Enviro-STEP Technologies inc.

CASE STUDY

Treatment of High Strength Wastewater from a small Slaughterhouse / Meat processing plant

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History, Context and Regulatory requirements

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History, Context and Regulatory requirements

- Small rural slaughterhouse and meat processing plant operating for 30 years;
- Slaughter once a week;
- Meat processing and boutique open 5 days;
- Failed bed overflowing toward a river less than 30m away;
- Started the process toward compliance in 2010;
- Two CofA are required: 1 for the wastewater system and 1 for the operation (industrial);
- We got involved in 2013;

Design

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Design Challenges

Principal challenges ;

- Very small water usage affecting the concentration of pollutants;
- Limited budget;
- Limited and unqualified manpower to operate and maintain a sewage treatment plant;
- Convincing MOE to remain simple;
- Bring high strength wastewater to domestic strength using the simplest way possible;

Things that were playing to our advantage:

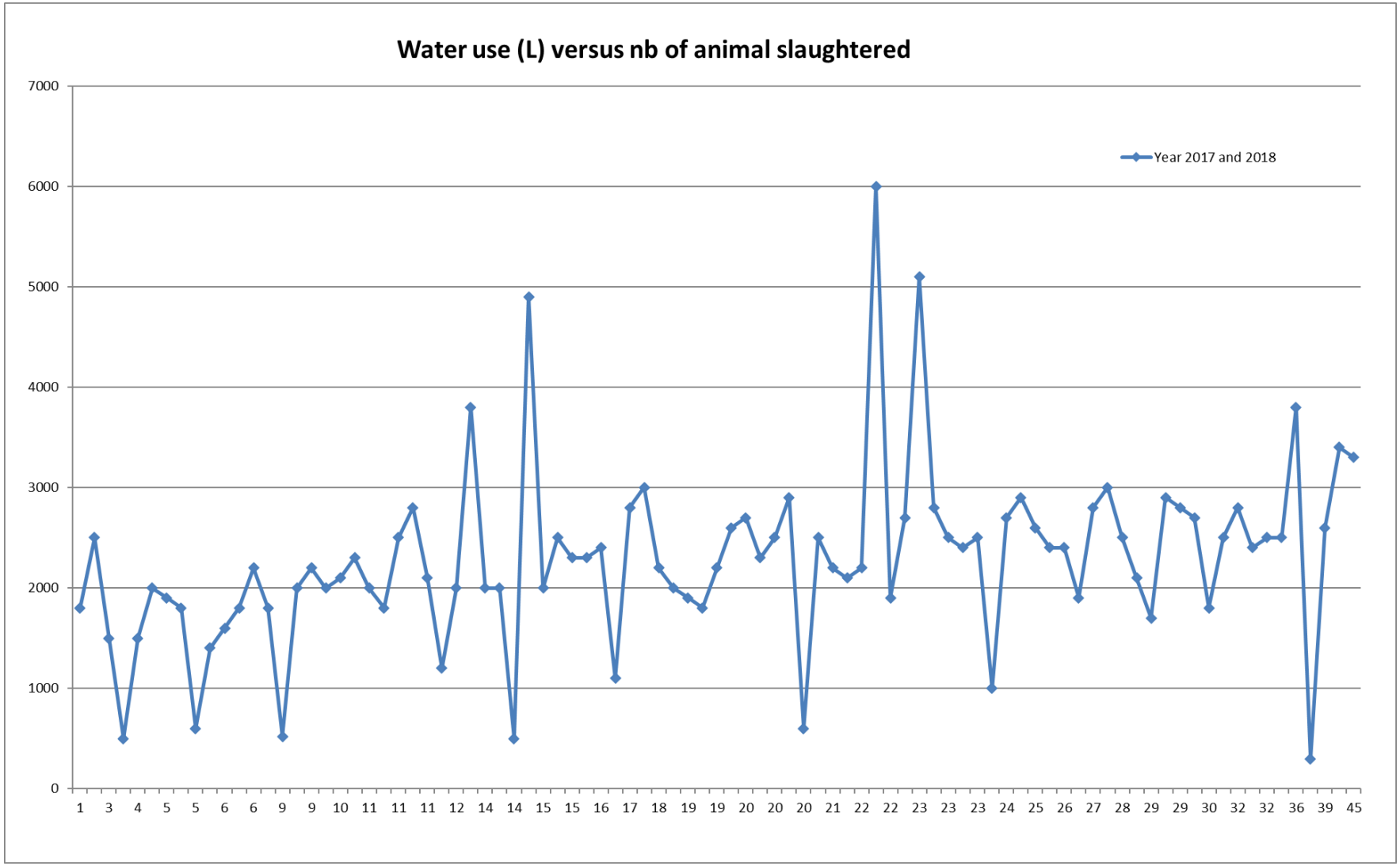
- Permeable soil making subsurface infiltration possible. Otherwise, disinfection and phosphorus removal to 1 mg/L would have been required for surface discharge;
- A water meter was present;
- Very understanding and collaborating clients;

Design Challenges

Things that were playing against us:

- Variations in loadings (type of animal, ritual practices, rigor of operation from staff, etc.)
- Literature and guidelines are rarely representative of small facilities;
- Authorities measure compliance based only on effluent concentration instead of daily discharge loading (kg/d or lbs/d). This can be detrimental to low water use facilities;
- Annual outside temperature ranging from -30 to +30 degree C;

Design – Flowrate during the kill day



Design – Sewage strength

Data from literature:

Reference	Soluble COD (mg/L)	TSS (mg/L)	TKN (mg/L)	TP (mg/L)
Massé, Agri-Food Canada	778 à 4 551	957 à 2 397	90 à 629	20 à 80
Sedmack, Wisconsin 2006	-	603	88	16
Chen, 2003	700 à 1400	137 à 500	-	-
Pozo, 2003	5500	910	690	3.3
Sectorial Technical Guide - slaughterhouses, MDDEFP 1999	2939	560	199	24

Data from 2011 characterization:

Parameter	Concentration (mg/L)	Parameter	Concentration (mg/L)
BOD_5	61	Azote NTK	481
Soluble BOD_5	50	Azote NH_4^+	13.3
COD	6250	Coliformes fécaux	> 60 000
Soluble COD	3240	Huiles et graisses	259
TSS	792	Température	10 degrés
Total Phosphorus	14.5	pH	7,4

Data from field sampling:

Date	$CBOD_5$ (mg/L)	TKN Grease interceptor effluent (mg/L)
24-07-2018	1760	334
03-08-2018	1080	222
09-08-2018	910	330

Design criteria

Design Flowrate:

- High strength portion: 4 400 L during the kill day (max high strength flow)
  1 600 L/d equalized high strength design flow
- Total flow: 2 000 L/d equalized total flow

Design concentrations:

High strength:

Parameters	Concentration (mg/L)
BOD_5	2 500
Soluble BOD_5	2 000
COD	6 250
Soluble COD	3 000
TSS	800
Total Phosphorus	20
TKN	400
Oils, fats and greases	259
Temperature	10 degree C
pH	7,4

Domestic:

Parameters	Concentration (mg/L)
BOD_5	250
TSS	300
Total Phosphorus	10
TKN	50

Design : Effluent Quality Objective

Effluent quality at the septic tank (before final treatment) :

Parameters	Concentration (mg/L)
Soluble BOD_5	200
TSS	100
Total Phosphorus	10
TKN	50
OFG	50
pH	5.5 to 9.5

Effluent quality before infiltration:

- $CBOD_5$: 15 mg/L
- TSS: 15 mg/L
- Fecal Coliform: 50 000 CFU/100ml

Phase I

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Phase I

Initial Treatment Train installed :

Treatment steps:

High strength:

- 2 x 5 000 L Grease Interceptor with effluent filter (in the last tank)
- 1 x 12 000 L BIO-REDOX single stage completely mixed bioreactor consisting in 4 000 L aerated compartment and 12 000 L settling and sludge accumulation compartment with lamellar tubes;

Mixed effluent (pretreated and domestic):

- 1 x 5 000 L septic tank with effluent filter
- 1 x 4 000 L dosing tank
- Eljen GSF combined and dispersal system (42 modules over 65 m^2)

Phase I

Phase I - Results

Observations:

- REDOX extremely powerful on BOD5C, COD, NH4 and TKN;
- Grease interceptor very efficient on FOG
- Domestic waste appears to contribute to increasing of overall concentrations (effects of very small flow)
- We had to conclude that we were not meeting the MOE discharge objective

Paramètre	Concentration (mg/L)
DBO_5 soluble	200
MES	100
Phosphore total	12
Azote NTK	60
Huiles et graisses	50
pH	5.5 à 9.5

Results : REDOX July 2018

	CBOD5	COD	TSS	TP	TKN	pH	NH4
Influent	1760				334		232
Effluent	119				60.2		39.7

Results : REDOX August 2018 (sample #1)

	DBO5C	DCO	MES	Ptot	NTK	pH	NH4
Affluent	1080	2300			222		200
Effluent	93	583			46.2		22.1

Results : REDOX August 2018 (sample #1)

	DBO5C	DCO	MES	Ptot	NTK	pH	NH4
Affluent	910	2740			330		209
Effluent	45	341			57.4		19.5

Results : Septic Tank Effluent

	CBOD5	COD	TSS	TP	TKN	pH	OFG
January 2018	109	1050	84	18.0	145	8.0	50
March 2018	280	746	87	11.9	138	7.7	40
April 2018	163	578	73	8.7	125	8.7	18
May 2018	72	312	104	7.7	133	8.0	5
June 2018	156	423	168	8.7	92	7July	36
July 2018	76	385	67	9.8	58	8.0	14

Phase II

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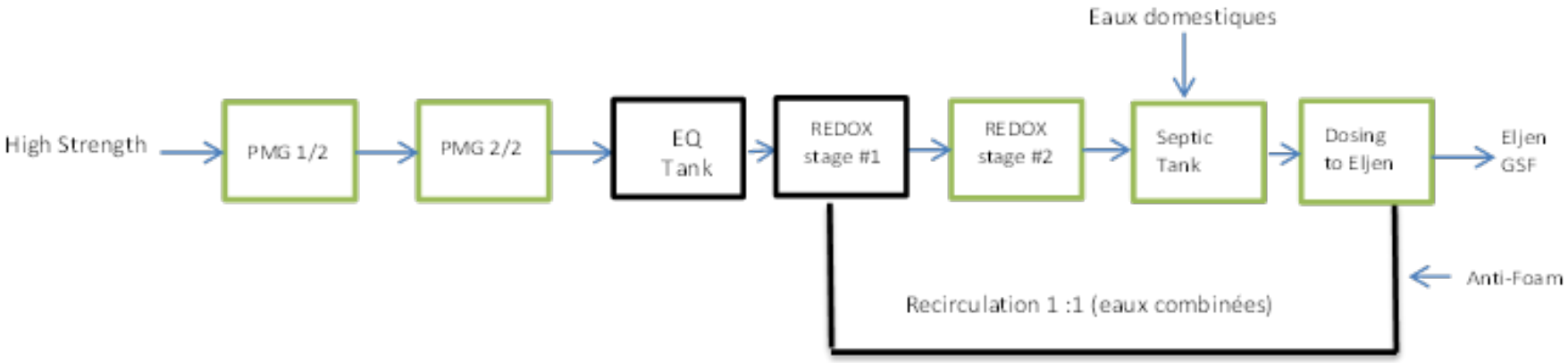
Phase II

Initial Treatment Train installed :



Modifications:

- Adding a 3 000 L dosing tank after the Grease Interceptor;
- Adding a 7 000 L REDOX unit as Stage I for BOD reduction;
- The existing 12 000 L (4 000 + 8 000) REDOX become Stage 2 for nitrogen reduction
- Add a recirculation loop from the final dosing tank back to REDOX Stage I with adjustable flow for flexibility (set to 50/50 at startup);

Phase II

Phase II

Phase II - Results

Date	08-07-2019	06-08-2019	28-08-2019	10-09-2019	19-09-2020	30-09-2019	03-10-2019	17-10-2019	7-11-2019	02-12-2019	09-01-2020	06-02-2020	05-03-2020
TSS (mg/l)	45	44	83	18	23	19	26	56	30	16	20	27	36
CBOD5 (mg/l)	27	12	39	4	5	3	12	18	11	7	18	7	28
TKN (mg/l)	64	54.7	65.9	16.4	57.6	62.1	70.6	74.9	53.2	37.5	27.4	54.6	37
Ptot (mg/l)	10.3	11.4	10.2	8.43	13.8	18.9	20.9	24.7	27	25.4	16.3	10.1	7.09

Date	14-04-2020	16-04-2020	07-05-2020	08-06-2020	06-07-2020	03-08-2020	01-09-2020	05-10-2020	02-11-2020	07-12-2020	06-01-2021	**Average**	**Objective**
TSS (mg/l)	60	88	64	24	24	10	9	13	15	19	11	**34.1**	**100**
CBOD5 (mg/l)	32	26	29	8	8	5	4	8	6	5	9	**14.7**	**200**
TKN (mg/l)	31.8	48.7	29.3	10.3	8.9	9.2	9.5	14.3	23.5	59.6	50.7	**52.0**	**60**
Ptot (mg/l)	5.94	9.66	7.22	21.3	22.7	24.3	5.37	23.5	15.3	11.2	10.6	**15.7**	**12**

Newest data 2021:

Date	08-02-2021	08-03-2021	07-04-2021	11-05-2021	07-06-2021	05-07-2021	09-08-2021	**Average (full)**	**Objective**
TSS (mg/l)	24	27	50	28	25	56	30	**34.14**	**100**
CBOD5 (mg/l)	9	6	30	10	8	7	8	**13.90**	**200**
TKN (mg/l)	71.7	89.1	79	48.1	37.8	46.3	33.9	**53.35**	**60**
TP (mg/l)	9.67	8.81	6.45	10	16.6	25	21	**15.30**	**10**
pH	7.91	7.98	6.46	7.42	7.84	7.55	7.48	**7.52**	**5.5 to 9.5**
OFG	< 5	9	< 5	< 5	11	6	8	**8.50**	**50**
Alcalinity (mg/l)	355	439	369	148	273	325	244	**307.57**	**N/A**

Observations:

- We meet the discharge criteria except for phosphorus;
- Client started in June 2020 a phosphorus source reduction pilot project using aluminum sulfide tablets;

Summary

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Summary

- Onsite Wastewater Treatment of very high strength application can be achieved successfully using the combination of properly designed simple processes;
- Flow and sewage characterization are essential in good design;
- Good practices and source reduction should be the first steps implemented;
- Client education on cause to effect relationship of cleaning practices on system performances are important;
- Pretreatment must be done using flexible technologies (sufficient safety factor, room for modifications, adaptability to flow and loading variation, etc.);
- Equalization is extremely important
- Sludge management must be planned and budgeted properly. High strength = higher volumes of sludge;

QUESTIONS

End of presentation

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