Decentralized SDGS Collection System Performance and Monitoring in Eastern Ontario Community

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The White Tail Ridge residential subdivision located near the town of Almonte in Eastern Ontario is serviced by a decentralized small diameter gravity sewer (SDGS) system, also called a septic tank effluent gravity (STEG) sewer system. This type of communal wastewater collection system consists of onsite interceptor tanks for each house that pre-treat wastewater before it enters the sewer collection network.

The SDGS collection system conveys pre-treated effluent wastewater to a small pumping station, and then by forcemain to the town's conventional sewer system. The SDGS sewer system was constructed in 2011 from thermally fused high density polyethylene (HDPE) pipe with small cleanouts in place of concrete maintenance holes to remove the risk of inflow and infiltration to the system.

SDGS Protects Downstream Infrastructure

SDGS interceptor tanks function similarly to septic tanks, using settling and anaerobic digestion to treat wastewater. Each house has a 4500-litre interceptor tank with two chambers, with inlet and outlet tee fittings that prevent large sewage solids and insoluble materials (diapers, wipes, etc.), as well as FOGs (fats, oils, and greases) from entering into the SDGS collection system and downstream wastewater infrastructure.

After 5 years of operation, the SDGS pumping station shows minimal solids accumulation and fouling (refer to Figure 1) compared to a typical whole sewage sanitary pumping station (refer to Figure 2). The operator of the SDGS system has indicated that the solids-free pumping station requires minimal upkeep, making it a very low maintenance (therefore, low cost) component of the town's wastewater infrastructure.

Monitoring of SDGS Performance

The main concern at the time of approval was the capacity of the downstream municipal lagoon to receive sewage from a new development when the existing lagoon was already operating near capacity. The engineering team provided supporting information that SDGS servicing would limit the impacts to the lagoon, making servicing feasible for the development. Approvals were granted by the Municipality of Mississippi Mills and the Ontario Ministry of the Environment for the first phase of development.
The Municipality wanted to confirm the design parameters for the SDGS system; therefore, a monitoring program was required to check the performance of the system. Field monitoring of the interceptor tanks was carried out every 6 months from July 2014 to December 2016 by Clearford Water Systems with assistance in the field from students in Algonquin College's Water and Waste Water Technician program. Monthly samples were also collected from the effluent pumping station to characterize the wastewater quality going to the municipal system.

The following parameters were measured:

- Raw and effluent wastewater constituent concentrations for:
  - o 5-day biochemical oxygen demand (BOD5),
  - o Total suspended solids (TSS),
  - o Total phosphorus (TP), and
  - o Ammonia-nitrogen;
- Interceptor tank scum and sludge accumulation rates.

Raw Wastewater Characterization

Raw wastewater characterization was estimated from inlet zone grab samples from each interceptor tank. While most practical, this approach may not accurately represent raw wastewater quality given that samples from the inlet zone have already been affected by conditions in the interceptor tank. When the collected data is compared to a more rigorous sampling study for raw wastewater characterization for single family homes (WERF, 2009), the measured concentrations are similar to the typical raw wastewater parameters from the study with the exception of more ammonia in the collected samples (refer to Table 1 on page 24). This appears to be an indication of the level of mixing and anaerobic digestion occurring in the interceptor tanks, as discussed in more detail below. Therefore, raw wastewater from the subdivision appears to be consistent with typical characterization from the study.

FIGURE 1: SDGS pumping station with minimal solids accumulation after 5 years of operation

FIGURE 2: Typical raw sewage pumping station with solids and scum accumulation (Environmental Biotech, 2017)

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Parameter	Measured Inlet Zone		Typical Raw Wastewater (WERF)	
	Range	Median	Range	Median
BOD5 (mg/L)	61-2000	425	112-1101	420
TSS (mg/L)	22-2170	380	22-1690	232
TP (mg/L)	1-27	10	0.2-32	10
Ammonia-N (mg/L)	3.4-165	60	1.6-94	14

TABLE 1: Comparison of Measured Inlet Zone and Typical Raw Wastewater Concentrations

Parameter	Range	Median
BOD5 (mg/L)	65-285	170
TSS (mg/L)	30-136	60
TP (mg/L)	4.8-14	9
Ammonia-N (mg/L)	41-98	70

TABLE 2: Measured Interceptor Tank Effluent Concentrations

Parameter	Typical Raw Wastewater	Median Measured Effluent	Typical Percent Removal
BOD_5 (mg/L)	420	170	60%
TSS (mg/L)	230	60	74%
TP (mg/L)	10	9	10%
Ammonia-N (mg/L)	14	70	(400)%*

Denotes increase in concentration

TABLE 3: Interceptor Tank Removal Rates

Effluent Wastewater Characterization
Monthly samples were taken at the pumping station—a composite of all wastewater effluent from the subdivision—and were sent to an accredited laboratory for analysis of BOD, TSS, TP, and total ammonia-nitrogen. These results are summarized in Table 2.

Interceptor Tank Performance
Comparing the pumping station data to the WERF study raw wastewater concentrations, the interceptor tanks reduce the BOD and TSS typically by around 60% and 74%, respectively, as shown in Table 3 below. This indicates that primary and partial secondary treatment have taken place. Phosphorus removal is a physical process, and is not significantly impacted by the biological treatment in the interceptor tanks. The ammonia-nitrogen increases significantly due to the conversion of organic nitrogen to ammonia-nitrogen as part of the anaerobic digestion.

Sludge & Scum Accumulation and Pump-Out Frequency

Like septic tanks, sludge and scum accumulate in the interceptor tanks requiring periodic pump-out when the volume of solids reaches a certain level that compromises effluent quality from the tank. The pump-out threshold level for SDGS interceptor tanks is greater than for septic tanks, typically around half the interceptor tank working depth. This is because interceptor tanks do not have such a strict solids removal requirement as septic tanks, which are required to protect onsite leaching beds.

The measured sludge depth increase in the tanks ranged from 2-18 cm/year (median of 6 cm/year), which corresponds to a rate of 20-175 L/person/year (median of 60 L/person/year). These findings show above average performance (i.e., lower sludge accumulation) relative to typical published values of 40-440 L/person/year for septic tanks (Philip et al., 1993).

Based on the measured sludge accumulation and operating time, pump-out periods were estimated for each tank. The results shown in Figure 3 below indicate that pump-out periods are expected to vary greatly, typically from 5-15 years, as a result of different individual household habits regardless of the number of occupants in each house. Instead, it appears that the estimated pump-out periods increase the longer that tanks are in operation. This may be explained by the anaerobic bacteria becoming more efficient in the tank environment, thereby increasing the amount of biological treatment that takes place and decreasing the rate of solids accumulation in the tanks.

Discussion
Field monitoring of the SDGS system at the White Tail Ridge subdivision indicates that interceptor tanks provide considerable pre-treatment of wastewater, typically by around 60% and 74% reduction of TSS and BOD, respectively. Additionally, the measured sludge accumulation in interceptor tanks indicates that pump-out frequencies are expected to range between 5-15 years for typical single family households. These infrequent pump-outs and minimal operational impacts on downstream wastewater collection, pumping and treatment facilities make SDGS an effective way to manage wastewater in communal systems.

References

Environmental Biotech, "FOG Waste Water Solutions," http://www.environmentalbiotech.co.uk/pump_stations.htm Accessed Feb. 8, 2017.

Lowe, K.S. et al., Influent Constituent Characteristics of the Modern Waste Stream from Single Sources. Water Environment Research Foundation (WERF), 2009.

Philip, H., Maunoir, S., Rambaud, A., and Philippi, L., "Septic Tank Sludges: Accumulation Rate and Biochemical Characteristics," Water Science and Technology, 28(10), pp. 57-64, 1993.