Forgotten Factors Needed in Wastewater Treatment System Design

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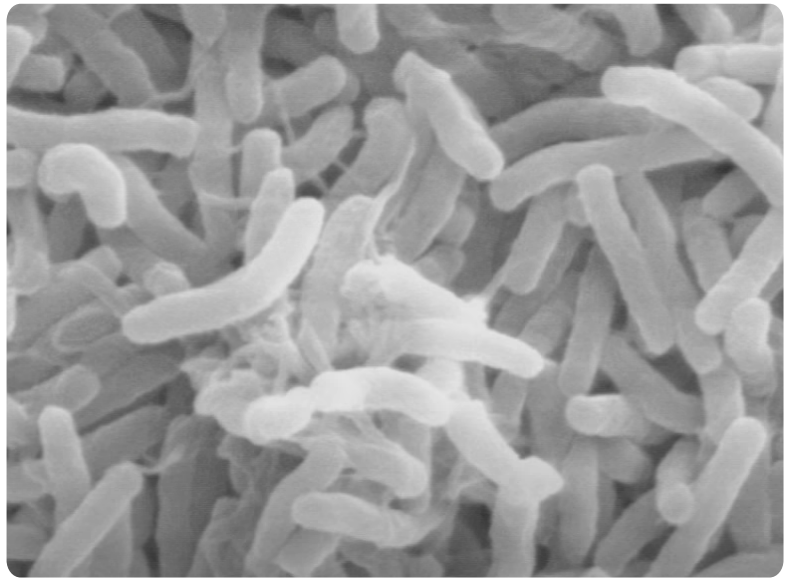
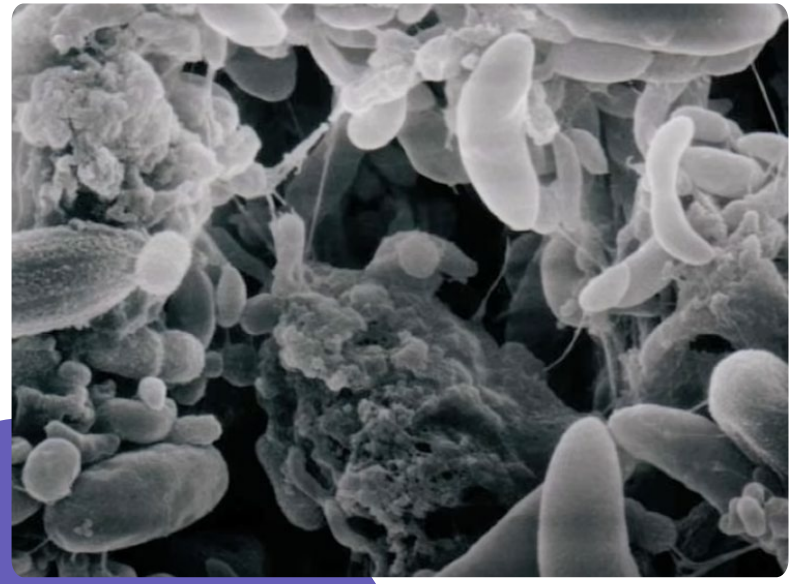
The materials being presented do NOT reflect the opinions of NOWRA.

Discussion Points

- How We Treat Wastewater
- Location
- Facility Type
- Loading





How Are We Treating?

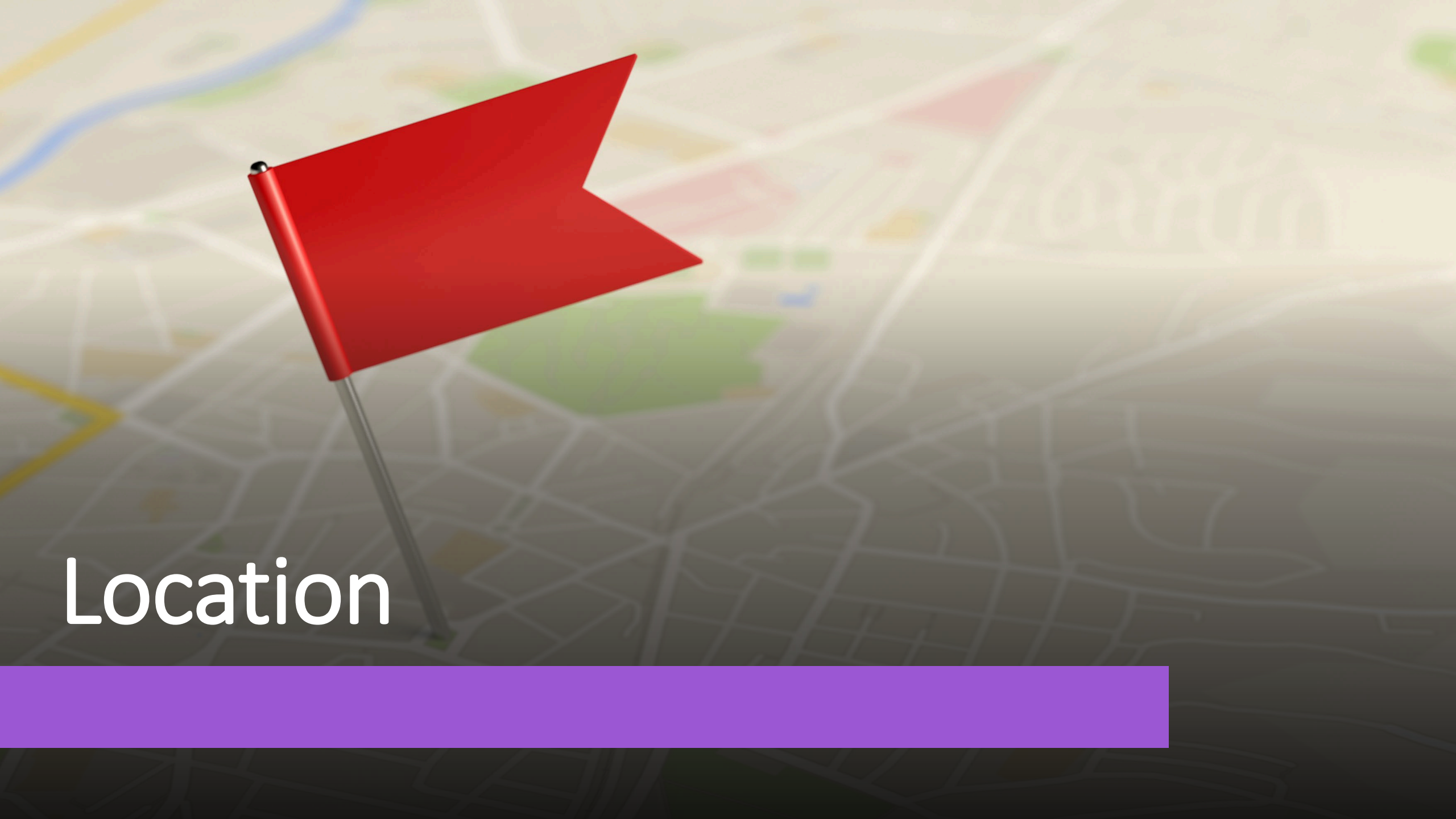
- **We Use Microbes**
  - **Bacteria and Other Microbes Need**
    - Water – always there
    - Oxygen – Big Role
    - Nitrogen and Phosphorus
    - Energy source = BOD/Alkalinity
    - Low toxicity

How Are We Treating?

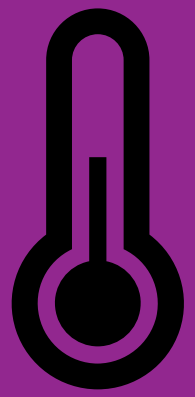
Air	Air introduced mechanically
The Goal	Dissolved Oxygen levels >2 mg/L and completely mixed

Dissolved Oxygen (DO) in Wastewater Treatment

- DO saturation in water relies on three factors:
  i) Water temperature
  ii) Altitude/Barometric Pressure
  iii) Specific conductance - salinity



Location



Temperature

Altitude

What is Around

Water Temperature and Dissolved Oxygen

TEMPERATURE INCREASE = HOLDS LESS OXYGEN

TEMPERATURE DECREASE = HOLDS MORE OXYGEN

Water Temperature and Biological Activity

TEMPERATURE INCREASE = INCREASED BIOLOGICAL REACTION RATE

TEMPERATURE DECREASE = SLOW BIOLOGICAL REACTION RATE

“Design oxygen [supply] for summer temperatures and retention time for colder temperatures.”

Sara Heger, PhD, UMN

Temperature Effects on Nitrification

Table 2 Temperature and nitrification (Adapted from Gerardi, 2002)

Temperature (°C)	Effect upon Nitrification
>45	Nitrification ceases
28 – 32	Optimal temperature range
16	Approximately 50% of nitrification rate at 30°C
10	Significant reduction in rate, approximately 20% of rate at 30°C
<5	Nitrification ceases

Determining Water Temperature

- Air Temperatures
- Collection methods
- Proximity to source
- Wastewater source

Henry's Law

- As altitude increases the % of Oxygen in the atmosphere is the same BUT

How to Design

Biological performance

- It is often colder at higher elevations
- Trade off??

Most blower manufacturers have a conversion table

Example

Barometric pressure varies in direct proportion to altitude

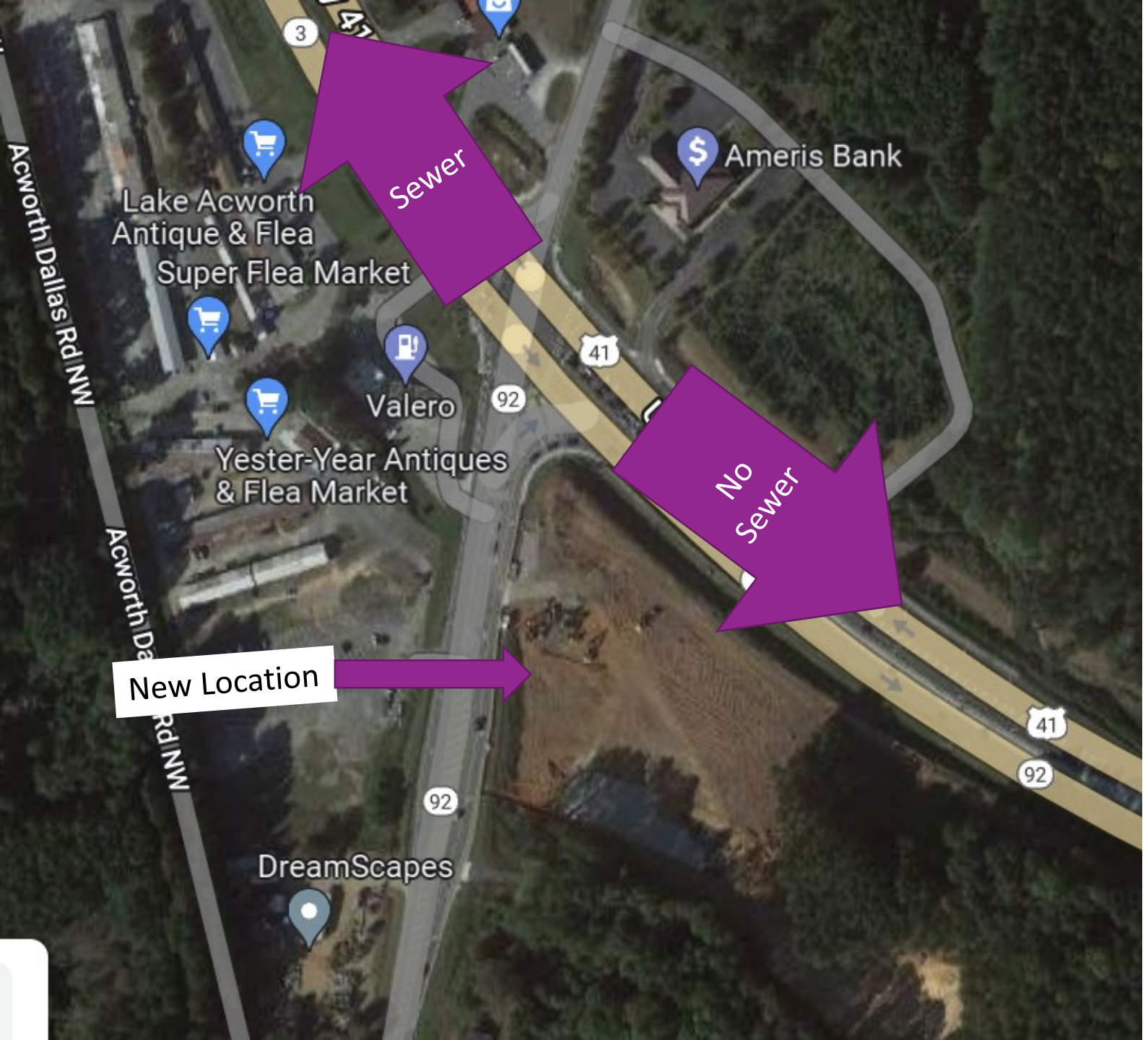
Example #1 – If a blower is required to deliver 2 psig at 5000 feet, what pressure at standard air is required?

Pressure = 29.92 / 24.89 x 2 = 2.4 psig

Example #2 – If a blower is required to deliver 2 psig at standard air, what pressure will it deliver at 5000 feet?

Pressure = 24.89 / 29.92 x 2 = 1.66 psig

What is around?

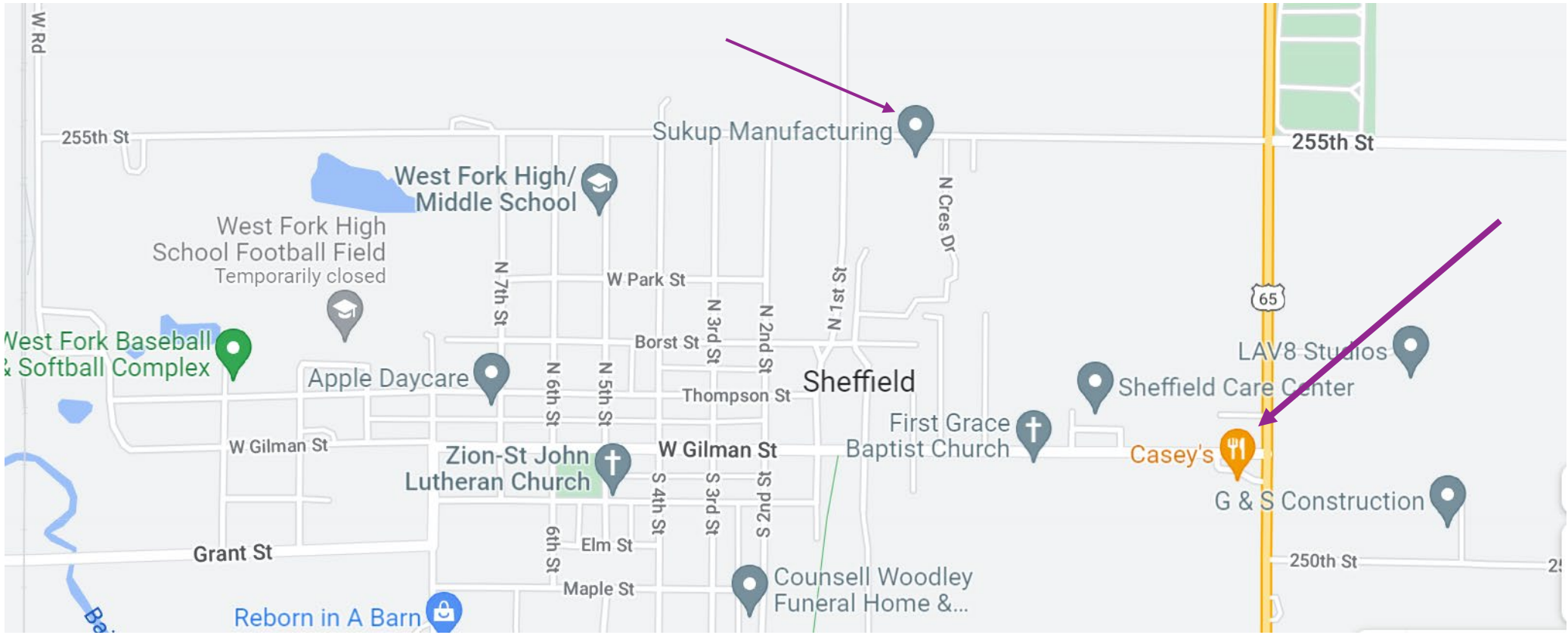


Location

- On the edge of a sewered area

Location

- Industry close by



Location

- Industry close by
- On an interstate

Facility Type

All Wastewater is Wastewater BUT…

Residential

Commercial

- Schools
- Restaurants
- Convenience Stores
- RV Parks
- Breweries
- Wineries
- Slaughterhouses


Not JUST Flow
BUT Strength

BOD and TKN Loading

- ALL designs should characterize both flow and BOD_5/TKN strength (mg/L) to size the system
- These two numbers together are used to determine the total load expressed in pounds per day

$$\frac{\text{Flow (gpd)} * \text{Influent BOD or TKN (mg/L)} * 8.34}{1{,}000{,}000} = \text{lbs/BOD or TKN/day}$$

Examples

- An American restaurant with an average equalized flow of 1200 gpd and a sampled influent BOD_5 value of 825 mg/L and 60 mg/L TKN

$$\frac{1200\ gpd * 870\ mg/L * 8.34}{1{,}000{,}000} = 8.70\ lbs\ of\ BOD/day$$

$$\frac{1200\ gpd * 60\ mg/L * 8.34}{1{,}000{,}000} = 0.60\ lbs\ of\ TKN/day$$

- These values are critical to the design…this is what needs to be treated and it tells the manufacturer how to apply their technology

THANK YOU

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