WATERSHED REVIEW
McQUARRIE CREEK WATERSHED

BIOPHYSICAL CHARACTERISTICS OF WATERSHED

Table 1. Summary Information – Watershed Characteristics – (see Figure 1)

Size (km^2)	Dominant BEC Zones	Dominant NDT	Elevation Range (m)	Dominant Surficial Geology	Stream Density (km/km^2)	Largest % 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
114.6	SBS	NDT3	637 - 1586	Coarse textured till on rolling terrain	2.04	73	40.3	53.3	6.2	0.2

[1] The entire watershed is divided into 300 m elevation bands of harvestable forest land-base. 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. Dominant soil textures in the watershed

Surficial Geology	**Total area of surficial material in watershed (km^2)**	**Percent in watershed**	**Sensitivity to disturbance (mostly roads, trails and crossings)**
Very Fine Textured Lacustrine	1.6	1.4	Very High Sensitivity
Fine textured fluvial	0	0.0	Very High Sensitivity
Fine textured till	0	0.0	High Sensitivity
Medium textured till	0	0.0	Moderate Sensitivity
Coarse textured till on rolling terrain	107.9	94.2	Low Sensitivity
Coarse textured fluvial	0	0.0	Moderate Sensitivity
Colluvial	0	0.0	Low Sensitivity
Organic	5.11	4.5	Very High Sensitivity
Bedrock	0	0.0	Very Low Sensitivity
Eolian	0	0.0	Very High Sensitivity
Marine (including glaciomarine)	0	0.0	Very High Sensitivity

Table 3. Rating of "Sensitivity" of Watershed to Increased Peak Flow at the lower reaches

Rosgen Stream Channel Score	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
C4-Lightly unstable/ disturbed	4	1	1.05	0.95	1.1	1.05	1	4.61	Very High

Table 4. Rating of "Sensitivity" of Watershed to Increased Production of Fine Sediment at lower reaches

Most sensitive fish species in watershed[1]	Species Sensitivity Score	Sensitivity score relative to topography	Sensitivity score relative to lateral connectivity	Sensitivity score relative to climate	Sensitivity Score	Sensitivity Rating
Coho Salmon	4.7	1	1.1	1.1	5.687	Extreme

[1]Note: See Figure 2 for distribution of fish species in this watershed.

Table 5. Rating of "Sensitivity" of Watershed to a Loss In riparian Function.

Most sensitive fish species in watershed	Species Sensitivity Score	Sensitivity score relative to loss of LWD	Sensitivity score relative to Aspect	Sensitivity score relative to climate	Overall watershed sensitivity to loss of riparian	Loss of Riparian Sensitivity Rating
Coho Salmon	4.7	1.25	1.1	1.1	7.11	Extreme

Table 6. Peak Flow Hazard Rating, as indexed by HEDA

Watershed area (km^2)	Total area Pine Leading (km^2)	Total area Pine Mixed (km^2)	Total area harvest (km^2)	Total HEDA from Pine Beetle alone (%)	Total HEDA from logging alone (%)	Total HEDA from logging and Pine Beetle mortality (%)
114.6	23.12	22.97	8.82	16.10	3.66	19.76

Table 6 (continued)

Total area in Agriculture (km^2)	Total area in Agriculture (% of watershed)	Total area in Other Openings[1] (km^2)	Total HEDA with Logging, O and G & Agriculture (%)	HEDA Hazard rating Score (includes Logging, O and G and Agriculture)	Peak flow Hazard Rating
0.93	0.81	0.00	20.57	2.50	Mod

[1]Note: This includes Oil and Gas and mining openings

Table 7. 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
114.6	58	58	0	0.5	0.5	0.0	1.98	Low

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

Table 8. Loss of Riparian Function Hazard Rating (See Figures 3 to 6)

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	C4- Lightly unstable/disturbed	50	100.0	Moderately De-stabilized
2	C5 - Unstable/disturbed	495	100.0	Lightly De-stabilized
3	C5 - Unstable/disturbed	466	100.0	Quite Unstable
4	C4 - Unstable/disturbed	319	0.0	Moderately De-stabilized
5	B4- Lightly unstable	1331	0.0	Lightly De-stabilized
Hazard Scores:			Hazard Rating Score	Hazard Rating
			3.75	High

Table 9. Risk Rankings for the Different Hazards in the watershed

Watershed Hazard Types	Sensitivity Score	Sensitivity Rating	Hazard Score	Hazard Rating	Risk Score	Risk Rating
Increased Peak Flow	4.61	Very High	2.00	Low	9.2	Mod
Increase in Production of Fine Sediment	5.69	Extreme	1.98	Low	11.3	Mod
Reduction in Riparian Function	7.11	Extreme	3.75	High	26.7	Very High

RECOMMENDATIONS FOR LAND-BASED INVESTMENT ACTIVITIES IN PRIORITY WATERSHEDS

1. Prior to the allocation of permits for treatment activities, the McQuarrie Creek watershed management plan should be reviewed and carefully considered in order to determine how any LBI planned activities may affect peak flow risk in the McQuarrie Creek watershed.
2. The allocation of permits for treatment activities in the McQuarrie Creek watershed should be planned in collaboration with all major licences that operate in the watershed so that the total disturbance does not exceed the peak flow risk threshold set by government for this priority watershed.
3. Maintain long term recruitment of large woody debris (LWD), shade and bank stability by retaining at least 90% of the riparian area. This riparian area refers to the management area measured from the closest streambank to a distance 15m upslope from the streambank on:
    i. S4 streams that are 0.5m or greater in stream channel width, or
    ii. S6 streams that are 0.5m or greater in stream channel width that flow directly into a fish stream.
4. Develop and implement effective erosion and sediment control plans for all stream crossings that are your responsibility, whether you are building them, using them or just maintaining them. The effectiveness of the erosion and sediment control at the stream crossing should be measured using the Water Quality Effectiveness Evaluation methodology developed by the Government of BC[1]
5. Prior to the initiation of any treatment activities, identify the presence of any 'flat-over steep" topography and manage appropriately where needed (Figure 4). These topographic features can be prone to slope instability when forest cover is removed and localized drainage is not well planned.
6. Consider under-planting as a reforestation treatment as this minimizes the detrimental effects on peak flow risk, compared to completely knocking down the stand.
7. In order to optimize hydrological recovery, planting of all treated sites should be done with the best growing stock that is appropriate for the site. The selection of appropriate species and planting densities should be done by a qualified professional based on a site specific assessment.
8. Not all of the dead pine stands in the watershed should be targeted for knock down treatments. Some should be left for natural regeneration and biodiversity thus creating a more diverse forest in the future with more age classes, i.e. the presence of dead pine stands in the watershed is not an ecological disaster.

[1] http://www.for.gov.bc.ca/ftp/hfp/external/!publish/frep/indicators/Indicators-WaterQuality-Protocol-2009.pdf

Table 10. Table of comments and observations

Comment #1	Reach #1 is highly disturbed by the highway bridge and the railway crossing. Reach #2 appears to have been historically very disturbed by the adjacent agriculture (Figure 5).
Comment #2	Reach #3 is highly disturbed and eroding into the agriculture land. Serious streambank restoration efforts are required here. This particular issue contributes greatly to the sensitivity of the watershed (Figure 6).
Comment #3	Reaches #3, #4 and #5 have serious signs of bank erosion and channel aggradation. Current riparian removal is limited. Could this be old riparian logging and its long term detrimental effects? Reaches above 5 go into a more confined B type reach and are less sensitive.
Comment #4	The current HEDA hazard is low in this watershed, however the sensitivity of the lower reaches is very high (mostly as a result of past riparian disturbances). Thus the main issue in this watershed is controlling the HEDA so that peak flows don't further aggravate the stream instability problem.
Comment #5	The terrain is flat, the soils are generally coarse and the road density quite low. So the current dominant issue in this watershed is the protection of the mainsteam from further riparian disturbances and increased peak flows. This being said, however, it is essential that good erosion and sediment control practices are always implemented at stream crossings.

INTERPRETATIONS AND RECOMMENDATIONS FOR MANAGEMENT STRATEGIES FOR PROTECTION OF FISH RESOURCES WITHIN THIS CANDIDATE FISHERIES SENSITIVE WATERSHED

This watershed has a Very High sensitivity to increased peak flows and Extreme sensitivities to both increases in fine sediment and a loss of riparian functions. However, the watershed has a high risk rating only for the loss in riparian function hazard (Table 9).

The risk associated with increased peak flows is currently at a moderate level (Table 9). As a fisheries sensitive watershed, one of the main land management objectives for this watershed is the protection of fish and their habitat. With this objective in mind, it is important to maintain the peak flow risk below a "Moderate" level. This means that further stand treatment and forest harvesting activities in this watershed will have to minimized and possibly curtailed until hydrological recovery has occurred on the newer cut-blocks if a low peak flow risk is desired.

One of this main reason this watershed has a Very High sensitivity to increased peak flows is due to the very sensitive nature of the lower reaches (Figures 3 to 7). The past land-use disturbances along these lower reaches (i.e. agriculture and highway and railway crossings) have contributed significantly to this sensitivity. A good land management objective for this watershed would be the implementation of some riparian restoration efforts along Reach #3 especially. However, given that this is private land, it may be difficult for government agencies to implement such a strategy.

The current fine sediment risk rating is moderate, thus it is recommended that a WQEE survey[2] be completed in the McQuarrie Creek watershed in order to identify individual stream crossings that may have erosion and sediment control problems and to develop site-specific prescriptions to address any such problems.

[2] http://www.for.gov.bc.ca/ftp/hfp/external/!publish/frep/indicators/Indicators-WaterQuality-Protocol-2009.pdf

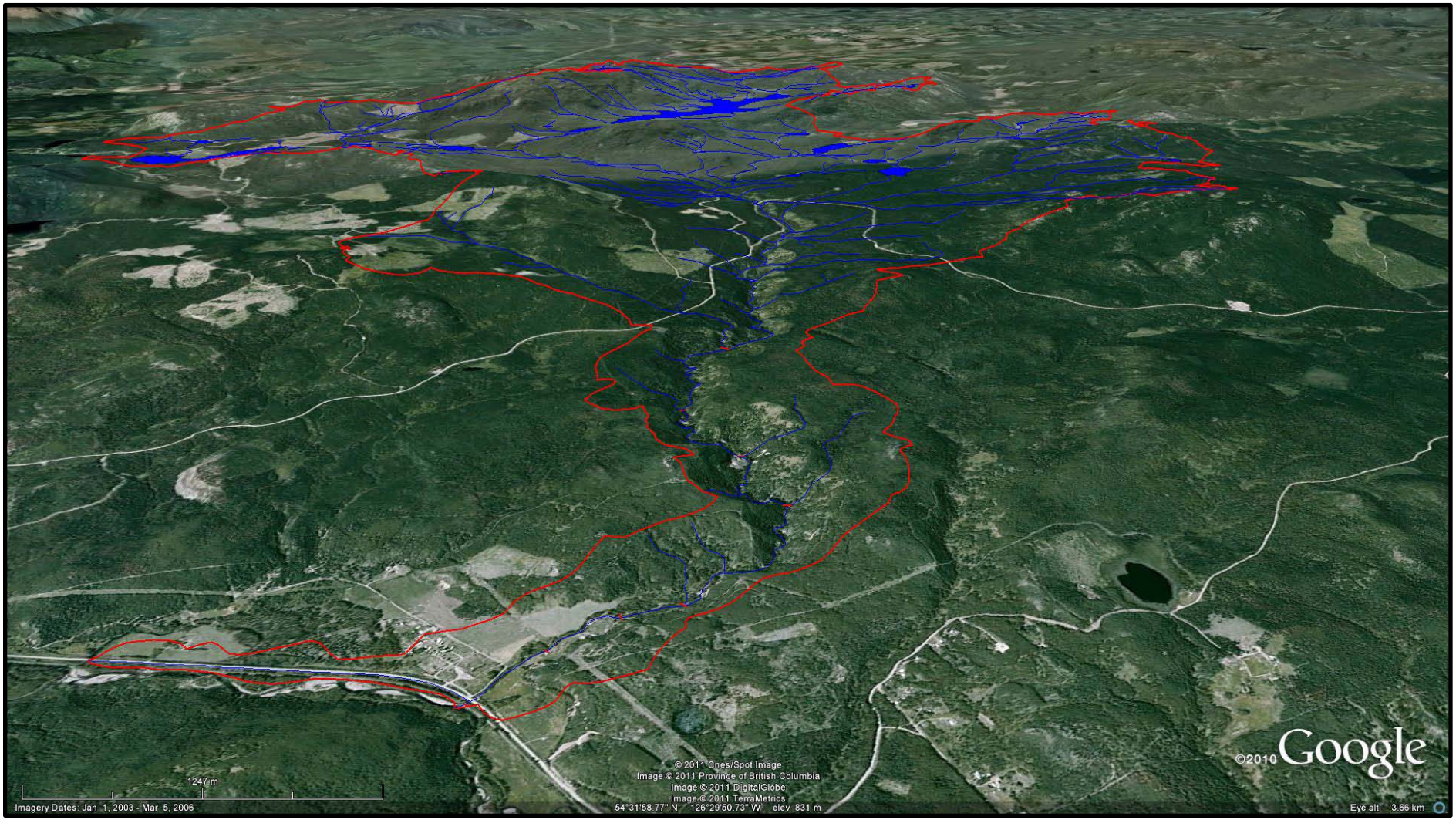

Figure 1. Google Earth image of McQuarrie Creek watershed looking upstream into the watershed.

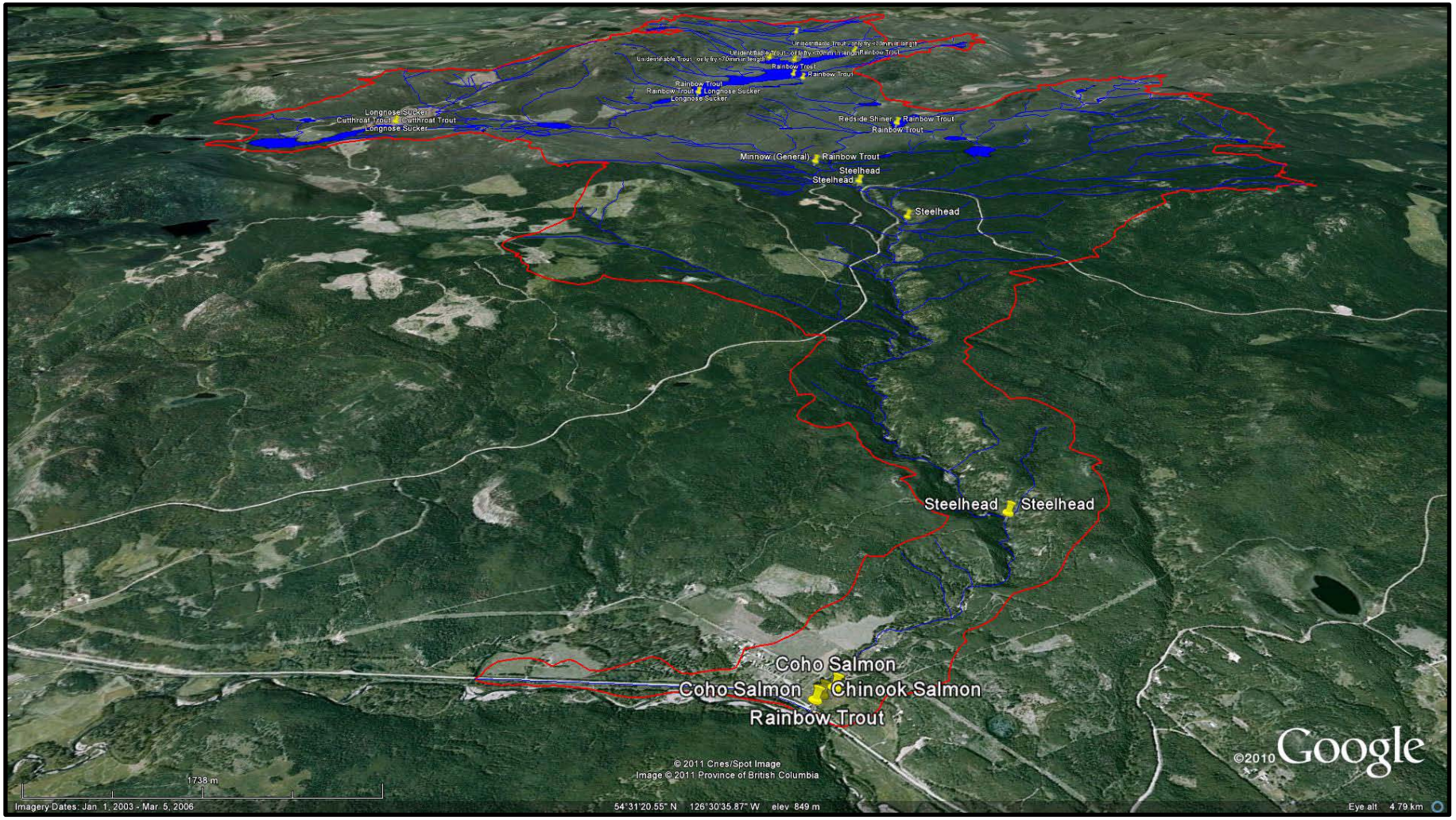

Figure 2. Google Earth image showing the general distribution of fish species in the lower part of the McQuarrie Creek watershed.

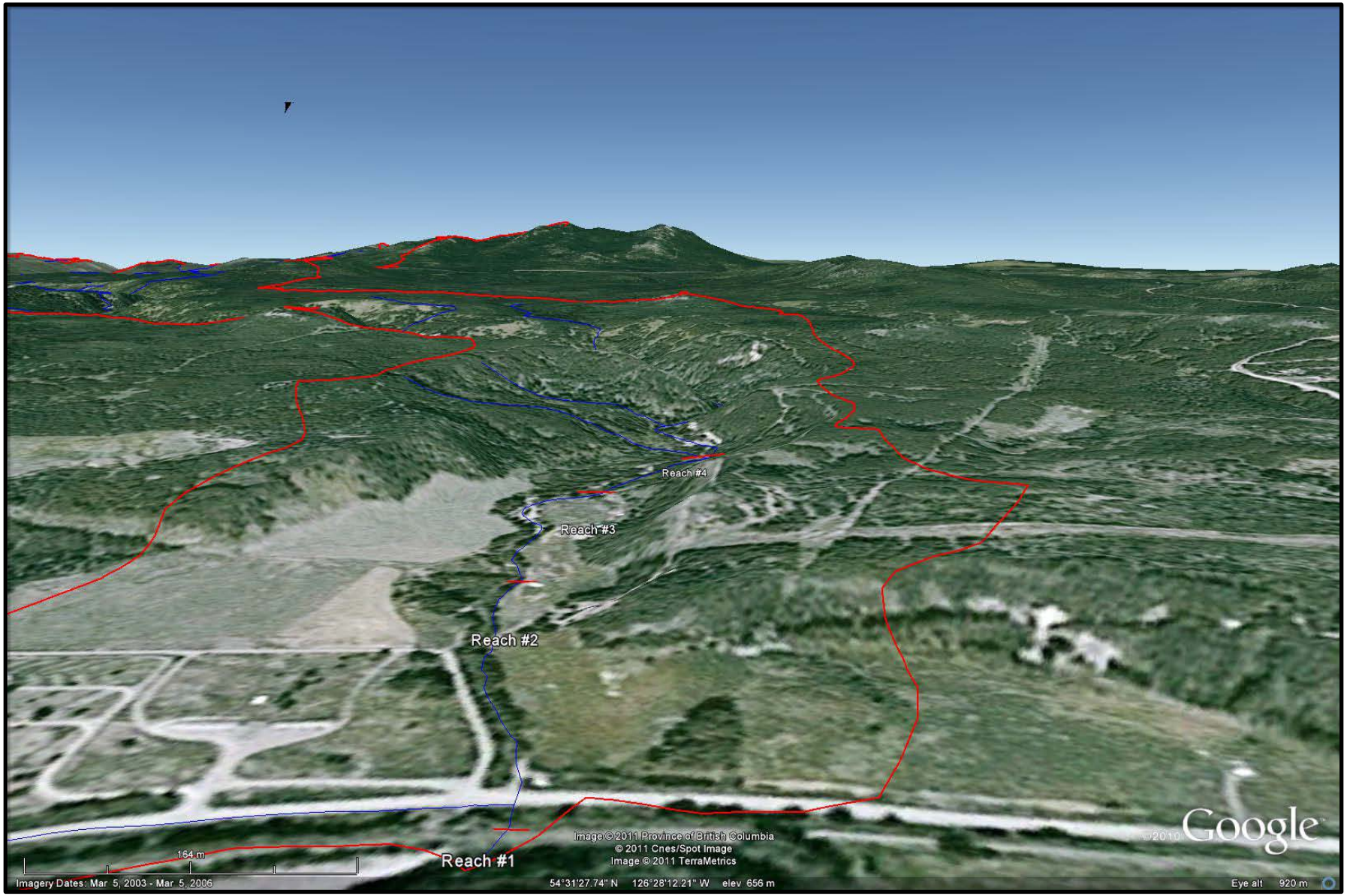

Figure 3.Google Earth image showing the location of the lower 4 stream reaches.

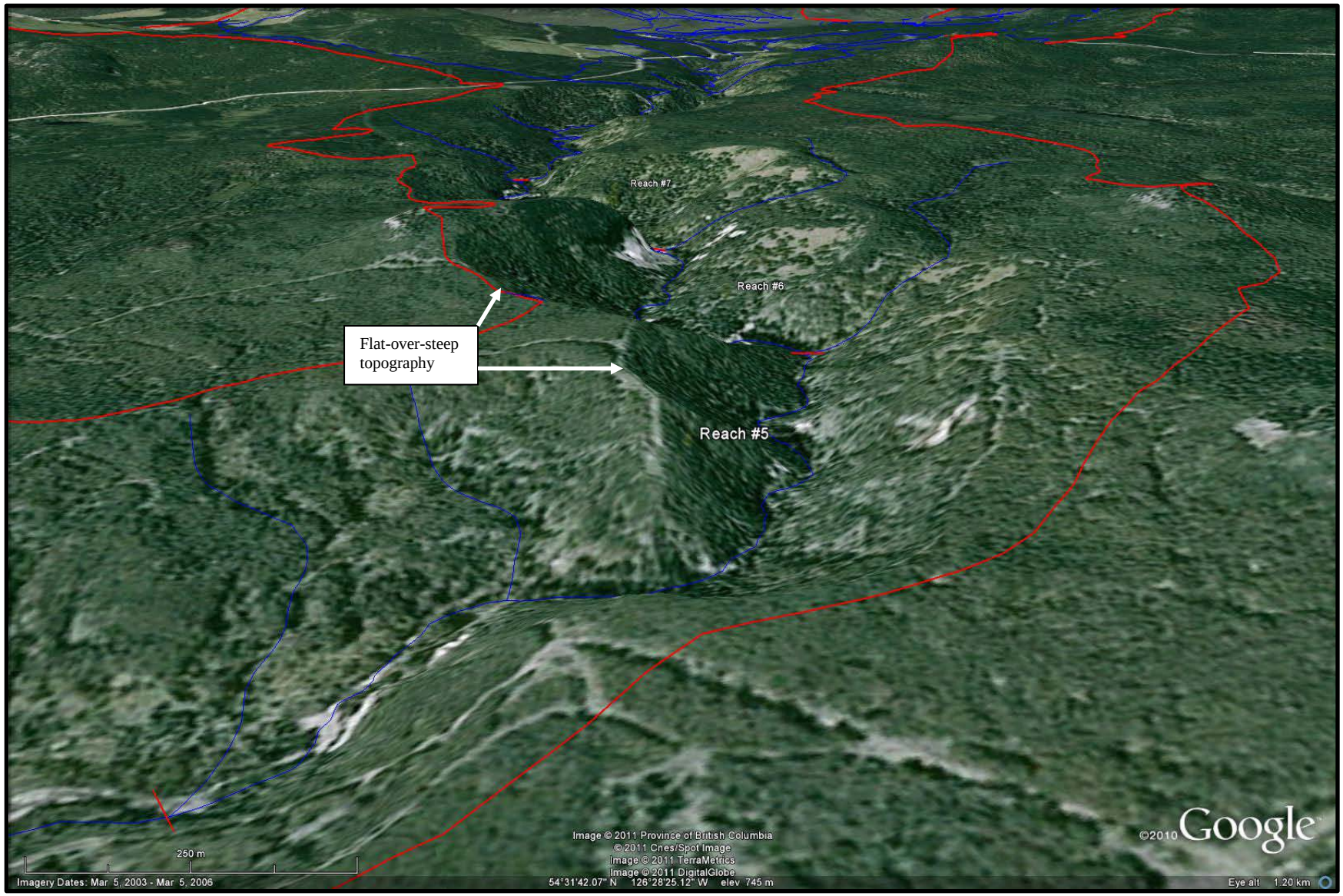

Figure 4.Google Earth image showing the location and general morphology of stream reaches #5, #6 and #7.

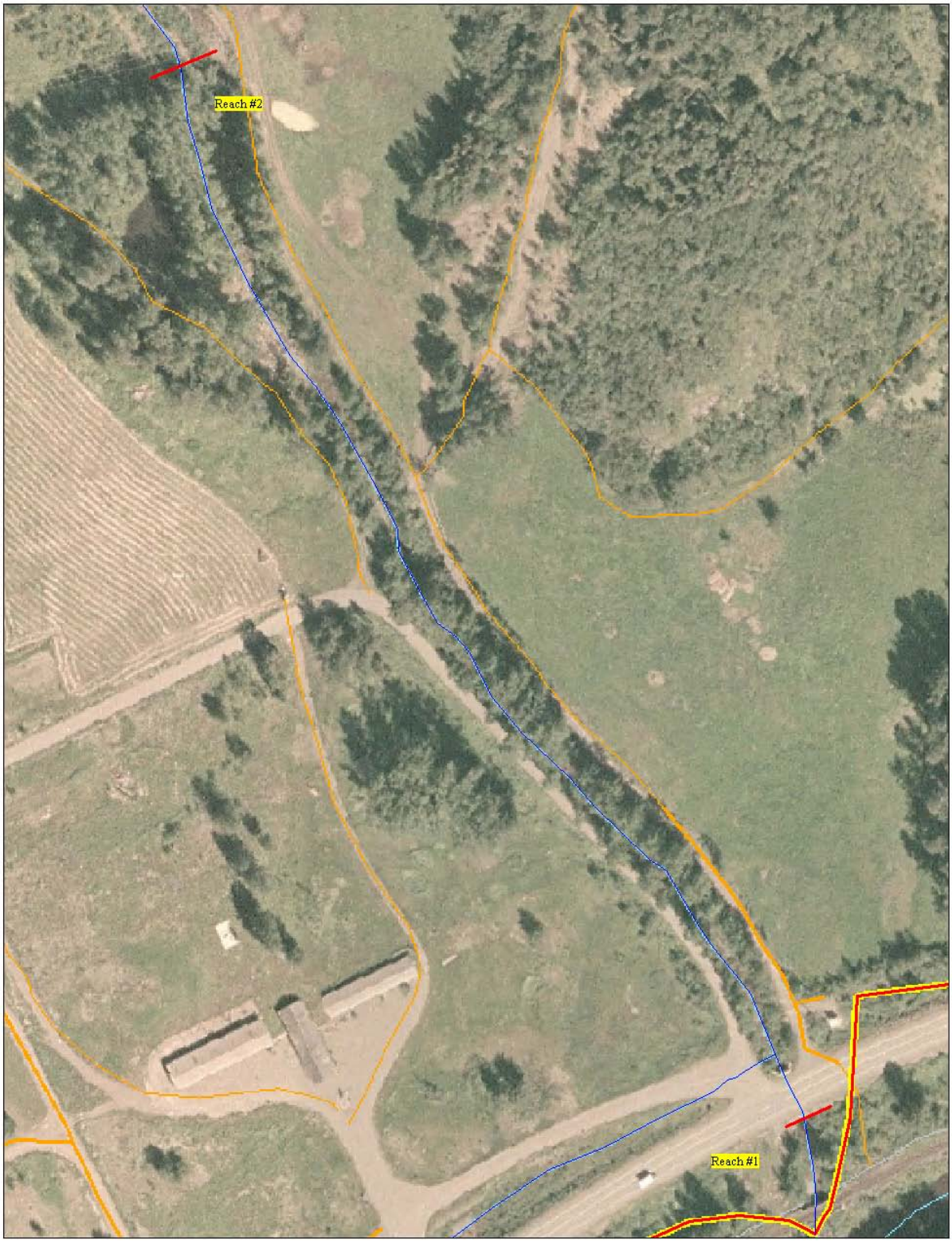

Figure 5. Vertical ortho-photo of Reaches #1 and #2 of McQuarrie Creek.

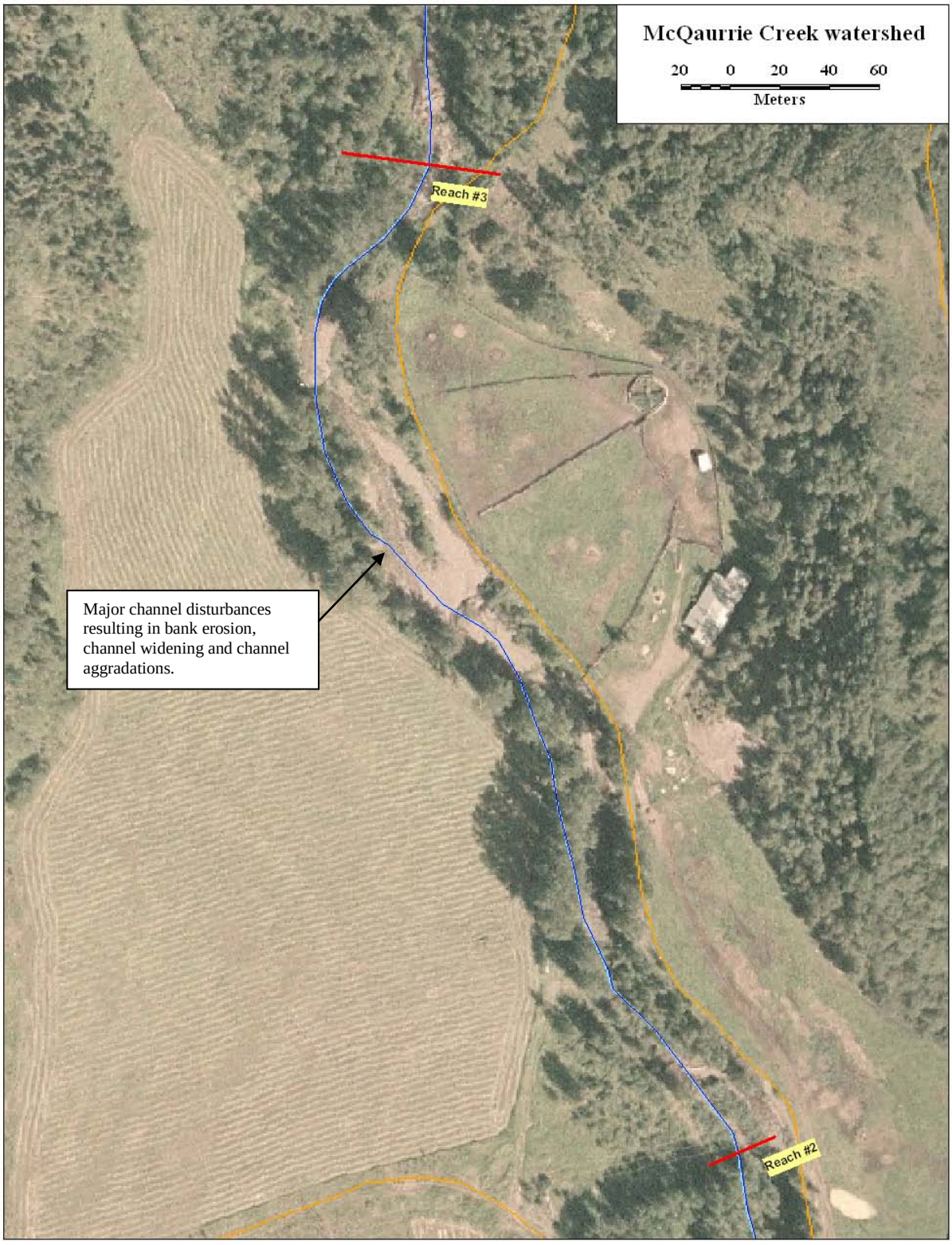

Figure 6. Vertical ortho-photo of Reach #3 of McQuarrie Creek.

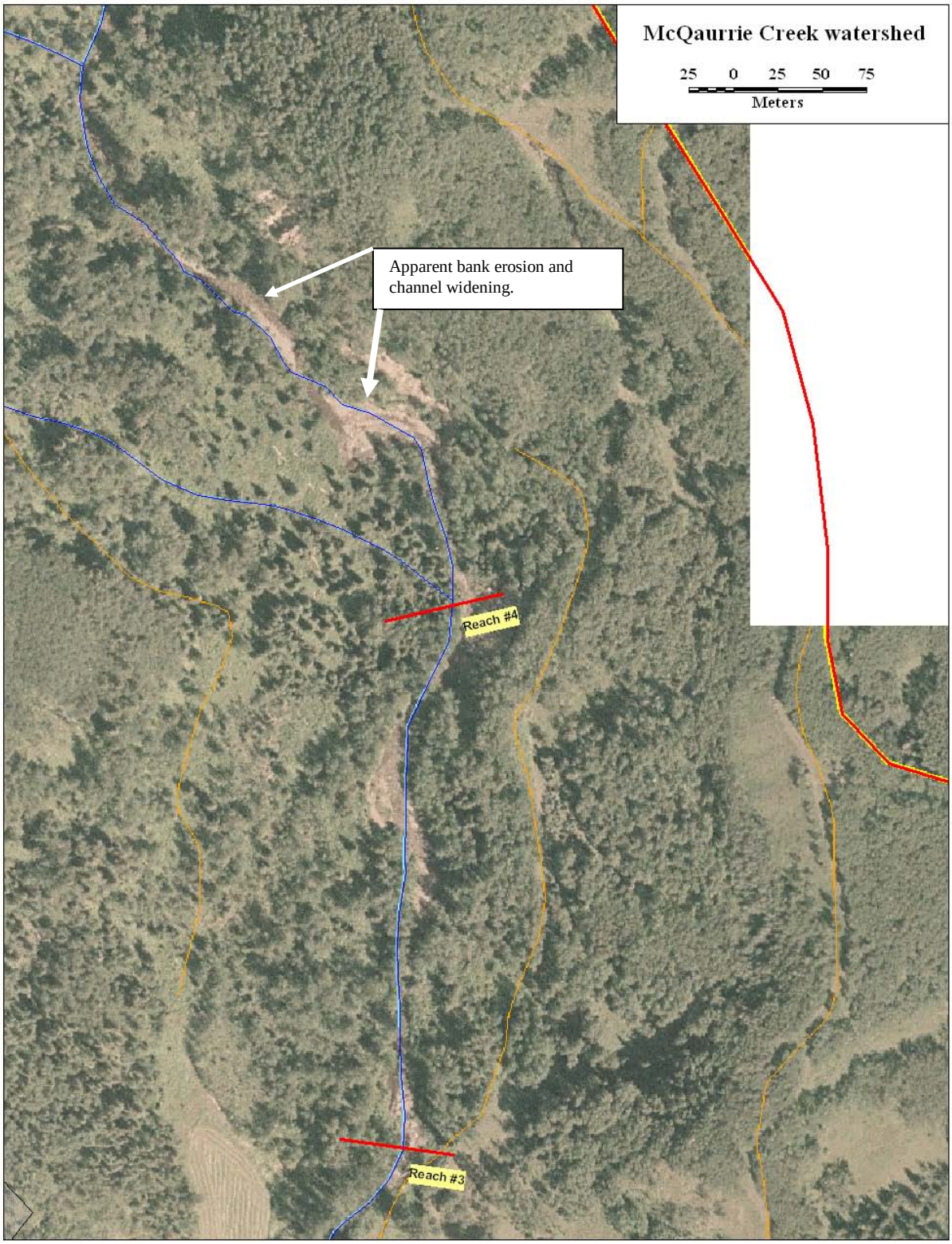

Figure 7. Vertical ortho-photo of Reaches #4 and #5 of McQuarrie Creek.