SUB-APPENDIX D6-H

Ridge Off-Site Leachate Infrastructure Memo

MEMO

TO:	Fabiano Gondim, Golder Associates
FROM:	Tihamer Csiba
cc:	Bill Allison, Sue Reimer
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OUR FILE:	15-2456

1. Forcemain from Charing Cross to Blenheim Wastewater Treatment Lagoons (BWTL)

This section describes the details of the forcemain from Charing Cross to the Blenheim Wastewater Treatment lagoons (BWTL), with an evaluation of the forcemain capacity for future use over the period of the landfill expansion.

The 200 mm diameter forcemain from Charing Cross to the BWTL receives flow from the Charing Cross sewage pump station (PS) and Ridge Landfill leachate transfer pump. The forcemain is 7,326 m long between Charing Cross and the BWTL. The leachate transfer pumping station at the Ridge Landfill connects to the 200 mm diameter forcemain (approximately midway along the forcemain route) on Erieau Road via a short 100 mm diameter underground pipe.

The forcemain will be required to convey the following flows:

Charing Cross five year average daily flow	141 m^3/day
Charing Cross future average daily flow (2040)	153 m^3/day
Ridge Landfill current five year average daily flow	173 m^3/day
Ridge Landfill future maximum average daily flow (2040)	919 m^3/day.

The forcemain construction details are as follows:

Invert at Charing Cross PS	190.15 masl
Invert at Ridge Landfill connection	197.50 masl
Station location of landfill connection from Charing Cross PS	3+968 (3968 m from Charing Cross PS)

The Charing Cross sanitary pumping station has a capacity of 30 L/s (2,592 m^3/day). The velocity in the forcemain is 0.96 m/s. The time to transfer the year 2040 future average daily sewage flow of 153 m^3/day through the Charing Cross forcemain to the BWTL will be about 2 hours.

The Ridge Landfill leachate pumping station has a capacity of 23.3 L/s (2,013 m^3/d). The velocity in the forcemain is 0.74 m/s, when only the Ridge Landfill pumping station is operating. It will take about 6.5 hours daily to transfer the estimated average daily leachate volume in 2021 (537 m^3/d) and it will take about 11 hours daily to transfer the future maximum daily volume of leachate (919 m^3/d) to the BWTL.

The velocities for both the leachate from the Ridge Landfill and the sewage from Charing Cross in the forcemain are acceptable and are at the lower end of the recommended velocity range for a sanitary forcemain (less than 1.0 m/s). Conveying the projected maximum future leachate and sanitary flows will required about 13 hours per day, and so there is about 11 hours of excess pumping time available per day.

We can conclude that the forcemain has sufficient capacity to convey the future maximum daily flow of Ridge Landfill leachate and the Charing Cross sanitary flows to the BWTL to the end of the landfill expansion duration in 2041 when the maximum leachate flows are anticipated.

2. Blenheim Wastewater Treatment Lagoons

The following describes the details of the Blenheim Wastewater Treatment lagoon (BWTL) facility, with an evaluation of the facility's hydraulics and contaminant loadings, for future projected use.

2.1 BWTL Description

Leachate from the Ridge Landfill is currently pumped to the BWTL. The lagoons are owned and operated by the Chatham-Kent Public Utilities Commission (PUC). The BWTL provides the treatment of wastewater for the communities of Blenheim and Charing Cross, as well as leachate from the Ridge Landfill. Wastewater from Blenheim and Charing Cross (including the leachate from the Ridge Landfill) is collected by separate sewer systems and conveyed by two raw sewage pumping stations and a leachate pumping station to the treatment lagoons. The final effluent is subsequently discharged to the receiver, the Cameron Drain. The Ridge landfill transfer pumping station connects to the Charing Cross forcemain on Erieau Road.

Approval was received in 1995 from the Ontario Ministry of Environment (now known as the Ministry of Conservation and Parks (MECP)) for the modification and expansion of the existing waste stabilization ponds to the New Hamburg Process. Based on the current Certificate of Approval (Environmental Compliance Approval, ECA) # 3-0427-94-957, the average day rated capacity of the BWTL is 4,045 m3/d, with a peak flow rated capacity of 12,046 m3/d.

The BWTL currently consist of the following unit processes, as illustrated in process flow schematic provided in Figure 1:

- Inlet screens
- One aerated lagoon cell with three blowers (1A)
- Chemical phosphorus removal
- Five facultative cells (1B, 2,3,4,5)
- One filter effluent pumping station
- Four effluent intermittent sand filters
- Filtered effluent underdrain pipes which discharge to the outfall structure, and subsequently to the Cameron Drain.

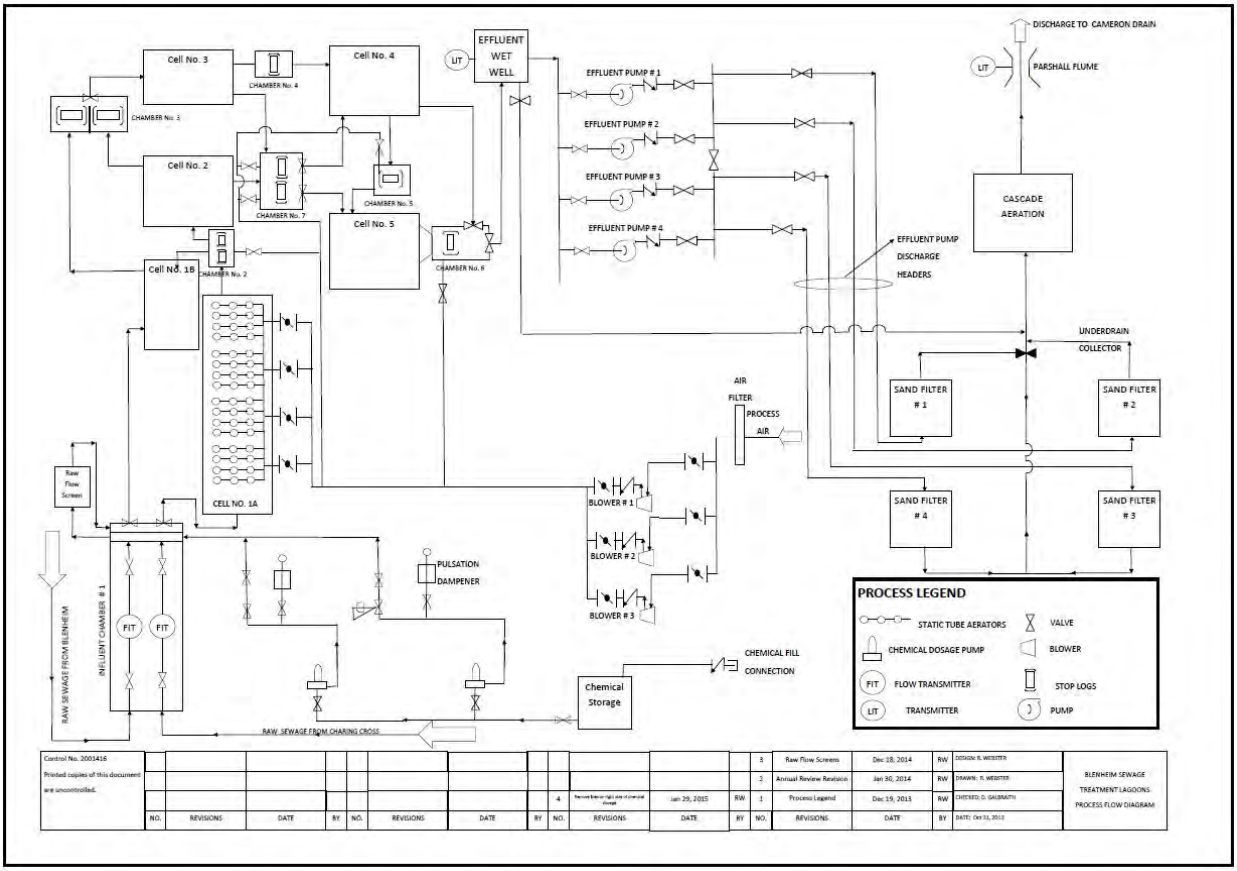
The lagoon cell volumes are:

- Aerated cell 26,500 m^3
- Facultative cells 607,800 m^3

The surface areas of the lagoons are as follows:

- facultative lagoons 302,950 m^2
- intermittent filters 12,100 m^2

Figure 1: Blenheim Lagoons Process Schematic



A preliminary evaluation of the capacity of the BWTL system was undertaken, for the anticipated hydraulic and contaminant load rates from the two communities and the Ridge Landfill. This has been completed in order to provide an initial indication if the lagoon system has sufficient capacity to treat projected future volumetric and contaminant load rates from sewage and leachate.

The following units and parameters relevant to treatment of combined sewage and leachate influent were reviewed:

- Hydraulic capacity according to the ECA
- Aerated lagoon hydraulic retention time
- Facultative lagoon BOD_5 load
- Intermittent sand filter TKN surface load
- Intermittent sand filter hydraulic surface load
- Total suspended solids load

- Phosphorus load.

2.2 Current BWTL Load

The Blenheim, Charing Cross Sanitary Sewage Environmental Study completed in 1994 allocated lagoon capacity, which is as summarized in Table 1.

Table 1. BWTL Allocated Capacity

Source	Maximum Daily Sewage Flow m^3/day
Blenheim	3,481
Charing Cross	415
Ridge Landfill	149
Total	**4,045**

A summary of annual average day flows to the BWTL from operational data provided by the PUC and Ridge Landfill operations between 2012 and 2016 is provided in **Table 2.** This time period was selected to be consistent with data available for both the BWTL and the Ridge Landfill. Based on this data, the BWTL is currently operating at less than half of its hydraulic rated capacity.

Table 2. Summary of Annual Average Day Flows for the BWTL

	Annual Average Day Flow (m^3/d), by year					Five-year Average Day Flow (m^3/d), 2012-2016
	2016	2015	2014	2013	2012	
Blenheim	1,250	1,152	1,589	1,950	1,789	1,546
Charing Cross Flow	122	136	146	171	128	141
Ridge Landfill Leachate	127	98	207	244	187	173
TOTAL	**1,499**	**1,386**	**1,942**	**2,365**	**2,098**	**1,860**

The five year (2012-2016) average volume of treated leachate was 173 m^3, and represented less than 10% of total flow to the BWTL. Upgrades to the Ridge Landfill leachate pumping system have been recently completed to restore the full capacity of the leachate extraction system. As a result in 2018, May was the highest discharge month with a total discharge from Ridge Landfill of 18,517

m^3/month, (597m^3/day). On average, the lagoons received 340 m^3/d of leachate from the Ridge Landfill in 2018. This volume of leachate was a result of pumping out leachate that had accumulated in the landfill due to malfunctioning of the leachate extraction pumps.

Based on leachate sampling data from the Ridge Landfill annual reports, it can be assumed that the concentration of contaminants in the leachate being extracted from the landfill has stabilized. The composition of waste to be received over the expansion period will be similar to what has historically been received. It can be assumed that the quality of leachate captured over the expansion period will be similar to current quality. Therefore, the average leachate quality from the last 5 years of data was used to estimate average contaminant loading to the BWTL from the landfill in the future. Table 3 summarizes the contaminant concentrations used to determine the lagoon loading.

Table 3. Leachate Contaminant Concentration

Contaminant	Concentration [mg/L]
BOD_5 - Carbonaceous five day Biological Oxygen Demand	185
TSS – Total suspended solids	46
TKN - Total Kjeldahl Nitrogen	**475**
Total Phosphorus	**2**

2.3 Future BWTL Contaminant Loads

The Chatham-Kent Water and Wastewater Master Plan had estimated sewage flows from Blenheim and Charing Cross will be 2,474 m^3/day in 2031. This is about 700 m^3/day more than the flow that the lagoons currently receive. Based on recent population growth projections provided by Chatham-Kent for completion of the Transportation Impact Assessment for the Ridge Landfill EA, the projected population growth for Blenheim and Charing Cross will be 0.4% annually for the next 20 years. Assuming that the per capita water consumption will be constant during that period, the sewage flow from Blenheim and Charing Cross in 2031 and 2040 (the maximum landfill leachate production year) was recalculated using the revised population growth data and is estimated at 1,769m^3/day and 1,835m^3/day respectively.

The estimated maximum annual landfill leachate flow is 335,550 m^3/year (919m^3/day). A summary of the projected leachate volumes production rates are provided in Table 4.

Table 4. Summary of Projected Leachate Production Rates

Year	m^3/year	m^3/day
2018	124,200	340
2021	195,900	537
2031	260,400	713
2040 (maximum future volume)	335,550	919
2051	285,300	782

2.4 BWTL Capacity Assessment

2.4.1 Hydraulic Capacity

The impact that leachate will have on the hydraulic flow rate at the BWTL is summarized in Table 5. The BWTL will be well under the average daily design flow rate of 4,045 m^3/d in 2040 (the year of maximum leachate generation).

Table 5. Hydraulic Flow Rate to BWTL

Year	Sewage [m^3/day]	Leachate [m^3/day]	Total [m^3/day]
2018	1,687	340	2,027
2021	1,687	537	2,224
2031	1,769	713	2,482
2040 (maximum future leachate volume)	1,835	919	**2,757**

Less than 70% of the current hydraulic capacity of the BWTL will be needed in 2040. The lagoons have sufficient hydraulic capacity to receive projected sanitary sewage and landfill leachate. Average hydraulic retention time in facultative cells will be 220 days in 2040.

2.4.2 TSS Load

The TSS concentration in leachate is lower than that found in the sanitary sewage from Blenheim and Charing Cross, and therefore TSS is not a limiting factor in evaluating BWTL performance for leachate treatment.

2.4.3 Phosphorus Load

The phosphorus concentration of the leachate is also lower than that found in sanitary sewage from Blenheim and Charing Cross. Therefore phosphorus is also not a limiting factor in evaluating the BWTL performance for leachate treatment.

2.4.4 BOD_5 and TKN Mass Loading

The leachate contaminant analysis data and BWTL influent analysis data were used to estimate the average BOD_5 and TKN concentration of the sanitary sewage in a five year period. It is estimated that the Blenheim sanitary sewage has a BOD_5 concentration of 115 mg/L and Total Kjeldahl Nitrogen (TKN) concentration of 22 mg/L. These values were assumed to remain constant throughout the design period (until 2041).

The combined sewage and leachate mass loading to BWTL is summarized in Tables 6 and 7.

Table 6. Bod_5 Loading to BWTL

Year	Sewage [kg/day]	Leachate [kg/day]	Total [kg/day]
2018	194	63	257
2021	194	99	293
2031	204	132	336
2040 (maximum future leachate volume)	211	170	381

Table 7. TKN Loading to BWTL

Year	Sewage [kg/day]	Leachate [kg/day]	Total [kg/day]
2018	37	162	199
2021	37	255	292
2031	39	339	378
2040 (maximum future leachate volume)	41	437	478

2.4.5 BOD_5 Mass Load Capacity

Design reports or design parameters for the BWTL were not available for the completion of this assessment. The BOD_5 treatment capacity of the BWTL was estimated using typical lagoon treatment efficiencies and lagoon surface loading information.

Aerated Lagoon

Aerated lagoon volume	26,500 m^3
Retention time in aerated lagoon in 2040	9.6 days
Minimum retention time required	4.5 days

Based on our analysis the aerated lagoon has sufficient capacity to treat the projected BOD_5 load from both the sewage and leachate it will receive over the design period.

Facultative lagoons

Aerated lagoon treatment efficiency (typical literature values):

- Winter 78%
- Summer 90%

BOD_5 load in 2040: 381 kg/day

Aerated lagoon effluent BOD_5:

- Winter 84 kg/d
- Summer 38 kg/d

Available facultative lagoon surface area: 30.3 ha
Facultative lagoon volume: 607,800 m^3

Number of non-discharge days: 120 days
Facultative lagoon HRT: 220 days

Surface loading rate:

- Winter 2.8 kg BOD_5/ha.day
- Summer 1.3 kg BOD_5/ha.day

MECP Guideline maximum surface loading rate is 22 BOD_5/ha day

The hydraulic retention time of the facultative lagoon is greater than the number of non-discharge days as required by the MECP Guidelines. In addition, the lagoons have sufficient capacity to treat the projected BOD_5 load from total volume of both the sewage and leachate that will be received.

2.4.6 Intermittent Filter TKN Hydraulic and Mass Load Capacity

Facultative lagoons typically do not provide sufficient removal of the TKN in northern climates during the winter. The spring effluent from facultative lagoons generally has elevated levels of TKN that are above regulatory limits. Intermittent sand filters are often used to oxidize the residual TKN in the facultative lagoon effluent to meet the discharge limit. The process involves the application of lagoon effluent on a periodic intermittent basis onto the surface of a sand filter bed. As the lagoon effluent passes through the sand, suspended and soluble matter is removed through a combination of straining and biochemical transformation. The intermittent filters operate only seasonally in non-freezing conditions (mid-April to mid-December) to process the annual sewage and leachate volume. The BWTL facility has a sand filter system to treat for TKN. The following provides an assessment on the TKN removal capacity of the BWTL system. The length of the non-freezing period was estimated at 245 days for the assessment.

The filters were assessed for both hydraulic load and TKN load.

Hydraulic Load

A review of the hydraulic capacity of the filters for seasonal discharge was completed. It is assumed that the total yearly flow has to be processed during the summer discharge period, in 245 days:

- Number of days for filtration 245 days
- Filter hydraulic loading rate 0.5 m^3/m^2.day
- Filter area available 9,075 $m^{2.}$

Intermittent filter hydraulic capacity evaluation is summarized in Table 8.

Table 8. Intermittent Filter Hydraulic Capacity

Year	**Yearly sewage flow** [m^3/year]	**Actual daily flow to be filtered** [m^3/d]	**Filter area required [m^2]**
2018	739,855	3.020	6,040
2021	811,760	3,313	6,626
2031	905,930	3,698	7,395
2040 (maximum future leachate volume)	1,006,305	4,107	8,215

Based on our analysis the filters have sufficient capacity to treat the projected hydraulic load during the summer period discharge from mid-April to mid-December during the expansion period.

TKN Load

Aerated lagoon TKN treatment efficiency: 0 %

Facultative lagoon treatment efficiency (typical literature values):

- Winter 75%
- Summer 95%

Average treatment efficiency of facultative lagoons assuming 120 days winter and 245 days summer conditions is 88%.

Area of intermittent sand filters: 4 cells 3,025 m^2 each
Area of intermittent sand filters available: 9,075 m^2
Maximum loading rate: 6 g TKN/m^2.day

Sand filter loading rate is calculated assuming 88% treatment efficiency of facultative lagoons and 245 days of intermittent filter operation.

Table 9 summarizes the required intermittent filter area required for TKN treatment.

Table 9. Intermittent Filter Area Required

Year	Facultative lagoon TKN effluent [kg/day]	Intermittent filter TKN load [kg/day]	Intermittent filter area required [m^2]
2018	23.9	35.6	5,929
2021	35.0	52.2	8,700
2031	45.4	67.6	11,272
2040 (maximum future leachate volume)	57.4	85.5	14,242

Based on 6 g TKN/m^2 day, it appears that the intermittent filter TKN treatment capacity of the BWTL will be reached in the years approaching 2031. This is primarily based on assumptions made for future leachate TKN concentrations and production rates.

Additional facultative lagoon effluent treatment capacity may be needed, in the future, at the BWTL to address the TKN load. This treatment capacity may involve additional filter cells, implementation of technologies allowing year round nitrification or emerging technologies which are being currently evaluated at lagoons in Ontario. Pre-treatment for removal of TKN at the Ridge Landfill prior to pumping to the BWTL is not recommended due to the complexity of the pre-treatment processes which would be required to remove TKN. It would be much more practical to complete the treatment process at the BWTL.

As this is a preliminary evaluation, monitoring of plant performance and ammonia/TKN treatment is recommended as the Ridge Landfill expansion commences in in order to monitor the need for and plan for additional potential treatment capacity at the BWTL in the future.

3. Conclusions

The evaluation of treatment units is summarized in Table 10.

Table 10. Capacity of Lagoon Treatment Units to Handle Future Load

Year	Hydraulic Capacity by ECA	Aerated Lagoon Retention Time	Facultative Lagoon BOD_5 Load	Intermittent Filter TKN Load	Intermittent Filter Hydraulic Load	Total Suspended Solids Load
2018	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
2021	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
2031	Sufficient	Sufficient	Sufficient	**Not Sufficient**	Sufficient	Sufficient
2040 (maximum future leachate volume)	Sufficient	Sufficient	Sufficient	**Not Sufficient**	Sufficient	Sufficient

There is sufficient conveyance capacity in the forcemain from the Ridge Landfill to the BWTL for the maximum daily leachate flow from the landfill during the expansion period. The BWTL are capable of treating the projected maximum flow of leachate from the Ridge Landfill expansion as well as the anticipated flow of sewage from Blenheim and Charing Cross with TKN being the only parameter identified that the BWTL may not have sufficient capability to treat as the leachate flow from the landfill increases. The TKN concentrations in the leachate and in the effluent from the BWTL should be monitored to plan for the need for additional treatment capacity.