



The Best Place on Earth

February 8, 2011

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## **Woodlot 2020 : Belgo Creek Area**

### **1.0 Introduction**

This is a response to a request by the Okanagan Shuswap Forest District to review the potential woodlot development within the Belgo, Cardinal and Darley Creek watersheds.

### **2.0 Background**

Woodlot 2020 is proposed to cover an area stretching from Highway 33 on the south side, running close to Cardinal Creek on the west edge, the south fork of Darley Creek to the north and along the private-crown land boundary above Philpott Road to the east.



Our review of the viability of the proposed woodlot began on December 11, 2009 when we completed a field trip to the plateau surface and the south facing slope above Highway 33 (Map 1). We also followed Philpott Road to the base of the debris flow and investigated the lower slopes and watercourses along Philpott Road. On January 7, 2010 we followed up this field trip with a meeting with residents of the area at the Joe Rich Hall. At this meeting we agreed that further study was needed at various times in the year to get a representative feel for the terrain and drainage conditions across the entire woodlot. A second field trip was undertaken on April 27, 2010 when we crossed the east facing slope on the mid-slope road and investigated the area around and above the big debris flow. We also re-visited the plateau surface to look at the drainage patterns and conditions during spring snowmelt season. A second, smaller meeting with residents occurred on June 11, 2010 and concerns over terrain stability, root rot, pest infestations, wildfire and visual quality were expressed. A final field visit to determine the moisture conditions on the lower east facing slope was made on October 18, 2010.

### **3.0 Terrain stability**

The entire area encompassed by Woodlot 2020 was originally mapped for Terrain Stability Mapping by AGRA Earth and Environmental Ltd. in 1997. This mapping was found to be inconsistent in detail and reliability, therefore, the steeper and more problematic areas, including

the majority of the proposed woodlot, were remapped in 2001 by Denny Maynard & Associates Ltd. The terrain mapping excludes all privately held land. This mapping was completed at terrain survey intensity level C where the entire ground surface is divided into polygons of similar terrain. There were two maps produced, the terrain classification map and the terrain interpretation map. The terrain classification map shows the polygons with the identified terrain (surficial material, sediment texture, surface morphology and geomorphic processes), plus slope gradients and drainage. The terrain interpretation map shows the terrain stability class (TSC I to V), the surface erosion potential class, the potential for landslide-induced sedimentation and the potential for sediment delivery from surface erosion sources.

From these maps (Maps 2 and 3), it is clear to see the slopes from Cardinal Creek east above Highway 33, and then north above Philpott Road up to Darley Creek are relatively steep and are dissected by several significant draws. There are two TSC V polygons identified and numerous TSC IV, but the majority of the slopes are considered to be relatively stable TSC III, II or I. The upper plateau surface is very gently rolling and the whole area is considered TSC I, II or III.

#### **4.0 Debris flows**

In June of 1990, there were 6 debris flows (Map 1) on the east and southeast face above Philpott Road (BC Ministry of Forests, 1990; Golder Associates Ltd., 1991; Cass et al., 1992). The cause of the debris flows was determined to be antecedent moisture conditions (record rain and snow in the previous 40 days), the large (300+ hectare) clearcut on the plateau surface and water diversion by roads and skid trails. Two of these events were relatively small, starting and stopping within 50 metres. The remaining four events are characterized by much longer runouts in well defined channels. The three most southerly events appear to be directly related to the presence of a road. It is likely that a road-related landslide initiated on the side slope of a draw and due to the extremely wet conditions translated into a debris flow in the confined channel. The largest debris flow began in a shallow depression and not in a well defined draw. Another debris flow initiated 20 m to the north, reached the forest access road and diverted south into the shallow draw. The combined debris flows then followed the shallow draw downslope expanding laterally as it went, becoming 134 m wide at its widest near Philpott Road. It struck a house below Philpott Road and three people died as a result. That no debris flows or landslides occurred in Cardinal Creek or the large gully system on the south face suggests that, if they were exposed to the same climatic conditions, the land use within the watersheds was likely a controlling factor.

#### **5.0 Field Observations**

The proposed area of woodlot 2020 covers three distinct areas, the east face above Belgo Creek, the south face above Highway 33 and the plateau (Map 4).

##### **PLATEAU**

The plateau is defined roughly at an elevation between 1300 to 1460 m and can presently be accessed by the Cardinal Creek Forest Service Road from the southeast and could potentially be reached from the northwest with an extension off the existing road system. The eastern half of the plateau surface was logged in the 1980's, with over 300 hectares of timber removed, and the gently rolling ground has now regenerated to 5 to 15 metre tall trees. The western half of the plateau remains covered with an even-aged stand of mature lodgepole pine. The plateau surface is mantled

with glacial till and has occasional bedrock outcroppings. On the plateau surface, drainages are broad shallow draws, but as the creek gradients increase towards the margins of the plateau they become more deeply incised.

### **SOUTH FACE**

The south face above Highway 33 is flanked by Cardinal Creek to the west, a deeply incised gully system in the centre and one well defined gully to the east. A debris flow initiated below the Cardinal Creek Forest Service Road in the eastern gully and sediment and debris travelled as far as Philpott Road. This face has a southerly aspect and is relatively dry with a mixed stand of predominantly Douglas firs. Timber has been removed all across the south facing slope, either selectively or in small patch cuts, and the removal of timber is minimally apparent at present. One main road crosses the slope to access the plateau, but there are numerous trails which can be reused to gain access to the majority of the slope. Several TSC IV polygons are identified; these either form part of one of the deeply incised, steep gully systems or are steeper rock, glacial till and colluvium areas. The majority of the upper slope is well drained glacial till with slopes 45 to 60% and rated as TSC III. The lower slopes are identified as a moderately to well drained glacial till blanket on slopes of 20 to 45% and rated as TSC II.

### **EAST FACE**

The east face above Belgo Creek is the most contentious due to its recent history of debris flows. The upper hillside is a well drained blanket of glacial till with slopes of 20 to 40% and rated as TSC II. The mid-slope is a steeper mix of glacial till, colluvium and has a band of bedrock which forms a steep cliff in places. The gradients in the mid-slope area are generally 40 to 90% and there are several smaller landslide and debris flow scars. The lower slopes above Philpott Road have gradients of 20 to 55%, and are moderately to well drained glacial tills. The lower slopes generally have well defined channels, but these are the transport or depositional zones and are not unstable.

In the upper and mid-slope areas there are deeply incised gully headwalls which are typically where landslides occur and therefore are the starting points for debris flows. One of the 1990 debris flows initiated from landslides on the sidewall of one of these incised drainages; two appear to have initiated below roads and are likely associated with road fill landslides which enter the creek and transform into debris flows. The landslides are likely a direct result of water concentration on logging roads and diversion at the wrong location into the valleys. Water directed onto the gully sidewalls should be directed into existing watercourses, but it is quite common that water is directed onto an open slope which is not conditioned to carry water. From the reports compiled in the 1990's (BC Ministry of Forests, 1990; Golder Associates Ltd., 1991; Cass et al., 1992) there were elevated flows that overwhelmed the capacity of the slope and landslides occurred. The landslide debris would then reach the creek at the base of the slope and translate into a debris flow which would have moved rapidly downslope through the creek.

The largest debris flow appears to have initiated in a more undefined watercourse where there is a small incised creek over shallow bedrock (BC Ministry of Forests, 1990). A second landslide headscarp immediately north indicates a second failure occurred and the road redirected the water and sediment flow downslope and the two slides coalesced immediately below the road and became a much larger debris flow. This debris flow then continued downslope in a broad draw, incorporating sediment and debris as it went and eventually crossed Philpott Road and struck the

house on the bench below the road. The widening pattern of the debris flow suggests that flow was not confined to a draw, or that the draw was too shallow and the mass of sediment overwhelmed it and spread out across the open slope.

## **6.0 Woodlot Recommendations**

### **PLATEAU**

The upper plateau holds good potential for further harvesting to the west of the old clearcut and into the headwaters of Cardinal and Darley Creeks. Access to the plateau is presently up the Cardinal Creek FSR, but an extension of roads to the northwest into the area is a possible alternative. The old clearcut may be a potential source of small posts or poles in the near future as the new plantation trees are reaching heights of between 5 and 15 m. At this height regenerating trees still have incomplete crown closure and allow more rain and snow to reach the ground surface and the ECA is considered to be approximately 50% recovered. When trees reach 20 m height the ECA is considered to be completely recovered as the crown closure is similar to a mature stand.

Timber harvesting on most of the plateau surface can be conducted with conventional skidders and there is a very low likelihood of landslide initiation. When slopes are between 25 and 45% or in the vicinity of watercourses the likelihood of landslide initiation is considered to be low. When slopes exceed 45% the likelihood of landslide initiation is considered to be moderate. The concern for much of the plateau is a recurrence of the climatic conditions of 1990, where excessive rain and snow overload the drainage systems. The plateau drains in all directions, to the north into Darley Creek; to the west into Cardinal Creek; and to the south and east into several smaller drainages. Drainage off the plateau appears stable right now, but an increase in the ECA or alteration of drainage by road construction into any of the watercourses could alter these conditions. Any timber harvesting or road construction should take into account these factors and plan to minimize the effect on downslope drainage.

### **SOUTH FACE**

Douglas fir dominates on the south face and has been removed all across the south facing slope, either selectively or in small patch cuts. As there are numerous existing roads and trails which can be reused to gain access to timber, new road construction is not recommended for the majority of this slope. Cardinal Creek FSR crosses the south face to reach the plateau and is still a good road which will need minor works to re-activate. In 1990, the gully, which forms the boundary between the south and east faces, failed from the fillslope below the road and the debris flow ran out as far as Philpott Road. The cause of this failure is probably related to road drainage and the thick fill at the crossing becoming saturated during the rainfall and snowmelt event. A review of the crossing to determine if the culvert is correctly sized and operating properly is recommended. The only other concern on the Cardinal Creek FSR is the steep and tight switchback located at around 1 km which may be difficult for some longer vehicles to negotiate going up the road. Downhill traffic should be okay, but the turn will still be quite tight.

Timber harvesting on the south face should avoid those areas rated as TSC IV (Maps 2 and 3), and should be especially careful when around and directly above gullies and watercourses. The south face is subdivided into 3 sections (Map 4): the south-western area from Cardinal Creek to the edge

of the steep gully, the gully itself, and the south-eastern area to the east of the gully. In the south-western area, there are some harvesting opportunities and the slopes have been roaded. The biggest issue is likely getting access to the area through the surrounding private land. Timber harvest is probably limited to smaller sized openings with random skidding techniques or using short spur trails. The gully is too steep for timber harvesting or road development and should be avoided. The south-eastern section of the slope has the most logging opportunities and again timber harvest should probably be limited to smaller sized openings with random skidding techniques or using short spur trails. On the lower slopes where the gradients are lower, the size of openings could be increased.

The likelihood of landslide initiation on the south slope is considered to be high on slopes in excess of 70% and in the well defined, steep-sided gullies. The likelihood of landslide initiation on the south slope is considered to be moderate when slopes are in the range of 50 to 70% or in the vicinity of shallow watercourses. Where the ground has gradients between 30 and 50%, the likelihood of landslide initiation is considered to be low and where slopes are less than 30%, very low.

#### **EAST FACE**

The east face is slightly wetter than the south face and this is reflected in the tree types; douglas fir and lodgepole pines with mixed deciduous varieties are present. Timber harvest has occurred all across this slope, from the older style of harvesting removing the better timber using multiple skid trails to small patch cuts and larger clear cuts. The northerly extension of the Cardinal Creek FSR (hereafter called the North Cardinal Creek FSR) crosses the slope from the south to reach the plateau. Further harvesting is possible on these slopes and with the existing roads and trails a lot of the slope is accessible. It is not recommended that harvesting occur on the steeper mid-slopes, around or above the gullies or in any of the TSC IV ground (Maps 2 and 3). Any road construction or harvesting on the east face must be planned to maintain the existing drainage patterns and flow volumes.

The east face is broken into four sections (Map 4), the north-eastern corner, the eastern section, the southern section and the upper slope area. The north-eastern corner is the area accessed from lower Darley Creek and encompasses the area of gentler slopes below the TSC IV ground (Maps 2 and 3). This area is only accessible from the north, not from the North Cardinal Creek FSR, and harvesting should be limited to smaller openings. The eastern section is located downslope of the North Cardinal Creek FSR. This area has some TSC IV ground within it and experienced a debris flow during the 1990 event. Small patches of moderately or gently sloped ground between Philpott Road and the North Cardinal Creek FSR have mature timber and these could be harvested with minimal impact to the slope or the drainage network. Logging opportunities are again smaller openings, patch cuts or selective harvesting. Harvesting this area might require re-activation of a short stretch of the North Cardinal Creek FSR or access could be from Philpott Road upslope. The southern section is located between the gullies at the south end of the east face, both of which had debris flows in 1990. The slope is crossed with four road segments and thus no new access roads should be built. Selective harvesting has already occurred on much of this slope, but there are some areas where more harvesting is viable.

The upper slope section is defined as all of the area above the North Cardinal Creek FSR, plus all the TSC IV and V ground and includes all the gentle and moderate ground downslope of the plateau cutblock and within the old growth management area. Access to the upper slopes could be attained by reactivating the North Cardinal Creek FSR across the east face, but this is not recommended. The upper slopes could be harvested but the drainage from this would need to be managed with extreme care. Timber harvesting of the upper slope on the east face is not recommended.

The likelihood of landslide initiation on the east slope is considered to be high on slopes in excess of 60% and in the well defined, steep-sided gullies. The likelihood of landslide initiation on the east slope is considered to be moderate when slopes are in the range of 45 to 60% or in the vicinity of shallow watercourses. Where the ground has gradients between 30 and 45%, the likelihood of landslide initiation is considered to be low and where slopes are less than 30%, very low.

## **7.0 References**

AGRA Earth and Environmental Ltd. 1997. Terrain Stability Mapping, Mission Creek Community Watershed. Map and report.

BC Ministry of Forests. 1990. Investigation into the cause of the destructive debris flow, Joe Rich – Belgo Creek Area, June 12, 1990. Forest Service Investigation Team.

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