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WX17989
23 September 2022

Bereket Assefa, PhD., P.Eng.
Industrial and Wastewater Section
Environmental Approvals Branch
Manitoba Environment, Climate and Parks
1007 Century Street, Winnipeg, MB R3H 0W4

Re: Response to the Technical Advisory Committee Comments for the Notice of Alteration for the Decommissioning Plan for Cell 4, City of Brandon Wastewater Treatment Lagoons, Environment Act Licence #2991, Client File # 5510.00

The Technical Advisory Committee (TAC) reviewed the Notice of Alteration filed for *Environment Act* Licence 2991, Client File No 5510.00 for the decommissioning plan for cell 4 of the City of Brandon's wastewater treatment lagoon. Comments and additional questions for clarification from the TAC were provided to Pfizer and Wood (now WSP E&I Canada) on 26 May 2022 and 16 June 2022. This letter provides the information and clarifications to those comments and questions posed by the TAC.

Question 1 Please provide the results of pharmaceutical monitoring program with respect to Clause 47 (c) (iv) of Licence No. 2991.

Response 1 The City of Brandon is developing a plan to implement a testing program for suspected EDCs related to pharmaceutical and hog processing operations.

Question 2 The NOA indicates from 1981 to 2013 Cell 4 was receiving industrial wastewater containing Spent Pregnant Mare Urine (SPMU, equine hormones) and a preservative compound referred to as Compound A. After 2013, the industrial wastewater stream has been directed to the new treatment plant and the SPMU facility no longer requires the use of Cell 4. However, the NOA also indicates Cell 3 receives flow directly from the facility during wet weather. Through pipe connection to Cell 3, Cell 4 and 5 would also receive some industrial wastewater stream during wet-weather. It is possible Cells 3, 4, and 5 sediments will be requiring the same such on-site containment cell for long term management?

The Water Quality Management notes that the lagoon system will still be receiving wastewater stream and biosolids from the SPMU industry. When the Cells 3, 4, and 5 reach end of design life, will the proponent handle the sludge in a similar manner to the Cell 4 decommissioning plan?

Response 2

The City of Brandon Lagoon System no longer receives wastewater from the Pfizer facility in Brandon. The wastewater from the Pfizer plant is now trucked directly to the City of Brandon Water Reclamation Facility for dosing into the treatment stream. Wet weather flows to the lagoon system would not include wastewater from the Pfizer facility.

Cell 3 has never receive wastewater from the Pfizer operation and therefore would not require assessment or management related to Compound A or Pfizer operations.

Cell 5 received treated wastewater from Cell 4 between 1981 and 2013. It is possible that sediments within Cell 5 could contain concentrations of Compound A. Fate and transport modelling has indicated sediment concentrations of Compound A in Cell 5 are likely below Ecological Risk-Based Screening Level for sediment (58 mg/kg), and therefore would not need the same sediment management as proposed for Cell 4.

Question 3

While wastewater treatment facilities cannot fully eliminate pharmaceuticals, did the proponent consider routing the Cell 4 supernatant to the mechanical plant?

Response 3

Treatment of the Cell 4 Lagoon water in the Water Reclamation Facility was investigated however considered unfeasible due to:

- Current piping connections between the plant and lagoon system would not allow for transporting wastewater from Cell 4, as it would require retrofit of the system;
- Not feasible within a 4 month period to truck the lagoon water within Cell 4 which has an estimated volume of 250,000 m³ (10,000 truck loads).
- Treatment of the water at the Water Reclamation Facility would be time consuming due to the need for volume-based dosing into the system. Incorporating a large volume from Cell 4, in addition to the wastewater from current operations, would require significant time frame for water treatment (10 years+). The Water Reclamation Facility is not designed for storage or dosing of the volume of water to be treated from Cell 4 in the timeframe required for the project.

Question 4

Please provide information on how 58 mg/kg as an Ecological Risk-Based Screening Level for Compound A was developed for the lagoon sediment?

Response 4

Appendix A of the Decommissioning Plan provides how the risk-based screening levels were derived. This was provided to Manitoba Conservation in 2014. A copy of the decommissioning plan has been included with this response.

Question 5

The flow diagram indicates the use of ALUM to treat effluent from Cell 4. Please confirm if ALUM precipitate will be placed into the containment cell?

Response 5

ALUM precipitate is expected to be placed into the containment cell.

Question 6

The sediments from Cell 4 are being moved into an on-site containment cell for long term management. What is the longer term management plan of the sediments inside the on-site containment cell?

Response 6

An agreement between the City and Pfizer will be developed for care and maintenance.

Section 3.2.5 of the NOA provides a preliminary plan for management of the Cell.

The half life of Compound A has been reported to be 290 days in soil and sediment, and over 50 years in water. Compound A is a recalcitrant compound, with an antimicrobial nature, and in anaerobic conditions likely present within the containment cell, degradation times are likely to be significantly longer > 20 years. As such sediment will remain in the containment cell for the foreseeable future.

A management plan for the Operation, Monitoring and Maintenance of the containment cell will be developed for agreement by all parties.

Question 7

The decommissioning plan indicates leachate from the on-site containment cell will be collected, analysed, and disposed of according to provincial requirements. It also indicates the long-term leachate generation potential of the material in the on-site containment cell is expected to be minimal. What are the expected volume and characteristics of the leachate from the on-site containment cell?

Response 7

Volume of leachate will depend on the moisture content of the material once deposited in the containment cell. Efforts will be made to reduce moisture content of sediment through drying of sediment, as well as potential use of solidification/bulking materials. A leachate analysis was conducted on sediment from Cell 4, the results indicated leachate chemistry concentrations to be within Manitoba waste classification regulations and concentrations of Compound A and hormones below detection limits. Data from leachate analysis is provided in Table 1 below.

Table 1 – Cell 4 Leachate Chemical Characteristics

Parameter	Units	Sample ID	12-SED27-05/06	12-SED36-04/05	12-SED42B-05 / 06
		Date	7/31/2012	8/1/2012	7/31/2012
		LOR	Waste	Waste	Waste
Compound A	mg/L	0.005	ND	ND	ND
Benzene	mg/L	0.025	ND	ND	ND
Ethyl Benzene	mg/L	0.025	ND	ND	ND
Styrene	mg/L	0.025	ND	ND	ND
Toluene	mg/L	0.025	ND	ND	ND
o-Xylene	mg/L	0.025	ND	ND	ND
m+p-Xylenes	mg/L	0.05	ND	ND	ND
Xylenes (Total)	mg/L	0.075	ND	ND	ND
Antimony	mg/L	0.5	ND	ND (0.05) *	ND
Arsenic	mg/L	0.2	ND	ND (0.01) *	ND
Barium	mg/L	0.5	1.36	1.1 (0.1) *	ND
Beryllium	mg/L	0.5	ND	ND (0.01) *	ND
Boron	mg/L	5	ND	ND (0.5) *	ND
Cadmium	mg/L	0.05	ND	ND (0.001) *	ND
Calcium	mg/L	5	565	416 *	548
Chromium	mg/L	0.5	ND	ND (0.01) *	ND
Cobalt	mg/L	0.2	ND	ND (0.005) *	ND
Copper	mg/L	0.5	ND	ND (0.01) *	ND
Iron	mg/L	5	ND	5.06 (0.05) *	ND
Lead	mg/L	0.5	ND	ND (0.01) *	ND
Magnesium	mg/L	5	56	57.3 *	81.7
Manganese	mg/L	0.05	2.34	6.61 (0.01) *	0.481
Mercury	mg/L	0.0001	--	ND *	--
Molybdenum	mg/L	0.05	ND	ND (0.01) *	0.059
Nickel	mg/L	0.5	ND	ND (0.02) *	ND
Potassium	mg/L	5	149	99 (10) *	119
Selenium	mg/L	0.2	ND	ND (0.05) *	ND
Silver	mg/L	0.5	ND	ND (0.001) *	ND
Strontium	mg/L	0.01	1.32	1.18 *	0.92
Thallium	mg/L	0.1	ND	ND (1.0) *	ND
Tin	mg/L	0.05	ND	ND (0.01) *	ND
Uranium	mg/L	0.05	ND	ND (0.05) *	ND
Vanadium	mg/L	0.5	ND	ND (0.01) *	ND
Zinc	mg/L	1	ND	0.149 (0.03) *	ND
Zirconium	mg/L	0.5	ND	-- *	ND

Note:

mg/L = milligrams per litre

ND = Not Detected

--" = Not Available

" * " = analysis done at ALS Labs in Waterloo, ON. Detection limit in brackets.

Question 8 On pdf page 16, the proposal indicates analytical results for lagoon water samples collected from Cell 4 have shown a substantial decline in a dissolved form of Compound A. Submit the concentrations of Compound A from sampling events in 2011, 2012, and 2016.

Response 8 See data provided below in Table 2.

Table 2 – Compound A Concentrations in Lagoon Water

Parameter	Lowest Detection Limit	Units	Data from 2003-2010 n=116			March 2011 n=14			August 2011 n=16			August 2012 n=4	August 2016 n=2
			Mean	Min	Max	Mean	Min	Max	Mean	Min	Max		
Compound A Total	5.0	ug/L	82	ND	260	15.88	12.2	18.5	2.5	2.5	7.2	ND	ND
Compound A Dissolved	5.0	ug/L	56	ND	185	12.86	10.9	14.4	ND	ND	ND	ND	ND

Note: ND=Non-Detect

Question 9 Collect bioassay sample(s) of wastewater effluent for acute and chronic toxicity for Cell 4 dewatering discharge(s) and submit the findings.

Response 9 Acute and chronic toxicity trout bioassay effluent monitoring testing can be conducted on wastewater from Cell 4 prior to treatment and could be conducted on treated wastewater prior to full implementation. The bioassay program for Cell 4 is being developed and the results will be submitted prior to full implementation.

Question 10 What is the estimated total quantity of Compound A in the impacted material that is to be removed from Cell 4 and stored in the new containment area?

Response 10 The impacted media requiring management includes approximately 111,500 m³ of material which consists of lagoon sediment (73,400 m³), soils, riprap and rock, sludge from water treatment, and soil from construction related berms and dykes.

Average concentration in sediment in Cell 4 is 150 mg/kg. = 22,020 kg Compound A.

Question 11 What are the known breakdown products of Compound A?

Response 11 Published studies indicate the known breakdown products are the mono- or bis-dechlorinated analogues of the parent Compound A.

Question 12 What is the expected degradation life time of Compound A in the impacted sludge after transferring it the containment?



Response 12

The half life of Compound A has been reported to be 290 days in soil and sediment, and over 50 years in water. Compound A is a recalcitrant compound, with an antimicrobial nature, and in anaerobic conditions likely present within the containment cell, degradation times are likely to be significantly longer.

Closure

Should you have any questions regarding the information provided, please do not hesitate to contact the undersigned directly.

Sincerely,

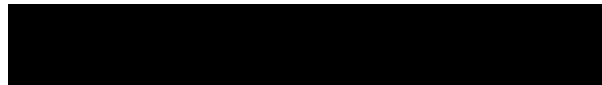
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Attachments

Appendix A from June 2014 Decommissioning Plan

Cc Alexia Stangherlin, P.Eng. Director of Utilities, City of Brandon
Keith Sears, AECOM
Tom Donohue, Pfizer Inc.

Attachment 1



APPENDIX A

Development of Site-Specific Compound A Ecological Risk-Based Sediment Screening Level



1.0 REFINEMENT OF COMPOUND A CELL 4 AND CELL 4A SEDIMENT SCREENING LEVEL GUIDELINE

A screening-level ecological risk assessment conducted by Golder & Gradient concluded potential future ecological risks associated with Cell 4 lagoon sediments, and that actions related to the lagoon sediment should be considered as part of the decommissioning, to manage these potential risks. Such actions could include, but not necessarily be limited to, capping, stabilizing, or removal of the organic carbon-rich Layer A (refer to Figure 3.1) that overlies most of the lagoon floor, as well as the depositional layers in the northwest corner and inlet pipe areas. Such removal would expose Layer B and/or Layer C underlying the active SPMU depositional Layer A. Layers B and C are inferred to represent liner material with distinctively different physical characteristics. Accordingly, to evaluate potential future ecological risks, an ecological screening level guideline was developed for this underlying Layer B and Layer C. This section presents the refinement of the prior sediment ecological screening level for COMPOUND A developed by Golder & Gradient (i.e., 25.7 milligrams per kilogram [mg/kg]), accounting for the characteristics of the underlying liner material comprising Layers B and C. The refined COMPOUND A screening level guideline was used for determining the extent and volume of inferred impacted material and to evaluate decommissioning options for Cell 4.

Another key element that warrants further consideration in the refinement of the prior COMPOUND A ecological screening level guideline are the ionization characteristics of COMPOUND A. Specifically, at neutral to high pH (i.e., pH greater than approximately 5), COMPOUND A is primarily present in its anionic rather than its neutral chemical state. In this chemical state, binding mechanisms other than organic carbon adsorption are expected to play an important role in sequestering COMPOUND A onto lagoon sediments. This is further discussed in the following sub-section.

1.1 pH Dependency of the Environmental Fate of COMPOUND A

COMPOUND A is an ionizable Compound and its speciation in water is pH dependent. At low pH, COMPOUND A is primarily in the polar, hydrophobic form. As the pH increases, COMPOUND A becomes primarily anionic and successively takes the form COMPOUND A⁻ and COMPOUND A²⁻. The two dissociation constants pKa₁ and pKa₂ for COMPOUND A are 4.89 and 10.83 (Tam & Takács-Novák, 2001). Current Cell 4 water pH ranges from approximately 9.0 to 9.7, which falls between the two pKa values, and COMPOUND A is therefore expected to be primarily in the ionic form COMPOUND A⁻. Following decommissioning from present Wyeth use and possible re-use of Cell 4 by the City of Brandon for wet weather waste water/effluent management, future pH is expected to be circumneutral or basic (i.e., around 7 or above), which would result in COMPOUND A remaining primarily in the same ionic form COMPOUND A⁻.

Because the speciation of COMPOUND A is pH dependent and the speciation status of ionizable compounds affects chemical fate, pH has an effect on the environmental fate of COMPOUND A. Accordingly, COMPOUND A partitioning behavior is dependent on pH—a mechanism that has been investigated for other ionizable compounds such as chlorophenols (e.g., Nowosielski, 1997), but not for COMPOUND A. It is expected that COMPOUND A's water solubility will increase and, as a result, the octanol-water partitioning coefficient (Log K_{ow}) will decrease as pH increases. Similarly, the organic carbon-water partition coefficient (Log K_{oc}) is expected to decrease with increasing pH.

While partitioning with organic carbon is expected to be less important at higher pH, other binding mechanisms are expected to play an important role in the distribution of COMPOUND A between Cell 4 water and lagoon



sediments. At present, under high pH conditions, dissolved concentrations of COMPOUND A in Cell 4 water are generally less than the detection limit of 5 micrograms per litre (µg/L), while COMPOUND A concentrations in Cell 4 lagoon sediments are generally in the hundreds of mg/kg to a few thousand mg/kg . These data indicate that COMPOUND A is bound to Cell 4 sediment through alternative mechanisms (i.e., beyond what would be predicted based on binding to organic carbon alone) that may include carbonate binding, humic acid binding, ion exchange, or the formation of complexes with naturally-occurring metal cations present on the surface of sediment particles. To account for these mechanisms, COMPOUND A concentration measurements in Cell 4 water and lagoon sediments were utilized to derive a site-specific K_d for Cell 4, which was then used to calculate the refined risk-based screening level.

1.2 Refinement of Ecological Risk-Based Screening Level Guideline for COMPOUND A in Sediment

As part of the COMPOUND A sediment screening refinement process, the previously calculated Cell 4 and Cell 4A sediment screening level (i.e., 25.7 mg/kg) was updated. The previously developed lagoon surface water ecological screening level guideline (i.e., 0.88 µg/L) was used to calculate an updated Cell 4 and Cell 4A sediment screening value for COMPOUND A; however, the pH-dependent environmental fate of COMPOUND A was also accounted for in these calculations.

At current and anticipated future pH in Cell 4 water, COMPOUND A is expected to be present in its anionic form, and consequently binding to just organic carbon is not adequate for defining partitioning between surface water and sediment. As part of the 2012 investigation, samples of the natural silty-clay liner material (Layer B) that underlie the lagoon were collected to analyze COMPOUND A concentrations in lagoon sediments and pore water in order to calculate a site-specific K_d value. However, there was insufficient pore water present in the sediment samples to achieve quantifiable levels of COMPOUND A. Consequently, the partition coefficient or K_d value was estimated using measured COMPOUND A concentrations in Cell 4 lagoon water and lagoon sediments, as discussed below.

Table A.1 presents a summary of COMPOUND A concentration data from water and shallow⁵ lagoon sediment samples (Layers A and B) collected from Cell 4 in August 2011 and July-August 2012. Summary statistics (i.e., data count, arithmetic mean, geometric mean, and median) are shown for each dataset. COMPOUND A concentrations measured in the shallow sediment samples were used in the calculation since they are more representative of sediment that is in contact with the overlying water column, (i.e., the water samples collected from Cell 4).

The partitioning coefficient K_d can be expressed as:

$$\text{Log } K_d = \text{Log} \left(\text{CF} \times \frac{C_s}{C_w} \right) \quad (1)$$

where:

K_d	=	surface water-sediment partition coefficient (L/kg)
C_s	=	COMPOUND A concentration in Cell 4 sediment (mg/kg)
C_w	=	COMPOUND A concentration in Cell 4 water (µg/L)
CF	=	conversion factor of 1000 (µg/mg)

⁵ These shallow sediments samples include samples collected from the active and depositional layers, but not the lower, silty-clay layer.



For the purpose of estimating the K_d value associated with COMPOUND A in Cell 4 lagoon sediments, we assumed:

- C_w is equal to the dissolved COMPOUND A concentration in water which was assumed to be 2.5 µg/L, or half the detection limit, given that dissolved COMPOUND A was undetected in the 2011 and 2012 investigations; and
- C_s is taken as the geometric mean⁶ of the COMPOUND A concentration in shallow lagoon sediments.

⁶ The geometric mean is preferred to the arithmetic mean because the Compound A concentrations in sediments span several orders of magnitude and the median Compound A concentration is closer to the geometric mean than the arithmetic mean (Table A.1). Given the distribution of Compound A concentrations, the geometric mean is believed to give a better representation of 'typical' Compound A concentrations in shallow sediments.



Table A.1: Summary of COMPOUND A Data in Cell 4 Water and Shallow Lagoon Sediments for the August 2011 and July-August 2012 Sampling Events and Estimates of Log K_d and Sediment Screening Level

Parameters		August 2011 Sampling Event	July-August 2012 Sampling Event
Cell 4 Lagoon Sediment	Average COMPOUND A Concentrations – Shallow Samples	<i>No. of Samples Analyzed</i>	16
		Arithmetic Mean (mg/kg)	571.25
		Geometric Mean (mg/kg)	163.48
		Median COMPOUND A Concentration	267.0
Cell 4 Lagoon Surface Water	Total COMPOUND A Concentration	<i>No. of Samples Analyzed</i>	16
		Arithmetic Mean (µg/L)	5.2 ¹
	Dissolved COMPOUND A Concentrations	<i>No. of Samples Analyzed</i>	16
		Arithmetic Mean of COMPOUND A Concentration (µg/L)	<5 (all non detect)
Estimated ² Log K _d (L/kg)		4.82	5.03
Sediment Screening Level³ (mg/kg)		58	94 ⁴

Notes:

- (1) For the calculation of the mean COMPOUND A concentration in water, half the detection limit (2.5 µg/L) was substituted for water samples with COMPOUND A concentrations below detection limit.
- (2) Log K_d was computed using the ratio of COMPOUND A concentration (geometric mean) in sediments to the dissolved COMPOUND A concentration in water (half the detection limit, 2.5 µg/L).
- (3) Sediment screening level computed using Equation (1) and assuming a surface water ecological screening level of 0.88 µg/L. The lower (i.e., more conservative) value of 58 mg/kg is retained as the screening level for COMPOUND A in sediment.
- (4) Shallow lagoon sediment samples for the July-August 2012 sampling event includes 13 samples from Cell 4 and one sample from Cell 4A (12-SED52-01).

L/kg = litres per kilogram; mg/kg = milligrams per kilograms; µg/L = micrograms per litre

Using these assumptions and the COMPOUND A sediment and water concentrations presented in Table A.1, the calculated Log K_d values for the two sampling events, were estimated to be 4.82 and 5.03 (Table A.1). The resulting COMPOUND A sediment screening value computed using Equation (1), the lower-bound K_d value (Log K_d of 4.82), and the surface water ecological screening level guideline of 0.88 µg/L is **58 mg/kg** — somewhat higher, but within the same order of magnitude as the prior screening level of **25.7 mg/kg**. Accordingly, the COMPOUND A lagoon sediment screening value guideline of **58 mg/kg** has been adopted going forward.

Due to the ionic nature of COMPOUND A and the potential changes in geochemistry that are likely to occur should removal of Cell 4 and Cell 4A lagoon sediments (Layer A and part or all of Layer B) occur as part of decommissioning activities, some uncertainties remain with the refined sediment risk-based screening level.

Remaining uncertainties include:

- **Binding of COMPOUND A to native material underlying the lagoon:** COMPOUND A concentrations measured in shallow Cell 4 and Cell 4A sediment samples and in Cell 4 water were used to estimate the partition coefficient value since the laboratory could not extract an adequate volume of pore water from the lower, clay liner material (Layer B) that underlie the lagoon's shallow lagoon sediments (Layer A). There could be some differences in the properties of Layer B material (e.g., mineralogy) compared to the Layer A



shallow Cell 4 lagoon sediments used in the K_d calculations, thereby affecting the binding affinity of COMPOUND A, and hence its potential bioavailability and toxicity to aquatic organisms. However, data collected as part of the investigation indicates that carbon content (both organic and inorganic) and calcium carbonate content in the lower silty clay layer (Layer B) and upper silty clay layer (Layer A) are comparable (Figure 3.5). Consequently, the binding affinity of COMPOUND A to Layer B sediments is expected to be comparable to Layer A sediments – the basis for the COMPOUND A sediment screening value guideline.

- **Potential effect of future pH changes:** Although the future use of the Brandon Treatment Lagoon Facility has not yet been defined precisely, the likely use is expected to be for waste water or effluent management. Under this future use scenario, the pH of the water in the lagoon could change, ranging from circumneutral (i.e., pH ~ 7) to basic. The pH under current conditions is about 9 to 9.7. Since the above K_d estimates are based on data collected under current pH conditions, the partitioning of COMPOUND A to sediments under future conditions may be somewhat different. However, the K_{ow} value for COMPOUND A and the affinity for COMPOUND A to bind to organics increase sharply at lower pH values. Consequently, the increased propensity for COMPOUND A to sorb to organics under future use conditions will enhance the contribution of this binding mechanism and is expected to offset any effects associated with changes in the water geochemistry.

Overall, the COMPOUND A lagoon sediment screening value of 58 mg/kg is health-protective and consistent with the continued future use of Cell 4 as a waste water treatment-related lagoon.

2.0 REFERENCES

Tam, KY; Takács-Novák, K. 2001. "Multi-wavelength spectrophotometric determination of acid dissociation constants: a validation study." *Analytica Chimica Acta* 434:157-167.