APPENDIX 11

MEMO

Date: January 16, 2015 HCP Ref No.: CZN6788

From: Chris Jaeggle

To: David Harpley – Canadian Zinc Corporation

Subject: **September 25, 2014 Liard River Bathymetry And Bank Survey**

1.0 INTRODUCTION

On September 25, 2014, Chris Jaeggle (Hatfield Consultants) and David Harpley (Canadian Zinc) performed a bathymetric survey of the Liard River in an area proposed for an all-season road crossing. The proposed crossing is located approximately six kilometres downstream of the community of Nahanni Butte, NWT, and directly downstream of the confluence of the South Nahanni and Liard Rivers (Figure 1). The purpose of the bathymetric survey was to identify channel morphology to assist in locating the future crossing.

Figure 1 Study site location.

Data collection also included a topographic survey of each river bank to determine bank slope(s), and the collection of annotated bank photos (with corresponding GPS coordinates) which were taken throughout the bathymetric survey. Following is a discussion of procedures followed and a summary of data gathered.

The weather during the survey was approximately 5°C and rainy, with moderate wind.

2.0 PROCEDURES

2.1 BATHYMETRIC SURVEY

The bathymetric survey was conducted from a small power boat owned and operated by Leon Konisenta, Nahanni Butte resident. The depth sounder used for the survey, a Lowrence HDS-7 (Gen 2), consisted of a transducer and a control module/GPS unit. Equipment accuracy is ±10cm for depth and ± 5m for gps location of track lines. The transducer was attached to the transom at the rear of the boat, 15 cm below the water surface. The control module was used to configure the data collection and GPS settings, following the user manual instructions.

The survey began on the upstream right bank (defined as the bank on the right when looking downstream) and proceeded downstream at 5-10 km/h, at a distance of approximately 5 m away from the bank. The boat travelled the length of the study area along the right bank, crossed the river and completed a similar survey of the left bank. The boat then returned to the starting point and then travelled downstream, sweeping from bank-to-bank following a serpentine path. Upon reaching the downstream end of the study area, the data collection cycle was ended. Collected data were saved to the control module.

Annotated photographs were taken of the river banks throughout the bathymetry survey, with GPS coordinates collected at each of the photograph locations (Figure 2). The photographs are attached to this memo.

Upon return from the field, Hatfield staff transferred bathymetry data from the depth sounder into DrDepth© software to generate a bathymetric chart. A coordinate grid was placed over the bathymetric chart using GIS software. Due to the large study area and the large horizontal distance between the serpentine survey tracks, the extrapolation and interpolation intervals in the DrDepth© software were maximized to 25 m and 250 m, respectively.

2.2 RIVER BANK SURVEYS

A single transect was surveyed on each bank of the river approximately where the crossing was expected to be located. Equipment included a level survey kit, consisting of an engineer's level (Can-Measure, Model CM-24) mounted onto a tripod, and a stadia rod. After setting up and levelling the tripod and engineer's level near the top of the bank, several points were surveyed, including top of bank, high water mark, water level surface, and several points between the top of bank and water surface. The top of bank survey point was given an arbitrary datum of 100.00 m, which was used to calculate relative elevations of the other survey points. Note that although the datum for both banks was 100.00 m, the datum of each bank was independent of the other bank. Horizontal distance between each survey point also was measured using a digital laser rangefinder. An overall bank slope was calculated for each bank, as well as the slope between the water surface and high water mark (i.e., the floodplain), and the slope between the high water mark and the top of bank., Table 1 provides the survey and slope data.

3.0 DATA AND RESULTS

The results of the bathymetry survey are provided as a bathymetric chart (Figure 3). The chart shows that the shallowest areas of the channel are located in the downstream third of the study area. Depths in this

area range from 2-8 m. The deepest areas of the channel are located in the upstream third of the study area, closer to the left bank of the river, where depths are up to 20 m.

Bank slopes were calculated from the river bank survey results. The right bank had a slope of 12.9% from the water's edge to the high-water mark (i.e., the floodplain) and a slope of 41.3% from the high-water mark to the top of the bank. On the left bank, the high-water mark co-occurred with the top of the bank assumed for the survey, although the actual top of the bank was more than 6m higher and the slope rises steeply, greater than 60 degrees. The slope of the left bank from the water's edge to the high-water mark/top of bank was 15.3%. Table 1 below provides the survey data used to calculate the bank slopes. Photographs of the right and left bank are provided in Attachment 2. All photographs were taken during the bathymetry survey, and coordinates for the locations of these photos can be found in Attachment 1.

Figure 3 Bathymetry of the Liard River near Prairie Creek Mine, September 2014.

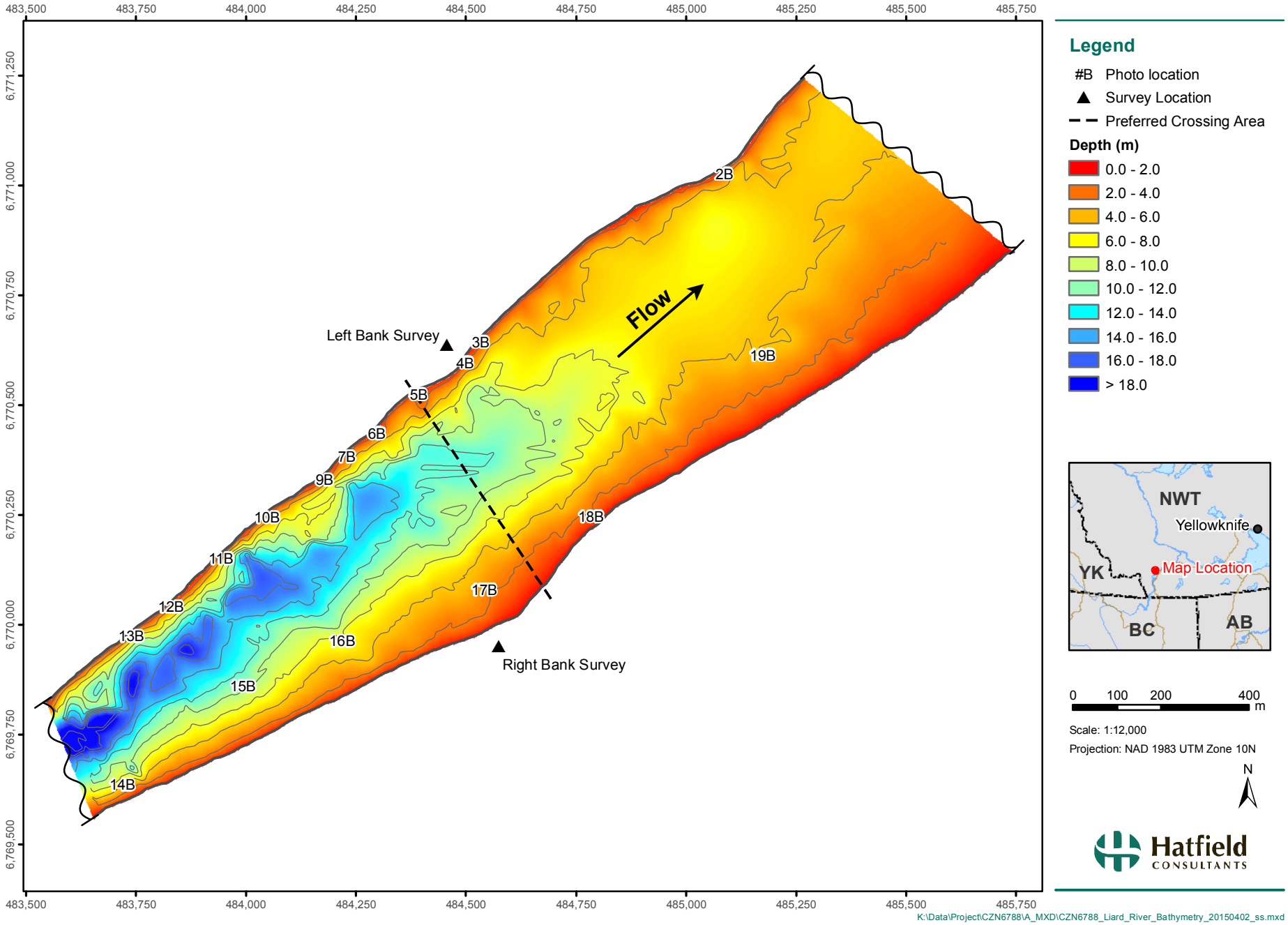

Table 1 Bank survey data.

River Bank	Measurement ID	Horiz. Distance (m)	Elevation (m) [1]
Right Bank	Top of Bank	41.5	100.00
Right Bank	1	39.9	99.61
Right Bank	High Water Mark	39.3	99.09
Right Bank	2	34.2	98.07
Right Bank	3	25	96.88
Right Bank	4	14	95.36
Right Bank	Water Level	0	94.01
Left Bank	High Water Mark/Top of Bank	36	100.00
Left Bank	1	34.8	98.55
Left Bank	2	33	97.93
Left Bank	3	28	96.55
Left Bank	4	18	95.19
Left Bank	Water Level	0	94.49

[1] Arbitrary value of 100.00 m set at the top of each bank.

For additional information, please contact either Chris Jaeggle or John Wilcockson at (604) 926-3261.

Attachment 1 GPS coordinates of Liard River bank photos.

Photo Name	UTM Coordinates (Zone 10V)
2B	485087 E, 6771031 N
3B	484533 E, 6770648 N
4B	484498 E, 6770601 N
5B	484392 E, 6770529 N
6B	484296 E, 6770441 N
7B	484229 E, 6770388 N
9B	484178 E, 6770334 N
10B	484048 E, 6770249 N
11B	483943 E, 6770155 N
12B	483830 E, 6770045 N
13B	483740 E, 6769978 N
14B	483719 E, 6769640 N
15B	483994 E, 6769865 N
16B	484219 E, 6769967 N
17B	484542 E, 6770084 N
18B	484785 E, 6770251 N
19B	485175 E, 6770618 N

Attachment 2 Photographs of Liard River banks in survey area.

Photograph 2B - Left Bank.

Photograph 3B – Left Bank.

Photograph 4B – Left Bank

Photograph 5B – Left Bank

Photograph 6B – Left Bank

Photograph 7B – Left Bank

Photograph 9B – Left Bank

Photograph 10B – Left Bank

Photograph 11B – Left Bank

Photograph 12B – Left Bank

Photograph 13B – Left Bank

Photograph 14B – Right Bank

Photograph 15B – Right Bank

Photograph 16B – Right Bank

Photograph 17B – Right Bank

Photograph 18B – Right Bank

Photograph 19B – Right Bank