minimum of 3 years, to show the vegetation was sustainable without the topsoil resource.
  - Third party impact – After trying to control the third party impacts, I would expect them to apply based on my methodology for controlling access. I would seem the consultant use air photos to show where possible that it wasn't related to my activity. That the area not associated with the third party impact did pass all vegetation criteria (1997 IL for Third Party Impacts).
  - Weeds fail in the forested zone. Before the 2013 update to the 2010 Forested Criteria, these would all have come in as non-routine (now called variances). However, now most

would not come in as variances as the criteria as specific justifications that must be present in order to apply and then it is routine (no variance required).

    - be on public forested lands.
    - Be from a single offsite point source. Applies to noxious weeds only.
    - All other forested vegetation criteria would need to be met.

- Can provide examples where many sites were built in the late 70's that were never really reclaimed but the trees grew back large and thick (up by Chipwan Lakes – North of Wabascaw). Met vegetation criteria and a reclamation certificate was granted in 2014 (for many sites).
  - Several of the sites did not meet soil criteria but generally met landscape criteria and always met vegetation criteria.
  - Sites were fly in access only (i.e., very remote).
  - Environmental impacts associated with accessing sites that are remote (upland sites) needs to be considered if the only limitation is the soil requirements. Accessing the site would be significant to re-clear (disturb) several km of access road and potentially other areas which have been vegetated to fix small disturbances or deficiencies.
  - Needs to be put into context of the size of the disturbance and the effort required to complete the reclamation for remote sites.
- Exceptions for deficiencies in criteria, including vegetation will be considered if an applicant makes a justifiable argument for integrated land management and an associated change in land use.
  - Example, a site was not vegetated well but was used for recreational camping or staging for a neighboring quad/skidoo trail network. Given the pressure in some areas, these exceptions would be acceptable if the appropriate information were provided and the discussions were initiated in collaboration with AEP lands officers.

Time / Age

- It completely depends on the length of time the site has been establishing. If the site has been establishing for years, but still has shortcomings, need to consider the ecological impact of those limitations. However, if the site has been revegetating for 30 years and has an established, functioning ecosystem, even if it isn't equivalent to offsite, more likely to leave as is.
- Favor intervention if the site is in the early stages and it will not be a large set back; if the site has been there for 30 years then it may be more appropriate to do hand work or leave as is.
- 1999 – did a lot of work on sites that had 30 year old trees growing on them. The trees were smaller (shorter and smaller diameter in comparison to fire sites or cutblocks) [Okso and McFarlane (2001) tables to reference)]. Trees were stunted or took longer to establish, but the composition and density was there. Based on the productivity, not sure that it is equivalent land capability according to the criteria, however the site is clearly functioning. There is a need to be more specific about the measurements, not just height.
- Sites have been neglected – i.e., they are so overgrown and would have passed a forested DSA 10 years ago … (this should not encourage the 'do nothing approach' to reclamation, simply allows for judgement to be used in assessment).
- How long have the trees been growing – sometime between the years 4 to 8 trees (good references: Alberta reforestation standards; Alberta forest genetic resource management and conservations standards; Alternative regenerative standards)

- No less than 4 years after planting would he consider an application
- Age of site and activities – construction, abandonment, remediation, built never drilled etc. Length of time pad has been in place

Site / Disturbance Type and Location

- Upland sites are more resilient even if the materials are not
- OSE sites are similar – small anomalies, create more damage
- Minimal versus full disturbance site- how was site constructed? How much soil is available to re-strip or distribute is active reclamation were to take place?
- Where is the site located, grazing lease disposition, etc.
- White Area forested = potential for cultivation, not in Green Area
- Depth of pad and/or amount of fill in place
- Peat depression under the pad – will removal of the entire pad result in a lake?
- Material under the pad – corduroy, geotextiles, nothing etc.

Site Access / Remoteness / Cost / Reclamation Impacts

- Sites that will create more damage to go back (very remote sites); clear access to allow it
- Depends on the remoteness of the site.
    - Very difficult to access sites may be given different considerations than sites that are easily accessed.
    - If the site is within an FMA, coordinate with a forestry company to utilize their resources for site access to complete reclamation.
    - Integrated land management with others utilizing the area.
- Consideration of additional disturbance of access roads, etc., weighed against the current site condition.
- Location and land use are driving factors. Crown land and sites that are expensive to access (e.g., sites far away and many creek crossings) are drivers as opposed to vegetation characteristics.
- Need to consider the impact of “reclamation to fix” deficiencies
- Need to understand if the activity is actually going to put the site on a different trajectory vs simply doing the activity to meet a checkbox on the criteria.
- Accessibility – how easy is it to access site and get equipment into site? Is the creation of kms of winter roads just to access site worth the end result?
- Condition of the borrow pit that would receive the fill material – Is it reclaimed? Well vegetated? Distance to site?

Local Conditions

- Consider whether the landscape/soil conditions are still homogenous within the surrounding area.
- If it blends into the environment and blends into some of the natural variation from the local context.

- Comparison to local offsite comparisons.
  - Extent of the coverage of vegetation
  - Depends on the criteria that were applicable when the site was constructed. More flexibility for older sites.
- If the vegetation species and soil conditions of the site are equivalent to other areas in close proximity to the site

Landscape

- Contouring to prevent erosion
- The site is not eroding and is stable.
- Currently pushing to allow more landscape variances for minor cut and fill (<2 m) (i.e, contour) where the landscape doesn't quite match the surrounding landscape, but the site is still functioning. The definition in forestry for "cut and fill" type of landscape function is operability for commercial forestry equipment, therefore there is opportunity to provide justification for landscape variances that have deficiencies in slope and contour.
  - Overall stability of the site, including offsite – erosion, slumping, ponding. Are offsite impacts negative or significant to ecosystem function? Is the landscape conducive to establishment of a functional forest?

Soils

- Compaction (if the has been de-compacted the forest will take it over in time). If there is still evidence of compaction then there will be limitations to ELC in the long term.
- From experience, soil limitations have led to failures in ecosystems with time (even if vegetation was acceptable at the time of certification) [case studies would be very valuable to validate this]
- Bare areas – are just the topsoil piles vegetated or is the majority of the site vegetated? Percent cover
- Soil types – sandy, shallow topsoil? Will disturbing soils set the site way back?
- Peat stripped and stockpiled? This is highly unlikely in conventional oil and gas, but could apply to in situ

Vegetation

- The variance being approved should not be having a negative effect on the vegetation.
- Vegetation density (stem count).
- Root restriction should be considered.
- It takes time for natural revegetation to evolve the ecosystem all the way to the centre of a wellsite. Tree density is high but concentrated along the edge of the lease. In time, that would begin to fill in to the center, and should be considered.
- If density is appropriate on a site then rooting restrictions would be less of an issue with time, thus a justification would be appropriate (justification information required to demonstrate that roots reduce density with time).

- Tree/shrub density – depending on species, if a species is capable of spreading/suckering (e.g., bearberry), it may not be as important; however, if the site requires conifers, then a minimum density should be met.
- Density and species composition must be within a pre-determined variance of the background vegetation.
- Site meets stem count or % cover native woody vegetation.
- Vegetation growth is reasonable; if the soil material is lacking/unavailable then it would be reasonable to try to certify if the vegetation growth is reasonable. Particularly if there were no material immediately available.
- Woody and herbaceous species growth and percentage.
- Growth rate – in terms of tree biomass (height) as well as spread of understory species.
- Appropriately revegetating is challenging – is everything alive? Is the species composition adequate? General comparison with offsite conditions or expectations for the area.
- Approved planting plan for the specific areas (ecosite comparison to reclaim to). Depends if there is a change in end land use.
- The following are considerations when making a decision regarding the health and/or site conditions when approving a site variance or change in land use:
    - Are the trees chlorotic;
    - Species assemblage
    - Growth patterns (looking to ensure that they are actually showing a mean annual incremental growth and are the trees healthy); took a forestry approach (trees showing annual incremental growth – the amount doesn't necessarily have to be equivalent to the control, but the trees must be growing)
- Undergrowth is difficult when you are doing a partial pad removal. There will be a bit of both worlds with a peatland and upland, thus focus more on the following:
    - Making sure there is no exposed soil thus no erosion
    - Understory is weed free
    - Supplementing with native grass seed to ensure there is no erosion.
    - Seed certificates are sent to the Agrologists for approval if they are provided to AEP for consideration.
- If the site is meeting the vegetation criteria for an upland ecosystem then apply for a criterial variance if there are soils or landscape deficiencies. Characteristics default to the criteria. Vegetation composition, density and growth.
- Well established vegetation
- If it is a very difficult area to re-vegetate there would be more exceptions.
- Age of the woody vegetation – is it well established?
- Quality of the vegetation – health, yearly growth indicators, browsing pressure.
- Percentage of undesirable species and/or "weeds" – is there an infestation or is the naturally encroached vegetation out-competing them? Noxious/prohibited versus nuisance weeds.
- Absence of weeds
- Presence of prohibited noxious weeds would trigger a rejected application and indicate that the site is not appropriately revegetating.

Structure / Function / Succession Status / Trajectory

- Trajectory of the site – desired plant species. Is there good species diversity (woody, shrubby, herbaceous) or is the site vegetated with a couple of species (e.g., raspberry)? Species can be early successional but should be compatible with surrounding ecosite.
- DSA and measurements (control points and on-site points – if the site is approaching the right trajectory then they try to minimize further reclamation requirements)
- Pioneer species that are representative of the ecosite
- There needs to be a trajectory showing plant community moving to a forest. Shrub and tree canopy should exist.
- Will vegetation meet criteria eventually? How long?
- Adequate/suitable density, cover, diversity, structure, productivity and composition of desirable forested, wetland or peatland species.
- What is the current situation on the site (resembling conditions offsite) encroachment of woody species (shrubs and trees) vs. grass that has been seeded
- Species composition
- Species composition, density (stem counts) – meeting the forested criteria
- Vegetation diversity (high diversity of native vegetation) – I would consider this more important than composition alone. The vegetation trajectory of wellsites is often unknown and the more diversity that is present, the greater possibility that some semblance of a forest will emerge. Depending on the ecosite, I would want at least 2-3 tree species, 2-3 shrub species, 3-5 herbaceous and 3 to 5 non-vascular species.

Hydrology

- Surface water management has been checked; contour
- Hydrological function of surrounding land – water movement on and off site

Summary

- Largely criteria variances are applied for/approved when the vegetation meets criteria but soil or landscape criteria have deficiencies (vegetation override).
- Industry may seek variances where woody stem density passes, but the herbaceous component does not.
- Characteristics considered when applying for a variance largely focus on trees (density and height) and shrubs (woody vegetation). Well established vegetation, good diversity, and the presence of desirable species are also considered.
- Sites that have been revegetating for longer (30+ years) are more likely to be left as is, even if not fully equivalent to offsite.
- A variance is more likely to be sought or approved where contouring has been done to blend the site into the landscape and prevent erosion (stable slopes).
- Where offsite conditions are not impacted (hydrology) a variance is more likely to be approved.
- A consideration for variance would be remote sites—will the damage done by going in and accessing the site be outweighed by the reclamation work that could be done?

- A variance may be approved where third party impacts are observed and cannot be controlled (i.e., ATV use).
- There is confusion regarding the AEP's role in approving variances (by reclamation practitioners, industry, and within government).
- Preface – sometimes the cure (or it's side effects) is not better than the problem itself
- Net gain to the site or the environment to reclaiming
- Net cost to the environment to "fix" the problem needs to be taken into consideration.
- What is the site area to start with (marginal lands may have different considerations than sites are in "productive" timber areas.
- Vegetation composition appears to match the area
    - Also consider the seeding mix (if there is documentation) that was used at the time of reclamation
- Is the vegetation established going to encourage woody species to establish with time. There needs to be evidence that the site will be on a trajectory towards a functional forested ecosystem and not remain a grassland in the middle of a forest.

3: How do you define and evaluate a functioning upland ecosystem at the scale of a wellsite?

General

- Staff are all over the map provincially.
- In the boreal – it is valuable to utilize forest practices and tools to evaluate functional ecosystems. Decades of research can be drawn upon for this.
- We have amazing references that we are not using!!! (All based on science)
- Ecological site description guides (forestry) (plant community guides) – not being used enough
- For upland sites that have some mineral pad left in place (i.e., cut and fill and or slight increase in elevation for site access or to prevent flooding during the active phase of the site), reclamation is not that concerning.
    - Mineral soil is left in place, it can be re-contoured to be representative of the surrounding topography. Much simpler to compare the natural topography of the area and the existing forested criteria.
    - Soil can be "created" on top of the mineral material if necessary, but if vegetation is growing an established, much less of a concern than leaving a mineral pad in a peatland because this is the same land use.

Definition

- I define a functioning ecosystem (at wellsite scale) as an assembly of flora and fauna species representative of the surrounding area that provide wildlife habitat, carbon sequestration, nutrient cycling, pedogenesis, temperature regulation, and water cycling (some functions may have been missed).
- Define [refer to what was there before, before the footprint took place]
- Conditions meet equivalent capability
- 2010 Reclamation Criteria for Forested Lands

- 2010 Reclamation Criteria for Forested and Peatlands – use assessment parameters for vegetation and landscape that are representative of the site type.
- Using the forested land criteria or peatland criteria
- Reclamation criteria define it.
- Is it comparable to control
- Key Factors to defining a functioning upland ecosystem include:
  - Multiple species established representing typical biotic parts of an upland ecosystem. (i.e., signs of multiple interactions and sp. of plants and animals)
  - Evaluation of the soil and topography (abiotic) to ensure it will be suitable to support an upland ecosystem. (i.e., soil chemistry can be a concern with borrow pit material and is topography diverse?)
- Providing the same benefits as the surrounding forest/system (vegetation, water, habitat).

Criteria / Policy

- Difficult to answer because we have criteria that sets the requirements. Bound by process.
- I evaluate it using the current reclamation criteria to describe or measure various landscape, soil, and vegetation parameters.
- The forested criteria were established to evaluate if a system is functioning. Need to look at each site individually. Not really necessary to include considerations from the larger region when evaluating if the site is functioning as an upland ecosystem. Only need the context for the larger region if considering a change in land use, which is only under exceptional circumstances.

Documentation

- Don't usually have boots on the ground thus need to base this evaluation on the information provided which includes DSA and photos
  - Species composition and comparison to references (ensure references are appropriate – can not be from miles away)
  - Progression that there is an infill of woody/forested species
  - Don't want to see a poster-card square on aerial photos
    - Rough edges, fits the ecosystem
- Evaluate it by aerial photos, soil types, age class and eco-district and landscape (streams, waterbodies). Historical data to reference in regards to previous disturbance.
- Bring in part of the reclamation monitoring work – the in-situ operators require camera work that could provide some useful information that would provide insights into ecosystem function (e.g., wildlife use).

Comparison / Control

- Fall back to criteria – does the site meet the parameters as per criteria.
- However, the forested vegetation criteria works in averages. For example the average site stem counts was chosen to capture the majority of sites. These would be mesic, open stands typical of the dry mixed wood sub-region.

- If the site is not in this stand, these measures can be too high or too low for a site. Care must be taken that future iterations allow for adaptability in regions where these are not representative of an early trajectory for the site type in question.
- If you burnt it, what would grow back. If the site has a history of weeds and grasses, there is a good chance those would return and you might not have a functioning ecosystem. To evaluate - could analyze the seed/propagule bank.
- Consider a 100 -200 year timeframe. The goal should be to not be able to identify the site with an air photo.
- Background comparison to onsite is pretty successful. More challenging is when doing a change in land use in peatlands.
- Mimic surrounding vegetation (that was what was there and that is what should be back). Forbs, shrubs, trees – composition.

Landscape

- Microtopography (forest floor)
- Woody debris (forest floor)
- Must demonstrate slope stability.
- Forested – is landscape conducive to drainage/species similar to offsite (or on trajectory)
- Stable (non-erosive and no slumping)
- No limiting factors affecting landscape

Vegetation

- Vegetation density and composition (primarily trees; however the structural layers also need to be factored in).
- Can the soil (or lack of soil), support tree growth/site-index similar to the surrounding area. To evaluate - tree height measurements or could employ remote sensing methods to evaluate heights and biomass (LiDAR).
- Pioneering species expect within that ecosite.
    - Trees, shrubs and ground cover
- Similar species growing as offsite.
- In reality: Everything is still alive; composition is adequate.
- Densities and composition of species are important.
- Point of measure is the vegetation complex – are we seeing the right vegetation that is comparable to an offsite scenario.
- 90% of a functional ecosystem can be explained by the vegetation. If the vegetation is appropriate and functioning then everything else will end up equilibrating.
- Ability to support productive and desirable vegetation
- No weeds problems
    - Within a threshold
        - Classes of weeds (invasive but not when there is bare ground to colonize) (e.g., Scentless chamomile). Need to understand the ecology of the weed to understand the long term impacts.

- Weeds are facilitator plants that are enabling the site to resume appropriate soil conditions. It's a very important component of succession.
- Species composition
- Vegetation is growing well
- Limited agronomic species
- Early successional native species present
- Vegetation is naturally encroaching with offsite vegetation (both shrubs and initial successional trees).
- No limiting factors affecting vegetation (root restrictions)
- Not concerned about small weed compositions – (sow thistle, thistle) because weeds will be squeezed out over time as the canopy closes. Experienced this will time and many site visits. The seed bank will not disappear, and canopy closure is what drives the succession. There is a threshold that can result in appropriate succession.
- With time, the occurrence of weeds decreases, as the canopy closes.

Structure / Function / Succession Status / Trajectory

- I would look to the components of a functioning forest in it's earliest stable trajectory, including:
  - Structural layers present
    - Layer 1: ground cover such as herbs, forbs, mosses, lichens, bear berry, bog cranberry, strawberry
    - Layer 2: herbaceous (non-woody) grasses, sedges, aster, fireweed, sarsaparilla
    - Layer 3: woody vegetation – willows, rose, raspberry, dogwood, alder, buffalo-berry, current
    - Layer 4: trees
  - Species richness – A variety of species in each structural layer.
    - Declining presence of non-native species, species that are known for disrupting a trajectory, commonly called undesirable species.
    - Tree growth including height, diameter,
    - Time – Performance of a community takes time. Silvicultural relies on the 8-10 year benchmark. Not enough data to know the risks of the shorter timeframes for wellsite criteria (min, 3 years of growth).
- Presence of 3 layers of vegetation development (ground cover, shrub layer, tree cover)
- When assessing function on smaller scale disturbances, it is often typical to pick just one site type and try to reclaim and assess it across the wellsite to the thresholds (eg. Structural layers, stem counts, etc.) typical for that eco-site at an early trajectory.
- Demonstrate that there is growth and it will go through the appropriate successional pathways.
- A forest is establishing with the appropriate trees and (incremental) growth (comparable to offsite) that will eventually evolve into a similar forest to the surrounding landscape
  - If there is limited growth (i.e., mean annual increment is not equivalent on and off-site) it is an indicator of problems and the likelihood of achieving equivalent land capability is reduced.
- Assessment of successional stage and overall trajectory of site.

- Stem counts resemble early trajectory site of similar moisture and nutrient regime, open/closed stands. Wellsite criteria sets a standard stem count for the average site. If my site did not fall into average, I may use the NE Athabasca Revegetation Guidelines for more specific stem counts.
- All the similar functions as off site
  - Diversity of species
  - Canopy of woody species
  - Leaf litter forming (self-sustaining cycles)
- Slopes must demonstrate trajectory for vegetation.
- Resilient to disturbance
- Succession of forest species is used to indicate trajectories. Trees and shrubs need to be established.
- At different stages within succession after disturbance there are going to be key indicators that you need to be looking for:
  - Diversity in species and composition of species at the appropriate stage of succession.
- Start with baseline (what is available and what the forest is producing on the peripheral edge and what the wellsite can/will provide in/from the current state)
- If the wellsite is currently not revegetated completely
  - Determine if the sites is on a trajectory that shows that it will re-vegetate and in the meantime will it provide some value in it's current state of the landscape.
  - Trajectory is determined by species composition and density. The periphery of the site should be revegetating which will then encroach on the rest of the site.
- Need to consider things other than vegetation growth from a trajectory perspective (soils are still developing/re-establishing its full function); from a functional perspective it would be useful to consider other components and how they are responding and what the trajectory of the soil is in terms of its function.
- Direct success rate of trajectory is directly correlated to the activity (plan your reclamation before you get your approval). Know your end goal for reclamation and develop your disturbance plan accordingly (full strip (2 strip lift) that is done well doesn't mean that the site will be able to meet the desired outcome because there are other factors that aren't taken into account (wind/water erosion, etc.). When the soils are disturbed you need to consider what the implications are for how it will impact the reclamation (soils are alive – which takes time to restore).

Hydrology

- Natural drainage not impeded by pad and soil erosion/slope stability is not an issue.
- Hydrological components should be considered – pooling water, erosion, etc.
- Surface and subsurface drainage similar to the surrounding landscape and does not impede site or off-site vegetation trajectory
- No limiting factors affecting water flow (erosion, ponding, runoff, etc.).

Other Information / Considerations

- Evidence of wildlife similar to background.
- Evidence of wildlife use, including insects and bugs (burrows, trails, nests, scat, etc.)

- If it's functioning then you will see evidence of animals, birds, amphibians, and insects.

- Provides habitat for various wildlife
- Are the wildlife that you would expect to be using the area actually present (or is there evidence of their presence).
- Need for additional monitoring and maintenance? If yes, then it may not be fully functional.
- Biogeoclimatic zone (B.C. Perspective).
- Ability to support desirable land uses (e.g., agriculture, forestry, recreation, traditional use)

Summary

- Numerous responses involved evaluating an upland ecosystem by comparing onsite conditions to offsite or background conditions.
- Vegetation was considered a key factor in evaluation. There was a focus on tree growth and density, but overall vegetation density and composition were key factors. A functioning ecosystem has layers of vegetation contributing to diversity – trees, shrubs, and herbaceous species.
- Vegetation characteristics that demonstrated the site was on the right trajectory to blending in with the surrounding area were considered positive.
- Evidence of wildlife use of the wellsite, comparable to offsite use, was a factor considered in evaluating the functioning of upland ecosystems.
- Functioning upland ecosystems were defined as having no drainage issues due to the pad, or erosion/slope stability concerns.
- Generally, the forested land criteria were used to define and evaluate uplands, utilizing vegetation and landscape parameters representative of the site type.

4: In your experience, how do you determine if a site is on an appropriate trajectory for natural revegetation to achieve equivalent land capability? Describe how this should be assessed.

General

- It is based on experience. There is no checklist that is available to assess trajectory other than the forested land criteria itself. A Lands Officer goes out and assesses the site and looks at the site in comparison to the surrounding area and makes a judgement call.
- Discussion amongst colleagues within the lands approvals team. Seek input from others to discuss the site if having a difficult time reaching a decision.
- If there are opportunities to "help" succession along with minimal effort – then the effort should be expended. For example, if all materials have not been re-distributed across the site, there is an opportunity to increase microsites, change the moisture regime at the surface, eliminate forest fire risk, etc. by spreading the piles.
    - i.e., if there are piles, etc., there is opportunity to use labour to re-distribute some of the debris to increase the success of the site.
- Ecological site description guides (forestry) (plant community guides) – not being used enough
    - 40-60 + years of work (forestry, public lands, etc.)

- Help to determine what community they are in; gives you an indication of what the reference site community was.
- We need long term information to evaluate if the sites are actually on a trajectory.
- In BC – don't have to plant trees.
    - This is subject to change in the upcoming months following a current lawsuit as well as more oversight from OGC following the Auditor General's recent review.

Definition

- I determine that a site is on appropriate trajectory if woody vegetation is establishing and able to grow freely, without limitations imposed by site conditions. This is based on equivalent land capability being defined as a functioning ecosystem capable of the functions listed in the previous answer, and able to support wildlife utilization, recreational users, and merchantable timber (in appropriate forest types).
    - I believe that woody vegetation drives the trajectory through forest floor development, soil temperature/moisture regulation, and attracting wildlife which in turn spread propagules and aid nutrient cycling. My experience is that for woody vegetation to 'grow freely' it needs to not be limited by vegetative competition, soil rooting restrictions, or pathogens/pests.
- Key factors to determining above:
    - Soil and topography factors suitable to support natural revegetation process and moisture regimes (i.e., organic matter appropriate, variable topography)
    - Regional seed bank material (LFH, woody debris etc.) either salvaged/stored/transplanted and is distributed across the site.
    - Natural encroachment occurring along the lease boundaries
    - Wildlife activity onsite
    - Invasive species are either not present or actively being outcompeted by natural vegetation
    - % cover pending the desired range of species
    - An evaluation of all of these factors needs to be documented and professional judgement used.
- Prove that a canopy cover is improving, native species are established and establishing on-site and filler species are declining (e.g., planted grasses or non-native species). At the end of the day, if the site meets the parameters of the criteria it should be headed that way.

Regulatory / Policy / Criteria

- Need to think on a landscape basis rather than step by step and site by site. Need to consider the net environmental benefit.
- Pads are treated very differently depending on what type of activity they are tied to. Some are underneath EPEA approvals that have very different requirements for pad builds vs reclamation requirements.
- Assessment process is different. "Program base" is different than the conventional wellsite reclamation certification assessment. EPEA requires more reporting/monitoring.
- Endpoint is different for all of them. Heavy oil would follow AER rec criteria

- Outcomes are the same – equivalent land capability. Process for certification is very different. Received 2 rec certs this year for their thermal.
- Determination is most often used through the application of the forested land and peatland criteria – stem counts, % coverage, species diversity, successional stages, plant health, desired ecosite trajectory.
- Even when not directly applicable (i.e., EPEA approved sites, such as in situ) the 2010 criteria provides a good frame of reference for assessing trajectory and equivalent land capability of a site. I do not know that there is another document that is science based, transparent or enforceable via compliance as the current reclamation criteria. Other forms of assessment may be more biased or subject to scrutiny.
- Default would be to use the reclamation criteria (forested land criteria).
- As per the forested land or peatland criteria
- Follow the criteria.
- Forested land criteria
- Using the 2010 Reclamation Criteria, as per the *Conservation and Reclamation Regulation*, if the 2010 Reclamation Criteria is met, equivalent land capability has been met.
- However, does meeting the 2010 Reclamation Criteria equate restoration of the pre-disturbance ecosystem function? Maybe not…
- Equivalent land capability consists of more than just the vegetation currently established on the site. To be a functioning site that can meet the desired end land use of a functioning ecosystem the soil conditions must meet the definition of equivalent land capability [as defined within the criteria]. If a site has vegetation currently established, however the soils do not meet the appropriate replacement depths, there is too much uncertainty associated with the long term capability of the site to consider the site "equivalent". Need to focus on the foundation, which is the soil – not the response, which is the vegetation.
- I think the woody stem density requirement from the current reclamation criteria is appropriate for assessing this because it requires a reasonable density and for those stems to show annual growth and appear healthy (although I don't understand the basis for the 5 stem requirement for natural recovery sites vs. 2 for planted). I think the herbaceous cover and weeds requirements are valuable in some regard, but are not perfect because they can require conditions that will not limit the succession of the site. That in turn can lead to some unnecessary and harmful practices. For example, not all noxious weeds (e.g., perennial sow-thistle) will limit natural recovery, and I would never sacrifice successful woody stems to try and control aspects of the herbaceous plant community that will not drive the trajectory.
- I think several aspects of the soil and landscape assessment are not appropriate, because they require conditions that will not limit a woody species ability to grow freely. I think the important aspects of the landscape assessment are those that demonstrate it is safe and stable, but not necessarily 'tied-in' perfectly to the surroundings. I think the most important aspect of the soil assessment is to demonstrate that there are no rooting restrictions to at least 50 cm (ideally 1 m).
- In my experience, I think the current landscape and soil criteria for upland sites can lead to unnecessary work and harm to established vegetation if practitioners try to satisfy all the 'routine' parameters instead of getting a variance. The way I look at it is this: it's almost unheard of, and reasonable to say unwarranted, to import topsoil to forested areas. And yet if topsoil was not salvaged correctly and has been lost or degraded, that is the only solution other than a variance. So if we would never employ the solution, why should it fail to begin with?

- Criteria indicators and targets – species diversity on the site (planted and ingress), plant communities establishing within the area, species density for all the woody species, growth height compared to baseline, presence of noxious weeds (at least in quantities that are not hindering succession)

Documentation

- Don't want to see a poster-card square on aerial photos
    - Rough edges, fits the ecosystem
- As a regulator can only look at paper. Not seeing the sites. Only a snap shot in time.
    - DSA and evaluation of site provided needs to be complete and thorough.
    - Always look for the worst things to identify if there is anything that will limit the site from achieving ELC. Not really looking for where the site is going. Look at what potential limitations there are and the potential implications of them.
- It would be helpful to show trajectory over time – photos and data of early succession over time

Age

- Older sites would be able to show any recruitment was a sign the site was recovering and exceeds the standards of the day.
    - Clear discussion of the site characteristics and mitigations completed to address them.
    - Longer monitoring and time to show the trajectories speed and sustainability was not being adversely affected by the site conditions.
- If the construction of the site pre-dates the need for topsoil replacement, then expectations need to be adjusted accordingly and there is much more flexibility in terms of what constitutes capability.
- How long it has been since the last activity occurred and given the timeframe is the vegetation appropriate (as evidenced by the photographs and measurement data provided)
- Time is a major factor (since the last activity).
- How long have the trees been growing – sometime between the years 4 to 8 trees (good references: Alberta reforestation standards; Alberta forest genetic resource management and conservations standards; Alternative regenerative standards)
- No less than 4 years after planting would he consider an application
- Need to realize that that trajectories imply that there are changes with time – thus need to consider the point in time that the site is at, where it has "come from" and what will likely happen with time.

Land Use

- Where commercial forestry is the end land use, rationale on how site characteristics are not going to impair future use (this would only be required based on the applicable age related standards).

Comparison / Controls / Goal

- Comparison to offsite.
- Need to know what the end goal is to be able to determine what trajectory should the site be on
- Need to consider the soil conditions, the level of disturbance and the end goal for ecological recovery before you consider what the site trajectory is.
    - Not just how the site was constructed but also the type of disturbances that might have happened as a result of reclamation activities as well.

Landscape

- Microtopography (forest floor)
- Woody debris (forest floor)
- Bare spots are an indication of limitations which are flags in terms of ELC
- Mostly focus on contour
- Does the landscape similar to the adjacent topography

Soils

- Measure/assess nutrient cycling. (If you can determine that the site is self-sustaining itself then it is likely on a mixed wood succession trajectory).
- Soil horizons (crucial component) if the soils are done right then you can have better confidence in the long term objectives and trajectory.
- Soil moisture regime and soil quality
- Need to consider things other than vegetation growth from a trajectory perspective (soils are still developing/re-establishing its full function); from a functional perspective it would be useful to consider other components and how they are responding and what the trajectory of the soil is in terms of its function.
- Ensure that soil characteristics are capable of supporting similar vegetation to pre-disturbance

Vegetation

- Distribution of species; minimum density of trees; healthy enough that they are going to be establishing a canopy.
- For transitions between wet and upland (peat less than 40 cm), the species composition is less important.
- Trees are the most important component of the trajectory because it will determine the success of all other species.
- Example: site was originally *Calamagrostis*; then it was *Calamagrostis* and raspberry, then willows started to come in at high densities (20 year time frame).
- Recruitment of trees whether through seeds or suckering can be a preferred indicator that the function is returning. Where recruitment occurs throughout the site in similar or higher densities then criteria and all reclamation material was replaced, this kind of reclamation would be considered highly successful at achieving ELC.

- Where recruitment is occurring despite the site characteristics (topsoil, rooting restrictions, coarse woody debris) then I would expect a more detailed case for ELC would make sense. Especially as I find in this scenario the recruitment is more limited to the parameters of the site. The foundation to the assessment of ELC would be the age of the site.
- Ultimately it comes down to tree density, composition and health.
- Species, densities and composition
- Well established and growing well.
- Species diversity, genetic diversity and ecosystem diversity, resilience and productivity.
- Trajectory for natural recovery is based on criteria (stem counts etc.).
- Forestry practices. Mean annual increment, species assemblage (particularly related to the canopy), if the trees are present, and doing well the understory will take care of its self as the site progresses.
- If the site is newly reclaimed, still look that the vegetation complex is appropriately developing considering the reclamation criteria indicators as they are appropriate to assess trajectories. Is the vegetation composition appropriate, is the right density present and are the trees growing and not showing any signs of poor health. Early on – just look at the trees, as time progresses start to look at the shrubs, forbs and understory.
- Presence of key indicator species associated with desired ecosystem
- Productive and healthy desirable vegetation
- Evidence of recruitment/establishment of desirable species
- Trajectory (pioneer species, successional species) species
- Mostly focus on % cover (doesn't matter what the cover is)
- Is the developing vegetation species sufficient in both quality and quantity
- Progression that there is an infill of woody/forested species
- Species composition and comparison to references (ensure references are appropriate – cannot be from miles away)
- Not concerned about small weed compositions – (sow thistle, thistle) because weeds will be squeezed out over time as the canopy closes. Experienced this will time and many site visits. The seed bank will not disappear, and canopy closure is what drives the succession. There is a threshold that can result in appropriate succession.
- With time, the occurrence of weeds decreases, as the canopy closes.

Succession / Trajectory / Ecology

- Equivalent land capability consists of more than just the vegetation currently established on the site. To be a functioning site that can meet the desired end land use of a functioning ecosystem the soil conditions must meet the definition of equivalent land capability [as defined within the criteria]. If a site has vegetation currently established, however the soils do not meet the appropriate replacement depths, there is too much uncertainty associated with the long term capability of the site to consider the site "equivalent". Need to focus on the foundation, which is the soil – not the response, which is the vegetation.
- Indicators of succession (which can be identified through some of the ecological site description guides).
    - Need to be able to determine if there are indicators that the site is starting to resemble the reference site community in terms of structure, composition and density.

- Pioneering species expect within that ecosite.
    - Trees, shrubs and ground cover
- Signs of disturbance still obvious (i.e., have moss/lichen established on the forest floor)
- Demonstrate that there is growth and it will go through the appropriate successional pathway.
- Trajectories can be assessed with the forestry criteria which were developed to objectively measure the things that define a functioning system.
- All the similar functions as off site
    - Diversity of species
    - Canopy of woody species
    - Leaf litter forming (self-sustaining cycles)
- The following are considerations when making a decision regarding the health and/or site conditions when approving a site variance or change in land use:
    - Are the trees chlorotic;
    - Species assemblage
    - Growth patterns (looking to ensure that they are actually showing a mean annual incremental growth and are the trees healthy); took a forestry approach (trees showing annual incremental growth – the amount doesn't necessarily have to be equivalent to the control, but the trees must be growing)
- Undergrowth is difficult when you are doing a partial pad removal. There will be a bit of both worlds with a peatland and upland, thus focus more on the following:
    - Making sure there is no exposed soil thus no erosion
    - Understory is weed free
    - Supplementing with native grass seed to ensure there is no erosion. Seed certificates are sent to the Agrologists for approval if they are provided to AEP for consideration.
- Species and structural diversity
- Conduct yearly site visits and within two to three years after reclamation you can tell if you are heading on a clear path to acceptability.
- At different stages within succession after disturbance there are going to be key indicators that you need to be looking for:
    - Diversity in species and composition of species at the appropriate stage of succession.
- If the wellsite is currently not revegetated completely:
    - Determine if the sites is on a trajectory that shows that it will re-vegetate and in the meantime will it provide some value in its current state of the landscape.
    - Trajectory is determined by species composition and density. The periphery of the site should be revegetating which will then encroach on the rest of the site.
- Plant health and species composition

Summary

- There is considerable difference in the views of respondents relative to the key factor determining Equivalent Land Capability – some said vegetation (specifically trees), some said soils and several had concerns with the effects of land scape and soil requirements in the criteria potentially limiting achievement of Equivalent Land Capability and/or creating unnecessary work.
- Need agreement of the end goal before you can determine if a site is on a trajectory to the goal.

- Time since last disturbance affects site (vegetation) conditions and also expectations.
- Recruitment of trees on the site (not just number of trees) is a good indicator that it is functioning and on a trajectory to recovery. Other factors were also suggested as useful indicators.

5: In your experience, what other site characteristics and/or considerations (landscape, soils, etc.) would lead you to fully reclaim a site which has revegetated through natural encroachment instead of applying for/approving a criteria variance?

General

- FMA's are dying from "death of a thousand cuts", thus if there are scenarios where some reclamation would ensure that "forest productivity equivalency" can be met, then the reclamation should be completed.
- This is a difficult question because there are instances [when a site meets the vegetation criteria but is deficient in soils or landscape and may have a different composition] where you know you could complete the reclamation and get a forest growing that resembles the surrounding landscape, however in practice this is not practical. Thus, likely no site characteristics that would lead to full reclamation of a site if it meets the vegetation criteria.
- Needs to be justified based on environmental factors (can't be completely driven by "cost")
- The site should represent what is in the immediate surroundings; for example if the site is supposed to be a upland half of the site should not be a slough
- Padded lease in the middle of a fen (no adjacent upland).
- If there is well established vegetation then it is important to identify any other potential limitations on the site and assess the long term risk of those limitations – but if vegetation is established and functioning well – likely apply for a variance.
    - Good success with regulator in getting criteria variances through to certification.
- Site is part of a large area-based program
- Pre-reclamation assessment (site visit); looking if the controls are matching what is happening on the site (rarely run into these issues with OSE sites)
    - Bare spots (that are more frequent or larger on site than off-site)
    - Thick mulch that needs to be spread
    - Subsidence that needs to be recontoured
    - Topsoil depth that are going to limit re-growth
    - Weeds

Rationale for Redisturbance

- It would have to have major limitations to provide a recommendation to do full reclamation.
- If it appears that they are only leaving the limitations purely because "it costs too much to put it back"
- Not meeting forest equivalency (although meeting vegetation criteria) then ask them to go back and do it.

- Offsite impacts – if the net benefit of reclaiming the site is for the greater good of the surrounding area (stability, hydrological function, wildlife habitat – especially caribou, stakeholder concerns (First Nations).
- The only time I would proceed with full reclamation of a naturally vegetated site that was safe and stable is if a client, regulator, or other stakeholder was against applying for or approving a variance.
- All other site characteristics/considerations are less important than the overall vegetation. No other factors should override the vegetation consideration.
- If the recruitment wasn't occurring in much of the site, monitoring indicated the trajectory was being impaired by site limitations, I would re-disturb the site to address the site limitations/issues.
- Safety and stability, or demand from a stakeholder. As mentioned earlier, the only parameter that I think overrides successful revegetation is safety and stability of the landscape. That assumes that the successful revegetation is indication there are no rooting restrictions in the top 50 cm (ideally 1 m). For that reason, I would not consider seedlings alone to represent successful revegetation because the roots may not have encountered the restrictive layers yet.
  - By safety and stability I mean that there should be no aspects of the landscape that pose a risk to wildlife or recreational users. That could mean steep slopes not representative of the surroundings, slopes or cavities that are unstable and prone to collapse, or industrial debris like a piling or cellar that would be an injury hazard in the understory.
- The only instance in which I would recommend fully reclaiming a site that has revegetated through natural encroachment would be if there were pre-existing agreements and conditions with an overlapping tenure holder (i.e., forestry cutblock) OR if the area was in a designated species at risk habitat restoration specific area and it was very clear that the existing reclamation did not support the species at risk.
- Refuse/debris present, or other issues that appear 'unnatural' (i.e., would a hiker or berry picker notice they were on a foreign feature?)
- Poorly reclaimed sites (poor soil, too much admixing, etc.) with bare soils and sparse vegetation – reclamation would be required
  - Add topsoil, mounding, planting, microsites, etc.
- A site which has had no reclamation completed which may have significant pits or depressions, poor contours that result in drainage problems on parts of the site, soil piles which remain in stockpiles, gravel which would impede vegetation growth, significant compaction either at surface or lower in the soil profile

Policy / Criteria / Jurisdiction

- Follow the criteria.
- Regulatory uncertainly or regulatory overlap in jurisdiction – default to the accepted criteria rather than pursue and take the risk a non-routine application.
- In his experience they do use the vegetation override a lot. They have had good success with getting approval. If a site meets the veg criteria (within the forested criteria) there is limited information that is required to justify other characteristics that are deficient.

Access / Remoteness / Cost

- Access
- Winter access and the amount of disturbance that is required.
- If a site is more accessible off a road then it makes for a different conversation than if it is less accessible (20 km off a road where it would only be possible to get equipment in under frozen conditions).
- Reasonable winter access
- Mostly cost and location driven.
- Easy equipment access to the site
- Remoteness of the site impacts the response (proximity to access and relative use); if it is being used for recreational use and there are multiple stakeholders that may be impacted then it makes more sense to have active work completed.

Landscape

- Large scale landscape issues, not as concerned about large cut and fills more about drainage and liabilities with hazards.
- Slope (consistency with surrounding landscape) and contour.
- Instability of the site – continued erosion, slumping etc. Presumably, if the site has been in existence such that vegetation has naturally encroached and established, one would expect there to be little to no erosion or slumping.
- Site stability (erosion) that would not likely have the ability to remedy itself
- Instability (Example, spring shows up in the middle of the wellsite if it is done on a hillslope and causing erosion that will not stabilize on its own)
- Major slumping or contour issues on site.
- Slope stability, erosion and maintaining natural drainage. Vegetation overrides when vegetation is well established even though soil depths/characteristics do not match the background.
- Erosion concerns
- Erosion and subsidence (well-center) (use different methods with contour to prevent certain amounts.
- If there was a substantial erosion scenario, they would complete reclamation (dirt work) activities.
- Other significant landscape issues; subsidence, soil piles, etc.
- Approximately 30 cm+ pad reveal
- Existing berms (need to be knocked down) before consideration will be given for justification.
- Sites with 3-4 + metre cut and fill (several examples where they are currently pushing down established trees and re-contour the site) (Refer to “operability” comment above – there may be instances where it makes sense to leave some cut and fill if the landscape is still “operable for commercial forestry”).

Soils

- Significant soil stockpiles on site – clearly defined soil stockpiles. Perhaps vegetation is merely adequate (could pass a DSA) on site without the soil redistribution, but spreading stockpiles soil would greatly benefit site establishment overall (vegetation would be considered excellent post-reclamation).

- If topsoil was conserved on site and was in volumes high enough to spread over the problem areas, while dealing with any other site limiting factors. Compaction/lack of micro-sites/soil chemistry.
- Soils. Topsoil depth specifically. If the soils have not been replaced (and are available), they need to be appropriately distributed on the site. It would not be adequate to have uneven distribution of the materials on the site, or apply the soil within bare areas. To achieve equivalent land capability the soil materials should be adequately replaced to a similar depth (and variability) as existed prior to disturbance or offsite.
- Compacted soils (evidence of this would lead to a direction to complete the reclamation)
- A lot of dirt work would be required to change the forest composition slightly if, for example, topsoil depths didn't meet the criteria, but the vegetation passed.
- Soil horizons (crucial component) if the soils are done right then you can have better confidence in the long term objectives and trajectory.
- Soils. If the site is deficient in soil it raises too many questions regarding the long term implications of equivalent land capability. Regardless of whether or not the vegetation is meeting criteria currently.
- Soil – might be able to tell when you are short on topsoil due to erosion or some other reason.
  - Do some minimal disturbance – but it depends on the site; if there is good growth then the smaller disturbances are not worth the ecological impacts for the areas that are surviving. Equivalent land capability doesn't mean that is exactly as it was before.
- Compaction

Vegetation

- Vegetation is good and coverage is good then they would go for a variance.
- Vegetation inappropriate – species that while native to the area, maybe be early successional or monoculture, but with no indications the site is evolving to a desired trajectory.
- Poor tree growth rates
- Survival of species that you have planted – may have to do a partial infill (for any number of reasons)
- If the vegetation diversity/composition is unlikely to ever meet surrounding equivalency
- Restrictions in the future in terms of vegetation growth (root restrictions)
- If there is any difficulty with vegetation re-growth
- Anything that influences vegetation growth
- Vegetation bare spots (generally need to not accumulate to more than 10% on a disturbance the size of a wellsite)
- Forest establishing needs to look healthy and there needs to be canopy cover.
- Undesirable species should not be present in trajectory towards a forest.
- Weeds on site (management as opposed to full reclamation)
- Weeds are probably the largest challenge with obtaining the reclamation certificate (weed management)

- Weeds (if they have taken over the planted tree, i.e., trees have died); being outcompeted by the weeds and/or grasses within a 3 year time frame after being planted
    - Perennial sow thistle, scentless chamomile – just having to manage not really inhibiting succession, particularly when trees are more established.
    - Agronomic species can inhibit success more than the weeds because they can take over much faster. Limit weed growth and outcompetes forest species (species dependant).
- Historical swales cut into the access road are not deep enough to allow water to flow around. The vegetation "upstream" side of the flow is being drowned out and the downstream flow is being dried out.

Hydrology

- Ensure there are no ridges along the edge of a site that would affect surface water flow.
- Blocking water flow or causing any hydrological concerns
- Blocking water flow across an access road or other linear disturbances i.e., PLA
- Major issues with hydrologic flow on site.
- Evidence of impacts to local hydrology
- Hydrology (any impacts to the surrounding area with water ponding)
- Restrictions to surface water flow or the topography isn't close enough to match the surrounding area
- Off-site impacts to drainage or potential for or on-going erosion/slumping/subsidence.

Ecology

- Wildlife considerations concerning habitat – is the site providing the habitat for the type of wildlife you would expect in that area.

Scale of Deficiency / Partial Reclamation

- Anomalies like well centre could be addressed with small scale modifications by hand, or with small equipment.
- Partial reclaim a site which has revegetated through
    - More inclined to make this recommendation
        - Ex: to supplement part of the plant community
        - Create a small drainage channel through a corner of a site
        - Small scale dirt work.

Summary

- There was a range of views – bracketed by these two views: (1) if there are scenarios where some reclamation would ensure that "forest productivity equivalency" can be met, then the reclamation should be completed; and (2) Thus, likely no site characteristics that would lead to full reclamation of a site if it meets the vegetation criteria. The latter viewpoint was often repeated.

- Small deficient areas may be accepted.
- Site remoteness and access are factors being used to decide on redisturbance requests and approvals.
- Safety, stability, slumping and erosion are all factors that would drive redisturbance.
- If soils are available on site and/or if the soils are deficient enough to raise concerns about long term viability of the vegetation then redisturbance may be requested.
- Impacts to hydrology (water flow) will likely drive redisturbance.

6: What information would be useful to enable site-specific decisions for managing upland wellsites that have had vegetation encroachment and/or mineral soil pads within a peatland. Describe type of information (empirical, case study, etc.). Do you have suggestions for specific documents, sites or people to contact?

General

- Going away from cookie cutter checkboxes would be more appropriate from an ecological perspective.
- Look at sites from a site/site basis and provide justification as to how it meets the equivalent land capability – is it serving an ecological function; is it impeding the hydrological function; is it a benefit to the surrounding landscape; not causing a detraction from the surrounding landscape.

6A: Naturally Revegetated Upland Wellsite

General

- Willingness of company to fully reclaim sites elsewhere (company track-record in area)
- Depends on what the limiting factor is – vegetation or soils.
- Buried surface soils? Contour issues? Slumping? Veg quality representative of offsite/ecosite.

Process

- Basic framework from the AEP/AER on how they evaluate justifications. What conditions lead them to refuse or approve a justification.
- Overall what would help is – a decision/criteria for in-situ pads and it is a lot different – thus they wouldn't need to use the reclamation criteria.
- Contact Regulator for variance providing:
    - Photos and data showing trajectory and encroachment of vegetation over 3-4 years
- Needs to be able to be verified/validated by AEP
- The only option right now is discussions with local regulators

Information Needs – Process

- Real world examples – database of case studies that describe decisions that have been made.
- Guideline for what would be deemed acceptable and what wouldn't.
- Case study database would be very valuable to draw upon when having discussions with government and stakeholders.
  - It is essential that the platform which houses the data be useful and available otherwise it would simply not be sustainable.
- Case studies of what was tried in different areas.
- Inventory of scenarios that have been successful would help to establish a baseline for how decisions have been made thus far.
- Checklist that can be used to generate the appropriate justification can be developed.
- Database of requests (list of case studies where AEP has made these decisions for and against certification). The AEP/AER currently has no way to compare sites where decisions have been made, thus no ability to conduct and QA/QC.
- Research projects and institutes – COSIA, Faster Forests
- Remote sensing options for providing information demonstrating the claims within an application.
- Determine a set of criteria to evaluate the diversity of species onsite to ensure resiliency present and in the future (to ensure the site continues on trajectory to natural upland ecosystem)
- Guides to help provide information about what trajectory the site is on.

Information Needs – Applications

- Photos
- Anything that will help visualize the site.
  - Survey plan
  - Quality photos of the site
- Airphotos showing trajectory towards a plant community for intended land use (e.g., forested site should be moving towards a forest).
- Photos to demonstrate encroachment, etc.
- Photos to demonstrate near-by equivalency that are reasonable.
- Justification for WHY things are acceptable if there are limitations
- Demonstrate the benefit (any type of document and/or information (both measured and observed) that builds the weight of evidence that there is an environmental benefit).
- Good information about who conducted the work and the methods that they used to obtained the data. Credibility of the source of information makes a difference.
- Construction practices can help support or make case for site specific anomalies
- Comprehensive package.
- Do an inventory of site and provide the information within the landscape context. Want to ensure that the site is part of the bigger ecosystem.
- Practitioners need to make decisions based on observations at a site and then collect the information at the site to support the application. Emphasize the things that are being used to support a vegetation override. Information that is gathered is done to support the claim/application. Site specific information that is provided should be enough to support the fact that the limitation is not meeting the criteria if the vegetation is established and productive.

- Mean annual increments, photos, etc.
- (i.e., he did not feel that additional information, like research or empirical studies or case studies would be useful).

- Better submissions from companies – justifications for predictions (based on experience, researcher, etc., how do they justify how the site is going to evolve).
- Always provide them with site specific information, but additional information would help to provide additional justification that the site will meet ELC that had similar characteristics.
- Regional landscape: Site-specific decisions need to be based on the surrounding landscape
- Detailed site assessment outcomes
- Having pre-existing conditions and the trajectory of succession.
- Site Specific Information:
  - Type and approximate composition of vegetation that is on the site in comparison to the control (reference community) – give an idea of whether the succession would ever evolve to the desired end land use based on the current composition.
  - Evidence of function (wildlife use) (caution with preferential use).
  - Less weight on the soil characteristics and more on the vegetation.
- Site-specific measured data and observations
  - Comparison to background
  - Length of time the site has been establishing (site history)
  - Vegetation composition
- Set of baseline criteria to evaluate the biotic and abiotic components are in place

Land Use / Goal

- Indication that the proposed end land use of the remaining pad was locally common in the natural subregion?
- That the forested eco-site selection was both locally common and suitable to the pad soil characteristics.
- Surrounding landscape and land use

Access / Remoteness / Cost

- Each site is a judgement call. Information to be considered includes:
  - Proximity of site to other infrastructure
  - Geographical remoteness (if 80% of the vegetation is there and similar in size/health compared to offsite and the site is remote – more likely to grant approval).
- Remoteness of the site, wildlife functionality, vegetation species composition where natural revegetation has occurred as some infill planting may be required.
- Access difficulty

Landscape

- That the pad would be contoured into the existing landscape?

- Contouring concerns
- Potential erosion concerns
- LIDAR may be advantageous for understanding the general landscape implications, however most information can be obtained from air photo interpretations, particularly when used in a time series.

Soils

- If you are having issues with a site – it is likely soil related. In the in-situ world, there will not be enough material balance to return 80% topsoil depth requirements, thus soil information that demonstrates that trees are able to grow to equivalent land capability, determine where the materials are best placed. What other soil considerations are important other than topsoil depth.
- Any investigation that the pad was chemically suitable to the forested site proposed (eg. Naturally occurring sulphates brought to surface).
- Soil texture on site

Vegetation

- Provide more vegetation information if it is beneficial to demonstrate the trajectory (not just consider what is required within the criteria); can use forestry practices as a substitute and/or other ecological information such as wildlife use, etc.
- Any discussion on how the risks of pad forested reclamation success will be managed (e.g., Additional monitoring of planted trees).
- Vegetation type onsite vs offsite
- Vegetation composition.
- Canopy cover, so if you start with nothing and are able to get canopy cover on 50% of site it shows that trajectory
- In my opinion, the only information necessary to enable site-specific management of upland sites are a successful woody stem count, indication that vegetation competition will not limit future growth, and demonstration that the site is free from rooting restrictions, is safe, and is stable. I believe that the RCAG working group who developed the current forested reclamation criteria did enough research and consultation to create a sound basis for the woody stem count requirement.
- Vegetation information (site specific). May be valuable to consider information that helps to demonstrate ecosystem function more than just the criteria if challenged to get a variance.
- Invasive species present criteria.

Hydrology

- Adjacent water courses
- No damming effect in terms of the hydrology (air photo interpretation). Ecosystems are observed from air photos at a landscape scale Useful to apply a time series

6B: A padded wellsite remaining within a peatland

General

- Are there any sensitive species in the areas (rare species – plants, mammals, birds, etc.).

Information Needs – Process

- Real world examples – database of case studies.
- Research may be beneficial for linear disturbances to assess impacts of removal.
- Research projects and institutes – U of Waterloo, U Laval, COSIA, iFROG
- Ton of research out there for the forest end of things (e.g., regeneration standards)
    - Just need to adopt it over and create a site that is appropriate for growth.
- More research is required to understand the environmental implications of removing and/or leaving a pad in place.
- Access to current research that helps to develop an understanding regarding pads in peatlands.
- Historical information (database of case studies)
- Remote sensing options for providing information demonstrating the claims within an application.
- Checklist that can be used to generate the appropriate justification can be developed.
- Guideline for what would be deemed acceptable and what wouldn't.
- Basic framework from the AEP/AER on how they evaluate justifications. What conditions lead them to refuse or approve a justification.

Information Needs – Applications

- Everything within Section 12 of the *Conservation and Reclamation Regulation*.
- 2. Cumulative effect – I think this needs a scientifically and geographically informed approach to establish a threshold of how much peatland/wetland in a given region can be 'lost' without degrading the region. A zero tolerance policy bothers me because I actually think that some pads left in place can enhance the habitat of a peatland area by creating upland refugia in an expanse of peatland. In my experience doing surveys in peatland areas (e.g., Wabasca area) the wildlife trails often appeared like pathways joining one upland to another. And proper reclamation/restoration of linear features 'connecting' the network of upland features should deter deer, moose, and predators that degrade caribou habitat.
- Always provide them with site specific information, but additional information would help to provide additional justification that the site will meet ELC that had similar characteristics.
- Any evidence that reflects the justification for the reasoning.
- Detailed site assessment outcomes
- Site Specific Information:
    - Type and approximate composition of vegetation that is on the site in comparison to the control (appropriate reference community)
    - Evidence of function (wildlife use) (caution with preferential use).
    - Less weight on the soil characteristics and more on the vegetation.
- Set of baseline criteria to evaluate the biotic and abiotic components are in place

- Good information about who conducted the work and the methods that they used to obtained the data. Credibility of the source of information makes a difference.
- Historical data from site visits and/or remote sensing information.
- It would be very useful to be able to extrapolate information from other sources for many of the remote sites. (i.e., not have to visit the site, particularly multiple times)

Policy / Regulatory

- What was applied for, what did they say
- Justification for the change in land use; "needs to be an appropriate reason for changing the land use"
- Land use change to upland from peatland
- If you are leaving an "improvement" you have to follow the wetland policy which means you have to demonstrate that there are no negative impacts on that wetland.
- Consider if you need a *Water Act* approval?
- Overlapping dispositions
- Needs to be able to be verified by AEP

Criteria

- Different information can be collected from an ecological perspective rather than just the checkboxes within the criteria. Easier to develop a trajectory. [may require clarification]
- As per peatlands – disturbed criteria

Planning

- Develop a plan that makes sense with other infrastructure or companies in the area (consider how to be creative with land use planning) – integrated land use planning.
- Information about what is recommended/planned for the padded access road; if the access road isn't padded – it may result in a different decision.

Impacts / Local and Regional Context / Land Use / Function

- Proximity of site to other infrastructure – would be helpful to lay out the plan and how leaving the site fits in with the longer term objectives.
- Site history for land use (recreational use)
- Negative implications of leaving the pad, but more importantly the linear features in place. Justification of the effects the linear features have would be useful.
- Evidence/information on what was done to ensure that the clay pad is a part of the functioning landscape in a self-sustaining manner.
    - Essentially a reclamation certificate application by a different name.
- 3. Location – is the pad on the fringes of a wetland and close to an upland area? If so, leave in place because it's a minor infringement on the wetland that is representative of the nearby/adjacent land.

- 5. Land use – Green Area or White Area? Remote or not? What is the proximity to land use other than forested/wetland and potential for future development? If adjacent to private land and not protected by any other mechanism (e.g., PNT, CNT, Park, etc.) then leave in place because potential for future development exists and if the area was a critical habitat for caribou or other species it would be protected already.
- Transitional areas are challenging (upland down to peat)
- Regional landscape: Site specific decisions need to be based on the surrounding landscape ("islands" need to tie into the broader landscape) [can't leave an island in the middle of the peatland if it is not within an area that has similar topography/landscape components).
- Does it look like it will fit within an area.
- Does it look like an upland

Impacts of Removal/ Environmental Net Benefit

- 6. Condition of borrow pit – This would be a lower consideration after points 1 to 4, but if the borrow pit is well vegetated and functioning as a wetland it could serve as a 'tie-breaker' if previous points are inconclusive.
- Incorporate a series of questions to determine the holistic cost of disturbance from an ecosystem services perspective (what is the true cost and impact vs. the gain of this reclamation) because often the landscape is more sensitive to disturbance and wildlife populations as well.
- Demonstrate the benefit (any type of document and/or information (both measured and observed) that builds the weight of evidence that there is an environmental benefit).
- Net cost to the environment to "fix" the problem needs to be taken into consideration.
    - Net gain to the site or the environment to reclaiming

Wetland Type / Disturbance Type

- Fen vs Bog (fen being perceived as more likely to have drainage impacts)
- Linear vs non-linear (linear being considered more likely to cause drainage impacts)
- Existing (occurred post disturbance but before applying for RC) presence of vegetation death or changes in community in the surrounding wetland.

Hydrology

- Data and/or observations to demonstrate that the flow of water has been returned and/or is not impacting the surrounding environment.
- 1. Hydrology – is the pad having significant adverse effect on water movement and vegetation? If so, can it be mitigated? If not, remove pad. Example: reshape pad to prevent 'damning' effect, or remove/break-up linear features to prevent 'damning'.
- Hydrology most important; whether meets peatland criteria
- Hydrology data (if it is available) – not required to utilize piezometers for site specific decision, but more related to major changes in vegetation response due to changes in hydrology (flow) and/or water ponding.
- Subsurface drainage direction

- Is it affecting anything like groundwater. Does not need to look the same as it was before.

Landscape

- 4. Landform – Could the pad be reclaimed to be representative of other upland features within the wetland, or is it a large, uninterrupted wetland? If so, and point #2 about cumulative effect is not a concern, then leave in place because it's representative of the regional landform.
- Presence of underlying fabric

Soils

- Soil compaction
- Subsoil conditions
- Surface stoniness
- Surrounding peat depth

Vegetation

- Need to be able to demonstrate that vegetation is already established on the site.
- 7. Vegetation – This would also be a lower consideration after points 1 to 4 because vegetation can be managed, but if natural revegetation is good it could also serve as a 'tie-breaker' if previous points are inconclusive.
- Determine a set of criteria to evaluate the diversity of species onsite to ensure resiliency present and in the future (to ensure the site continues on trajectory to natural upland ecosystem)
- Invasive species present criteria.
- Vegetation type onsite vs offsite
- Proximity to similar vegetation type

6C: Response not specific to a or b

- Acceptable Justifications – cost/benefit analysis (i.e., will the outcomes for the site and the surrounding land be better if actively reclaimed or will the result be the same or less?)
- Entire pad is removed only to result in an open waterbody with cattails
- How quickly does peat rebound after pad material is in place? Does it matter how many years it has been padded? Does the weight of the pad and the amount of pad material matter? What about material under the pad, if any?
- Clear guidelines from the regulator – possible change to the 2010 Reclamation Criteria

Summary

- Corporate performance history and information on who did the work are important considerations.

- Several suggestions were made regarding decision support tools and process flow descriptions that could be developed to help users provide better information and help regulators make more consistent decisions.
- Regulators want more detailed justification, supported by data, photos, etc., to show why deficiencies are not a problem.
- Fit with surrounding land use (positive or negative) will be considered.
- Environmental net benefit of redisturbance was raised frequently, particularly where the borrow pit has already been reclaimed so there is no place to "return" the borrow material.
- Hydrology, wetland type and cumulative effects (regional scale) are key factors in decision to allow pad to remain in place.

7: In your experience, what information is important for practitioners/industry to discuss with local forest officers/regulators when making decisions with respect to variances from criteria for …?

General

- Company supplies 1 variance and gets approval in advance
    - When the application comes in there are actually multiple variances that weren't previously approved and government is not able to provide an appropriate decision for the site because all the information wasn't available.

7A: An upland wellsite with vegetation encroachment

General

- 3rd party impacts that are often present due to recreational vehicles and/or use by the forestry industry. Oil and Gas companies should not have to continue to incur reclamation costs due to 3rd party impacts that are not within their control. More cooperation and communication between the Oil and Gas and Forestry industry to ensure that newly reclaimed sites are not damaged once reclamation has occurred.
- The limitations associated with the failure
- Vegetation quality, appropriate contour, sufficient surface soil? – consider potential for becoming cutblock, will it be able to support forest veg. (surrounding cutblock); need to forecast potential end land use.
- Currently not in a position in BC where the regulator vetos reclamation activities.

Goals / Objectives / Equivalent Land Capability

- If a site is not meeting criteria, focus on how it is still meeting equivalent land capability.
- Open a discussion about the common goals.
- If a site doesn't meet criteria – brainstorm a list of questions that should be asked that indicate if the site is meeting the common goal and/or what interventions may be required.
- Land use of the site

- Improvements in place need to be discussed and justified.

Responsibility / Process / Communication

- AER closure group, AEP lands officers don't have authority here.
- Generally, never talk to AEP.
- Just providing the justification in a non-routine application (i.e., not engaging with government before conducting the assessments).
- Communicate all the time. Frequency rather than detail initially. Keep the AEP informed. Call them. Develop a relationship with your AEP lands officer. Sooner the better.
- It depends on the nature of the variance. AEP doesn't need to be involved in the conversation if a change in land use is not requested. When approving a variance, it is important to consider the long-term implications, thus practitioners/industry should be considering how they can provide assurances that any deficiencies will not have a long-term impact.
- Engage early on in the process
- Early decision point.
- Timing of discussion should be done before the well is drilled at the planning stage.
- Upfront discussion (before activity occurs).
- Have the conversation before reclamation activities and/or making a formal request for change in land use and/or certification.
- Ensure that all information is provided to begin with. Don't just paint part of the picture when making the requests
- Pre-reclamation - Submit a reclamation plan for approval. Peace River AEP group seems interested in being involved from a 30,000 ft level in the reclamation process for some of these sites. They are also willing to consider trials on reclamation procedures.
- Ensure that the full conversation is occurring.
- Discuss with the AER variances and provide:
    - Data and photos showing progression and trajectory is on the correct path
    - Data and photos on weed control plans over years showing weeds decreasing and weeds offsite.
    - Data and photos showing native vegetation increase over time.
    - Data and photos before and after showing 3rd party use by Forest Companies or Recreational use.
    - Data and photos showing pre-existing trails/access roads (before and after) plus survey plans
    - Pre-site inspections
    - Routine disclosure GOA department file inspections.

Information Needs

- Current characteristics of the site, landscape, soil and vegetation
- The purpose of not completing the full reclamation.
- DSA data?

- DSA with pictures to support the application, particularly if you are going to submit a non-routine application. Provide all the information to justify vegetation override to ensure AER does not need to come back and request additional information.
- Detailed site assessment outcomes
- Why does the site fall into “a different” realm
    - 20/30 years of vegetation establishment
- Have data (survey information, photos, professional justification) to show that the site is functioning [Need to be able to provide AER with confidence that the site is set on a trajectory to a functioning ecosystem]
- Important to discuss any overlapping tenures (grazing, forestry, traditional lands) and set goals and objectives based on historical and present use. Also the holistic evaluation of ecosystem services as noted below.
- Disturbance required and the timelines required to achieve reclamation certification
- Lists of sites that they plan to do reclamation/remediation on.
- What they actually did finish activities on.
- Remaining features at the site
- Ensure that all concerns that represent the site are provided.
    - Examples: weeds, soil depth, brush piles, etc.
- Off-site impacts (actual or potential impacts – drainage, erosion, subsidence, slumping)

Criteria

- Does it meet standards such that they are satisfied. Go back to forested land criteria.
- Soil, landscape criteria and how far the vegetation would be set back.

Impacts of Removal / Impacts of Leaving in Place / Environmental Net Benefit

- Negative impacts of reclaiming the site (Remoteness of the location and how much vegetation may need to be disturbed just to access the site)
- What are the risks to not reclaiming the site – future land uses/users, ecosystem function
    - 6. Condition of borrow pit – This would be a lower consideration after points 1 to 4, but if the borrow pit is well vegetated and functioning as a wetland it could serve as a ‘tie-breaker’ if previous points are inconclusive.
- Ease of access
- Determine if disturbance due to reclamation will cause net loss or gain
- Come prepared to discuss what the environmental implications are for the request.
- Example: Cut and fill landscape variance – discuss potential limitations and demonstrate that they are not having an adverse effect (Example, water pooling, etc.).
- What are the benefits to the environment for proceeding with reclamation within this context.

Age

- Timeframes (how long has the site been growing).
- Age of site.

Local and Regional Context / Impacts

- Area that a variance is applicable to (less tolerance in caribou areas for example)
- 2. Cumulative effect – I think this needs a scientifically and geographically informed approach to establish a threshold of how much peatland/wetland in a given region can be 'lost' without degrading the region. A zero tolerance policy bothers me because I actually think that some pads left in place can enhance the habitat of a peatland area by creating upland refugia in an expanse of peatland. In my experience doing surveys in peatland areas (e.g., Wabasca area) the wildlife trails often appeared like pathways joining one upland to another. And proper reclamation/restoration of linear features 'connecting' the network of upland features should deter deer, moose, and predators that degrade caribou habitat.
- 3. Location – is the pad on the fringes of a wetland and close to an upland area? If so, leave in place because it's a minor infringement on the wetland that is representative of the nearby/adjacent land.
- 5. Land use – Green Area or White Area? Remote or not? What is the proximity to land use other than forested/wetland and potential for future development? If adjacent to private land and not protected by any other mechanism (e.g., PNT, CNT, Park, etc.) then leave in place because potential for future development exists and if the area was a critical habitat for caribou or other species it would be protected already.

Hydrology

- 1. Hydrology – is the pad having significant adverse effect on water movement and vegetation? If so, can it be mitigated? If not, remove pad. Example: reshape pad to prevent 'damning' effect, or remove/break-up linear features to prevent 'damning'.

Landscape

- 4. Landform – Could the pad be reclaimed to be representative of other upland features within the wetland, or is it a large, uninterrupted wetland? If so, and point #2 about cumulative effect is not a concern, then leave in place because it's representative of the regional landform.
- Overall contour of the site

Vegetation

- 7. Vegetation – This would also be a lower consideration after points 1to 4 because vegetation can be managed, but if natural revegetation is good it could also serve as a 'tie-breaker' if previous points are inconclusive.
- Relaxation of the weed requirements (not relevant to a huge infestation)
    - Perennial sow thistle – herbicide spray is causing more damage to permanent reclamation.
    - Scentless chamomile
- Vegetation cover and type
- Weeds

7B: A mineral soil pad within a peatland

General

- This is considered a change in land use.
- Did the application/request for a change in lands use, show any of the following. None of these things are currently policy requirements, just items that strengthen a request.
    - o Indication that the proposed end land use of the remaining pad was locally common in the natural subregion?
    - o That the pad would be contoured into the existing landscape?
    - o That the forested eco-site selection was both locally common and suitable to the pad soil characteristics.
    - o Any investigation that the pad was chemically suitable to the forested site proposed (e.g., Naturally occurring sulphates brought to surface).
    - o Any discussion on how the risks of pad forested reclamation success will be managed. (e.g., Additional monitoring of planted trees).
- Negligence is not a form of justification.
- Soil, landscape criteria and how far the vegetation would be set back.
- If a payment was made and it will be reclaimed to an upland
- Try to have some planning for reclamation before construction. This can have a cumulative impacts approach so that areas can be engineered appropriately to create the targeted land uses.

Examples

- Only asked for 1 pad to be released (i.e., left in place) and it got rejected (acid sulphate soils 10 to12 thousand ppm sulfates and pH of 3 and it didn't grow anything)
    - o The justification provided was that with time the site would begin to weather and vegetation would establish and that removing the material would cause more environmental impact due to cross contamination with high acid/high sulphate soils and that reclamation of the borrow would be confounding the success. (He wanted to avoid making a larger disturbance because of the nature of the materials.
    - o Application was rejected (by Kevin Ball) (not a good enough justification to leave it – remove the pad material and learn how to deal with the material) [site is still sitting]
    - o Relates to maybe 30 out of 50,000 sites that he has been involved with in NW Alberta and NE BC where the mineral material that is used for a borrow is high in sulphates.

Rationale / Land Use

- Integrated land management. Not just good enough to say that "people want it" – have to provide a more in-depth ecological justification.
- The purpose of leaving it in place.
- Explanation for WHY they think a change in land use is appropriate. Needs to be ecologically based.

- Discuss potential limitations associated with a site and demonstrate that they are not having an adverse effect on the environment and that the potential for them to have an adverse effect on the environment in the future is low (water pooling, etc.).
- Why does the site fall into "a different" realm
  - 20/30 years of vegetation establishment
- Industry need to make the argument of why the pad should be left. Need to convince the province why it should be left there.
- Prepare information for how the site fits in with the landscape

Process / Communication

- AEP is landowner (need to discuss it with them first)
- All over the map about when AEP should be consulted in the conversation [requires clarification]; sooner the better from AEPs perspective.
- Discuss with the AER and provide:
  - Data and photos showing progression and trajectory is on the correct path
  - Data and photos on weed control plans over years showing weeds decreasing and weeds offsite.
  - Data and photos showing native vegetation increase over time.
  - Data and photos before and after showing 3rd party use by Forest Companies or Recreational use.
  - Data and photos showing pre-existing trails/access roads (before and after) plus survey plans
  - Pre-site inspections
  - Routine disclosure GOA department file inspections.
- Land use change request process
  - Go to AER
  - Put together information package
  - Submit to AEP (by industry)
  - Assess package and send out to decision matter experts
  - Provide AER with a response (essentially sign of on change in land use)
- AER needs an explanation why they should accept the variance so that if accepted it can be supported and pass in a hearing. Variances need good rationale why there is no risk and justifications need to be supported with facts rather than simple statements indicating there is no risk. Professional judgement needs to be show there is no environmental risk.
- If a company is planning to change the end land use (e.g., from peatland to upland) they need to involve the AEP in the discussion before going too far down the path. They need to provide justification as to why the change in land use is appropriate.
- Pre-reclamation - Submit a rec plan for approval. Peace River AEP group seems interested in being involved from a 30,000 ft level in the reclamation process for some of these sites. They are also willing to consider trials on reclamation procedures. Local forest officers have requested to accompany on site visits prior to considering approvals.
- Engage early on in the process
  - Early decision point.
- Upfront discussion (before activity occurs)

- Needs to encourage discussion earlier in the process. Discuss with AEP so that they have the opportunity to provide input so that at the end of the day there a higher likelihood to have a change in land use. Come prepared to discuss what the environmental implications are for the request.
- Have the conversation before reclamation activities and/or making a formal request for change in land use and/or certification.
- First and foremost – what was agreed upon. If a company got approval for an application to construct the site they stated what they would do in terms of reclamation. Only in extreme circumstances should applications be made for a change in end land use. Before initiating a conversation make sure you know what was agreed up. An extremely sound argument would be required to justify why the reclamation that was agreed upon is not what is being done.

Information Needs

- Current characteristics of the site, landscape, soil and vegetation
- Detailed site assessment outcomes

Local and Regional Context / Impacts

- Off-site impacts (actual or potential impacts as well as providing information on peatland type, peat depth, drainage directions)
- Number of pads in a peatland or bog? How are they cumulatively affecting ecosite.
- Is it having a negative effect on the surrounding environment.
- If there are concerns regarding the impact of the mineral material on the peatland - chemistry impact of the mineral material on the surrounding peatland (water chemistry analysis)
- Landscape consistency. Try to make the pad look more natural (re-contour around the edges and create more of a hummock as it is in with the surrounding landscape.
- 2. Cumulative effect – I think this needs a scientifically and geographically informed approach to establish a threshold of how much peatland/wetland in a given region can be 'lost' without degrading the region. A zero tolerance policy bothers me because I actually think that some pads left in place can enhance the habitat of a peatland area by creating upland refugia in an expanse of peatland. In my experience doing surveys in peatland areas (e.g., Wabasca area) the wildlife trails often appeared like pathways joining one upland to another. And proper reclamation/restoration of linear features 'connecting' the network of upland features should deter deer, moose, and predators that degrade caribou habitat.
- 3. Location – is the pad on the fringes of a wetland and close to an upland area? If so, leave in place because it's a minor infringement on the wetland that is representative of the nearby/adjacent land.
- 5. Land use – Green Area or White Area? Remote or not? What is the proximity to land use other than forested/wetland and potential for future development? If adjacent to private land and not protected by any other mechanism (e.g., PNT, CNT, Park, etc.) then leave in place because potential for future development exists and if the area was a critical habitat for caribou or other species it would be protected already.

Impacts of Removal / Impacts of Leaving in Place / Environmental Net Benefit

- Carbon footprint associated with removal
- Potential damage through pad removal, especially if deep mineral or severely depressed peat.
- Site access.
- Ease of access
- Determine if disturbance due to reclamation will cause net loss or gain
- Status and accessibility of borrow pit
- Availability of location to return pad material to if no borrow pit
- What are the benefits to the environment for proceeding with reclamation within this context.
- Incorporate a series of questions to determine the holistic cost of disturbance from an ecosystem services perspective (what is the true cost and impact vs. the gain of this reclamation) because often the landscape is more sensitive to disturbance and wildlife populations as well.
- Where to put fill? Borrow pits cannot be used to return soil because they are now considered wetlands.
- If you are taking away the pad then you need to consider the trade- off of removing a wetland from where the borrow would be.
- Site access challenges
- Discuss how the problem would be fixed and do a cost/benefit analysis.
    - Where to put the mineral soils, etc.
- Consideration of where the material will go
- 6. Condition of borrow pit – This would be a lower consideration after points 1 to 4, but if the borrow pit is well vegetated and functioning as a wetland it could serve as a 'tie-breaker' if previous points are inconclusive.

Hydrology

- Drainage, site productivity before and after
- Groundwater flow/hydrology
- Area subsurface drainage pattern
- 1. Hydrology – is the pad having significant adverse effect on water movement and vegetation? If so, can it be mitigated? If not, remove pad. Example: reshape pad to prevent 'damning' effect, or remove/break-up linear features to prevent 'damning'.

Landscape

- Erosion (no sediment transport into the peatland)
- Presence of underlying fabric
- 4. Landform – Could the pad be reclaimed to be representative of other upland features within the wetland, or is it a large, uninterrupted wetland? If so, and point #2 about cumulative effect is not a concern, then leave in place because it's representative of the regional landform.

Soils

- Decompaction is a key thing that needs to be addressed.
    - Sites have been left in place and re-vegetated.
    - Significant limitation to achieving ELC in the long term because they may have vegetation growing, but the capability is lacking.
    - Corduroy/filter cloth that will limit root development in the future (long term impacts for achieving ELC.
- Surface soil conditions

Vegetation

- Vegetation that is meeting a functioning upland ecosystem (demonstrated by vegetation meeting the upland forested criteria with a reasonable representative control)
- Vegetation cover and type
- Proximity to similar vegetation type
- 7. Vegetation – This would also be a lower consideration after points 1to 4 because vegetation can be managed, but if natural revegetation is good it could also serve as a 'tie-breaker' if previous points are inconclusive.
- Vegetation composition

7C: Response not specific to a or b

- Justification and data to support the plan or reclamation outcomes
- Robust mitigation and adaptive management.
- Site specific plans while keeping in mind the bigger picture – are you in caribou habitat? Is the entire project going to be short on reclamation materials as a result of having to spread topsoil around to all upland AND padded sites? What will the effect be on hydrological function in the surrounding areas?
- Specific criteria for which pads will remain in place (e.g., Pads will be selected to remain in place if they meet XXX criteria – something standardized that is in alignment with their closure goals and outcomes).

Summary

- Communication with the decision makers early in the process (ideally before any work is done) is critical to gaining acceptance. However, knowing who the "right" decision maker is can be a problem (AER for sites with natural vegetation encroachment and AEP for pad in place).
- Rationale for change in land use and ability to demonstrate no impacts of the change are important factors.
- Environmental net benefit of redisturbance was raised frequently especially for pad removal cases, particularly where the borrow pit has already been reclaimed so there is no place to "return" the borrow material.

- Location in sensitive areas (e.g., caribou range), land use and cumulative effects are all considerations.

8: In your experience, what information would be beneficial for practitioners/industry to provide (empirical, case studies, etc.) justification for variances from criteria?

General

- At the end of the day the justification should be prepared to so AER has confidence that is defendable in a hearing setting.

Responsibility / Process

- That the regulator responsible for variances is the AER.
- Heavy burden of proof required to justify that the desired outcome would be achieved.

Information Needs – Process

- Long-term monitoring of sites where justifications have been utilized.
- Potentially case study examples where the long term implications can be demonstrated.
- Cited public references and/or case studies (PTAC meetings, CLRA, RemTech) and evidence that help to support the argument and demonstrate similarities to references and site.
- Guidance/roadmap and case studies or examples
- Need a standardized assessment methodology for approval of variances and change in land use (to provide clarity to industry and regulator/AEP the type of information required to make the decision). Also need a formalized process for how decisions regarding a change in land use are made for leaving a pad in place – what is required (landscape context, vegetation criteria, contour edges, hydrology, etc.).

Information Needs – Applications

- Additional information supporting:
    - Success of natural revegetation in and around pads in peatlands - how successful is natural encroachment in transitional areas and pads (especially the centre of pads).
    - How much topsoil is needed to reclaim a pad site to an upland? Is there a bare minimum requirement? Can pads be reclaimed without out topsoil and if so, what determines success and long term resiliency (site prep, fill material, depth of water table under pad, etc.)?
    - Shear strength of peat and how removal of the top layers affects stability during construction.
- I think it would be beneficial to provide projections based on the history of the recent site evaluations and relevant case studies. A follow-up to confirm or negate projections should be implemented as well. This doesn't need to deter the issuance of a Certificate but rather be seen

as a contribution to the development of case studies that can be referred to in the future. The follow-up evaluation should be a standard enough (empirical) evaluation that it would not need to be a peer reviewed research paper, but rather two professional sign-off for example.

- Professional judgment with supporting evidence
- Within professional justification
    - Scientific evidence that supports the justification will provide AEP with more confidence that the variance is not going to impose liability on the province of Alberta.
    - Anything that helps to provide more confidence
    - A complete package of information with considerations from the site and regional perspective.
- When requesting a release for a pad to be left in place I have provided information for each of the 7 points discussed in #6, except for the cumulative effect (#2) because the data required to develop that justification was beyond the scope of the single upstream well pads I worked on (more applicable to in-situ facilities).
- Consistent package to demonstrate function
- Proof that the site conditions do not impede natural drainage, erosion/slope stability is not a concern and that the vegetation is on the trajectory to be the same composition and density as in the background.
- Site specific data.
- Site specific information
- Site specific information (comparison on-site to off-site)
- Full DSA that was done and justification letters (measurement data that demonstrates that onsite conditions are similar to off site.)
- Passing detailed site assessment
- Photographs
- Surveys
- Observation information
- Measurements and observations
- Not really required to provide much additional information.

Rationale

- Site specific information that provides a good explanation as to why the “limitation and/or deficiency” will not hinder equivalent land capability in the long term (generally demonstrated by the fact that the vegetation meets the criteria).
- In my experience preparing justifications and variance requests for upland sites I try to prepare them in three sections. 1) a clear definition of the criteria failure, 2) an explanation of why the failure is not considered a problem to achieving equivalent land capability, and 3) an explanation of why the available mitigation is not recommended. I have rarely, if ever, referred to published literature because I relied almost exclusively on a successful woody stem assessment. I provided several examples to Bonnie in a separate email.
- In a couple of cases where the EFR for a location stated that the pad would be left in place I relied on it as pre-approval for the reclamation plan.
- References to information that justifies why a “limitation” will not cause long term adverse effects (within the context of the site conditions).

- Any, and all information that provides justification towards the benefit of the variance.

Summary

- Respondents provided a number of information types that could be used to support applications / decisions, ranging from simply providing a DSA to very specific examples of application content.
- Site specific information that provides a good explanation as to why the “limitation and/or deficiency” will not hinder equivalent land capability in the long term

The following questions applied to industry stakeholders and practitioners conducting reclamation activities and preparing a variance to criteria when applying for Reclamation Certification:

9: What have been the main discussion points with, and questions raised by, Land Managers, Forest Officers and Regulators when discussing reclamation and certification of:

9A: An upland wellsite with vegetation encroachment

General

- None applicable. The applications he has provided have been approved without follow up.
- Just reclaim if timeline doesn’t work, need to get in and get out
- ‘One off’ sites are not worth having discussions if they slow the entire program
- If remediation required, do the reclamation
- Regulator in BC is disconnected from this issue (auditor general recently challenged them so this is subject to change).

Policy / Regulatory

- Conversations around interim reclamation (AER)
    - Industry is being asked (Push) to complete interim reclamation yet re-establishing vegetation on portions of the site mean that the vegetation will have to be disturbed at the time of final reclamation or a variance will have to be approved at the time of certification for certain deficiencies in soils and landscapes). The Landscape component of the criteria will need to facilitate interim reclamation to allow for variances. Thus a formalized process that gives both industry and government confidence that this is acceptable is required.
    - Huge cost to industry if a variance is not allowed and they have to disturb areas on a site that they have already invested in for reclamation.

Responsibility / Communication / Process

- There isn’t a lot of feedback from any of those agencies in my experience. It used to be an option to leave pads in place but the mandate from the AER has been to move away from that because of concerns with the issues outlined in the previous questions. However, there is no criteria to determine if the pad remaining in place actually poses a problem to the functionality of the surrounding environment.

- AER is taking a risk based approach, thus they want details about what environmental considerations have been made about the improvement and implications of the pad being left in place.
    - Better information about the justification as to WHY from an environmental perspective that the decision is being made.
- Difficult timeline/arena with land managers
- Hasn't had to converse with AEP for the variance discussions.

Rationale / Objectives

- Explanation of why site wasn't reclaimed
- Has the overall land use capability been maintained for future overlapping tenure users (i.e., agricultural grazing, forestry cutblock)
- First Nations are the main stakeholder and they want pre-disturbance conditions. Not entirely sure how they are going to meet this expectation, but the conversation is started.
    - Haven't really had many conversations about this as of yet
- Consideration of location and accessibility

Information Needs

- Review of EFRs
- Review of construction records
- Review of detailed site assessment
- Conduct site visit
- Reclamation records
- Is wildlife using the site? Grazing on the site? Using the site bedding down?
- Have all contaminants of concern been removed and is there an appropriate cap of suitable material over any onsite sump areas or impacted areas?

Landscape

- Ponding, erosion, slumping and bare areas – how much is too much. 2010 Criteria provides some guidance around what is considered "small and localized (<$4m^2$)", but often a difference in opinion regarding professional judgement
- Broader landscape cut and fill conversations (contour) (what is "operable from a commercial forestry perspective")
    - Erosion
    - Contours
- Subsidence

Soils

- No guideline with respect to topsoil depths in terms of forest development. Trees grow everywhere.
- Topsoil replacement depth – there can be hang-ups with topsoil replacement and topsoil replacement depths, despite the fact that the site is thriving and well vegetated.
- Topsoil depths

Vegetation

- Take a similar approach to forestry in a cutblock for weed tolerance. Ongoing debate. Do we go in with more herbicide and hurt the trees than what it's worth.
- Generally, I've had consensus that meeting/exceeding the woody stem requirements overrides deficiencies with herbaceous cover, weeds, soil, or landscape. The only time I had a variance request rejected for an upland site was one that had very low total herbaceous cover (acid-sulphate soil in the Chinchaga region). That was in ~2014 and SRD requested that we make an effort to seed it with native grass and improve the herbaceous cover.
- Vegetation trajectory (if the approver sees good growth)
- Vegetation establishment
- Are some of these weeds really impeding a forest. (Requires consideration for amount and volume of weeds in comparison). Good success with certification of these sites. Compare with cutblocks in the area. Getting regulator across all industries regulating similarly (forestry and oil and gas).
- Weeds – undesirable species or noxious weeds – little to no tolerance. Annual spraying can lead to a vicious cycle of spraying, replanting, waiting for re-growth of desirable herbaceous, spraying etc.
- Weeds
- Are invasive weeds obviously being outcompeted by desired species
- Weeds and productivity

Hydrology

- Water issues
- Regional Drainage and hydrology are not impacting landscape and vegetation species

9B: A mineral soil pad within a peatland

General

- Realistically the number of sites this refers to is multiple thousands of sites (pads that have functioning uplands (as islands) within a peatland. (more than 1,000 for Canadian Natural alone).
- Big pads can be a challenge (100 x 100 m x 1 m deep = a lot of mineral soil) – can cost $1M for large in situ pad.

Rationale

- End land use remains the same:
  - Traditional harvesting
  - Traditional recreation, hunting, hiking etc.
  - Wildlife habitat
- Although the lease does not share similar characteristics it is not creating ponding or inhibiting surface water flow offsite and overall vegetation growth and soil development offsite are not affected and a suitable macrosite is being created on the lease and access road.
- Come back to what they said they were going to do in the plan.
- When leaving a borrow, and creating a wetland, what led to that decision to ensure that it stays as a wetland.
- Explanation of why site wasn't reclaimed
- The level of disturbance required to fully reclaim it

Information Needs

- Research in support of the strategy to leave a pad in place. Too much uncertainty to do the research and then pursuing it and then site rejected anyway
  - Groundwater focus – what is the pad going to do in the long term to the groundwater
  - Cumulative effect of multiple pads in an area.
  - Vision (overgrown/legacy veg is there) different. New pads – in areas to create upland islands within peatlands and discontinued from other linear features. One of the biggest questions is "what will you use for surface materials". Need examples of this from a research perspective.
  - Operational applied research needs to be accepted as well (functional practical field level).
    - What study required to show whether pad impacts hydrology or not? What is even involved in that (cost/timeline).
- Review of EFRs
- Review of construction records
- Review of detailed site assessment
- Consideration of location and accessibility
- Conduct site visit
- Reclamation records
- What would the third-party impact be if the site were left in place (road or site).
- Have all contaminants of concern been removed and is there an appropriate cap of suitable material over any onsite sump areas or impacted areas?
- Does leaving the soil pad create/disrupt sensitive wildlife habitat areas (i.e., calving areas)
- Have attempts been made to distribute native woody debris and seed bank material;

Examples

- Experimental block – which included one treatment where the surface was smoothed out.
    - o Need to be open to trialing new techniques and processes if we are going to develop best management practices for sites under various conditions.
- Example: Well pad on a fen, removed most of the clay and made the surface rough and loose and turned it up, bringing peat up and sending clay down. Heterogeneous mix of organic/mineral on the surface. 50-90 cm of elevation difference.
- A third perspective was the example I provided in #8 where we relied on the EFR as a written pre-approval. In that case the individual was receptive to discussion of the 7 factors (see #6), but was hesitant to authorize the approval until the EFR was provided.
- Inverted pad on a site and currently in discussion (TBD whether certified)

Responsibility / Process

- The discussion for pads was more difficult than upland sites and varied significantly by the approving individual. On the other hand, one individual I took on a field tour in the Chinchaga region (helicopter flight) and gained approval for several pads in one day by looking at the 7 factors outline in #6 for each site. Note that we also agreed on some pads that should be removed and agreed to disagree on others.
- Even when a site is "functioning as an "upland island" in the right environmental regional context and borrow pit is a functional wetland there is little interest in having a discussion about a change in land use. Stopped engaging in the conversations presently and defaulting these sites to a later date.
- In-Situ: A more holistic approach to "land use" – the overall land use doesn't change, some of the sites may change slightly and the reclamation requirements may be slightly different but the end land use doesn't change. Project level planning for reclamation.

Communication

- Discussions with AEP in the fall of 2018 – Focused on the fact that the policy is to remove the pad and that is what they would like to see on all the sites, but if there are strong environmental reasons to leave it in place they would like recommendations from practitioners as to the sites that are most likely going to succeed with a change in end land use. Out of 50 sites in an area – this should only be relevant to a small handful (3-5).
- When a company is wanting to try something – don't necessarily penalize them if it isn't a complete success (i.e., you can't ask for a trial and then expect it to finish with successful reclamation).
- Considerable challenges with discussion with AEP around land use changes
    - o Easier to default to take the pad and return the mineral material to the borrow (conservative approach).
    - o Not seeing the cost or prioritization of work for industry and impact of moving the material on the environment (both the peatland and to the borrow pit)
    - o Need a more formalized process for the land use change discussions/decisions

Reclamation Options

- Cut a portion of the pad down to leave only+/-20 cm of reveal. This should be discussed with the AEP rep prior to completing.
- Take the pad material and partially reclaim a borrow pit or cut down multiple pad sites and fully reclaim one borrow pit.

Impacts of Removal / Impacts of Leaving in Place / Environmental Net Benefit

- Status or availability of borrow pit
- Has the overall holistic benefit/cost been determined of leaving the soil pad vs. removing?
- Functioning ecosystem, try to reclaim; remoteness and isolated without a lot of other pads would help to make the case.
- Borrow pit – open water, reclamation of borrow?

Hydrology

- Drainage channels were insufficient for the long term.
- Drainage
- Disruption of watercourse
- Not impeding surface water flow or diverting water with pads or flow

Landscape

- Contour and landscape - how will pad be recontoured?
- Stability of pad
- Geotextiles – what effect do they have if left in place on vegetation establishment and hydrological function.

Soils

- Lack of topsoil, how to reclaim without topsoil if, even possible
- Topsoil replacement depths – upland or lowland etc.
- Suitability of pad material to support vegetation long term

Vegetation

- Weeds, agronomics
- Are invasive weeds obviously being outcompeted by desired species;
- Species composition and balance

9C: Transitional sites (i.e., sites with components considered upland and sites considered peatlands/wetlands, as is the case with many access roads)

Examples

- 3 large pad sites in the thermal operation did multiple strategy. Removed some components, re-contoured, exposed peat, etc. Monitoring to determine success.
- Did a full pad removal that they are monitoring. Monitoring the groundwater component. Re-instated the peat component.
- Made the edge of a site into each (upland and peatland) then aim for certification with the respective criteria (also depends on the proportion of the site). If a site is predominantly one type – apply that criterial. If it is more evenly distributed then apply both criteria and/or have a discussion with regulator/AEP about options for reclamation.
- Many of their sites are on the edge or have a peninsula into a wetland (the pad itself – not talking about the access road)
    - Haven't formally done a land use change and used the criteria that was originally planned. Simply recontoured the site and applied the upland criteria to the area that had extended into the wetland. Several examples of success with AER accepting these applications.
- Removal of the patterned fen – EPEA required that they needed to remove/salvage peat
    - Peatlands were part of a larger peatland complex; underlying hydrological connectivity. Construction required that the fill material be applied on top and thus it would require it be removed at the end of the days.
    - Small peatlands that are not connected hydrologically to anything (independent pocket).

Policy / Regulatory

- Typically do not want to see trends in having numerous wellsites with justifications or not doing reclamation and hoping to get variances for everything. Typically want to see vegetation on a trajectory to becoming a mature forest and do not want any negative impacts to future land uses/users (large cut and fills, holes, refuse). They often have a more regional perspective as well, as practitioners are often only focused on the wellsite itself and may not have as much regional information.
- Asking for more clearly defined closure plans. It may make sense to use clay elsewhere, and it may not. Thus it is difficult to plan too far in advance.

Rationale

- Overall – try to address through front end planning to avoid delays in getting permission
- Explanation of why site wasn't reclaimed

Information Needs

- Information can be shared publicly over the next few years. Doing this in terms of wetland research iFROG (research group).

- Reclamation records
- Does leaving the site in the existing state/disrupt sensitive wildlife habitat areas;
- Have attempts been made to distribute native woody debris and seed bank material;
- Have all contaminants of concern been removed and is there an appropriate cap of suitable material over any onsite sump areas or impacted areas?
- Review of EFRs
- Review of construction records
- Review of detailed site assessment
- Conduct site visit
- Reclamation records
- For wellsites, it depends whether it would blend in with the surrounding topography.
- Regional siting and biophysical inputs

Reclamation Options

- For sites that are in a transition from peatland to upland – reclaim by using the pad material to create an extension of the upland area. This seemed to be the preferred method for the Peace River group.
- Generally, I've been able to treat transitional sites as upland and address them accordingly because they don't typically have borrow pits that require approval to leave as wetlands. That's because if the fill material is available on an upland side of a site they will take it from there instead of opening a separate borrow pit. The exception would be if it was necessary to pad a section of access road that required a borrow pit. In that instance the discussions proceeded as described above in part b. I have a good example of a site I am currently working with that fits this scenario.

Impacts of Removal / Impacts of Leaving in Place / Environmental Net Benefit

- Consideration of location and accessibility
- Status or availability of borrow pit
- Constructability
- Economics

Landscape

- Are there any significant contour/topography changes that impact the transitional areas and associated habitat both plants and animals?

Vegetation

- Weeds
- Are invasive weeds obviously being outcompeted by desired species

Hydrology

- Consider hydrology and contour appropriate
- Is the regional and immediate hydrology/drainage impacted negatively

Summary

- Concerns were expressed that there is a default "No" mentality emerging. Discussions regarding leaving pads in place were more difficult.
- Look to forestry experiences with tree growth and weeds rather than criteria numbers.
- Pads in peatlands occur in large numbers and cost to remove can be considerable – therefore consideration of cumulative effects of removal requests should be considered.
- Approaches to transitional sites varied from reclaim to both upland and peatland, or remove pad and reclaim to peatland, or leave pad and reclaim as upland.

10: How did you come to a conclusion regarding certification/management of the sites discussed above?

General

- Usually involved lots of communication (email, phone), justifications, pictures, aerial photographs, a joint site visit and approval of a "plan" to leave site as is

10A: What are the main reasons they said yes to certification?

General

- I have not received certification under these circumstances.
- Still waiting for certification.
- All of the considerations noted above were addressed and an evaluation was in favor of no further disturbance or work. Follow-up evaluations were a condition of the COR Applications two years after the certification.

Process

- Pre-approved plan in place (written communication)
- Generally, try to get a pre-application clearance to not have to do a non-routine application because the process goes faster.
- In most instances for upland sites applications are submitted as non-routine and approved because appropriate justification is provided to demonstrate that a vegetation override was appropriate (i.e., the site met the vegetation criteria within the forested criteria) and the deficiencies were not impeding equivalent land capability (as evidenced by the vegetation established on the site).

- Need to provide more information about what the type of information that AEP, AER would require to have confident in professional justification decision.
    - We can provide examples for the type of information they are looking for with respect to the variances.
    - With respect to land use change – what are the main factors being considered and a formalized process for how to make the decisions.
    - Justification information available that is specific to the individual sites (a checklist for things to include when considering using professional justification and applying for a variance.

Communication

- Persistence, open discussion and providing a logical rationale
- The main reason seems to be willingness of the approving individual to discuss it. For upland sites it was willingness to accept a successful woody stem assessment as justification for other deficiencies. For peatland sites it was a willingness to discuss and consider the 7 points (see #6) instead of defaulting to a 'no' answer.

Rationale / Supporting Information

- Functioning ecosystem with little to no off site impacts.
- Meet applicable/applied criteria
- Detailed and scientifically rationale presented with good professional judgement
- Most have been based on the quality of the package and the professional justification. Photo documentation and why they feel it meets ELC. 98% of the time if the appropriate information is provided, these are being approved.
- Evidence of functioning ecosystem and otherwise compliance with reclamation criteria
- Focus was based on end land use and vegetation cover
- Assessing the potential negative effects of the overall disturbance to complete a site to meet criteria

10B: What are the main reasons they said no to certification?

General

- There is an on-going trend that shows that reclamation practices are not improving.
- Not relevant for upland sites. He doesn't typically make an application if he doesn't believe that it meets equivalent land capability.
- Insufficient information
- Criteria is not met on the site, therefore need to reclaim to standard

Examples

- For the one peatland site where he suggested a mineral pad be left in place, the application was rejected because AEP did not feel the argument was strong enough from an environmental perspective.
- Never happened for upland except the one situation noted above where additional seeding was requested and warranted.
- The main reason a certification was denied on a transitional site was due to insufficient cover over an onsite sump area. The topography was slightly settled in this particular area and although it was not impacting the regional drainage/onsite drainage significantly, there was a concern that there may be capillary movement of COC's from the sump area without sufficient clean cap of material.
- Waiting for approval, but had the discussions with the regulator. Improvements in place rather than a land use change (access roads, etc.).
- For a large portion of the sites, the pad was removed via landscape borrow on access roads. As the sites are gas there isn't padded material on wellsite. Has seen some instances where they had to leave pad on-site left in place because of the pipeline.

Process

- No pre-approved plan in place (written communication)

Rationale / Supporting Information

- Cost justifications – it costs too much (uneconomical), borrow pit is too far away etc. without any other justification/rationale.
- Project level reclamation plans
  - (90,000 ha; 9 townships – approved footprint is only a small percentage (3%) (16,000 ha). – won't change the regional land use.
- If there is some "grey" when there could be a land use change (e.g., edge of a wellsite is within a peatland).

Site Conditions / Land Use

- Off-site impacts – erosion, slumping, disruption in hydrology, within a caribou zone
- Borrow pit has open water and is not accepted

Landscape

- There is a significant landscape issue that could be hazardous to land users or cause future problems on-site or off-site.

Soils

- Large amounts of stockpiled soil on site
- No topsoil

Vegetation

- Vegetation not desirable – maybe the woody stem requirements are met, but the species diversity isn't there, no structural layers to site etc.
- Depends on the DSA and if the species composition and densities are appropriate. Easier to apply rather than not and try to establish a good justification.

Hydrology

- For peatland sites the main reason was a 'damning' effect to hydrology of a peatland
- Evidence of impacts to hydrology or ecological dysfunction
- Site impeded overall area drainage

Summary

- Concerns were expressed that there is a default "No" mentality emerging. Discussions regarding leaving pads in place were more difficult.
- Some examples of refusals due to misses of specific were provided.
- Refusal appears to occur less frequently on upland sites than pad in place sites.

The following questions apply to regulator/government representatives:

11: What are the main topics/issues/questions addressed in your discussions with practitioners and/or industry regarding reclamation and certification of:

11A: An upland wellsite with vegetation encroachment

General

- AEP only on the change in land use topic.
- Lessee wants this – "Please approve" – Not their role. They are not the landowner and that is not a good enough justification.
- Industry seems to want a black and white standard.
- 3rd party use
- Seasonal consideration
- Not sure how the construction would have occurred due to a transfer of the site from a historical perspective.
- What are the conditions of the site (is it in an area that is typically difficult to get things to grow within)

- Should each site be looked at as site specific?

Policy

- Industry/practitioner – what length of time that AEP is comfortable with before applying for a rec cert.
- Forested sites and caribou range – practitioners want to know what is enough, in terms of time, to ensure that AEP is confident that the forest is appropriately functional.
- Caribou range changes what would be accepted.

Criteria

- Looking for a minimum such as with the forested land criteria and that is generally the starting point. If the standard for the criteria can't be met then a dialogue needs to be initiated with local AEP staff.
- Aerial assessments (working on updating criteria to allow for more aerial assessments)

Information Needs

- Information requests from AEP to industry. Not enough information was provided thus AEP is forced to request more information.

Rationale

- If it would meet the criteria, then it would be approved.
- Ecological focus or cost savings.
- "What is the benefit"
    - Example, grazing lease increasing carrying capacity (water hole)
- Leaving pads in place on older sites that are fully vegetated.

Impacts of Removal / Impacts of Leaving in Place / Environmental Net Benefit

- "Doing more harm in going in there and removing" than if the site is left in place.
- Cost

Landscape

- Contour issues not meeting "criteria"; not overly concerned with 60/90 cm differences. Only paying attention to 3 m cuts.
- Erosion

Soils

- Topsoil replacement depths with respect to 80% requirement
- Topsoil replacement; removing existing vegetation, regardless of the quality/composition of the vegetation if topsoil is available for replacement.
- Soil depths (only in certain areas)
- Not sure where the surface soil was stored.
- Short surface soil for portions of the lease

Vegetation

- Weeds, agronomic species
- Vegetation (presence of weeds)
- Weeds
- How important is it weed control if native vegetation is encroaching?
- Offsite land use affecting onsite vegetation.
- "Trees are good, it's going to do more damage to go in and complete reclamation activities than to leave it as is".
    - This is not a strong enough argument. If the trees meet criteria, that is one thing. If they don't, but there is growth on the site that is a different thing.
- Growth is "OK" and compatible in terms of composition but not necessarily comparable to offsite.
- Jackpine ecosites (a ecosite non-productive due to lack of herbaceous cover)

11B: A mineral soil pad within a peatland

General

- Industry seems to want a black and white standard.
- They don't want to disturb anything that has been established.
- What is the offsite peatlands type – may be different but still meet criteria.
- How many assessment points are needed on access roads and wellsites that are transitional Forested and Peatlands sites?
- Example – Grazing disposition and a client came and was only talking about a borrow pit. No consideration was being given to the wellsite.
- Functionality of the wetland, and how it is being affected by the asset (well pad or access road). Need to have a good understanding of the implications for the decision, and that needs to be provided to enable a decision.
- Looking for a minimum such as with the forested land criteria and that is generally the starting point. If the standard for the criteria can't be met then a dialogue needs to be initiated with local AEP staff.

Policy / Regulatory

- Regulatory uncertainty on end land use, AEP and AER jurisdictions etc.

- Obtaining approval to leave pad in place from AEP.
- The WHY [a change in end land use is appropriate] needs to be addressed with better justification.
- We are looking at a 200 year horizon, thus if disturbing 5-10 years of growth is a minor setback in time, then that is appropriate. Re-contouring, soil, etc. are more important than a few years of vegetation growth.
- Industry/practitioner – what length of time that AEP is comfortable with before industry should be applying for a rec cert.

Environmental Net Benefit / Reclamation Options

- "Doing more harm in going in there and removing" than if the site is left in place.
- "What is the benefit"
- Cost
- Costs, feasibility, logistics and outcomes (does pad removal result in a better outcome and more desirable site type?) – this seems be to highly variable and dependent on so many factors
- Ecological focus or cost savings.
- Progressive reclamation of borrow pits – reclaimed to open water, nowhere to place fill at end of life from the pads
- They don't want to put the borrow material back; they are focused on the borrow pit itself rather than the pad.
- Seasonal consideration (multiple water course crossings, timings, etc.) – may influence what would be required on a site
- Ability to re-contour site into the surrounding land, or is it just a big pad in the middle of a fen?

Landscape

- Geotextile removal and the problems it presents – not easy to remove or pick out
- Geotextiles settle below underlying water table and roots are not significantly restricted, but rather limited by the water table
- Shear strength of peat – claims that the stability is lost when top 40 cm of peat is salvaged

Soils

- Topsoil replacement depths, conversion to upland requirements, topsoil deficiencies for the project and lack of topsoil, less than 80% topsoil replacement depths
- What is the chemistry of the soil? (brittle sand stone – no structure to promote root growth, difficult to de-compact, sterile soil) – makes for great pads but do not grow anything; sulphate soils
    - Demonstrating poor vegetation growth

Vegetation

- Weeds and agronomic species

Hydrology

- Hydrology and issues with pads restricting water movement and subsurface flow

Impacts

- Offsite impacts assessed by surrounding vegetation and hydrology at each specific location.
- Is the mineral soil pad affecting – vegetation and drainage- cross site flow and water movement on the lease?

Summary

- There is a sense that industry is avoiding reclamation via the variance and change in land use requests.
- Understanding the reason for departing from the criteria and the implications of redisturbing the site to undertake reclamation.

12: How did you come to a conclusion regarding certification/management of the sites discussed above?

General

- Not necessarily certification, but authorization to proceed with reclamation plans that allow pads to remain in place
- Cost/benefit analysis – intuitive, based on professional judgement or empirical knowledge
- Was there progressive reclamation of the associated borrow pit?
- Judgement call.

12A: What are the main reasons you have said yes to certification?

General

- Company track record; expectation within approval/disposition were met; justification for long term plan within an area; no adverse effects demonstrated by offsite vegetation and hydrology.
- Decisions are made with the benefit to the province/public in mind, thus it comes down to what an individual feels comfortable defending in a public context.
- If enough information and justification is provided, and it is reasonable, generally agree to certification to a variance.
- Approval for pad to remain has been provided.

Rationale / Supporting Information

- Not AEP role, however if they agreed to an change in end land use it is for the following reasons:
  - Accept the change in end land use based on the information provided fitting into (1) an integrated land management plan (for upland sites or pads within peatlands);
    (2) justification provided that demonstrates the implications/rational for the decision from an environmental perspective with a long term outlook; (3) mineral pads have been partially removed, decompacted and re-contoured to blend with the surrounding landscape and a minimum of 4 years of growth can be used to qualify the trajectory of the site.
- Site specific plans and detailed rationale as to which pads were remaining in place and why
- Magnitude of requirement (Example, wood pile that was a potential fire hazard) – only a consideration for older sites.
- Reclamation material balance checks out for the entire project, or proposed “alternate plan to obtain topsoil” makes sense based on information provided
- Detailed discussion on site prep techniques, mitigative measures and adaptive management, and monitoring
- Demonstration equivalent land capability is achieved using indicators from 2010 criteria or as outlines within plans and proposals
- Holistic approach to justification was provided.
- Grazing sites are pretty easy. Good justification provided, thus site meets appropriate criteria.
- Consideration for the surrounding area. Does a change in the land use meet the objective of the overall plan for the surrounding disposition.
- Strong/ reasonable justification for the change in land use is aligned with the surrounding land uses.
- Completely depends on the strength of the argument
  - Includes access and what is prohibiting them from going back in.
  - The more information that is provided the better the application submission will go. [complete information is very difficult]

Environmental Net Benefit

- Removing the pad would cause more damage to the site if fully vegetated.
- Did consider costs from industry perspective as well as the amount of disturbance that would be required to go and reclaim a smaller disturbance.
- Spraying weeds would cause more damage to a site where vegetation is on the right trajectory – weeds decreasing and native vegetation on the correct trajectory.

Vegetation

- Appropriate revegetation
- Vegetation establishing well as shown by the data and photos over a few years.
- The site is remote and fully vegetated.

12B: What are the main reasons you have said no to certification?

General

- No approval or variance for failures
- If it is being driven purely for financial reasons.

Uncertainty

- Uncertainty around outcomes – what is actually best and will result in best outcome? When in doubt, the default is always back to the approval conditions.
- Need more acceptable practice to assess sites this way

Justification / Rationale / Supporting Information

- AEP will not approve a change in land use if appropriate rationale is not provided. Stating: removing the pad will do more harm than good; is not strong enough justification to make the decision. The implications for the decisions are required. Cost cannot be the only factor in the rationale.
- Site wasn't a legacy site.
- Insufficient information – lack of justification (weak arguments, lack of scientific evidence or research), insufficient detail and lack of a plan, poor assessment and lack of data on the project as a whole, justification based on costs savings alone
- Didn't consider the regional perspective and/or cumulative impacts.
- No range improvements, etc.
- No justification provided that had any ecological information associated with it.
- No information.
- Not enough information was provided.
- No environmental benefit was provided.

Alternative Approaches Possible

- If it is clear that the site would be more productive if reclamation were completed.
- Did not believe the site met equivalent land capability due to lack of soil in areas of the lease and excess soil in others – requested the site be mulched, the soil be redistributed and the site revegetated. Seedbank was present as a result of the vegetation that was growing therefore re-establishment does not take as long as one may think and there are less concerns about the long-term capability of the site to reach a mature functioning ecosystem.
- If the borrow pit is available for the mineral material to be returned to, it is unlikely that a change in land use would be approved. The borrow pit and pad MUST be considered together. [e.g., said no to a change in land use for leaving a pad in place because the borrow pit was not considered in the application].
- Site was accessible
- The site is not remote and vegetation does not meet criteria.

Soils

- Topsoil deficiencies or material balance deficiencies that are not sufficiently addressed with a plan (lack of detail and data, too conceptual)

Vegetation

- Vegetation is not growing well in a large part of the site.
- Significant areas of vegetation deficiency. Bare areas. No evidence of similar examples in the area (Example, sand blow out)

Summary

- "Yes" comes from strength of the argument and supporting information.
- "No" comes from poor rationale for departing from the normal process and criteria, lack of, or poor quality of, supporting information, and the potential for reclamation or partial reclamation to improve the site.

Other Comments

General

- Site is required to be reclaimed – and it needs to be demonstrated that it would meet reclamation criteria.
- Quote: "Just because you didn't have to do it before doesn't mean that it shouldn't be done– companies need to be re-visiting what they said they would do when the disposition was granted and budget resources accordingly."
- Regulator and government need to be willing to integrate changes.
- Every region might have completely different drivers.
    - Socio-economic concerns
    - Wildlife
    - Access
    - Etc.
- Seismic line reclamation
    - Many years of seismic lines (8 m) wide that are being used and re-used

Policy / Regulatory

- AER needs to be able to stand behind the decision and they need to be comfortable with making the decision.
- In-situ projects – all have to do a wetland research trial (condition within the approval). All conditions are the same for all companies. It would be more strategic to create different

requirements under different approval conditions. Identify the questions that the AER has and ensure that they are being addressed strategically at different locations.
   - 10 companies addressing the same question. End up repeating the same experiments and not generating a lot of new information.
   - Companies are eager to do other things but their hands are tied because their approvals have very specific requirements.
- Asking them to do a trial but then asking them to ensure they are going to be successful.
- In general, the government should stop doing draft guidance documents. If a guidance document does not advance to a fully-fledged guidance document, it should not be released because it sets unrealistic expectations. Industry will begin to use the "drafts" without recognizing that the "rule of the day" is still the existing documents.
- As a government body they cannot be prescriptive about what they tell a company to do if it is not meeting criteria (because then they are responsible if it fails). Do detail why the site is not satisfactory but DO NOT tell them WHAT to do about it.
- Security in the fact that it was the "requirement of the day" – as long as it is not causing severe limitations, then requests would not be made to disturb areas that had been previously reclaimed and planted.
   - Forest cover is highly variable and dynamic and some variation is not a bad thing so as long as it is compatible it would be acceptable.
- These are legacy sites and we need to be reasonable in our expectations as the regulator.

Process

- Main interest is to develop some guidance around certification of padded sites.
- The biggest thing we can get out of this project is a formalized process to approve land use change that AEP uses to inform the decisions they make with respect to land use change requests.
- Want a framework for land use change that is appropriate and gives the government confidence that the industry is going to reclaim the sites into functioning uplands appropriately.
- Regulatory guide/rules for which sites you can leave pads in place and which sites you can't would be helpful
   - Ex. First Nations territory but not reserves and they were told they can't leave them without an "environmental context"
- AER is trying to make things simpler, check-box approach, but it is unclear how AEP can best utilize the simple checkboxes to consider change in land use or to approve an "improvement" in place.
- Process to get to approval has changed and it is more convoluted. But, on the other side (construction) practices have generally remained the same. The equipment and practices are the same to construct a site - they build a road, build a lease, get a borrow pit, etc. Nothing has changed. Activities haven't changed therefore why are we changing the directives for how we approve reclamation.
- Is there a thought for how to understand the needs for aboriginal stakeholders??
   - And/or any other stakeholder engagement
   - Consideration for how to incorporate "integrated land management" into the decision making process.
- When asking for variance or change in land use industry NEEDS to provide good information and justification for the variance/change in land use.

Criteria

- If you have a peatland that is not deep (less than 1.5 m of peat) – the fill can be removed easily and can likely be re-used. However the criteria is not set up to encourage it. Criteria encourages companies to convert bogs to fen and introduce different species. [particularly relevant to access roads- that don't have a significant volume of mineral material]
- Difficult to "nail the jello to the wall" (hard to develop a checklist that covers the entire province); there does need to be an element of professional judgement because there are so many regional differences.

Regional Context

- Overall – focus has been on a site by site but need to be looking at things from a holistic perspective. Need to be considering this from a regional perspective (potentially with other operators)
  - As an industry – from a regional perspective there would be an opportunity to consider the cumulative impacts. Net environmental benefits and impact.
  - Or even within a given peatland.
- With a lot of other upland sites – it would be beneficial to consider an integrated land management approach.
  - Integrated land management – need to consider what other land uses are occurring within an area and come up with creative solutions in collaboration with AEP to meet multiple land use goals within an area (i.e., Develop an alternative land use plan with appropriate justification).
    - There is a lot of other recreational pressures on land
    - Particularly for roads – network of opportunities
    - ATV staging area for a quad trail

Examples

- Road was impeding water flow; try for full reclamation rather than partial pad removal. Site demonstrated good success and rebounded
- Road at JACOS
  - Peat is 4-5 meters thick with approximately 5 metres of clay on top.
  - Don't want to pull all the clay out – want to lower the surface to re-establish the right about of peatland vegetation.
- Road was used as an ice-road at a later date – thus they may have influenced the success of re-establishment. [haven't re-visited the site since year 2].
- 2010/2011 initiated project; 3 experimental blocks.
  - 1) Lowered road down to water table and set up vegetation plots.
  - 2) Refilled some with peat (at different depths)
  - 3) Half road revegetated with mineral, half with peat.
  - Earthworks completed in October 2018.

- Revegetation treatments in 2019.
  - Found going down to water table is a too low.
- Site they are on now is a nice pine wall where the edge drops off into a large peatland. The mineral material is being re-contoured and removed from the wetland to be incorporated into the access and site. Not that difficult to do.

Reclamation Methods

- Partial Pad Removal – total waste of time to take out some of the mineral material and not remove it all. A bit of mineral material changes the reclamation trajectory dramatically. Ultimately, not likely going to save any money because it will be difficult to meet criteria for either upland or peatland. Highly recommends this is not a favorable direction.
- Transitional Linear features
  - AEP is willing to meet in the middle (remove some, leave some); open a dialogue and discuss the options that meet the needs of the area and the environment.
  - Upland portions should be reclaimed back to what they were (no exceptions).
  - Do a deep rip on the other areas within the wetland [expectation for vegetation – let it naturally evolve with both upland and wetland species]. Do not restrict the peatland to function under the road itself and not prevent any vegetation growth. No planting required.
  - Pull areas of road to restrict access to recreational use.
- Significant benefit to progressive reclamation to reforest areas that interim reclamation can completed on

Soils

- Quote: "If it grew trees once, it can grow trees again, but the dirt will never move itself back"
- How to create an appropriate growing medium?
  - Compost piles (with drilling wastes) – as long as the contaminant criteria are met then re-use the materials.
  - Amendments are an appropriate option for establishing a growing medium for pads left in place.
- Decompaction is a key thing that needs to be addressed.
  - Sites have been left in place and re-vegetated.
  - Significant limitation to achieving ELC
  - Corduroy/filter cloth that will limit root development in the future (long term impacts for achieving ELC

Vegetation

- When they were in government as Forest Officer they were responsible for reclamation in Red Earth and they had a lot of applications where sites was growing trees and the applicant claimed that they thought it was growing well but the species were either irrelevant (completely different than surrounding area) or it was scrub brush. This was not an acceptable argument then, and it shouldn't be now. For a vegetation override to be applicable, the vegetation should meet the forested criteria.

- If the site already has some vegetation established then the weed management is easier to manage from a weed perspective. Requires a very targeted approach.
    - Perennial Sow thistle
    - Scentless Chamomile
    - Buttercup
    - Canada thistle
- Multiple years of weed management if the site is a full disturbance site. Reclamation disturbance. (i.e., need to consider the implications of the disturbance to conduct reclamation (particularly full reclamation) activities.

APPENDIX B: SUMMARY OF CASE STUDIES

B1: Complete Pad Removal Case Studies

Case Study 1: Complete Removal of Pad and Peat Inversion (IPAD) in a Bog

The IPAD (acronym referring to well Pad Inversion) is located within a treed bog/poor fen complex about 50 km northeast of the town of Peace River (56.397°N, 116.890° W), Alberta. This area is characterized by typical continental climate, with a mean temperature of 13.8 °C and mean precipitation of 214.4 mm during growing season (June – September) between 1981 to 2010 (Government of Canada, 2019). The peatlands surrounding the well pad are dominated by *Picea mariana*, *Salix* spp., *Rhododendron groenlandicum*, *Vaccinium vitis-idaea*, *Carex* spp. (sedges), *Sphagnum* spp. (peat mosses) and fen mosses including *Aulacomnium palustre* and *Tomenthypnum nitens*.

The 1.4 hectare well pad (120 m x 120 m) was constructed in December 2006 by laying down the woody vegetation, covering the area with a semi-permeable geotextile liner and introducing a 1.4 m thick clay overburden excavated from a nearby upland site (Figure 9). The site was then drilled but not actually operated (i.e., no oil was produced). Prior to reclamation in 2011, the mineral pad was mostly barren with scattered upland forest species and weeds (Figure 9).

The well pad was reclaimed using an inversion technique in which the underlying peat substrate was inverted either with or without the burial of some of the mineral soil fill depending on the amount of compression of the peat profile compare to the surface level of the surrounding natural peatland (Bird et al., 2017b). An excavator was used to remove the layer of mineral fill that were higher than the level of hollows (low-points) of the surrounding natural peatland. The removed soil was returned to a nearby borrow pit used in the original well pad construction. In areas where peat under the pad was deep (>1 m), the remaining clay fill and geotextile was completely removed and the buried peat (up to 1 m deep) fluffed with an excavator bucket (Figure 9). For simplicity, this treatment is referred to as “Peat Inversion (PI)”. In areas where very shallow peat was present (less than 1 m), the remaining mineral soil fill thickness (and associated geotextile liner) was buried under excavated peat, resulting in an inverted soil profile compared to the original pad. This treatment is referred to as “Clay Inversion (CI)”. The result after site adjustment was the creation of a uniform, flat peat surface with an elevation ~10 cm below the adjacent natural peatland hollows at the four corners of the pad.

Revegetation started in June 2012. As per the Moss Layer Transfer Technique (MLTT) developed for harvested peat fields, moss fragments, along with roots, rhizomes, seeds, and spores were collected from three distinctive communities (*Sphagnum* dominated, brown moss dominated, and *Polytrichum* dominated) from the surrounding cutlines. At each donor site, the top 10 cm of the living moss was harvested with a rototiller and spread across the restored site, following the standard MLTT protocol. The entire site was then fertilized with rock phosphate (0-13-0, 150 kg/ha) to promote the growth of the *Polytrichum strictum*. Refer to (Sobze et al., 2012) for detailed description on the moss collection and transfer procedures.

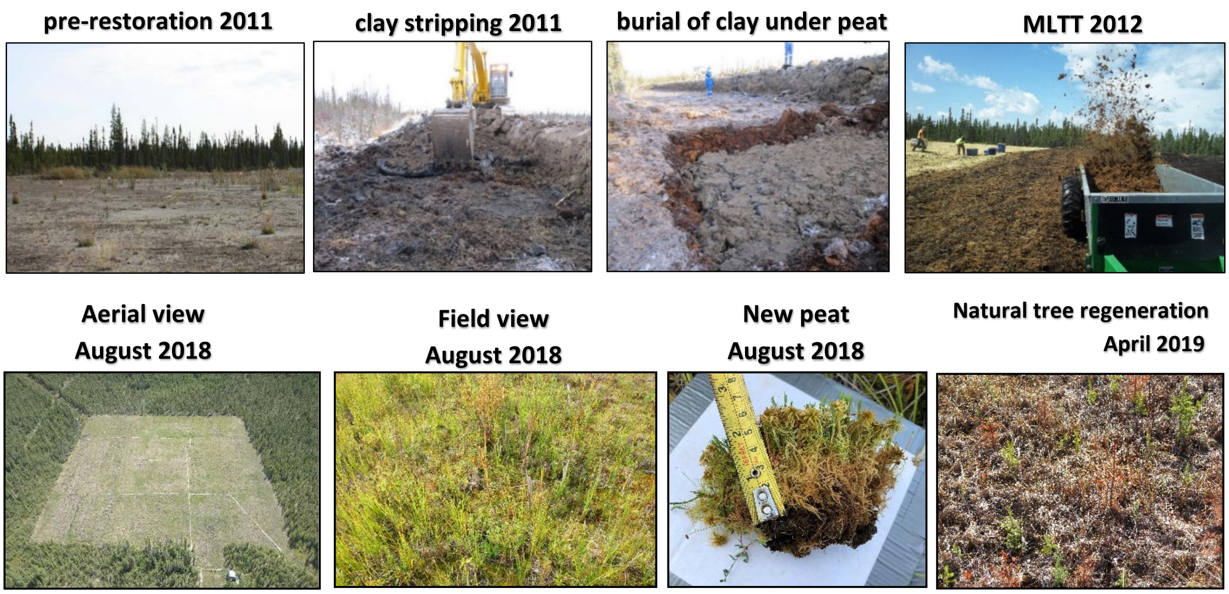

Figure 9. The IPAD site during site work and MLTT and field performance as of 2018 and 2019.

Learnings:

- The pad is doing very well with high peatland plant cover including a healthy moss as thick as 10 cm in some areas.
- Mosses account for almost half (50%) of all vegetation. Sphagnum moss start to develop in the drier areas while true mosses dominate the low lying areas.
- Cattail was no longer abundant and dominant in wet areas, and overall there was very little weed present.
- There is a good amount of litter accumulating across the site.
- There was not obvious distinction among different treatment areas.
- The site is stable without signs of erosion, gullying or presence of industrial debris.
- The site is well on its way towards a functional peatland. It has passed two separate assessments using the provincial peatland criteria, in 2015 and 2018.

Case Study 2: Complete Pad Removal and Peat Inversion (8-22) in a Fen

Pad 8-22 was a full pad replicate utilizing the learnings from the first IPAD trial. Civil earthwork started in January 2015, but due to inclement weather conditions was deferred to November 2015. The entire pad was removed and the clay returned to reclaim the original borrow pit. The buried peat was fluffed to raise the surface elevation, then smoothed to remove air pockets and create a uniform surface. Donor moss was immediately transferred from a nearby cutline, and roughly 1,200 black spruce seedlings were planted in June 2016.

NAIT CBR team visited the site in 2018 and found that the moisture condition has greatly improved (Figure 10) since 2016. Graminoid and brown moss species have established across the site and there is less standing water than in previous years. Compared to the IPAD, the surrounding areas are treed fen and the reclaimed area is overall wetter. Local hydrology and peat chemistry likely contributed to the development of fen and marsh like communities. There is less *Sphagnum* development as a result. However, the entire site is dominated by wetland and peat-forming species.

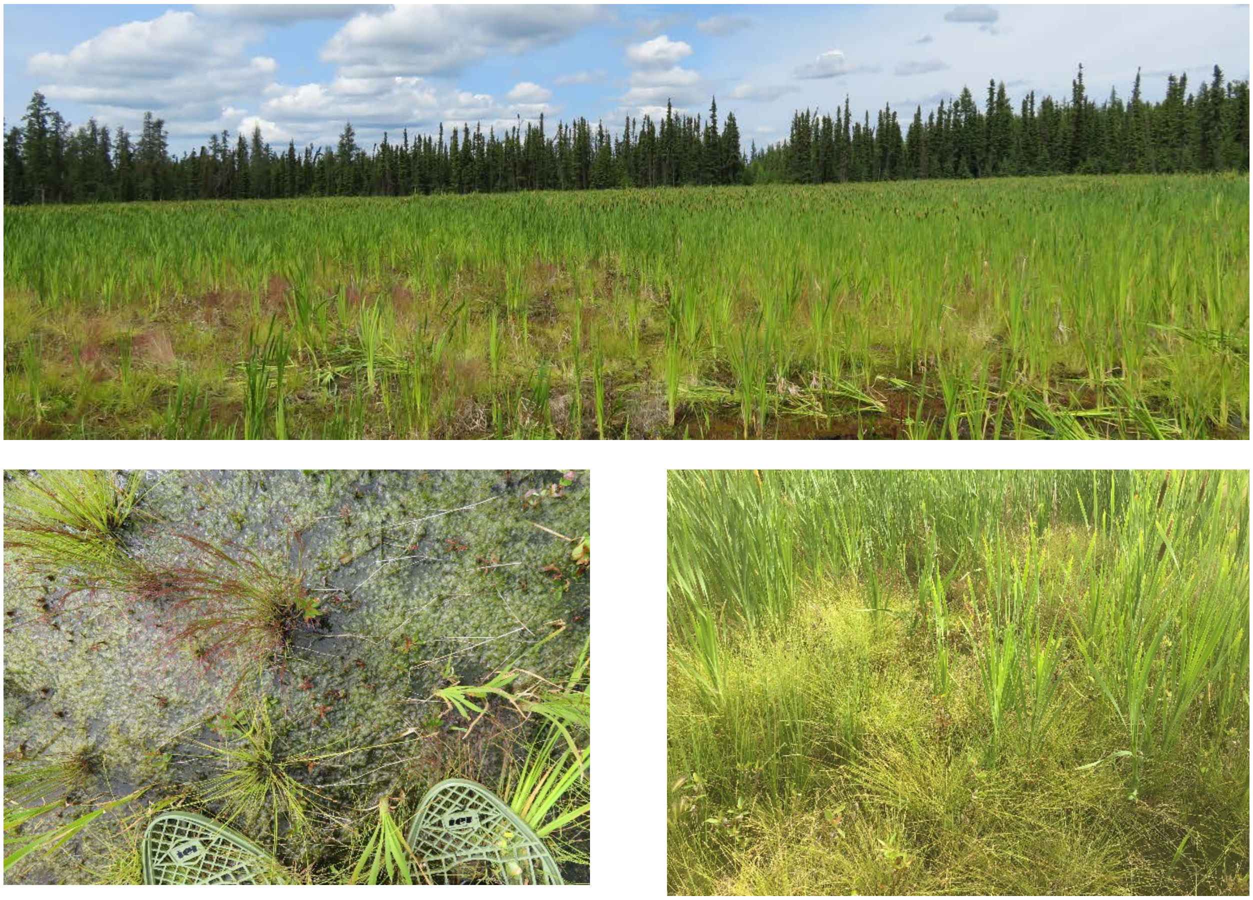

Figure 10. Pad-22 during a visit in July 2018.
Top: overview of the reclaimed pad. Lower Left: pool of moss developing in an open area of the pad. Lower Right: Close up view of a densely vegetated area of the pad.

Learnings:

- Complete pad removal in a fen led to more flooding in early years
- Donors from bog had little influence on vegetation, there is very low establishment of Sphagnum mosses across the site.
- Instead, hydrology and soil chemistry played critical roles in vegetation development
- Vegetation is marsh like but ground layer is dominated by true mosses
- There is a visible decline in cattail dominance in many areas

Case Study 3: Burial of Wood Chips under Peat – the Wood Chip Road in a Fen.

A 400 m long temporary access road was built through a wet, circumneutral fen (Figure 11). An average of 1 m wood chips was placed directly on top of fen peat with a separating geotextile layer. Although abundant seed sources were present adjacent to the road, the wood chip surface prevented successful re-establishment of any vegetation. Civil earthwork was carried out in February 2015 to invert the wood chip layer with the buried peat beneath to create a moist surface for fen vegetation establishment (Figure 11, top right). This negated the transportation costs associated with removing the chips off site. Adapting the peat inversion technique developed at our first IPAD trial, the chips were first removed to the side, the buried peat then excavated to another pile, and the chips replaced in the bottom of the hole followed by placing the excavated peat on top (Bird et al., 2017a).

Figure 11. Burial of Wood Chips under Peat.
Top left: the woodchip road before reclamation in 2014. Top right: field operation and burial of woodchips under excavated peat. Bottom left: The road in summer 2015. Bottom right: the road in August 2018

The peat surface was smoothed to remove air pockets and to create a uniform surface, then left to settle over the next 6 months. Below average precipitation in early summer of 2015 resulted in less than expected peat settling and dry surface conditions. In August 2015 a dozer was brought in to track pack the surface, lowering it by another 15-20 cm (Figure 11, bottom left).Because the road was only 6 m wide and abundant wetland propagule sources were present on either side of the road, the reclaimed road was left to naturally regenerate, except for the planting of 750 black spruce (contractor) and 750 larch (NAIT) in June 2016.

B2: Partial Pad Removal Case Studies

Case Study 4: Partial Pad Removal – SKEG sites (Vitt et al., 2011a)

SKEG Pads 12 and 16 were the first trials to initiate fen vegetation on rewetted mineral substrate (mineral initiation or paludification) of in-situ well pads. Both pads were built in the early 2000s in a treed poor fen near the central processing facility of CNRL (formerly Shell). On each pad, 25 m by 120 m of the pad bordering nearby peatlands was reclaimed by removing most of the overburden clay in 2007. Trenches were created to connect the pads with the surrounding peatlands and to promote seasonal inundation of the mineral surface (Figure 12a and Figure 12b). The lowered soil surface was either fluffed or left alone, then amended with various materials including woodchips and farm peat, followed by planting of various wetland species including willow cuttings, sedge transplants, and stock larch trees (Figure 12c). The lower section of each site is dominated by sedges, both planted and natural ingression, and willows, resembling an early successional fen community growing on wet mineral substrate. Higher sections of both sites suffer from presence of weeds and upland species. Stockpiled farmer's peat contributed to weed infestation in these areas.

NAIT CBR finished a criteria assessment of both pad 12 and 16 in 2017. They concluded that both areas suffered from high undesirable species cover and therefore failed to meet the peatland criteria as of 2017. Parts of both pads were too high and dry during the growing season, leaving room for non-wetland species to establish Figure 12d). In the lower, wetter sections, water table is closer to surface facilitating growth and dominance of sedges and willows. True moss is starting to grow but its cover is still very low.

Figure 12. SKEG pad 12.
a: trenching after partial pad removal in 2007. b: experimental blocks (2 m x 2 m) with different soil amendment treatments. c: planted sedge seedlings in 2008. d: overview as of July 2018.

Case Study 5: Partial Pad Removal + MLTT – ASPEN PAD (Gauthier et al., 2018)

About 2 km away from the SKEG sites, a section of a well pad (10 m x 100 m) was reclaimed by mechanically shaving and reprofiling clay loam to the average elevation of the surrounding peatland water table (close to peat surface) in 2009. On average a layer of 20-25 cm of clay was left in place on top of the buried peat, due to subsidence created by the weight of the pad. The excavated fill was piled next to the lowered section. Donor plant material was collected from nearby treed and shrubby fens and spread across rewetted mineral fill by hand following MLTT (Gauthier et al., 2018).

True mosses such as *Tomenthypnum nitens* and *Aulacomnium palustre*, both typical of fens established quickly, covering up to 58% of ground cover after only one growing season. The origin of the plant community, rather than the substrate type, was the determining factor for vegetation growth. Sphagnum mosses were abundant in the donor communities but did not establish successfully on the reclaimed mineral pad. Vascular plant establishment was slow and highly variable.

Based on field observation in 2018, different soil adjustment and vegetation treatment is no longer discernable from each other (Figure 13). Cattail is not a dominant species on site. Shrub cover has increased significantly while ground layer cover by true moss is approaching 100% in some areas.

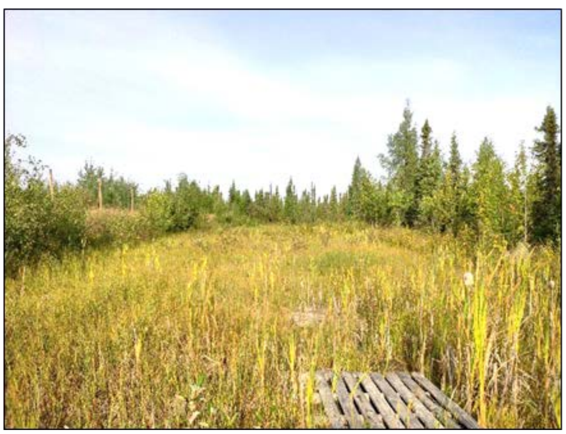

Figure 13. Partial Pad Removal + MLTT.
Left: Partial removal pad 9 years after reclamation. Note the elevated berm on the left side where excavated mineral fill was piled. Right: Close up of the ground layer bryophytes (true mosses) typical of fen communities.

Learnings:

- Partial pad removal followed by MLTT is very successful to promote moss dominated ground layer vegetation development.
- Source of donor plant material is more important than the substrate treatment alone.

- True mosses from fens establish well on wet mineral substrate while Sphagnum mosses, typical of bogs and poor fens, do not grow well, at least in early stages.
- Woody species establishment will be slow and highly variable. Fen shrubs are most successful colonizers.

Case Study 6: Partial Removal, Planting, and Natural Regeneration – Airstrip

A mineral linear feature (airstrip) was built in the 1960s through the edge of a peatland complex with the complete peat profile removed down to the mineral subsoil. The reclaimed area is roughly 4 hectares. No buried peat or nearby donor peat material could be found so the area was reclaimed as a mineral wetland with a variety of stock seedlings planted in 2015.

Civil earthwork was completed in June 2014 after the partial removal of mineral fill and trenching, followed by revegetation in June of 2015. The adjacent natural area consists of a sedge fen, a treed bog and an open area near the original drainage feature across the road. A vegetated berm separating the airstrip from the natural areas was rolled over onto the reclaimed area to introduce vegetative diaspores. Three planting treatments plus a control were installed in each area in summer 2015. Fixed densities of willow seedlings + sedges, sedges only, and willow cuttings + sedges were planted while non-planted treatments served as control. Low densities of larch and birch were also deployed on suitable microsites.

After four growing seasons, the site hydrology has stabilized, and the wetland is dominated by obligate wetland species (up to 45% percent cover) with a community similar to marshes (sedge and graminoid dominance) typical of the region. True mosses now account for up to 15% of the total cover in many parts of the site (Figure 14). They were not introduced in the initial revegetation but have come on site through water flow or wind. Bayley and Mewhort (2004) had shown that the distinction between marshes and fens is driven by surface water level and the presence/absence of true mosses despite otherwise similar vegetation assemblages. The reclaimed airstrip wetland is a combination of marsh and emerging fen communities. Over time, the system may evolve more towards fens as the ground layer of mosses further develop and acidify the substrate.


Figure 14. Partial Removal, Planting, and Natural Regeneration
Left: overview of the intermediate area in 2018. Right: close up of the ground in the dry area showing moss growth in-between sedges.

Leanings:

- By 2018, the reclaimed wetland areas are dominated by obligate wetland species with total cover ranging between 35% and 45%.
- Moisture conditions have greatly improved, and the site has remained wet to inundated through the entire summer.
- The dry area has switched from an area dominated with upland and ruderal species to a diverse wetland, with mosses accounting for up to 15% of the total vegetation.
- All wetland areas are dominated by graminoids, mainly sedge species. Planted individuals are no longer distinguishable and most of the plants on site developed through natural ingression and lateral expansion.
- Ground layer true mosses are developing in many areas. The impact of their growth on soil chemistry and hydrology will be monitored closely in the next few years.

Case Study 7: Partial Pad Removal and Natural Regeneration – Cold Lake

Imperial's Cold Lake Operations commenced a wetland reclamation trial in 2008 at Mahihkan H-38 pad. The pad was constructed in 2002 with 38,800 m^3 of borrow fill material on a treed rich fen that had an average depth of 148 cm of organic material (peat). This wetland reclamation trial included partial and complete pad removal. The trial reclamation was conducted in the north-east corner with full or partial pad removal followed by spontaneous colonization by plants (i.e., no active revegetation strategy). In spring 2008, the first section was reclaimed by completely excavating the mineral soil fill and geotextile liner. Due to peat compression that occurred during well-site construction and use, up to 4 m of fill was excavated, resulting in deep inundation. Based on these results, the next section was reclaimed by scraping the surface mineral fill down to the level of the adjacent peatland in fall 2009 with the goal to limit flooding (Figure 15). Some areas of the pad remain unreclaimed with all mineral soil fill intact and act as a negative control. The reclaimed areas were left to naturally re-vegetate.

Figure 15. Partial Pad Removal and Natural Regeneration – Cold Lake.
Left: Partial removal section of H38. Right: Peat formation from true mosses and sedges above mineral substrate.

Learnings:

- Partial pad removal leaving remnant fill in place does not hinder peatland vegetation, particularly moss, development if the surface is suitably saturated. Pad H38 borders a wet fen to the north. Water flows freely around the reclaimed areas, bringing propagules for natural revegetation.
- Open water areas are too deep for most wetland species to establish, although floating moss mats start to occur along the edges in some areas. Deep open water should be avoided as much as possible.
- Achieving proper surface elevation and restoring hydrological connectivity is critical in order to reclaim mineral material well pads like H38.
- Almost all treatments measured on the reclaimed well pad had net CO_2 exchange under full light conditions that were similar to the adjacent undisturbed fen.
- Remnant fill left during well pad reclamation to peatland does not appear to result in large mineral N pools or elevated N_2O emissions. This indicates that partial pad removal is likely a viable reclamation option considering biogeochemical function.

Case Study 8: Partial Pad Removal, Site Adjustment, Donor Transfer and Planting (CNRL PAD Terry Osko)

A pad (140 m x 130 m) built in a treed poor fen was reclaimed in 2011. Instead of synthetic geotextile, mineral fill was placed over corduroy constructed from on-site woody debris over peat surface. Most of the clay-loam fill was removed in November 2010 and returned to the original borrow 100 m west of the pad. The remaining fill (~10 cm thick) was mounded using two track-hoes to bring buried peat to surface and incorporate the remaining fill underneath, resulting in a rough (up to 1 m relief) mounded surface of exposed peat and thin fill veneer across the site (Figure 16a).

Sub-sections of the site was later compacted to create smooth macroplots (<15 cm relief) in 2012. Both rough and smooth macroplots were divided into sub-plots to receive live fen moss transfer or left for natural recovery. These sub-plots were further divided to compare natural recovery (with or without moss transfer) to recovery through live transplants of black spruce, Labrador tea, and sedges from adjacent fens.

Site assessments were conducted in 2013 and 2017. Initial survival of woody species (black spruce, Labrador tea) were high (40-79%) but declined in 2013. Smooth plots saw further decline in survival rates, particularly Labrador tea, by 2017. The entire site is dominated by herbaceous species such as *Carex* spp. and cattail although trees and woody vegetation are slowly colonizing the site (Figure 16b). Woody species cover remained low as most of the site remains wet to flooded due to the close proximity to a highway and overall poor drainage.

Shunina et al. (2016) studied early development of vegetation in 2012 and 2013, one and two growing seasons after reclamation. Rough areas had higher species richness through natural recovery of trees, shrubs, and perennial herbs. Survival of transplanted woody species were also greater at the top and mid positions. Acrotelm application had no impact on overall vegetation growth during the first two seasons. By 2017, there was no difference in species richness and diversity among different surface roughness or moss application. Natural regeneration of larch, willow, birch was common across the site regardless of surface treatment or moss application (Figure 16c). However, bryophyte species richness was higher in plots received moss application. Moss application also led to differences in species composition in 2017. Typical fen mosses such as common hook moss (*Drepanocladus aduncus*), rusty hook moss (*Drepanocladus revolvens*), small red peat moss (*Sphagnum capillifolium*), and wooly feather moss (*Tomenthypnum nitens*) were commonly associated with plots that received moss application (Osko, 2018).

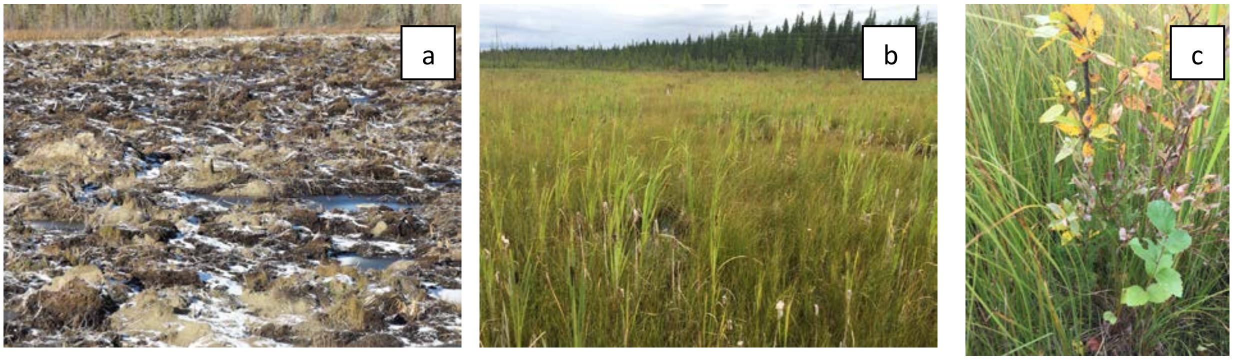

Figure 16. Partial pad removal, site adjustment, donor transfer and planting.
a: the well pad after partial removal of mineral fill and mounding in 2011. b: site overview in August 2017. c: natural ingress of poplar, birch, willow and larch in 2017.

Case Study 9: Partial Mineral Fill Removal – JACOS Road

The JACOS road is an access road built with mineral borrow and geotextile in a treed bog/poor fen. The JACOS Road Reclamation Study includes two phases. The initial trials (first phase) were carried out in three blocks in 2010 by removing 80 cm of the mineral fill from each block (Figure 17 left). This was followed by the establishment of study plots where a number of revegetation treatments were applied. Vegetation recovery was assessed in 2012 and 2013. In addition, off-site hydrology, vegetation, GHG dynamics, and nutrient dynamics were studied from 2010 through 2014. Two of the blocks experienced prolonged flooding, leading to cattail prevalence and large areas of standing water. The third block was least flooded and had the best natural revegetation by 2014.

The second phase of the study is to reclaim the rest of the road (~200 m) including the two flooded blocks. In 2018, JACOS worked with University of Laval and NAIT to test two different approaches of mineral removal and transfer of moss donors onto rewetted peat or mineral substrates. Drainage devices made of wood corduroy and hay bales were installed to ensure subsurface flow. In the peat substrate study, 50-100cm of mineral fill was removed and filled with salvaged peat back to the surrounding peatland elevation. *Sphagnum* dominated moss donor material was collected and spread on the peat surface as per MLTT, followed by mulch covering and fertilization with rock phosphate. In the mineral substrate study, mineral fill was partially removed, and the surface lowered to the surrounding peatland elevation. Half of the mineral surface was scarified to create roughness (~0.5 m relief) using a track hoe while the other half remained relatively flat (Figure 17 centre). Fen donor material was applied as per MLTT on the rough and smooth mineral surfaces, followed by mulch covering and no fertilization (Figure 17 right). Hydrologic responses to the reclamation treatments, and the effectiveness of drainage structures to facilitate water flow across the road will be evaluated. Peat-forming vegetation development in response to MLTT on peat vs. mineral substrates will be monitored and assessed to inform reclamation practices for future trials on mineral in-situ footprint reclamation in peatlands. The second phase is ongoing as of April 2019.

Figure 17. Partial Mineral Fill Removal – JACOS Road
Left: three reclaimed basins in 2017. Two of the sections were reclaimed in 2018. Centre: partial removal of mineral fill, followed by surface treatment in 2018. Right: transferred donor covered with straw mulch to preserve surface moisture in 2019.

Learnings:

- Site progress is very good considering the minimal site preparation and revegetation efforts.
- Surface conditions are promising for further peatland vegetation development.
- The road surface is level with surrounding areas.
- Significant increases in overall vegetation cover since 2017, driven by exponential growth of sedges and the establishment of mosses.
- Woody species remain low in abundance and cover in the permanent plots.
- Planted tree seedlings are visually healthy.

APPENDIX C: ECOLOGICAL FUNCTIONALITY OF UPLAND FORESTS

C1: Evaluating Functional Forest Ecosystems

In addition to the discussion of evaluating ecosystem function presented in Section 3.1, a few other papers and reports discussed alternative methods that are summarized here.

Other work on monitoring previously certified forested wellsites in Alberta suggests that the key metrics of ecosystem development on reclaimed wellsites are those influenced by construction and reclamation and are thus indicators of ecological recovery (Lupardus et al., 2018). Factors identified in the study were soil bulk density, pH, introduced species richness, grass cover, live tree basal area, noxious weed presence, canopy cover, downed wood cover and LFH depths (Lupardus et al., 2018). Some of these parameters may not be ideal indicators. For example, introduced species richness may not be relevant as the impact of introduced species may depend on the specific species in question. Also, bulk density may not be a suitable indicator due to difficulties in sampling representative horizons and confounding effects of soil replacement. Reclaimed topsoils may be the mixture of the LFH and underlying Ae horizon, while in undisturbed soils the LFH and Ae horizons remain distinctly intact.

Oil sands reclamation research has also identified criteria and indicators that can be used to measure ecosystem sustainability, in this case specifically in reconstructed oil sands soils. Soil characteristics proposed included nutrient supply (soil solution supply, net/gross/potential mineralization rates), organic matter quality (carbon pools and forms, carbon structural composition and molecular biomarkers) and microbial communities (microbial biomass and activity and structural, molecular and functional diversity) (reviewed in Macdonald et al. (2012)). The use of simple microbial functional profiles (community level physiological profiling (CLPP)) has recently been found to be useful for assessing the effects of stockpiling on soil quality, and provides results that are comparable to other more sophisticated methods (Gupta et al., 2019).

C2: Forest Ecosystem Recovery after Industrial Disturbance

Forest ecosystem recovery after disturbance and reclamation depends on the re-creation of the necessary abiotic and biotic components as well as the structure, composition and function of the boreal forest (Audet et al., 2015; Lupardus et al., 2018; Polster, 2011). Reclamation success is not achieved by a re-establishing vegetation, but by establishing the entire self-sustaining ecosystem (Bradshaw, 1984; Ruiz-Jaén and Aide, 2005).

The factors that drive regeneration after natural disturbances (e.g., fire) in boreal forests, listed below, are the same factors that drive recovery from industrial disturbances (Bergeron et al., 2014; Macdonald et al., 2012):

- Availability of reproductive propagules (regional species pool)
- Microenvironment (site and environmental conditions)
- Regeneration microsites
- Species traits

These factors are in turn determined by site level factors (landscape composition, soil conditions, climate, and pre-disturbance stand composition) and disturbance characteristics (severity, frequency and size), all with the underlying impact of stochasticity (random chance; typically includes uncontrollable elements such as dispersal events, seed rain and weather patterns) (Bergeron et al., 2014; Macdonald et al., 2012). After regeneration, longer term vegetation trajectories are determined by competitive and facilitative interactions between species. The main difference between recovery from fire and from industrial disturbance are the conditions created by the disturbance and how that impacts the four factors listed above.

The first factor that determines forest regeneration is the availability and composition of propagules. Wellsite construction removes the pre-disturbance vegetation on the site, limiting the sources of plant material for revegetation to the following three pools: viable seeds in the seed bank of the on site topsoil, re-sprouting vegetative plant parts in the on site topsoil (propagule bank) and seed dispersed into the revegetating area from surrounding undisturbed areas (reviewed in Macdonald et al. (2012) and Skrindo (2005)). The availability and composition of propagules for regeneration is impacted by the following factors (Bergeron et al., 2014; Macdonald et al., 2012):

- Vegetation composition on site prior to disturbance and in surrounding areas
- Pre-disturbance propagule bank composition and density
- Distance to undisturbed forest
- Nature and severity of the disturbance:
  - Construction practices (soils disturbed or undisturbed)
  - Topsoil salvage depth
  - Topsoil placement depth
  - Length of stockpiling

The second factor in forested regeneration is the microenvironmental conditions present on the site after the disturbance. Ultimately the post-disturbance microenvironment determines the levels of the five limiting factors for plant growth (light, temperature, nutrients, moisture/aeration and competition). Sites with low levels of resources for plant growth (e.g., low moisture, low nutrients) have lower productivity and thus more growing space which results in reduced levels of competition (Alberta Environment, 2010). In contrast, when there are no limitations for plant growth, plant establishment and productivity is much greater, growing space and access to light is reduced and there are higher levels of competition (assuming that the necessary propagules adapted to those conditions are available in sufficient abundance). At reclamation initiation, the lack of vegetation on the site results in increased light and temperature on the site through the removal of shade, which can also result in reduced humidity and moisture at the soil surface (Roberts, 2004). At increased light levels, shade intolerant species are favoured over shade tolerant ones. Warmer soil temperatures have positive impacts on seed germination (Gärtner et al., 2011) and aspen sucker expansion (Landhäusser et al., 2006), and can stimulate aspen and white spruce seedling root growth, and aspen leaf and shoot growth (at temperatures greater than 5 °C (Landhäusser et al., 2001)). Warmer temperatures can also have impacts on microbial activity, and thus on decomposition and nutrient cycling. Specific microenvironmental conditions that occur on a site are impacted by the following (Bergeron et al., 2014; Macdonald et al., 2012):

- Pre-disturbance site and soil conditions
- Nature and severity of the disturbance:
    - Construction practices (soils disturbed or undisturbed)
    - Topsoil salvage depth
    - Topsoil placement depth
    - Length of stockpiling
    - Compaction

Propagule availability and microenvironmental conditions related to soil organic matter and nutrients are affected by disturbance and reclamation in similar ways. In the context of forest reclamation, topsoil is salvaged as a mixture of the litter layers and some of the underlying mineral soil. Ideally, forest topsoil is salvaged as the LFH and the Ah, Ahe and Ae horizons; however, if the A horizons are greater than 15 cm, best practice is to limit the salvage depth to 15 cm and any additional Ae material below 15 cm should be salvaged separately (Alberta Environment and Sustainable Resource Development, 2013a). Incorporation of subsoil material from the B horizon with the LFH and A horizons (admixing) during soil salvage prior to wellsite construction is generally not encouraged as subsoil typically has a higher clay content and a firmer consistence which can be detrimental to plant establishment; however, depending on the actual soil texture of the topsoil and subsoil "improvements in texture class […], or water holding capacity, on the lease compared to the control would be acceptable" according to the forested land criteria (Alberta Environment and Sustainable Resource Development, 2013a). The actual depth of the litter layers and depth at which salvage occurs affects the ratio of the litter layer to mineral soil. Increased mineral content may result in dilution of the propagule bank and organic matter found in the litter layers, resulting in fewer propagules at the surface at placement as well as changes carbon, nitrogen and available nutrient concentrations, water holding capacity, pH, impacts to the microbial community composition and the reactions they mediate, and increased surface bulk density compared to natural LFH layers (Beasse, 2012; Frerichs, 2017; Hahn, 2012; Jones et al., 2018; Mackenzie, 2013; Mackenzie and Naeth, 2010; McMillan et al., 2007; Naeth et al., 2013). Deeper salvage depths (e.g., greater than 20 or 30 cm), through their increased mineral content, may provide greater soil contact for root fragments (Wachowski, 2012). Effects of differences in salvage depths on vegetation response may become more pronounced with deeper salvage depths (40 cm) (Fair, 2011; Naeth et al., 2013) and are influenced by the ecosite and soil conditions of the site (Alberta Environment, 2010; Alberta Environment and Water, 2012; Archibald, 2014; Naeth et al., 2013).

Stockpiling (particularly longer term stockpiling, greater than 8 months) has additional impacts on soil properties and propagules banks. Seed and propagule viability can decline substantially due to anaerobic conditions (Dickie et al., 1988; Mackenzie, 2013), high temperature and moisture (Rokich et al., 2000), in situ germination (Mackenzie, 2013; Rivera et al., 2012) and decay or rotting (Mackenzie, 2013). The effects of stockpiling on propagule viability may vary with the size of the pile (Mackenzie, 2013). Stockpiling for 8 months can result in changes in available nutrients; magnitude of changes varies with porosity (impacted by texture), organic matter content, water content and temperature (Mackenzie, 2013). Research on impacts to organic matter and nutrient contents in long term stockpiles are inconclusive. Some studies seem to show declines in organic matter over 10 years (e.g., Ghose (2001)), while others show no negative impact of stockpiling on organic matter over 5 to 10 years (e.g., Anderson et al. (2008); Gupta et al. (2019)), but there are confounding factors. Some studies do not examine the effects on the same materials over time, rather samples were collected from materials of different ages; observed trends could be related to natural differences between these soils (e.g., if they came from different ecosites). The impacts at multiple depths within the stockpile are not well studied; studies that do examine different depths exist, but are not long term (e.g., MacKenzie (2013); Visser et al. (1984)).

Topsoil placement depth has implications for propagule burial and also determines the volume of soil organic matter and nutrients that are available for plant growth and influences the ability of soil to hold water. In oil sands mining reclamation research, depth of topsoil placement may have a greater effect on plant community development than salvage depth, depending on the ecosite and substrate (Mackenzie and Renkema, 2013; Naeth et al., 2013). In contrast to oil sands mining reclamation, where soils from large mining areas are stockpiled together and then divided up over time among reclamation areas as they become available, for wellsite reclamation, placement depth is fixed by the amount of material that was salvaged on the site. Topsoil placement at depths greater than 5 cm likely results in burial of seeds at depths from which they cannot emerge (Grant et al., 1996), although maximum depth from which emergence can occur varies with soil texture (Benvenuti, 2003). Shallow topsoil placement depths (less than 10 cm) may also result in increased admixing of topsoil with the underlying material during soil placement (Mackenzie and Naeth, 2010).

Soil salvage, stockpiling and placement collectively cause damage to propagules through severing, wounding and fragmentation (Frerichs, 2017; Jones et al., 2018; Landhäusser et al., 2015; Osko and Glasgow, 2010; Wachowski et al., 2014). Additionally, excavation results in mixing of seeds within the seed bank – the composition, density and viability of which is naturally stratified by depth (Rydgren and Hestmark, 1997; Whittle et al., 1997) – and ultimately alters the expression of the seed bank compared to natural recovery trajectories from undisturbed seed banks.

Microenvironment is additionally impacted by soil compaction. Soil compaction occurs as a result of vehicle and heavy equipment traffic on the wellsite during operation and reclamation of the wellsite and is exacerbated when soils are wet. Compaction is especially a problem on mineral soil pads left in place because they are compacted during construction to create a flat, level surface for drilling operations. Soil compaction can damage soil structure, reduce aeration porosity, water infiltration and drainage, restrict nutrient availability and impede root penetration and growth (Mackenzie and Renkema, 2013; McNabb et al., 2013; Powers, 1999). Tree growth can be restricted by compacted soils (Corns, 1988), and at severe levels of compaction, growth of herbaceous plants and shrubs can also be impacted (Mackenzie and Renkema, 2013). A variety of decompaction techniques can be applied to the site to mitigate compaction effects. Impact of soil compaction and effectiveness of decompaction techniques varies with soil texture.

The third factor in regeneration of forested sites is the availability of regeneration microsites (Bergeron et al., 2014; Macdonald et al., 2012). Microsites can modify the microenvironmental conditions and create greater surface heterogeneity. Theoretically, greater surface heterogeneity results in variations in resource availability (e.g., moisture, temperature) which accommodates a wider variety of species with different tolerances, and decreased competition through spatial segregation (Beatty, 2003). Availability of regeneration microsites is impacted by the following:

- Range of regeneration microsites available after reclamation and whether reclamation practices that create microsites were conducted (e.g., soil microtopography vs. coarse woody debris)
- Correspondence between available microsites and microsites required for the species that are available to regenerate

Species life history traits are a fourth factor that interacts with the previous three to drive regeneration (Bergeron et al., 2014). The post-disturbance vegetation community is impacted by the differential abilities of species to do the following (Macdonald et al., 2012):

- Survive the disturbance

  The ratio of species that survive the disturbance as remnant roots and rhizomes vs. seed is impacted by the disturbance type and severity (Archibold, 1979; Rydgren et al., 2004; Whittle et al., 1997).
- Disperse onto the site

  Wind and animal dispersal of seeds generally occurs across larger distances than vegetative spread through rhizomes and stolons, which are relatively local (Lee, 2004).
- Establish on the site after disturbance

  Species that become established on the site are those whose germination cues, microsites preferences and habitat requirements such as shade tolerance/intolerance, nutrient demand and other substrate needs are compatible with the site microenvironment and microsites. Species that are tolerant to a wide range of conditions may be more able to establish on disturbed sites.

Once species have become established on a site after disturbance, dynamics between species play an increasing role in determining the trajectory of the plant community that develops (Macdonald et al., 2012). For forest development, the key interplay is between understory species and trees. As understory grasses, forbs and shrub species grow and expand, they can compete with tree species and can have an impact on their establishment and growth (Landhäusser and Lieffers, 2011; Lieffers et al., 1993; Mundell et al., 2007). When trees are suppressed, the forest recovery trajectory is arrested, as a key structural layer of the forest ecosystem is not able to form. Noxious and problem weeds and seeded non-native agronomic species can have the same impact, and can additionally also suppress native herbaceous vegetation, further altering the recovery trajectory. The outcome of competition between desirable tree and understory species and undesirable species depends on which species colonize and establish on the site first and the competitive ability of the species in question (Small et al., 2018). If tree species do become established, the composition of the tree canopy is a function of habitat preferences and ecological properties of individual species (e.g., growth rate) (Macdonald et al., 2012). Faster growing shade intolerant trees such as aspen, poplar and pine tend to dominate the canopy initially, while slower growing shade tolerant spruce can become more dominant later on as the earlier species senesce (Bergeron et al., 2014; Macdonald et al., 2012).

C3: Suggested Further Reading

Boreal forest specific papers are bolded (sorted chronologically)

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APPENDIX D: ECOLOGICAL FUNCTIONALITY OF PEATLANDS

D1: Key Factors that Control Functional Peatland Ecosystems

Peatlands are important ecosystems of global significance, accounting for 56% of all organic soil carbon in Canadian soils. They play an important role in the global carbon cycle by removing atmospheric CO_2 and storing it in the form of peat and releasing significant amounts of greenhouse gases (GHGs) such as CH_4, and supplying dissolved organic carbon (DOC) to downstream ecosystems (Price et al., 2016; Tarnocai et al., 2009). Sequestration of carbon dioxide (CO_2) and the storage of peat has had a net cooling effect of global climate since the late Holocene (Frolking et al., 2006). Initiation of peatlands in continental Canada began around 12,000 – 15,000 years ago after glacier retreat, through primary peat formation on wet, unvegetated mineral soil and infilling of wet basins and depressions as wetland vegetation developed and built up (terrestrialization). However, the majority of boreal peatlands in western Canada formed through cycles of paludification or swamping of previously dry mineral soil vegetated with non-wetland species (Kuhry and Turunen, 2006). Paludification started relatively late in the Holocene (around 8,000 years ago) as the climate of western continental Canada became wetter and cooler. A young, paludifying wetland that is actively accumulating peat through the growth of peat-forming plants is called a "mire" (Rydin and Jeglum, 2015; Sjors, 1948). A mire is not yet a peatland as it lacks the 40 cm of peat. The distinction between mire and peatland is critical for peatland management and restoration because in most cases newly reclaimed sites with a developing, peat-forming vegetation are essentially mires with the hope that they are on a trajectory towards becoming true peatlands by definition.

After initiation, development of a peatland usually proceeds along two pathways (Kuhry and Turunen, 2006; Yu, 2006). First, newly formed wetlands (e.g., marshes) develop into either poor or rich fens that can persist on the landscape for thousands of years under the influence of overriding effects of allogenic (external) factors of climate and local water chemistry with little successional change. Secondly, early marshes and fens undergo successional changes driven by autogenic (internal) factors including the isolation of growing peat surface from local groundwater as peat builds up, acidification, and oligotrophication, which leads to the eventual formation of bogs (Bauer et al., 2003).

Broadly speaking, boreal peatlands can be divided into ombrogenous bogs and minerogenous fens based on topography, hydrology, chemistry (Halsey et al., 2003; Vitt et al., 1994). Bogs are different from all other types of peatlands in that bogs receive water and nutrient inputs only from precipitation (snowfall and rain) and the live growing surface is isolated from mineral rich water. They are usually dominated by oligotrophic species of peat mosses (genus *Sphagnum*). Fens can be topogenous (influenced by stagnant waters pooled in depressions), soligenous (influenced by seepage), or limnogenous (influenced by flood waters from water courses) (von Post and Granlund, 1926; Rydin and Jeglum, 2015). As such, fens are supplied with water that had contact with mineral rich soils from the surrounding area. These minerogenous waters have nutritional and buffering effects and can support the development of a wide range of fen types, from sedge-dominated open fens to larch- or birch-dominated wooded fens (Bragazza and Gerdol, 2002; Tahvanainen, 2004; Wood et al., 2016). Calcareous rich fens are characterized by the high number of species of high fidelity (e.g., true mosses) to basic to slightly acid, base cation-rich environment. Poor fens have relatively few differential species in comparison. They are acid, have low base cations, little or no alkalinity, and are dominated by *Sphagnum* mosses.

Within each peatland type, vegetation can vary greatly, both structurally and compositionally. All peatlands can be dominated by a combination of species in the tree layer (black spruce, larch), the shrub layer (birch, willow), the field layer (sedges, forbs, and grasses), and the ground layer (mosses) (Zoltai and Vitt, 1995). Therefore, vegetation of a peatland is usually not a good indicator of basic peatland types (bogs, poor fens, and rich fens), unlike non-peat forming wetlands that can be easily distinguished by species in the tree layer (swamps) or the field layer (marshes). In Alberta, mature bogs are usually wooded with an open canopy while fens vary greatly from open to wooded. Growth of trees in peatlands significantly lags behind upland counterparts (Dimitrov et al., 2014; Wieder, 2006). Therefore, slow tree growth on reclaimed peatland sites should not be considered a critical factor or failure unless other functions rely on the fast recovery of the tree layer (e.g., wildlife habitat restoration).

A key concept in peatland ecology is the “Acrotelm/Catotelm Model” first developed by Clymo (1984). A peat bog is simplified and divided into two layers: a top, aerobic layer (acrotelm) and an underlying anaerobic layer (catotelm). Primary productivity and aerobic respiration (both microbial and autotrophic) occurs in the acrotelm layer where a surficial ground layer of mosses and associated litter, roots and moss plants exists**.** The catotelm layer receives biomass from the above acrotelm that undergoes slow anaerobic decomposition which produces CH_4 that can be released back to the atmosphere or DOC that can be lost through subsurface water flow. The separation between the two layers is not well defined for fens and subject to climate and water table fluctuation. This concept is a simplification but critical to understanding the functioning of natural peatlands and the effective reclamation of disturbed peatlands. In essence, peatland restoration is the process of recreating a functional acrotelm/catotelm profile driven by fluctuating water tables and a developing peat forming vegetation on top (Joosten et al., 2016).

A ground layer of bryophytes, often covering 80-100% of the surface, is a unique and defining characteristic of boreal peatland ecosystems. Bogs and poor fens are dominated by *Sphagnum* spp. while rich fens are dominated by true mosses (Bryopsida) (Rydin and Jeglum, 2015). The development and succession of different vegetation as a peatland evolves is not only a result of local hydrology and water chemistry but also a self-regulated process driven by highly adapted vegetation, particularly mosses. Unlike higher plants, bryophytes lack vascular tissues to transport water and nutrients over long distances (Glime, 2009). Germination and growth of bryophytes are highly sensitive to moisture and temperature (Glime, 2007). This is critical for the introduction of suitable peatland vegetation, particularly bryophytes, in reclamation. The reclaimed substrate should be moist and relatively flat to ensure good contact of introduced moss plants (e.g., spores, fragments) with the substrate. The surface can be covered with straw mulch or other types of material to preserve near surface moisture for bryophyte germination.

All mosses, and particularly *Sphagnum* mosses, common in bogs and poor fens can acidify the environment they are growing in, through the production of acids through decomposition (organic acidity) and through the exchange of cations by releasing H^+ (inorganic acidity) (Clymo, 1984). pH of 5.5 is a fundamental dividing point in the habitat preference of many peatland species. Alkalinity (bicarbonate) is completely absent below pH 5.5 and increases to about 150 – 200 mg L^{-1} HCO_3^- + CO_3^{2-} at pH 8.0 (Vitt, 2017). Abundance of oligotrophic *Sphagnum* mosses decreases from bog, poor fen to fens with surface water pH over 5.5 where true mosses dominate the ground layer. Some mesotrophic *Sphagnum* moss species can grow in environments where pH >5.5 and the continued growth of mosses will lower the site pH over time. Eventually oligotrophic *Sphagnum* species will take over and further lower the site pH below 5.5, eliminating early fen species and create true ombrotrophic conditions by elevating the growing surface away from mineral rich groundwater (Vitt, 2017) . Therefore, pH less than 5.5 is not a feasible condition to create through reclamation since either the acidifying vegetation is lost (compression of surface, clearing of vegetation) or the introduction of mineral soil (e.g., well pad, roads) changes the surface water chemistry which is needed to support the oligotrophic vegetation. In other words, re-creation of bogs and poor fens with a ground layer dominated by *Sphagnum* mosses is NOT a feasible end goal in the time span of a reclamation project. Instead, a fen type of community with a true moss dominated ground layer should be targeted with the assumption that these systems will either remain as fens or evolve towards poor fens and bogs following natural peatland development pathways.

Peatlands, particularly bogs, have varying ground surface topography with high hummocks and low hollows. Hummocks are usually dry, while hollows range from dry (lichen dominated in mature bogs), moist to wet in fens. At the site level, peatland ground surface can be further divided into pools (small bodies of open water filled with submerged vegetation), carpets (areas where the mosses have emergent upper parts and form unconsolidated substrates), lawns (low, relatively level, moist habitats of consolidated peat), and hummocks (Figure 18 and Figure 19) (Rydin and Jeglum, 2015). The elevation difference between hummocks and hollows or pools is relatively small (no more than 1 m) and is thus referred to as "microtopography". The size and distribution of hummocks and hollows depend on the hydrology and vegetation within the peatland. Microtopography is a secondary feature developed as a result of natural variation of ground surface and fluctuating water table, and accentuated by the growth and differential decomposition rates of highly adapted species along the water table gradient. Microtopography is one feature of a natural peatland that could be replicated through site preparation such as mounding and scarification. Creating a variable ground surface will likely contribute to the overall vegetation diversity and resilience against environmental uncertainties. Higher microsites are critical for woody vegetation establishment in wetlands. However, care should be taken to avoid too much dry exposed ground if bryophytes are to be introduced.

Figure 18. A peatland complex in northwestern Alberta.

Notice the sharp transition from open pool of moss carpets to shrubby hummocks to open canopy treed bogs in the background.

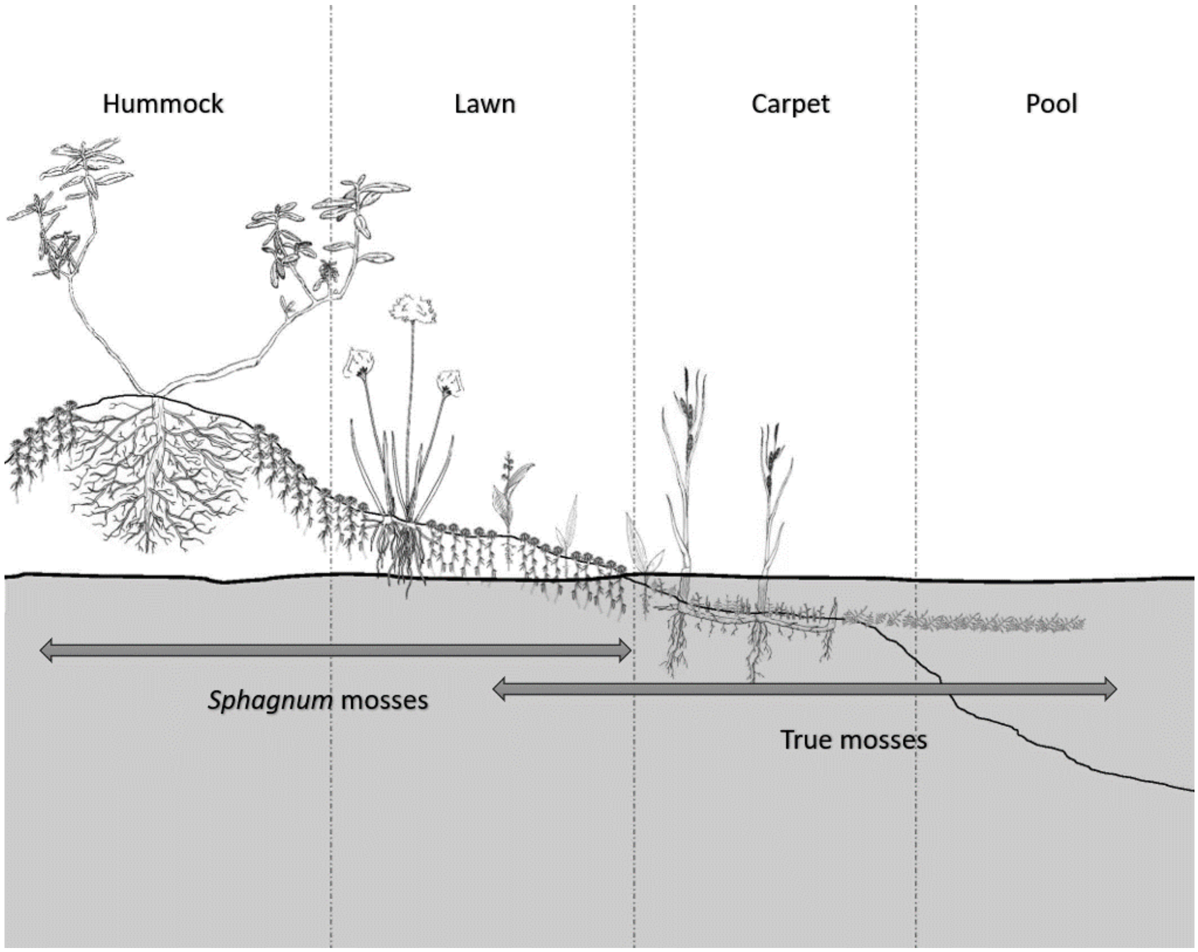

Figure 19. Illustration of peatland microtopography along a hydrological gradient. *Sphagnum* mosses increases as the growing surface is isolated from mineral rich surface water. Credit: Melissa Kucey

D2: Implications for Reclamation

Based on the early field trials, a functional peatland or a reclaimed site on the trajectory towards becoming a funtional peatland should have the following characteristics:

1. A moist to wet substrate (either peat or mineral) and a fluctuating water table that fits in with the local and regional topography and hydrology:

   The reclaimed substrate should be moist and relatively flat (but not necessarily smooth) to ensure good contact of introduced moss plants (e.g., spores, fragments) with the substrate. The surface can be covered with straw mulch or other types of material to preserve near surface moisture for bryophyte germination. The soil should be decompacted or loose enough to promote vegetation growth. Geotextile may be a limiting factor on rooting depth, although roots of most peatland plants are concentrated within the top 30-50 cm of soil profile due to high water table in most peatlands (Fan et al., 2017; Lieffers, 1987). The exact impact of geotextile on plant growth is unclear and warrants further investigation. Buried peat may or may not rebound after the removal of clay overburden. This may lead to prolonged flooding due to continued decomposition of underlying peat. The soil surface should also be stable without signs of erosion and slumping. Any berms or barrier to block water flow around or across the reclaimed site should be removed.

2. Mitigated and reduced impact on the surrounding areas around and along the in-situ features:
   Barriers and/or berms blocking water flow should be removed or mitigated. Drainage devices or trenches can be created to connect water flow from surrounding areas with the reclaimed surfaces. There should be no erosion or slumping of soil surface to minimize continued input of mineral soil into surrounding peatlands. The impact of mineral input on peatland chemistry is not well studied. Different types of peatland (bogs vs. fens) may have different buffering capacity against input of mineral nutrients. A well pad may affect local and regional hydrology differently from a linear features (e.g., access road). Regional context should be considered when leaving well pads in place.
3. A diverse vegetation community consists of mostly peat forming species well adapted to local soil and water chemistry conditions and matches the structural components of nearby reference peatlands (wooded, shrubby, open etc.):
   Vegetation composition, coverage, species richness are often mentioned as key considerations for assessing equivalent land capability of reclaimed well pads and/or pads left in place. Vegetaiton on site is often compared to off site to determine if a site is on the trajectory towards meeting either upland or peatland criteria. There is a concensus that a diverse community with native trees, shrubs, and herbs is more likely to persist and grow over time. Non-native, invasive or weedy species should be minimal. Non-peat forming species such as cattail should not dominate the site.
4. A healthy ground layer dominated by bryophytes, particularly mosses, which is a key differentiator from other non-peat forming wetlands such as marshes (dominated by sedges, herbs and grasses) and swamps (dominated by trees with poor ground layer vegetation).
   Most respondents agreed that woody vegetation is a good indicator for natural encroachment on well pads left in place. For reclaimed sites (complete or partial removal), respondents default to the peatland criteria for assessing peatland development progress.

5. Minimal non-peat forming species although some may persist on early successional sites with high nutrients and exposed microsites.

   Weeds and invasive species present key challenges for well pads left in place. For reclaimed peatland sites, non-peat forming species will not be included in reclamation assessment according the peatland criteria. Cattails may become dominant if a site is too wet due to improper topography or hydrology. There is concern about upland grasses (e.g., *Calamagrostis*) on newly reclaimed peatland sites. Non-peat forming species, even upland species, can establish on reclaimed peat and mineral substrates. In some cases, these early colonizers fall out of the community as the site chemistry changes as other peatland vegetation starts to develop. However, this is another knowledge gap to address through field trials.
6. Accumulation of biomass and the formation of peat in the catotelm layer.

   Peat accumulation is a defining character of a functional, healthy peatland ecosystem (Rydin and Jeglum, 2015). A healthy, carbon accumulating cover of peatland species and the eventual accumulation of peat is a widely considered a key indicator of success in peatland restoration trials (Graf and Rochefort, 2009; Lucchese et al., 2010; Rochefort, 2000). However, it is unknown if any of the current reclamation approaches can lead to the eventual accumulation of peat on reclaimed mineral features. This is a major knowledge gap in reclamation practice as well as general peatland ecology.