WATERSHED REVIEW
KINUSEO CREEK WATERSHED
Draft March 23, 2012

Ministry Contract No: CS12NRH-011

BIOPHYSICAL AND LAND-USE CHARACTERISTICS OF THE WATERSHED

Table 1. Summary Information – Watershed Characteristics – (see Figures 1 and 2)

Size (km^2)	Dominant BEC Zones	Dominant NDT	Elevation Range (m)	Surficial Geology near the Mouth (i.e. sensitive area)	Stream Density (km/km^2)	Biggest % of watershed in same elevation band[1]	Distribution of slope gradients within the watershed (% of watershed)			
							<10% slope	10 to 30% slope	30 to 60% slope	>60% slope
617.0	ESSFmv2 / SBSwk2	NDT 2	790-2229	Medium textured till	2.2	39.9	24.8	47.0	24.7	3.5

[1] The entire watershed is divided into 300 m elevation bands. The less elevation bands there are and the more area is represented by any given single elevation band, then the greater will likely be the effect of forest harvesting on increased peak flows due to the theoretical concept of "synchronization" (i.e. the melt from the cutblocks is synchronized as much of it comes from the same elevation), and the greater sensitivity it will have.

Table 2. Rating of "Sensitivity" of Watershed to Increased Peak Flow at the lower reaches

Rosgen Stream Channel Type	Rosgen Stream Channel Sensitivity Score	Sensitivity score relative to topography	Sensitivity score relative to lateral connectivity	Sensitivity score relative to vertical conductivity	Sensitivity score relative to climate	Sensitivity score relative to flow synchroniza-tion potential	Sensitivity score relative to NDT type	Sensit-ivity Score	Sensitivity Rating
Big D4- Lightly unstable/disturbed	4.25	1	1.1	1	1.1	1.03	1.03	5.47	Very High

Table 3. Rating of "Sensitivity" of Watershed to Increased Production of Fine Sediment at lower reaches

Stream Channel Type	Reach Sensitivity Score	Sensitivity score relative to topography	Sensitivity score relative to lateral connectivity	Sensitivity score relative to drainage density	Sensitivity score relative to climate	Sensitivity score relative to soils	Sensitivity Score	Sensitivity Rating
Riffle pool cobble	4	1	1.2	1	1.1	1	5.3	Very High

Table 4. Rating of "Sensitivity" of Watershed to a Loss In riparian Function.

Stream Channel Type	Reach Sensitivity Score	Sensitivity score relative to Aspect	Sensitivity score relative to climate	Overall watershed sensitivity to loss of riparian	Loss of Riparian Sensitivity Rating
F3-F6 w FP	4.5	0.9	0.9	3.65	Mod

Table 5. Peak Flow Hazard Rating, as indexed by HEDA – current scenario (i.e. no proposed harvesting considered)

Watershed area (km^2)	Total area Pine Leading (km^2)	Total area Pine Mixed (km^2)	Total area harvest (km^2)[1]	Total HEDA from Pine Beetle alone (%)	Total HEDA from logging alone (%)	Total HEDA from logging and Pine Beetle mortality (%)
617.0	69.5	78.86	43.84	9.47	6.13	15.59

[1]Note: This includes openings from VRI database, and non-overlapping openings from RESULTS and FTEN databases.

Table 5 (continued)

Total area in Agriculture (km^2)	Total area in Agriculture (% of watershed)	Total area in Proposed Harvest (km^2)	Total HEDA (%)	HEDA Hazard rating Score	HEDA Hazard Rating
0.00	0.00	0.00	15.59	0.08	Very Low

Table 6. Fine Sediment Hazard Rating, as indexed by the Stream Crossing Density

Watershed area (km^2)	# of x-ings	#of fish bearing X-ings[1]	#of non-fish bearing X-ings	density of x-ings (#/km^2)	Density of fish bearing X-ings (#/km^2)	Density of non-fish bearing X-ings (#/km^2)	Hazard Rating Score	Hazard Rating
617.0	153	150	3	0.2	0.2	0.00	1.65	Low

[1]Note: The information on stream crossings was provided by MoE and was generated with a GIS model, not fieldwork.

Table 7. Loss of Riparian Function Hazard Rating

Reach Number	Rosgen Stream Type	Reach Length (m)	% riparian logged (as interpreted from air photos)	Apparent stability and other comments (as viewed from air photos)
1	D4- Lightly unstable/disturbed	1356	0.0	Lightly De-stabilized
2	B4- Lightly unstable	4076	0.0	Lightly De-stabilized
3	B4- Lightly unstable	2825	0.0	Lightly De-stabilized
4	A3-Stable	6259	0.0	Stable
5	E4-Stable	7451	0.0	Stable
6	E4- Lightly unstable/disturbed	5480	0.0	Lightly De-stabilized
7	C4- Mod unstable/disturbed	1437	0.0	Moderately De-stabilized
8	E4- Lightly unstable/disturbed	4087	0.0	Lightly De-stabilized
9	C4- Lightly unstable/disturbed	3799	0.0	Lightly De-stabilized
10	C4- Stable	3974	0.0	Stable
11	E4-Stable	6038	0.0	Stable
Hazard Scores:			Hazard Rating Score	Hazard Rating
			0.25	Very Low

Table 8. Risk Rankings for the Different Hazards in the watershed current scenario (i.e. no proposed harvesting considered)

Watershed Hazard Types	Sensitivity Score	Sensitivity Rating	Hazard Score	Hazard Rating	Risk Score	Risk Rating
Increased Peak Flow	5.47	Very High	1.30	Very Low	7.1	Mod
Increase in Production of Fine Sediment	5.28	Very High	1.65	Low	8.7	Mod
Loss of Riparian function	3.65	Mod	0.25	Very Low	0.9	Very Low

Table 9. Fisheries Sensitive Watershed Score and Rating

Name	Size (km^2)	Peak Flow Sensitivity	Sed Sensitivity Rating	Riparian Sensitivity	Fish Value[1]	FSW Score PF vs Fish	FSW Score Seds vs Fish	FSW Score Rip vs Fish	Overall FSW Score	Overall FSW Rating
Kinuseo Creek	617.0	Very High	Very High	Mod	High	4	4	2	10	High

[1]Note: The "Fish Values" were assessed and provided by Fisheries Biologists from the Ministry of Forest, Lands and Natural Resource Operations. This report does not describe fish values.

INTERPRETATIONS AND RECOMMENDATIONS FOR MANAGEMENT STRATEGIES FOR PROTECTION OF WATER RESOURCES IN THIS WATERSHED

Brief Watershed Description (Table 1 and Figures 1 and 2)

Kinuseo Creek watershed is a relatively large watershed (617 km ^{2}) that flows directly into the Murray River. Most of the watershed has rolling to mountainous topography, with steeper terrain and alpine tundra in the southern portion of the watershed. Elevations in this watershed range between 790 and 2,229 m. The watershed is distributed over several 300 m elevation bands, with the biggest proportion (40%) being in the elevation band between 1090 and 1390 m. There is a relative abundance of steep terrain in this watershed with 28% of the watershed having slopes greater that 30% and 3.5% of the watershed having slopes greater than 60%. The dominant biogeoclimatic zones in this watershed are the ESSFmv2 and SBSwk2.

The lower reaches of the mainstem of Kinuseo Creek is a moderate gradient, wandering, confined channel that flows through steeply entrenched canyons and finally flows out onto an unconfined alluvial reach and into the Murray River (Figure 1 and 5). The confined reaches have minimal floodplain and there are several unstable slopes that likely deliver large volumes of sediment directly to Kinuseo Creek (Figures 13 and 14). The upper reaches, above reach #5, are very low gradient, tortuously meandering channels with very wide floodplains (Figures 7, 8 and 9). The surficial geology of this watershed is a combination of a mixture of fine and moderately coarse morainal tills with areas of colluvial rubble and alpine tundra (Figure 1 and 2). The mainstem stream reaches are a combination of B, C and E channel types (Table 7). None of the mainstem stream reaches appear to have been directly disturbed by land use activities. There are patches of pine leading stands distributed throughout the watershed (Figure 3). The mainstem has

been well protected from riparian harvesting throughout the watershed (Table 7) and thus has a very low riparian hazard rating.

Sensitivities, Hazards and Risks in this Watershed

The overall sensitivity of the watershed to increases in peak flows and increases in fine sediments have both been classified as very high (Table 2). This is due mainly to a combination of very sensitive reach types near the lower end of the watershed, some steep terrain, high lateral conductivity and steep banks that are locally unstable (Figures 5 and 13 and 14). There are also some very unstable tributary streams that are contributing large volumes of sediment directly to Kinuseo Creek (Figures 9, 10, 11 and 12)

The overall sensitivity to a loss in riparian function has been assessed as a moderate because much of the watershed is located in the ESSF biogeoclimatic zone where sensitivities to temperature increases are not as significant.

None of the current risk ratings are high which is largely due to low and very low hazard ratings for all three variables (Table 8). Although some forest harvesting activities have occurred in this watershed, they appear quite limited.

When considering both the overall physical sensitivities in this watershed and the fisheries values, the Fisheries Sensitive Watershed (FSW) rating is assessed as High (Table 9).

Suggested Special Management Objectives To Protect Fish Habitat Values <u>Above and Beyond</u> What is Already Required by FPPR

1) Risks associated with an increase in peak flows
   Given that the current peak flow sensitivity for this watershed is <u>very high,</u> recommendations are as follows:

   a. Maintain peak flow risks to a maximum of a <u>Low level</u>
      i. Current HEDA= <u>15.6%</u>
      ii. Max HEDA to maintain low risk = <u>15.5%</u>
      iii. Current risk rating: <u>Moderate</u>
      iv. Available harvest in green timber to maintain low risk <u>= 0 ha</u>. This means that further hydrological recovery would have to occur in this watershed before additional forest harvesting was to proceed, that is if the objective is to maintain a low risk.
      v. Use the peak flow risk calculator to determine the maximum suggested harvest of different combinations of healthy stands and mountain pine beetle affected stands in order to maintain the risk level below moderate.

2) Risks associated with the accelerated delivery of fine sediments
   Given that the current fine sediment sensitivity for this watershed is <u>very high,</u> recommendations are as follows:

   a. Minimize erosion and the delivery of fine sediments at all stream crossings and keep the WQEE stream crossing rating to a maximum of a Low hazard level.

i. To complete these assessments, use the most recent WQEE protocol which can be found at the following web link: http://www.for.gov.bc.ca/ftp/hfp/external/!publish/frep/indicators/Indicators-WaterQuality-Protocol-2009.pdf
ii. All flat over steep terrain that is planned for development should be assessed by a qualified professional and managed accordingly to prevent accelerated slope failures into Gordon Creek.

3) Risks associated with a loss in riparian function

Given that the current riparian sensitivity for this watershed is only moderate, no special recommendations are provided for special management objectives above and beyond what is already required by the Forest Planning and Practices Regulations (FPPR):

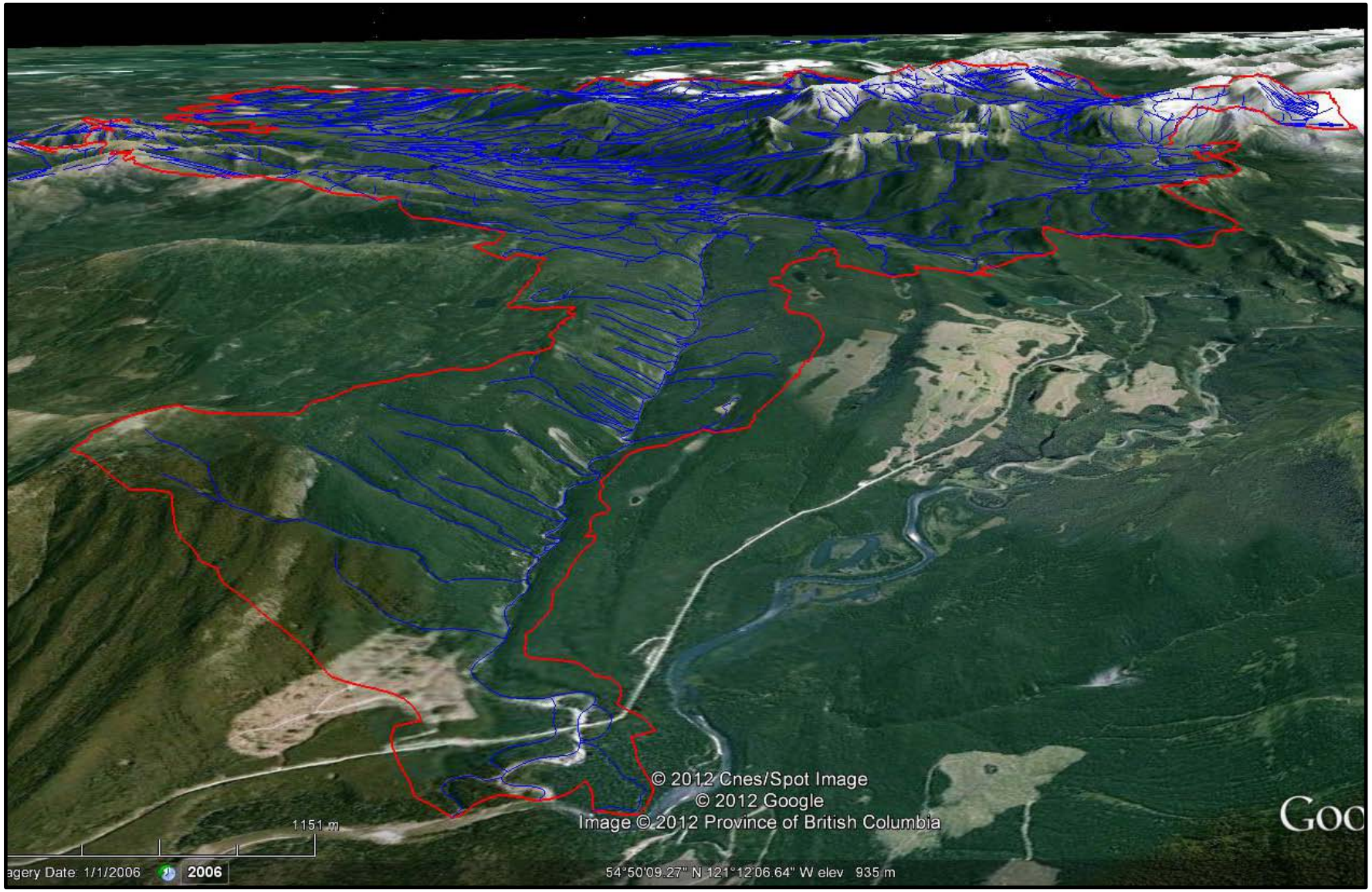

Figure 1. Google earth overview image of Kinuseo Creek watershed, looking upstream into the watershed.

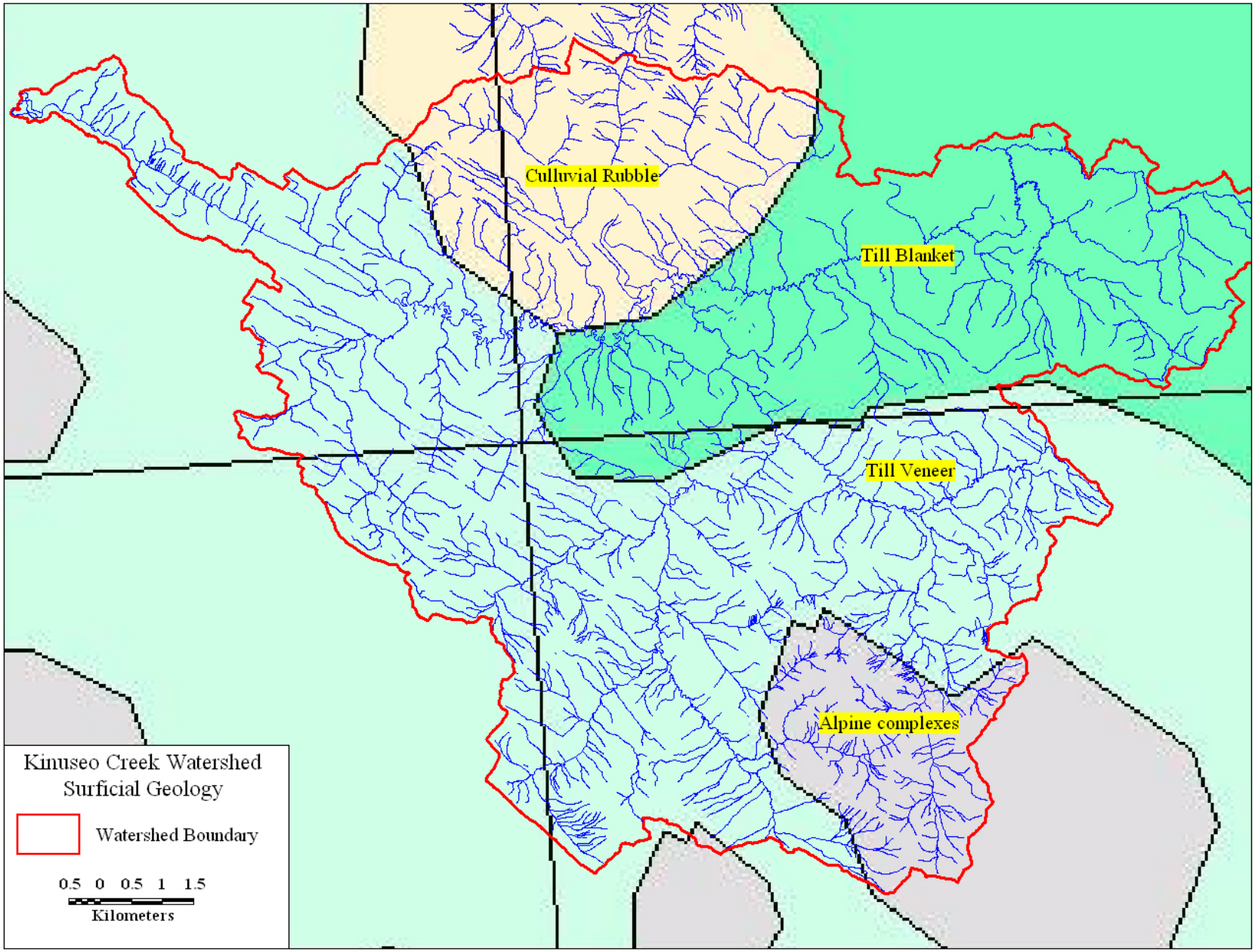

Figure 2. Distribution of dominant surficial geology types in the Kinuseo Creek watershed (from 1:5M BC Geological Survey Maps).

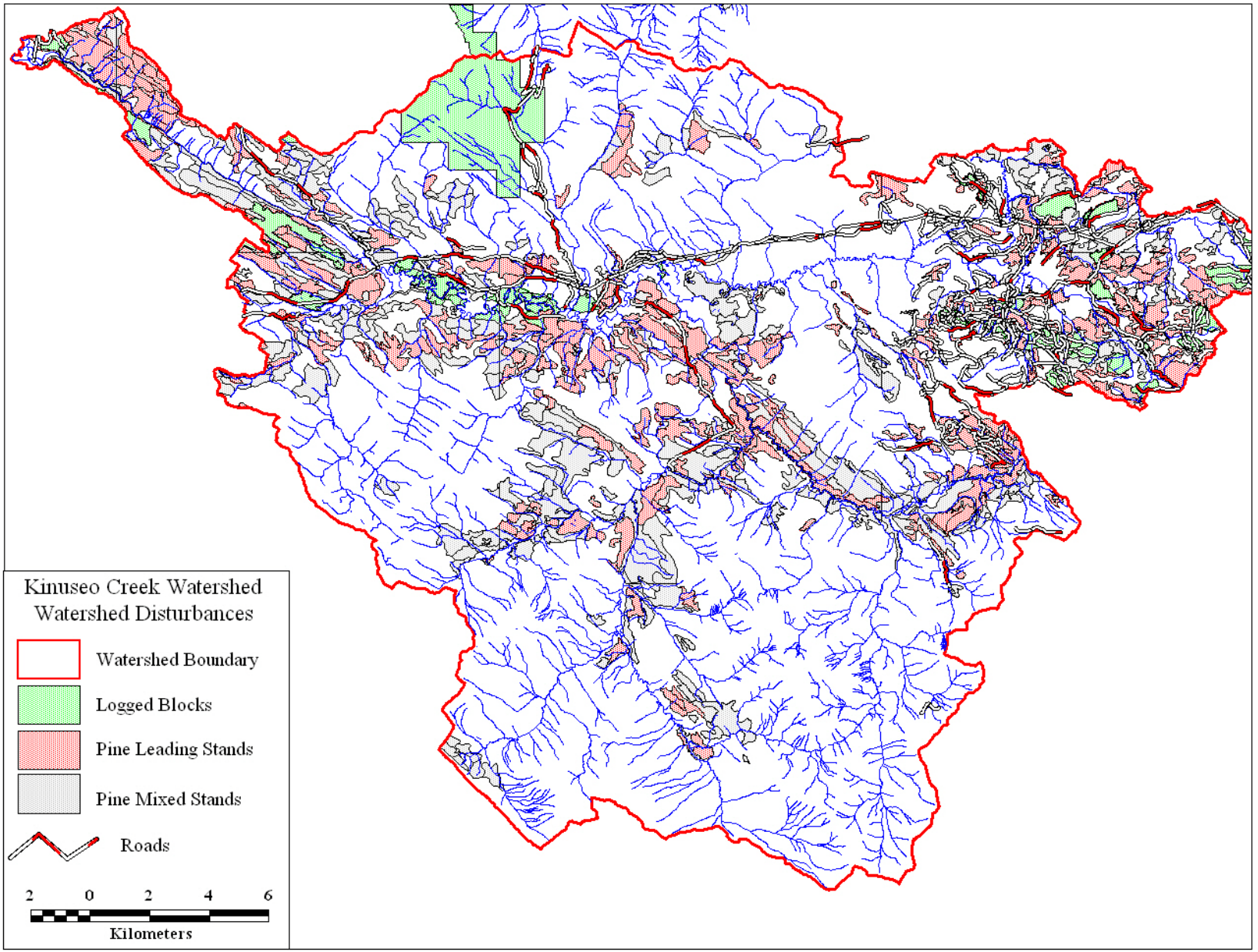

Figure 3. Land-use related and large natural disturbances in the Kinuseo Creek Watershed

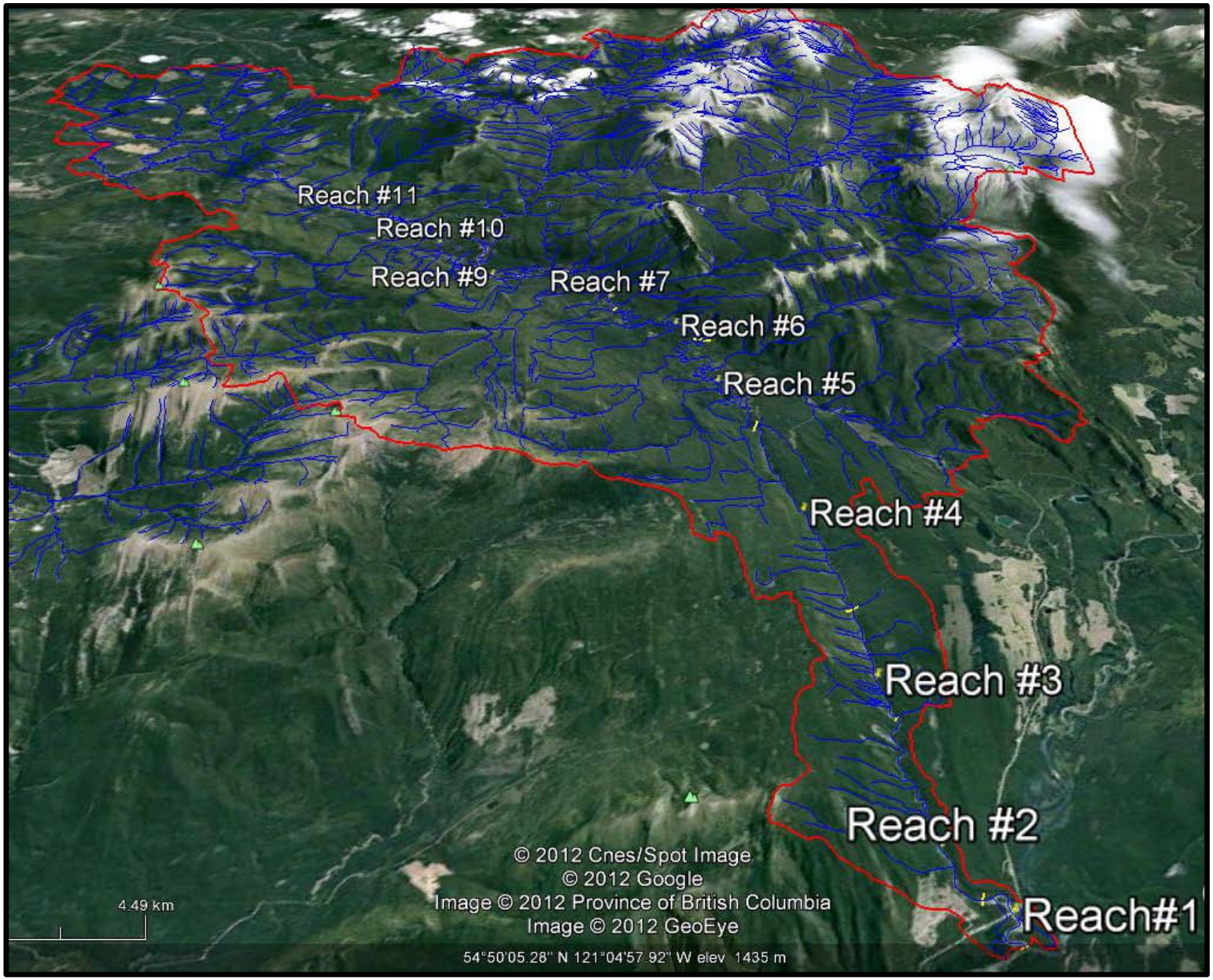

Figure 4. Identification of reaches along the mainstem of Kinuseo Creek watershed

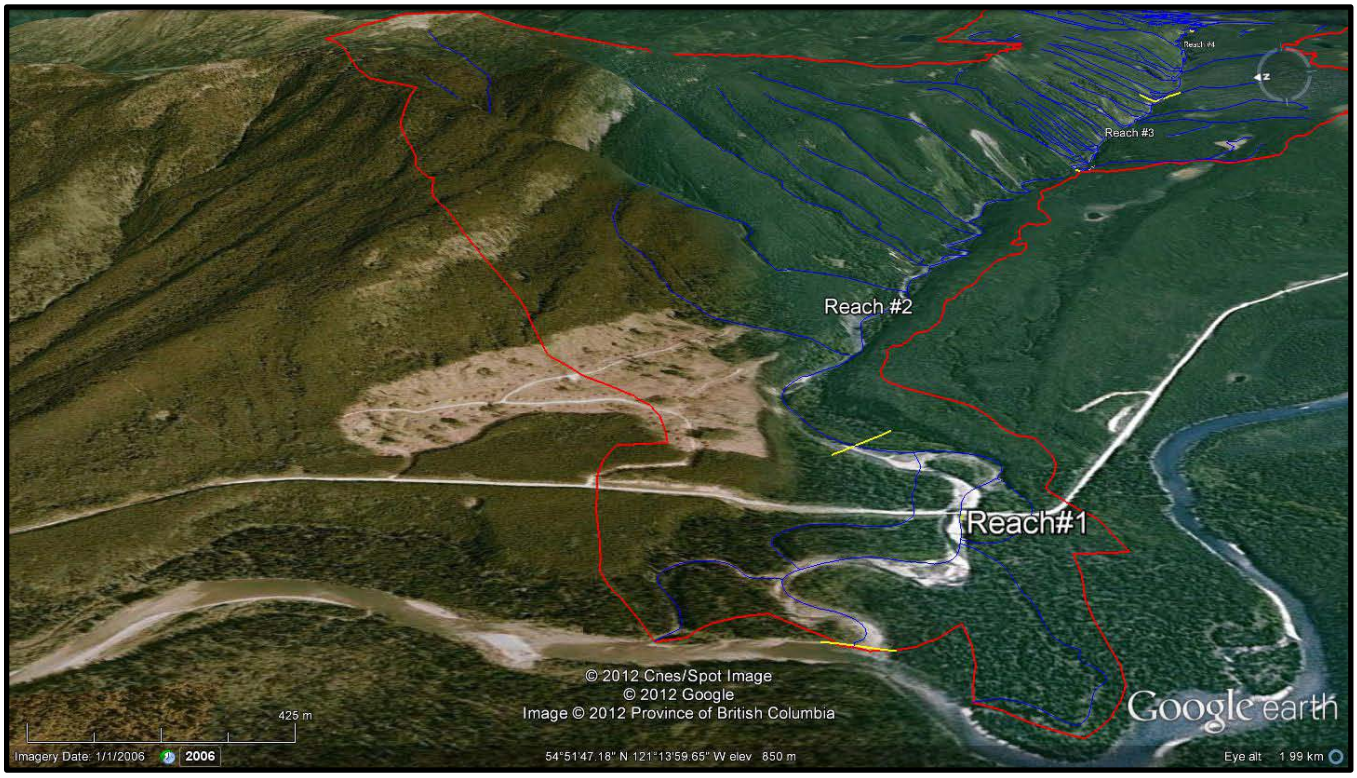

Figure 5. Google Earth image looking upstream along Reaches #1 and 2 of Kinuseo Creek.

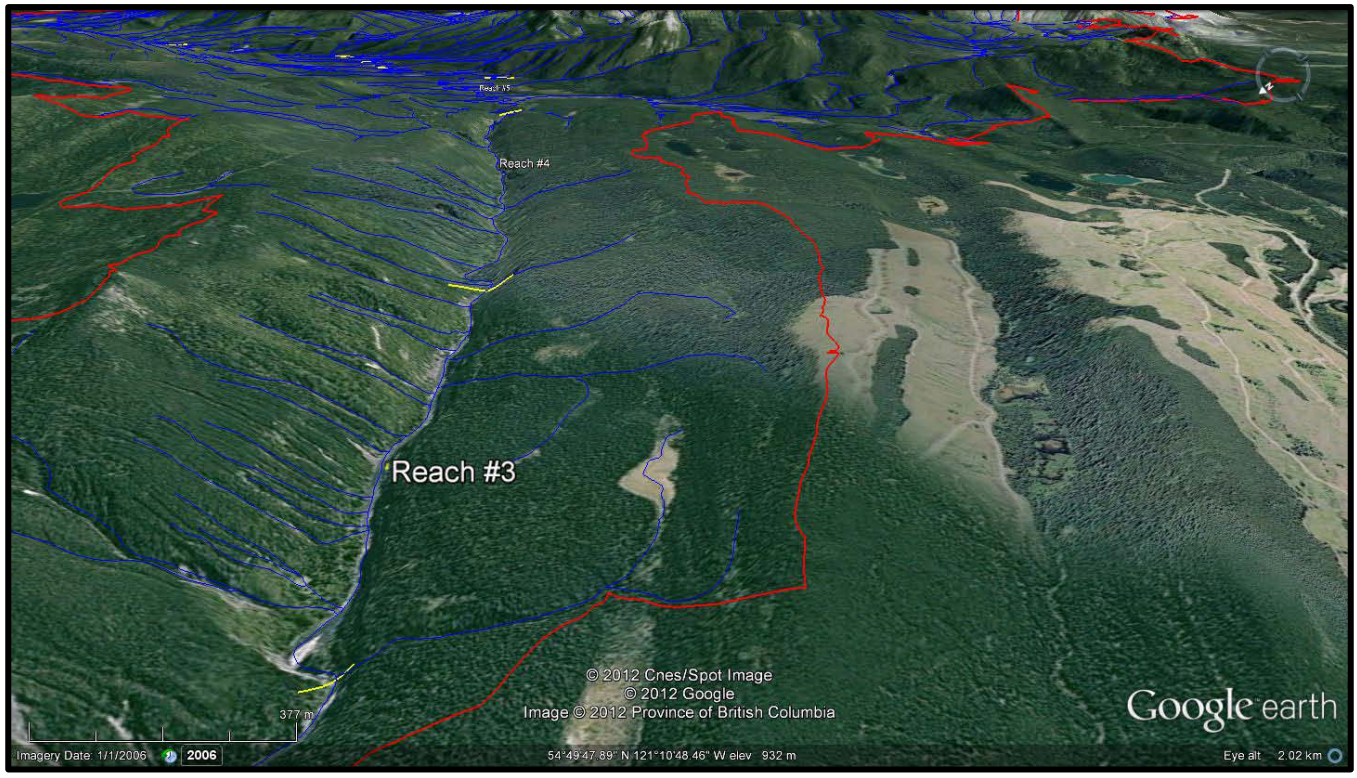

Figure 6. Google Earth image looking upstream along Reaches #3 and 4 of Kinuseo Creek.

Figure 7. Google Earth image looking upstream along Reaches #5 and 6 of Kinuseo Creek.

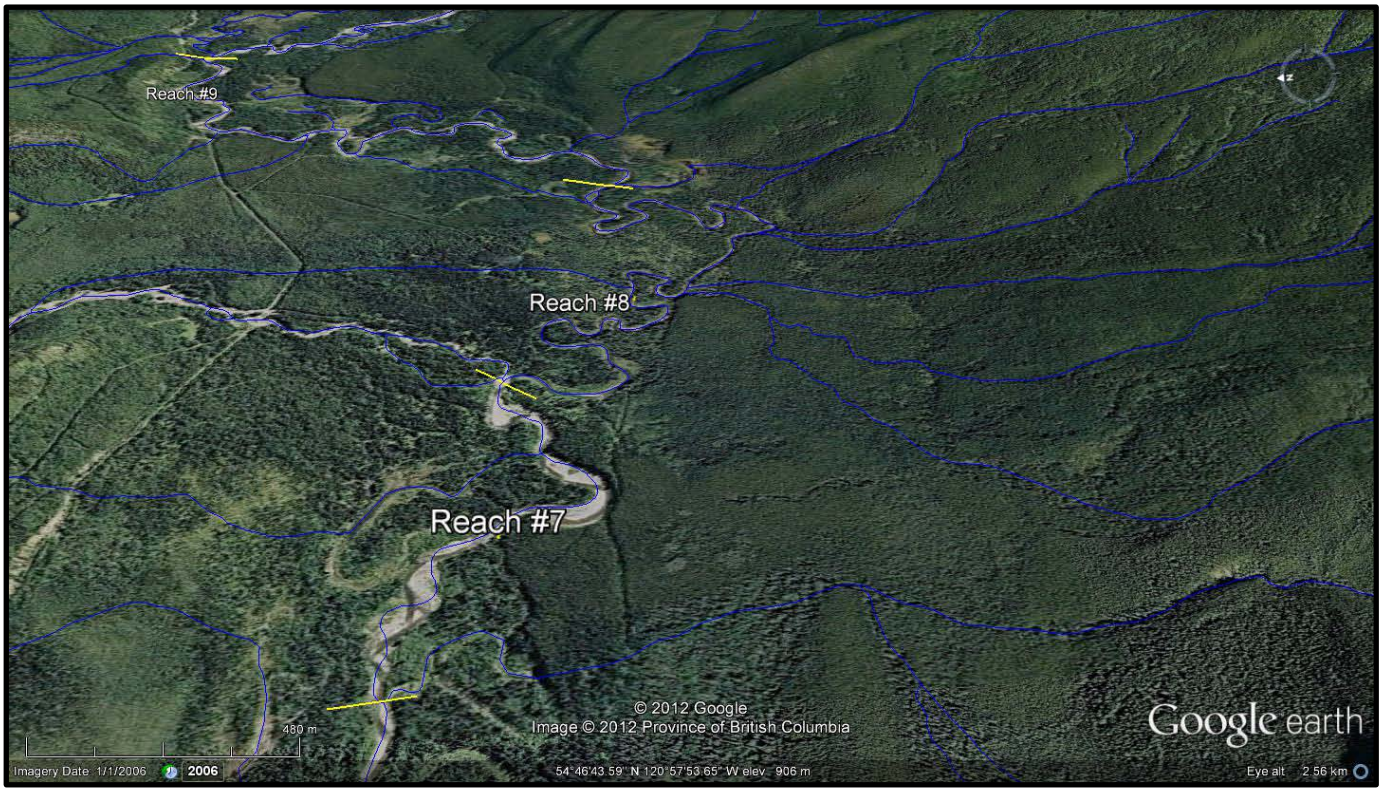

Figure 8. Google Earth image looking upstream along Reaches #7, 8 and 9 of Kinuseo Creek.

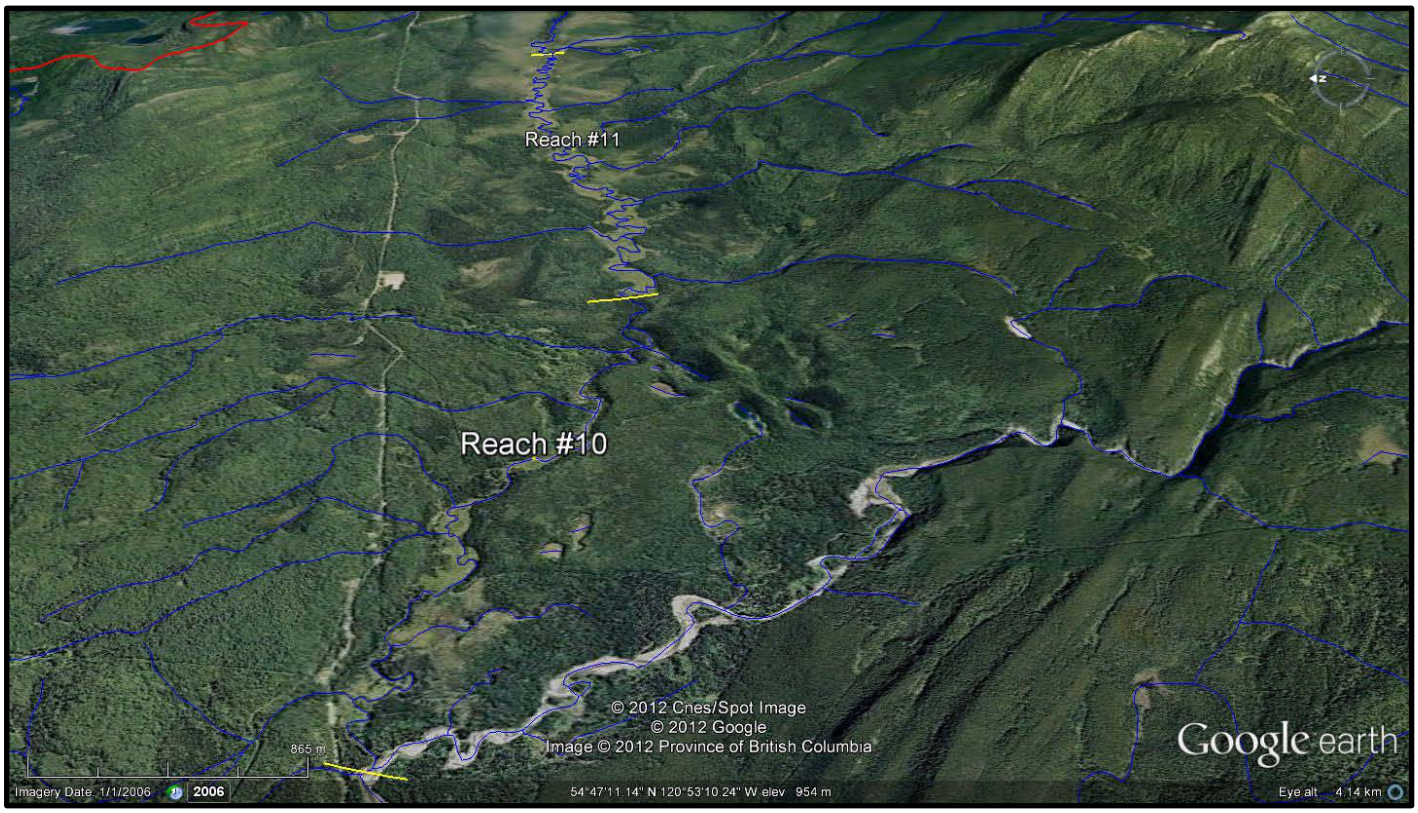

Figure 9. Google Earth image looking upstream along Reaches #10 and #11 of Kinuseo Creek.

Figure 10. Google Earth image looking at unstable tributary reach above Reach #7 of Kinuseo Creek.

Figure 11. Google Earth image looking at unstable tributary reach above Reach #7 of Kinuseo Creek (R1).

Figure 12. Google Earth image at unstable tributary reach above Reach #7 of Kinuseo Creek (R2).

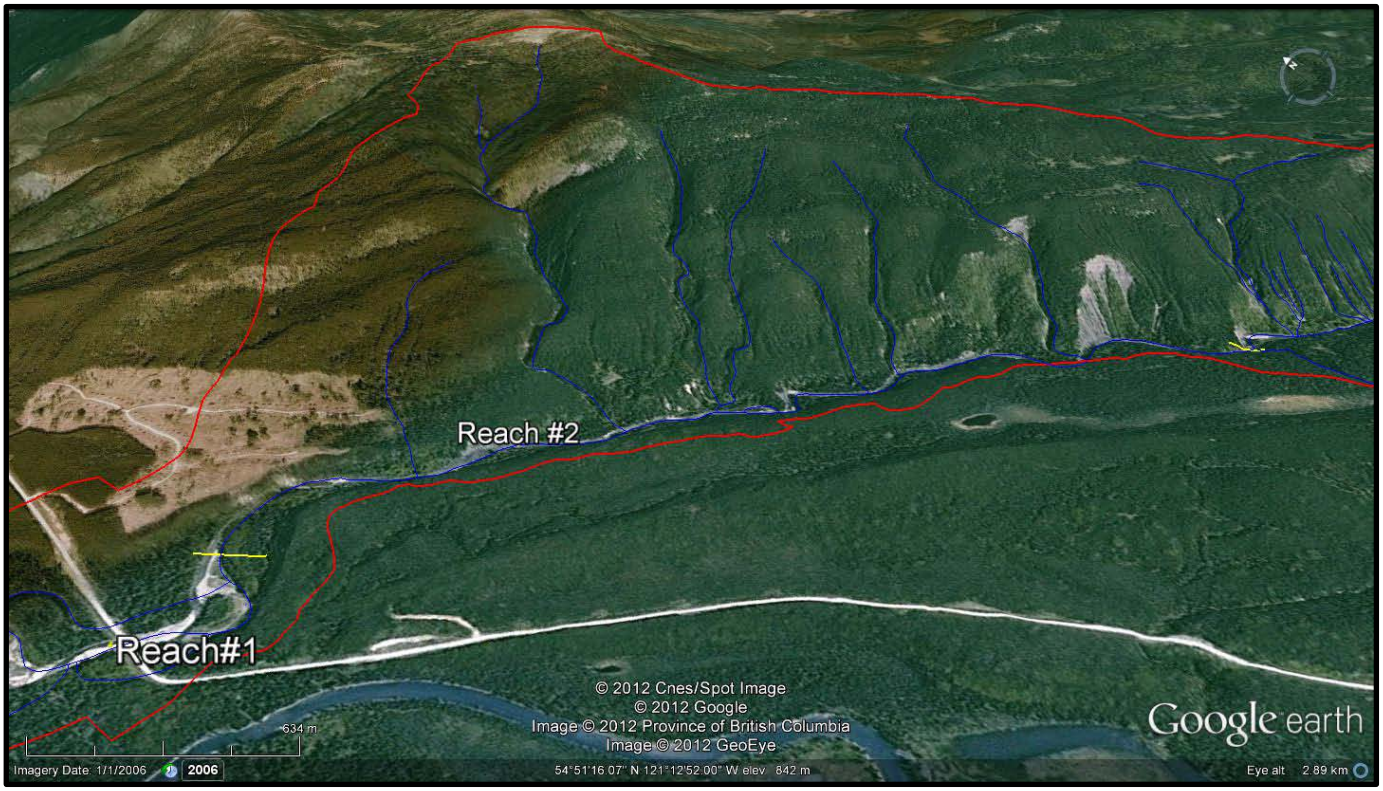

Figure 13. Google Earth image looking at unstable slopes along Reach #2.

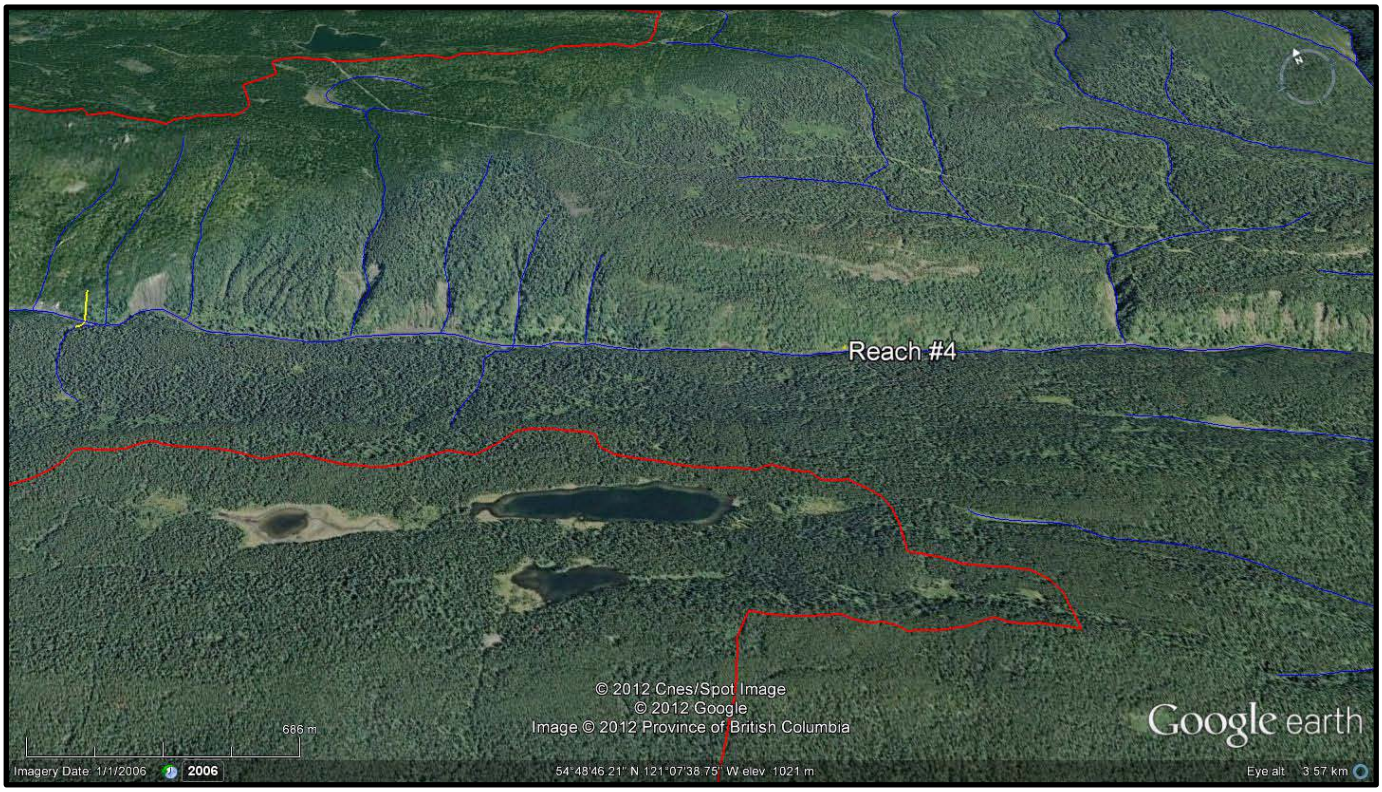

Figure 14. Google Earth image looking at unstable slopes along Reach #4.