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TO:	David Morrison Yukon Energy Corporation	DATE:	July 8, 2009
C:		MEMO NO:	
FROM:	Lea Menzies, B.Sc., B.I.T Jack Dennett, P.Geo.	FILE:	W23101159.029
SUBJECT:	**Larson Creek/Beaver River Open Water Survey**		

1.0 INTRODUCTION

Yukon Energy Corporation (YEC) has retained EBA Engineering Consultants Ltd. to conduct exploration program to locate and evaluate potential geothermal prospects in the Yukon. The Geothermal Reconnaissance Program consists of numerous phases, including preliminary geological mapping, geochemical sampling, air photo interpretation (API), remote sensing and hydrological modelling. This information is being collected to enhance our understanding of geothermal activity in the Yukon and to acquire pre-development data at potential energy sources.

As part of this program, open water surveys were conducted during winter conditions in selected areas around southern Yukon with known or potential geothermal activity. Six study areas were selected (Figure 1) for transect based winters surveys to look for open water that may indicate geothermal anomalies. Open water surveys were conducted in the following areas: Shakwak Trench (Haines Junction Area), Volcano Mountain (Fort Selkirk Area), Nash Creek (north of Mayo, YT), McArthur Hotsprings Area, Takhini-Alligator Lake (Whitehorse Area) and Larson Creek – Beaver River (southeast Yukon).

This report summarizes the open water surveys conducted in the Larson Creek – Beaver River study area, which was conducted as a separate phase of the overall program. The results of open water surveys in the other areas are documented in a separate report.

2.0 METHODS

The preliminary Larson Creek – Beaver River survey area was delineated based on known geothermal activity in the area and an overview of the regional geology. The open water survey area was limited to make the initial assessment of the area cost effective. Transects were flown at a height between 250 m (820 ft) and 300 m (985 ft) at a speed of 70 knots (130 km/hr). Transect line spacing was approximately 2,000 m (6,560 ft) but was altered as needed based on topography and density of vegetation that increased efficiency without compromising survey quality.

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The probability of geothermal influence causing open water features were rated as high, moderate or low. The general criteria for these ratings are summarized in Table 1.

TABLE 1. CRITERIA FOR THE PROBABILITY OF THERMAL INFLUENCE

Probability of Thermal Influence	Criteria
HIGH	Round ponds not associated with a water course. May have snow-free ground vegetation and algae growth. Open streams may have flow from the ponds. May be associated with channel openings in adjacent water courses.
MODERATE	Open water in streams, rivers or lakes that does not appear to be solely the result of current or other non-thermal influence. Unusually long reach of open water in a small, shallow-gradient stream.
LOW	Open water in a water course channel that is likely due to current or other non-thermal influence.

The visual survey was designed to detect open water during the winter when most water bodies are frozen. Depending on the type of open water (i.e., round pond vs. open stream channel), the presence of open water can be used to infer underlying geothermal activity.

Surveys were conducted using a Cessna 206 fixed wing aircraft with two EBA observers seated in the rear seats for optimum visibility. Each open water site was recorded, described, rated for probability of geothermal influence and located with a Garmin Colorado 300 GPS. Once observed, most open water sites were circled for additional observations, accurate location and description. Photographs were taken at most of the sites.

3.0 RESULTS

The survey was conducted on April 2 and 3, 2009. The weather conditions on April 2 consisted of 100% cloud cover and light snow for short periods. Visibility was still adequate for detecting open water. On April 3, weather conditions were ideal for surveying with no cloud cover and low winds. The total survey time for the Larson Creek – Beaver River study area was just over nine hours.

During the survey, 46 areas with open water were observed and documented. Of these sightings, seven were ranked as 'high', 15 ranked as 'moderate' and 24 ranked as 'low' probability. The open water sites ranked as high potential typically included what appeared to be a spring seeping out of a bank just upslope of a stream with an open channel, along with snow-free areas with visible ground vegetation. At some high rated sites distinct pools were apparent. Descriptions of the high probability sites are summarized in Table 2. Photos of all the high ranked sites are also attached.

Data for all recorded open water observations are included Table 3. Note, each open water observation is referred to by its waypoint number (i.e., WP151 is from the observation at waypoint 151), which corresponds to a location in Figure 2. During travel between Watson Lake and the study area, some incidental open water sites were observed and recorded (Table 4). However, none of the sightings noted during ferrying were ranked as high, except for the Coal River springs which is a cool water springs located within a territorial park property.

4.0 DISCUSSION AND RECOMMENDATIONS

The seven open water sites with high probability of geothermal influence [WP120, WP123 (Pool Creek Springs), WP136, WP137 (Larson Creek Hotsprings), WP146/WP147 and WP154] contained round pools and/or seepage areas with open patches of vegetation that drained into a nearby stream or river channel. The associated streams were typically open downstream of the springs but were partially or completely frozen upstream. From this we infer that warm water discharging from the springs was preventing the main channel from freezing. Many of the sites with high potential were first identified by such open channels. Source ponds and areas of snow-free ground vegetation were typically discovered upon follow-up inspection when circling the aircraft. Areas with snow-free vegetation strongly indicate geothermal influence, since snow cover in the surrounding area was 100% and air temperatures were below freezing. Detailed observations of the vegetation was not possible during the aerial survey, but typically the vegetation was brown and appeared dormant.

The open water surveys in the Larson Creek – Beaver River area yielded successful results. Numerous potential occurrences of geothermal activity were located. Linear transect-based winter surveys to detect open water caused by geothermal activity is a cost-effective method of regional exploration to identify targets for ground-based assessment.

Geothermal springs or seeps could not be confirmed during the open water survey and ground reconnaissance is required to assess water parameters. All high and moderate probability sites should be evaluated with ground-based assessment methods including water sampling. Many of the moderate sites contained unusual sections of open channels that could not be attributed to hydrologic activity. When convenient, during ground checking of high and moderate ranked sites, low ranked sites could also be documented with a brief ground stop.

TABLE 2. DESCRIPTIONS OF OPEN WATER SITES WITH HIGH POTENTIAL OF GEOTHERMAL INFLUENCE				
WAYPOINT	OPEN WATER TYPE	VEGETATION COVER	VEGETATION TYPE	COMMENTS
WP120	pond and stream	dense	coniferous forest	Opening out of bank, 2 ponds flow into stream. Very shallow but open. Stream then flows into Beaver River. Likely springs - some vegetation visible. Photos were not feasible
WP123	river	open	coniferous forest	Pool Creek Hot Springs. Open area, quite large in size (> 2 city blocks in size) on Beaver River; 3 distinct areas, 2 sites on east side of river and one on west side. Open vegetation areas (with herbs and shrubs); river is completely frozen upstream of this site and open for >2 km downstream
WP136	< 1 pond/stream	sparse	coniferous forest	Lots of open water upslope of stream which then flows into the stream; vegetated areas open. 4 main open areas on the north side of stream. Stream fully open downstream for >1 km section.
WP137	stream	sparse	coniferous forest	Larson Creek Hot Springs 2 open areas; 1 distinct pool with vegetation down slope; turquoise colour. Large open sections in river; lots of exposed areas (i.e. with veg showing
WP146	stream	dense	coniferous forest	Side stream tributary; some pooling areas; seepage out of ground; starts from spring; some vegetation on rocks; entire channel is open for significant portion of the stream
WP147	stream	dense	coniferous forest	Same site as WP146 but upstream
WP154	> 1 pond/stream	sparse	coniferous forest	Open vegetated seepage area and then flows into open stream for large portion

TABLE 3. FIELD OBSERVATIONS FOR THE OPEN WATER SURVEY OF THE LARSEN CREEK – BEAVER RIVER AREA

WP	Date	UTM Zone	Northing	Easting	Open Water Type	Veg Cover	Veg Type	Priority	Comments
119	2-Apr-09	8	6738580	1001949	river	dense veg	conifer	L	Beaver River - lots of small open sections - small but continuous; mostly narrow openings and along stream banks
120	2-Apr-09	8	6733441	1009956	pond/stream	dense veg	conifer	H	Opening out of bank, 2 ponds and then into stream; very shallow but open - then flows into Beaver River; likely springs - some vegetation visible; no photo b/c too mountainous, no room for tight turns
121	2-Apr-09	8	6733378	1010871	stream	dense veg	conifer	M	Open section Beaver River
122	2-Apr-09	8	6726980	1014119	river	dense veg	conifer	M	A lot of open water flowing into beaver river from Trib, trib is open and has open pools up stream; Beaver River is open for a good section (> 2km) below confluence and then freezes back up again
123	2-Apr-09	8	6730957	1017767	river	open	conifer	H	Likely spot that Jack was talking about (> 2 city blocks in size) on Beaver River; 3 distinct areas, 2 on east side of river and one on west side. Open vegetation areas (with herbs and shrubs); river is completely frozen upstream of this site and open for 2+km downstream
124	2-Apr-09	8	6732407	1021413	river	dense veg	conifer	M	Side channels open; also open side channels just down stream
125	2-Apr-09	8	6732423	1027378	river	dense veg	conifer	M	Side channels open and then river is frozen downstream
126	2-Apr-09	8	6742906	1028346	stream	sparse veg	conifer	L	A couple of spots open; less than 1 m in diameter
127	2-Apr-09	8	6743701	1022024	stream	dense veg	conifer	L	Openings in stream channel, numerous for 1 - 2 km
128	2-Apr-09	8	6744835	1017454	stream	dense veg	conifer	L	WP127 stream is still open downstream but closed upstream
129	2-Apr-09	8	6743974	1015606	stream	dense veg	conifer	L	Stream open in sections
130	2-Apr-09	8	6735855	1010719	stream	sparse veg	conifer	L	Open stream channel for large section of stream
131	2-Apr-09	8	6728949	1030854	river	sparse veg	mixed	M	Open areas in side channel of Beaver River - rusty coloured and large; photos
132	2-Apr-09	8	6710085	1045233	> 1 pond	dense veg	conifer	M	5 - 6 openings between 1 and 4 m long in opening in forest; could be a stream
135	2-Apr-09	8	6706591	1004740	stream	open	mixed	M	~ 3 m of creek open in 1 km section
136	2-Apr-09	8	6709546	1009566	< 1 pond/stream	sparse veg	conifer	H	Lots of open water upslope of stream which then flows into the stream; vegetated areas open - 4 main open areas on the north side of stream. Stream fully open downstream for > 1 km section
137	2-Apr-09	8	6711237	1024172	stream	sparse veg	conifer	H	2 open areas ; 1 distinct pool with vegetation down slope; turquoise colour. Large open sections in river; lots of exposed areas (i.e. with vegetation showing)
138	2-Apr-09	8	6709898	1032574	stream	-	-	M	Downstream of WP137 - still most of it open.
139	2-Apr-09	8	6703727	1039657	stream	dense veg	conifer	L	~ 50 m of open water in stream
140	2-Apr-09	8	6691340	1027968	stream/river	open	conifer	L	Open channel - Crow River
141	2-Apr-09	8	6690656	1029206	river	open	conifer	L	Open stream channel and then open in the Crow River - open all the way upstream to the creek south of the river
142	2-Apr-09	8	6689388	1024626	stream	dense veg	conifer	L	Open stream channel ~ 1-2 m wide
143	2-Apr-09	8	6682880	1004738	stream	-	-	L	Open stream
144	2-Apr-09	8	6685801	993399	stream	sparse veg	conifer	L	Open stream for ~ 200 m section
145	2-Apr-09	8	6690427	1020236	river	sparse veg	conifer	L	Oval openings in river mostly upstream
146	2-Apr-09	8	6689604	1015786	stream	dense veg	conifer	H	Side stream trib; some pooling areas; seepage out of ground; starts from spring ; some vegetation on rocks; entire channel is open for significant portion of the stream
147	2-Apr-09	8	6689064	1014608				H	Same is WP146

TABLE 3. FIELD OBSERVATIONS FOR THE OPEN WATER SURVEY OF THE LARSEN CREEK – BEAVER RIVER AREA

WP	Date	UTM Zone	Northing	Easting	Open Water Type	Veg Cover	Veg Type	Priority	Comments
148	2-Apr-09	8	6690173	1001275	stream	open	conifer	L	Open stream channel
149	2-Apr-09	8	6690887	994863	> 1 pond and stream	open	mixed	M	4 open vegetated spots and then open stream channel downstream
152	3-Apr-09	8	6693997	998579	stream	sparse veg	mixed	L	Open stream that is open for a long way upstream
153	3-Apr-09	8	6698795	997958	stream	sparse veg	conifer	M	Upstream of WP152 a large portion of stream is open continuously - some seepage pools from banks
154	3-Apr-09	8	6698459	1014502	> 1 pond/stream	sparse veg	conifer	H	Open vegetated seepage area and then flows into open stream for large portion
155	3-Apr-09	8	6703699	1006249	1 pond/stream	open	shrubs	M	Small seepage area that is vegetated and then open stream but has some ice
157	3-Apr-09	8	6726513	1000695	stream	sparse veg	conifer	L	Partially open stream channel
158	3-Apr-09	8	6730631	1007811	stream	sparse veg	conifer	L	Partially open stream channel in sections
159	3-Apr-09	8	6721106	1014592	stream	open	conifer	M	Open stream flows into Beaver River.; fully open for entire length; can see rocks on stream bottom; some algae growth. Followed upstream to headwaters - appears to just be a high gradient, shallow stream with high velocity through canyon - but is open all the way down to the river.
160	3-Apr-09	8	6720829	1015661	stream	open	conifer	M	Same as WP159
161	3-Apr-09	8	6714515	1013390	stream	open	conifer	L	Deep open pool in stream (on bend) - appears to be a bit of seepage from side slope
162	3-Apr-09	8	6711057	1007408	> 1 pond/stream	open	conifer	M	Open vegetated patches up and down stream and then small pools around it.
165	3-Apr-09	8	6698845	937235	river	open	mixed	M	Vegetation growing in open river for about 2 - 3km

TABLE 4. OPEN WATER SITES OBSERVED OUTSIDE OF THE STUDY AREA

WP	Date	UTM Zone	Northing	Easting	Open Water Type	Veg Cover	Veg Type	Priority	Comments
134	2-Apr-09	8	6698890	981812	1 pond/stream	open	mixed	M	Seepage out of trees and into lake - looks interesting - worth checking out
150	3-Apr-09	8	6692268	919844	> 1 pond/stream/river	dense veg	conifer	H	Coal River springs; as described in email; 3 distinct open pools (turquoise colour) flows down terraced slope into a big open pool and then into coal river. Veg growing around area. Photos (out of study area)
151	3-Apr-09	8	6693109	974413	stream	dense veg	conifer	L	Open stream channel for quite a large section; some seepage out of side hills - no veg areas or pools though.
163	3-Apr-09	8	6709948	994706	stream	open	conifer	L	Open meandering stream for about 150 m
164	3-Apr-09	8	6707641	979585	lake	open	-	M	Opening on west side of small lake that is north of Tobally Lakes; open vegetated patch
166	3-Apr-09	8	6694482	946530	river	open	mixed	M	Open channel and a pool up slope of stream and areas around with vegetation.

142°W 140°W 138°W 136°W 134°W 132°W 130°W 128°W 126°W 124°W

N°65 N°64 N°63 N°62 N°61 N°60

N W E S

Nash Creek
Dawson City
Yukon Hwy 2
Stewart Crossing
McArthur
Volcano Mountain
Carmacks
Yukon Hwy 2
Faro
Yukon Hwy 6
Ross River
Yukon Hwy 4
Yukon Hwy 1
Shakwak Valley
Haines Junction
Takhini
Whitehorse
Whitehorse
Johnsons Crossings
Teslin
Study Area for this Report
Larson Creek/Beaver River
Watson Lake

LEGEND

Survey Areas

- McArthur
- Nash Creek
- Shakwak Valley
- Volcano Mountain
- Whitehorse
- Larson Creek/Beaver River

- Populated Place
- Road
- Watercourse
- Waterbody
- Yukon Territory Border

ISSUED FOR USE

NOTES

Base data source: Geomatics Yukon

2009 GEOTHERMAL ASSESSMENT PROGRAM

Survey Areas Overview

PROJECTION: Albers	DATUM: NAD83
Scale: 1:3,000,000 (50 25 0 50 Kilometers)	
FILE NO.: W23101159_029_Figure1.mxd	
PROJECT NO.: W23101159.029	DWN: MEZ / CKD: LM / REV: 0
OFFICE: EBA-VANC	DATE: July 8, 2009

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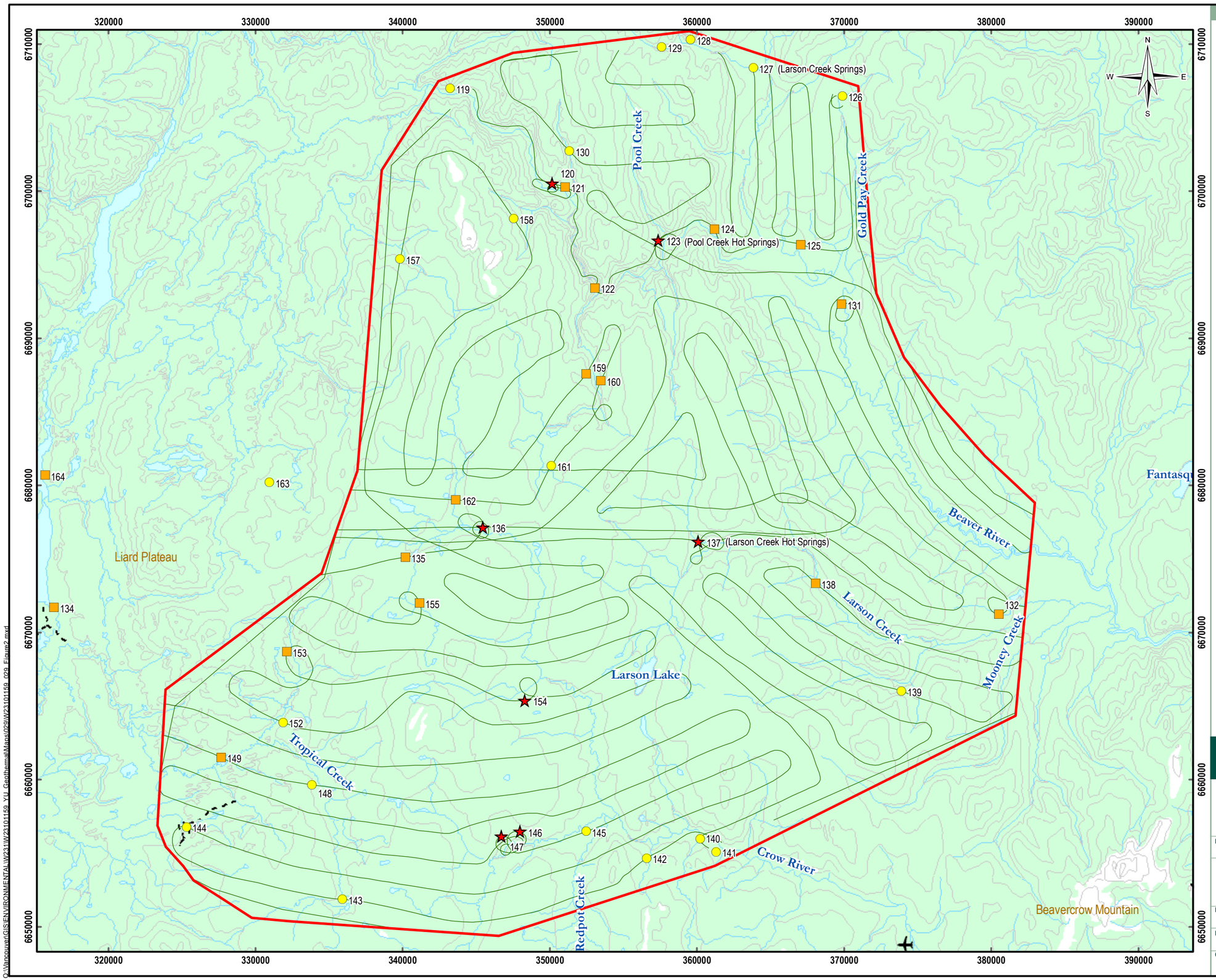
Figure 1

Q:\Vancouver\GIS\ENVIRONMENTAL\W23\W23101159_YU_Geothermal\Mapsit\02\W23101159_029_Figure1.mxd



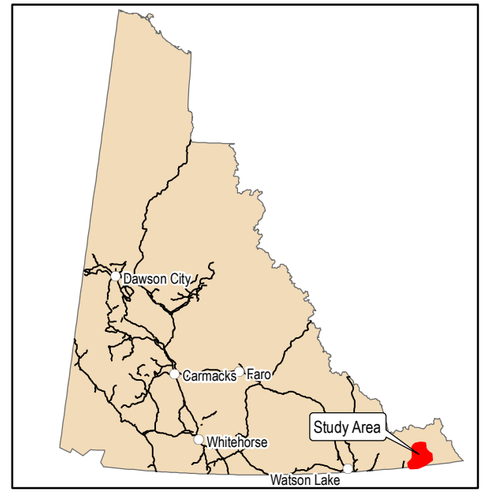
LEGEND

Probability of Thermal Influence

- High
- Moderate
- Low
- Flight Lines
- Study Area Boundary
- Remote Airstrip
- Contour (100m)
- Trail
- Watercourse
- Waterbody
- Wetland
- Vegetation

Criteria for probability of thermal influence:

High	Round ponds with openings not associated with a water course
Moderate	Unusual stretch of open water
Low	Stretch of open water within a watercourse



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NOTES

Base data source: NTS (1:250K)

2009 GEOTHERMAL ASSESSMENT PROGRAM

Larsen Creek / Beaver River - Open Water Survey

PROJECTION: UTM Zone 10			DATUM: NAD83
Scale: 1:250,000 (5 2.5 0 5 Kilometers)			
FILE NO.: W23101159_029_Figure2.mxd			
PROJECT NO.: W23101159.029	DWN: MEZ	CKD: LM	REV: 0
OFFICE: EBA-VANC	DATE: July 8, 2009		

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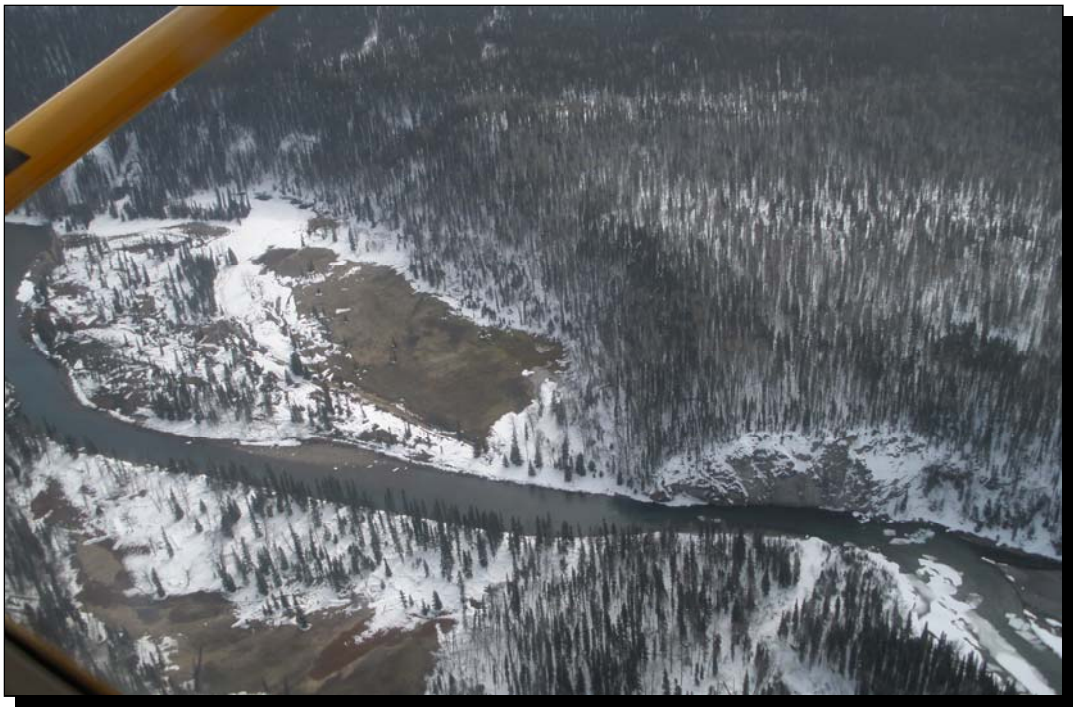
Figure 2

Q:\Vancouver\GIS\ENVIRONMENTAL\W23\W23101159_YU_GeothermalMaps\MapFiles\W23101159_029_Figure2.mxd

Photograph 1
April 2, 2009. WP123. Pool Creek Hot Springs (upstream site).



Photograph 2
April 2, 2009. WP123. Pool Creek Hot Springs (down stream site).
Note open patches of vegetation on both left and right bank of the Beaver River

Photograph 3
April 2, 2009. WP136. Upper Crow River, north side of the stream.

Photograph 4
April 2, 2009. WP136. Upper Crow River. Closer view of the previously undocumented upstream thermal springs

Photograph 5
April 2, 2009. WP137. Larson Creek Hot Springs. Note the large pool draining Larson Creek.

Photograph 6
April 2, 2009. WP137. Larson Creek Hot Springs. Closer view.

Photograph 7
April 2. 2009. WP146 and WP147. Open channel with vegetation.

Photograph 8
April 3, 2009. WP154. Previously undocumented geothermal spring with exposed patches of vegetation, open spring and stream channel.