New EPA Guidance on Cost-Effective Design of Pump and Treat Systems

Kathy Yager
EPA - OSRTI

Peter Rich, Doug Sutton, and Rob Greenwald
GeoTrans, Inc.

Accelerating Site Closeout, Improving Performance, and Reducing Costs through Optimization

Dallas, TX – June 15-17, 2004

EPA

Presenters

- Kathy Yager
  - EPA Office of Superfund Remediation and Technology Innovation (OSRTI)
    - yager.kathleen@epa.gov
- Peter Rich, P.E.
  - GeoTrans, Inc.
    - prich@geotransinc.com

EPA

Presentation Objective

- Introduce the new EPA fact sheet titled

Cost-Effective Design of
Pump and Treat Systems

OSWER 9283.1-20FS, EPA 542-R-04-004
(Coming Soon!)

EPA

Presentation Objective

- Please note that there are three other new companion EPA fact sheets
  - *Elements for Effective Management of Operating Pump and Treat Systems*
    - OSWER 9355.4-27FS-A, EPA 542-R-02-009, December 2002
  - *O&M Report Template for Ground Water Remedies with Emphasis on P&T Systems*
    - OSWER 9283.1-22, EPA 542-R-04-003, Coming Soon!
  - *Effective Contracting Approaches for Operating Pump and Treat Systems*
    - OSWER 9283.1-21FS, EPA 542-R-04-005, Coming Soon!

Look for all of the fact sheets at www.cluin.org/optimization

EPA

Background

- All of these fact sheets were inspired by the results of a nationwide pilot to optimize operating Fund-lead P&T systems
  - 20 optimization evaluations (RSEs) were conducted
  - RSEs identified a number of useful practices
  - RSEs also identified over 200 opportunities for improvement
    - Over 60 related to improving or evaluating protectiveness
    - Over 60 related to cost reduction

Results suggested need for more specific guidance on P&T design and O&M

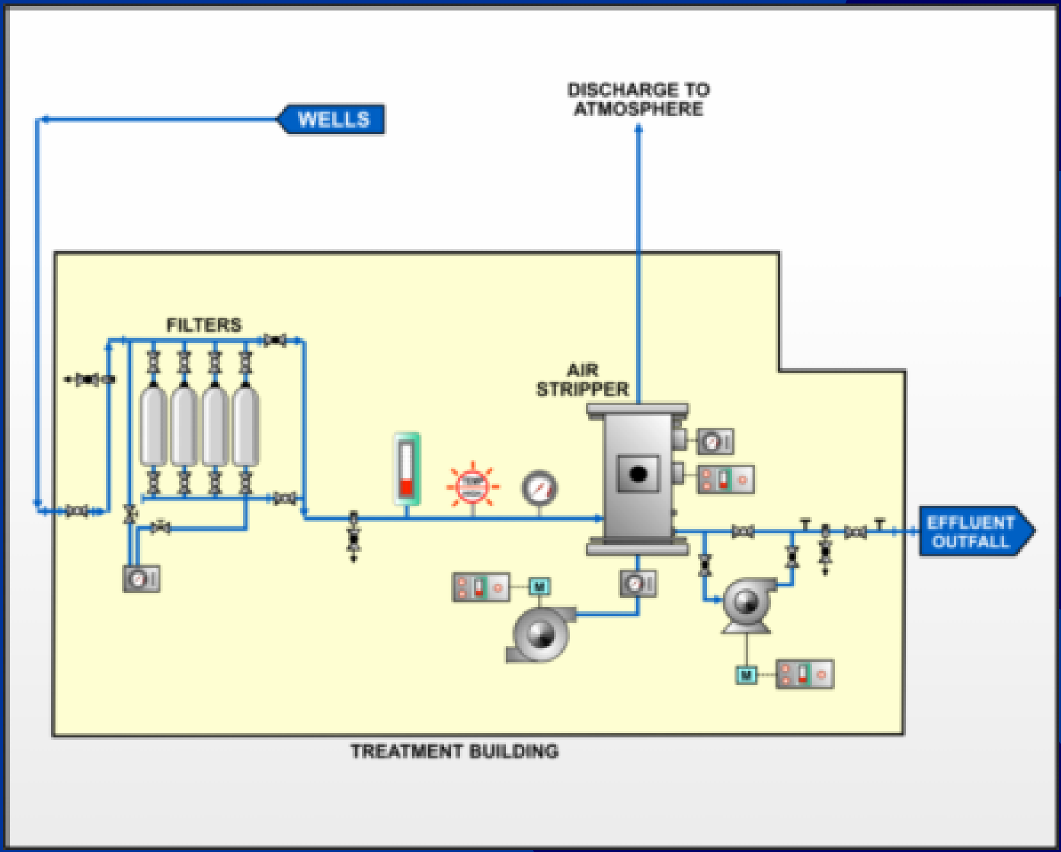
EPA

Background

- These fact sheets are intended to
  - Demonstrate the need for active management during O&M
  - Outline primary responsibilities during O&M
  - Provide general information, tools, and "rules of thumb" for addressing those responsibilities
- They are NOT intended to
  - Replace hydrogeological or engineering expertise
  - Replace the need for external or independent optimization evaluations

EPA

Cost-Effective Design of Pump and Treat Systems



EPA

Topics

- Remedy Goals and Performance Monitoring
- System Design Parameters
- The Extraction System
- Selecting the Appropriate Treatment Technology
- Discharge Options
- Controls/Redundancy/Failsafes

EPA

General Themes

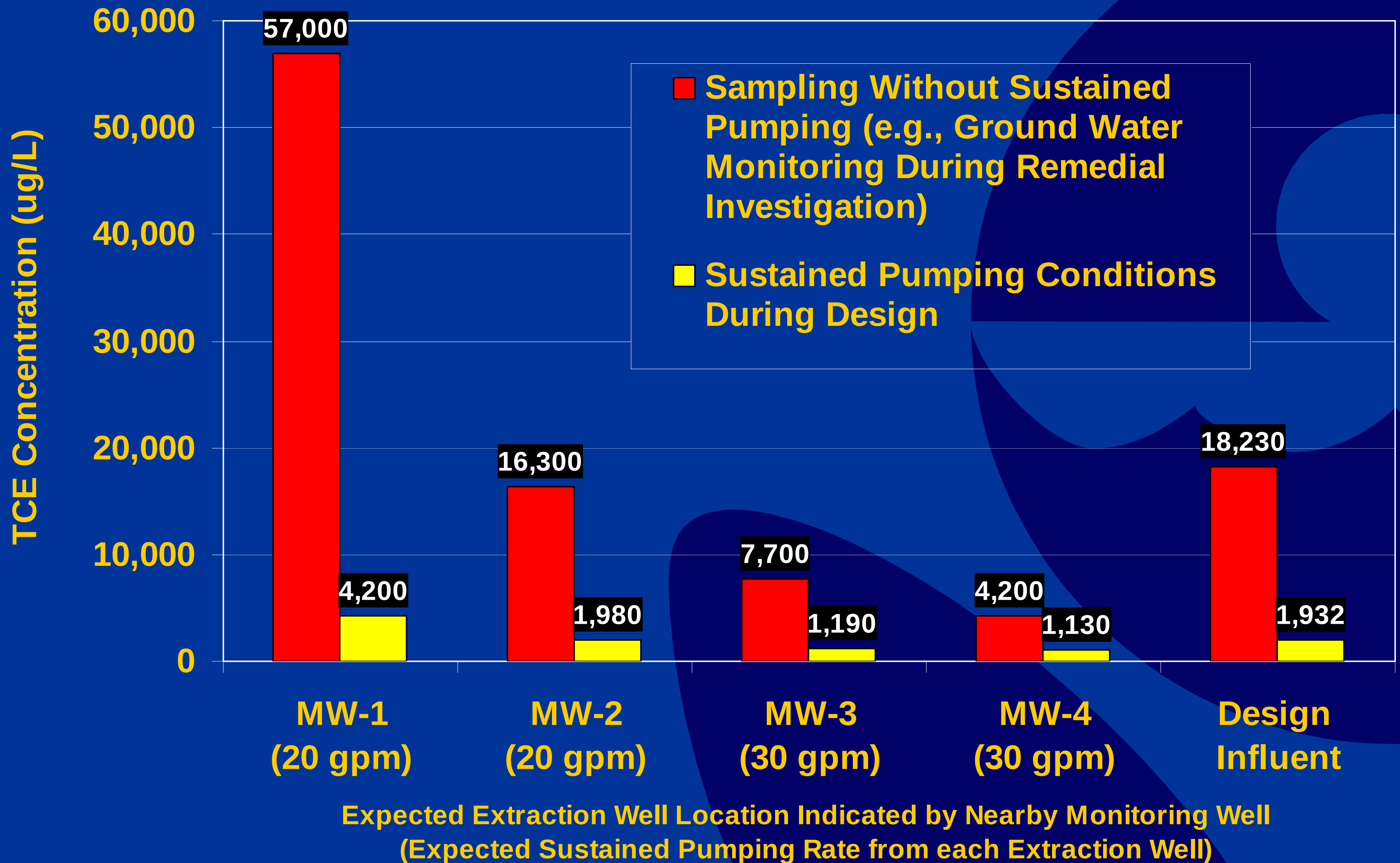
- Use the appropriate design parameters
- Avoid redundant treatment components and treatment trains
- Avoid costly items (consider both capital and O&M costs) and plan for the long-term
- Weigh all of your options
  - Treatment components
  - Discharge options
  - Etc.

System Design Parameters

- Flow rate
  - Design extraction rate – base it on pumping data and perhaps modeling
  - Hydraulic capacity – design extraction rate × a factor of safety
- Design concentration
  - Determine for each constituent
  - Base it on samples collected during sustained pumping
  - Do NOT base it on maximum concentration from RI
- Design mass removal rate
- NAPLs
  - LNAPL, DNAPL, etc.
  - Is it recoverable?

EPA

System Design Parameters



Do NOT use the maximum RI concentration for design concentration!!!

EPA

System Design Parameters

- Perform and interpret process monitoring, for example…
  - Calculate mass loading/removal rate in influent water

$$\text{influent concentration} \times \text{flow rate} \times \text{conversion factors} = \frac{\text{lbs}}{\text{day}}$$

$$\downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow$$

$$\frac{1{,}000\ \text{ug}}{\text{L}} \times \frac{250\ \text{gal.}}{\text{min.}} \times \frac{3.785\ \text{L}}{\text{gal.}} \times \frac{2.2\ \text{lbs.}}{1 \times 10^{9}\ \text{ug}} \times \frac{1{,}440\ \text{min.}}{\text{day}} = \frac{3.0\ \text{lbs.}}{\text{day}}$$

- Compare results to design specifications for system and system components

Treatment Technologies

Technology	<u>Example</u> Comments
For removing NAPL	
• Phase separators	• Easy to maintain, do not remove emulsified product
• Oleophilic filters	• Remove emulsified product, costly for large volumes
• Dissolved air flotation	• Removes neutral NAPL, costly to operate
Treating organic compounds	
• Air stripping	• Good for most VOCs, low operator requirements
• GAC	• Good for many organics, low operator requirements
• Polymeric resin	• Effective for high concentrations, compound specific
• Biological treatment	• Useful for ketones, requires more operator attention
• UV oxidation	• Destroys most organics, high energy costs
Treating inorganic compounds	
• Filtration	• Low operator requirements, removal may not be sufficient
• Settling and/or metals precip.	• Effective and reliable, operator and material intensive
• Ion exchange	• Low operator requirements, compound specific

These and other provided comments are general "rules of thumb".

EPA

Treatment Technologies

- Preliminary design estimates for GAC
  - Determine influent concentration
  - Determine mass loading rate
  - Determine ratio (R) for pounds of contaminants to pounds of GAC

$$R = \frac{1}{1{,}000} \times K \times C^{1/N}$$

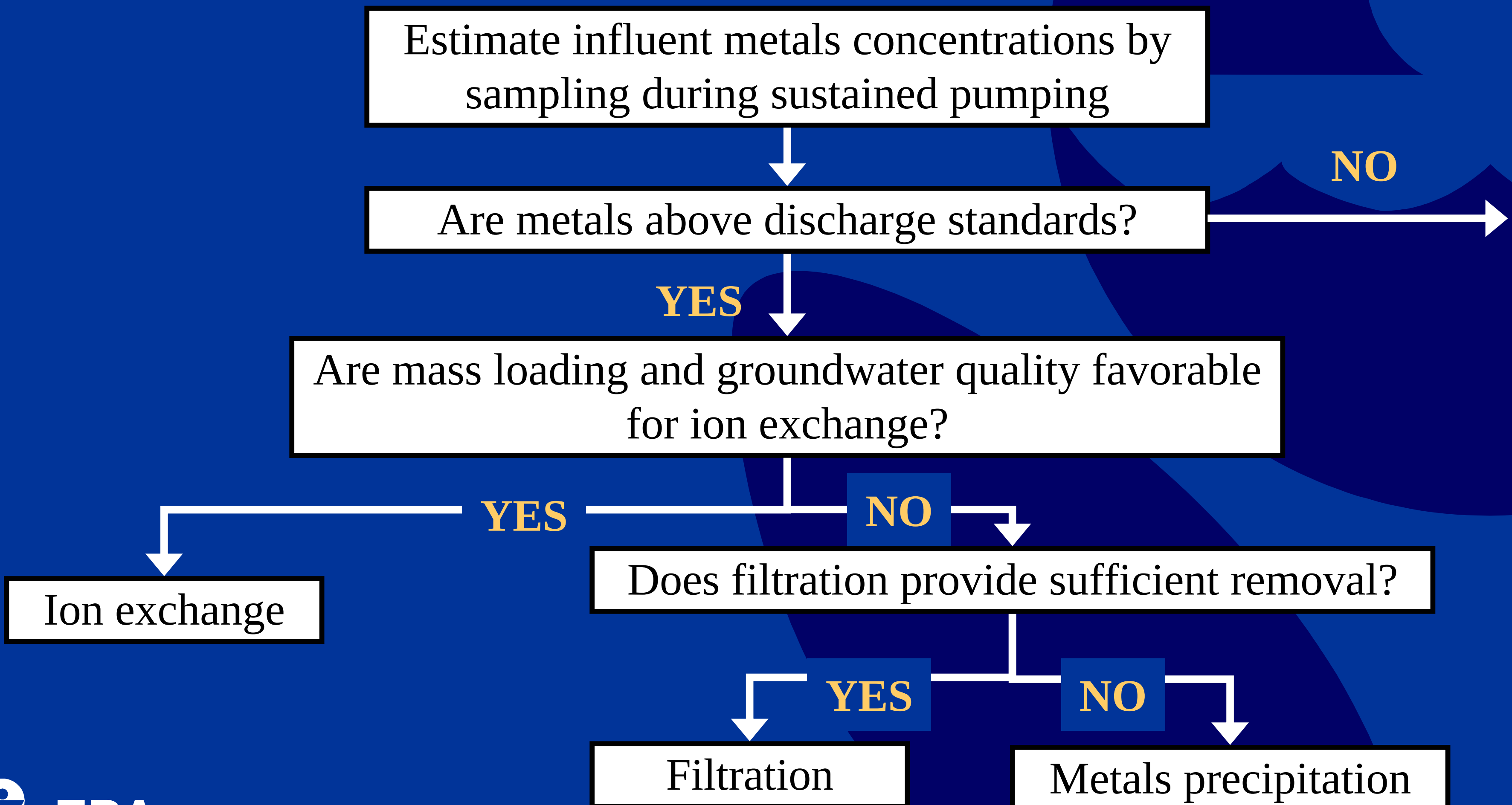
C is concentration in mg/L

Compound	PCE	TCE
K (mg/kg)(L/mg)$^{1/N}$	51	28
1/N	0.56	0.62

  - Calculate GAC usage (mass loading rate / R) and associated cost per year
  - Calculate vessel size based on usage and empty bed contact time

Treatment Technologies

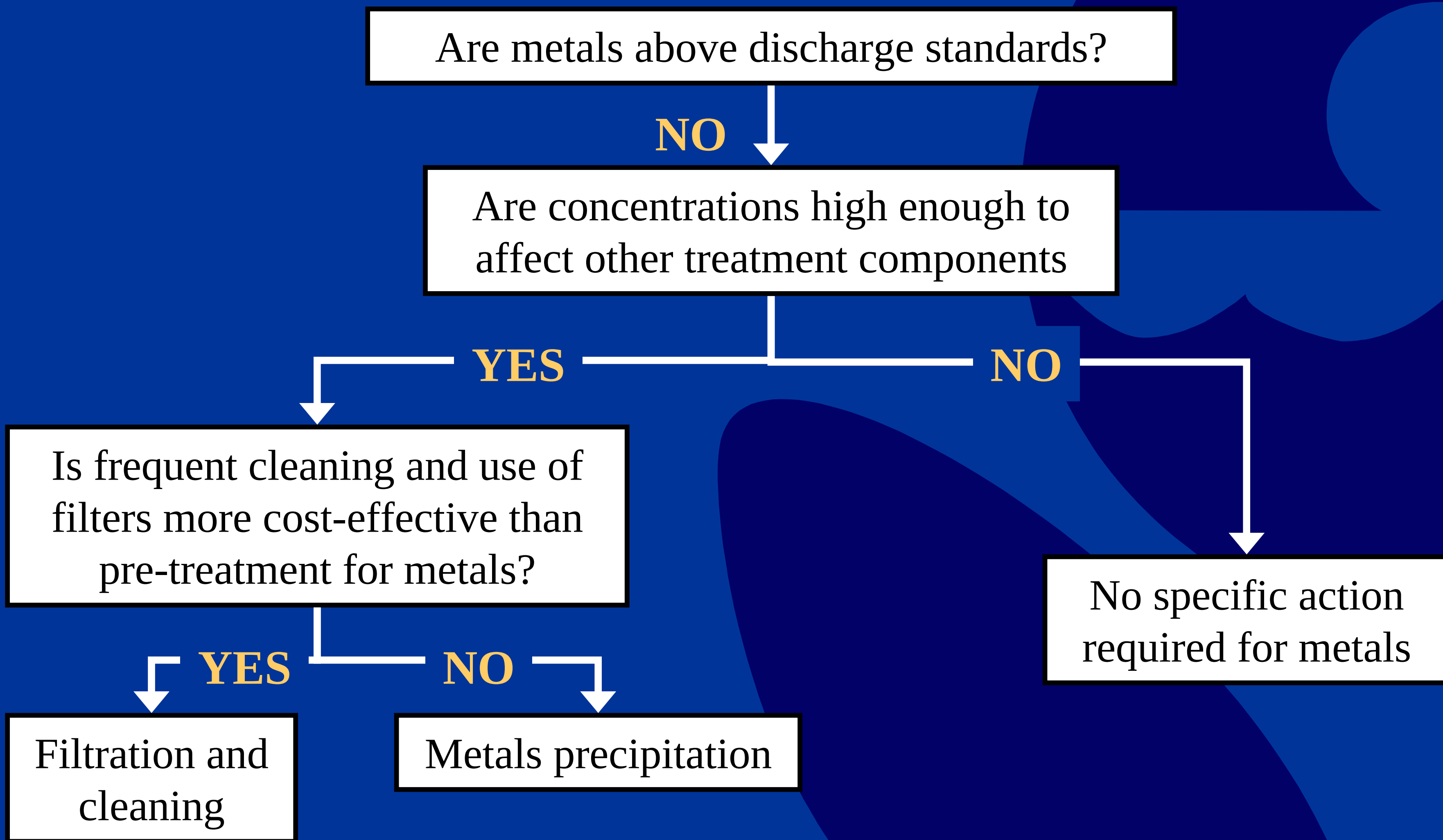
- Consider ALL of your options before selecting a remedy, particularly if the presumptive remedy is known to be costly. Consider the following example decision tree for addressing metals in extracted groundwater



EPA

Treatment Technologies

Continued



Discharge Options

Pros	Option	Cons
Often take ketones, may have relaxed limits (TTO)	POTW	Pay by volume, may have limit on flow rate
Low cost, easy conduit to surface water	Storm Sewer	May have strict limits, require extensive sampling
Low cost, may allow high flow rates	Surface Water	Distance from site, strict discharge criteria, aesthetics/public perception
Resource conservation, plume control	Reinjection	Capital cost, maintenance (fouling), potential to spread plume

Controls, Failsafes, and Automation

- General guidelines for labor typically required at various types of treatment plants

Treatment Train	Estimated Labor
Air stripping Vapor phase GAC for offgas treatment	• Weekly checks by local operator (8-12 hrs/wk) • Quarterly checks by engineer
GAC	• Weekly checks by local operator (8-12 hrs/wk) • Quarterly checks by engineer
Filtration UV/Oxidation GAC	• Weekly or semi-weekly checks by local operator (8-16 hrs/wk) • Quarterly checks by engineer
Metals removal Filtration (perhaps including air stripping, GAC, biotreatment, or UV/Oxidation)	• One operator full time with potential for part time assistance (40 - 60 hours/wk)

EPA

Discussion

EPA