

# IPR to DPR:

## Balancing treatment, monitoring, and storage

**January 22, 2014**

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*Trussell Technologies*



Trussell  
TECHNOLOGIES INC

# Indirect Potable Reuse (IPR) Components



Source Control



WWTP



Advanced Water Treatment



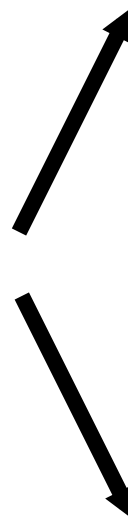
Aquifer Injection / Spreading



Reservoir Augmentation



WTP / Distribution



# DPR: no environmental buffer



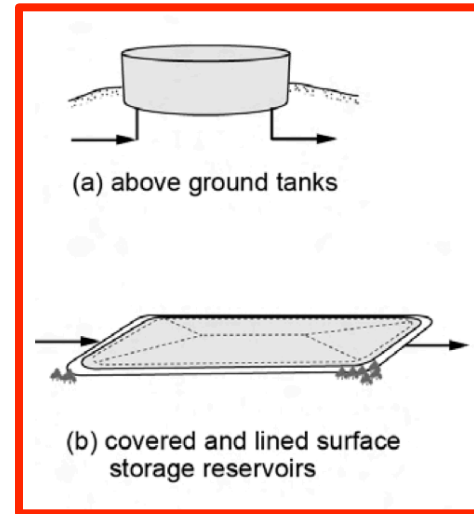
Source Control



WWTP



Advanced Water Treatment



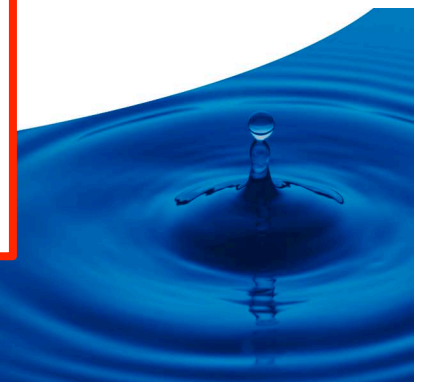
Engineered Storage Buffer (ESB)



Flange-to-flange



WTP / Distribution



# Role of environmental buffer in IPR



- Contaminant removal
- Dilution / blending
- Storage capacity
- Time to detect & respond to failures



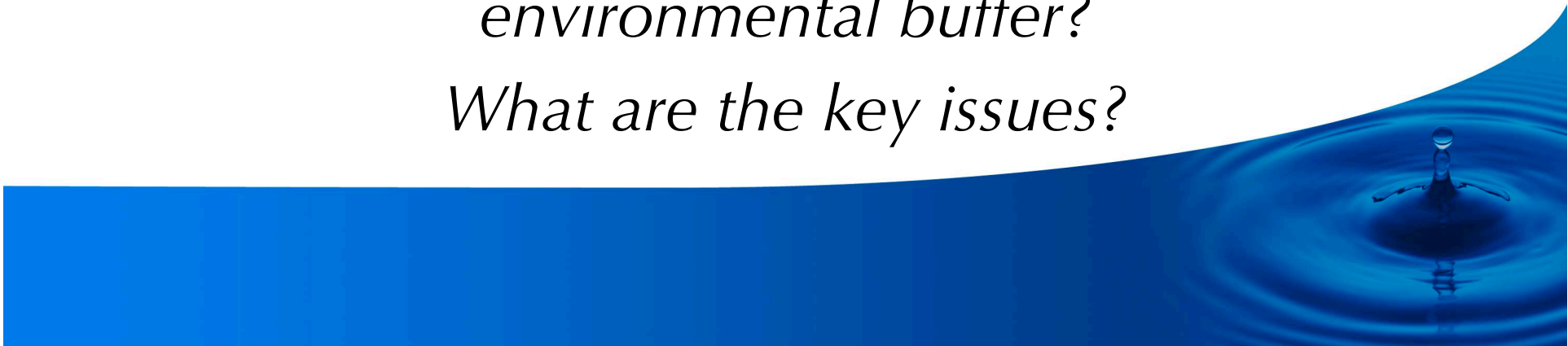
# Role of environmental buffer in IPR



- Contaminant removal
- Dilution / blending
- Storage capacity
- Time to detect & respond to failures

*How do maintain these protections without an environmental buffer?*

*What are the key issues?*



# Moving from IPR to DPR

- A clear requirement for DPR: protect public health
- Main challenge identified by CDPH: loss of environmental buffer → reduced storage → less ***response time***
- **Reduced response retention time** is the key issue in transition to DPR



# Fundamental Question

*How do we justify shorter response retention times for DPR?*



# Balancing Potable Reuse Elements

- All 3 elements—***treatment***, ***monitoring***, and ***retention time***—contribute to public health
- No “ideal” combination; involves trade-offs
- Precedents? Groundwater Recharge Regulations

## Option 1

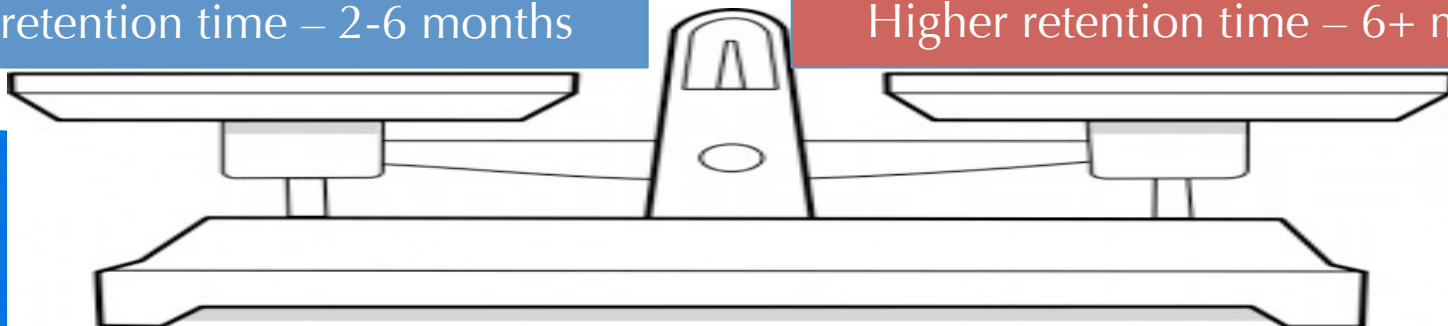
Higher treatment – full adv. treatment

Lower retention time – 2-6 months

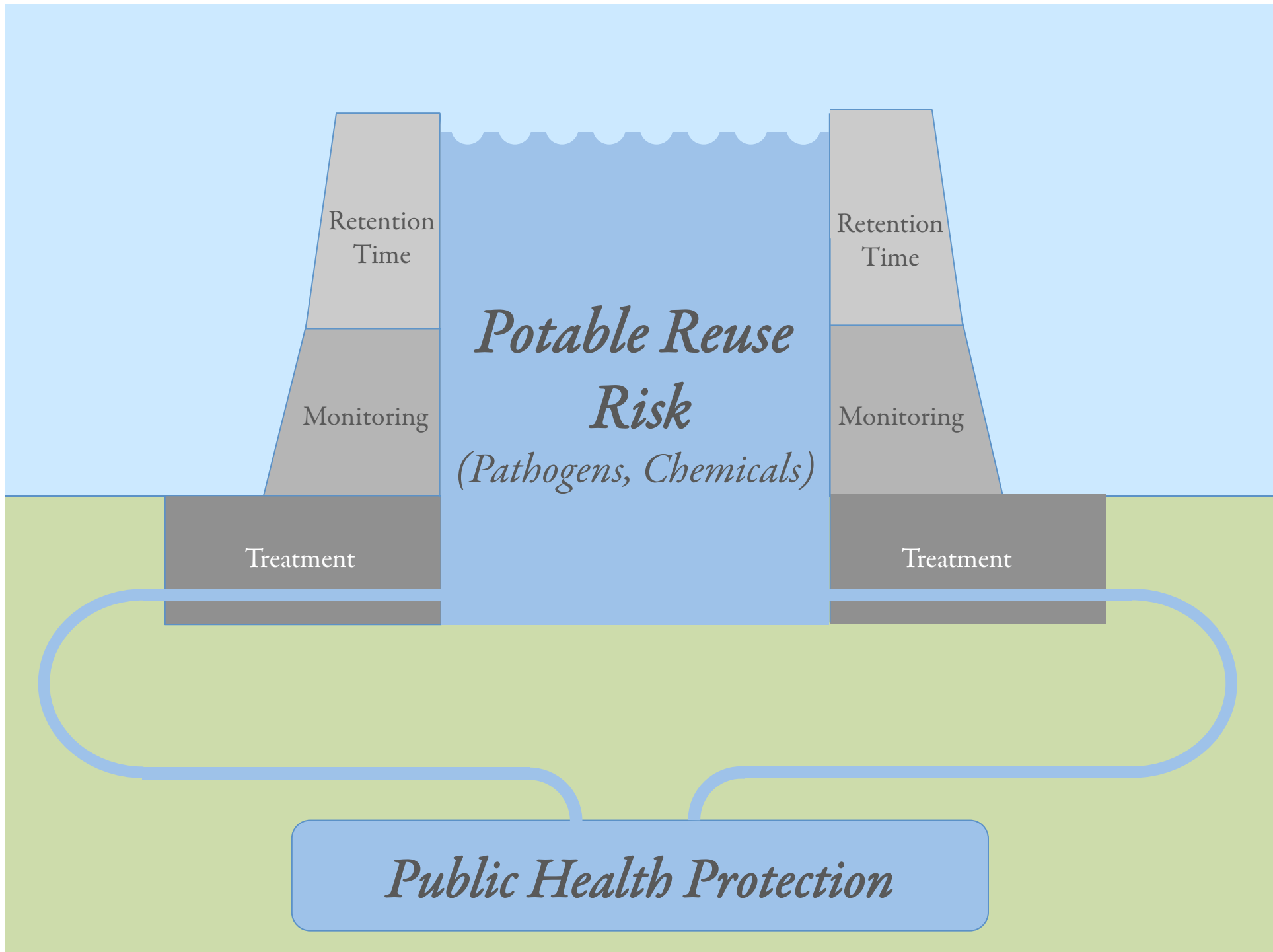
## Option 2

Lower treatment – tertiary, disinfected

Higher retention time – 6+ months







IPR

DPR

Retention  
Time

Retention  
Time

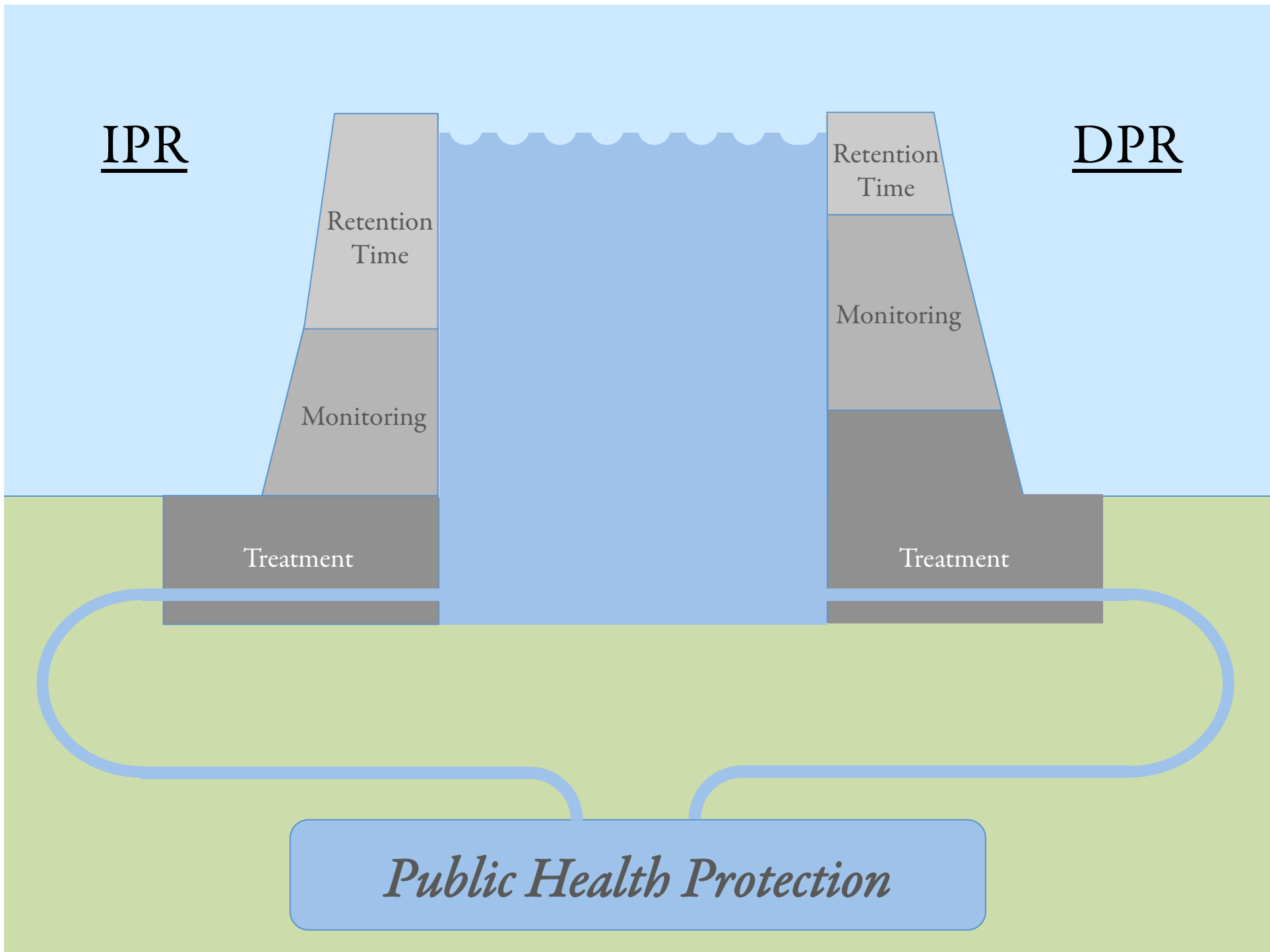
Monitoring

Monitoring

Treatment

Treatment

*Public Health Protection*



IPR

DPR

Decreased retention time

Retention Time

Retention Time

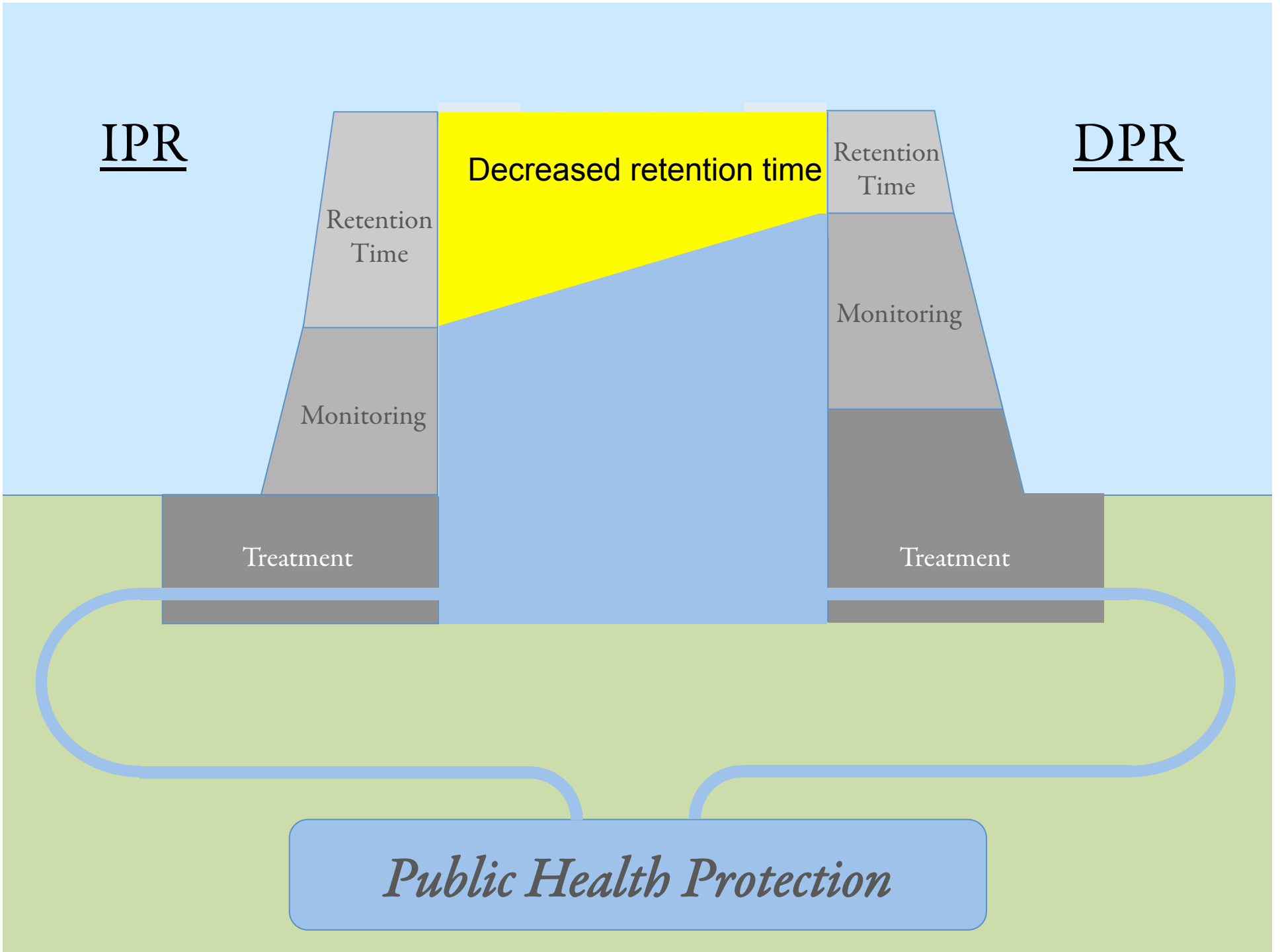
Monitoring

Monitoring

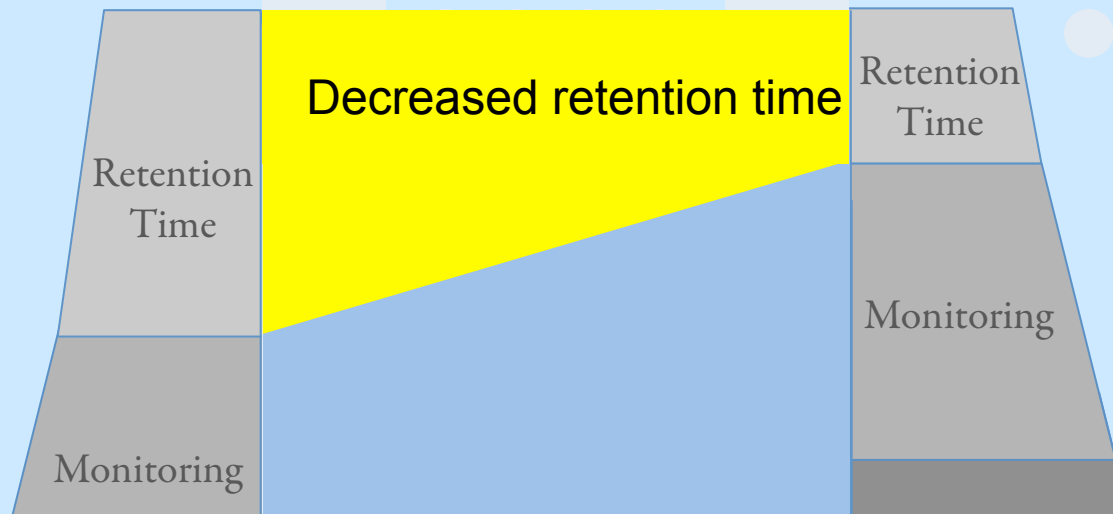
Treatment

Treatment

*Public Health Protection*



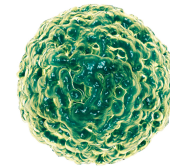
IPR

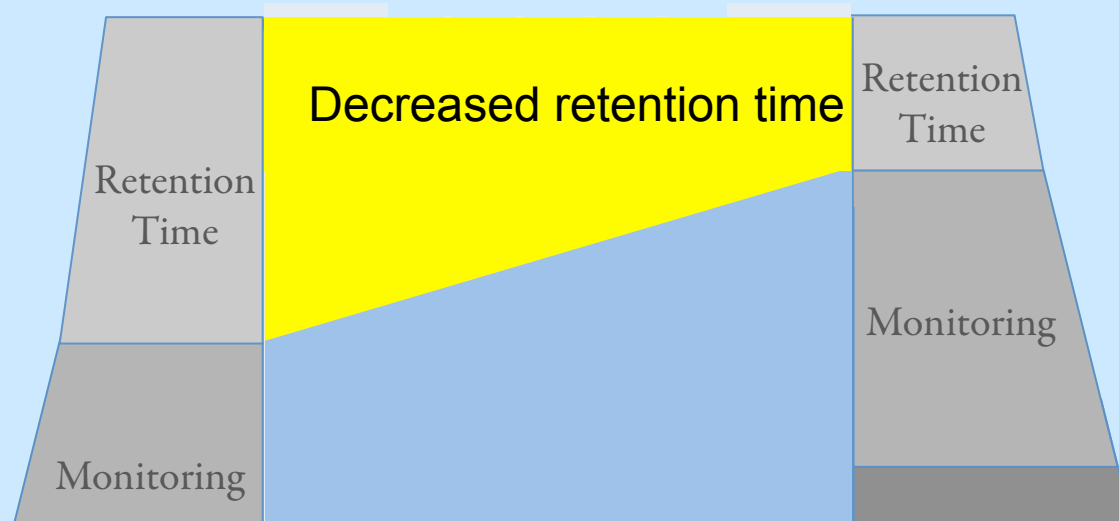


DPR

Main two things we are losing:

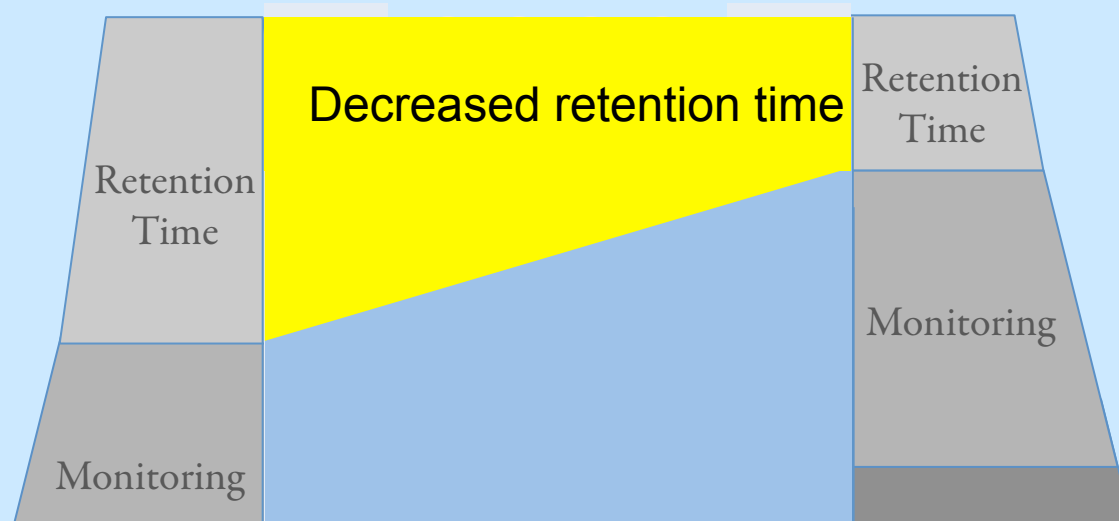
- Retention time for **treatment**
- Retention time for **failure response**





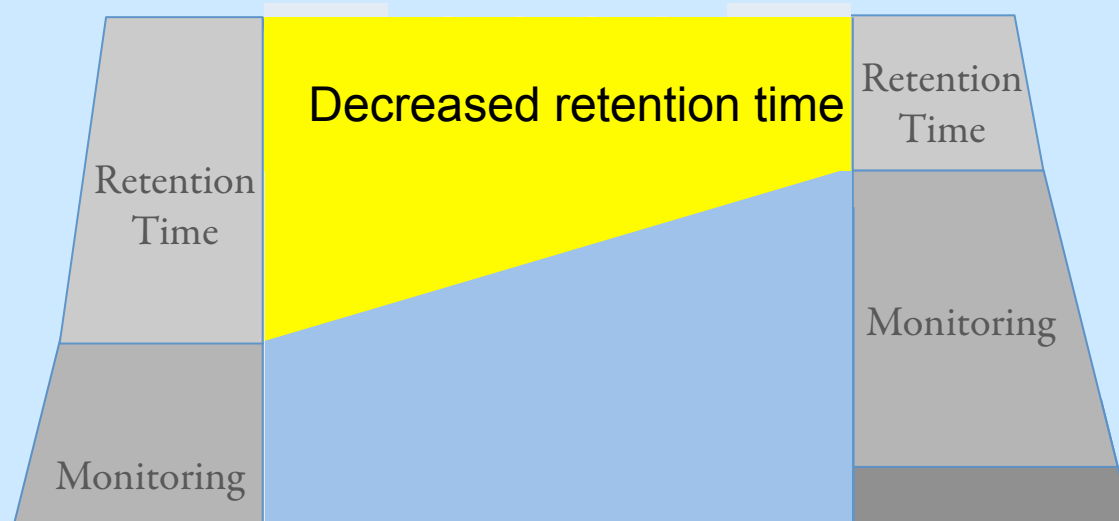
Main two things we are losing:

- Retention time for **treatment**  
Enhance treatment above ground
- Retention time for **failure response**  
Decrease time needed to detect compromise or failure



Main two things we are losing:

- Retention time for **treatment**  
Enhance treatment above ground
- Retention time for **failure response**  
Or, Make system FAILSAFE



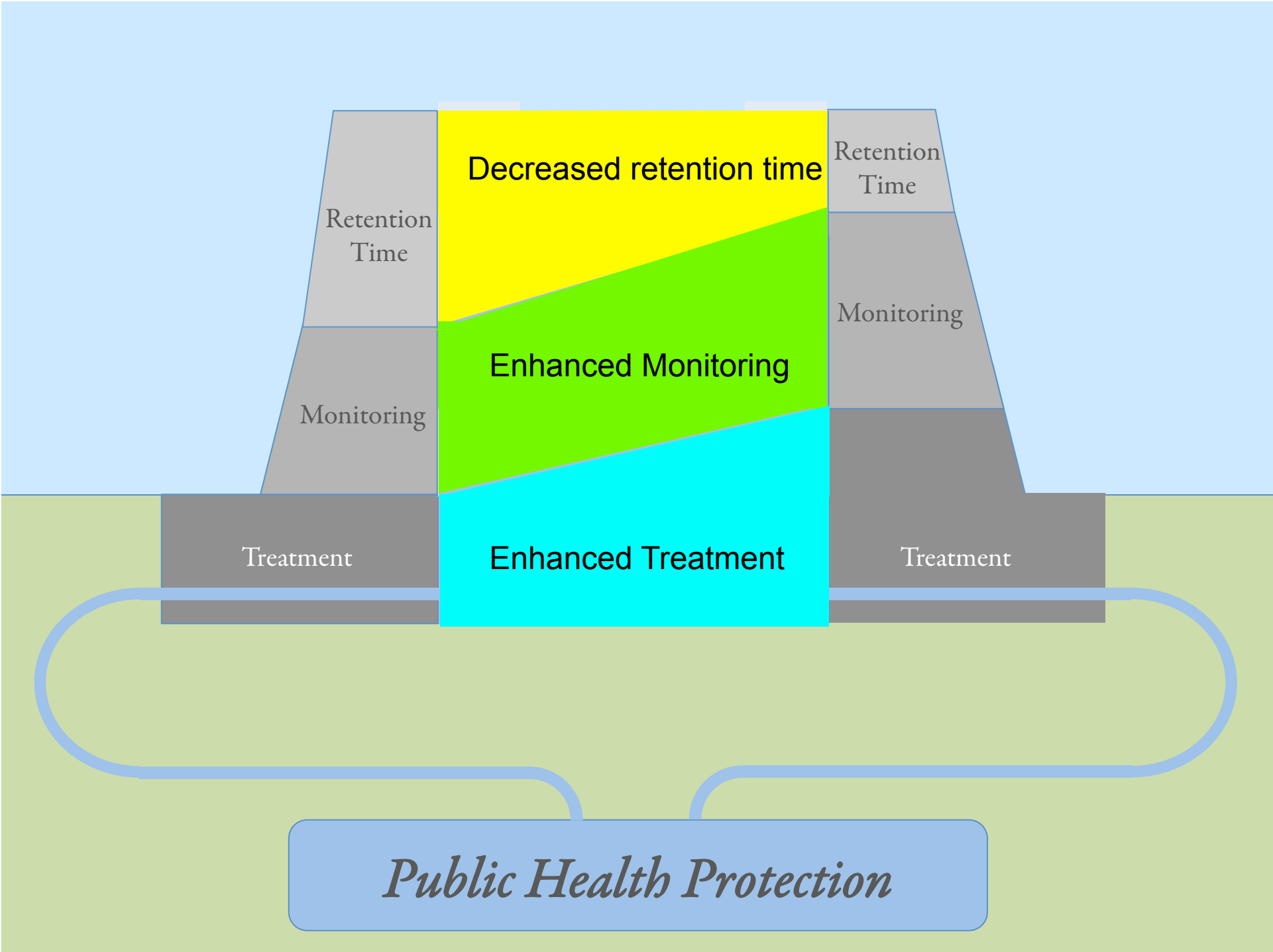
Main two things we are losing:

- Retention time for **treatment**

Enhance treatment above ground

- Retention time for **failure response**

Or, reduce response time and reduce risk of failure at the same time

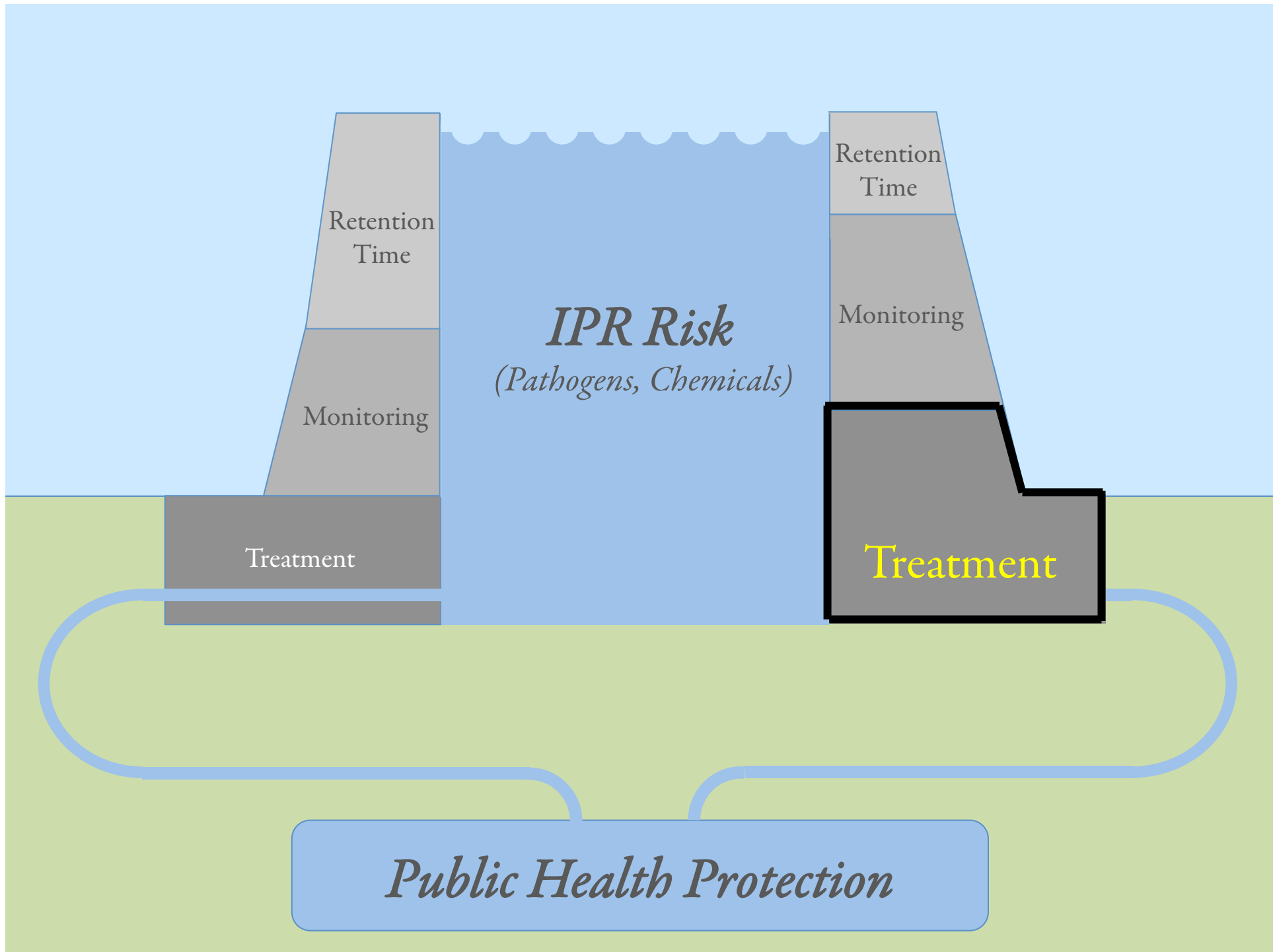




# Goals for today's presentation

- Discuss balance of 3 potable reuse elements
- How shorter response retention time (RRT) can be compensated with:
  - Enhanced treatment
  - Enhanced monitoring
- Discuss trade-offs of different options





Retention  
Time

Monitoring

Treatment

*IPR Risk*  
*(Pathogens, Chemicals)*

Retention  
Time

Monitoring

Treatment

*Public Health Protection*

# Enhanced Treatment

How does enhanced treatment work?

*By reducing the risk of treatment failures*

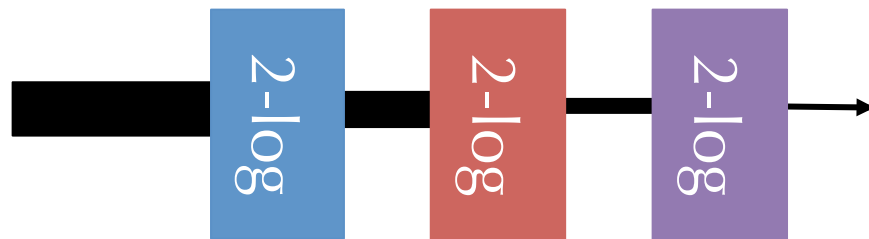
What is the key to treatment reliability?

*Redundancy with multiple barriers*



# Types of Treatment Redundancy

## 1. Multiple barrier approach



3 barriers  $\rightarrow$  6-log performance  
(*requirement: 6-log removal*)



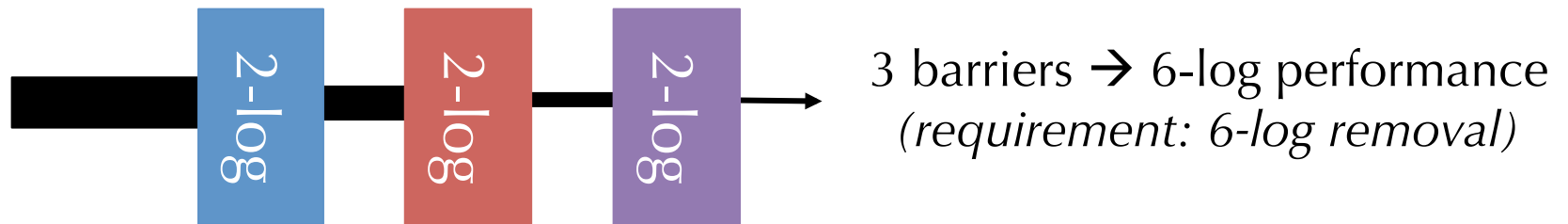
# Types of Treatment Redundancy

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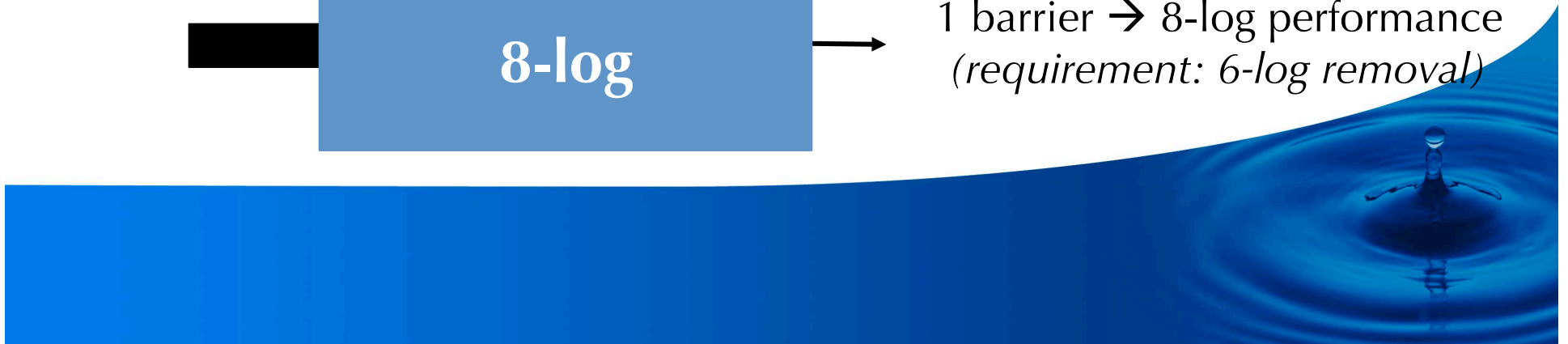
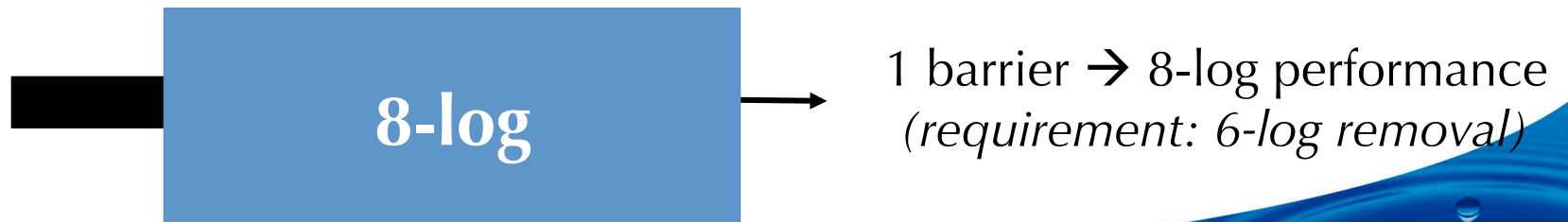


# Types of Treatment Redundancy

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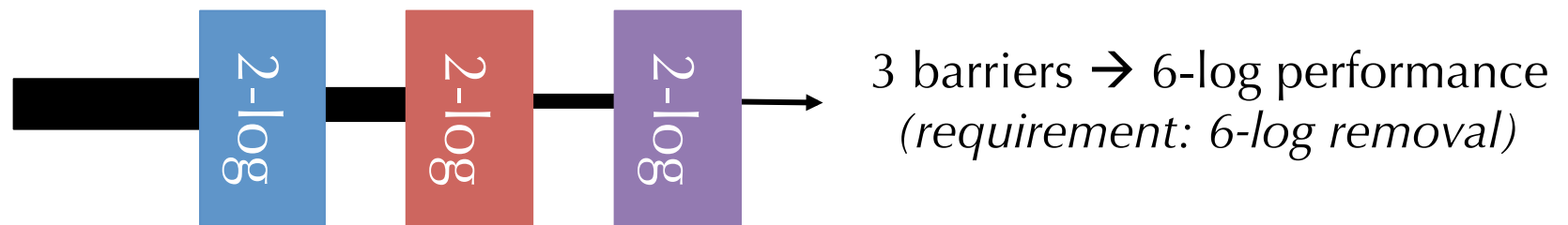


## 2. Greater than minimum performance

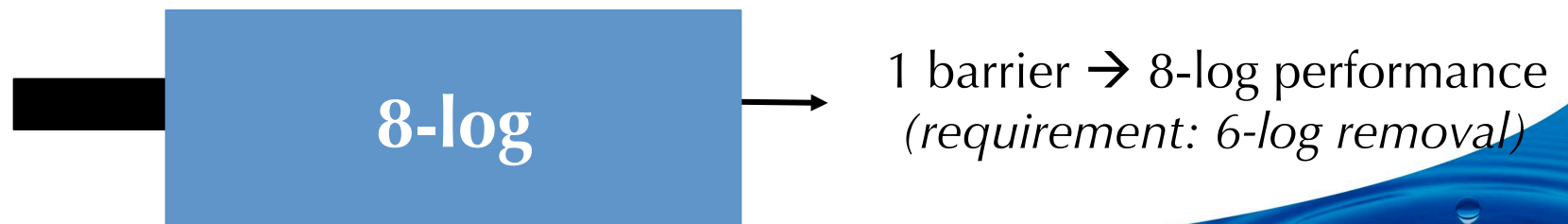


# Types of Treatment Redundancy

## 1. Multiple barrier approach



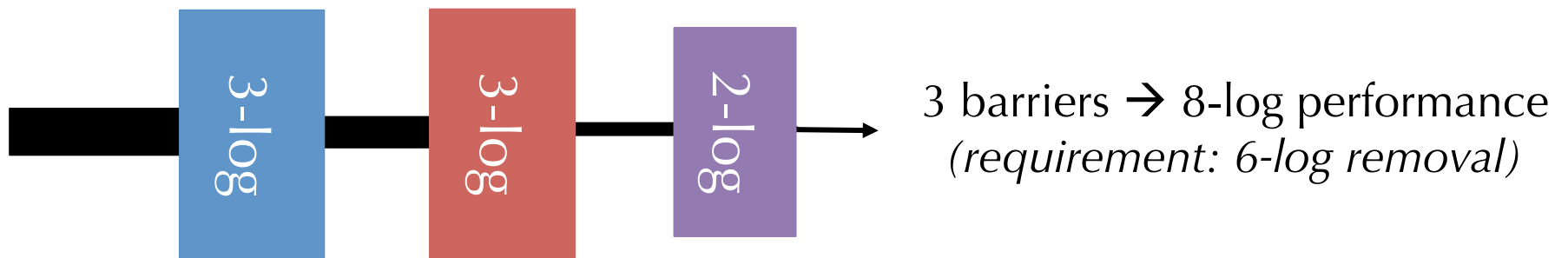
## 2. Greater than minimum performance



Benefit: small failures can occur **without any compromise to performance goals**

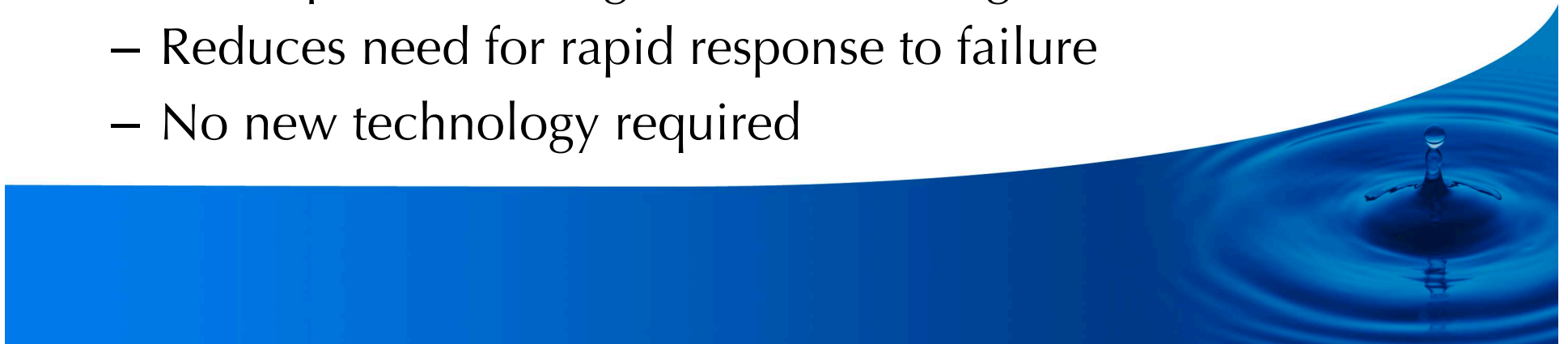
# Treatment Concept for DPR

Employ **both** forms to ensure treatment reliability



## Benefits

- Meets performance goals, even during failure events
- Reduces need for rapid response to failure
- No new technology required

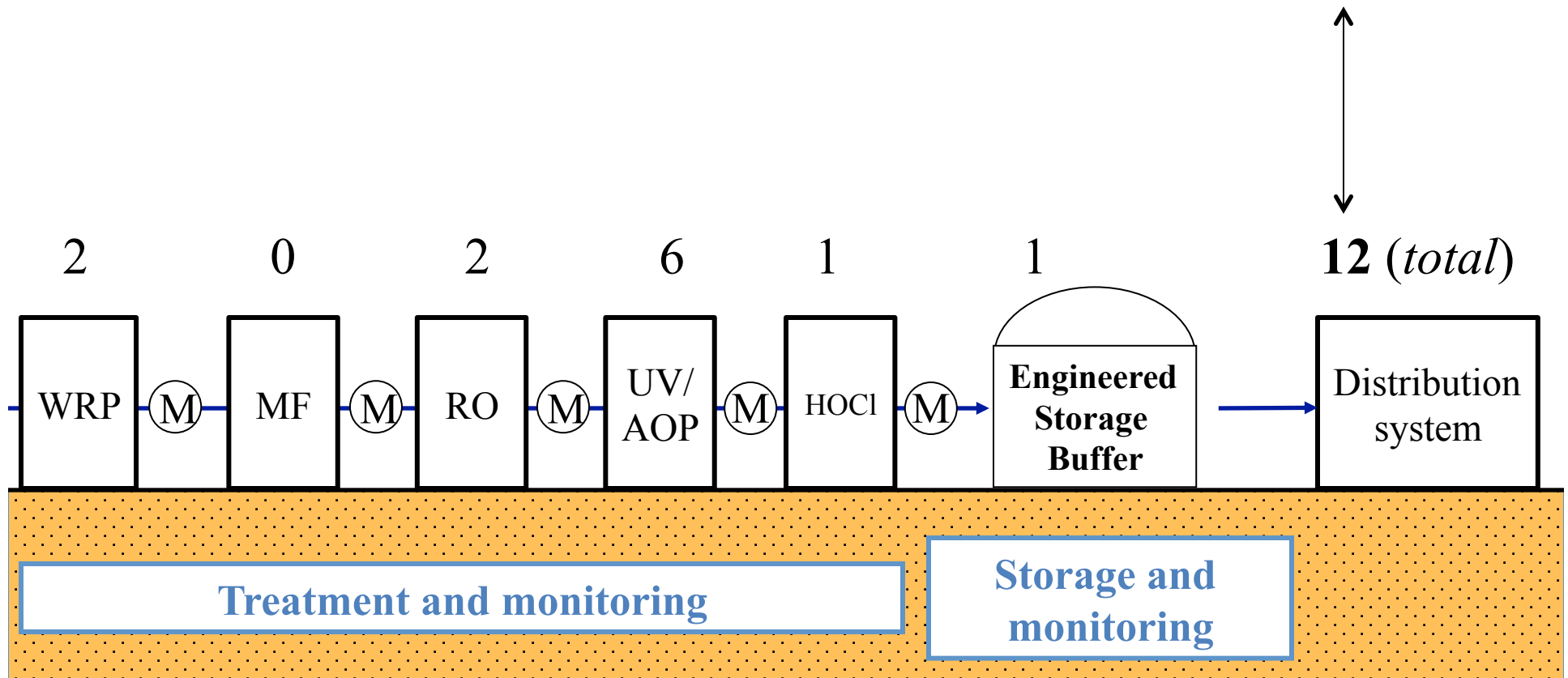




# Example: reliability thru multiple barriers

**Design pathogen removal: 12-log**

**Goal: 12-Log**

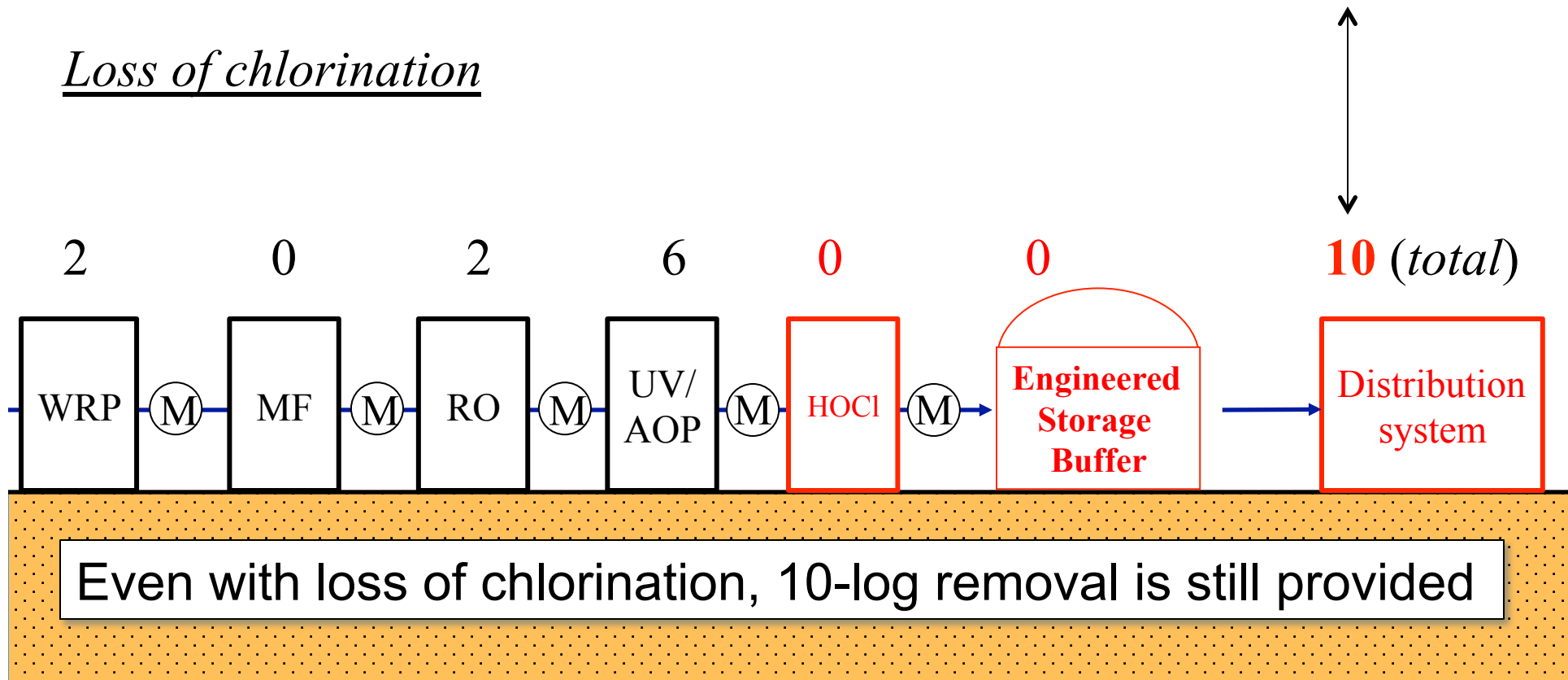


# Example: reliability thru multiple barriers

**Design pathogen removal: 12-log**

**Goal: 12-Log**

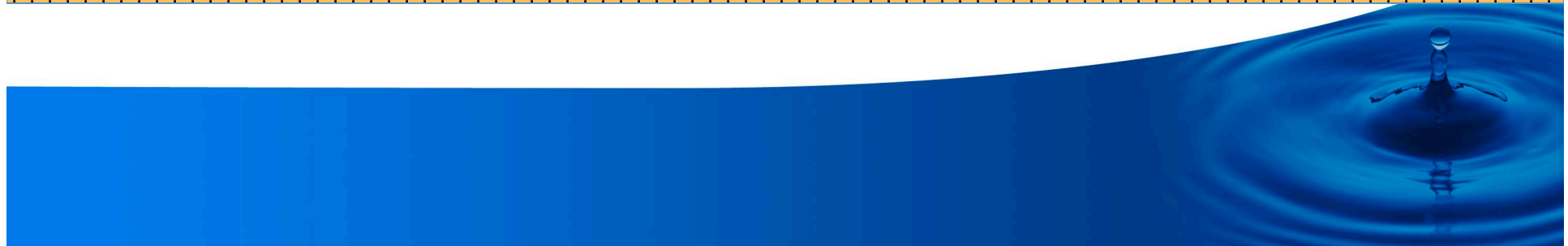
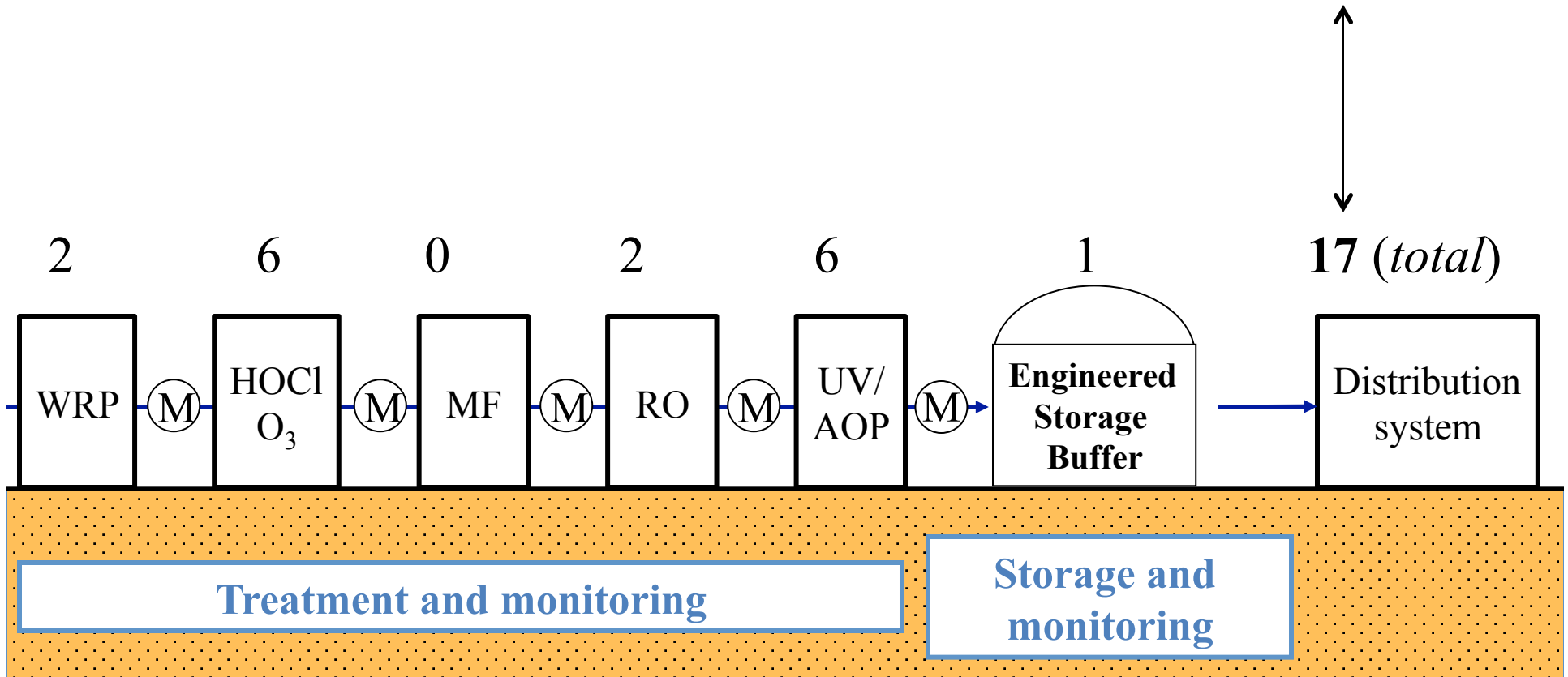
*Loss of chlorination*



# Example: add reliability thru redundancy

**Design pathogen removal: 17-Log**

**Goal: 12-log**

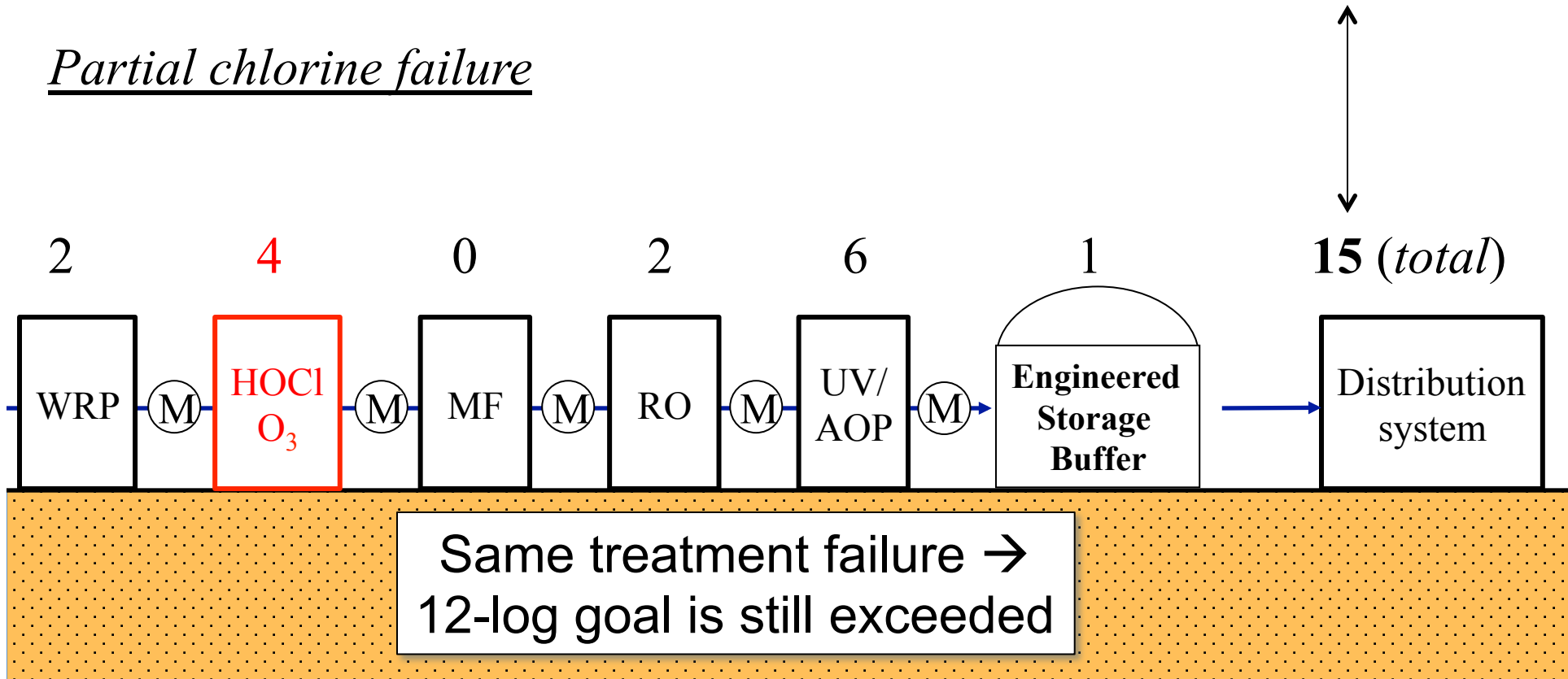


# Example: add reliability thru redundancy

**Design pathogen removal: 17-Log**

**Goal: 12-log**

*Partial chlorine failure*

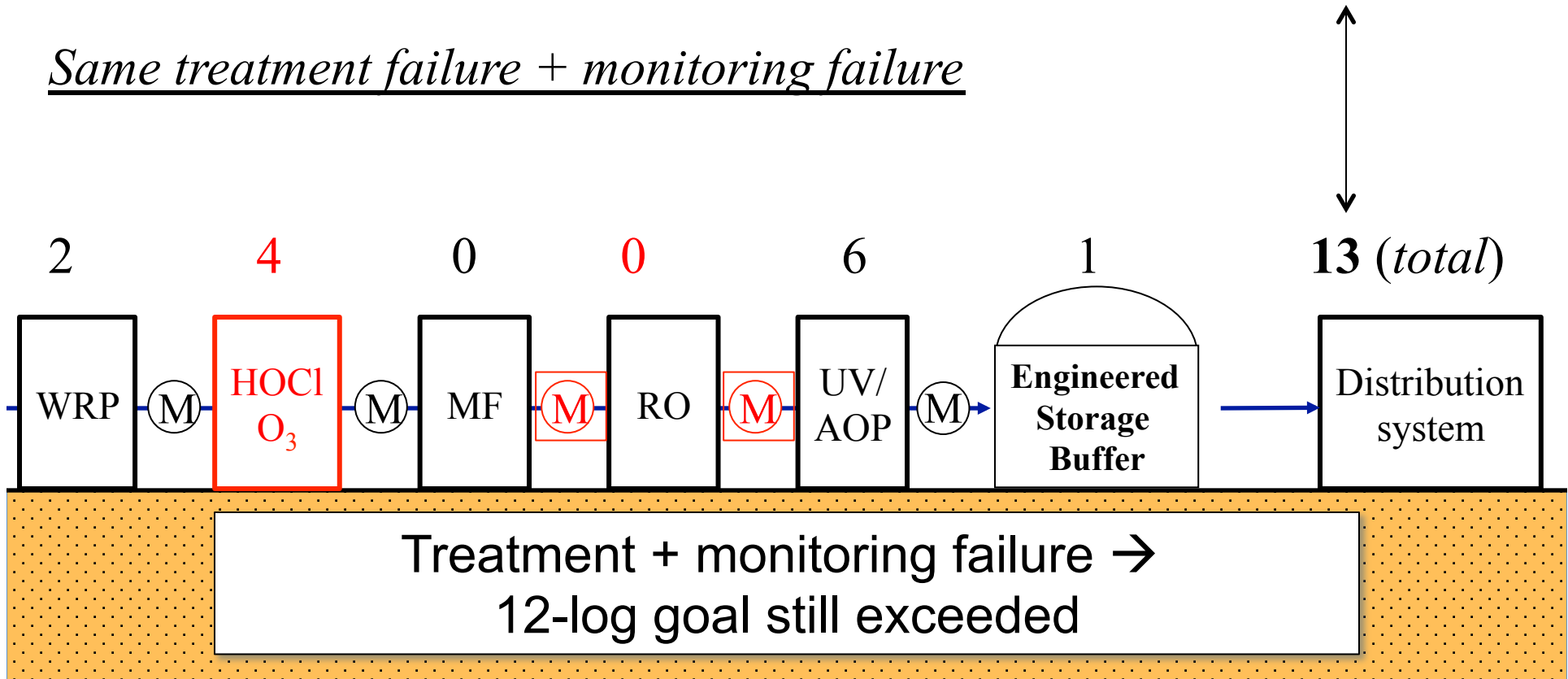


# Example: add reliability thru redundancy

**Design pathogen removal: 17-Log**

**Goal: 12-log**

*Same treatment failure + monitoring failure*

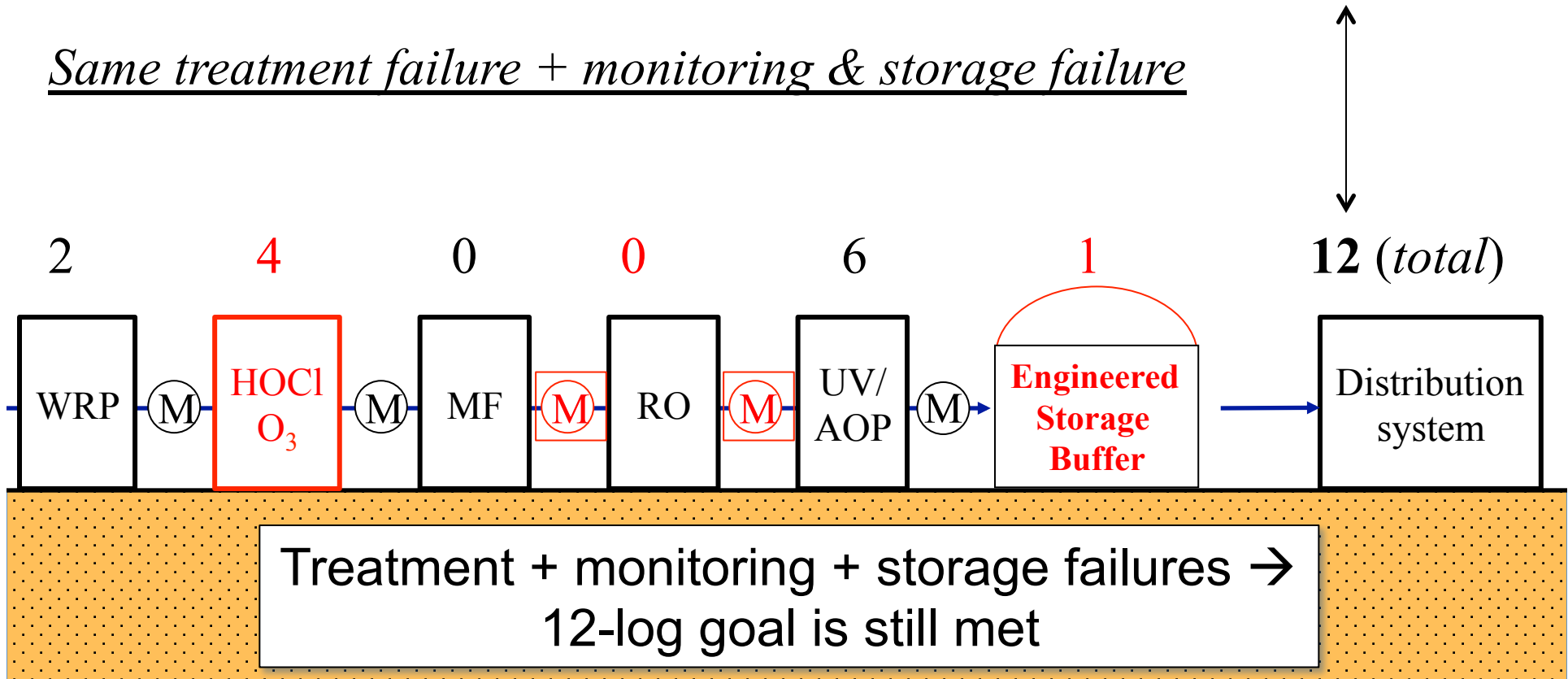


# Example: add reliability thru redundancy

**Design pathogen removal: 17-Log**

**Goal: 12-log**

Same treatment failure + monitoring & storage failure



# Implementing improved treatment

To justify shorter retention times:

- Design treatment train to achieve above the minimum removal requirements
- Quantify performance of unit processes to demonstrate redundancy



# Trade-Offs with Enhanced Treatment

## Benefits:

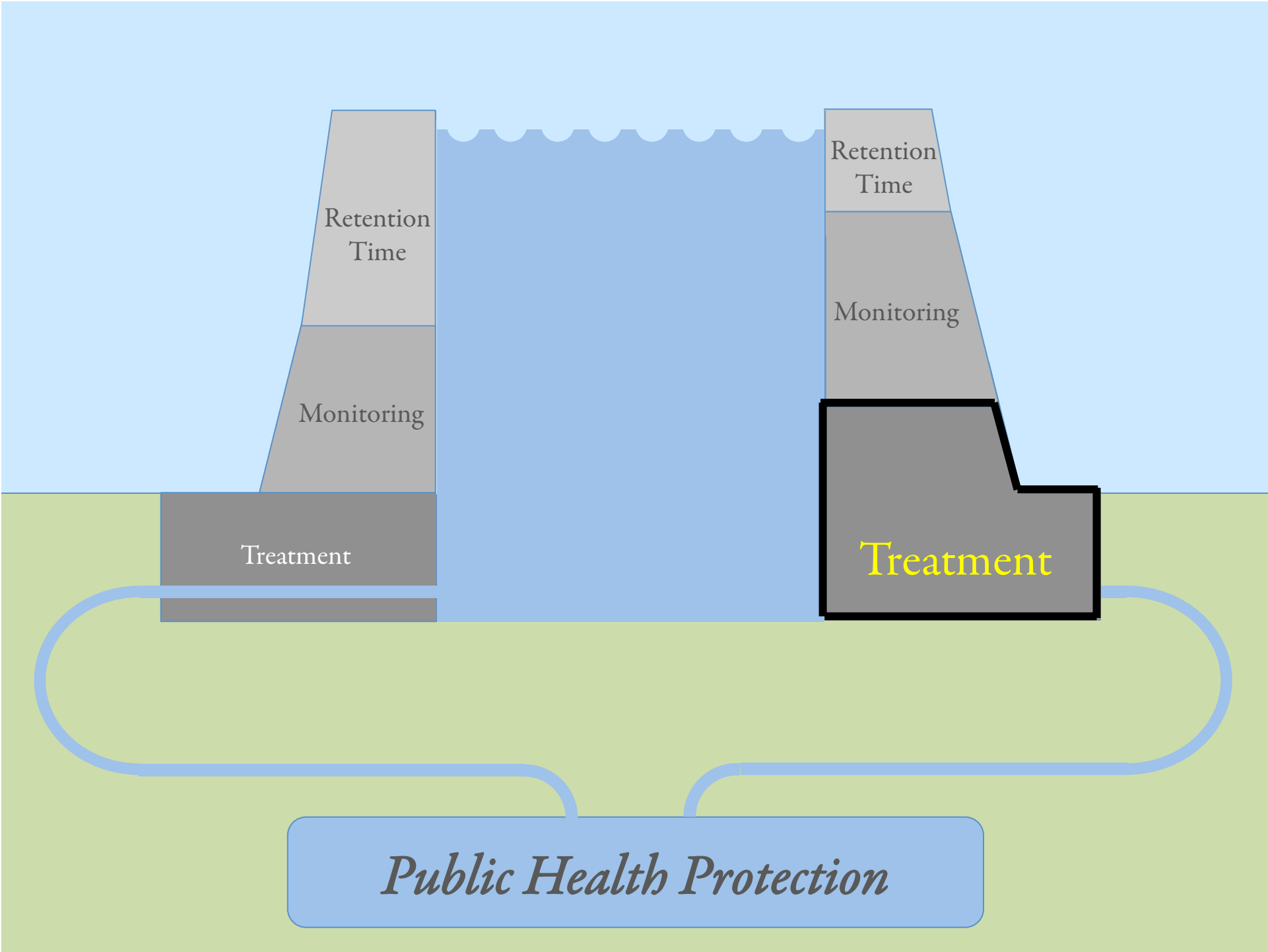
- Ensures reliability during failure of any other potable reuse element
- Achievable with existing technologies

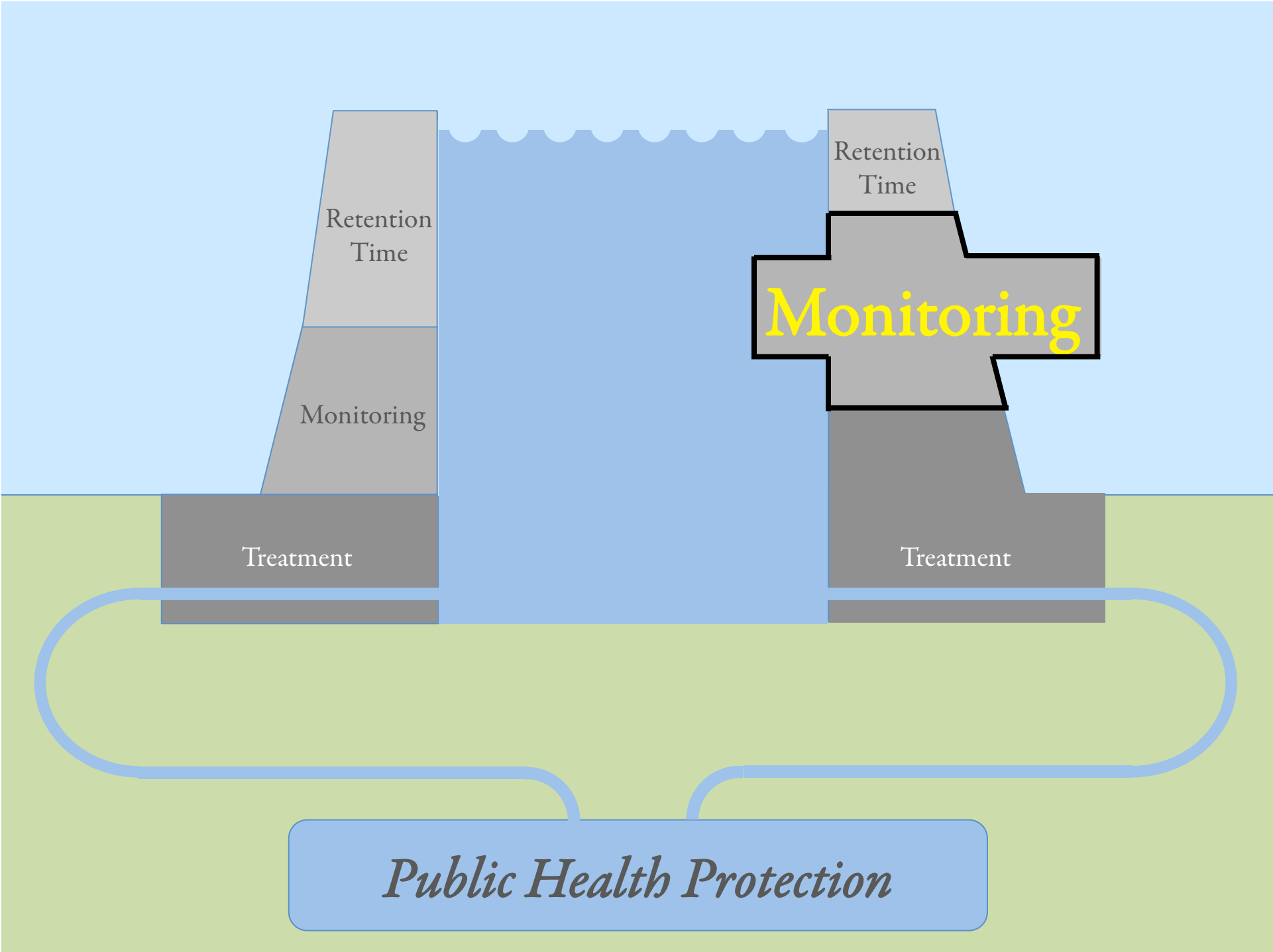
## Disadvantages:

- Cost of additional treatment
- What level of redundancy is *enough*?
  - Balance of reliability vs. response time









Retention Time

Monitoring

Treatment

Retention Time

**Monitoring**

Treatment

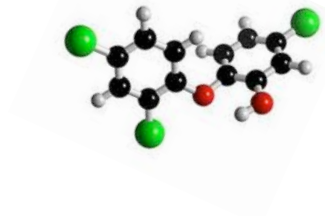
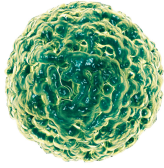
*Public Health Protection*

# Role of monitoring in potable reuse

- Assess process performance and reliability
- Control processes
- Verify compliance with public health and regulatory requirements



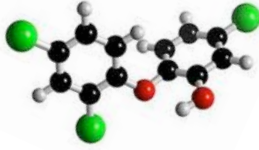
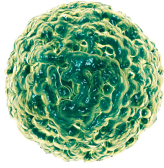
# Acute vs. chronic contaminants



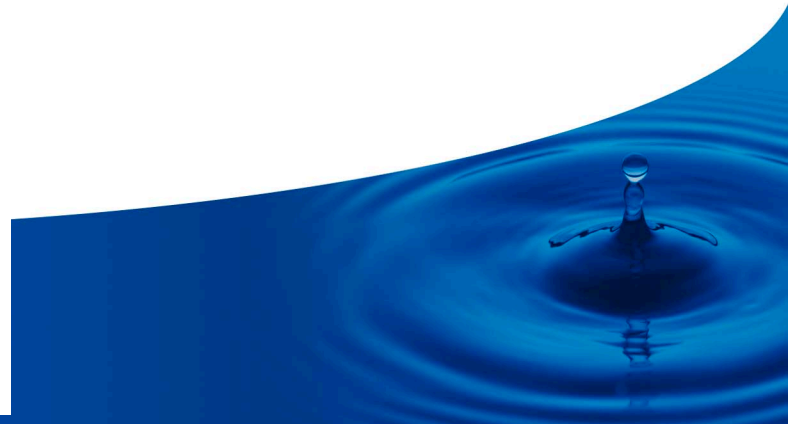
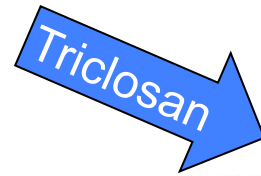
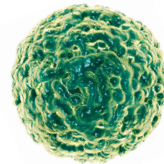
- Pathogen control: the most important aspect



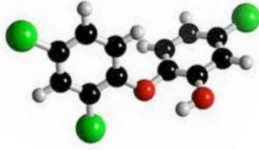
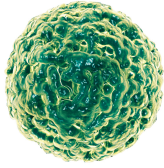
# Acute vs. chronic contaminants



- Pathogen control: the most important aspect
- Why is this the case?

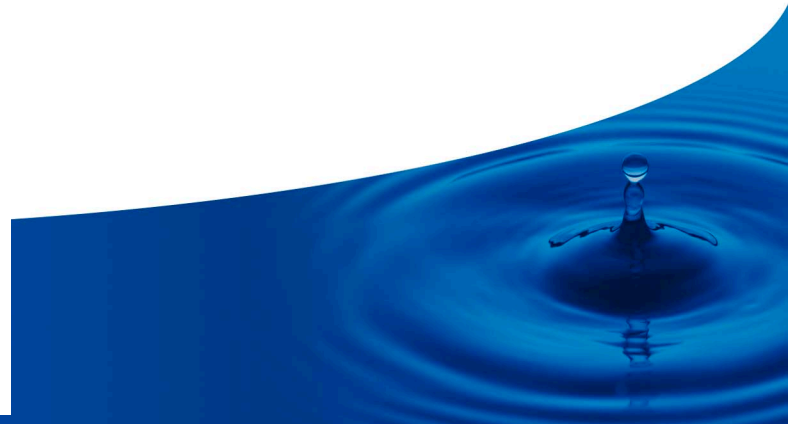
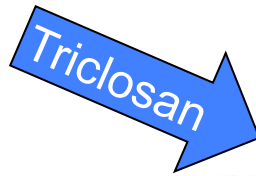
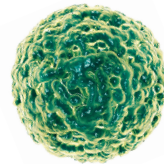


# Acute vs. chronic contaminants

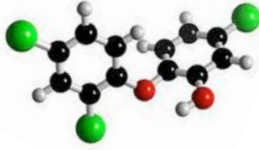
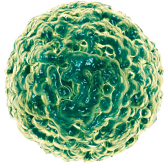


- Pathogen control: the most important aspect
- Why is this the case?

One time exposure



# Acute vs. chronic contaminants

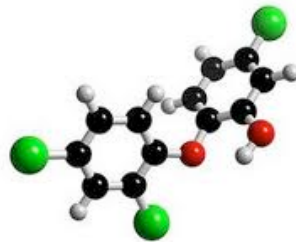
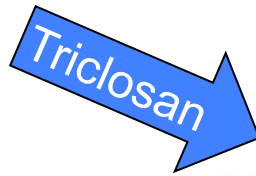
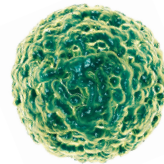


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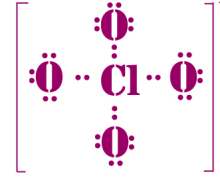
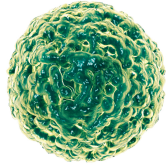
One time exposure



Lifetime Exposure



# Even Acute is a matter of degree

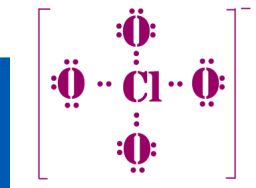
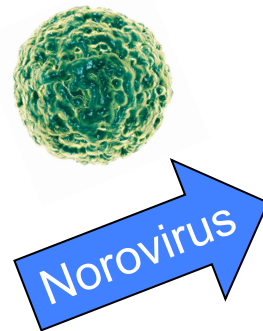


- Pathogen control: the most important aspect
- Why is this the case?

One time exposure



Exposure, 30-d+





# Implementing Enhanced Monitoring

Compensate for shorter RRTs by ensuring proper treatment and rapid response to treatment deterioration or failure

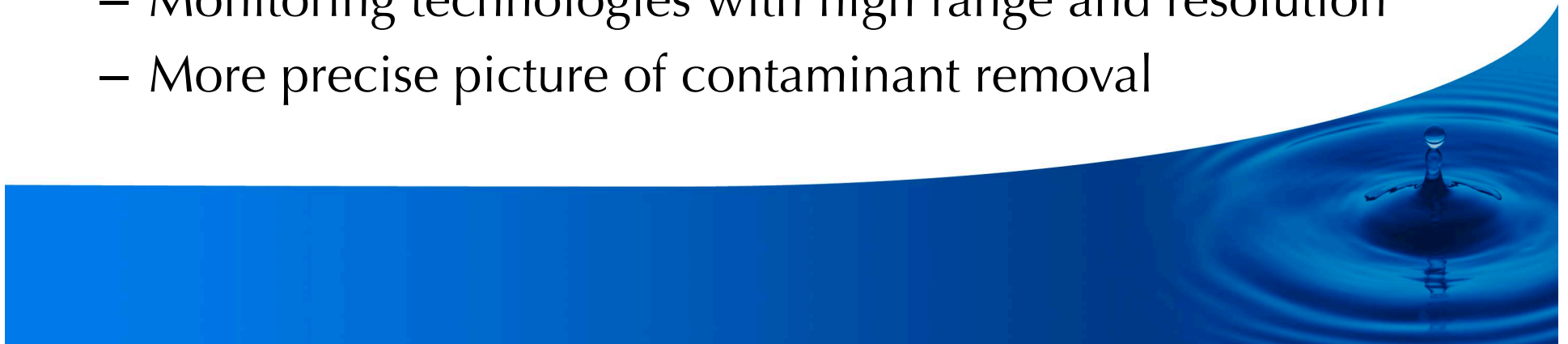


# Enhanced Monitoring

	Pathogens (Acute)	Chemicals (Acute)	Chemicals (Chronic)
Example	Virus, bacteria, <i>Giardia</i> , <i>Cryptosporidium</i>	Nitrate, nitrite, perchlorate	MCLs, CECs, trace organic contaminants
Priority	Highest	High	Medium
Strategy	<ul style="list-style-type: none"> <li>• Multiple barriers</li> <li>• Focus on CCPs</li> <li>• Provide on-line monitoring of CCPs</li> <li>• Periodic testing (DIT)</li> </ul>	<ul style="list-style-type: none"> <li>• Multiple, robust barriers (BNR, RO)</li> <li>• Source control/ characterization</li> <li>• Routine monitoring</li> </ul>	<ul style="list-style-type: none"> <li>• Multiple, robust barriers (biological, physical, chemical)</li> <li>• Source control / characterization</li> <li>• Routine monitoring</li> <li>• Follow proposed CDPH regulations</li> </ul>

# Enhanced Monitoring – Overview

- Higher temporal sensitivity
  - Pathogens and acute chemicals – on-line surrogate measurement of all CCPs
  - Sampling location: minimize time between treatment and monitoring
- Analytical sensitivity
  - Monitoring technologies with high range and resolution
  - More precise picture of contaminant removal



# Trade-Offs with Enhanced Monitoring

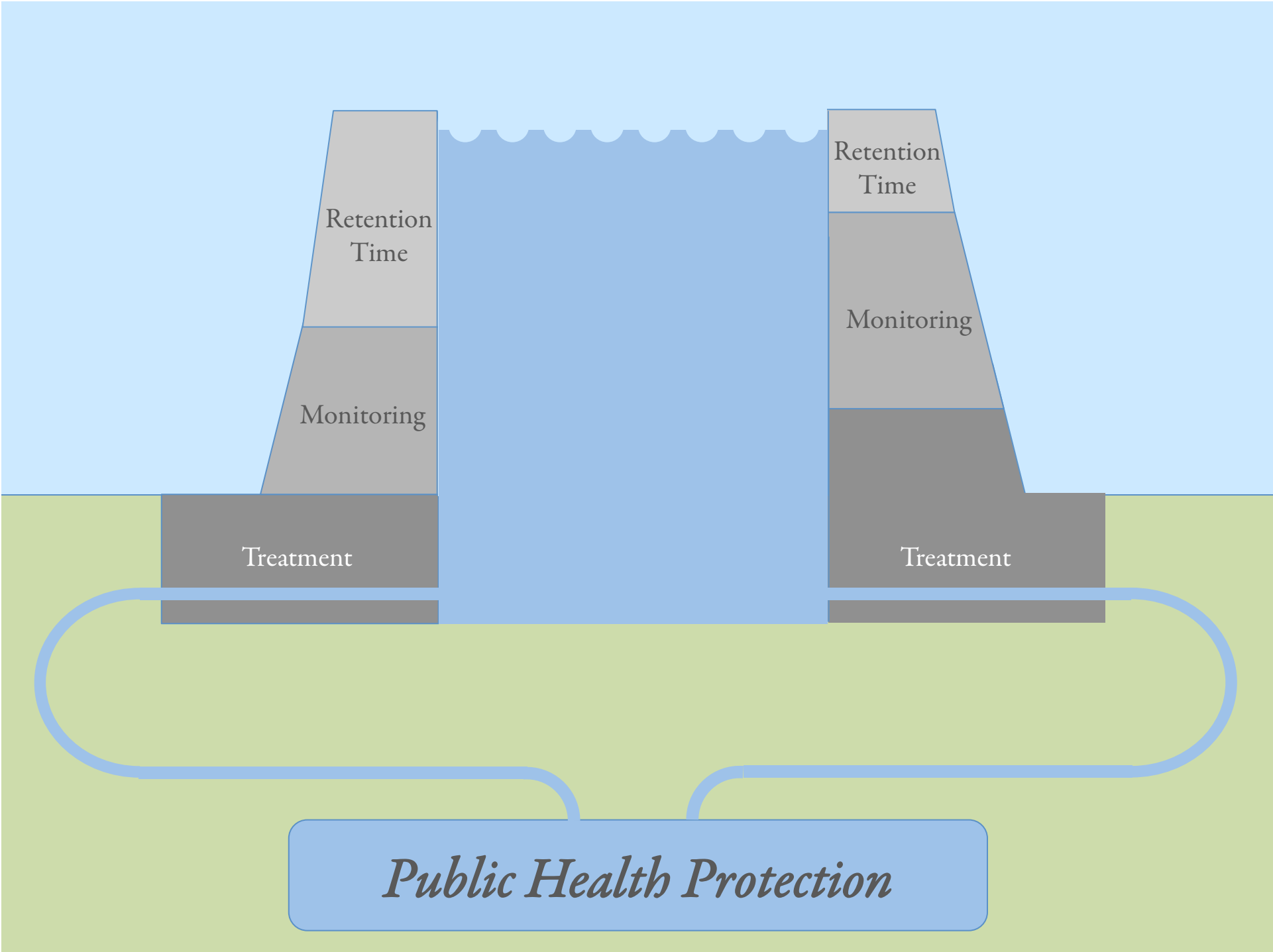
## Benefits:

- Rapid notification of treatment lapses or failures
- Can demonstrate achievement of some WQ standards

## Disadvantages:

- Cannot (*yet*) demonstrate finished water meets microbial water quality goals
- On-line, continuous instrumentation not available for all contaminants of concern





Treatment

Monitoring

Retention Time

Treatment

Monitoring

Retention Time

*Public Health Protection*

# Conclusions

By providing:

1. High level of redundant pathogen treatment
2. Robust train for control of acute and chronic chemicals
3. Tight temporal monitoring and control of **all** critical control points

**DPR can ensure public health at shortened response retention time**



# Acknowledgements

- Rhodes Trussell
- Shane Trussell
- Aleks Pisarenko



*The End*

