PROTECTING THE WORLD'S WATER

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Prelos Life Cycle Costs

Recommended Life Cycle Inputs

Operation and maintenance (O&M) of a Prelos Sewer is almost entirely focused on the Prelos Processor. There is very little O&M associated with the collection mains, other than exercising valves and servicing air release assemblies. Since a Prelos Processor is not installed until a home is built or an existing home opts to connect, O&M costs do not start until a rate-paying customer exists. This important attribute of Prelos Sewer assures that O&M costs are always closely aligned with incoming revenue.

O&M costs can be categorized as either preventative maintenance or reactive maintenance. Finding the correct balance of preventative and reactive maintenance is critical in assuring the lowest overall O&M cost possible.

Preventative maintenance is maintenance that can be planned and done proactively to keep the system running at its best. For a Prelos Sewer, preventative maintenance includes sludge and scum management, and would also include a periodic comprehensive system check. Orenco recomends that sludge and scum accumulation be measured every three years and that tanks be pumped in accordance with recommendations from Orenco. The tanks are sized to target 10- to 12-year pump-out intervals, on average. Orenco recommends that comprehensive system checks occur every 3 to 5 years. Preventative maintenance can be programmed and completed during a single site visit. When determining life-cycle costs for preventative maintenance, one full-time employee can perform four (4) preventative maintenance visits in an hour. The activity can be performed with a basic service vehicle (pick-up truck) and basic tools.

Reactive maintenance is unplanned maintenance, usually required due to unperformed preventative maintenance or equipment failure. For a properly managed Prelos Sewer, we anticipate roughly 1.5 hours per month of reactive maintenance for every 100 connections. Again, this activity would be completed by one full time employee with a basic service vehicle and basic tools.

Additionally, maintenance will periodically require parts and materials to complete repairs. Inventoried parts are minimal. During the first 10 years, the Prelos Sewer will require very little maintenance and the annual costs will be very low. The Prelos unit is warrantied for the first 5 years and pumps can be warrantied for up to 10 years. We do suggest that preventative maintenance be conducted during this period on the prescribed schedule.

After 10 years, as the system matures, we anticipate that material costs will occur in accordance with the following schedule:

Component	*Statistical Service Life (yrs)*	*Typical Material Cost (2022)*	*Annual Cost Per Connection (2022)*
Pump Motor Ends	50	$450.00	$9.00
Pump Impeller Stacks	30	$160.00	$5.30
Misc. Control Panel Components	Varies	$60.00	$1.20
Tank Lids	40	$100.00	$5.00
Pump Vaults	100	$400.00	$4.00
Discharge Piping	Varies	$30	$2.90
Control Floats (2 Per Systems)	25	$40.00	$3.20
Misc. Electrical Components	Varies	$60.00	$2.60
Annual Material Cost Per Connection (2022)*			***$33.20***

*Mature system costs (systems > 10 years old)

Material cost and anticipated service life information contained in this table is conservatively based on actual costs expended by the City of Lacey, Washington, based on a 27-month sample size. Lacey is averaging approximately 6.7 years between preventative maintenance visits and is averaging approximately 11 years between reactive maintenance calls. Lacey has more than 3600 connections in their sample size and has liquid only sewer connections dating back to 1992. It should be noted that Lacey has a very aggressive maintenance protocol.

The homeowner is responsible for electrical supply to operate the pump in the Prelos Processor. This cost is typically between $10 and $15 annually.

Indirect Life Cycle Cost Savings – Existing wastewater treatment

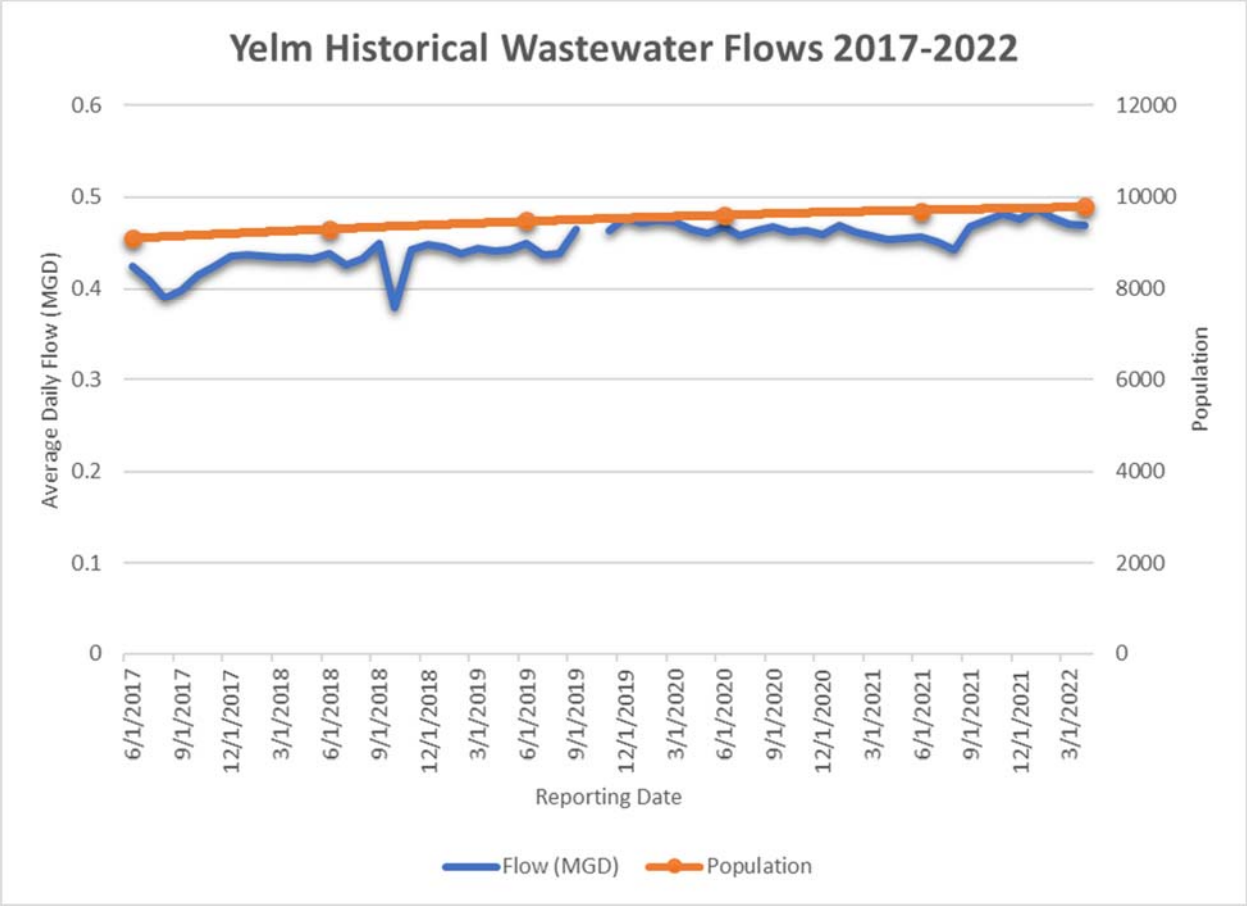
Prelos Sewer provides primary treatment at the source of the wastewater, resulting in indirect savings in sludge handling and final treatment costs. Additionally, Prelos Sewers are designed to be watertight, mitigating the capital and operating costs of I&I (infiltration and inflow of extraneous groundwater and surface water). Wastewater treatment and collection are typically evaluated independently; however, we would recommend that the indirect life-cycle savings from a Prelos Sewer be considered when evaluating wastewater collection systems.

Sludge yield from an aerobic wastewater treatment process is generally estimated at 0.5 kg of dry sludge per kg chemical oxygen demand, or “COD” (https://pubs.acs.org/doi/pdf/10.1021/acs.est.5b01931). We can conservatively estimate that COD coming from a Prelos Sewer is 60% less in mass than that coming from a gravity sewer system or grinder pump system. For the purposes of this evaluation, we have assumed that a Prelos unit serving a single-family home is reducing the mass of COD delivered to the treatment plant by 55 kg COD per EDU (equivalent dwelling unit) annually. To establish typical O&M costs, we have used the 1999 costs from the Operations and Maintenance Study found at https://your.kingcounty.gov/dnrp/library/wastewater/wtd/pubs/9912Benchmarking/om.pdf. All costs were translated to 2022 values using the general Consumer Price Index (CPI) inflation rate. It should be noted that the CPI for small wastewater facilities is significantly outpacing the general CPI. Based on this approach, Prelos is conservatively saving $6.00 per connection annually in residuals management costs at a typical wastewater plant. The actual cost will vary significantly as residual handling costs vary significantly depending on the residuals processing approach utilized.

Prelos Sewers will deliver all wastewater directly to the first stage of treatment without any need for a plant lift station or headworks. Without headworks, there are no screenings to process and odor control can often be mitigated. Again, using the referenced Operations & Maintenance Study and adjusting costs to 2022, savings that can be attributed to a Prelos Sewer are approximately $2.27 annually per EDU.

Prelos Sewers provide primary treatment at the source. If we assume 0.17 lbs of BOD per capita daily and 2.6 persons per household, the anticipated BOD produced per household would be approximately 161 lbs/year. With an anticipated reduction of BOD in the range of 60%, the anticipated lbs of BOD per EDU annually would be reduced to 100 lbs. Based on this reduction and the costs noted in the referenced Operations & Maintenance Study, The BOD reduction will result in a reduced treatment cost in the range of $6.04 annually per EDU.

Prelos Sewer is designed to be watertight. The following flow chart is from a 27-year-old system in Yelm, Washington, with 40 miles of collection mains. The close correlation between population and flow rates, as well as the linear projection of monthly flow rates, demonstrates that little to no I&I exists.



A four-year study in Tennessee (https://trenchlesstechnology.com/big-problem-inflow-infiltration/) estimated that 45.38% of the flow to the state's 227 municipal wastewater treatment plants in Tennessee is attributed to I&I. Furthermore, 2/3 of the wastewater plants in Tennessee have wastewater flows that include more than 50% I&I. The lowest I&I, as a percentage of total flow, was greater than 15%. Accordingly, if we very conservatively use 15% as a basis and apply it against the cost to treat 1000 gallons of I&I, we can determine the minimal annual savings Prelos can generate. The cost to treat 1000 gallons is highly variable, depending on the treatment process utilized. For the purpose of this analysis, we have used the study "Wastewater Management Systems Applicable to Cape Cod" (https://www.wellfleet-ma.gov/sites/g/files/vyhlif5166/f/file/file/wastewater_costs.pdf). It states that the cost to

treat 1000 gallons at plants less than 100,000 gpd flow was $5.00 per gallon in 2010. This cost has been adjusted for inflation to 2022 costs. Based on 15% infiltration mitigated and a 2022 cost of $6.83 per 1000 gallons treated, Prelos would save approximately $74.83 per EDU annually.

A summary of indirect life cycle cost savings are summarized in the table below.:

Treatment Stage	Reference Cost	Unit	2022 Adjusted Cost*	Prelos Savings	Annual Prelos Savings Per EDU (2022)
Influent pumping and screening	$ 17.42	Per Million Gallons	$ 31.16	100%	$ 2.27
Treatment of BOD	$ 117.46	Per Ton	$ 210.14	60%	$ 10.09
Residuals	$ 122.73	Per Dry Ton	$ 219.56	70%	$ 6.04
Reduced Flow Volume	$ 5.00	Per 1000 Gallons	$ 6.83	15%	$ 74.83
Total Annual O&M Savings					$ 93.23

Finally, capital costs associated with providing wastewater treatment can be reduced. Headworks are not required, the size of aeration basins can be reduced, blower sizes can be reduced, clarifier surface area can be reduced, and the size and approach for residual handling can be all reduced due to filtering and pretreatment occurring in the Prelos Sewer. Additionally, the hydraulic capacity of the plant can be reduced due the mitigation of I&I. This capital cost savings can easily be in the range of $1,000 to $3,000 per EDU depending on the treatment process used.