

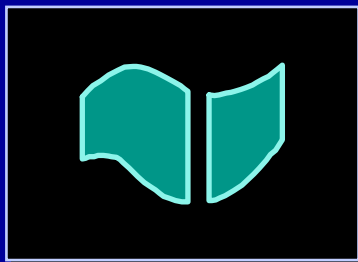
# Use of Long Term Monitoring Data to Better Understand Plume Behavior at Gasoline Retail Sites

*Charles Newell*

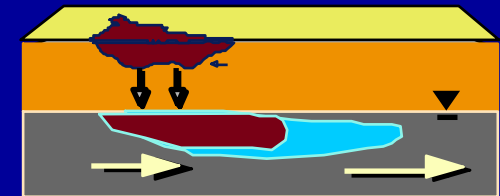
Roopa Kamath, Mai P. Le, Andrea Ryan

Thomas E. McHugh and John A. Connor

November 2009

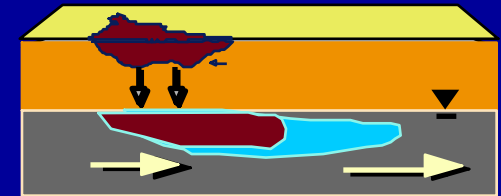


**GSI Environmental Inc. (GSI)**  
**Houston, Texas**



# GSI PLUM-A-THON STUDY

- Review of Prior Plume Studies
- Key Questions
- Overview of GSI Study
- Results
- Summary and Conclusions



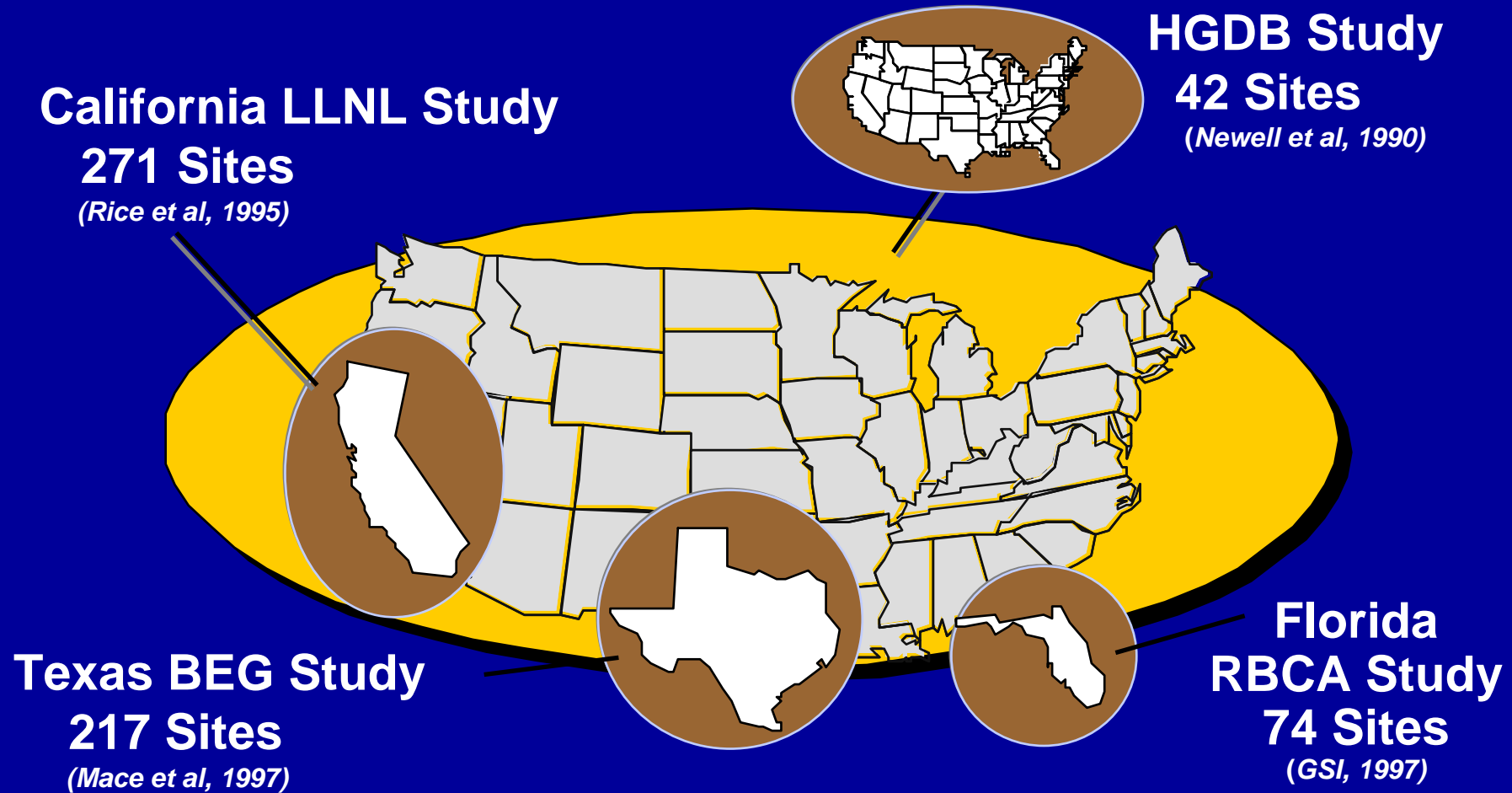
# GSI PLUM-A-THON STUDY

## ➔ *Review of Prior Plume Studies*

- Key Questions
- Overview of GSI Study
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- Summary and Conclusions



# BTEX Plume Studies: 1990 – 1997



# MTBE Plume Studies: 1997 – 2004

**California LLNL Study -  
50 Sites** (*Happel et al, 1997*)

**California Study - 96 Sites**  
(*Shih et al, 2004*)

**South Carolina  
212 Sites**  
(*Wilson, 2004*)



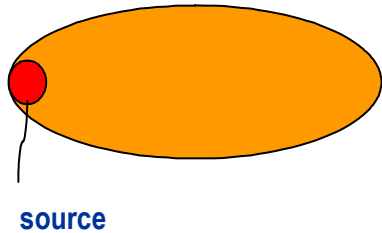
**Texas BEG Study - 99  
Sites** (*Mace et al, 1998*)

**Texas Study - 36 Sites**  
(*Rifai & Rixey, 2004*)

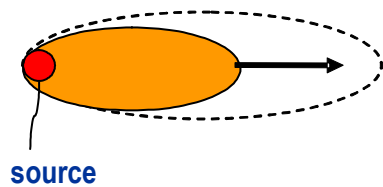
**Florida  
55 Sites**  
(*Reid, 1999*)

# Plume Life Cycle

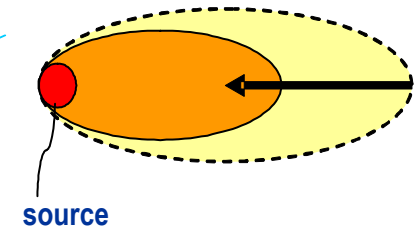
## 2. STABLE



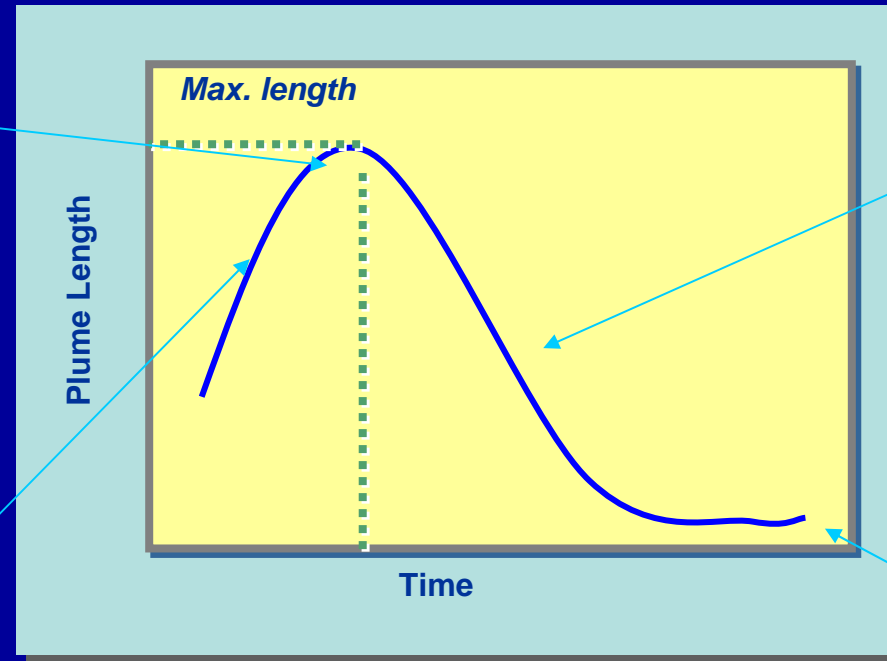
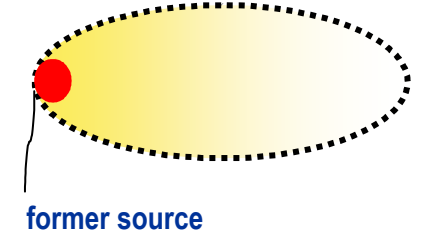
## 1. EXPANDING



## 3. SHRINKING

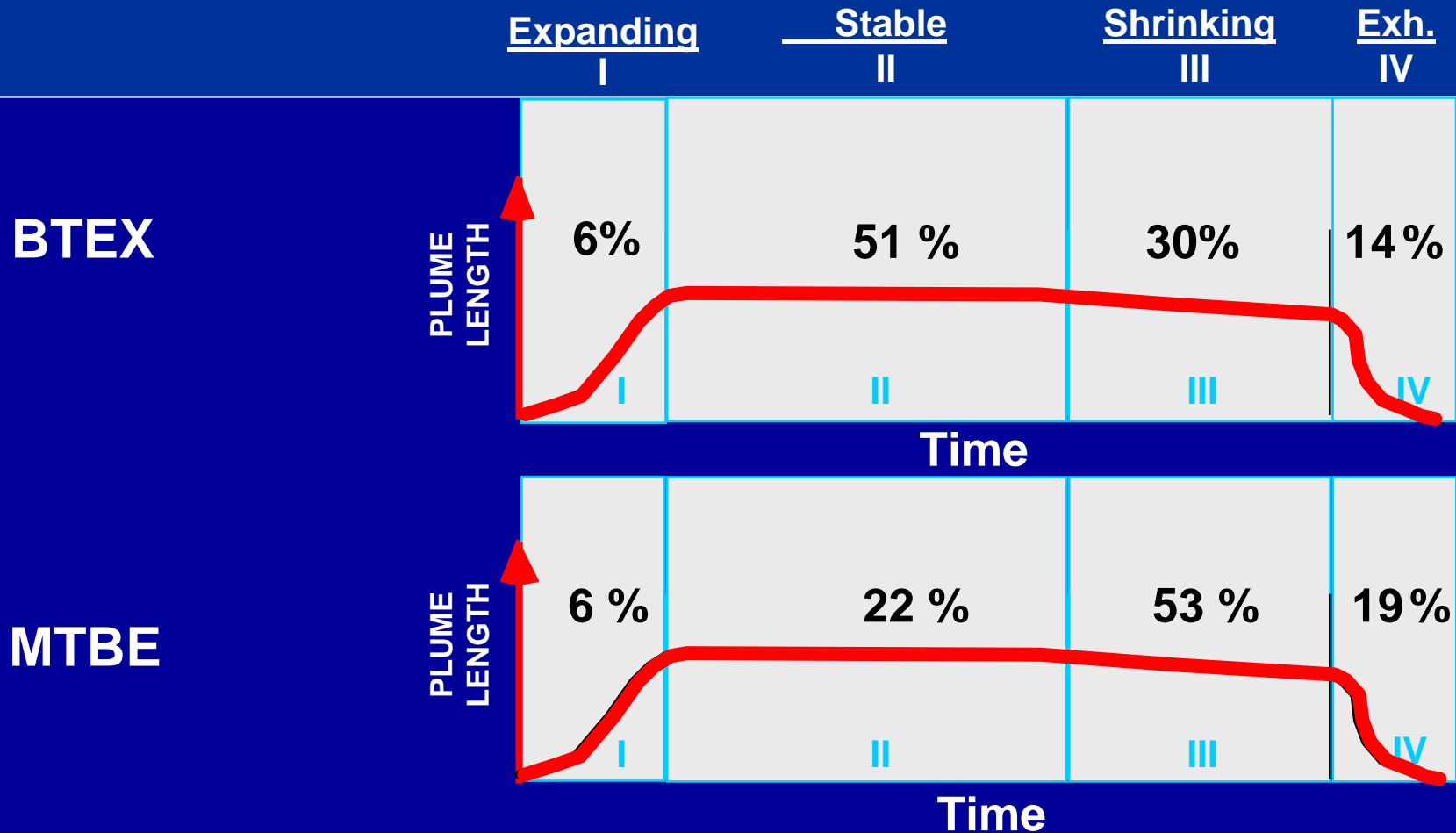


## 4. EXHAUSTED



# How Many Plume Lengths are Shrinking? Stable? Expanding? (1990 – 2004)

*Percent of Plumes That Are:*



# GSI PLUM-A-THON STUDY

- Review of Prior Plume Studies

➔ ***Key Questions***

- Overview of GSI Study
- Results
- Summary and Conclusions

**Benzene,  
MTBE, TBA**



# KEY QUESTIONS

1. How large is the average benzene, MTBE, and TBA plume?
2. Is the groundwater cleaner now?
3. What is the attenuation rate in individual wells?

**Benzene,  
MTBE, TBA**



# GSI PLUM-A-THON STUDY

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- Review of Prior Plume Studies
- *Key Questions*

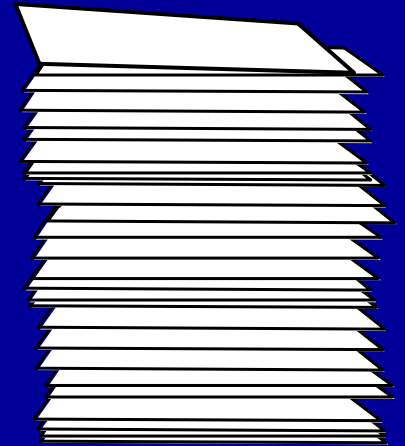
## *Overview of GSI Study*

- Results
- Summary and Conclusions

# Data Collection and Analysis

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- State Agencies (e.g. Washington, Iowa)
- State Databases (e.g. California)
- Oil Industry (e.g. BP, Chevron)
- Other Consultants (e.g. Stantec)



# Minimum Requirements for Inclusion in Study

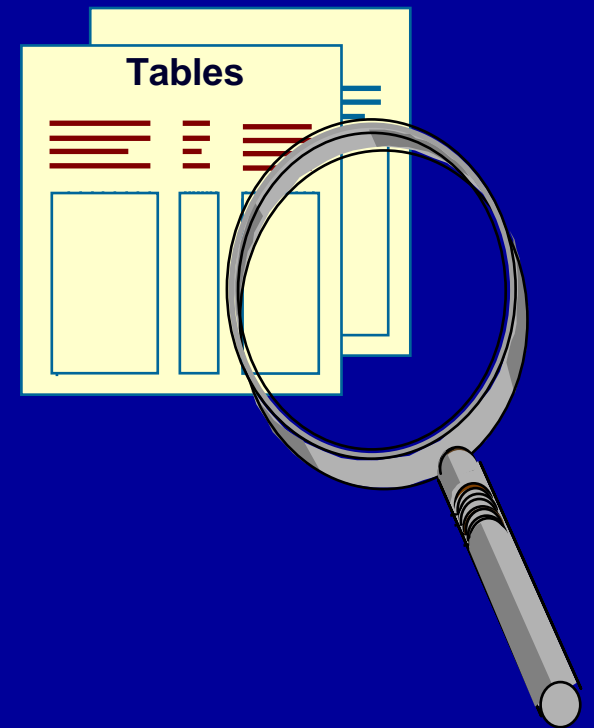
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Gasoline retail site has

- 6 or more years of monitoring data (*Actual Average of sites in the study = 15 years*)
- Minimum of 6 monitoring wells (*Actual Average = 20 wells per site*)

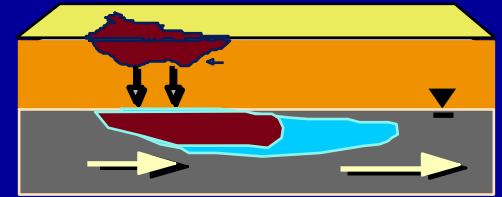
# DATA ANALYSIS

- Current Plume Lengths
  - Measure Plume Length
- Concentration Trends
  - Individual Wells
- Source Decay Rates (C vs T)



# DATA ANALYSIS: *GW CLEANUP LEVELS*

- Benzene: MCL = 5  $\mu\text{g/L}$
- MTBE: California Primary MCL = 13  $\mu\text{g/L}$
- TBA: California Provisional Action Goal = 12  $\mu\text{g/L}$



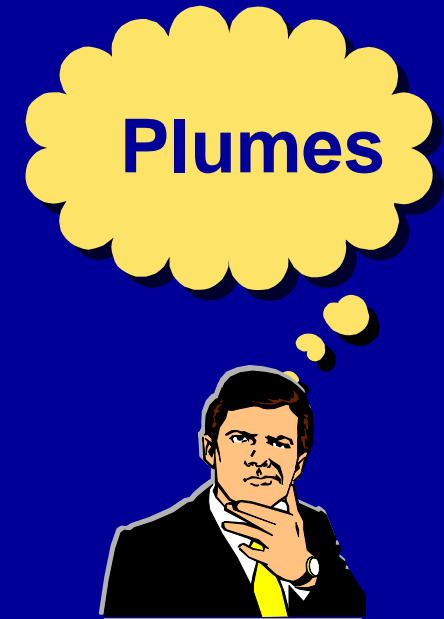
*Cleanup levels used for delineation of plume lengths*

# GSI PLUM-A-THON STUDY

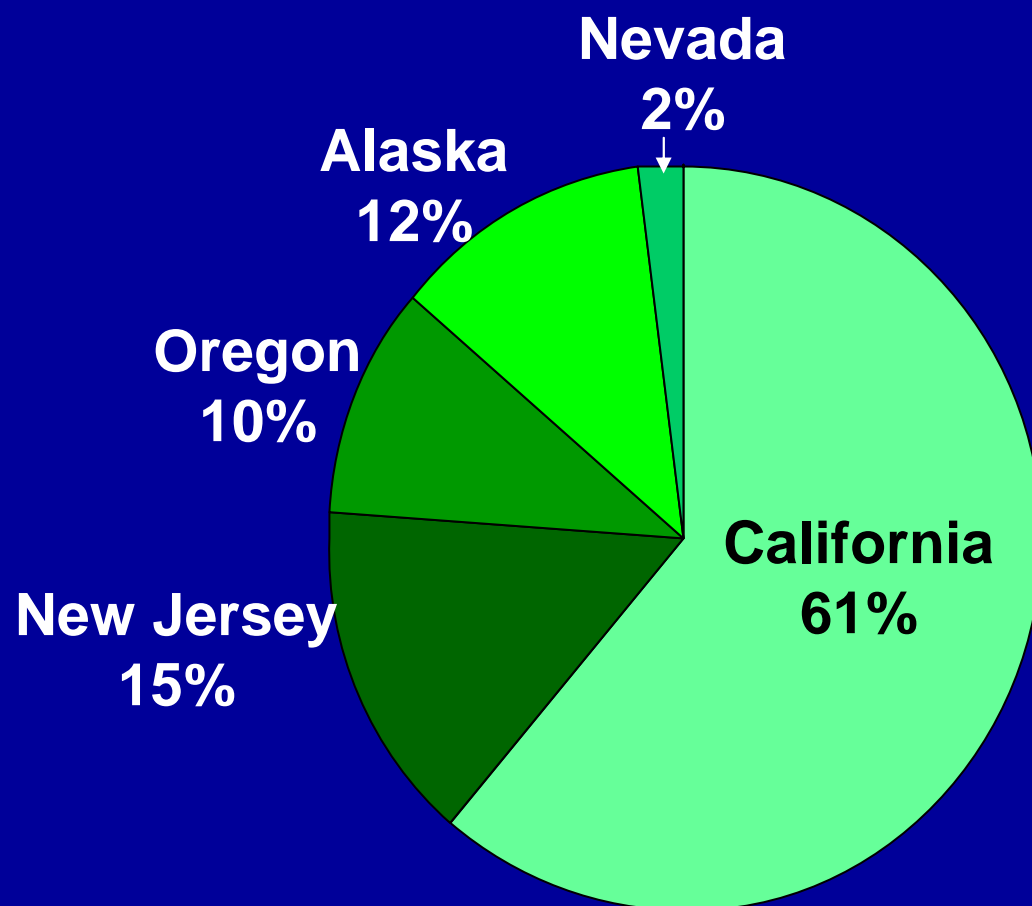
- Review of Prior Plume Studies
- Key Questions
- Overview of GSI Study

➔ ***Results***

- Summary and Conclusions



# Distribution of Sites Included in Study



- No. of Sites: 52
- No. of Wells with
  - Benzene: 763
  - MTBE: 714
  - TBA: 575

## **Key Point:**

Sites from East Coast and West Coast included in the study. CA and NJ had highest MTBE use prior to 2004.

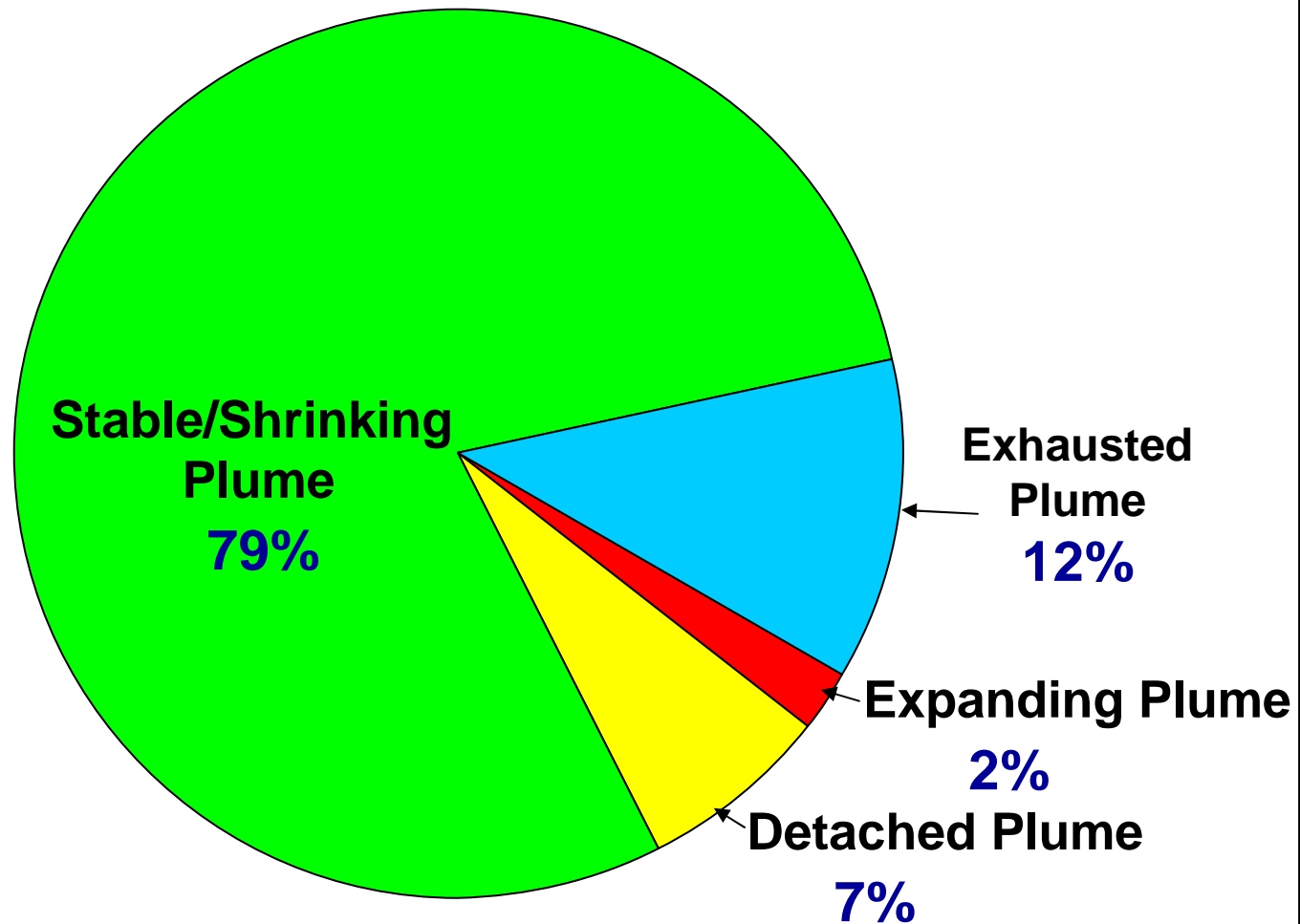
# BENZENE PLUME STABILITY



**Key  
Finding:**

The majority of benzene plumes are stable or shrinking in length.

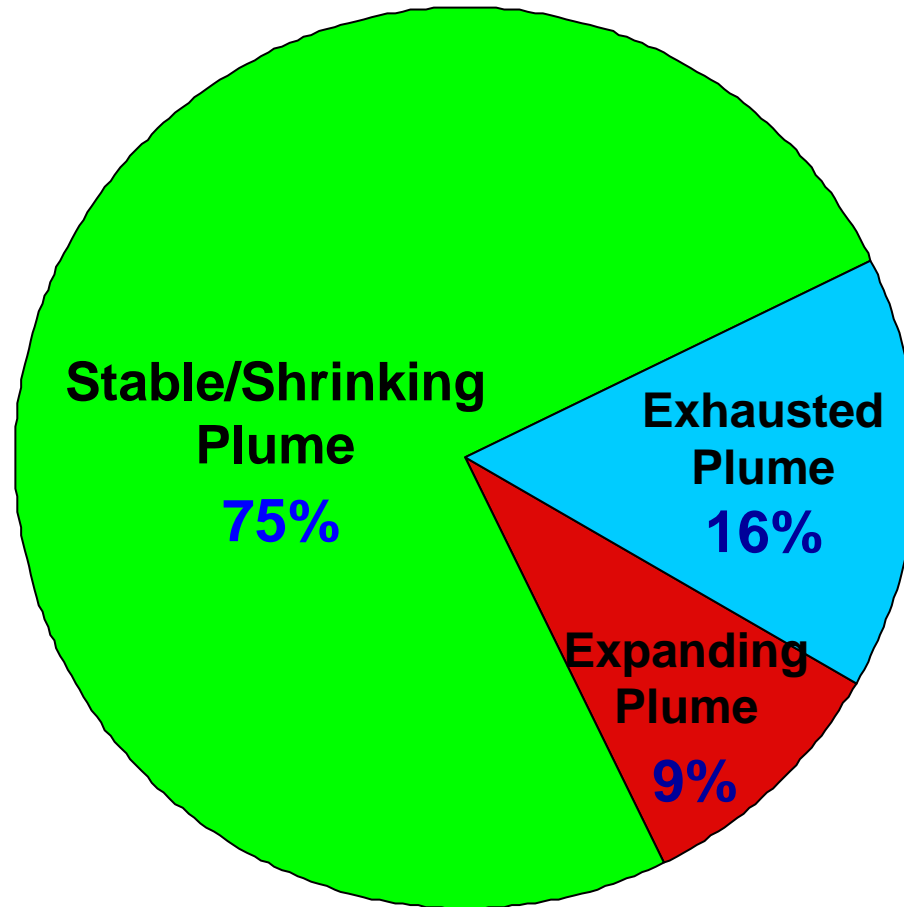
# MTBE PLUME STABILITY



**Key  
Finding:**

The majority of MTBE plumes are stable or shrinking in length.

# TBA PLUME STABILITY



**Key  
Finding:**

The majority of TBA plumes are stable or shrinking in length.

# KEY QUESTIONS

1. How large is the average benzene, MTBE, and TBA plume?

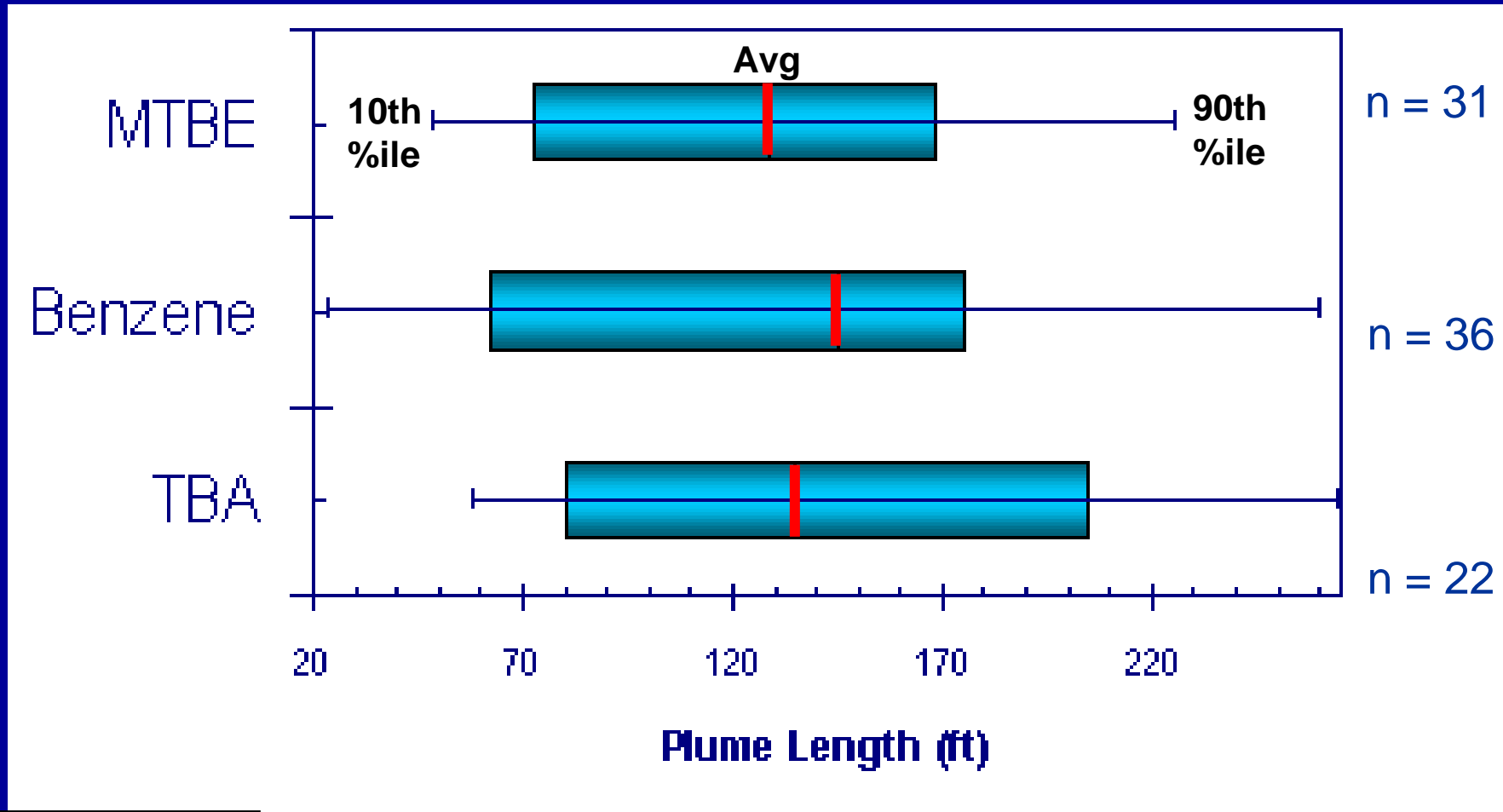
Benzene,  
MTBE, TBA

2. Is the groundwater cleaner now?



3. What is the attenuation rate in individual wells?

# RESULTS: *AVERAGE PLUME LENGTH*



**Key Finding:**

Benzene, MTBE and TBA plume lengths show similar distributions.

# KEY QUESTIONS

1. How large is the average benzene, MTBE, and TBA plume?

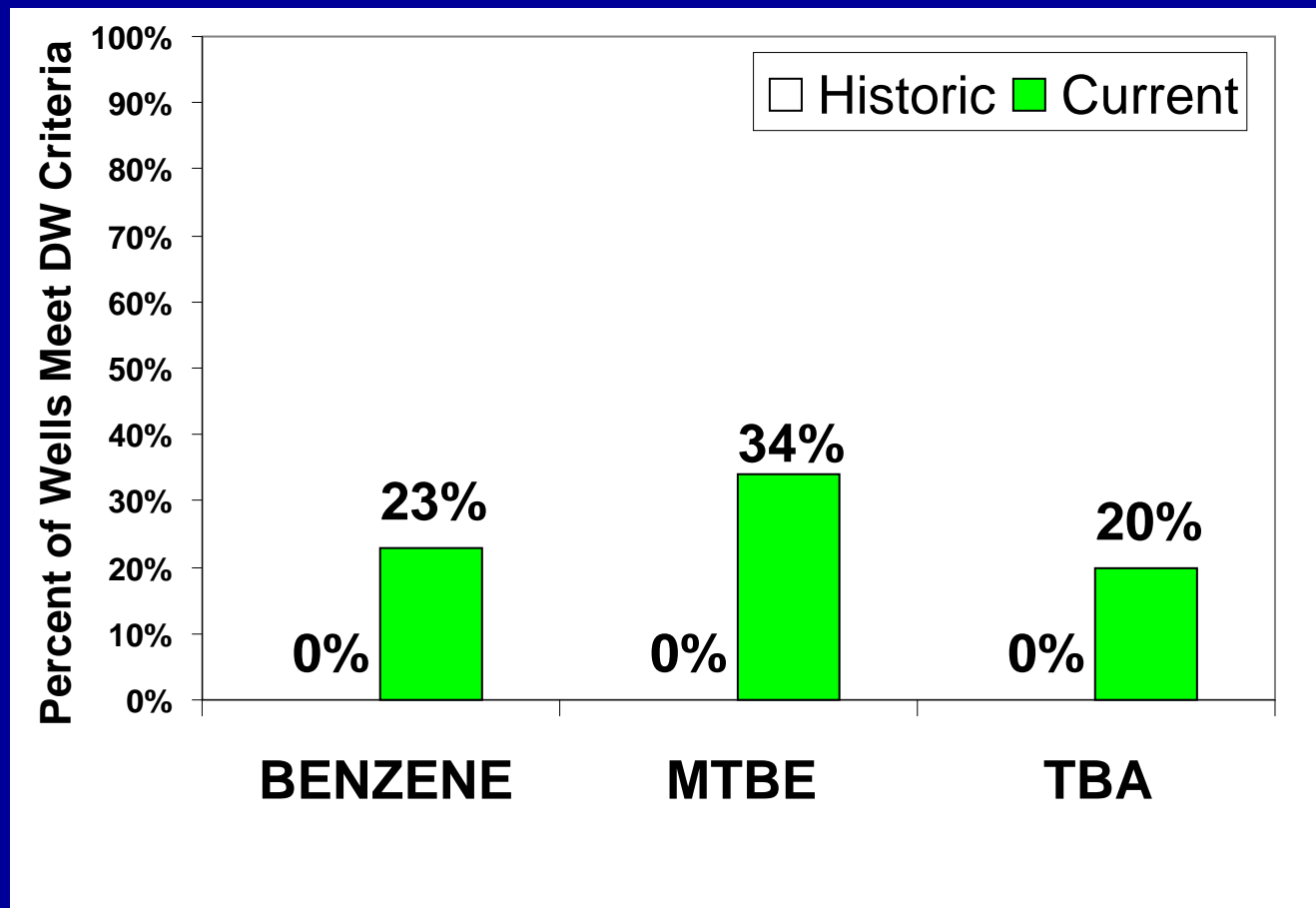
Benzene,  
MTBE, TBA

2. Is the groundwater cleaner now?



3. What is the attenuation rate in individual wells?

# Compliance with DW Criteria: *Individual Source Wells*



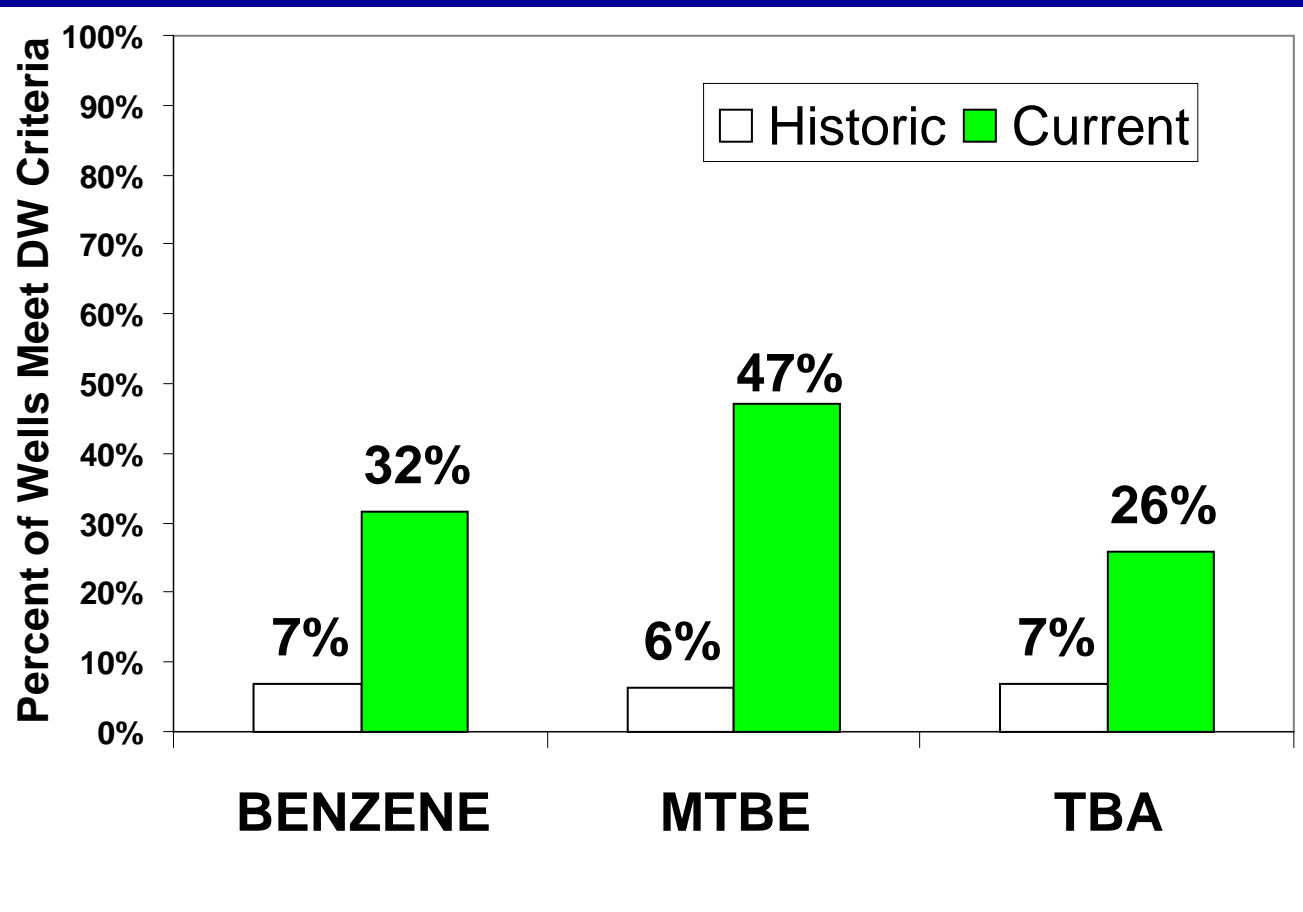
## *Well Count*

- Benzene: 70
- MTBE: 71
- TBA: 50

### **Key Finding:**

Many source wells that were impacted are now clean.

# Compliance with DW Criteria: *Individual Wells located within the Plume*



## *Well Count*

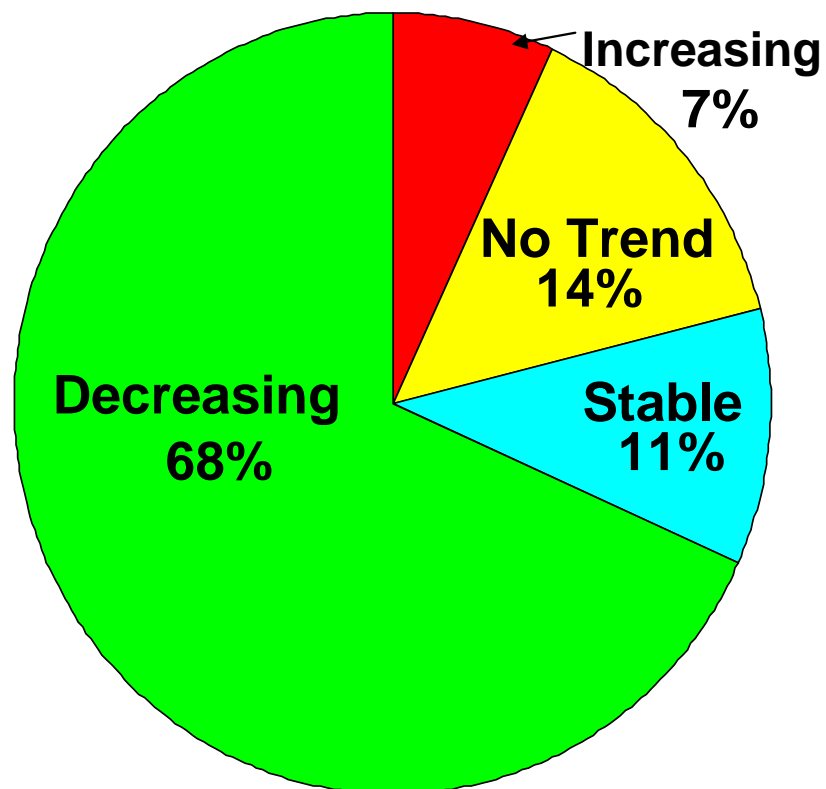
- Benzene: 203
- MTBE: 223
- TBA: 162

### **Key Finding:**

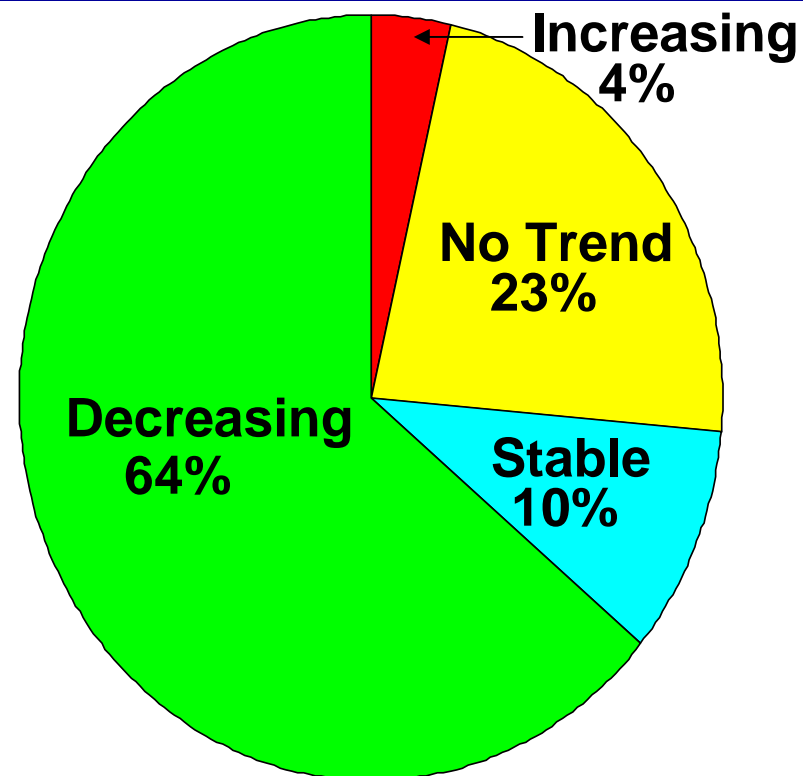
Many plume wells that were impacted are now clean.

# Mann-Kendall Concentration Trends: *Benzene in Individual Wells*

**SOURCE WELLS (n = 58)**



**PLUME WELLS (n = 210)**

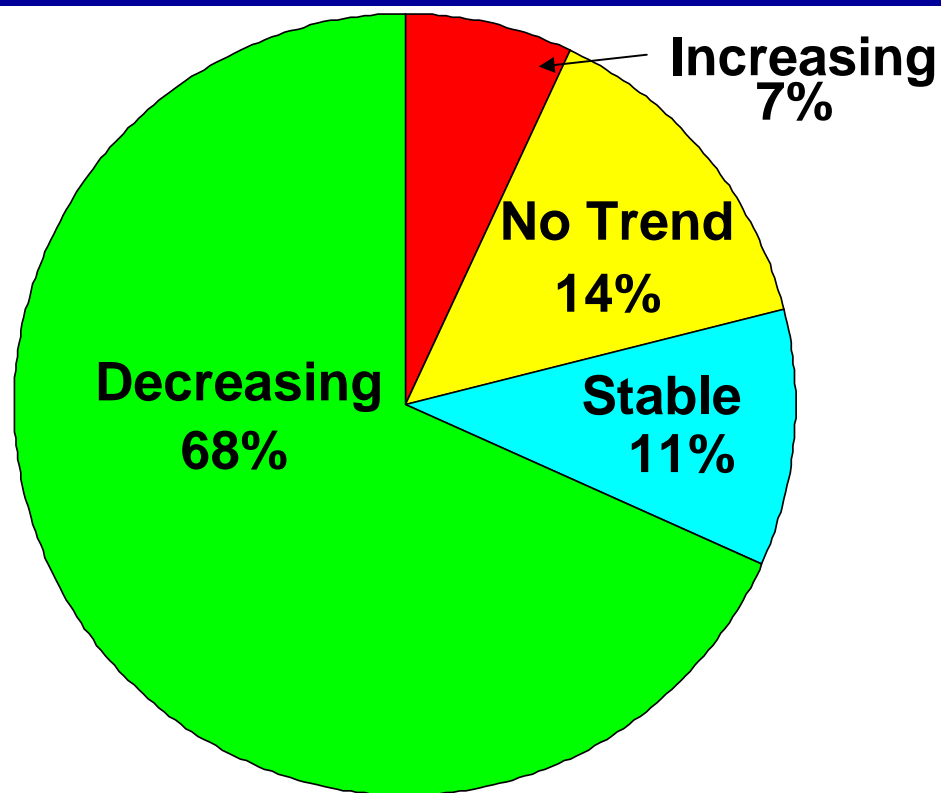


**Key  
Finding:**

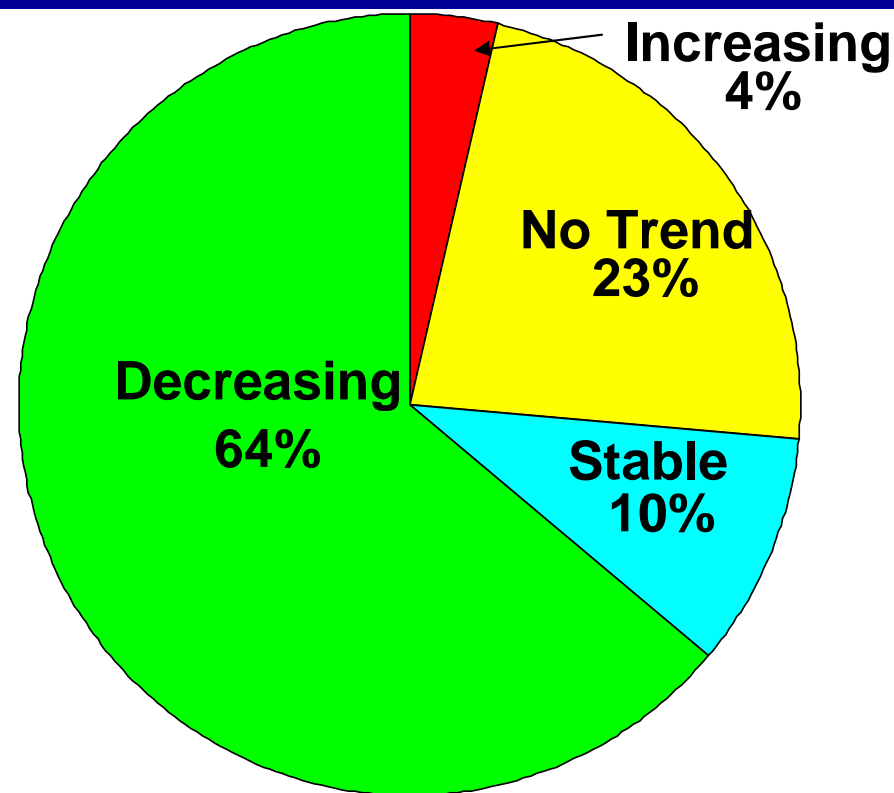
Overall, groundwater Benzene concentrations in source and plume wells are stable/decreasing.

# Mann-Kendall Concentration Trends: *MTBE in Individual Wells*

**SOURCE WELLS (n = 72)**



**PLUME WELLS (n = 285)**

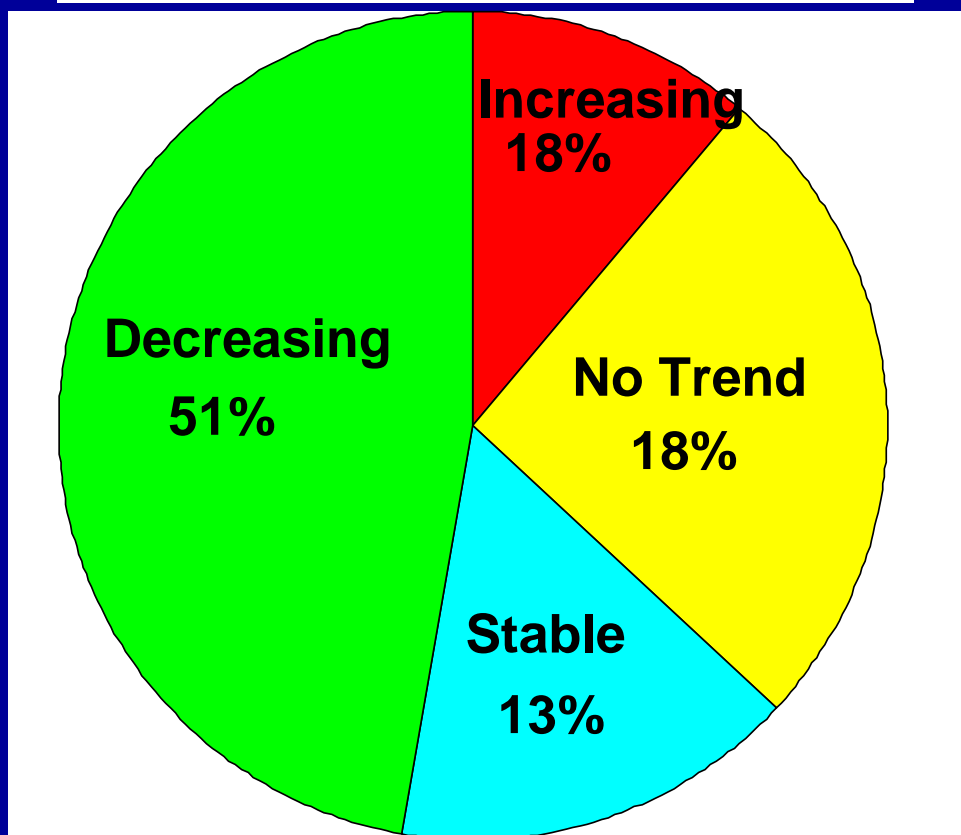


**Key  
Finding:**

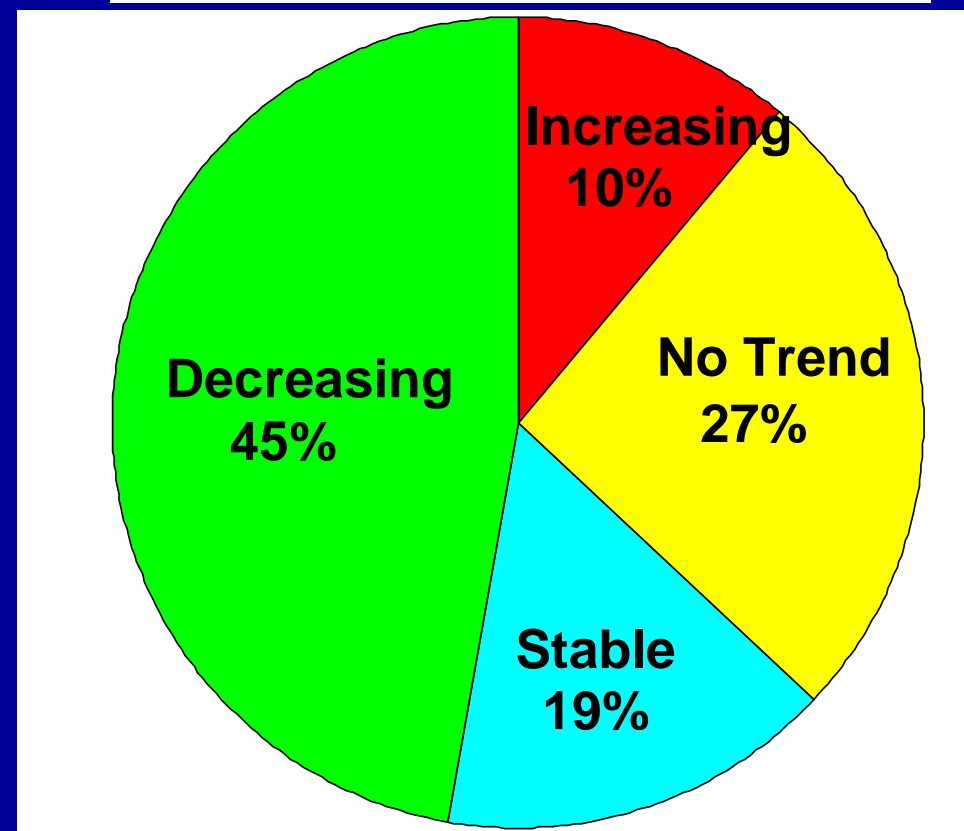
Overall, groundwater MTBE concentrations in source and plume wells are stable/decreasing.

# Mann-Kendall Concentration Trends: *TBA in Individual Wells*

**SOURCE WELLS (n = 48)**



**PLUME WELLS (n = 173)**



**Key  
Finding:**

Overall, groundwater TBA concentrations in source and plume wells are stable/decreasing.

# KEY QUESTIONS

1. How large is the average benzene, MTBE, and TBA plume?

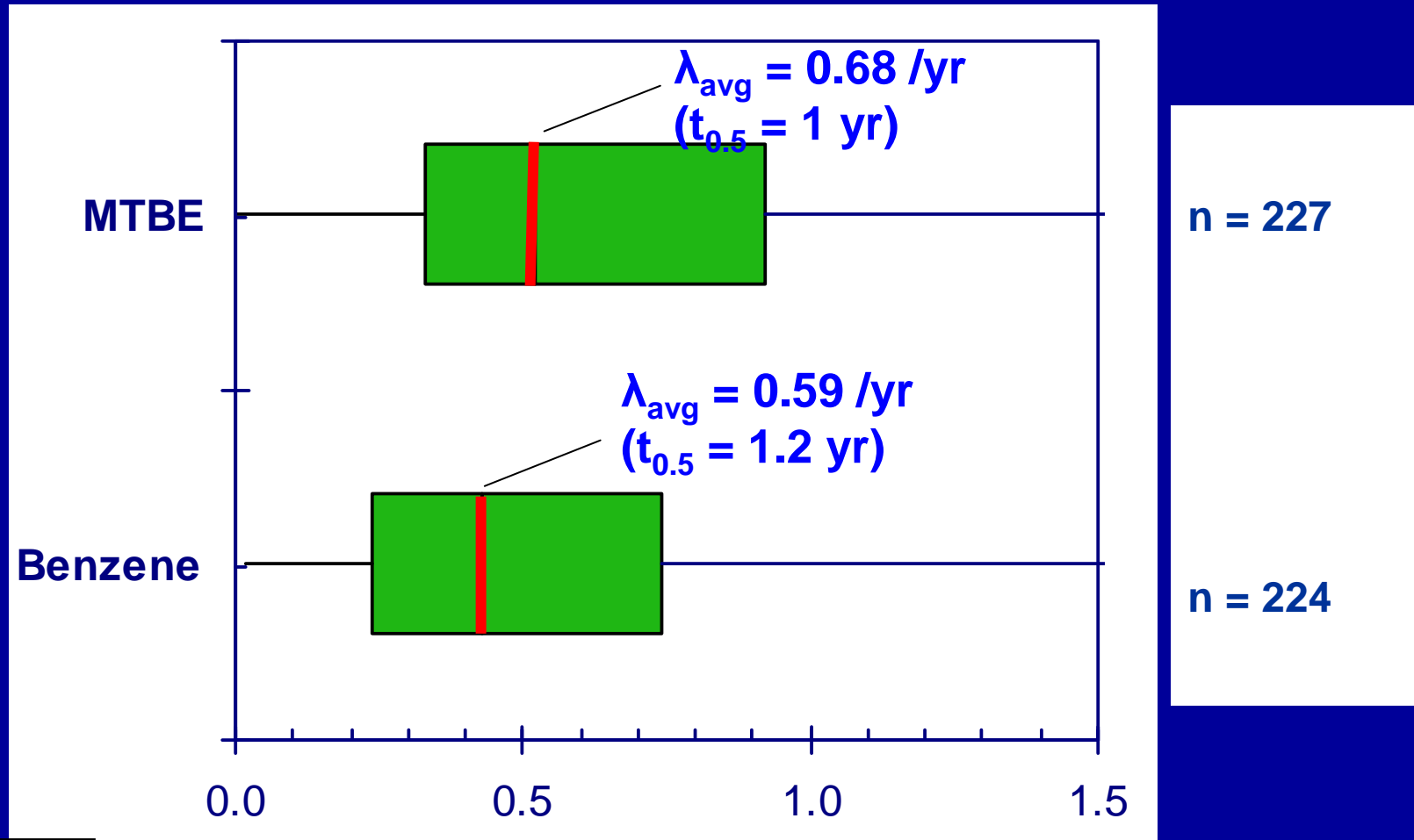
Benzene,  
MTBE, TBA

2. Is the groundwater cleaner now?



3. What is the attenuation rate in individual wells?

# Source Decay Rates: *C vs T in Individual Wells*



**Key  
Finding:**

MTBE source decay rates in individual wells are similar to benzene

# GSI PLUM-A-THON STUDY

- Review of Prior Plume Studies
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- Results

**Benzene,  
MTBE, TBA**



**➔ *Summary and Conclusions***

# SUMMARY AND CONCLUSIONS

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- MTBE plumes are similar in length compared to benzene plumes. ***Consistent with historic studies.***
- Groundwater within the source and plume is significantly cleaner now than in the past.
- MTBE decay rates within individual wells is comparable to benzene.

# Questions?

