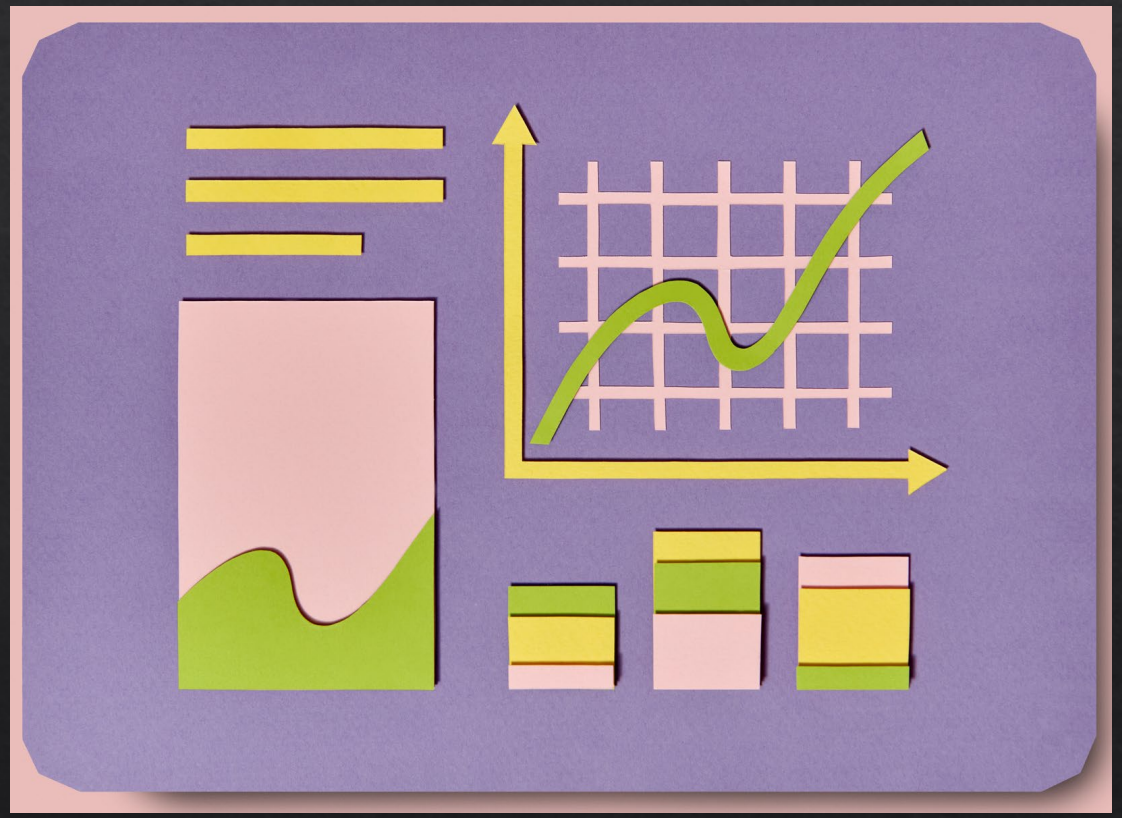
Part 4 – LL Calculations Concepts

Data

- By this point, data should be reviewed and ready for meaning to be derived from it.
- Reference EPA's LL manual appendices for missing data.



NERPCA
New England
Regional Pretreatment Coordinators Association

Get Organized

- Using a workbook like Microsoft Excel or Google Docs can help organize data sets.
- Build with future use in mind and add labels to cells.



NERPCA
New England
Regional Pretreatment Coordinators Association

Objectives



Understand the types of calculations that will need to be made.



Be able to document decisions.

Calculations Within Calculations



Many calculations go into the LL calculation.



Understanding loading is key.



The LL process is a mass balance exercise.

NERPCA
New England
Regional Pretreatment Coordinators Association

Detention Time

Add up units such as:

- Primary Clarifiers;
- Aeration Tanks;
- Secondary Clarifiers;
- Disinfection.

$$\frac{24\ \frac{\mathrm{hr}}{\mathrm{D}} * \text{POTW Tank Volumes [MG]}}{\text{Average POTW Flow [MGD]}}$$

Do not use the permitted flow!



NERPCA
New England
Regional Pretreatment Coordinators Association

Removal Efficiency

- Mass balance.
- Nothing is ever really gone.
  - Assigned to new output.
- Copper comes in at .2 lbs per day and only .05 lbs per day leaves in the effluent.
  - Copper is removed from the wastewater but transferred into the sludge.



Removal, Mass Balance, Conservative Pollutants

- Total metals are measured on their elemental form.
- Ammonia is measured as a compound.
- Ammonia is converted into other compounds like nitrate and nitrite through treatment.
- The mass balance on just ammonia will not show: influent = effluent + sludge.
- Similar concept with VOCs that may volatilize.



Removal Efficiency

Ways to calculate removal efficiency (R):

- Average daily removal efficiency (ADRE);
- Mean removal efficiency (MRE);
- Decile method; and
- Sludge balance.

ADRE (Paired)

- This comes back to the residence time calculated earlier.
- Influent sample is taken followed by a lagged effluent sample.
- See 5.1.1 of EPA's Manual.

$$R_{POTW} = \frac{\sum \frac{I_n - E_{POTW,n}}{I_n}}{N}$$

- In other words, find the average of the paired sets.

Not Paired

Day	Inf.	Eff.	%R Not Paired
Tues.	0.86	0.56	35%
Wed.	0.25	0.62	-148%
Thurs.	0.44	0.18	59%
Fri.	0.66	0.32	52%
		Average	-1%

NERPCA
New England
Regional Pretreatment Coordinators Association

Paired

Day	Inf.	Eff.	%R Not Paired
Tues.	0.86		
Wed.	0.25	0.62	28%
Thurs.	0.44	0.18	28%
Fri.		0.32	27%
		Average	28%

NERPCA
New England
Regional Pretreatment Coordinators Association

Not Paired vs. Paired

Day	Inf.	Eff.	%R Not Paired
Tues.	0.86	0.56	35%
Wed.	0.25	0.62	-148%
Thurs.	0.44	0.18	59%
Fri.	0.66	0.32	52%
		Average	-1%

Day	Inf.	Eff.	%R Paired
Tues.	0.86		
Wed.	0.25	0.62	28%
Thurs.	0.44	0.18	28%
Fri.		0.32	27%
		Average	28%

NERPCA
New England
Regional Pretreatment Coordinators Association

Non-Detects

- Use half the detection level with non-detects but with prudence.
- Influent of <0.05mg/l and effluent of <0.0005mg/l does not necessarily mean removal is occurring.



Questions?



MRE (Not Paired)

- More accommodating and better for large sets.
- Good for TSS and BOD if those are already being collected regularly.

$$R_{POTW} = \frac{\overline{I_r} - \overline{E_{POTW,t}}}{\overline{I_r}}$$

- In other words, the average influent subtract the average effluent divided by the average influent.

Decile Method

- Essentially calculates the median (not average) of the data.
  - Middle average or value between the two middle averages.
- Can help compensate for widely varying data.

5,5,4,2,5,5,4,5,4	25,25,4,2,5,5,4,5,4
Average = 4.33	8.78
Median = 5	5

R Based on Sludge

- If you have lots of effluent and sludge data, consider the "Conservative Pollutant Removal Efficiency Derived from Sludge Data" method.
- Metals are considered conversative in this instance as the analyte won't change through treatment.
- Ammonia, BOD, and TSS will change and are not conservative.
- Equation can be used with ADRE or MRE.

Choosing

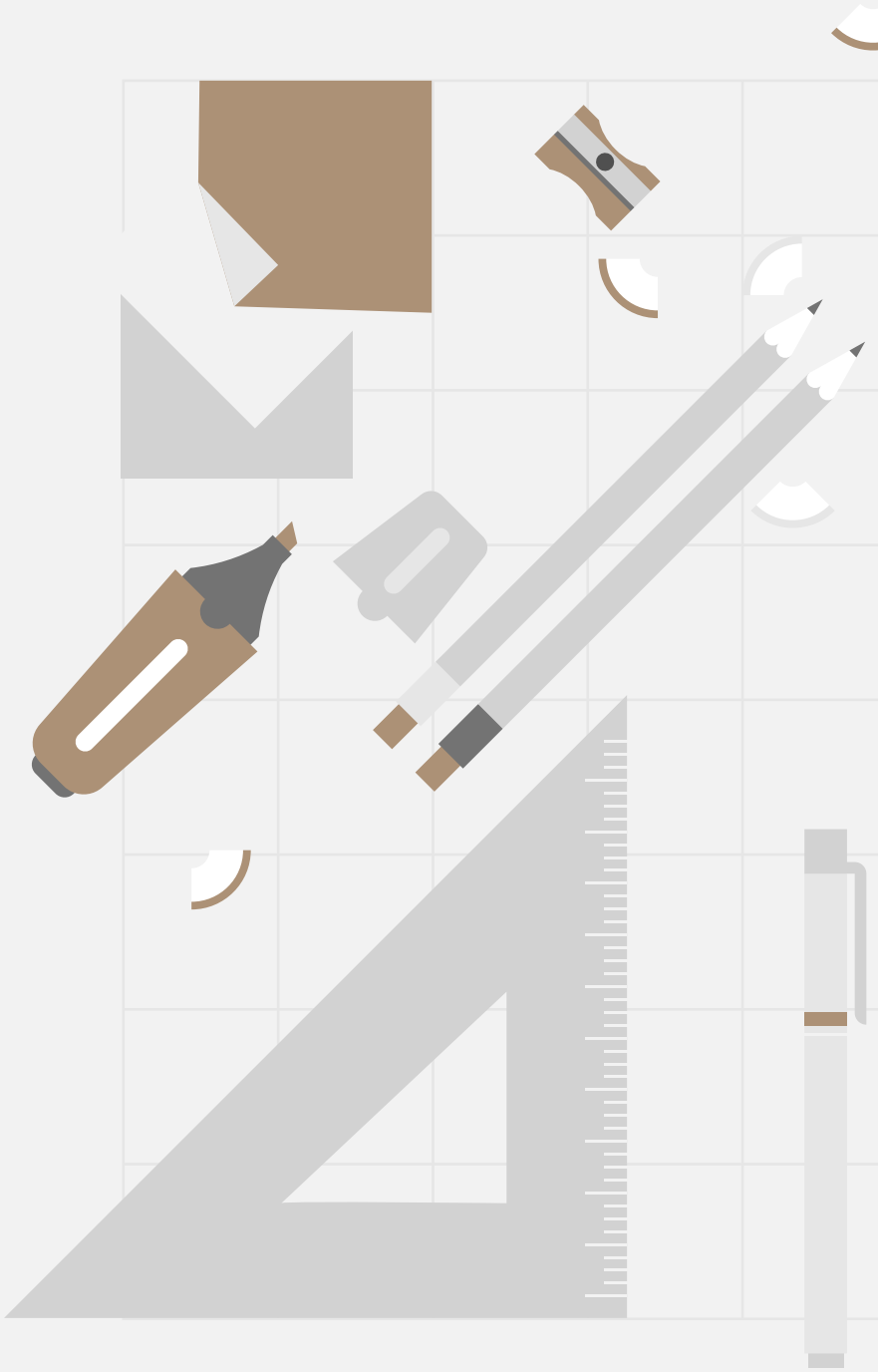
EPA’s guidance manual recommends MRE when there are less than ten pairs.

MRE (not paired) is a clear winner for frequently sampled pollutants.

No or Faulty R

EPA has some guidance values.

If you don't know R, consider why.



MAHL

- To calculate the MAHL, the AHLs for each applicable criteria needs to be evaluated.
- Removal rates will need to be known.

AHLs

- NPDES limits (convert from concentration).
- WQS.
- Sludge disposal considerations.
- Inhibition (activated sludge, nitrification).
- Design Criteria (conventional pollutants).

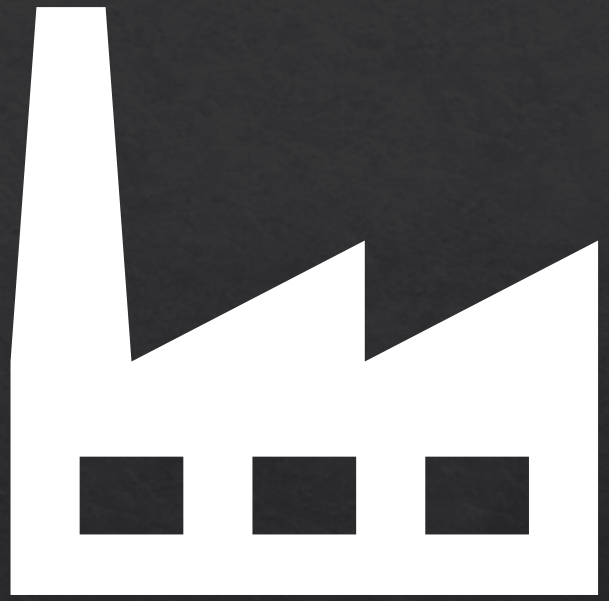


Photograph courtesy of North Conway Water Precinct

NERPCA
New England
Regional Pretreatment Coordinators Association

Less Common AHLs

- Air criteria.
  - Sludge incineration.
  - VOC emission through POTW.
- Worker health (plant and sewer).
  - Asphyxiation
  - Explosion

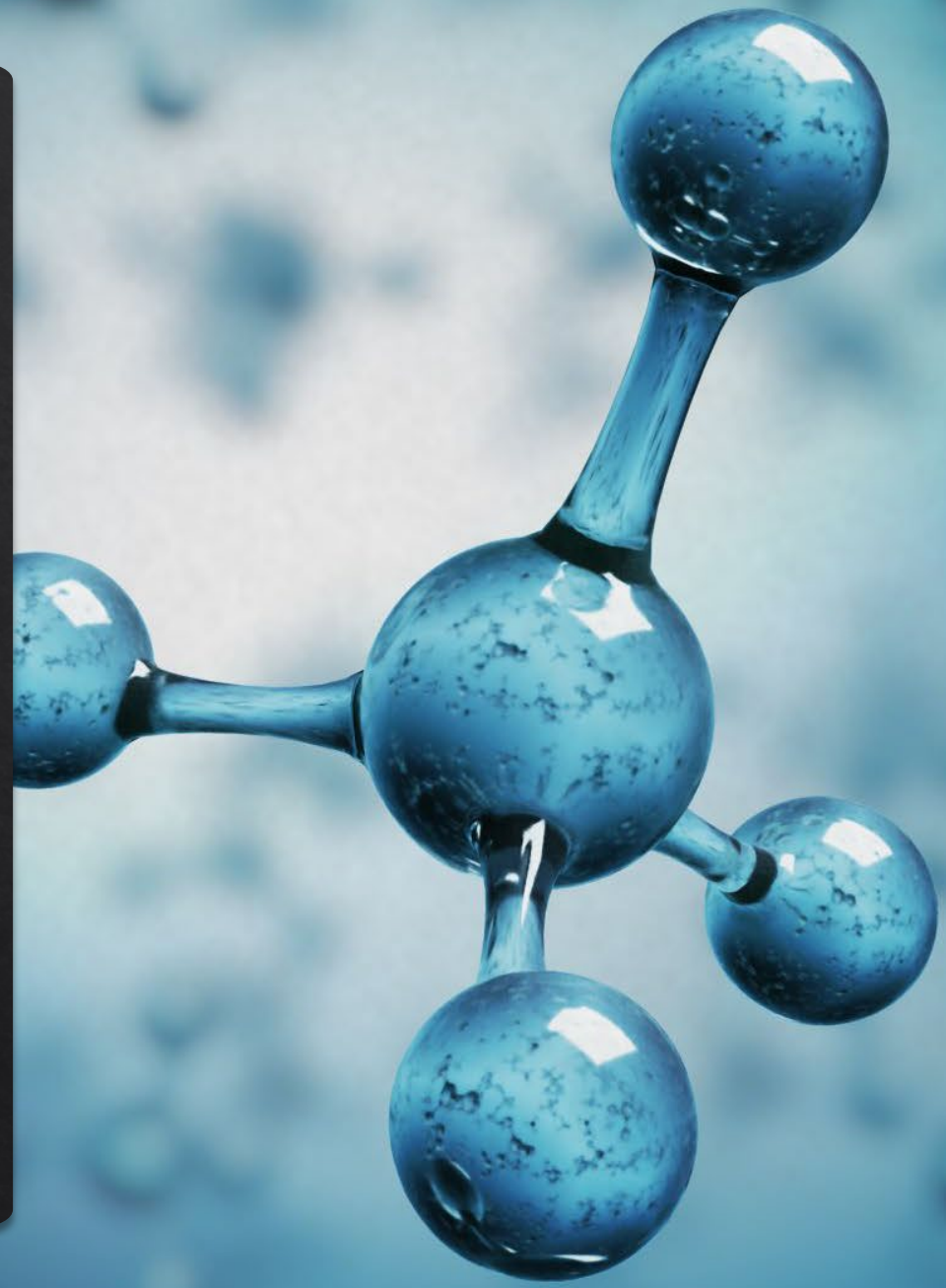


Questions?



Permit AHL

- Some NPDES limits are concentration based and others are load.
- Concentration needs to be converted into load.
- Limits already in lb/day do not need to be converted.



WQS AHL

- NPDES permit limits are often the outcome of developing a WQS by the NPDES permitting authority.
- Even if a limit is not in the permit for an analyte, the POTW is still prohibited from violating WQS.
- Doing the exercise is helpful in case a limit is ever developed or a specific industry wants to come in and would need that capacity.
- Will include ambient sampling.
- Both chronic and acute criteria.

NPDES vs. WQS

- NPDES limits are often derived from design flow.
- WQS AHL are derived using average flow.
  - If you have a NPDES permit limit and calculate the WQS as double check, they may be different for this reason.

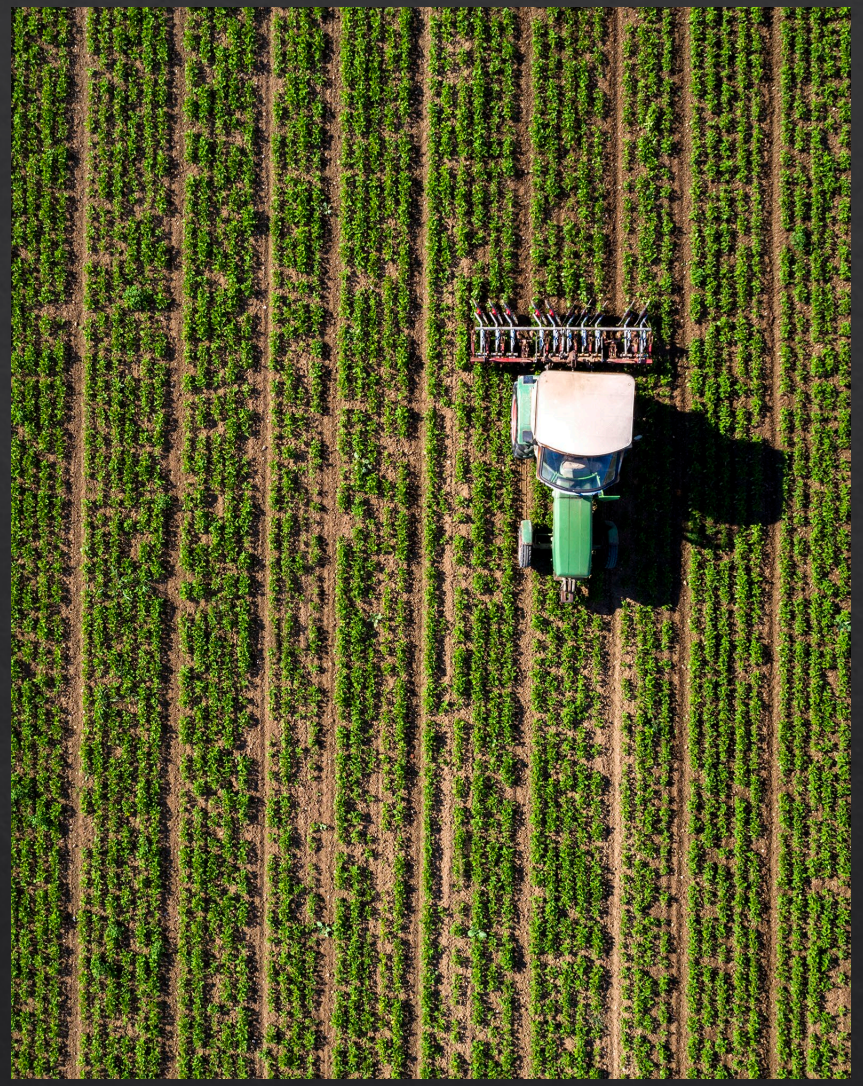


NERPCA
New England
Regional Pretreatment Coordinators Association

Photograph courtesy of the
Winnipesaukee River Basin Program

Sludge AHL

- Land Application
  - Directly or after being blended.
- Incineration
- Landfill
  - Can’t be a hazardous waste.
  - Any additional requirements from the landfill.



NERPCA
New England
Regional Pretreatment Coordinators Association

Inhibition AHL

- This would be a disruption to a specific part of the POTW treatment process.
- For example, certain pollutants interfere with nitrification.
- EPA has a list of inhibition values for activated sludge, trickling filters, nitrification and anaerobic digestion.



Inhibition AHL

- Are there times where your plant works extra hard?
- Responsive sampling during upsets can also inform this.
- Credit for removal prior to the step.

Design Criteria AHL

- Some POTWs have criteria that they are designed to meet.
- Often for conventional pollutants.
- Removal rate may be calculated when the system isn't stressed and stress may add a diminishing R.



Domestic Only

- Data on domestic only loading will be important at the end of the calculations.
- Should not account for commercial or industrial loading.
- This is part of the uncontrolled loading.

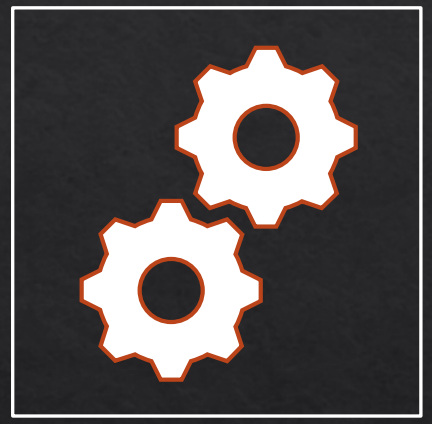


NERPCA
New England
Regional Pretreatment Coordinators Association

IUs



Will need to convert all data from IUs into load.



Will only be used at the end of the process.

NERPCA
New England
Regional Pretreatment Coordinators Association

Significant Figures

- Exponential gain.
- Assuming 15 mg/l and 5 MGD.

R	MAHL [lbs/day]	Difference
96.5%	17,871	
97%	20,850	2,979
97.5%	25,020	4,170
98%	31,275	6,255
98.5%	41,700	10,425
99%	62,550	20,850
99.5%	125,100	62,550

Review

Removal Rates

- ADRE (paired);
- MRE (not paired);
- Decile method; and
- Sludge balance.

AHL

- Permitted
- WQS
- Sludge Disposal
- Inhibition
- Design Criteria

MAHL

- Once the AHLs are calculated, determine which is the most stringent.
- AHLs can be monthly average or daily maximum depending on their source.
- If it is inhibition:
  - Has your facility already exceeded it without issue?
  - Monitoring for it moving forward to help make the limit more defensible.



Keep Going?

- Just because a MAHL is calculated does not necessarily mean a limit will be derived.
- Develop LL for toxic pollutants if influent:
  - Average loading > 60% of MAHL; or
  - Maximum daily loading of toxic pollutants > 80%.
- Develop LL for BOD, TSS and ammonia if monthly average > 80% of design capacity in the last 12 months.



Abandon?

- If you don’t meet those criteria, consider next steps.
- Consider making a set of parameters that are “notify only” if they are exceeded.
  - You did all the work; it can still be used!

MAIL

- Once the MAHL is selected, the MAIL can be calculated.
- Allotment to industries.
- “L” is for loading.
- Considers growth and a safety factor.



Allocation or Uniform Concentration

- Will the MAIL be evenly distributed to all industries or allocated more to some?
- Do industries widely vary in their need for this one POC?
- Can allocate for some analytes and do uniform concentration for others.
  - For example, lead LL can be 25 lbs/day and the copper LL can be 0.5mg/l

Granular

If one IU needs most of the allotment but you still want to track it for others:

- Publish the LL as the MAIL;
- Include the allotment in the one IU's IDP;
- Include the remaining load as a concentration or allotment for others.

For example, 5lbs of lead to Sinker Co. and 0.05mg/l for others.

SUO

- LL implementation is determined.
- Now the SUO needs to be updated to include them.
- Public involvement is key.
- If an EPA approved program is relaxing a LL, this would be public noticed by EPA.
  - Still a good idea to public notice even if a non-approved program.



NERPCA
New England
Regional Pretreatment Coordinators Association

IDPs

Once the local limits go into effect in the SUO, IDPs need to be updated.

Review

MAIL is based on the MAHL which is based on the most stringent AHL.

The MAIL may appear as the LL in lbs/day in the SUO or may be concentration based.

The LL needs to be in the SUO.