SOP Title: FO-SOP 18 Determining Soil Disturbance Area

Although, this procedure may be used as a "point in time" inspection, the application of this SOP shall be within the scope of the

I. approved forest management plan and silviculture strategy if applicable;
II. operating ground rules;
III. approved values, objectives, indicators and targets table (if applicable); or
IV. approved FHP, AOP and amendments

The inspecting officer must review these documents and understand the exact obligations of the disposition holder prior to carrying out formal soil disturbance surveys.

Purpose:

A. To define a method that quantifies soil disturbance when conducting forest operations inspections. This protocol applies to forest sites after ground disturbing management activities for physical attributes that could influence site resilience and long-term sustainability.

B. To define a method to measure cut block road widths when conducting forest operations inspections and investigations. This portion does not address right of way width, this would be assessed the same as a harvest area boundary.

Note: In the assessment methods for soil disturbance, site preparation should not be used as an excuse to operate under adverse ground conditions. In other words, critical soil properties can be impacted by site preparation prime movers and/or implements.

Definitions:

Adverse ground conditions – conditions where operations or activities result in environmental damage (i.e. rutting, erosion, siltation). Adverse ground conditions varies across the landscape based on weather, site conditions and the nature (scale/intensity) of the activity.

Ruts – refer to applicable OGR definition

Rutting – refer to applicable OGR definition

Soil displacement - The lateral movement of mineral soil by moving equipment and logs. Displacement includes excavation, scalping, exposure of underlying materials, and burial of more fertile surface soils. Three effects of displacement can compromise soil productivity and site hydrology: (1) exposure of unfavorable subsoils (dense, gravelly, or calcareous with high pH); (2) redistribution and loss of nutrients; and (3) alteration of slope hydrology, which can lead to the hydrologic effects.

Soil disturbance - Any disturbance that changes the physical, chemical, or biological properties of the soil. Soil disturbances of concern to forest managers include compaction, puddling, rutting, organic matter and topsoil displacement, and disruption of soil drainage. Soil disturbance results from construction of access roads, bared landing areas, temporary roads or displaced soil.

1.0 Soil Disturbance Area

Timing of this inspection should be considered. Assessment of displaced soil and debris piles can be completed at any time, but the inspector must be aware that under certain instances of soil disturbance cannot be measured, or will be difficult to measure depending on the block stage (e.g., whether road reclamation has occurred)

1.1 Assessment Procedure

Often an ocular assessment is sufficient to determine that a soil disturbance is within acceptable (or approved) limits. In many cases, it will not be necessary to complete all of the measurements, as~~for example~~ there may be no rutting or landings to measure.

However, the “field sampling” measurement procedure is applied when the extent of disturbance appears to exceed what has been approved. Visual cues can include areas susceptible to rutting, concentrated skid trails, evidence of activity when soil conditions are (were) saturated, road widths appear to exceed what was approved. These visual cues can also be used in conjunction with one or more tangible measurements (road width actual, bared areas, or multiple ruts) to determine if a full “field sampling” measurement is required.

In cases of exceptional variability and large size of disturbance, disturbed areas can be measured using hand held Global Positioning System (GPS).

1.2 Field Sampling

When ocular assessments are completed and the inspector deems it necessary to further evaluate the extent of soil disturbance, the following sampling methodology and field measurements are followed.

1.2.1 Temporary Roads

Note: Inspectors can also assess the road classification independently without including it as part of the soil disturbance. This would be a specific process to determine appropriate road classification and construction as per the relevant OGRs. Comments or issues arising would fall under the “Roads” category on the FOM form.

To determine the area of temporary roads an average width should be obtained by measuring the width at a regular interval, such as every 100m. The measurement interval can be measured off of a vehicle odometer, from a hip chain/topofil or GPS. Width measurements are taken to the nearest 0.5m using a logger’s, carpenter’s, or other tape measure.

For roads measured prior to reclamation activities, the *road surface* and ditches are included in the width measurement. Displaced soil or strippings are not included in the width measurement.

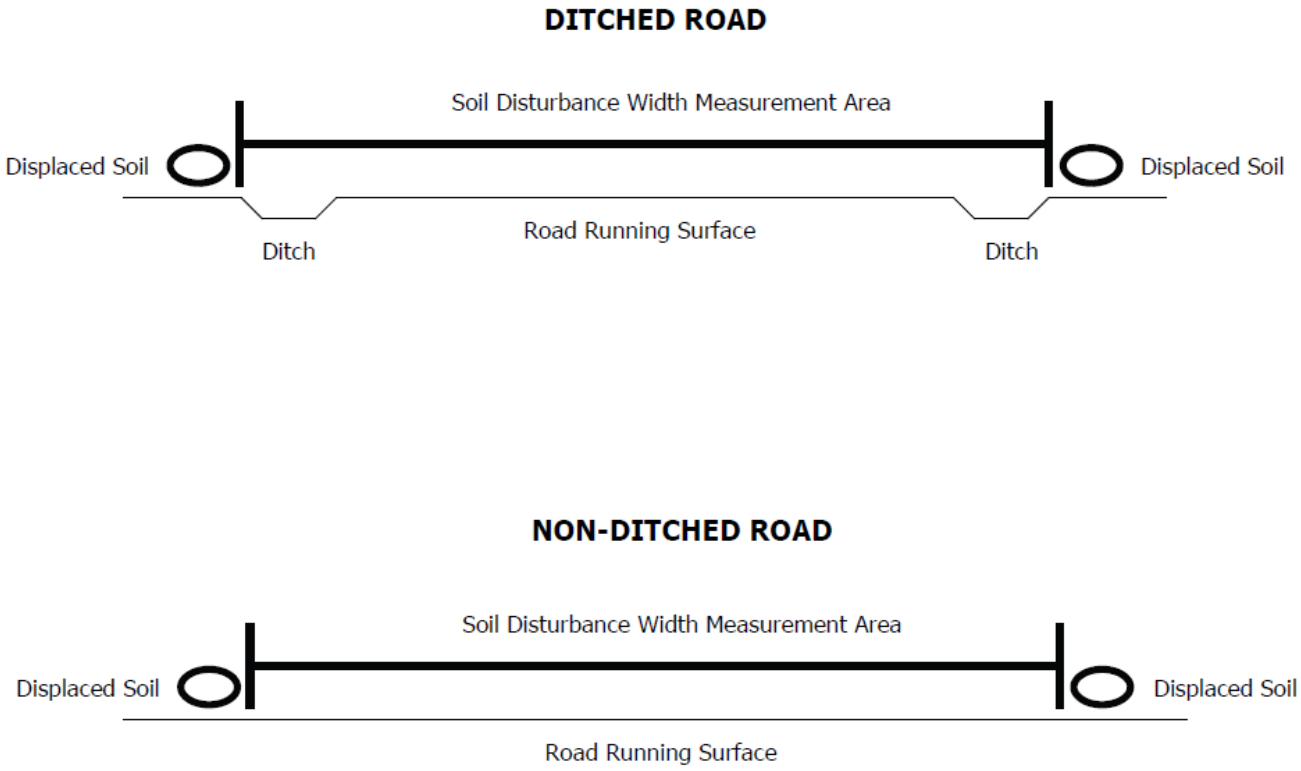

Figure 1. Measuring soil disturbance from “ditched” and “non-ditched” roads.

If surface soil (topsoil) has been removed exposing subsoil, this area would be included in the width measurement. Abnormal widening of the road such as pull outs and large intersections should not be measured when determining the average width. They should be measured separately, as for a landing, and added to the total area.

For roads measured after reclamation activities, areas in which surface soil has been removed exposing subsoil would be included in width measurements. This would include the reclaimed road surface, ditched areas, and areas disturbed during the rollback of displaced soil.

Road lengths can be determined in the same manner as the width measurement interval indicated above, or else measured off an accurate map. This length is

multiplied by the average width to determine the area of disturbance from temporary roads.

1.2.2 Bared Landing Areas

Landings are bared areas where trees are decked and processed in preparation for hauling. "Bared" indicates that this does not include undisturbed areas where trees are decked and processed, such as ground adjacent to roads in roadside harvesting operations. Areas adjacent to roads that have been stripped of topsoil for reasons other than decking and processing wood, such as pull outs and temporary campsites, would also be measured as disturbance.

The area of landings is determined by measuring their length and width and multiplying the two. Measurements are made from a hip chain/ topofil, GPS or surveyor's or logger's tape. Landings are seldom perfectly square or rectangular so it will often be necessary to "cut and paste" or "square off" to estimate appropriate dimensions. This involves assigning regular dimensions to an irregular shape. When doing this you estimate that the undisturbed area included within these regular dimensions is equal to the disturbed area excluded (see Figure 2.). As for roads, any displaced soil not reclaimed, or areas with topsoil removed by reclamation, would be included in the disturbed area.

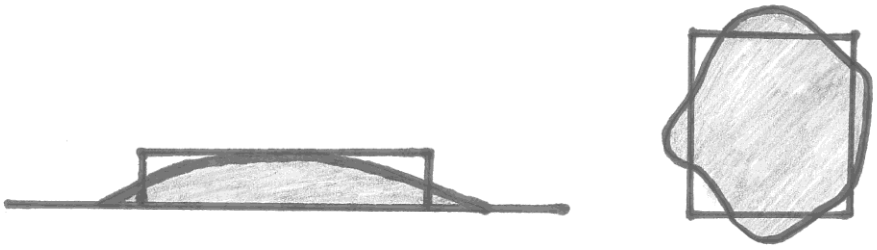

Figure 2. Examples of "cut and paste" or "squaring off". Area of pull out on left, debris pile on right would be calculated based on dimensions of regular polygon projected around them.

1.2.3 "In Block" Soil Disturbance – Non-transect Areas of Soil Disturbance

Any known areas of soil disturbance that are mappable (minimum 10 metres X 10 metres or 0.1 ha) or can be measured with a GPS, can also be applied to the total soil disturbance (recorded under "D." on Soil Disturbance Tally Sheet - FO FORM 18). Examples include but are not limited to: concentrated areas of rutting, 0.1 ha of confirmed soil compaction, 0.1 ha of slumping ground,etc.)

1.2.4 “In Block” Soil Disturbance – Number of Plots to EstablishThe proposed sampling protocol for monitoring forest soil disturbance within the cut block follows the “**Systematic Transects with a Random Start**” procedure. The protocol involves the following steps, as illustrated in **Figures 3a through 3c**.

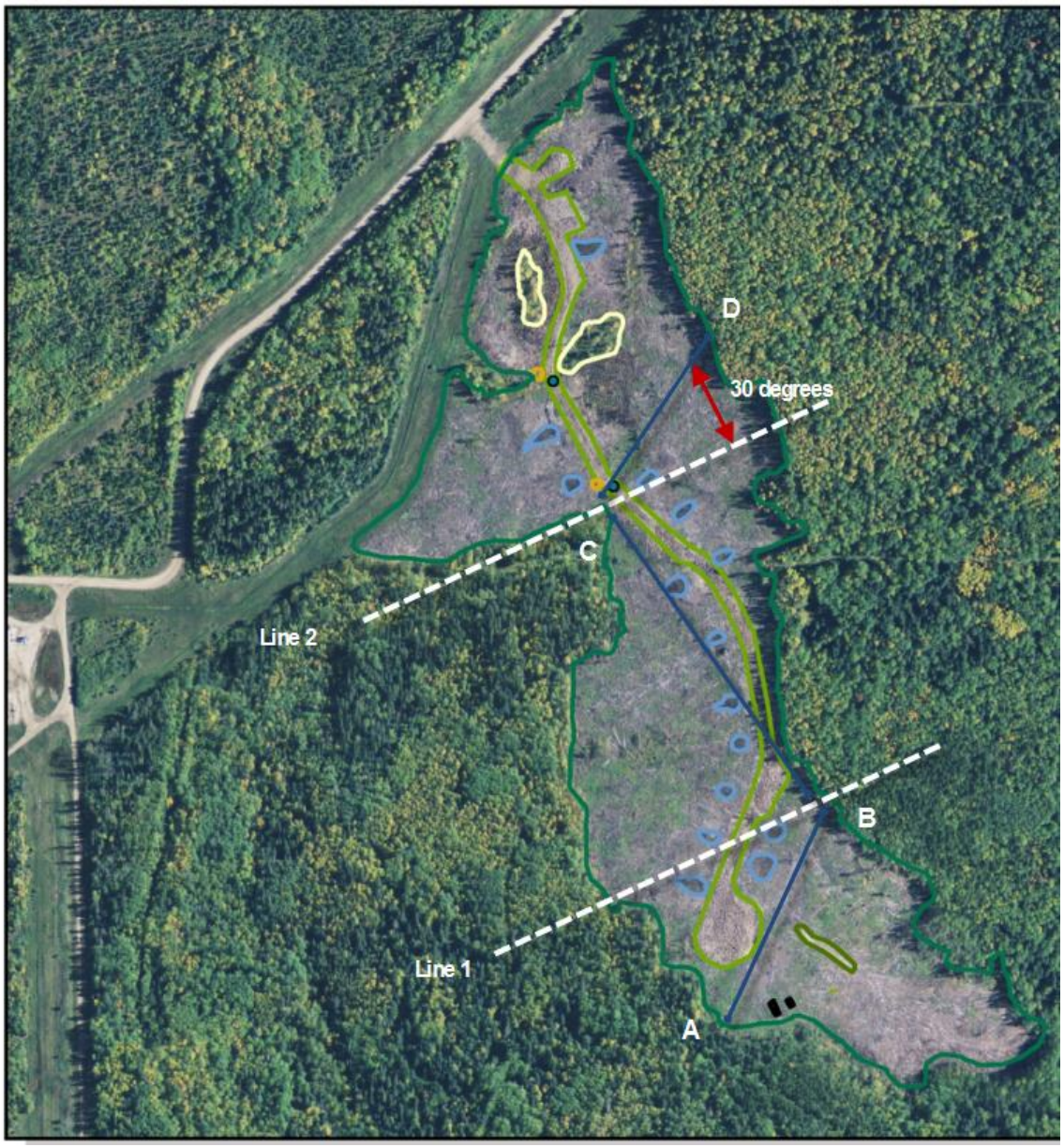

Figure 3a. An illustration of the sampling protocol for monitoring forest soil disturbance.

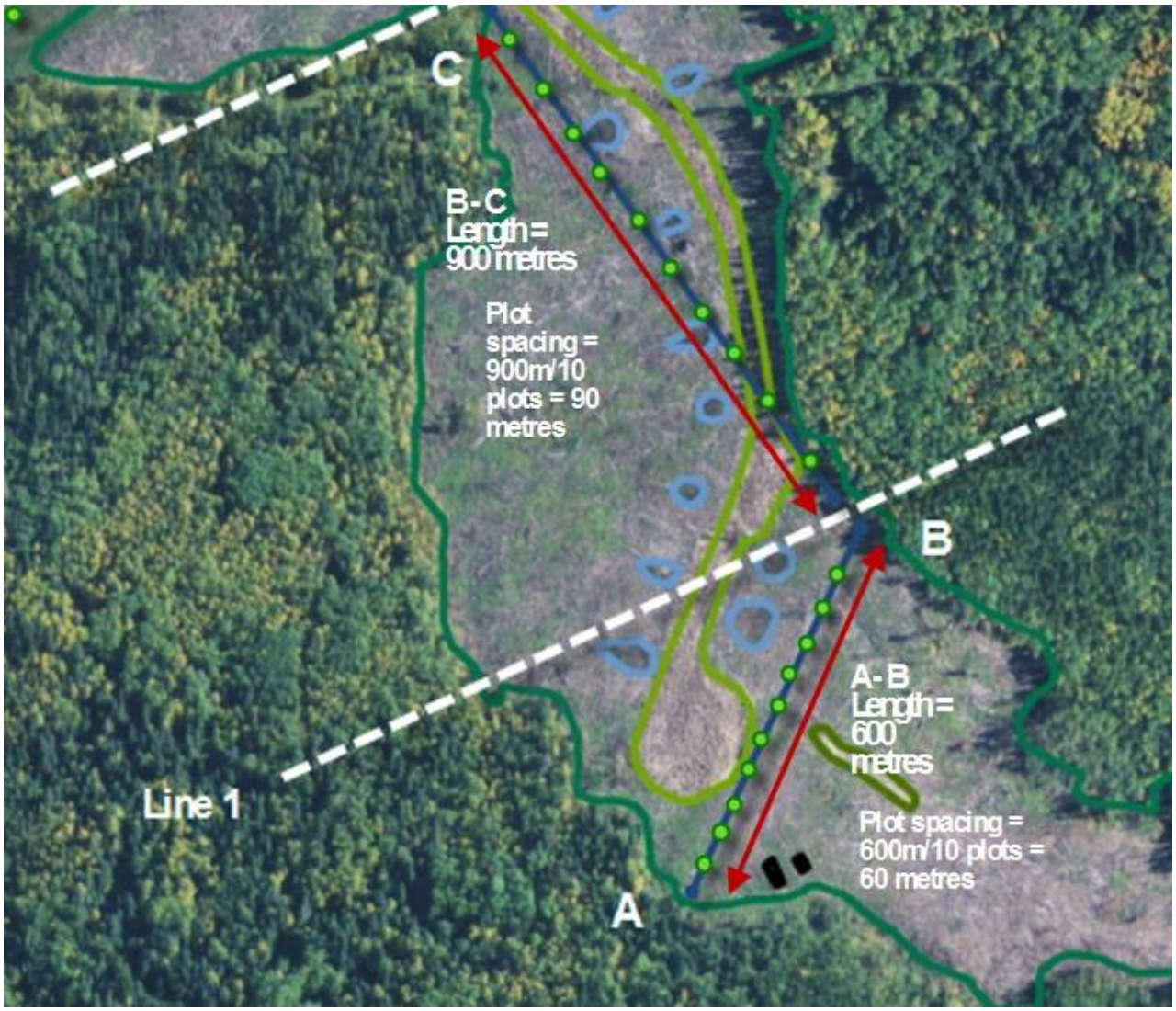
C
B-C
Length=
900 metres
Plot
spacing =
900m/10
plots = 90
metres
B
A-B
Length=
600
metres
Plot spacing =
600m/10 plots =
60 metres
Line 1
A

Figure 3b.

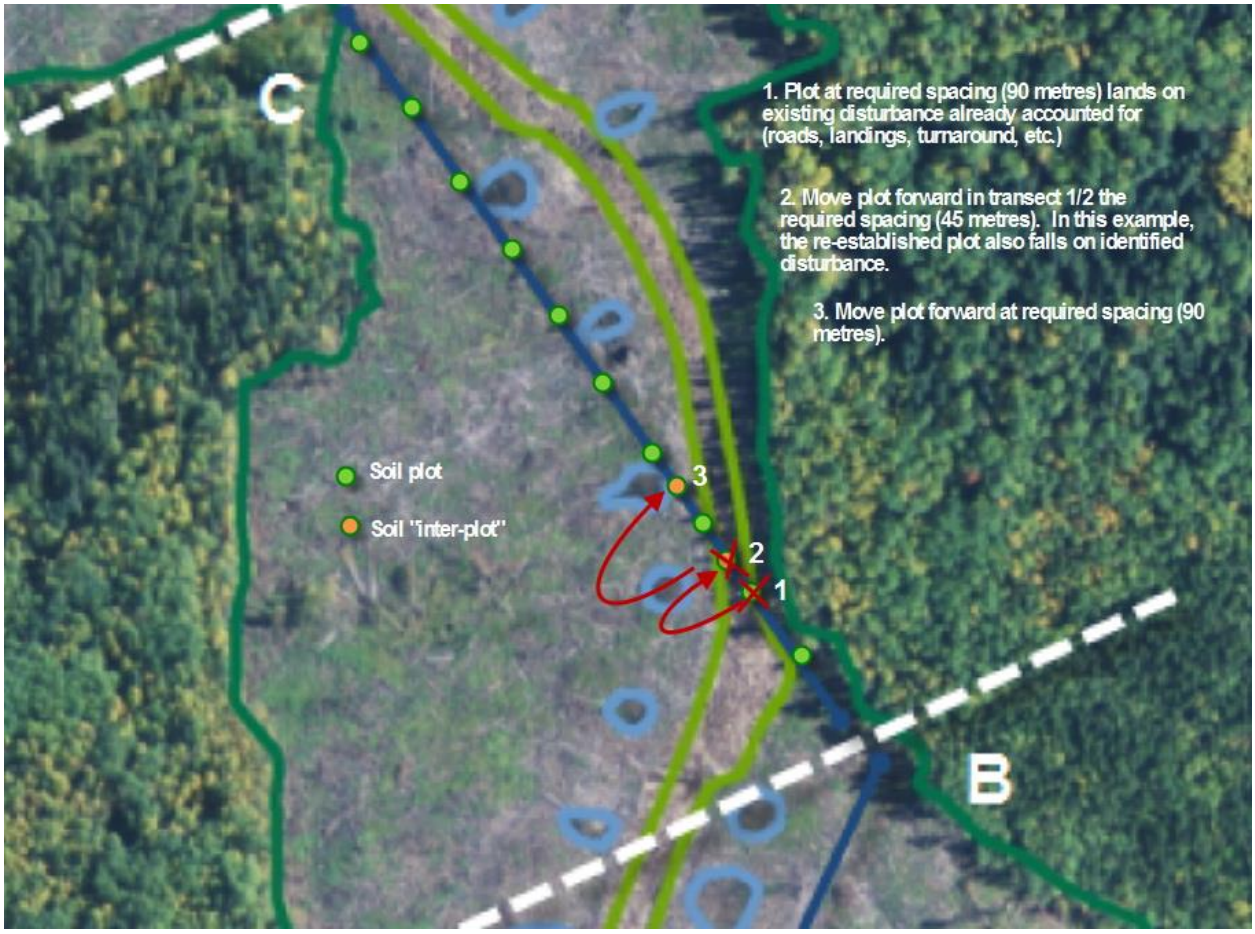
C
1. Plot at required spacing (90 metres) lands on existing disturbance already accounted for (roads, landings, turnaround, etc.)
2. Move plot forward in transect 1/2 the required spacing (45 metres). In this example, the re-established plot also falls on identified disturbance.
3. Move plot forward at required spacing (90 metres).
Soil plot
Soil "inter-plot"
3
2
1
B

Figure 3c.

1. Randomly locate a starting point (A) at or near the road access point, and keep the starting point at least 5 m inside the cut block edge;

2. Divide the length of the cutblock into three equal portions using virtual lines 1 and 2;

3. Layout the first transect from the starting point (A) to the longer point (B) where line 1 and cut block edge intercepts. Get the length between AB (Length_AB).
    - Divide the length by 10: L1 = Length_AB/10;
    - Layout 10 monitoring plots at an equal distance of L1, with plot 1 at the starting point. (**Figure 3a**)

4. Layout the second transect across the second cutblock portion in a diagonal fashion (i.e., from point B to C). Get the length between BC (Length_BC).
    - Divide the length by 10: L2 = Length_BC/10;
    - Layout 10 monitoring plots at an equal distance of L2, with plot 1 at L2/2 distance from B. (**Figure 3b**)

5. Layout the third transect across the third cutblock portion at 30 degree to virtual line 2 (i.e., from point C to D). Get the length between CD (Length_CD).
    - Divide the length by 10: L3 = Length_CD/10;
    - Layout 10 monitoring plots at an equal distance of L3, with plot 1 at L3/2 distance from C. (**Figure 3a)**

6. IF the monitoring plot lands on a temporary road or bared area, move the plot ½ the interplot distance forward. The inspector must be consistent in moving plots throughout the soil disturbance survey procedure (i.e. always move plots forward).

The above protocol ensures a consistent and repeatable sampling procedure. It also covers the entire cutblock and is reasonable easy to implement in practice. The 30 degree requirement ensures that block shape is not a factor when completing three transects, and it maintains a consistent approach in terms of a measuring protocol.

As for the size of the 30 monitoring plots, it is recommended that each monitoring plot should be a 10 square meter circular plot (1.78 m in radius). The most obvious or the most predominant forest soil disturbance conditions should be recorded as described in **Table 1**.

1.2.4.1 Data Collection at the Plot

At each monitoring plot, record the soil disturbance class that is observed or most prominent– refer to **Table 1** below for a description of the 3 soil disturbance classes. If Class 2 disturbance is noted at the plot, record the total area (up to 10 m^2) of disturbance on the Soil Disturbance Tally Sheet (FO FORM 18).

Table 1 – Soil Disturbance Classes use in SOP – Determining Soil Disturbance Area [1]

Soil Disturbance Class 0	Soil Disturbance Class 1	Soil Disturbance Class 2
Soil Surface	**Soil Surface**	**Soil Surface**
• no evidence of compaction (i.e., past equipment operation, ruts, skid trails • no depressions or wheel tracks evident • forest floor layers present & intact • no soil displacement evident • no management-generated soil erosion	• wheel tracks or depressions evident and are 5-10 cm deep • forest floor layers partially intact or missing • surface soil partially intact and may be mixed with subsoil	• wheel tracks and depressions highly evident with depth > 10 cm • forest floor layers missing • evidence of surface soil removal, gouging and piling • most surface soil displaced; surface soil may be mixed with subsoil; subsoil partially or totally exposed

[1] Adapted from Forest Soil Disturbance Monitoring Protocol Volume 1: Rapid Assessment. USDA. http://www.fs.fed.us/rm/pubs_other/wo_gtr082a.pdf

Summarize the total number of monitoring plots that fall within the respective soil disturbance classes (see section 3.0 Sample Calculations) and record on Soil Disturbance Tally Sheet.

2.0 Sample Calculation

Please refer to **Form 18** – **Soil Disturbance Survey Tally Sheet** as you read through the remainder of this procedure.

3.1 Soil Disturbance –

A. Temporary Roads

A 15 ha cutblock was found to have 1200m of road with average width measurements of 8.5m, 6.0, 12.5, 14, 8.5, 6.0, 8.5 10.5, 9.5. 9.0, 7.5 and 11.5 meters.

Temporary Road Area

1200m x 9.3 m / 10,000 = 1.12 ha

B. Bared Landing Areas

There were 2 bared areas - a 40m by 40m landing and a 10m by 20m pullout.

Bared Areas

40m x 40m / 10,000 = 0.16ha
10m x 20m / 10,000 = 0.02ha

Total disturbance area = **0.18 ha**

C. "In block Soil Disturbance" – Class 2 Area

Is the sum of all the area disturbed found at plot centers during the field sampling exercise. In this case from the example on Form 18, the total "class 2" soil disturbance area for the block is **.0117 ha or 117 m2.**

Therefore, in total there is **1.31** hectares of 'disturbed soil' made up of the following

Temporary Roads = 1.12
Bared areas = 0.18
"In block" soil disturbance 0.0117

D. Miscellaneous "In block Soil Disturbance" – GPS or mapped areas outside of transect

Concentrated area(s) of rutting = 0.00
Mappable area(s) of soil compaction = 0.00

And

The % soil disturbance for the block = (1.31 ha/15 ha) * 100 = **8.73 %**

Where the soil disturbance % for the block exceeds the amount noted in the respective OGR ~~5%~~ and there is no amendment or approval to exceed that amount~~5%~~, then a variance o~~i~~n the FOM form under the soils category is noted. Measurements and digital images should be posted along with the FOM inspection.

Authorities:
Timber Management Regulation - Section 100(1) (a) and (b)

Revision History

Revision #	Revision Date	Revision Reason	Reviewed by	Approved by
~~4.0~~	~~April 19, 2009~~	~~Program review edits~~		~~Chris Valaire~~
5.0	July 1, 2010	Numbering		Andre Savaria
6.0	April 28, 2011	Annual Document Review/Incorporated Road Width SOP		Darren Fearon
7.0	April 29, 2012	Include new content on measuring displaced soil	Mark Feser/Andre Savaria	Robert Popowich
8.0	January 7, 2013	Include new protocol to measure soil disturbance	Isaac Amponsah/ Darren Fearon/ Andre Savaria	Robert Popowich
9.0	April 18, 2013	Revise tally sheet	Andre Savaria/ Darren Fearon	Robert Popowich
10.0	May 30, 2014	Include measurement of non-trasect disturbance	Darren Fearon	Robert Popowich
11.0	April 20, 2015	Annual Review	Darren Fearon	Robert Popowich