# EPA 2015 Monthly Webinar Series

## Treatment Technologies for Small Drinking Water and Wastewater Systems

*Presented by EPA's Office of Research and Development and Office of Water*

January 27, 2015

# TODAY'S TOPIC:

## Research and Implementation of Arsenic Removal Technologies at Small Community Water Systems

**Webinar Support Phone Number:** 1-800-263-6317

**Audio Controls:** Your audio is muted by the organizer

**To Ask a Question:** Type your question in the text box located in the lower section of your screen

# Highlights

**Continuing Education Credit:** 1 Contact Hour

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**Next month's webinar:**

February 24 – *Biological Treatment, Ammonia and Nitrates/Nitrites*

# Barriers to Arsenic Compliance for Small Public Water Systems

Jamie Harris, Environmental Scientist
U.S. EPA
Office of Ground Water and Drinking Water
January 27, 2015

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## Overview

- Arsenic Rule
- Compliance Status
- Treatment Options
- Barriers to Compliance
- Possible Actions to Overcome Barriers

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## Arsenic Rule

- In 2001 EPA reduced the arsenic MCL from 50 µg/L to 10 µg/L.
- The new MCL became effective January 23, 2006.
- Ground water and surface water systems monitor according to the Standard Monitoring Framework.
- Only applies to CWS and NTNCWS.
- If running annual average greater than the MCL then MCL violation.

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## Arsenic Exemptions

- All exemptions expired January 23, 2015.
- Exemptions allowed water systems additional time to achieve and maintain compliance with the new MCL.
- Systems with exemptions were not considered to be in violation of the arsenic MCL.

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## FY2014 Compliance Status

- There are 68,228 active CWS and NTNCWS subject to the Arsenic Rule.
- The total number of systems with an arsenic MCL violation peaked in 2008 to 967, declining to 538 systems in 2014.
- As of January 2015, approximately 195 exemptions had been issued to small water systems and 4 became MCL violations or enforcement actions.
- 63,914 systems serve ≤ 10,000 persons.
  - 526 of all arsenic MCL violations in FY14 were from CWS & NTNCWS serving ≤ 10,000 persons.
  - 404 of those MCL violations were from systems serving ≤ 500 persons.

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## FY2014 Compliance Status

- 45,417 active CWS and NTNCWS with one or more of the treatment processes that apply to arsenic.
- 296 systems with arsenic MCL violations have one or more bilateral compliance agreements or administrative orders.

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## Non-Treatment Compliance Options

- Non-Treatment
  - Find a new source
  - Consolidate with another PWS
  - Blending
- Temporary fix
  - Bottled water (SDWA restriction as permanent fix)
  - Water vending machine (considered NTNCWSs and subject to the drinking water regulations)

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## Treatment Compliance Options

- Treatment
  - Point of Use Device (POU)
  - Point of Entry Device (POE)
  - Centralized Treatment
    - Iron assisted coagulation/filtration,
    - Adsorptive media and
    - Ion exchange

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## Barriers to Compliance - POU/POE

- Barriers:
  - Customer participation and access to private property
  - Monitoring requirements
  - Limited expertise or adequate information
- Potential Solutions:
  - Increase outreach to customers
  - Clarify requirements through training or guidance
  - Collaborate with technical service providers for help on costs and device selection

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## Barriers to Compliance - Centralized Treatment

- Barriers:
  - Limited expertise or adequate information
  - Waste Disposal
  - Limited number of experienced operators
- Potential Solutions:
  - Collaborate with technical service providers to develop more training
  - Work with State and Federal agencies to help streamline processes for waste disposal
  - Develop on-line training, and encourage knowledge sharing between operators

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## Barriers to Compliance – Funding

- Barriers:
  - O&M costs unclear to small systems
  - Inadequate rate structure to cover treatment
  - Small systems lacking financial capacity
- Potential Solutions:
  - Share best practices from Federal Agencies and States that currently coordinate funding to better assist the needs of small systems.
  - Educate small systems on how to apply for State and Federal funding

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## Possible Actions to Overcome Barriers

- Develop and deliver training to states on best practices from existing state POU primacy programs
- Re-initiate outreach and communication on existing arsenic rule compliance assistance tools for small systems
- Summarize lessons learned from the EPA Arsenic Demonstration Program

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## Resources

- Arsenic in Drinking Water Webpage
  http://water.epa.gov/lawsregs/rulesregs/sdwa/arsenic/index.cfm
- Arsenic Research Webpage
  http://www.epa.gov/nrmrl/wswrd/dw/arsenic/index.html

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# Questions?

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# An Overview of the Performance and Cost Effectiveness of Small Arsenic Removal Technologies

Tom Sorg, PE
U.S. EPA Office of Research and Development

January 27, 2015

# Source of Performance and Cost Information

USEPA Arsenic Demonstration Program Projects

# Arsenic Chemistry

Arsenic species- pH dependent

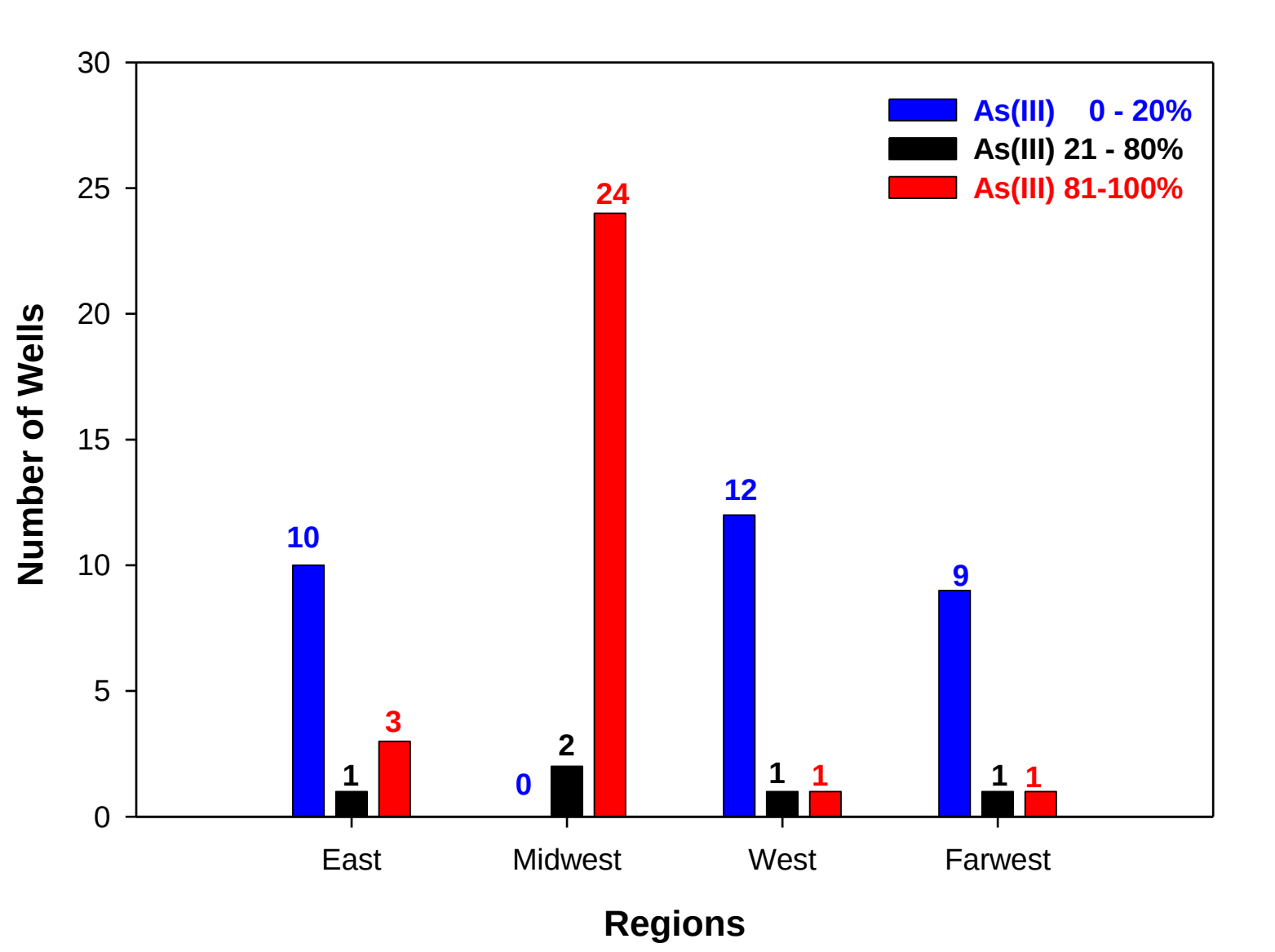
**As (III) - $H_3AsO_3^0$, $H_2AsO_3^{-1}$, $HAsO_3^{-2}$**

**As (V) - $H_3AsO_4^0$, $HAsO_4^{-1}$, $AsO_4^{-2}$**

What is the significance of arsenic speciation?

**As (V) more effectively removed than As (III) by most treatment technologies**

# Arsenic Species



# Arsenic III Oxidation

**Effective!**

- **Free Chlorine**
- **Potassium Permanganate**
- **Ozone**
- **Solid Oxidizing Media (MnO$_2$ solids)**

**Ineffective**

- **Aeration**
- **Chloramine**
- **Chlorine Dioxide**
- **UV Radiation + Sulfide**

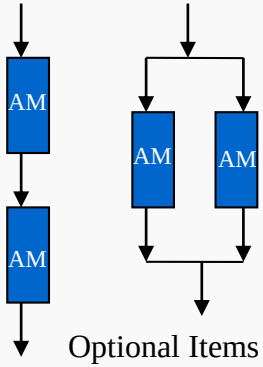
# Arsenic Demonstration Program

| Technologies – Arsenic Demo Program | Number |
|---|---|
| Adsorptive Media (26 sites) | 28 |
| Iron Removal | 10 |
| Iron Removal w/ Adsorptive Media | 4 |
| Coagulation/ Filtration | 4 |
| Ion Exchange | 2 |
| Reverse Osmosis | 1 |
| POU – RO | 1 |
| POE – Adsorptive Media | 1 |
| System/Process Modification | 1 |

# System Designs – As Demonstration Program

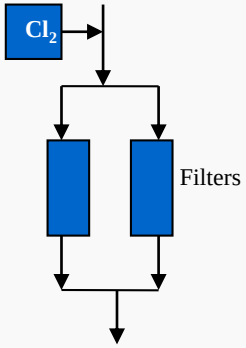
**Adsorptive Media Systems**

**Series** **Parallel**

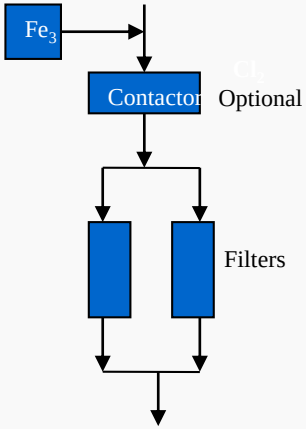



Optional Items
- pH Adjustment
- Backwash Tank

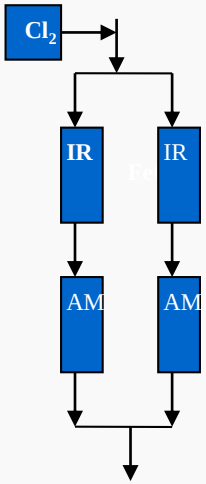
**Iron Removal System**




**Coagulation/ Filtration System**




**Iron Removal + Adsorptive Media System**

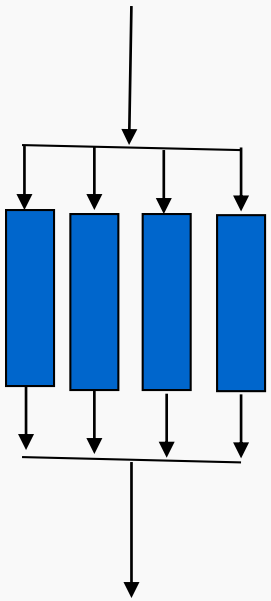


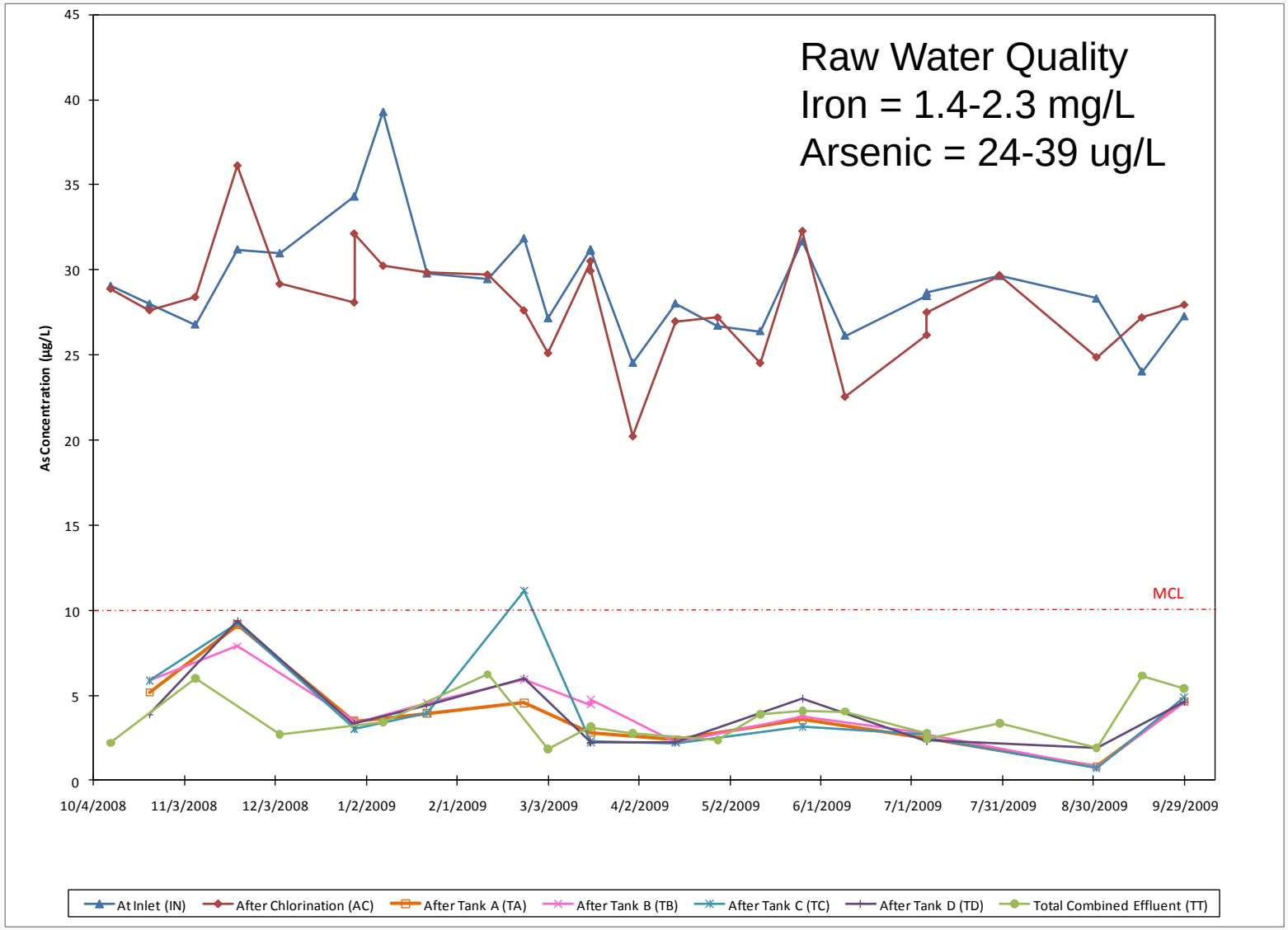
# System Performance

# IR & C/F Systems

# Iron Removal System (60 gpm - School)

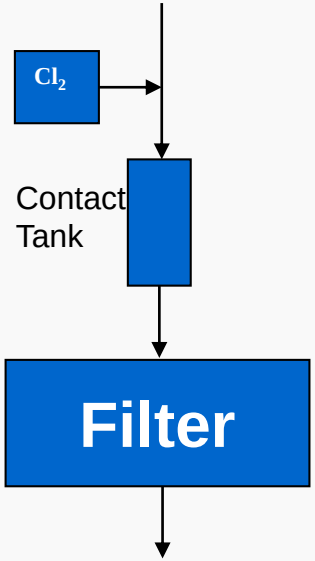
Filtration Media Filters

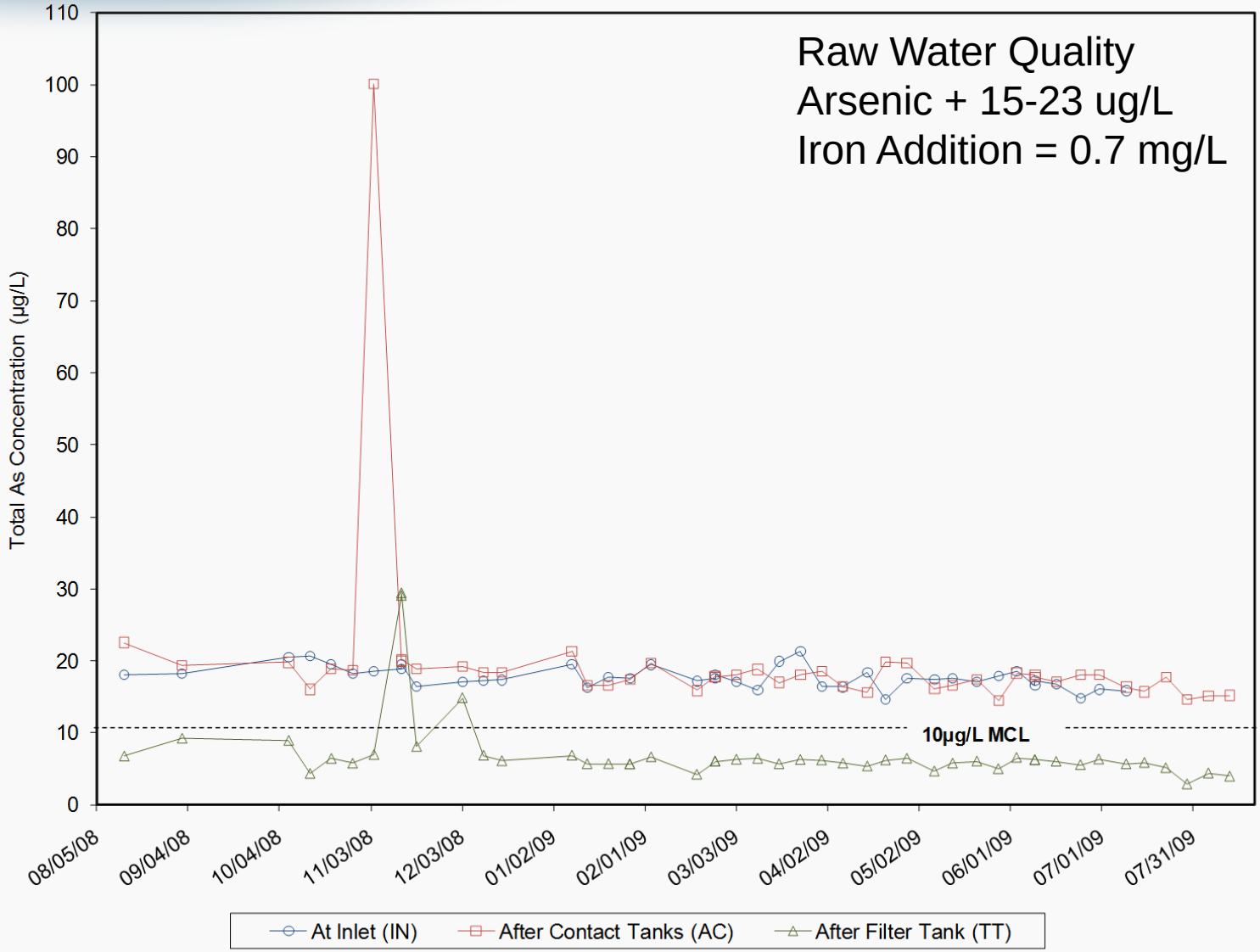




# C/F System (750 gpm – CWS)

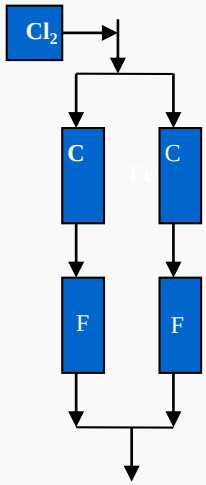
**Iron Removal System**
**750 gpm**

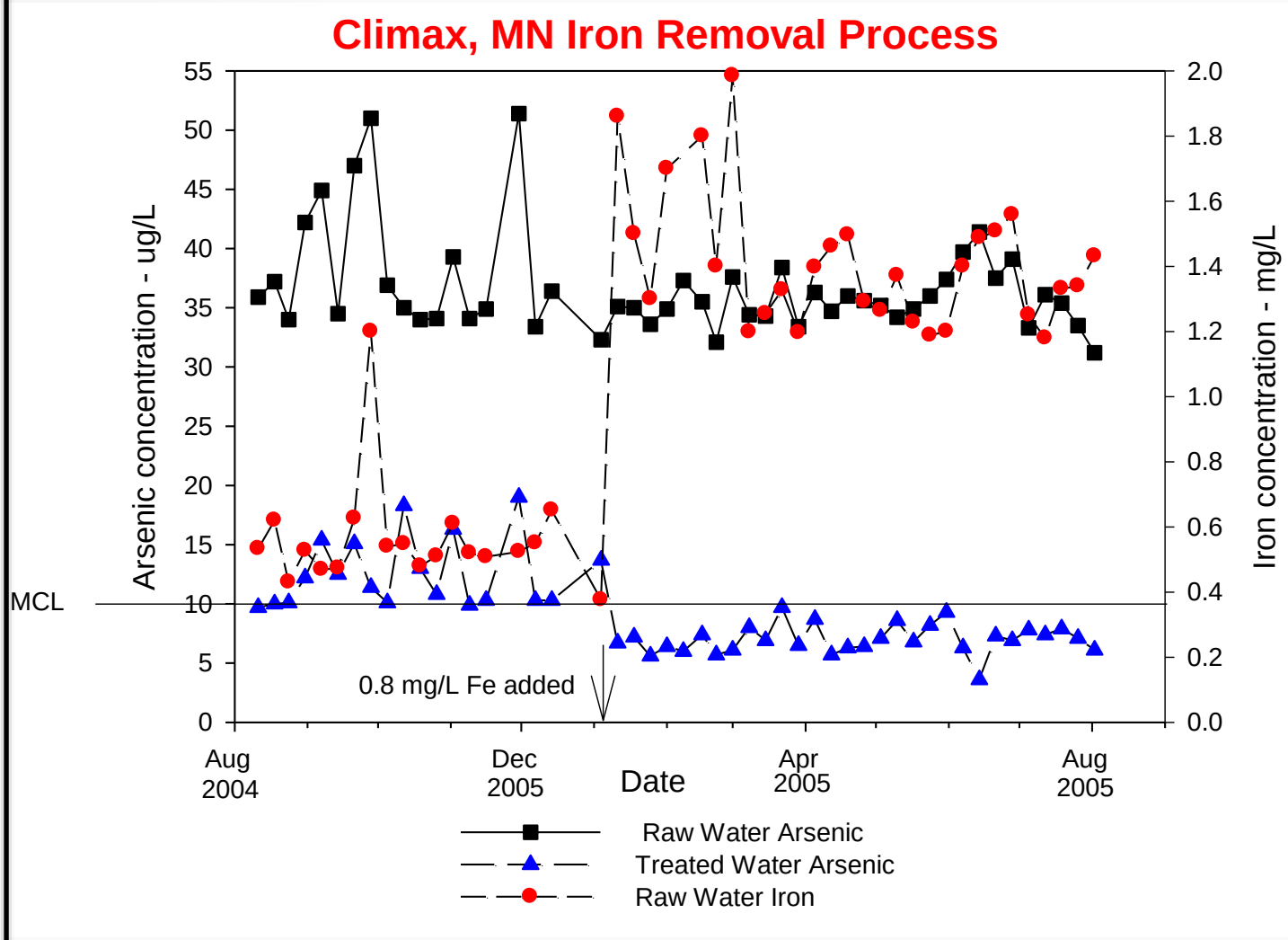


# Iron Removal Process Converted to C/F

**Iron Removal – C/F System**
**140 gpm**




## Raw Water – As III

# AM Systems

## SU System

## WS System

## BL System

## VV System

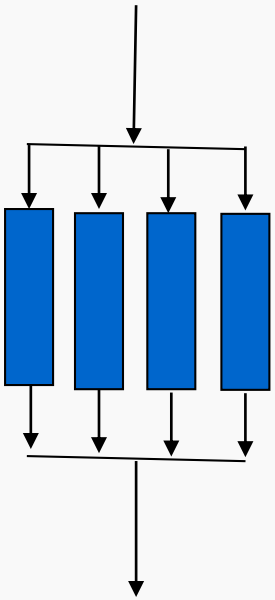
## KF System

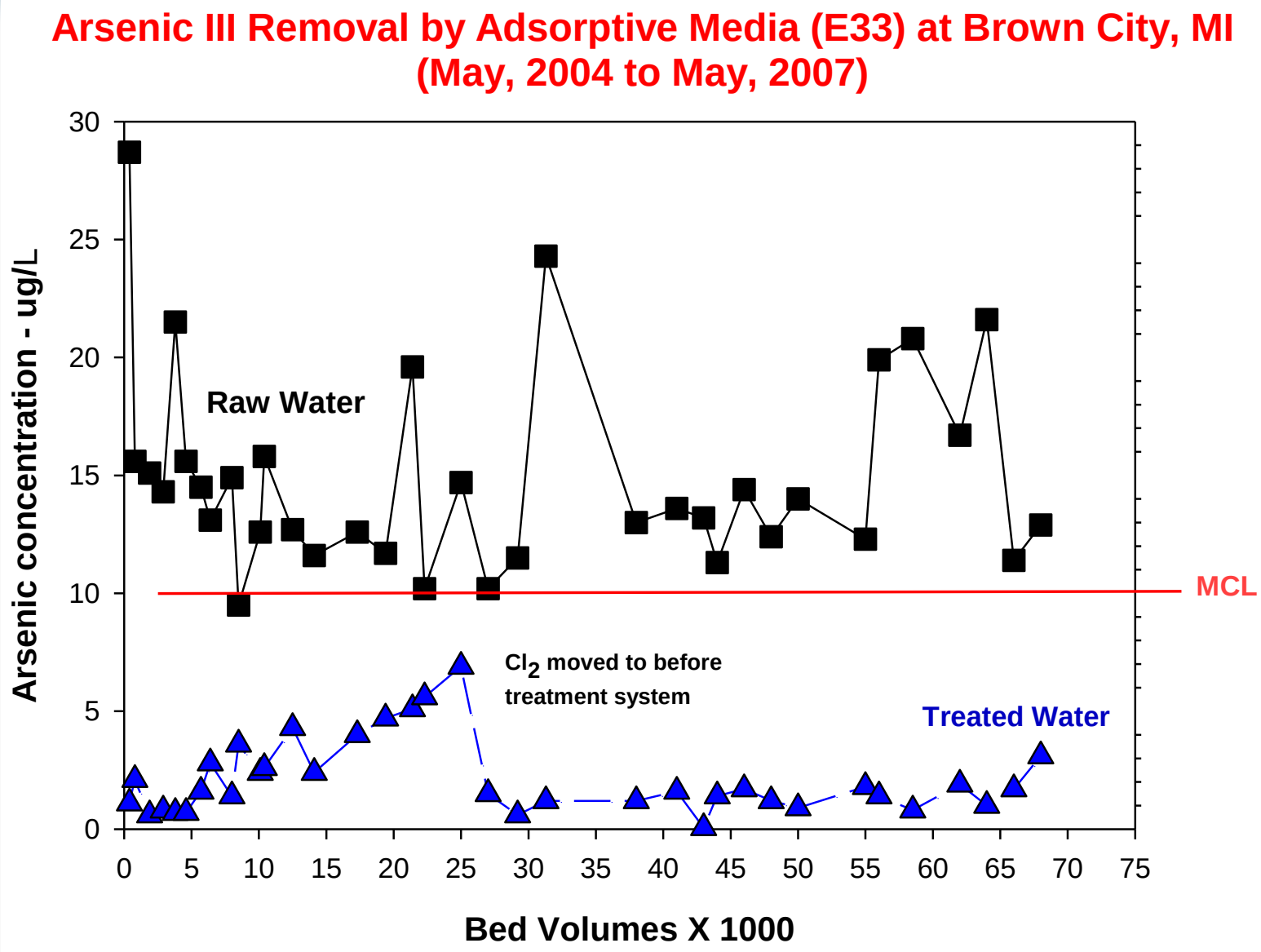
## BW System

## BR System

# AM System Performance

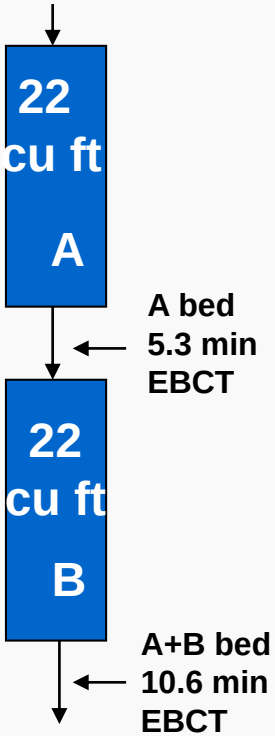
Parallel Design

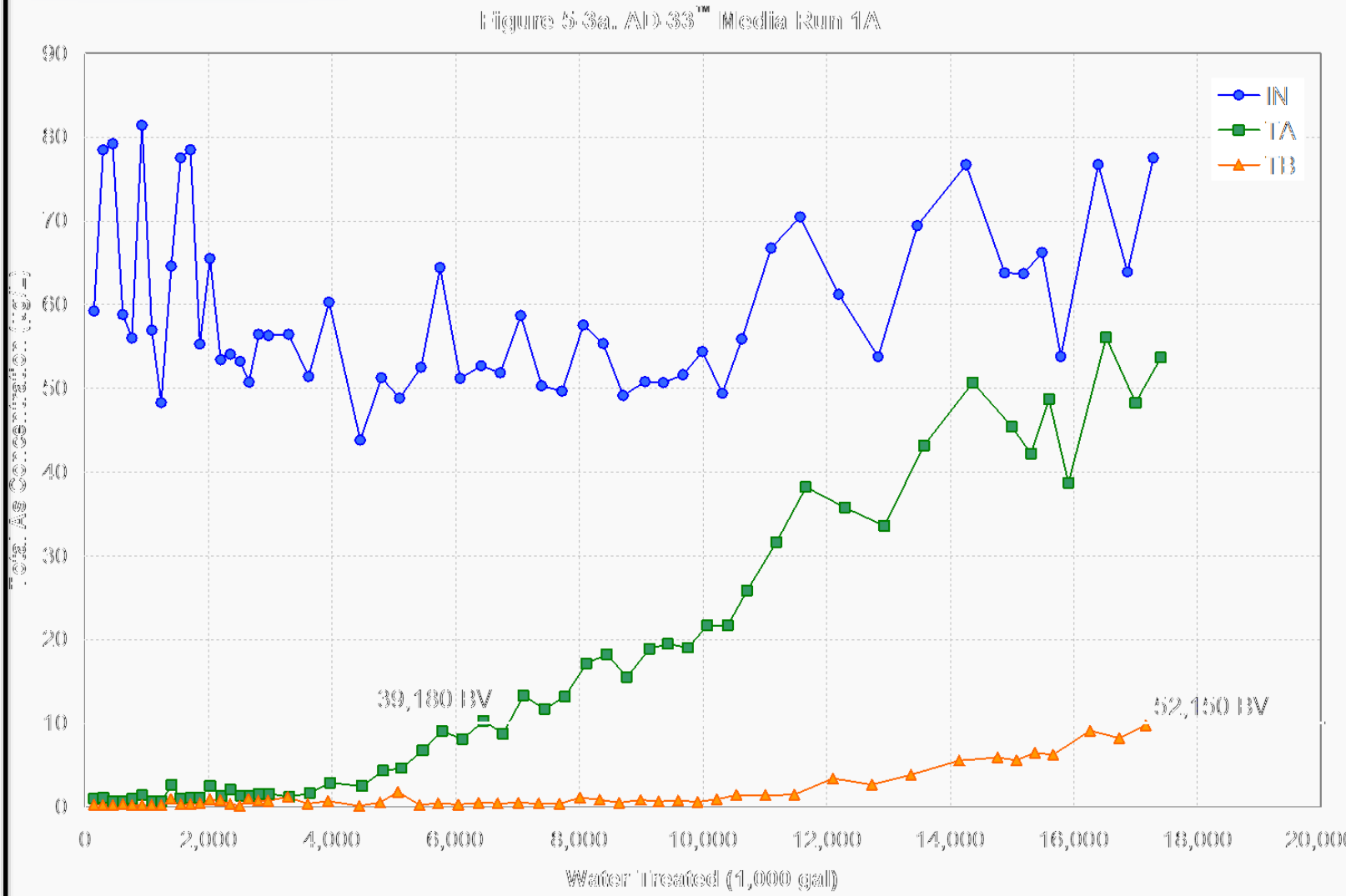




# AM System Performance

Series Design
31 gpm



# System Costs

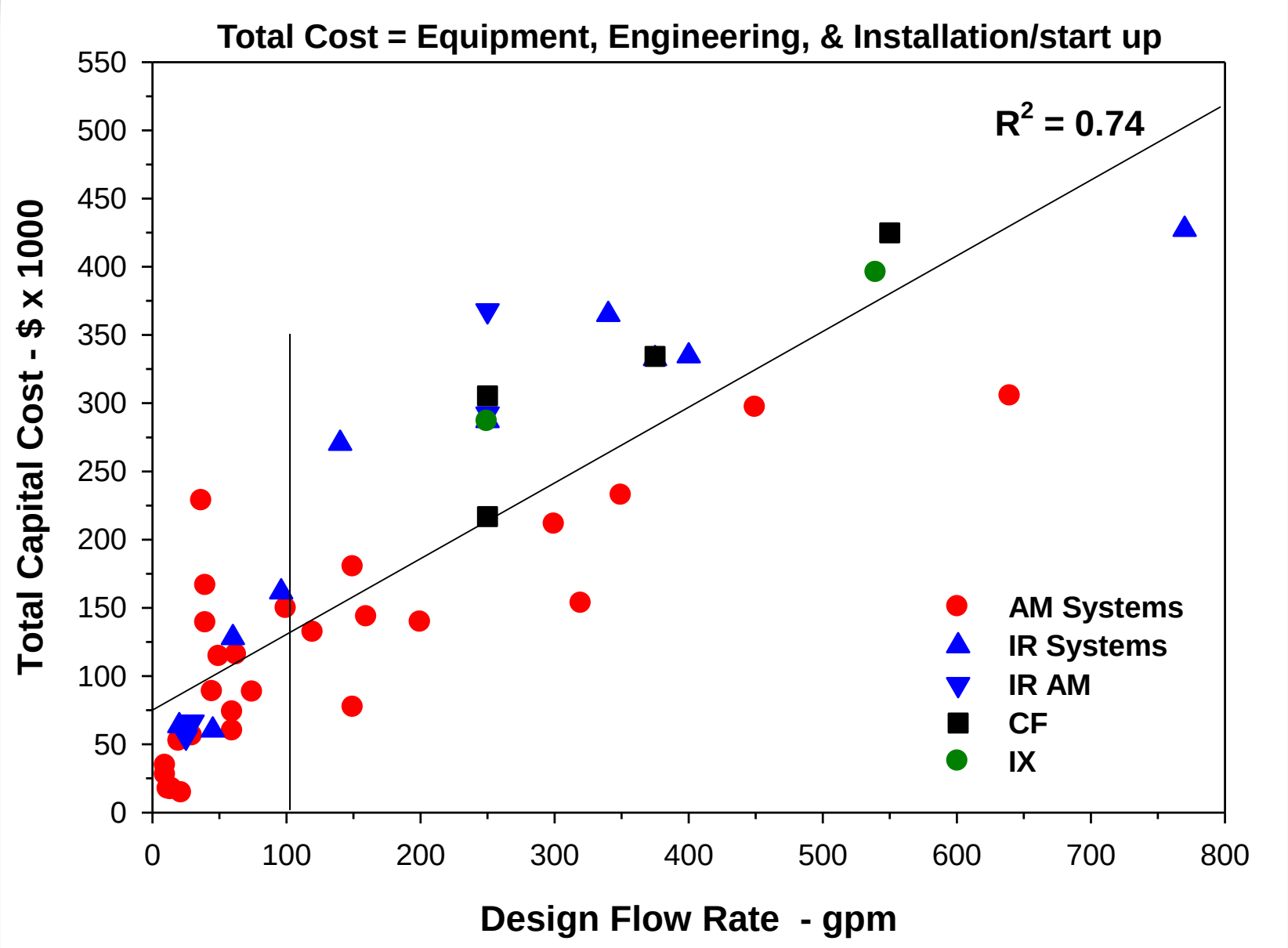
- Capital
- O/M

# Systems Capital Costs

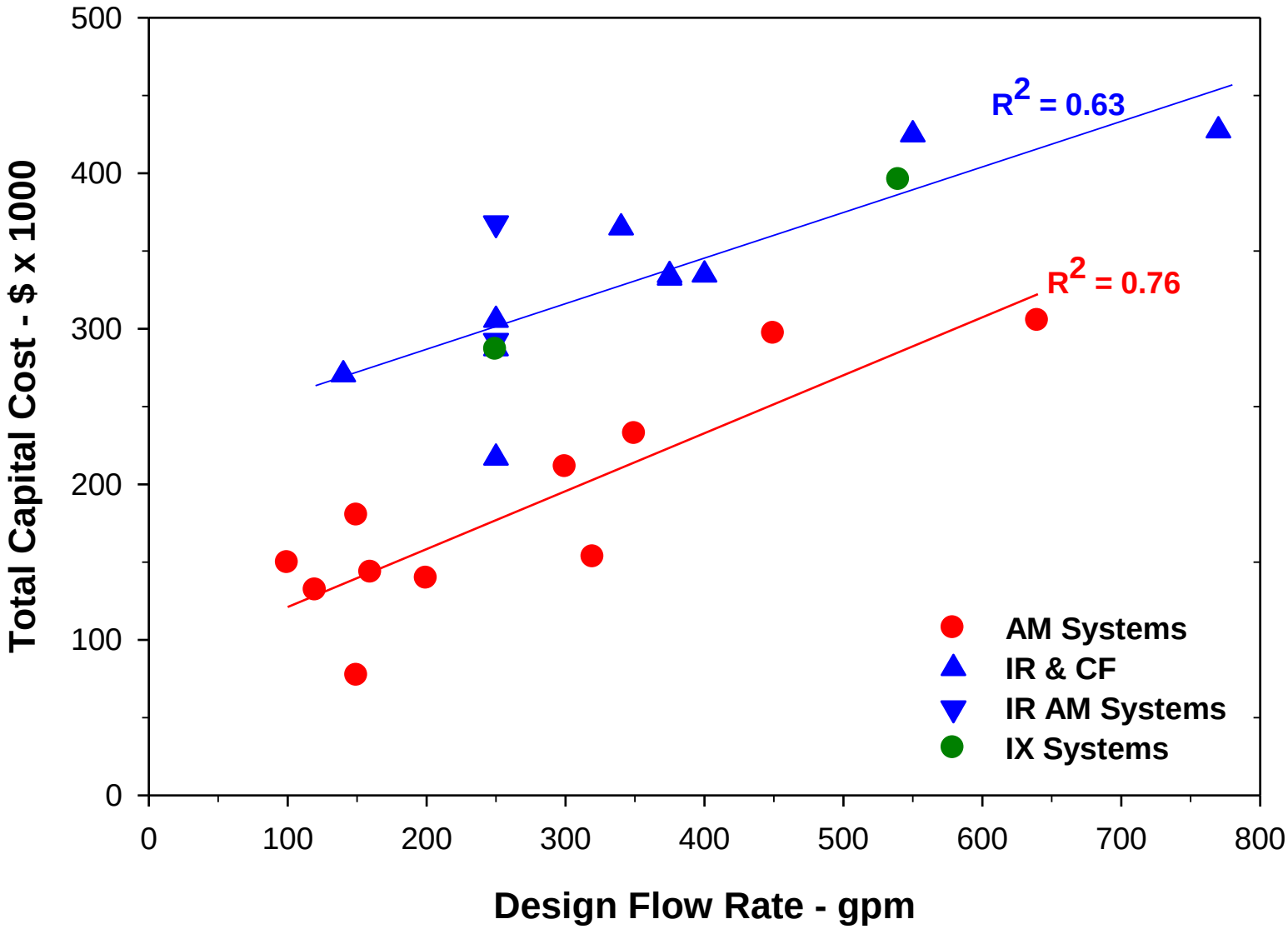
# Capital Cost Funding Sources

| |
|---|
| **Capital Costs – EPA Funds** |
| Equipment |
| Engineering |
| Installation |
| **Capital Costs – Utility Funds** |
| Site Improvements - Building |
| Residual Disposal Items – Sewer, pond, etc. |

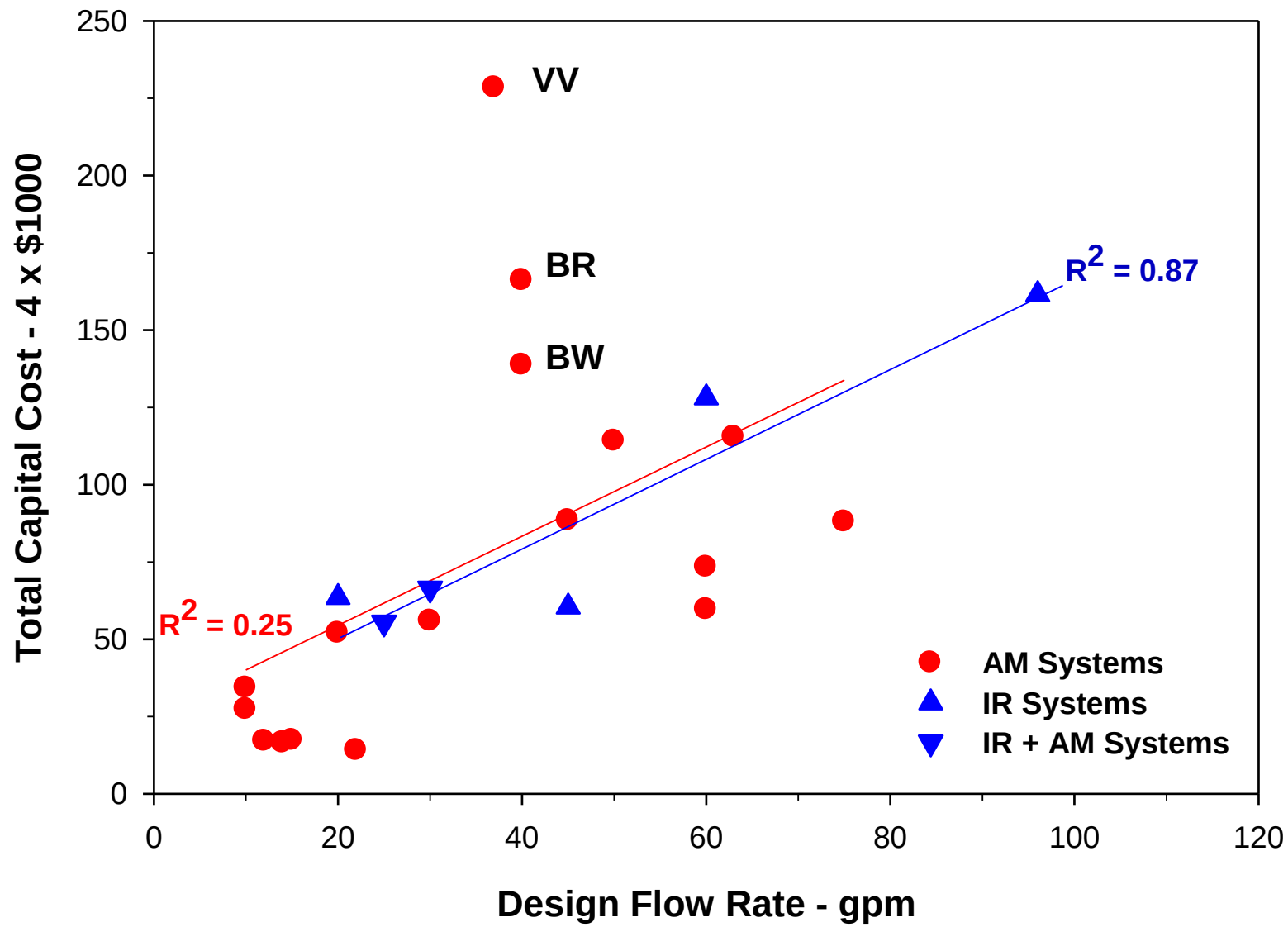
# Capital Costs -Total



# Capital Costs - > 100 gpm Systems



# Capital Costs - < 100 gpm Systems



# Total Capital Cost Categories

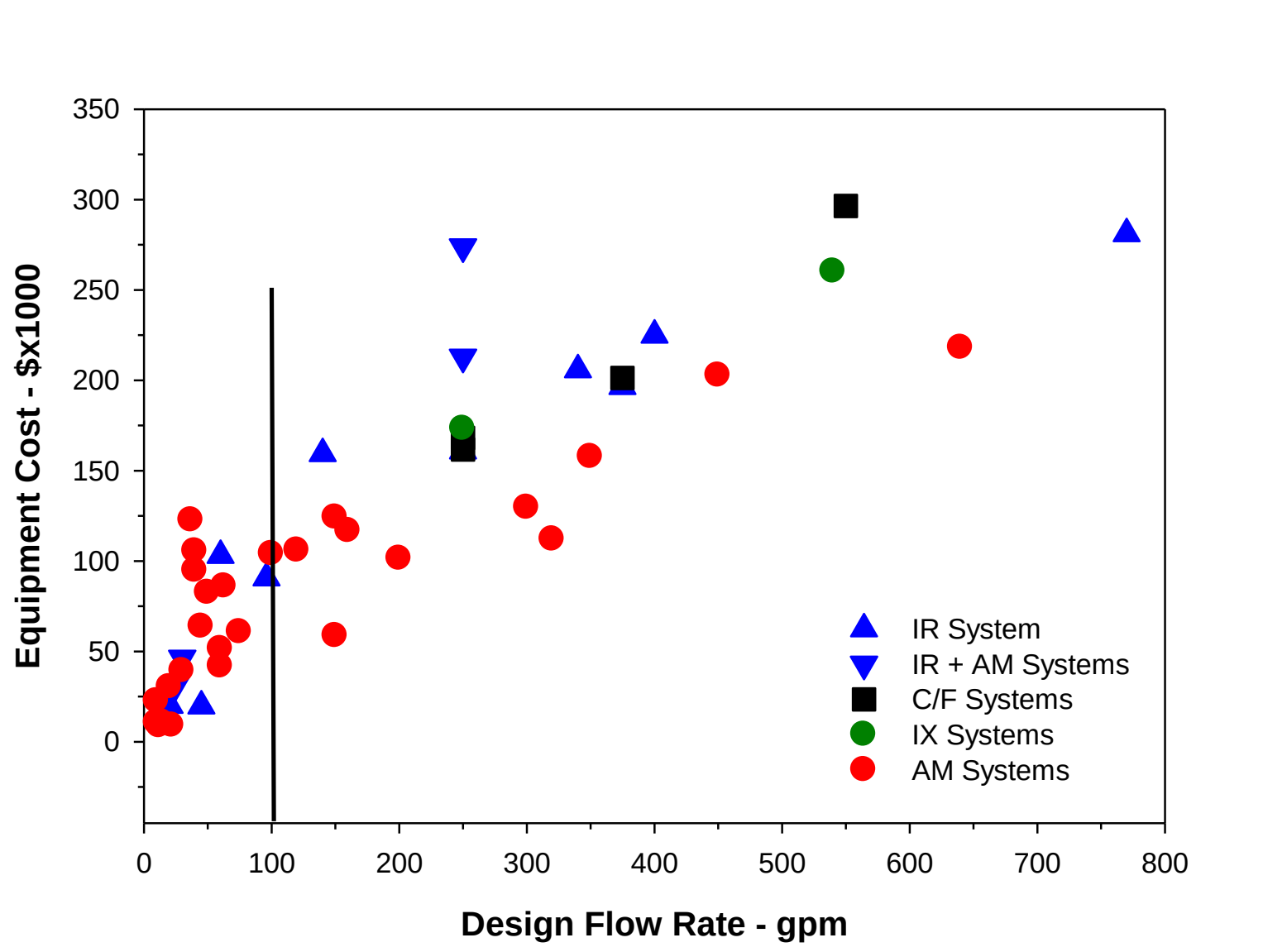
| Total Capital Costs – EPA Funds |
| --- |
| • Equipment |
| • Engineering |
| • Installation |

# Cost Categories - Percentages

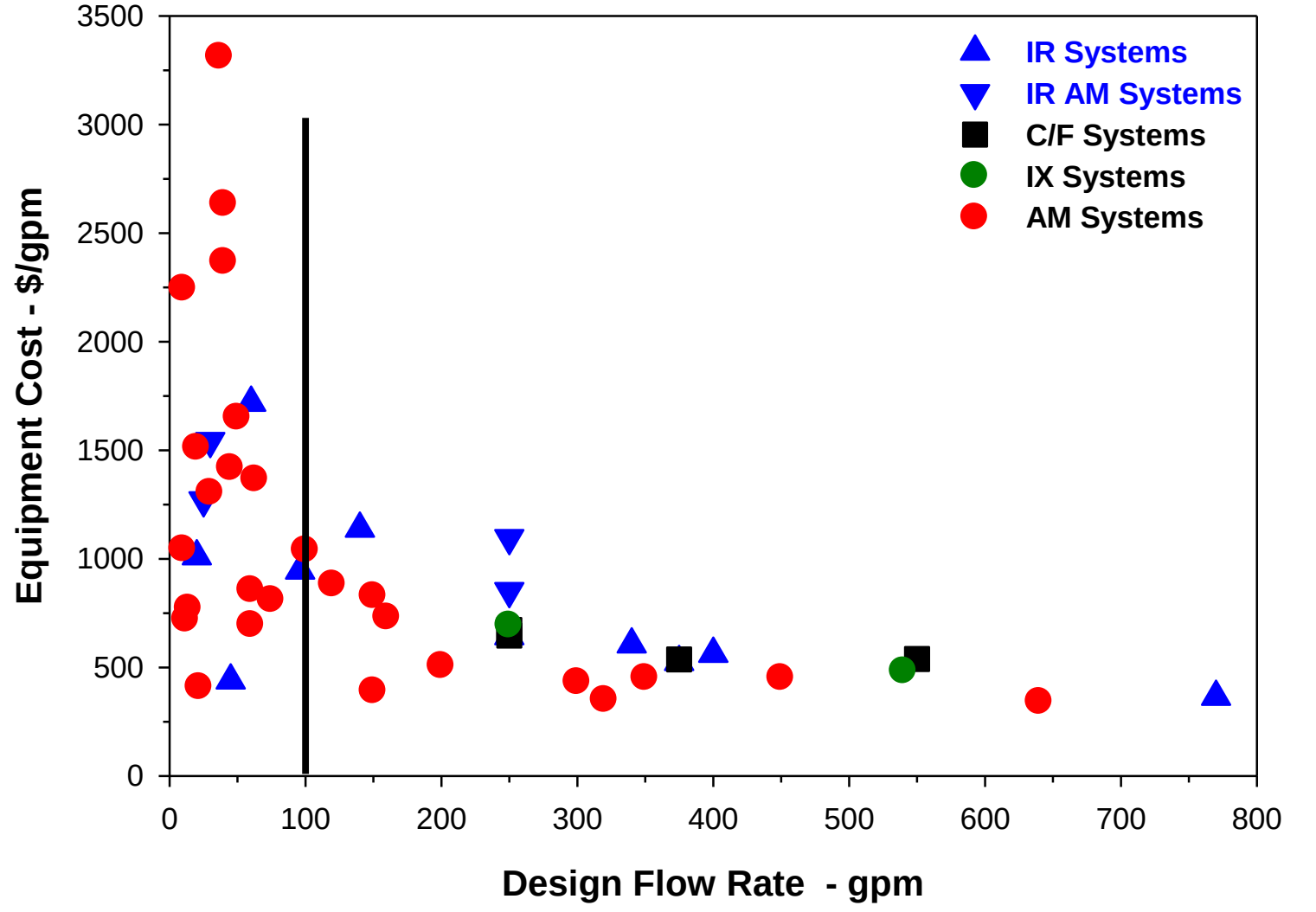
| Systems | Equipment % | Engineering % | Inst & Start Up % |
|---|---|---|---|
| AM (All) | 67 | 15 | 18 |
| AM - <100 gpm | 64 | 17 | 18 |
| AM - >100 gpm | 72 | 11 | 17 |
| Other (All) | 61 | 14 | 24 |
| **All Systems** | **65** | **14** | **20** |

Approximately 2/3 of Total System Cost is for Equipment
or
Total Cost = 1.5 (Equipment Cost)

# Equipment Costs: Total vs Size (gpm)



# Equipment Costs: $/ gpm vs Size ($/gpm)



# AM Equipment Cost

| System Cost Variables | Range/Number |
|---|---|
| System design | Series vs parallel |
| Tank size/number | |
| Tank material | 4 – FRP, CS, SS, Polyglass |
| Media products (Costs) | 9 ($40 - $559/cf) |
| EBCT min/tank | 1 - 16 |
| Instrumentation | |
| Valves | Automatic vs manual |
| pH adjustment | 7 |
| Backwash holding tanks | 3 |

# Water Systems – Tanks Cost

**KF System**

RFP

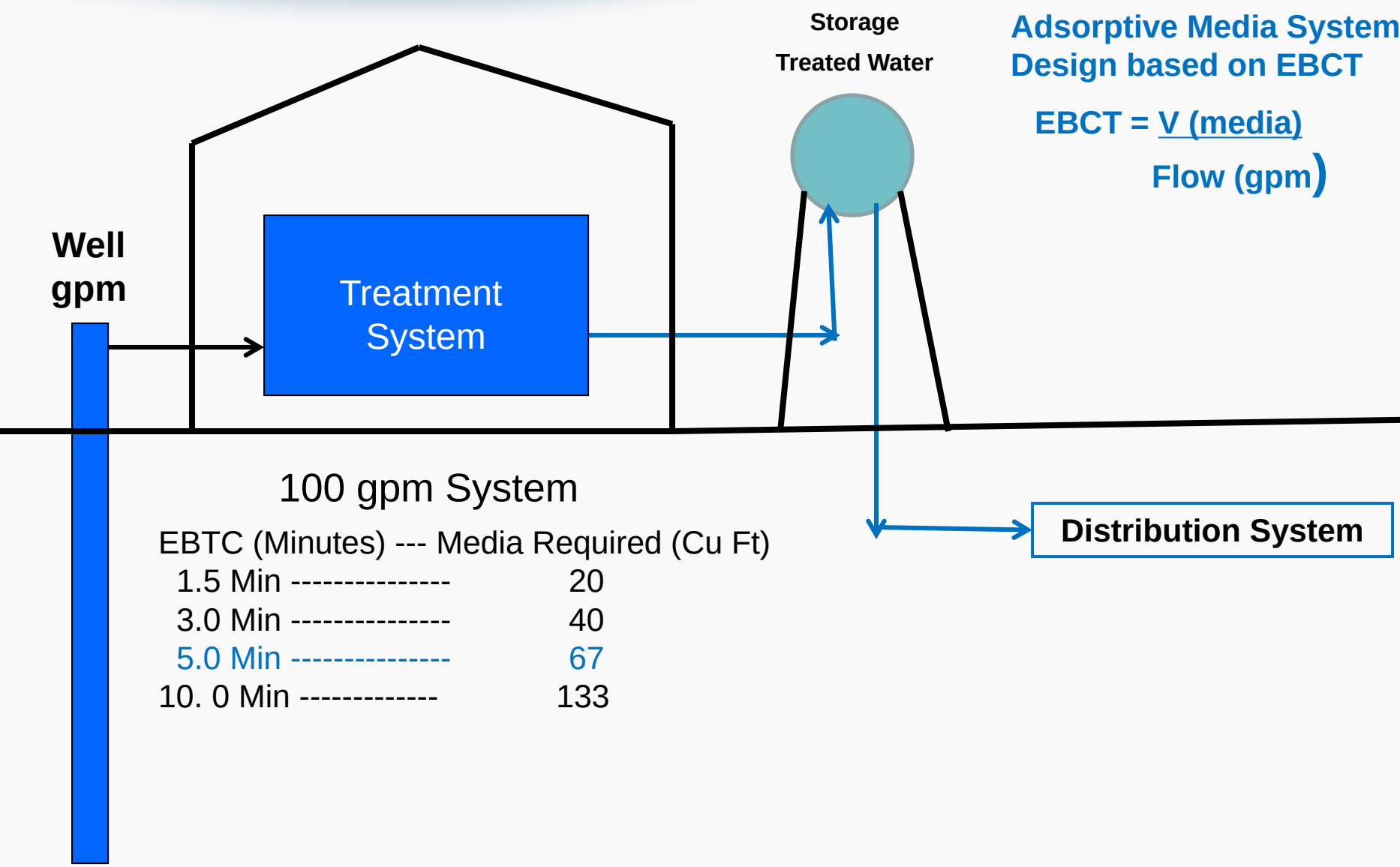
**BW System**

Carbon Steel

**BR System**

Stainless Steel

# AM System – EBCT Variable



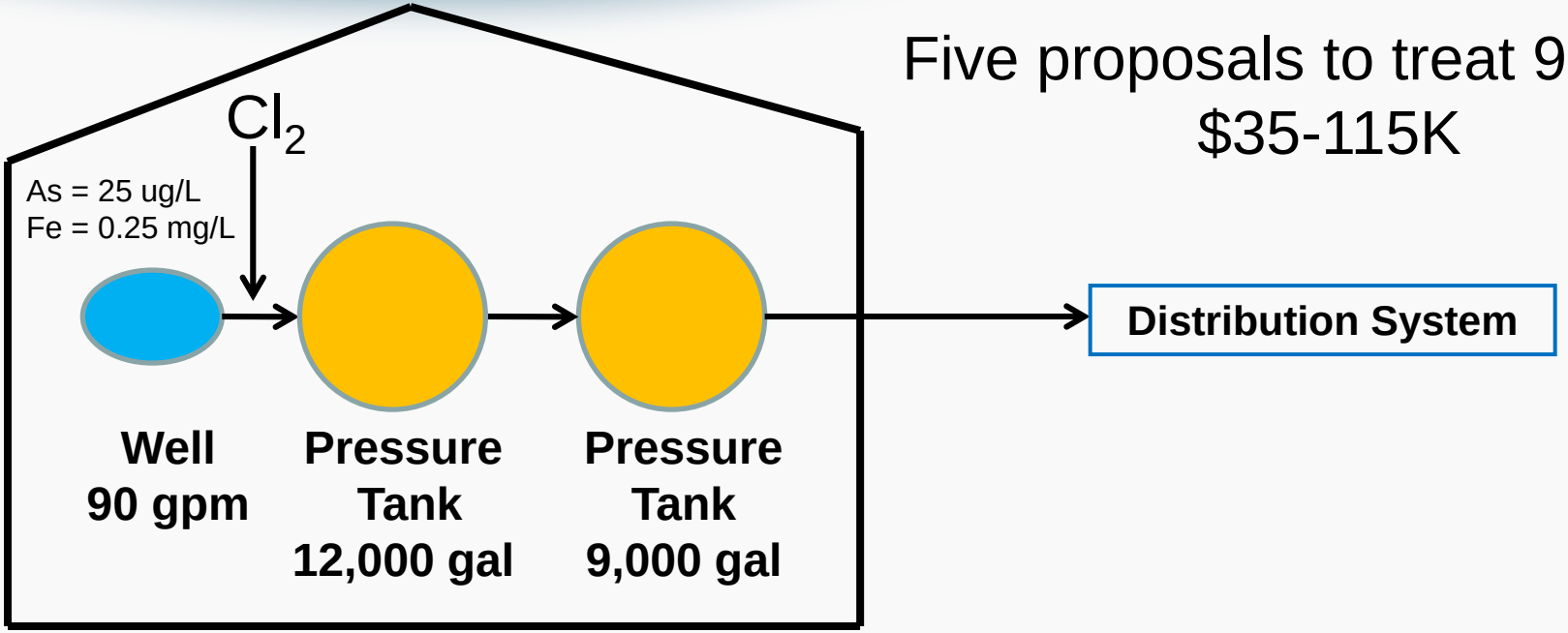

**Adsorptive Media System Design based on EBCT**

**EBCT = V (media) / Flow (gpm)**

100 gpm System

| EBTC (Minutes) --- | Media Required (Cu Ft) |
|---|---|
| 1.5 Min ---------- | 20 |
| 3.0 Min ---------- | 40 |
| 5.0 Min ---------- | 67 |
| 10. 0 Min ---------- | 133 |

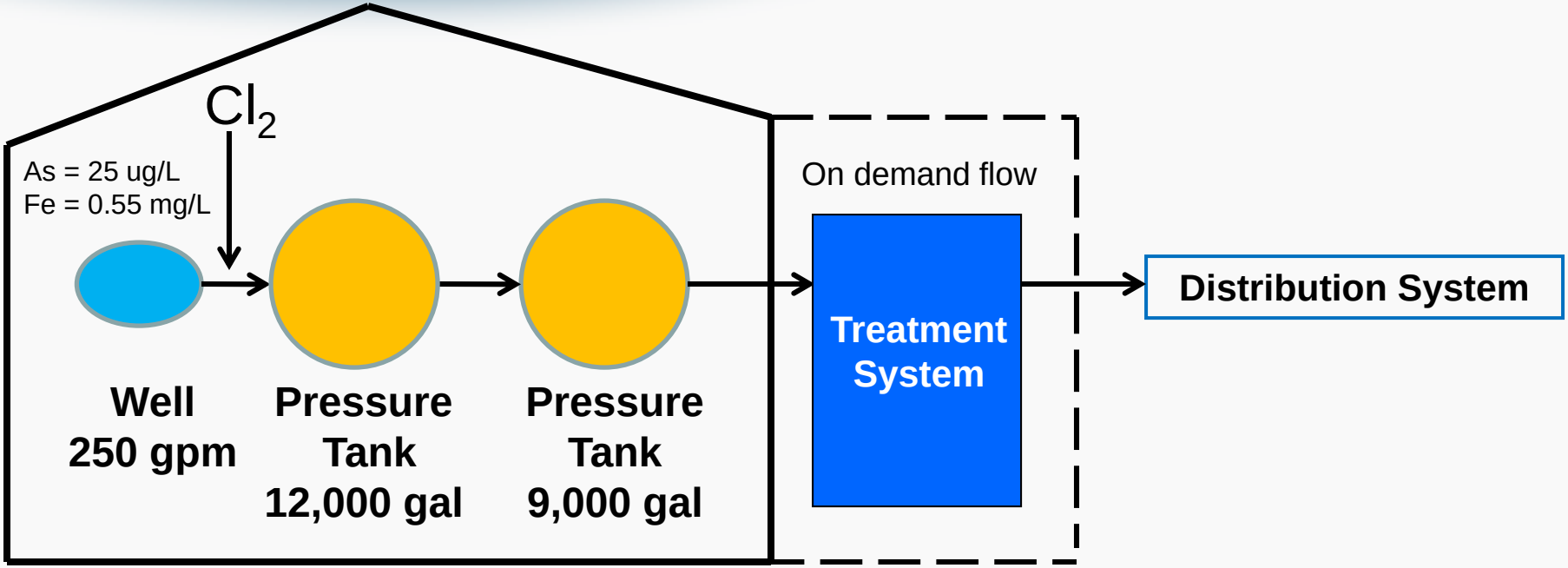
# AM System – Serves 480 people




Five proposals to treat 90 gpm
$35-115K

Pressure tank

# AM System – Serves 480 people




**Decision** – Place system after storage/pressure tanks to treat on demand flow where average flow was 32 gpm.

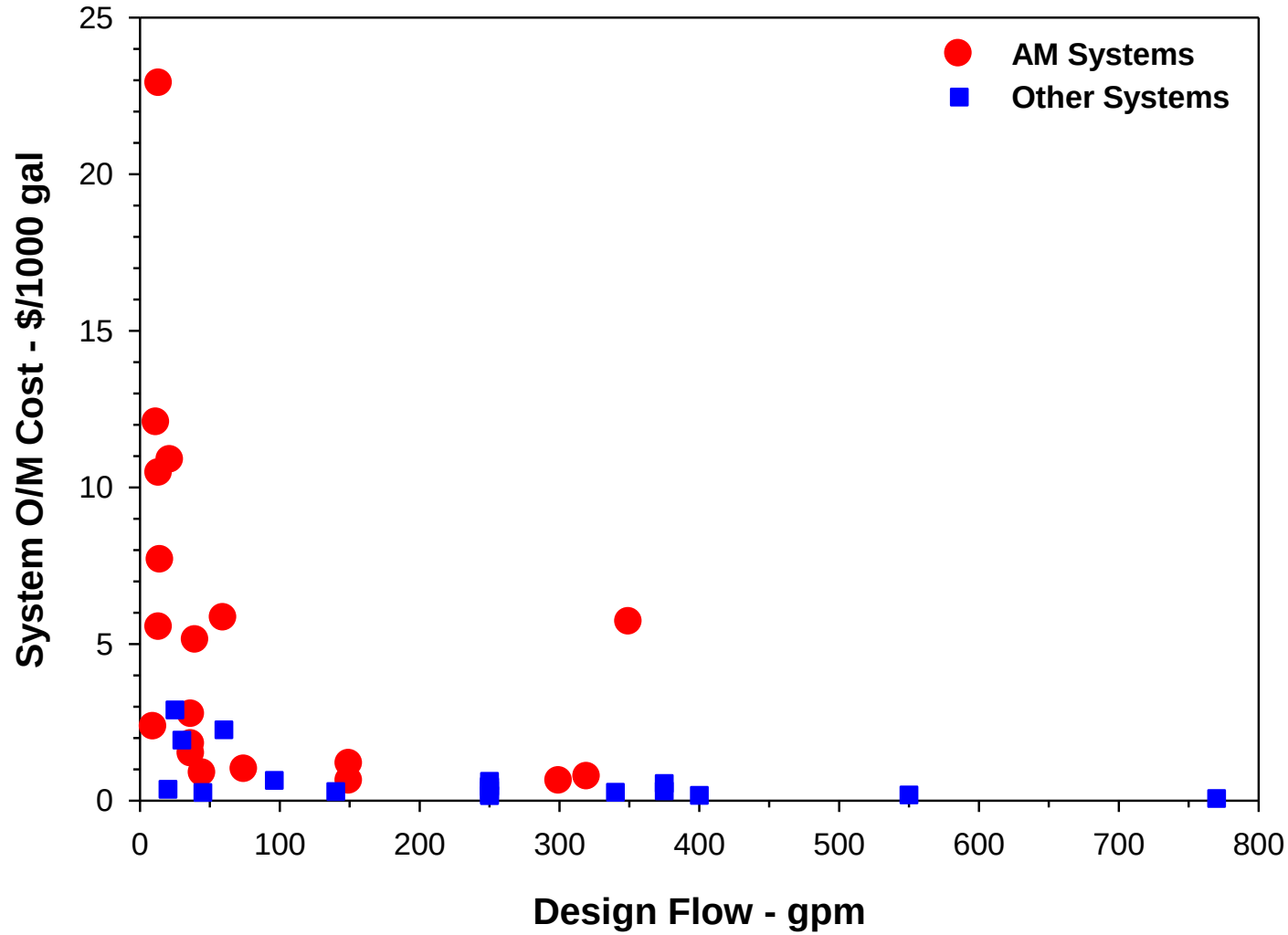
Series system reconfigured to parallel system to handle a State required 165 gpm peak flow.

# O/M System Costs

# O/M Costs

**Based upon data collected during performance evaluation studies that lasted from 1 to 5 years**

# O/M Costs - $/1000 gal treated water



# Comparison of O/M Costs of All Demo Systems

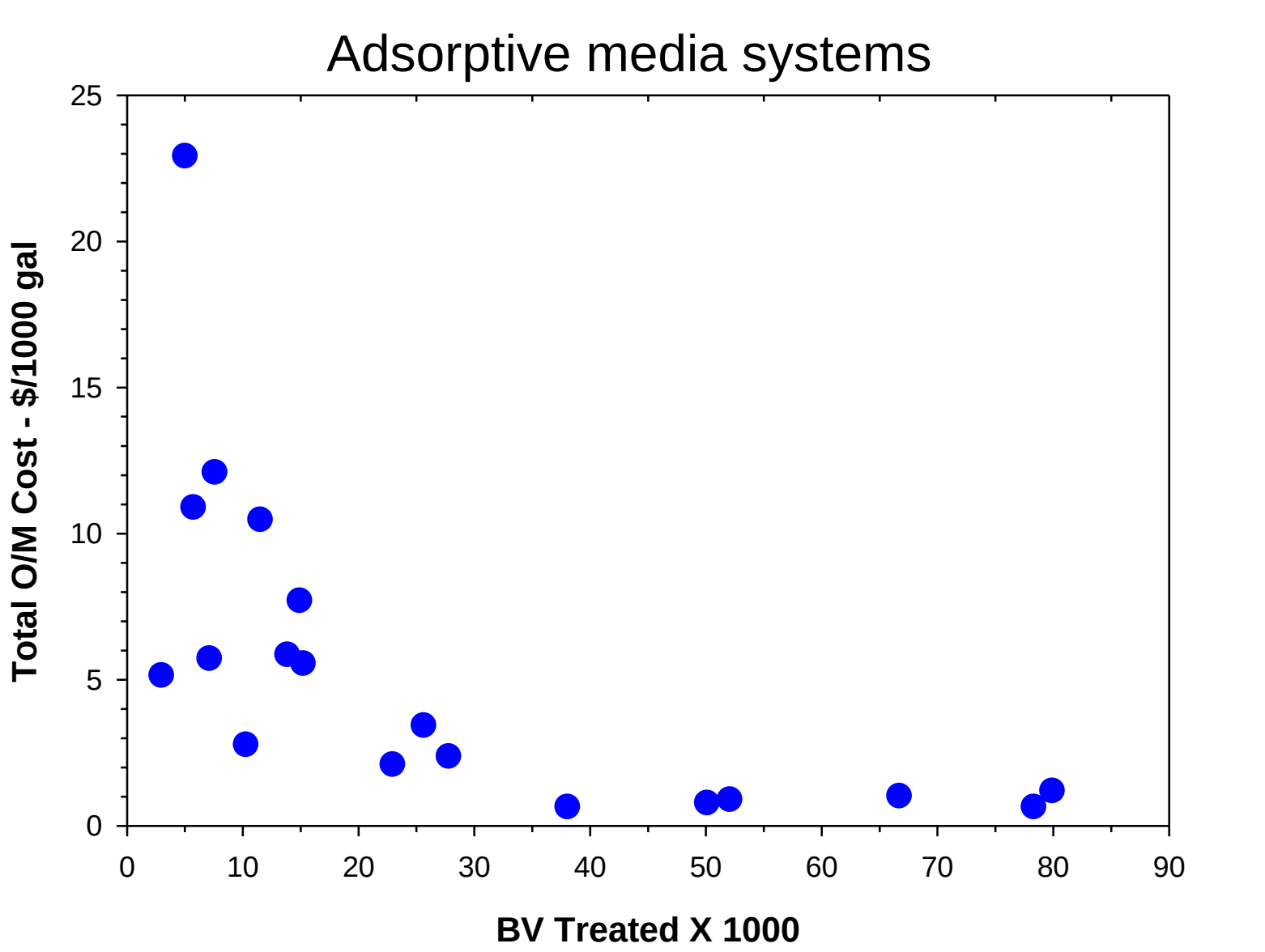
| Technology | Total O&M (Avg) | Media Replacement Cost | Chemical Cost | Electricity Cost | Labor Cost |
|---|---|---|---|---|---|
| *Systems<100 gpm* | | | | | |
| AM | **6.47** | **5.58** | 0.08 | 0.03 | 0.78 |
| IR/CF | **1.39** | NA | 0.14 | 0.10 | **1.15** |
| *Systems>=100 gpm* | | | | | |
| AM | **1.76** | **1.57** | 0.01 | 0.01 | 0.17 |
| IR/CF | **0.28** | NA | 0.04 | 0.05 | **0.19** |
| IX | **0.49** | NA | 0.39 | 0.06 | 0.04 |

**Note:** O/M cost of AM systems based upon 15 systems having to replace media during performance evaluation studies

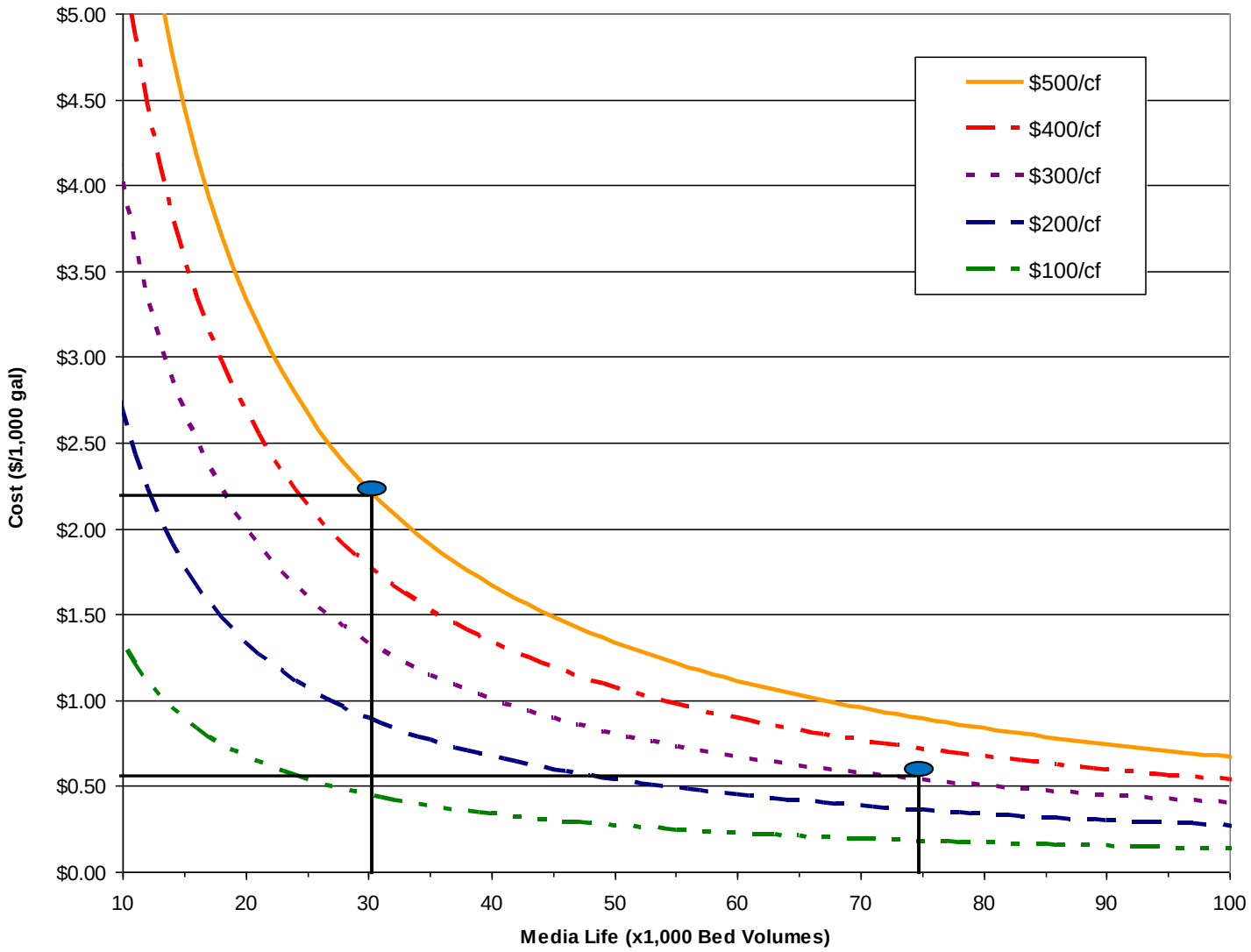
# O/M Costs of Systems w/ Media Change Out (15 Systems)

| Cost Categories | % of Total (Avg) | Min % | Max % |
|---|---|---|---|
| **Media Replacement** | **81** | **49** | **98** |
| Chemical ($Cl_2$, pH Adj.) | 2 | 0 | 9 |
| Power ( Electricity) | <1 | <1 | 8 |
| Labor | 8 | 1 | 41 |

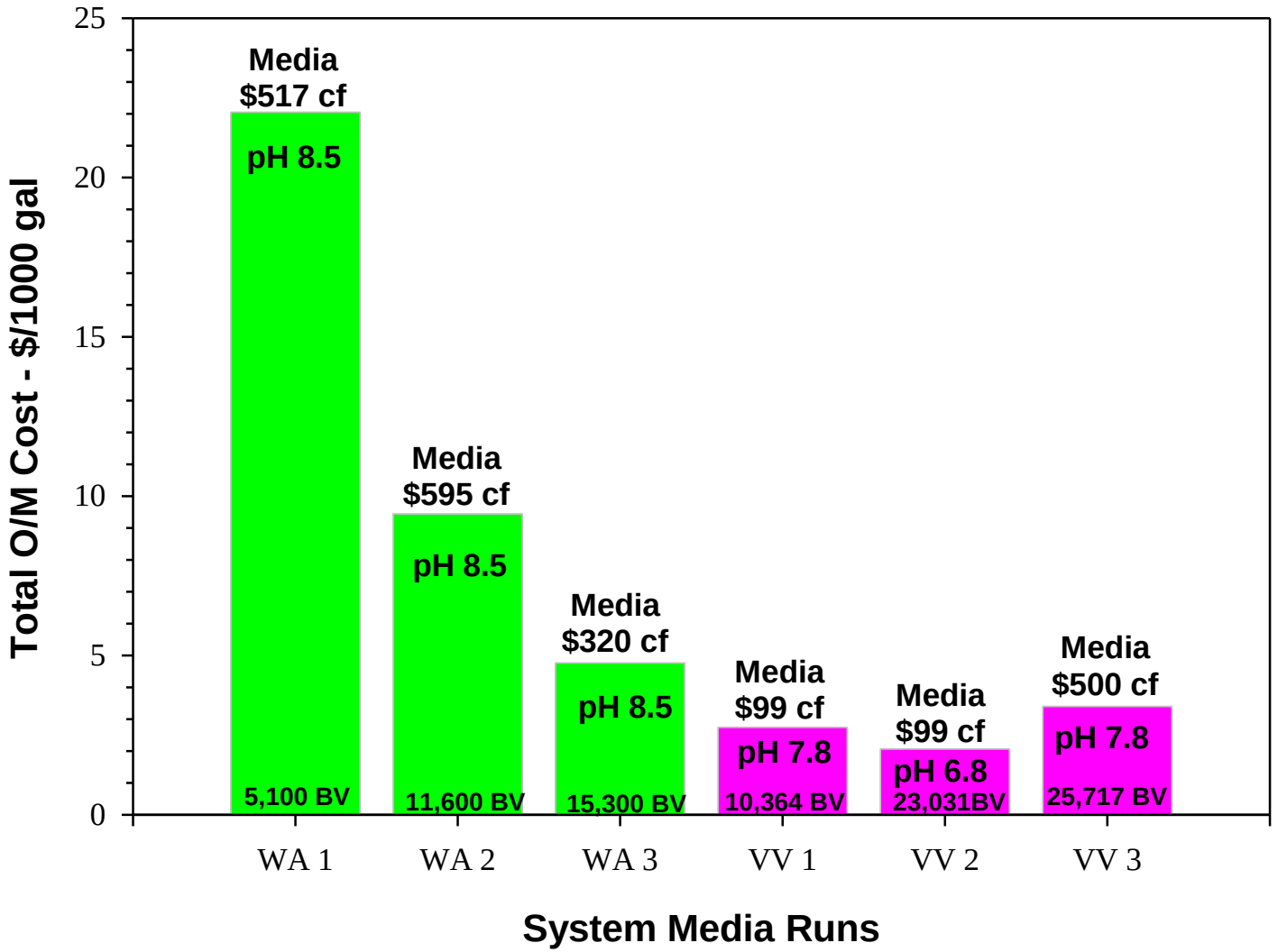
# AM O/M Cost ($/1000) vs BV Treated Water



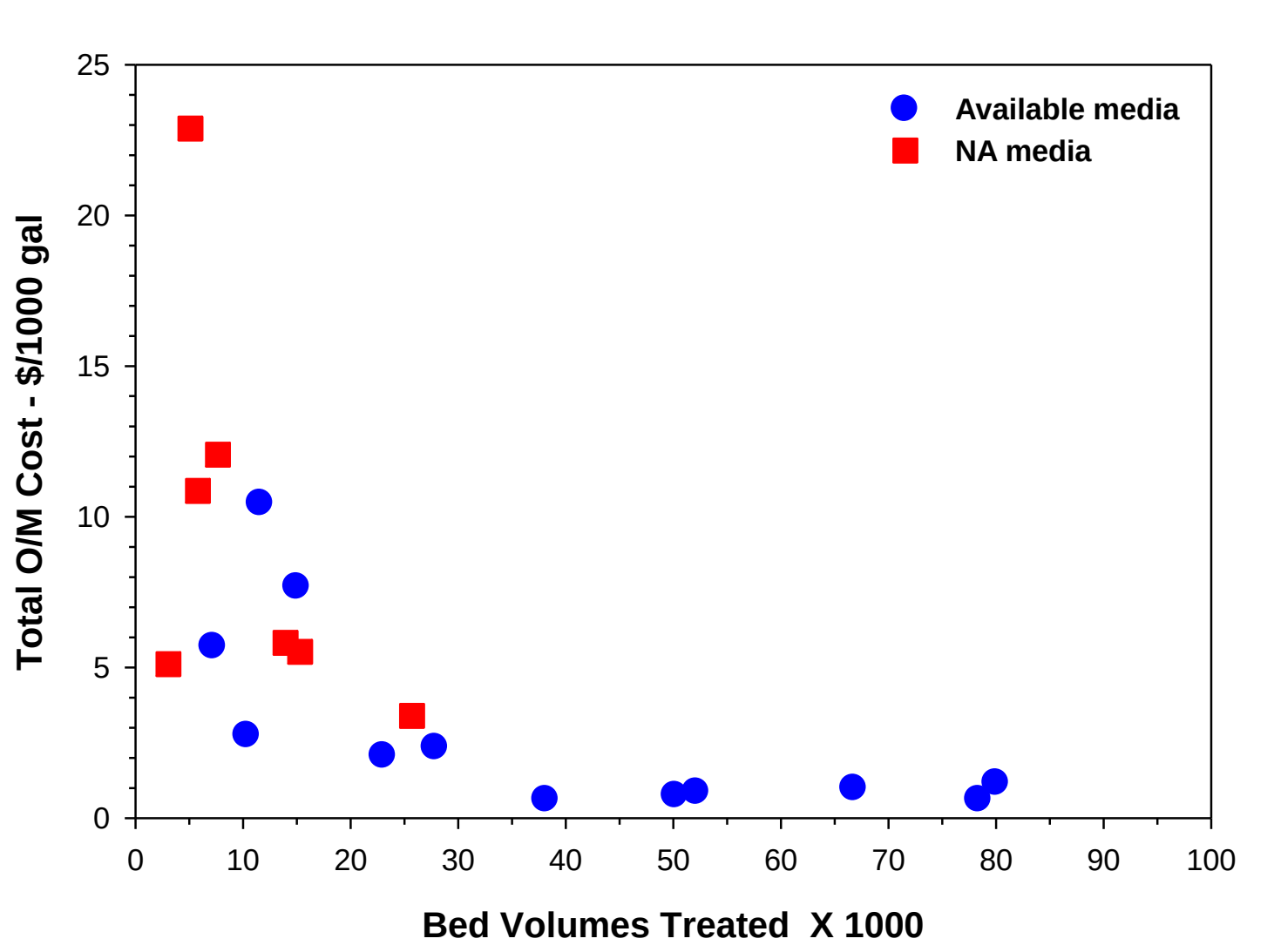
# AM Media Cost



# Reducing Media Cost



# Impact of Media Performance



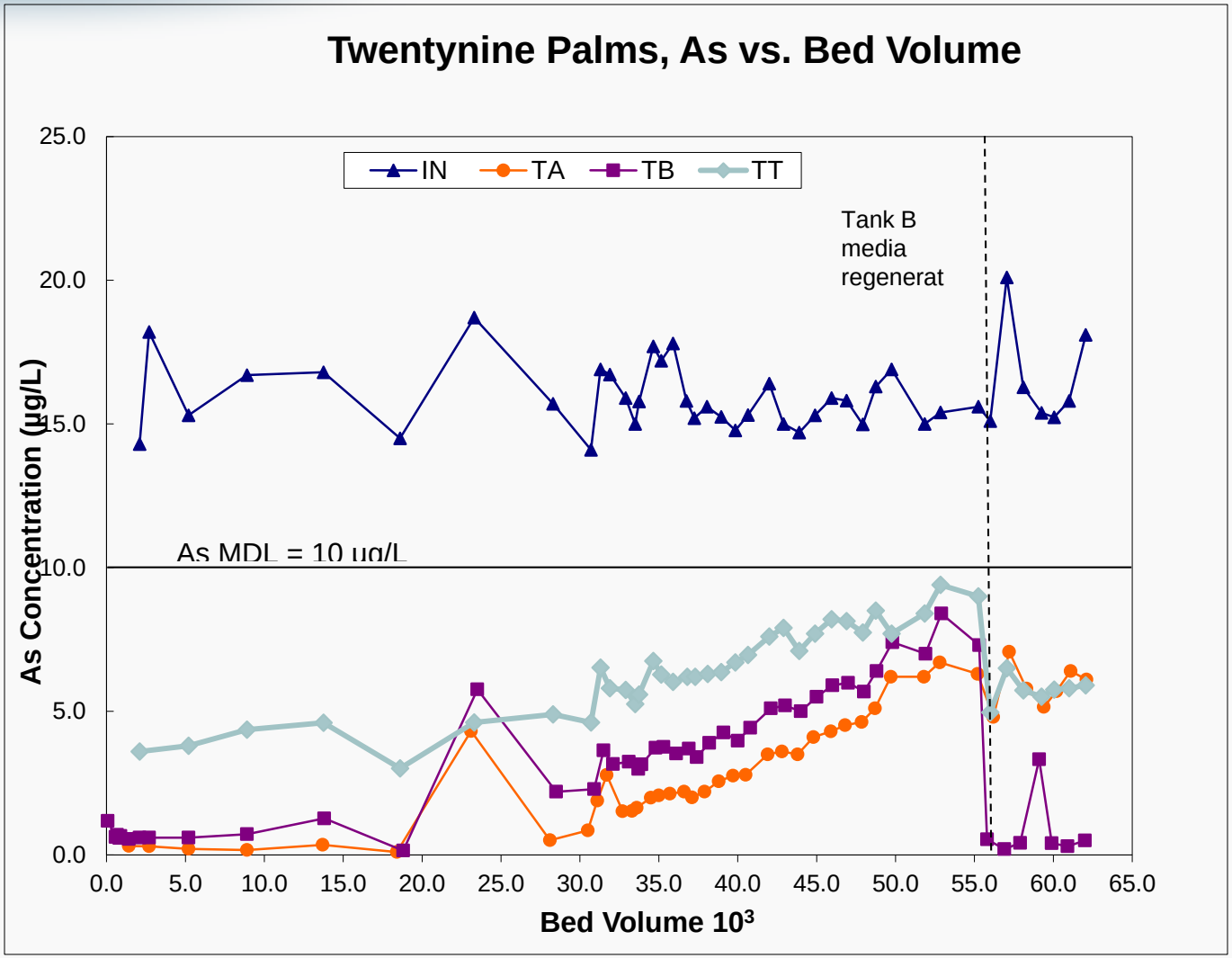
# Regeneration of Media

Extend life of media replacement

by

on-site regeneration of exhausted media

# AM Regeneration




Regeneration saving around $10,000

# Summary – Capital Costs

## System Capital Costs

- Total capital costs varied widely for all sizes and types, but particularly for the very small (< 100 gpm) AM systems. The AM equipment costs are impacted by many design features including tank material, EBCT, media cost, valving and instrumentation.

- Equipment is a major cost component (2/3) of total capital cost of a treatment system.

- For > 100 gpm systems, total capital cost of adsorptive media systems slight low than other types of arsenic removal systems.

# O/M Costs

- O/M costs of AM systems are generally higher than IR, C/F and IX technology.
- Media change out of AM systems accounts for around 80% of O/M cost. Thus, media performance and cost is the major factor in determining total O/M of AM system.
- AM systems have reduced their O/M costs by switching to a lower cost, higher performance AM media product.
- Some AM systems have converted to C/F system that have lower O/M costs.
- Regeneration of media has potential to lower O/M cost for larger systems.

# Questions?

**Thomas Sorg**
**Sorg.Thomas@epa.gov**
**513-569-7370**

EPA's Office of Research and Development and Office of Water invite you to a **free webinar**

# Research and Implementation of Arsenic Removal Technologies at Small Community Water Systems

**Tuesday, January 27, 2015**
**2:00 to 3:00 EST**

## Arsenic treatment implementation

This presentation will provide an overview of the wide variety of challenges faced by small water systems to implementing arsenic treatment for compliance with the Arsenic Rule of the Safe Drinking Water Act.

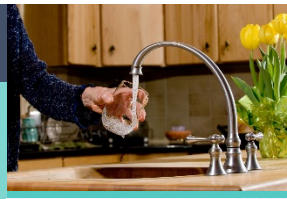
**Presented by Jamie Harris – *EPA's Office of Ground Water and Drinking Water.*** Jamie has been in the field of hydrology for more than 20 years. Her experience is related to water quality, water supply and regulatory issues both related to the Clean Water Act and the Safe Drinking Water Act. Jamie has worked as an environmental consultant overseas as well as in Maryland. She has also worked for the Southern Nevada Water Authority and Maryland Environmental Service at Maryland Department of the Environment. At the U.S. EPA Jamie oversees the implementation of a number of the National Primary Drinking Water Regulations including the Chemical Phase Rules which includes over 65 Inorganic and Organic Contaminants, one of which is arsenic.

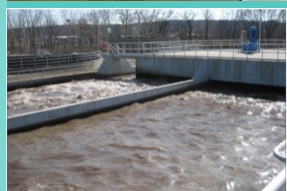
## Performance and cost effectiveness of arsenic removal technologies for small drinking water systems

This presentation will provide a general overview of the effectiveness of arsenic removal technologies and their cost, including capital and operating costs. Emphasis will be placed on the three technologies that are most commonly utilized by small systems: adsorptive media, iron removal, and coagulation/filtration. The major source of information provided will be from EPA's Arsenic Demonstration Program. This program collected performance and cost data from 50 full scale arsenic removal systems installed in 26 different states.

**Presented by Thomas Sorg, PE, BCEE – *EPA's Office of Research and Development.*** Tom has over 51 years of experience with federal environmental programs. His experience includes the past 42 years with the drinking water research and development program of EPA, and 25 years as Chief of the Inorganics and Particular Control Branch of the Drinking Water Research Division. Tom's research emphasis has been on drinking water treatment technology for the removal of inorganic and radionuclide contaminants from water supplies, including the removal of arsenic. During the past 12 years, his research has focused mainly on treatment technologies to remove arsenic from drinking water in support of the revised arsenic MCL of 10 µg/L. This effort has included oversight of the EPA Arsenic Removal Full-Scale Demonstration Program.

**Webinar Registration:** https://www2.gotomeeting.com/register/118343202





### Who should attend?

State primacy agencies, tribes, community planners, technical assistance providers, academia, and water systems interested in issues facing community water systems and solutions to help solve them.

**In 2015, EPA's Office of Research and Development and Office of Water will host monthly webinars to discuss various treatment technology topics for small community drinking water and wastewater systems.**