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EVALUATION OF GREY WATERS ADDITION TO BIODISK TREATMENT SYSTEM

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AGNICO-EAGLE
MELIADINE SITE

EVALUATION OF GREY WATERS ADDITION TO BIODISK TREATMENT SYSTEM

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TABLE OF CONTENTS

1. TERMS OF REFERENCE

The present study is intended to evaluate the treatment potential of grey waters from ongoing operations at Meliadine exploration site, using the wastewater treatment system already in place.

2. CURRENT SITUATION

Meliadine mining site has about 140 workers. Wastewaters are sent to a biodisk type biological treatment system. Two (2) units of three (3) treatment stages each are operating to treat black waters only (faeces).The technology used is BIODISK. Manufacturing characteristics are:

- Model : LJ-166
- Capacity : 45 m^3/d (166 people)
- Hourly peak flow : 7,5 m^3/h
- Effective rotors surface : 651 m^2
- Speed : 4,8 rpm
- Primary clarifier volume : 19,3 m^3
- Secondary clarifier volume : 4,4 m^3
- UV disinfection system : TROJAN UV 3000 PTP

A black waters characteristics monitoring was made on four (4) occasions at the biodisks' affluent (May 5 to June 27 2012) and on a weekly basis at the treatment system effluent (October 2011 to August 2012). Table 1 shows black waters average characteristics at biodisks' entry/exit on mentioned periods.

Table 1: Black waters characteristics

	INFLUENT			EFFLUENT		
	Average	Min	Max	Average	Min	Max
Ammonia nitrogen (mg-N/L)	176	152	201	83	14	158
BOD_5 ($mg\text{-}O_2/L$)	365	128	635	34	6	215
Nitrate (mg-N/L)	<0,2	<0,05	<0,25	16	0	57
Nitrate and nitrite (mg-N/L)	<0,280	<0,071	<0,35	24	1	59
Oils and fats	2	<1,0	4,3	3	1	6
Pt (mg-P/L)	24	22,9	25,2	11	1	25
NTK (mg-N/L)	201	183	219	66	31	143
TSS (mg/L)	405	157	873	132	13	1460
Transmittance	2	<1,0	1,8	23	14	36
pH	8	7,94	8,75	7,24	4,33	8,22
Fecal coliforms (CFU/100 ml)	>110000	>110000	>110000	26955	3	>110000
Total coliforms (CFU/100 ml)	>110000	>110000	>110000	46165	3	>110000

Wastewaters treatment plant is regulated regarding BOD_5 discharges, oils and fats, TSS, pH and fecal coliforms. Table 2 outlines discharges objectives.

Table 2: Biodisk discharges standards

Parameters	Discharges standards
BOD_5 (mg-O2/L)	80
Oils and fats	5
TSS (mg/L)	100
pH	6,5 à 9,0
Fecal coliforms (CFU/100 ml)	1000

We note that the average discharges standards are exceed for the BOD5, TSS and fecal coliforms. In addition, the minimum pH values as well as oils and fats maximum value are also out of range. These results are due, among other things, to improper operation of treatment works before April 10, 2012 (see Nordikeau report - Evaluation of sewage treatment plant Meliadine camp (Nunavaut). Since our technician visit from April 3 to April 10, 2012, biodisks' further meet discharges standards. Table 3 presents the weekly tests results after April 10 and the average percentage abatement through certain parameters.

Table 3: Biodisks effluent characteristics after April 10, 2012

	EFFLUENT			
	Average	Min	Max	Average reduction (%)
Ammonia nitrogen (mg-N/L)	50	14	138	
BOD_5 (mg-O_2/L)	17	10	31	95,4
Nitrate (mg-N/L)	26	0	57	
Nitrate and nitrite (mg-N/L)	42	15	59	
Oils and fats	4	2	5	0,0
Pt (mg-P/L)	18	9	25	
NTK (mg-N/L)	55	31	116	
TSS (mg/L)	42	13	82	89,6
Transmittance	23	14	36	
pH	6,86	4,33	7,86	
Fecal coliforms (CFU/100 ml)	1296	4	7500	98,8
Total coliforms (CFU/100 ml)	14717	9	50000	

3. GREY WATERS CHARACTERISTICS

Grey waters are coming from the laundry and kitchen activities. The characteristics were obtained using tests results from June 20, 25 and 27, 2012 and those of July 24 and 26, 2012. Table 4 presents the grey waters average characteristics from the kitchen and laundry room.

Table 4: Grey waters characteristics

	GREY WATERS (KITCHEN)			GREY WATERS (LAUNDRY)		
	Average	Min	Max	Average	Min	Max
BOD_5 ($mg\text{-}O_2/L$)	474	31	1070	399	300	485
Oils and fats	23	6	52	32	1	118
TSS (mg/L)	240	121	540	247	151	427
pH	6,29	4,70	8,18	7,44	6,95	7,96
Fecal coliforms (CFU/100 ml)	>110000	<10	>110000	-	15000	>110000
Fecal coliforms (CFU/100 ml)	>110000	-	-	>110000	-	-

4. ARTIFICAL WASTEWATER CHARACTERISTICS

Grey waters flow is about 7 m³/d and was supplied by Mr Jack Dutil. The flow value was equally distributed to the two (2) grey waters sources (3,5 m³/d). Flow rates considered for black waters is the one obtained by averaging flows registered at the biodisks' entry from August 1 to August 7, 2012, inclusive. The average flow is 14,3 m³/d with a minimum of 11,8 m³/d and a maximum of 17,0 m³/d. Mr Dutil had supplied a flow value of about 13 m³/d for black waters. However, higher flow values in August 2012 were used to estimate artificial water characteristics (black waters + grey waters). Table 5 shows estimated characteristics of new artificial wastewater at the biodisks' influent.

Table 5 : Artificial wastewater characteristics at biodisks' influent

	INFLUENT		
	Average	Min	Max
BOD_5 (mg-O_2/L)	389	142	677
Oils and fats	11	2	28
TSS (mg/L)	352	149	759
pH	7,84	7,15	8,55
Fecal coliforms (CFU/100 ml)	>110 000	71 756	>110 000
Fecal coliforms (CFU/100 ml)	>110 000	-	-

5. DISCUSSION

At first, it is important to determine expected values at the treatment system effluent according to the artificial wastewater new characteristics. To do so, reduction values currently obtained for black waters were considered for this evaluation. Table 6 presents expected values at the biodisks' effluent for all black and grey treated waters.

Table 6 : Artificial wastewater characteristics at biodisks' effluent

	EFFLUENT		
	Moyenne	Min	Max
BOD_5 (mg-O_2/L)	18	7	31
Oils and fats	11	2	28
TSS (mg/L)	37	16	79
pH	6,46	5,89	7,05
Fecal coliforms (CFU/100 ml)	1296	-	-
Fecal coliforms (CFU/100 ml)	14 717	-	-

Biochemical oxygen demand and total suspended solids values comply with discharge standards. Oils and fats values are higher than standard but they should be intercepted in the primary clarifier when it is well operated. No reduction factor for oils and fats has been considered for treatment in the biodisks. Furthermore, fecal coliforms should be reduced below 1000 CFU/100 ml by the UV system. Despite a lack of data on grey waters transmittance, it should not further damage fecal coliforms treatment with UV lamp system.

Finally, minimun pH is slightly acid but the average is still acceptable for a biological treatment. In addition, a well operated primary treatment system should eliminate about 30% of BOD_5 and 70% TSS. This is why it is reasonable to expect performances listed in Table 6 for these parameters.

5.1 Validation according to biodisk treatment system design standards

To determine the biodisks ability to treat all charges sent, it is essential to know the biodisk's effective surface area. Indeed, the effective surface area allows calculating the maximum permitted surface on the biodik's first stage. Considering an effective surface area of 651 m^2 for one (1) biodisk, the artificial water maximum BOD_5 charges and a maximum flow of 24,0 m^3/d (grey waters + black waters) we obtain a 24,9 g BOD_5 / $m^2 \cdot d$ maximum surface charge on the biodisk first stage.

Moreover, it is relevant to calculate the hydraulic charge rate at maximum flow rate on the secondary clarifier. According to supplier dimensions and the new maximum flow rate, we obtain a value of 19,6 m³/m²žd.

To find biodisk first stage' maximum charge values and hydraulic charge at secondary clarifier's maximum flow rate, one refers to the "*Guide pour l'étude des technologies conventionnelles du traitement des eaux usées d'origine domestique du Ministère du Développement Durable, de l'Environnement et des Parcs du Québec*". This guide design standards are listed in Table 7.

Table 7 : Biodisk design standards
Adapted from MDDEP 2001

Parameters	Values
Maximum charge on biodisk first stage	30 g total BOD_5 /m²*d
Hydraulic charge at secondary clarifier's maximum flow rate	20 à 36 m³/m²*d

We note that calculated values for the new artificial wastewater (grey waters + black waters) meet the Guide's design standards. In addition, only one (1) biodisk processing unit has been considered for calculation. The two (2) processing units meet these design standards.

6. CONCLUSION

It would be important to check the products and detergents sent to the wastewaters treatment system. Indeed, some items may interfere with proper operation and development of the bacteria flora in a biological treatment system (concentrated bleach in particular). Finally, the addition of a purifying artificial sump downstream biodisks will allow further reducing of charges residual shown in Table 6.

Despite a lack of regulations on phosphorus discharges towards Lake Meliadine, it would be appropriate to design a purification sump with the perspective of a tertiary treatment allowing effluent phosphorus removal.