Appendix A

1:10,000 Terrestrial Ecosystem Mapping Report and Map

Tulsequah Chief Mine
Terrestrial Ecosystem Mapping
Expanded Legend Report

Prepared for

Redfern Resources

Submitted by

Gartner Lee Limited

September 2007

Gartner Lee

Tulsequah Chief Mine
Terrestrial Ecosystem Mapping
Expanded Legend Report

Prepared for

Redfern Resources

September 2007

Reference: **GLL 72604**

Distribution:

1 Redfern Resources Limited

1 Gartner Lee Limited

Gartner Lee

Executive Summary

Terrestrial Ecosystem Mapping (TEM) at 1:10,000 scale was completed within the infrastructure development areas for the Tulsequah Chief Mine in northwestern BC. Ecosystem mapping followed the established standards from the Resource Inventory Committee, completing air-photo interpretation and field assessments to confirm ecosystem identification. The terrestrial ecosystems found in the project study area are quite typical of those found in northern coastal forested areas and in large river floodplains elsewhere in BC and Alaska. Cold air drainage influences the floodplain ecosystems, and the water fluctuations associated with outburst floods from the Tulsequah Glacier dominate the vegetation of the floodplain, causing vegetation complexes to shift and modify on a regular basis. Information gained from this ecosystem mapping will be used to guide site restoration and reclamation upon mine closure.

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1. Introduction

Additional Terrestrial Ecosystem Mapping (TEM), following up on previous work undertaken for the original Tulsequah Chief Mine Environmental Assessment (EA) application, was conducted by Gartner Lee Limited in 2007 in support of the mine permit application. The ecosystem mapping was completed at a scale of 1:10,000 within the proposed infrastructure development areas in the lower Shazah and Rogers Creek watersheds including the mine site, the airstrip, tailings pond, rock waste dumps and associated roads. A survey intensity level of 3 was chosen for this project, which aimed at achieving a polygon inspection percentage of between 26 and 50%. Information obtained from the ecosystem mapping will be used to develop the site reclamation and restoration planning when the mine closes.

2. Methods

Mapping was completed using the provincial standards outlined in *Standards for Terrestrial Ecosystem Mapping in British Columbia* (RIC 1998), with the bioterrain component following the terrain mapping standards found in the *Terrain Classification System for British Columbia* (Howes and Kenk 1997). Existing information was reviewed, including topographic mapping of the study area, aerial photography, BEC subzone mapping and site series descriptions, and any available descriptions of bedrock geology, surficial geology, soils and hydrology. Fuller (2002) and Marcoux (1997) reports from the original EA application were consulted, as well as the provincial documents, *A Field Guide to Site Identification and Interpretation for the Prince Rupert Forest Region* (Banner *et al.* 1993), and *Wetlands of British Columbia: A Guide to Identification* (Mackenzie and Moran 2004). A working legend of potential ecosystems was developed from these sources to guide sampling; this working legend was followed-up with field verification and subsequent modifications. Ecosystem polygons were delineated on air photos prior to field sampling, based on air photo signatures, and polygon delineations were also modified following the sampling.

The majority of the TEM field sampling was undertaken between June 29 and July 1, 2007, although plot information from experienced ecosystem mapping crews working in the area at other times during the 2007 field sessions was also incorporated into results. These included visual and aerial inspections during wildlife assessments in June and ground inspections during vegetation trace metals sampling in early September. In areas where ecosystems did not appear to match information available in Banner et al (1993), MacKenzie and Moran (2004), or in the previous ecosystem mapping (Marcoux 1997 and Fuller 2002), full plots were conducted, which allowed for a thorough description of site features and soil horizons as well as a complete vegetation species list. At more typical sites, ground inspection plots were completed using the *Ground Inspection Form* (GIF), with more general site, vegetation and soils information obtained. Visual inspections were completed when field crews were traveling between plots and recorded using GIFs, providing general information on ecosystems such as site unit, structural stage, and vegetation.

Ecosystem Field Form data were entered into the VENUS database program, while ground and Form visual inspection data were recorded into GRAVITI.

Final bioterrain and ecosystem mapping were completed following a review of field data and the incorporation of additional site series. Line work on the air-photos was transferred to a digital file using mono-restitution. Water features on air photos were matched to existing TRIM features. ArcView GIS was used to produce the final digital mapping and TEM legends.

3. Results

A total of 92 polygons were mapped within the proposed development area. Within the mapped area 39% of the polygons were assessed on the ground (11 Full plots, 9 GIF and 18 Visuals) with an additional 7 polygons assessed from the air. The total number of polygons assessed was 49% with a ratio of (24% Full : 20% GIF : 64% Visual/Air) which exceeds the standard for survey intensity level 3.

Within the tailings area in the lower Shazah Creek watershed, forested and wetland floodplain ecosystems were shrubby, consisting primarily of young cottonwood forests with an extensive understory of slide alder and devil's club (low fluvial bench 07 Act - Willow [CW] and middle fluvial bench 06 Act - Red-osier dogwood [CD]). Within the airstrip area, ecosystems were primarily identified as high fluvial bench floodplain forest (05 Ss - Salmonberry [SS]) that showed evidence of the periodic jökulhlaups (periodic outflows from a glacier lake) at the Tulsequah glacier, with successive layers of sand and silt appearing to limit herb and shrub growth. These ecosystems were identified with an 'f' subscript to distinguish them from the more typical shrub and herb dominated SS ecosystem. In addition to the high bench floodplain ecosystem, small areas containing a dry, coarse textured ecosystem type that may have been influenced by cold-air ponding was found which contained stunted sub-alpine fir and western hemlock, Nootka lupine and an extensive cover of grey rock-moss (*Racomitrium canescens*). This ecosystem was tentatively called BlHw - Lupine and given a site series code of BL.

Upland forested ecosystems observed above the floodplains of Shazah Creek and the Tulsequah River were typically mesic mature and previously harvested forested ecosystems (01 HwSs - Blueberry [Code = HB]) with wet and rich oak fern and devil's club forested ecosystems (03 SsHw - Oak fern [SO] and 04 SsHw - Devil's club [SD]) found on lower slopes, riparian areas and gullies. The lower Roger's Creek area, where the proposed temporary waste rock dumps are located, contained typical low to high bench floodplain sites dominated by cottonwood, slide alder and devil's club. Wetland ecosystems were also found in this area, dominated by sedge meadows.

A summary of the ecosystems found in the TEM area are provided below:

Table 1. Summary of terrestrial ecosystems within the Tulsequah Chief infrastructure development area.

CWHwm – Coastal Western hemlock wet maritime subzone					
Map Code	**Site Series**	**Ecosystem Name**	**Site Description**	**SMR**	**SNR**
Upland Forest Ecosystem Units					
AC	00	Avalanche chute	Occurs on steep slopes, subject to avalanches. Typically with deep, rich, moist soils and is dominated by Sitka alder, devil's club and ferns.	4-6	D-E
AD	00	Alder Devil's club shrub site	Occurs on level to steep slopes that are not necessarily subject to avalanching. Typically with deep, rich, moist soils and is dominated by Sitka alder, devil's club and ferns.	4-5	D-E
BL	00	BlHw - Lupine	Coarse textured cold air drainage site dominated by 1.5 to 10 m subalpine fir and western hemlock, Nootka lupine and Racomitrium moss cover.	2-3	B-C
HB	01	Western Hemlock - Sitka Spruce - Blueberry	Zonal site series. Occurs primarily at mid to level slope positions on a range of parent materials.	3-4	C
SO	03	Sitka Spruce - Western Hemlock - Oakfern	Fresh to wet site. Generally located at mid to lower slopes on moderately well drained, rich soils as well as level glaciofluvial terraces and toe of slopes.	2-4	C-E
SD	04	Sitka Spruce - Western Hemlock - Devil's Club	Fresh to wet site. Productive site occurring on fluvial and colluvial fans and on fluvial veneers overtop glaciofluvial deposits.	4-5	D
Floodplain Forest Ecosystem Units					
SS	05	Sitka Spruce - Salmonberry	Floodplain site. Occurs on elevated floodplain sites with seasonally fluctuating water tables. Highly productive forested sites.	5-6	D-E
CD	06	Cottonwood - Red-osier Dogwood	Floodplain site. Occurs on middle fluvial benches which experience prolonged elevated water tables.	5-6	D-E
CW	07	Cottonwood - Willow	Floodplain site. Located on low fluvial benches usually directly adjacent to rivers or in back channels.	6-7	C-E
Wetland Ecosystem Units					
AS	00	Alder - Sitka sedge - Bluejoint	Shrub swamp that typically occurs on level sites with organic soils. It can occur on fluvial terraces and is dominated by alder, Sitka sedge and bluejoint	6-7	C-E
SF	00	Organic sedge-fen	Occurs in level areas on organic soils over fluvial deposits; adjacent to bodies of water.	6-7	C-E
Non-vegetated and Anthropogenic Sites					
GB	-	Gravel Bar	An elongated landform generated by waves and currents. Composed of un-consolidated small rounded cobbles, pebbles, stones and sand.		
MI	-	Mine	An unvegetated area used for the extraction of mineral ore and other materials.		
MZ	-	Rubbly Mine Spoils	Discarded overburden or waste rock moved so that ore can be extracted in a mining operation.		

CWHwm – Coastal Western hemlock wet maritime subzone					
Map Code	**Site Series**	**Ecosystem Name**	**Site Description**	**SMR**	**SNR**
OW	-	Shallow Open Water	A wetland composed of permanent shallow open water (<2 m deep) and lacking extensive emergent plant cover.		
RI	-	River	A watercourse formed when water flows between continuous, definable banks. The flow may be intermittent or perennial.		
RO	-	Rock Outcrop	A gentle to steep, bedrock escarpment or outcropping, with little soil development and sparse vegetative cover.		

3.1 Previously Undescribed Ecosystems

Only one previously undescribed ecosystem, the Subalpine fir - western hemlock - lupine ecosystem, was identified during the field work conducted in 2007.

Code	BL	***Name***	Subalpine fir - Western hemlock - Lupine	***Site Series***	00
Distribution		***# of Polygons***	7	***Total Area (ha)***	13.7

Structural Stages

All BL ecosystems in the study area were classified as structural stage 3a.

Site Description

The BL occurs on level slopes in middle bench floodplain areas of the Tulsequah River in areas influenced by both cold air drainage and regular outburst floods from the Tulsequah Glacier. Soils are coarse-textured and poor, and are frequently exposed. Stunted (1.5 to 10 m high) subalpine fir (*Abies lasiocarpa*) and western hemlock (*Tsuga heterophylla*) co-dominate the shrub layer, with willows (*Salix* spp.), mountain ash (*Sorbus sitchensis*), Sitka alder (*Alnus viridis* spp. *sitchensis*), black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) and Douglas maple (*Acer glabrum*) occasionally present. Nootka lupine (*Lupinus nootkatensis*) is typically the dominant herb layer species, and may be associated with bastard toad-flax (*Geocaulon lividum*), river beauty (*Epilobium latifolium*), graminoids and other species composing a sparse, scattered herb layer. Extensive cover of grey rock-moss moss typifies this ecosystem type, often intermixed with coastal reindeer lichen (*Cladina portentosa*).

3.2 Previously Described Ecosystems

The following site series descriptions for the CWHwm are extracted largely from the *Field Guide to Site Identification and Interpretation for the Prince Rupert Forest Region* (Banner *et al.* 1993), as well as Fuller (2002) and Marcoux (1997). For more detailed descriptions of these ecosystem types, refer to the above references.

Code	AC	***Name***	Avalanche chute	***Site Series***	00
Distribution		***# of Polygons***	6	***Total Area (ha)***	6.8

Structural Stages

The AC ecosystems within the study area were classified as structural stages 3a and 3b.

Site Description

The AC is relatively common in the study area, with avalanching originating in the subalpine (MH) and alpine tundra (AT) zones and terminating in this unit. The shrub-dominated vegetation is composed predominantly of Sitka alder, often associated with devil's club (*Oplopanax horridus*) and red elderberry (*Sambucus racemosa*). Conifers do not typically establish in AC sites. Productivity is high for the subzone, supported by the rich, deep and moist soils. The herb layer is poorly developed, and is dominated by ferns such as lady fern (*Athyrium felix-femina*) and oak fern (*Gymnocarpium dryopteris*). The moss layer is likewise poorly developed, owing to low light levels at the forest floor, frequent disturbance, and heavy accumulations of leaf litter.

Code	AD	***Name***	Alder - Devil's club shrub	***Site Series***	00
Distribution		***# of Polygons***	4	***Total Area (ha)***	4.9

Structural Stages

All AD ecosystems in the study area were classified as structural stage 3b.

Site Description

The AD occurs on level to steep slopes that are not necessarily subjected to avalanching, but are affected by snow press. Like the AC, the vegetation in these sites is composed predominantly of Sitka alder, and devil's club. Productivity is high, with deep, rich, moist soils enriched by the nitrogen-fixing alder. Conifers are not common in these sites, suppressed by the competitive growth of the shrub layer. The herb layer is poorly developed, and is dominated by ferns, and the moss layer is almost absent owing to the heavy accumulations of leaf litter at the site.

Code	AS	***Name***	Alder - Sitka sedge - Bluejoint	***Site Series***	00
Distribution		***# of Polygons***	7	***Total Area (ha)***	6.3

Structural Stages

All AS ecosystems in the study area were classified as structural stage 3a.

Site Description

The AS is a rich, shrub swamp typically located on level sites with deep organic soils, as well as on fluvial terraces. Dominant shrubs are green and mountain alders (*Alnus tenuifolia* and *A. crispa*), associated with willows (*Salix* spp.). Bluejoint grass (*Calamagrostis canadensis*) and Sitka sedge (*Carex sitchensis*) dominate the herb layer, and is often associated with marsh horsetail (*Equisetum palustre*), marsh cinquefoil (*Potentilla palustris*) and small-flowered bulrush (*Scirpus microcarpus*). *Drepanocladus* moss may be present in the moss layer.

Code	SF	***Name***	Organic Sedge fen	***Site Series***	00
Distribution		***# of Polygons***	3	***Total Area (ha)***	5.7

Structural Stages

All SF ecosystems in the study area were classified as structural stage 2b.

Site Description

The SF is a sedge-fen occurring adjacent to water bodies on level sites that have organic soils over fluvial deposits. The dominant species is beaked sedge (*Carex rostrata*), and is associated with marsh cinquefoil.

Code	HB	***Name***	Western hemlock - Sitka spruce - Blueberry	***Site Series***	01
Distribution		***# of Polygons***	20	***Total Area (ha)***	79.3

Structural Stages

HB ecosystems in the study area were classified as structural stages 5, 6 and 7.

Site Description

The HB is the zonal site series for the CWHwm, and is one of the more common sites in the study area. The zonal sites occur mainly at mid to level slope positions, on morainal, colluvial or fluvial blankets, or with shallow soil veneers over bedrock or colluvium. Productivity is moderate. The tree layer is heavily dominated by western hemlock, sometimes mixed with Sitka spruce (*Picea sitchensis*) in both the canopy and understory. Blueberries (*Vaccinium alaskense* and *V. ovalifolium*) are frequent understory species. The herb layer is mainly composed of scattered dwarf dogwood (*Cornus canadensis*), five-leaved bramble (*Rubus pedatus*), and oak fern. The moss layer forms extensive carpets dominated by lanky moss (*Rhytidiadelphis loreus*) and step moss (*Hylocomium splendens*).

Code	SO	***Name***	Sitka spruce - Western hemlock - Oakfern	***Site Series***	03
Distribution		***# of Polygons***	22	***Total Area (ha)***	117.8

Structural Stages

SO ecosystems in the study area were classified as structural stages 3, 5, 6 and 7.

Site Description

The SO site series occurs on mid to lower slope positions on moderately well-drained, rich colluvial or fluvial substrates. Tree growth is good and the tree layer is composed predominately of western hemlock and Sitka spruce (*Picea sitchensis*). The shrub layer is dominated by blueberries. The herb layer is diverse and is dominated by ferns, such as oak fern and spiny wood fern (*Dryopteris expansa*). Rich site indicators such as foam flower (*Tiarella trifoliata*) and scattered devil's club are also common.

Code	SD	***Name***	Sitka spruce - Western hemlock - Devil's club	***Site Series***	04
Distribution		***# of Polygons***	15	***Total Area (ha)***	23.5

Structural Stages

SD ecosystems in the study area were classified as structural stages 3b, 4, 5, 6 and 7.

Site Description

The SD is a productive unit. It is found at lower to level slope positions on sites with subhydric to hydric moisture regimes and rich or very rich nutrient regimes. The tree layer is composed of well-growing western hemlock and Sitka spruce. Devil's club dominates the shrub layer, although a variety of other shrubs may be present. The herb layer includes a variety of rich site indicators including oak fern, spiny wood fern, lady fern, foam flower and enchanter's nightshade (*Circaea alpina*).

Code	SS	***Name***	Sitka spruce - Salmonberry	***Site Series***	05
Distribution		***# of Polygons***	14	***Total Area (ha)***	129.1

Structural Stages

SS ecosystems in the study area were classified as structural stages 3, 5 and 6.

Site Description

The SS is a floodplain site located on high fluvial benches subject to seasonally fluctuating water tables and infrequent flooding. It is a productive unit with well-growing western hemlock and Sitka spruce dominating the tree layer, although deciduous species may be present. A variety of species make up the dense shrub layer including devil's club, salmonberry (*Rubus spectabilis*), stink current (*Ribes bracteosum*), red-osier dogwood (*Cornus stolonifera*) and Douglas maple. The herb layer is less well-developed and is dominated by ferns. Leafy mosses (*Mnium* spp.) are common in the moss layer.

Several ecosystems along the floodplain of the Tulsequah River at Shazah Creek showed evidence of the periodic jökulhlaups (periodic outflows from a glacier lake) from the Tulsequah glacier, with successive layers of sand and silt appearing to limit herb and shrub growth. These ecosystems were identified with a 'f' subscript to distinguish them from the more typical shrub and herb dominated SS ecosystem.

Code	CD	***Name***	Cottonwood - Red-osier dogwood	***Site Series***	06
Distribution		***# of Polygons***	29	***Total Area (ha)***	110.1

Structural Stages

CD ecosystems in the study area were classified as structural stages 3, 4 and 5.

Site Description

The CD is a floodplain site located on middle fluvial benches and subject to prolonged elevated water tables and flooding at least every five years. Due to the prolonged high water table, conifers

only occur on elevated microsites and the tree layer is dominated by deciduous species such as black cottonwood and Sitka alder. The dense shrub layer is composed of a variety of species including devil's club, salmonberry, stink current and red-osier dogwood. Herb and moss layers are poorly developed, although wet and rich site indicators are often present.

Code	CW	***Name***	Cottonwood - Willow	***Site Series***	07
Distribution		***# of Polygons***	12	***Total Area (ha)***	17.1

Structural Stages

CW ecosystems in the study area were classified as structural stages 3, 3a, 3b and 5.

Site Description

The CW is a floodplain site located on low fluvial benches usually situated directly adjacent to rivers and backchannels. These areas are generally subject to annual flooding. Conifer species are notably absent and the tree layer, if present, is composed of deciduous species such as black cottonwood, red alder and willows (*Salix* spp). The shrub layer is well-developed but can be quite variable ranging from willow- and alder-dominated thickets to more diverse mixtures including salmonberry, stink current and red-osier dogwood. The herb and moss layers, if present, are very poorly developed.

Report Prepared By:

Amanita Coosemans, RPBio.

Report Reviewed By:

Laurence Turney, RPBio.

4. References

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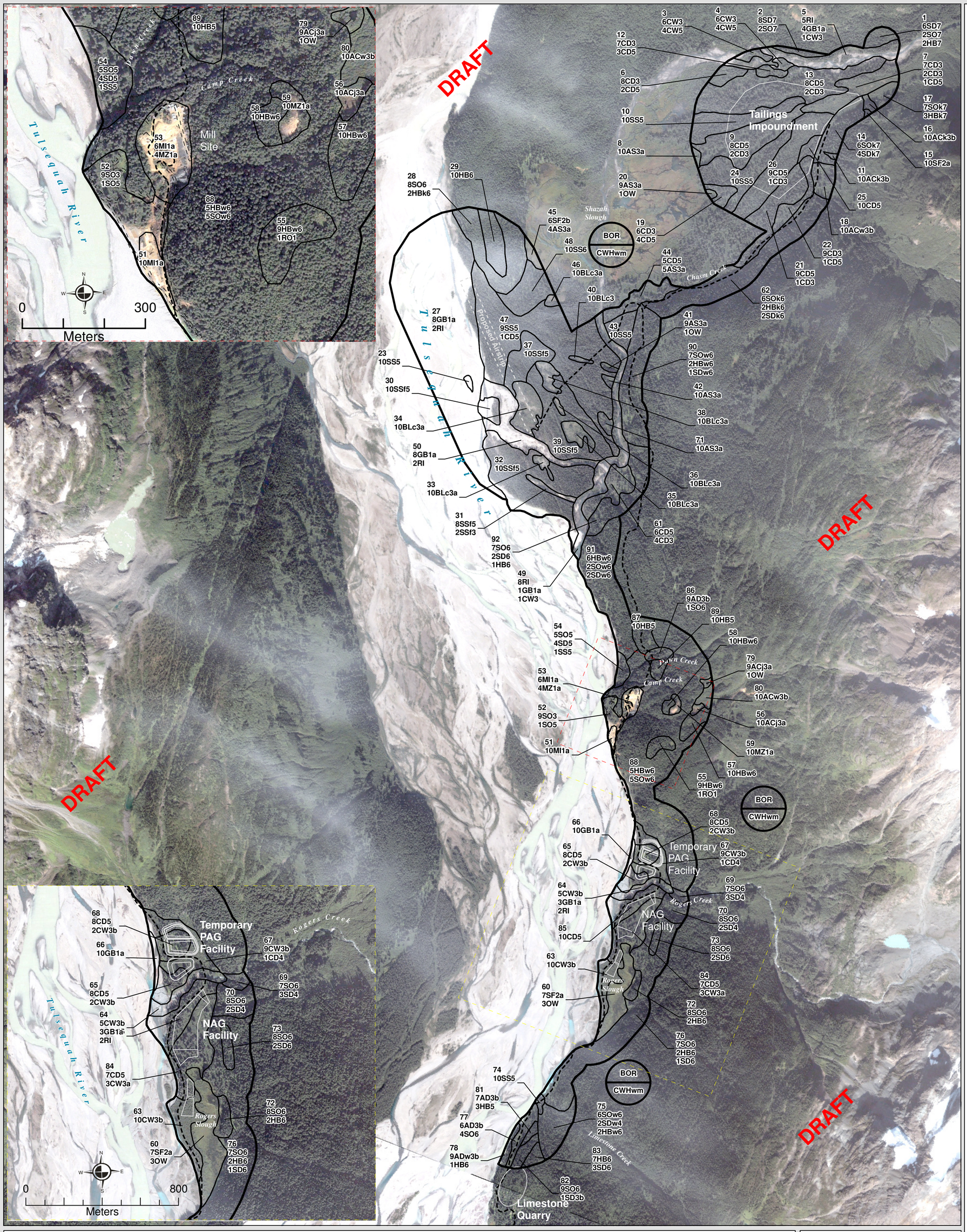

Introduction

This project provides detailed ecosystem mapping of the proposed infrastructure development area of the Tulsequah Chief Project located in northwest British Columbia, south of Atlin BC. Mapping was completed following the methods as outlined in *Standards for Terrestrial Ecosystem Mapping in British Columbia* (RIC, 1998). Fieldwork for this mapping was completed in June and July 2007.

Ecosection and Biogeoclimatic Units Label

Ecosection: BOR
Biogeoclimatic Unit: CWHwm

Ecosystem Unit Label

Decile 1 | Ecosystem Code 1 | Structural Stage 1
4CW3aB | Structural Modifier
6SS7C | Stand Type
Decile 2 | Ecosystem Modifier | Structural Stage 2

Map Boundaries

Ecosystem Unit
Study area boundary
Field Plot

Ecosections:
BOR: Boundary Ranges

Biogeoclimatic Units:
CWHwm: Coastal Western Hemlock wet maritime

Ecosystem Modifiers	
Code	**Description**
Topography	
c	coarse-textured with over 70% coarse fragment volume
f	fine-textured soils with less than 20% to 35% coarse fragment volume
j	gentle to moderate slope (less than 35% slope)
k	cool aspect (aspect = 285°–135°, slope = 25%–100%)
w	warm aspect (aspect = 135°–285°, slope = 25%–100%)

Stand Type	
Code	**Description**
C	Coniferous
B	Broadleaf
M	Mixed

Structural Stage					
Code	Structural Stage and Structural Stage Modifiers				
1	Sparse/Bryoid	1a	Sparce	1b	Bryoid
2	Herb	2a	Forb-dominated	2b	Graminoid dominated
3	Shrub/Herb (forested)	3a	Low Shrub (< 2 m tall)	3b	Tall Shrub (2 – 10 m tall)
4	Pole/Sapling (> 10 m tall, usually greater than 10 – 15 years old)				
5	Young Forest (generally 40–80 years but may begin as early as age 30)				
6	Mature Forest (80-250 yrs).				
7	Old Forest (>250 yrs).				

CWHwm – Coastal Western hemlock wet maritime subzone

Map Code	Site Series	Ecosystem Name	Site Description	SMR	SNR
Upland Forest Ecosystem Units					
AC	00	Avalanche chute	Occurs on steep slopes, subject to avalanches. Typically with deep, rich, moist soils and is dominated by Sitka alder, devil's club and ferns.	4-6	D-E
AD	00	Alder Devil's club shrub site	Occurs on level to steep slopes that are not necessarily subject to avalanching. Typically with deep, rich, moist soils and is dominated by Sitka alder, devil's club and ferns.	4-5	D-E
BL	00	BlHw - Lupine	Coarse textured cold air drainage site dominated by 1.5 to 10 m subalpine fir and western hemlock, Nootka lupine and Racomitrium moss cover	2-3	B-C
HB	01	Western Hemlock - Sitka Spruce - Blueberry	Zonal site series. Occurs primarily at mid to level slope positions on a range of parent materials.	3-4	C
SO	03	Sitka Spruce - Western Hemlock - Oakfern	Fresh to wet site. Generally located at mid to lower slopes on moderately well drained, rich soils as well as level glaciofluvial terraces and toe of slopes.	2-4	C-E
SD	04	Sitka Spruce - Western Hemlock - Devil's Club	Fresh to wet site. Productive site occurring on fluvial and colluvial fans and on fluvial veneers overtop glaciofluvial deposits.	4-5	D
Floodplain Forest Ecosystems Units					
SS	05	Sitka Spruce - Salmonberry	Floodplain site. Occurs on elevated floodplain sites with seasonally fluctuating water tables. Highly productive forested sites.	5-6	D-E
CD	06	Cottonwood - Red-osier Dogwood	Floodplain site. Occurs on middle fluvial benches which experience prolonged elevated water tables.	5-6	D-E
CW	07	Cottonwood - Willow	Floodplain site. Located on low fluvial benches usually directly adjacent to rivers or in back channels.	6-7	C-E
Wetland Ecosystem Units					
AS	00	Alder - Sitka sedge - Bluejoint	Shrub swamp that typically occurs on level sites with organic soils. It can occur on fluvial terraces and is dominated by alder, Sitka sedge and bluejoint	6-7	C-E
SF	00	Organic sedge-fen	Occurs in level areas on organic soils over fluvial deposits; adjacent to bodies of water.	6-7	C-E
Non-vegetated and Anthropogenic Sites					
GB	-	Gravel Bar	An elongated landform generated by waves and currents. Composed of un-consolidated small rounded cobbles, pebbles, stones and sand.		
MI	-	Mine	An unvegetated area used for the extraction of mineral ore and other materials.		
MZ	-	Rubbly Mine Spoils	Discarded overburden or waste rock moved so that ore can be extracted in a mining operation.		
OW	-	Shallow Open Water	A wetland composed of permanent shallow open water (<2 m deep) and lacking extensive emergent plant cover.		
RI	-	River	A watercourse formed when water flows between continuous, definable banks. The flow may be intermittent or perennial.		
RO	-	Rock Outcrop	A gentle to steep, bedrock escarpment or outcropping, with little soil development and sparse vegetative cover.		

Map Sources/Notes:
Exploration road alignment (cartographic representation by Gartner Lee Limited), Wardrop Engineering
Mine layout, Wardrop Engineering
Quickbird Imagery (2003) Copyright 2007 DigitalGlobe Incorporated
All other data, Gartner Lee Limited

250 125 0 250 500 750 1,000
Meters
1:15,000
UTM Zone 8N, NAD 83

File Name: 72602_TEM_V2.mxd
Reviewed By: LT
Date Issued: September 2007
Prepared By: JW
Project Number: 72602

Legend

Proposed Activities

- Proposed Exploration Access Road
- Proposed Mine Development
- Proposed Mill Site Roads

Redfern Resources Ltd.

TEM Map

10 September 2007

Gartner Lee

Figure 5-1
Version 2

Credits

This project was completed for Redfern Resources Vancouver, British Columbia by Gartner Lee Limited, Smithers, BC. Bioterrain mapping was completed by Nancy Steffen, and the ecosystem mapping by A Coosemans and Laurence Turney. Field work was completed by Amanita Coosemans, Patrick Borden, Anne MacLeod, Laurence Turney and Patrick Williston. Monorestitution and final mapping by Gartner Lee Limited.

Data Sources

This project was based on 1:16,000 and 1:32,000 black and white stereo aerial photography taken on August 6, 1994, and Terrain Resource Inventory Mapping (TRIM) base mapping. Data was obtained from Geographic Data BC. A polygon inspection rate of 45% was achieved of 92 polygons (18 full plots, 11 ground inspections, and 12 visual checks).

Citation

Coosemans, A., L. Turney and N. Steffen. 2007. Terrestrial Ecosystem Mapping of the Proposed Tuslequah Chief Mine Site. Prepared for Redfern Resources Ltd. Gartner Lee Limited. Terrace, BC. 1:10,000 map.

Appendix B

Bird Species Observed in Tulsequah Valley During Field Assessments in 2007

Species	Status	West Side of Tulsequah River	East Side of Tulsequah River	Total
Alder Flycatcher	Yellow	20	1	**21**
American Dipper	Yellow	1		**1**
American Redstart	Yellow	26	2	**28**
American Robin	Yellow	73	12	**85**
Arctic Tern	Yellow	1		**1**
Bald Eagle	Yellow	10	5	**15**
Barn Swallow	Blue	1		**1**
Belted Kingfisher	Yellow	4		**4**
Black-capped Chickadee	Yellow	4		**4**
Blackpoll Warbler	Yellow	3	2	**5**
Blue Grouse	Yellow		6	**6**
Canada Goose	Yellow	7	8	**15**
Chestnut-backed Chickadee	Yellow	8	3	**11**
Common Rail	Yellow	1		**1**
Common Raven	Yellow	2		**2**
Common Yellowthroat	Yellow	34		**34**
Dark-eyed Junco	Yellow	1	1	**2**
Downy Woodpecker	Yellow	2		**2**
Dusky Flycatcher	Yellow	3		**3**
Fox Sparrow	Yellow	15	2	**17**
Golden Eagle	Yellow	1		**1**
Golden-crowned Kinglet	Yellow	2	2	**4**
Gray-cheeked Thrush	Yellow	2		**2**
Greater Scaup	Yellow		1	**1**
Green-winged Teal	Yellow	2		**2**
Hairy Woodpecker	Yellow	4	1	**5**
Hermit Thrush	Yellow	9	2	**11**
Hooded Merganser	Yellow	1		**1**
Least Flycatcher	Yellow	4		**4**
Lincoln's Sparrow	Yellow	6	1	**7**
Mallard	Yellow	7	6	**13**
MacGillivray's Warbler	Yellow	9	2	**11**
Northern Flycatcher	Yellow		1	**1**
Northern Waterthrush	Yellow	36		**36**
Olive-sided Flycatcher	Yellow	4	1	**5**

Species	Status	West Side of Tulsequah River	East Side of Tulsequah River	Total
Orange-crowned Warbler	Yellow	32	2	**34**
Oven Bird	Yellow	1		**1**
Pied-billed Grebe	Yellow	1		**1**
Pine Siskin	Yellow	1	1	**2**
Purple Finch	Yellow	2		**2**
Red-breasted Nuthatch	Yellow	2	1	**3**
Red-breasted Sapsucker	Yellow	7	2	**9**
Red-eyed Vireo	Yellow	1	2	**3**
Red-tailed Hawk	Yellow	4	1	**5**
Red-winged Blackbird	Yellow	1	1	**2**
Ring-necked Duck	Yellow	1		**1**
Ruby-crowned Kinglet	Yellow	27	8	**35**
Ruffed Grouse	Yellow	3	3	**6**
Rufous Hummingbird	Yellow	6	2	**8**
Savannah Sparrow	Yellow	3		**3**
Semi-palmated Plover	Yellow	1		**1**
Song Sparrow	Yellow	20	1	**21**
Spotted Sandpiper	Yellow	11		**11**
Stellar's Jay	Yellow	3		**3**
Swainson's Thrush	Yellow	49	17	**66**
Tennessee Warbler	Yellow	7		**7**
Townsend's Warbler	Yellow	7	1	**8**
Tree Swallow	Yellow	3	6	**9**
Trumpeter Swan	Yellow	13	2	**15**
Varied Thrush	Yellow	44	8	**52**
Veery	Yellow	3		**3**
Violet-green Swallow	Yellow	3		**3**
Warbling Vireo	Yellow	23	5	**28**
Water Pipit	Yellow	1		**1**
Western Tanager	Yellow	8	2	**10**
Western Wood Pewee	Yellow	2	4	**6**
Wilson's Snipe	Yellow	11	2	**13**
Wilson's Warbler	Yellow	18		**18**
Winter Wren	Yellow	6	1	**7**
Yellow Warbler	Yellow	86	19	**105**
Yellow-rumped Warbler	Yellow	14	7	**21**
Unidentified Goldeneye		1		**1**
Unidentified Gull		6	1	**7**
Unidentified Raptor		1		**1**
Unidentified Swan		1		**1**
Unidentified Tern		2	1	**3**
Unidentified Woodpecker		1	1	**2**
Total Number of Birds		**740**	**160**	**900**
Total Number of Species		**74**	**45**	**77**

Appendix C

Summary of Habitat Assessment Information Collected within the Infrastructure Areas and Access Road in 2007

Plot Name	Plot Type	General Location	General Ecosystem	Evidence of Use				Suitability Ratings			
				Species	Sign	Descrip.	Number	Species	Season.	Feeding	Security /Thermal
LT-V1	Field Notes	Camp and Laydown Area	Mature Floodplain Forest (Act-Red-Osier)	Moose	Pellets	Young Old	6 15	Grizzly bear	Spring Summer Fall	4 4 2	3 3 3
				Moose	Feeding	Young Old	Extensive	Moose	Growing Winter	1 1	2 2
2-1	GIF & WHA	Camp and Laydown Area	Mature Floodplain Forest (Act-Red-Osier)	Grizzly bear	Bed	Young	1	Grizzly bear	Spring Summer Fall	4 3 2	3 3 3
				Grizzly bear	Scat	Young	6				
				Moose	Pellets	Winter	4	Moose	Growing Winter	1 1	2 2
				Moose	Feeding	Young Old	Extensive				
LT-V2	Field Notes	Maple Ridge	Mature Floodplain Forest (SS-Salmonberry)	Unknown bear	Scat	Fresh	2	Grizzly bear	Spring Summer Fall	2 2 3	3 3 3
								Moose	Growing Winter	2 2	2 2
LT-V3	Field Notes	Maple Ridge	Alder-Devil's Club Shrub	Unknown bear	Scat	Young	2	Grizzly bear	Spring Summer Fall	2 2 3	3 3 3
				Wolf	Scat	Young	1	Moose	Growing Winter	2 2	2 2
LT-V4	Field Notes	Above Large Wetland Complex	Mature Mesic Forest (HwSs-Blueberry)	Moose	Pellets	Winter	4	Grizzly bear	Spring Summer Fall	5 5 4	3 3 3
								Moose	Growing Winter	5 5	3 3

Plot Name	Plot Type	General Location	General Ecosystem	Evidence of Use				Suitability Ratings			
				Species	Sign	Descrip.	Number	Species	Season.	Feeding	Security /Thermal
LT-V5	Field Notes	Near Large Wetland Complex	Shrubby Floodplain (Act-Red-Osier)	-	-	-	-	Grizzly bear	Spring	4	3
									Summer	4	3
									Fall	2	3
								Moose	Growing	1	3
									Winter	1	3
26-1	GIF & WHA	Above Large Wetland Complex	Mature Rich-Wet Forest (SsHw-Oak Fern)	-	-	-	-	Grizzly bear	Spring	4	3
									Summer	4	3
									Fall	4	3
								Moose	Growing	5	3
									Winter	5	3
26-2	GIF & WHA	Above Large Wetland Complex	Mature Rich-Wet Forest (SsHw-Oak Fern)	-	-	-	-	Grizzly bear	Spring	4	3
									Summer	4	3
									Fall	4	3
								Moose	Growing	5	3
									Winter	5	3
26-3	GIF & WHA	Forest South of Quarry	Mature Swamp Forest (Ss-Skunk Cabbage)	-	-	-	-	Grizzly bear	Spring	2	4
									Summer	2	4
									Fall	2	4
								Moose	Growing	3	4
									Winter	4	4
26-4	GIF & WHA	Forest South of Quarry	Young Rich-Wet Forest (SsHw-Devil's Club)	Unknown bear (Black?)	Scat	Fresh Young	2 3	Grizzly bear	Spring	3	3
									Summer	3	3
									Fall	3	3
				Unknown bear (Black?)	Feeding	Fresh Young	3 8	Moose	Growing	4	3
									Winter	4	3
27-1	GIF & WHA	Forest South of Quarry	Mature Rich-Wet Forest (SsHw-Devil's Club)	-	-	-	-	Grizzly bear	Spring	3	3
									Summer	3	3
									Fall	3	3
								Moose	Growing	4	3
									Winter	4	3
27-2	GIF & WHA	Forest South of Quarry	Old Mesic Forest (HwSs-Blueberry)	-	-	-	-	Grizzly bear	Spring	5	3
									Summer	3	3
									Fall	3	3
								Moose	Growing	5	3
									Winter	5	3

Plot Name	Plot Type	General Location	General Ecosystem	Evidence of Use				Suitability Ratings			
				Species	Sign	Descrip.	Number	Species	Season.	Feeding	Security /Thermal
29-4	GIF & WHA	Forest South of Quarry	Mature Rich-Wet Forest (SsHw-Devil's Club)	-	-	-	-	Grizzly bear	Spring	3	3
									Summer	3	3
									Fall	3	3
								Moose	Growing	4	3
									Winter	4	3
1-3	GIF & WHA	Limestone Quarry area	Mature Rich-Wet Forest (SsHw-Oak Fern)	-	-	-	-	Grizzly bear	Spring	3	2/4
									Summer	3	2/4
									Fall	4	2/4
								Moose	Growing	5	4
									Winter	5	3
V-08	Field Notes	Limestone Quarry area	Alder-Devil's Club Shrub	-	-	-	-	Grizzly bear	Spring	3	3
									Summer	3	3
									Fall	3	3
								Moose	Growing	3	3/4
									Winter	3	3/4
1-4	GIF & WHA	Limestone Quarry area	Alder-Devil's Club Shrub	-	-	-	-	Grizzly bear	Spring	4	3
									Summer	4	3
									Fall	5	3
								Moose	Growing	4	3/4
									Winter	4	3/4
30-4	GIF & WHA	South of Rogers Creek	Mature Rich-Wet Forest (SsHw-Oak Fern)	-	-	-	-	Grizzly bear	Spring	5	3/2
									Summer	4	3/2
									Fall	4	3/2
								Moose	Growing	5	4
									Winter	5	3
V-02	Field Notes	Rogers Creek (Wetland)	Shrubby Floodplain (Act-Willow)	-	-	-	-	Grizzly bear	Spring	4	5
									Summer	4	5
									Fall	4	5
								Moose	Growing	3	4
									Winter	3	4
30-3	GIF & WHA	Rogers Creek (Wetland)	Sedge Fen Wetland	Beaver	Dam	Old	2	Grizzly bear	Spring	2	5/3
									Summer	3	5/3
									Fall	5	5/3
								Moose	Growing	3	3
									Winter	3	3

Plot Name	Plot Type	General Location	General Ecosystem	Evidence of Use				Suitability Ratings			
				Species	Sign	Descrip.	Number	Species	Season.	Feeding	Security /Thermal
V-01	Field Notes	Rogers Creek (Waste Rock)	Young Floodplain Forest (Ss-Salmonberry)	-	-	-	-	Grizzly bear	Spring Summer Fall	3 2 4	2/4 2/3 2/3
								Moose	Growing Winter	-	-
30-2	GIF & WHA	Rogers Creek (Waste Rock)	Shrubby Floodplain (Act-Willow)	Beaver	Cut trees	Young	1	Grizzly bear	Spring Summer Fall	2 3 5	2/4 2/3 2/3
								Moose	Growing Winter	2 2	3/4 3/4
30-1	GIF & WHA	Rogers Creek (Waste Rock)	Mature Floodplain Forest (Ss-Salmonberry)	Grizzly bear	Mark Tree & Trail	Fresh	1	Grizzly bear	Spring Summer Fall	3 3 4	2/4 2/3 2/3
								Moose	Growing Winter	4 4	4 4
1-2	GIF & WHA	Tulsequah Mine area	Mature Mesic Forest (HwSs-Blueberry)	Unknown bear	Scat	Young	1	Grizzly bear	Spring Summer Fall	5 4 3	3/2 3/2 3/2
								Moose	Growing Winter	4 4	3 3
1-1	GIF & WHA	Tulsequah Mine area	Mature Dry Forest (HwSs - Step moss)	-	-	-	-	Grizzly bear	Spring Summer Fall	5 5 4	3/2 3/2 3/2
								Moose	Growing Winter	5 5	3 5
1-99	GIF & WHA	Tulsequah Mine area	Shrubby Rich-Wet Forest (SsHw-Oak Fern)	-	-	-	-	Grizzly bear	Spring Summer Fall	4 4 3	4 4 4
								Moose	Growing Winter	5 5	5 5
29-3	GIF & WHA	Tulsequah River (Airstrip)	Scrub Forest (BlHw-Lupine)	-	-	-	-	Grizzly bear	Spring Summer Fall	5 4 5	5 5 5
								Moose	Growing Winter	5 5	5 5

Plot Name	Plot Type	General Location	General Ecosystem	Evidence of Use				Suitability Ratings			
				Species	Sign	Descrip.	Number	Species	Season.	Feeding	Security /Thermal
29-2	GIF & WHA	Tulsequah River (Airstrip)	Mature Floodplain Forest - Fine Texture (Ss-Salmonberry)	-	-	-	-	Grizzly bear	Spring	4	4
									Summer	5	4
									Fall	5	4
								Moose	Growing	5	4
									Winter	5	4
29-1	GIF & WHA	Tulsequah River (Airstrip)	Mature Floodplain Forest - Fine Texture (Ss-Salmonberry)	-	-	-	-	Grizzly bear	Spring	4	4
									Summer	5	4
									Fall	5	4
								Moose	Growing	5	4
									Winter	5	4
28-4	GIF & WHA	Shazah Creek (Tailings Area)	Mature Floodplain Forest (Ss-Salmonberry)	-	-	-	-	Grizzly bear	Spring	3	3
									Summer	3	3
									Fall	4	3
								Moose	Growing	4	4
									Winter	4	4
28-3	GIF & WHA	Shazah Creek (Tailings Area)	Mature Floodplain Forest (Ss-Salmonberry)	Marten	Den	Old	1	Grizzly bear	Spring	3	3
									Summer	2	3
									Fall	3	3
				Marten	Scat	Young	2	Moose	Growing	4	3
									Winter	3	3
28-2	GIF & WHA	Shazah Creek (Tailings Area)	Shrubby Floodplain (Ss-Salmonberry)	-	-	-	-	Grizzly bear	Spring	2	3/5
									Summer	2	3/5
									Fall	4	3/5
								Moose	Growing	2	3/4
									Winter	2	3/4
28-1	GIF & WHA	Shazah Creek (Tailings Area)	Mature Rich-Wet Forest (SsHw-Oak Fern)	-	-	-	-	Grizzly bear	Spring	4	3
									Summer	5	3
									Fall	5	3
								Moose	Growing	4	3
									Winter	4	3

Memorandum
18 January 2008

Attachment 2

Taku River Mainstem Channel Profile

Redfern Resources Ltd – Suite 800 – 1281 West Georgia St. – Vancouver, BC V6E 3J7

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Taku River Mainstem Channel Profile

Prepared for
Redfern Resources Limited

Submitted by
Gartner Lee Limited

January, 2007

Gartner Lee

1. Introduction

Navigation on the Taku River is largely constrained by the tidally influenced sand flats at the mouth the river between Taku Lodge and Taku Point. Navigation becomes increasingly challenging upstream of the US/Canada boarder where the river becomes more braided and less constrained to a single mainstem channel. Accordingly, detailed bathymetric analysis have been completed of these two river sections to characterize constraints to navigation. Between the sand flats and the border, the mainstem river channel is relatively better defined and presents less of a limitation to normal river navigation. To confirm this interpretation, a mainstem channel depth profile was measured in summer 2007 as part of the sand flats bathymetric survey. Further details on the sand flats survey and methods are presented in the "*Channel Depth Analysis of the Lower Taku River*", Gartner Lee Limited 2007.

2. Methods

Continuous depth soundings were collected along the mainstem channel from Taku Point to the mouth of the Tulsequah River in British Columbia on July 6th, 2007. Measurements were collected using a Sonarmite v2.0 Portable Bluetooth Echo Sounder linked to a Trimble XT GPS and digital data recorded mounted on the transom of a locally charted river boat. The local river boat operator generally followed the mainstem channel, although given the relatively high river stage at the time of the survey, the route followed does not absolutely follow the deepest part of the river, or thalweg. However, the results of the profile do provide a general indication of typical minimum channel depth associated with the river mainstem.

River discharge at the time of the survey was relatively high due to high discharge and flooding in the summer of 2007. Accordingly, the channel depth data was reduced to represented normal summer river conditions and levels when normal open water barging would occur. Discharge at the time of the survey was 34,900 cfs (3,185 m3/s). Average summer discharge is 26,000 cfs (740 m3/s). Measured channel depth data was corrected using the stage-discharge relationship for the USGS's hydrology station at Canyon Island for the upstream end of the survey. The stage-discharge relationship developed by Sandwell (1995) for Taku Lodge was used to reduce the downstream end of the channel profile survey.

3. Results and Discussion

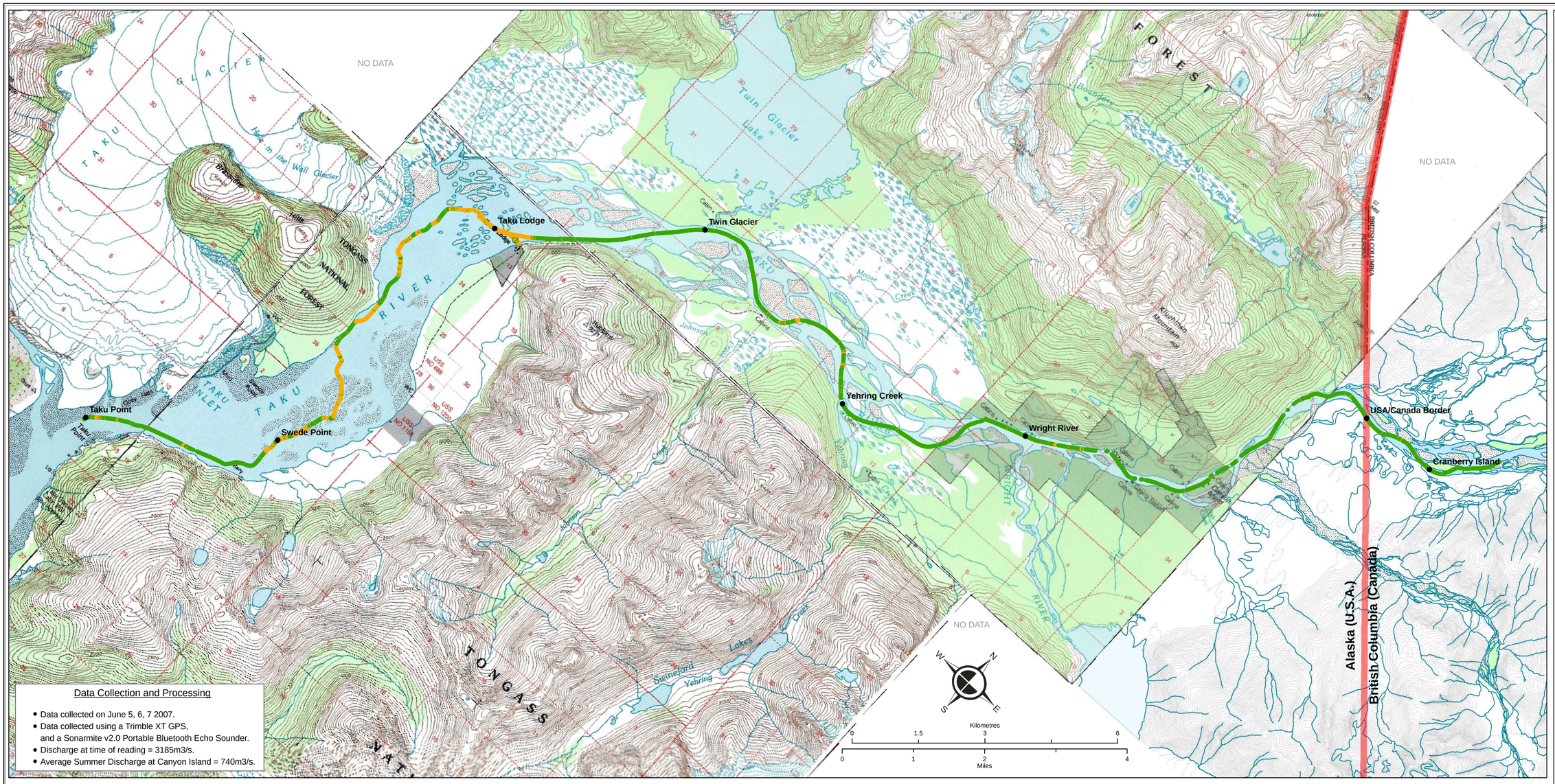
Mainstem channel depth results are illustrated in Figure 1, attached. The profile shows the reduced depth data corresponding to average summer water levels. Water depth measurements less than 3 ft (1 m) are portrayed with a yellow dot, whereas water depths greater than 3ft (1m) are shown in green. Three feet is the typical depth required to operate a shallow draft river tug and barge.

The profile confirms that constraints to navigation on the river is the sand flats area. The detailed bathymetric survey work conducted in 2007 maps the channels in detail through the sand flats. Upstream of the mudflats, the mainstem channel depth is typically 10 feet (3 m) increasing to 18 feet (5.5 m) deep on average in the Canyon Island area. The water depth data shows occasional shallow measurements upstream of the sand flats. Given the sporadic nature of these measurements, these likely represent locations where the boat strayed from the thalweg and/or anomalous measurements.

Fluctuation in river level throughout the year is presented on Figure 2 based on data from the Canyon Island river level gauge. The river stage chart shows that river levels typically fluctuate between gauge height 33 ft to 37 ft (a fluctuation range of 4 feet (1.2 m)) during the “open water season” as described in the Tulsequah Chief ACB Transportation System project description. The water level / gauge height corresponding to “average” summer flow is 34.7 ft. The water depth profile shown on Figure 1 corresponds to this gauge height. During the transition season (freeze-up and break-up), river levels range between 29 and 33 ft gauge height. Therefore, water levels at Canyon Island during lowest river stage (occurring during winter) is 5.7 ft (1.7 m) below summer average water depths illustrated on Figure 1.

4. Conclusion

The Taku River mainstem channel profile data confirms the presence of a continuous channel with depth adequate for the operation of shallow draft tug and barge during the open water season. The empirical evidence presented by the historical barging operations on the Taku River and the successful river barging completed in 2007 compliments this conclusion.



Data Collection and Processing

- Data collected on June 5, 6, 7 2007.
- Data collected using a Trimble XT GPS, and a Sonarmite v2.0 Portable Bluetooth Echo Sounder.
- Discharge at time of reading = 3185m3/s.
- Average Summer Discharge at Canyon Island = 740m3/s.

Key To Features

Survey Route

Depths Along Route (ft)

- >3
- <3

Land Cover

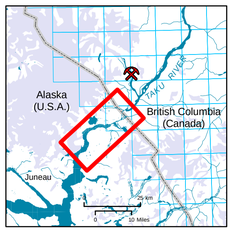
- Vegetated area
- Glacier
- Sandbar

Topography

- Index (100m)
- Intermediate (20m)

Water Features

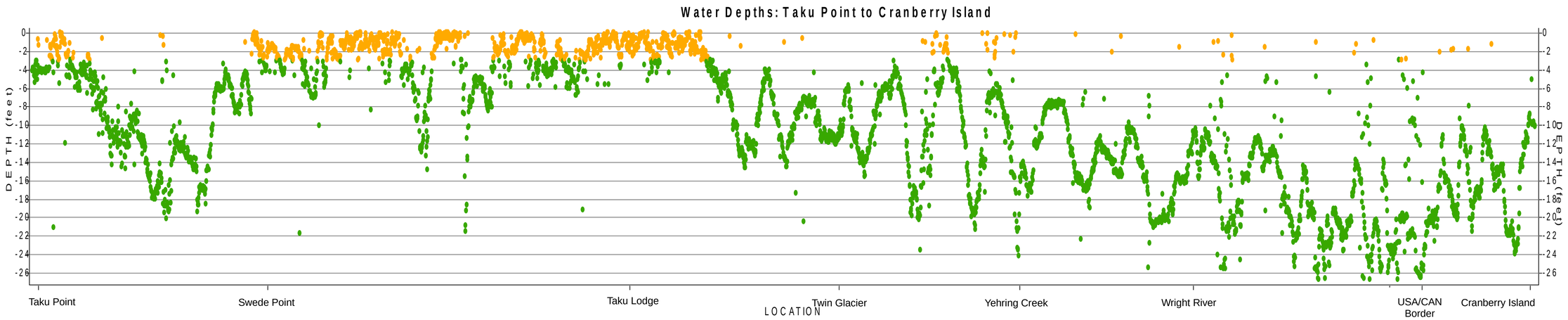
- Streams
- Lakes / Rivers



Map Sources/Notes:
Water Depth Measurements Collected on June 7/2007 by Gartner Lee Ltd. field staff.

Topographic Images derived from Digital Raster Graphic (DRG) Images produced by the USGS. Terrain Resource Information Management (TRIM) base data compiled by the Ministry of Environment, Lands and Parks, Geographic Data BC, Province of British Columbia at a scale of 1:20,000

UTM Zone 8N, NAD 83



Redfern Resources Ltd.

Channel Depth During Taku River Flood Discharge = 740m3/s

Gartner Lee

Figure 1
Version 1

Revision: 0
File Location: S:\GIS_Plots\Redfern\bathymetry\2008_Johnny_reduction_transom_added.mxd
Date Revised: January 8, 2008
Date Plotted: January 8, 2008

Memorandum
18 January 2008

Attachment 3

Tulsequah Chief Wildlife Log Form

Tulsequah Chief –WILDLIFE LOG 2008

Date/Time (ddmmyy/24hr)	**Observer**	**Species***	**Number**	**Activity****	**Observer Location** (UTM or Lat Long)	**Wildlife Location** (distance & direction from observer)	**Weather *****			**Comments** (age/sex of animal, behaviour of animal, reaction to disturbance, photo number, any other relevant info)
							Temp (^{0}C)	**Wind** (N, L, M, S)	**Precip** (N, L, M, H, S)	

***Species Codes:** Moose-ALAM, Black Bear-URAM, Grizzly Bear-URAR, Mountain Goat-ORAM, Harbour Seal-PHVI**,** Bald Eagle-BAEA, Golden Eagle-GOEA,
Species Groups (if species unknown): Duck – DU, Swan – SW, Goose – GO, Eagle – EA, Hawk – HA, Other Bird – OB, Frog/Toad – FT, Ungulate – UN, Carnivore – CA, Small Mammal – SM,
****Activity:** Swimming – TS, Feeding – FD, Flying – TF, Territorial – TE, Walking – TW, Nesting – NE,
***Weather:** Report for wind: N – none, L – light, M - moderate, S – strong; Report for precipitation: N – none, L – light, M – moderate, H – hard, S – snow

Memorandum
18 January 2008

Attachment 4

Wildlife Incident Risk Report

Wildlife Incident/Risk Report

If a staff member has an incident, "near miss" incident, or identifies a situation that may pose or could have posed a risk to wildlife, they must complete this report immediately and bring it to the attention of the Supervisor, Project Manager.

Observer(s):_____
Supervisor / Manager:_____
Date / Time:_____

Incident Type (circle one): vehicle collision, near collision, (vehicle Type: barge, boat, truck, helicopter, all terrain)
other: _____

Incident Results (circle one): death, injury, defensive behaviour, no injury, other:_____

Describe Results:_____
_____

Exact Location:_____

Habitat Description:_____

Species:_____ **Number:** _____

Sex:_____ **Age Class:** _____

Wildlife Activity:_____
_____
_____
_____
_____

Description of Incident:_____
_____
_____
_____
_____
_____

Corrective Action Suggested:_____
_____
_____
_____
_____

Corrective Action Completed By:_____
Signature:_____
Date:_____

Copies of this report to: ☐ Resource Agency ☐ Supervisor/Manager ☐ Employee