# Monitoring and Remediation Optimization System Software 3.0

# AFCEE MAROS 3.0 New Release

Mindy Vanderford, Ph.D.
GSI ENVIRONMENTAL INC
Houston and Austin, TX
(713) 522-6300

Monitoring Optimization

## Overview: *MAROS 3.0 New Release*

- Goals and Objectives
- Software Structure and New Features

QUESTIONS?

- Detailed Descriptions
- Wrap Up

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## MAROS – the origin

*How can we get more meaning from the data we collect?*

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## MAROS – the origin

*What makes a good data collection network?*

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## MAROS – the origin

- *Good Networks*
  - Meets goals
  - Not too much, not too little
  - Reveal what has happened
  - Help 'prepare for' what will happen

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## Method: *Good Networks*

- *What are we looking for?*
  - Variability vs. Consistency
  - Increasing / Decreasing vs. Stable
  - Expected vs. 'Interesting'
  - Moving vs. Stationary
  - Where is most of the mass?

**RATE**

**SCALE**

**VARIABILITY**

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## Goals: *MAROS 1998 -2003*

- Reduce monitoring effort
  - Demonstrate Plume Stability
  - Reduce Long-Term O&M Costs
  - Reduce Number of Wells
  - Reduce Sampling Frequency
- ***Make Recommendations for improving network – for long-term O&M***

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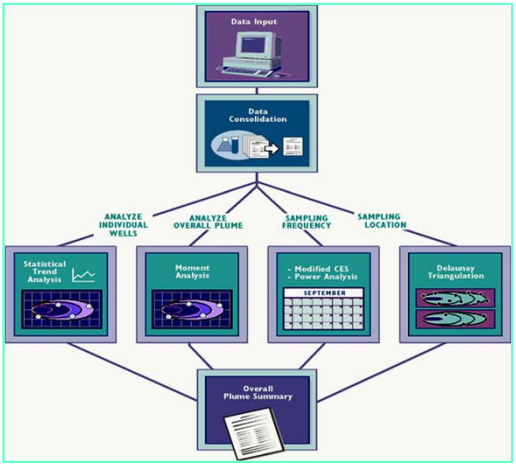
## MAROS – 2.X

- Concentration Trends
- Total mass and distribution
- Spatial uncertainty
- Sampling frequency

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## Goals: *MAROS 2009-2012*

- Improve analysis of existing data
  - Demonstrate Remedial Performance
  - 'Best Choice' wells and frequency
  - Support Cessation of Active Remedies
  - Support Exit Strategies


- ***Make Recommendations for improving network – to attain closure***

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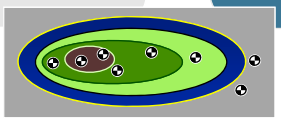
## MAROS 2.2 → MAROS 3.0

- Limited Individual Well Statistics
- Limited spatial analysis options
- Limited User choice and interactivity
- Usability issues
- Limited data export options

- ***Expanded Individual Well Statistics***
- ***Improved spatial analysis***
- ***More User choice and comparison options for spatial analysis***
- ***Improve Usability***
- ***More export opportunities and options***



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## Overview: *MAROS 3.0 New Release*

- Goals and Objectives
- Software Structure and New Features

QUESTIONS

- Detailed Description
- Conclusions

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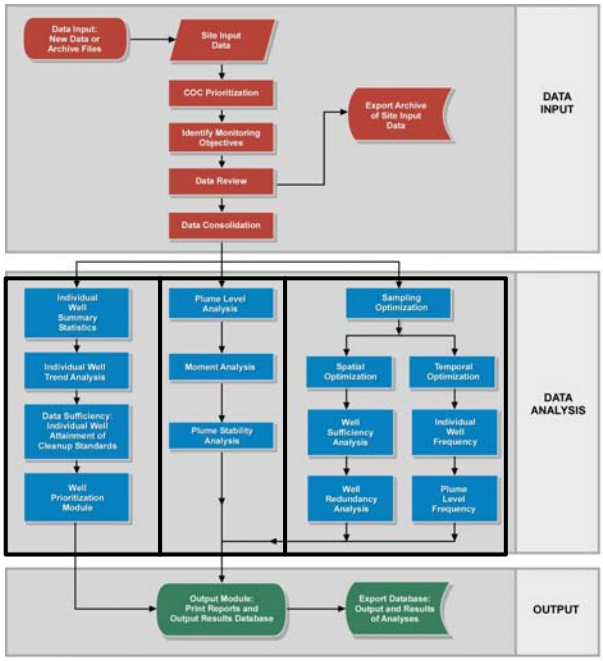
*Data Input*

*Individual Well Analysis*

*Plume-Level Analysis*

*Spatial and Temporal Optimization*

*Data Export*

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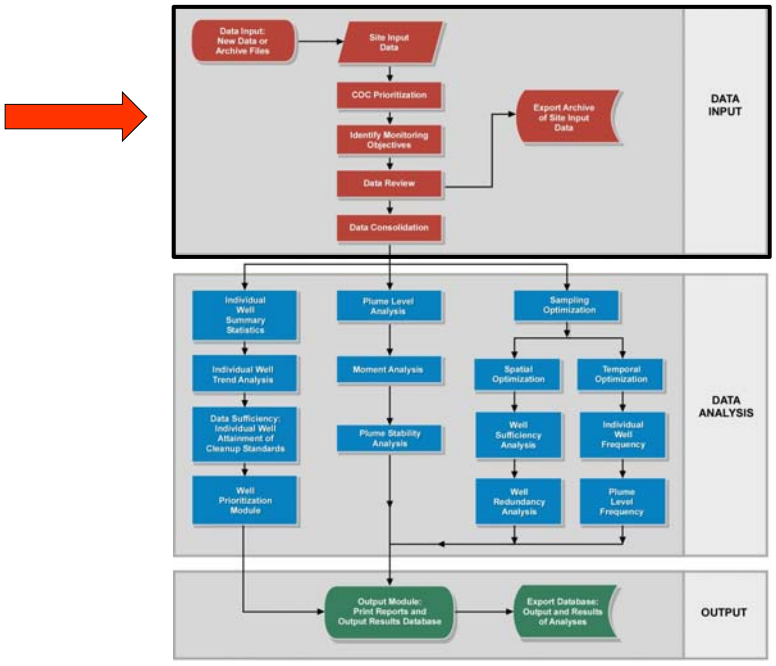


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| Column Number | Field Name | Data Type | Description |
|---|---|---|---|
| *Initial Input Data* | | | |
| 1 | WellName | Text | Name of the groundwater well sampled, all well names should be spelled consistently. *(Required)* |
| 2 | XCoord | Number (Double) in Feet | X coordinate or Easting coordinate of the well, although not mandatory for statistical analysis, it is required for spatial analysis purposes. *(Required)* |
| 3 | YCoord | Number (Double) in Feet | Y coordinate or Easting coordinate of the well, although not mandatory for statistical analysis, it is required for spatial analysis purposes. *(Required)* |
| 4 | Constituent | Text | Constituent of Concern – the User has the option of using the MAROS Constituent Name ***or*** the ERPIMS Code for constituent names. *(Required)* |
| 4 | CODE | Text | Constituent of Concern – ERPIMS codes and MAROS Constituent names can be found in the MAROS_ConstituentName_List.xlsx. *(Required)* |
| 5 | Sample Date | Short Date | Date Sample was collected: format mm/dd/yyyy. *(Required)* ***NOTE: No Hours: Minute Time Codes.*** |
| 6 | Result | Number (Double) | Analytical result: enter result as a number, if value is below detection limit (non-detect) then leave the cell blank (null value). *(Required)* |
| 7 | Units | Text | Measurement units for result: choices mg/L; ug/L; ng/L; g/L; pg/L. (no Greek symbols) *(Required)* |
| 8 | DetLim | Number (Double) | Reporting Limit (detection limit) – units must be the same as the Result field. *(Required)* |
| 9 | Flags | Text | Flag "ND" for non-detect (must enter the detection limit in the DetLim field), or "TR" for trace amount (must enter both detection limit and the result). If result is not qualified, the cell should be blank. No other flags should be included in this field. *(Required)* |

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## Monitoring Optimization
# Software: *Data Input*

- Site Details- Data checker ***NEW!***
  - ***MAROS 2.2***
- Monitoring Objectives- ***NEW!***
  - ***Primary – Source, Tail, Delineation***
  - ***Secondary - Sources, Remedy, Delineation***
- Priority COCs
  - ***Cleanup Goals***
  - ***Priority by Well – NEW!***

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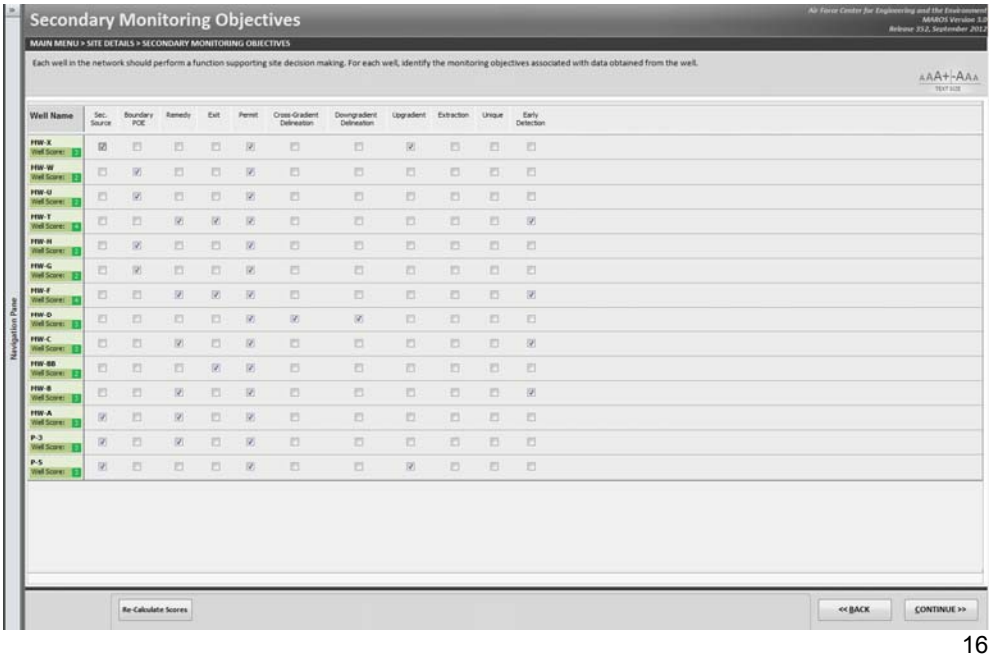


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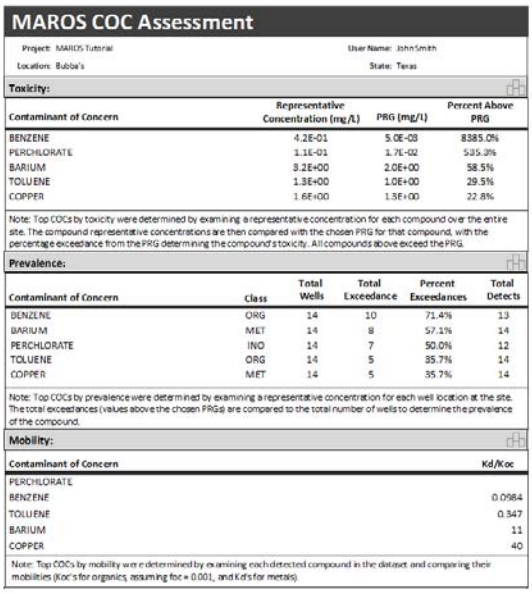


**MAROS COC Assessment**

Project: MAROS Tutorial — User Name: JohnSmith
Location: Bubba's — State: Texas

**Toxicity:**

| Contaminant of Concern | Representative Concentration (mg/L) | PRG (mg/L) | Percent Above PRG |
|---|---|---|---|
| BENZENE | 4.2E-01 | 5.0E-03 | 8385.0% |
| PERCHLORATE | 1.1E-01 | 1.7E-02 | 535.3% |
| BARIUM | 3.2E+00 | 2.0E+00 | 58.5% |
| TOLUENE | 1.3E+00 | 1.0E+00 | 29.5% |
| COPPER | 1.6E+00 | 1.3E+00 | 22.8% |

Note: Top COCs by toxicity were determined by examining a representative concentration for each compound over the entire site. The compound representative concentrations are then compared with the chosen PRG for that compound, with the percentage exceedance from the PRG determining the compound's toxicity. All compounds above exceed the PRG.

**Prevalence:**

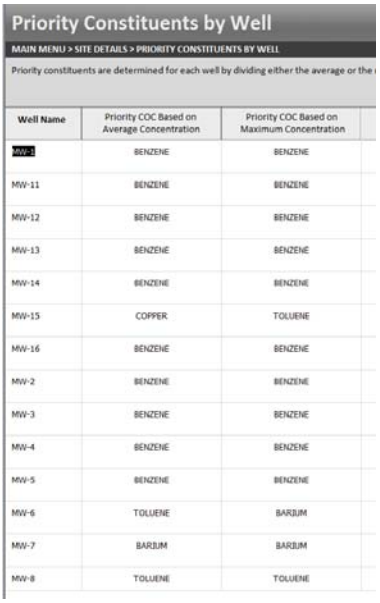
| Contaminant of Concern | Class | Total Wells | Total Exceedance | Percent Exceedances | Total Detects |
|---|---|---|---|---|---|
| BENZENE | ORG | 14 | 10 | 71.4% | 13 |
| BARIUM | MET | 14 | 8 | 57.1% | 14 |
| PERCHLORATE | INO | 14 | 7 | 50.0% | 12 |
| TOLUENE | ORG | 14 | 5 | 35.7% | 14 |
| COPPER | MET | 14 | 5 | 35.7% | 14 |

Note: Top COCs by prevalence were determined by examining a representative concentration for each well location at the site. The total exceedances (values above the chosen PRGs) are compared to the total number of wells to determine the prevalence of the compound.

**Mobility:**

| Contaminant of Concern | Kd/Koc |
|---|---|
| PERCHLORATE | |
| BENZENE | 0.0984 |
| TOLUENE | 0.347 |
| BARIUM | 11 |
| COPPER | 40 |

Note: Top COCs by mobility were determined by examining each detected compound in the dataset and comparing their mobilities (Koc's for organics, assuming foc = 0.001, and Kd's for metals).



**Priority Constituents by Well**

MAIN MENU > SITE DETAILS > PRIORITY CONSTITUENTS BY WELL

Priority constituents are determined for each well by dividing either the average or the

| Well Name | Priority COC Based on Average Concentration | Priority COC Based on Maximum Concentration |
|---|---|---|
| MW-1 | BENZENE | BENZENE |
| MW-11 | BENZENE | BENZENE |
| MW-12 | BENZENE | BENZENE |
| MW-13 | BENZENE | BENZENE |
| MW-14 | BENZENE | BENZENE |
| MW-15 | COPPER | TOLUENE |
| MW-16 | BENZENE | BENZENE |
| MW-2 | BENZENE | BENZENE |
| MW-3 | BENZENE | BENZENE |
| MW-4 | BENZENE | BENZENE |
| MW-5 | BENZENE | BENZENE |
| MW-6 | TOLUENE | BARIUM |
| MW-7 | BARIUM | BARIUM |
| MW-8 | TOLUENE | TOLUENE |

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## Software: *Data Input*

- **Moment Analysis Options**
  - ***Moved to Site Details***
- **Export MAROS 3.0 Archive File**
- **Data Consolidation**
  - ***First consolidation for Individual Well Analysis***
  - ***Second consolidation under Plume Analysis***

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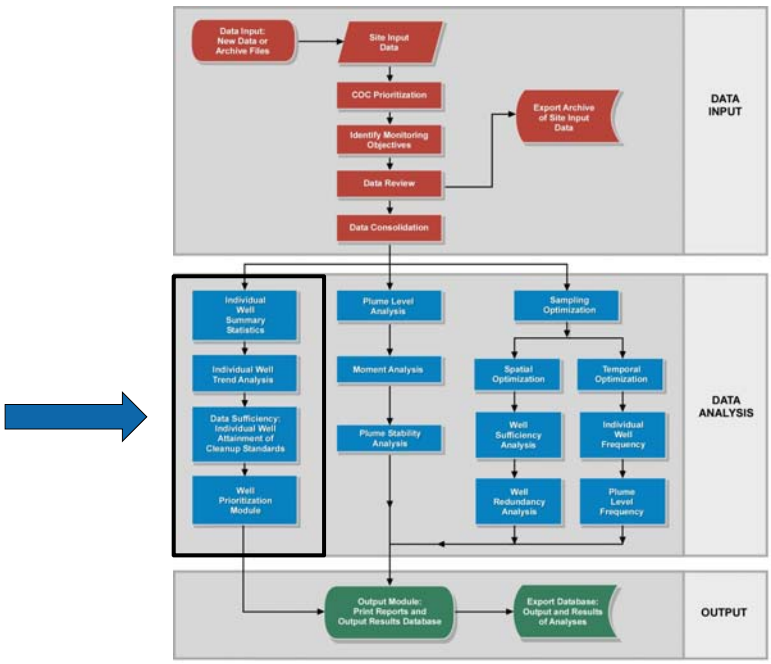


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## Software: *Individual Well Analysis*

- **Summary Statistics – *NEW!***
  - ***Detection Frequencies***
  - ***Kaplan-Meier – Ave., Median, SD.***
  - ***Outliers by Dixon's***
  - ***Shapiro-Wilk Normality***
- **Statistical Trends**
  - ***Mann-Kendall***
  - ***Linear Regression***


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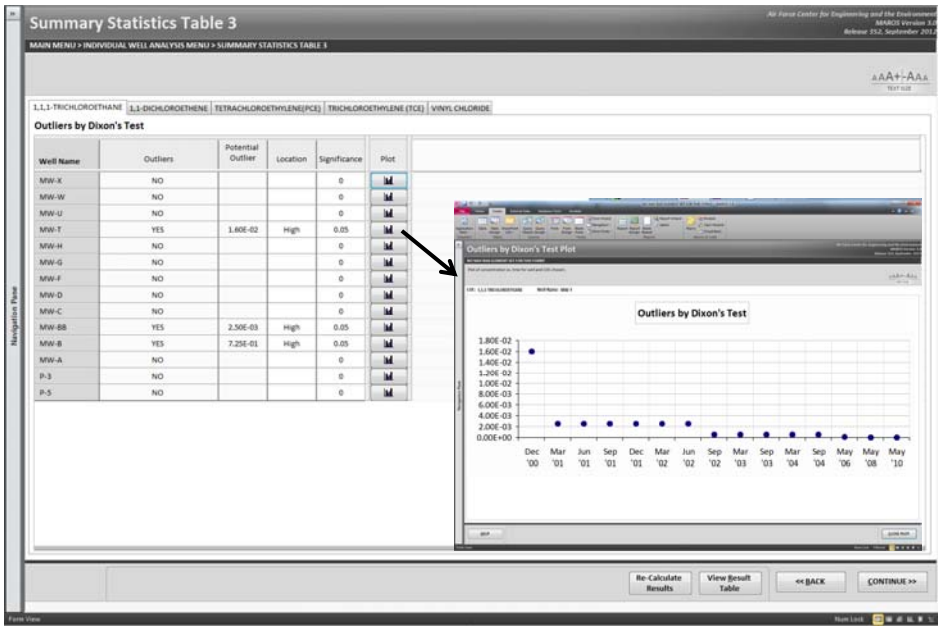


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## Software: *Individual Well Analysis*

- **Data Sufficiency – *NEW Location!***
  - ***Attainment of Cleanup Goals***
  - ***Number of Samples to Attain Goals***
- **Well Scoring – *NEW!***
  - ***Individual Well Summary***
  - ***Well Score – prioritization***

| | |
|---|---|
| Priority COC | Recent Sample above MCL |
| Detection frequency | COV |
| Median above MCL | Distribution |
| MK Trend | |


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## Well Priority Decision Logic

Navigation Pane

| Well Name | Source / Tail / Delineation | Monitoring Objective Score | Total Number of Samples | Overall Detection Frequency (%) | Attained Cleanup Goals? | All Samples ND? | Well Score |
|---|---|---|---|---|---|---|---|
| P-5 | S | 3 | 76 | 91% | NO | NO | 52 |
| P-3 | S | 3 | 75 | 100% | NO | NO | 66 |
| MW-X | S | 3 | 45 | 73% | NO | NO | 44 |
| MW-W | T | 2 | 54 | 2% | YES | NO | 54 |
| MW-U | T | 2 | 54 | 4% | YES | NO | 56 |
| MW-T | T | 4 | 72 | 6% | NO | NO | 57 |
| MW-H | T | 2 | 34 | 3% | YES | NO | 52 |
| MW-G | T | 2 | 66 | 0% | YES | YES | 45 |
| MW-F | T | 4 | 76 | 21% | NO | NO | 63 |
| MW-D | T | 3 | 70 | 6% | YES | NO | 61 |
| MW-C | T | 3 | 80 | 27% | NO | NO | 58 |
| MW-BB | T | 2 | 45 | 2% | YES | NO | 49 |
| MW-B | T | 3 | 75 | 79% | NO | NO | 70 |
| MW-A | S | 3 | 75 | 100% | NO | NO | 68 |

High score- most important

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## Software: *Individual Well Analysis*

- **Export – *NEW!***
  - ***Screen by Screen - spreadsheet***
  - ***Reports – link on screen***
  - ***Graphs – link on screen***
  - ***Access Database – default export button***


*Note: Export Results here- Data consolidation can change under spatial analysis section.*

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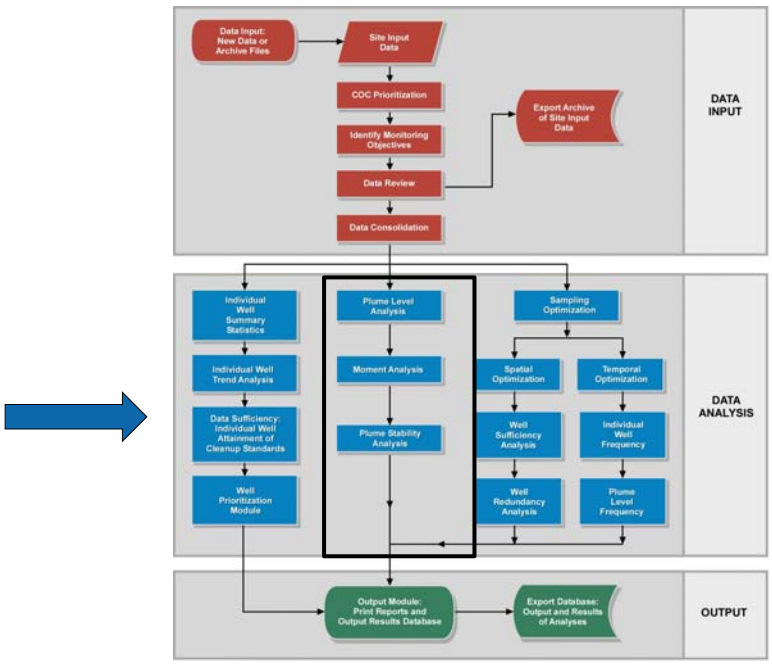


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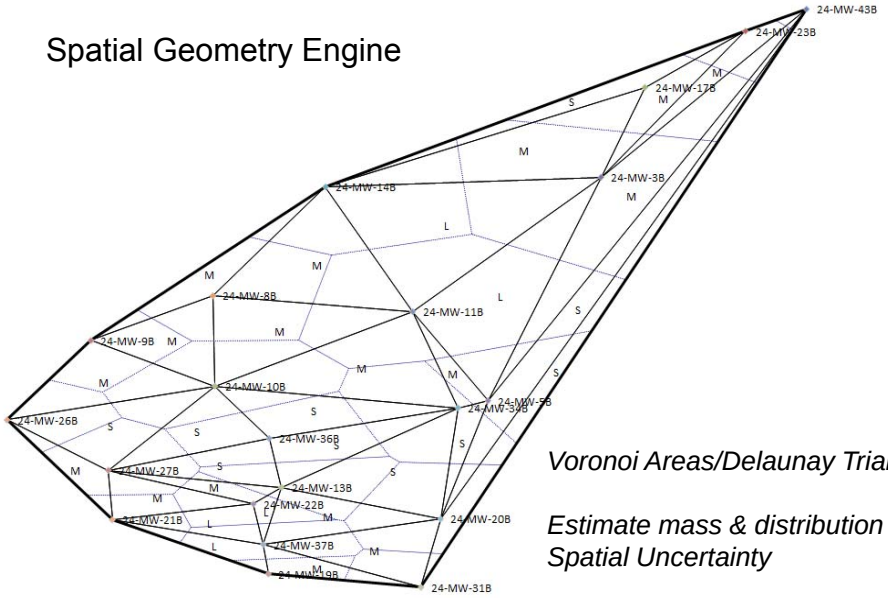
## Spatial Geometry Engine




*Voronoi Areas/Delaunay Triangles:*

*Estimate mass & distribution of mass*
*Spatial Uncertainty*

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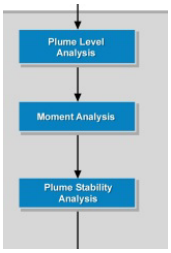
## Software: *Plume-Level Analysis*

- **Moment Analysis**
  - ***Expanded Data Input Choice- NEW!****
    - ***Wells to include***
    - ***Missing Sample Events***
    - ***Data Consolidation***
  - ***Moments***
    - ***As in MAROS 2.2***




* Requires new data consolidation

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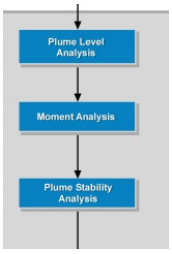
## Software: *Plume-Level Analysis*

- **Percent Mass by Well – *NEW!***
  - ***Voronoi Area***
  - ***Estimate mass in well area***
  - ***Percent mass and area each well monitors***

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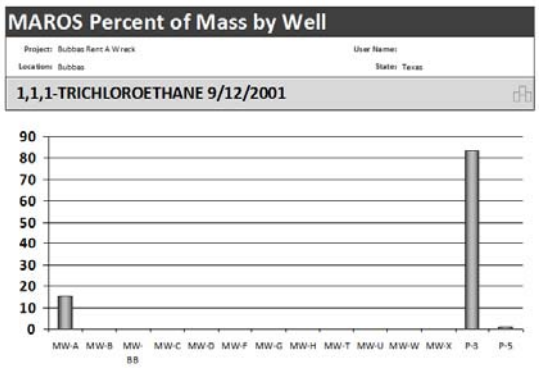


| Well | Area (ft2) | Mass (mg) | Percent of Mass | Percent of Area |
|---|---|---|---|---|
| MW-A | 6,096.17 | 1,265.79 | 15.50 | 5.76 |
| MW-B | 8,953.17 | 5.17 | 0.06 | 8.46 |
| MW-BB | 1,488.18 | 0.08 | 0.00 | 1.41 |
| MW-C | 12,352.90 | 1.62 | 0.02 | 11.67 |
| MW-D | 4,362.82 | 0.23 | 0.00 | 4.12 |
| MW-F | 16,624.12 | 2.18 | 0.03 | 15.71 |
| MW-G | 19,702.07 | 1.03 | 0.01 | 18.62 |
| MW-H | 3,113.66 | 0.16 | 0.00 | 2.94 |
| MW-T | 7,634.34 | 1.00 | 0.01 | 7.21 |
| MW-U | 587.28 | 0.03 | 0.00 | 0.55 |
| MW-W | 1,396.62 | 0.07 | 0.00 | 1.32 |
| MW-X | 10,979.09 | 0.58 | 0.01 | 10.37 |
| P-3 | 8,819.32 | 6,806.31 | 83.34 | 8.33 |
| P-5 | 3,726.62 | 82.56 | 1.01 | 3.52 |

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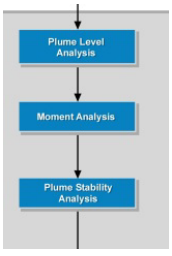
## Software: *Plume-Level Analysis*

- **MAROS Analysis – Aggregate Trends**
  - ***Source and Tail***
  - ***Two custom groups – NEW!***
  - ***Aggregate MK Trend***
  - ***% Mass for the well group – NEW!***
- **Monitoring System Category**

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## Plume Area Trends

MAIN MENU > PLUME ANALYSIS MENU > MAROS ANALYSIS > AGGREGATE TRENDS

The results of the Plume Area Trend assessment are shown. Choose the tab for the COC of interest.

1,1-DICHLOROETHENE | TETRACHLOROETHYLENE(PCE) | TRICHLOROETHYLENE (TCE) | VINYL CHLORIDE

**Aggregate Trends**

| Area | Number Of Wells | Aggregate Trend | Aggregate Mass % |
|---|---|---|---|
| Source | 5 | PD | 96 % |
| Tail | 8 | PD | 4 % |
| Custom Group 1 | 3 | D | 10 % |
| Custom Group 2 | 7 | PD | 90 % |

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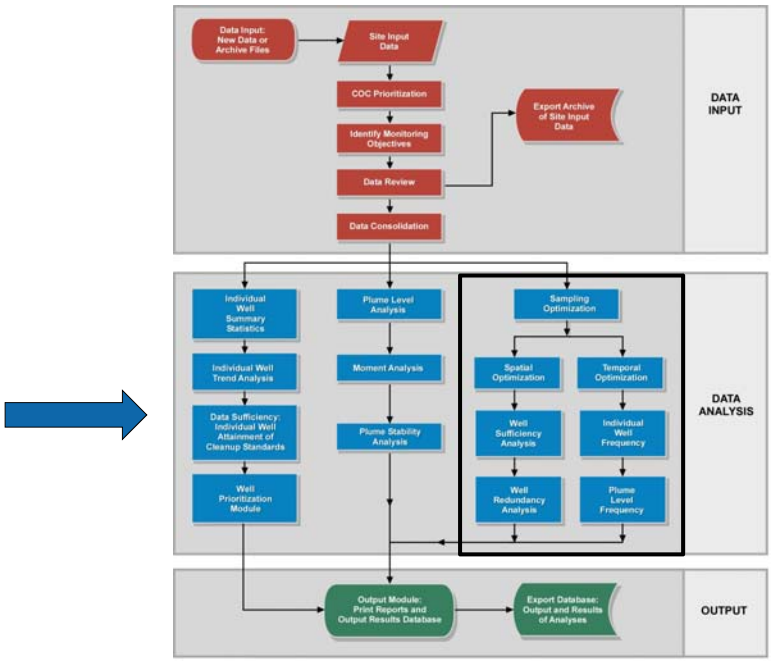


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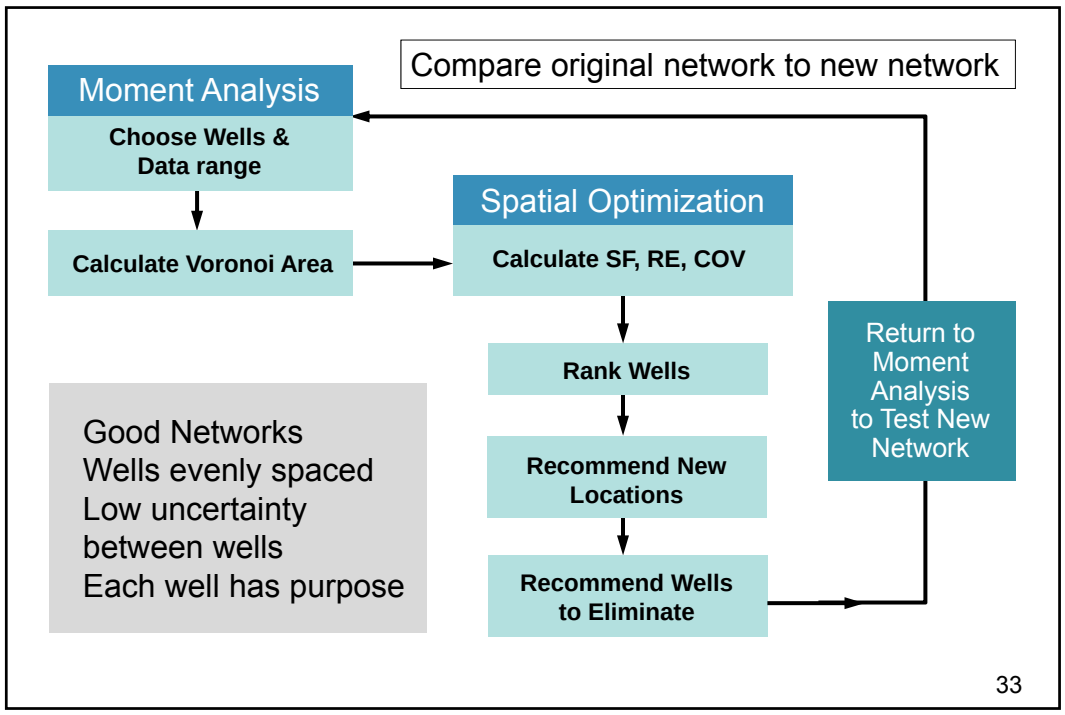
Compare original network to new network
Moment Analysis
Choose Wells & Data range
Calculate Voronoi Area
Spatial Optimization
Calculate SF, RE, COV
Rank Wells
Recommend New Locations
Recommend Wells to Eliminate
Return to Moment Analysis to Test New Network
Good Networks
Wells evenly spaced
Low uncertainty between wells
Each well has purpose
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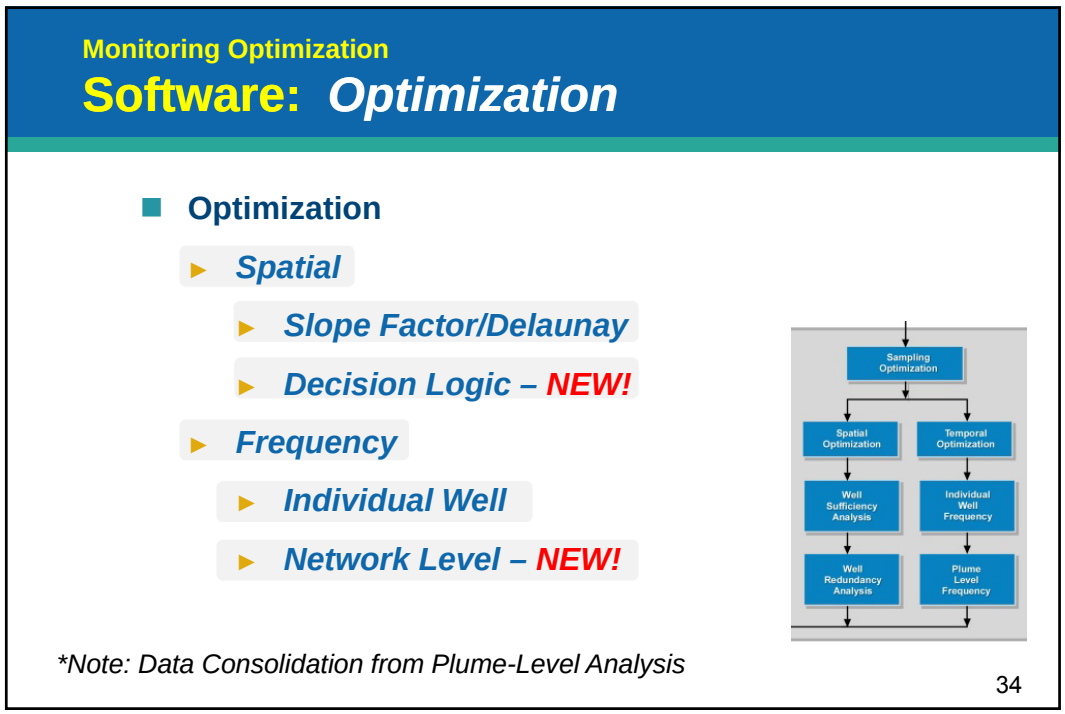
Monitoring Optimization
Software: Optimization
Optimization
Spatial
Slope Factor/Delaunay
Decision Logic – NEW!
Frequency
Individual Well
Network Level – NEW!
Sampling Optimization
Spatial Optimization
Temporal Optimization
Well Sufficiency Analysis
Individual Well Frequency
Well Redundancy Analysis
Plume Level Frequency
*Note: Data Consolidation from Plume-Level Analysis
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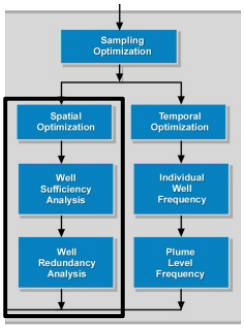
Monitoring Optimization

## Software: *Spatial Optimization*

- **Spatial Optimization**
  - *Slope Factor/Delaunay*
    - *From MAROS 2.2*
  - *Decision Logic – NEW!*
    - *Voronoi Areas*
    - *Slope Factor and Relative Error*
    - *Concentration*

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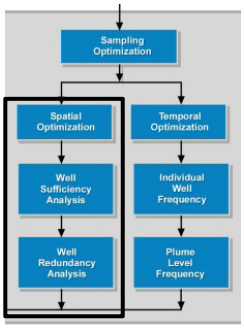
## Software: *Spatial Optimization*

- **Spatial Optimization**
  - *Decision Logic – NEW!*
    - *Interactive*
    - *Multiple Well Configurations*
    - *Well Sufficiency*
    - *Well Redundancy*

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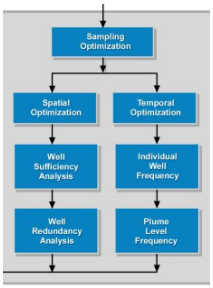
## Monitoring Optimization
# Software: *Spatial Optimization*

- ***Decision Logic – NEW!***
  - ***Uncertainty –***
    - ***High SF, RE, COV – new well***
    - ***Low SF, RE, COV - redundant***
  - ***Voronoi Area***
    - ***Large – new well***
    - ***Small – redundant***
  - ***Interior vs. Hull wells***
  - ***Trends***

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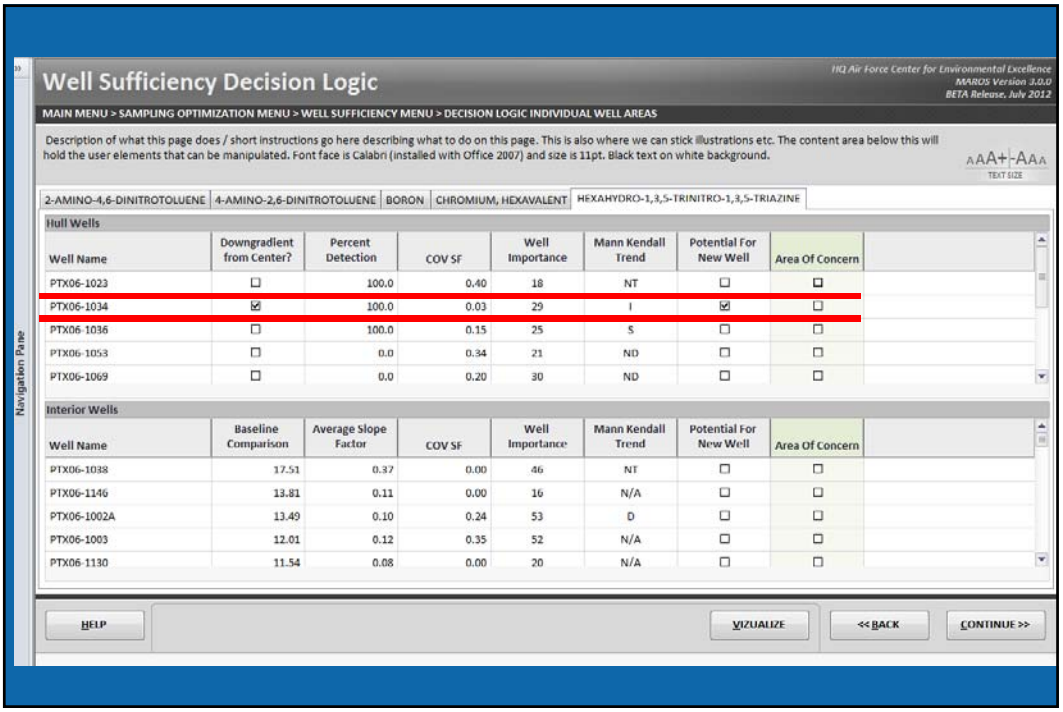
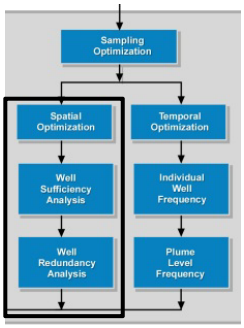


Monitoring Optimization

## Software: *Spatial Optimization*

- **Spatial Optimization**
  - *Well Redundancy*
    - *Lowest 25% Rank*
    - *User can choose to eliminate*
      - *Return to Moment Analysis*
      - *Re-run stats*

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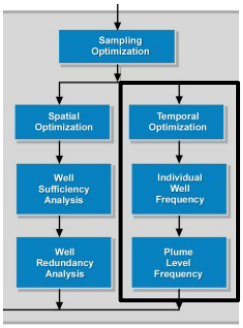
Monitoring Optimization

## Software: *Optimization*

- **Optimization**
  - *Frequency*
    - *Individual Well*
    - *Network Level – **NEW!***

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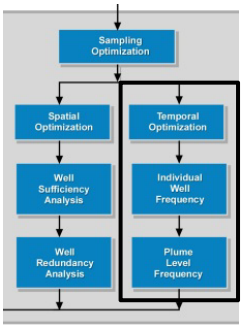
Monitoring Optimization

## Software: *Optimization*

- Individual Well Sampling Frequency
  - *Summary info – NEW!*
    - *Reporting Frequency*
    - *Travel Time*
    - *Current Sampling Frequency*
  - *Modified CES Method*

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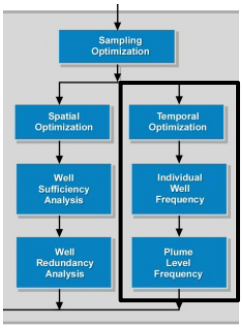
Monitoring Optimization

## Software: *Optimization*

- Network Sampling Frequency *– NEW!*
  - *Based on Zeroth Moment*
    - *Rate of change of mass*
    - *Coefficient of variation*
    - *Correlation (R2)*
  - *Recommendation*

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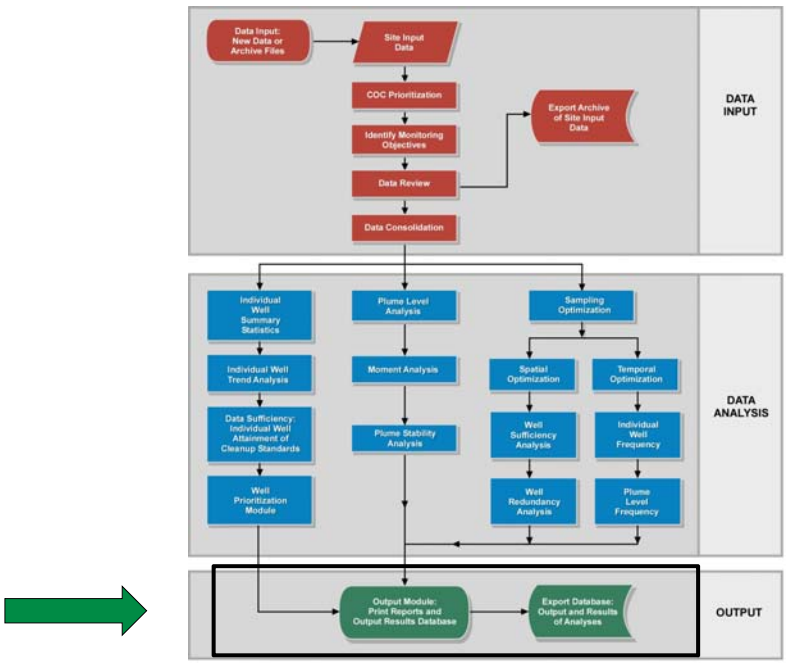


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Monitoring Optimization

## Software: *Export Options*

- **MAROS Output**
  - ***Screen by Screen – spreadsheet cut and paste as you go***
  - ***Reports***
    - ***Print as you go***
    - ***Output – view and print reports***
  - ***Graphs***
    - ***View and Print***


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## Monitoring Optimization
# Software: *Export Options*

- **MAROS Output**
  - ***Excel Tables***
    - ***Multiple tables – default***
    - ***Single Tables***
  - ***Access Database***
    - ***Multiple Tables – default***
    - ***User choses Tables***


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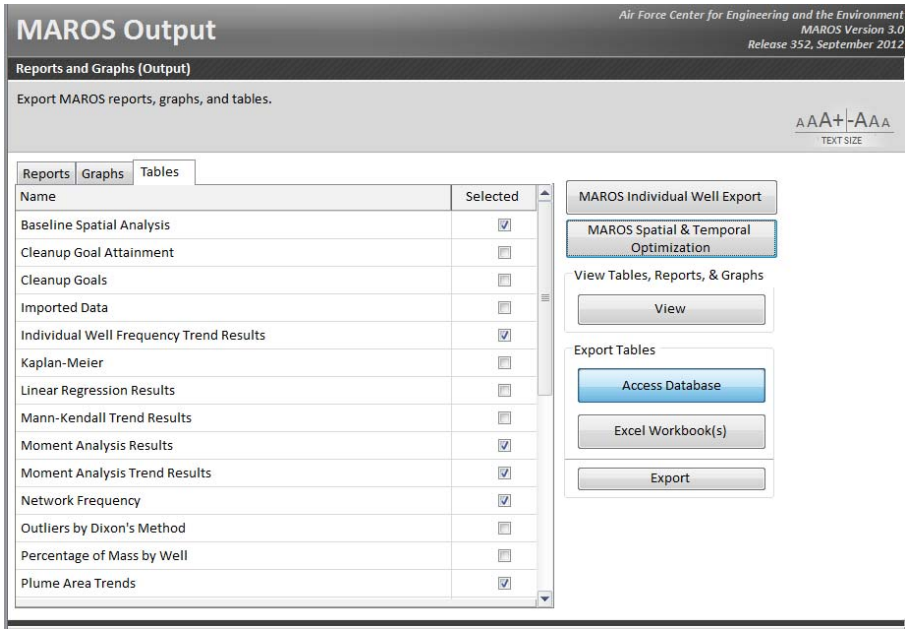


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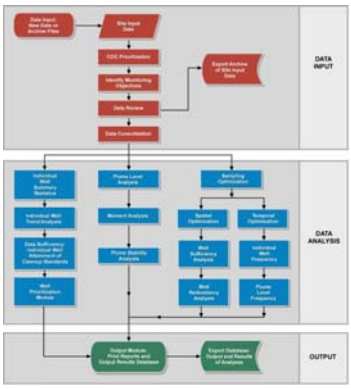
Monitoring Optimization

# QUESTIONS?

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Monitoring Optimization

## Overview: *MAROS 3.0 New Release*

- Goals and Objectives
- Software Structure and New Features
- Detailed Description
- Conclusions

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Monitoring Optimization

## Overview: *MAROS 3.0 New Release*

- **Detailed Description- *New Features***
  - **Individual Well Statistics**
  - **Plume-Level Analysis**
  - **Optimization**

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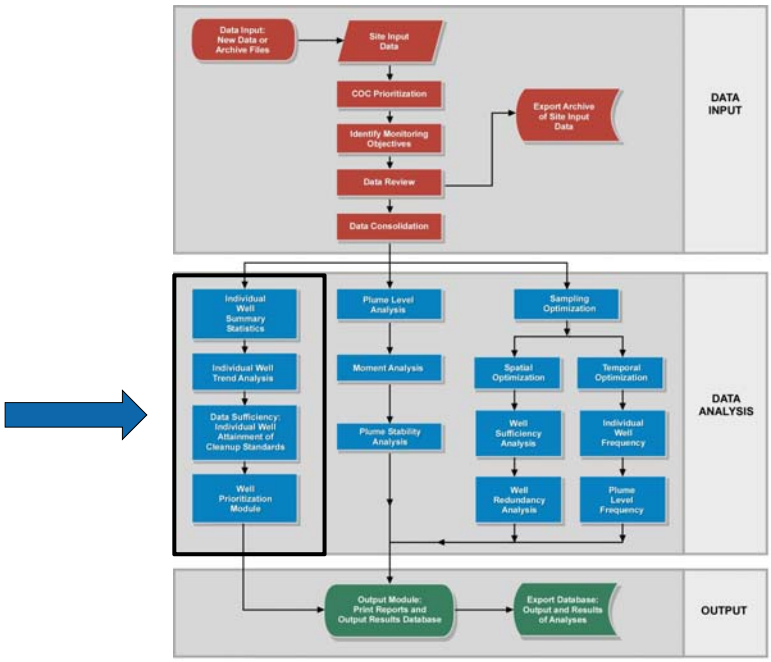


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Monitoring Optimization

## Software: *Individual Well Statistics*

**Individual Well Concentrations**

- Summary Statistics
- Statistical Trends
- Attainment of Goals
- Well Score

- *How much? How often?*
- *When? Where?*
- *Lognormal? Normal?*
- *Outliers?*
- *Increasing or Decreasing? Variable?*
- *Clean?*
- *Important?*

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Monitoring Optimization

## Software: *Individual Well Analysis*

- Summary Statistics – ***NEW!***
  - *Detection Frequencies*
  - *Kaplan-Meier – Ave., Median, SD.*
  - *Outliers by Dixon's*
  - *Shapiro-Wilk Normality*


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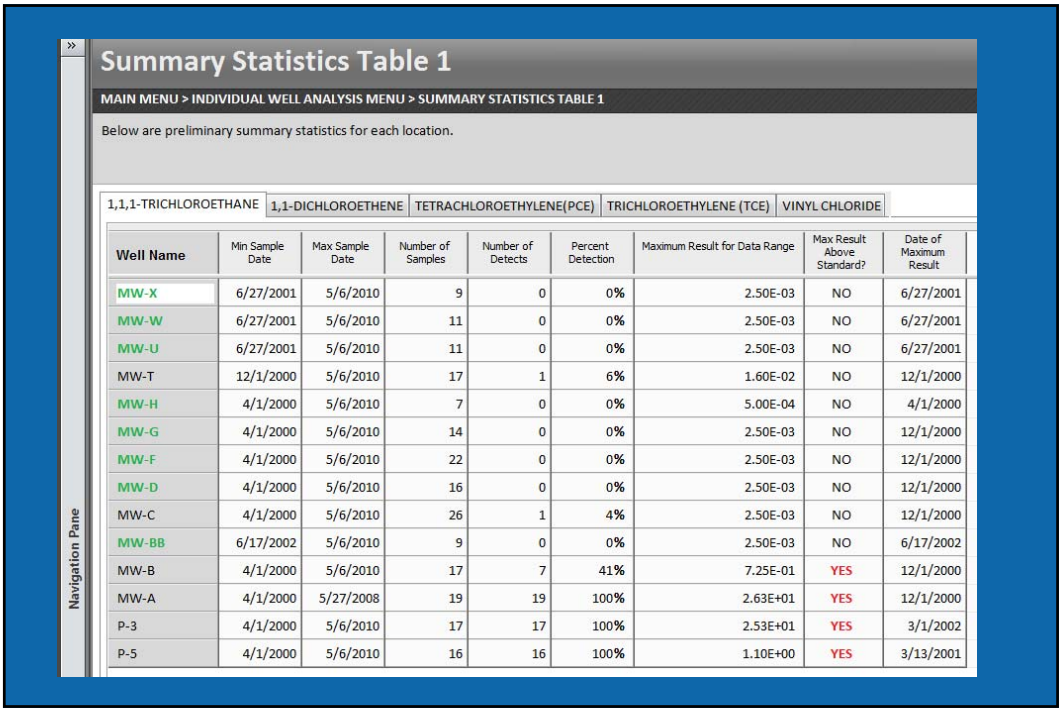


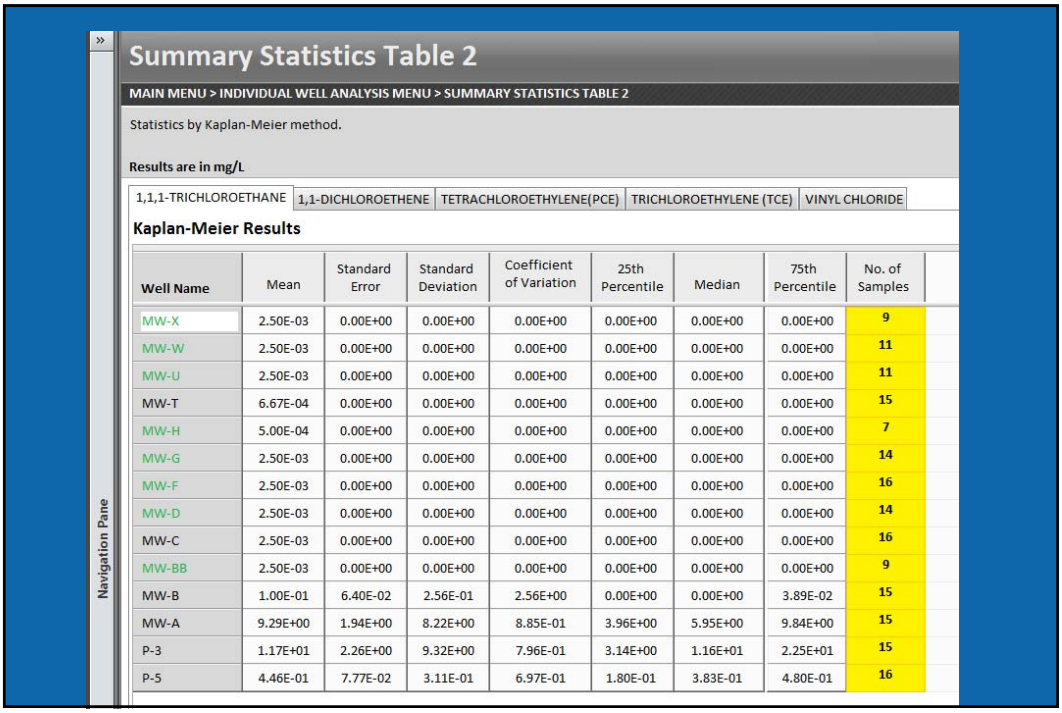
## Summary Statistics Table 1

MAIN MENU > INDIVIDUAL WELL ANALYSIS MENU > SUMMARY STATISTICS TABLE 1

Below are preliminary summary statistics for each location.

1,1,1-TRICHLOROETHANE | 1,1-DICHLOROETHENE | TETRACHLOROETHYLENE(PCE) | TRICHLOROETHYLENE (TCE) | VINYL CHLORIDE

| Well Name | Min Sample Date | Max Sample Date | Number of Samples | Number of Detects | Percent Detection | Maximum Result for Data Range | Max Result Above Standard? | Date of Maximum Result |
|---|---|---|---|---|---|---|---|---|
| MW-X | 6/27/2001 | 5/6/2010 | 9 | 0 | 0% | 2.50E-03 | NO | 6/27/2001 |
| MW-W | 6/27/2001 | 5/6/2010 | 11 | 0 | 0% | 2.50E-03 | NO | 6/27/2001 |
| MW-U | 6/27/2001 | 5/6/2010 | 11 | 0 | 0% | 2.50E-03 | NO | 6/27/2001 |
| MW-T | 12/1/2000 | 5/6/2010 | 17 | 1 | 6% | 1.60E-02 | NO | 12/1/2000 |
| MW-H | 4/1/2000 | 5/6/2010 | 7 | 0 | 0% | 5.00E-04 | NO | 4/1/2000 |
| MW-G | 4/1/2000 | 5/6/2010 | 14 | 0 | 0% | 2.50E-03 | NO | 12/1/2000 |
| MW-F | 4/1/2000 | 5/6/2010 | 22 | 0 | 0% | 2.50E-03 | NO | 12/1/2000 |
| MW-D | 4/1/2000 | 5/6/2010 | 16 | 0 | 0% | 2.50E-03 | NO | 12/1/2000 |
| MW-C | 4/1/2000 | 5/6/2010 | 26 | 1 | 4% | 2.50E-03 | NO | 12/1/2000 |
| MW-BB | 6/17/2002 | 5/6/2010 | 9 | 0 | 0% | 2.50E-03 | NO | 6/17/2002 |
| MW-B | 4/1/2000 | 5/6/2010 | 17 | 7 | 41% | 7.25E-01 | YES | 12/1/2000 |
| MW-A | 4/1/2000 | 5/27/2008 | 19 | 19 | 100% | 2.63E+01 | YES | 12/1/2000 |
| P-3 | 4/1/2000 | 5/6/2010 | 17 | 17 | 100% | 2.53E+01 | YES | 3/1/2002 |
| P-5 | 4/1/2000 | 5/6/2010 | 16 | 16 | 100% | 1.10E+00 | YES | 3/13/2001 |



## Summary Statistics Table 2

MAIN MENU > INDIVIDUAL WELL ANALYSIS MENU > SUMMARY STATISTICS TABLE 2

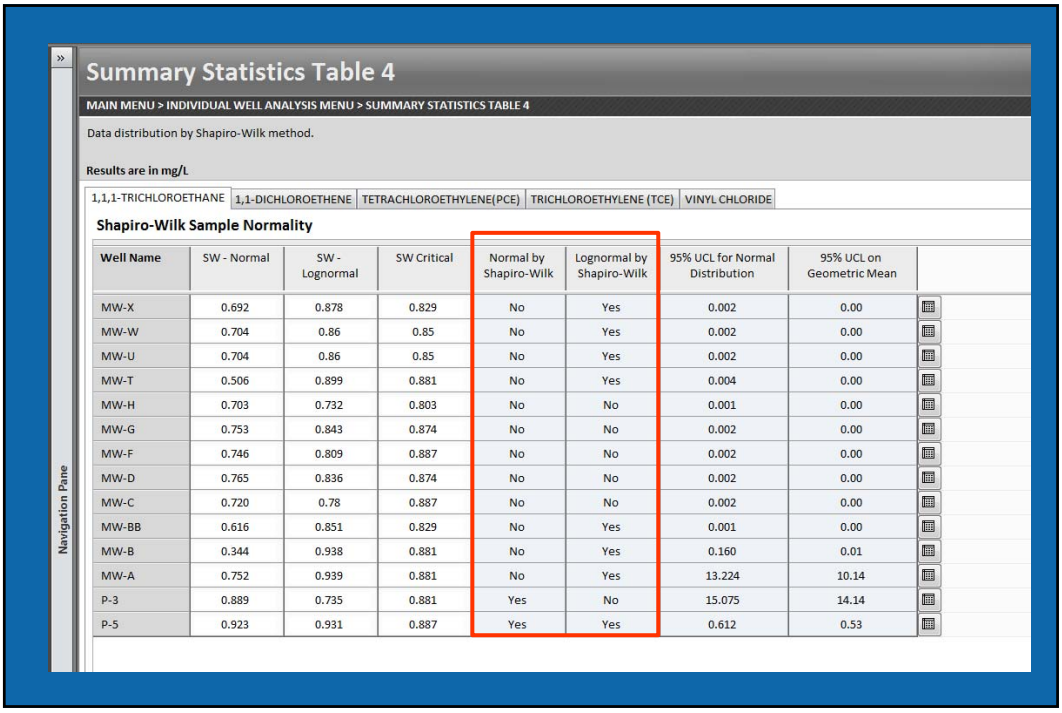
Statistics by Kaplan-Meier method.

**Results are in mg/L**

1,1,1-TRICHLOROETHANE | 1,1-DICHLOROETHENE | TETRACHLOROETHYLENE(PCE) | TRICHLOROETHYLENE (TCE) | VINYL CHLORIDE

**Kaplan-Meier Results**

| Well Name | Mean | Standard Error | Standard Deviation | Coefficient of Variation | 25th Percentile | Median | 75th Percentile | No. of Samples |
|---|---|---|---|---|---|---|---|---|
| MW-X | 2.50E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9 |
| MW-W | 2.50E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 11 |
| MW-U | 2.50E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 11 |
| MW-T | 6.67E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 15 |
| MW-H | 5.00E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7 |
| MW-G | 2.50E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 14 |
| MW-F | 2.50E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 16 |
| MW-D | 2.50E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 14 |
| MW-C | 2.50E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 16 |
| MW-BB | 2.50E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9 |
| MW-B | 1.00E-01 | 6.40E-02 | 2.56E-01 | 2.56E+00 | 0.00E+00 | 0.00E+00 | 3.89E-02 | 15 |
| MW-A | 9.29E+00 | 1.94E+00 | 8.22E+00 | 8.85E-01 | 3.96E+00 | 5.95E+00 | 9.84E+00 | 15 |
| P-3 | 1.17E+01 | 2.26E+00 | 9.32E+00 | 7.96E-01 | 3.14E+00 | 1.16E+01 | 2.25E+01 | 15 |
| P-5 | 4.46E-01 | 7.77E-02 | 3.11E-01 | 6.97E-01 | 1.80E-01 | 3.83E-01 | 4.80E-01 | 16 |



## Summary Statistics Table 4

MAIN MENU > INDIVIDUAL WELL ANALYSIS MENU > SUMMARY STATISTICS TABLE 4

Data distribution by Shapiro-Wilk method.

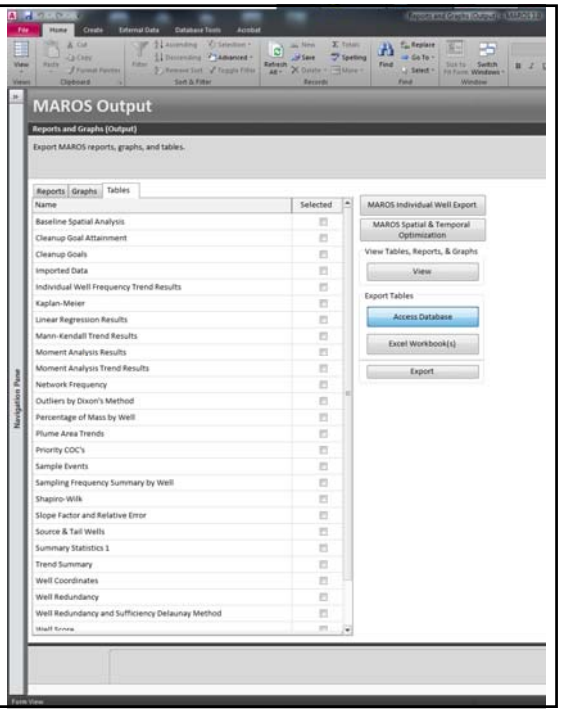
Results are in mg/L

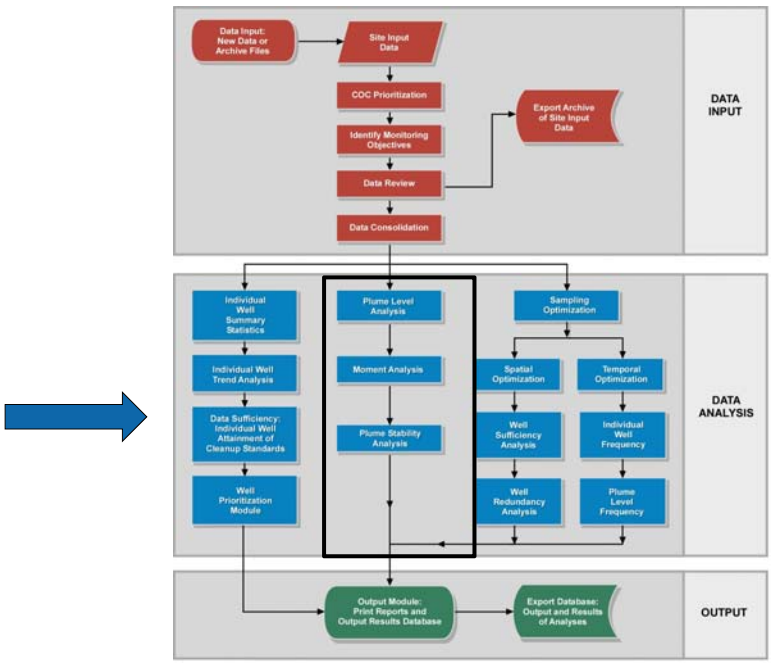
1,1,1-TRICHLOROETHANE | 1,1-DICHLOROETHENE | TETRACHLOROETHYLENE(PCE) | TRICHLOROETHYLENE (TCE) | VINYL CHLORIDE

**Shapiro-Wilk Sample Normality**

| Well Name | SW - Normal | SW - Lognormal | SW Critical | Normal by Shapiro-Wilk | Lognormal by Shapiro-Wilk | 95% UCL for Normal Distribution | 95% UCL on Geometric Mean |
|---|---|---|---|---|---|---|---|
| MW-X | 0.692 | 0.878 | 0.829 | No | Yes | 0.002 | 0.00 |
| MW-W | 0.704 | 0.86 | 0.85 | No | Yes | 0.002 | 0.00 |
| MW-U | 0.704 | 0.86 | 0.85 | No | Yes | 0.002 | 0.00 |
| MW-T | 0.506 | 0.899 | 0.881 | No | Yes | 0.004 | 0.00 |
| MW-H | 0.703 | 0.732 | 0.803 | No | No | 0.001 | 0.00 |
| MW-G | 0.753 | 0.843 | 0.874 | No | No | 0.002 | 0.00 |
| MW-F | 0.746 | 0.809 | 0.887 | No | No | 0.002 | 0.00 |
| MW-D | 0.765 | 0.836 | 0.874 | No | No | 0.002 | 0.00 |
| MW-C | 0.720 | 0.78 | 0.887 | No | No | 0.002 | 0.00 |
| MW-BB | 0.616 | 0.851 | 0.829 | No | Yes | 0.001 | 0.00 |
| MW-B | 0.344 | 0.938 | 0.881 | No | Yes | 0.160 | 0.01 |
| MW-A | 0.752 | 0.939 | 0.881 | No | Yes | 13.224 | 10.14 |
| P-3 | 0.889 | 0.735 | 0.881 | Yes | No | 15.075 | 14.14 |
| P-5 | 0.923 | 0.931 | 0.887 | Yes | Yes | 0.612 | 0.53 |

- **Summary Statistics –**
  - ***Export Spreadsheet***
  - ***Export Database***
  - ***Export Reports***
  - ***Export Graphs***



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Monitoring Optimization

## Software: *Plume-Level Analysis*

**Plume-Level Analysis**

- **Moment Analysis**
- **Well % Mass & Area**
- **Trend by Area**
- **Mass by Area**

- ***How much mass? Where?***
- ***How is it changing?***
- ***Which wells monitor the most mass?***
- ***Which wells monitor the most area?***
- ***Increasing or Decreasing? Variable?***

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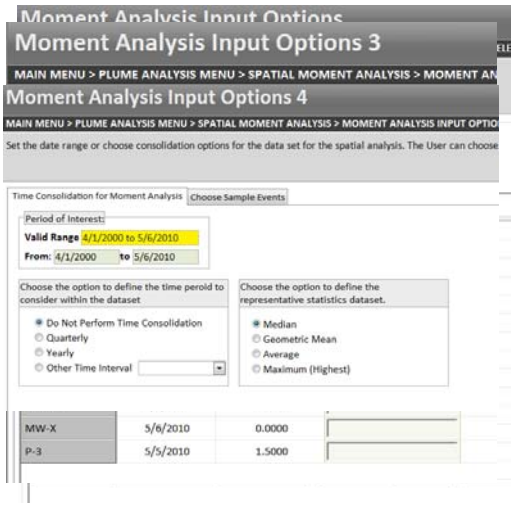
Monitoring Optimization

## Software: *Moment Analysis User Choice*




### More User Choice

- Well Choice
- Time Frame/Sample Events
- Missing Sample Results

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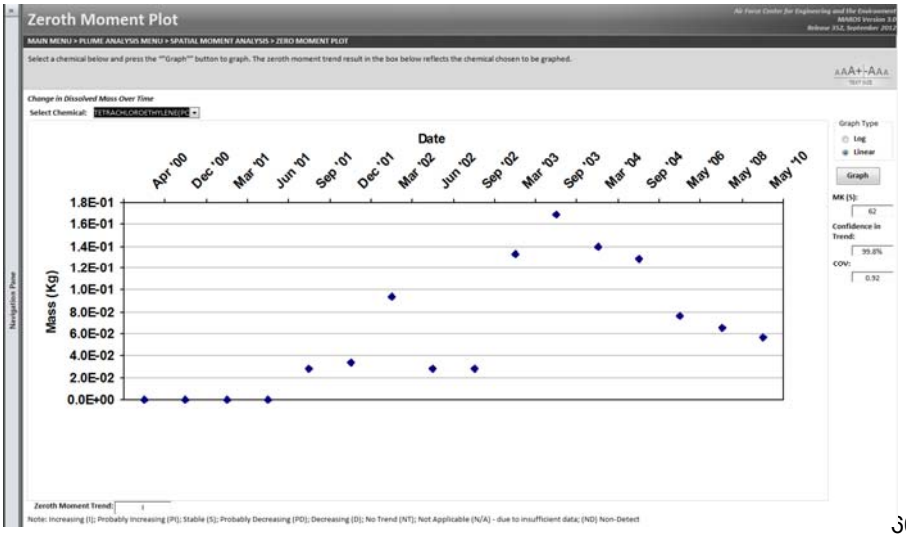
Monitoring Optimization

## Software: *Moment Analysis*

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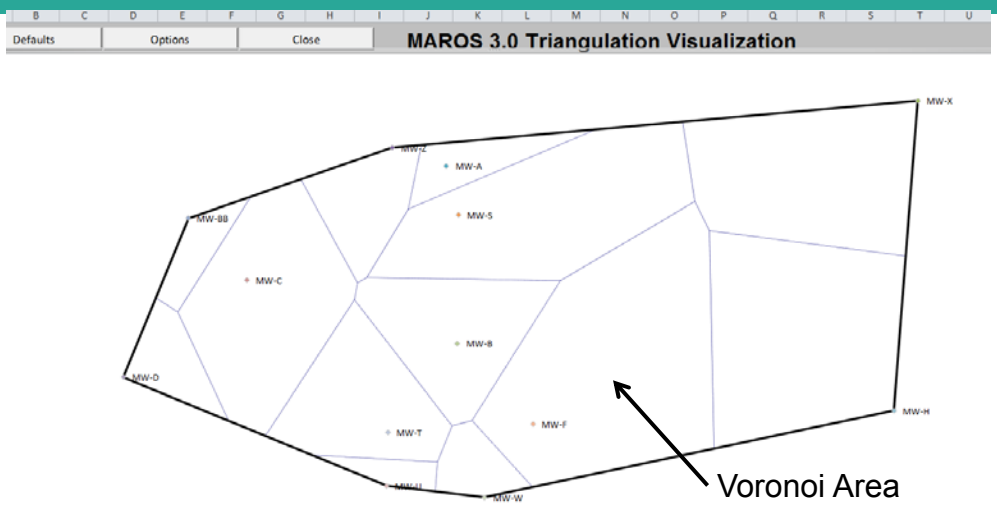
Monitoring Optimization

## Software: *Plume Mass by Well*

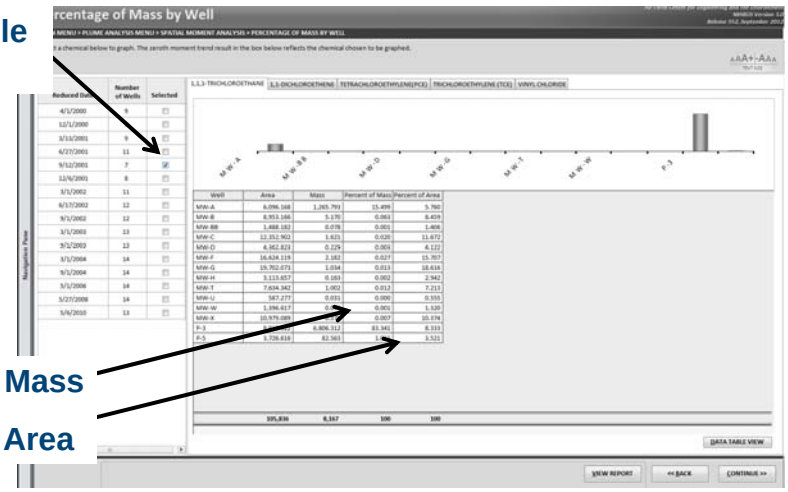



Mass = Area * [C] * Thickness * Porosity

Monitoring Optimization

## Software: *Plume Mass by Well*

**Choose Sample Event**




**% Plume Mass**

**% Plume Area**

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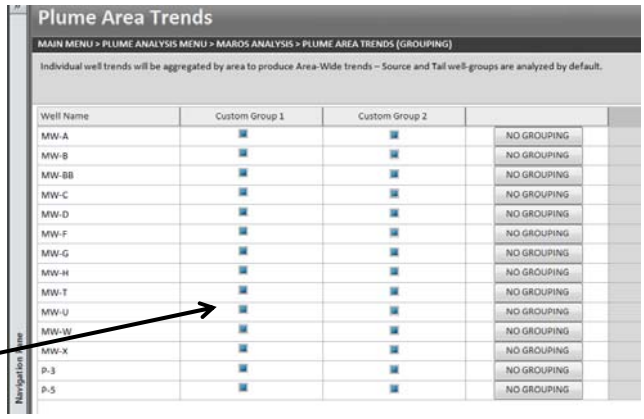
Monitoring Optimization

## Software: *Plume Area Trends*

**Plume Area Trends**

- Source Wells
- Tail Wells
- 2 Custom Groups
  - Choose Wells

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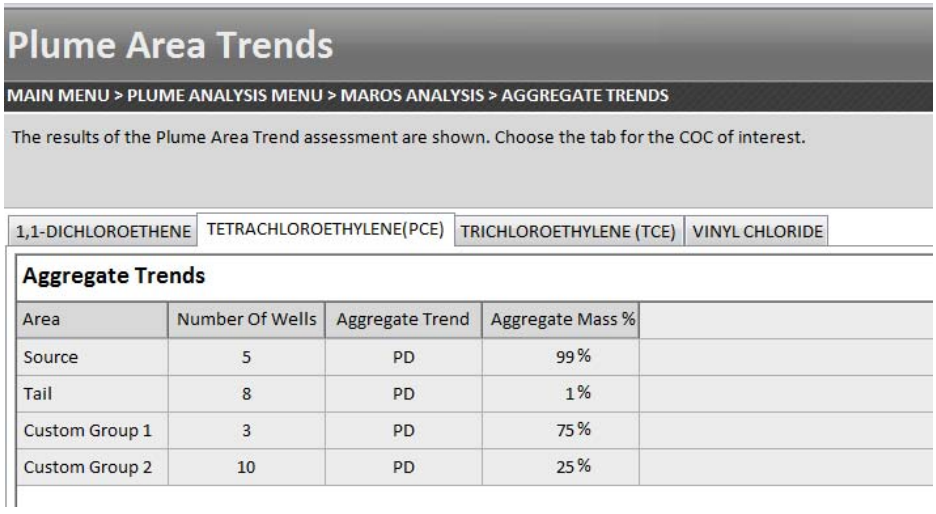
Monitoring Optimization

## Software: *Plume Area Trends*

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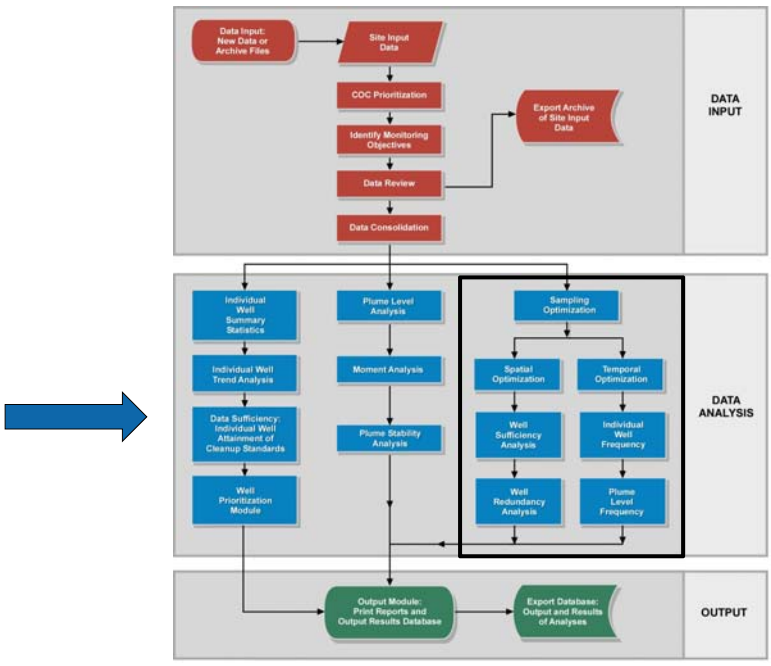


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Monitoring Optimization

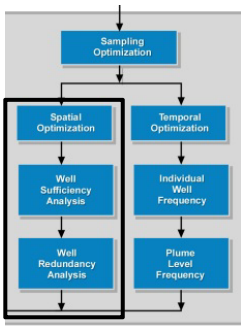
## Software: *Spatial Optimization*

- Spatial Optimization
  - *Decision Logic – Theory*

**Spatial Optimization is dependent on goals of the program –**

**It is hard to *automate* diverse goals.**

**Give the User *useful* information to make their own decisions.**

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Monitoring Optimization

## Software: *Spatial Optimization*

**Spatial Optimization**

- **Slope Factor – Delaunay Triangulation**
- **Voronoi Areas**
- **Relative Error and Variability**
- **Trends**
- **Concentration**

- ***Uncertainty between wells?***
- ***Size of monitoring area?***
- ***Variability in uncertainty?***
- ***Increasing or Decreasing? Variable?***
- ***Magnitude of concentration?***

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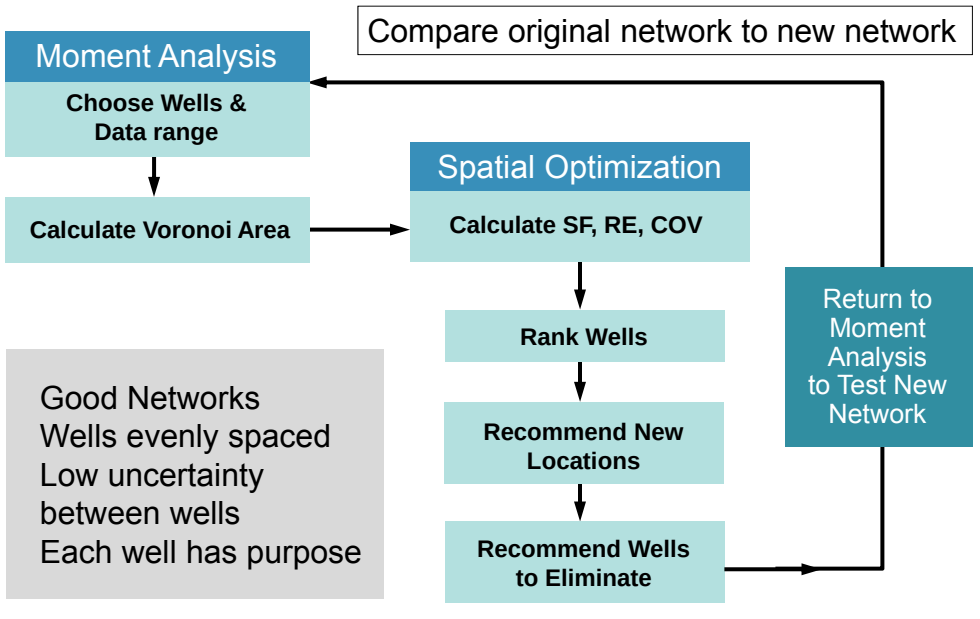


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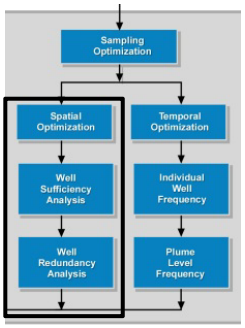
Monitoring Optimization

## Software: *Spatial Optimization*

- Spatial Optimization
  - *Decision Logic – NEW!*
    - *Well Sufficiency*
      - *Hull vs. Interior Well*
      - *Downgradient Hull*
      - *Baseline – VA vs. Ave*
      - *MK Trend*
      - *COV SF*

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Monitoring Optimization

## Software: *Spatial Optimization*

- Spatial Optimization – Uncertainty
  - *Slope Factor*
    - *Uncertainty between points normalized by maximum of estimated or known result*
  - *Relative Error*
    - *Uncertainty between points normalized by maximum of known result*
  - *Coefficient of Variation*
    - *Variability in uncertainty between points over time*

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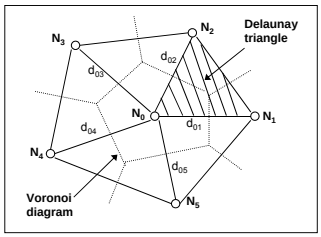
Monitoring Optimization

## Software: *Spatial Optimization*

- **Slope Factor and Relative Error**

$$SF_i = \left| \frac{EC_i - NC_i}{Max(EC_i, NC_i)} \right|$$




Estimated concentration of node:

$$EC_i = \left[ \sum_{j=1}^{M} NC_j \cdot \frac{1}{d_{ij}} \right] \Big/ \left[ \sum_{j=1}^{M} \frac{1}{d_{ij}} \right]$$

where, M = number of triangles surrounding the node

SF → 1, well is important; SF → 0, well is not important



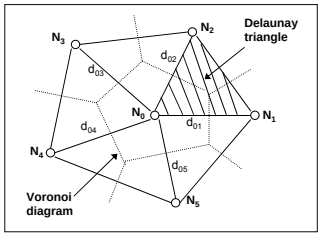
Monitoring Optimization

## Software: *Spatial Optimization*

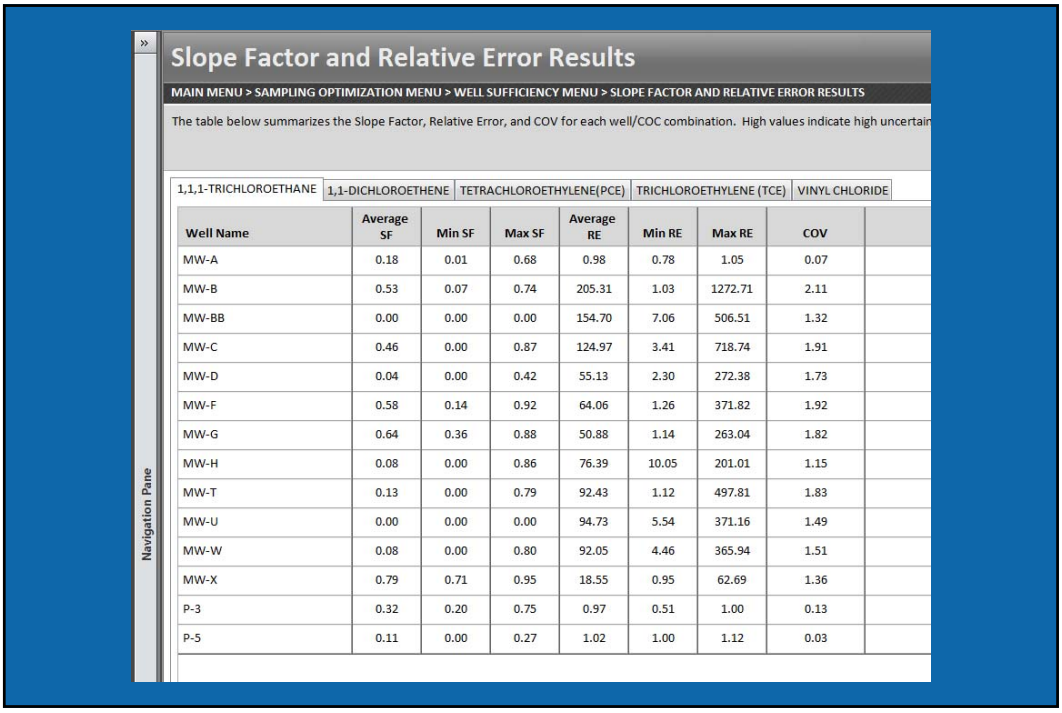
- **Slope Factor and Relative Error**

$$SF_i = \left| \frac{EC_i - NC_i}{Max(EC_i, NC_i)} \right|$$

$$RE_i = \left| \frac{EC_i - NC_i}{NC_i} \right|$$




- Varies over orders of magnitude
- RE → 10000, well is important; RE→ 0, well is not important
- COV – standard deviation/mean for all sample events



## Slope Factor and Relative Error Results

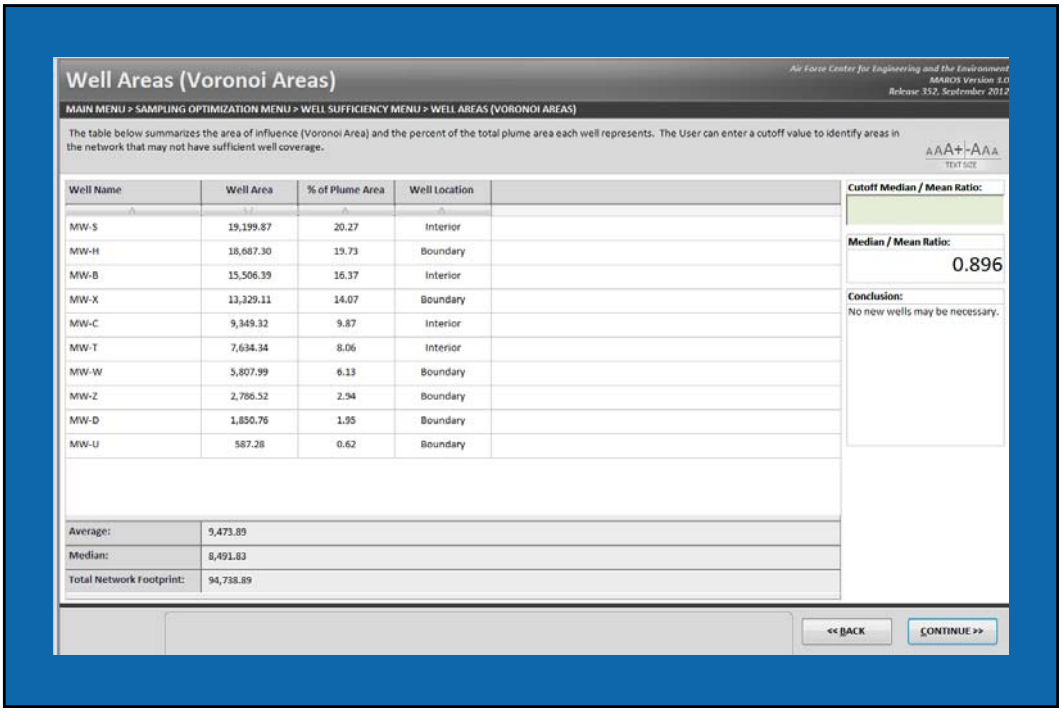
MAIN MENU > SAMPLING OPTIMIZATION MENU > WELL SUFFICIENCY MENU > SLOPE FACTOR AND RELATIVE ERROR RESULTS

The table below summarizes the Slope Factor, Relative Error, and COV for each well/COC combination. High values indicate high uncertain

Navigation Pane

1,1,1-TRICHLOROETHANE | 1,1-DICHLOROETHENE | TETRACHLOROETHYLENE(PCE) | TRICHLOROETHYLENE (TCE) | VINYL CHLORIDE

| Well Name | Average SF | Min SF | Max SF | Average RE | Min RE | Max RE | COV |
|---|---|---|---|---|---|---|---|
| MW-A | 0.18 | 0.01 | 0.68 | 0.98 | 0.78 | 1.05 | 0.07 |
| MW-B | 0.53 | 0.07 | 0.74 | 205.31 | 1.03 | 1272.71 | 2.11 |
| MW-BB | 0.00 | 0.00 | 0.00 | 154.70 | 7.06 | 506.51 | 1.32 |
| MW-C | 0.46 | 0.00 | 0.87 | 124.97 | 3.41 | 718.74 | 1.91 |
| MW-D | 0.04 | 0.00 | 0.42 | 55.13 | 2.30 | 272.38 | 1.73 |
| MW-F | 0.58 | 0.14 | 0.92 | 64.06 | 1.26 | 371.82 | 1.92 |
| MW-G | 0.64 | 0.36 | 0.88 | 50.88 | 1.14 | 263.04 | 1.82 |
| MW-H | 0.08 | 0.00 | 0.86 | 76.39 | 10.05 | 201.01 | 1.15 |
| MW-T | 0.13 | 0.00 | 0.79 | 92.43 | 1.12 | 497.81 | 1.83 |
| MW-U | 0.00 | 0.00 | 0.00 | 94.73 | 5.54 | 371.16 | 1.49 |
| MW-W | 0.08 | 0.00 | 0.80 | 92.05 | 4.46 | 365.94 | 1.51 |
| MW-X | 0.79 | 0.71 | 0.95 | 18.55 | 0.95 | 62.69 | 1.36 |
| P-3 | 0.32 | 0.20 | 0.75 | 0.97 | 0.51 | 1.00 | 0.13 |
| P-5 | 0.11 | 0.00 | 0.27 | 1.02 | 1.00 | 1.12 | 0.03 |



## Well Areas (Voronoi Areas)

Air Force Center for Engineering and the Environment
MAROS Version 3.0
Release 352, September 2012

MAIN MENU > SAMPLING OPTIMIZATION MENU > WELL SUFFICIENCY MENU > WELL AREAS (VORONOI AREAS)

The table below summarizes the area of influence (Voronoi Area) and the percent of the total plume area each well represents. The User can enter a cutoff value to identify areas in the network that may not have sufficient well coverage.

AAA+|-AAA TEXT SIZE

| Well Name | Well Area | % of Plume Area | Well Location |
|---|---|---|---|
| MW-S | 19,199.87 | 20.27 | Interior |
| MW-H | 18,687.30 | 19.73 | Boundary |
| MW-B | 15,506.39 | 16.37 | Interior |
| MW-X | 13,329.11 | 14.07 | Boundary |
| MW-C | 9,349.32 | 9.87 | Interior |
| MW-T | 7,634.34 | 8.06 | Interior |
| MW-W | 5,807.99 | 6.13 | Boundary |
| MW-Z | 2,786.52 | 2.94 | Boundary |
| MW-D | 1,850.76 | 1.95 | Boundary |
| MW-U | 587.28 | 0.62 | Boundary |

| | |
|---|---|
| Average: | 9,473.89 |
| Median: | 8,491.83 |
| Total Network Footprint: | 94,738.89 |

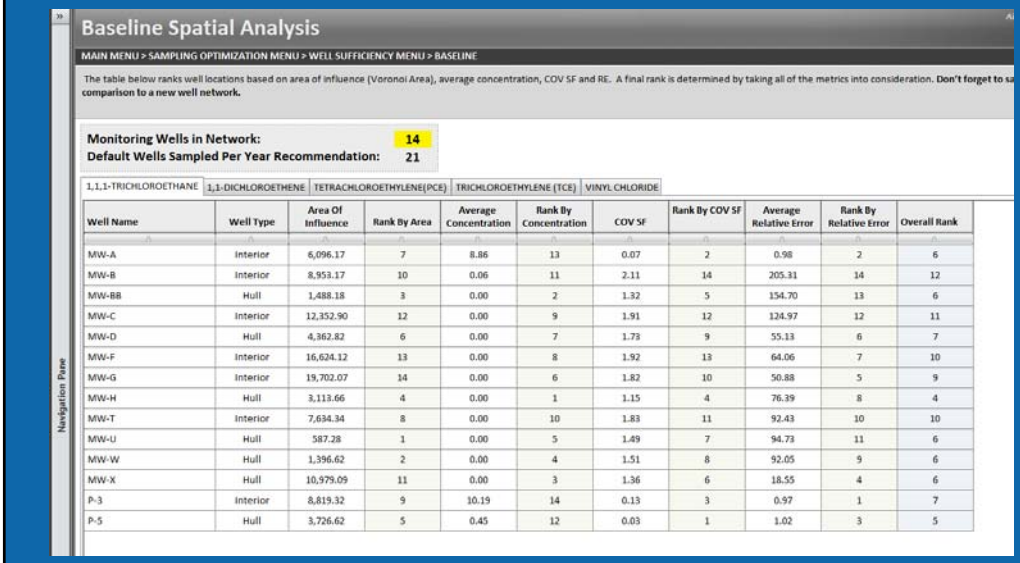
Cutoff Median / Mean Ratio:

Median / Mean Ratio: 0.896

Conclusion: No new wells may be necessary.

<< BACK | CONTINUE >>

## Save Table for Later Comparison



### Baseline Spatial Analysis

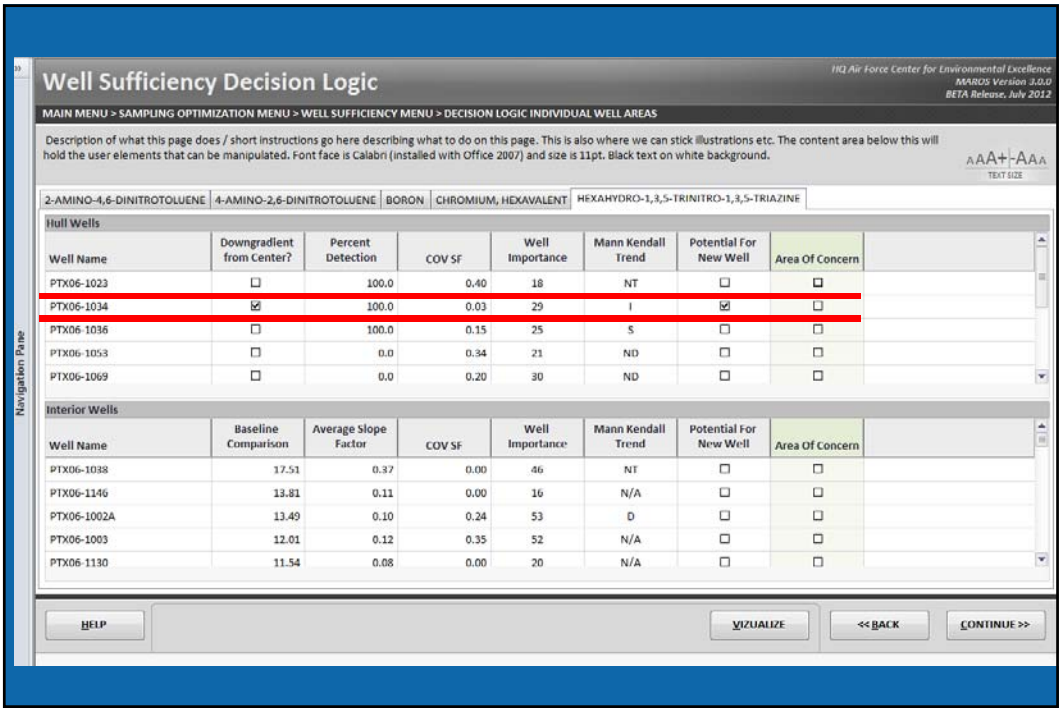
MAIN MENU > SAMPLING OPTIMIZATION MENU > WELL SUFFICIENCY MENU > BASELINE

The table below ranks well locations based on area of influence (Voronoi Area), average concentration, COV SF and RE. A final rank is determined by taking all of the metrics into consideration. **Don't forget to sa comparison to a new well network.**

**Monitoring Wells in Network:** 14
**Default Wells Sampled Per Year Recommendation:** 21

1,1,1-TRICHLOROETHANE | 1,1-DICHLOROETHENE | TETRACHLOROETHYLENE(PCE) | TRICHLOROETHYLENE (TCE) | VINYL CHLORIDE

| Well Name | Well Type | Area Of Influence | Rank By Area | Average Concentration | Rank By Concentration | COV SF | Rank By COV SF | Average Relative Error | Rank By Relative Error | Overall Rank |
|---|---|---|---|---|---|---|---|---|---|---|
| MW-A | Interior | 6,096.17 | 7 | 8.86 | 13 | 0.07 | 2 | 0.98 | 2 | 6 |
| MW-B | Interior | 8,953.17 | 10 | 0.06 | 11 | 2.11 | 14 | 205.31 | 14 | 12 |
| MW-BB | Hull | 1,488.18 | 3 | 0.00 | 2 | 1.32 | 5 | 154.70 | 13 | 6 |
| MW-C | Interior | 12,352.90 | 12 | 0.00 | 9 | 1.91 | 12 | 124.97 | 12 | 11 |
| MW-D | Hull | 4,362.82 | 6 | 0.00 | 7 | 1.73 | 9 | 55.13 | 6 | 7 |
| MW-F | Interior | 16,624.12 | 13 | 0.00 | 8 | 1.92 | 13 | 64.06 | 7 | 10 |
| MW-G | Interior | 19,702.07 | 14 | 0.00 | 6 | 1.82 | 10 | 50.88 | 5 | 9 |
| MW-H | Hull | 3,113.66 | 4 | 0.00 | 1 | 1.15 | 4 | 76.39 | 8 | 4 |
| MW-T | Interior | 7,634.34 | 8 | 0.00 | 10 | 1.83 | 11 | 92.43 | 10 | 10 |
| MW-U | Hull | 587.28 | 1 | 0.00 | 5 | 1.49 | 7 | 94.73 | 11 | 6 |
| MW-W | Hull | 1,396.62 | 2 | 0.00 | 4 | 1.51 | 8 | 92.05 | 9 | 6 |
| MW-X | Hull | 10,979.09 | 11 | 0.00 | 3 | 1.36 | 6 | 18.55 | 4 | 6 |
| P-3 | Interior | 8,819.32 | 9 | 10.19 | 14 | 0.13 | 3 | 0.97 | 1 | 7 |
| P-5 | Hull | 3,726.62 | 5 | 0.45 | 12 | 0.03 | 1 | 1.02 | 3 | 5 |



### Well Sufficiency Decision Logic

HQ Air Force Center for Environmental Excellence
MAROS Version 3.0.0
BETA Release, July 2012

MAIN MENU > SAMPLING OPTIMIZATION MENU > WELL SUFFICIENCY MENU > DECISION LOGIC INDIVIDUAL WELL AREAS

Description of what this page does / short instructions go here describing what to do on this page. This is also where we can stick illustrations etc. The content area below this will hold the user elements that can be manipulated. Font face is Calabri (installed with Office 2007) and size is 11pt. Black text on white background.

TEXT SIZE

2-AMINO-4,6-DINITROTOLUENE | 4-AMINO-2,6-DINITROTOLUENE | BORON | CHROMIUM, HEXAVALENT | HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE

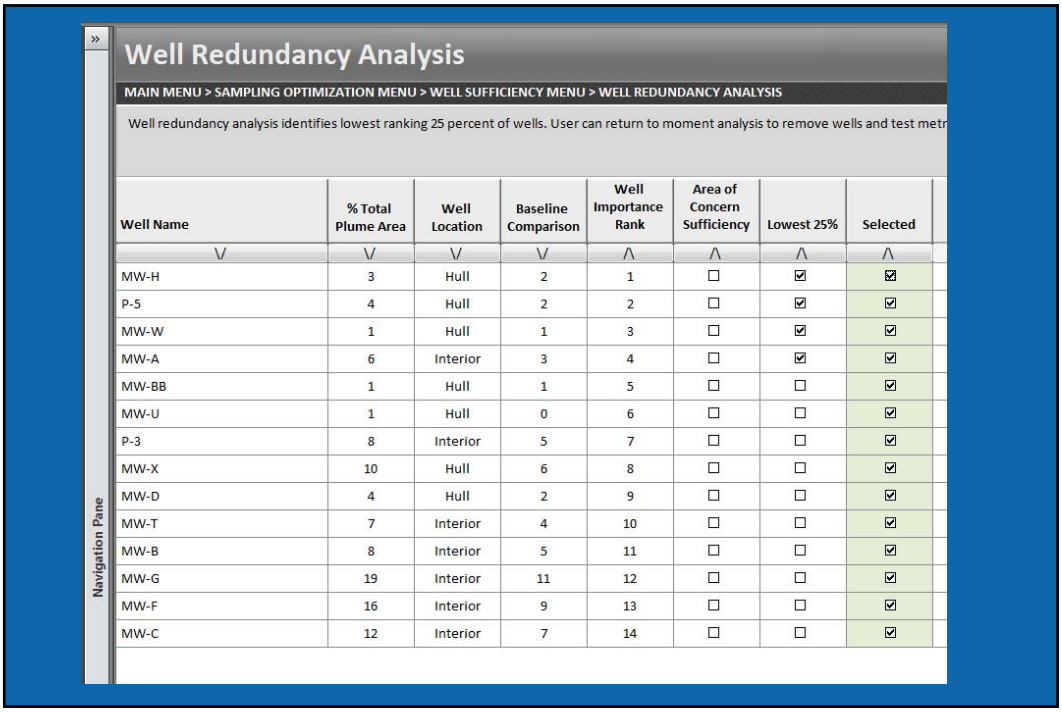
**Hull Wells**

| Well Name | Downgradient from Center? | Percent Detection | COV SF | Well Importance | Mann Kendall Trend | Potential For New Well | Area Of Concern |
|---|---|---|---|---|---|---|---|
| PTX06-1023 | ☐ | 100.0 | 0.40 | 18 | NT | ☐ | ☐ |
| PTX06-1034 | ☑ | 100.0 | 0.03 | 29 | I | ☑ | ☐ |
| PTX06-1036 | ☐ | 100.0 | 0.15 | 25 | S | ☐ | ☐ |
| PTX06-1053 | ☐ | 0.0 | 0.34 | 21 | ND | ☐ | ☐ |
| PTX06-1069 | ☐ | 0.0 | 0.20 | 30 | ND | ☐ | ☐ |

**Interior Wells**

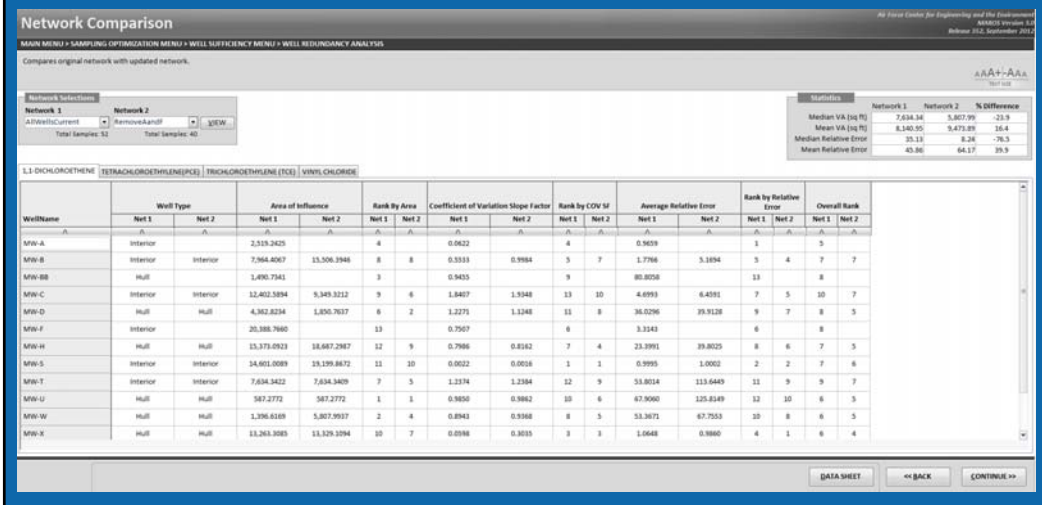
| Well Name | Baseline Comparison | Average Slope Factor | COV SF | Well Importance | Mann Kendall Trend | Potential For New Well | Area Of Concern |
|---|---|---|---|---|---|---|---|
| PTX06-1038 | 17.51 | 0.37 | 0.00 | 46 | NT | ☐ | ☐ |
| PTX06-1146 | 13.81 | 0.11 | 0.00 | 16 | N/A | ☐ | ☐ |
| PTX06-1002A | 13.49 | 0.10 | 0.24 | 53 | D | ☐ | ☐ |
| PTX06-1003 | 12.01 | 0.12 | 0.35 | 52 | N/A | ☐ | ☐ |
| PTX06-1130 | 11.54 | 0.08 | 0.00 | 20 | N/A | ☐ | ☐ |

HELP | VIZUALIZE | << BACK | CONTINUE >>




| Well Name | % Total Plume Area | Well Location | Baseline Comparison | Well Importance Rank | Area of Concern Sufficiency | Lowest 25% | Selected |
|---|---|---|---|---|---|---|---|
| MW-H | 3 | Hull | 2 | 1 | ☐ | ☑ | ☑ |
| P-5 | 4 | Hull | 2 | 2 | ☐ | ☑ | ☑ |
| MW-W | 1 | Hull | 1 | 3 | ☐ | ☑ | ☑ |
| MW-A | 6 | Interior | 3 | 4 | ☐ | ☑ | ☑ |
| MW-BB | 1 | Hull | 1 | 5 | ☐ | ☐ | ☑ |
| MW-U | 1 | Hull | 0 | 6 | ☐ | ☐ | ☑ |
| P-3 | 8 | Interior | 5 | 7 | ☐ | ☐ | ☑ |
| MW-X | 10 | Hull | 6 | 8 | ☐ | ☐ | ☑ |
| MW-D | 4 | Hull | 2 | 9 | ☐ | ☐ | ☑ |
| MW-T | 7 | Interior | 4 | 10 | ☐ | ☐ | ☑ |
| MW-B | 8 | Interior | 5 | 11 | ☐ | ☐ | ☑ |
| MW-G | 19 | Interior | 11 | 12 | ☐ | ☐ | ☑ |
| MW-F | 16 | Interior | 9 | 13 | ☐ | ☐ | ☑ |
| MW-C | 12 | Interior | 7 | 14 | ☐ | ☐ | ☑ |

## Compare network stats before and after optimization



Monitoring Optimization

## Software: *Frequency Optimization*

**Frequency Optimization**

- Reporting frequency
- Current Frequency
- Transport-based Frequency
- Decision logic

- *How often do I sample now?*
- *How fast is groundwater moving?*
- *How fast are concentrations changing?*
- *Variability?*
- *Increasing or Decreasing? Variable?*

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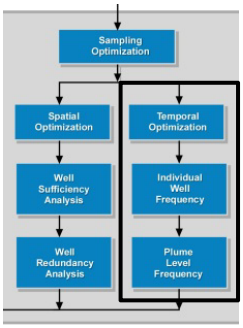
Monitoring Optimization

## Software: *Optimization*

- Optimization
  - *Frequency*
    - *Individual Well*
    - *Network Level – NEW!*

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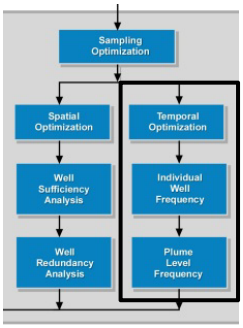
## Monitoring Optimization
# Software: *Optimization*

- **Individual Well Sampling Frequency**
  - ***Summary info – NEW!***
    - ***Reporting Frequency***
    - ***Travel Time***
    - ***Current Sampling Frequency***
  - ***Modified CES Method***

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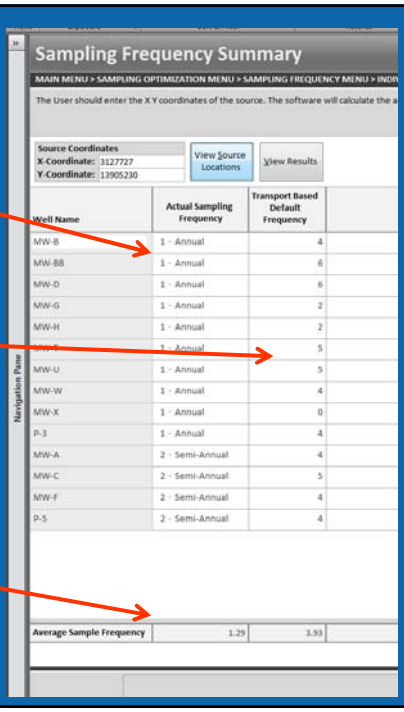
Current Sampling Frequency by well [samples/year]

½ * Distance to source /seepage velocity [years]

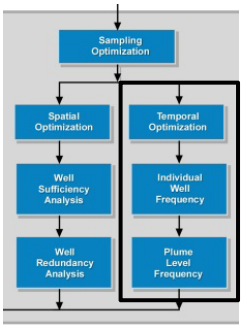
Network Average



Monitoring Optimization

## Software: *Optimization*

- **Network Sampling Frequency** – ***NEW!***
  - ***Based on Zeroth Moment***
    - ***Rate of change of mass***
    - ***Coefficient of variation***
    - ***Correlation (R2)***
  - ***Recommendation***

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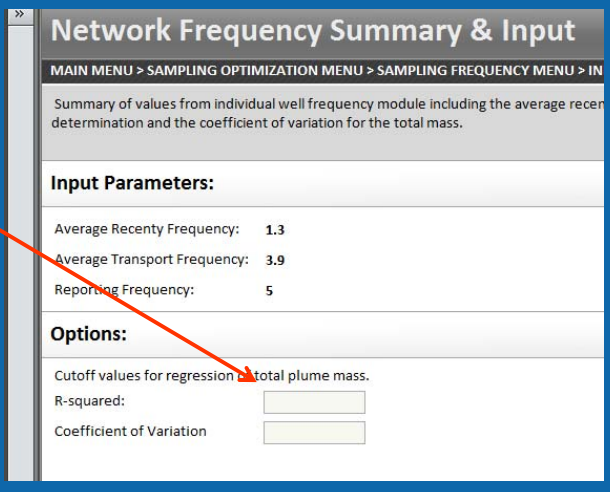
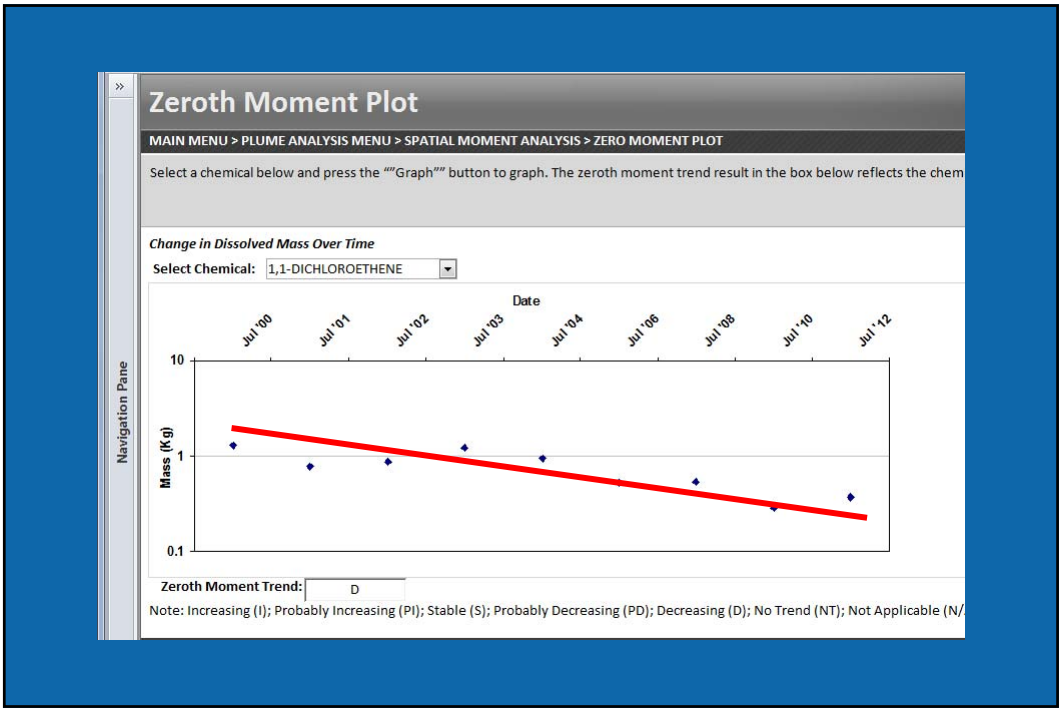
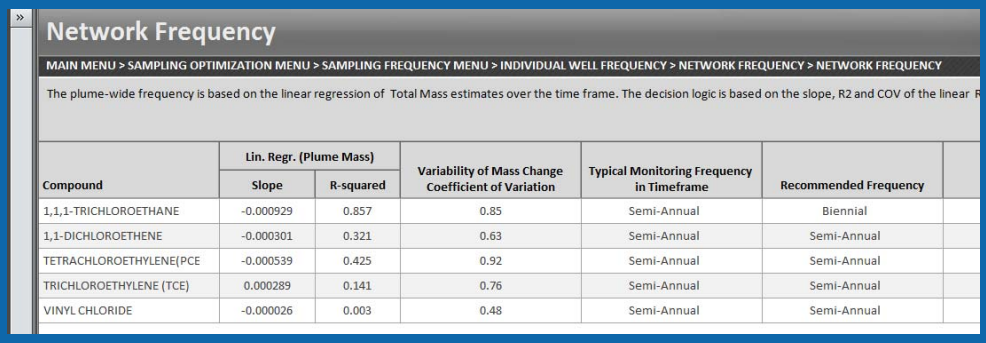
User supplies $R^2$ and COV cutoff





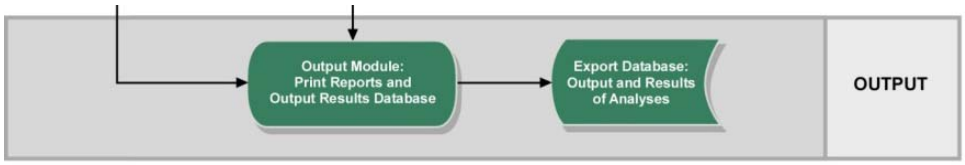




| Compound | Lin. Regr. (Plume Mass) Slope | Lin. Regr. (Plume Mass) R-squared | Variability of Mass Change Coefficient of Variation | Typical Monitoring Frequency in Timeframe | Recommended Frequency |
|---|---|---|---|---|---|
| 1,1,1-TRICHLOROETHANE | -0.000929 | 0.857 | 0.85 | Semi-Annual | Biennial |
| 1,1-DICHLOROETHENE | -0.000301 | 0.321 | 0.63 | Semi-Annual | Semi-Annual |
| TETRACHLOROETHYLENE(PCE | -0.000539 | 0.425 | 0.92 | Semi-Annual | Semi-Annual |
| TRICHLOROETHYLENE (TCE) | 0.000289 | 0.141 | 0.76 | Semi-Annual | Semi-Annual |
| VINYL CHLORIDE | -0.000026 | 0.003 | 0.48 | Semi-Annual | Semi-Annual |

| Slope | COV | R2 | Result |
|---|---|---|---|
| **All** | < User cutoff | < User Cutoff | Keep current sample frequency (Average current) |
| **< 0 (negative)** | < User cutoff | >= User Cutoff | 2 steps less frequent |
| **All** | >=User cutoff | < User Cutoff | 1 step more frequent |
| **< 0 (negative)** | >=User cutoff | >=User cutoff | 1 step less frequent |
| **Mass = 0** | Do not calculate | | Minimum of the reporting frequency or the transport-based frequency |

Monitoring Optimization

## Software: *Export and Output*




***Export and Output***

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Monitoring Optimization

## Software: *Export Options*

- **MAROS Output**
  - ***Screen by Screen – spreadsheet cut and paste as you go***
  - ***Reports***
    - ***Print as you go***
    - ***Output – view and print reports***
  - ***Graphs***
  - ***Databases***

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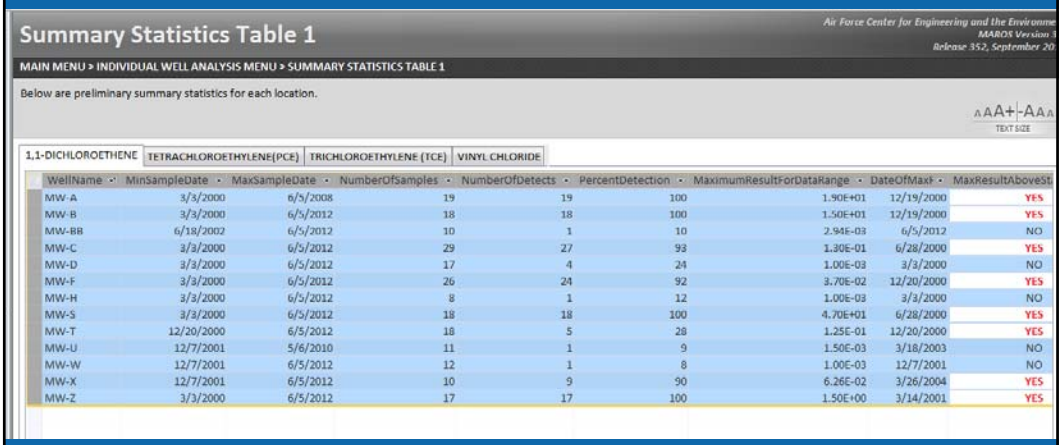
## Datasheet View by Screen



Summary Statistics Table 1

Air Force Center for Engineering and the Environme
MAROS Version 3
Release 352, September 20

MAIN MENU > INDIVIDUAL WELL ANALYSIS MENU > SUMMARY STATISTICS TABLE 1

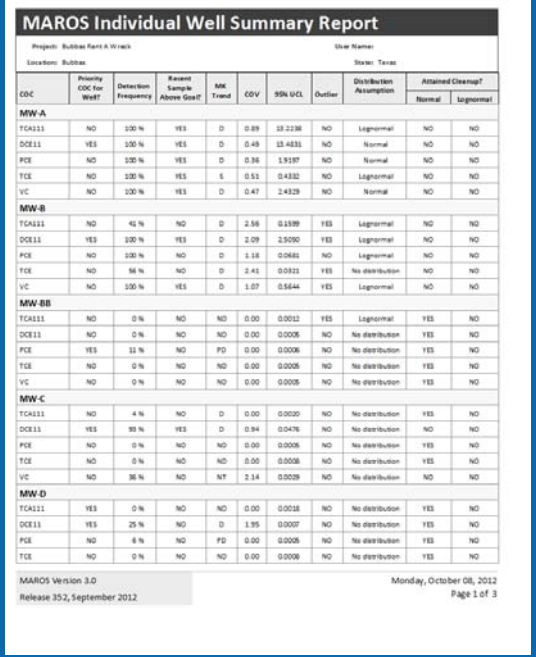
Below are preliminary summary statistics for each location.

TEXT SIZE

1,1-DICHLOROETHENE | TETRACHLOROETHYLENE(PCE) | TRICHLOROETHYLENE (TCE) | VINYL CHLORIDE

| WellName | MinSampleDate | MaxSampleDate | NumberOfSamples | NumberOfDetects | PercentDetection | MaximumResultForDataRange | DateOfMaxR | MaxResultAboveSt |
|---|---|---|---|---|---|---|---|---|
| MW-A | 3/3/2000 | 6/5/2008 | 19 | 19 | 100 | 1.90E+01 | 12/19/2000 | YES |
| MW-B | 3/3/2000 | 6/5/2012 | 18 | 18 | 100 | 1.50E+01 | 12/19/2000 | YES |
| MW-BB | 6/18/2002 | 6/5/2012 | 10 | 1 | 10 | 2.94E-03 | 6/5/2012 | NO |
| MW-C | 3/3/2000 | 6/5/2012 | 29 | 27 | 93 | 1.30E-01 | 6/28/2000 | YES |
| MW-D | 3/3/2000 | 6/5/2012 | 17 | 4 | 24 | 1.00E-03 | 3/3/2000 | NO |
| MW-F | 3/3/2000 | 6/5/2012 | 26 | 24 | 92 | 3.70E-02 | 12/20/2000 | YES |
| MW-H | 3/3/2000 | 6/5/2012 | 8 | 1 | 12 | 1.00E-03 | 3/3/2000 | NO |
| MW-S | 3/3/2000 | 6/5/2012 | 18 | 18 | 100 | 4.70E+01 | 6/28/2000 | YES |
| MW-T | 12/20/2000 | 6/5/2012 | 18 | 5 | 28 | 1.25E-01 | 12/20/2000 | YES |
| MW-U | 12/7/2001 | 5/6/2010 | 11 | 1 | 9 | 1.50E-03 | 3/18/2003 | NO |
| MW-W | 12/7/2001 | 6/5/2012 | 12 | 1 | 8 | 1.00E-03 | 12/7/2001 | NO |
| MW-X | 12/7/2001 | 6/5/2012 | 10 | 9 | 90 | 6.26E-02 | 3/26/2004 | YES |
| MW-Z | 3/3/2000 | 6/5/2012 | 17 | 17 | 100 | 1.50E+00 | 3/14/2001 | YES |

## Reports



MAROS Individual Well Summary Report

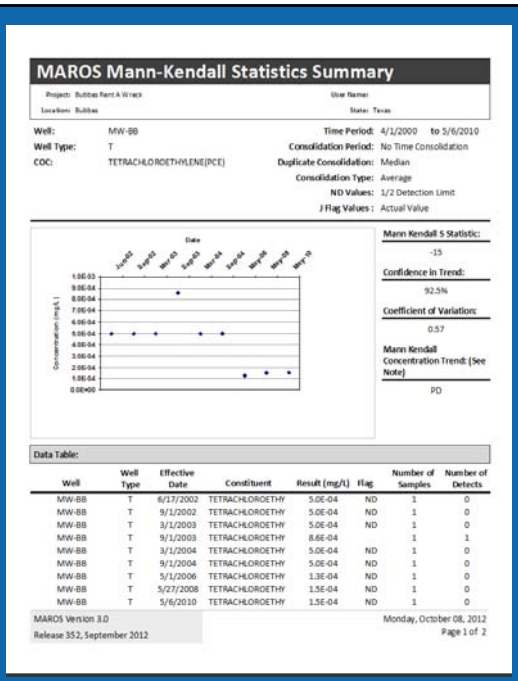
Project: Bubbas Rent A Wreck
Location: Bubbas
User Name:
State: Texas

| COC | Priority COC for Well? | Detection Frequency | Recent Sample Above Goal? | MK Trend | COV | 95% UCL | Outlier | Distribution Assumption | Attained Cleanup? | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Normal | Lognormal |
| MW-A | | | | | | | | | | |
| TCA111 | NO | 100 % | YES | D | 0.89 | 13.2238 | NO | Lognormal | NO | NO |
| DCE11 | YES | 100 % | YES | D | 0.49 | 13.4831 | NO | Normal | NO | NO |
| PCE | NO | 100 % | YES | D | 0.36 | 1.9187 | NO | Normal | NO | NO |
| TCE | NO | 100 % | YES | S | 0.51 | 0.4332 | NO | Lognormal | NO | NO |
| VC | NO | 100 % | YES | D | 0.47 | 2.4329 | NO | Normal | NO | NO |
| MW-B | | | | | | | | | | |
| TCA111 | NO | 41 % | NO | D | 2.56 | 0.1599 | YES | Lognormal | NO | NO |
| DCE11 | YES | 100 % | YES | D | 2.09 | 2.9090 | YES | Lognormal | NO | NO |
| PCE | NO | 100 % | NO | D | 1.16 | 0.0681 | NO | Lognormal | NO | NO |
| TCE | NO | 56 % | NO | D | 2.41 | 0.0821 | YES | No distribution | NO | NO |
| VC | NO | 100 % | YES | D | 1.07 | 0.5644 | YES | Lognormal | NO | NO |
| MW-BB | | | | | | | | | | |
| TCA111 | NO | 0 % | NO | ND | 0.00 | 0.0012 | YES | Lognormal | YES | NO |
| DCE11 | NO | 0 % | NO | ND | 0.00 | 0.0005 | NO | No distribution | YES | NO |
| PCE | YES | 11 % | NO | FD | 0.00 | 0.0006 | NO | No distribution | YES | NO |
| TCE | NO | 0 % | NO | ND | 0.00 | 0.0005 | NO | No distribution | YES | NO |
| VC | NO | 0 % | NO | ND | 0.00 | 0.0005 | NO | No distribution | YES | NO |
| MW-C | | | | | | | | | | |
| TCA111 | NO | 4 % | NO | D | 0.00 | 0.0020 | NO | No distribution | YES | NO |
| DCE11 | YES | 93 % | YES | D | 0.94 | 0.0476 | NO | No distribution | NO | NO |
| PCE | NO | 0 % | NO | ND | 0.00 | 0.0005 | NO | No distribution | YES | NO |
| TCE | NO | 0 % | NO | ND | 0.00 | 0.0008 | NO | No distribution | YES | NO |
| VC | NO | 36 % | NO | NT | 2.14 | 0.0029 | NO | No distribution | NO | NO |
| MW-D | | | | | | | | | | |
| TCA111 | YES | 0 % | NO | ND | 0.00 | 0.0018 | NO | No distribution | YES | NO |
| DCE11 | YES | 25 % | NO | D | 1.95 | 0.0007 | NO | No distribution | YES | NO |
| PCE | NO | 6 % | NO | FD | 0.00 | 0.0005 | NO | No distribution | YES | NO |
| TCE | NO | 0 % | NO | ND | 0.00 | 0.0008 | NO | No distribution | YES | NO |

MAROS Version 3.0
Release 352, September 2012

Monday, October 08, 2012
Page 1 of 3

## Graphs



MAROS Mann-Kendall Statistics Summary

Project: Bubbas Rent A Wreck — User Name:
Location: Bubbas — State: Texas

Well: MW-BB
Well Type: T
COC: TETRACHLOROETHYLENE(PCE)

Time Period: 4/1/2000 to 5/6/2010
Consolidation Period: No Time Consolidation
Duplicate Consolidation: Median
Consolidation Type: Average
ND Values: 1/2 Detection Limit
J Flag Values: Actual Value

Mann Kendall S Statistic: -15
Confidence in Trend: 92.5%
Coefficient of Variation: 0.57
Mann Kendall Concentration Trend: (See Note) PD

Data Table:

| Well | Well Type | Effective Date | Constituent | Result (mg/L) | Flag | Number of Samples | Number of Detects |
|---|---|---|---|---|---|---|---|
| MW-BB | T | 6/17/2002 | TETRACHLOROETHY | 5.0E-04 | ND | 1 | 0 |
| MW-BB | T | 9/1/2002 | TETRACHLOROETHY | 5.0E-04 | ND | 1 | 0 |
| MW-BB | T | 3/1/2003 | TETRACHLOROETHY | 5.0E-04 | ND | 1 | 0 |
| MW-BB | T | 9/1/2003 | TETRACHLOROETHY | 8.6E-04 | | 1 | 1 |
| MW-BB | T | 3/1/2004 | TETRACHLOROETHY | 5.0E-04 | ND | 1 | 0 |
| MW-BB | T | 9/1/2004 | TETRACHLOROETHY | 5.0E-04 | ND | 1 | 0 |
| MW-BB | T | 5/1/2006 | TETRACHLOROETHY | 1.3E-04 | ND | 1 | 0 |
| MW-BB | T | 5/27/2008 | TETRACHLOROETHY | 1.5E-04 | ND | 1 | 0 |
| MW-BB | T | 5/6/2010 | TETRACHLOROETHY | 1.5E-04 | ND | 1 | 0 |

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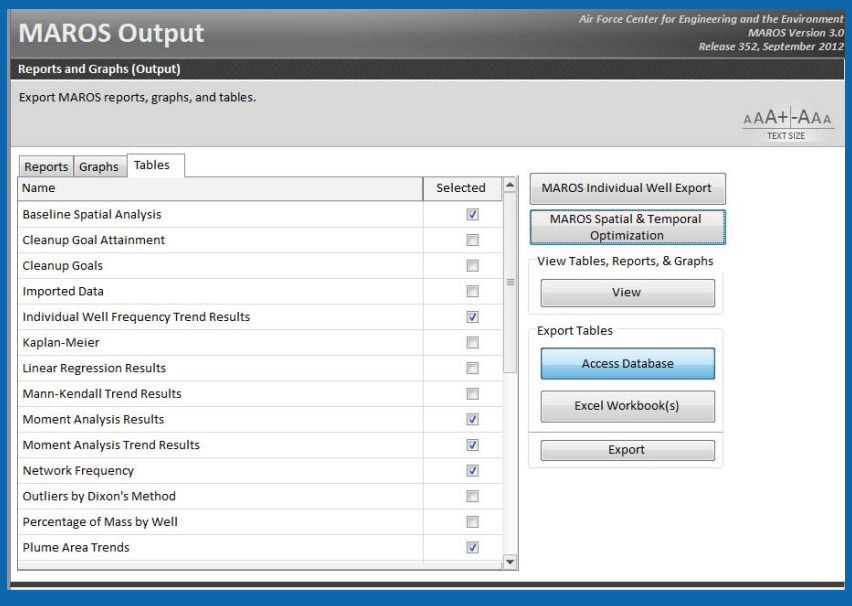
Release 352, September 2012

Monday, October 08, 2012
Page 1 of 2

## Databases



MAROS Output

*Air Force Center for Engineering and the Environment*
*MAROS Version 3.0*
*Release 352, September 2012*

Reports and Graphs (Output)

Export MAROS reports, graphs, and tables.

AAA+-AAA TEXT SIZE

Reports | Graphs | Tables

| Name | Selected |
|---|---|
| Baseline Spatial Analysis | ☑ |
| Cleanup Goal Attainment | ☐ |
| Cleanup Goals | ☐ |
| Imported Data | ☐ |
| Individual Well Frequency Trend Results | ☑ |
| Kaplan-Meier | ☐ |
| Linear Regression Results | ☐ |
| Mann-Kendall Trend Results | ☐ |
| Moment Analysis Results | ☑ |
| Moment Analysis Trend Results | ☑ |
| Network Frequency | ☑ |
| Outliers by Dixon's Method | ☐ |
| Percentage of Mass by Well | ☐ |
| Plume Area Trends | ☑ |

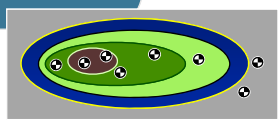
MAROS Individual Well Export
MAROS Spatial & Temporal Optimization
View Tables, Reports, & Graphs
View
Export Tables
Access Database
Excel Workbook(s)
Export

Monitoring Optimization

## MAROS 3.0

- *Expanded Individual Well Statistics*
- *Improved spatial analysis*
- *More User choice and comparison options for spatial analysis*
- *Improve Usability*
- *More export opportunities and options*

- *Goals and COC Choice– NEW!*
- *Individual Statistics– NEW!*
- *Plume mass by well– NEW!*
- *Aggregate Trends – NEW!*
- *Spatial Decision Logic – NEW!*
- *Travel time data – NEW!*
- *Frequency Network Level – NEW!*



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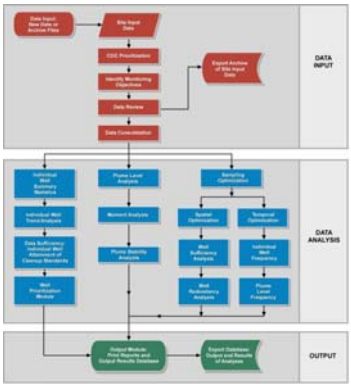
Monitoring Optimization

## QUESTIONS?

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