Resilient, Adaptable, Liquid-Only Sewers

Jeff Pringle

Disclaimer:

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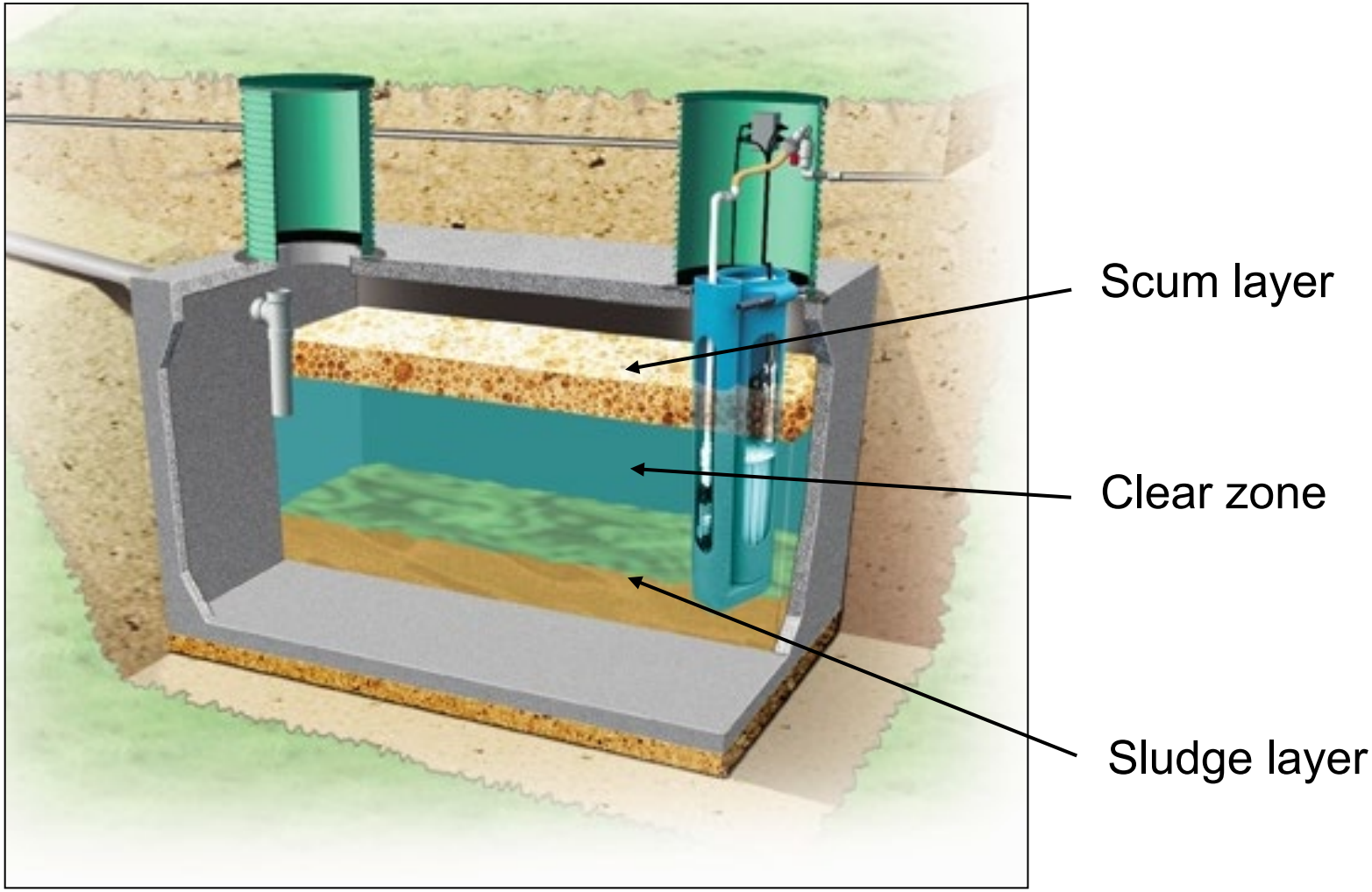
The Basic Concept



So, What Is It Really Called?

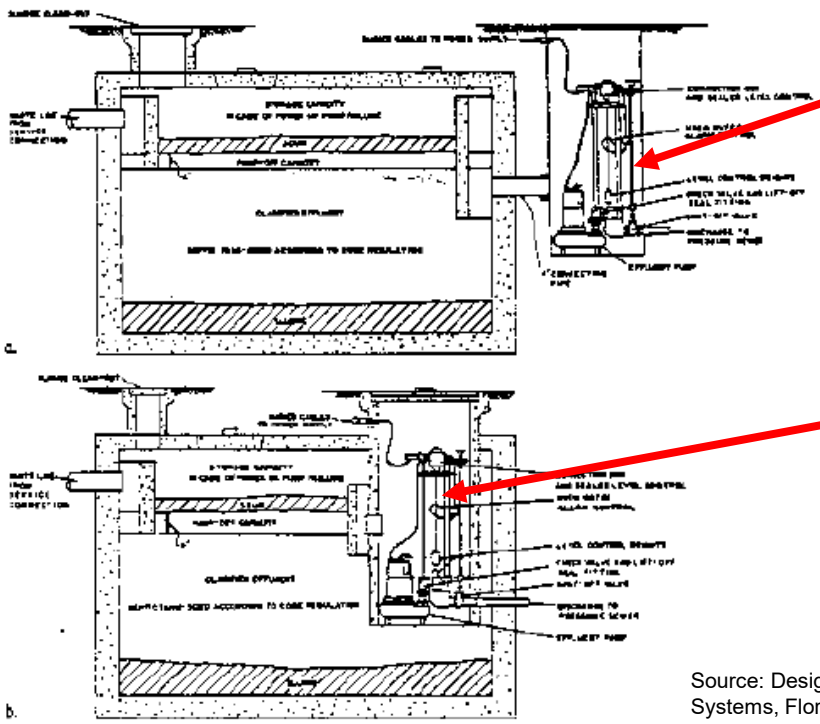
- Low-Pressure Sewer (Florida)
- STEP (Septic Tank Effluent Pump)
- STEG (Septic Tank Effluent Gravity)
- Effluent Sewer
- Liquid-Only Sewer

Florida STEP System (1981)

"STEP" is defined as a Septic Tank Effluent Pump system

FIGURE II-2

TYPICAL SEPTIC TANK EFFLUENT PUMPSYSTEMS



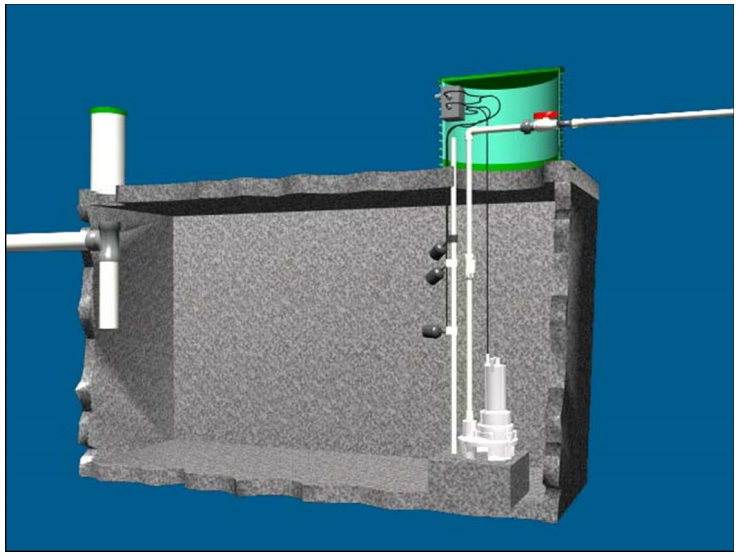
External pump basin

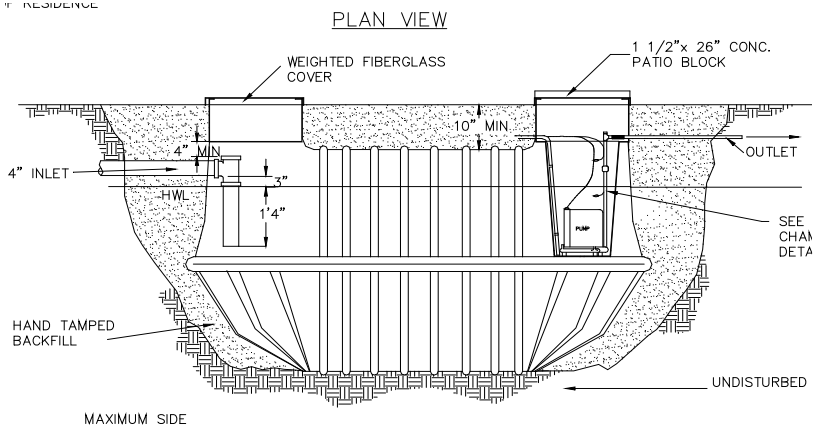
Pump on a shelf

Source: Design and Specification Guidelines for Low Pressure Sewer Systems, Florida DEP 1981

Early STEP Systems

- Poor quality, leaking tanks
- “Pump-on-a-block” configuration
- “Pump-on-a-shelf” configuration
- Undersized, unbaffled tanks
- Low-head effluent pumps
- Little or no filtering
- “Frankenstein systems”





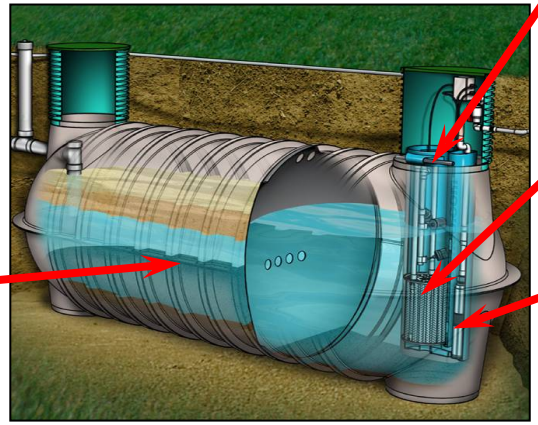
Source: Charlotte County Utilities FL Standard Details

Commercialization and Advancement of Liquid-Only Sewer

Filtered
Pump Vault
1984

Biotube®
Pump Vault
1994

Biotube®
Filter 1996

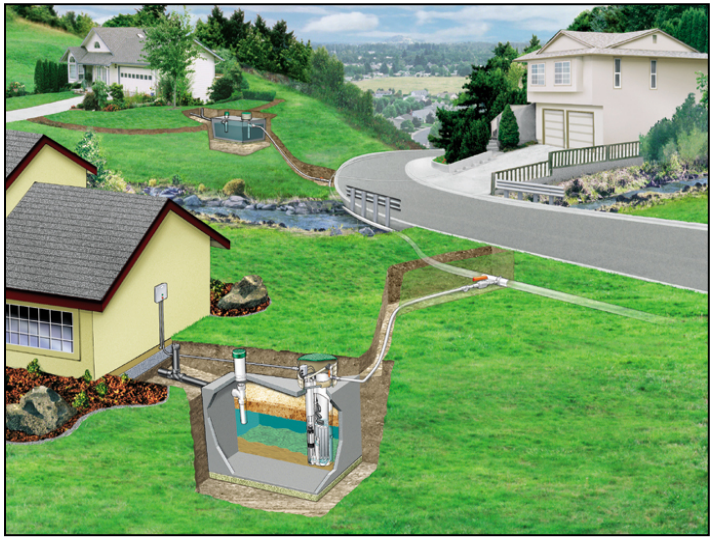


Molded
Fiberglass Tanks
2001

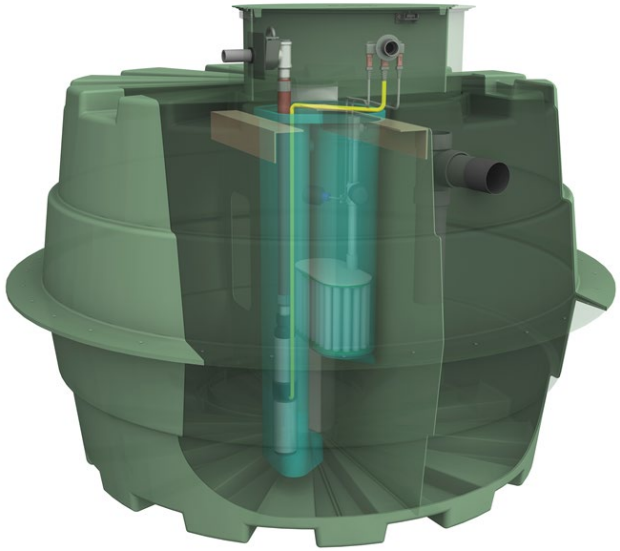
Turbine
Effluent Pump

Liquid-Only Sewer

- Watertight tanks at each home/business
- Effluent pumps in each tank push effluent to WWTP
- 1/8" mesh effluent filter protects the pump
- Uses small-diameter transport and main lines
- Solids remain in tank



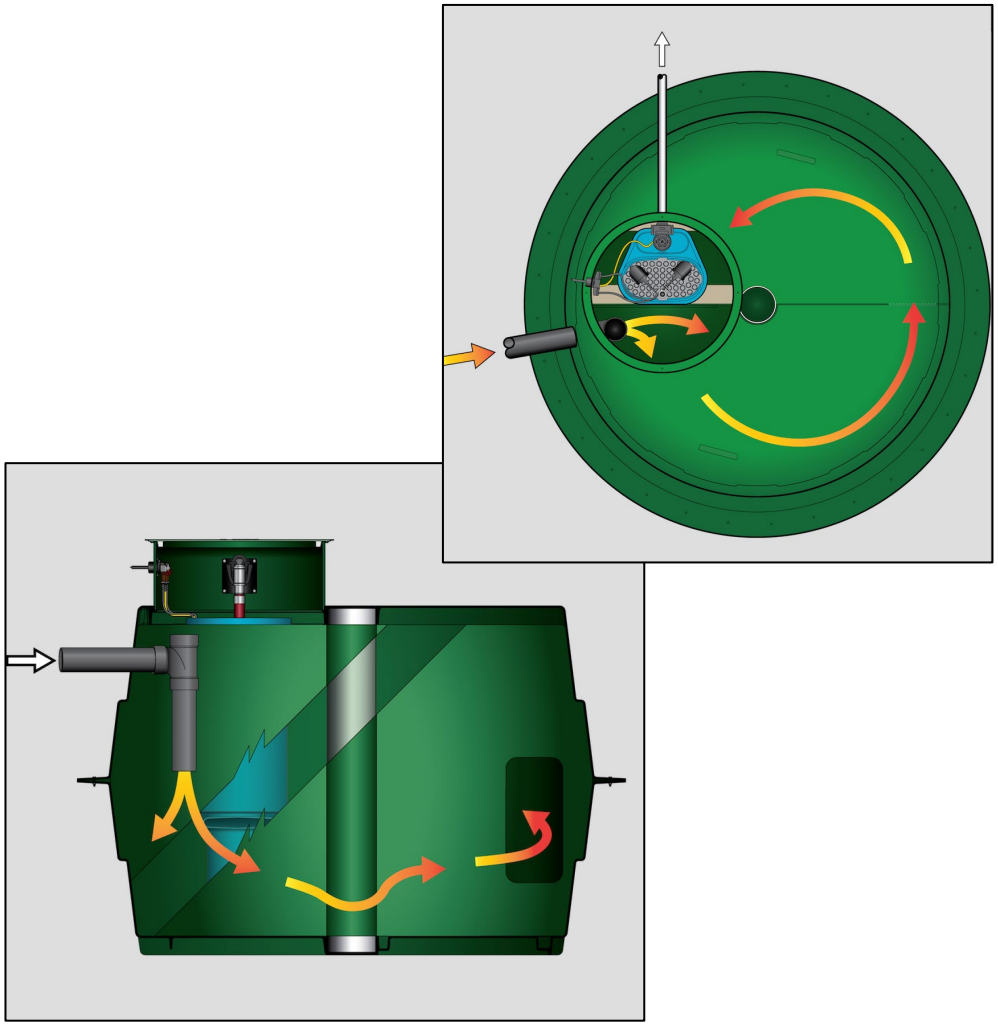
Modern Liquid-Only Sewer



The Meander Tank?

- Two compartments
- 90% longer flow path*
- Molded DCPD construction
- Structural integrity assured
- Integrated fiberglass riser
- Provides primary treatment

*internal calculations



Liquid-Only Sewer

Availability Cost

- Making sewer available for connection

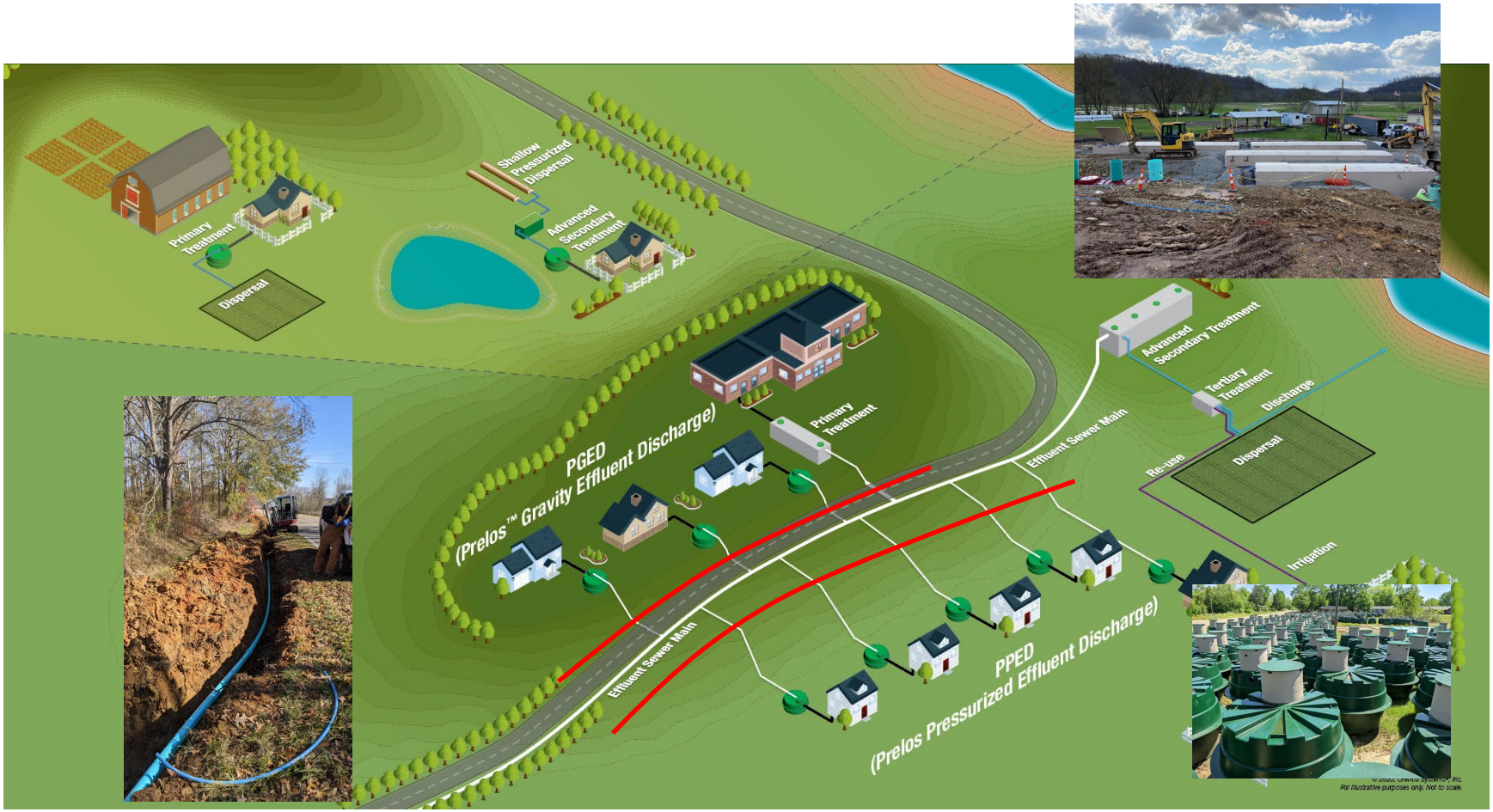
Liquid-Only Sewer

- ✓ Typically, 2" pressure mains buried 3' to 5'
- ✓ Typically, 1" laterals top property line (occupied properties only)

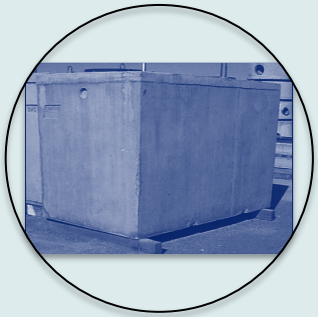
Gravity Sewer

- ✓ Manholes every 400' min.
- ✓ 8" min. diameter mains at 0.4% min slope
- ✓ 4" service laterals (all properties)
- ✓ Lift stations
- ✓ Force mains

Liquid-Only Sewer
Up-Front vs. Deferred Capital Cost



Tank Options

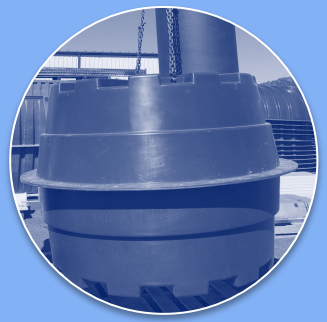


Concrete

- High compressive strength
- Low tensile strength
- Compromised by hydrogen sulfide
- QC/QA very important
- Heavy

FRP

- High strength
- High stiffness
- Some flexibility
- Lightweight
- Fiber reinforcement critical



DCPD

- High strength
- Flexible
- High impact resistance
- Lightweight
- No reinforcement required

HDPE

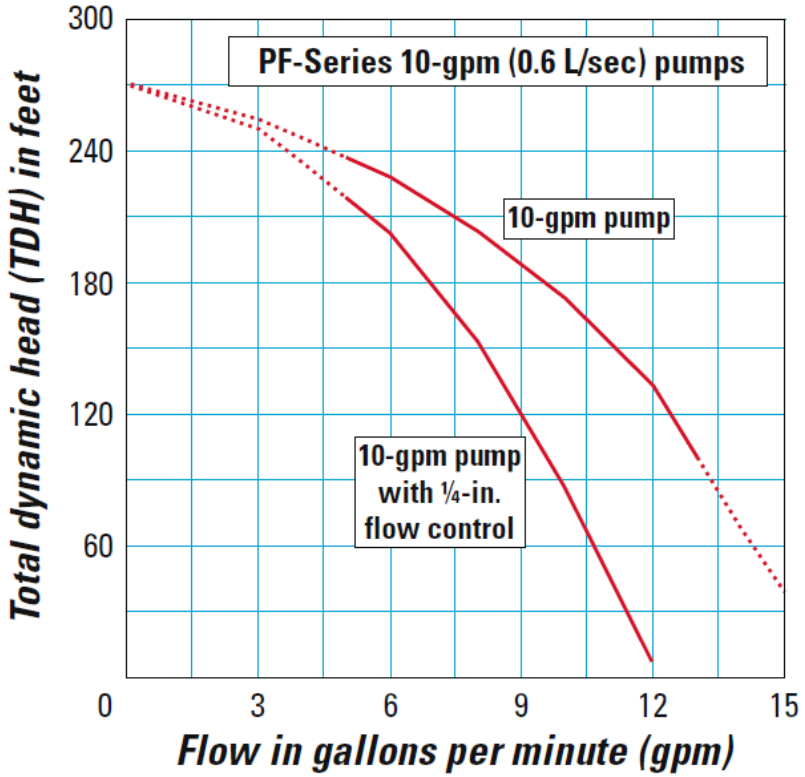
- High tensile strength
- Highly flexible
- Strength established by shape & thickness
- Joints compromised by creep
- Lightweight

More Rigid ← → More Flexible

Liquid-Only Sewer Effluent Turbine Pumps

- Application adapted from water well industry in the 80s
- Only passes solids up to 1/8“ (3.175 mm)
- High head - > 200’ (60 metres)
- Low cost: ~ $750
- Lightweight: ~ 30 lbs (13.6 kg)
- Robust: up to 10-year warranty
- 20 to 25-year life cycle
- Rebuildable
- One pump for all residential applications

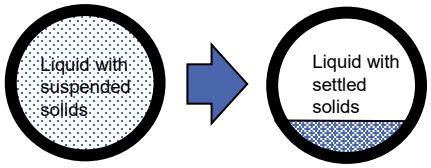
Pump Curve



PF-Series 10-gpm pump curve

- Steep vertical curve
- Very high shut-off head
- One pump for virtually all residential applications

Force Mains

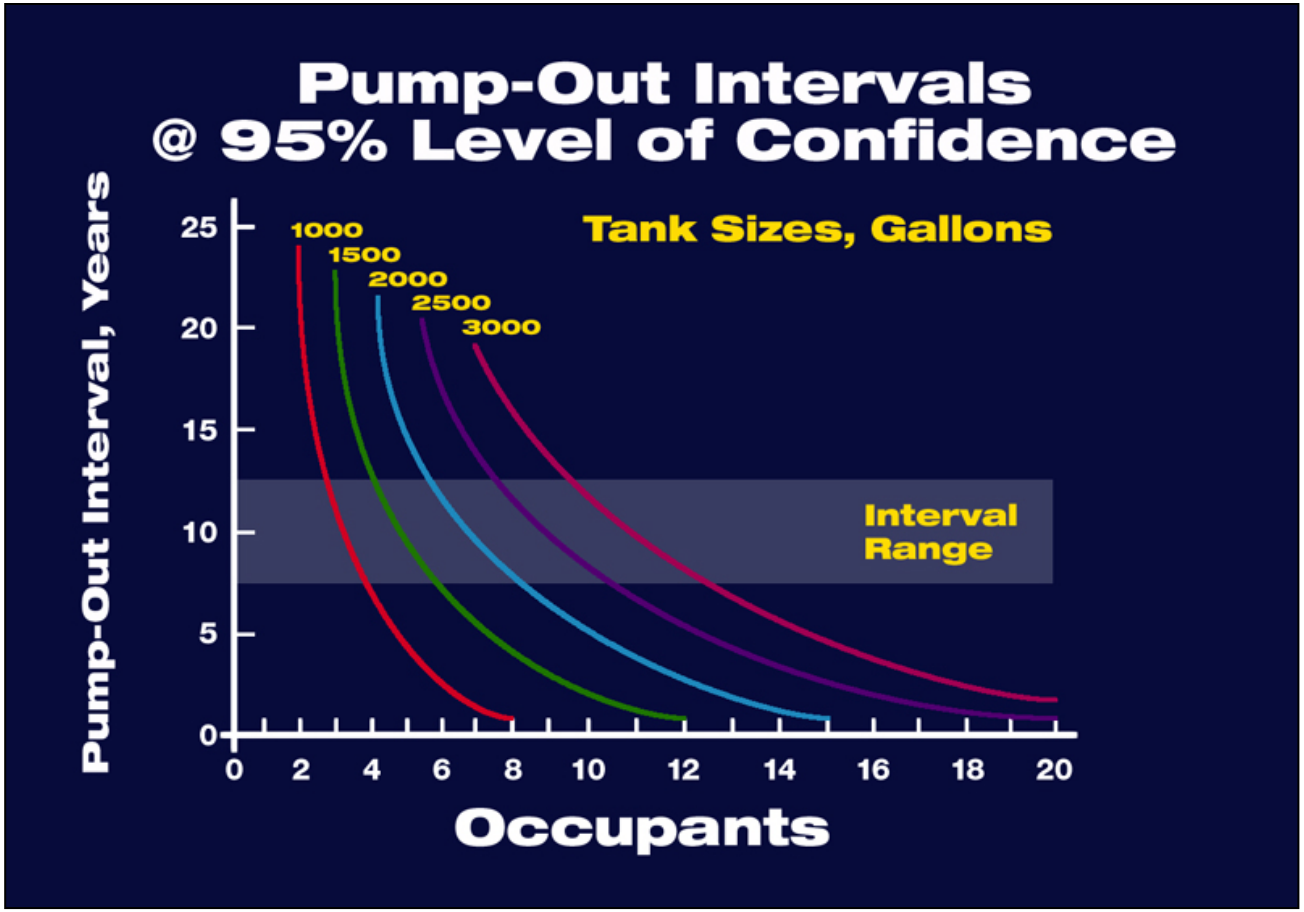


Factor	Prelos Sewer	Grinder Pumps & Lift Stations
Flow Velocity	Not Critical	>2 ft/s
Oversizing for future capacity	No limitation	Limited by flow velocity
Low build-out	No issue	Can cause sedimentation and odor problems
Pumping distances	Theoretically, tens of miles	Limited by flow velocity
Extensions and additions	Typically, no problem	Could require pump upgrades, new lift station or replacement of mains
Fats oils and grease	Reduced by Prelos	Can plug mains

Solids Detention at the Source

- Settling and digestion
- Heavier solids sinks to the bottom, lighter solids float to the top
- Anaerobic microbes digest the waste
  - Produce methane, sulfur dioxide, and other gases
  - Heavier solids produce a dense sludge
- Efficiency increases over time
- Liquid-only sewer systems combine passive primary treatment and collection in one package. They are the only technology to do so.

Pump-Out Intervals



The pumping interval for properly sized and managed watertight tanks is about 12-20 years.

Source: Bounds, T., PE. (1995). *Septic Tank Septage Pumping Intervals* [PDF]. Sutherlin, Oregon: Orenco Systems, Inc.

Biosolids

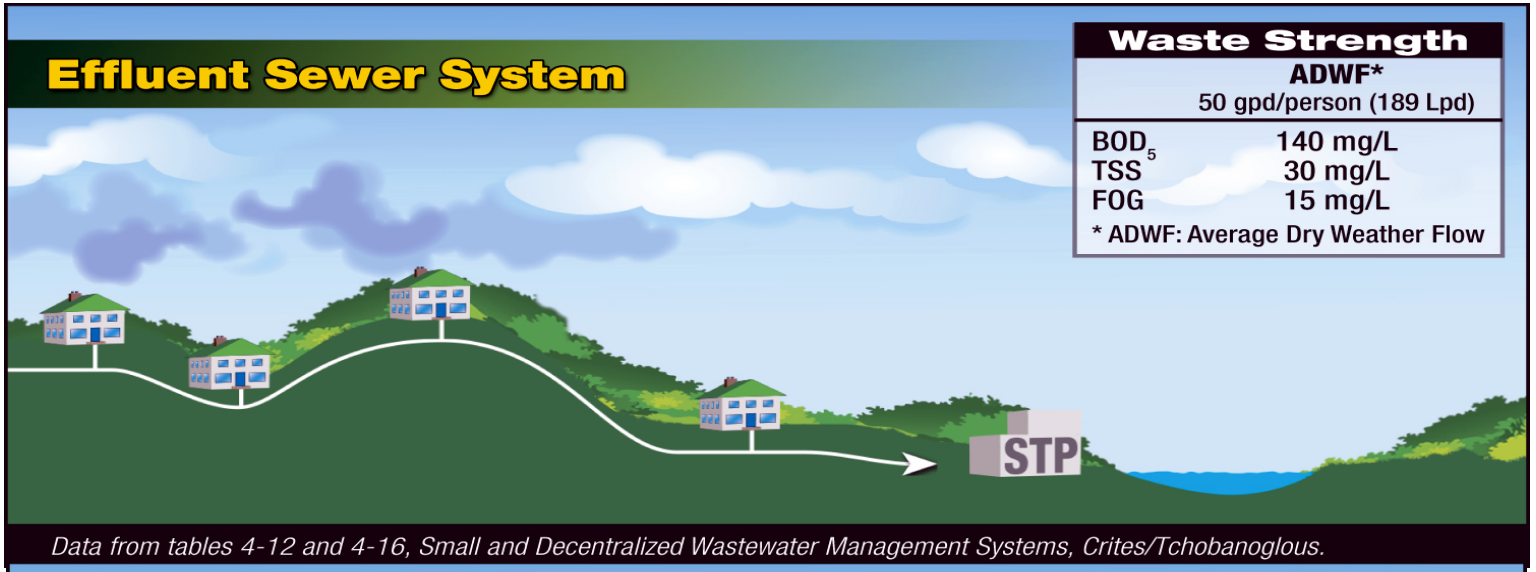
- Liquid-only sewer reduces biosolids wasting at the plant by up to 80% when compared to grinder or gravity sewer*
- Biosolids handling costs are a major component of total wastewater treatment costs
- Liquid-only sewers don't need headworks
- Liquid-only sewers require less clarifier and digester capacity

*Internal calculations

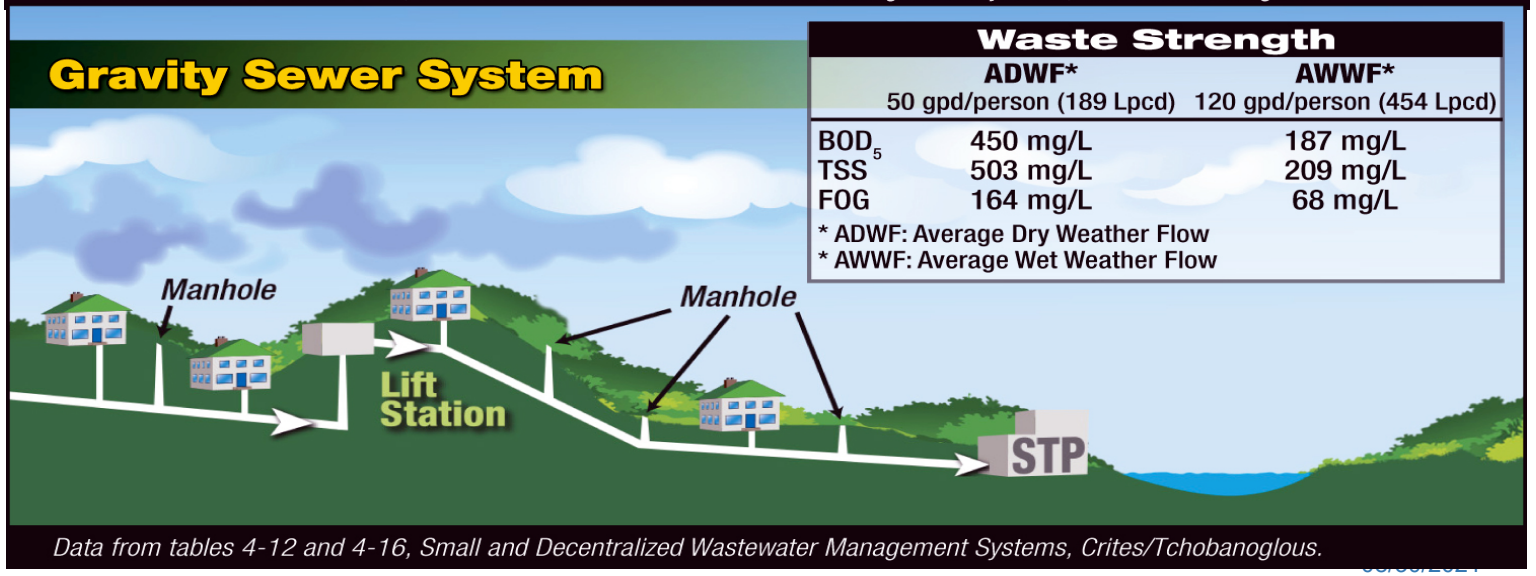
Two years of biosolids (20 cubic yards) for over 1000 connections in Glide, Oregon, naturally dried in a drying bed.

1 Week Below Sludge Chute – Coburg Oregon MBR. 700 Connections

Indirect Life-Cycle Costs (Treatment)

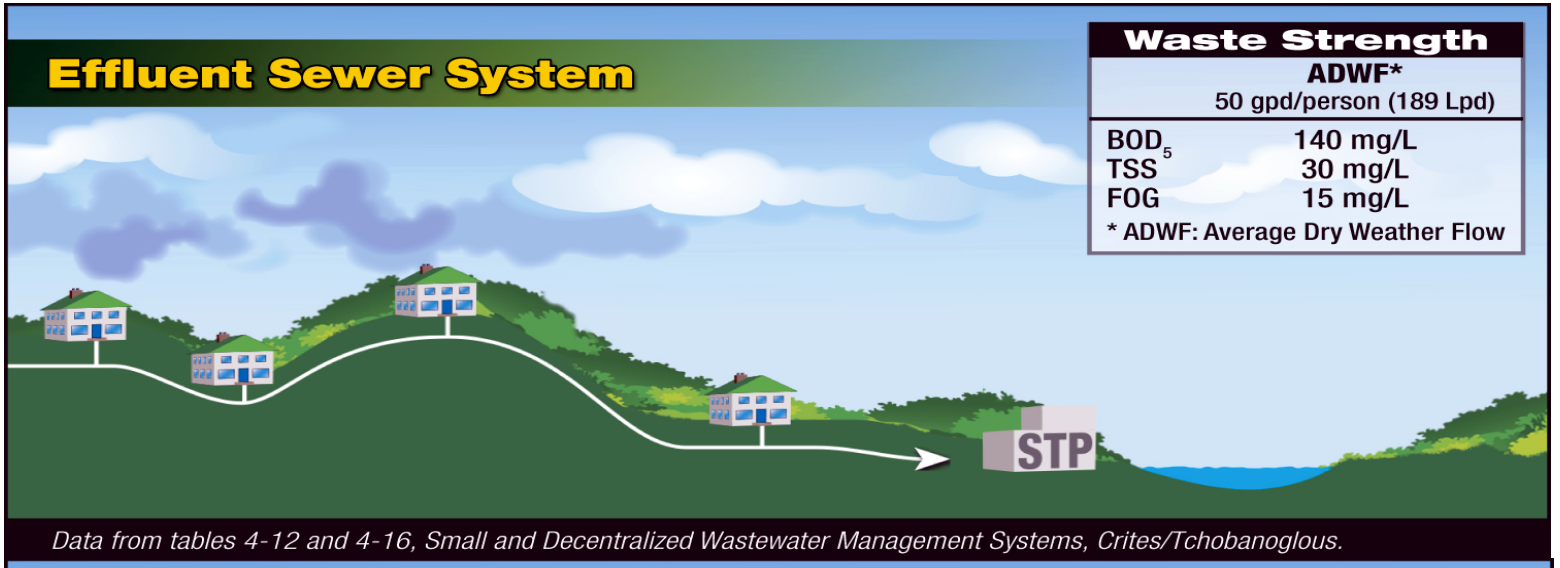


Data from tables 4-12 and 4-16, Small and Decentralized Wastewater Management Systems, Crites/Tchobanoglous.



Data from tables 4-12 and 4-16, Small and Decentralized Wastewater Management Systems, Crites/Tchobanoglous.

Wastewater Strength



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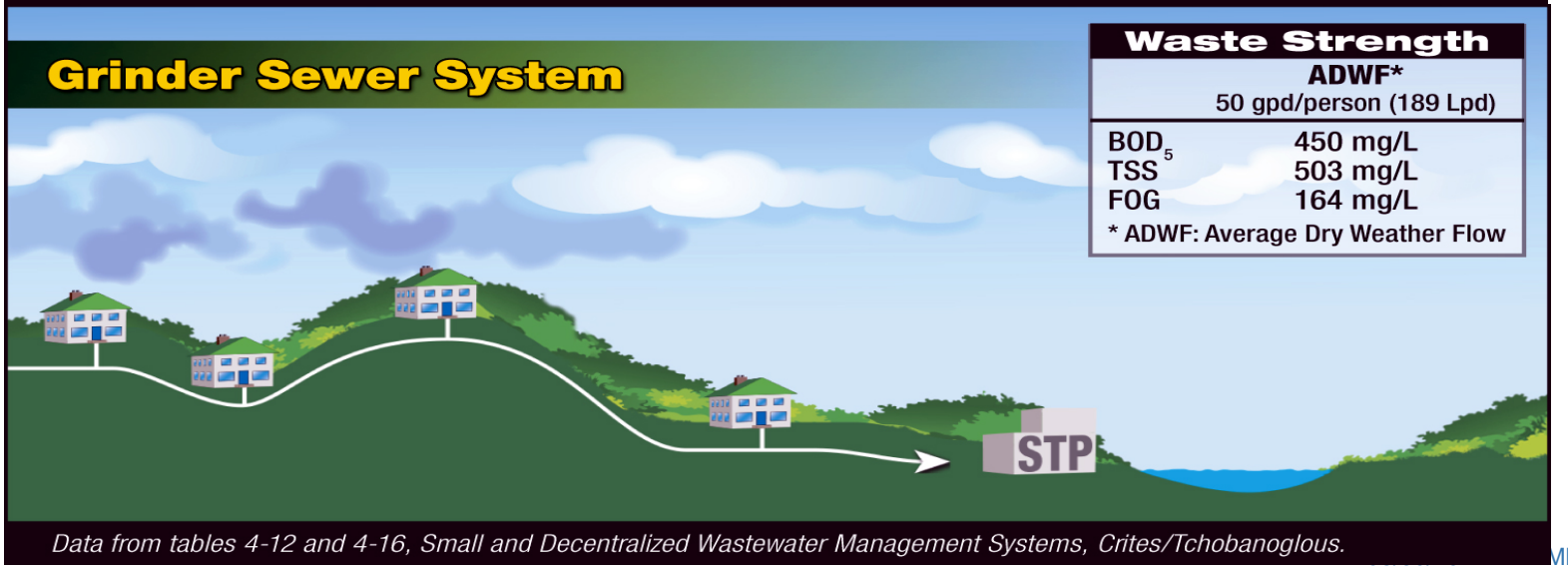
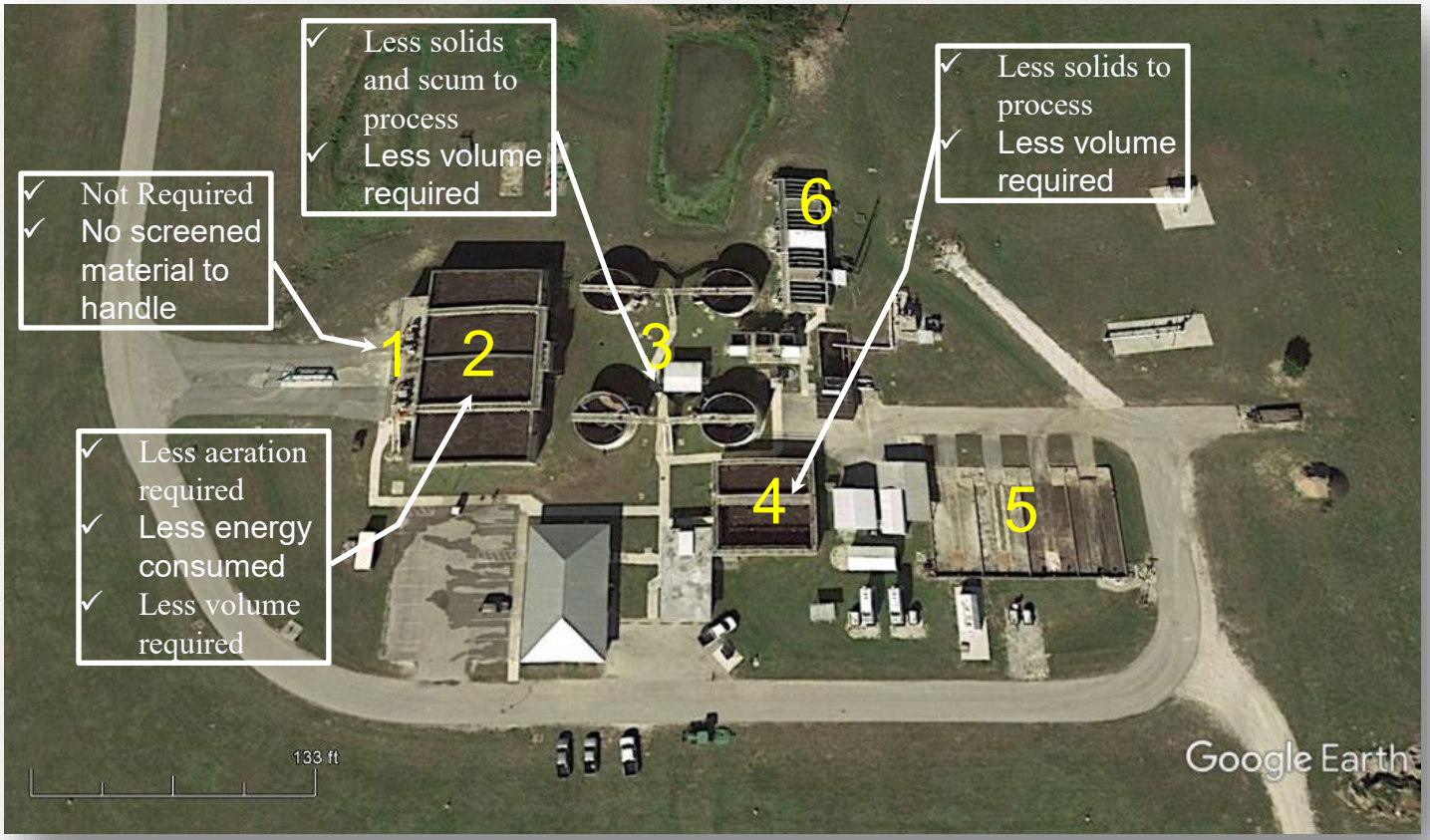


Data from tables 4-12 and 4-16, Small and Decentralized Wastewater Management Systems, Crites/Tchobanoglous.

1.2 mgd Activated-Sludge Plant



1. Headworks
2. Aeration basin
3 Clarifiers
4. Digester
5. Drying beds
6. Disinfection

Effects of Liquid-Only Sewers on WWTP's Influent Waste Stream Characteristics

Typical Wastewater Collection System Daily Per Capita Organic Loads

	Effluent Sewer	Grinder Sewer	Gravity Sewer
Oxygen Requirements			
Carbonaceous O_2	0.063 lbs/day	0.188 lbs/day	0.200 lbs/day
Nitrogenous O_2	0.103 lbs/day	0.111 lbs/day	0.133 lbs/day
Sludge Production			
Heterotrophic, $P_{x,vss}$	0.019 lbs/day	0.058 lbs/day	0.061 lbs/day
Autotrophic, $P_{x,nvss}$	0.0014 lbs/day	0.0015 lbs/day	0.0018 lbs/day

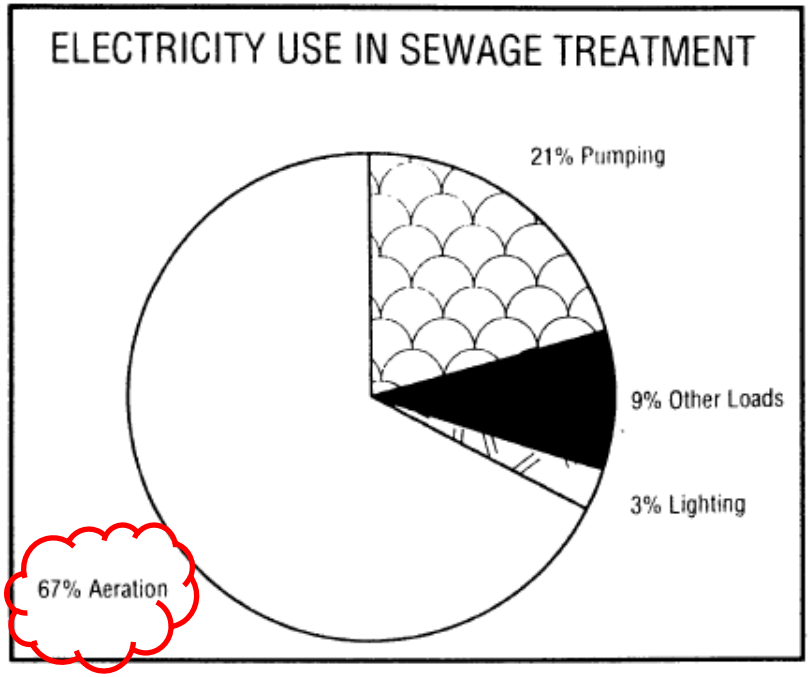
Metcalf & Eddy, 2003. Crites and Tchobanoglous, 1998.
"Optimizing MBR Treatment Facilities with Effluent Sewer Collection Systems" T.R.Bounds, PE, Tyler J. Molatore, PE

Electrical Costs Associated with Wastewater Treatment

Figure 6 WWTP Efficiency Baseline Ranges

Treatment Type	Flow (MGD)	MWh/MG	kWh/lb BOD
Extended Air	<0.1	1.1 - 46.0	1.9 - 20.3
Conventional Activated Sludge	0.1 - <0.5	3.3 - 6.9	2.5 - 4.9
	0.1 - <0.5	2.5 - 5.3	2.8 - 6.3
	0.5 - <5	1.1 - 6.1	0.9 - 4.7
	>5	0.4 - 1.2	0.2 - 2.2
Sequential Batch Reactor	<0.1	8.7 - 25	3.2 - 7.1
	0.1 - <0.5	1.2 - 12.6	1.6 - 7.2
	0.5 - <5	1.8 - 6.6	1.4 - 4.5
Oxidation Ditch	0.1 - <0.5	2.2 - 6.6	2.1 - 6.4
	0.5 - <5	3.3 - 4.5	1.6 - 5.1

Source: Electric Use at Pennsylvania Sewage Treatment Plants (PDEP 2011).

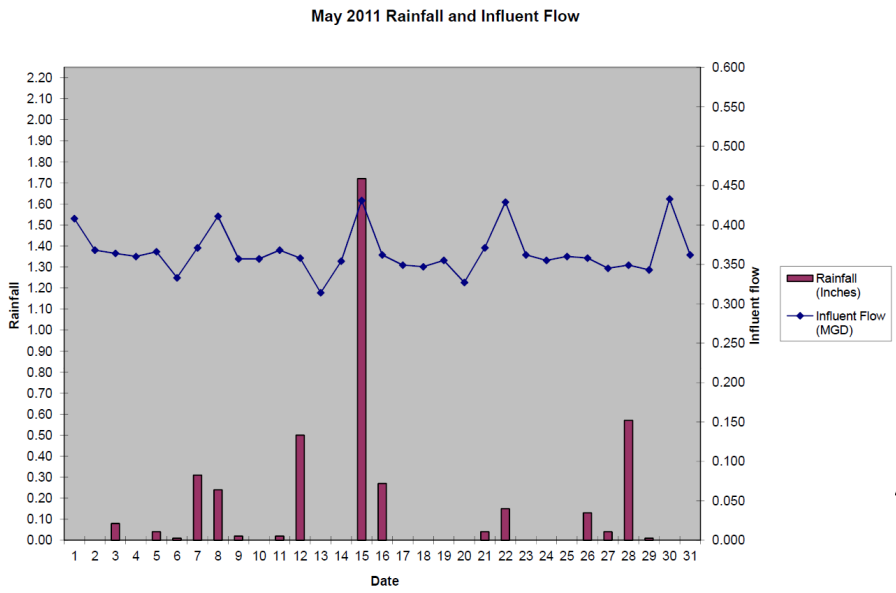


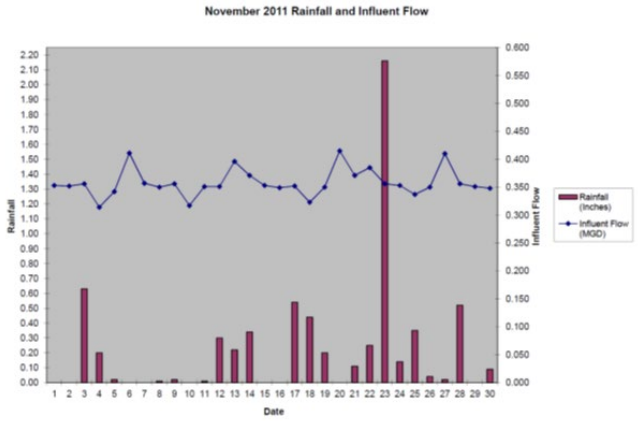
Source: New York State Energy Research and Development Authority

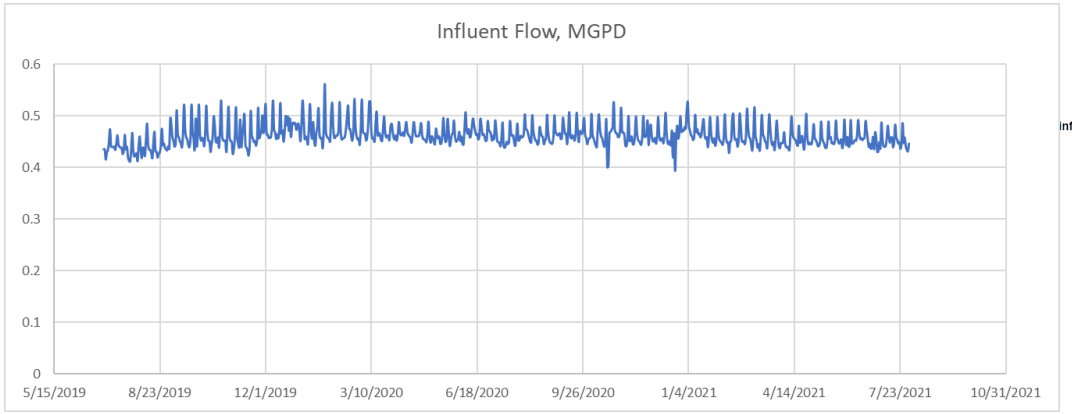
Higher wastewater strength and more biosolids equate to more energy use.

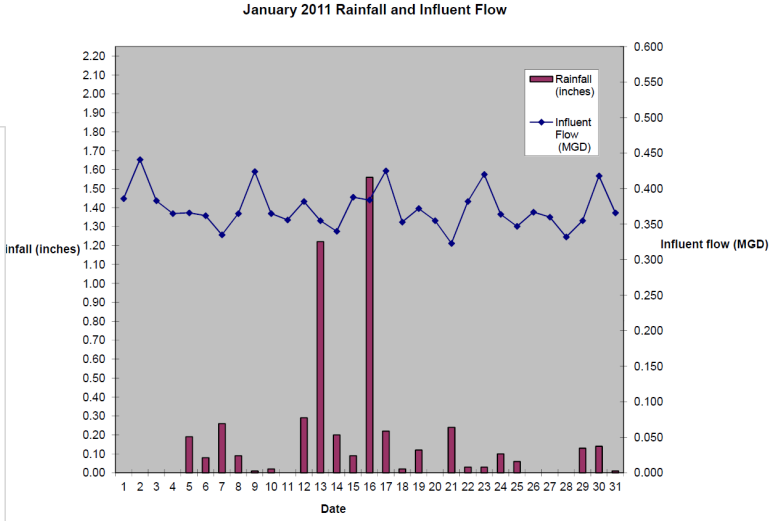
Inflow & Infiltration

The Yelm system (25 years old) has little to no I&I

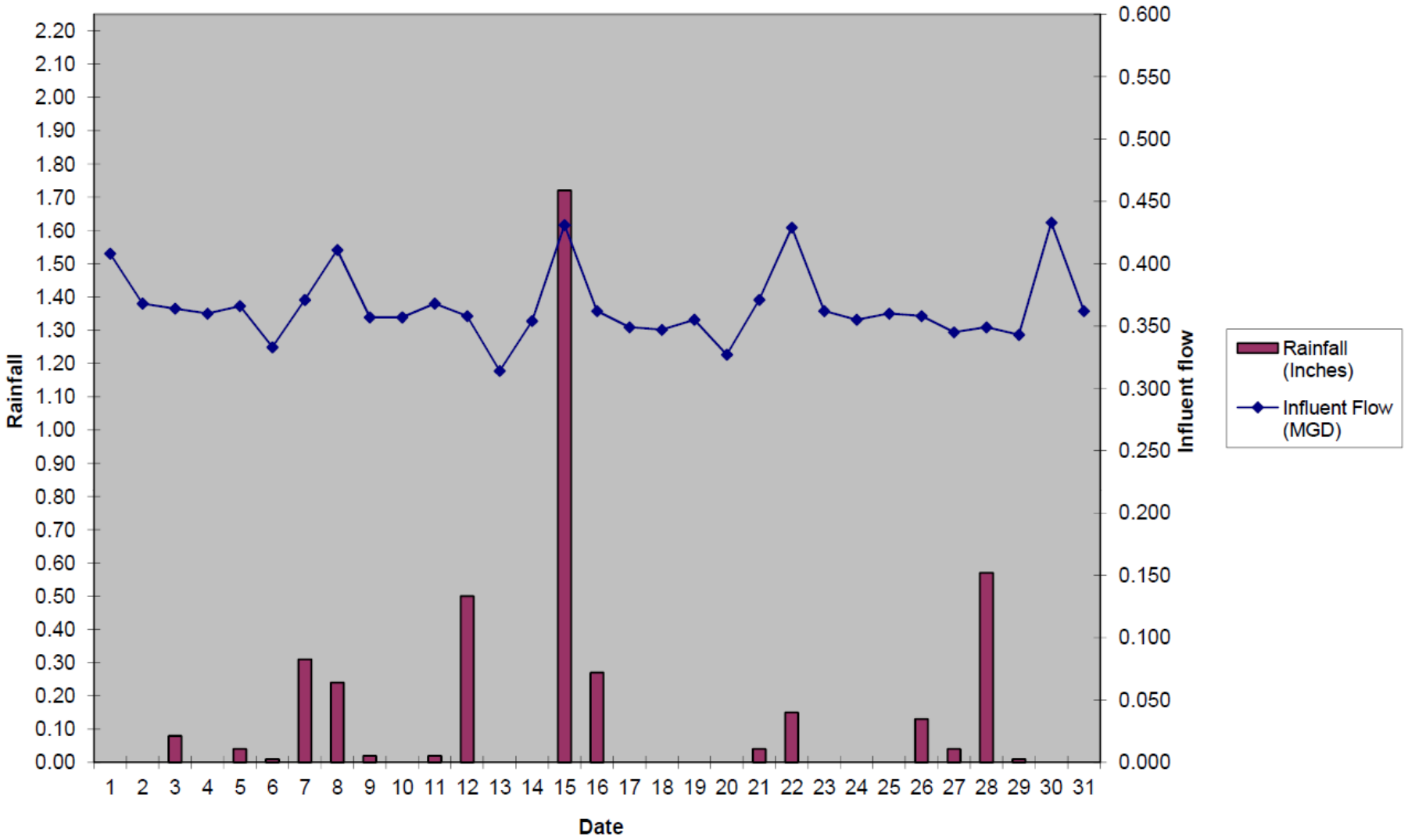


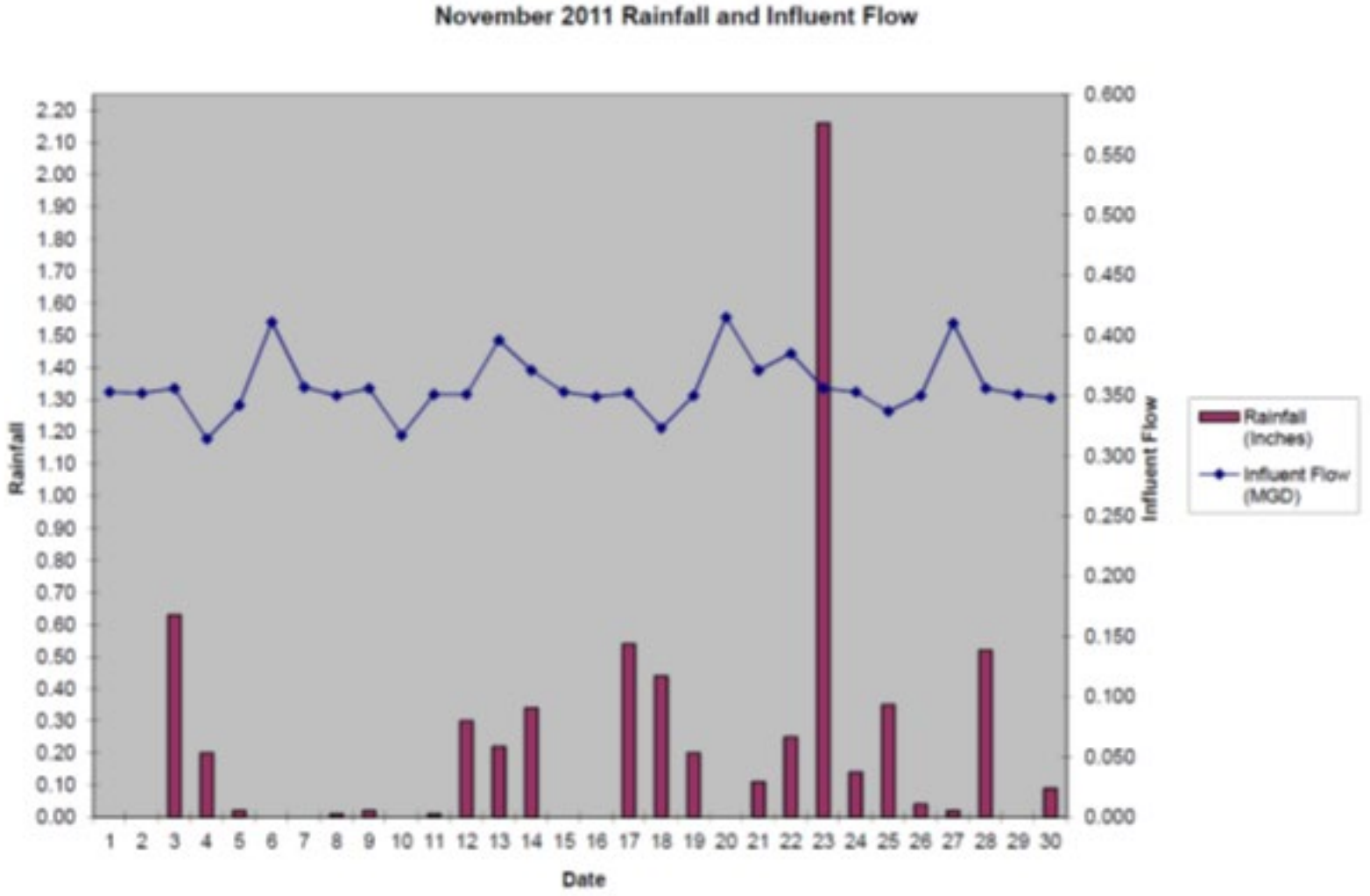






May 2011 Rainfall and Influent Flow

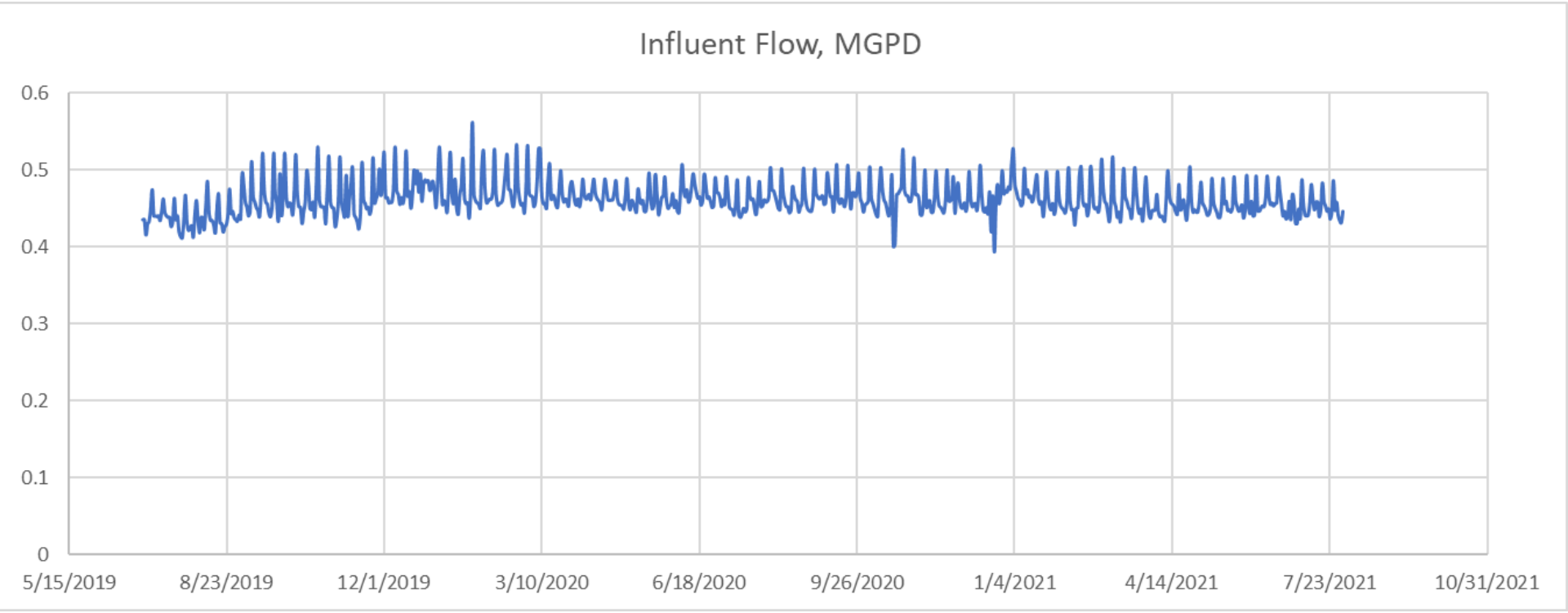


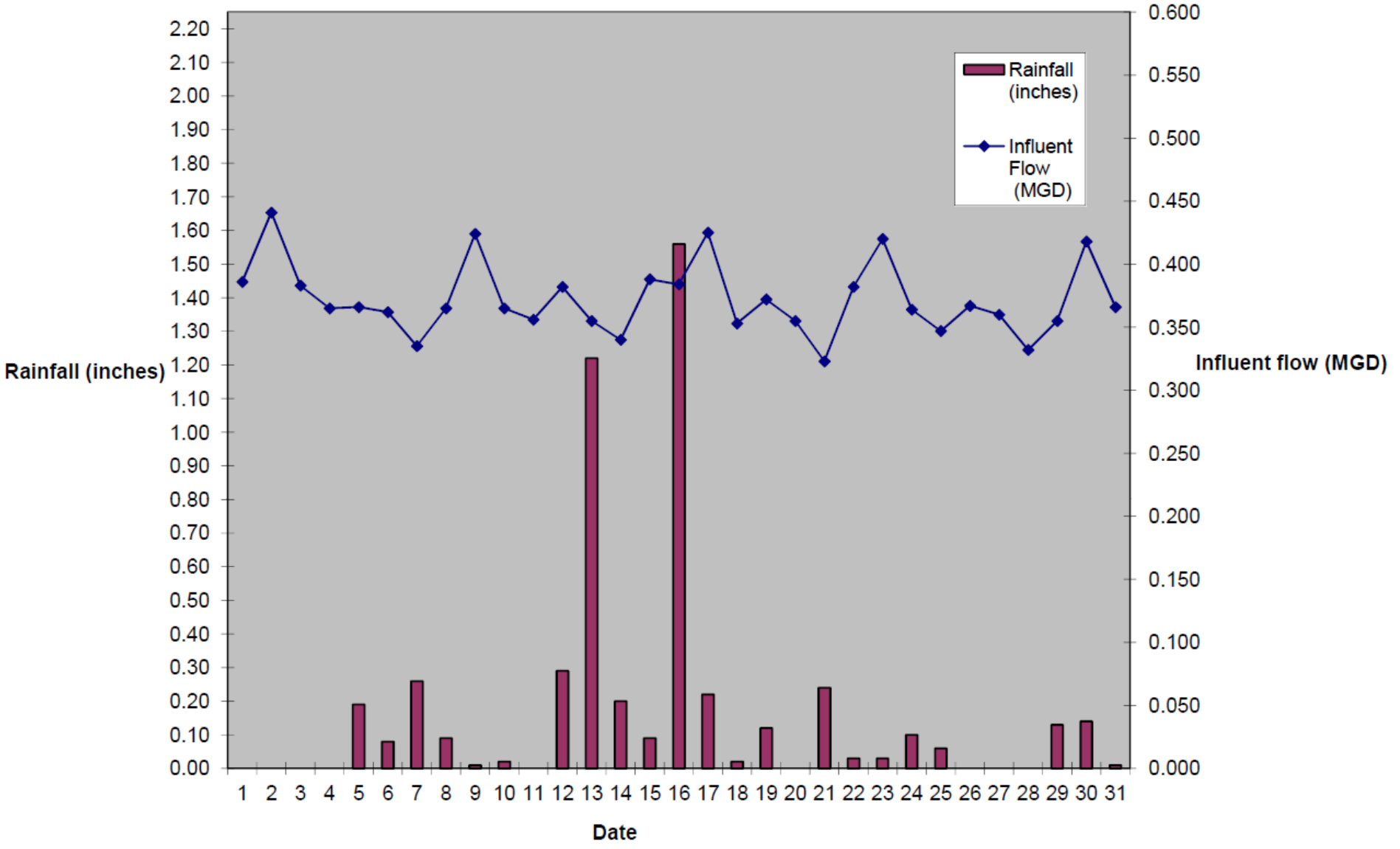

November 2011 Rainfall and Influent Flow
Rainfall
Influent Flow
Date
Rainfall (Inches)
Influent Flow (MGD)
2.20
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.600
0.550
0.500
0.450
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

v (MGD)

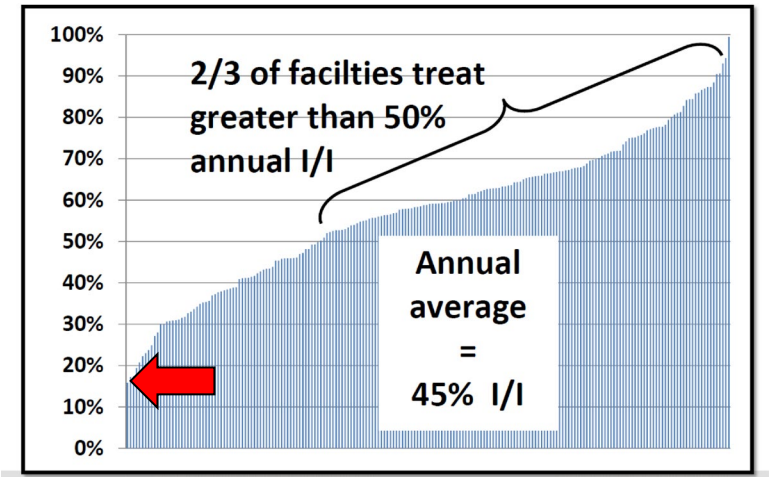
Inflow & Infiltration

The Yelm system (25 years old) has little to no I&I

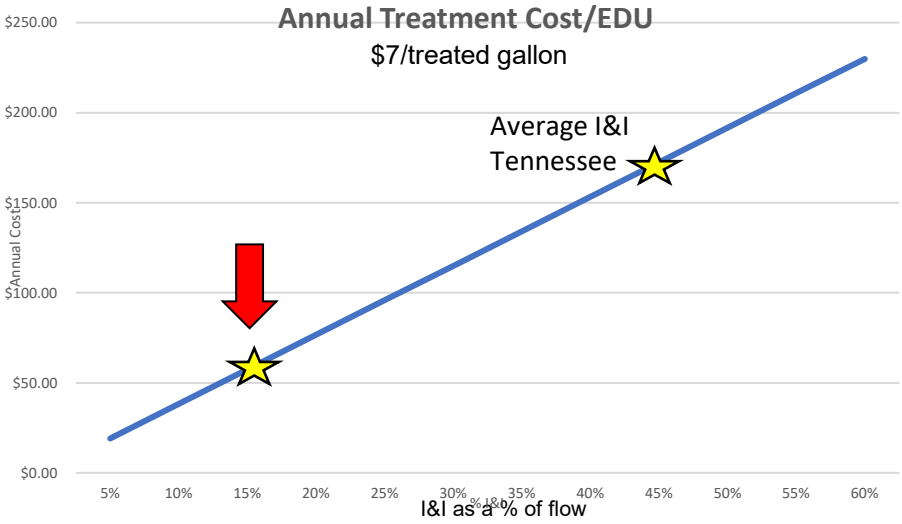



January 2011 Rainfall and Influent Flow
Rainfall (inches)
Influent flow (MGD)
Date
Rainfall (inches)
Influent Flow (MGD)
2.20
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.600
0.550
0.500
0.450
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

The Cost of Inflow & Infiltration



Source: Tennessee Department of Environment & Conservation, Environmental Show of the South "How to Get Your Wastewater Plans Approved Faster", May 17, 2018

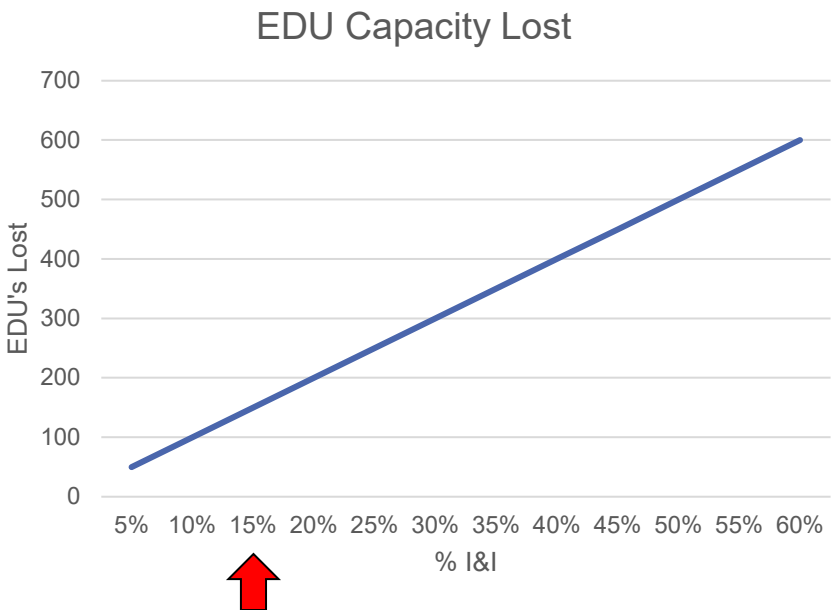


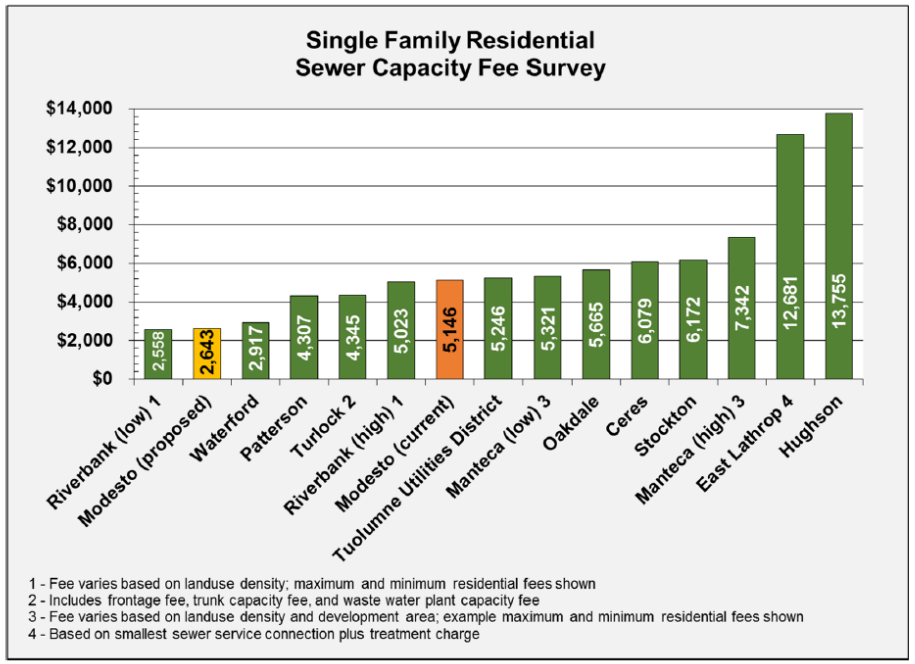
EDU Capacity Lost

I&I as a % of flow

Source: https://insideclimatenews.org/news/01032016/ft-lauderdale-climate-change-global-warming-rising-sea-level

Lost Capacity Due To Inflow & Infiltration (1000 home community)





Source: https://www.modestogov.com/DocumentCenter/View/5183/Sewer-Capacity-Fee-PDF

AX-Max

- Attached growth
- No open tanks
- Modular
- Low energy
- No headworks
- No clarifiers
- No aeration/no blowers

Treatment cost is typically 1/10 the cost of an activated-sludge plant

Liquid-Only Sewer System O&M

- Occasional inspection and cleaning
  - Pull and clean effluent filter
  - Record depth of sludge and scum layer
  - Verify pump amperages
  - Verify float operation

30 minutes Preventative Maintenance (3-5 years)

- Documented tank pump-out intervals of 10 to 12 years
- About $1 per month for electricity per household

Electrical Usage: Liquid-Only Sewer (LOS)

- All costs typically funded by homeowner

	Pump	Pump Run Time	Power Cost	Equivalent Monthly Costs ($/month/EDU)
LOS or Orenco Effluent Sewer	0.5 Hp, 115 VAC, 12 amps	20 mins/day	$0.10/kWh	**$1.38**

Reactive Maintenance (RM):
Liquid-Only Sewer Systems

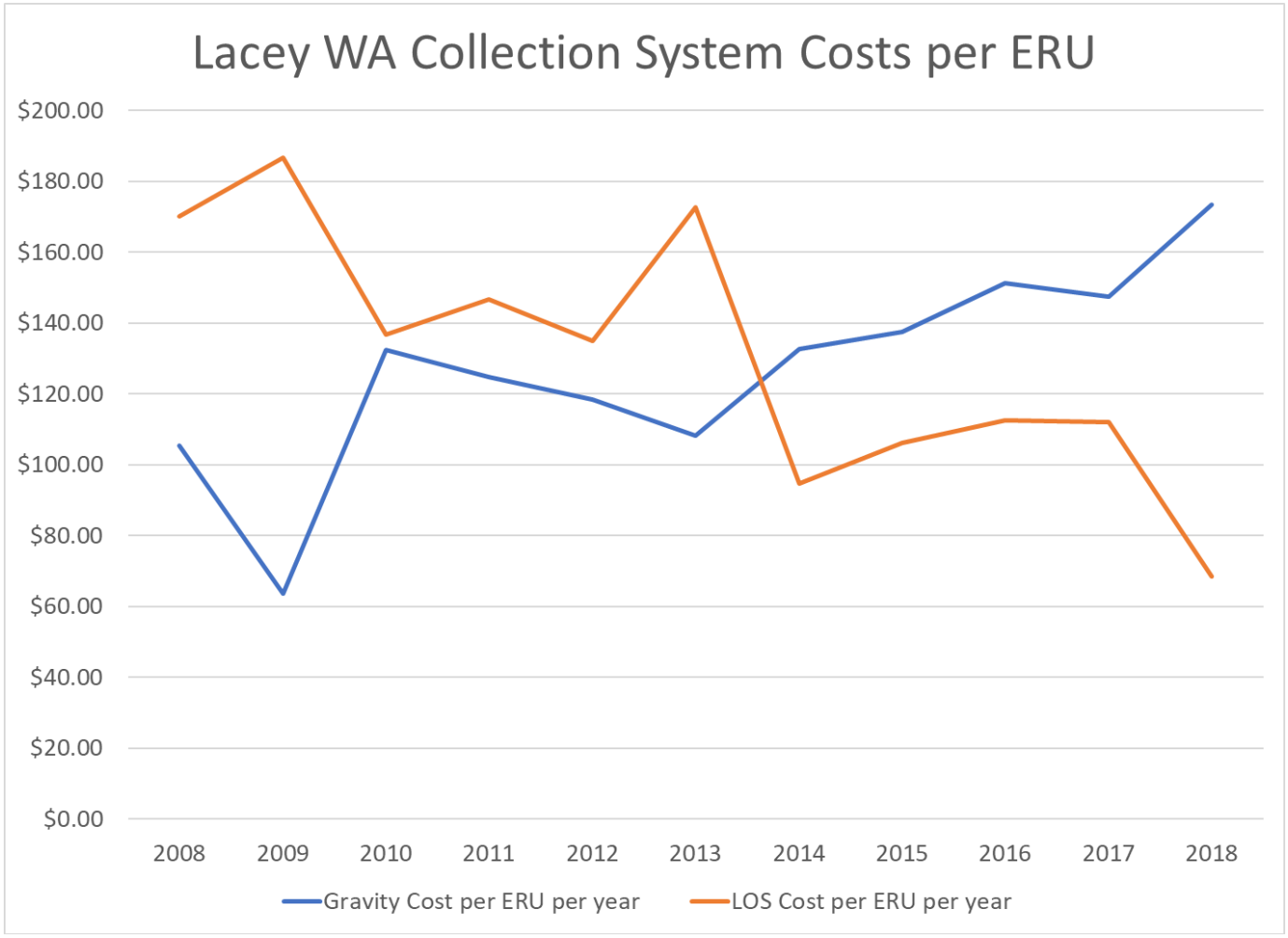
State	Community	EDUs	Screened	Hrs/mo./100 EDUs
CA	Mt. Lake Estate	8	yes	1.0
CA	Villa Verona	337	yes	2.5
MT	Missoula	350	yes	1.5
OR	Elkton	135	yes	0.7
OR	Glide	1,054	30%	1.5
OR	Lakeside	51	yes	0.3
OR	La Pine	215	yes	1.8
OR	Tangent	180	yes	2.5
WA	Boston Harbor	166	yes	1.6
WA	Conconnully Lake	75	yes	0.5
WA	Diamond Lake	525	yes	1.2

Typical to see 1 FTE with small service truck maintaining > 3000 connections

City of Lacey, Washington
Liquid-Only Sewer System O&M

- Installed in 1989
- ~ 4,000 total Liquid-only sewer, 12,000 gravity, and 3,000 grinder connections
- City utilizes 2 full-time employees for liquid-only sewer
- Since 2008, all properties are on an 8-year maintenance cycle
- Fewer than 20 pumps replaced
- Cost for operating liquid-only sewer is currently lower than the gravity sewer

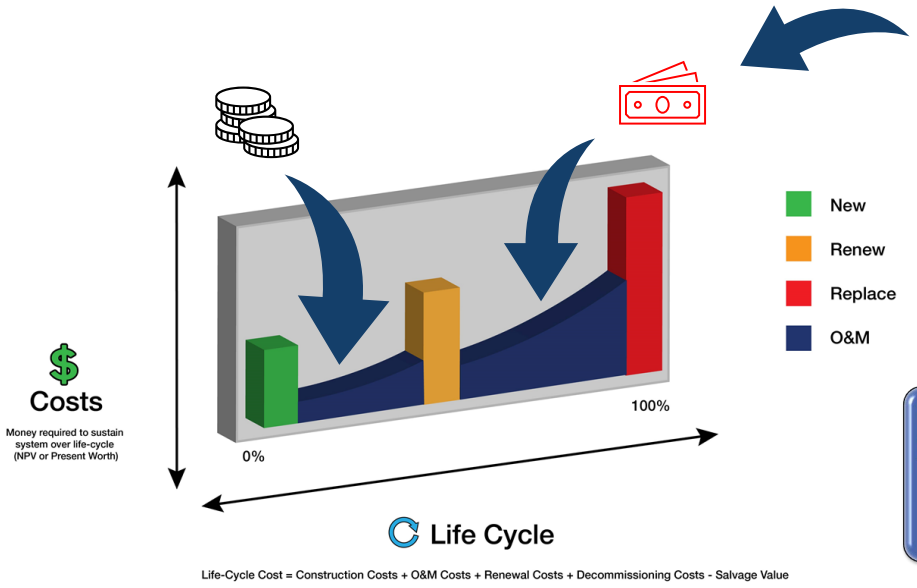
Liquid-Only Sewer vs Gravity – Lacey, WA

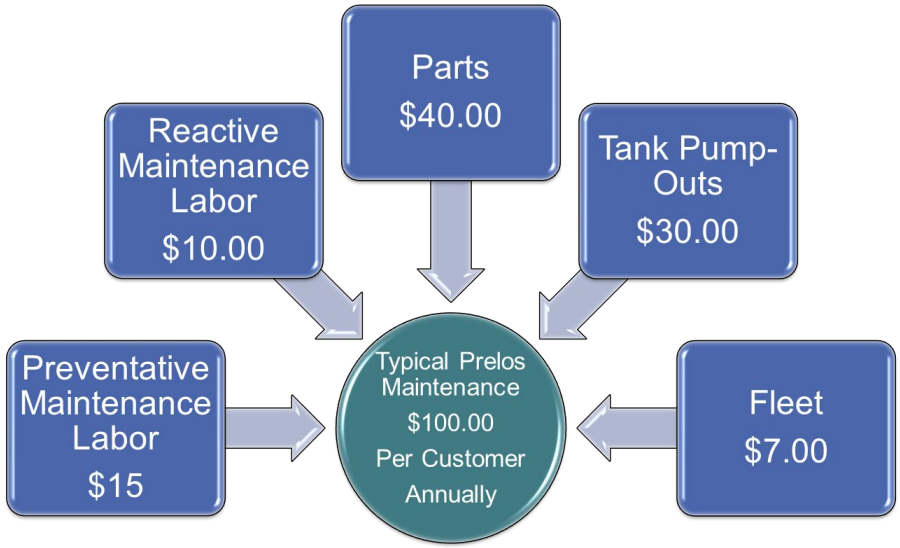


Source: City of Lacey annual budgets

Liquid-Only Sewer
Mature System Cost

Estimated potential savings at treatment plant
≈ $15 for sludge handling and $10 for electricity annually

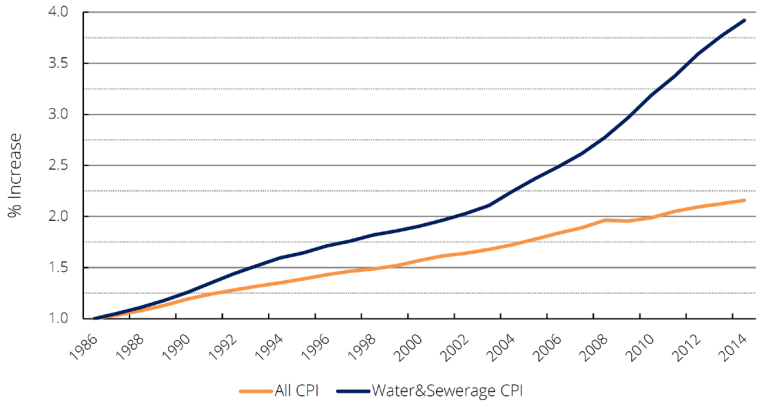




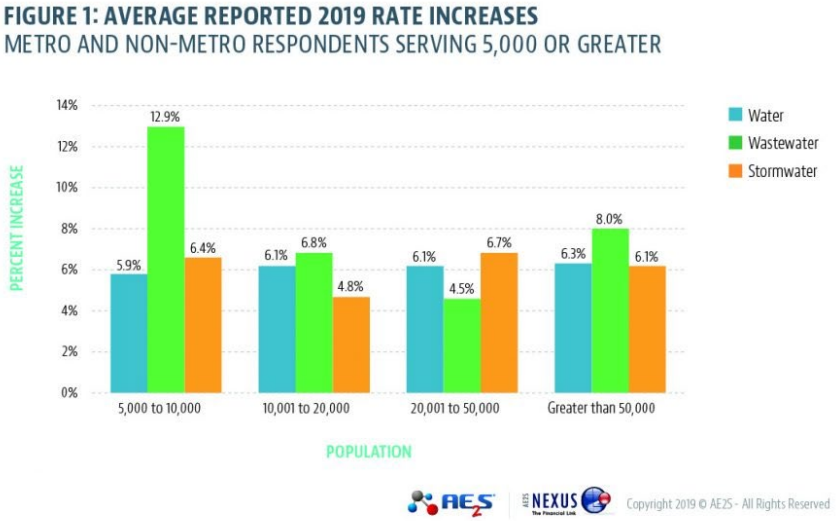
Annual Power use is $10 to $15 per year

Sustainability

"Sustainable development … meets the needs of the present without compromising the ability of future generations to meet their own needs."
Brundtland Report, United Nations, 1987



Source: Water and Wastewater Rate Hikes Outpace CPI, Lawrence Berkeley National Laboratory May 2016



Source: https://www.ae2snexus.com/2019-utility-rate-survey-results/

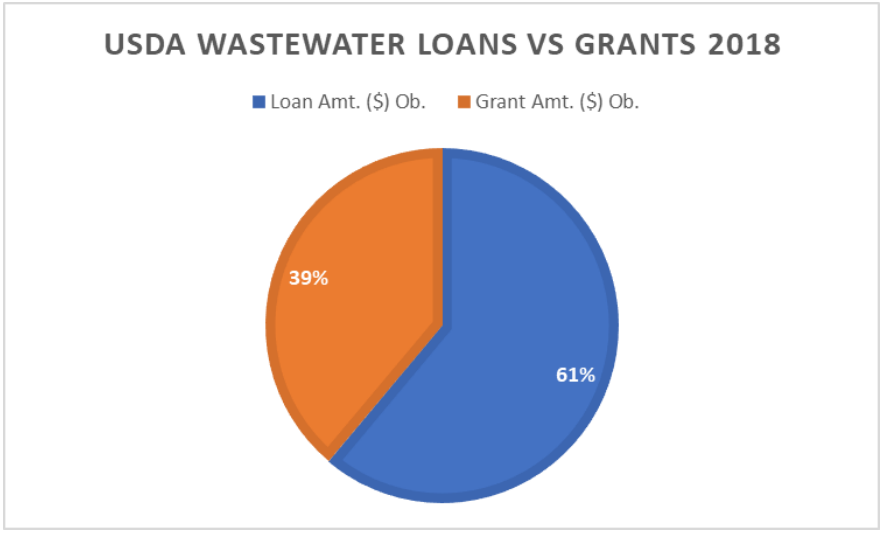
Mokane, Missouri

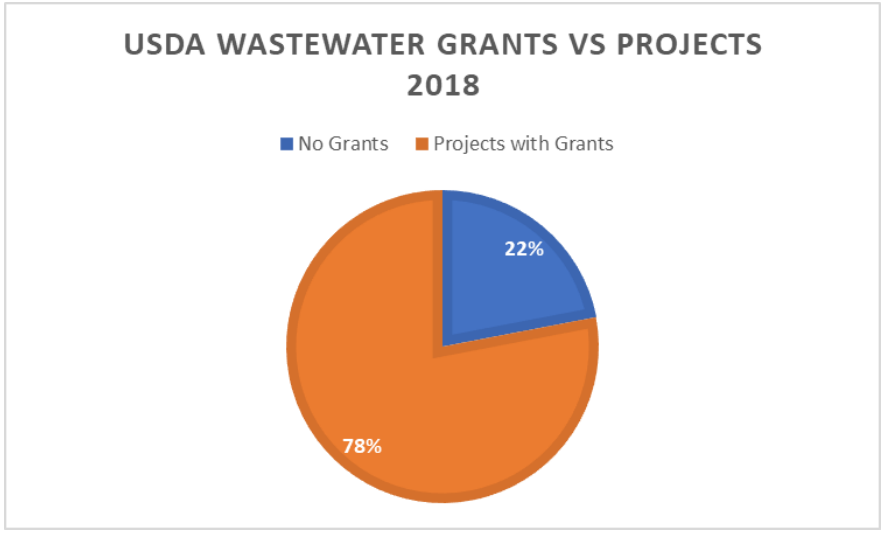
- Homes: 73
- Population: 185
- Growth: none
- Current sewer: gravity
- Current fees: $25 for water, $35 for sewer
- Maintenance & upgrades: virtually none
- Bond funds required to ***update*** the system: $2,469,692
- Cost/home: $33,831.40
- Years of enforcement cases: 15

- Current delinquency rate: 31.9%
- Proposed fees: $60 for water, $70 for sewer -- with grants
- Public system may need to go into receivership

Data taken from articles in The Fulton (Missouri) Sun

2018 USDA Wastewater Funding



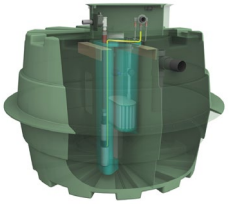


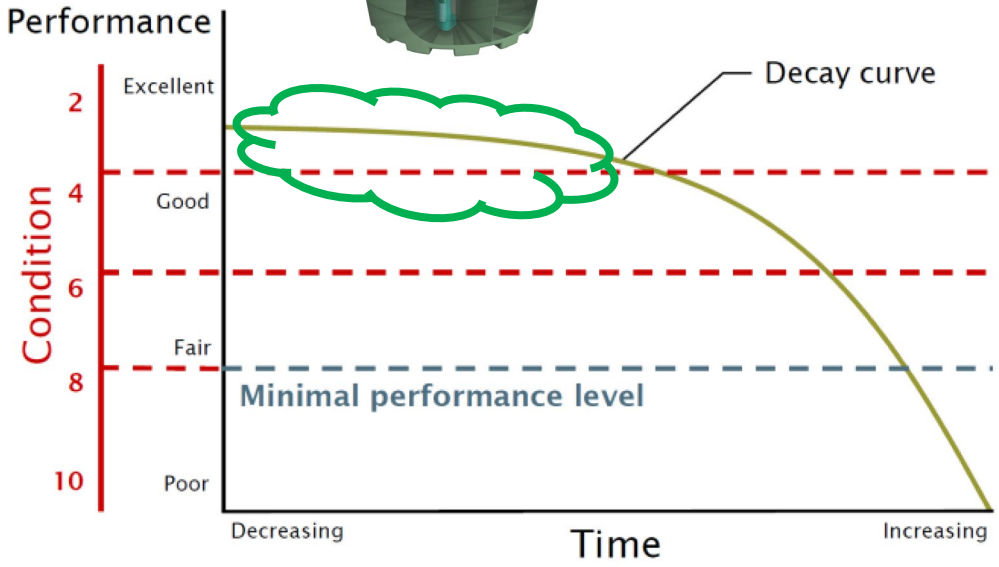
Source: USDA 2018 Wastewater Project List Responsive Records Request

Is this sustainable?

Renewal & Replacement (R&R)

- Gravity sewer systems are allowed to decay to minimal performance
- Most liquid-only sewer R&R is part of the O&M cost.





THEORETICAL DECAY CURVE

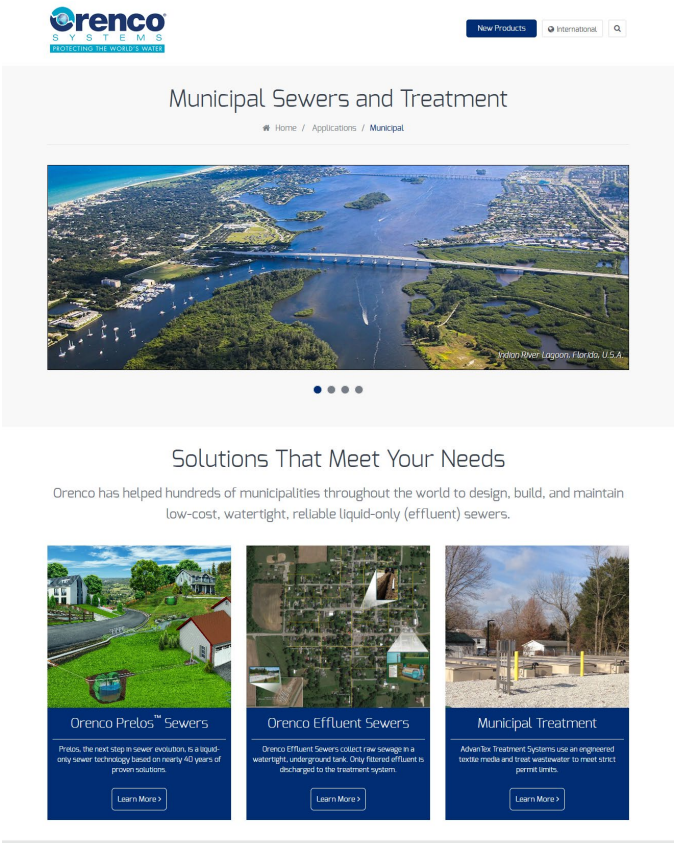
Source: Town of Cary Buried Infrastructure Management Plan 2018

Summary

- Liquid-only sewer has been in use for almost 50 years
- Liquid-only sewer provides primary treatment, collection and conveyance
- Solids retention results in more efficient pumping, less costly treatment, and lower O&M costs
- There are different configurations of liquid-only sewer
- Liquid-only sewer provides a sustainable O&M cost
- Liquid-only sewer reduces initial capital costs

Orenco Website:

- https://www.orenco.com/applications/municipal



Prelos™ The Next Step In Sewer Evolution

Questions?