
Defending your Local Limits

# Greetings from Utah

# Statutory Authority

The Federal Water Pollution Control Act of 1948

As amended in 1972, the law became commonly known as the Clean Water Act (CWA)

# Statutory Authority

The Federal Water Pollution Control Act

Sec. 307 (d)

Toxic and Pretreatment Effluent Standards

(d) After the effective date of any effluent standard or prohibition or pretreatment standard promulgated under this section, it shall be unlawful for any owner or operator of any source to operate any source in violation of any such effluent standard or prohibition or pretreatment standard.

# Statutory Authority

40 CFR 403.5 - National pretreatment Standards: Prohibited discharges

(c) When specific limits must be developed by POTW.

(1)…***<u>Each POTW with an approved pretreatment program</u>*** shall ***<u>continue</u>*** to develop these limits as necessary and effectively enforce such limits.

# Statutory Authority

## The Federal Water Pollution Control Act

### Sec. 307 (d)

### Toxic and Pretreatment Effluent Standards

(d) After the effective date of any effluent standard or prohibition or pretreatment standard promulgated under this section, it shall be unlawful for any owner or operator of any source to operate any source in violation of any such effluent standard or prohibition or pretreatment standard.

# Statutory Authority

40 CFR 403.5 - National pretreatment Standards: Prohibited discharges

(c) When specific limits must be developed by POTW.

(2) ***All other POTW's*** shall, in cases where pollutants contributed by User(s) result in Interference or Pass-Through, and such violation is likely to recur, ***develop and enforce specific effluent limits*** for Industrial User(s)….

# Statutory Authority

40 CFR 403.5 - National pretreatment Standards: Prohibited discharges

(c) When specific limits must be developed by POTW.

(4) POTWs may develop Best Management Practices (BMPs) to implement paragraphs (c)(1) and (c)(2) of this section. Such BMPs shall be considered ***local limits*** and Pretreatment Standards for the purposes of this part and section 307(d) of the Act.

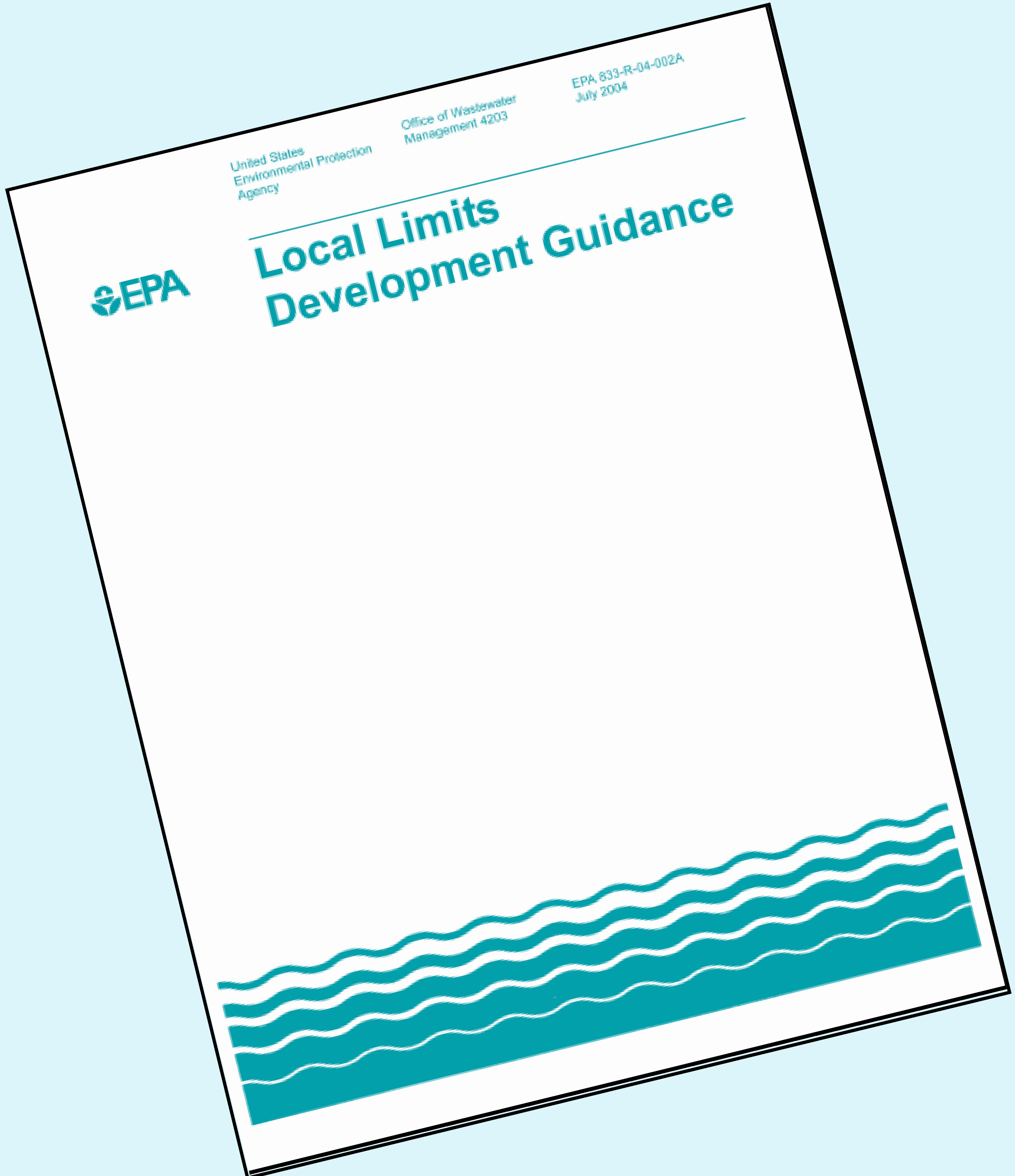
# Statutory Authority

40 CFR 403.5 - National pretreatment Standards: Prohibited discharges

(c) When specific limits must be developed by POTW.

(d) ***Local limits.*** Where specific prohibitions or limits on pollutants or pollutant parameters are developed by a POTW in accordance with paragraph (c) above, such limits shall be deemed Pretreatment Standards for the purposes of section 307(d) of the Act.

# Guidance


United States
Environmental Protection
Agency

Office of Wastewater
Management 4203

EPA 833-R-04-002A
July 2004

EPA

Local Limits
Development Guidance

United States
Environmental Protection
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July 2004

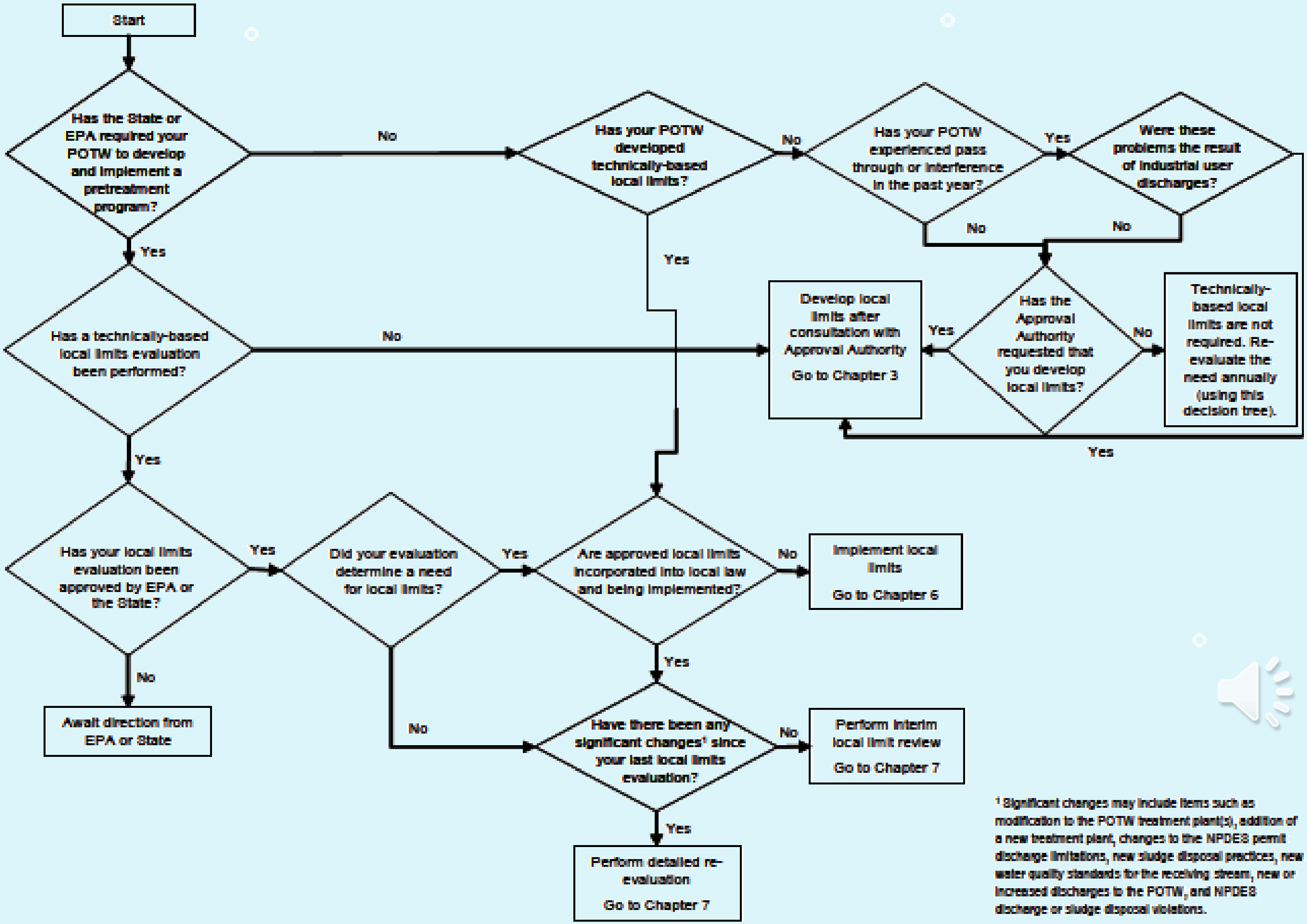
EPA

# Local Limits Development Guidance

# Guidance Outline

| | | |
|---|---|---|
| Chapter 1 | - | Introduction |
| Chapter 2 | - | Overview |
| Chapter 3 | - | Pollutants of Concern |
| Chapter 4 | - | Data Needs |
| Chapter 5 | - | Calculating MAHL |
| Chapter 6 | - | Implementation |
| Chapter 7 | - | Review / Re-Evaluation |
| Chapter 8 | - | Collection Systems |
| Chapter 9 | - | Q and A |

## Figure 2-1: POTW Local Limits Decision Tree



# Local Limits Steps

Determining pollutants of concern (POCs)

Collecting and ***analyzing*** data

Calculating maximum allowable headworks loadings (MAHLs) for each POC

Designating and implementing local limits

Performing local limits re-evaluations

# Pollutants of Concern

Determine by final disposal

Effluent receiving

Solids disposal

# Pollutants of Concern

## 15 Minimum!

Ammonia
Arsenic
$BOD_5$
Cadmium
Chromium
Copper
Cyanide
Lead
Mercury
Molybdenum
Nickel
Selenium
Silver
TSS
Zinc

# Pollutants of Concern

Any Existing Effluent Limit

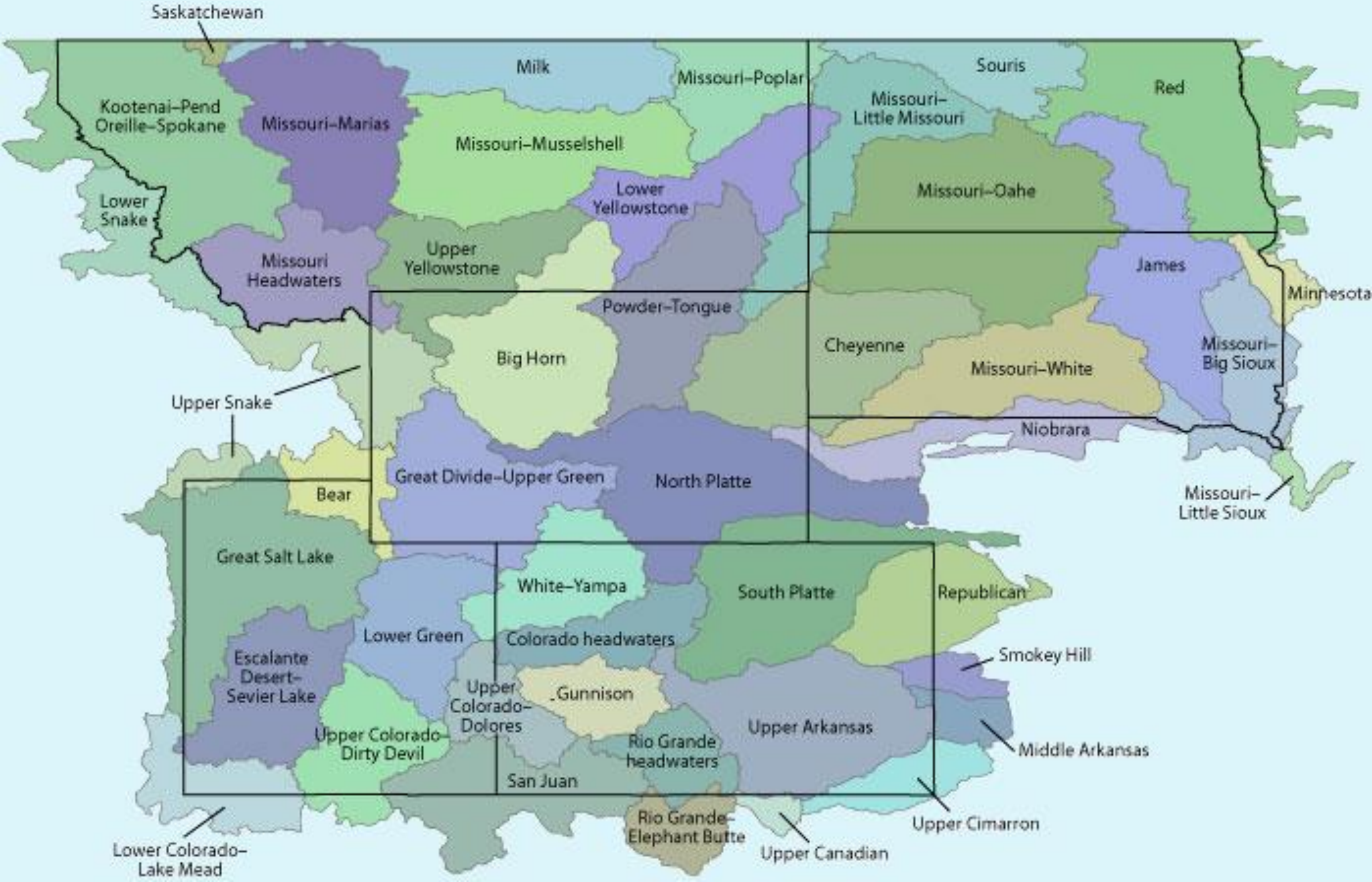
Any Existing Local Limit

126 Priority Pollutants

- Organics
- Metals

Any in your Current Waste Load Analysis

# Region 8


Saskatchewan
Milk
Missouri–Poplar
Souris
Red
Kootenai–Pend Oreille–Spokane
Missouri–Marias
Missouri–Musselshell
Missouri–Little Missouri
Missouri–Oahe
Lower Snake
Lower Yellowstone
Missouri Headwaters
Upper Yellowstone
James
Minnesota
Powder–Tongue
Cheyenne
Missouri–White
Missouri–Big Sioux
Big Horn
Upper Snake
Niobrara
Great Divide–Upper Green
North Platte
Bear
Missouri–Little Sioux
Great Salt Lake
White–Yampa
South Platte
Republican
Lower Green
Colorado headwaters
Smokey Hill
Escalante Desert–Sevier Lake
Upper Colorado–Dolores
Gunnison
Upper Arkansas
Upper Colorado–Dirty Devil
Rio Grande headwaters
Middle Arkansas
San Juan
Rio Grande–Elephant Butte
Upper Cimarron
Upper Canadian
Lower Colorado–Lake Mead

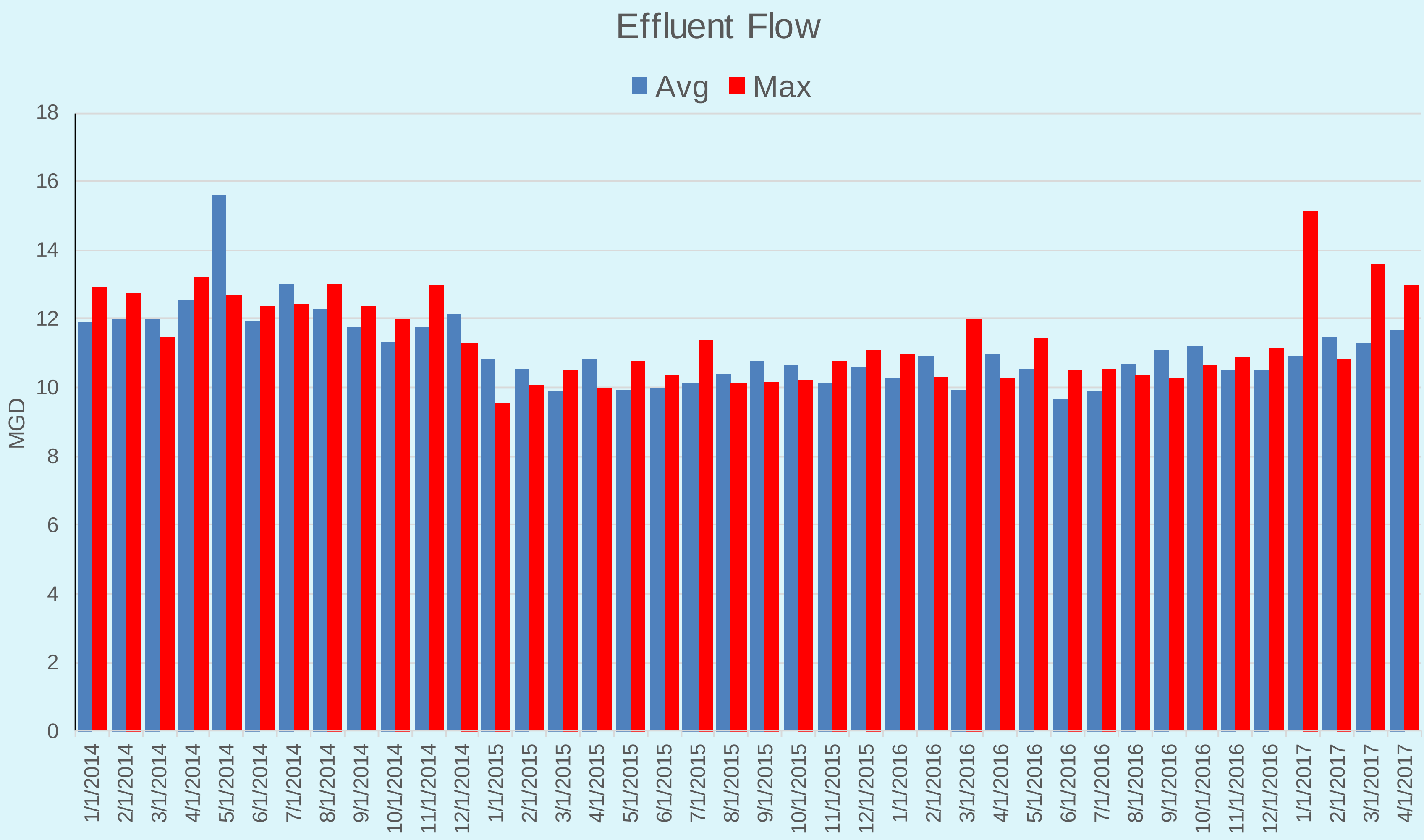
# Exercise 1

# Exercise 1

Given the Flow Data in the Spreadsheet

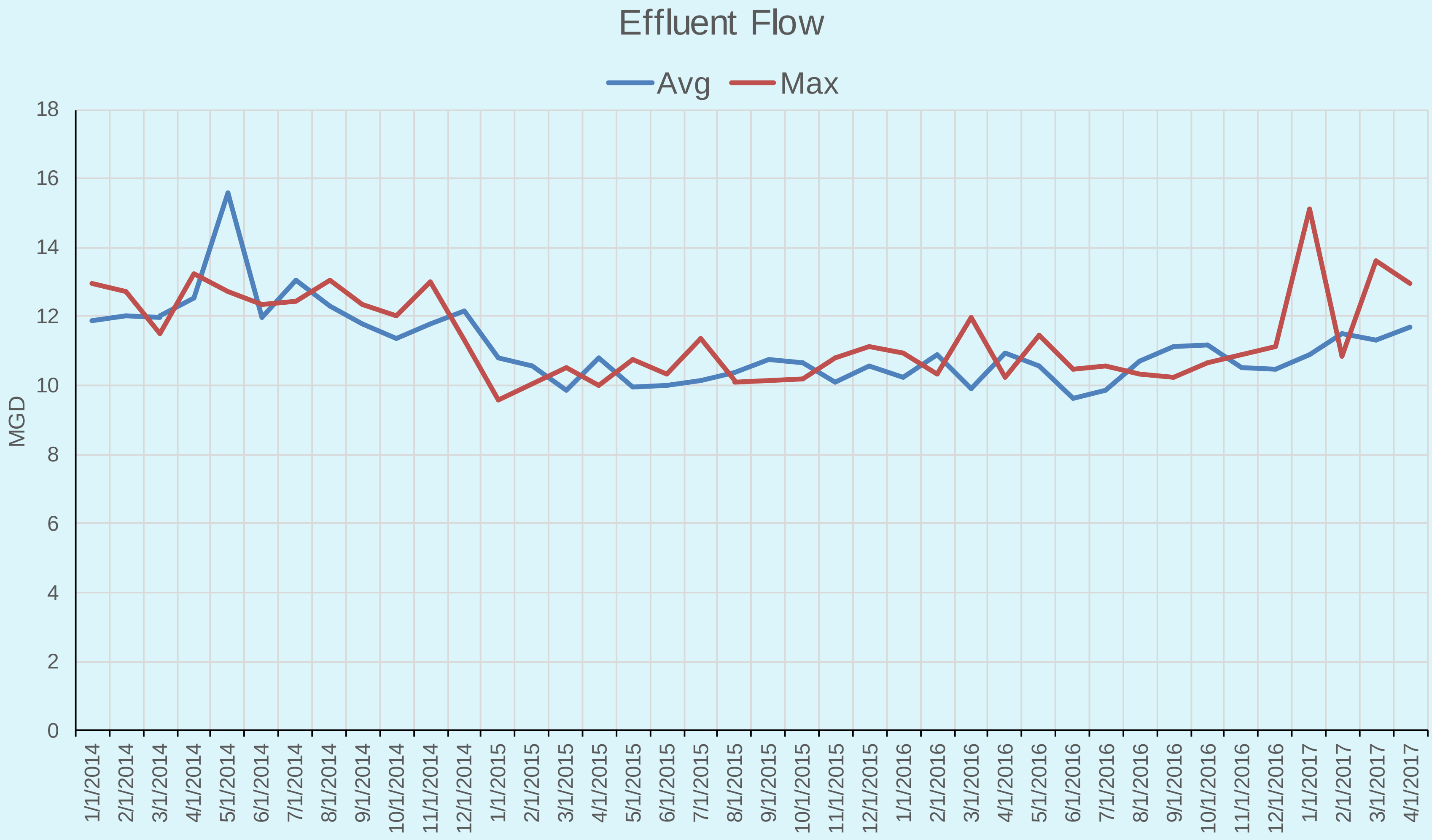
Review data and discuss any issues

# Exercise 1



Effluent Flow
Avg
Max
MGD
0
2
4
6
8
10
12
14
16
18
1/1/2014
2/1/2014
3/1/2014
4/1/2014
5/1/2014
6/1/2014
7/1/2014
8/1/2014
9/1/2014
10/1/2014
11/1/2014
12/1/2014
1/1/2015
2/1/2015
3/1/2015
4/1/2015
5/1/2015
6/1/2015
7/1/2015
8/1/2015
9/1/2015
10/1/2015
11/1/2015
12/1/2015
1/1/2016
2/1/2016
3/1/2016
4/1/2016
5/1/2016
6/1/2016
7/1/2016
8/1/2016
9/1/2016
10/1/2016
11/1/2016
12/1/2016
1/1/2017
2/1/2017
3/1/2017
4/1/2017

# Exercise 1


Effluent Flow
Avg
Max
MGD
18
16
14
12
10
8
6
4
2
0
1/1/2014
2/1/2014
3/1/2014
4/1/2014
5/1/2014
6/1/2014
7/1/2014
8/1/2014
9/1/2014
10/1/2014
11/1/2014
12/1/2014
1/1/2015
2/1/2015
3/1/2015
4/1/2015
5/1/2015
6/1/2015
7/1/2015
8/1/2015
9/1/2015
10/1/2015
11/1/2015
12/1/2015
1/1/2016
2/1/2016
3/1/2016
4/1/2016
5/1/2016
6/1/2016
7/1/2016
8/1/2016
9/1/2016
10/1/2016
11/1/2016
12/1/2016
1/1/2017
2/1/2017
3/1/2017
4/1/2017

# Exercise 1

16 times maximum reported BELOW average

40% error rate!

# Data Needs

- Sample Types
  - Grab
  - Composite
    - Time Weighted
    - Flow Composite

# Data Needs

## Grab Sampling

Grab samples are individual samples collected over a period of time not exceeding 15 minutes and are representative of conditions at the time the sample is collected.

# Data Needs

## Grab Sampling

Cyanide

Flashpoint

Oil and Grease

pH

Sulfides

Temperature

Total Petroleum Hydrocarbons

Total Phenols

VOCs

# Data Needs

## Composite Sampling

A Composite sample should contain a minimum of eight discrete samples taken at equal time intervals over the compositing periods or proportional to the flow rate over the composting period.

# Data Needs

## Composite Sampling

# Data Needs

## Composite Sampling

Time Composite Sample

This method requires discrete sample aliquots collected in one container at constant time intervals.

# Data Needs

## Composite Sampling

Flow-Proportional Composite Sample

One method collects a constant sample volume at varying time intervals proportional to stream

The other method, collect the sample by increasing the volume of each aliquot as the flow increases, while maintaining a constant time interval between the aliquots.

# Data Needs

Local limits may be established on an instantaneous, daily, weekly or monthly-average basis.

The sample type used to determine compliance with local limits should be linked to the duration of the pollutant limit being applied.

# Data Needs

Compliance with instantaneous limits should be established using individual grab samples. Exceedances identified by composite sampling are also violations.

# Data Needs

Compliance with daily, weekly or monthly average limits should be determined using composited sampling data, with the same exceptions noted.

# Data Needs

Minimum Sample Days

- Initial Development
- Ongoing / Re-Evaluation

# Data Needs

## Initial Development

| **Parameter** | **POTW** | | |
|---|---|---|---|
| | Influent days to sample | Effluent days to sample | Sludge days to sample |
| Organic Priority Pollutants | **1 - 2** | **1 - 2** | **1** |
| National POCs | **7 - 14** | **7 - 14** | **2** |
| POTW-specific POCs | **7 - 14** | **7 - 14** | **2** |
| Percent solids, sludge | | | **2** |
| TCLP pollutants | | | **1** |

# Data Needs

## Ongoing / Re-Evaluation

| **Parameter** | Location | Less than 5 MGD | 5 – 10 MGD | 10 – 50 MGD | >50 MGD |
|---|---|---|---|---|---|
| Adopted Local Limits | Influent<br>Effluent<br>Sludge | 4 / year | 4 / year | 4 / year | 6 / year |
| MAHLs Calculated | Influent<br>Effluent<br>Sludge | 1 / year | 2 / year | 2 / year | 4 / year |
| Organic Priority Pollutants | Influent | 1 / year | 1 / year | 1 / year | 2 / year |
| TCLP Pollutants | Sludge | 1 / year | 1 / year | 1 / year | 1 / year |
| Sludge Percent Solids | Sludge | 2 / year | 3 / year | 4 / year | 6 / year |

# Pollutants Defined

Conventional – pollutants that treatment plants are typically designed for.

Non-Conventional – all other pollutants or toxic pollutants.

Conservative – pollutant partitions in a recoverable form.

Non-Conservative – pollutant maybe transformed into new compound.

# Non - Conservative Pollutants

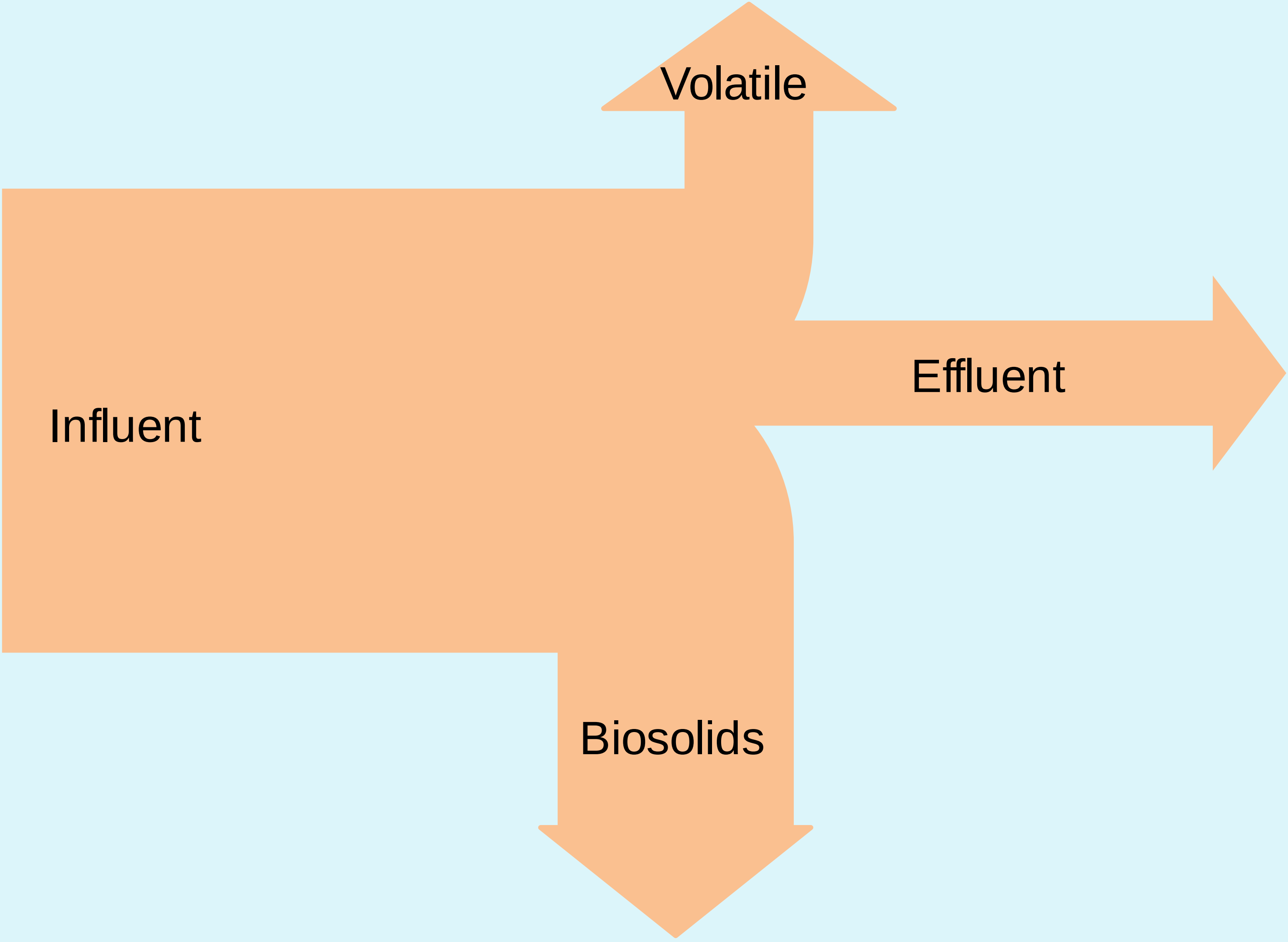
Incoming Pollutant

Effluent Water

Biosolids

Atmosphere

# Pollutant's Fate



# Non - Conservative Pollutants

Examples

Conventional

$BOD_5 + O_2 \rightarrow CO_2$

Non-Conventional

$NH_4 + O_2 \rightarrow NO_3$

# Conservative Pollutants

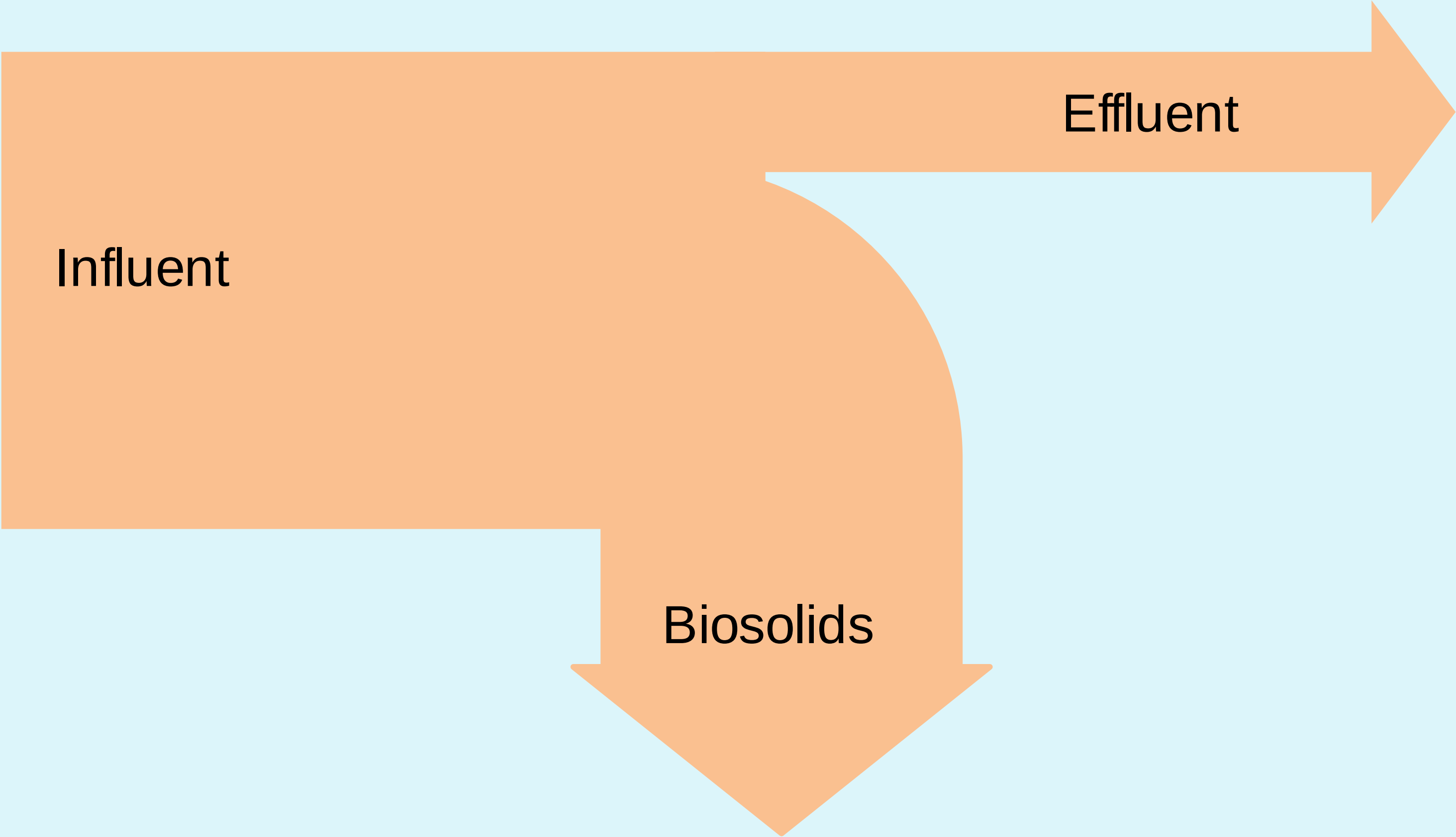

Incoming Pollutant

Effluent Water

Biosolids

Atmosphere

# Pollutant's Fate



# Conservative Pollutants

Arsenic
Cadmium
Chromium
Copper
Lead
Mercury
Molybdenum
Nickel
Selenium
Zinc

# Analytical Methods

40 CFR Part 136

40 CFR Part 503

- Anticipated pollutant concentration.
- Potential interferences.
- Total vs. a fraction thereof (e.g., Total vs. dissolved metals, or total vs. amenable cyanide).

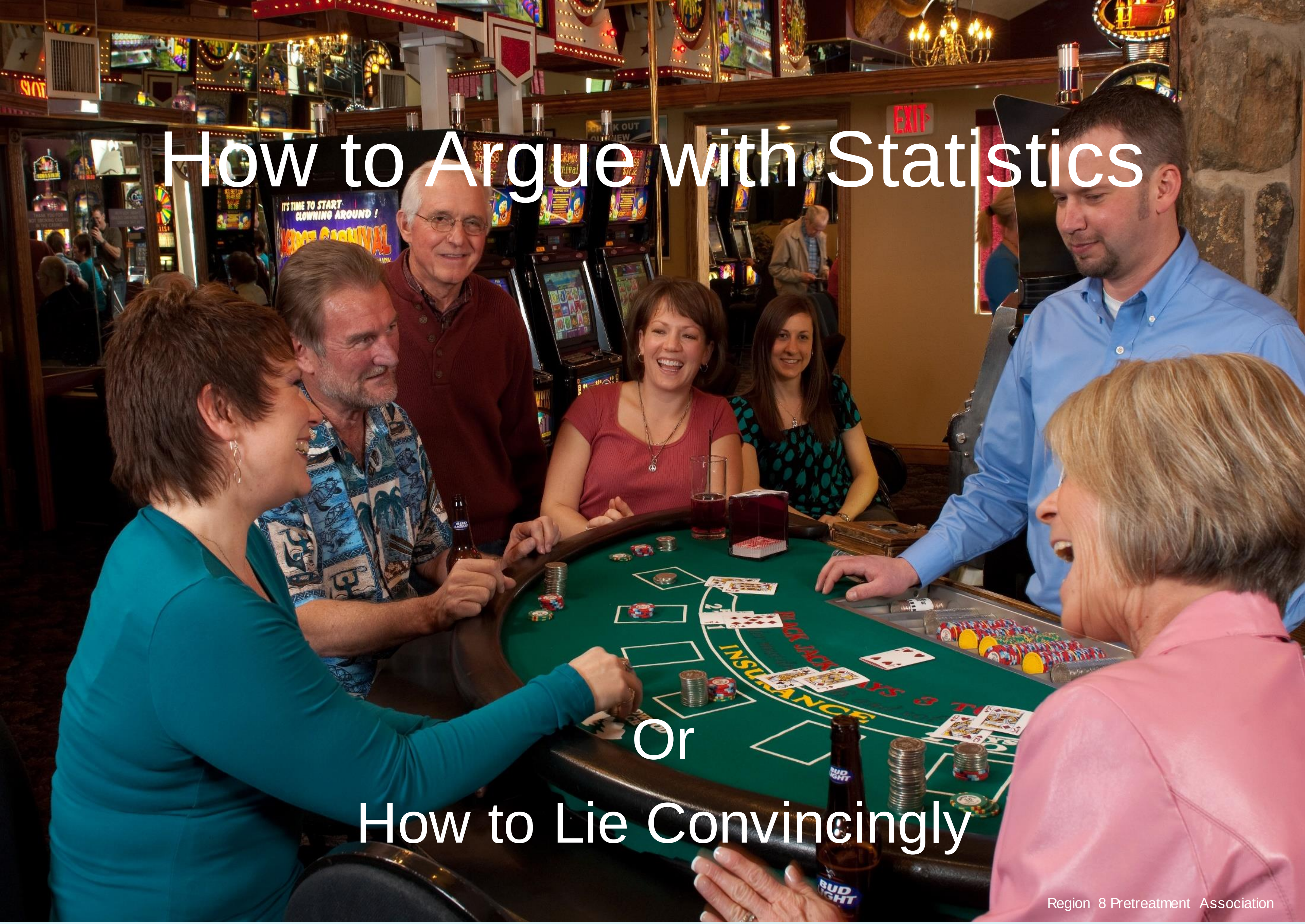
# Analytical Methods

40 CFR Part 136

40 CFR Part 503

The minimum detection level (MDL) of the analytical method to detect the presence of pollutants in trace amounts and the corresponding minimum level (ML) of quantitation (generally 3.18 times the MDL) to determine removal efficiencies.

# Data Analysis




# How to Argue with Statistics

Or

## How to Lie Convincingly

# Introduction to Statistics

Two Types

Descriptive Statistics

Entire POPULATION

Inferential Statistics

SAMPLES from a population.

# Introduction to Statistics

Descriptive Statistics

Greek notation

μ  - mean

N  - population size

Σ - sum

# Introduction to Statistics

Inferential Statistics

Roman Notation:

X - mean

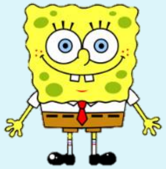
n - sample size

Σ - sum

Assume the sample size is unbiased

# Introduction to Statistics

Univariate Statistics – one variable

- Mean 
- Median 
- Mode 
- Range (min, max) 
- Variance 
- Standard Deviation 

# Introduction to Statistics

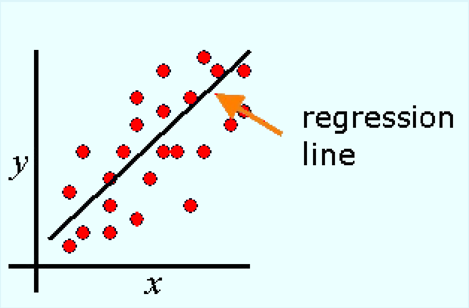
Bivariate Statistics – two variables

Dependence

Independence

Association

Linear Regression

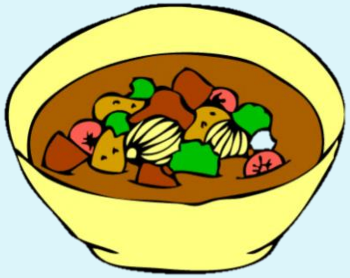


# Introduction to Statistics

Multivariate Statistics – multiple variables

Factor Analysis

Multiple Regression



# Univariate Statistics

The “mean” is the average score or value, such as flow from an industry.

Mean of a population

$$\mu = \frac{\Sigma X}{N}$$

Inferential mean of a sample

$$X = \frac{\Sigma X}{n}$$

# Univariate Statistics

Because the mean average can be sensitive to extreme values, the “median” is sometimes useful and more accurate.

The “median” is simply the middle value among some scores of a variable.
(no standard formula for its computation)

# Univariate Statistics

The “mode” is simply the most frequent value for a variable. Multiple modes are possible: bimodal or multimodal.

# Univariate Statistics

Measures of dispersion tell us about variability in the data.

Basic question: how much do values differ for a variable from the min to max, and distance among values in between. We use:

Range

Variance

Standard Deviation

# Univariate Statistics

The “range” gives us the value between the minimum and maximum values of a variable.

*range = maximum – minimum*

# Univariate Statistics

The “variance” is a measurement of the spread between numbers in a data set.

Variance of a population

$$S^2 = \frac{\Sigma\,(x - \mu)^2}{N}$$

Variance of a sample

$$S^2 = \frac{\Sigma(x - X)^2}{n-1}$$

# Univariate Statistics

The “standard deviation” is a measure that is used to quantify the amount of variation or dispersion of a set of data values.

Standard Deviation of a population

$$\sigma = \sqrt{\frac{\Sigma(x - \mu)^2}{N}}$$

Standard Deviation of a sample

$$\sigma = \sqrt{\frac{\Sigma(x - X)^2}{n - 1}}$$

# Exercise 2

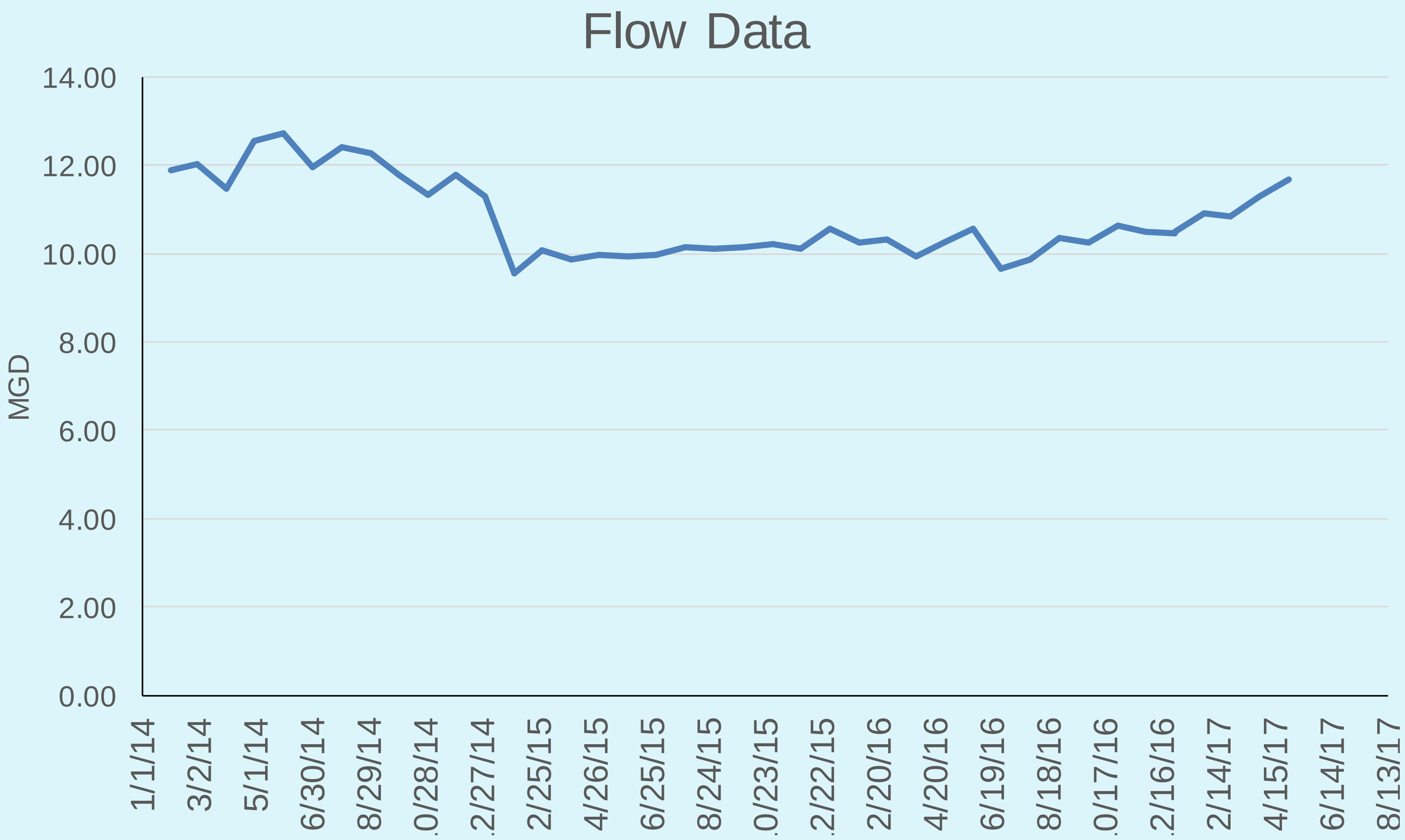
# Exercise 2

Used the flow data (corrected)

Calculate and plot the

- Mean
- Median
- Mode
- Range
- Variance
- Standard Deviation

# Exercise 2



Flow Data
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
MGD
1/1/14
3/2/14
5/1/14
6/30/14
8/29/14
0/28/14
2/27/14
2/25/15
4/26/15
6/25/15
8/24/15
0/23/15
2/22/15
2/20/16
4/20/16
6/19/16
8/18/16
0/17/16
2/16/16
2/14/17
4/15/17
6/14/17
8/13/17

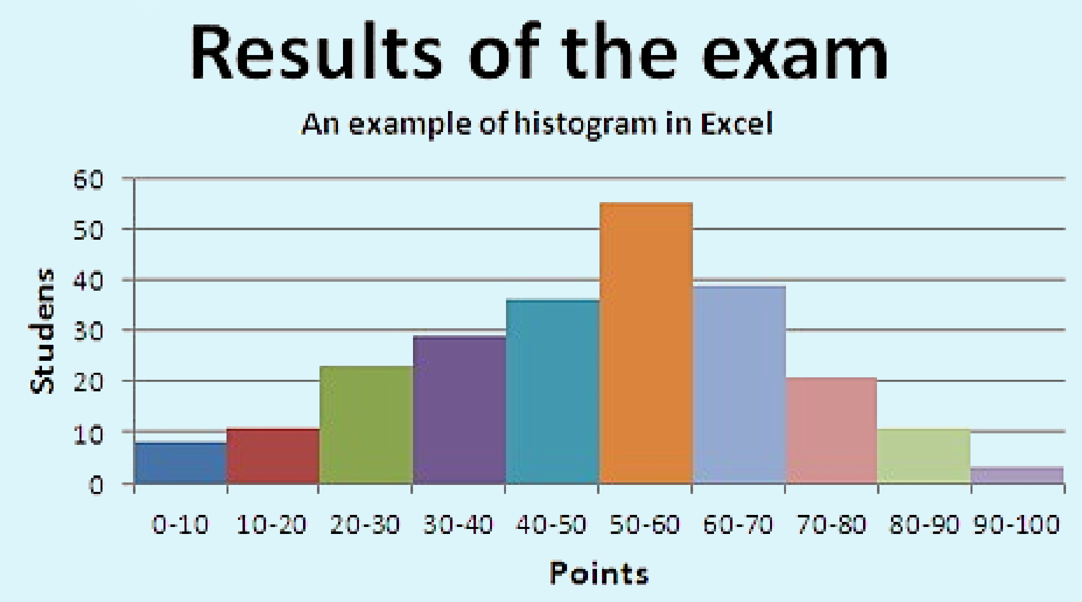
# Exercise 2

| | |
|---|---|
| Mean | 10.80075 |
| Standard Error | 0.141629884 |
| Median | 10.49 |
| Mode | 11.31 |
| Standard Deviation | 0.895746036 |
| Sample Variance | 0.802360962 |
| Kurtosis | -0.821368771 |
| Skewness | 0.670888047 |
| Range | 3.16 |
| Minimum | 9.56 |
| Maximum | 12.72 |
| Sum | 432.03 |
| Count | 40 |

# Histogram

A histogram is a graphical representation of the distribution of numerical data.

It is an estimate of the probability distribution of a continuous variable



# Histogram

Organize data into groups (bins)

Use between 8 and 16 when dealing with a lot of data.

Adjusted bin width round up the bin width to the higher value

$$\text{Bin size} = \frac{\text{Range}}{\text{Number of Bins}}$$

# Exercise 3

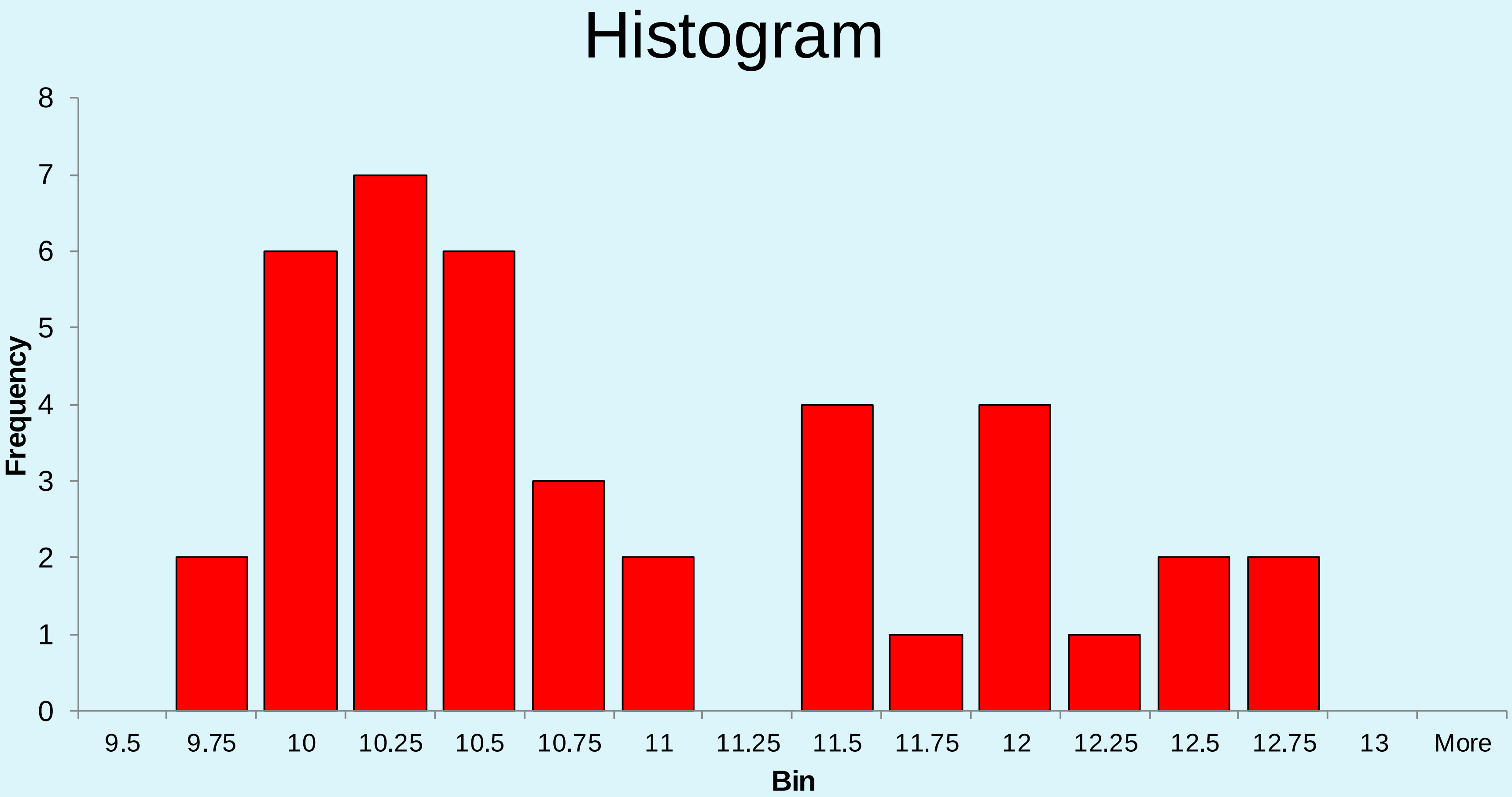
# Exercise 3

Used the flow data (corrected)

Develop a 15 bin Histogram

Range 9.5 to 13 with step 0.25

# Exercise 3


Histogram
Frequency
8
7
6
5
4
3
2
1
0
9.5
9.75
10
10.25
10.5
10.75
11
11.25
11.5
11.75
12
12.25
12.5
12.75
13
More
Bin

# Normal Distribution

Assuming a normal distribution allows us to take advantage of its properties and make inferences from our sample to the population.

The theoretical *sampling distribution* of various statistics do seem to be normally distributed.

# Normal Distribution

The Classic Bell-Shaped curve is symmetric, with mean = median = mode = midpoint

Also known as Gaussian distribution

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}}(e)^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

# Normal Distribution

Curve has a total area or probability = 1

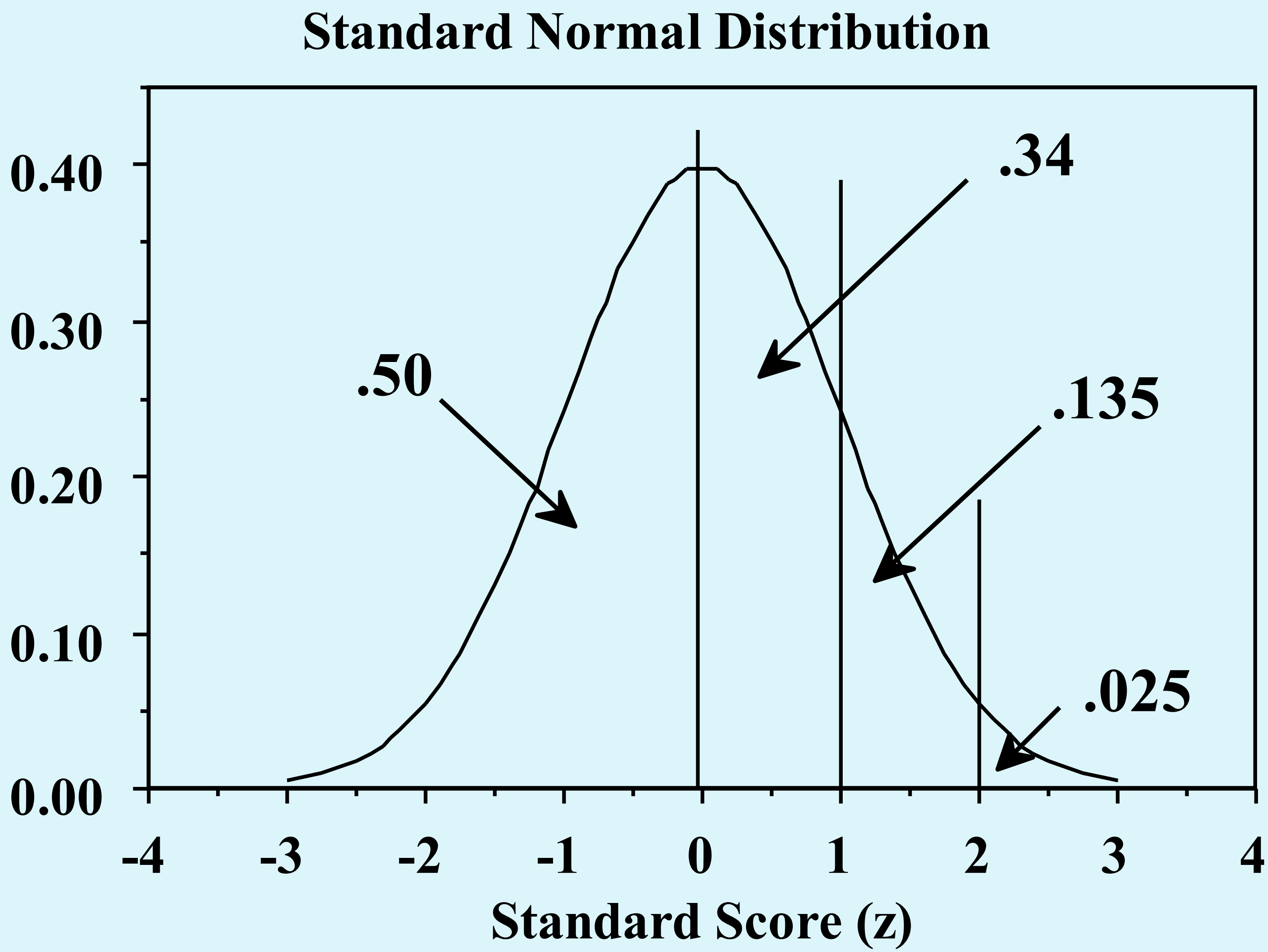
For normal distributions

$\pm$ 1 SD ≈ 68%

$\pm$ 2 SD ≈ 95%

$\pm$ 3 SD ≈ 99.9%

# Normal Distribution



# Exercise 4

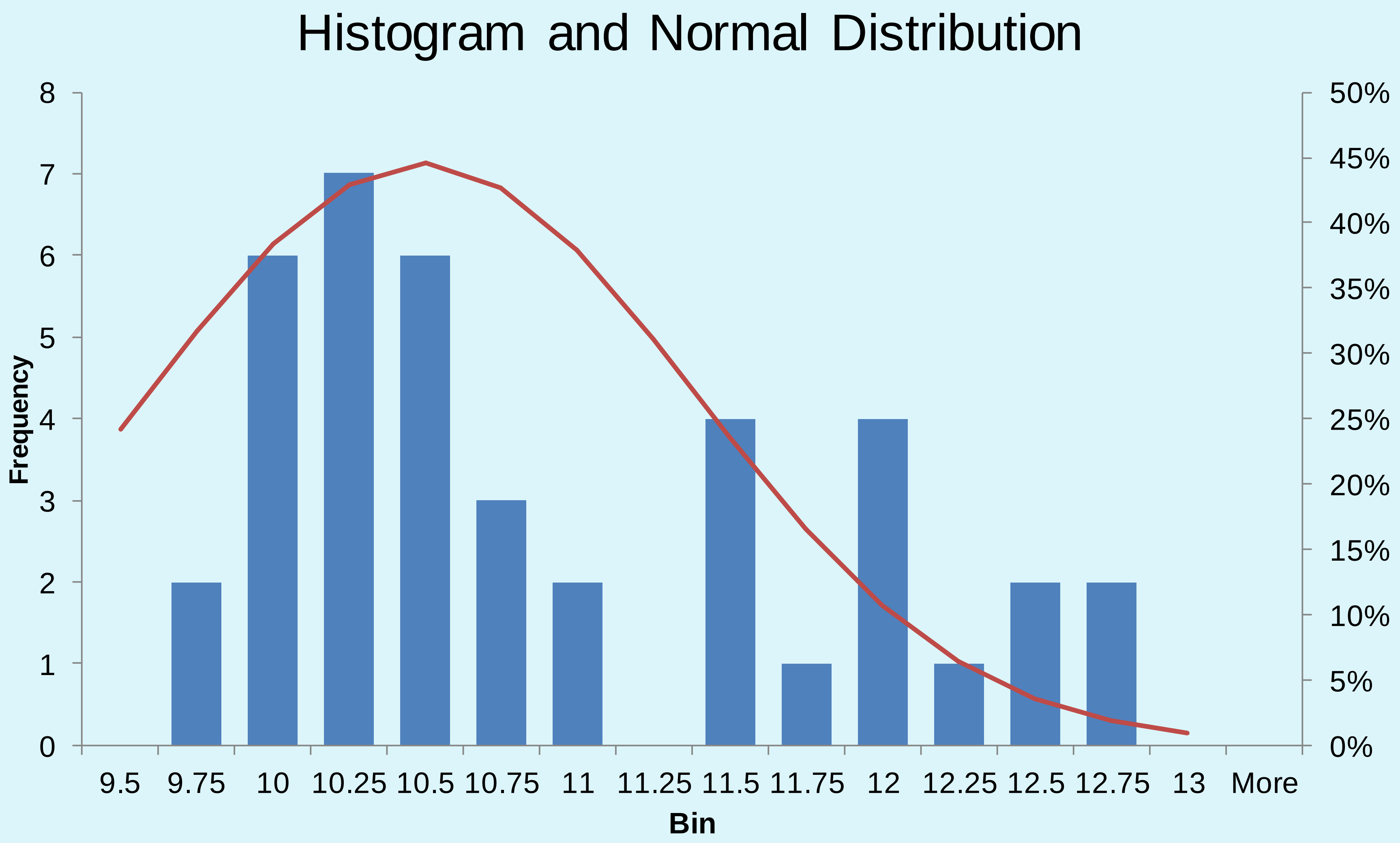
# Exercise 4

Used the flow data (corrected)

And the 15 bin Histogram developed before

Overlay a Normal distribution plot

# Exercise 4


Histogram and Normal Distribution
Frequency
8
7
6
5
4
3
2
1
0
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
9.5
9.75
10
10.25
10.5
10.75
11
11.25
11.5
11.75
12
12.25
12.5
12.75
13
More
Bin

# Bivariate Statistics

Bivariate Statistics – two variables

Dependence

Independence

Association

Linear Regression

# Bivariate Statistics

The dependent variable is 'dependent' on the independent variable.

An independent variable is the variable that is changed or controlled in a scientific experiment to test the effects on the dependent variable.

# Bivariate Statistics

Association between two variables means the values of one variable relate in some way to the values of the other. Association is usually measured by correlation for two continuous variables and by cross tabulation and a Chi-square test for two categorical variables.

Linear Regression

# Exercise 5

# Exercise 5

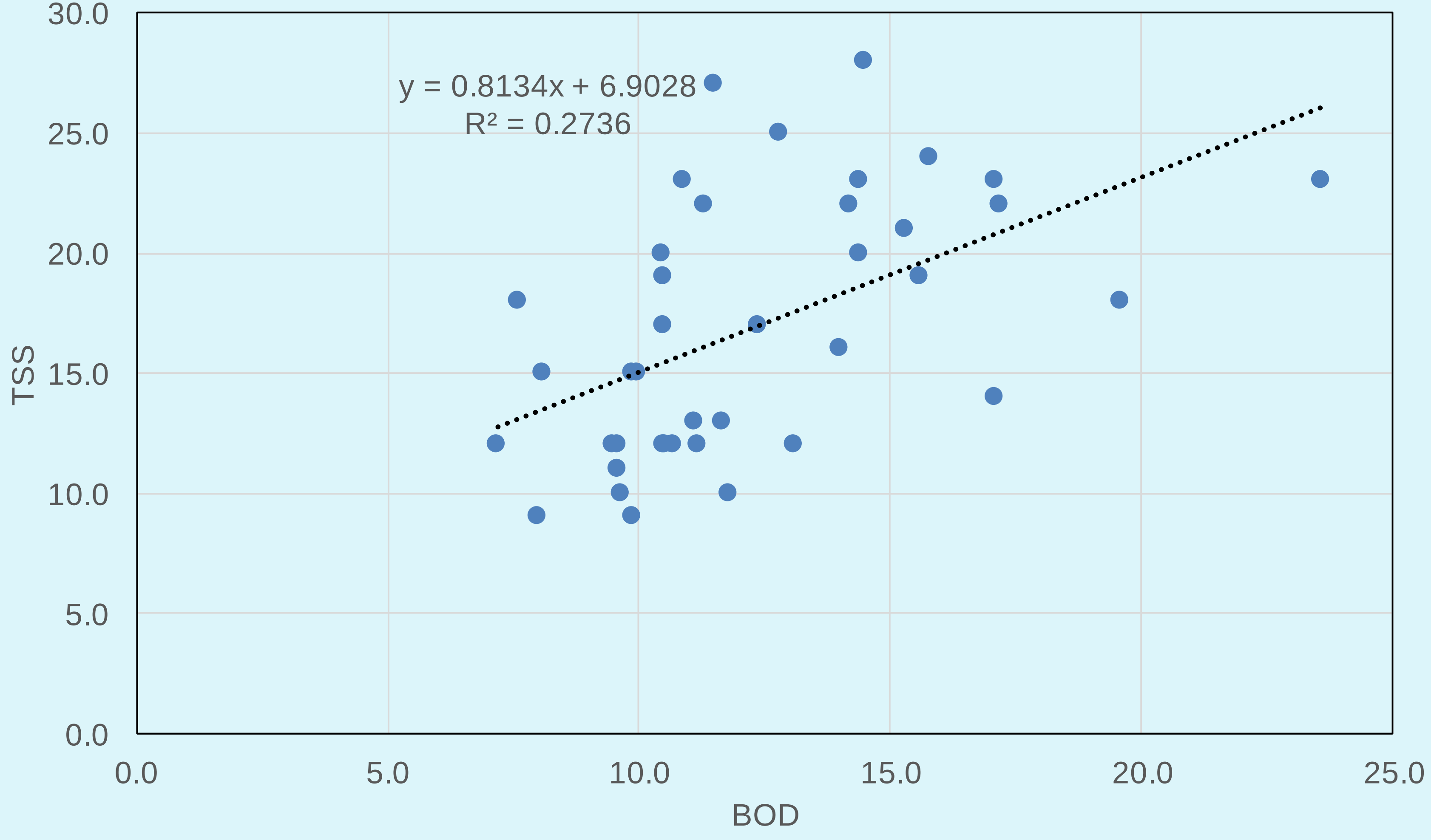
Given the BOD and TSS data from the thumb drive

Plot $BOD_5$ vs TSS

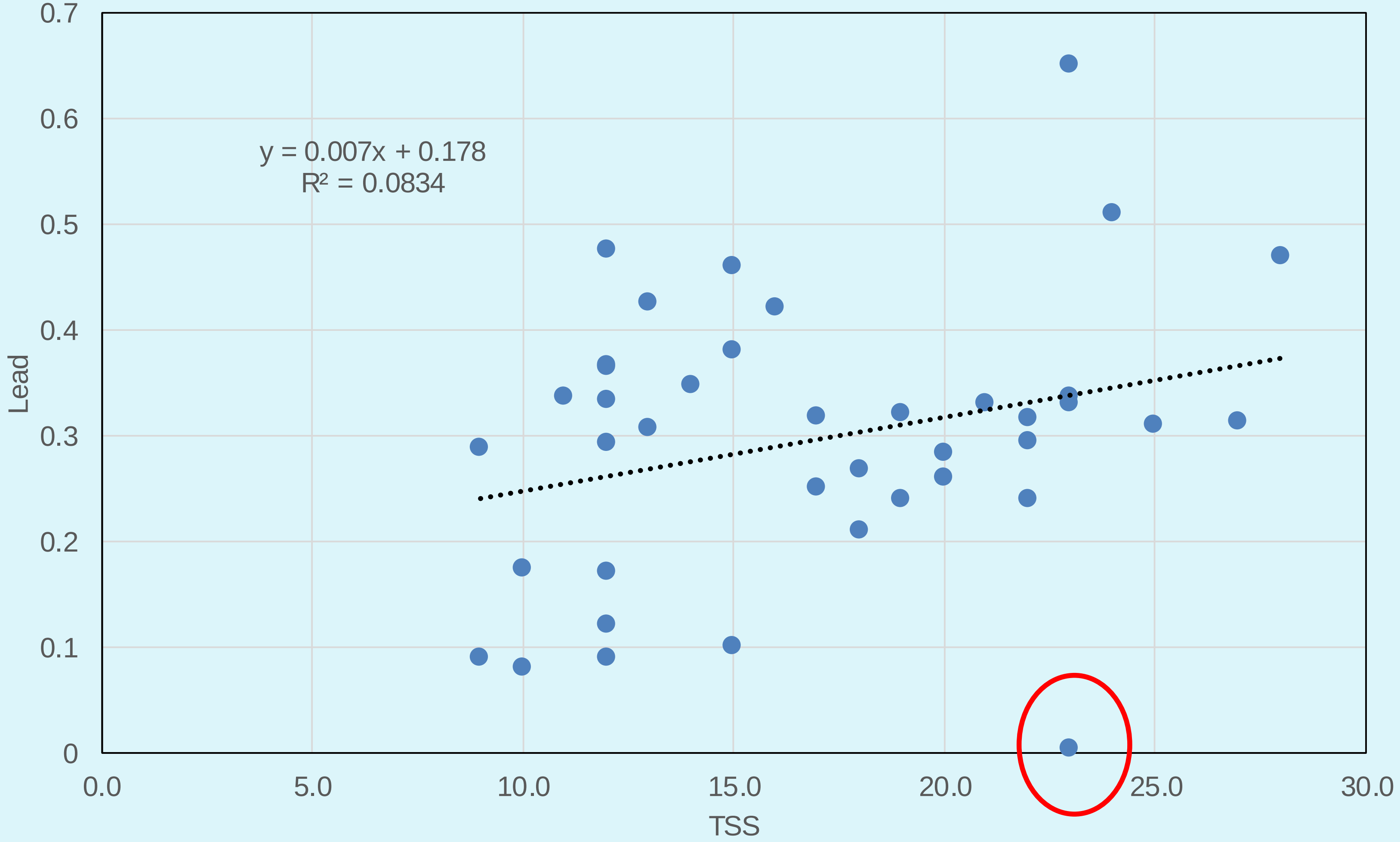
Plot TSS vs Lead

Calculate linear curve fit and regression coefficient

# Exercise 5


y = 0.8134x + 6.9028
R² = 0.2736
30.0
25.0
20.0
15.0
10.0
5.0
0.0
TSS
0.0
5.0
10.0
15.0
20.0
25.0
BOD

# Exercise 5



y = 0.007x + 0.178
R² = 0.0834
Lead
TSS
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.0
5.0
10.0
15.0
20.0
25.0
30.0

# Calculating MAHL

# Calculating MAHL

Calculate POTW removal efficiency for the POC

Calculate allowable headworks loadings (AHLs) for each environmental criterion

Designate as the MAHL the most stringent AHL for the POC

# Removal Calculations

Pollutant removal efficiency is defined as the percent change of a pollutant's mass flow taken before and after treatment:

$$\text{Removal Efficiency} = \frac{\text{Influent Mass} - \text{Effluent Mass}}{\text{Influent Mass}} \times 100\%$$

# Removal Calculations

Removal efficiency is the most important Calculation in determining Local Limits.

If they are wrong

Everything else is wrong TOO

# Removal Calculations

# Sample Decision Tree

Influent → present / absent

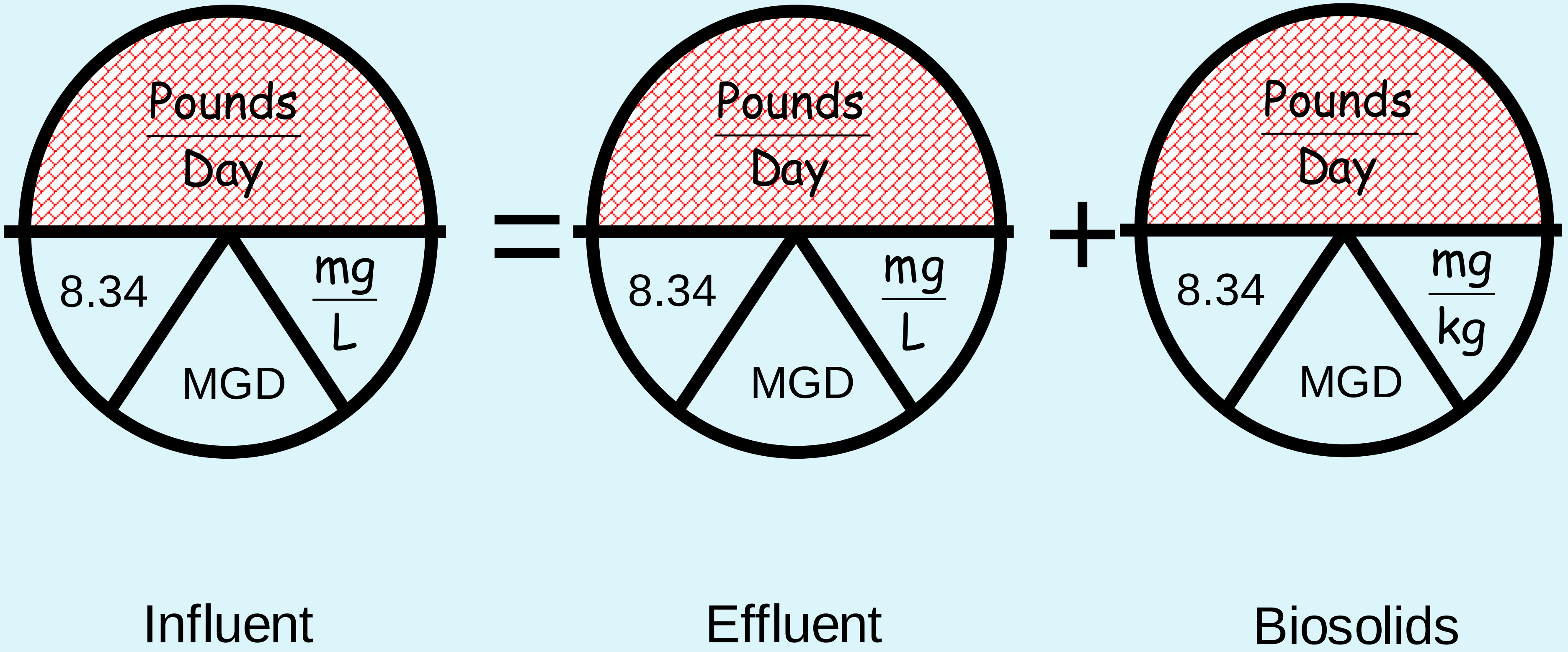
Effluent → present / absent

Biosolids → present / absent

Can you mass balance the pollutant?

Influent = Effluent + Biosolids

# Mass Balance



# Exercise 6

# Exercise 6

Find the influent and effluent data for copper

Enter the data in the removal spreadsheet

Calculate removals

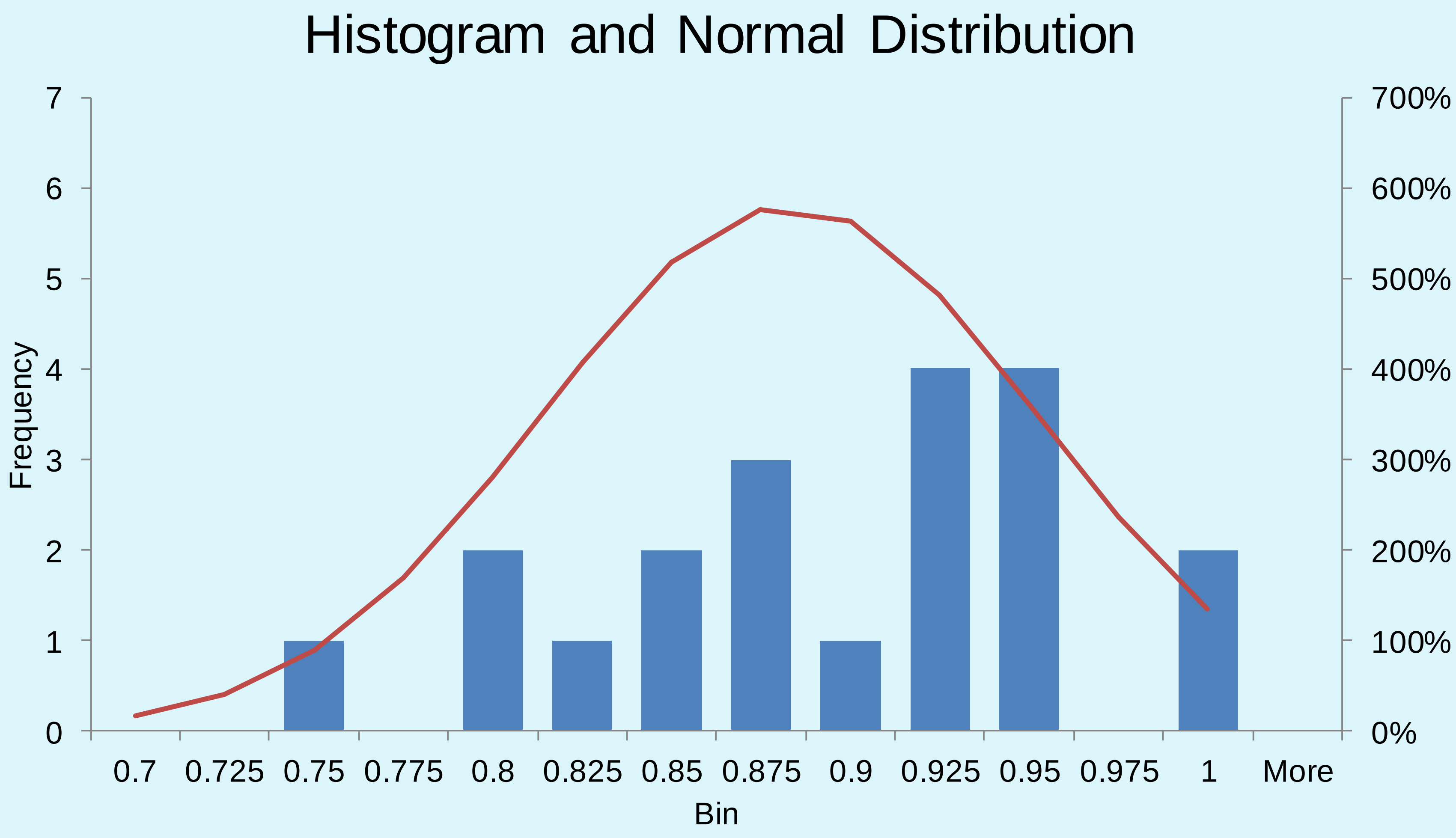
MRL Limits

| | |
|---|---|
| 200.7 | 0.01000 mg/L |
| 200.8 | 0.00050 mg/L |

# Exercise 6

| | |
|---|---|
| Mean | 0.882872318 |
| Standard Error | 0.015370544 |
| Median | 0.898670954 |
| Mode | |
| Standard Deviation | 0.068739164 |
| Sample Variance | 0.004725073 |
| Kurtosis | -0.762478147 |
| Skewness | -0.327196628 |
| Range | 0.24278438 |
| Minimum | 0.746543779 |
| Maximum | 0.989328159 |
| Sum | 17.65744637 |
| Count | 20 |

# Exercise 6


Histogram and Normal Distribution
Frequency
0
1
2
3
4
5
6
7
0%
100%
200%
300%
400%
500%
600%
700%
0.7
0.725
0.75
0.775
0.8
0.825
0.85
0.875
0.9
0.925
0.95
0.975
1
More
Bin

# Calculating AHL

Calculate the allowable discharge from the Wastewater Analysis

Remember the to look at Chronic Standard

Calculate the allowable discharge from the Sludge disposal

Use the lower of the two loadings

# Calculating AHL

Calculate the allowable headworks loading using the following equation

$$AHL_{npdes} = \frac{WLA_{npdes}}{\left(1 - R_{potw}\right)}$$

$AHL_{npdes}$ - allowable headworks loading (water quality)

$WLA_{npdes}$ - permitted water quality load

$R_{potw}$ - pollutant removal efficiency

# Calculating AHL

Calculate the allowable headworks loading using the following equation

$$AHL_{solids} = \frac{8.34 \times Q_{sludge} \times 503_{npdes} \times Solids\ \%}{R_{potw}}$$

$AHL_{solids}$ - allowable headworks loading (sludge disposal)

Q sludge - daily sludge flow (MGD)

$503_{solids}$ - maximum sludge concentration (disposal driven)

Solids % - percent solids of sludge

$R_{potw}$ - pollutant removal efficiency

# 40 CFR 503

| Parameter | Maximum ppm | Maximum lbs-ac | Annual ppm | Annual lbs-ac/yr |
|---|---|---|---|---|
| Arsenic | 75 | 223 | 41 | 11 |
| Cadmium | 85 | 212 | 39 | 10 |
| Copper | 4,300 | 8,172 | 1,500 | 409 |
| Lead | 840 | 1,634 | 300 | 82 |
| Mercury | 57 | 93 | 17 | 5 |
| Molybdenum | 75 | | | |
| Nickel | 420 | 229 | 420 | 114 |
| Selenium | 100 | 545 | 100 | 27 |
| Zinc | 7,500 | 15,254 | 2,800 | 76 |

# Exercise 7

# Exercise 7

Calculate the allowable headwork loading for copper based upon water quality

Remember the to look at Chronic Standard

Calculate the allowable discharge from the Sludge disposal

Use the lower of the two loadings

# Exercise 7

| | | |
|---|---|---|
| Average Removal | - | 0.8829 |
| Permitted effluent | - | 10 lbs/day |
| 503 limit | - | 1500 mg/kg |
| Sludge flow | - | 0.090 MGD |
| Solids percentage | - | 2.45% |

# Exercise 7

| | | |
|---|---|---|
| Average Removal | - | 0.8829 |
| Permitted effluent | - | 10 lbs/day |
| 503 limit | - | 1500 mg/kg |
| Sludge flow | - | 0.090 MGD |
| Solids percentage | - | 2.45% |
| $AHL_{NPDES}$ | - | 85.397 lbs/day |
| $AHL_{503}$ | - | 31.243 lbs/day |

# MAIL

MAHLs estimate the maximum combined loadings that can be received at the POTW's headworks from all sources.

MAILs developed by the POTW represent the amount of pollutant loadings the POTW can receive from controlled sources (i.e.,industrial users, some commercial sources)

# MAIL

| Parameter | Comments | Source of Data |
|---|---|---|
| IU and SIU flow | Sum of all flows for IU and SIU | POTW local use sampling program, periodic reports from SIUs |
| Uncontrolled Source Pollutant Concentrations and Flows | Levels of POCs in domestic and commercial discharges that the POTW does not intend to control with local limits | POTW local use sampling program |
| Hauled Waste Loadings | Based on volume and pollutant concentration data | POTW sampling of waste hauler loads |
| Safety Factor | Varies depending on quality and amount of data | POTW choice based on data analysis |
| Growth Allowance | Varies based on the projected growth for the area | POTW choice based on data analysis |

# MAIL

Calculate the maximum allowable industrial loading using the following equation

$$MAIL = MAHL\ (1-SF) – ((Load_{res/com} + Load_{hauled})\ (1+GF))$$

| | | |
|---|---|---|
| MAIL | - | maximum available industrial load |
| MAHL | - | maximum available headworks load |
| SF | - | safety factor |
| $Load_{res/com}$ | - | load from residential commercial areas |
| $Load_{hauled}$ | - | load from hauled waste |
| GF | - | growth factor |

# Hauled Wastes

| | | |
|---|---|---|
| Ammonia | - | 1.6 lbs |
| $BOD_5$ | - | 108 lbs |
| TSS | - | 215 lbs |
| Copper | - | 1.2 lbs |

# Growth Factors

| Population Growth 2010-2016 | | |
|---|---|---|
| US Rank | State | Percent |
| 1 | North Dakota | 12.69% |
| 3 | Utah | 10.40% |
| 4 | Colorado | 10.17% |
| 14 | South Dakota | 6.30% |
| 16 | Montana | 5.37% |
| 27 | Wyoming | 3.88% |

# Growth Factors

| Population Growth 2015-2016 | | |
|---|---|---|
| | State | Percent |
| | North Dakota | 0.14% |
| | Utah | 1.81% |
| | Colorado | 1.52% |
| | South Dakota | 0.81% |
| | Montana | 0.92% |
| | Wyoming | -0.10% |