Memorandum

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SUBJECT: 2013 Fuel Containment Area Water Sampling

1. Introduction

Starfield Resources Inc. constructed and operated a lined embankment secondary containment fuel storage area as part of their Ferguson Lake Project. Canadian North Resources and Development Corp. has acquired the property recently and at their request, ERM Rescan visited the Project area August 7 to 9, 2013 to assess the quality of the impounded water and to provide recommendations on its management.

The fuel containment area (FCA) is approximately 40 m × 40 m (Plates 1 and 2). The containment area was constructed using local materials for the embankments and a HDPE liner was welded as the impermeable membrane. The liner was keyed into the top of the embankment and was covered with a non-woven geotextile fabric. A layer of sand and gravel was placed on top of the fabric to form a ramp and a working area within the embankment.

Contact water from snowmelt and rainfall collects seasonally in the containment area. Regular management of this contact water involves assessing water quality prior to discharge of untreated water onto the tundra from a point west of the FCA (Plate 3).

2. Methodology

Untreated water within the flooded FCA was sampled and tested for hydrocarbons and polycyclic aromatic hydrocarbons (PAHs) during one sampling event. An oil water separator was not available to test treated water.

Plate 1. Aerial view of flooded fuel containment area looking south.

Plate 2. Fuel barrels stored on site at the time of sampling.

Plate 3. Western water discharge point.

Sampling occurred on August 9, 2013. Untreated water samples were collected from the eastern, western, northern and centre portions of the FCA at depth, at the middle of the water column by way of a portable water pump installed at each of the sampling locations (Plate 4). For QA/QC purposes, duplicates were collected along the eastern and western portions of the FCA in addition to a field blank. An additional sample set was collected from the FCA for analysis of general water quality parameters, including pH, turbidity and nutrients. As requested by the onsite geologist, a grab sample was also collected from a separate area with a liner where crushed fuel barrels were stored on the eastern side of Ferguson Lake Camp (Plates 5 and 6).

Plate 4. Maintenance worker setting up pump at the centre of the northern edge of the fuel berm area.

Plate 5. Crushed fuel barrel storage area.

Plate 6. Standing water in crushed fuel barrels berm with amber colour and visible oil sheen.

Samples were kept cool and sent to ALS Environmental Laboratories in Burnaby for analytical analysis. Upon arrival at the laboratory, all samples were analyzed except for the general parameters sample because holding times had been exceeded (flights were delayed during the shipment). As a result of laboratory error all samples were analysed twice (thus for each sample location there are duplicate results; e.g., East 1 and East 2). Analytical results were compared to applicable CCME guidelines for the protection of aquatic life (CCME 2011).

3. Analytical Results and Observations

During the field visit, water observed within the fuel containment area showed no sign of contact with hydrocarbons. There was no sheen or free product visible on the surface of the water and the water had no odour.

There are 11 CCME water quality guidelines for PAHs and no CCME guidelines for other hydrocarbons (e.g. EPH10-19). All analytical detection limits were lower than corresponding CCME guidelines. No PAHs were detected in untreated waters within the north, east or west sampling locations of the FCA (Appendix 1). Napthalene and pyrene were detected in the sample collected from the centre location, but at levels less than the CCME guideline value. Pyrene and fluoranthene were detected in the water located under the crushed barrels and exceeded the CCME guideline value by 42% and 38%, respectively (average of the two results; Appendix 1). The volume of water under the crushed barrels was minimal. Field observations confirmed the analytical results, as field technicians did not observe sheen or odour coming from the water in the FCA during the sampling events, but did observe a sheen and odor under the crushed barrels.

Hydrocarbons including extractable petroleum hydrocarbons (EPH), light extractable petroleum hydrocarbons (LEPH), heavy extractable petroleum hydrocarbons (HEPH) and three hydrocarbon fractions (F2, F3 and F4) were generally less than the analytical detection limit in all samples collected from the FCA, except in the centre area sample. Detectable levels of EPH, LEPH, HEPH, F2, and F3 were identified in the centre location (Appendix 1). Detectable hydrocarbons in the centre area sample may be attributed to collection technique. It is likely that fine sediment lining the bottom of the FCA was stirred up by repositioning the pump equipment, thus contaminating the sample. Detectable levels of EPH, LEPH, HEPH, and F3 were observed in the sample collected from under the crushed barrels (Appendix 1). The presence of detectable hydrocarbons in the crushed barrel sample confirms field observations.

4. Conclusions

Untreated water collected from the FCA was mostly free of detectable PAHs and fell below defined CCME guidelines for the protection of aquatic life (CCME 2011). Untreated water collected from under the crushed barrels, situated on a separate liner, slightly exceeded the CCME guidelines for pyrene and fluoranthene.

The low portion of samples containing hydrocarbons in the contact water suggests that fuel handling practices within the fuel containment area have been good. Given the lack of observable or detectable hydrocarbons in the untreated water located in the FCA, the water meets discharge criteria and can be discharged without treatment provided measures are taken to mitigate other potential impacts from the discharge (e.g., erosion). However, the untreated water located in the separate bermed liner, where the crushed barrels are stored, should not be discharged onto the tundra as a result of collected samples exceeding CCME guidelines. Measures should be taken to ensure the impacted water from the crushed barrels does not breach the liner and water is treated prior to discharge.

References

CCME. 2011. *Canadian water quality guidelines for the protection of aquatic life: Summary table.* Canadian Council of Ministers of the Environment: Winnipeg, MB. http://st-ts.ccme.ca (accessed September 2013).

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Appendix 1. Analytical results of hydrocarbon and PAH testing of untreated water (FCA), August 9, 2013

Water Type		Untreated Water (FCA) Pump Sample												Untreated Water Grab Sample		Blanks	
		East				Centre		North		West				Crushed Barrel WQ		Field Blank	Travel Blank
Sample ID		EAST 1	EAST 2	EAST 1 DUP	EAST 2 DUP	CENTER 1	CENTER 2	NORTH 1	NORTH 2	WEST 1	WEST 2	WEST 1 DUP	WEST 2 DUP	CB1	CB2	F BLANK	T BLANK
Date Sampled		9-Aug-13	9-Aug-13	9-Aug-13	9-Aug-13	9-Aug-13	9-Aug-13	9-Aug-13	9-Aug-13	9-Aug-13	9-Aug-13	9-Aug-13	9-Aug-13	9-Aug-13	9-Aug-13	9-Aug-13	
ALS Sample ID	CCME Guidelines[a] (mg/L)	L1349142-1	L1349142-2	L1349142-3	L1349142-4	L1349142-5	L1349142-6	L1349142-7	L1349142-8	L1349142-11	L1349142-12	L1349142-13	L1349142-14	L1349142-15	L1349142-16	L1349142-9	L1349142-10
Aggregate Organics																	
Oil and Grease	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Hydrocarbons																	
EPH10-19	-	<0.25	<0.25	<0.25	<0.25	1.98	0.43	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.74	<0.25	-
EPH19-32	-	0.26	<0.25	<0.25	<0.25	0.57	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.26	<0.25	-
LEPH	-	<0.25	<0.25	<0.25	<0.25	1.98	0.43	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.74	<0.25	-
HEPH	-	0.26	<0.25	<0.25	<0.25	0.57	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.26	<0.25	-
F2 (C10-C16)	-	<0.30	<0.30	<0.30	<0.30	1.19	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	-
F3 (C16-C34)	-	0.38	0.35	<0.30	<0.30	1.38	0.34	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0.33	0.77	<0.30	-
F4 (C34-C50)	-	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	-
Polycyclic Aromatic Hydrocarbons																	
Acenaphthene	0.0058	<0.000030	<0.000030	<0.000010	<0.000010	<0.00010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	-
Acenaphthylene	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.00010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	-
Acridine	0.0044	<0.000010	<0.000010	<0.000010	<0.000010	<0.00010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.00010	<0.00010	<0.000010	-
Anthracene	0.000012	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.00010	<0.000010	-
Benz(a)anthracene	0.000018	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	-
Benzo(a)pyrene	0.000015	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	-
Benzo(b)fluoranthene	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.00010	<0.000010	<0.000010	<0.000010	<0.000010	-
Benzo(g,h,i)perylene	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	-
Benzo(k)fluoranthene	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	-
Chrysene	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	-
Dibenz(a,h)anthracene	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	-
Fluoranthene	0.00004	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000056	0.000054	<0.000010	-
Fluorene	0.003	<0.000010	<0.000010	<0.000010	<0.000010	<0.00010	<0.00010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.00010	<0.00010	<0.000010	-
Indeno(1,2,3-c,d)pyrene	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	-
Naphthalene	0.0011	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000052	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	-
Phenanthrene	0.0004	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	-
Pyrene	0.000025	<0.000010	<0.000010	<0.000010	<0.000010	0.000020	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000032	0.000039	<0.000010	-
Quinoline	0.0034	<0.000030	<0.000030	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.000010	-
Surrogate: Acenaphthene d10		105.4	94.6	95.9	93.0	99.1	115.5	91.3	93.8	94.1	89.7	102.9	89.7	98.4	96.4	91.7	-
Surrogate: Acridine d9		115.5	103.5	106.5	106.1	103.9	125.3	102.3	103.0	108.4	99.2	115.5	102.1	104.0	110.6	103.7	-
Surrogate: Chrysene d12		99.6	91.8	101.2	97.9	99.8	119.6	97.1	99.8	101.7	95.5	108.5	95.9	99.8	100.4	99.5	-
Surrogate: Naphthalene d8		100.4	91.0	94.2	90.2	91.7	112.7	87.5	91.5	91.2	86.9	99.7	86.5	90.7	89.9	89.3	-
Surrogate: Phenanthrene d10		105.6	96.0	98.1	97.3	94.1	119.1	93.2	93.9	98.6	90.6	104.4	93.4	90.9	95.5	95.5	-

[a] *Canadian water quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment.*

Dashes indicated analysis not completed or no applicable guideline

Shaded values indicate sample exceeded CCME guidelines.