SUMMARY REPORT

on

EL 470 GROUNDWATER MONITORING WELL ABANDONMENT PROGRAM

for

CONOCOPHILLIPS CANADA

May 2, 2016

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by

Hobbit Environmental Consulting Corp.

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1.0 BACKGROUND

ConocoPhillips Canada (CPC) acquired Exploration Licence (EL) 470 from Aboriginal Affairs and Northern Development Canada (AANDC) in 2011. In 2015, EL 470 was transferred from AANDC to the Government of Northwest Territories (GNWT) Office of Regulator of Oil and Gas Operations (OROGO) in response to devolution. The licence permitted CPC to explore the area for oil and gas resources in EL 470 parcel located in the central part of the Mackenzie River valley south of Norman Wells, Northwest Territories. A groundwater monitoring program was implemented by Hobbit Environmental Consulting Corp. (Hobbit) to provide baseline groundwater data in association with the exploration program. Figure 1 provides a site location of EL 470 and Figure 2 is the CPC survey of the activity area of EL 470. A summary of the drilling, installation and well development work is included as Appendix A.

In 2013 and 2014, CPC drilled and tested two vertical (O-06 and N-20) and two horizontal (E-76 and P-20) oil and gas exploration wells. Four groundwater monitoring wells were installed in 2013. In 2015, CPC decided to abandon the exploration and groundwater monitoring wells. Abandonment work was completed in the first quarter of 2016. Strip logs of the groundwater wells are included in Appendix B.

As part of their exploration work in EL 470, CPC was required to obtain land and water use licences with the Sahtu Land and Water Board (SLWB). The current Type A Land Use Permit (S15A-001) was issued for the period June 29, 2015 to June 29, 2020. The current Type B Water Licence (S14L1-003) was issued on July 31, 2014 and expires on August 1, 2019. This water licence superceded previously issued licences.

With respect to abandonment activities, the land use permit and water licence allowed CPC to proceed with their planned well abandonments. The land use permit authorized CPC to:

- Mobilize equipment to the site using the NWT winter road;
- Mobilize personnel via air to Norman Wells;
- Construct a 5 ± kilometer (km) ice bridge across the Mackenzie River from Norman Wells to the south bank;
- Construct 65 km± of pre-existing winter access including access to licenced water sources;
- Construct ice pads at existing wellsites;
- Transport and set up service rigs at each wellsite;
- Abandon the two vertical wells (O-06 and N-20);
- Abandon the two horizontal wells (E-76 and P-20);

- Abandon the four groundwater monitoring wells;
- Manage waste - demobilize equipment and supplies via the winter road and via air to Alberta and/or British Columbia; and,
- Install emergency shelters consisting of skid mounted or wheeled wellsite trailers at each active site.

The water licence authorized ConocoPhillips to:

- Use up to 348,490 cubic meters of water per year. This water was to be withdrawn from a number of surface water bodies within EL 470.

2.0 ABANDONMENT

Between September 2014 and November 2015, CPC decided to abandon the exploration and groundwater monitoring wells in EL 470.

Prior to proceeding with the coordination and planning of the abandonments, CPC notified the appropriate regulatory agencies of their intent to abandon the wells. Among the agencies contacted were SLWB, OROGO, and GNWT ENR.

Abandonment of the groundwater monitoring wells was completed between January 29 and March 2, 2016. A summary of significant events related to the abandonment of the groundwater monitoring wells is summarized below.

Table 1
Summary of Abandonment Events
Groundwater Monitoring Wells
Chinook EL 470
January-March 2016

Event	Well Designation			
	WW02-A	WW02-B	WW04-A	WW05-A
Pump Well	February 3, 2016	Not Pumped	February 7, 2016	February 5, 2016
Sample Collection	February 3, 2016	No Sample	February 7, 2016	February 5, 2016
Thaw	February 4, 2016	February 3, 2016	February 7, 2016	February 6, 2016
Pull Pump	February 4, 2016	No Pump	February 8, 2016	February 6, 2016
Video Survey	February 5 and 19, 2016	February 4 and 19, 2016	February 9, 2016	February 9 and 27, 2016
Shock	February 8 and 10, 2016	February 8 and 10, 2016	February 9, 2016	February 9, 2016
Abandon	February 21, 2016	February 25, 2016	February 26 and 27, 2016	February 28 and 29, 2016
Cut and Cap	February 29, 2016	February 29, 2016	March 1, 2016	March 2, 2016

The groundwater monitoring well abandonment program was conducted in the following sequential order.

1) The three wells with pumps (WW02-A, WW04-A and WW05-A) were prepared for sampling. For wells WW02-A and WW05-A with static water levels coincident with the

permafrost, the discharge lines for these two wells were depressurized prior to starting the pumps. Well WW02-B did not have a pump due to permafrost interference in the wells screen. The volume of water pumped from WW02-A, WW04-A and WW05-A prior to sampling was 57,000, 60, and 2400 litres respectively. Discharge water from WW02-A and WW05-A was discharged directly to ground surface based on previous analytical results and field screening results indicating criteria below SLWB values. Discharge water from WW04-A was disposed by evaporation.

2) Samples from the three pumped wells were collected for laboratory analysis.
3) Thawing of the wells was completed after the wells had been pumped and sampled. Well WW02-B was thawed while well WW02-A was being pumped prior to sampling.
4) After each well was thawed, the pumps and infrastructure were pulled from the wells (except for well WW02-B which had no pump or infrastructure).
5) After the pumps and infrastructure were pulled from the wells a video survey of the inner casing of the wells was completed to confirm that ice accumulations and blockages associated with the presence of permafrost would not compromise the cement seal to be injected into the wells.
6) Once the downhole video surveys were completed the wells were shocked with a 12% concentration of hypochlorite.
7) A repeat of the thawing and video confirmation process was undertaken prior to the abandonment activities. A repeat of the downhole video confirmation of WW04-A was not completed.
8) Each well was plugged using Arctic Set Cement followed by cutting and capping the wells.

The table below summarizes the volumes and density of cement (Arctic Set) used to plug the wells.

Appendix B includes the schematics of the groundwater monitoring wells that were abandoned by CPC.

Table 2 **Abandonment Volume of Cement** **Groundwater Monitoring Wells** **Chinook EL 470** **February-March 2016**		
Well	Cement Volume (m^3)	Density (kg/m^3)
WW02-A	5	1880
WW02-B	2	1820
WW04-A	7.9	1880
WW05-A	1.85	1880

With the exception of well WW02-A, each of the wells was abandoned by inserting a permanent bridge plug above the aquifer unit that was accessed for monitoring.

3.0 PROGRAM RESULTS

3.1 SAMPLE COLLECTION AND ANALYSIS

Samples obtained during the groundwater monitoring program can be placed into two categories:

1) pre well development samples
2) post well development samples.

Pre development samples are defined as samples collected before the February 2014 pumping development work. Post development samples are defined as samples collected after well development by pumping in February 2014. Although the wells were developed to a limited degree shortly after the installation phase in the first quarter of 2013, the development was not deemed to be sufficient to provide samples indicative of baseline conditions.

Prior to installing the pumps in the wells, grab samples were collected in March 2013 from wells WW02-A, WW02-B and WW05-A. Samples retrieved from these three well were submitted for the analysis of hydrocarbons, dissolved metals and routine parameters. Grab samples were retrieved using disposable bailers. A grab sample was not collected from well WW04-A due to the depth to water being greater than 300 mbsg which precluded collection with a bailer.

Samples analysed after March 2013 were collected from the discharge lines of the submersible pumps installed in WW02-A, WW04-A and WW05-A.

The March 2013 sampling of well WW02-B was the only time this well was sampled. Along with wells WW02-A and WW05-A, WW02-B froze because of the influence of permafrost at depth. Unlike wells WW02-A and WW05-A, WW02-B could not be thawed sufficiently to allow the submersible pump to operate without flow blockage. The blockage of flow was due to the freezing effect of the permafrost extending to the top of the well screen.

Analytical results were compared to the Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines for the Protection of Aquatic Life (PAL) (CCME 2007). Comparison to the PAL was based on the SLWB permit conditions related to PAL and the potential discharge of groundwater to surface.

Summary tables of the sampling results obtained from the groundwater wells since March 2013 are provided below. Copies of the analytical reports are included in Appendix C.

TABLE 3
SUMMMARY OF GROUNDWATER ANALYTICAL RESULTS
CONOCO EXPLORATION LEASE 470 (EL 470)
MARCH 2013 TO FEBRUARY 2016

Parameter	WELLS												Guideline PAL
	WW02-A					WW02-B	WW04-A						
	Mar-13	Feb-14	Jun-14	Sep-14	Feb-16	Mar-13	Jun-13	Sep-13	Feb-14	Jun-14	Sep-14	Feb-16	
ROUTINE													
pH	**9.77**	8.16	8.25	8.03	7.55	**10**	**9.02**	**9.37**	8.93	8.9	8.98	8.69	6.5-9.0
EC	681	830	820	750	814	290	5780	6680	6150	6810	6200	6750	ng
TDS	458	509	521	523	505	177	3340	3880	3870	3960	3840	3920	ng
Bicarbonate	117	372	300	326	299	34	1530	1400	1590	1470	1450	1490	ng
Calcium	29.7	15.9	16.1	17.4	17.2	8.3	5.1	5.8	5.5	1.5	3.7	3.2	ng
Magnesium	7.2	5.9	6	5.8	5.7	2.1	3	4.9	3.9	3	3.2	3.0	ng
Sodium	136	158	167	154	149	48.4	**1140**	**1660**	**1590**	**1610**	**1500**	**1460**	200
Potassium	7.8	5.8	6.5	6.6	5.7	8.7	26.7	26.7	13.3	16.2	18.8	16.6	ng
Sulphate	127	121	122	121	125	50	6	12	3	<1	<1	<1	ng
Chloride	28	19	20	19	20	17	**1230**	**1230**	**1310**	**1350**	**1340**	**1460**	640 (ST) 120 (LT)
Nitrate	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	13
Fluoride	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**0.75**	0.06	<0.05	<0.05	<0.45	0.12
Ionic Balance	121	90.7	109	97.8	99	102	84.8	111	102	106	99.4	93	ng
DISSOLVED METALS													
Aluminum	**0.39**	<0.002	0.026	<0.004	<0.004	**0.861**	0.005	0.004	<0.002	0.004	<0.004	<0.004	0.1 variable
Antimony	0.004	<0.001	<0.001	<0.001	<0.001	0.006	0.003	0.002	0.001	<0.001	<0.001	<0.001	ng (DW)
Arsenic	**0.005**	<0.001	<0.001	<0.001	<0.001	0.003	0.001	**0.009**	<0.001	<0.001	<0.001	<0.001	0.005
Barium	0.75	<0.05	<0.05	<0.05	<0.05	0.13	2.75	1.48	1.36	1.49	<0.05	**2.32**	ng (DW)
Boron	0.08	0.08	0.1	0.05	0.08	0.03	0.81	0.96	0.8	1.02	0.04	0.9	29 (ST) 1.5 (LT)
Cadmium	**0.000121**	<0.00005	<0.00005	<0.00005	<0.000016	0.000039	**0.00016**	**0.000341**	0.00009	0.0001	<0.00005	0.000093	0.001 (ST) 0.00009 (LT)
Chromium	0.012	<0.001	<0.001	<0.001	<0.001	0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0089
Chromium, Hexavalent	na	*<0.01*	*<0.005*	<0.001	<0.005	na	na	na	*<0.005*	*<0.005*	<0.001	<0.005	0.001
Copper	**0.021** (0.002)	<0.002	<0.002	<0.002	<0.001	**0.004** (0.002)	<0.002	**0.019** (0.002)	<0.002	<0.002	<0.002	0.001 (0.002)	hardness based
Iron	**23.3**	<0.1	0.3	<0.1	0.2	**1.7**	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.3
Lead	**0.052** (0.003)	<0.001	<0.001	<0.001	<0.0005	**0.002** (0.001)	**0.002** (0.001)	<0.001	<0.001	<0.001	<0.001	**0.006** (0.001)	hardness based
Manganese	**0.406**	0.009	0.01	0.015	<0.005	0.018	0.02	0.032	0.044	0.021	0.014	<0.005	0.05
Mercury	na	<0.000025	<0.000025	<0.000025	<0.000005	na	na	0.000026	**0.000076**	**0.00203**	<0.000025	<0.000005	0.000026
Molybdenum	0.039	<0.003	<0.003	<0.003	<0.001	0.043	**0.148**	**0.173**	**0.078**	**0.092**	0.01	0.144	0.073
Nickel	0.01 (0.0985)	<0.003	<0.003	<0.003	<0.01	<0.01	<0.01	<0.01	<0.003	<0.003	<0.003	<0.01	hardness based
Nitrite	<0.05	<0.05	<0.05	<0.05	<0.02	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06
Selenium	**0.004**	<0.001	<0.001	<0.001	<0.0005	<0.001	**0.02**	**0.017**	**0.002**	<0.001	<0.001	<0.0005	0.001
Silver	<0.00005	<0.00001	<0.00001	<0.00005	<0.00006	<0.00005	<0.00005	<0.00005	0.00001	<0.0001	<0.00005	0.00008	0.0001
Thallium	<0.0005	<0.0001	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0001	<0.0001	<0.0001	<0.001	0.0008
Uranium	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.01	0.015
Zinc	**0.174**	<0.001	<0.001	<0.004	<0.01	**0.035**	<0.001	0.002	0.008	<0.004	<0.004	<0.005	0.03
ORGANICS													
Benzene	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0023	0.0012	0.0006	0.0005	<0.0005	<0.0005	0.37
Toluene	<0.0005	0.0006	<0.0005	**0.0028**	<0.0003	<0.0005	**0.0074**	**0.0061**	**0.018**	**0.0333**	**0.0405**	0.0550	0.002
Ethylbenzene	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	ng
Xylenes	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.009	<0.0005	<0.0005	ng
Styrene	<0.0005	<0.0005	<0.001	<0.0005	na	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	na	72

NOTES:
1) All concentrations expressed in parts per million (ppm) equivalent to milligrams per litre (mg/L) except pH, EC and ionic balance.
2) pH in logarithmic pH units, electrical conductivity (EC) in micro-Siemens per centimeter uS/cm and ionic balance as a percentage.
3) Bold indicates parameter exceeds CCME Protection of Aquatic Life (PAL) Guidelines.
4) Copper, Lead and Nickel have hardness derived values that need to be calculated to provide a guideline value. Calculated guideline values are in green with the constituent concentration above the guideline value in bold.
5) Guideline values with (ST) and (LT) are for short term (ST) and long term (LT) exposure periods.
6) ng indicates no PAL guideline for that parameter
7) *Italicize and underline* indicates the reported detection limit exceeds the PAL Guidelines.
8) na-not analysed

TABLE 3 (cont.)
SUMMMARY OF GROUNDWATER ANALYTICAL RESULTS
CONOCO EXPLORATION LEASE 470 (EL 470)
MARCH 2013 TO FEBRUARY 2016

Parameter	WW05-A						Guideline PAL
	Mar-13	Jun-13	Feb-14	Jun-14	Sep-14	Feb-16	
ROUTINE							
pH	**9.73**	**11.5**	7.81	8.01	8.03	7.46	6.5-9.0
EC	427	1870	500	<1	482	549	ng
TDS	257	534	337	328	316	325	ng
Bicarbonate	<5	<5	224	190	178	212	ng
Calcium	16.1	142	47.9	43.8	39	39.2	ng
Magnesium	8.8	<0.2	21	19.1	15.6	17.1	ng
Sodium	46.1	113	40.9	44.9	46.8	41.2	200
Potassium	11.3	31.4	7.3	8.1	10.7	6.6	ng
Sulphate	126	45	104	89	86	83	ng
Chloride	25	105	5	7	9	9	640 (ST) 120 (LT)
Nitrate	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	13
Fluoride	**0.7**	<0.05	<0.05	<0.05	<0.05	<0.05	0.12
Ionic Balance	92.5	51.1	102	115	112	98	ng
DISSOLVED METALS							
Aluminum	0.021	0.081	0.009	<0.004	<0.004	<0.004	0.1 variable
Antimony	0.004	0.002	<0.001	<0.001	<0.001	<0.001	ng (DW)
Arsenic	0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.005
Barium	<0.05	0.28	<0.05	<0.05	<0.05	0.07	ng (DW)
Boron	0.03	<0.01	0.04	0.05	0.06	0.05	29 (ST) 1.5 (LT)
Cadmium	**0.000088**	**0.000175**	<0.00005	<0.00005	<0.00015	<0.000016	0.001 (ST) 0.00009 (LT)
Chromium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0089
Chromium, Hexavalent	na	na	*<0.005*	*<0.005*	<0.001	<0.005	0.001
Copper	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	hardness based
Iron	<0.1	<0.1	0.2	0.3	<0.1	0.2	0.3
Lead	0.001	0.006 (0.007)	<0.001	<0.001	<0.001	<0.0005	hardness based
Manganese	<0.005	<0.005	**0.055**	0.042	0.044	0.047	0.05
Mercury	na	na	<0.000025	<0.000025	<0.000025	<0.000005	0.000026
Molybdenum	0.065	**0.15**	0.006	0.007	**0.117**	0.004	0.073
Nickel	<0.01	<0.01	<0.003	<0.003	<0.003	<0.01	hardness based
Nitrite	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06
Selenium	0.002	**0.005**	<0.001	<0.001	<0.001	<0.0005	0.001
Silver	<0.00005	0.00005	<0.00001	<0.00001	<0.00005	<0.00006	0.0001
Thallium	<0.0005	<0.0005	<0.0001	<0.0001	<0.0001	<0.0005	0.0008
Uranium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.015
Zinc	0.009	<0.001	0.009	0.014	<0.004	<0.01	0.03
ORGANICS							
Benzene	<0.0005	0.001	<0.0005	<0.0005	<0.0005	<0.0005	0.37
Toluene	0.0008	**0.01**	0.0012	**0.0051**	**0.0402**	0.0008	0.002
Ethylbenzene	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	ng
Xylenes	<0.0005	0.0008	<0.0005	0.0008	<0.0005	<0.0005	ng
Styrene	<0.0005	<0.0005	<0.0005	<0.001	<0.0005	na	72

NOTES:

1) All concentrations expressed in parts per million (ppm) equivalent to milligrams per litre (mg/L) except pH, EC and ionic balance.

2) pH in logarithmic pH units, electrical conductivity (EC) in micro-Siemens per centimeter uS/cm and ionic balance as a percentage.

3) Bold indicates parameter exceeds CCME Protection of Aquatic Life (PAL) Guidelines.

4) Copper, Lead and Nickel have hardness derived values that need to be calculated to provide a guideline value. Calculated guideline values are in green with the constituent concentration above the guideline value in bold.

5) Guideline values with (ST) and (LT) are for short term (ST) and long term (LT) exposure periods.

6) ng indicates no PAL guideline for that parameter

7) *Italicize and underline* indicates the reported detection limit exceeds the PAL Guidelines.

8) na-not analysed

3.2 SUMMARY OF ANALYTICAL RESULTS

Analytical results obtained prior to the development of the wells had a greater range of variability than samples collected after development. This variability is more evident for pre and post development result comparisons for each well than well to well comparisons. Post development samples seem to be indicative of a more stable sample medium as evidenced by the narrower range of variation of the constituent values between sample events. The relative stability of pH, TDS, conductivity and ionic balances in samples collected since development support the opinion of greater stability and representativeness of the sampled medium. Piper plots (Piper 1944) of the major cations and anions for each of the three wells (WW02-A, WW04-A and WW05-A) that could be sampled periodically are provided in Appendix D. Each of the wells had pre and post development samples that could be plotted on the Piper diagram. The Piper plots for wells WW02-A, WW04-A and WW05-A provide a distinct illustration of the difference in pre and post development chemistry comparisons for individual wells and well to well comparisons. A Piper plot for WW02-B is also included for the single sample event results for this well.

The March 2013 pre-development results for WW02-A and WW02-B had very similar plots. The similarity in the plots could be interpreted to infer that the samples were collected from the same aquifer source waters. The comparable chemistry of the two wells from a single event should not be considered as the sole basis in concluding the wells are completed in a groundwater source having a common origin. Several factors should be considered with regard to determining the common origin of the groundwater including:

1) Results are from a single event in wells not fully developed;
2) Both wells were drilled using mud rotary methods which could result in masking potential, ambient chemistry differences in groundwater samples retrieved from wells not fully developed.
3) The wells are in close proximity (within 12 m) at roughly the same ground elevation (286 masl) but groundwater elevations differ by almost 6 meters (depth to water in WW02-A is 6 meters shallower than depth to water in WW02-B);
4) There is a 100 meter interval between the bottom of the well screen of WW02-B (96 mbsg) and the top of the well screen in WW02-A (196 mbsg); and,
5) Using points 3 and 4 would result in an upward vertical gradient of 0.06m/m.

An intriguing aspect of the commonality of the analytical chemistry between WW02-A and WW02-B is the apparent upward vertical gradient from WW02-A to WW02-B (0.06m/m). Coupling the upward vertical gradient with similarity of chemistry from March 2013 indicates a reasonable possibility that WW02-A and WW02-B are completed in the same aquifer.

Analytical results obtained from WW04-A have been consistently distinct from results obtained from the other wells. Specifically, the samples analysed from WW04-A have had elevated (greater than 1000 ppm) chloride and sodium concentrations that, at a minimum, are an order of magnitude greater than chloride and sodium values detected in the other wells. The elevated chloride values are assumed to be naturally occurring. This assumption is based on the fact that WW04-A primarily was drilled using air rotary techniques thus precluding the possibility that the chlorides could have been introduced while drilling with additives (salinity based weighing agents) common to mud rotary methods. Also all of the wells were completed using conventional cementing methods. The cement mixtures for the wells had consistent composition. Therefore, the possibility that the chlorides detected in WW04-A could be related to a cement accelerator such as calcium chloride does not seem reasonable as the chloride concentrations detected in WW04-A would have been detected in the other wells.

Development efforts on well WW04-A produced a relatively low volume of water (9.5 m^3). This relatively low development volume is probably the result of the inflow into the well being through perforations and not well screen and the well perforations being in a low production interval of the formation. Purging prior to sampling events also resulted in low discharge volumes. Typically purge volumes have been 100 liters or less. These low volumes are further indication of the low productivity of the perforated interval.

The detected chloride and sodium levels are naturally occurring, therefore the perforated interval of WW04-A (399 to 408 mbsg) is in the approximate depth coinciding with the transition zone from potable to saline water.

The ionic chemistry of samples analysed from well WW05-A consistently have been indicative of a potable water source. Analytical results from this well are not in alignment with chemistry from the other wells. This non alignment is specifically relevant in comparing the chemistry of WW05-A with the results of WW02-A. The groundwater elevations of these two wells are approximately equal which could be interpreted as the wells being completed in the same aquifer. The comparison of chemistry of the two wells, however, is not strongly indicative of the wells being completed in a common aquifer.

Based on the Piper plots, water collected from the wells could be classed as the following types:

WW02-A Sodium Bicarbonate Type

WW02-B Sodium Sulfate Type

WW04-A Sodium Chloride Type

WW05-A Bicarbonate Type

With the exception of well WW02-B, each of the wells has had at least one sample event above the PAL. Well WW04-A has had increasing concentrations of toluene above the PAL. The detected concentrations of toluene are related to the adhesive compound on the electrical tape used to secure the electrical cable, support cable and discharge line together at periodic intervals as the submersible pump was lowered down the well. Binding these lines together is necessary to lower the pump and assembly down the well to reduce the likelihood of the cables obstructing the well. Some of the electrical tape used to bind the cables to the discharge line was in contact with groundwater thus resulting in detectable levels of toluene.

Well WW02-B provided a toluene concentration below the method detection limit. This sample was collected before the pump and associated lines were placed in WW02-B. The toluene result obtained from WW02-B supports the conclusion that toluene detections in the other wells are related to the use of electrical tape.. After the installation of the pump and lines in well WW02-B, the well froze due to permafrost and subsequent attempts to rehabilitate this well for sampling with the pump were not successful. As a result, a pump produced sample from well WW02-B was never collected.

Conversely samples from WW04-A had toluene concentrations consistently greater than the PAL that increased over time. The trend of increasing concentrations above the PAL could possibly be related to the fact that WW04-A had the greatest length of discharge pipe, electrical wire and support cable of the four wells which would result in this well having the greatest number of electrical tape secure points. The greater number of secure points would increase tape adhesive exposure to groundwater relative to the other wells. Well WW04-A is also the lowest producing well. The combination of greater number of electrical tape secure points and low volume of production would concentrate the effect of electrical tape adhesive residuals leaching from the tape. Two other considerations that could influence the toluene levels detected in samples from WW04-A could be the more corrosive character of the water from this well and the restricted withdrawal of water from the well prior to sampling. The more corrosive character of the water from well WW04-A is substantiated by the chloride and sodium concentrations consistently detected in this well. These concentrations resulted in the water being classed as sodium-chloride type water. The more corrosive character of this water has decreased the volume of water removed from well WW04-A prior to sampling due to limited treatment/disposal options for this water. This low volume of purge water removal may not sufficiently purge the well to provide a sample that would contain a toluene concentration representative of ambient conditions.

Toluene concentrations detected in well WW04-A are likely anthropogenic due to the following conditions: 1) greater number of electrical tape secure points; 2) low production (low hydraulic conductivity) from the water bearing unit accessed by WW04-A; 3) greater corrosivity of the water; and, 4) low volume of purge water removed from well prior to sampling.

Wells WW02-A and WW05-A were sampled six times before abandonment. Well WW02-A had one toluene exceedance marginally above the PAL detected in the sample collected in September 2014.

Well WW05-A had three toluene exceedances above the PAL detected in samples collected in June 2013, June 2014 and September 2014.

Wells WW02-A and WW05-A did not have toluene exceedances above PAL detected in the February 2016 samples.

The wells (WW04-A and WW05-A) with the more frequent detection of toluene above PAL were completed wholly or partially in bedrock types (shale and siltstone) known to have naturally occurring levels of hydrocarbons. Although the presence of the toluene can be attributed the electrical tape, potential natural contributions from bedrock cannot be ignored.

Metals constituents above the PAL detected in the wells since development generally can be linked to natural concentrations present in shale, siltstone and or coal. Each of the wells (WW02-B, WW04-A and WW05-A) with metals concentrations above PAL had all or part of the screened/perforated section of the well in a shale/siltstone. Well WW02-A did not have metals exceeding PAL. The well screen in WW02-A was installed in sandstone which does not have the naturally occurring concentrations of metals detected in the other wells.

4.0 DISCUSSION/CONCLUSIONS

The baseline groundwater program in EL 470 yielded some useful information. Drilled depths of the four wells ranged from 97 m (WW02-B) to 472 m (WW04-A).

Stratigraphic profiles generated from the four wells were compared to the Loon Creek O-06 and Mirror Lake N-20 stratigraphic profiles (Figures 6 and 7). The Loon Creek O-06 exploration well was drilled approximately 500 m northwest of WW04-A, whereas the Mirror Lake N-20 exploration well was drilled approximately 1000 m southeast of WW02-A and WW02-B. A comparison of stratigraphic profiles is illustrated in the cross section on Figure 8. It is evident that more of the Little Bear Formation is preserved in the southern portion of EL 470 which coincides with an increase in structural depth of the syncline. The increase in the presence of the Little Bear Formation was apparent in the stratigraphic profiles generated for WW02-A, WW02-B and Mirror Lake N-20.

The Little Bear Formation is more difficult to distinguish from Quaternary deposits (glacial sediments) in the northern portion of the EL 470 block. Limited biostratigraphy completed on the shallow sequence of Loon Creek O-06 could not differentiate between the Little Bear and Slater River Formations. Coupling the Loon Creek and Mirror Lake stratigraphic profiles with the four groundwater monitoring well profiles provides clear evidence that the lateral continuity of formations (specifically the Little Bear) across the EL 470 block is not distinct.

The range of drilled groundwater monitoring well depths resulted in the identification of two and possibly three distinct groundwater units. One of the distinct units was the Little Bear Aquifer encountered in WW02-A and probably WW02-B. The productivity noted during the development and subsequent pre-sampling purging of WW02-A is indicative of productivity anticipated from the Little Bear Aquifer. The well screen in WW02-A was installed in sandstone of the Little Bear Formation between 196 to 202 mbsg. The well screen in WW02-B was installed in an interlayered siltstone/sandstone of the Little Bear Formation between 87 to 96 mbsg. The productivity difference noted between WW02-A and WW02-B is probably partially due to the homogeneity of the material type in which the well screen for WW02-A was installed and the heterogeneity of material in which the well screen for WW02-B was installed. Well WW02-B was completed in close proximity (within 12 m) to WW02-A. The groundwater elevation for WW02-A has been consistently near 253 masl, whereas the groundwater elevation for WW02-B has been consistently near 247 masl. The calculated upward vertical gradient between these two wells was 0.06 m/m. Due to the influence of permafrost on the well screen of WW02-B, the only time this well was sampled was in March 2013. This sample was collected before WW02-B was developed sufficiently. A comparison of the analytical results obtained from wells WW02-A and WW02-B indicates that the water quality of these wells is similar. The similarity of the chemistry and the upward vertical gradient are two factors that point to the wells being completed in a common source. With the productivity differences between wells WW02-A and WW02-B, well WW02-A seems to be completed in the Little Bear Aquifer and well WW02-B in a water bearing interval of the Little Bear Formation not necessarily in the Little Bear Aquifer.

The groundwater elevation measured in WW05-A corresponded closely to the elevation of WW02-A. Similar to well WW02-B, well WW05-A was completed in a water bearing, interlayered siltstone and sandstone of the Little Bear Formation with observed productivity an order of magnitude less than WW02-A. Chemistry of groundwater samples from WW05-A was distinct from WW02-A and WW02-B which could be inferred that well WW05-A was completed in a water bearing unit not laterally continuous with either wells WW02-A or WW02-B.

The characteristics documented for well WW04-A are unique relative to the other three wells. Chemistry of groundwater from WW04-A was slightly saline. The well was completed in the Slater River Formation in a low production water bearing unit. Based on the analytical chemistry obtained from this well, potable water in the area of EL 470 was shallower than 400 m. Whether the occurrence of potable water was associated with the presence of the Little Bear Formation or in the upper portions of the Slater River Formation is not known.

Using the limited number of data points in EL 470, the inferred direction of groundwater flow in the Little Bear Formation appeared to be from northwest to southeast. This inferred flow direction would be more definitive with a greater number groundwater wells completed in common water bearing units.

The depth of influence of the permafrost ranged between 33 to 70 m. The maximum depth of influence was greater than what was accounted for prior to the initiation of the baseline groundwater work.

Although the number of monitoring points was less than the maximum estimated, results of the program identified the depth and productivity of a few water bearing units. In the instance of well WW02-A, a productive aquifer of potential benefit has been identified.

The limited number of monitoring locations did not provide sufficient areal coverage to definitively project the depth and lateral extent of water bearing units or the Little Bear Aquifer.

5.0 REFERENCES

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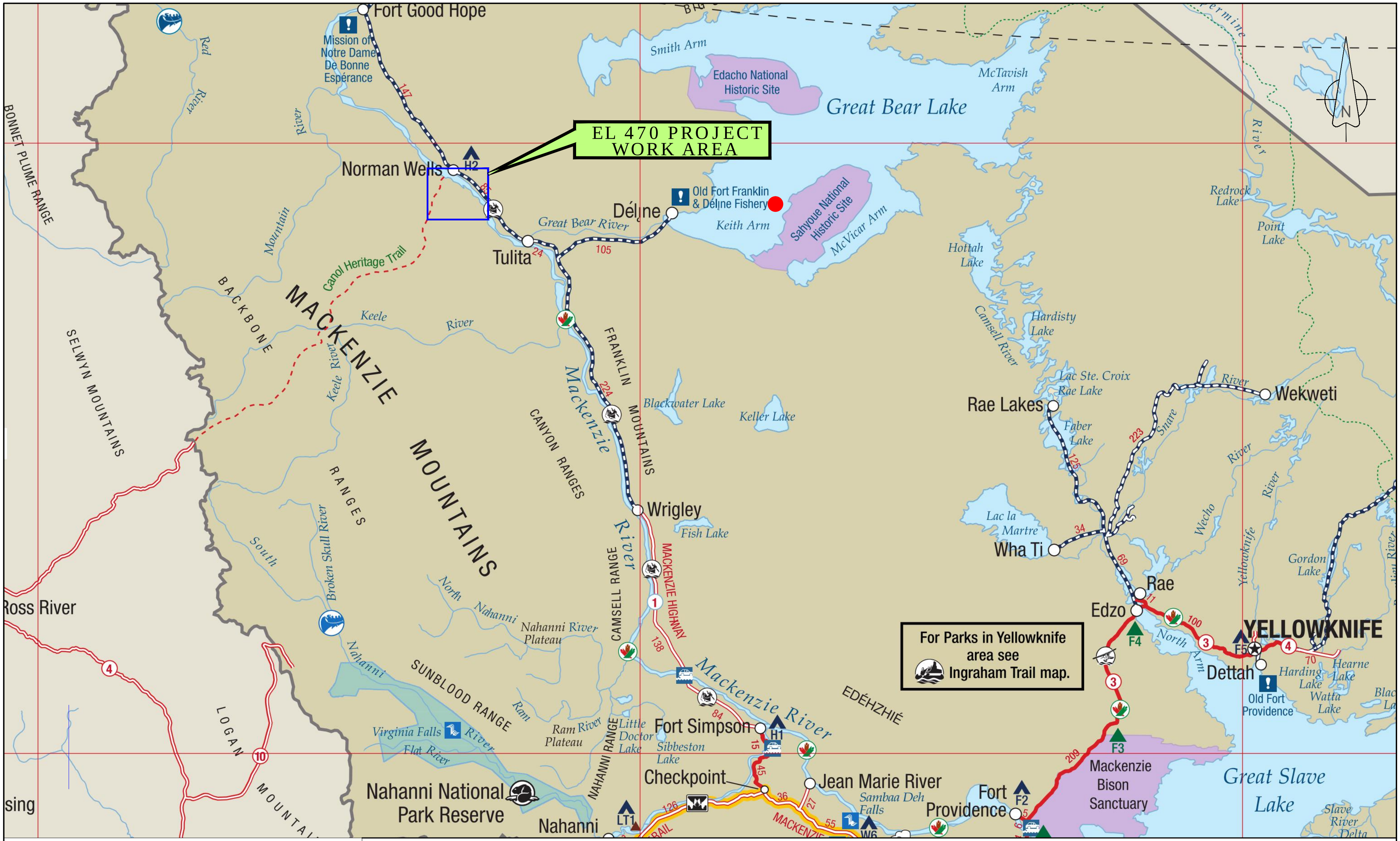


CONOCOPHILLIPS
EL 470 PROJECT WORK AREA
SITE LOCATION MAP

HOBBIT
ENVIRONMENTAL

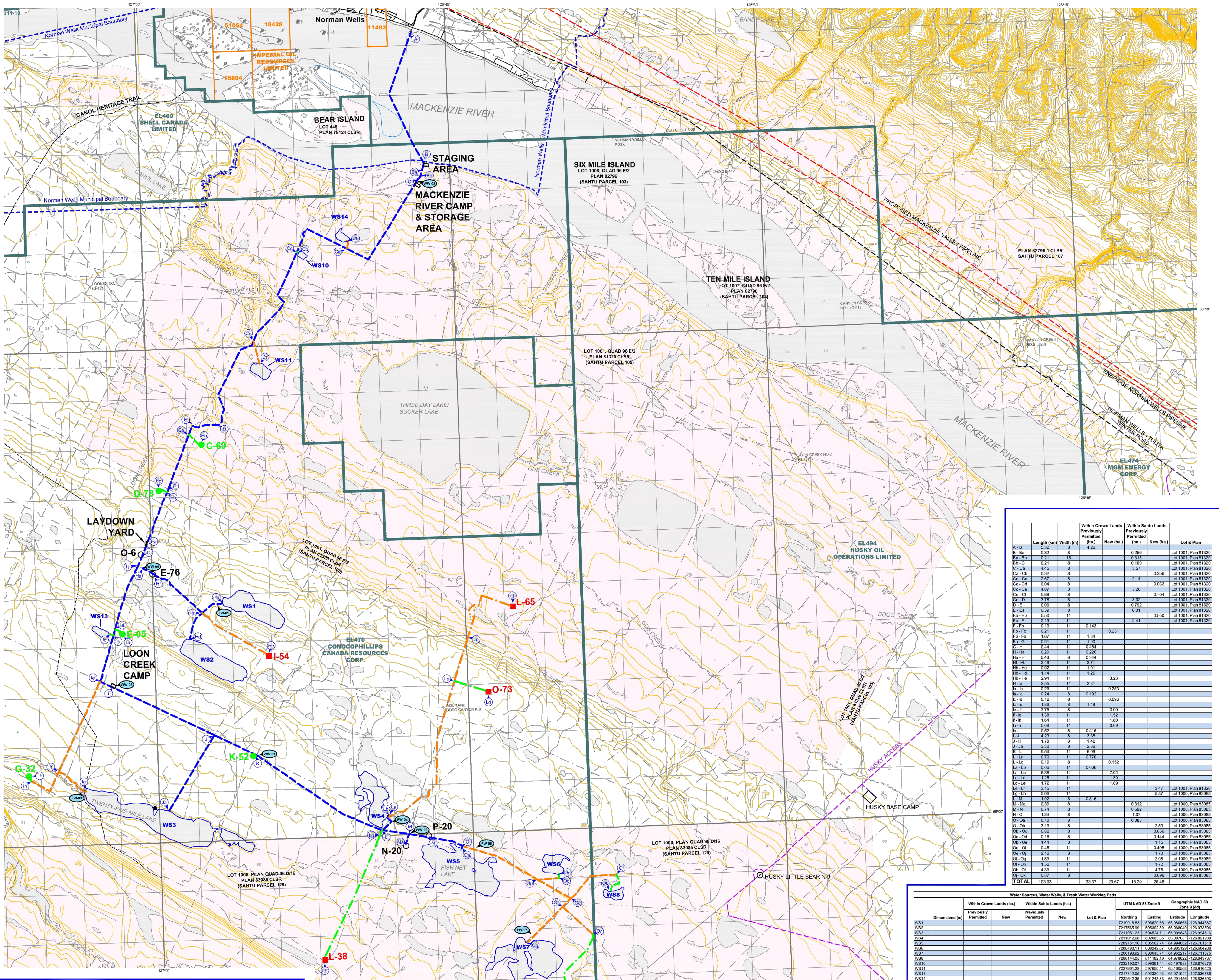
Sampled Date: APRIL 29, 2016

Checked by: JP

Figure No. 1

Drawn by: JMM

Filename: EL 470 FIGURE 1



	Length (km)	Width (m)	Within Crown Lands Previously Permitted (ha.)	Within Crown Lands New (ha.)	Within Sahtu Lands Previously Permitted (ha.)	Within Sahtu Lands New (ha.)	Lot & Plan
A - B	5.32	8	4.26				
B - Ba	0.32	8			0.256		Lot 1001, Plan 81320
Ba - Bb	0.21	15			0.315		Lot 1001, Plan 81320
Bb - C	0.21	8			0.160		Lot 1001, Plan 81320
C - Ca	4.45	8			3.57		Lot 1001, Plan 81320
Ca - Cb	0.32	8				0.256	Lot 1001, Plan 81320
Ca - Cc	2.67	8			2.14		Lot 1001, Plan 81320
Cc - Cd	0.04	8				0.032	Lot 1001, Plan 81320
Cc - Ce	4.07	8			3.26		Lot 1001, Plan 81320
Ce - Cf	0.88	8				0.704	Lot 1001, Plan 81320
Ce - D	3.78	8			3.02		Lot 1001, Plan 81320
D - E	0.99	8			0.792		Lot 1001, Plan 81320
E - Ea	0.39	8			0.31		Lot 1001, Plan 81320
Ea - Eb	0.50	11				0.550	Lot 1001, Plan 81320
Ea - F	2.19	11			2.41		Lot 1001, Plan 81320
F - Fb	0.13	11	0.143				
Fb - Fc	0.21	11		0.231			
Fb - Fa	1.67	11	1.84				
Fa - G	0.91	11	1.00				
G - H	0.44	11	0.484				
H - Ha	0.20	11	0.220				
Ha - Hf	0.43	8	0.344				
Hf - Hb	2.46	11	2.71				
Hb - Hc	0.92	11	1.01				
Hb - Hd	1.14	11	1.25				
Hb - He	2.94	11		3.23			
H - Ia	2.55	11	2.81				
Ia - Ib	0.23	11		0.253			
Ia - Ic	0.24	8	0.192				
Ic - Id	0.12	8		0.096			
Ic - Ie	1.86	8	1.49				
Ie - If	3.75	8		3.00			
If - Ig	1.38	11		1.52			
If - Ih	1.64	11		1.80			
Ih - Ii	0.08	11		0.09			
Ie - I	0.52	8	0.416				
I - J	4.23	8	3.38				
J - K	1.78	8	1.42				
J - Ja	3.32	8	2.66				
K - L	5.54	11	6.09				
L - La	0.70	11	0.770				
L - Lg	0.19	8		0.152			
La - Lb	0.06	11	0.066				
La - Lc	6.38	11		7.02			
Lc - Ld	1.26	11		1.39			
Lc - Le	1.72	11		1.89			
Le - Lf	3.15	11				3.47	Lot 1001, Plan 81320
Lg - Lh	5.06	11				5.57	Lot 1000, Plan 83085
L - M	1.02	8	0.816				
M - Ma	0.39	8			0.312		Lot 1000, Plan 83085
M - N	0.74	8			0.592		Lot 1000, Plan 83085
N - O	1.34	8			1.07		Lot 1000, Plan 83085
O - Oa	0.10	8			0.083		Lot 1000, Plan 83085
O - Ob	3.13	8				2.50	Lot 1000, Plan 83085
Ob - Oc	0.82	8				0.656	Lot 1000, Plan 83085
Oc - Od	0.18	8				0.144	Lot 1000, Plan 83085
Ob - Oe	1.44	8				1.15	Lot 1000, Plan 83085
Oe - Of	0.45	11				0.495	Lot 1000, Plan 83085
Oe - Oj	2.12	8				1.70	Lot 1000, Plan 83085
Of - Og	1.89	11				2.08	Lot 1000, Plan 83085
Of - Oh	1.56	11				1.72	Lot 1000, Plan 83085
Oh - Oi	4.33	11				4.76	Lot 1000, Plan 83085
Oj - Ok	0.87	8				0.696	Lot 1000, Plan 83085
TOTAL	103.93		33.37	20.67	18.29	26.48	

Water Sources, Water Wells, & Fresh Water Working Pads

	Dimensions (m)	Within Crown Lands (ha.) Previously Permitted	Within Crown Lands (ha.) New	Within Sahtu Lands (ha.) Previously Permitted	Within Sahtu Lands (ha.) New	Lot & Plan	UTM NAD 83 Zone 9 Northing	UTM NAD 83 Zone 9 Easting	Geographic NAD 83 Zone 9 (dd) Latitude	Geographic NAD 83 Zone 9 (dd) Longitude
WS1							7219016.83	596620.65	65.080668	-126.944587
WS2							7217565.99	595302.50	65.068040	-126.973596
WS3							7211051.23	594524.71	65.009843	-126.994516
WS4							7211012.60	602665.05	65.007081	-126.821980
WS5							7209751.10	605562.74	64.994862	-126.761510
WS6							7208798.11	609242.87	64.985129	-126.684288
WS7							7206198.92	608043.71	64.962217	-126.711675
WS8							7208144.05	611182.16	64.978622	-126.643737
WS10							7232192.07	599391.44	65.197983	-126.876270
WS11							7227961.29	597650.41	65.160568	-126.916423
WS13							7217812.05	592320.93	65.071091	-127.036785
WS14							7232642.35	601243.83	65.201456	-126.836393
WW-01	60 x 60	0.360					7213220.66	597830.11	65.028339	-126.922930
WW-02	60 x 60	0.357		0.003		Lot 1000, Plan 83085	7210301.38	603628.67	65.000404	-126.802080
WW-03	60 x 60			0.360		Lot 1001, Plan 81320	7234847.42	603867.69	65.220409	-126.778714
WW-04	60 x 60	0.360					7220335.11	593542.20	65.093373	-127.009143
WW-05	60 x 60	0.360					7215785.68	592528.40	65.052862	-127.033716
FW-01	50 x 50		0.25				7218986.39	596346.75	65.080475	-126.950340
FW-03	50 x 50		0.25				7211944.47	591281.48	65.018761	-127.062697
FW-04	50 x 50		0.25				7210710.41	602784.01	65.004334	-126.819680
FW-05	50 x 50				0.25	Lot 1000, Plan 83085	7209738.72	606022.73	64.994604	-126.751744
FW-07	50 x 50				0.25	Lot 1000, Plan 83085	7206468.80	608269.62	64.964563	-126.706688
TOTAL		1.44	0.75	0.363	0.50					

Ancillary Disturbances

	Dimensions (m)	Within Crown Lands (ha.) Previously Permitted	Within Crown Lands (ha.) New	Within Sahtu Lands (ha.) Previously Permitted	Within Sahtu Lands (ha.) New	Lot & Plan	UTM NAD 83 Zone 9 Northing	UTM NAD 83 Zone 9 Easting	Geographic NAD 83 Zone 9 (dd) Latitude	Geographic NAD 83 Zone 9 (dd) Longitude
Loon Creek Camp	120 x 180	2.16					7215864.93	592433.92	65.053602	-127.035678
Staging Area	120 x 200			2.40		Lot 1001, Plan 81320	7235497.40	604215.09	65.226141	-126.770768
Mackenzie River Camp & Storage Area	Irregular			2.00	1.27	Lot 1001, Plan 81320	7234742.73	603885.91	65.219464	-126.778403
Laydown Yard	30 x 180	0.54					7221234.06	593678.31	65.101396	-127.005644
TOTAL		2.70		4.40	1.27					

References:
Base Mapping, Cadastral data, Contours, Sahtu Land Claims, and Road Network data provided by Natural Resources Canada (NRCAN).
Sahtu Land Use Designations provided by the Sahtu Land Use Planning Board.
Oil & Gas Wells provided by the National Energy Board (NEB).
Oil & Gas Dispositions provided by Aboriginal Affairs and Northern Development Canada (AANDC).
NOTE: The Oil & Gas Grid uses the North American Datum of 1927 (NAD27)

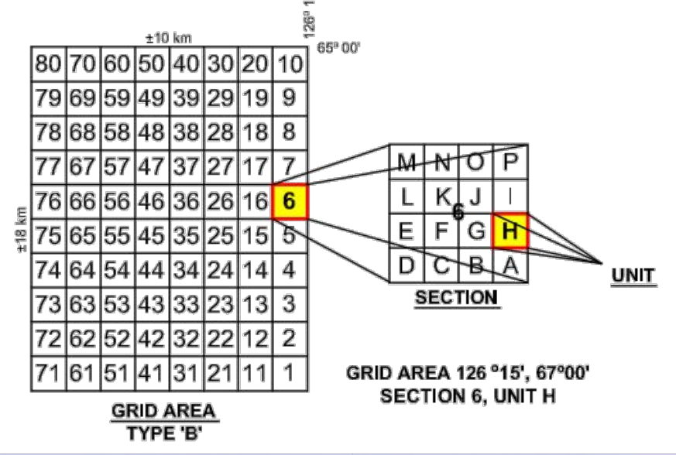
LEGEND

Perennial Waterbody	⬭
Perennial Watercourse	—
Contours (50m)	∼
Contours (10m)	∼
Roads	—
Winter Access Roads	– – –
Pipeline	– – –
Cutlines	— · —
Oil and Gas Parcels - PPL	▭
Oil and Gas Parcels - EL	▭
First Nations Surface Rights	▭
Ancillary Disturbances	▭
Fresh Water Working Pad	FW-01
Ground Water Well Pad	WW-01
Water Source	WS1
Municipal Boundary	[–]
Winter Road Access Route	– –
Existing Access Route on Cutline	– –
New Cut Access Route	– –
Conceptual Access Route on Cutline	–·–
Conceptual New Cut Access Route	–·–
Husky All Weather Access	– –
2014-2015 Proposed Well Locations	●
2015-2019 Conceptual Well Locations	■
Existing Well Locations	○

WELL LEGEND

- OIL WELL
- SUSPENDED OIL
- CAPPED OIL
- SUSPENDED
- HEAVY OIL
- SERVICE
- ABANDONED SERVICE
- ABANDONED OIL
- STANDING
- DRY & ABANDONED
- DRILLING
- LOCATION

OIL & GAS GRID AREA DIAGRAM



GRID AREA 126 °15', 67°00'
SECTION 6, UNIT H

REVISION TABLE

NO.	DESCRIPTION	DATE	BY
1	Update Access Widths	2014-03-25	SR

Wells

	Dimensions (m)	Within Crown Lands Previously Permitted (ha.)	Within Crown Lands New (ha.)	Within Sahtu Lands Previously Permitted (ha.)	Within Sahtu Lands New (ha.)	Lot & Plan	UTM NAD 83 Zone 9 Northing	UTM NAD 83 Zone 9 Easting	Geographic NAD 83 Zone 9 (dd) Latitude	Geographic NAD 83 Zone 9 (dd) Longitude
C-69	140 x 180				2.52	Lot 1001, Plan 81320	7224957.45	595747.62	65.134191	-126.959063
D-78	140 x 180		2.52				7223219.04	594145.06	65.119063	-126.994373
E-05	140 x 180		2.52				7217818.65	592768.22	65.071025	-127.027275
G-32	140 x 180		2.52				7212452.98	589253.29	65.023873	-127.105390
K-52	140 x 180		2.52				7213228.98	597710.58	65.028449	-126.925460
I-54	140 x 180		2.52				7216996.02	598292.69	65.062055	-126.910467
L-38	140 x 180				2.52	Lot 1000, Plan 83085	7205542.42	600424.23	64.958717	-126.873380
L-65	140 x 180				2.52	Lot 1001, Plan 81320	7218865.25	607492.34	65.075957	-126.713642
O-73	140 x 180		2.52				7215652.38	606576.42	65.047448	-126.735553
H-77	140 x 180				2.52	Lot 1000, Plan 83085	7203598.71	607691.54	64.939018	-126.721110
TOTAL		0.00	15.12	0.00	10.08					

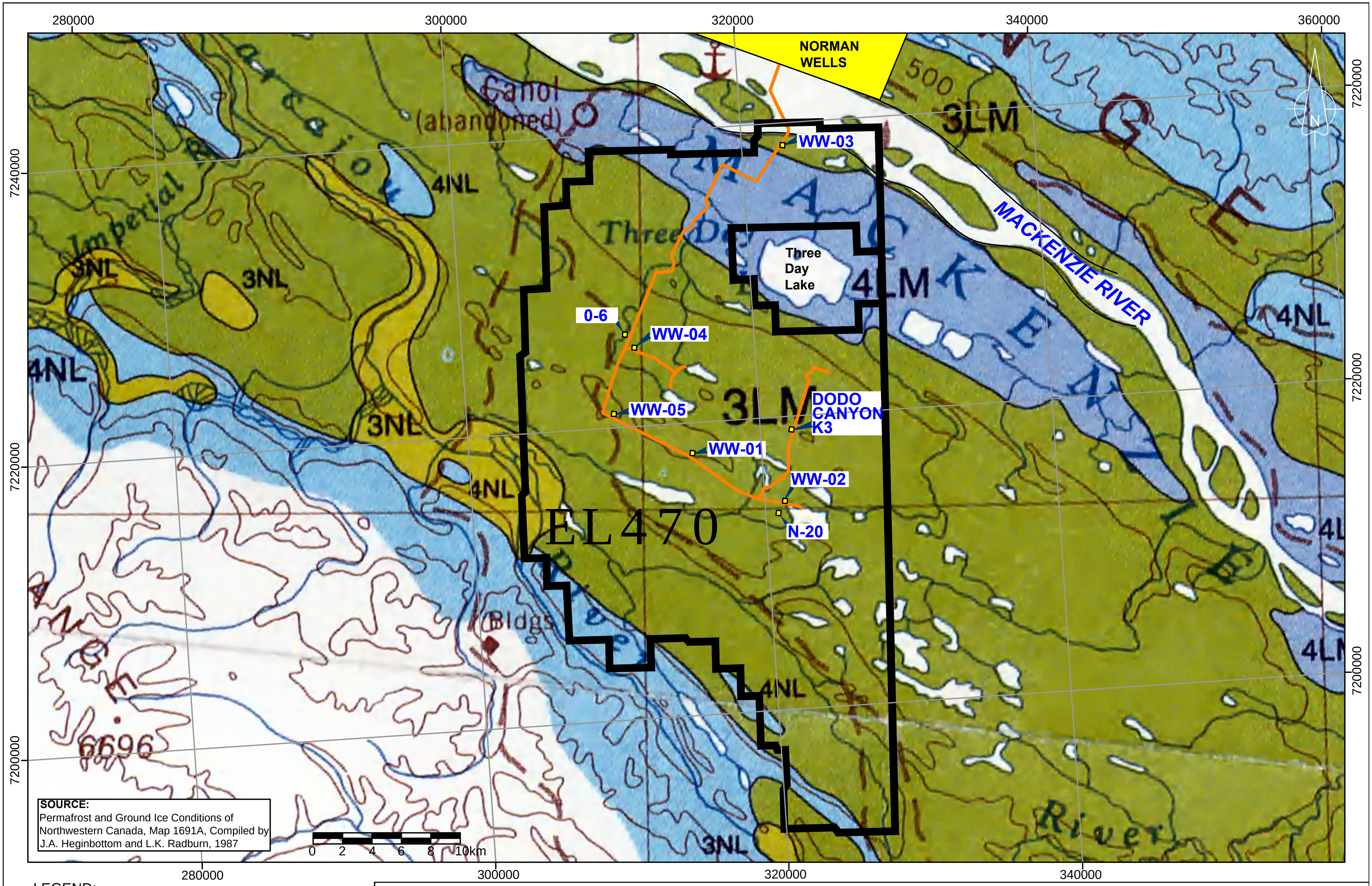
EL470 SITE MAP

HOBBIT ENVIRONMENTAL

Date: APRIL 29, 2016	Checked by: JP
Drawn by: JMM	Filename: EL470 SITE MAP
Figure No. 2	

1000 500 0 1000 2000 3000 4000 Metres
SCALE 1:55,000

MAP SOURCE: 2014-2019 EL470 EXPLORATION PROGRAM BY SAHTU GEOMATICS LTD. MARCH 25, 2014 FIGURE 1



SOURCE:
Permafrost and Ground Ice Conditions of Northwestern Canada, Map 1691A, Compiled by J.A. Heginbottom and L.K. Radburn, 1987

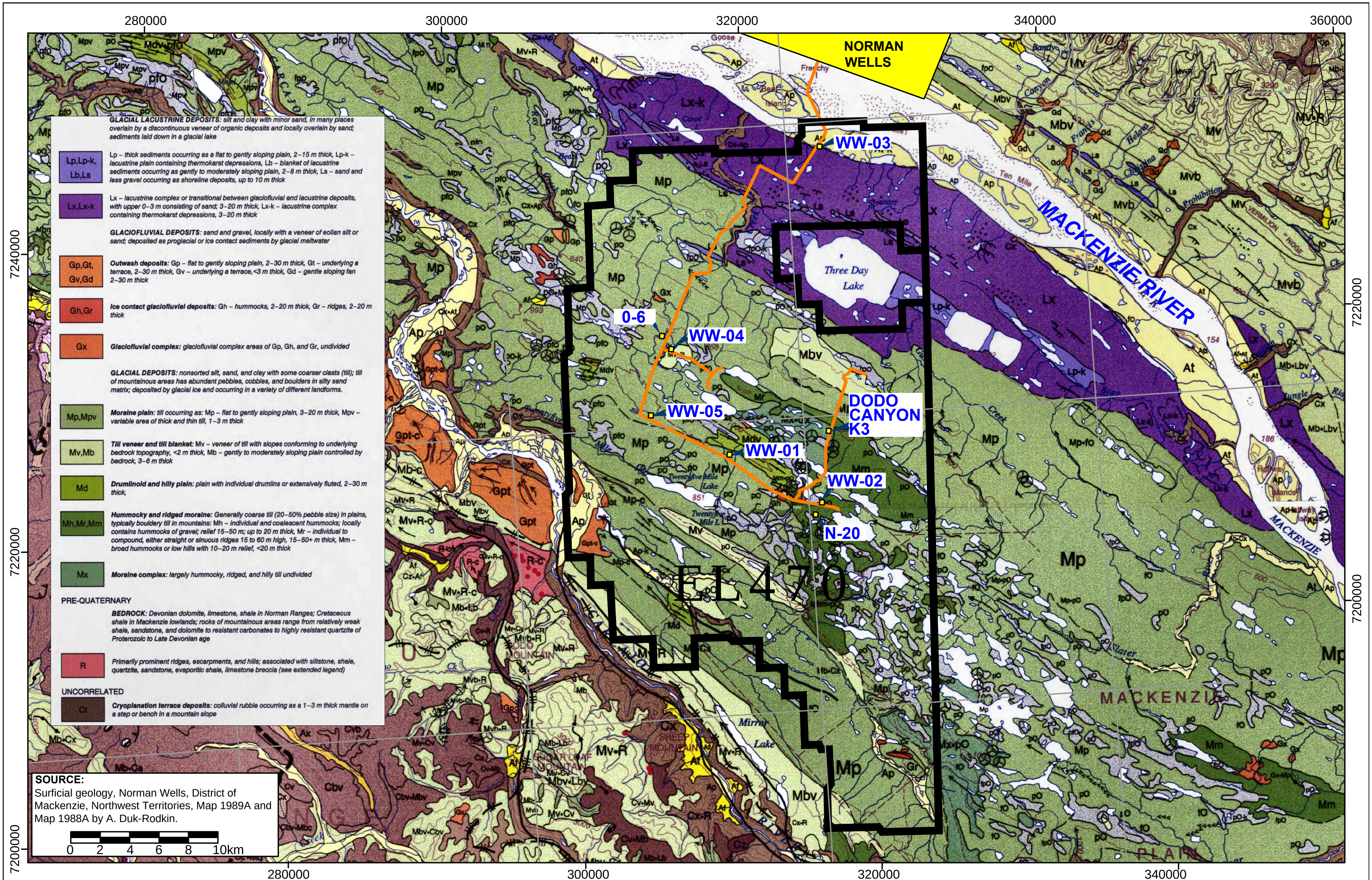
LEGEND:

🟪 4LM - Low to Moderate Ice Content
🟦 4NL - Nil to Low Ice Content
🟦 4N - Ice Content Nil
🟩 3LM - Low to Moderate Ice Content
🟨 3LN - Nil to Low Ice Content

PERMAFROST AND GROUND ICE CONDITION

HOBBIT ENVIRONMENTAL

Date: APRIL 29, 2016	Checked by: JP	Figure No. 3
Drawn by: JMM	Filename: EL470 PERMAFROST	



GLACIAL LACUSTRINE DEPOSITS: *silt and clay with minor sand, in many places overlain by a discontinuous veneer of organic deposits and locally overlain by sand; sediments laid down in a glacial lake*

Lp,Lp-k, Lb,Ls	Lp – *thick sediments occurring as a flat to gently sloping plain, 2–15 m thick,* Lp-k – *lacustrine plain containing thermokarst depressions,* Lb – *blanket of lacustrine sediments occurring as gently to moderately sloping plain, 2–8 m thick,* Ls – *sand and less gravel occurring as shoreline deposits, up to 10 m thick*
Lx,Lx-k	Lx – *lacustrine complex or transitional between glaciofluvial and lacustrine deposits, with upper 0–3 m consisting of sand; 3–20 m thick,* Lx-k – *lacustrine complex containing thermokarst depressions, 3–20 m thick*

GLACIOFLUVIAL DEPOSITS: *sand and gravel, locally with a veneer of eolian silt or sand; deposited as proglacial or ice contact sediments by glacial meltwater*

Gp,Gt, Gv,Gd	***Outwash deposits**:* Gp – *flat to gently sloping plain, 2–30 m thick,* Gt – *underlying a terrace, 2–30 m thick,* Gv – *underlying a terrace,<3 m thick,* Gd – *gentle sloping fan 2–30 m thick*
Gh,Gr	***Ice contact glaciofluvial deposits**:* Gh – *hummocks, 2–20 m thick,* Gr – *ridges, 2–20 m thick*
Gx	***Glaciofluvial complex**: glaciofluvial complex areas of* Gp, Gh, *and* Gr, *undivided*

GLACIAL DEPOSITS: *nonsorted silt, sand, and clay with some coarser clasts (till); till of mountainous areas has abundant pebbles, cobbles, and boulders in silty sand matrix; deposited by glacial ice and occurring in a variety of different landforms.*

Mp,Mpv	***Moraine plain**: till occurring as:* Mp – *flat to gently sloping plain, 3–20 m thick,* Mpv – *variable area of thick and thin till, 1–3 m thick*
Mv,Mb	***Till veneer and till blanket**:* Mv – *veneer of till with slopes conforming to underlying bedrock topography, <2 m thick,* Mb – *gently to moderately sloping plain controlled by bedrock, 3–6 m thick*
Md	***Drumlinoid and hilly plain**: plain with individual drumlins or extensively fluted, 2–30 m thick,*
Mh,Mr,Mm	***Hummocky and ridged moraine**: Generally coarse till (20–50% pebble size) in plains, typically bouldery till in mountains:* Mh – *individual and coalescent hummocks; locally contains hummocks of gravel; relief 15–50 m; up to 20 m thick,* Mr – *individual to compound, either straight or sinuous ridges 15 to 60 m high, 15–50+ m thick,* Mm – *broad hummocks or low hills with 10–20 m relief, <20 m thick*
Mx	***Moraine complex**: largely hummocky, ridged, and hilly till undivided*

PRE-QUATERNARY

BEDROCK: *Devonian dolomite, limestone, shale in Norman Ranges; Cretaceous shale in Mackenzie lowlands; rocks of mountainous areas range from relatively weak shale, sandstone, and dolomite to resistant carbonates to highly resistant quartzite of Proterozoic to Late Devonian age*

R	*Primarily prominent ridges, escarpments, and hills; associated with siltstone, shale, quartzite, sandstone, evaporitic shale, limestone breccia (see extended legend)*

UNCORRELATED

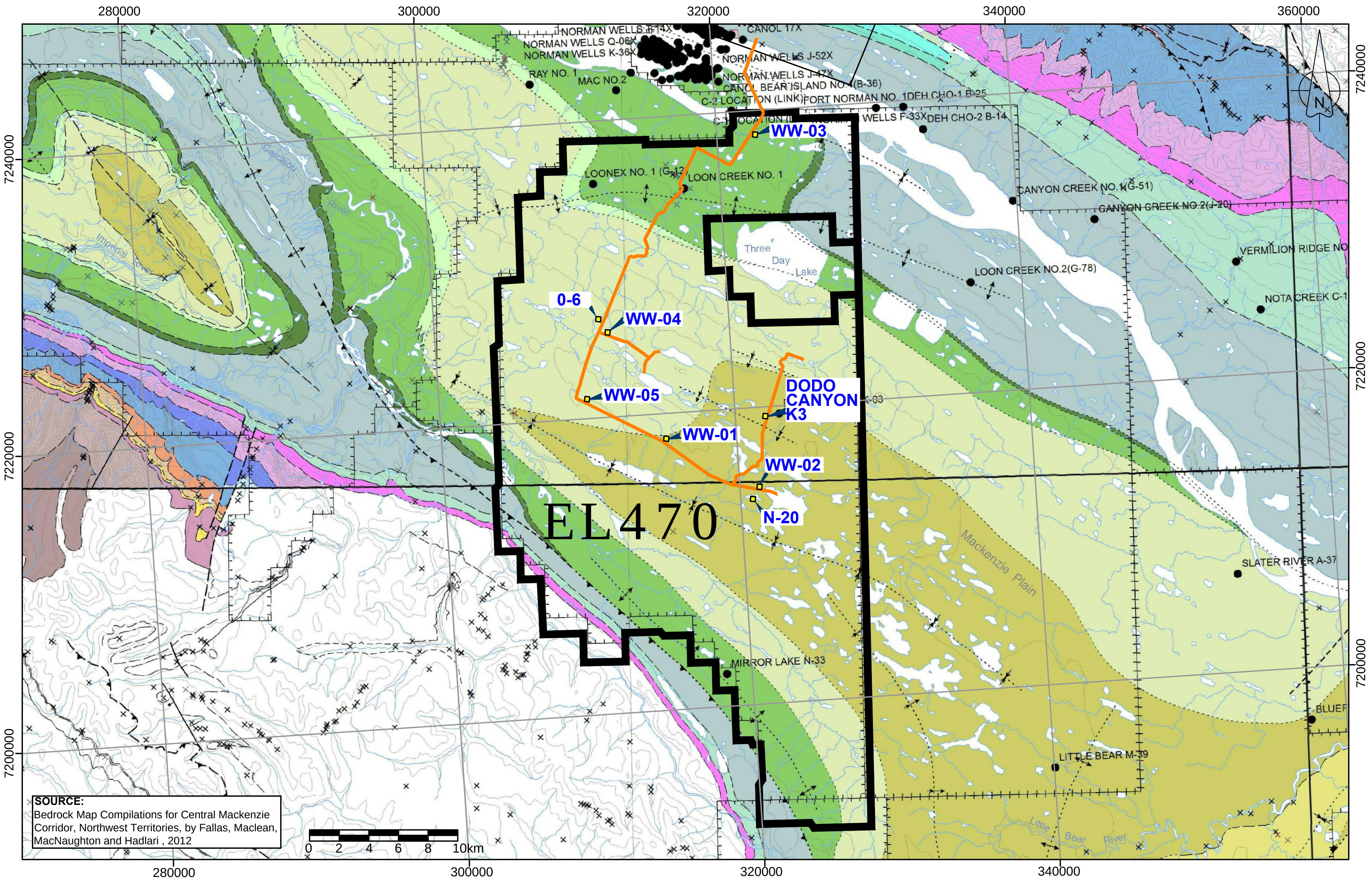
Ct	***Cryoplanation terrace deposits**: colluvial rubble occurring as a 1–3 m thick mantle on a step or bench in a mountain slope*

SOURCE:
Surficial geology, Norman Wells, District of Mackenzie, Northwest Territories, Map 1989A and Map 1988A by A. Duk-Rodkin.

SURFICIAL GEOLOGY

HOBBIT ENVIRONMENTAL

Date: APRIL 29, 2016	Checked by: JP	Figure No. 4	
Drawn by: JMM	Filename: EL470 GEOLOGY		



SOURCE:
Bedrock Map Compilations for Central Mackenzie Corridor, Northwest Territories, by Fallas, Maclean, MacNaughton and Hadlari , 2012

LEGEND:

Ct-EF	East Fork Fm
Ct-LB	Little Bear Fm
Ct-SR	Slater River Fm
Ct-ML	Mahony Lake Fm
Ct-SS	Sans Sault Mbr
Ct-MA	Martin House and Arctic Red fms
Ct-AR	Arctic Red Fm
Ct-MH	Martin House Fm

BEDROCK GEOLOGY

HOBBIT ENVIRONMENTAL

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Figure No. 5