

**A GUIDE TO:
RECLAMATION CRITERIA FOR WELLSITES
AND ASSOCIATED FACILITIES – 2007-
FORESTED LANDS IN THE GREEN AREA
UPDATE**



April 2007

ON-GOING COMMITMENT

The Government of Alberta is committed to working with all affected stakeholders to ensure that guidance and criteria for reclamation practices and endpoints in Alberta are harmonized and that reclaimed sites are productive and equivalent in nature to that of pre-disturbance conditions.

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OVERVIEW

The purpose of this document is to provide guidance on reclamation certification criteria (Forested Lands in the Green Area) for oil and gas wellsites and access roads, and associated facilities such as borrow pits, campsites, and off-site (remote) sumps. Although many of the factors are relevant, it is not intended as a construction guide. This document should, however be considered when planning for oil and gas construction. This guide also applies to oil production sites, and will be in effect until revisions to the 1995 Reclamation Criteria for Wellsites and Associated Facilities have been completed and implemented. ****Please note: Bolded text-boxes in this document indicate documents or elements of an assessment that are required to qualify for reclamation certification.***

At the end of this document is Appendix: Proposed Sampling Design for Forested Criteria Assessment. It is a **proposed** Forested Land use assessment protocol. The procedures outlined in this protocol have not been field tested nor tested for statistical rigour. Further review and testing of this protocol will be conducted throughout 2007 to substantiate if these procedures best satisfy both the intended level of accuracy and the intent of this document. Other valid levels of assessments other than the proposed assessment attached in the appendix that provide the assurances required by the guideline will also be evaluated in requests for reclamation certification. In addition, any improvements or alternative assessment procedures developed by other sub-committees within the Reclamation Criteria Advisory Group in the future will be incorporated where appropriate.

Guide to: RECLAMATION CRITERIA FOR WELLSITES AND ASSOCIATED FACILITIES – 2007-FORESTED LANDS IN THE GREEN AREA UPDATE

1.0 BACKGROUND

Forests provide a wide variety of goods and services for Albertans and Canadians. The conservation and restoration of the ecosystem functions that will support these goods and services is the primary goal of reclamation practices.

The 1995 Reclamation Criteria for Wellsites and Associated Facilities (“1995 Criteria”) is currently under review by a multi-stakeholder Reclamation Criteria Advisory Group (RCAG). This guideline adopts concepts developed through that group’s efforts to be brought into the existing 1995 Forested Lands in the Green Area Criteria to provide enhanced assurances of successful conservation and reclamation. **This guide will be in effect until revisions to the 1995 Reclamation Criteria for Wellsites and Associated Facilities have been completed and implemented.**

Forested Landuse Equivalent Capability: The goal of reclamation is to return a disturbed land to a state of equivalent capability. Equivalent capability for forested landscapes is defined as the condition in which ecosystem processes are functioning in a manner that will support the production of ecosystem goods and services consistent in quality and quantity as present prior to disturbance.

This guide does not place minimums or maximums on assessment variables, rather the guide places emphasis on documenting the conditions of the wellsite and associated facilities in relation to the control conditions and ecosite characteristics. Demonstrating ecosystem functioning is a difficult and complex task. For the purposes of reclamation certification, equivalent capability is assumed to have been achieved where no limitations to normal ecosystem functioning are found. The presence of these limitations is determined through a systematic assessment of the reclaimed site and adjacent landscapes. RCAG recognizes that it is a simplification to assume that a lack of limiting factors equates to a healthy functioning ecosystem.

2.0 SOLUTION

Forested Land reclamation criteria have been developed with an understanding that where forest presently exists, the post-reclamation land use will also be forested. Forested land encompasses any treed land, whether or not the forest vegetation is exploited for commercial ventures. Separate criteria for peatlands (within forested lands) and well pad reclamation techniques are currently being developed by the RCAG group.

1995 Forested Lands in the Green Area Criteria (Section 4.0) Revisited:

3.0 Top Soil Conservation and Reclamation:

Topsoil conservation and replacement in reclamation is key to providing nutrients for plant development and a foundation of re-establishing a functioning ecosystem. Although the 1995 Criteria do not require soil assessment for Forested Lands in the Green Area, there are requirements for conservation and replacement of surface soils.

“Reclamation Criteria For Wellsites and Associated Facilities – 1995 Update” states “...all surface soils must be salvaged and replaced on the site.”

All topsoil must be salvaged. Topsoil is defined as the surface forest floor and all “A horizon” soil (LFH, Ah, Ahe and Ae). If the topsoil depth is less than 15 cm conservation must include the topsoil plus the B-horizon up to a total depth of 15cm unless the B-horizon is considered unsuitable (chemical or physical limitations).

A key principle in salvage and redistribution of topsoil is to not dilute and/or bury the nutrient-rich LFH and A horizons by over or under stripping. Where a thick Ae horizon exists (i.e. >15cm), the intent would be to not dilute the nutrient rich layers (LFH, Ah, Ahe) with the less nutrient rich Ae horizon. However, generally the Ae horizon has better soil physical qualities than the underlying B-horizon. Two lift stripping (LFH, Ah, and Ahe) and (Ae) would ensure all organic rich and texturally valuable topsoil is available for reclamation.

*** Assurances that topsoil has been conserved and redistributed satisfactorily is now required in order for a reclamation certificate to be issued.**

Where there has been no soil disturbance (stripping, compaction, etc), and it is documented, this assurance will not be required. This allowance does not apply to padded locations. *A proposed forested land sampling design follows in the Appendix.*

Padded Locations: Wellsites and any associated facilities that have not had the clay pad removed must comply with the following:

All pads left in place are considered a change in landuse and must be approved in writing by the landowner (ASRD). Receiving approval for pads to be left in place should be considered during the planning and Environmental Field Report (EFR) stage of site development.

- *All accepted pads left in place based on documented change in land use must meet the soils expectations of this guide as well as any approved vegetative requirements.*
- *If a clay pad is to remain un-vegetated based on the documented change in land use (i.e. bale storage, pipeyard, etc) the site will not require soils or vegetation assessment but must be stable, non-hazardous and non-erosive.*

4.0 Landscape Criteria:

The Criteria requires surface and subsurface drainage be consistent with the surrounding landscape, and that the landscape of the reclaimed site does not pose a negative impact to site capability. Research has also indicated that restrictions to water or air movement within the soil profile (vertically and horizontally) are one of the major inhibitors to the establishment of a forest ecosystem. For this reason, newly reclaimed sites must not have any profile restrictions.

Identification of negative impacts to site drainage are done by documenting the presence of restricted soil layers, assessment of surface water flow both on, and off-site, and assessment of subsurface water flow.

Restricted layers: presence of soil layers that restrict vertical water movement can create perched water tables and impact vegetation development and soil. Presence of massive, dense or layered structure (i.e. compacted horizon within the soil profile) or abrupt textural or structural changes are limitations to vertical moisture flow and would normally not be consistent with original or surrounding forest conditions.

*** The presence of restricting layers within 50 cm of the surface is not permitted in a reclaimed soil.**

Assessing soil moisture dynamics is consistent with the 1995 Criteria, where visual indicators of soil moisture dynamics and/or structure that would preclude normal vertical moisture movement are assessed. Presence of these indicators would result in the conclusion that vertical soil moisture processes are likely impaired. Visual indicators of a compacted subsurface layer include those listed as “Water Permeability Restriction Indicators” in the table below.

*** Presence of any of these indicators is to be documented at the assessment time.**

Commonly Observed Indicators of Root, Permeability and Aeration Restrictions.	
<p>Vertical Root Elongation Restriction Indicators</p> <ul style="list-style-type: none"> • Presence of root mats and bunches • Presence of flattened and highly branched roots • Presence of horizontal roots • Presence of exped roots • Presence of soil layers or abrupt texture or structure transitions • Absence of roots within or below reconstructed profile zones • Presence of dense and massive soil structure • Absence of roots within soil aggregates 	<p>Water Permeability Restriction Indicators</p> <ul style="list-style-type: none"> • Presence of surface ponding • Presence of surface vehicle (equipment) ruts • Presence of stratified or abrupt moisture changes within the soil profile • Presence of dense, massive or layered structure (compaction) • Presence of abrupt texture or structure transitions <p>Soil Aeration Restriction Indicators</p> <ul style="list-style-type: none"> • Presence of dense, massive or layered soil structure (compaction) • Presence of reduced pore size and pore space • Presence of distinct or prominent mottles • Presence of sour odours and/or grey-green soil colouration indicative of reduced conditions

4.1 Surface water flow

On-site drainage: Standing water (“ponding”) may be normal depending on pre-disturbance and surrounding landscape (i.e. knob and kettle topography) as well as timing of assessment relative to moisture events (snow melt or recent precipitation). Sites with significant soil compaction; those with sub-surface hard-pans; or those that have been poorly re-contoured often exhibit ponding. Other indicators of ponding include the presence of ‘bathtub rings’, water-loving vegetation types (either alive or recently dead), or lack of vegetation in depressions. Ponding is not necessarily evidence of poor reclamation.

***The presence of on-site ponding must be noted and a rationale provided to show it is consistent with the site’s normal state.**

Direction and dispersion of water on the lease will also help assess if surface drainage has been adequately restored. Ponding is one indication that a site’s water direction and/or dispersion may have been disrupted. Another indicator of disrupted water direction and/or drainage is the presence of erosion on the lease. The use of pre-disturbance air-photos can help establish what “normal” direction and dispersion patterns should be.

*** Direction/dispersion of on-site drainage is assessed visually and confirmed during the assessment to be consistent with pre-disturbance conditions and/or surrounding landscape.**

Off-site drainage (water movement off the lease): The location of a lease may result in drainage patterns being disrupted. Ensuring the surrounding contours are carried into the lease and that landscape features adjacent to it are conserved should prevent a change in pattern of flow from pre-disturbance condition. Similarly, where onsite drainage may serve to collect and re-direct water, off-site impacts are possible. Off-site sediment fans, deposition of organic matter fans, and/or ponding on the up- or down- slope land adjacent to the lease are evidence of off-site impacts to surficial drainage.

*** Assessment of off-site drainage is done visually, with written acknowledgement that off-site lands show no evidence of drainage disruption due to the lease.**

4.2 Sub-surface flow

Cross site drainage: Surface water movement is often more readily apparent than sub-surface flow. However, lease impacts to soil conditions may extend into the immediate subsurface and disrupt water movement.

Pattern of sub-surface flow: Sub-surface water movement is often identified by changes in the health/vigour or type and amount of off-site vegetation and the presence of abnormal off-site ponding.

*** Assessment of subsurface water movement is done visually, with written acknowledgement and supporting evidence that any impacts to sub-surface hydrological patterns (if identified) have not occurred due to the disturbance.**

4.3 Erosion

Gullying – the creation of channels/valleys caused by flowing water - is typically evidence of a problem of excessive water movement and its presence would normally result in the site not being eligible for reclamation certification. Occasionally, gullying may be part of normal processes on certain sites.

*** Where gullying is found, evidence from pre-disturbance and/or similar off-site control areas that would suggest gullying is normally found must be provided to substantiate that the degree, spatial extent, rate and severity of the documented on-lease gullying is consistent with the surrounding area.**

Rilling, pedistaling or presence of off-site soil ‘fans’ are evidence of excessive surface water flow and often result in a loss of the nutrient-rich topsoil. Movement of soil across

the site and especially to off-site areas are significant concerns as these conditions can reduce the productivity of the site. Evidence of small-scale erosion (i.e. movement of materials on the order of centimetres) does not constitute risks to a site's functioning and is therefore not considered as a negative characteristic.

*** Documentation of any rilling or pedistaling or presence of off-site soil 'fans' found on a reclaimed site is required. Also, evidence from adjacent areas or pre-disturbance should be included to demonstrate the scale and amount discovered is 'normal' for the area and that the lease is as stable as the surrounding area.**

Slumping/wasting - mass movement of soil - is not normally seen on most forested sites. If present, it would typically be evidence of inadequate reclamation. Where naturally unstable slopes are encountered, slumping/wasting may be considered normal.

*** Documentation of any slumping and/or wasting found on a reclaimed site is required. Evidence from adjacent areas or pre-disturbance should be included to demonstrate the scale and amount of slumping/wasting seen on-lease is considered normal for the area and that the lease is as stable as the surrounding area.**

Subsidence – the settling of soil in place – is seen as a structural failure in the reclamation efforts and therefore is not normally allowed.

*** Documentation as to the degree and severity of subsidence must be included in the detailed site assessment and justification for acceptance provided.**

4.4 Landscape Operability

Contour - micro (small scale, on the order of cm): Minor variations in topography on reclaimed areas can often enhance conditions that will promote forest vegetation species recruitment, survival and growth. "Obstacle planting" is a common practice in forestry where tree seedlings are planted adjacent to large woody debris or rocks to enhance protection from excess wind or sun and/or to provide a vegetation-free space for plant development. Creation of small elevated sites (on soil ridges) can enhance localized drainage, and increase soil temperature to enhance root development. **Creation of a 'flat' lease during reclamation can often retard vegetation development and is undesirable.**

Contour – meso & macro (medium to large scale in the order of 10 to 100m): Ensuring that a reclaimed site’s meso and macro contours integrate with the surrounding area is important in re-establishing surface water movement. It also helps prevent soil erosion and should be assessed with these factors.

Surface stoniness: Presence of naturally occurring stones within reclaimed areas is assumed to present no significant risks to ecosystem functioning, or normal forested land uses and can often aid in creating small scale roughness to enhance vegetation development. Where excessive concentrations of stones/rocks are present beyond that normally found in the surrounding area, vegetation and soil quality criteria should capture any detrimental effects. The “Gravel and Rocks” criterion as outlined in the 1995 Criteria will be assessed through assessment of soils and vegetation conditions.

Organic debris: As currently stipulated in the 1995 Criteria, coarse woody debris should be spread evenly over the site and may not be piled, windrow or concentrated in one area. As with micro-contours and stones, coarse woody debris can moderate environmental extremes and enhance vegetation development. As it decomposes, woody debris will also contribute to soil litter and organic matter content and provide habitat requirements for smaller species. Excessive fine debris (>10cm depth) such as mulched sites can be detrimental to both soil thermal conditions and plant recruitment. Excess debris may require windrowing or other forms of accumulation within the lease or disposal.

*** Where there is excessive >10cm debris accumulation, it must be documented and rationale must be provided. Documentation must indicate how any potentially negative effects on soil thermal properties and/or vegetation development have been (or will be) addressed.**

Managing fuel risks for wildfire threats must also be considered where accumulation techniques are practiced, particularly in areas near settlements.

5.0 Vegetation Criteria:

One of the primary objectives of reclamation in green areas is re-establishing a forest ecosystem. In the past, species were planted in an attempt to meet the default 80 per cent cover requirement of the 1995 Criteria. Observations have found that this approach is often detrimental to forest development. The following references provide direction on best management revegetation practices:

- *R&R/ 03-03: Revegetation Using Native Plant Materials: Guidelines for Industrial Development Sites*
- *R&R/ 03-04: Weeds on Industrial Development Sites: Regulations and Guidelines*

- *R&R 03-06: Sites Reclaimed Using Natural Recovery Methods: Guidance on Site Assessment*
- *Native Plant Revegetation Guidelines for Alberta*, February 2001; AAFRD.
- *Standards for Tree Improvement in Alberta* ASRD, July, 2005. (seed zone requirements for tree seedlings)
- *Field Guide to Ecosites of: West-central Alberta; Northern Alberta; and Southwestern Alberta*; Natural Resources Canada, Canadian Forest Service, Northern Forestry Center, Edmonton, 1996; UBC Press

Prior to revegetation of reclaimed sites, the operator should contact the applicable Forest Management Agreement (FMA) holder (where applicable) and Alberta Sustainable Resource Development to discuss proposed revegetation plans. FMA holders have extensive local knowledge in soil, site and vegetation that may aid in cost effective and appropriate revegetation of leases.

The following clarify vegetation criteria expectations:

Plant Community/Diversity: Forest vegetation is characterized by the presence of a variety of species and plant sizes. A mixture of both woody and herbaceous species indicates development of forested conditions and can help prevent the dominance of a single species that might slow vegetation growth (i.e. heavy grass cover). A diverse plant community will also help re-establish nutrient cycling as well as support forest ecosystems and habitat.

*** The presence of a sub-set of woody and herbaceous species from target (control) forest types is required and a list of the species present on site must be included in the documentation.**

Natural Resources Canada published a series entitled “*Field Guide to Ecosites of.*”, which provides species lists for mature forest types for Northern, West-Central and Southwest Alberta.

*** The presence of a community of native forest species is evidence of re-vegetation of species compatible with the target (original/control) forest type, as required in the 1995 Criteria.**

Structure; Layers: A properly reclaimed site should contain both the presence of herbaceous and woody species that are distributed across the site. Complete colonization of a site by herbaceous vegetation (i.e. grass) can preclude the recruitment of shrubs and/or trees due to the lack of appropriate micro-sites. Preventing aggressive herbaceous colonizers that could inhibit or preclude the recruitment and/or development of the target forest community is desirable. If provided space to establish, larger stature species

(woody shrubs and tree seedlings) will eventually out-grow the herbaceous vegetation and reduce their extent on the site.

*** A minimum of two layers (herbaceous and woody) of vegetation compatible with the target (control) forest that is reasonably distributed over the lease is required to be present and must be documented.**

5.1 Vegetation Quantity

Historically, reclamation of forested lands has focused on the development of rapid vegetation growth (e.g. grass or forage) in order to satisfy the requirement for minimum cover, and to retard erosion. This guideline focuses on the use of appropriate species that provide cover and retard erosion but also help the recovery of the forest ecosystem.

Where structural impediments to erosion (i.e. surface roughness, adequate vertical water flow) are in place, a greater variety of species can better facilitate the redevelopment of a forested plant community. The actual amount of cover is a function of both the timing of the assessment and the target forest community. Rather than a minimum cover value as a measure of equivalent capability, evidence of a reasonable spatial distribution of vegetation together with documentation of the growth (i.e. expansion and/or increase in size) will provide evidence that vegetation is developing towards the desired end forest type. Evidence of growth also provides assurances there are no significant site limitations that could preclude woody plant growth and development.

*** It is proposed that woody plant growth should be assessed using measures of shrub crown expansion (amount of current growth vs. previous growth using bud scale scars). For trees, assess growth of the leader (main stem) for multiple years based on the length of the current and past year's terminal growth using bud scale scars (Appendix A) This is a one-time assessment.**

Where growth is found to be lacking (relative to other similar sized vegetation for similar time periods) the presence of site stress conditions is likely. Stress conditions may occur where evidence of poor growth is not linked to inadequate site conditions alone, but to heavy wildlife and/or domestic animal browsing or drought conditions. Where browse and/or weather related stress can be directly linked to a failure to attain necessary growth targets, documentation must be included within the detailed site assessment.

5.2 Quality

Vegetation health or quality is partially assessed with the 'growth' criteria above, and also through a visual assessment of "health." Onsite vegetation should not appear chlorotic (yellow), as this is often an indication of poor plant health or severe limitations caused by poor soil/site conditions (excessive surface soil moisture, compacted subsoils, lack of adjacent organic matter). Localized chlorosis within one area of a lease may

indicate localized site limitations. Widespread chlorosis may be indicative of significant site limitations or plant response to severe weather conditions (i.e. drought).

*** Plant vigour (e.g. chlorotic vegetation) must be documented as to the severity and spatial extent.**

5.3 Undesired Plants

Restricted Weeds as designated in the *Weed Control Act* must be eliminated. Sections 31 of the *Weed Control Act* states:

31 *An occupant of land, or if the land is unoccupied, the owner of the land, shall as often as is necessary*

(a) destroy all restricted weeds located on the land to prevent the spread, growth, ripening or scattering of the restricted weeds,

The presence of Noxious Weeds as designated in the *Weed Control Act* (or by the local municipality) can be no more abundant than in representative controls. Non-native species are to be used only where their benefits to site properties are known and the species are part of a plan to improve and/or stabilize a site. These species may not be persistent and must not contribute to the vegetation criteria. For example, use of agronomic annuals for early erosion control is an appropriate use of non-native species.

5.4 Vegetation Over-ride

The proposed changes to the *1995 Reclamation Criteria for Wellsites and Associated Facilities* are largely aimed at future development and ongoing reclamation. Historical practices may preclude the ability to meet some of these criteria on older sites. For old sites, where appropriate vegetation reestablishment is evident, criteria in this document may not be applicable. The concept of a vegetation over-ride has been carried over from the 1995 criteria document and its applicability to a particular lease must be approved in writing by the landowner (ASRD). Where reasonable forest cover (amount, species and distribution) is present, and where activities to meet the conditions described in this guideline may risk existing ecosystem functioning, a vegetation over-ride may be appropriate. Vegetation override criteria, however, must establish that equivalent capability for forested landscapes has been achieved.

6.0 Assessment Locations and Protocol

For the purposes of this document, assessment locations detailed, cursory and controls (Appendix) consist of a localized area of 2 m diameter.

The procedures outlined in the proposed *Sampling Design for Forested Criteria Assessment* have not been field tested nor tested for statistical rigour. Further review and testing of this protocol will be conducted throughout 2007 to substantiate if these

procedures best satisfy both the intended level of accuracy and the intent of this guideline.

7.0 Implementation

A) Sites that have been constructed **after** the release of this guideline will be required to comply with all aspects outlined in this document.

B) Sites that have been abandoned and/or reclaimed* **after** release of this guideline shall be assessed as follows:

- Sites that were constructed after April 30, 1994 and prior to release of this document are expected to comply with all aspects of this guideline. Where extenuating conditions exist, topsoil justifications may be accommodated upon written request.
- Sites constructed prior to April 30, 1994 are expected to comply with all landscape and vegetation components of this document and are encouraged but not required to comply with soil expectations.

C) Sites abandoned and/or reclaimed* **prior** to release of this guideline shall be assessed as follows:

- Sites constructed after April 30, 1994 are expected to comply with the soils and landscape components (extenuating soil situations may arise) and encouraged but not required to comply with the vegetation expectations.
- Sites constructed prior to April 30, 1994 are expected to comply with all landscape components of this document and are encouraged but not required to comply with soils and vegetation expectations.

D) Sites that have been assessed prior to release of this guideline and have been shown to meet the requirements of the 1995 Reclamation Criteria are eligible for a reclamation certificate under the 1995 Reclamation Criteria and can continue to be submitted until December 31, 2007.

** Reclaimed in this situation refers to sites that have had site re-contouring, soil replacement and seeding completed.*

If soils have not been disturbed (stripping, compaction, etc) and all other criteria have been met, assurances of soil conditions will not be required.

This document will be in effect until revisions to the 1995 Reclamation Criteria for Wellsites and Associated Facilities have been completed and implemented.

8.0 Evaluation Period

Following a period of 12 months after the release and implementation of this guideline, an evaluation will be completed of submitted assessments and further clarification will be provided regarding what constitutes acceptable assurances.

9.0 Reclamation Audits

Alberta Sustainable Resource Development land managers will perform surface audits on sites that have received a reclamation certificate. Land managers may not complete a full site assessment (as outlined in the Appendix) but will focus on expectations outlined within this guideline.

Appendix

“Proposed” Sampling Design for Forested Criteria Assessment: 2007 Forested Lands in the Green Area Update

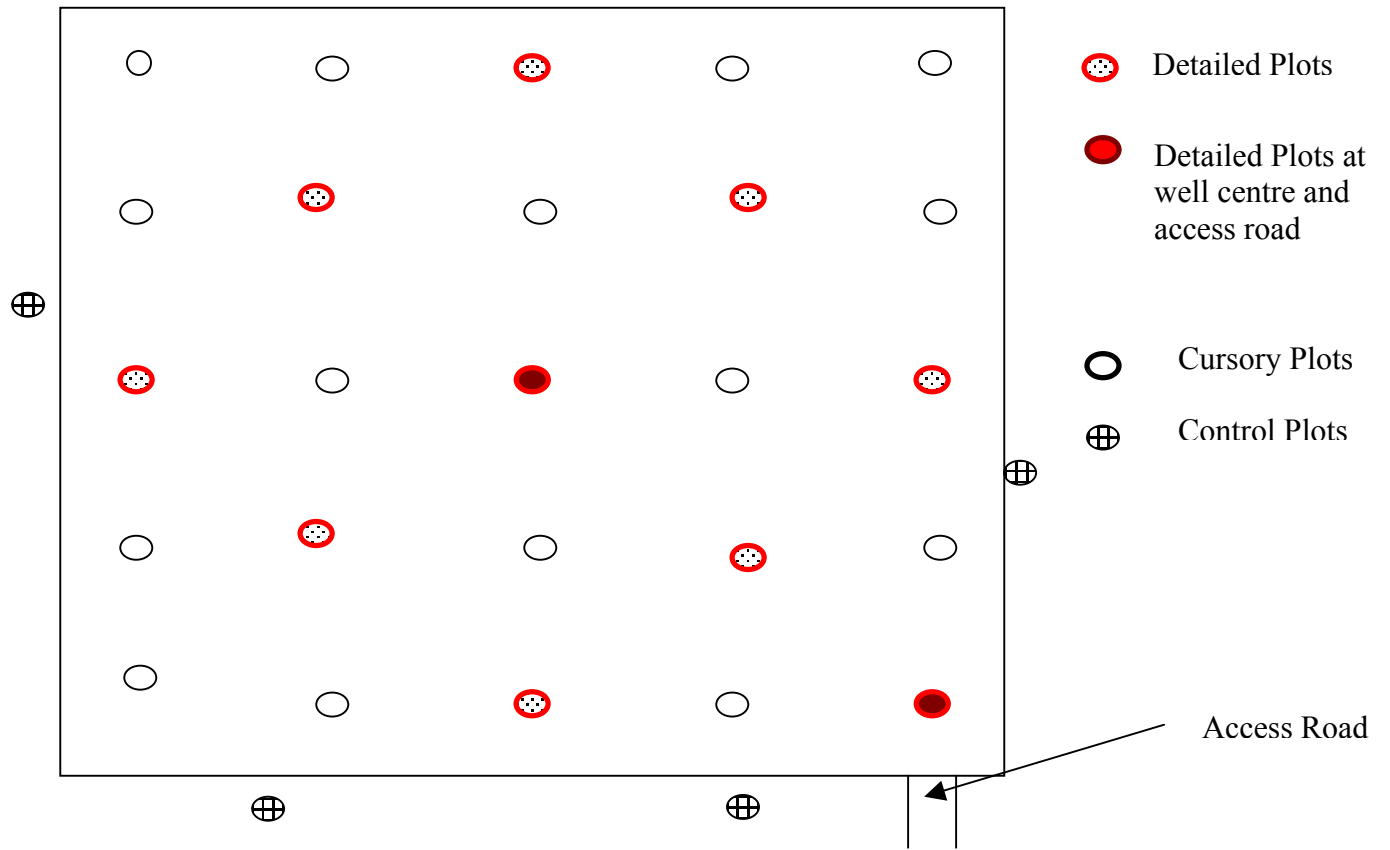
This is a **proposed** Forested Land use assessment protocol. The procedures outlined in this protocol have not been field tested nor tested for statistical rigour. Further review and testing of this protocol will be conducted throughout 2007 to substantiate if these procedures best satisfy both the intended level of accuracy and the intent of this document. Other valid levels of assessments other than this proposed assessment that provides the assurances required by the guideline will also be evaluated in requests for reclamation certification. In addition, any improvements or alternative assessment procedures developed by other sub-committees within the Reclamation Criteria Advisory Group in the future will be incorporated where appropriate.

A ‘risk-based’ sampling approach has been taken in the “Forested Lands in the Green Area” detailed site assessment requirements. The number of assessment points is limited and concentrated to the areas likely to have been subjected to the greatest impact. This approach assumes that if limiting factors at these heavily impacted points cannot be determined, there is a significantly less chance of these limitations occurring in other locations of the lease.

Two approaches have been developed to help balance cost and rigour of assessments (Figure 1). “Detailed” assessment points are strategically located where soil and detailed vegetation data are collected. Interspersed between these points, “cursory” assessment points are located where presence/absence data is collected but no detailed measures are conducted. The detailed points provide the basis for determining if limiting conditions exist, while the cursory points provide data to describe spatial distribution of characteristics.

Assessment locations are intended to be small localized areas (2m diameter) rather than point locations.

Figure 1. Assessment plots for wellsite and other rectangular features:



Plot layout:

Rectangular Leases:

With the exception of the well-centre and access road points, all other assessment locations should be systematically placed on a grid (**30x30m**) that samples across the entire lease area (Figure 1). Assessment points should be offset from the lease boundary by several metres to ensure the effective lease area is appropriately sampled.

The well-centre plot should be as close to the wellbore location as possible to assess the reclamation conditions at this heavily affected location. Similarly, the access road plot should be placed to assess conditions at the point where expected high levels of traffic impacts are likely to impact on the site.

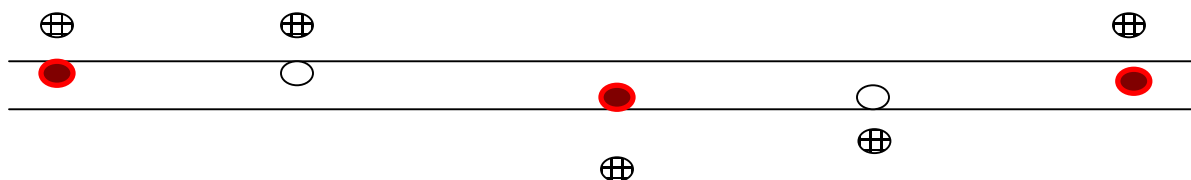
Cursory plots are to be located mid-way between each detailed plot. These plots serve as vegetative assessment and soil presence/absence locations only (see Figure 1).

A minimum of four control points should be located outside the lease boundary in areas that are representative of the pre-disturbance forest condition. Care must be taken to ensure that control points are appropriately representative. Use of aerial photography from pre-disturbance conditions, local knowledge of the site/area, and an understanding of site variability should be used to select these points. Generally, the four control points should be distributed evenly around the lease unless there is evidence that adjacent areas are of a differing condition than the lease area. Control points are meant to be in areas with minimal to no impact during lease activity. Where control points are placed differentially than on the four margins of the lease, a description of how and why the control points were selected must be included.

Linear Leases (roads):

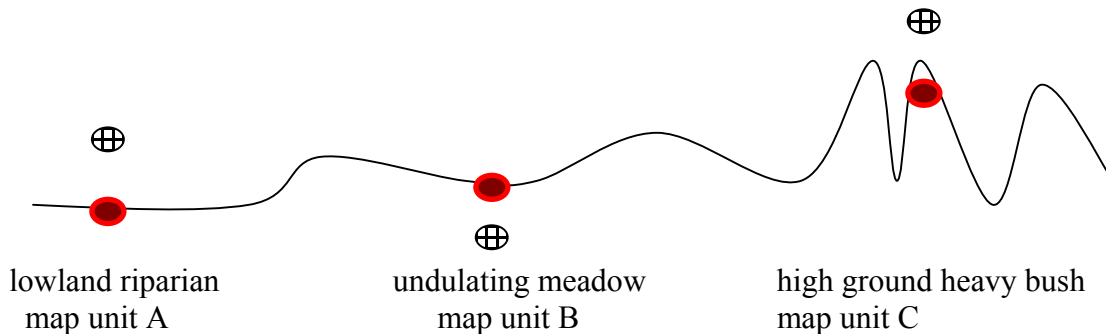
Assessment of linear leases poses additional limitations in that the spatial distribution of both the control and on-site assessment points must address variability in site conditions. Use of assessment points randomly located within the lease width and periodically along the lease length can compensate for the anticipated variability. On-site and off-site plots should be paired (to control variability) and plot location should be placed to ensure the plot is entirely within either the disturbed or control areas. For access roads of less than 400m, location of detailed plots within the lease should be every 100m and cursory plots every 50 m (Figure 2).

Figure 2. Plot location on linear leases (<400m length)



For access roads of greater than 400m, it is proposed that an assessment scheme recognizing distinctly different units: i.e. topographic, vegetation and/or soils variability (as per the AENV “2001 Draft Reclamation Assessment Criteria for Pipelines”) be used (Figure 3). Under this scenario differing map units must be identified within the assessment document. The minimum number of detailed plots is 1 per 800m. The detailed plot location must be representative of the area under investigation. Selection of this location requires knowledge, experience and common sense and must be justifiable.

Figure 3. Plot location on linear leases (>400m length)



Detailed Plot Assessments:

Controls: Soil assessments should be conducted on each of the 4 control plots. Determinations of soil physical properties (i.e. compaction and soil structure) and topsoil depth should be assessed at each control plot to determine both quantity, including spatial distribution requirements, and quality.

Vegetations assessments at control locations are intended to identify the target community, ecosite and community variability.

Soils: Soil assessments should be conducted on each of the nine detailed plots. Determining physical properties of soil (i.e. compaction and soil structure) may be restricted to the well-centre and access road locations as appropriate. Additional soil assessments may be carried out at other locations as necessary to provide sufficient assurance of soil condition. Topsoil depth should be assessed at each detailed plot to determine quantity, including spatial distribution requirements, and quality. *Topsoil depth estimation may be most effectively assessed immediately after topsoil redistribution rather than at the time of site assessment, however, use of a 2m-plot size should overcome problems where topsoil has been disturbed due to site rehabilitation techniques (plowing).* Current soil compaction rehabilitation recommendations are for deep ripping/tillage of the site. Rooting depth, root morphology and soil water permeability assessments must be made at the well-centre and access points at the minimum, and are highly recommended at all nine detailed plots. *If soils have not been disturbed (stripping, compaction, etc) soils assessment will not be required. This does not apply to padded locations.*

Vegetation: Vegetation assessments are to be carried out at each detailed plot.

- A listing of dominant herbaceous and wood species, cover of each of herbaceous and woody species groups, presence of layers (wood and herbaceous) and assessment of woody and tree growth (vegetative performance indicator) should be carried out at each location in addition to a visual assessment of plant health.
- The three dominant (by per cent of vegetation cover) herbaceous species are to be recorded in addition to all woody species (identification to the genus may be sufficient).
- Cover estimates of each of the three dominant herbaceous species together with a total herbaceous species cover estimate is to be taken. A total per cent cover of all woody species combined is also to be recorded (shrubs only). The number of tree seedlings present by genus is also to be recorded.
- Tree growth indicators of leader increment for the past two years (length of the current and past year's terminal growth using bud scale scars) should be documented/assessed. Assess and document the occurrence and extent of browse if it occurs. Woody shrub's average current years branch growth (using budscale scars) are to be recorded on the dominant species present on each plot.
- Visual indication of poor health (chlorosis or very limited amount of foliage) should also be noted.

Landscape Characteristics: Landscape parameters, surface and sub-surface water flow, erosion, and landscape operability are to be assessed by examining the site as a whole. Documentation of the presence or absence of these parameters must be included in the assessment report.

Cursory (visual) Plot Assessments:

Soils: The presence or absence of topsoil is to be recorded at each cursory plot. No other soil measurements are required individual cursory plots unless the assessor suspects poor soil conditions and requires documentation of the conditions at a cursory plot location. *If soils have not been disturbed (stripping, compaction, etc) soil assessment will not be required. This does not apply to padded locations.*

Vegetation: Three vegetation variables are to be recorded for each cursory plot:

- 1) the presence or absence of herbaceous vegetation, and
- 2) the presence or absence of woody vegetation, and
- 3) the number of tree seedlings found.