

Overview Assessment of Kobes Creek Watershed for Fish and Riparian Habitat

Prepared for

**Ministry of Water, Land and Air Protection
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EXECUTIVE SUMMARY

A fish habitat, riparian, stream channel and sediment source overview assessment was conducted for the Kobes Creek Watershed including the lower mainstem below the fork and the east main branch above the fork. The Kobes Creek Watershed is part of the Kobes/Ground Birch Landscape Unit which is a target watershed under the Watershed Restoration Program. In these assessments, the procedures outlined in Watershed Restoration Program Technical Circulars were followed. The study focused on stream and riparian habitats in the Kobes Creek Mainstem.

The mainstem of Kobes Creek is known to support a number of salmonid species including Arctic grayling, mountain whitefish, rainbow trout and bull trout and a number of non-salmonid fish species include large scale sucker, slimy sculpin and lake chub. No barriers to fish migration are known in the study area.

The total area disturbed (harvested or burned and/or silviculturally treated) in the Kobes Creek Mainstem and the east tributary to upper Kobes Creek is 1906 ha, or 12.8 % of the watershed area. Three hundred and seventy-three ha were disturbed in the tributaries representing 24.4 % of sub-watershed areas.

The extent of forestry activity in the watershed has been modest and forestry impacts are limited. No natural or forestry-related landslides were noted on the air photos, and the sediment supply to the creek has been steady. Channel conditions are generally good. Most of the mainstem channel is alluvial and very low gradient (<0.5%), with a sinuous and tortuous meandering pattern, and active floodplain. Reaches 3-5 have extensive floodplain, with numerous oxbow cut-off channels. Channel disturbance is uncommon, and is generally limited to Reach 6, where some disturbance associated with riparian logging may be evident.

The best stream rehabilitation opportunities are in Reaches 6, 10 and 11, and may include LWD placement, rock riffle placements, and bank stabilization measures. Logging impacts have been identified in Reaches 6 and 12 of the mainstem and in Reaches 6, 10, and 11 of tributaries. Logged areas along and within riparian polygons R6-F and R12-A of the mainstem, as well as T6-1-1A, T6-1-1B, T6-1-2B, T6-1-2D, T10-1-1B, T10-1-2A, T10-2-2A, T10-2-2B, T11-1-2A, T11-1-2B, T11-2-2A, and T11-1-2C, received high priority for additional riparian assessment and possible rehabilitation work. Riparian rehabilitation options include measures aimed at increasing the long-term input of LWD and short-to-medium term stabilization of slopes in order to arrest sediment inputs into the stream.

ACKNOWLEDGMENTS

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INTRODUCTION

In 2000, LGL Limited of Sidney, BC, was awarded a contract by the Ministry of Environment, Lands and Parks, Fort St. John Region, to conduct an overview assessment of three Sub-Region Landscape Units: Kobes/Ground Birch, Colt, and Black/Nig Landscape Units. These landscape units are target watersheds under the Watershed Restoration Program (WRP). The overview assessment includes a Fish Habitat Assessment, a Riparian Habitat Assessment, a Channel Assessment, and a Sediment Source Survey. Chapman Geoscience Ltd. was sub-contracted to perform the sediment source survey and channel assessment. The purpose of this report is to identify stream and riparian habitats that have been impacted by previous logging activities and to identify stream and riparian areas for further assessment and restoration for the Kobes Creek Mainstem Watershed within the Black/Nig Landscape Unit. The other four watersheds comprised in the three landscape units are reported on separately.

The goals of the stream and riparian overview assessments were to identify stream and riparian sections impacted by logging or with the potential to be impacted by logging activities. From this, and with consideration of upslope impacts (i.e., cut-blocks, roads, slides and gullies), stream sections were assigned a priority for further assessments and rehabilitation. Natural hazards to stream habitat (e.g., natural slides and barriers) were also considered.

In general, the following types of stream habitat degradation and rehabilitation opportunities were identified as best as possible from the air photographs:

- bank erosion and sediment source areas;
- debris and sediment accumulation;
- lack of LWD;
- channel pattern effects;
- road crossings;
- potential barriers to fish migration; and
- inadequate riparian vegetation.

Based on the assessments conducted and *Watershed Restoration Program Guidelines*, a prioritized list and schedule of stream and riparian field assessments and rehabilitation opportunities was developed.

BACKGROUND INFORMATION

Physical Features

Kobes Creek is located in the Peace River drainage near Fort St. John, BC. The creek drains northward into the Halfway River approximately 50 km north of Hudson Hope, BC (Figure 1). Kobes joins the Halfway River approximately 65 km upstream from its confluence with the Peace River. From the headwaters, the mainstem flows for 21 km in a northerly direction and then turns to the east and flows for 17 km before joining the Halfway River. At approximately 32 km upstream from the mouth of Kobes Creek, the channel splits into two main branches. The east branch is the Kobes Creek Mainstem and the west branch is an unnamed tributary.

The study area is the east tributary to the upper Kobes Creek Mainstem and the mainstem below the tributary confluence. The mainstem of the tributary is approximately 19 km for a total mainstem length in the study area of 50 km. The drainage area of the study area is 176 km². The lower mainstem of the Kobes Creek study was divided into 5 reaches and the east tributary above the fork was assigned 8 additional reaches (Appendix A).

Almost the entire Kobes Creek Watershed lies in the Boreal White and Black Spruce biogeoclimatic zone (BWBS). Reaches 1 to 11 lie in the Peace Moist Warm variant of the Boreal White and Black Spruce biogeoclimatic zone (BWBSmw1). Further to the mountains, Reach 12 and upper reaches of right tributaries within Reaches 6-12 lie in the Murray Wet Cool variant of the Boreal White and Black Spruce biogeoclimatic zone (BWBSwk1). Still upwards, the upper end of Reach 13 lies in the Moist Warm subzone of the Engelmann Spruce – Subalpine Fir biogeoclimatic zone (variant ESSFmw1). Upper areas of some small left tributaries of Kobes Creek lie in the Graham Wet Cool variant of the Boreal White and Black Spruce biogeoclimatic zone (BWBSwk2).

The overall slope of the Kobes Creek Mainstem below the confluence of east and west branches is low at 0.4% (Figure 2). The lower 32 km of mainstem (Reach 1-5 below the forks) is a relatively wide, low gradient meandering channel with an average bankfull width of 30 m.

The first 10 km of the east tributary mainstem is a relatively low gradient meandering channel. Habitat consists of a mixture of riffle, pool and glide with cover provided by deep pool, LWD and boulder. Farther upstream there is a slight increase in confinement and gradient. Here the amount of fines is reduced and substrate is dominated by cobbles and boulder. Habitat is mainly riffle pool with cover provided by LWD, boulder and cutbank.

Climate and General Hydrology

Watershed and sub-basin boundaries were defined on 1:20,000 TRIM maps. The climate and hydrology of the study basins is described by reviewing and interpreting the information collected by the Atmospheric Environment Service of Environment Canada, and the Water Survey of Canada (Table 1). Precipitation characteristics are presented for monthly and annual time periods (Table 2). Stream discharge and runoff estimates are presented for annual and monthly time periods. Peak discharge estimates are derived through frequency analysis of regional discharge data, and presented for 2 yr and 50 yr return periods. Peak discharge estimates are based on a Log Pearson III distribution. Low flow discharge estimates are derived through frequency analysis of regional discharge data, and presented for 2 yr and 50 yr return periods. Low flow estimates are based on a Gumbel distribution.

Based on Atmospheric Environment Service climate stations, annual precipitation for the study area is estimated to be approximately 470 mm (Table 2). About two-thirds of this occurs as rain and about one-third occurs as snow. The snow is stored during the winter and released as streamflow during spring freshet. Mean annual runoff for Kobes Creek is estimated to be about 215 mm. The remaining portion of the annual precipitation is returned to the atmosphere through evapotranspiration.

The hydrology of watersheds in the Peace River area is dominated by a mixture of spring snowmelt, and summer frontal and convective rainfall. However, the number of Water Survey of Canada stations in the study area from which to estimate peak and low flow values are few. For mid-sized watersheds, such as Kobes Creek (drainage area = 175.62 km² for the study area), annual peak flows can occur from either spring snowmelt or summer rainfall. As an example, for a similarly sized watershed for the 14 years of peak flow record for Alces Creek (drainage area = 263 km²) 4 years (28%) had rain caused peak flows and 10 years (72%) had snowmelt-caused peak flows as the largest discharge of the year. For the 19 years of peak flow data for Dickebusch Creek (drainage area = 88.5 km²), 5 years (26%) had rain-caused peak flows and 14 years (74%) had snowmelt-caused peak flows. The snowmelt-caused peak flows are the most commonly occurring, but the rain-caused peak flows are the largest in magnitude. For Dickebusch Creek, the 14 snowmelt-caused peak flows had an average daily discharge of 11.9 m³/s, while the 5 rain-caused peak flows had an average daily discharge of 26.9 m³/s. Daily average peak flow estimates for basins in the region are shown in Table 3, and instantaneous peak flow estimates are shown in Table 4. Summer season 7-day average low flows are shown in Table 5. For preliminary design purposes for Kobes Creek, the return period estimates shown in Tables 3 and 4 should be used. These estimates are the average of the regional stations, excluding Alces Creek, which appears to have unusually different discharge characteristics.

Geology and Slope Stability

Kobes Creek is located east of the Rocky Mountains, mostly on the Alberta Plateau of the Interior Plains physiographic unit (Holland, 1976). Bedrock geology is dominated entirely by sedimentary rocks, predominantly Triassic and Cretaceous siltstones, sandstones and shale. Surficial materials are mainly glacial till and outwash deposits. Relief is low throughout most of the watershed (except Reaches 11-13), and topography is subdued. Slope instability is generally rare.

Vegetation

Vegetation of the watershed is dominated by trembling aspen (*Populus tremuloides* Michx.), balsam poplar (*Populus balsamifera* ssp. *balsamifera* L.), white spruce (*Picea glauca* (Moench) Voss), lodgepole pine (*Pinus contorta* var. *latifolia* Engelm. ex S. Wats.), and black spruce (*Picea mariana* (P. Mill.) B.S.P.). Balsam poplar and white spruce are particularly common on wetter well-drained sites and along streams, where fires are less frequent and succession can proceed further along uninterrupted. Lodgepole pine is a most common seral species on drier and nutrient-poor sites, such as flat sandy river terraces. Dry pine – lichen communities are common. Black spruce, sometimes with a minor admixture of tamarack (*Larix laricina* (Du Roi) K. Koch), is abundant in wet forests and wetlands, mainly with *Sphagnum*, on poorly drained organic soils (DeLong et al. 1990). Such sites are common though usually not extensive.

Forest fires are frequent throughout the region and are believed to be a vital ecological factor preventing the stagnation of nutrient cycles and maintaining a diversity of successional stages across landscape. Late-seral forest is dominated by white spruce, sometimes with minor proportion of black spruce. Most older stands have at least a few veteran aspen and lodgepole pine remaining as the legacy of the early successional stages. Most of the landscape is occupied by a mosaic of seral stands of lodgepole pine, aspen, and mixed white spruce – aspen. Dry grassland and scrub vegetation is locally common on steep, sunburnt south-facing slopes along Kobes Creek and other creeks.

On more or less zonal, mid-slope sites, shrub and herb layers are poorly to moderately developed. Most characteristic understory species include highbush cranberry (*Viburnum edule* (Michx.) Raf.), prickly rose (*Rosa acicularis* Lindl.), bunchberry (*Cornus canadensis* L.), twinflower (*Linnaea borealis* L.), heart-leaved arnica (*Arnica latifolia* Bong.), fireweed (*Epilobium latifolium* L.), and tall bluebells (*Mertensia paniculata* var. *paniculata* (Ait.) G. Don). On wetter sites and along streams, a denser white spruce-dominated forest prevails with a more developed shrub and herb layer consisting typically of highbush cranberry, prickly rose, black gooseberry (*Ribes lacustre* (Pers.) Poir.), black twinberry (*Lonicera involucreta* Banks ex Spreng.), red-osier dogwood (*Cornus sericea* ssp. *stolonifera* (Michx.) Fosberg), and

palmate coltsfoot (*Petasites frigidus* var. *palmatus* (Ait.) Cronq.).

By far the most common mosses throughout the area are step moss (*Hylocomium splendens* (Hedw.) Schimp. in B.S.G.), red-stemmed feathermoss (*Pleurozium schreberi* (Brid.) Mitt.), and knight's plume (*Ptilium crista-castrensis* (Hedw.) De Not.). On dry sites, lichens (*Cladonia* spp, *Cladina* spp, etc.) are widespread, whereas on wetter sites the above-mentioned three common moss species are joined by leafy mosses (*Mnium* spp.) and many other species which are rarely abundant.

Resource Values

Kobes Creek and the east tributary to Upper Kobes Creek support a number of salmonid species that include Arctic grayling, Mountain whitefish, rainbow trout and Bull trout. Non-salmonid fish species include lake chub, slimy sculpin, large scale sucker, and longnose sucker.

Salmonids including rainbow trout, Bull trout, Mountain whitefish and Arctic grayling have been captured in the lower mainstem. Since Arctic grayling and Mountain whitefish have been captured in the west branch (Brendan Anderson, *personal communication* 2001), they are also suspected to occur in the east branch. Bull trout are known to use headwaters of the Halfway River for spawning and juvenile bull trout are known to penetrate the upper reaches of relatively small streams, provided suitable rearing habitat and cover are available. Rainbow trout have been found throughout the mainstem of the study area (Diversified Environmental Services, 1997) and are therefore likely to occur in the east branch as well.

Numerous wildlife species occur in the Kobes Watershed. These include game and fur bearing species; ducks, geese, grouse, swans, beaver, wolverine, fisher, black bear, grizzly bear, moose, white tailed deer, mule deer, lynx, bobcat, river otter, mink, marten, muskrat, squirrel, snowshoe hare, coyote, fox, cougar, goat and elk. Other bird species present include eagles, hawks, loons, owls, thrashes, warblers and sparrows. Endangered species (red listed) within the biogeoclimatic zones of the Kobes Watershed include Peregrine falcon, Northern pocket gopher, American White pelican, Prairie falcon, Upland Sandpiper, Forster's tern, Purple Martin, various warbler species, Sharp tailed sparrow, Northern long-eared myotis and the Bison.

Logging History

Logging in the Kobes Creek Watershed is a recent phenomenon that started in the 1980's. Most cutblocks were logged in 1986 and are scattered throughout the watershed. The logging in or near the riparian areas was carried out unevenly throughout the watershed. The lower reaches are almost untouched with only one cutblock in the vicinity of the RMA in Reach 1. Few

cutblocks over the length of the creek extend to the banks of the river. The upper reaches are more extensively logged. Cutblocks extend to the stream in Reach 6 and along the upper tributaries.

The total area logged in the Kobes Creek Mainstem (below the forks) and the east tributary to upper Kobes Creek is 1906 ha or 12.8 % of the watershed area (Table 6).

METHODS

The 1:10,000 colour (obtained in 2000) and 1:20,000 black and white ortho-photographs were acquired for the mainstem area and major tributaries in the Kobes Creek Watershed. Air photograph analysis was used to describe habitat characteristics of the stream channel and the riparian zone. Details of the methodology, including the determination of reaches and sections, types of physical features assessed, and the determination of impacts, are provided in Watershed Restoration Technical Circular No. 8 (WRPTC 1996) and Watershed Restoration Technical Circular No. 6 (WRPTC 2000). Any deviations from the methods described in the circulars are noted below.

Reach Designation

Stream reaches were determined by examining channel form and confinement from the ortho-photos and 1:10,000 air photos, along with gradients from 1:20,000 TRIM maps. Potential barriers to fish distribution, and slope and channel stability were also considered for reach designation.

Fish Distributions

Information on the distribution of fish species in the watershed was compiled from the Fish Information Summary System (1997), Aquatic Biophysical Maps and recent inventory reports (Diversified Environmental Services, 1997). Brendan Anderson, WRP Coordinator, MELP, Fort St. John, should be contacted for further information on fish distributions.

Fish Habitat Assessments

Habitat assessments were conducted according to WRP Technical Circular No. 8 (WRPTC 1996) with no deviations in methodology. A preliminary habitat evaluation was conducted based on qualitative comparisons and indicators of habitat disturbances. Using the information on fish distribution, fish use and habitat quality, we delineated and prioritized areas to be examined in Level 1 field surveys.

Sediment Source Survey

The sediment source survey was completed using a standard procedure of air photo interpretation and mapping. The 1:10,000 air photos were used for the sediment source survey. Each sediment source is identified with a unique number and coded with the following information:

- type of sediment source (e.g., road failure, open slope debris slide, channelized debris flow, rock fall, avalanche, etc.);
- initiation point (e.g., natural forest, road or landing, within harvested block, etc.);
- termination point (e.g., mainstem stream channel, tributary stream channel, road or landing, slope); and
- existing and possible future impact on streams.

All sediment sources are georeferenced and mapped to 1:20,000 TRIM data. The sediment source and hillslope characteristics of the study basins are interpreted in relation to channel stability and potential fish habitat rehabilitation.

Channel Assessment

The channel assessment was completed using a standard procedure of air photo interpretation and mapping, using the recent 1:10,000 air photos listed earlier in this report. The air photos are used to define channel characteristics and potential disturbance indicators for each reach, based on an evaluation of bed load characteristics, bank erosion and lateral shifting, riparian disturbance, hillslope conditions and erosion, and watershed hydrology conditions.

A preliminary assessment of the following channel conditions is derived from the air photo and map interpretation:

- channel morphology;
- bankfull channel width and gradient;
- bed and bank materials and sediment load characteristics;
- channel stability and disturbance;
- type and extent of channel disturbance;
- riparian vegetation characteristics; and
- potential for future impacts from hillslope or upstream areas.

Riparian Assessments

The procedures and decision criteria used to prioritize riparian polygons for Level 1 Assessment generally followed the procedures as set out in the Watershed Restoration Technical Circular No. 6 (2000). Recently acquired 1:10,000 color aerial photography and

GIS generated forest opening maps were used to delineate riparian polygons boundaries, assess RVT designations and stand structure. The use of digital FC1 data and/or CANFOR Development Plan History Maps assisted in the description of polygon stand structure, logging history and other disturbances. Dominant and co-dominant species are provided in stand structure descriptions. Grease pencils were used to mark riparian polygon boundaries directly on the aerial photographs versus the prescribed use of acetate overlays.

Mapping

A set of 1:20,000 black and white ortho-photos was supplied by Canadian Forest Products Ltd., Peace Region, Fort St. John Division. These images were utilized in the reach break designation and channel condition assessment. TRIM data were supplied from Information Systems Branch, BC Ministry of Environment, Lands and Parks, Victoria. Base map features including roads, contours, streams and lakes were utilized from these data for all map products (Appendix A and C). Forest cover data (FC1) was supplied by the Land Information Management Officer of the BC Ministry of Forests, Fort St. John Forest District. These data were used to map out disturbance areas (logging, burns). Appendix A shows reach break assessment, sediment sources, fish distribution, logged areas and riparian RVT polygons. Refer to Appendix B for ortho-photo prints showing reach breaks and RVT polygons. Appendix C shows reach break assessment, sediment sources, fish distribution, logging history and stream gradient.

RESULTS

Reach Designations

Stream reaches for the upper Kobes Creek Watershed are shown on the maps presented in Appendix A and on the ortho-photo prints in Appendix B. A total of 13 reaches were identified: 5 reaches on the mainstem of Kobes Creek below the fork and additional 8 reaches on the east tributary. All mainstem reaches were assessed for habitat and riparian impacts since 1:10,000 photography covered this area. Tributaries that were impacted were identified, but not assessed because habitat features were not easily assessed from the photographs.

Fish Distributions

The species of salmonids known to be present in Kobes Creek Watershed include Arctic grayling, Bull trout, Mountain whitefish and rainbow trout. Non-salmonid fish species known to occur in the watershed include lake chub, slimy sculpin, red side shiner, long nose dace, long nose, coarse scale, and white suckers. Salmonids and non-salmonids occur in the lower Kobes Mainstem (Table 7). No salmonids have been captured above Reach 5, however rainbow trout, arctic grayling and mountain whitefish have been captured in the

west branch of the upper west tributary and are therefore assumed to also occur in the east tributary. No barriers to migration are noted in the study area. A gradient analysis has been completed and results are presented on the map in Appendix C.

Fish Habitat Assessments

The results of the air photograph assessment of stream fish habitat are summarized in Table 8. Habitat features for the mainstem of Kobes Creek and the east tributary were assessed from ortho photos for Reaches 1 to 13. Habitat features were not visible on the 1:10,000 air photographs. Average gradients for the 13 stream reaches (Figure 2) were calculated from reach lengths and elevation data reported in Table 8.

Cutblocks occur adjacent to the mainstem in Reaches 6 and 12 of the east tributary mainstem and in tributaries to Reaches 6, 7, 10 and 11 (see map in Appendix A). The mainstem and the east tributary show only minor disturbances that include bank erosion, isolated channels and LWD jams. Much of disturbance is probably natural.

The percentage of pools is less than 25% in Reaches 1-3 and 6-13, whereas Reaches 4 and 5 have > 25% pools. Few LWD pieces were observed in all reaches except 9 and 12 and no LWD was observed in Reaches 2 and 3. Off-channel habitat was abundant throughout most of the mainstem channel, with the only exception of Reach 12, where no off-channel habitat was observed.

Fish habitat is considered sub-optimal because of a lack of cover and low percentage of pools. This is particularly evident in Reaches 7, 8 and tributaries to Reaches 6-11.

Sediment Source Survey

No forestry-related sediment sources were noted in the study area of the Kobes Creek Watershed. In general, the extent of forestry activity in the watershed has been low (Table 6) and no forestry impacts are apparent. The major sediment sources to Kobes Creek are natural, and consist of large eroding bedrock slopes along the canyon portions of the channel (Reaches 1 and 2). The eroding cutbanks are large in size and are commonly located at the outside of meander bends. The erosional characteristics appear stable, indicating that these sources probably provide a low, chronic source of sediment to Kobes Creek, but that changes are not large scale or catastrophic. Refer to Table 9 for a summary of sediment sources for Kobes Creek.

Channel Assessment

The air photo channel assessment was conducted on 64 km of the mainstem

channel and East tributary of Kobes Creek. Channel characteristics are summarized in Table 10.

The results indicate that the mainstem and East tributary of Kobes Creek have a low natural rate of bed load transport and a low natural rate of lateral shifting. Human-related disturbance of the channel is low. All the study reaches are alluvial, generally with low gradient. Reaches 1 and 2 (0.2% gradient) are incised into bedrock and Holocene sediment, and exhibit natural bank erosion at the outside of meander bends where the channel cuts into the confining sediment. Reaches 3-5, below the confluence with the West tributary, are generally <0.5% gradient, and exhibit a highly sinuous meandering pattern, with extensive lateral bar development. Adjacent to both banks is active floodplain, with numerous back and side channels and cut-off meanders. Reaches 6-8, upstream of the confluence with the West tributary of Kobes Creek, are similarly low gradient (approximately 0.5%), alluvial and sinuously meandering, but with a narrower bankfull width than the lower reaches and with less extensive development of meander cut-offs. Some disturbance in Reach 6 may have occurred because of riparian logging. However, channel effects are subtle and difficult to discern on the air photos, and should be field examined. Reaches 9-12 are narrow, single thread, and become increasingly higher gradient. Reach 13 (the headwaters of the East tributary) arises from Butler Ridge and has an average gradient of 7%.

No sediment aggradation is evident on the air photos, and there is no evidence for recent change in the patterns of erosion and deposition, channel width and form, and other morphological characteristics. Channel processes appear to be operating as natural, with change occurring slowly and dynamically as would be expected for a low energy, low gradient alluvial river. Refer to Table 11 for a channel condition summary.

Riparian Assessments

Table 12 summarizes riparian polygon delineation and classification. Little logging occurred in the riparian zone. Fire seems to have played a less important role in the riparian zone than in the upland portions of the landscape; therefore, most of the RMA is at mature and maturing stages. The complex nature of many polygons, which are dense mosaic of various structural stages, makes delineation of polygons somewhat subjective. The pattern of riparian polygons is quite complex in the lower part of the watershed, reflecting the complex geomorphologic settings, disturbance history, and the silviculture history.

Logging occurred within riparian zones in Reaches 6 and 12, and near, but not within, the riparian zone of Reach 7 of the mainstem. Logged areas, *i.e.*, polygons R6-F and R12-A of the mainstem, as well as T6-1-1A, T6-1-1B, T6-1-2B, T6-1-2D, T10-1-1B, T10-1-2A, T10-2-2A, T10-2-2B, T11-1-2A, T11-1-2B, T11-2-2A, and T11-1-2C, may have been impacted by logging activities. Within these riparian polygons, logging has occurred

relatively recently (in late 80s – early 90s) and was often carried out to the bank, which probably increased erosion rate and may have destabilized the bank. Other riparian function, such as stream shading, LWD supply, sediment trapping and solute filtering, and wildlife habitat features, were likely lost or impaired as a result of clearcutting.

DISCUSSION AND RECOMMENDATIONS

Most of the Kobes Creek and east tributary is undisturbed and would not benefit from rehabilitation activity. However, there are a few areas of disturbance where rehabilitation would improve fish habitat or prevent future loss of fish habitat. The highest priority for both further fish habitat assessments and riparian assessments are Reaches 6 and 12 of the mainstem and tributaries in Reaches 6, 10, and 11. From our overall analysis of watershed condition, we believe that potential restoration work in these Reaches will have a low likelihood of being negatively impacted by current or potential watershed conditions and processes, and would provide a high benefit to fish and fish habitat (Table 13). Level 1 field assessments are recommended for all above-mentioned sections of the watershed; the assessments should include a field-based channel conditions assessment and a riparian assessment.

Further Level 1 FHAP Assessment Needs

Table 8 summarizes potential instream rehabilitation opportunities for fish habitat in Kobes Creek Watershed. Reach 6 received the highest priority for Level 1 habitat assessments. This low gradient (<1%), fish-bearing reach provides the greatest opportunities for instream rehabilitation of fish habitat. Tributaries to Reaches 6, 10 and 11, and Reach 12 of the mainstem also received high priority for Level 1 assessments.

Stream Rehabilitation Options

Rehabilitation opportunities in Reaches 6, 12, and tributaries to Reaches 6, 10 and 11 include LWD placement, rock riffle placements, and bank stabilization measures (Table 8).

Further Riparian Assessment Needs

Site visitation priorities, riparian rehabilitation opportunities and other comments are summarized in Table 12. Logged areas within the riparian zone, i.e., polygons R6-F and R12-A of the mainstem, as well as T6-1-1A, T6-1-1B, T6-1-2B, T6-1-2D, T10-1-1B, T10-1-2A, T10-2-2A, T10-2-2B, T11-1-2A, T11-1-2B, T11-2-2A, and T11-1-2C, received high priority for Level 1 field assessment and possible rehabilitation work. The main objective of riparian work is to restore key riparian functions: shading of the stream, complex fish habitat, increasing bank stability, preventing fine and coarse sediments from entering the stream, and providing

habitat for wildlife.

Stream-side vegetation plays a critical role in shaping both channels and in-stream habitats. Therefore, riparian polygons most promising for fish habitat enhancement have received high site visitation priority. All logged areas appear to have been planted. These are now at the shrub structural stage. Regeneration is difficult to assess without a field reconnaissance; therefore, we recommend field assessment of all logged riparian areas (Table 12).

Riparian Rehabilitation Options

Riparian rehabilitation options in areas that received high visitation priority include increasing the long-term input of LWD in order to provide a range of riparian functions. Additions of LWD to the river will increase the complexity of fish habitat, provide cover and hiding space for juveniles. Healthy riparian forest will stabilize the banks and arrest sediment supply into the stream. It will also filter and selectively trap solutes from the soil. Stabilization of adjacent slopes in order to prevent or retard waste events and formation of gullies is also important. The riparian polygons containing mature forest and those with extensive wetlands are also valuable wildlife habitats supporting the disproportionately high biodiversity.

Riparian areas affected by the forest service roads (most of the logged polygons (Table 12) and an unlogged polygon T10-1-2B) will require rehabilitation work as well. If the roads are decommissioned, rehabilitation options will include mechanical scarification of the road surface and planting conifers. In several areas bank stability is high priority (Table 12), and revegetation of slopes may be needed to arrest erosion and possible waste events. The use of conifers (spruce) and native fast-growing early successional deciduous tree species (aspen, birch) and/or willow stakes maybe needed. The exact strategy must be defined after the field assessments.

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TABLES

Table 1. Locations of Water Survey of Canada Stations and Atmospheric Environment Service Stations cited in this report.

Water Survey of Canada Gauge			Drainage Area km ²	Years of Record	Latitude	Longitude
07FB004	Dickebusch Creek	near the mouth	85.5	19	55 32 07 N	121 35 40 W
07FB005	Quality Creek	near the mouth	29.5	20	55 08 45 N	120 55 24 W
07FB007	Sukunka River	above Chamberlain Cr.	927	8	55 11 16 N	121 45 40 W
07FB010	Pine River	Above Mountain Cr.	677	4	55 30 30 N	122 34 29 W
08FB011	Windrem Creek	Near Chetwynd	22.9	10	55 41 45 N	121 37 48 W
08HF007	Alces River	At 22 nd Base Line	298	14	56 20 01 N	120 09 17 W
Atmospheric Environment Service Station				Years of Record	Latitude	Longitude
	Baldonnel			64	56 14 N	120 41 W
	Dawson Creek	Airport		35	55 44 N	120 11 W
	Fort St. John	Airport		56	56 14 N	120 44 W
	Taylor Flats			31	56 10 N	120 41 W

Table 2. Climate summary for Atmospheric Environment Service Stations in the Peace River study area.

AES Station	Annual Precipitation (mm)			Mean Temperature		
	Rain	Snow	Total	Jan	July	Annual
Baldonnel	313	168	481	-15.1	13.6	1.4
Dawson Creek A	327	160	487	-14.9	15.1	1.4
Fort St. John A	296	171	467	-15.0	15.8	1.6
Taylor Flats	301	134	435	n/a	n/a	n/a
Average	309	158	468	-15.0	14.8	1.5

Table 3. Summary of return period daily average peak flows for streams in the Peace River study area.

Gauge	Station Name	Years	Area (km ²)	Discharge (m ³ /s)				
				2 yr	10 yr	25 yr	50 yr	Max
07FB004	Dickebusch C. near the Mouth	19	85.5	15.9	24.9	43.6	64.1	89.4
07FB005	Quality C. near the Mouth	19	29.5	3.2	6.3	8.8	11.0	9.2
07FB007	Sukunka R. above Chamberlain C.	8	927	193	251	282	304	266
07FB010	Pine R. above Mountain C.	4	677	179	264	342	413	272
07FB011	Windrem C. near Chetwynd	8	22.9	4.1	3.4	5.2	7.0	21.5
07FD004	Alces R. at 22 nd Base Line	14	298	11.0	25.3	40.6	55.2	33.1

Gauge	Station Name	Years	Area (km ²)	Unit Flows (l/s/km ²)				
				2 yr	10 yr	25 yr	50 yr	Max
07FB004	Dickebusch C. near the Mouth	19	85.5	186	291	510	750	1,046
07FB005	Quality C. near the Mouth	19	29.5	108	214	298	373	312
07FB007	Sukunka R. above Chamberlain C.	8	927	208	271	304	328	287
07FB010	Pine R. above Mountain C.	4	677	264	390	505	610	402
07FB011	Windrem C. near Chetwynd	8	22.9	179	147	226	303	939
07FD004	Alces R. at 22 nd Base Line	14	298	37	85	136	185	111
Estimates for Kobes Creek				159	221	294	360	410

Note 1: Dickebusch Creek had a daily average discharge of 89.4 m³/s on 01-Aug-1987. This flow is estimated to be >100-200 year return period, and was removed from the statistical frequency analysis. Similarly, a discharge of 21.5 m³/s on the same day at Windrem Creek is estimated to be >200 year return period and was removed from the frequency analysis.

Note 2: Estimates for Kobes Creek are an average of all stations except one. The Alces River station was excluded due to its unusual discharge characteristics.

Table 4. Summary of return period instantaneous peak flows for streams in the Peace River study area.

Gauge	Station Name	Years	Area (km ²)	Discharge (m ³ /s)				
				2 yr	10 yr	25 yr	50 yr	Max
07FB004	Dickebusch C. near the Mouth	14	85.5	32.2	35.6	71.0	115	273
07FB005	Quality C. near the Mouth	19	29.5	4.8	10.1	17.9	26.5	24.5
07FB007	Sukunka R. above Chamberlain C.	8	927	236	292	311	323	289
07FD004	Alces R. at 22 nd Base Line	14	298	12.6	28	45.8	63.8	40.7

Gauge	Station Name	Years	Area (km ²)	Unit Flows (l/s/km ²)				
				2 yr	10 yr	25 yr	50 yr	Max
07FB004	Dickebusch C. near the Mouth	14	85.5	377	416	830	1,345	3,193
07FB005	Quality C. near the Mouth	19	29.5	161	342	607	898	831
07FB007	Sukunka R. above Chamberlain C.	8	927	255	315	335	348	312
07FD004	Alces R. at 22 nd Base Line	14	298	42	94	154	214	137
Estimate for Kobes Creek				264	357	590	863	

Note 1: Dickebusch Creek had an instantaneous discharge of 273 m³/s on 01-Aug-1987. This flow is estimated to be >100-200 year return period, and was removed from the statistical frequency analysis.

Note 2: Estimates for Kobes Creek are an average of all stations except one. The Alces River station was excluded due to its unusual discharge characteristics.

Table 5. Summary of June - September 7-day low flows for streams in the Peace River study area.

Gauge	Station Name	Area (km ²)	Years	June-Sep 7-Day Average Low Flows				
				2 Yr Return Period		10 Yr Return Period		Ratio 10 Yr:2 Yr
				m ³ /s	l/s/km ²	m ³ /s	l/s/km ²	
07FB004	Dickebusch C. near the Mouth	85.5	14	0.09	1.05	0.05	0.58	0.56
07FB005	Quality C. near the Mouth	29.5	19	0.02	0.68	0.01	0.34	0.50
07FB007	Sukunka R. above Chamberlain C.	927	8	4.3	4.64	2.2	2.37	0.51
07FB010	Pine R. above Mountain C.	677	4	0.21	0.31	0.12	0.18	0.57
07FD004	Alces R. at 22 nd Base Line	298	14	0.002	0.01	0.001	0.00	0.50
Estimate for Kobes Creek					1.6		0.9	0.54

Note 1: Estimates for Kobes Creek are an average of all stations except one. The Alces River station was excluded due to its unusual discharge characteristics.

Table 6. Forest disturbance summary for Kobes Creek Watershed.

Basin Name	Drainage Area (ha)	Area Disturbed (harvested or burned and/or silviculturally treated) (ha.)	Percent Harvested, Burned and/or Treated (%)
Kobes Creek, Mainstem	14,896	1,906	12.8%
Tributary, T6-1	58	20	34.4%
Tributary, T6-2	50	15	30.6%
Tributary, T6-3	46	15	33.7%
Tributary, T7-1	120	32	26.5%
Tributary, T8-1	431	70	16.2%
Tributary, T10-1	1,316	52	3.9%
Tributary, T10-2	197	50	25.4%
Tributary, T11-1	130	25	18.9%
Tributary, T11-2	317	94	29.7%
Total	17,562	2,279	13.0%

Table 7. Fish distribution summary for the Kobes Creek watershed.

Watershed Name: Kobes Creek TRIM Maps: 94B - 049, 039, 038, 028, 029Data Sources: FISS, ABM, FOR
Watershed Code: 235-2594-609 Forest District: Ft. St. John

	Survey Method		GR	GR	GR	LW	LW	LW	MW	MW	MW	RB	RB	RB	BT	BT	BT	LKC	LKC	LKC	LSU	LSU	LSU	RSC	RSC	RSC	LNC	LNC	LNC	WSU	WSU	WSU	CSU	CSU	CSU	CCG	CCG	CCG
Reach	Juv	Ad	juv	ad	sp	juv	ad	sp	juv	ad	sp	juv	ad	sp	juv	ad	sp	juv	ad	sp	juv	ad	sp	juv	ad	sp	juv	ad	sp	juv	ad	sp	juv	ad	sp	K	S	S
1	EL	VO	K	K	S	U	U	U	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S
2	EL	VO	K	K	S	U	U	U	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S
3	EL	VO	K	K	S	U	U	U	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S
4	EL	VO	K	K	S	U	U	U	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S
5	EL	VO	K	K	S	U	U	U	K	S	S	K	S	S	S	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S	K	S	S
6	U	U	S	S	S	U	U	U	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
7	U	U	S	S	S	U	U	U	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
8	U	U	S	S	S	U	U	U	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
9	U	U	S	S	S	U	U	U	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
10	U	U	S	S	S	U	U	U	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
11	U	U	S	S	S	U	U	U	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
12	U	U	S	S	S	U	U	U	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
13	U	U	S	S	S	U	U	U	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
T6-1-1	EL	VO	S	S	S	U	U	U	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
T6-1-2	U	U	S	S	S	U	U	U	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
T8-1-1	U	U	S	S	S	U	U	U	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
T8-1-2	U	U	S	S	S	U	U	U	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
T10-1-1	U	U	S	S	S	U	U	U	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
T10-1-2	U	U	S	S	S	U	U	U	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
T10-2-1	U	U	S	S	S	U	U	U	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
T10-2-2	U	U	S	S	S	U	U	U	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
T11-1	U	U	S	S	S	U	U	U	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
T11-2	U	U	S	S	S	U	U	U	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

RB = rainbow trout or steelhead.

BT = bull trout or dolly varden.

GR = artic grayling

LW = lake whitefish

MW = mountain whitefish

LKC = lake chub

LSU = longnose sucker

RSC = reddsider shiner

LNC = longnose dace

WSU = white sucker

CSU = largescale sucker

CCG = slimy sculpin

Table 8. Stream habitat assessment summary for Kobes Creek.

System: Kobes Creek TRIM Maps: 94B - 049, 039, 038, 028, 029
Watershed Code: 235-2594-609 Photo Scale: 1:10,000

Reach	Elevation			Gradient (%)	Width (Wb) (m)	Channel Type	Barriers	Pools Code	LWD Codes	Off-channel Habitat	Channel Code	Habitat Value	Upslope Impact	Major Disturbances	Priority	Restoration Opportunities
	Length (m)	Upper (m)	Lower (m)													
1	3,000	640	620	0.7%	24	RPgw	N	1	F	M	RPgw	M	L	BC EB	L	LWD BANK ST
2	9,000	670	640	0.3%	24	RPgw	N	1	N	A	RPgw	M	L	MB EB	L	BANK ST
3	8,000	700	670	0.4%	24	RPgw	N	1	N	A	RPgw	M	L	MB EB MC	L	BANK ST
4	4,000	720	700	0.5%	25	RPgw	N	2	F	A	RPgw	M	L	MB EB LR	L	BANK ST
5	7,900	760	720	0.5%	27	RPgw	N	2	F	M	U	M	L	MB EB WG I	L	LWD BANK ST
6	4,900	790	760	0.6%	26	RPgw	N	1	F	A	RPgw	M	L	EB MB BC	H	LWD BANK ST
7	3,000	810	790	0.7%	28	RPgw	N	1	F	M	RPgw	M	L	EB MB BC	M	LWD BANK ST
8	1,600	815	810	0.3%	21	RPgw	N	1	F	A	RPgw	M	L	EB MB BC	M	LWD BANK ST
9	1,800	840	815	1.4%	24	RPcw	U	1	A	M	RPcw	M	L	JM EB MB	M	ASSESS JAMS
10	1,400	845	840	0.4%	18	RPgw	N	1	F	A	RPcw	M	L	EB MB BC	N	NONE
11	4,400	940	845	2.2%	25	RPgw	U	1	F	M	RPcw	M	L	EB MB BC	N	NONE
12	1,320	980	940	3.0%	10	RPcw	U	1	A	F	RPcw	M	L	JM MC EB	H	LWD BANK ST
13	2,540	1,180	980	7.9%	5	CPb	U	1	F	F	CPb	L	L	LR FP	N	NONE
T10-1-1	900	880	845	3.9%	21	Rpgw	N	1	F	A	Rpgw	H	L	U	H	LWD BANK ST
T10-1-2	2,200	920	880	1.8%	16	Rpgw	N	2	F	A	Rpgw	H	L	U	H	LWD BANK ST
T10-2-1	300	860	845	5.0%	9	Rpgw	U	U	U	U	Rpgw	H	L	MB EB	H	LWD BANK ST
T10-2-2	540	890	860	5.6%	5	Rpgw	U	U	U	U	Rpgw	H	L	MB	H	LWD BANK ST
T11-1	400	880	870	2.5%	10	Rpgw	U	U	U	U	Rpgw	H	L	MB	H	LWD BANK ST
T11-2	500	900	880	4.0%	7	Rpgw	U	U	U	U	Rpgw	H	L	U	H	LWD BANK ST
T6-1-1	500	820	800	4.0%	5	Rpgw	U	U	U	U	Rpgw	H	L	U	H	LWD BANK ST
T6-2-1	700	840	800	5.7%	5	Rpgw	U	U	U	U	Rpgw	H	L	U	H	LWD BANK ST

Table 9. Major sediment sources for Kobes Creek Watershed.

REF	TYPE	SOURCE	LOCATION
1	Bank Erosion	Escarpment, natural	Reach 1
2	Bank Erosion	Escarpment, natural	Reach 1
3	Bank Erosion	Escarpment, natural	Reach 2
4	Bank Erosion	Escarpment, natural	Reach 2
5	Bank Erosion	Escarpment, natural	Reach 2
6	Bank Erosion	Escarpment, natural	Reach 3

Table 10. Channel assessment summary for Kobes Creek Watershed.

Reach	Length (m)	Gradient %	Description	Disturbance	Width (m)	Riparian
1	3,355	0.21%	Alluvial, confined, narrow active floodplain, lateral bars	Dynamic, natural shifting, no disturbance	30-40	Forest
2	11,450	0.26%	Alluvial, confined, narrow active floodplain, lateral bars	Dynamic, natural shifting, no disturbance	30-40	Forest
3	10,068	0.26%	Alluvial, sinuous meandering, large active floodplain, lateral bars, abundant back channels	Dynamic, natural shifting, no disturbance	30-40	Forest
4	6,078	0.30%	Alluvial, tortuous meandering, large active floodplain, lateral bars, abundant back channels	Dynamic, natural shifting, no disturbance	30-40	Forest
5	8,790	0.40%	Alluvial, tortuous meandering, large active floodplain, lateral bars, abundant back channels	Dynamic, natural shifting, no disturbance	30-40	Forest
6	6,050	0.58%	Alluvial, single thread, partial confinement	No change apparent	15-25	Forest
7	3,946	0.56%	Alluvial, meandering, large lateral bars, active floodplain	No change apparent	10-20	Some riparian logging
8	2,954	0.41%	Alluvial, meandering, large lateral bars, active floodplain	No change apparent	10-20	Forest
9	1,556	1.03%	Alluvial, single thread, narrow floodplain	No change apparent.	5-15	Forest
10	1,465	1.02%	Alluvial, single thread, narrow floodplain	No change apparent	5-15	Some riparian logging
11	5,114	1.62%	Alluvial, single thread, narrow floodplain	No change apparent	5-15	Some riparian logging
12	1,319	3.49%	Alluvial, single thread, narrow floodplain	No change apparent.	5-15	Some riparian logging
13	2,669	7.49%	Alluvial, single thread, narrow floodplain	No change apparent	5-15	

Table 11. Channel condition summary for Kobes Creek Watershed.

Watershed: Kobes Creek	Sub-Basin:
Drainage Area (km²)	176
Tenure	100% TFL
Area Logged (%)	Less than 10%
Equivalent Clearcut Area (%)	Less than 10%
Channel	
Type:	Riffle-pool, alluvial
Width (m):	Estimated at 20 m
Gradient (%):	Generally very low gradient. Reaches 1-8 are <0.5%, 1-3% for the remainder
Bed Material	Gravel, sand, with some cobble
Watershed Type	Type B-2. In the downstream portion, the stream channel is uncoupled from the hillslopes. Floodplains are well developed.
Channel Conditions	Good. Low natural rate of bedload transport and a low natural rate of shifting. Low gradient and sinuously meandering. Possible minor disturbance in Reach 6, 11, and 12 associated with riparian logging.
Hillslope Conditions	Good. Relief is extremely low, and no forestry-related landslides are evident. Some natural stream escarpment erosion is occurring along Reach 2, but the rate and extent of sediment input to Kobes Creek appears to be low. The extent of logging has been low, and no logging-related stream flow changes are anticipated.
Riparian Conditions	Good. Most of riparian forest is mature conifer. Harvesting occurred to streambank in parts of Reaches 6, 11 and 12. LWD recruitment to the channel from riparian zone is low in these sections.
Potential Hillslope Impacts on Study Reach	Hillslope impacts are limited to the natural escarpment erosion along Reaches 1 and 2.
Risk to Local and Downstream Rehabilitation	Very Low
Peak Flow Hydrology	
2 Yr	260 l/s/km ²
50 Yr	860 l/s/km ²
Low Flow Hydrology	
2 Yr	1.6 l/s/km ²
10 Yr	0.9 l/s/km ²
Date of Field Reconnaissance	None conducted

Table 12. Riparian assessment summary for Kobes Creek watershed.

Watershed Name: Kobes Creek
 Watershed Code: 235-2594-609

NTS Map: 94B - 049, 039, 038, 028, 029
 Air Photo Series/ Scale 1:10,000

Reach No.	Polygon No.	Stand Structure	Tentative RVT No.	Stream Class	Reserve Zone Width (m)	Logging History	Other Disturbances/Comments	Restoration Opportunities	Priority Level 1
1	A	MFc/S,Pl and Init/Herb	5	S1	50		steep eroding bank		L
1	B	MFd/At,Ac and Init/Herb	5	S1	50				L
1	C	MFc/S,Pl and Init/Herb	5	S1	50				L
1	D	MFm	5	S1	50				L
1	E	MFc and Init/Herb	5	S1	50				L
2	A	Init/Herb - MFm	5	S1	50				L
2	B	MFm	5	S1	50				L
2	C	Init/Herb - MFm	5	S1	50				L
2	D	MFc	5	S1	50				L
2	E	MFm and SH	5	S1	50				L
2	F	MFm and Init/Fen	5	S1	50		shrub fen with mature forest; valuable wildlife habitat		L
2	G	MFm	5	S1	50		powerline cross, possible erosion		L
2	H	Init/Herb	5	S1	50		steep eroding bank		L
2	I	MFm	5	S1	50				L
2	J	Init/Herb	5	S1	50		steep eroding bank		L
2	K	MFm	5	S1	50		powerline cross, possible erosion		L
3	A	MFc and Init/Fen	5	S1	50		vast fens, very high wildlife value; clearcut close to RMZ		L
3	B	MFc and Init/Fen	5	S1	50		vast fens, very high wildlife value; clearcut close to RMZ		L
4	A	MFc and Init/Fen	5	S1	50		vast fens, very high wildlife value; clearcut close to RMZ		L
4	B	MFc and Init/Fen	5	S1	50		vast fens, very high wildlife value; clearcut close to RMZ		L
5	A	MFm and Init/Fen	5	S1	50		mature forest, frequently flooded wet area with fen; valuable wildlife area		L
5	B	MFc	5	S1	50				L

A portion of Reach 6 upstream to the confluence of West and East Kobes has been delineated in 1999 and is not considered here

6	A	MFc	5	S1	50				L
6	B	PSc and Init/Bog	5	S1	50		mature stunted forest, frequently flooded wet area with fen and bog; valuable wildlife area		L

Reach No.	Polygon No.	Stand Structure	Tentative RVT No.	Stream Class	Reserve Zone Width (m)	Logging History	Other Disturbances/Comments	Restoration Opportunities	Priority Level 1
6	C	MFc	5	S1	50		road and bridge; possible erosion		L
6	D	YFc and (SH)	5	S1	50		possible erosioin		L
6	E	MFc	5	S1	50				L
6	F	SH and (MFc)	2	S1	50	logged in 1985-86; planted in 1990	portions logged to bank; road and bridge	Improve LWD function and shading; bank stabilization	H
7	A	MFc	5	S2	30				L
7	B	MFc	5	S2	30				L
7	C	PSc and Init/Bog, Fen	5	S2	30		shrub fen with forest; valuable wildlife habitat		L
8	A	YFc	5	S2	30		mature stunted forest, frequently flooded wet area		L
8	B	MFc	5	S2	30				L
9	C	YFc	5	S2	30		mature stunted forest, frequently flooded wet area		L
9	D	YFc	5	S2	30		mature stunted forest, frequently flooded wet area		L
10	A	MFc	5	S2	30				L
10	B	MFc	5	S2	30				L
11	A	MFc	5	S2	30		mature forest, frequently flooded wet area		L
11	B	MFc	5	S2	30		mature forest, frequently flooded wet area		L
12	A	SH	2	S2	30	logged (1986?); planted (1990?)		Improve LWD function and shading; bank stabilization	H
12	B	MFc	5	S2	30				L
12	C	MFc	5	S2	30				L
13	A	MFm	5	S2	30				L
13	B	MFm	5	S2	30		shrub fen with forest; valuable wildlife habitat		L

TRIBUTARIES

T6-1

1	A	SH	2	S2	30	logged in 1985-86; planted in 1990	road crossing, culvert; probable erosion	Improve LWD function and shading; bank stabilization	H
1	B	SH	2	S2	30	logged in 1985-86; planted in 1990	road crossing, culvert; probable erosion	Improve LWD function and shading; bank stabilization	H
2	A	MFc	5	S2	30				L
2	B	SH	2	S2	30	logged in 1985-86; planted in 1990	road crossing, culvert; probable erosion	Improve LWD function and shading; bank stabilization	H
2	C	MFc	5	S2	30				L

Reach No.	Polygon No.	Stand Structure	Tentative RVT No.	Stream Class	Reserve Zone Width (m)	Logging History	Other Disturbances/Comments	Restoration Opportunities	Priority Level 1
2	D	SH	2	S2	30	logged in 1985-86; planted in 1990	road crossing, culvert; probable erosion	Improve LWD function and shading; bank stabilization	H

T7-1									
1	A	MFc and Init/Fen	5	S2	30		shrub fen with forest; valuable wildlife habitat		L
1	B	SH	2	S2	30	logged in ??	logged close to bank; but the fen downstream will trap most of sediments		M
1	C	MFc and Init/Fen	5	S2	30		shrub fen with forest; valuable wildlife habitat		L
1	D	SH	2	S2	30	logged in ??	logged close to bank; but the fen downstream will trap most of sediments		M

T10-1									
1	A	PSc and SH	5	S2	30		shrub fen with forest; valuable wildlife habitat		L
1	B	SH and (MFc)	2	S2	30	logged in 1986; planted in 1990	road crossing, bridge; possible erosion	Improve LWD function and shading; bank stabilization	H
1	C	PSc and SH	5	S2	30		shrub fen with forest; valuable wildlife habitat		L
2	A	SH and (MFc)	2	S2	30	logged in 1986; planted in 1990	road crossing, bridge; possible erosion	Improve LWD function and shading; bank stabilization	H
2	B	MFc (Init)	5	S3	30		road in RMA; road crossing, bridge; possible erosion	bank stabilization	H
2	C	MFc and (SH)	2	S2	30		road crossing, bridge; possible erosion	bank stabilization	M

T10-2									
1	A	MFc	5	S2	30				L
1	B	MFc	5	S2	30				L
2	A	SH	2	S2	30	logged in 1985-86; planted in 1990	logged to bank; possible erosion	Improve LWD function and shading; bank stabilization	H
2	B	SH	2	S2	30	logged in 1985-86; planted in 1990	logged to bank; possible erosion	Improve LWD function and shading; bank stabilization	H

T11-1									
1	A	MFc	5	S2	30				L
1	B	MFc	5	S2	30				L

Reach No.	Polygon No.	Stand Structure	Tentative RVT No.	Stream Class	Reserve Zone Width (m)	Logging History	Other Disturbances/Comments	Restoration Opportunities	Priority Level 1
2	A	SH	2	S2	30	logged in 1985-86; planted in 1990	logged to bank; possible erosion	Improve LWD function and shading; bank stabilization	H
2	B	SH	2	S2	30	logged in 1985-86; planted in 1990	logged to bank; possible erosion	Improve LWD function and shading; bank stabilization	H

T11-2									
1	A	MFc	5	S2	30				L
1	B	MFc	5	S2	30				L
2	A	SH	2	S2	30	logged in 1985-86; planted in 1990	logged to bank; possible erosion	Improve LWD function and shading; bank stabilization	H
2	B	MFc	5	S2	30				L
2	C	SH	2	S2	30	logged in 1985-86; planted in 1990	logged to bank; possible erosion	Improve LWD function and shading; bank stabilization	H

Table 13. Evaluation of the likelihood of restoration activities benefiting fish habitat for subbasins in Kobes Creek.

Subbasin	Target Species	Limiting Fish Habitat	Watershed Condition and Restoration Benefits	Watershed Components					
				Landslide s	Gullies	Roads	Riparian	Channel	Instream Fish Habitat
Kobes Creek - Mainstem	Grayling, Whitefish, Rainbow Trout, Bull Trout	Summer and Winter Rearing	Level of Existing or Potential Disturbance	Low	Low	Low	Moderate	Low	Moderate
			Impact or Risk to Fish Habitat	Low	Low	Low	Moderate	Low	N/A
			Likelihood of Benefits to Fish Habitat from Restoration of Component	Low	Low	Moderate	High (Long Term)	Low	High for Reaches 6 & 12
Kobes Creek - Tributary 6	Grayling, Whitefish, Rainbow Trout, Bull Trout	Summer and Winter Rearing	Level of Existing or Potential Disturbance	Low	Low	Low	Moderate	Low	High
			Impact or Risk to Fish Habitat	Low	Low	Low	Moderate	Low	N/A
			Likelihood of Benefits to Fish Habitat from Restoration of Component	Low	Low	Low	High (Long Term)	Low	High
Kobes Creek - Tributary 10	Grayling, Whitefish, Rainbow Trout, Bull Trout	Summer and Winter Rearing	Level of Existing or Potential Disturbance	Low	Low	Low	Moderate	Low	High
			Impact or Risk to Fish Habitat	Low	Low	Low	Moderate	Low	N/A
			Likelihood of Benefits to Fish Habitat from Restoration of Component	Low	Low	Low	High (Long Term)	Low	High
Kobes Creek - Tributary 11	Grayling, Whitefish, Rainbow Trout, Bull Trout	Summer and Winter Rearing	Level of Existing or Potential Disturbance	Low	Low	Low	Moderate	Low	High
			Impact or Risk to Fish Habitat	Low	Low	Low	Moderate	Low	N/A
			Likelihood of Benefits to Fish Habitat from Restoration of Component	Low	Low	Low	High (Long Term)	Low	High

FIGURES

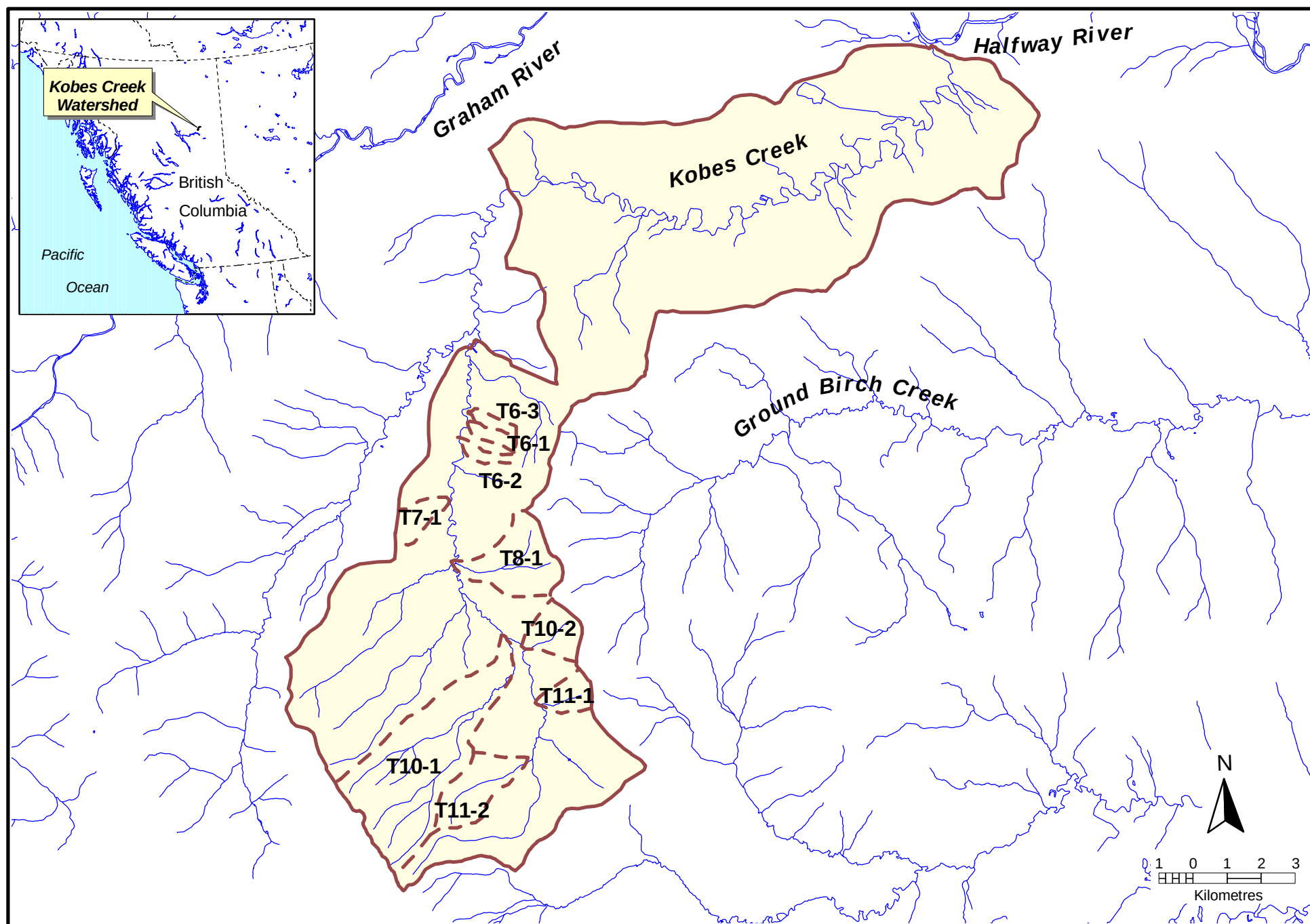


Figure 1. Overview of the Kobes Creek watershed showing the location of the study area in British Columbia.

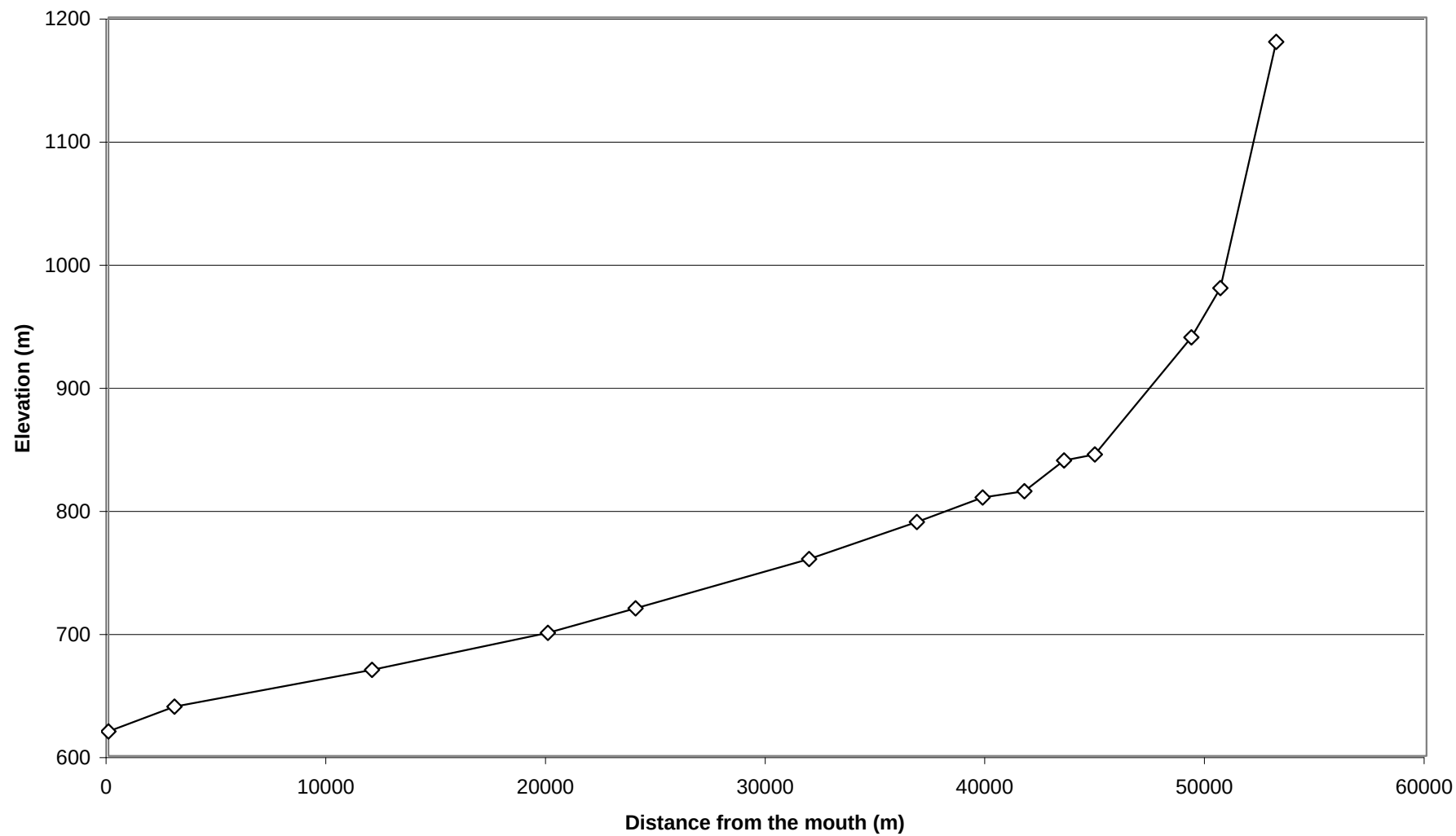
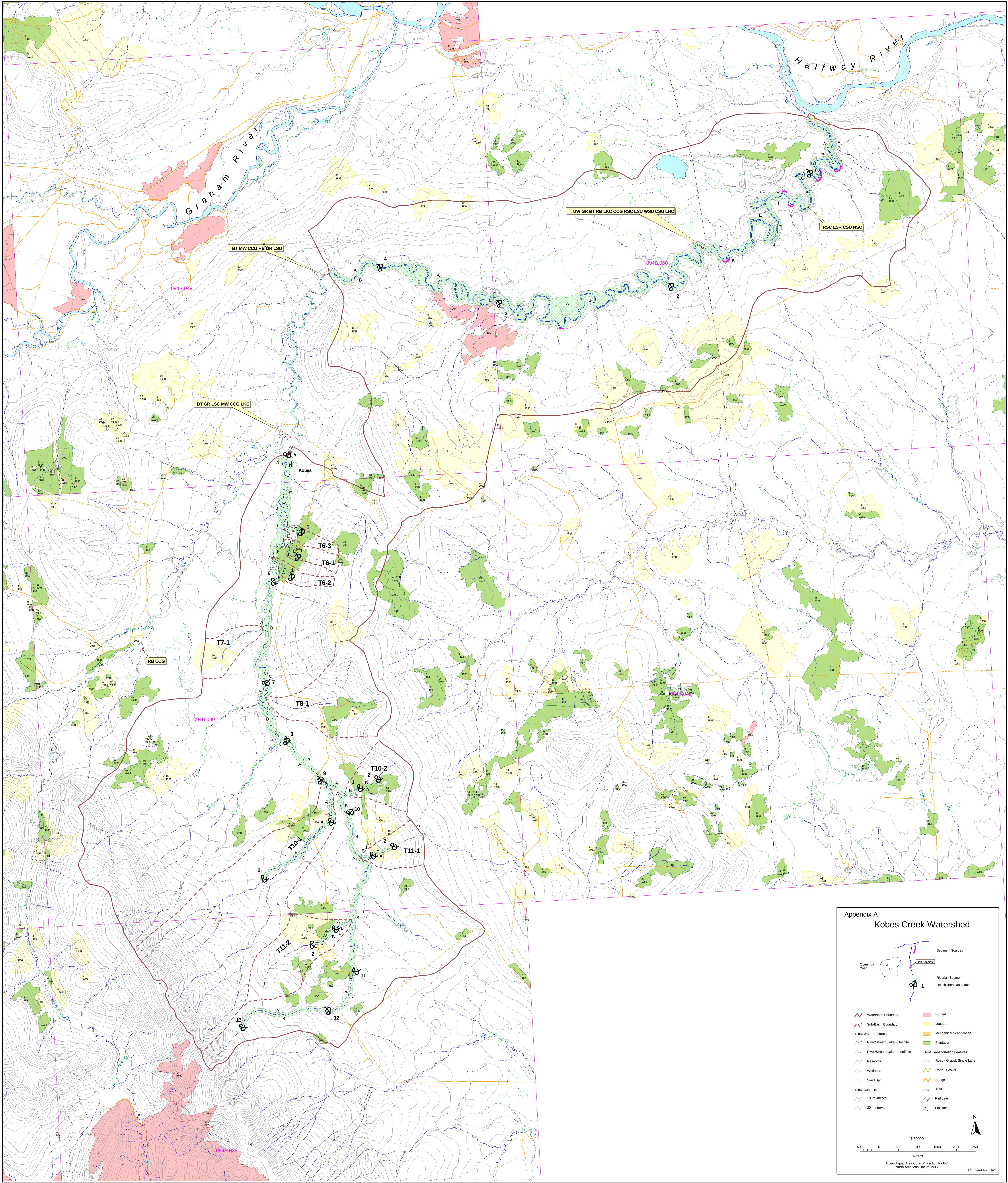


Figure 2. Longitudinal profile for Kobes Creek.

APPENDICES



Appendix A
Kobes Creek Watershed

Opening Year
4 1992

Sediment Sources
Fish Species
Riparian Segment
Reach Break and Label

1

Watershed Boundary
Sub-Basin Boundary
TRIM Water Features
River/Stream/Lake - Definite
River/Stream/Lake - Indefinite
Reservoir
Wetlands
Sand Bar
TRIM Contours
100m Interval
20m Interval

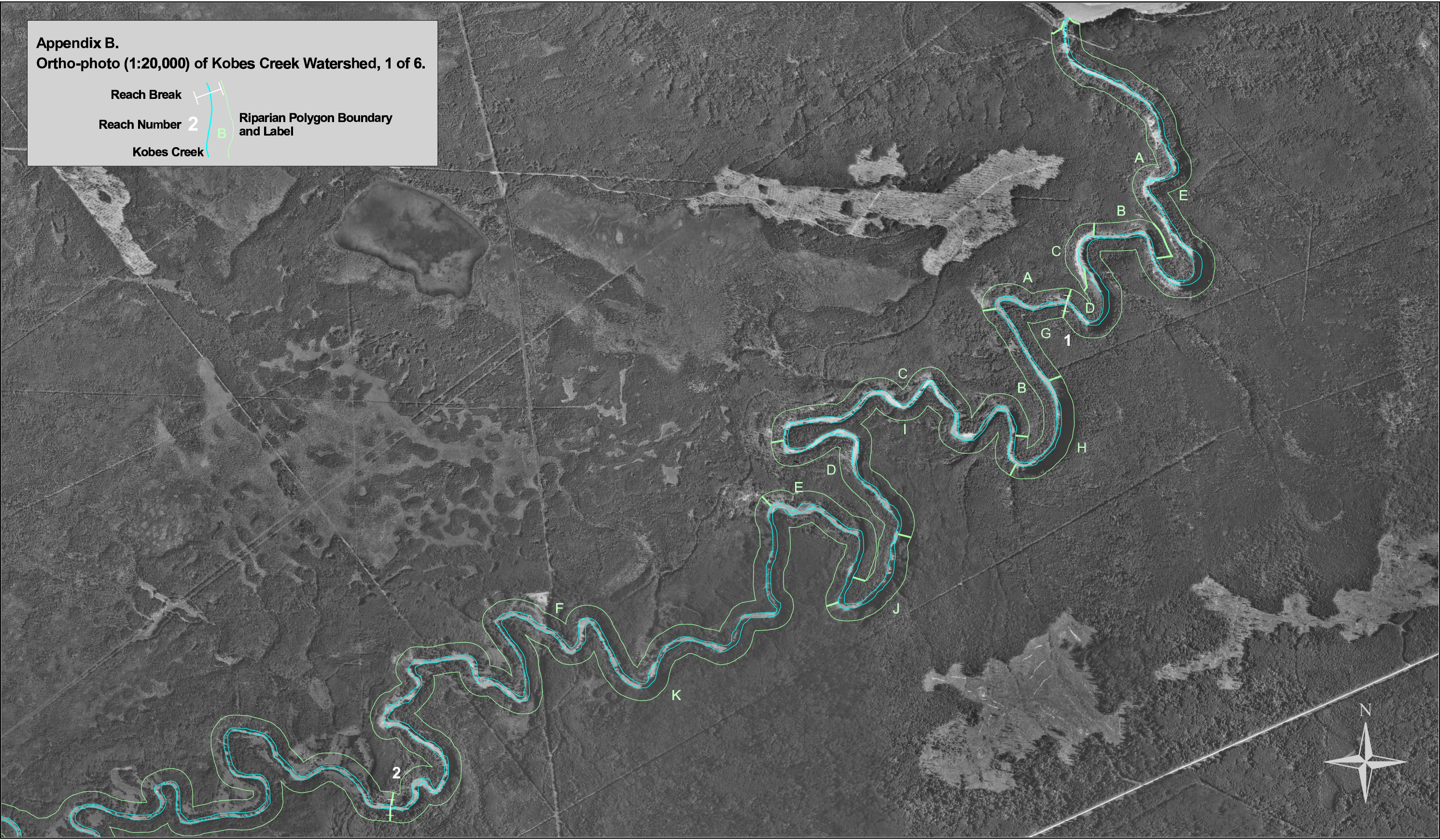
Burned
Logged
Mechanical Scarification
Plantation
TRIM Transportation Features
Road - Gravel, Single Lane
Road - Gravel
Bridge
Trail
Rail Line
Pipeline

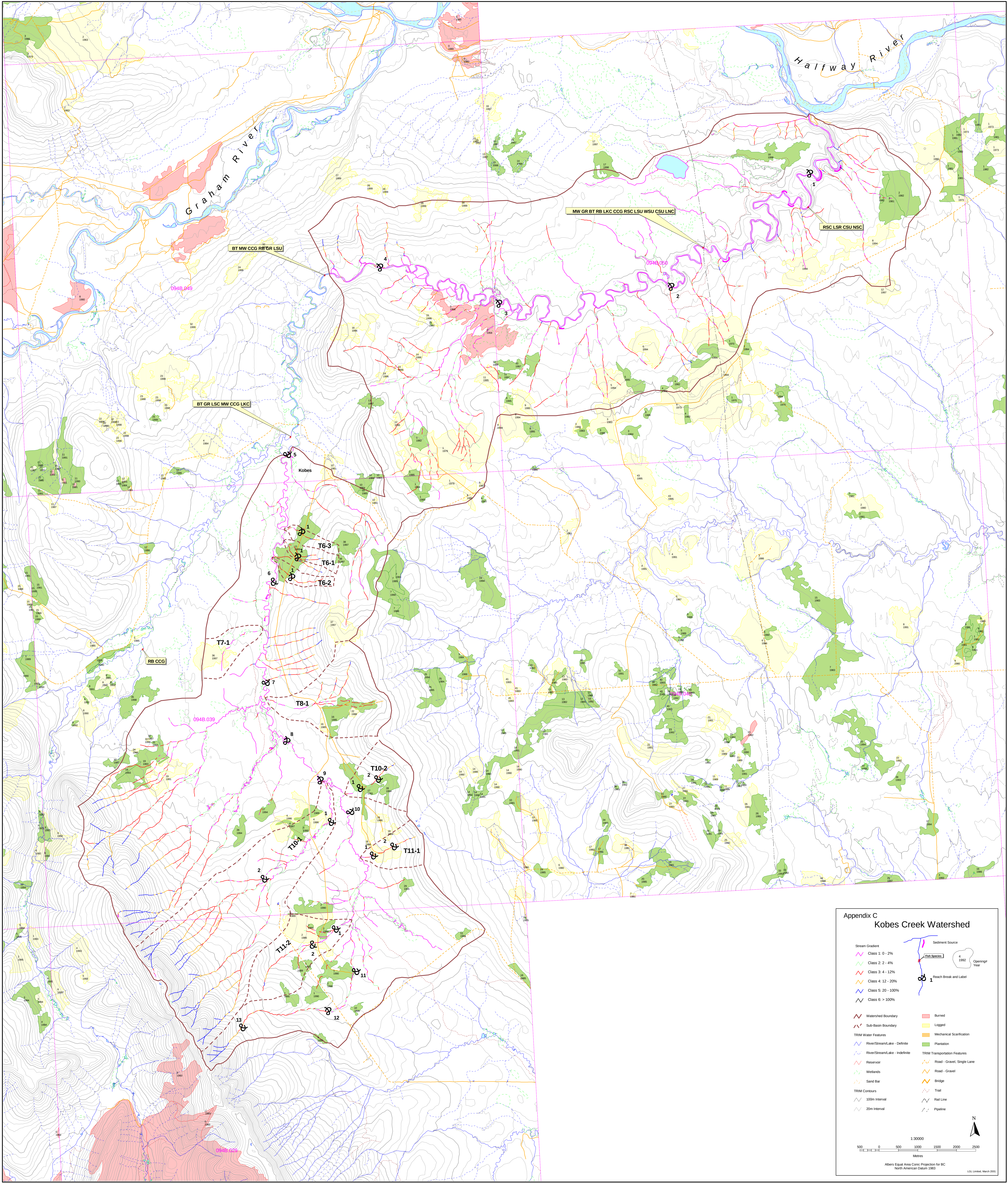
1:30000
500 0 500 1000 1500 2000 2500
Metres
Albers Equal Area Conic Projection for BC
North American Datum 1983
LGI Limited, March 2003

Appendix B.
Ortho-photo (1:20,000) of Kobes Creek Watershed, 1 of 6.

Reach Break
Reach Number 2
Kobes Creek

Riparian Polygon Boundary
and Label
B





Appendix C
Kobes Creek Watershed

Stream Gradient

Class 1: 0 - 2%

Class 2: 2 - 4%

Class 3: 4 - 12%

Class 4: 12 - 20%

Class 5: 20 - 100%

Class 6: > 100%

Watershed Boundary

Sub-Basin Boundary

TRIM Water Features

River/Stream/Lake - Definite

River/Stream/Lake - Indefinite

Reservoir

Wetlands

Sand Bar

TRIM Contours

100m Interval

20m Interval

Sediment Source

Fish Species

Reach Break and Label

1

4 1902 Opening Year

Burned

Logged

Mechanical Scarification

Plantation

TRIM Transportation Features

Road - Gravel, Single Lane

Road - Gravel

Bridge

Trail

Rail Line

Pipeline

1:30000

500 0 500 1000 1500 2000 2500

Metres

Albers Equal Area Conic Projection for BC
North American Datum 1983

LGL Limited, March 2002