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Wellsite Clay Pad Removal and Inversion – A Peatland Restoration Pilot Project

NAIT Boreal Research Institute, Shell Canada Ltd., and Laval University

Jean-Marie Sobze, PhD, RPF, Tech Transfer Coordinator, NAIT Boreal Research Institute; Amanda Schoonmaker, PhD Candidate, Field Research Coordinator, NAIT Boreal Research Institute; Line Rochefort, Professor, Laval University

Background

NAIT's Boreal Research Institute (nBRI) provides industry-relevant research, knowledge exchange, and boreal forest education from its base in the Town of Peace River, in the heart of Alberta's boreal forest. nBRI's mission is to promote the wise use of boreal resources through science, innovation, and partnerships.

nBRI is well established as a centre of excellence in wellsite forest land reclamation. The program is in its third year of field trials, enabled by $1.5m from Alberta Innovates – Bio Solutions; $2.3m from NSERC (2011-16) for research in soil & vegetation trials; plant & seed delivery; First Nation reclamation; best management practices; and wetlands restoration. Shell Canada Ltd. is our foundational industry partner.

To respond to the challenge of restoring oil & gas 'in situ' sites in wetland settings, nBRI developed a collaborative applied research team including nBRI researchers, NAIT faculty, Laval University, and Shell Canada environmental and construction staff. This article describes a pilot project to remove an 'in situ' clay pad of a wellsite in a wetland setting. 'In situ' is the process of drilling for bitumen which is too deep to be mined at surface level. Alberta's 'in situ' oilsands are projected to exceed surface mineable production by 2025, and will carry the bulk of oilsands activity moving forward (Oilweek, 2011). While 'in situ' wellpads have a smaller environmental footprint than surface mining, 'in situ' still requires access roads, pipelines and utility corridors, all of which contribute to forest fragmentation.

The current practice of reclaiming peatland oil and gas sites is to leave the mineral or clay material used in wellpad and road construction in place and to re-vegetate as upland sites. However, reclaiming to upland ecosystems will fall short of restoring the hydrological and peat-accumulating functions of peatlands (Ball, 2010). Furthermore, government regulations for land reclamation are becoming more stringent, with new criteria for forested wetlands under development.

THE GOAL OF THIS RESEARCH TRIAL IS TO RESTORE BOTH THE HYDROLOGICAL FUNCTIONALITY AND THE PEAT ACCUMULATING CHARACTERISTICS OF AN INDUSTRIALLY DISTURBED SPHAGNUM-DOMINATED POOR FEN.

Objectives

The goal of this research trial is to restore both the hydrological functionality and the peat accumulating characteristics of an industrially disturbed Sphagnum-dominated poor fen. This

FIGURE 1. COMPLETE REMOVAL OF CLAY PAT WITH FLUFFING/DECOMPACTION.

pilot project addresses the hydrology, civil earth works, and plant - community considerations of restoring large scale, unconventional, 'in situ' wellpads that are typically located in sensitive wetland ecosystems. The site adjustments tested in this trial should aid in restoring surface peat hydrologic connectivity with the surrounding peatland and in creating a stable saturated - but not inundated - surface for deployment of the moss and other shrub and tree species present in the surrounding natural peatland. The outcome of this project is to contribute to the development of peatland restoration criteria currently under development by Alberta Sustainable Resource Development.

Study Area and Method

The research site is located within a poor fen in the Peace River oilsands region. The wellsite was constructed in December 2006 by Shell Canada using borrowed clay from a nearby upland site. The site is 1.4 hectares and was constructed by laying down the woody vegetation, and covering it with geo-textile and filled clay. The pad was 1.4 metres thick and the wellsite was drilled but not operated. The south side (the highest side overall) of the wellpad was on average 30 cm higher in elevation than the north side (the lowest side overall).This indicates that surface water would flow from the south to the north. The elevations were measured on natural peatland near each corner of the wellpad.

NAIT's objective is to identify cost-effective procedures and techniques that can be emulated in commercial "in situ" restoration projects. This is the first full scale pad removal project in northwest Alberta. The procedure took place in November-December of 2011, entirely under frozen conditions capitalizing on frozen winter road access. Clay pad overburden was returned to a nearby borrow pit, thus contributing to the restoration of the borrow pit in addition to the wellsite.

Three methods were applied to remove the pad and raise the compressed peat surface to the same elevation as the surrounding natural peatland. Until the publication of the peatland restoration criteria by the government of Alberta, the monitoring and assessment criteria described in the 2010 reclamation criteria for forested lands (AENV, 2010) will be utilized. Success will be determined by comparisons with control plots established in the surrounding undisturbed peatland and include; water flow, percent cover of native species, and stem count of woody species.

Site Adjustment Methods

For all methods used, attention was given to the water flow connection between the edge of the natural peatland and the newly uncovered peat. The strips were 3 to 4 m wide and 110 m long.

(1) Complete Pad Removal with Fluffing/Decompaction

"Fluffing" is the process of using an excavator or rake attachment to 'work-up' the surface of peat and to add volume and promote break-up by frost. The aim of this method was to expose and decompact the peat layer that was compressed under the clay pad. It consisted of removing the pad material and the geo-textile, followed by the fluffing (pseudo decompacting) of underlying peat as shown in Figure 1. An uneven peat depth across the site was noted, thus the fluffing helped to achieve the target elevation only where the compressed peat depth was greater than 60 cm.

(2) Inversion Strip Methods

In areas with shallow underlying peat, fluffing alone was insufficient to raise the peat to the level of the adjacent natural peatland. The inversion method involves inserting a layer of pad material under the peat (Figure 2, page 12). This process resulted

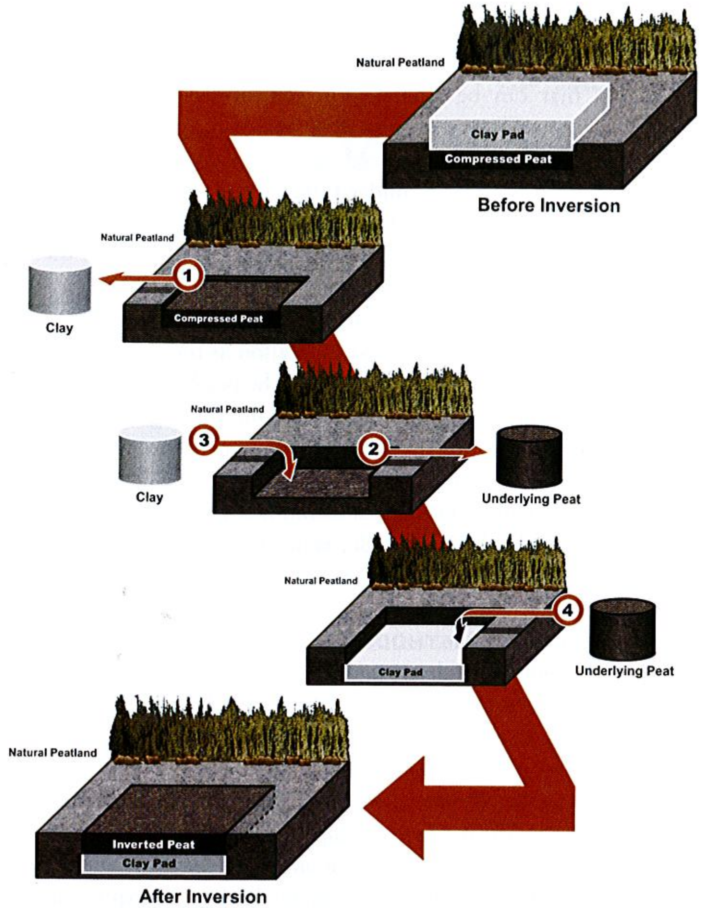

FIGURE 2. PEAT INVERSION PROCESS.

in a layer of surface peat above the wellpad material. For both inversion methods (outlined below) tested, the following objectives were achieved:

- No clay was left on the site within 40 cm of the peat surface.
- A minimum layer of 40 cm of peat was replaced on the restored peatland surface.
- An appropriate amount of clay was added under the peat to raise the peatland surface to the targeted level.
- The final surface level was 10 cm below the surrounding peatland to account for any rebound of the compressed peat or clay.

FIGURE 3. PEAT FROM SECOND STRIP PILED ON THE FIRST STRIP (LEFT), ELEVATION MARKERS ESTABLISHED FOR CLAY LAYER AND SURFACE PEAT LAYER (MIDDLE) AND CLAY PAD PARTIALLY REMOVED FROM THE THIRD STRIP (RIGHT).

(2a) Six-step Inversion

The inversion of the first strip appeared more challenging as there were no 'clean' spots to pile the peat without mixing it with the clay. For this reason a 'complete pad removal with fluffing' method was used on the first strip. The six-step inversion of the second (and subsequent) strip consisted of:

1. Complete removal of the clay pad and geo-textile from the second strip for reclaiming the borrow pit.
2. Removal of the peat from the second strip to pile along the first strip (Figure 3).
3. Establishing temporary markers for clay and peat depth to aid the excavator operator. A laser level was used (Figure 3).
4. Half-filling the second strip with clay from the third strip (or adjusting the clay to required depth given the quantity of peat).
5. Returning the peat piled on the first strip to the top of the second strip.
6. Lightly compressing the peat surface for the first and second strip and using the markers to monitor the elevation of the peat on both strips. When the correct elevation was achieved the inversion was complete.

(2b) Partial Pad Removal with Inversion

Partial removal of the clay pad means removing the top layer of the clay from the site and leaving the lower 20 to 30 cm and the

FIGURE 4. RESEARCH TEAM AND CONTRIBUTORS. FROM LEFT TO RIGHT: MARIE-EVE GAUTHIER (LAVAL UNIVERSITY); DR. LINE ROCHEFORT (LAVAL UNIVERSITY); AMANDA SCHOONMAKER (NAIT BOREAL RESEARCH INSTITUTE); DOUG FRITH (SHELL); HUGH SEATON (NAIT BOREAL RESEARCH INSTITUTE); MARGARET MARRA (SHELL); DR. KEVIN KEMBALL (IFTECH); DR. JEAN-MARIE SOBZE (NAIT BOREAL RESEARCH INSTITUTE)

geo-textile on site. The 'partial pad removal with inversion' method was used in an attempt to shorten the 'six-step inversion' process and reduce the cost of peatland restoration. Ideally, this method consists of partially removing the pad material off site followed by a one scope inversion (flip) of the remaining pad, geo-textile, wood debris and peat. However, it appeared very difficult to break the geo-textile without mixing the clay with the peat. This method was modified as follows:

- A portion of the pad material was removed along the strip for reclaiming the borrow pit (removed from site).
- An opening (5m by 5m) was created on the first section of the strip by removing all clay and peat.
- The remaining clay and geo-textile was removed from the second section to fill the bottom of the first section.
- The peat from the second section was removed to cover the clay on the first section. This created an opening on the second section that was filled by the clay and peat from the third section.
- Reference markers established at the edge of the strip were used to assess the surface elevation.

Conclusion

Adequate understanding and cost-effective methods are imperative to restoring peatland ecosystems. From the three methods used, the 'partial pad removal with inversion' appeared to be the most cost effective. The inconvenience of this method is that geo-textile remains 'on site', although it was buried under the peat layer. Maintaining the broken geo-textile on the reclaimed site was not a major concern since transporting it to reclaim a borrow pit does not remove it from the landscape.

Our next step is to determine how hydrology responds to the pad removal. Starting in the summer of 2012, we will determine if the peat surface is suitable to receive moss transplantation. We intend to monitor water connectivity with the surrounding natural peatland and determine substrate conditions. Re-vegetation will include a 'live plant transfer method' from an adjacent donor site. This is described as the North American Approach (Rochefort et al., 2003; Cobbaert et al., 2004) which has been successful on peat mined sites in eastern Canada and on bogs and fens. ■

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For more information on this project please contact Jean-Marie Sobze at jeanmars@nait.ca or (780) 618-2624.