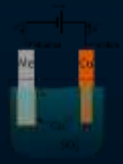
Frank Dick, P.E.
City of Vancouver, Department of Public Works

TYPES OF INDUSTRIAL WASTE AND HOW THEY CAN IMPACT A TREATMENT PLANT

Types of Industrial Waste

Airport Deicing

Breweries



Electroplating

Fruits and Vegetable Processing

Semiconductor

Metal Finishing

Transportation Equipment

Dairy Products Processing

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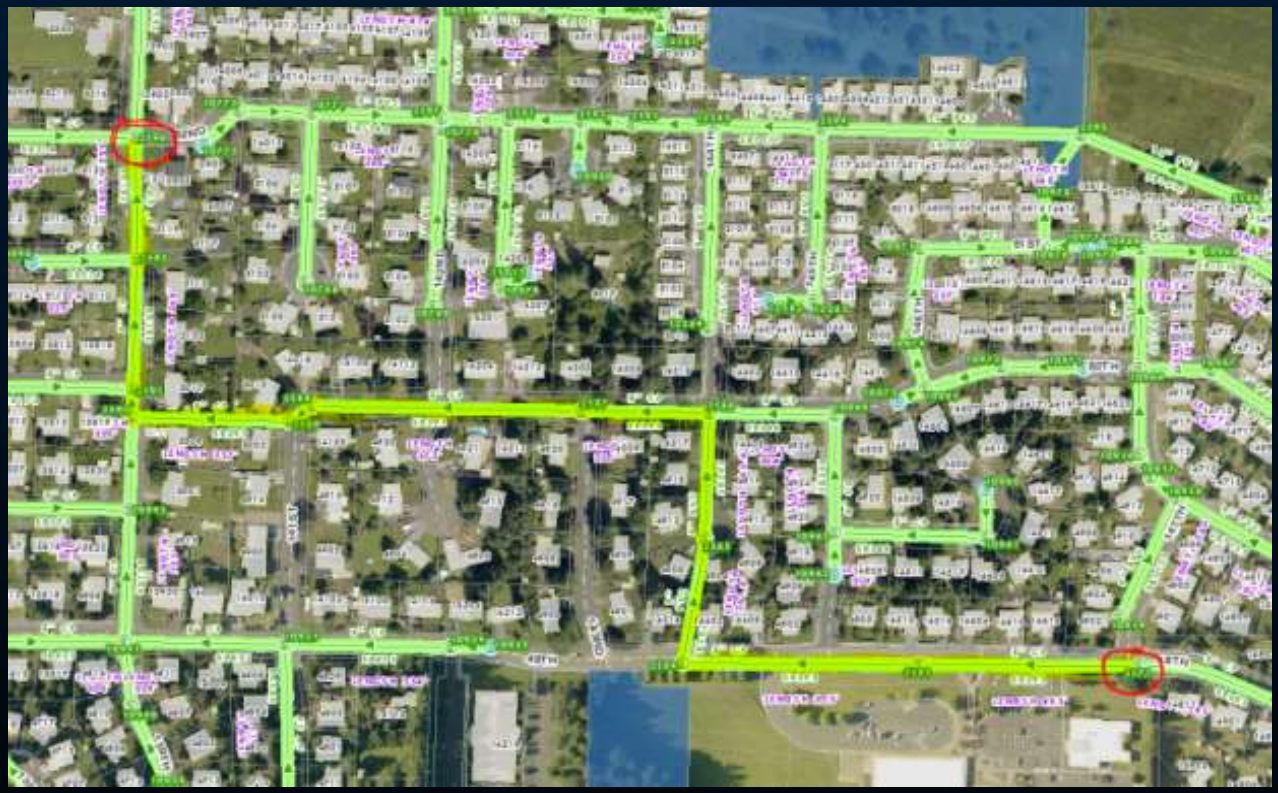
Effects on Collection System

- Hydraulic Loading
- pH
- Blockages
- Odors
- Flammables
- Inhalation Hazards / Toxic Fumes
- Corrosion
- Reactive



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Hydraulic Capacity

Large slug wastewater or continuous flow

- sewer backup or pump station overflow

- process disruptions at treatment plant

Flow equalization

Flow monitoring

Slug discharge or flow control plan

Industries of Concern	
Dairy Products Processing	Breweries
Meat & Poultry Products	Electrical/Electronic Components
Transportation Equipment Cleaning	Soap & Detergent Manufacturing
Fruits & Vegetable Processing	Centralized Waste Treatment

Source: Industrial Waste Treatment Volume I, Office of Water Programs CSU Sacramento
http://www.foxeng.com/work/sequencing-batch-reactor-wastewater-treatment-plant/

pH

Acidic or alkaline wastewater - corrosion of sewer pipes and facilities

Typical limits 5.5 - 10 on standard units scale (0 - 14)

- pH neutralization equipment
- Equalization
- Slug discharge control plans

Industries of Concern	
Dairy Products Processing	Breweries
Meat & Poultry Products	Electrical/Electronic Components
Transportation Equipment Cleaning	Soap & Detergent Manufacturing
Fruits & Vegetable Processing	Centralized Waste Treatment

Most Common Chemicals Used	
Sodium Hydroxide	Hydrochloric Acid
Sulfuric Acid	Potassium Hydroxide
Sodium Hypochlorite	
Citric Acid	

Source: Industrial Waste Treatment Volume I, Office of Water Programs CSU Sacramento

Blockages

- Fibrous or stringy materials
- Heavy solids
- Floatable solids
- FOG
  - Drain traps
  - Grease traps & interceptors
  - Dissolved Air Flotation
  - Precipitation / Clarifiers / Filter Presses

Industries of Concern	
Detention Centers (Jails)	Breweries
Meat Poultry Products	Transportation Equipment Cleaning
Restaurants	Dairy Products Processing
Fruits & Vegetable Processing	

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Flammables

Petroleum fuels
Plant based fuels / alcohols
Organic solvents
H2S

- Storage / containment
- Solvent Mgmt Plans
- LEL gas sensors

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Toxic Fumes

Toxic organic solvents
H2S
Cyanide
Chlorine
Phosgene
Arsine / Phospine

Solvent Mgmt Plans
Lab Mgmt Plans

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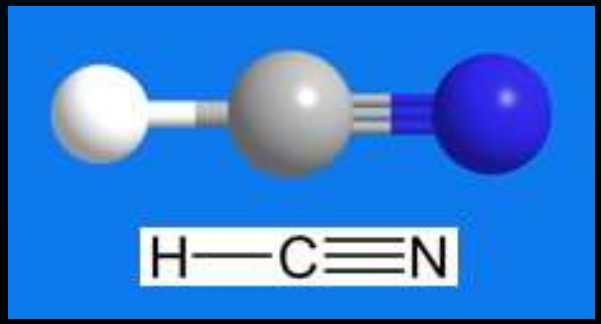
Toxic Fumes

Phosgene

- **$COCl_2$**
- **Produced UV, O_2, chloromethanes**
- **Disrupts blood-oxygen barrier in lungs**
  - **Suffocation**
- **Odor threshold 0.4 ppm, 4X TLV**

Hydrogen Cyanide

- **Colorless**
- **Flammable**
- **Extremely poisonous - binds to Fe in blood and**
- **Inhibits cellular respiration**



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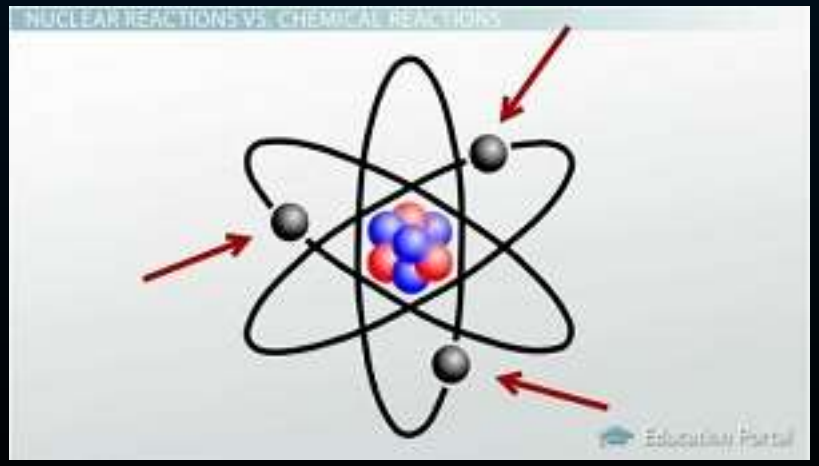
Reactive

Sodium azide
Hydrogen-producing reactions
H2S-producing reactions
Phosgene-productions reactions
    Solvent mgmt plans
    Lab mgmt plans



ts on Treatment Plant Processes

Loading

es

Hazards /

nes

n

Metals

Dyes / Photoresist

Dissolved solids

Hydraulic Loading

Large slug wastewater or continuous flow

Decrease efficiency of treatment processes

Increase solids carryover

Unit processes such as neutralization, sedimentation, and biological treatment operate best at a constant flow rate

- Flow equalization
- Flow monitoring
- Slug discharge or flow control plan

Source: Industrial Waste Treatment Volume I, Office of Water Programs CSU Sacramento
http://www.foxeng.com/work/sequencing-batch-reactor-wastewater-treatment-plant/

pH

Acidic wastewater

- Increased H2S production and odor
- Increased suspended solids from secondary clarifier such
- Decreased COD removal

Typical limits 5.5 - 10 on standard units scale (0 - 14)

- pH neutralization equipment
- Equalization
- Slug discharge control plans

Source: Industrial Waste Treatment Volume I, Office of Water Programs CSU Sacramento

Odors

H2S - sulfur bearing compounds

Amines - nitrogen bearing compounds

Putrescibles

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Flammables

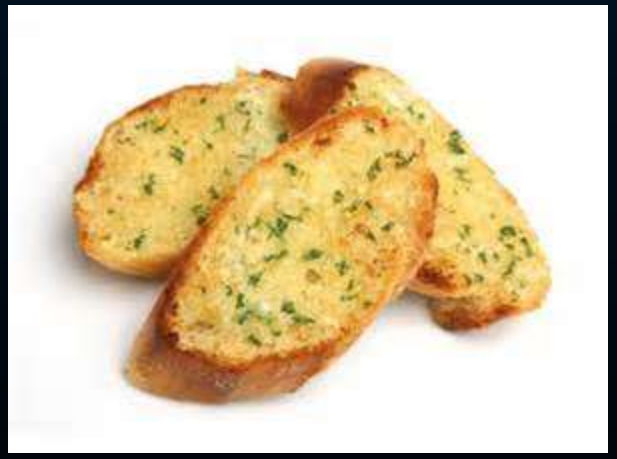
Petroleum fuels
Plant based fuels / alcohols
Organic solvents
H2S

LEL gas sensors

Toxic Fumes

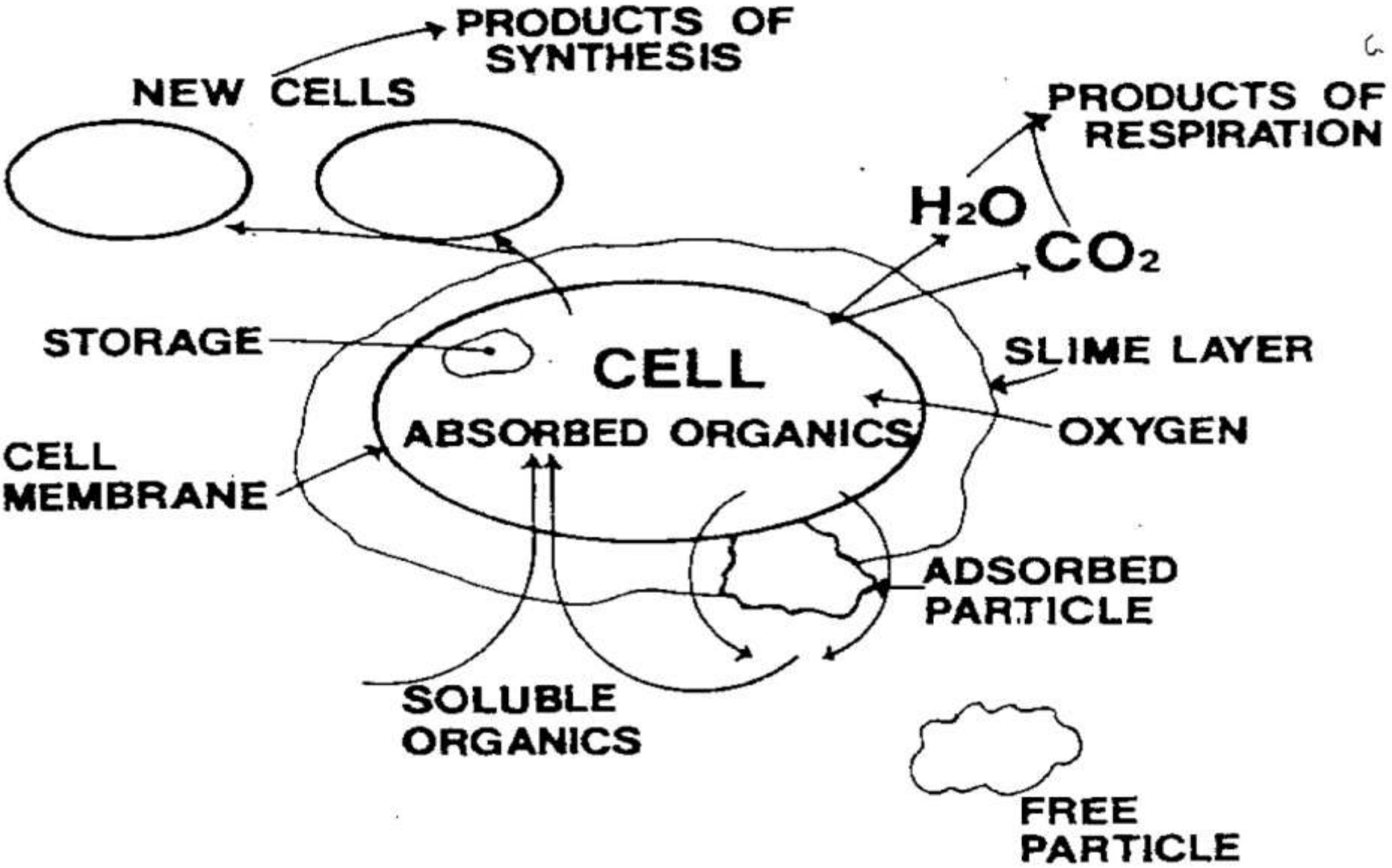
- Toxic organic solvents
- H_2S
- Cyanide
- Chlorine
- Phosgene
- Arsine / Phospine

A Word About Phosphine . . .



Metals - Zinc

- Essential for life of organisms
- Excess - toxicity *anti-microbial*
- Balance of binding with proteins & essential for numerous cellular functions - viability
- Intoxication - disrupts balance of functions especially oxidative stress and ability to take up carbon


PRODUCTS OF SYNTHESIS
NEW CELLS
PRODUCTS OF RESPIRATION
H_2O
CO_2
STORAGE
CELL
SLIME LAYER
ABSORBED ORGANICS
OXYGEN
CELL MEMBRANE
ADSORBED PARTICLE
SOLUBLE ORGANICS
FREE PARTICLE

Metals - Copper

Essential for life of organisms

Excess - toxicity *anti-microbial*

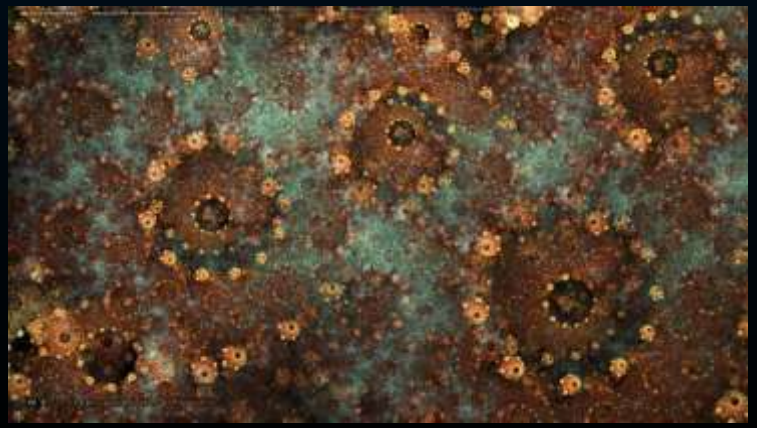
Oligodynamic effect

Balance of binding with proteins & essential for numerous cellular functions - viability

Intoxication - disrupts balance of functions - promotes development of oxygen reactive compounds

Drinking water - 1.3 mg/L EPA Standard

Organic ligand vs. metallic



Metals - Copper

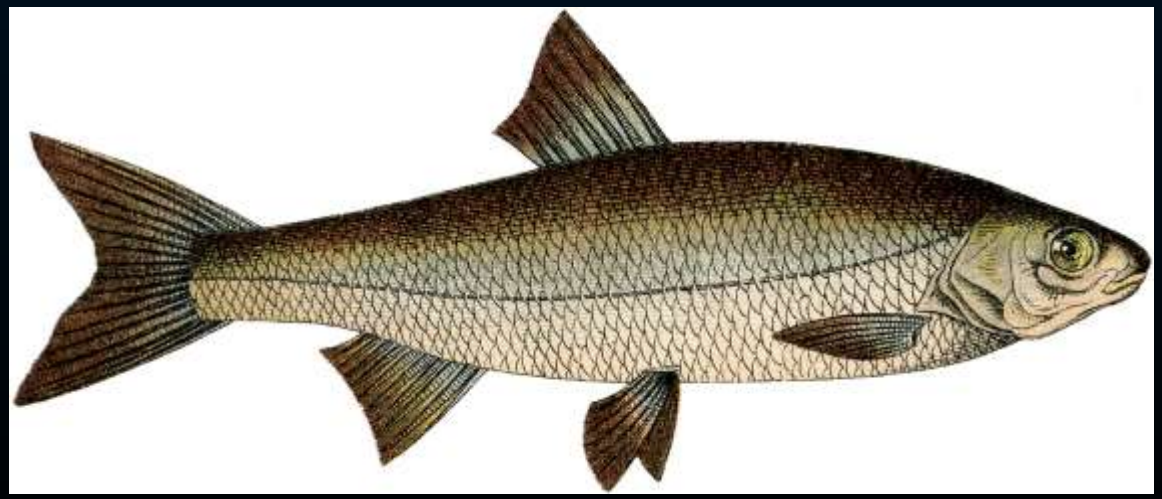
Essential for life of aquatic life

Excess . . .

Acute - mortality

Chronic - survival, growth and reproduction

(Brain function, metabolism, enzyme activity, blood chemistry)



Metals - Cadmium

Catalyst in forming reactive oxygen compounds

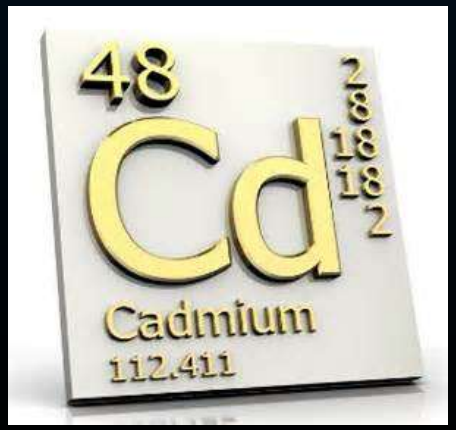
Exposure:

- Uptake in plants from soils
- Cigarette smoke
- Workplace inhalation

Low limits for Biosolids application

Batteries, pigments, plastic stabilizers, platings, photovoltaics

Buildup in kidneys - renal failures



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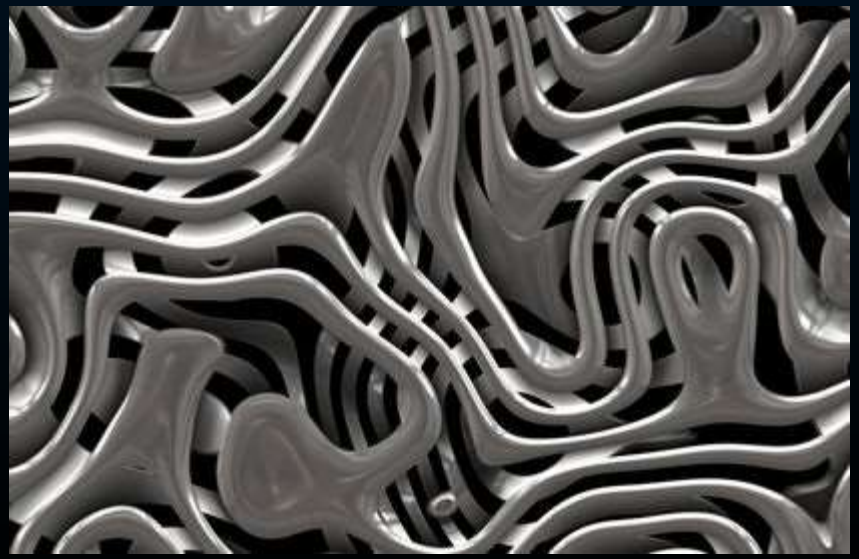
Metals - Chromium

- Inhibits respiratory activity and cellular growth - activated sludge
- Inhibition of nitrification process Cr+6
- Higher concentrations
- Cr+6 crosses membrane into cell & forms Cr+3



Lead

7-day toxicity much greater than 24-hour
Particularly degrading to nitrification
OUR responds quickly to addition of Pb

Developing nervous systems - children
Wide range neurological effects
Renal effects and gout
Interferes and inhibits enzymatic and hormonal conversions e.g. Vitamin D

Mercury

May inhibit cellular growth

Accumulates in aquatic food chain - methylated form

Treatment plants removed 90% of Hg

Ingestion of metallic mercury - typically 0.01% absorbed into body. For organic mercury, 95%

Inhalation of vapors - 80%

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Nickel

Inhibits respiratory activity and cellular growth – activated sludge
Inhibition of nitrification process

Carcinogen (Ni compounds)
Dermatitis

Effects on Plant Effluent / Receiving Waters

Bioaccumulation in aquatic life & food chain
Hormonal disruptions
Fish behaviorial disruptions

Anaerobic Digestion

Anaerobic systems have a narrower spectrum of life forms and are more sensitive to heavy metals

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Microbeads

Tiny bits of plastic - soaps, cosmetics
Can adsorb toxic compounds
Ingested by fish

Microbead-Free Waters Act
Of 2015

2017 !

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Total Dissolved Solids

Minerals, salts, anions, cations, metals dissolved in water

Typ. Magnesium, sodium, potassium, borates, chlorides, calcium, carbonates, sulfate

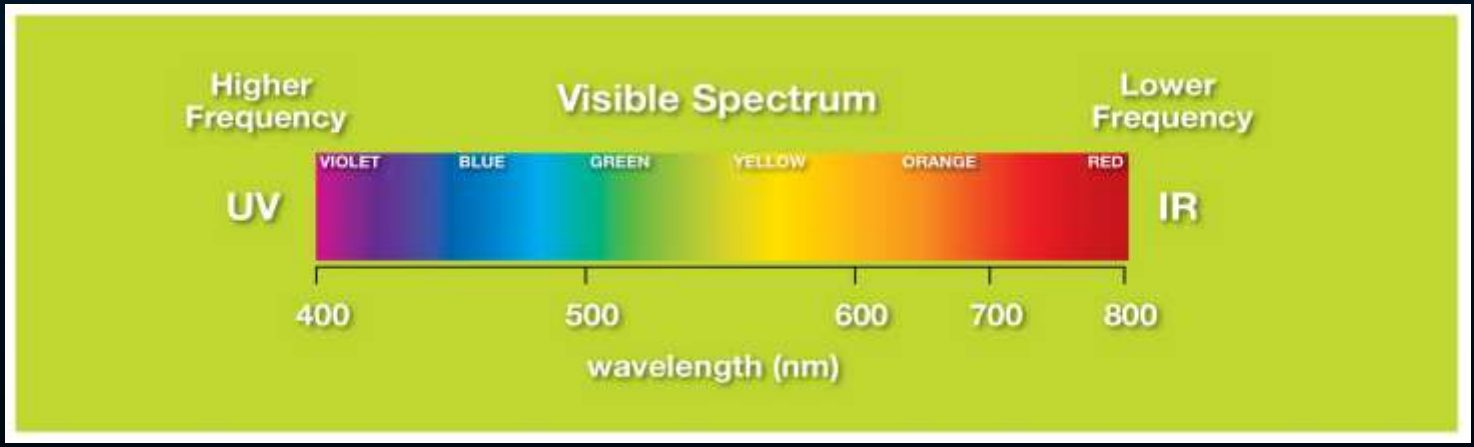
Affects to Whole Effluent Toxicity tests

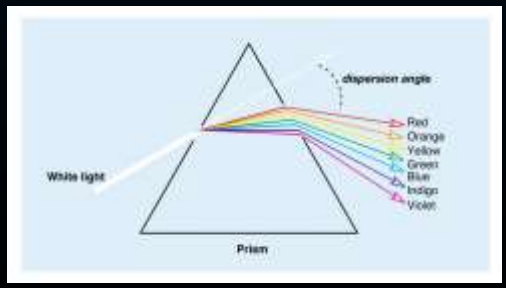
General ROT: 1,500 mg/L or higher

Varies - hardness, composite of TDS, species tested

Dyes / Photoresist

Affects transmittance of UV light in water for disinfection





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A Word on Perfluorinated Compounds

PFAS – perfluoroakyl substances
PFOA – perfluorooctanoic acid
PFOS – perfluorooctane sulfonate
Bioaccumulative, persistent
Possible growth inhibition, mortality

Water and stain resistant materials
Keep food from sticking to packaging

A Word on Nonylphenols . . .

Highly toxic to fish, aquatic invertebrates, plants

As low as 0.12 mg/L

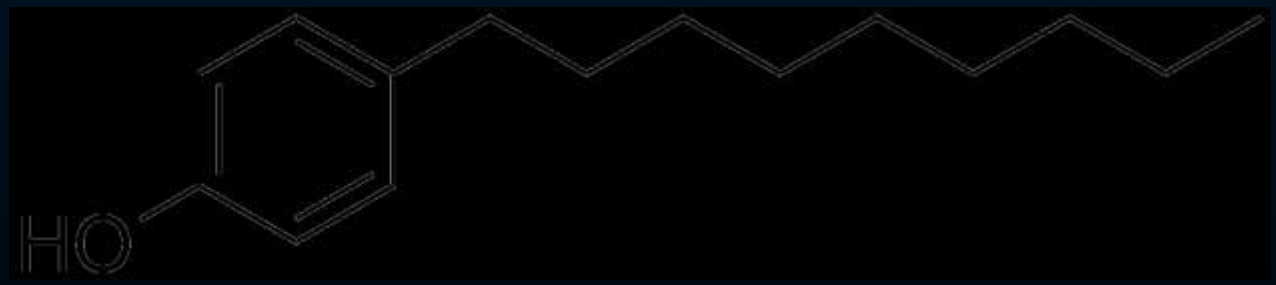
Industrial laundries

Textile & paper coatings

Adhesives

Degreasers

Deicers



Encourage uses of other alkylphenols

A Word on Sodium Azide . . .

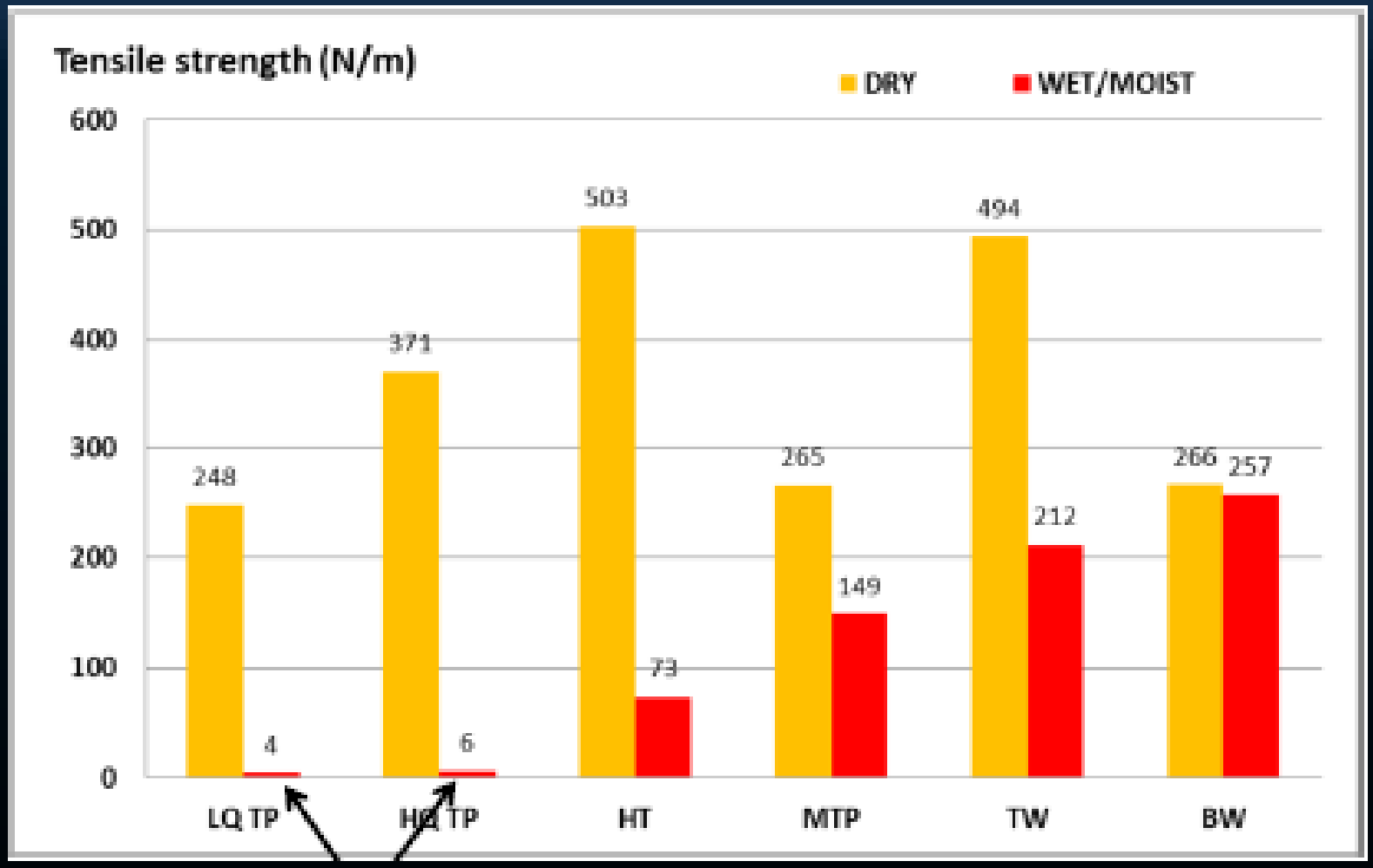
NaN_3

Biocide in hospitals

Similar to CO – attaching to hemoglobin

Reactive – acids

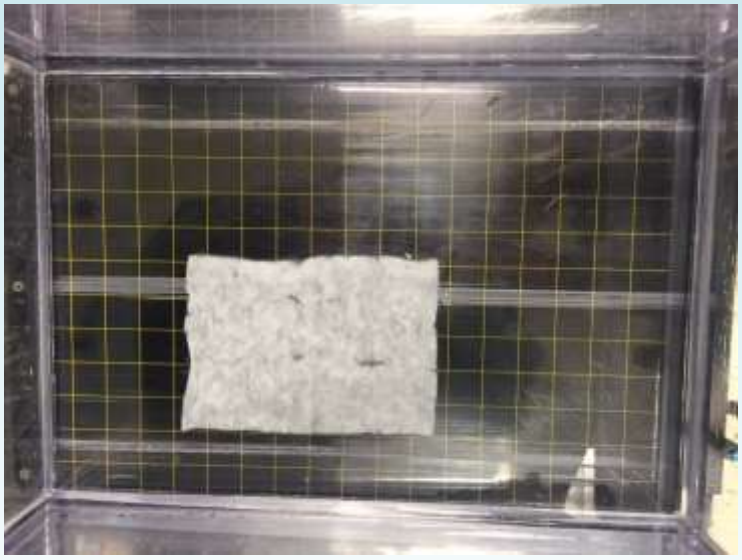
Dry & Wet Strength



Slosh Box – Reynold's # Correlation

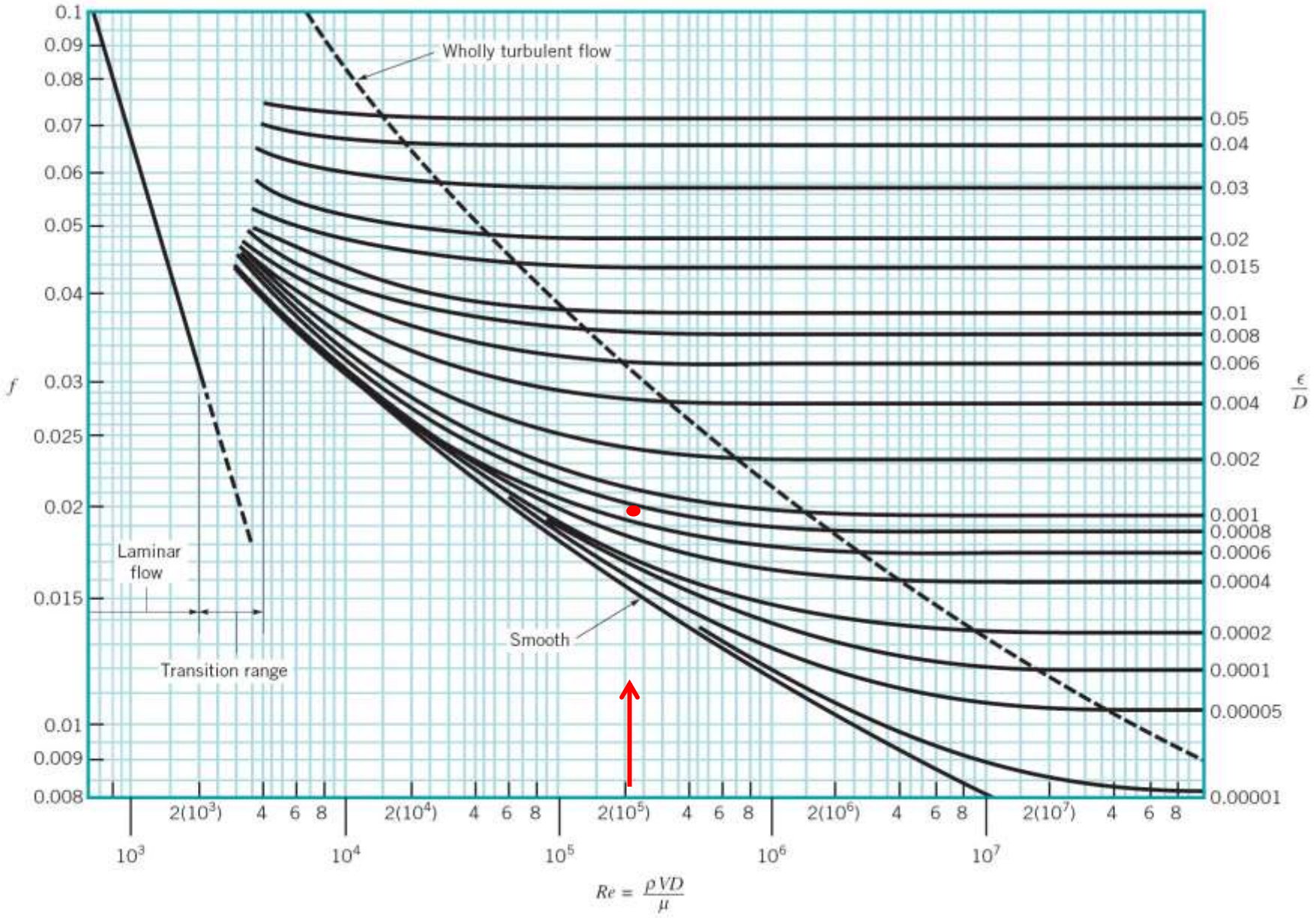
$$Re = R_h V \rho / \mu$$

Ratio of inertia force, and viscous (friction) force

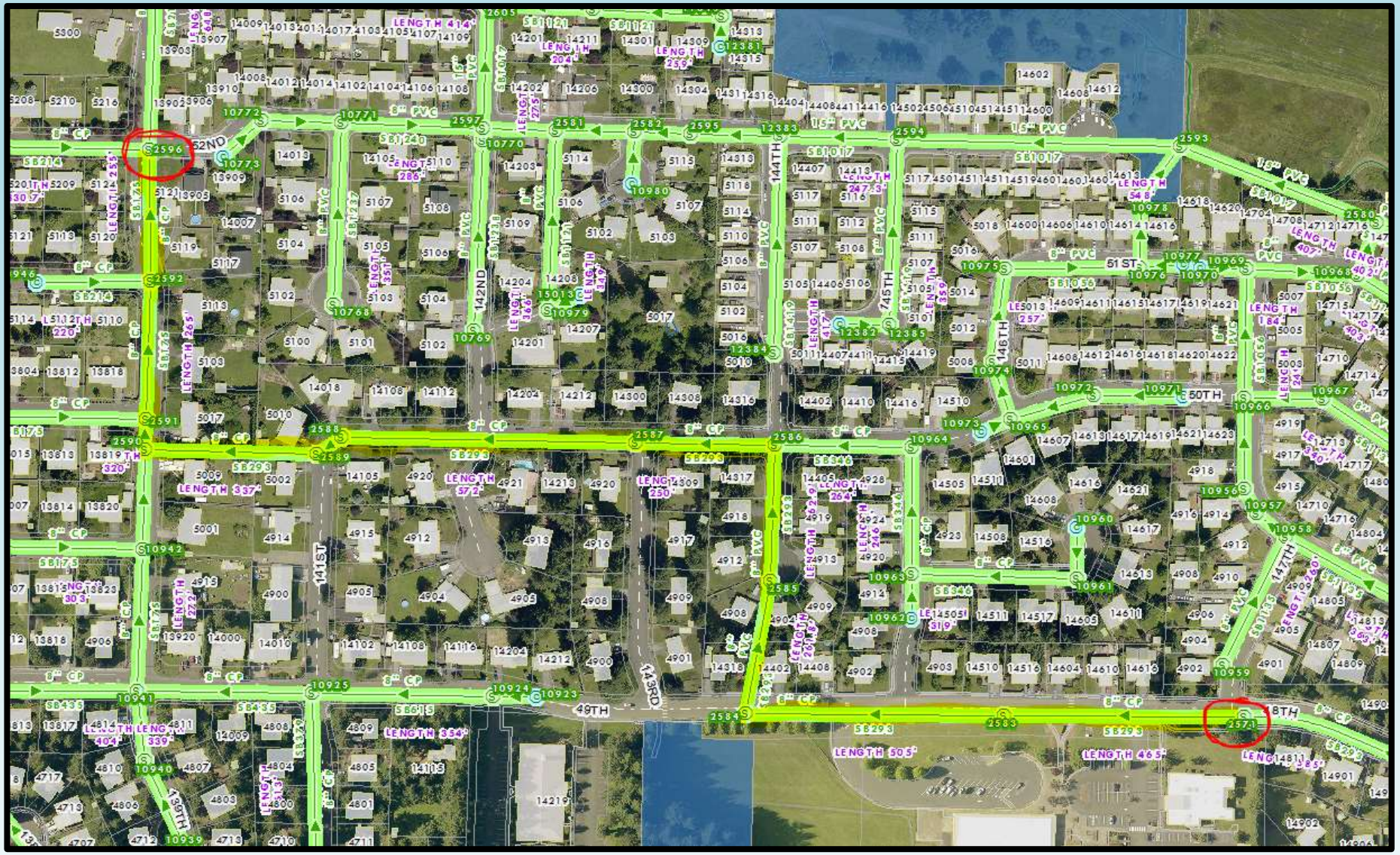


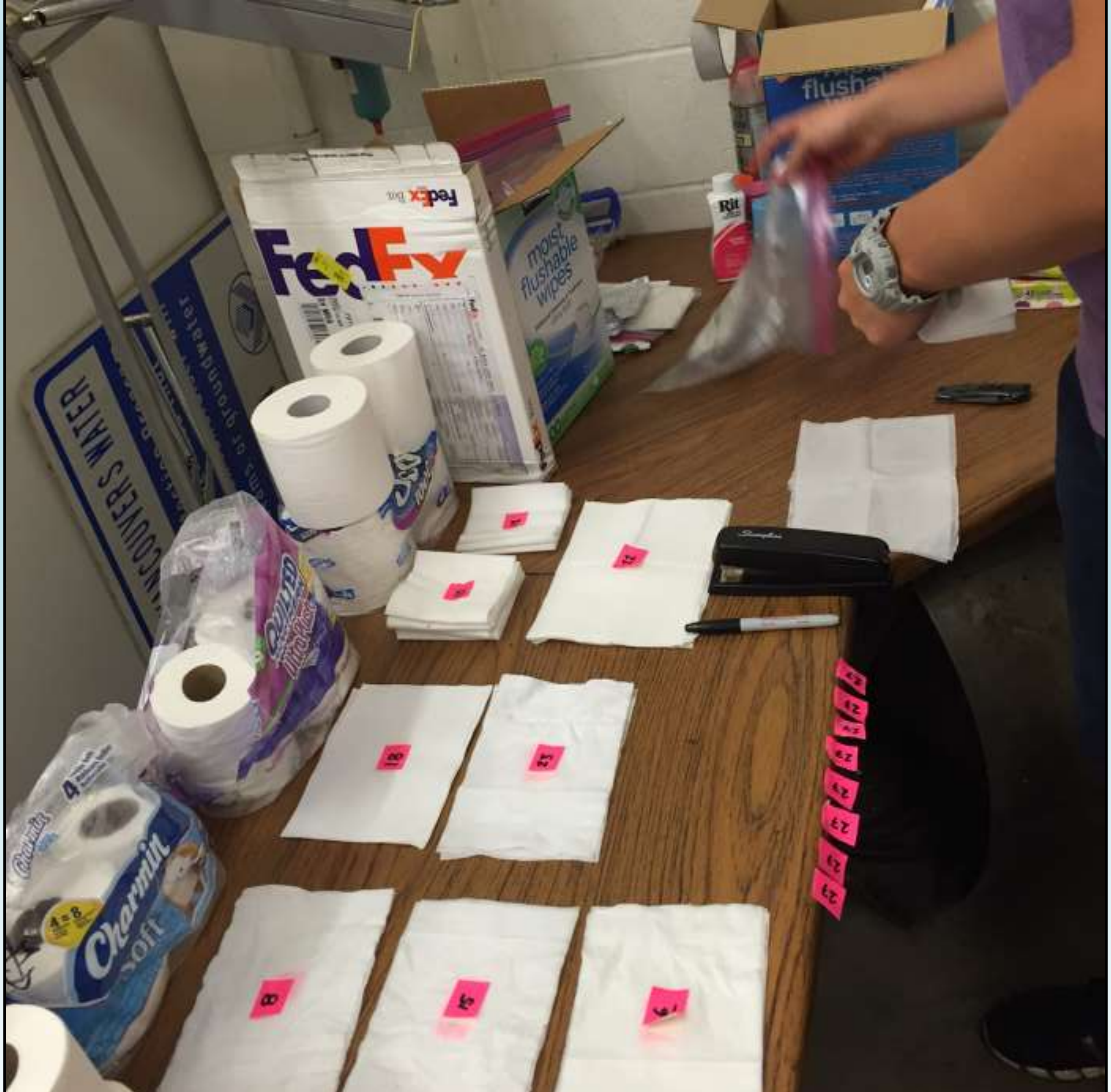
20,000

8” sewer lines
2 fps
0.0022 slope


Wholly turbulent flow
Laminar flow
Transition range
Smooth
f
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.025
0.02
0.015
0.01
0.009
0.008
0.05
0.04
0.03
0.02
0.015
0.01
0.008
0.006
0.004
0.002
0.001
0.0008
0.0006
0.0004
0.0002
0.0001
0.00005
0.00001
ε/D
2(10^3)
4
6
8
2(10^4)
2(10^5)
2(10^6)
2(10^7)
10^3
10^4
10^5
10^6
10^7
Re = ρVD/μ

South Interceptor 1.5 fps 32 min (2,816 ft)


52ND
51ST
50TH
49TH
141ST
142ND
144TH
145TH
146TH
147TH
148TH


moist flushable wipes
Charmin
Soft
Rit


HOMER'S
ALL-PURPOSE
BUCKET
5 Gallons