WASTEWATER IN-PLANT TRAINING SESSION 3

SESSION 3: Primary Solids & Clarification

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Thank You!

Sponsor:

Better Plants
U.S. DEPARTMENT OF ENERGY

Host:

Opportunity Register Thoughts?

Opportunity #	Opportunity Name	Description	Location	System*	Submitted By

Today's Agenda

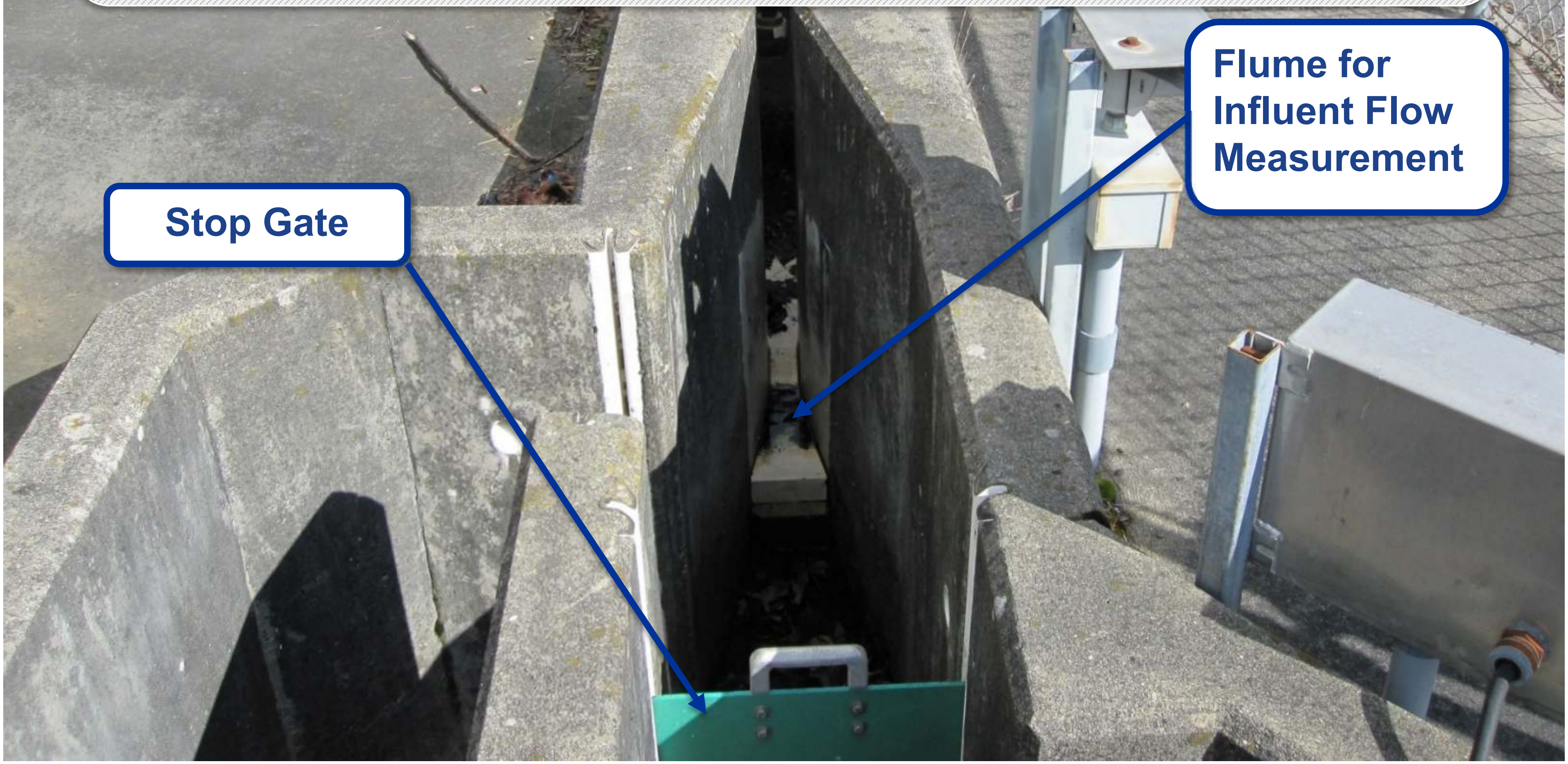
	Welcome/Opening
	Headworks
	Primary Solids & Clarification
	Break
	W3 Check-in & Report outs
	Energy & PD Blowers
	Opportunity Register Jam
	Wrap-up

Value Matrix

HEADWORKS

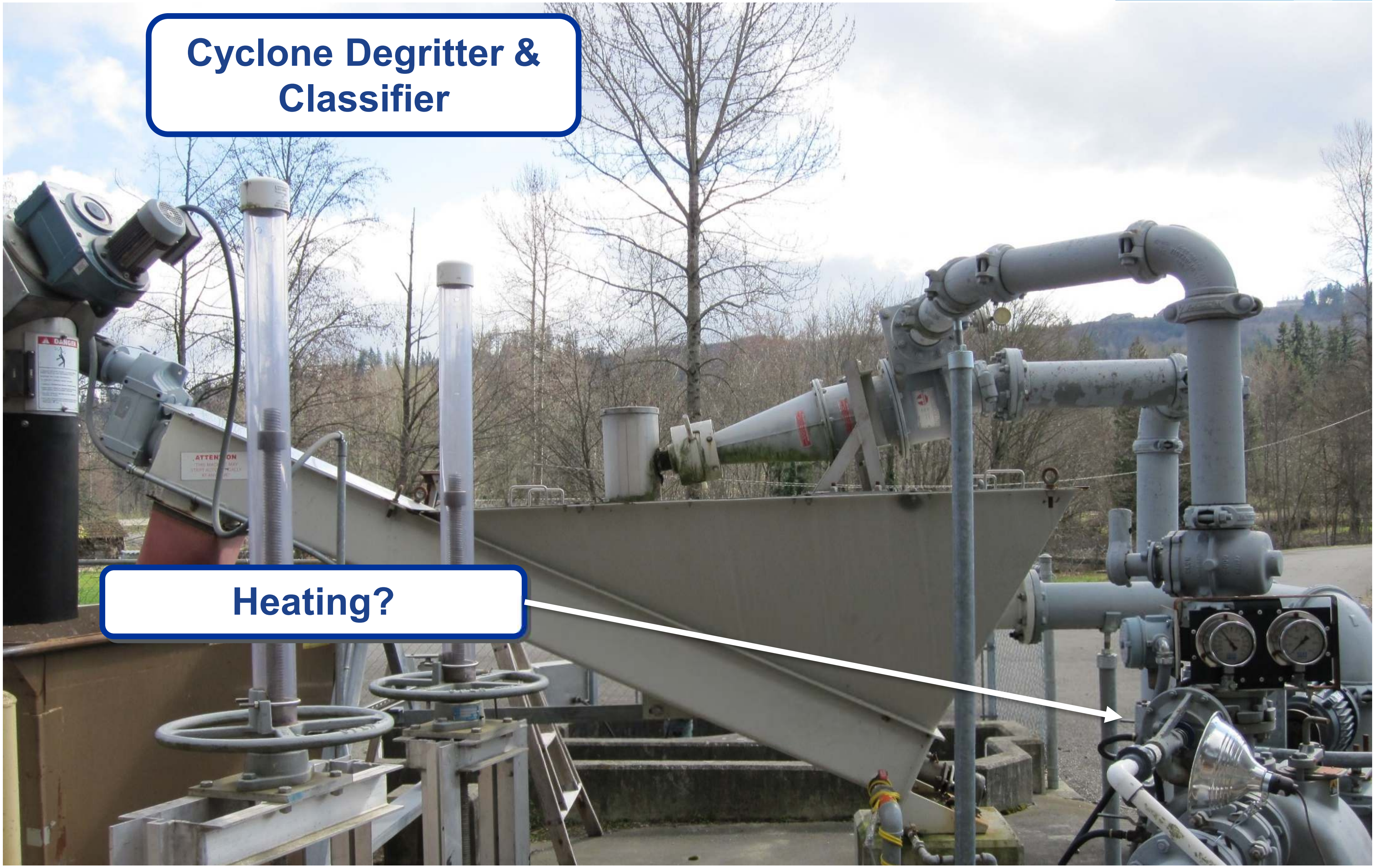
Headworks

- Fine and/or coarse screening
- Grit removal
- Goal is to remove inorganic material from the waste stream

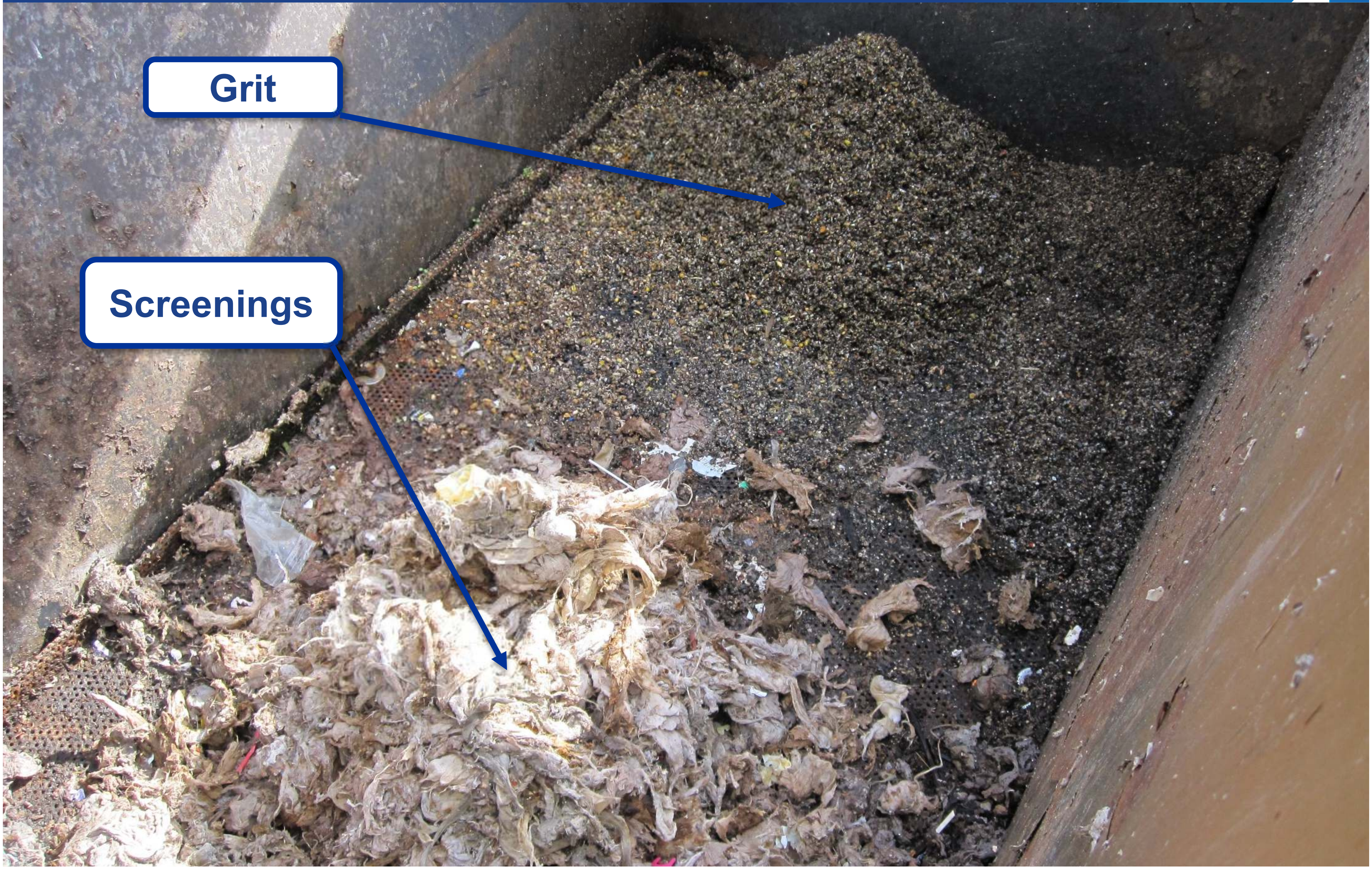


Screening

Grit Removal



Grit Removal



Headworks - What You Can Control to Save Energy

Process

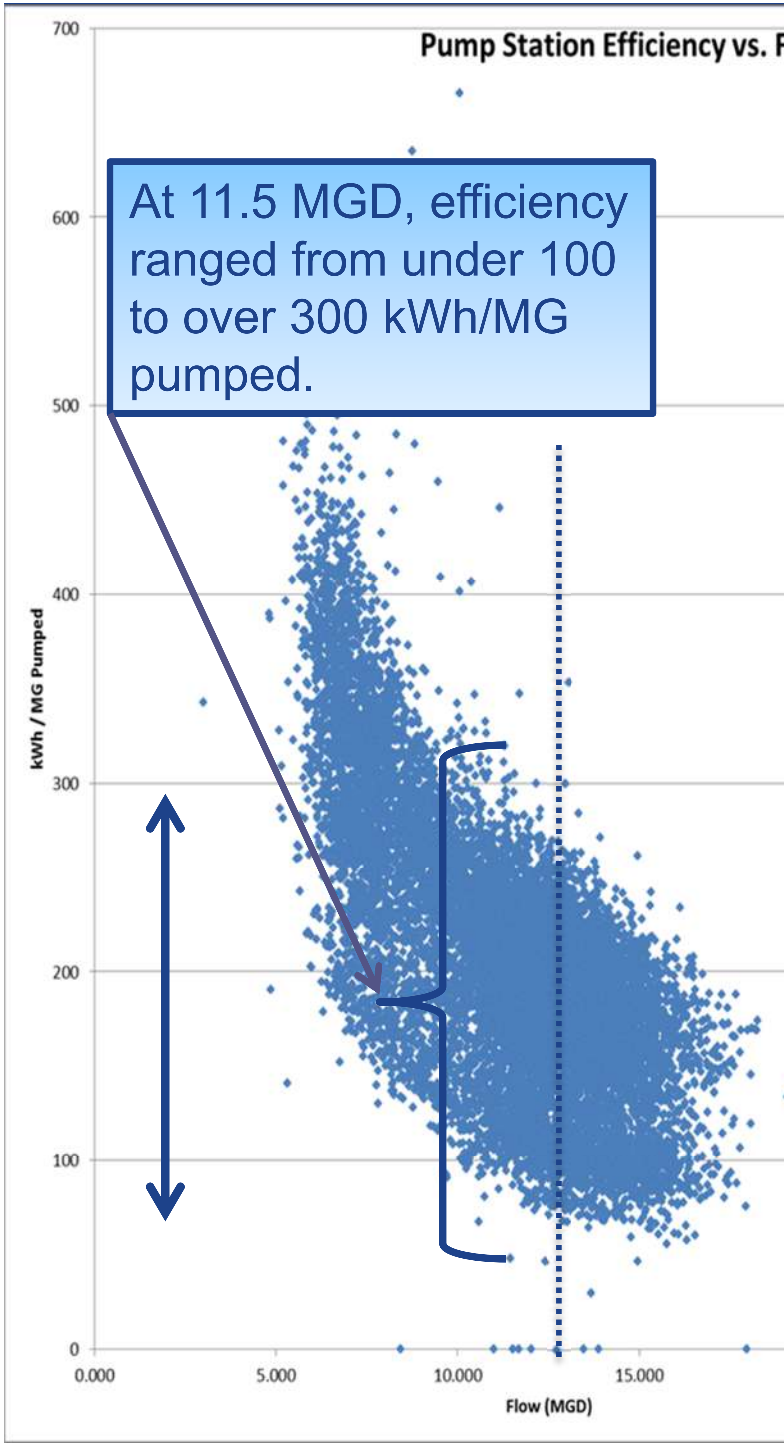
→ Good capture saves $ and energy in downstream process

Mechanical

- Aeration (for aerated grit)
- Minimize plant water use (e.g. sluice water)
- Timing cycle
- Interlocks on ancillary equipment

Other Headworks Considerations

- How much channel agitation air do you need (really)?
- Can you run fewer trains? Perhaps seasonally?
- The better your screens, the less you need to worry about downstream equipment. Consider semi-open impellers rather than full open for sludge pumps, ML recirc., etc.
- Are you taking advantage of NFPA allowance for reduced airflow in cold weather?



At 11.5 MGD, efficiency ranged from under 100 to over 300 kWh/MG pumped.

Pump Operating Regime	Total operating time (HOURS)	Percent of Total Runtime	Average flow (MGD)	Average kWh/MG Pumped	Flow % Offset from Ave	Eff % Offset from Ave
Pump Station Overall	1156.3		11.5	204.3	0.0%	0.0%
BIG ALONE						
Pump 1 Alone	63.8	5.5%	10.9	140.2	-5.9%	31.4%
Pump 5 Alone	143.8	12.4%	12.2	126.8	6.0%	37.9%
Subtotal / average		**17.9%**	**11.5**	**133.5**	**0.1%**	**34.7%**
SMALL ALONE						
Pump 3 Alone (only 4 points)						
SMALL COMBO						
Pump 3+4	38.2	3.3%	12.9	100.3	12.2%	50.9%
Subtotal / average		**3.3%**	**12.9**	**100.3**	**12.2%**	**50.9%**
BIG COMBO						
Pump 1+2	19.8	1.7%	11.6	222.3	0.8%	-8.8%
Pump 1+5	234.8	20.3%	11.5	246.1	-0.7%	-20.4%
Pump 2+5	24.0	2.1%	11.4	243.3	-1.6%	-19.1%
Subtotal / average		**24.1%**	**11.5**	**237.2**	**-0.5%**	**-16.1%**
ONE BIG, ONE SMALL						
Pump 4+1	90.3	7.8%	11.7	202.4	1.4%	0.9%
Pump 4+5	182.6	15.8%	11.3	209.3	-1.9%	-2.5%
Pump 3+1	73.6	6.4%	11.6	200.6	0.3%	1.8%
Pump 3+5	117.8	10.2%	11.1	208.7	-3.6%	-2.1%
Subtotal / average		**40.1%**	**11.4**	**205.3**	**-0.9%**	**-0.5%**
TWO BIG, ONE SMALL						
Pump 3+2+5 (3 points)						
Pump 3+2+1 (5 points)						
TWO SMALL, ONE BIG						
Pump 4+3+1	34.6	3.0%	13.3	206.1	15.3%	-0.9%
Pump 4+3+5	128.7	11.1%	10.9	260.0	-5.8%	-27.3%
Subtotal / average		**14.1%**	**12.1**	**233.1**	**4.7%**	**-14.1%**
TWO SMALL, TWO BIG						
Pump 4+3+1+5 (only 5 points)						

Some pump combinations should be avoided.

DISINFECTION

Chlorination vs. UV
(Energy Perspective)

Chlorination

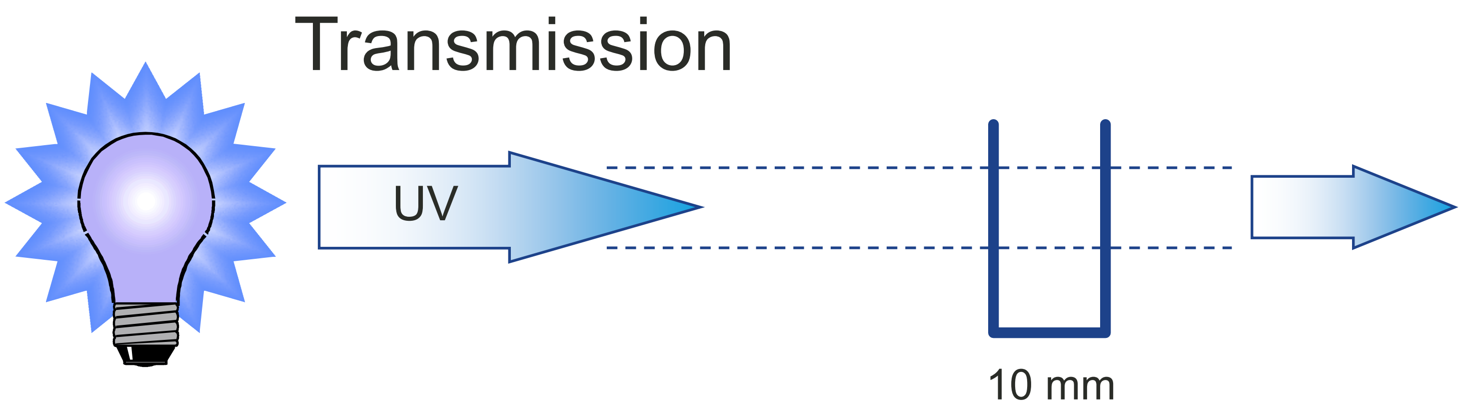
1. Chlorine's energy footprint is invisible to the plant
2. Over-chlorination is expensive and prohibited by regulations

UV

1. UV is a known "energy hog"
2. Overkill is rampant
3. Regulators promote overkill

UV Disinfection

UV Dose



UV Dose = Intensity x Retention time

Expressed as: mWsec/cm^2 or mJ/cm^2

UV Transmission (UVT) is a measurement of the ability of UV light to penetrate water

*Acknowledgement: Cynthia Bratz, Tetratech

Typical Transmittance Values

Wastewater	UV Transmittance,%
Primary	28 to 50
Secondary	45 to 70
Nitrified secondary	56 to 79
Filtered secondary	56 to 86
Microfiltration	79 to 91
Reverse osmosis	89 to 98

Lower % UVT requires higher UV energy input for equal UV dose

Acknowledgement: Cynthia Bratz, Tetratech

Factors Affecting Performance

- Factors affecting intensity
  - UVT
  - Suspended solids
  - Dissolved organics, humic materials, dyes
  - Metals (particularly iron and manganese)
  - Particle size
  - Lamp and sleeve condition

**Acknowledgement: Cynthia Bratz, Tetratech*

Factors Affecting Performance

- Lamp and sleeve conditions
  - Quartz sleeve fouling
    - Effluent total hardness
    - Metals
    - Other fouling
  - Lamp age
  - Lamp temperature
  - Power supply

*Acknowledgement: Cynthia Bratz, Tetratech

Miminizing the “Hog” in the UV Energy Hog

- Start now: Collect UVT data
- Get involved with the consultants during planning through design. . . Ask hard questions!
- Designate one UV ops expert

Opportunity Register Thoughts?

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Relating Plant Process to Energy

Session 3: Solids and Primary Clarification

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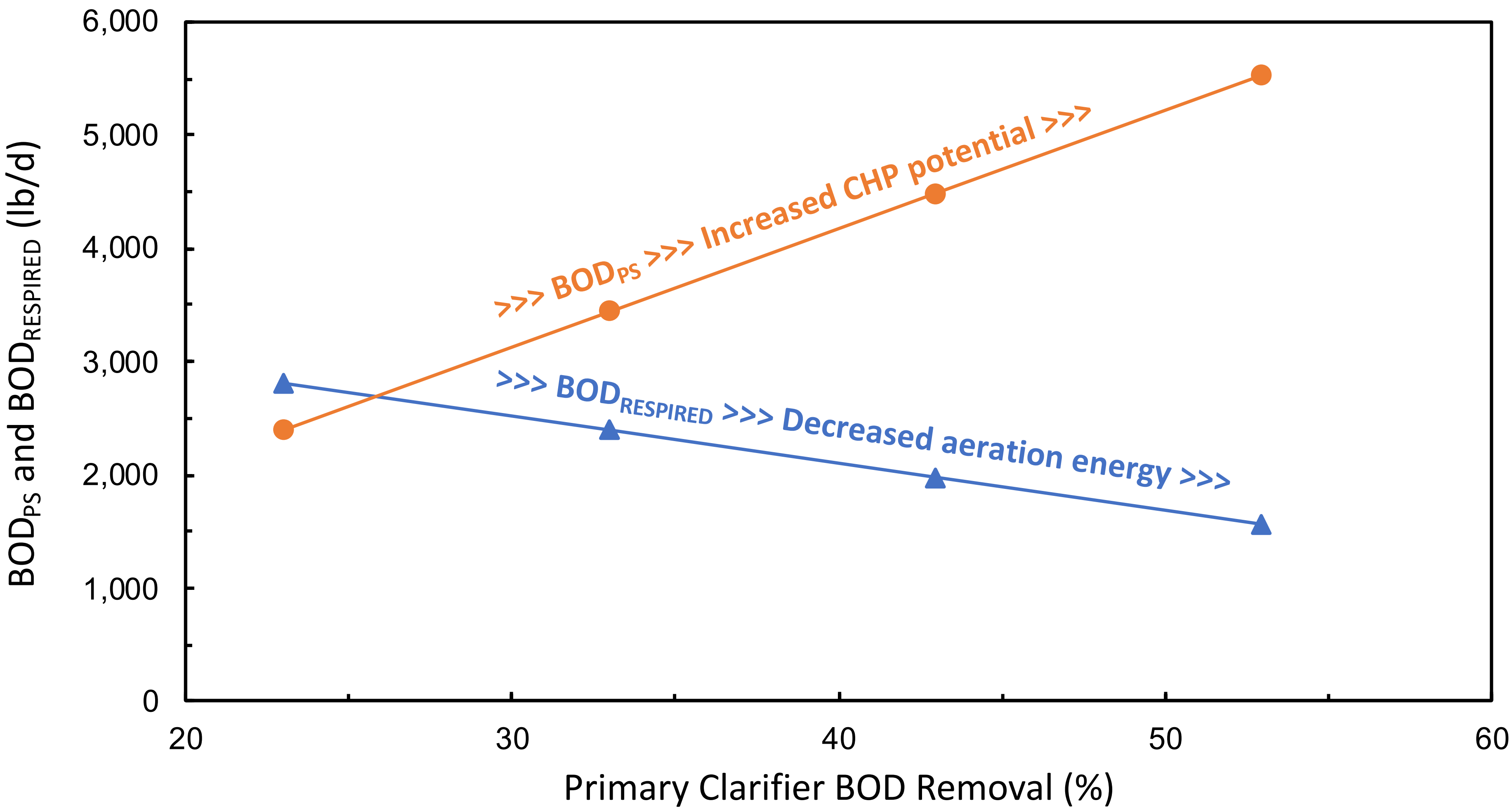
Primary Clarifiers: Why We Should Care

Primary clarifiers remove more BOD for less operating expense than any other treatment process.

An Optimized Primary Clarifier is an Optimized Plant

Primary clarifier BOD removal (%)	BOD_{PS} (lb BOD/d)	BOD_{PE} (lb BOD/d)	BOD_{WAS} (lb BOD/d)	$BOD_{RESPIRED}$ (lb BOD/d)	BOD_{PS}/BOD_{WAS}
23	2,398	8,027	4,816	2,811	0.50
33	3,440	6,985	4,191	2,394	0.82
43	4,483	5,942	3,565	1,977	1.26
53	5,525	4,900	2,940	1,560	1.88

Increasing BOD Removal Efficiency in Primary Clarifiers Gives Double Whammy

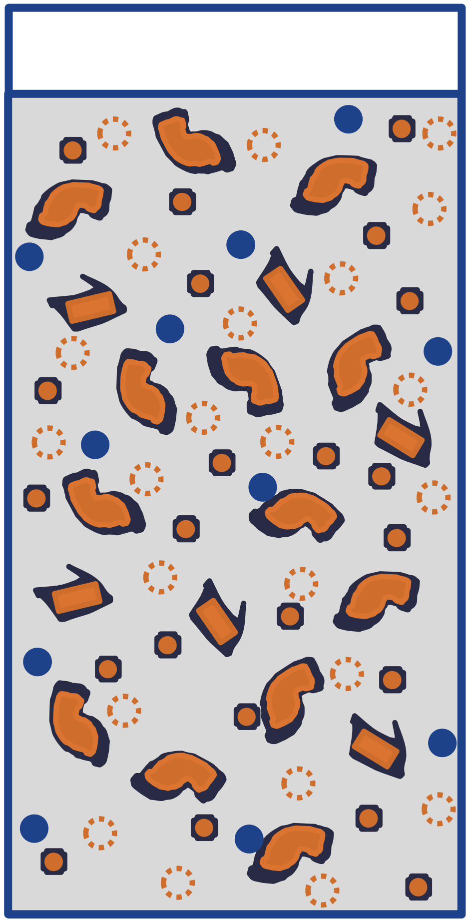


Primary Clarifier Removal Efficiencies All Operators Have Committed to Memory

1. >95% settleable solids
2. 40−60% TSS
3. 20−40% BOD

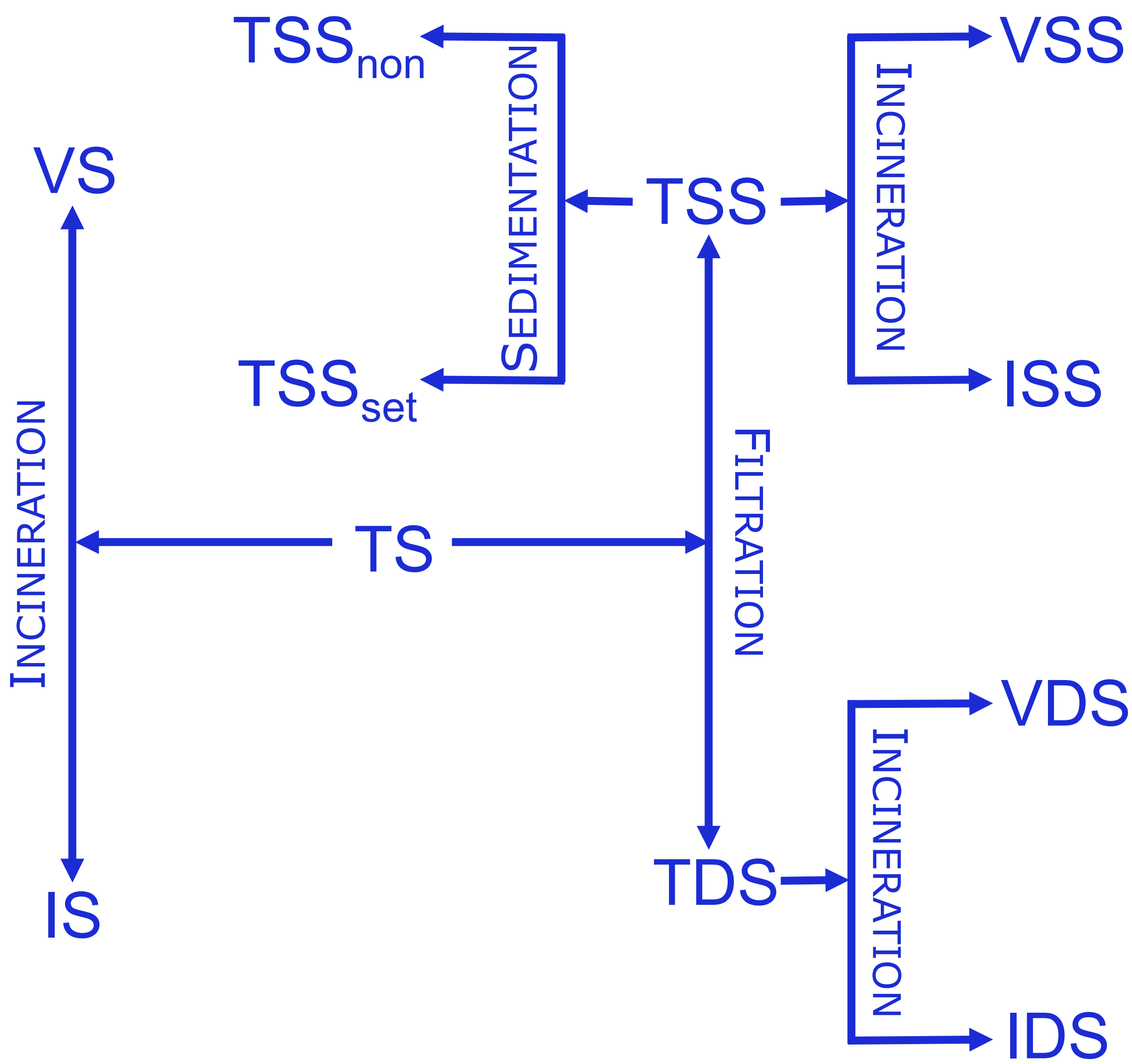
Where do these numbers come from?
Are they in our control?

Plant-wide Energy Impacts Require Understanding Solids



Primary clarifier performance **defined** by two kinds of solids: those that settle and those that don't

Presenting the Universe of Wastewater Treatment



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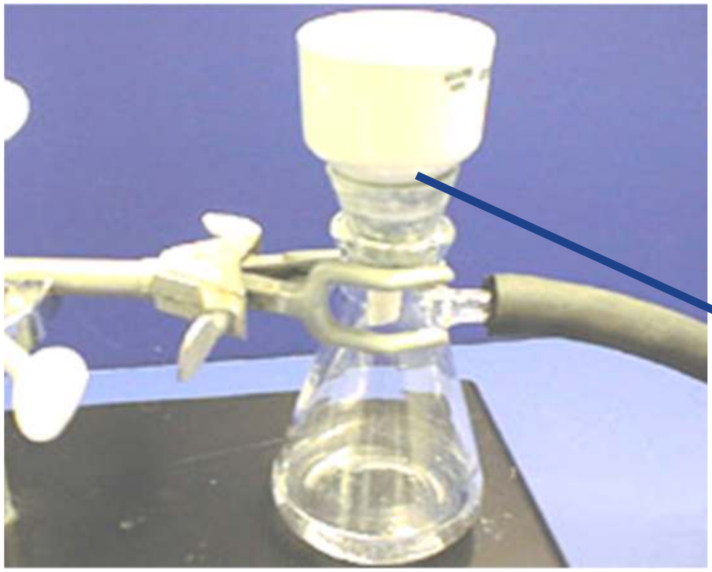
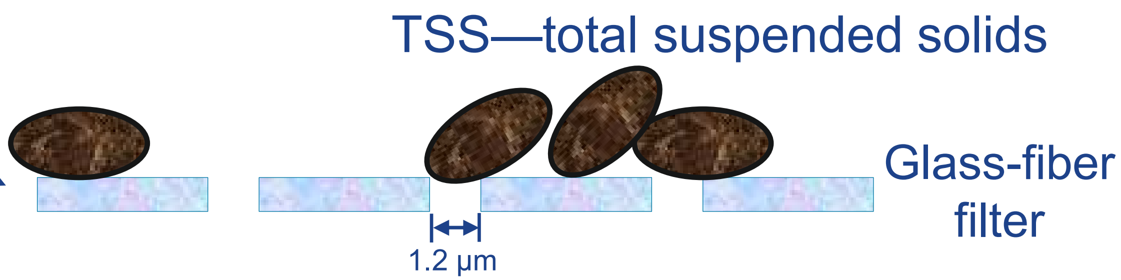
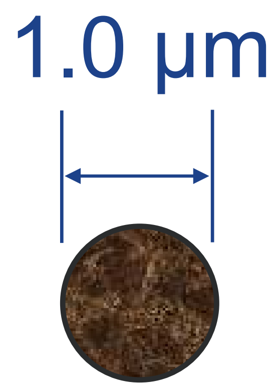
Filtration Separates TS into TSS and TDS

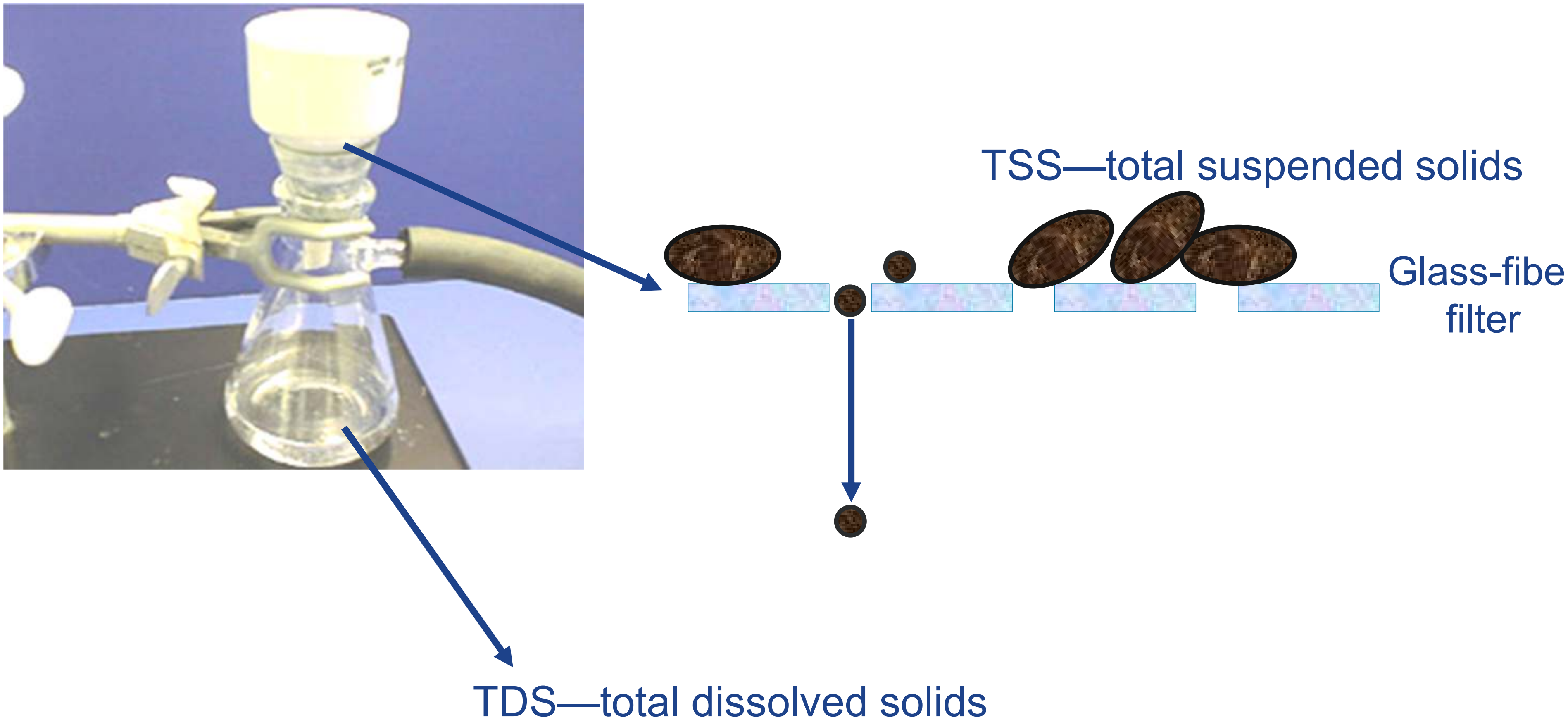




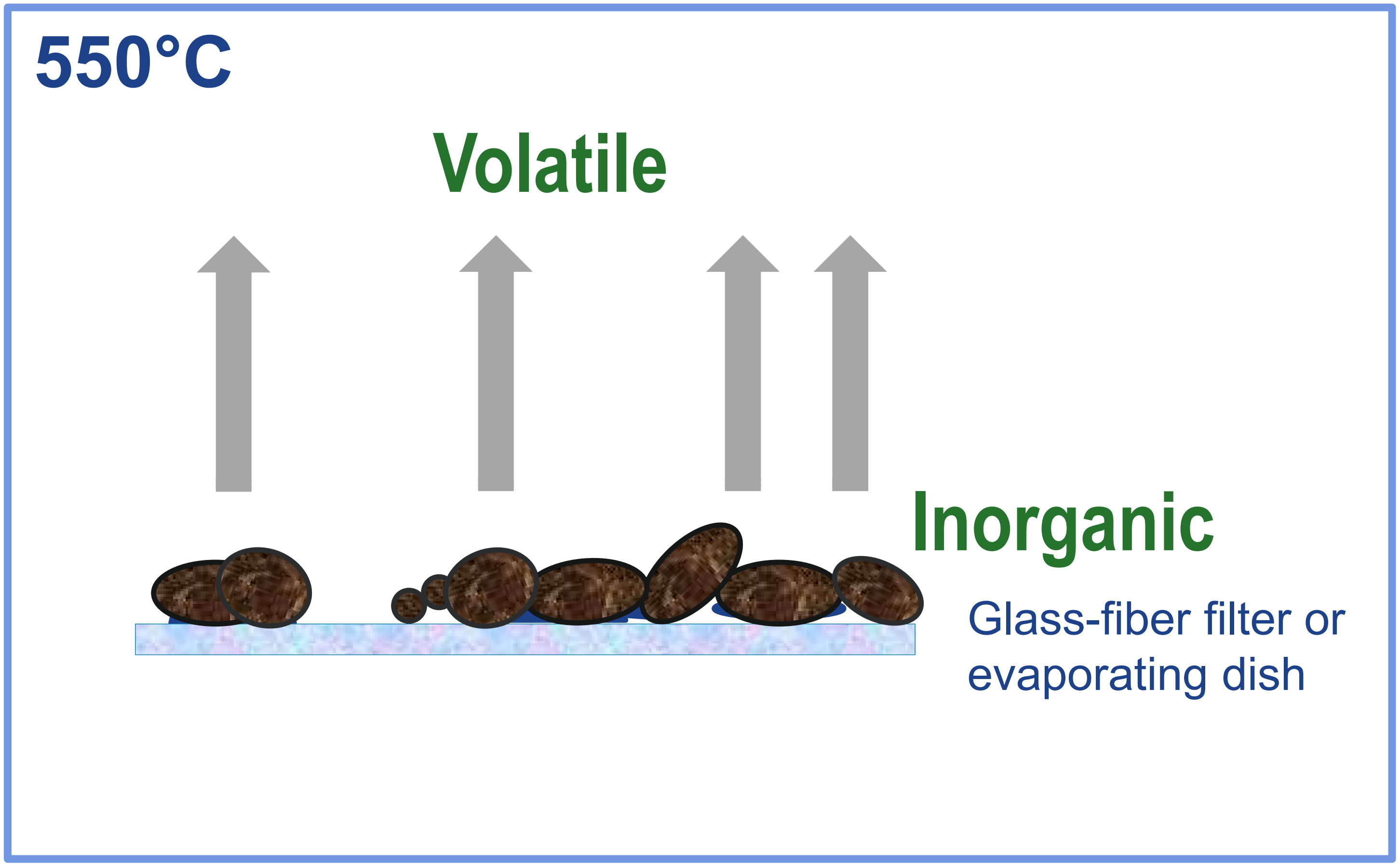
Colloids Are Particles with a Maximum Dimension Between 0.001 and 1.0 µm



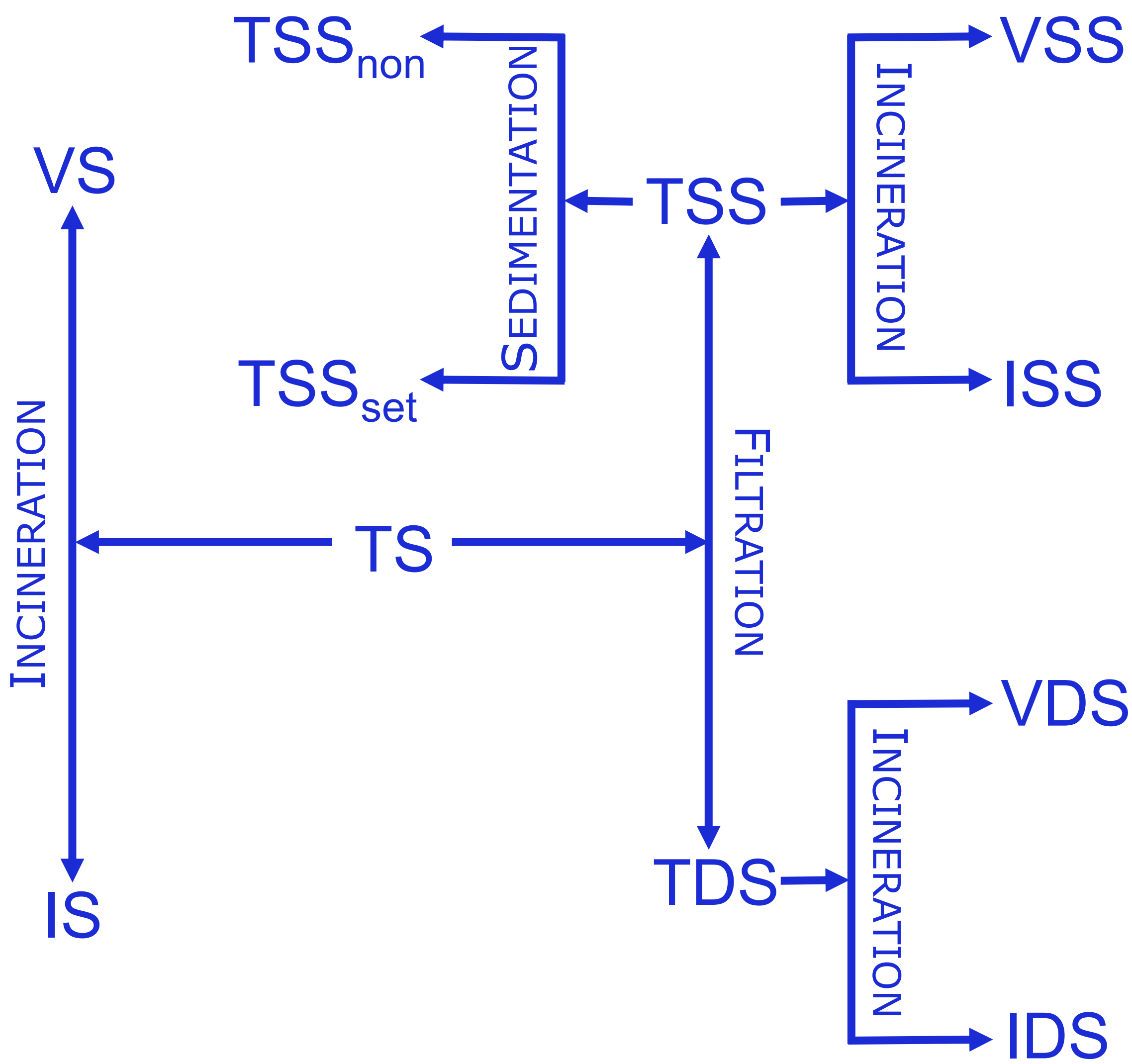
Filtration Separates TS into TSS and TDS



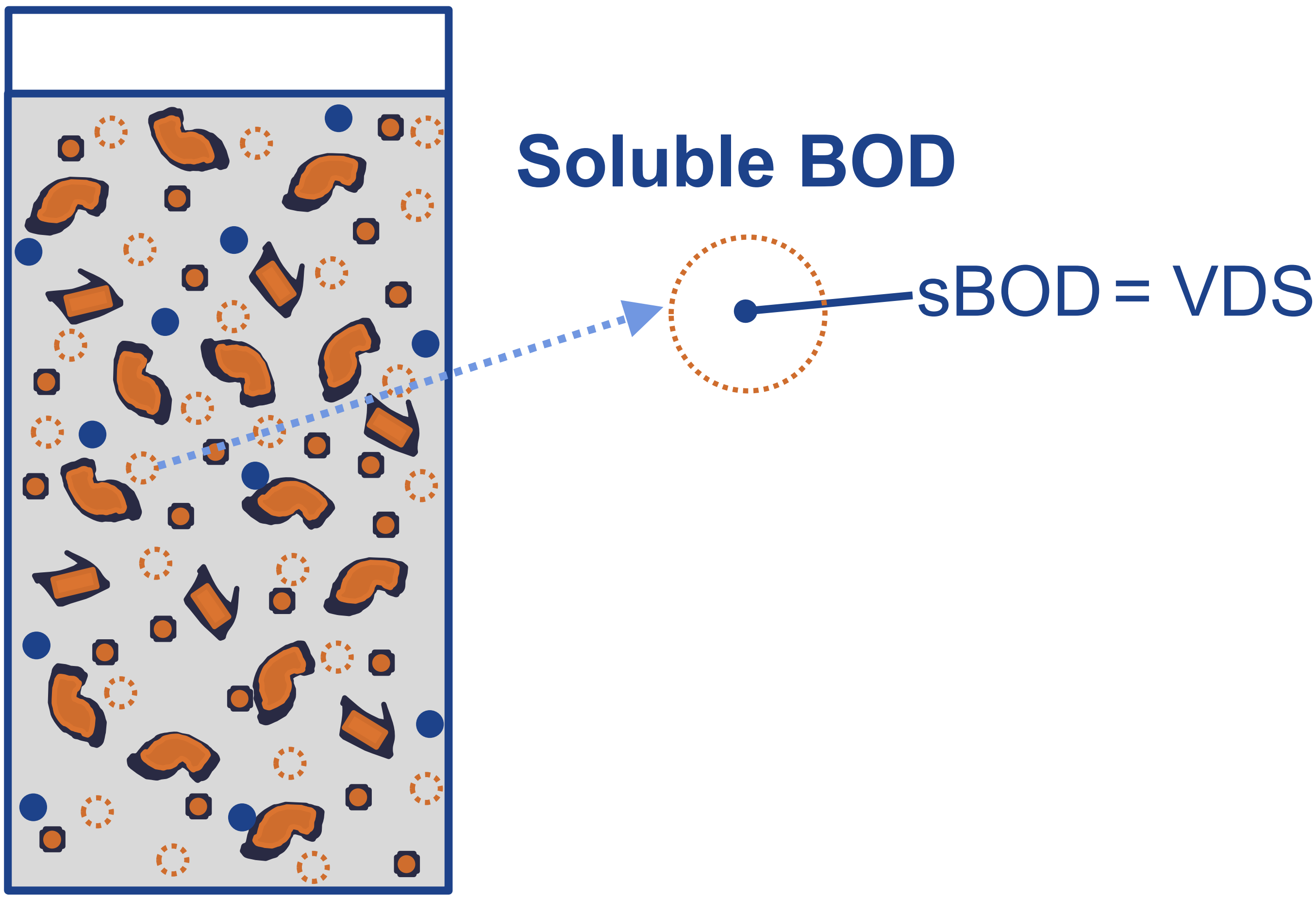
Incineration Separates TS into VS and IS; TSS into VSS and ISS; TDS into VDS and IDS



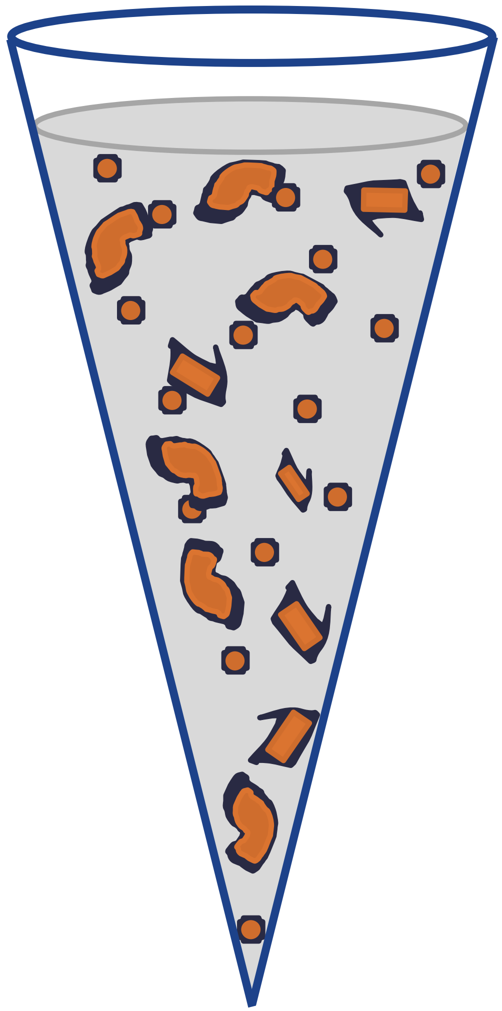
Where's the BOD?



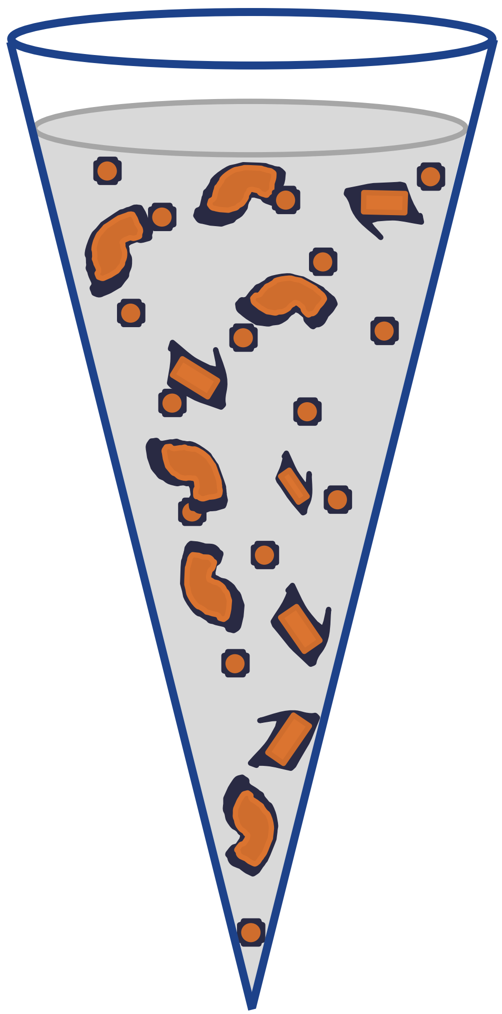
Some is Soluble, Measured as VDS



“Settleable Solids” Measured in an Imhoff Cone

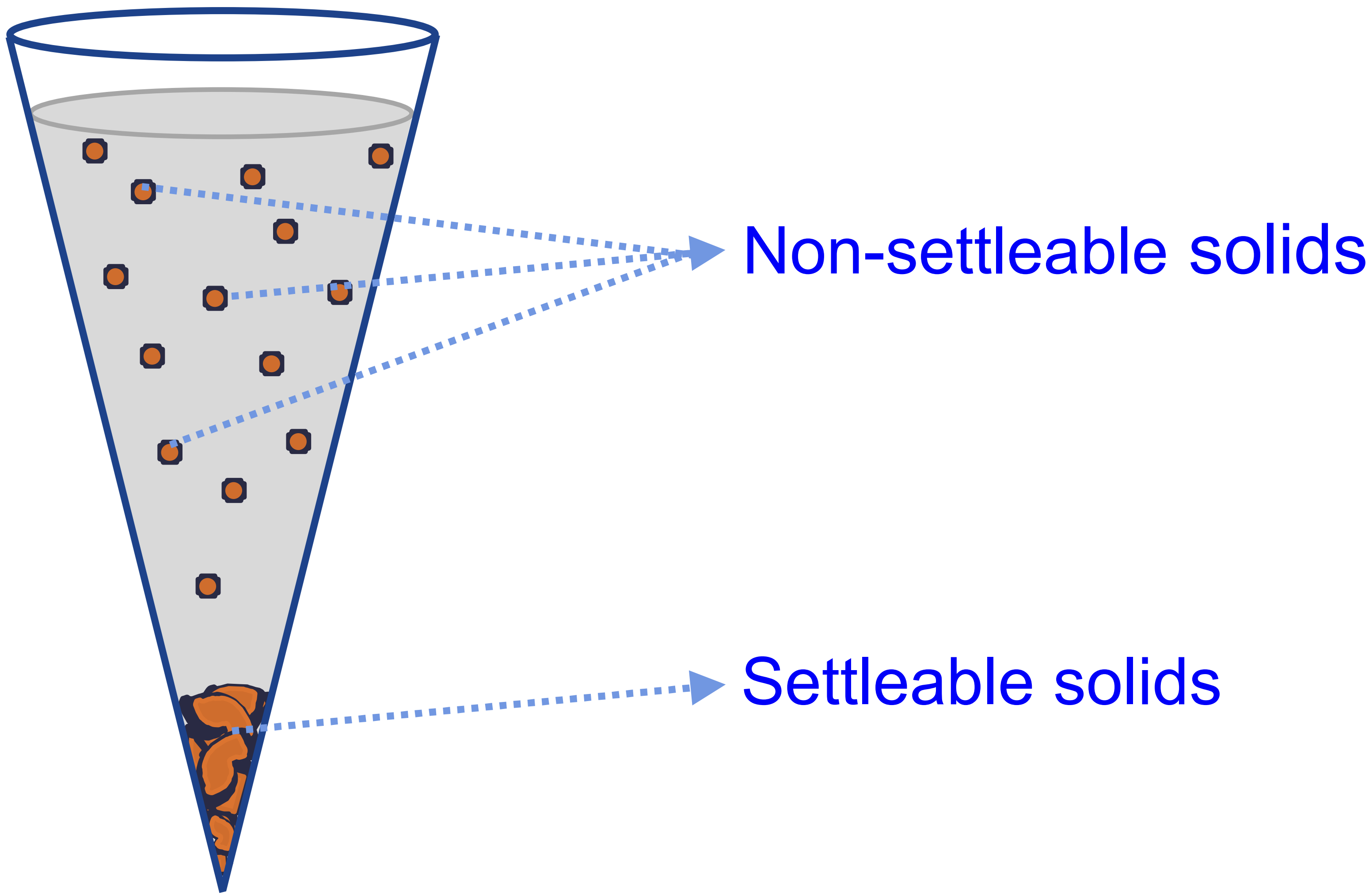


If We Can See It, It Will Be Measured as TSS

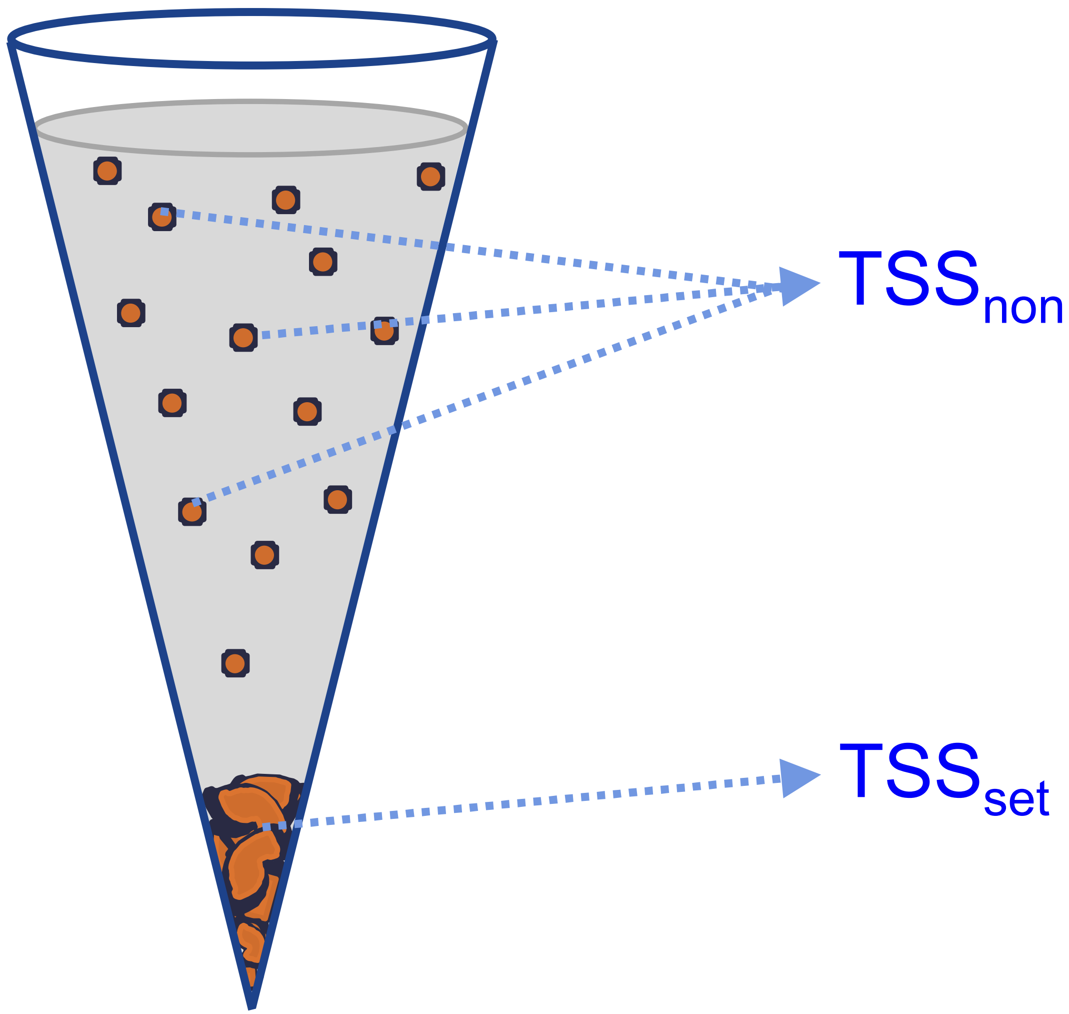


The human eye can see down to the diameter of a human hair, about 100 µm (way bigger than 1.2-µm pore size).

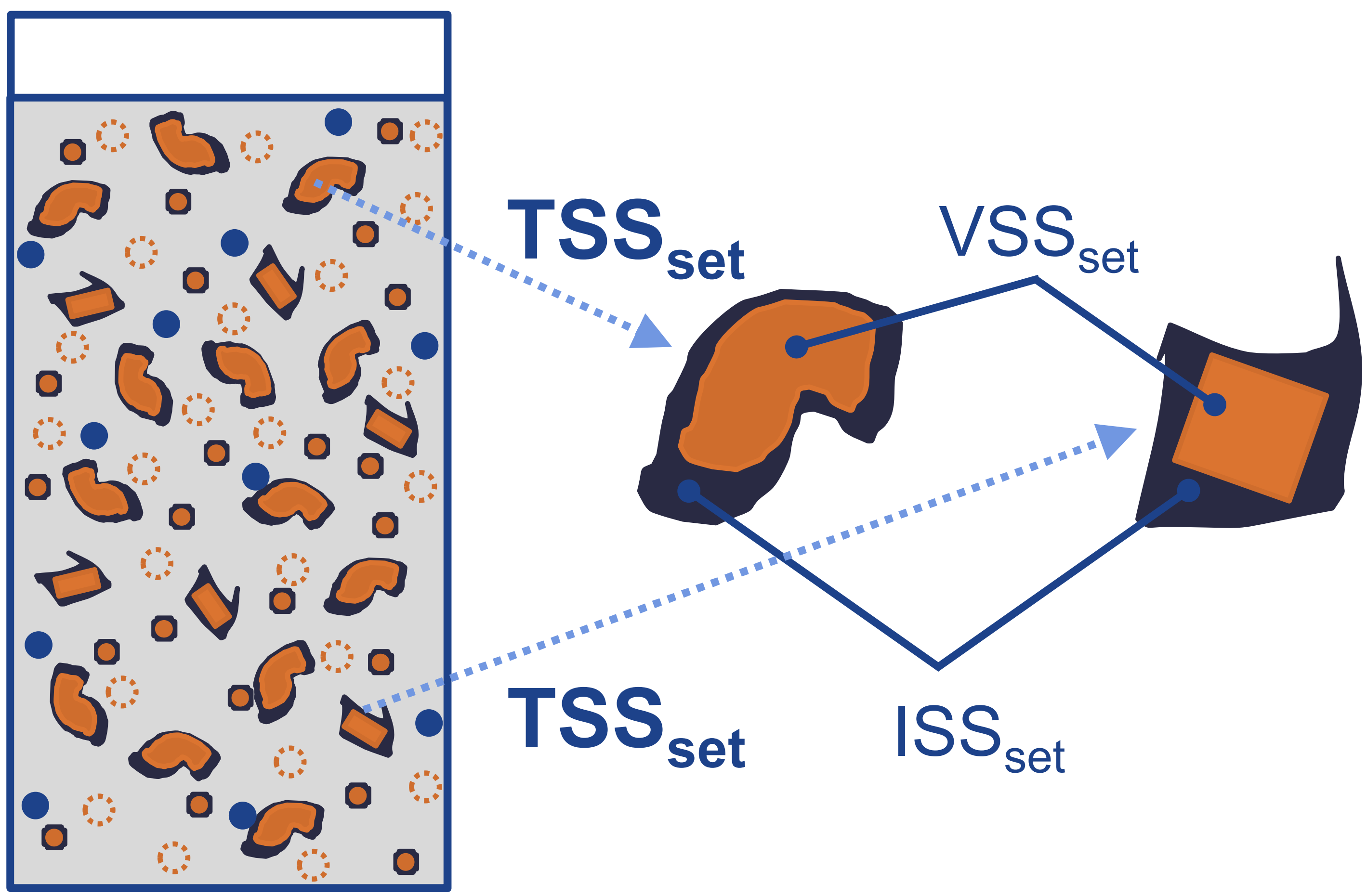
Both Settleable and Non-settleable Solids Must be TSS Because They're Visible



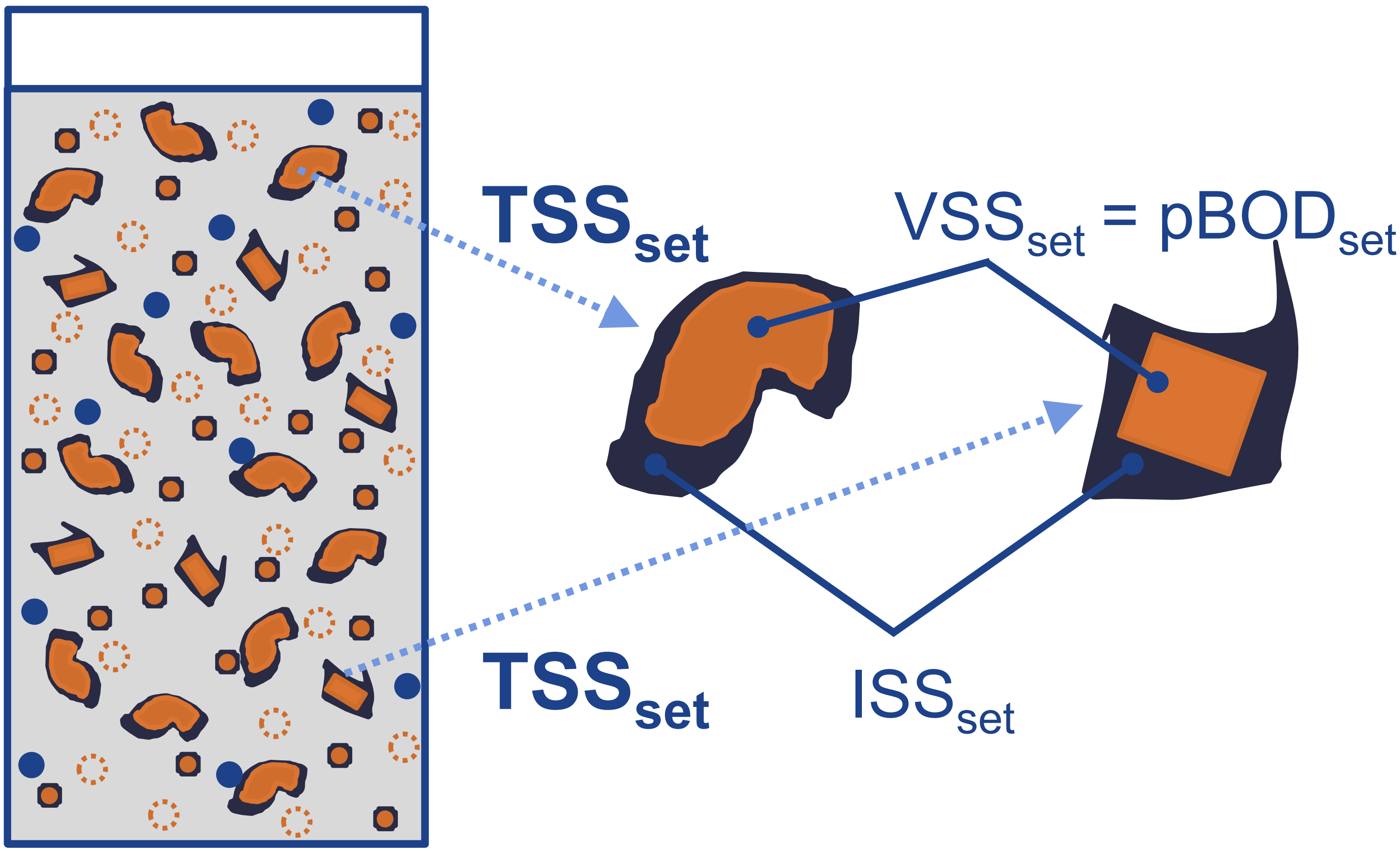
All Settleable Solids are TSS but Not All TSS are Settleable



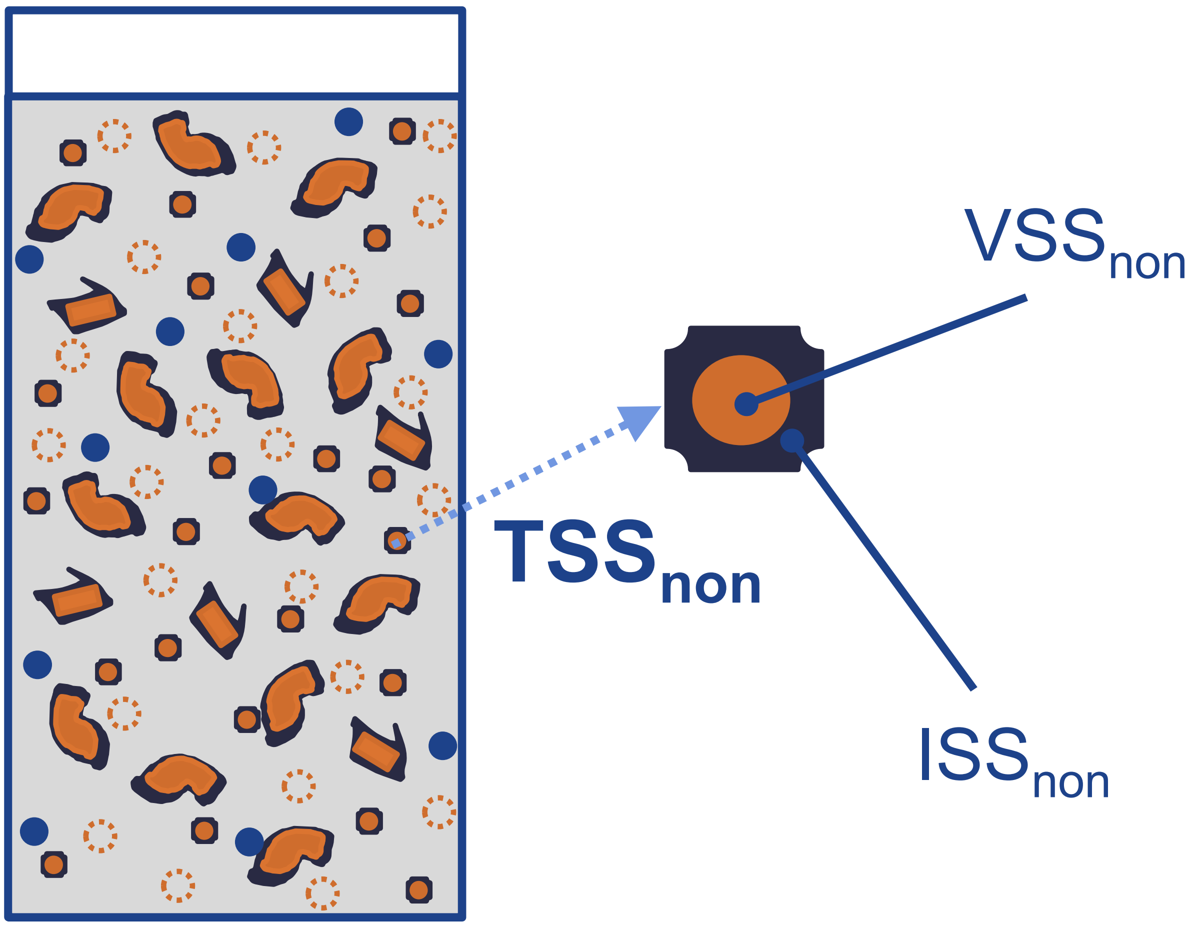
Each TSS_{set} Particle is Made up of Volatile and Inorganic Fractions



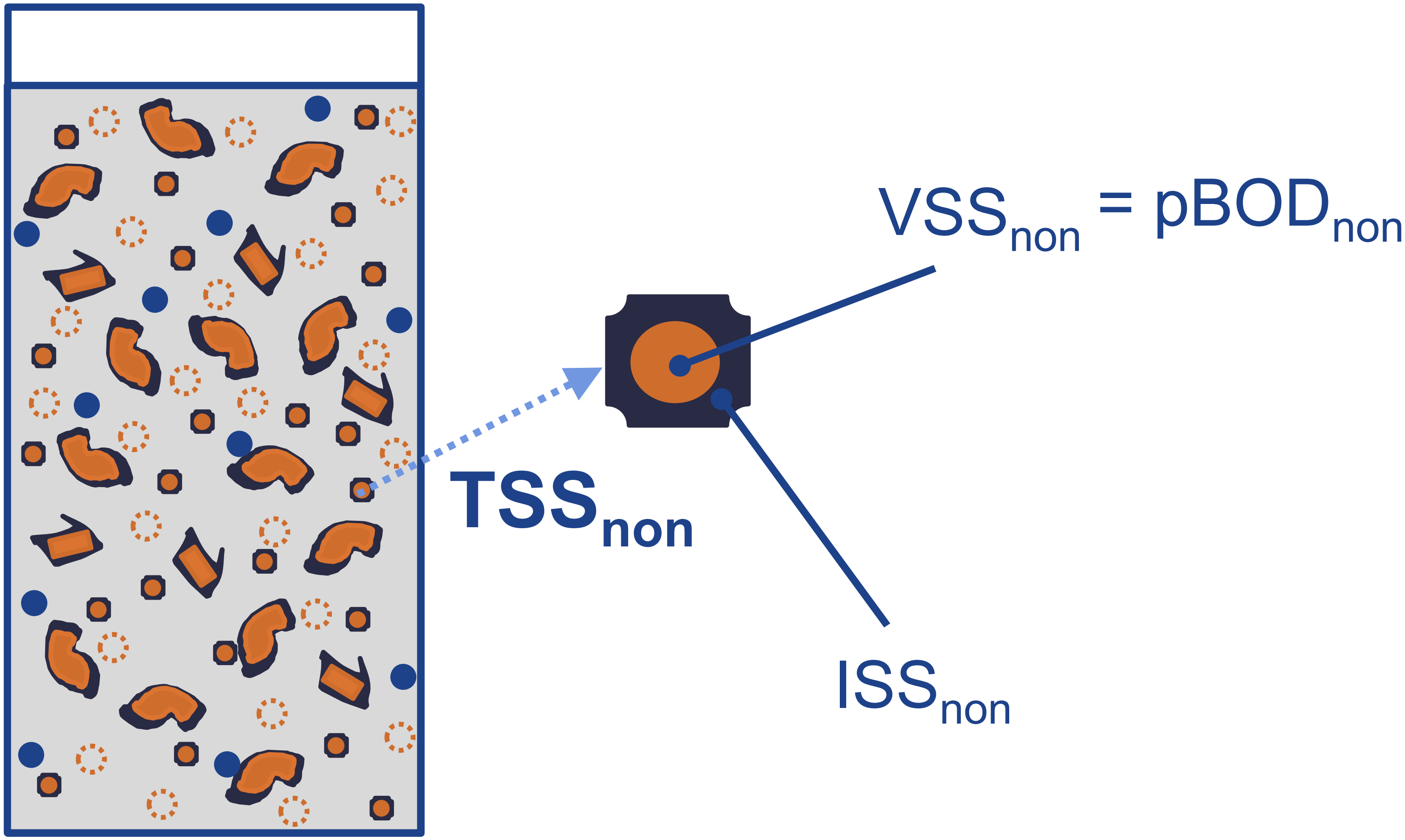
VSS Equivalent to Particulate BOD (pBOD) Thus, $pBOD_{set}$



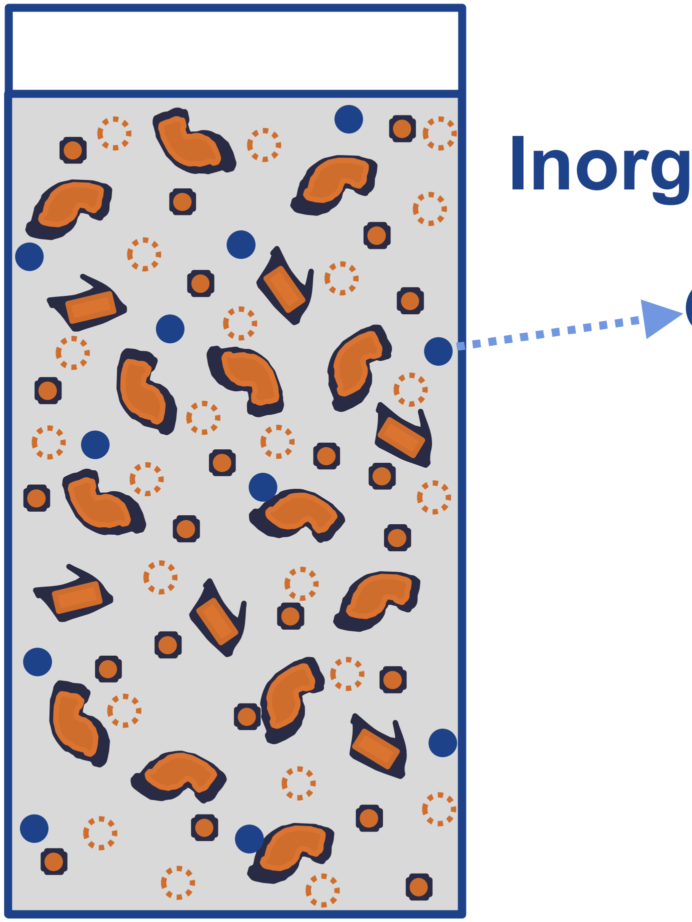
Each TSS_{non} Particle is Made up of Volatile and Inorganic Fractions



VSS Equivalent to Particulate BOD (pBOD) Thus, $pBOD_{non}$

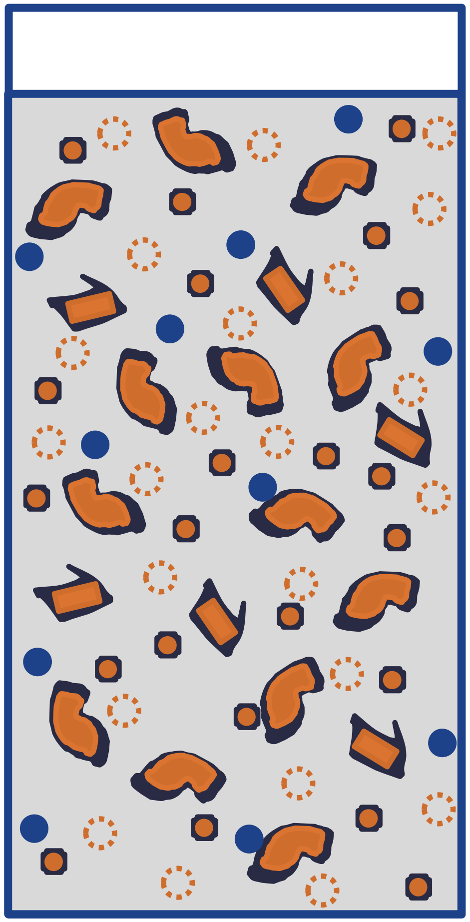


Last of the Solids, IDS
Essentially Untouched Through Treatment



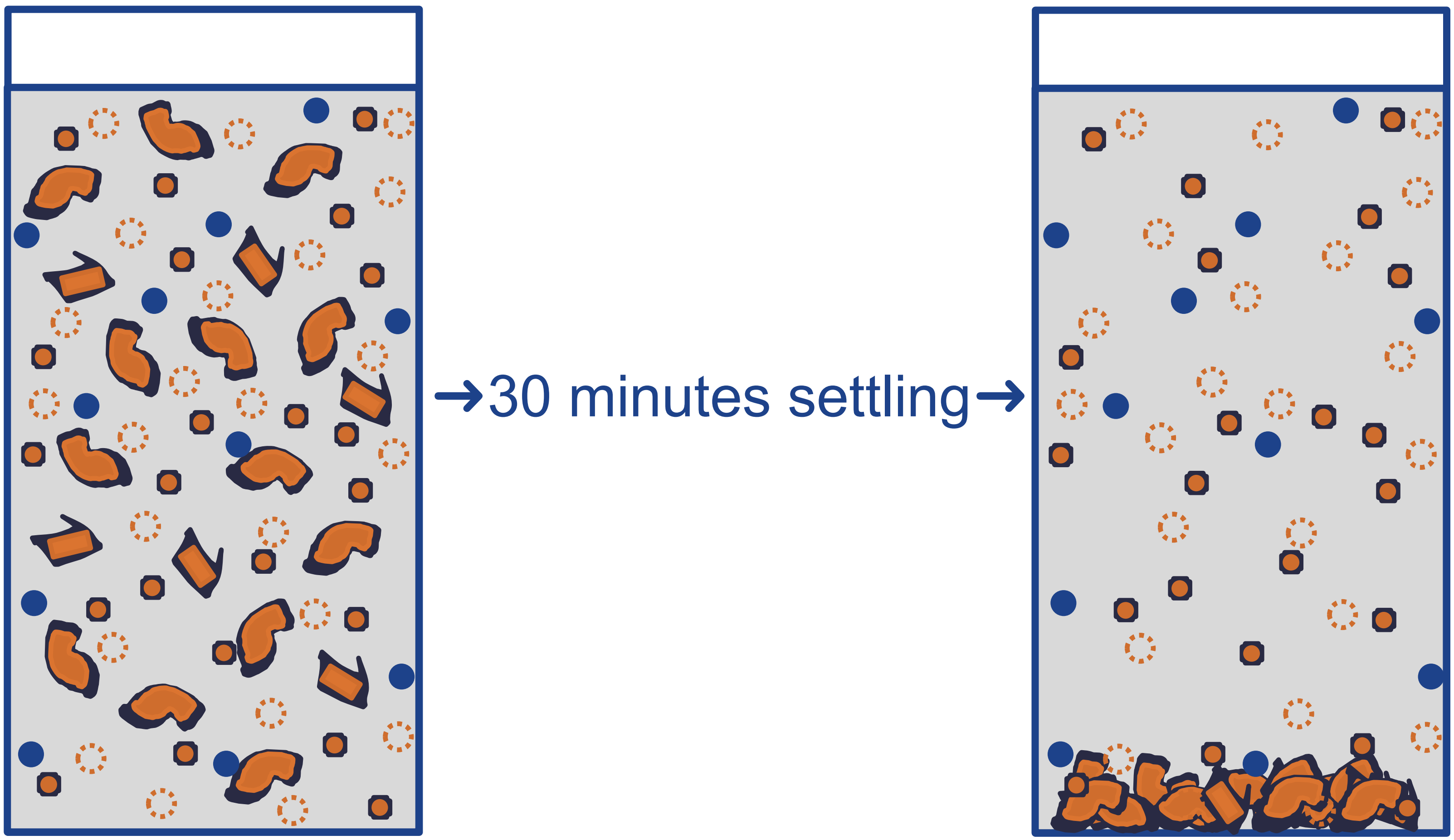
Inorganic Dissolved Solids

What’s removed? What’s remaining?

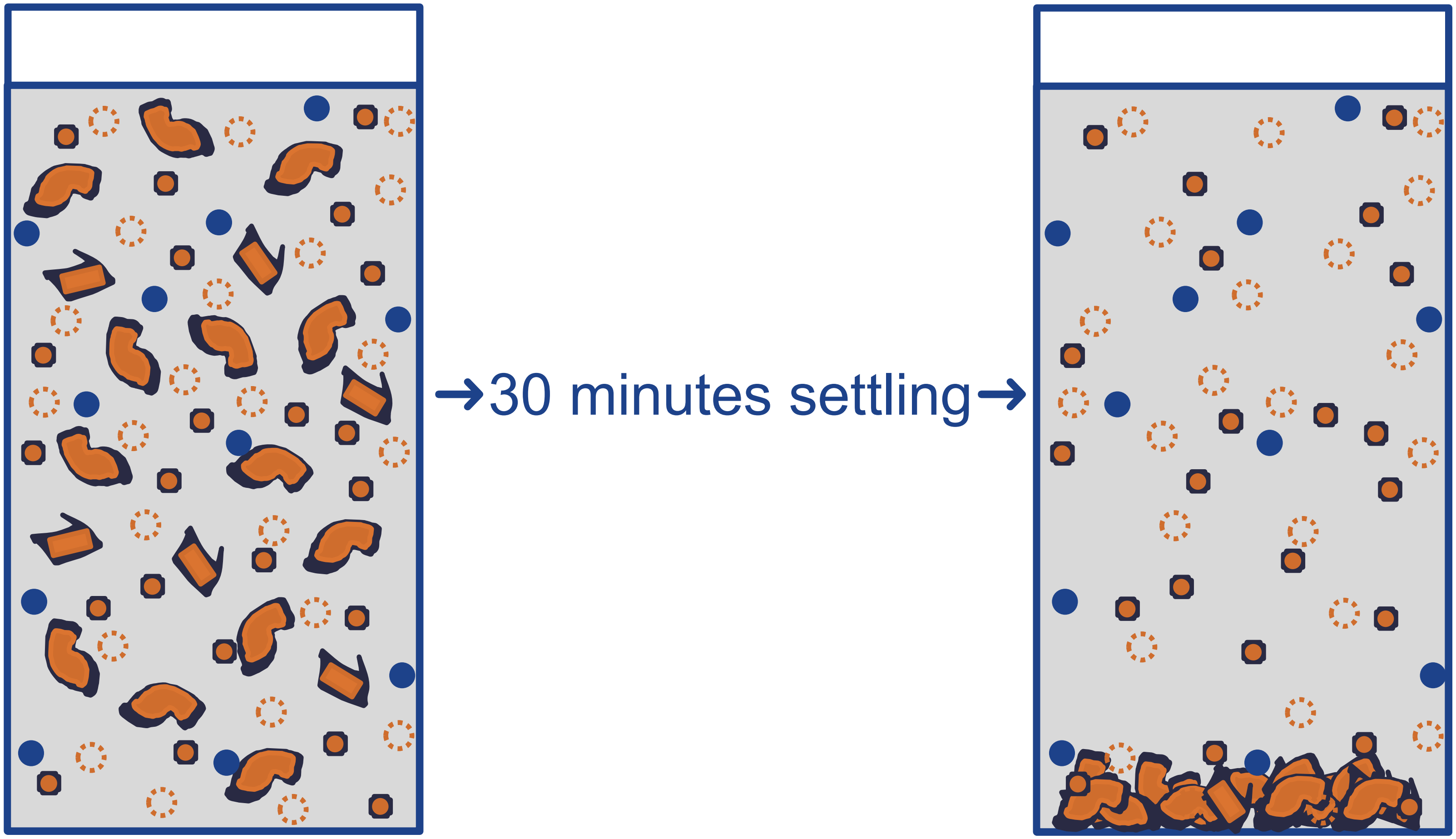


→30 minutes settling→

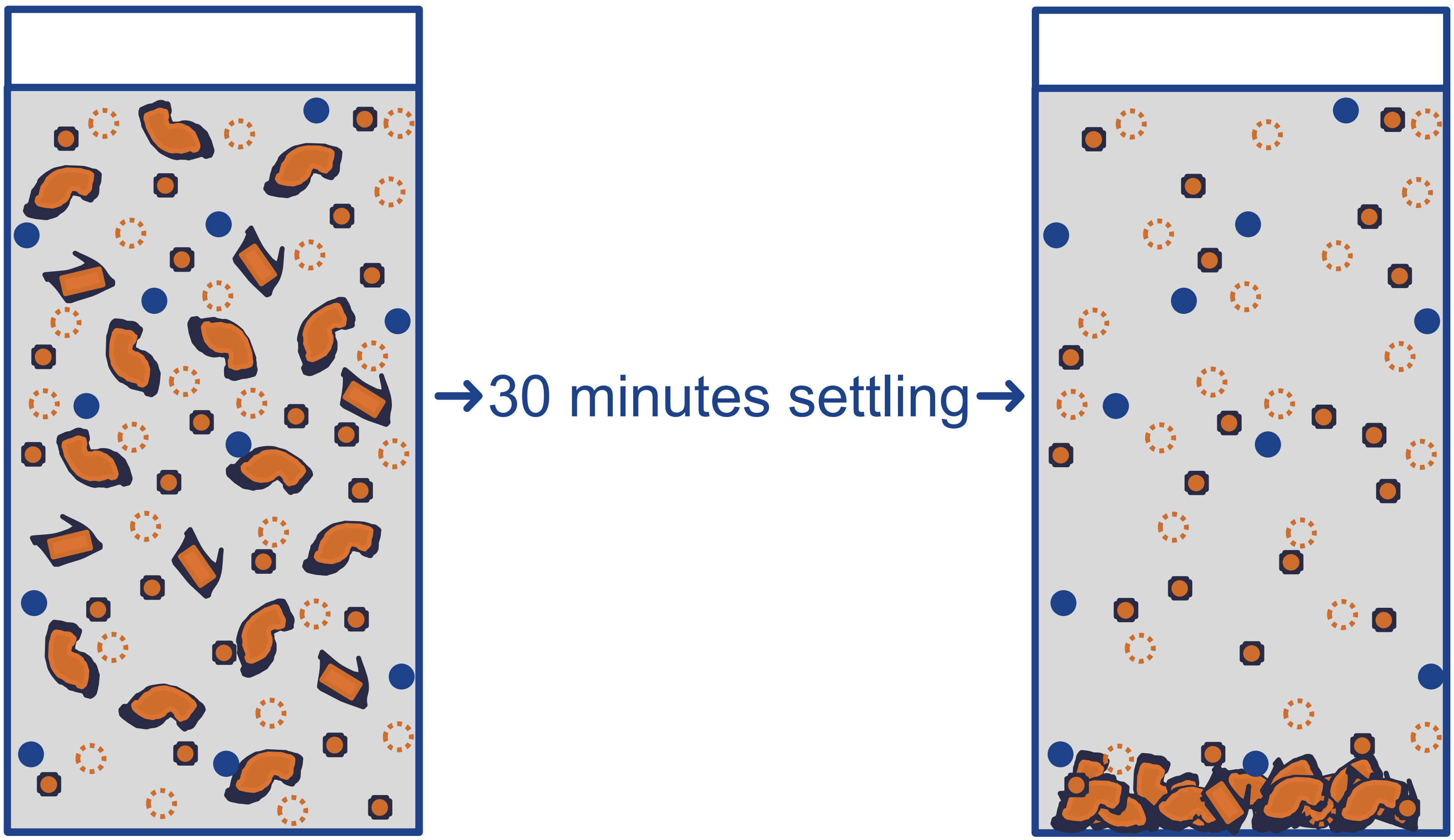
Removed: TSS_{set} (ISS_{set}, VSS_{set} and $pBOD_{set}$)



Not Removed: sBOD, IDS, TSS_{non} (ISS_{non}, VSS_{non} and $pBOD_{non}$)



As Operations Professionals, We Have Little Control Over What's Settleable, What's Not



As Operations Professionals, We Have Little Control Over What's Settleable, What's Not

Settleable

- TSS_{set} (ISS_{set}, VSS_{set} and $pBOD_{set}$)

Not Settleable

- TSS_{non} (ISS_{non}, VSS_{non} and $pBOD_{non}$)
- sBOD
- IDS

Primary Clarifier Removal Efficiencies All Operators Have Committed to Memory **Explained**

1. >95% settleable solids

   [All TSS_{set} are settleable]

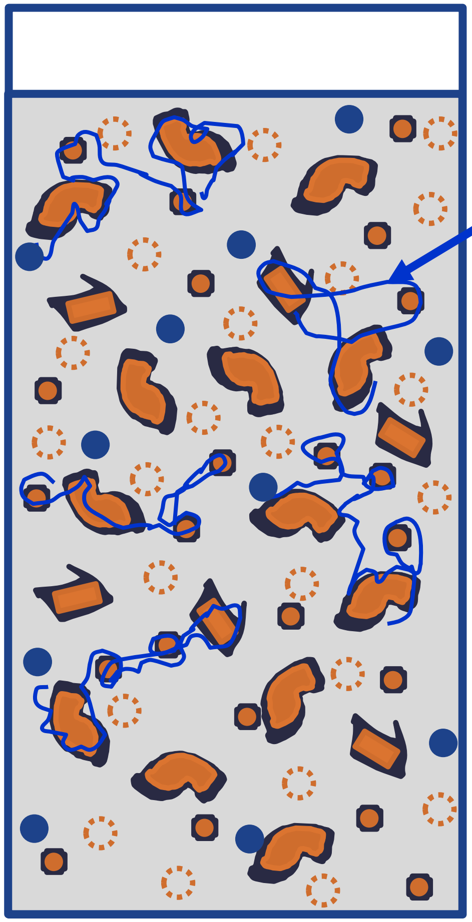
2. 40−60% TSS

   [40−60% of TSS_{INF} are TSS_{set}]

3. 20−40% BOD

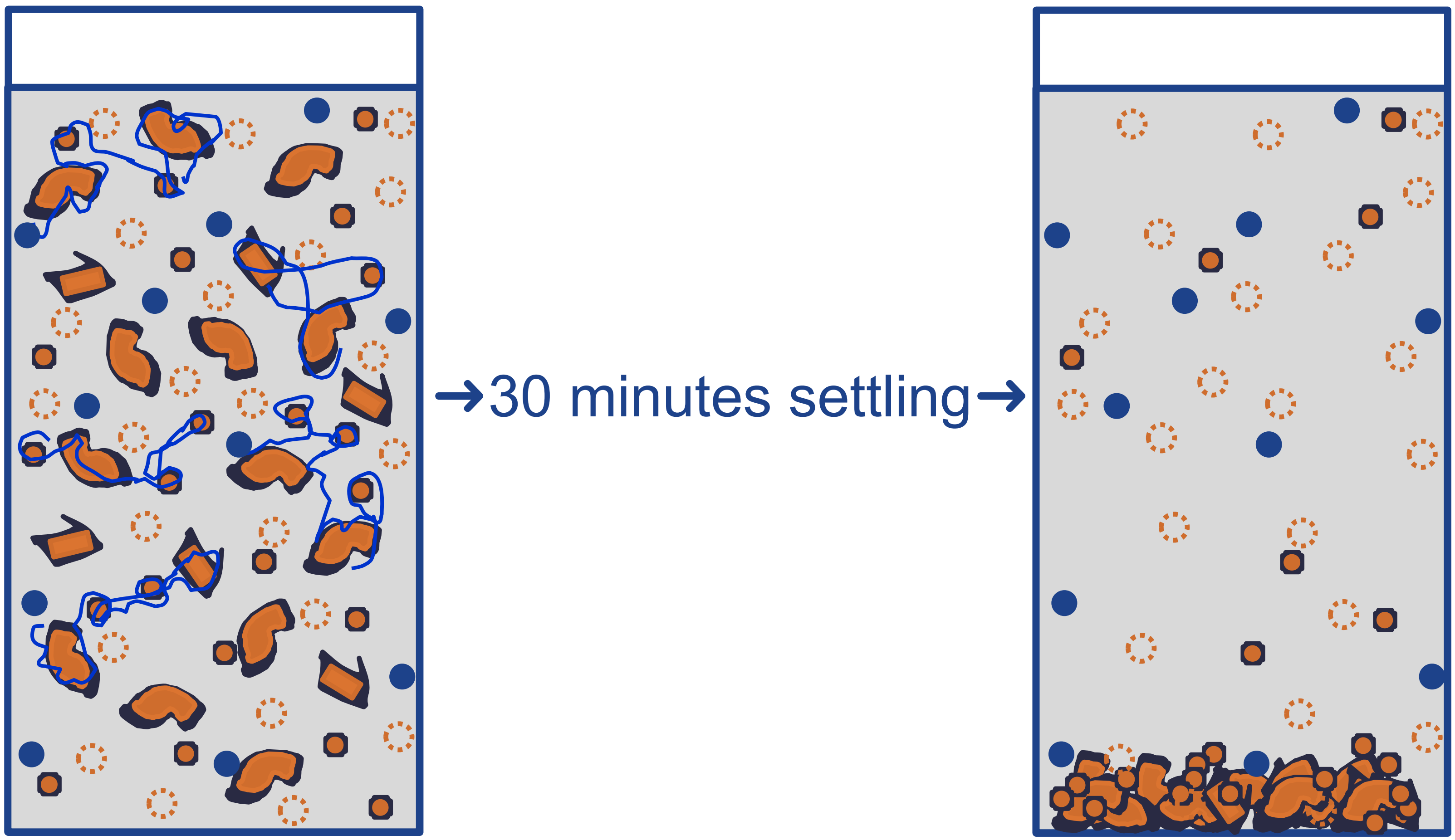
   [20−40% BOD_{INF} is $pBOD_{set}$]

Chemically Enhanced Primary Treatment (CEPT)—Two Different Objectives

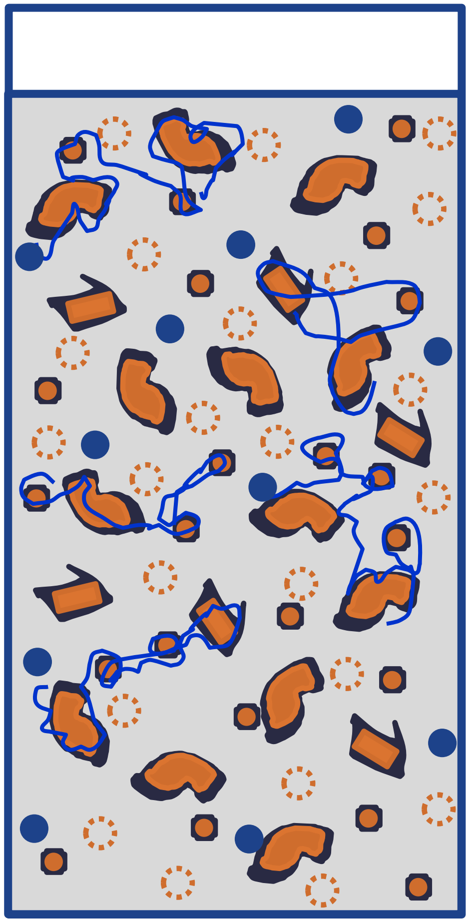


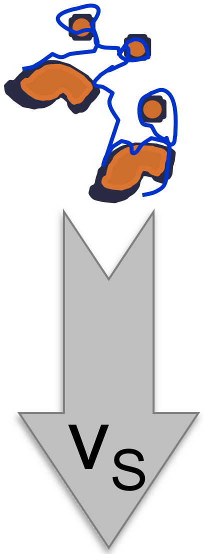
Chemicals (coagulants and flocculants)

1. CEPT “Converts” Some TSS_{non} to TSS_{set} Increasing Removal Efficiencies

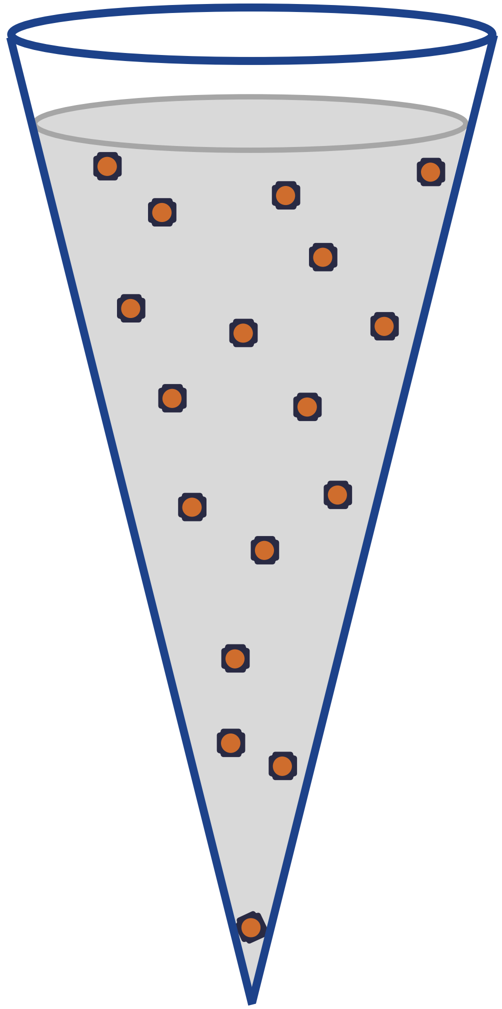


2. Larger TSS_{set} Settle Faster Maintaining Performance at High Flows





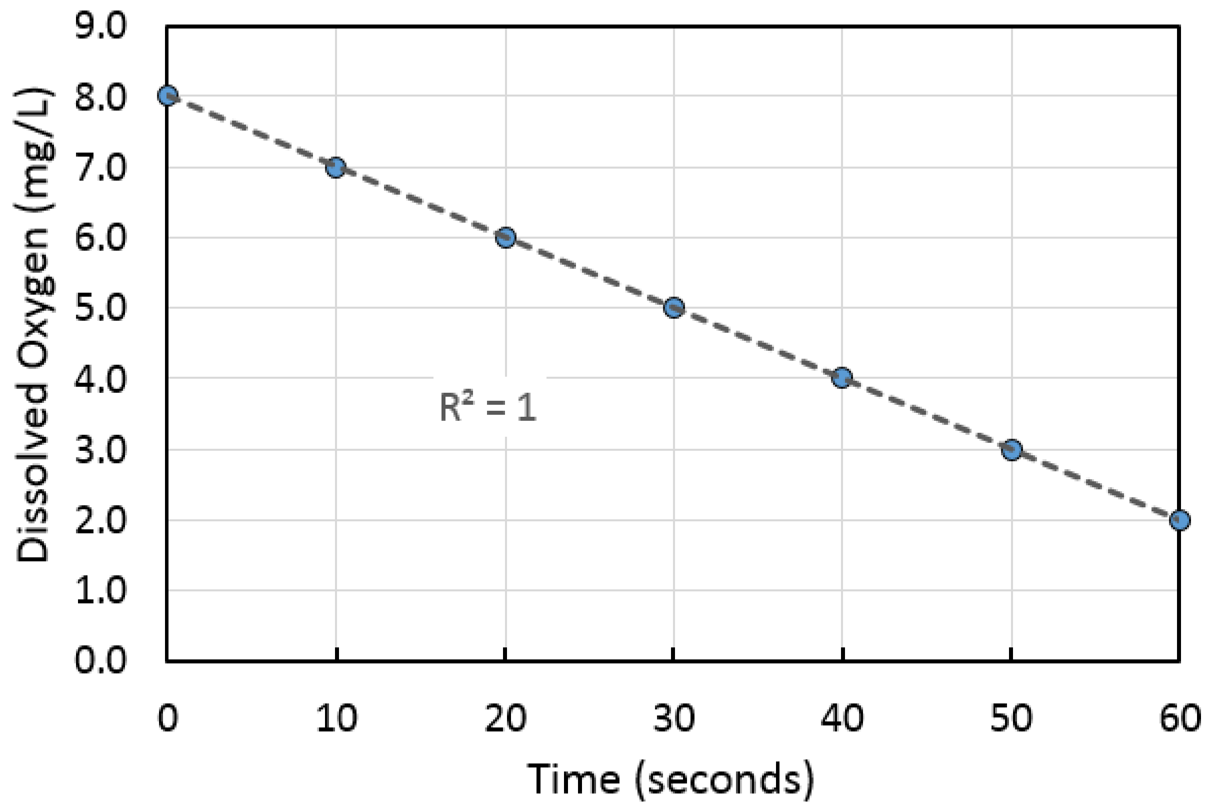
Bottomline (Simple KPI)



NO *TSS_{set} in primary clarifier effluents*

OUR Exercise

	Enter DO data in green area
Time (seconds)	DO (mg/L)
0	8.00
10	7.00
20	6.00
30	5.00
40	4.00
50	3.00
60	2.00



OUR = 360.0 mg DO/L.hr

W3 System Exercise - Report Out

PD Blowers


DANGER
THIS MACHINE STARTS
AUTOMATICALLY

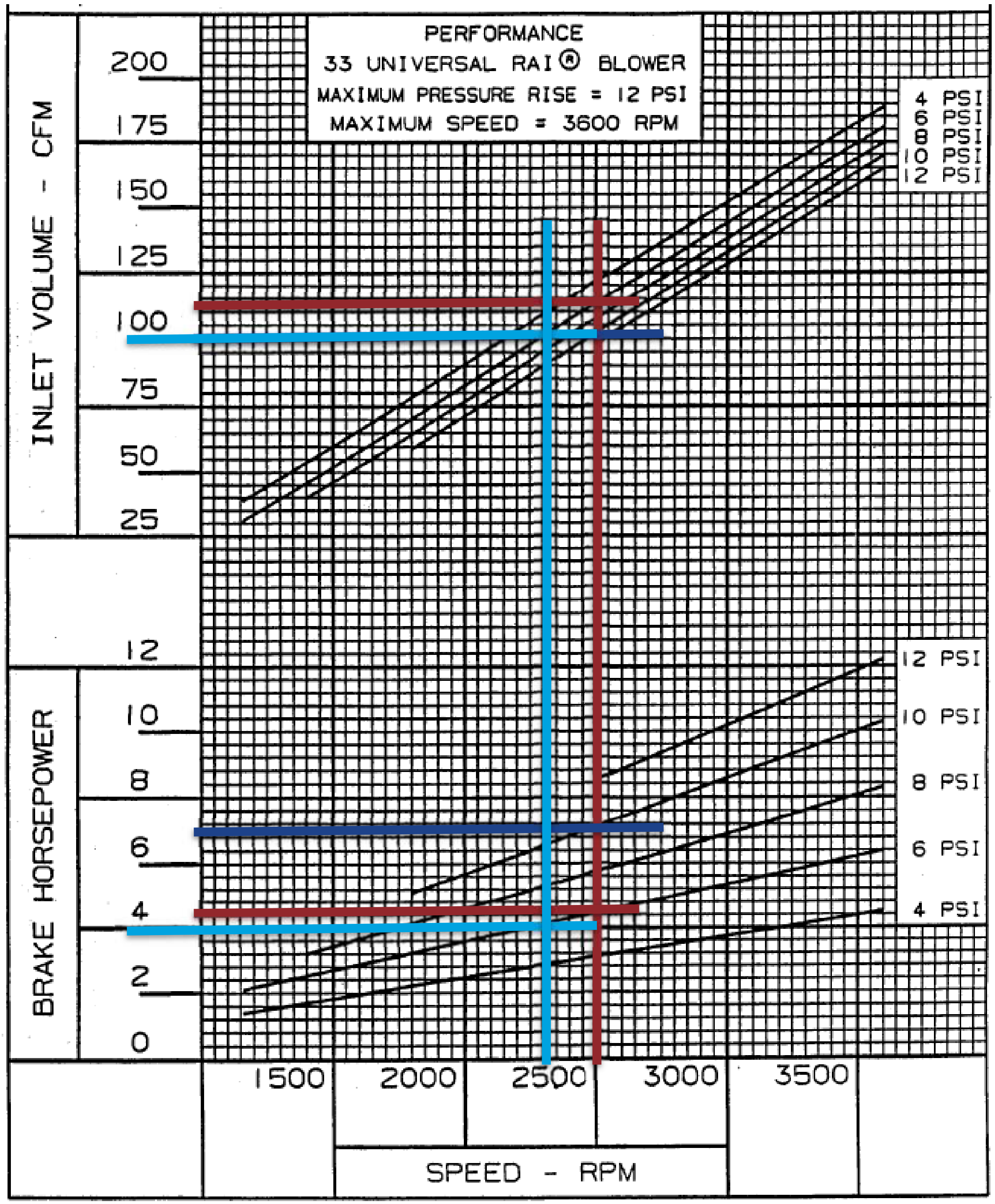
Quarter-turn valve

@ 2500 RPM & 6 PSI:
4.8 BHP & 112 CFM.

@ 2500 RPM & 10 PSI:
7.1 BHP (UP 48%) & 102 CFM (DOWN 9%)

@ 2300 RPM & 6 PSI:
4.0 BHP (DOWN 16%) & 102 CFM.

CHANGE THE SHEAVE OR USE A VFD.



Turning Ideas Into Savings

- List your "top three" ideas
- List the motor equipment involved in the table in your Workbook:

Equipment	HP	Current runtime	New runtime

- Estimate savings

Closing

SEE YOU TOMORROW!

Cascade Energy

WasteWater Technology TRAINERS