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A FRAMEWORK FOR RECLAMATION CERTIFICATION CRITERIA AND INDICATORS FOR MINEABLE OIL SANDS

Reclamation Working Group Final Report

December 10, 2009

Report Prepared By:
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This report uses the following definitions for the proposed criteria and indicator (C&I) framework:

Goal: The final result or outcome toward which effort is directed.

Objective: A purpose toward which a reclamation effort is directed.

Criteria: (plural) A category of conditions or processes by which the achievement of a reclamation objective is assessed. A *Criterion* (singular) is characterized by one or more related *indicators* which are used to determine success or to assess change over time.

Indicator: An attribute which can be measured or described and used to evaluate if a *criterion* has been met.

Measure: A qualitative or quantitative aspect of an *indicator*; a variable which can be measured (quantified) or described (qualitatively) and demonstrates either a trend in an *indicator* or whether or not a specific *standard* was met.

Method: A description of a way, technique, process or procedure for attaining a *measure*.

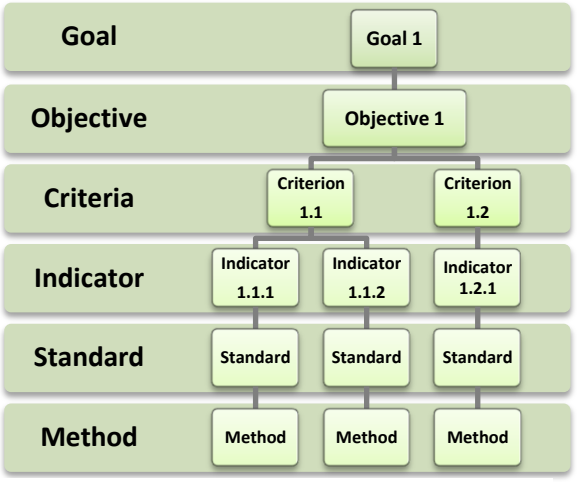
Standard: A definite rule established by authority. Environmental standards often take the form of prescribed numerical values that must be met.

Appendix 2 provides a glossary of other terms used in this document.

EXECUTIVE SUMMARY

The reclamation goal for oil sands mines set by the Government of Alberta and stated in the Environmental Protection Enhancement Act (EPEA) approvals is "*The reclaimed soils and landforms are capable of supporting a self-sustaining, locally common boreal forest, regardless of the end land use."* Currently there is no adequate set of decision criteria to evaluate when reclaimed oil sands mine landscapes have achieved the goal and are suitable for reclamation certification. The Government of Alberta must have the appropriate criteria so that decisions are consistent and the rational is transparent to stakeholders. For industry the absence of appropriate criteria introduces uncertainty as to whether reclamation efforts will produce results acceptable to the government within a reasonable period of time.

This report proposes a criteria and indicator (C&I) framework and recommendations for development of reclamation certification criteria for oil sands mines. The C&I framework proposed, portrayed in the diagram to the right, is based on a Goal – Objective – Criteria – Indicator – Standard – Method hierarchy. There can be multiple objectives to a goal, multiple criteria to an objective and multiple indicators to a criterion. The criterion determines what has to be met to qualify that the objective has been achieved. The indicator describes what specifically is measured to determine if the criterion has been met. The standard describes the regulatory target. The method sets a common procedure for measuring the indicator.



Criteria and Indicator Framework Example

The goal, objectives and criteria proposed for oil sands mine reclamation certification are:

GOAL: THE RECLAIMED SOILS AND LANDFORMS ARE CAPABLE OF SUPPORTING A SELF SUSTAINING, LOCALLY COMMON BOREAL FOREST, REGARDLESS OF THE END LAND USE

Objective 1: Establish and Integrate Natural Features on the Reclaimed Landscape	
Criteria	1.1 Integrated Landscape 1.2 Create Natural Landforms 1.3 Establish Watershed (drainage, lakes and wetlands) 1.4 Cover Soil Placement 1.5 Establish Terrestrial and Aquatic Vegetation
Objective 2: Natural Functions are Occurring on the Reclaimed Landscape	
Criteria	2.1 Carbon Cycling 2.2 Hydrologic Cycle 2.3 Nutrient Cycling 2.4 Self Sustainability 2.5 Biodiversity (ecosite scale)
Objective 3: End Land Use Capability is Equivalent to that Prior to Disturbance	
Criteria	3.1 Commercial Forestry 3.2 Wildlife Capability 3.3 Traditional Use 3.4 Other End Land Uses

The reclamation goal is set by the Government of Alberta in the EPEA approvals. The objectives and criteria were developed by the Reclamation Certification Task Group (RCTG) over several workshops focused on determining the work required to achieve the goal, developing the objectives, and brainstorming the potential C&Is to be measured to assure the objectives are being met. The ideas of what would need to be measured became the list of indicators presented in this report. The indicators require further evaluation as to their suitability and are not an exhaustive list of all that could be considered.

Fifty nine potential indicators were identified and categorized under the reclamation criteria. For each of the indicators, the RCTG assessed whether a measure, standard and method existed. If one of these components did not exist, it indicated a gap. A correlation of the indicators to recent EPEA approvals was completed to determine the relative alignment of the indicators to the approval conditions. The Reclamation Working Group (RWG) Technical Program Managers conducted a review of the work being undertaken by the RWG in relation to the indicators, specifically to determine the relative alignment of the work in relation to the gaps identified.

Key findings of the analysis are:

- 59 possible indicators were identified as being important to determine reclamation certification.
- 46 of these indicators have gaps in the measure, standard or measurement method.
- 13 of these indicators have no gaps, the measure, standard or measurement method exists.
- 31 of these indicators are directly aligned to an EPEA approval clause.
- 28 of these indicators are not aligned to an EPEA approval clause.
- 23 of these indicators aligned to the EPEA approval have gaps.
- 8 of these indicators aligned to the EPEA approval have existing measures, standards and methods.

Key findings of the work analysis against the indicators revealed:

- Of the 59 possible indicators, CEMA has work progressing on 42 of them; associated with or closely aligned to an identified gap, or purposefully being conducted to enhance an existing measure, standard or method.
- 17 of the 59 indicators have no work in progress.
- Of the 23 indicators aligned with the EPEA approval that have gaps, CEMA is working on 22 of them.

Based on the analysis and conclusions of the RCTG, the following recommendations are made:

Recommendation 1	**CEMA adopt the criteria and indicator framework and definitions as applicable.**

CEMA's acceptance of Recommendation 1 will standardize definitions and clearly demonstrate how reclamation criteria are aligned with achievement of objectives. The benefit will be a standard framework and common terminology between the working groups and task groups.

Recommendation 2	**CEMA seek endorsement from Alberta Environment and Alberta Sustainable Resource Development, on the concept of the criteria and indicator framework and the definitions.**

Recommendation 2 is made subject to the understanding there is further work required to define the C&Is and to address the gaps identified in this report. It proposes the use of a common framework to describe a C&I approach. Recommendation 2 is not proposing endorsement of the C&Is identified in this report. It is specific to the concept

of the C&I framework, and its use as a means to portray the oil sands reclamation certification requirements which can support decision making.

Recommendation 3	**The Reclamation Working Group initiate a review of the draft criteria and indicators listed for the purpose of planning the next stage of criteria development.**

The development of C&Is requires investment of time and resources. The next step for the RWG is to undertake a technical review of the C&Is presented in this report, and others that may be suggested, so that further work on C&Is is aligned to those that are most suitable to implement.

In support of the recommendations additional actions that should be considered by the RWG are:

- Consultation with the Government of Alberta for input and understanding on how the C&I work can support government policy and guideline development.
- Assess if each of the indicators has a clear measure, standard, and method (or explicitly define the gap).
- Estimate the cost, resources and time it will take to develop the indicators for the gaps that are identified.
- Estimate the cost of implementing the recommended suite of C&Is.
- Present the findings to Government with recommendations.

CEMA is well positioned to partner in and support the development of a C&I framework, because of its stakeholder representation and the value of the research work that has been completed or is underway. Accepting the recommendations will provide CEMA with confidence that the reclamation C&Is developed will be aligned with the Government of Alberta's direction and regulatory requirements.

Reclamation certification C&Is will primarily arise as a result of conditions under an operator's EPEA approval as well as other regulatory guidelines and directives. Indicators can be grouped into two categories: reclamation milestones and trend based indicators. These two types of indicators are used at different times in a mine's life cycle. Of the indicators identified in this report those listed under Objective 1*"Establish and integrate natural features on the reclaimed landscape"* are examples of *reclamation milestones* while *trend based* indicators are associated with the remaining two objectives, Objective 2 "*Natural functions are occurring on the reclaimed landscape*" and Objective 3 "*End land use capability is equivalent to that prior to disturbance*".

Establishing a C&I framework for reclamation certification is beneficial to stakeholders, government and the oil sands mining companies. Development of a C&I approach for reclamation certification supports assurance that the long term reclamation outcomes are achieved. Having a C&I framework in place introduces transparency, fairness and equal treatment within the oil sands mining industry. To a global audience, it demonstrates that both the government and the industry are committed to achieving the reclamation goals and objectives and are proactively addressing the environmental challenges of oil sands mine reclamation.

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A FRAMEWORK FOR RECLAMATION CERTIFICATION CRITERIA AND INDICATORS FOR MINEABLE OIL SANDS

INTRODUCTION

It is important to have clear reclamation certification criteria for oil sands mines. Criteria influence the work requirements, processes and timelines for certification. Criteria provide certainty for the industry because the operators and reclamation practitioners know the expectations. Transparency for all stakeholders is improved because it is clear on what criteria certification decisions will be based on. Meeting the criteria provides confidence that the reclamation objectives are being met. Having common criteria ensures consistent application of standards among the oil sands mines.

Alberta's oil sands reside underneath the northern boreal forest. Oil sand mine operators are required by their regulatory approval to demonstrate that the reclaimed soils and landforms are capable of supporting a self-sustaining, locally common boreal forest.

This report outlines a proposed framework for oil sands mine reclamation certification criteria and identifies where there are gaps in defining and or measuring the criteria. The report includes a list of possible indicators upon which to determine if the criteria have been met. The criteria and indicators (C&I) presented in this report require further evaluation as to their suitability. It was necessary to develop a draft list of indicators to determine where there are potential gaps in standards, measures, or methods, and to determine the degree of alignment by identifying the work being done within the Cumulative Environmental Management Association (CEMA) in relation to the gaps.

Reclamation is a requirement of the *Environmental Protection and Enhancement Act, Conservation and Reclamation Regulation* which states:

> ***Objective***
> *2. The objective of conservation and reclamation of specified land is to return the specified land to an equivalent land capability.*
>
> *AR 115/93 s2;167/93*
>
> *(e) "equivalent land capability" means that the ability of the land to support various land uses after conservation and reclamation is similar to the ability that existed prior to an activity being conducted on the land, but that the individual land uses will not necessarily be identical*
>
> ***Standards, criteria and guidelines:***
> *3**(1)** The Director may establish standards, criteria and guidelines for conservation or reclamation of specified land and may develop and release information documents respecting those standards, criteria and guidelines.*
> ***(2)** An operator must*
> *(b) reclaim specified land*
> *in accordance with the applicable standards, criteria and guidelines that are established by the Director.*
>
> *AR 115/93 s3;167/96;247/2003*

This report will highlight where criteria and standards exist and where there are gaps in the measure, standard, or method to determine if the criteria have been met. Recommendations are focused on proceeding with refining reclamation criteria development along with the support of the Government of Alberta and in alignment with reclamation policy and process development.

Reclamation certification criteria can have two purposes:

1. Criteria can be used to document that an element of the reclamation work was conducted to a specific standard or target at a particular point in time.[1]

2. Criteria can be used to determine elements of reclamation that will be assessed at the final stage against specific requirements to determine a reclamation certification decision.

A challenge is selecting a framework to represent a criteria based assessment approach which supports good reclamation certification decisions. Other challenges are defining and representing how the criteria can be applied (process wise) and defining terms (definitions) in a manner that can be supported by all stakeholders.

The Reclamation Certification Task Group (RCTG) identified the gaps associated with possible criteria that may be used to determine reclamation certification. Decisions of the RCTG represented in this report are based on consensus.

The RCTG membership for the preparation of this report and their representation are:

Alberta Environment	Kelly Williams (Co-chair)
Alberta Sustainable Resource Development	John Begg (Co-chair)
Canadian Natural Resources Limited	James Agate
CEMA	Kyle Harrietha Gillian Donald
Energy Resources Conservation Board	Chris Hale
Fort McKay IRC	John Errington
Imperial Oil	Lori Neufeld
Petro Canada	Ben Parsons Richard Mah
Shell Albian Sands	Fred Kuzmic
Suncor	Melinda Mamer Bruce Anderson
Syncrude	Rob Vassov Audrey Lanoue

[1] This purpose is related to the 'record of reclamation milestone' concept introduced in "*A Review of and Recommendations for the Reclamation Certification process and Criteria for Alberta's Oil Sands*" report, CEMA, 2008.

Mike Poscente of OPABIN Environmental Ltd. was engaged in the project under CEMA contract No. 2008-0042 as a 'Reclamation Specialist/Facilitator' to support development of "*A Framework for Reclamation Certification Criteria and Indicators for Mineable Oil Sands*" report.

Appendix 3 lists a glossary of terms used in this document.

1.0 METHOD USED TO IDENTIFY RECLAMATION CERTIFICATION GAPS

The RCTG commenced by first defining the reclamation goal, and three broad categories of objectives that would need to be accomplished to achieve the goal. At that point the project entered three stages:

Stage 1 – Gap Identification

This stage of the project involved:

- Understanding the reclamation goal (which is documented in the EPEA approvals).
- Development of the objectives to be met to achieve the goal.
- Refinement of the objectives.
- Brainstorming possible C&I for each objective.
- Identification of the key C&Is and where gaps in measures, standards, or methods occurred.
- Synthesizing the information and categorizing it by Goal – Objective – Criteria – Indicator (defining the criteria framework).

Stage 2 – Validation, Consultation and Report Writing

This stage of the project involved:

- Review of completed reports published by CEMA related to reclamation criteria.
- Review of work in progress within CEMA to identify where existing work could support filling some of the gaps identified.
- RCTG member consultation within their respective organizations.
- Development and reviews of draft reports.
- Input from the Reclamation Working Group (RWG).

Stage 3 – Project Closure

This stage of the project involved:

- Draft final report (camera ready).
- Submit final report.
- Project review and closure.

Previous reports prepared for CEMA regarding reclamation criteria were reviewed and their findings incorporated into this document.[2] For the gaps that were identified, the RWG Technical Program Managers reviewed if work currently underway within the RWG would support filling any of the gaps identified by the RCTG. This report will provide a comprehensive list of gaps that are not currently being addressed, on which future work plans can be based on, pending a decision by the RWG to pursue refinement of the C&I framework.

2.0 CRITERIA AND INDICATOR FRAMEWORK

The RCTG defined a C&I framework by which to organize and describe the reclamation certification criteria. Gaps were identified specific to the lack of existing standards, measures, or method by which to assess if the indicator was met. An understanding of when the criteria are applied within the timeline of a reclamation project is presented to demonstrate when criteria could be used as a record of reclamation milestone[3], or when it can apply to a final reclamation certification decision. Finally, demonstrating how the criteria 'fits' into the general reclamation process is portrayed. Criteria can originate from within legislation, policy, guidelines, or the mine closure plan (arising from a site specific need).

All of these factors were examined because during the reclamation certification criteria development stage, it is important to understand how criteria will be used, where it fits in the reclamation process, and the ownership implied in a suite of criteria by the government, oil sands mine operators, and stakeholders.

The Canadian Council of Forest Ministers C&I approach was adapted for use as a framework in presenting the C&I information for oils sands reclamation with consideration of the following:

- Previous reports commissioned by CEMA either refer to or recommend this option.[4]
- It is a nationally recognized approach to assessing forest sustainability (important because the reclamation goal is to re-establish a self sustaining boreal forest on reclaimed oil sands lands).
- The C&I framework has been adopted by 12 countries covering 90% of the worlds temperate and boreal forests (it has international recognition and acceptance).[5]

---

[2] Reports reviewed include: "*Reclamation Criteria Document Review: Criteria Gaps, Overlaps and Conflicts"*, Golder Associates, Feb. 2007; and *"Proposed Criteria and Indicators of Ecosystem Function for Reclaimed Oil Sands Sites",* FOR_{RX} Consulting Inc., October 2006.

[3] "Record of Reclamation Milestone" is a term introduced in "*A Review of and Recommendations for the Reclamation Certification Process and Criteria for Alberta's Oil Sands*" report, CEMA, 2008.

[4] CEMA, "*Proposed Criteria and Indicators of Ecosystem Function for Reclaimed Oil Sands Sites*", Reclamation Working Group, approval date October 13, 2006, p4, recommend a C&I approach.

- Australia, which has a significant mining sector, uses a C&I framework to define its mine reclamation standards and closure criteria.[6]

The C&I framework proposed is a science-based framework used to define and measure the factors to assess the suitability of a reclaimed oil sands mine landscape for reclamation certification.

Definitions[7] of a C&I framework used in oil sands mine reclamation context and for the purpose of this document are:

Goal: The final result or outcome toward which effort is directed.

Objective: A purpose toward which a reclamation effort is directed.

Criteria: (plural) A category of conditions or processes by which the achievement of a reclamation objective is assessed. A Criterion (singular) is characterized by one or more related *indicators* which are used to determine success or to assess change over time.

Indicator: An attribute which can be measured or described and used to evaluate if a criterion has been met.

Measure: A qualitative or quantitative aspect of an indicator; a variable which can be measured (quantified) or described (qualitatively) and demonstrates either a trend in an indicator or whether or not a specific *standard* was met.

Method: A description of a way, technique, process or procedure for attaining a measure.

Standard: A definite rule established by authority. Environmental standards often take the form of prescribed numerical values that must be met.

Refer to *Figures 1, 2 and 3* for examples of the application of these terms.

The framework takes the hierarchical approach of Goal – Objective – Criteria – Indicator – Measure – Standard – Method as portrayed in *Figure 1*. There can be multiple criteria for an objective, and multiple indicators for a criterion. *Figure 2* demonstrates a C&I with no gaps; *Figure 3* demonstrates a C&I with gaps.

---

[5] Through the Montréal Process, the criteria and indicator model was adopted by 12 countries covering 90% of the world's temperate and boreal forests.

[6] Government of Australia, *Mine Decommissioning*, section 2.2, http://www.ret.gov.au/resources/mining/leading_practice_sustainable_development_program_for_the_mining_industry/Pages/mineclosure_handbook.aspx

[7] The definitions for criteria, indicator and measure are adapted from those published in the "*Montreal Process*", http://www.rinya.maff.go.jp/mpci/criteria_e.html

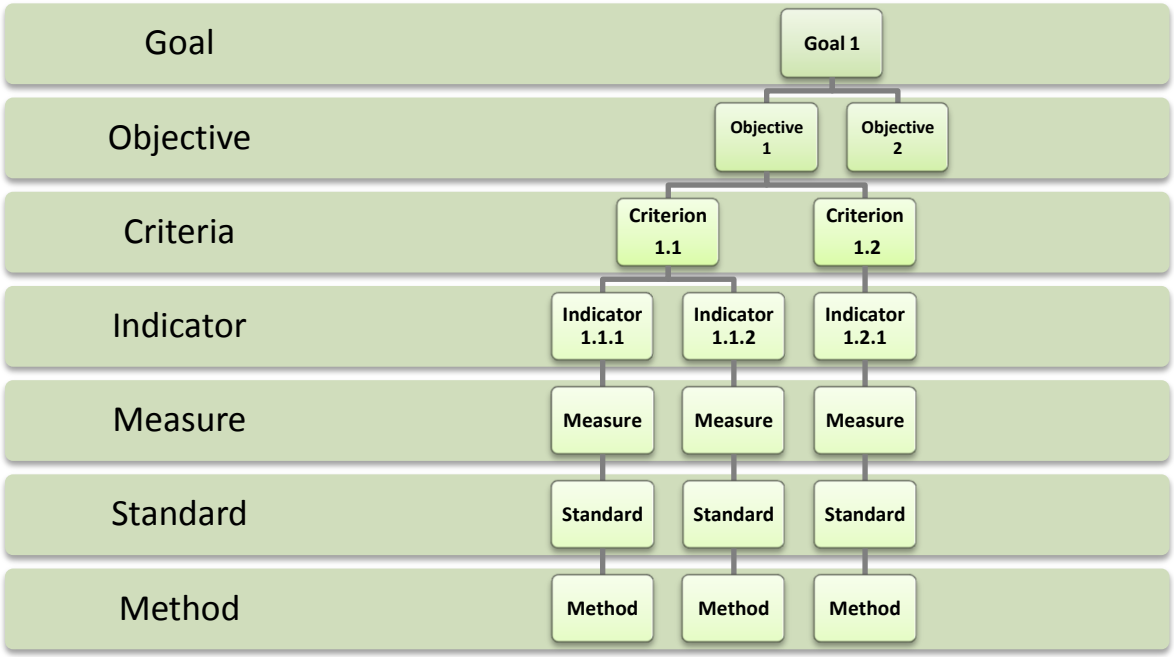

Figure 1 Criteria and Indicator Framework

An example of a complete reclamation criteria and indicator (no gaps) using the framework is demonstrated in *Figure 2*.

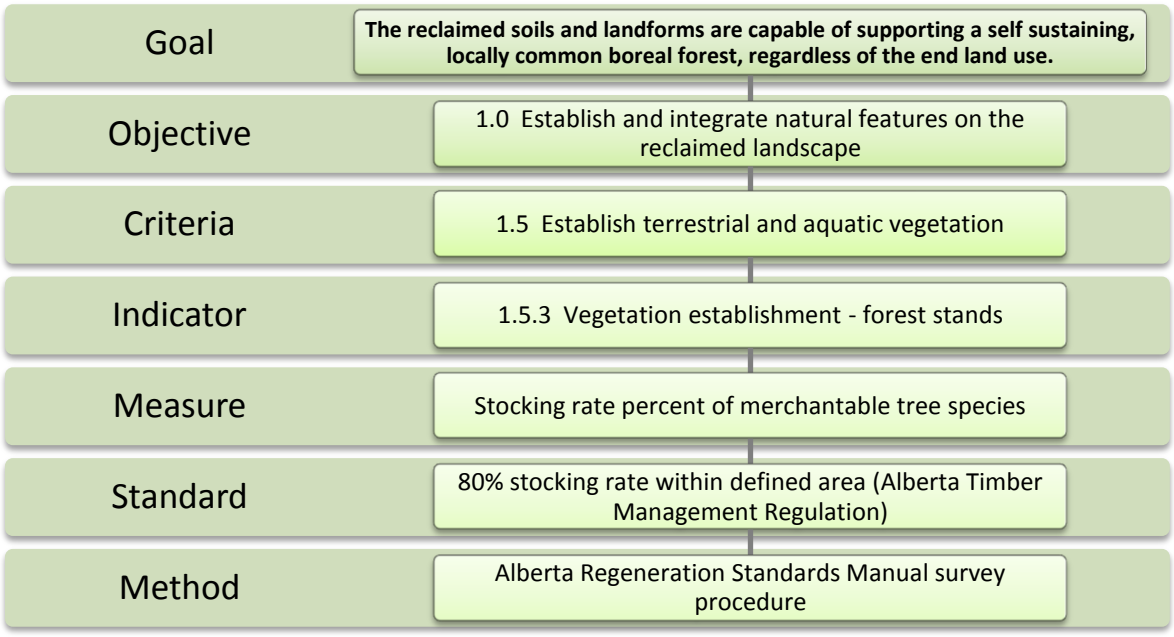

Figure 2 Criteria and Indicator Example - No Gaps

An example of an incomplete C&I (one that has gaps) is demonstrated in *Figure 3*.

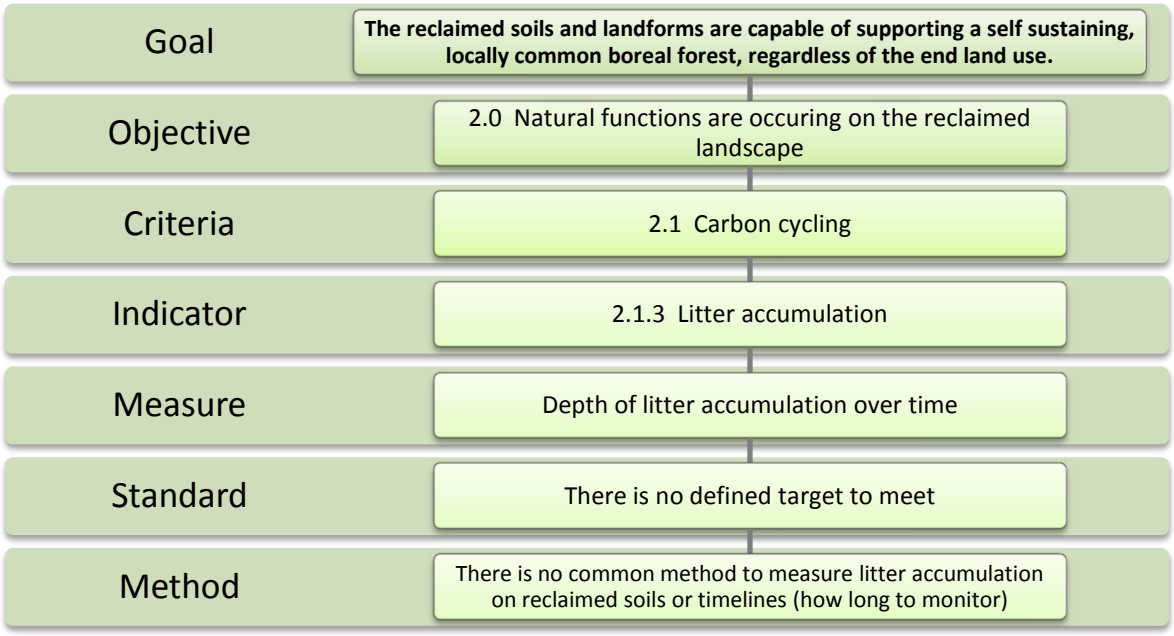

Figure 3 Criteria and Indicator Example - With Gaps

The following sections will define the reclamation goals and objectives, and the C&Is that could apply using this framework and definitions.

2.1 OIL SANDS MINE RECLAMATION GOAL AND OBJECTIVES

The reclamation certification goal is set by the Government of Alberta within the EPEA approval and is consistent between the oil sands mines.

The reclamation goal is:

"THE RECLAIMED SOILS AND LANDFORMS ARE CAPABLE OF SUPPORTING A SELF-SUSTAINING, LOCALLY COMMON BOREAL FOREST, REGARDLESS OF THE END LAND USE"

The objectives were developed by the RCTG and reflect the outcomes of three broad categories of work to be accomplished in order to achieve the goal.

Proposed objectives:

1. **Natural features are established on the reclaimed landscape**
2. **Natural functions are occurring on the reclaimed landscape**
3. **End land use capability is equivalent to that existing prior to disturbance**

The assumption is that if the objectives are achieved the goal will be met. Achievement of the objectives is determined through meeting the criteria that have been defined for each objective.

2.2 CRITERIA AND INDICATOR COMPONENTS

As part of the reclamation certification decision process, each criterion identified would need to be satisfied to ensure the objective had been achieved. The criteria presented in *Table 1* are examples to demonstrate the C&I Framework. The RCTG recognizes that they will require further refinement. The Government of Alberta has authority over development and approval of policy related to reclamation certification criteria.

Table 1 Example of Potential Criteria by Objective

Objective 1: Establish and Integrate Natural Features on the Reclaimed Landscape	
Criteria	1.1 Integrated Landscape 1.2 Create Natural Landforms 1.3 Establish Watershed (drainage, lakes and wetlands) 1.4 Cover Soil Placement 1.5 Establish Terrestrial and Aquatic Vegetation
Objective 2: Natural Functions are Occurring on the Reclaimed Landscape	
Criteria	2.1 Carbon Cycling 2.2 Hydrologic Cycle 2.3 Nutrient Cycling 2.4 Self Sustainability 2.5 Biodiversity (ecosite scale)
Objective 3: End Land Use Capability is Equivalent to that Prior to Disturbance	
Criteria	3.1 Commercial Forestry 3.2 Wildlife Capability 3.3 Traditional Use 3.4 Other End Land Uses

For each set of criteria, the RCTG identified indicators that could be used to determine if a criterion was met. A gap existed if the RCTG members determined there were no specific measures, standards or method established for an indicator within existing regulatory guidelines, legislation, directives or approval documents.

The RCTG did not assess whether the indicators were the 'appropriate suite' to adequately assess the criteria. Assessment and refinement of the indicators were both considered out of scope for this project.

Figure 4 represents the C&Is broadly defined by the RCTG, aligned by Goal, Objective, Criterion and Indicator. It provides an example of what a C&I framework for oil sands mine reclamation certification could look like, and the level of detail that it would encompass.

Goal: ***THE RECLAIMED SOILS AND LANDFORMS ARE CAPABLE OF SUPPORTING A SELF-SUSTAINING, LOCALLY COMMON BOREAL FOREST, REGARDLESS OF THE END LAND USE***

Objective 1 Establish and integrate natural features on the reclaimed landscape

Criteria and Indicators:

1.1 Integrated Landscape

- 1.1.1 Landscape connectivity
- 1.1.2 Habitat connectivity
- 1.1.3 Watershed integration
- 1.1.4 Ecosite targets

1.2 Create Natural Landforms

- 1.2.1 Representative topography
- 1.2.2 Natural appearance
- 1.2.3 Geotechnical stability (landforms)
- 1.2.4 Alluvial channels and wetlands
- 1.2.5 Compatibility with proposed ecosite

1.3 Establish Watershed (Drainage, Lakes and Wetlands)

- 1.3.1 EPL littoral zone targets
- 1.3.2 Construction of alluvial channels
- 1.3.3 Watershed size (to supply wetlands)
- 1.3.4 Planned fish habitat
- 1.3.5 Wetland area targets (by type)

1.4 Cover Soil Placement

- 1.4.1 Thickness
- 1.4.2 Layering (cover, subsoil and overburden)
- 1.4.3 Land capability class

1.5 Establish Terrestrial and Aquatic Vegetation

- 1.5.1 Species composition and abundance
- 1.5.2 Native species, genetic similarity
- 1.5.3 Vegetation establishment – forest stands
- 1.5.4 Vegetation establishment - ground cover, forbs and shrubs
- 1.5.5 Canopy structure
- 1.5.6 Aquatic vegetation establishment

Objective 2 Natural functions are occurring on the reclaimed landscape

Criteria and Indicators:

2.1 Carbon Cycling

- 2.1.1 Soil carbon content (rate of accumulation)
- 2.1.2 Litter, Fermenting, Humified (LFH) depth development
- 2.1.3 Litter accumulation
- 2.1.4 Biomass accumulation
- 2.1.5 Peat accumulation (in peat accumulating wetlands)

2.2 Hydrologic Cycle

- 2.2.1 Water holding capacity
- 2.2.2 Depth to water table
- 2.2.3 Rate of flow (recharge/discharge rates)

2.3 Nutrient Cycling

- 2.3.1 CNPK
- 2.3.2 Foliar analysis
- 2.3.3 Acid deposition (associated with NOx and SO2 emissions)

2.4 Self Sustainability

- 2.4.1 Landform sustainability (geotechnical failure acceptance standard)
- 2.4.2 Erosion (acceptance allowance)
- 2.4.3 Wetlands and uplands vegetation trend on succession path for target ecosite
- 2.4.4 Absence of noxious and restricted weeds
- 2.4.5 EPL water balance
- 2.4.6 EPL water quality
- 2.4.7 EPL biological activity
- 2.4.8 EPL beach stability
- 2.4.9 EPL toxicity (system)
- 2.4.10 EPL hydrology (stratification and mixing)
- 2.4.11 Aquatic biological activity
- 2.4.12 Water quality
- 2.4.13 Watershed stability (stream banks)
- 2.4.14 Stream toxicity (system)

2.5 Biodiversity (ecosite scale)

- 2.5.1 Species richness (for represented ecosites)
- 2.5.2 Soil fauna

Objective 3 End land use capability is equivalent to that prior to disturbance

Criteria and Indicators:

3.1 Commercial Forestry

- 3.1.1 Forest stands of merchantable species are viable
- 3.1.2 Productivity of forest stands
- 3.1.3 Area of commercially viable forest stands established

3.2 Wildlife Capability

- 3.2.1 Quantity of habitat for candidate species
- 3.2.2 Quality of habitat for candidate species
- 3.2.3 Wildlife usage capability

3.3 Traditional Use

- 3.3.1 Capability for trapping, hunting or gathering
- 3.3.2 Medicinal plants

3.4 Other End Land Uses

- 3.4.1 As defined in the mine closure plan

NOTE: Figure 4 portrays more indicators than could be reflected in a final version, and it is not a fully exhaustive list for consideration. The indicators listed have not been assessed as to their validity.

Figure 4 Concept of a Reclamation Certification Criteria and Indicator Framework

2.3 RECOMMENDATIONS

The C&I framework presented provides an example of the criteria that could be used to assess whether a reclamation objective has been met. Diligent and deliberate selection of the appropriate C&Is to support reclamation certification decisions would define the reclamation requirements with a higher degree of certainty than what exists today.

Recommendation 1	**CEMA adopt the criteria and indicator framework and definitions as applicable.**

CEMA's acceptance of Recommendation 1 will standardize definitions and clearly demonstrate how reclamation criteria are aligned with achievement of the proposed objectives. The benefit will be a standard framework and common terminology between the working groups and task groups.

The Government of Alberta has the final authority over establishing reclamation certification criteria. It is important that the RWG seek alignment with the government prior investment in additional work involving development of C&Is, or filling the gaps identified in this report.

Recommendation 2	**CEMA seek endorsement from Alberta Environment and Alberta Sustainable Resource Development, on the concept of the criteria and indicator framework and the definitions.**

Recommendation 2 is made subject to the understanding there is further work required to define the C&Is and to address the gaps identified in this report. It proposes the use of a common framework to describe a C&I approach. This recommendation is not proposing endorsement of the C&Is identified in this report. It is specific to the concept of the C&I framework, and its use as a means to portray the oil sands reclamation certification requirements which can support decision making.

Recommendation 3	**The Reclamation Working Group initiate a review of the draft criteria and indicators listed for the purpose of planning the next stage of criteria development.**

The development of C&Is requires investment of time and resources. The next step for the RWG is to undertake a technical review of the C&Is presented in this report, and others that may be suggested, so that further work on C&Is is aligned to those that are most suitable to implement.

The technical review would be assigned by the RWG to the appropriate sub-groups or task groups and could include the following evaluation questions:

- Are the C&Is appropriate?
- Are there other C&Is to be considered?
- Are the C&Is measureable, reliable and repeatable?
- Is there sufficient knowledge to incorporate the indicators at this point in time?
- Which of the proposed indicators are the 'key' indicators?

- Are the proposed indicators aligned to existing monitoring protocols?

2.3.1 NEXT STEPS

In support of the recommendations the following next steps should be considered by the RWG:

- Consultation with the Government of Alberta for input and understanding on how the work can support government policy and guideline development.
- Assess if each of the indicators has a measure, standard, and method (or explicitly define the gap).
- Estimate the cost, resources and time it will take to develop the indicator for the gaps that are identified.
- Estimate the cost of implementing the recommended suite of C&Is
- Present the findings to Government with recommendations.

The above steps need to be defined more thoroughly in a comprehensive work plan with target completion dates for the various stages of the work.

There will be a need to define policy, process, and implementation guidance if a C&I framework is adopted. The C&Is presented in this report are a broad list of ideas, but do not reflect any official direction or certainty on what will be acceptable as a final suite of criteria by the Government of Alberta.

It is critical that there is an official indication of support within the Government of Alberta to move in the direction of developing and using a C&I framework in the reclamation certification process, prior to the RWG making further investments in refining indicators or in working on the gaps.

3.0 KEY FINDINGS – CRITERIA AND INDICATOR GAP ANALYSIS

For each of the indicators, the RCTG identified the existing measures, standards and methods in place, and where there are gaps (no known approved existing measures, standards or methods). The tables in *Appendix 1* detail these findings, including a description of the existing standard and what each gap is.

The key findings of this analysis are:

- 59 possible indicators were identified as being important to determine reclamation certification.
- 46 of these indicators have gaps in the measure, standard or measurement method.
- 13 of these indicators have no gaps, the measure, standard or measurement method exists.
- 31 of these indicators are directly aligned to an EPEA approval clause.
- 28 of these indicators are not aligned to an EPEA approval clause.
- 23 of these indicators aligned to the EPEA approval have gaps.
- 8 of these indicators aligned to the EPEA approval have existing measures, standards and methods.

Where a gap was identified in the proposed indicators, the RWG Technical Program Managers were consulted to determine if there was any work in progress within the RWG that would support filling the gap. The tables in *Appendix 2* document the work in progress at the time of this report by the RWG, which may contribute to filling the identified gaps.

Analysis of the work being conducted in relation to the list of reclamation certification C&Is revealed:

- Of the 59 possible indicators, CEMA has work progressing on 42 of them; associated with or closely aligned to an identified gap, or is purposefully being conducted to enhance an existing measure, standard or method.
- 17 of these indicators have no work in progress.
- Of the 23 indicators aligned with the EPEA approval that have gaps, CEMA is working on 22 of them.

Some important considerations when interpreting this analysis are:

- The C&Is have not been evaluated.
- The assumption is that the C&Is listed in the EPEA approval are relevant.
- There are C&Is that are important for reclamation certification, which are not directly associated to an EPEA approval clause.

To understand where there is no alignment, or where there are gaps between the proposed indicators, the EPEA approval, and the work of CEMA, the following summary is provided by reclamation objective:

Objective 1 Establish and Integrate Natural Features on the Reclaimed Landscape

- 5 criteria and 23 indicators listed
- 19 of these indicators have gaps
- 18 of these indicators are directly aligned with the EPEA approval clause
- 3 of these indicators aligned with the EPEA approval have standards/measures (15 have gaps)
- 19 of these indicators have work in progress within CEMA
- 1 indicator has a gap and no work in progress

Objective 2 Natural Functions are Occurring on the Reclaimed Landscape

- 5 criteria and 27 indicators are listed
- 21 of these indicators have gaps
- 4 of these indicators are directly aligned with an EPEA approval clause
- 2 of these indicators aligned with the EPEA approval have standards/measures (2 have gaps)
- 16 of these indicators have work in progress within CEMA
- 7 indicators have gaps but no work in progress

Objective 3 End Land Use Capability is Equivalent to that Prior to Disturbance

- 4 criteria and 9 indicators are listed
- 6 of these indicators have gaps
- 9 of these indicators are directly aligned with an EPEA approval clause
- 3 of these indicators aligned with the EPEA approval have standards/measures (6 have gaps)
- 7 of these indicators have work in progress within CEMA
- All 6 indicators with gaps have work in progress

3.1 CONCLUSIONS

The following conclusions can be made from this analysis:

- For Objective 1, the indicators are closely aligned with the EPEA approval.
    - The work conducted by CEMA is closely aligned to the gaps identified.
- For Objective 2, the indicators are not directly aligned with the EPEA approval.
    - If natural functions are important criteria for reclamation certification, they are not being explicitly represented in the approval (but may be inherent in the intent).
    - There is significant work being conducted within CEMA on natural functions, which may qualify that the indicators listed have a high degree of importance in reclamation certification, or knowledge development at the very least.
- For Objective 3, there is very close alignment of the indicators to the EPEA approval.
    - Work is progressing within CEMA on all of the gaps identified.

This analysis reveals that there is a very close alignment between the EPEA approval requirements and Objective 1 - N*atural features are established on the reclaimed landscape* and Objective 3 - *End land use capability is equivalent to that existing prior to disturbance*. With respect to Objective 2 - *Natural functions are occurring on the reclaimed landscape*, while there is a general alignment with the overall goal of creating a locally common self sustaining boreal forest, there are few specific EPEA approval conditions addressing natural functions. There is a need to be clear on the strategy and criteria by which to provide assurance these reclamation objectives will be achieved.

4.0 CRITERIA AND INDICATORS IN THE RECLAMATION CERTIFICATION PROCESS

Reclamation certification criteria and indicators will primarily arise as a result of conditions under an operator's EPEA approval as well as other regulatory guidelines and directives. Some criteria may be applied consistently across all the oil sands mines; others may reflect mine specific criteria to address site specific requirements. At present, a reclamation goal is identified in the EPEA approval but many of the objectives, criteria, indicators, standards and/or measures are not. In many instances, particularly before C&Is have been established in regulatory documents, operators will need to identify and monitor certain ecosystem attributes in order to demonstrate that the goals and objectives have been met. In these cases, industry would present the government with monitoring data, predictive modelling and certification assessments to demonstrate successful reclamation and that a reclamation certificate is

merited. Therefore, industry will also play an important role through the development of internal C&Is that will be important in the reclamation certification decision process.

The adoption of a C&I framework as part of the reclamation certification process would be valuable to regulators, operators and other stakeholders at various stages of reclamation including reclamation and closure planning, research, monitoring and the development and evaluation of reclamation certification application documents (*Figure 5*). For example, some criteria, such as end land use, may be used during the planning stage to set out the mosaic of ecosites on the reclaimed landscape and again during the final application for certification to confirm that certain land use objectives have been met.

Furthermore, the adoption of a C&I framework will result in efficiencies by simplifying and standardizing the reclamation certification process through the establishment of common measures, standards and methods for evaluating reclamation success (i.e. the achievement of objectives and goals).

C&Is will undoubtedly need to be reviewed and revised over time using a continuous improvement approach. Some of the gaps which the RCTG has identified will need to be resolved through additional research and trials before relevant and defensible indicators can be developed. In addition, advancements in science, technology and knowledge will need to be incorporated into the C&I framework through periodic reviews.

In order for C&Is to be appropriate for certification they should satisfy the following conditions:

- Operational Practicality – There is a need for the data/sample collection to be simple, yet credible, and appropriately account for the observed heterogeneity of the site.
- Sampling Clarity – For selected indicators, appropriate sampling methods (standard processes) must be provided.
- Cost Effective – It is critical to ensure that the cost of the indicator data is aligned with the indicators value in demonstrating that the criteria, and subsequently the objectives, have been achieved.

A key consideration from a process perspective will be how to manage changes to the C&Is that will occur over the life of a mine's reclamation time period. If a new criterion or a new indicator is approved:[8]

- When and where will it apply to reclamation already in progress?
- Is reclamation certification based on the criteria in place at the time of a mine approval?
- Is reclamation certification based on the criteria in place at the time of land disturbance?
- Can new criteria or a new indicator be introduced and applied at anytime in the reclamation process?

These questions need to be considered no matter what type of criteria framework is adopted.

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[8] This topic is presented in detail in the report, "*A Review of and Recommendations for the Reclamation Certification Process and Criteria for Alberta's Oil Sands*" report, CEMA, 2008.

CRITERIA AND INDICATORS IN THE RECLAMATION CERTIFICATION PROCESS

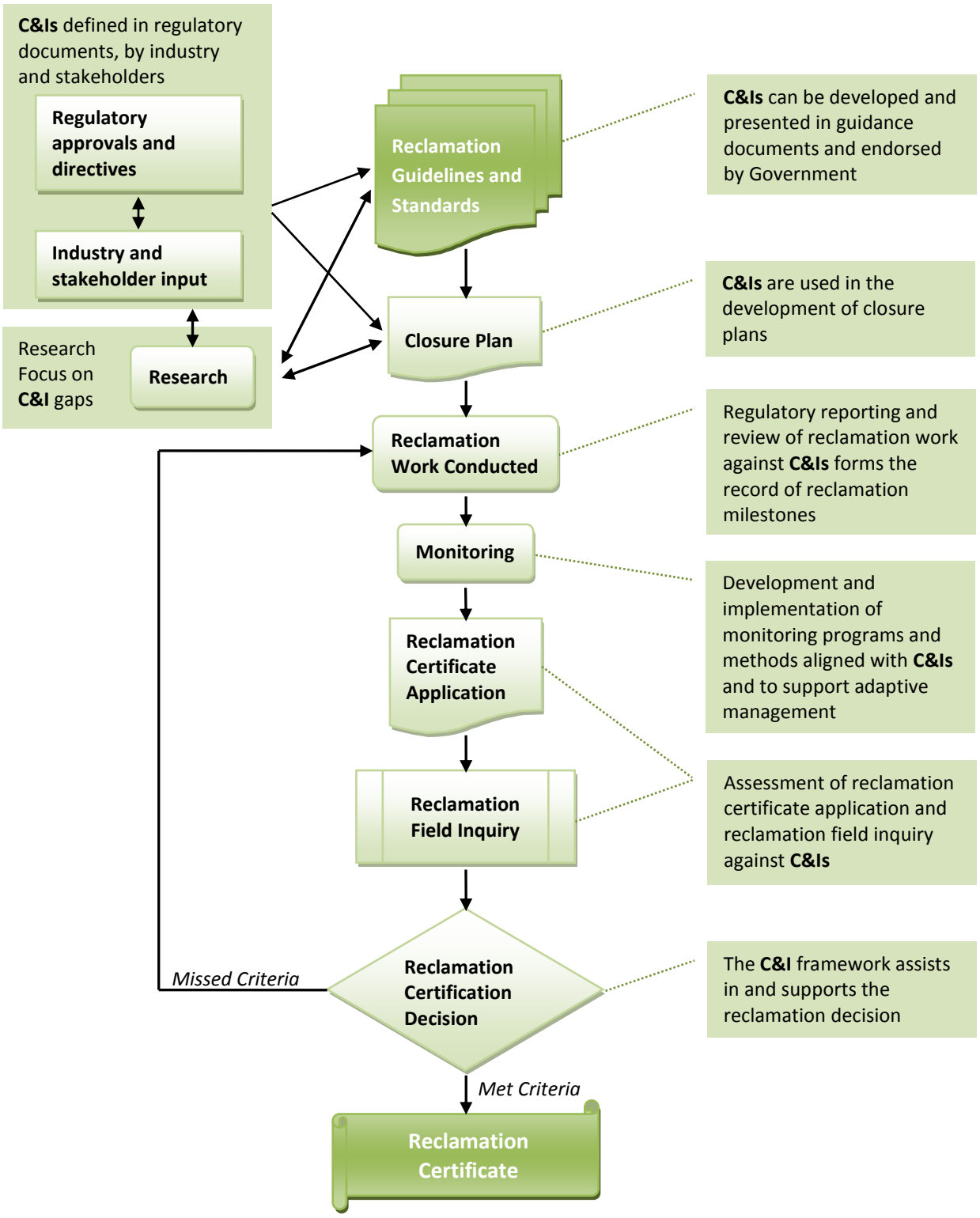

Figure 5 Criteria and Indicators in the Reclamation Certification Process

4.1 RECLAMATION MILESTONES AND TREND BASED INDICATORS

The list of example indicators presented in this document can be grouped into two categories: reclamation milestones and trend based indicators. These two types of indicators are used at different times in the generalized reclamation certification process illustrated in *Figure 6*. All of the indicators listed under Objective 1*"Establish and integrate natural features on the reclaimed landscape"* are examples of *reclamation milestones* while *trend based* indicators are associated with the remaining two objectives, Objective 2 "*Natural functions are occurring on the reclaimed landscape*" and Objective 3 "*End land use capability is equivalent to that prior to disturbance*".

Reclamation Milestones

Reclamation milestones are those elements of reclamation work that meet the standards that were applicable at that point in time. This provides a degree of certainty (to both government and operators) that it is appropriate to continue with the next steps in the reclamation process. Risk of failure of that element of reclamation work due to improper practice, procedure or application is managed if the criteria are met. However, overall success is not guaranteed. Documentation of the achievement of these criteria forms a 'record of reclamation milestones' to support certification decisions. Although this concept has not been approved by the GOA at this time it is presented in this report to support the RCTG's earlier process recommendations[9].

Trend Based Indicators

Assuming that Objective 1 is met in the initial stages of the reclamation process (i.e. landscape components are established), trend based indicators are required to monitor performance and to model or predict outcomes at appropriate times within the mine life cycle and at the time of the certification inquiry. Trend based indicators are focused on elements of the reclamation work that require monitoring and/or predictive modelling for supporting final reclamation certification decisions.

[9] This concept is recommended in the "*A Review of and Recommendations for the Reclamation Certification Process and Criteria for Alberta's Oil Sands*" report, CEMA, 2008.

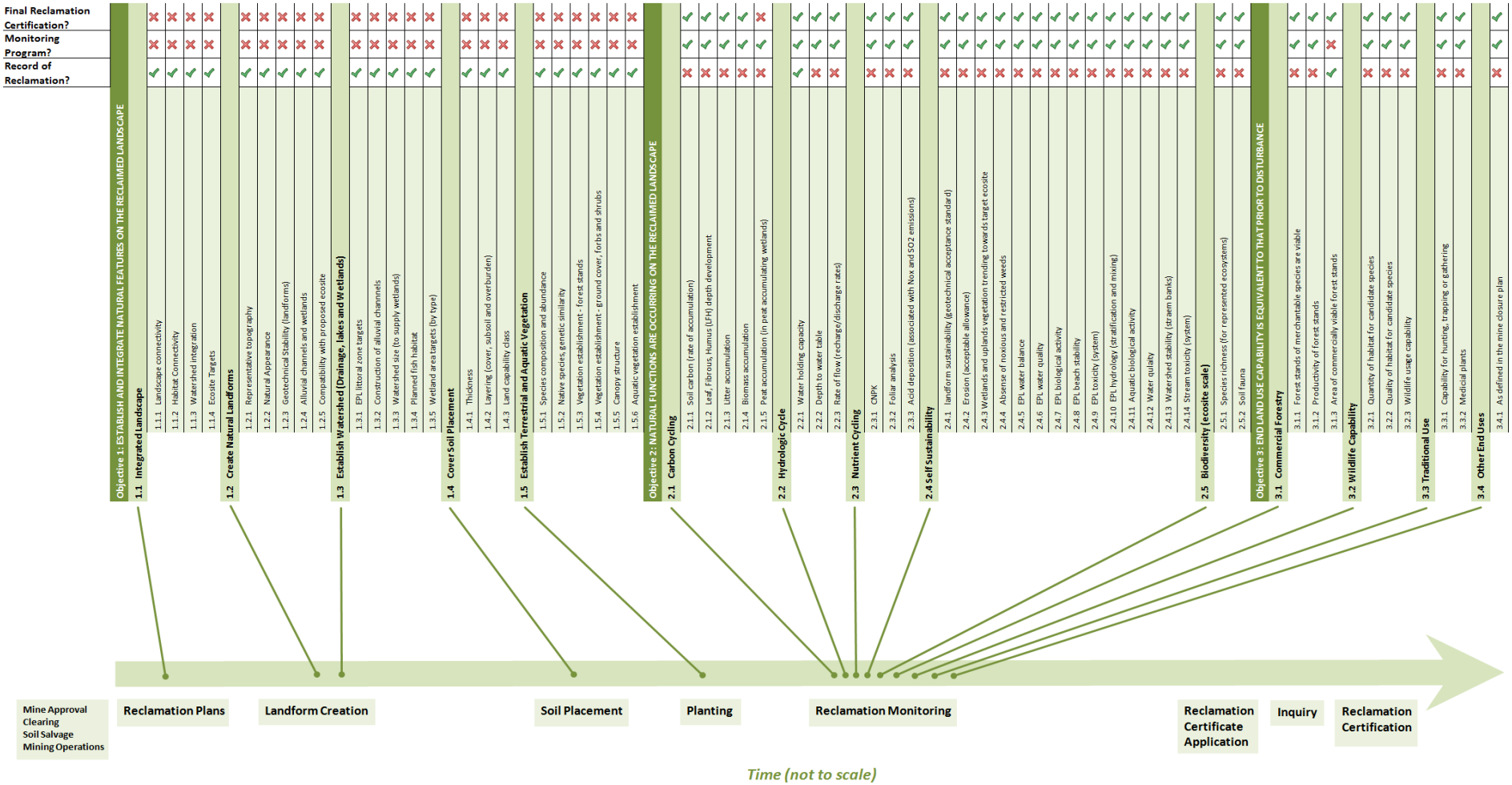

Figure 6 Criteria and Indicator Use in the Mine Life Cycle

5.0 WRAP-UP

The framework for reclamation certification C&Is for mineable oil sands recommended by the RCTG is based on a Goal – Objective – Criteria – Indicator – Standard – Method hierarchy. The reclamation goal is set by the Government of Alberta in the EPEA approval. The objectives, criteria and indicators were developed by the RCTG and are presented in this report as examples. They require further review to determine their appropriateness.

Against the list of draft indicators, the RCTG conducted assessments of:

- Gaps, determined by the absence of a measure, standard or method.
- Correlation of the indicators to the EPEA approval.
- Alignment of the work being undertaken by the RWG in relation to the gaps.

The findings and conclusions of the RCTG from these assessments validates the work being undertaken by the RWG is important towards and supports the development of criteria for reclamation certification.

C&I use in the reclamation certification process is demonstrated to enhance the understanding of where C&Is originate from and how they support reclamation planning and certification decisions. The two types of indicators, *reclamation milestones* and *trend based indicators* are defined, including how these two types of indicators are used to measure reclamation progress over the life cycle of the mine.

The RCTG made three recommendations to the RWG summarized as; CEMA adoption of the C&I framework, endorsement of the C&I framework by the Government of Alberta, and the need for the RWG to conduct a technical review on the C&Is presented in this report. Responsibility now resides with the RWG to consider and decide on the recommendations, inclusive of initiating the next steps.

The work of the RCTG to develop a C&I framework for oil sands mine reclamation certification was completed in accordance with the terms of reference for the project. Submission of this report concludes this phase of the initiative to develop oil sands mine reclamation criteria.

APPENDICES

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APPENDIX 1 CRITERIA AND INDICATOR GAP ANALYSIS

OBJECTIVE 1 ESTABLISH AND INTEGRATE NATURAL FEATURES ON THE RECLAIMED LANDSCAPE

Criterion 1.1 Integrated Planning			
Indicators:	**Gap or Existing Standard**	**Existing Standard Description**	**Comments**
1.1.1 Landscape connectivity	Gap	EPEA approval states: "*The mine reclamation plan…shall address …. integration of landforms, topography, vegetation, water bodies, and watercourses with adjacent undisturbed areas within or adjacent to the plant, and mine areas adjacent to the plant*"	No standards defined as to what is acceptable or how to assess if the requirement has been met.
1.1.2 Habitat connectivity	Gap	EPEA approval states: "*The mine reclamation plan…shall address …. integration of landforms, topography, vegetation, water bodies, and watercourses with adjacent undisturbed areas within or adjacent to the plant, and mine areas adjacent to the plant*"	No standards defined as to what is acceptable or how to assess if the requirement has been met.
1.1.3 Watershed integration	Gap	EPEA approval states: "*The approval holder shall establish surface drainage on disturbed land that is integrated with undisturbed land*"	No standards defined as to what is acceptable or how to assess if the requirement has been met.
1.1.4 Ecosite Targets	Gap	EPEA approval states: "*The Revegetation Plan ... shall comply with the Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 1998, as amended, and shall include, at a minimum...* *(a) forest ecosystems and wetland ecosystems on disturbed land...* *The approval holder shall consider the following in developing the Soil Placement Plan...:* *(g) matching pre-disturbance upland*	There are statements in the EPEA approval suggesting replacing landscape and soils sufficiently to represent pre-disturbance ecosystem conditions and to replace specific land capability class to pre-disturbed levels. The revegetaion manual directs companies to plan for specific target ecosites based on the outcome of terrain and soil establishment. The gap is, are ecosite targets established first, on which the terrain design and cover soil placement is based? Or does the planned

		ecosystem types of salvaged upland surface soil to targeted ecosystem types of reclaimed areas;"	terrain and cover soil placement determine the range of ecosites possible?

Criterion 1.2 Create Natural Landforms			
Indicators:	**Gap or Existing Standard**	**Existing Standard Description**	**Comments**
1.2.1 Representative topography	Gap	The EPEA approval only sets out standards for the Life of Mine Closure Plan: "*...shall outline the most recent concepts for development and reclamation of the plant. The plan shall:* (b) *ensure that reclaimed features have natural appearances characteristic of the region;..."*	No standards defined as to what is acceptable or method to assess if the designed landforms are representative topography.
1.2.2 Natural appearance	Gap	The EPEA approval only sets standards for the Life of Mine Closure Plan: *"...shall outline the most recent concepts for development and reclamation of the plant. The plan shall:* (c) *ensure that reclaimed features have natural appearances characteristic of the region;...*"	No standards defined as to what is acceptable or how to assess if the designed landforms are representative of topography.
1.2.3 Geotechnical stability (landforms)	Existing	EPEA approval states: "*The approval holder shall construct all structures and slopes to be geotechnically stable with minimal erosion.*" The ERCB requires industry to design and construct landforms to Canadian Professional engineering standards. The ERCB requires industry to monitor landform stability and document acceptable trends for the factor of safety (FOS).	N/A
1.2.4 Design alluvial channels and wetlands	Gap	EPEA approval states: "*The Mine Reclamation Plan… shall address, at a*	No measures defined or standards established to guide what is acceptable (for example

		minimum, the following: - *surface water hydrology* - *wetlands and end pit lakes* - *watercourse and riparian design and development, including specific design for fish habitat*"	wetland targets or stream type targets). The "*Alluvial Channels Guidelines" (CONRAD)* and *"Vegetated Waterway Design Guidelines" (Syncrude)* are two documents that can support fulfilling the gap.
1.2.5 Compatibility with proposed ecosite	Gap	N/A	No standards defined. Present planning model is to define ecosite targets after landform construction and soil placement.

Criterion 1.3 Establish Watershed (Drainage, Lakes and Wetlands)			
Indicators:	**Gap or Existing Standard**	**Existing Standard Description**	**Comments**
1.3.1 EPL littoral zone targets	Gap	EPEA approval states: "*The Mine Reclamation Plan… shall address, at a minimum, the following:* - *wetlands and end pit lakes"*	There are no minimum targets or standards for creating littoral zones in EPL's on which to base reclamation decisions.
1.3.2 Construction of alluvial channels	Gap	N/A	Unclear if regulator accepts "*Guidelines for Construction of Alluvial Channels*" document. Document should undergo a peer review and direction be provided by government on its applicability.
1.3.3 Watershed size (to supply wetlands)	Gap	EPEA approval states: "*The Mine Reclamation Plan… shall address, at a minimum, the following:* - *surface water hydrology*"	No standards defined as to what is acceptable or method to assess if the requirement has been met.
1.3.4 Planned fish habitat	Gap	EPEA approval states: "*The Mine Reclamation Plan… shall address, at a minimum, the following:* - *fish and wildlife habitat as defined by Habitat Suitability Indices (or other habitat assessment tools recommended by the Director) for key species consistent with pre-disturbance capabilities*" Federal Fisheries Act Sec. 35(2) Authorizations	Unclear if fish habitat creation is a reclamation requirement.

1.3.5 Wetland area targets (by type)	Gap	The EPEA approval states: "*The approval holder shall submit a plan and schedule to reclaim wetlands to the Director, by ...* *The plan referred to... shall comply with Guideline for Wetland Establishment on Reclaimed Oil Sands Leases, 2000, as amended, and shall include at a minimum, all of the following:* - *identification of the type and amount of wetlands to be created on the reclaimed landscape;* - *measures to ensure wetland sustainability, ecological function, traditional use, and biodiversity;* - *establishment of wetland and wetland watershed hydrology to support wetlands;* - *for wetlands specifically designed for treatment, effective water treatment;* - *availability and source of soil and planting materials;* - *soil placement;* - *monitoring of constructed wetlands; and* - *performance measures.* *The approval holder shall implement the plan and schedule... as authorized in writing by the Director*."	Wetland targets are set in the reclamation planning process, reviewed and approved by government. While this indicator is partly addressed through the planning requirements, there is opportunity to standardize the performance measures and monitoring processes so that each company does not have to 'reinvent the wheel'. This would ensure that investments are made in reclamation results rather than in developing individual processes and monitoring programs.

Criterion 1.4 Cover Soil Placement			
Indicators:	**Gap or Existing Standard**	**Existing Standard Description**	**Comments**
1.4.1 Thickness	Gap	The EPEA approval states: "*The approval holder shall place an average total depth of 0.5 m of coversoil and subsoil combined, on all reclamation areas of land capability Class 1 through 5, unless otherwise authorized in writing by the Director*.""*When upland surface soil is used in reclamation, the approval holder shall place it at an average minimum depth of 0.05 m (5 cm)"*.	There is no standard process or method on how to measure and when to measure coversoil placement. Methods used to measure the average coversoil depth must be statistically valid and recognize the heterogeneity of the reclamation site.
1.4.2 Layering (cover, subsoil and overburden)	Gap	EPEA approval is very comprehensive in establishing the standards and requirements for soil layering in respect to the various conditions that can be encountered in oil sands mine reclamation.	There is no standard process or method on how to measure and when to measure compliance to soil layering conditions.
1.4.3 Land capability class	Existing	The EPEA approval states: "*The approval holder shall return disturbed land at a minimum, to meet the pre-disturbance area of land capability class as illustrated in TABLE 6.1-A, or as otherwise authorized in writing by the Director.*"	N/A

Criterion 1.5 Establish Terrestrial and Aquatic Vegetation			
Indicators:	**Gap or Existing Standard**	**Existing Standard Description**	**Comments**
1.5.1 Species composition and abundance	Gap	EPEA approval states "*The approval holder shall submit a Revegetation Plan that complies with the Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region and shall include:* • *Incorporation of vegetation and*	There is no standard process or method on how to measure and when to measure establishment of aquatic vegetation, or upland vegetation comprised of lichens, mosses, forbs or shrubs. There is a gap in defining the standards for

			vegetation communities of traditional value and that are characteristic of those communities on adjacent undisturbed lands".	aquatic species composition and abundance targets by wetland type (to the same level that it is defined for upland vegetation).
1.5.2	Native species, genetic similarity	Existing	The *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region* (referred to in EPEA approval) and the *Standards for Tree Improvement in Alberta (ASRD)* set standards for native species and provenance. Includes documenting seed varieties and provenance with the Alberta Tree Improvement and Seed Centre.	N/A
1.5.3	Vegetation establishment – forest stands	Existing	The EPEA approval states: "*The Revegetation Plan... shall comply with the Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 1998, as amended, and shall include, at a minimum, all of the following:* - *commercially-viable forest ecosystems;* - *areas equivalent to the pre-disturbance areas of commercially-viable White Spruce Mixedwood, Deciduous, White Spruce and total Coniferous ecosite phases; and* - *having productivity consistent with TABLE 6.1-B...*"	N/A
1.5.4	Vegetation establishment – ground cover, forbs and shrubs	Gap	*The Guidelines for Reclamation of Forest Vegetation in the Athabasca Oil Sands Region* provide key species indicators and densities for each ecosite type, respective to the ecosite phase (Table 3.4 Planting Prescription by Ecosite Phase).	There is no standard process or method on how to measure and when to measure establishment of upland vegetation comprised of lichens, mosses, forbs or shrubs. There are no standards to determine successful establishment of ground cover, forbs and shrubs. For example: health, vigor,

			or survival timelines to determine 'establishment'.
1.5.5 Canopy structure	Gap	N/A	There are no standards defining acceptable canopy structure to create at time of vegetation establishment.
1.5.6 Aquatic vegetation establishment	Gap	The APEA approval states: "*The plan...shalll comply with Guideline for Wetland Establishment on Reclaimed Oil Sands Leases, 2000, as amended, and shall include at a minimum, all of the following:* - *availability and source of soil and planting materials"* *The Guideline for Wetland Establishment on Reclaimed Oil Sands Leases, 2000 describes indicator vegetation species for wetland types"*.	The gap is that there are no standards as to densities of vegetation or method on how to measure aquatic vegetation establishment. Reclamation criteria and indicators have not been developed.

OBJECTIVE 2 NATURAL FUNCTIONS ARE OCCURRING ON THE RECLAIMED LANDSCAPE

Criterion 2.1 Carbon Cycling			
Indicators:	**Gap or Existing Standard**	**Existing Standard Description**	**Comments**
2.1.1 Soil carbon content (rate of accumulation)	Gap	N/A	There are no accumulation targets for soil carbon content.
2.1.2 Litter, fermenting, humified (LFH) depth development	Gap	N/A	There is no LFH development target or method established for measuring LFH depth development in soils.
2.1.3 Litter accumulation	Gap	N/A	There is no accumulation target or method established for measuring litter accumulation in soils.
2.1.4 Biomass accumulation	Gap	N/A	There is no accumulation target or method established for measuring biomass accumulation on reclaimed land.
2.1.5 Peat accumulation (in peat accumulating wetlands)	Gap	N/A	There is no accumulation target or method established for measuring peat accumulation.

Criterion 2.2 Hydrologic Cycle				
	Indicators:	**Gap or Existing Standard**	**Existing Standard Description**	**Comments**
2.2.1	Water holding capacity	Existing	LCCS	LCCS is used for nutrient and moisture regime.
2.2.2	Depth to water table	Gap	N/A	A monitoring program is required to better understand the hydrology on a reclaimed site.
2.2.3	Rate of flow (recharge/discharge rates)	Gap	N/A	What is the defined monitoring period for rate of flow to determine if wetlands are sustainable?

Criterion 2.3 Nutrient Cycling				
	Indicators:	**Gap or Existing Standard**	**Existing Standard Description**	**Comments**
2.3.1	CNPK	Existing	LCCS establishes minimum standards.	
2.3.2	Foliar analysis	Gap	N/A	The Terrestrial Sub-group (TSG) is working on a sampling process.
2.3.3	Acid deposition (associated with NOx and SO_2 emissions)	Gap	N/A	Sampling intensity and deposition standards are unclear as they relate to reclamation certification.

Criterion 2.4 Self Sustainability				
	Indicators:	**Gap or Existing Standard**	**Existing Standard Description**	**Comments**
2.4.1	Landform sustainability	Existing	The EPEA approval states: "*The approval holder shall construct all structures and slopes to be geotechnically stable with minimal erosion*."	The ERCB requires industry to design and construct landforms to Canadian professional engineering standards. Monitoring is conducted to document acceptable trends to determine a factor of safety.
2.4.2	Erosion (acceptance allowance)	Existing	The EPEA approval states: "The approval holder shall construct all structures and slopes to be geotechnically stable with minimal erosion."	The ERCB requires industry to design and construct landforms to Canadian professional engineering standards. Monitoring is conducted over a number of years to document acceptable trends to determine a factor of safety.
2.4.3	Wetlands and uplands vegetation trend on succession path for target ecosite	Gap	N/A	There are no standards defining health or vigor to demonstrate self sustaining vegetation.
2.4.4	Absence of noxious and restricted weeds	Existing	Absence of noxious and restricted weeds as per by the Weed Control Act	N/A

2.4.5 EPL water balance	Gap	N/A	No standard for water recharge rates to sustain an EPL.
2.4.6 ELP water quality	Gap	N/A	Water quality and toxicity gaps specific to naphthenic acids, potential fish tainting compounds, and PAH's.
2.4.7 EPL biological activity	Gap	N/A	No targets/standards for biological activity in EPL's.
2.4.8 EPL beach stability	Gap	N/A	No standards to define stability requirements, specifically minimum acceptable instability.
2.4.9 EPL toxicity (system)	Gap	N/A	No standards established or determination if surface water quality guidelines apply.
2.4.10 EPL hydrology (stratification and mixing)	Gap	N/A	Gap is whether there are specific design requirements for closure of EPL's that would minimize or mange lake turn-over.
2.4.11 Aquatic biological activity	Gap	N/A	No targets/standards for biological activity in streams.
2.4.12 Water quality	Gap	Industrial waste water guidelines. CCME 2007 Surface Water Guidelines	Water quality standards for discharge are established. Need direction on acceptable water quality standards prior to discharge – for example a wetland designed for water treatment.
2.4.13 Watershed stability (stream banks)	Gap	N/A	No standards for acceptable minimum occurrences of stream bank instability.
2.4.14 Stream toxicity (system)	Gap	N/A	No standards established or determination which water quality guidelines apply.

Criterion 2.5 Biodiversity (ecosite scale)			
Indicators:	**Gap or Existing Standard**	**Existing Standard Description**	**Comments**
2.5.1 Species richness (for represented ecotypes)	Gap	The EPEA approval states: "*The Biodiversity Program… shall include, at a minimum, all of the following:* - *a determination of the technology required to establish best practices for development of biodiversity for a range of target ecosystems through reclamation (such as addressed by the Biodiversity and Wildlife subgroup of the Reclamation Working Group of CEMA);* - *a determination of reclamation coversoil and*	Measures need to be identified for species richness. Need confirmation that biodiversity measurement will be an indicator on a reclamation project scale and if so ensure that the measures are aligned with early succession stages of ecosite development.

		subsoil composition and key species and their roles in supporting the return of biodiversity and native ecosystems in the reclaimed landscape; - *a plan and schedule to monitor and document the return of biodiversity in the reclaimed landscape and to evaluate and compare changes in biodiversity on reclaimed sites and in the region;…"*	Would be beneficial to have a common biodiversity program that is consistent across all oil sands mines rather than each company designing a program as per their approval requirement.
2.5.2 Soil fauna	Gap	Same as 2.5.1	Measures need to be identified for biodiversity in soil fauna.

OBJECTIVE 3 END LAND USE CAPABILITY IS EQUIVALENT TO THAT PRIOR TO DISTURBANCE

Criterion 3.1` Commercial Forestry			
Indicators:	**Gap or Existing Standard**	**Existing Standard Description**	**Comments**
3.1.1 Forest stands of merchantable species are viable	Existing	EPEA approval states "*commercial forest" means land characterized by all of the following:* - *forest stands stocked with trees to meet the standards of a commercial forest as defined in the Alberta Timber Harvest Planning and Operating Groundrules, 2000 as amended;* - *forest stands stocked with native tree species as defined by the Timber Management Regulations AR 60-73 (144.2), 2000 as amended that may include White Spruce, Black Spruce, Jack Pine, Aspen Poplar, Balsam Poplar, Balsam Fir, White Birch and Larch;* - *forest stands not limited by operating restrictions such as slopes steeper than 45 percent, with the exception of tailing sand structures with slopes over 20 percent; stream buffers; potential recreational lakes; stand size; arrangement or accessibility as identified in the Alberta ALPAC Timber Harvest Planning and Operating Groundrules, 2000 as amended"*	N/A
3.1.2 Productivity of forest stands	Existing	The EPEA approval states: "*...commercially-viable forest ecosystems:*	Productivity in the EPEA approval is based on "*Timber Productivity Rating*".

		- *having productivity consistent with TABLE 6.1-B"*	
3.1.3 Area of commercially viable forest stands established	Existing	The EPEA approval states: "*...commercially-viable forest ecosystems:* - *areas equivalent to the pre-disturbance areas of commercially-viable White Spruce Mixedwood, Deciduous, White Spruce and total Coniferous ecosite phases; …*	The EPEA approval requires the pre-disturbance area, categorized by the "*Timber Productivity Rating*", be re-established as a reclamation target.

Criterion 3.2 Wildlife Capability			
Indicators:	**Gap or Existing Standard**	**Existing Standard Description**	**Comments**
3.2.1 Quantity of habitat for candidate species	Gap	The EPEA approval states: "*The Life of Mine Closure Plan … shall address, at a minimum, the following:* - *fish and wildlife habitat as defined by Habitat Suitability Indices (or other habitat assessment tools recommended by the Director) for key species consistent with pre-disturbance capabilities…*"	Pre-disturbance capability is estimated in the EIA's. There are no standards or measures for evaluating what the pre-disturbance capability was compared to the post disturbance reclamation result.
3.2.2 Quality of habitat for candidate species	Gap	The EPEA approval states: "*The Life of Mine Closure Plan … shall address, at a minimum, the following:* *fish and wildlife habitat as defined by Habitat Suitability Indices (or other habitat assessment tools recommended by the Director) for key species consistent with pre-disturbance capabilities…*"	Gap is defining an acceptable monitoring program to follow (modeling or monitoring).
3.2.3 Wildlife usage capability	Gap	The EPEA approval states: "*The Life of Mine Closure Plan … shall address, at a minimum, the following:* *fish and wildlife habitat as defined by Habitat Suitability Indices (or other habitat assessment tools recommended*	The gap is determination of what point in time in the reclamation process that wildlife usage capability exists (acknowledging the succession stages of habitat). Some wildlife capability may not exist for a number of years beyond when reclamation certification would be expected to

		by the Director) for key species consistent with pre-disturbance capabilities…"	occur.

Criterion 3.3 Traditional Use			
Indicators:	**Gap or Existing Standard**	**Existing Standard Description**	**Comments**
3.3.1 Capability for trapping, hunting or gathering	Gap	The EPEA approval states: "*The approval holder shall re-establish moose, fish and other wildlife habitat levels, at a minimum, similar to that which existed prior to disturbance, in proportions appropriate relative to the approved Life of Mine Closure Plan.* *The Revegetation Plan ...shall include...:* - *incorporation of vegetation and vegetation communities of traditional value that are characteristic of the locally common boreal forest…*"	The gaps are there are no measures to apply to determine the capability of a reclaimed landscape for traditional uses.
3.3.2 Medicinal plants	Gap	Same as 3.3.1	Need to define the measurement or monitoring program to determine if medicinal plants are established (and in sufficient quantities).

Criterion 3.4 Other End Land uses			
Indicators:	**Gap or Existing Standard**	**Existing Standard Description**	**Comments**
3.4.1 As defined in the mine closure plan	Gap	EPEA approval states that: "*the closure planning and reclamation landform design shall address:* • *Land uses {recreation (intensive recreation), forest resource, traditional land use, fish and wildlife habitat, miscellaneous uses, commercial/industrial*" The *Fort McMurray – Athabasca Oil Sands Sub-regional Integrated Resource Plan 1996* lists objectives and guidelines for reclamation end land uses.	Require qualitative descriptions (standards) of end land use capability, on a reclamation project basis, which are measureable and achievable within the reclamation time frame.

APPENDIX 2 WORK IN PROGRESS ANALYSIS

The following tables summarize where work in progress within CEMA contributes toward fulfilling a criteria gap. A gap having no existing work aligned with it will identify a potential work plan item to be addressed within the CEMA Reclamation Working Group.

OBJECTIVE 1: ESTABLISH AND INTEGRATE NATURAL FEATURES ON THE RECLAIMED LANDSCAPE

Criteria 1.1 Integrated Landscape				
Indicators	**Existing Standard (E) or Gap (G)?**	**Is work being conducted?**	**If Yes by which group?**	**What stage is the work?**
1.1.1 Landscape connectivity	Gap	Yes	CCTG	Preliminary
1.1.2 Habitat connectivity	Gap	Yes	CCTG	Preliminary
1.1.3 Watershed integration	Gap	Yes	CCTG	Preliminary
1.1.4 Ecosite targets	Gap	Yes – Update to Revegetation Manual.	TSG	Final Stage

Criteria 1.2: Create Natural Landforms				
Indicators	**Existing Standard (E) or Gap (G)?**	**Is work being conducted?**	**If Yes by which group?**	**What stage is the work?**
1.2.1 Representative Topography	Gap	Yes – Guide to the Landscape Design Checklist in the Athabasca Oil Sands Region.	RWG	In Progress
1.2.2 Natural appearance	Gap	Yes – Guide to the Landscape Design Checklist in the Athabasca Oil Sands Region. (The document "*Identify, Characterize, Quantify the Types of Landforms and Landscape Patterns Present in the Regional Municipality of Wood Buffalo", CEMA 2006 is published as a reference.)*	RWG	In progress
1.2.3 Geotechnical Stability Design(landforms)	Existing (Engineered designs)	Yes – work is being conducted on geotechnical stability for EPLs.	EPLTG	In Progress
1.2.4 Design Alluvial Channels and Wetlands	Gap	Yes- CONRAD is working on a guide for alluvial channels	CONRAD	Final stage
1.2.5 Compatibility with proposed ecosite	Gap	Yes – update to Revegetation Manual.	TSG	Final stage

Criteria 1.3: Establish Watershed (Drainage, Lakes and Wetlands)				
Indicators	**Existing Standard (E) or Gap (G)?**	**Is work being conducted?**	**If Yes by which group?**	**What stage is the work?**
1.3.1 EPL littoral zone targets	Gap	Yes - EPL technical guidance document recommendations. CONRAD and ASG addressing this further in terms of indicators for success.	EPLTG, ASG, CONRAD	In progress
1.3.2 Construction of alluvial channels	Gap	Yes - CONRAD is working on a guide for alluvial channels.	CONRAD	Final stage
1.3.3 Watershed size (to supply wetlands)	Gap	Yes - ASG guidelines being field validated by CONRAD	ASG, CONRAD	In progress
1.3.4 Planned fish habitat	Gap	Yes - EPLTG initiating a project in 2009 to address this.	EPLTG	Preliminary
1.3.5 Wetland area targets (by type)	Gap	Yes - A task group has recently been initiated to work on wetland equivalent capability	ASG	Preliminary

Criteria 1.4: Cover Soil Placement				
Indicators	**Existing Standard (E) or Gap (G)?**	**Is work being conducted?**	**If Yes by which group?**	**What stage is the work?**
1.4.1 Thickness	Gap - EPEA Approval sets standards, but there is no standard process or methods on how to measure and when to measure compliance to soil layering conditions	Yes – Best Management Practices task group is preparing a best management practices document on soil salvage and placement by 2010.	BMPTG	In progress
1.4.2 Layering (Cover, sub-soil and overburden)	Gap – same as above.	Yes	BMPTG	In progress
1.4.3 Land Capability Class	Existing – EPEA approval sets land capability class targets.	Yes – TSG is planning to refine the focus of the LCCS to moisture and nutrient regimes primarily, and decouple LCCS from site index.	TSG	In progress

Criteria 1.5: Establish[10] Terrestrial and Aquatic Vegetation				
Indicators	**Existing Standard or Gap?**	**Is work being conducted?**	**If Yes by which group?**	**What stage is the work?**
1.5.1 Species composition and abundance	Gap	Yes – BWTG project to develop a monitoring program for biodiversity indicators is in early stages. Yes – Update to the Revegatation Manual uses number of characteristic species per site type as the threshold for measuring success.	BWTG TSG	In progress Final stage
1.5.2 Native species, genetic similarity	Existing - AB Genetics Manual	No	N/A	N/A
1.5.3 Vegetation establishment – forest stands	Existing - AB Regeneration Standards	No	N/A	N/A
1.5.4 Vegetation establishment -ground cover, forbs and shrubs	Gap	Yes – project investigating the establishment of native shrubs on reclaimed sites.	TSG	In progress
1.5.5 Canopy structure	Gap	Yes – FPTG project developing planting densities based on ecosite and cover class targets Yes – BMPTG likely incorporating direct placement of LFH as a best management practice to support understory canopy development. Yes – Revegetation Manual incorporating planting densities and LFH amendments to support overstory or understory canopy development.	FPTG BMPTG TSG	In progress In progress Final stages
1.5.6 Aquatic vegetation establishment	Gap	No - Work is being conducted but it is not clear if it will support progress towards the gaps identified	ASG	Preliminary

[10] 'Establishment' of vegetation refers to the planting/seeding stage of vegetation establishment. A field survey conducted after a defined time period demonstrates that the vegetation has been established on the site in sufficient quantity (density) as planned and that it is healthy and demonstrates acceptable vigour. This time period is often short-term, being a three to five year period. Beyond the establishment stage, sustainability and reproduction is determined by different criteria.

OBJECTIVE 2: NATURAL FUNCTIONS ARE OCCURRING ON THE RECLAIMED LANDSCAPE

Criteria 2.1: Carbon Cycling				
Indicators	**Existing Standard or Gap?**	**Is work being conducted?**	**If Yes by which group?**	**What stage is the work?**
2.1.1 Soil Carbon Content (rate of accumulation)	Existing - LCCS	No	N/A	N/A
2.1.2 Litter, Fermenting, Humified (LFH) depth development	Gap	Yes – to be incorporated as a measure in the TSG long term monitoring plot network; method to measure LFH to be developed.	TSG	Preliminary
2.1.3 Litter accumulation	Gap	No	N/A	N/A
2.1.4 Biomass accumulation	Gap	No	N/A	N/A
2.1.5 Peat accumulation (in Peat accumulating wetlands)	Gap	Yes - ASG Guide recommends net peat accumulation for peatlands. Net peat accumulation rates to be similar to natural, which we have numbers for. Much new work being done on peatland construction that will field-validate numbers.	CONRAD	In progress

Criteria 2.2: Hydrologic Cycle				
Indicators	**Existing Standard or Gap?**	**Is work being conducted?**	**If Yes by which group?**	**What stage is the work?**
2.2.1 Water holding capacity	Existing - LCCS	No	N/A	N/A
2.2.2 Depth to water table	Gap	Yes	TSG	Preliminary
2.2.3 Rate of flow (recharge/discharge rates)	Gap	Yes - ASG Guide provides guidance on initial hydrological considerations for building wetlands. Current work to validate hydrologic performance of constructed watersheds (CONRAD).	ASG, CONRAD	in progress

Criteria 2.3: Nutrient Cycling				
Indicators	**Existing Standard (E) or Gap (G)?**	**Is work being conducted?**	**If Yes by which group?**	**What stage is the work?**
2.3.1 CNPK	Existing - LCCS	No	N/A	N/A

2.3.2 Foliar analysis	Gap	Yes – to be incorporated as an indicator in the TSG long term monitoring plot network.	TSG	Preliminary
2.3.3 Acid deposition (associated with NOx and SO_2 emissions)	Gap	Yes –work towards establishing environmental capacity guidelines, environmental management objectives	NSMWG	In progress

Criteria 2.4: Self Sustainability				
Indicators	**Existing Standard (E) or Gap (G)?**	**Is work being conducted?**	**If Yes by which group?**	**What stage is the work?**
2.4.1 Landform sustainability (geotechnical failure standard)	Existing	Yes - Geotech task group to recommend EPL geotechnical criteria in 2010	EPLTG	Preliminary
2.4.2 Erosion (acceptable standard)	Existing	No	N/A	N/A
2.4.3 Wetlands and uplands vegetation trend on succession path for target ecosite.	Gap	Yes – developing monitoring program on long-term plot network.	TSG, ASG, CONRAD	In progress
2.4.4 Absence of noxious and restricted weeds	Existing - Alberta Weed Act.	No	N/A	N/A
2.4.5 EPL water balance	Gap	No	N/A	N/A
2.4.6 EPL water quality	Gap	Yes – working on long-term goal towards surface water quality guidelines.	EPLTG, ASG, CONRAD	In Progress
2.4.7 EPL biological activity	Gap	No	N/A	N/A
2.4.8 EPL beach stability	Gap	Yes – Geotech Task Group addressing this.	EPLTG	Preliminary
2.4.9 EPL toxicity (system)	Gap	Yes – working on long-term goal towards surface water quality guidelines. EPLTG working on strategies for water treatment efficiency through modeling (EPL Technical Guidance Document).	EPLTG, ASG, CONRAD	In progress
2.4.10 EPL hydrology (stratification and mixing)	Gap	No – *EPL Technical Guidance Document* (March 2007) is not endorsed by regulators as further research is required.	N/A	N/A
2.4.11 Aquatic biological activity	Gap	No	N/A	N/A
2.4.12 Water quality	Gap	Yes – working on long-term goal towards surface water quality guidelines.	EPLTG, ASG, CONRAD	

2.4.13 Watershed stability (erosion)	Gap	Yes – CONRAD is working on a guide for alluvial channels that will address stability.	CONRAD	Final stage
2.4.14 Stream toxicity (system)	Gap	Yes – working on long-term goal towards surface water quality guidelines.	EPLTG, ASG, CONRAD	In progress

Criteria 2.5: Biodiversity				
Indicators	**Existing Standard (E) or Gap (G)?**	**Is work being conducted?**	**If Yes by which group?**	**What stage is the work?**
2.5.1 Species richness (for represented ecosites)	Gap	Yes. Have natural wetland species richness as target to shoot for. Current BWTG project developing monitoring program and guidelines for establishing biodiversity on reclaimed landscapes.	BWTG, ASG	In progress
2.5.2 Soil fauna	Gap	Yes – BWTG project is in the review stage. Recommendations for evaluating soil biota as indicators on reclaimed sites were presented and current state of knowledge in NE Alberta was summarized.	BWTG	Final stage

OBJECTIVE 3: END LAND USE CAPABILITY IS EQUIVALENT TO THAT PRIOR TO DISTURBANCE

Criteria 3.1: Commercial Forestry				
Indicators	**Existing Standard (E) or Gap (G)?**	**Is work being conducted?**	**If Yes by which group?**	**What stage is the work?**
3.1.1 Forest stands of merchantable species are viable	Existing – *Alberta Timber Harvesting and operating Ground Rules (2000)* and *Timber Management Regulation*.	No	N/A	N/A
3.1.2 Productivity of forest stands	Existing –Timber Productivity Ratings.	No	N/A	N/A
3.1.3 Area of commercially viable forest stands established	Existing – based on pre-disturbance area by *Timber Productivity Rating*	Yes – FPTG project is developing methods to revise the current timber productivity rating tables in the EPEA approval.	FPTG	In progress

Criteria 3.2: Wildlife Capacity				
Indicators	**Existing Standard (E) or Gap (G)?**	**Is work being conducted?**	**If Yes by which group?**	**What stage is the work?**
3.2.1 Quantity of habitat for candidate species	Gap	Yes, however no one addressing this for aquatics. BWTG will issue a RFP to develop a wildlife monitoring program on reclaimed landscapes.	BWTG	Preliminary
3.2.2 Quality of habitat for candidate species	Existing - HSI Index	Yes, however not for aquatics. Current BWTG project is developing a monitoring program for biodiversity which proposes other options for evaluation beyond HSI index.	BWTG, EPLTG	In progress
3.2.3 Wildlife usage capability	Gap	Yes - Same as 3.2.2	BWTG, EPLTG	In progress

Criteria 3.3: Traditional Use				
Indicators	**Existing Standard (E) or Gap (G)?**	**Is work being conducted?**	**If Yes by which group?**	**What stage is the work?**
3.3.1 Capability for trapping, hunting or gathering	Gap	Yes	TSG, ASG	Final stage, In progress
3.3.2 Medicinal Plants	Existing - wetlands Gap - uplands	Yes (info included in ASG Guide). ASG is developing further communication w/aboriginal groups.	TSG, ASG	Final stage, In progress

Criteria 3.4: Other End Land Uses				
Indicators	**Existing Standard (E) or Gap (G)?**	**Is work being conducted?**	**If Yes by which group?**	**What stage is the work?**
3.4.1 As defined in the mine closure plan	Gap	Yes – recreation is included as an end land use in the update to the Revegetation Manual – but mainly identified as being out of scope for the Revegetation Manual recommendations.	TSG	Final stage

APPENDIX 3 GLOSSARY OF TERMS

Referenced from Alberta Environment Glossary of Terms: REPORT#: SSB/LM/02-1

Canopy
The tallest vegetation layer in an area. Overhanging cover, shelter or shade.

Capability (land) *Equivalent Capability/Land Classification*
An evaluation of land performance that focuses on the degree and nature of limitation imposed by the physical characteristics of a land unit on a certain use, assuming a management system. The suitability of land for use without permanent damage. It is an expression of the effect of physical land conditions, including climate, on the total suitability for use, without damage, for crops that require regular tillage, for grazing, for woodland and for wildlife. Land capability involves consideration of the risks of land damage from erosion and other causes and the difficulties in land evaluation owing to physical land characteristics, including climate.

Consolidated Tailings/Composite Tailings (oil sands)
Composite (Syncrude) or consolidated (Suncor) tailings are formed by injecting mature fine tailings from the tailings pond into the regular (whole) tailings sand stream, with a flocculent such as gypsum. This mixture is sent to the tailings ponds to form a non-segregating soil mixture which will result in a trafficable surface in the reclaimed landscape.

Continuous Improvement
The process of enhancing a system to achieve improvement in performance.

Coversoil *Regolith/Surface Soil/Topsoil*
Unconsolidated materials including salvaged surface soil, salvaged Regolith, or selected bedrock spoil used to top-dress spoils to build a better quality minesoil.

Criteria [*plural]*
A category of conditions or processes by which the achievement of a reclamation objective is assessed. A Criterion [singular] is characterized by a set of related indicators which are used to determine success or to assess change over time.

Ecosite
(1) A subdivision of an ecosystem that consists of an area of land with a particular parent material, having a homogeneous combination of soils and vegetation. A Canadian ecological land classification (ELC) system mapping unit, usually mapped at a scale of 1:50 000 to 1:10 000. Originally referred to as a “land type”.
(2) In Alberta, ecosite is defined as an area with a unique recurring combination of vegetation, soil, landform, and other environmental components

Ecosystem
A complex of living organisms and their environment, linked by energy flows and material cycling.

Ecotype
A local ecological race adapted through natural selection to a particular habitat.

End Land Use *Equivalent Land Capability*
The allowable use/s of disturbed land following reclamation. Municipal zoning/approval may be required for specific land uses.

End Pit Lake
A waterbody greater than 2 metres deep which has been created as a result of mining/extraction activities.

Equivalent Land Capability *Capability (land)/End Land Use*
The ability of the land to support various land uses after reclamation is similar to the ability that existed prior to any activity being conducted on the land, but the ability to support individual land uses will not necessarily be equal after reclamation. (Regulatory definition)

Erosion
The wearing away of the land surface by running water, wind, ice, other geological agents, activities of man or animals, and including such processes as gravitational creep. Erosion may be either normal or accelerated; the latter being brought about by changes in the natural cover or ground conditions, including those due to human activity.

Fen *Bog/Marsh/Peatland*
A peat-covered or peat-filled wetland with a high water table that is usually at or above the surface. The waters are mainly nutrient-rich, minerotrophic waters from mineral soils. The dominant peat materials are shallow to deep, well to moderately decomposed fen peat. The associated soils are Mesisols, Humisols, and Organic Cryosols. The vegetation consists dominantly of sedges, grasses, reeds, and brown mosses, with some shrub cover and, at times, a scanty tree layer.

Fibric *Humic/Mesic*
Organic materials containing large amounts of weakly decomposed fibres whose botanical origins are readily identifiable; fibric material has 40% or more of rubbed fibre by volume (or weight of rubbed fibre retained on a 100 mesh sieve) and is classified in the von Post scale of decomposition as class 1 to class 4.

Fine Tailings (Fine Tails, Sludge) *Consolidated Tailings /Tailings*
A term used in the oil sands industry to refer to the material accumulating at the bottom of oil sands tailings ponds. It is a matrix of dispersed clays, fine minerals, residual hydrocarbons, and various contaminants. Note that whole tailings (plant tailings) includes tailings sand which settles rapidly and is used to form tailings dykes.

Goal
The final result or outcome toward which effort is directed.

Guideline *Criteria/Objective/Standard*
A basis for determining a course of action. An environmental guideline can be either:
• procedural, directing a course of action, or
• numerical, providing a numerical value that is generally recommended to support and maintain a specified use.
A numerical concentration or narrative statement recommended to support and maintain a designated use. In contaminant work a guideline is generally derived from the lowest observable effect level (LOEL) obtained from biological tests of chronic toxicity. The LOEL is multiplied by a safety factor to provide for long-term protection of species or uses.

Habitat
The natural environment of an organism.

Habitat Effectiveness
The ability of a habitat to be used by wildlife. Includes the physical characteristics of a habitat.

Habitat Suitability Index (HSI)
The value of habitat for wildlife species is estimated/modeled by relating a species' need for food and cover to structural and spatial attributes of vegetation types within a defined area. The HIS refers to the quality or suitability for a species or species group, and ranges from 1.0 (optimal value) to 0.0 (no value).

Humus
(1) The fraction of the soil organic matter that remains after most of the added plant and animal residues have decomposed. It is usually dark coloured.
(2) Used in the broader sense to refer to forest humus forms (mor, moder, mull).
(3) All the dead organic material on and in the soil that undergoes continuous breakdown, change, and synthesis.

The more or less stable fraction from the decomposed soil organic material, generally amorphous colloidal, and dark coloured.

Indicator
An attribute which can be measured or described and used to evaluate if a criterion has been met.

Land Capability *Capability*
The ability of the land to support a given land use, based on an evaluation of the physical, chemical and biological characteristics of the land, including topography, drainage, hydrology, soils and vegetation.

Landforms
The various shapes of the land surface resulting from a variety of actions such as deposition or sedimentation (eskers, lacustrine basins), erosion (gullies, canyons) and earth crust movements (mountains).

Litter *Duff/Strippings*
The amount of previous year's plant growth left on the soil surface for nutrient recycling.

Littoral Zone
Productive shallow-water zone of lakes, rivers or seas with light penetration to the bottom – often occupied by rooted aquatic plants. The biogeographic zone between the high- and low-water marks.

Measure
A qualitative or quantitative aspect of an indicator; a variable which can be measured (quantified) or described (qualitatively) and demonstrates either a trend in an indicator or whether or not a specific *standard* was met.

Method:
A description of a way, technique, process or procedure for attaining a *measure*.

Merchantable Forest
A forest area with potential to be harvested for production of lumber/timber or wood pulp.

Native Species *Agronomic/Alien/Exotic Species*
A species that is a part of an area's original fauna or flora.

Noxious Weed *Nuisance Weed/Restricted Weed*
A designation in Alberta for weeds that have the ability to spread rapidly and cause severe crop losses and economic hardship. These weeds must be controlled to prevent further establishment and spread.

Nutrient *Essential Element/Macronutrient/Micronutrient*
A chemical that is an essential raw material for the growth and development of organisms.

Objective
A purpose toward which a reclamation effort is directed.

Peat *Amorphous Peat/Brown Moss Peat/Forest Peat*
Material constituting peatlands, exclusive of the live plant cover, consisting largely of organic residues accumulated as a result of incomplete decomposition of dead plant constituents under conditions of excessive moisture (submergence in water and/or waterlogging).

Peatland *Bog/Muskeg*
A generic term including all types of peat-covered terrain.

Reclamation *Rehabilitation/Restoration*
The process of reconverting disturbed land to its former or other productive uses.
All practicable and reasonable methods of designing and conducting an activity to ensure:
(1) stable, non-hazardous, non erodible, favourably drained soil conditions, and
(2) equivalent land capability.
(1) The removal of equipment or buildings or other structures and appurtenances,
(2) The decontamination of buildings or other structures or other appurtenances, or land or water,
(3) The stabilization, contouring, maintenance, conditioning or reconstruction of the surface of land,
(4) Any other procedure, operation or requirement specified in the regulations. (Regulatory definition)

Revegetation
The establishment of vegetation that replaces original ground cover following land disturbance.

Slope
The degree of deviation of a surface from horizontal, measured in a numerical ratio, percent, or degrees. Expressed as a ratio or percentage, the first number is the vertical distance (rise) and the second is the horizontal distance (run), as 2:1 or 200 percent. Expressed in degrees, it is the angle of the slope from the horizontal plane with a 90o slope being vertical (maximum) and 45o being a 1:1 slope.

Species
A taxonomic grouping of genetically and morphologically similar individuals. A group of organisms that actually or potentially interbreed and are reproductively isolated from all other such groups.

Species Abundance
The number of individuals of a particular species within a biological community (e.g., habitat type). Species Composition The species found in the sampling area.

Species Diversity
The number of different species and their abundance. Provides a measure of the variation in number of species in a region, depending on the variety of habitats and resources, and the degree of specialization of the species with respect to the habitats and resources.

Species Richness
The number of different species occupying a given area.

Stability
The resistance of a structure, spoil heap, or a clay bank to sliding, overturning or collapsing. A structure is only as stable as its foundations and those in turn upon the soil or rock on which they are constructed. Soil stability, such as mountain slopes, spoil heaps, and embankments, depends on the shearing strength of the material and that is a function of internal strength and cohesion

Standard
A definite rule established by authority. Environmental standards often take the form of prescribed numerical values that must be met.

Subsoil *Topsoil*

Soil material identified (or described) as B and C in the Canadian System of Soil Classification. The soil material found beneath the topsoil but above the bedrock. Technically, the B horizon; broadly, the part of the profile below plough depth.

Sustainability *Conservation*

The process of managing biological resources (e.g., timber, fish) to ensure replacement by regrowth or reproduction of the part harvested before another harvest occurs.

Tailings *Fine Tailings*

Mineral refuse from a milling operation usually deposited from a water medium.

Topography

The shape of the ground surface, such as hills, mountains, or plains. Steep topography indicates steep slopes or hilly land; flat topography indicates flat land with minor undulations and gentle slopes.

Water Quality *Environmental Quality/Soil Quality*

A measure of the condition of water relative to the requirements of one or more species and/or any human need or purpose.

Watershed *Drainage Basin*

All lands enclosed by a continuos hydrologic-surface drainage divide and lying upslope from a specified point on a stream.