California Bay-Delta Authority Funded Research:

Integrating UV Light to Achieve Multiple Treatment Objectives

California Bay-Delta Public Advisory Committee Meeting

June 27, 2003

Discussion Topics

- Water quality issues of concern
- Available treatment technologies
- UV research at Metropolitan
- Bay-Delta Authority funded project

Southern California's Imported Water

Metropolitan's Treatment Plants

SPW = California State project water
CRW = Colorado River water

Plant	Source	Flow (mgd)
Jensen	SPW	500
Mills	SPW	160
Weymouth	CRW/SPW	520
Diemer	CRW/SPW	520
Skinner	CRW/SPW	520

Water Treatment Philosophy

Source Protection

Treatment Effectiveness

Distribution Integrity

Formation of Disinfection By-Products

TOC and bromide

React with

Disinfectants

and Form

Disinfection By-Products

Water Quality Issues

- Disinfection by-products
- Disinfection
- Salinity
- Aesthetics (T&O, color)
- Other contaminants (perchlorate, NDMA, chrome VI, MTBE, …)
- Intentional contamination

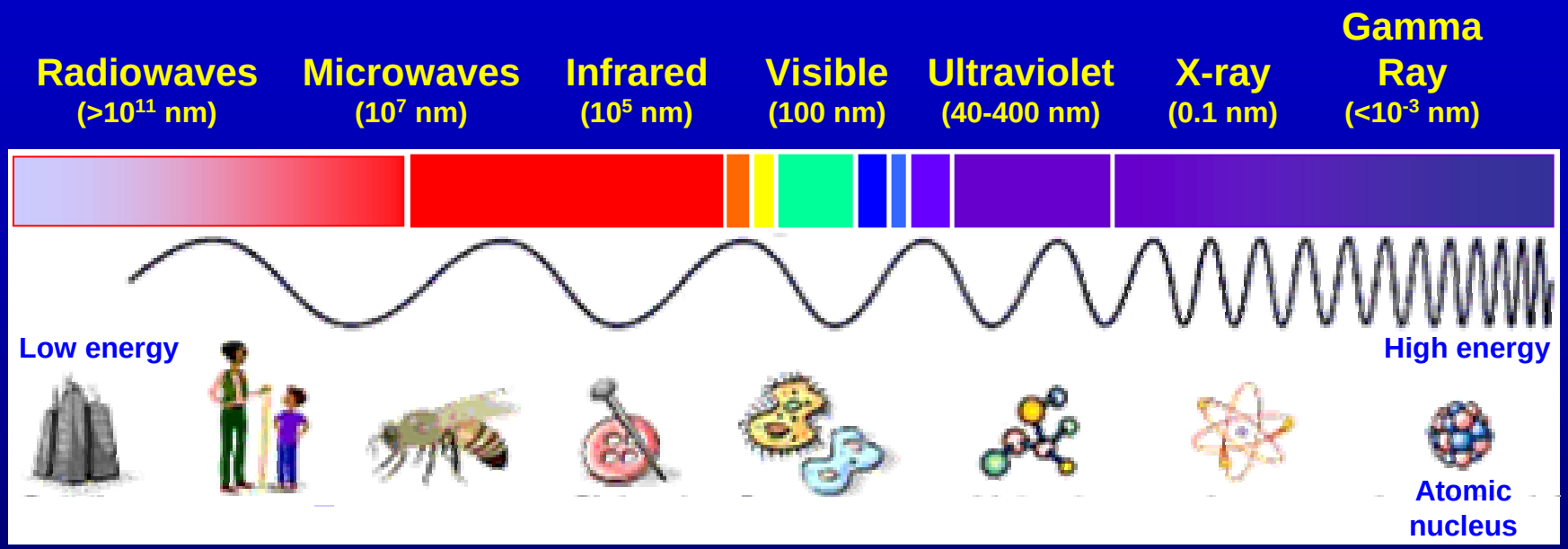
→ *Multiple Objectives*

T&O Control
Disinfection
DBP Control
Technology Selection
Salinity Control
Cost

Past Technology Evaluation Activities

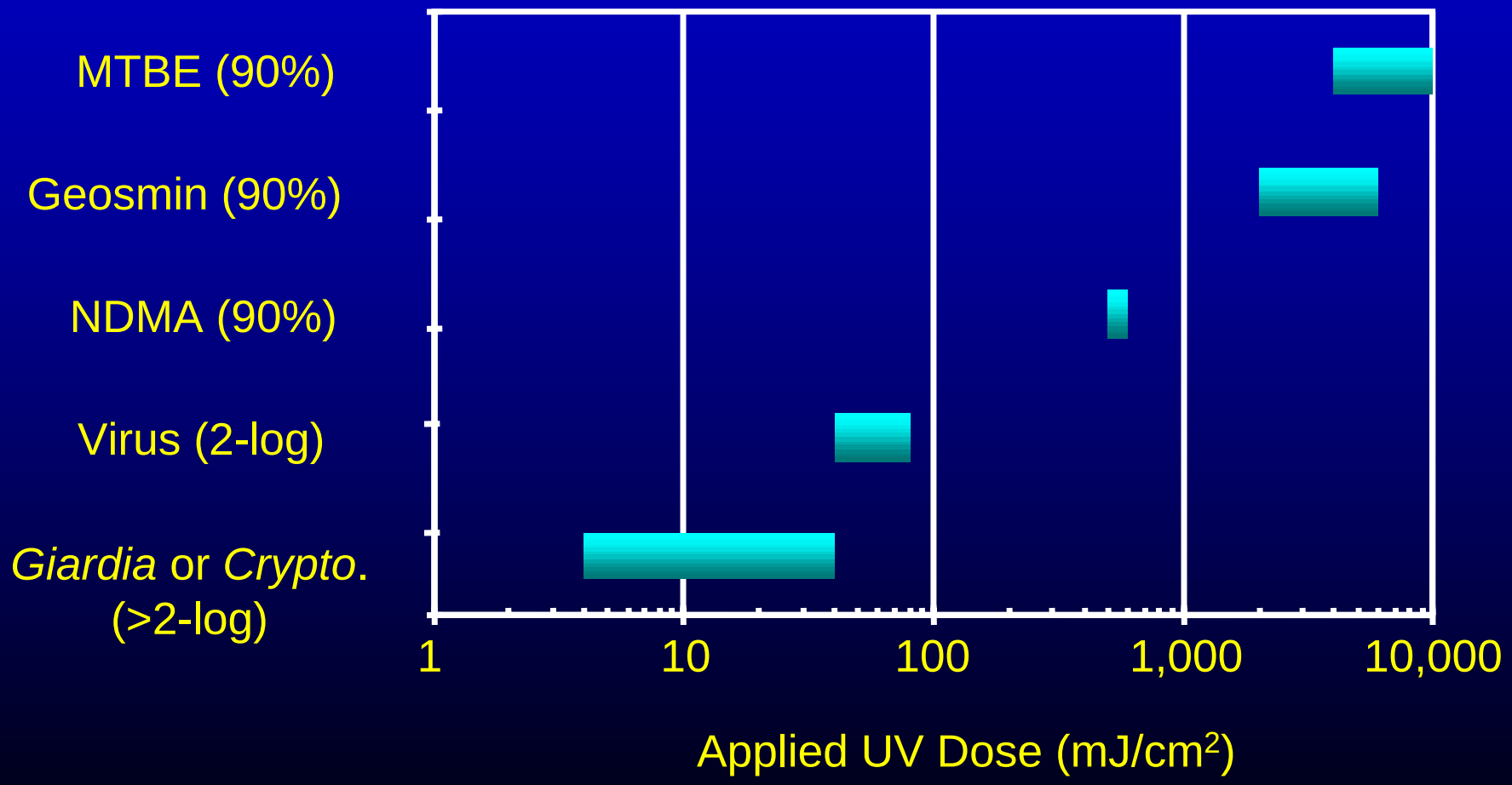
- Regulatory participation
- Technology evaluations
  - Ozone
  - Chlorine dioxide
  - UV
- Process design
- Construction
  - Ozone for SPW treatment
  - UV not required for regs

UV Basics


Radiowaves
(>10^11 nm)
Microwaves
(10^7 nm)
Infrared
(10^5 nm)
Visible
(100 nm)
Ultraviolet
(40-400 nm)
X-ray
(0.1 nm)
Gamma Ray
(<10^-3 nm)
Low energy
High energy
Atomic nucleus

Near Ultraviolet
(300-400 nm)
Germicidal Ultraviolet
(200-300 nm)
Vacuum Ultraviolet
(40-200 nm)
Sun Tan (UVA)
Sun Burn (UVB)
DNA Damage (UVC)

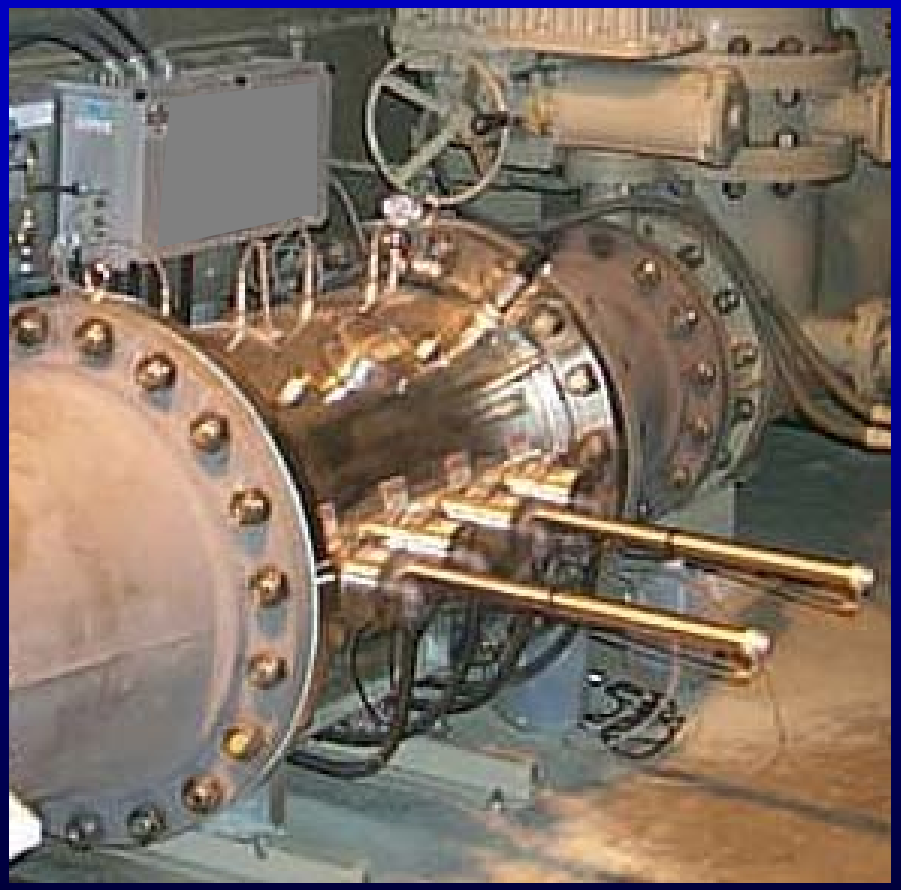
UV Effectiveness



Scale-Up of UV Disinfection

Bench-scale UV research

(10 to 500 mL batch)

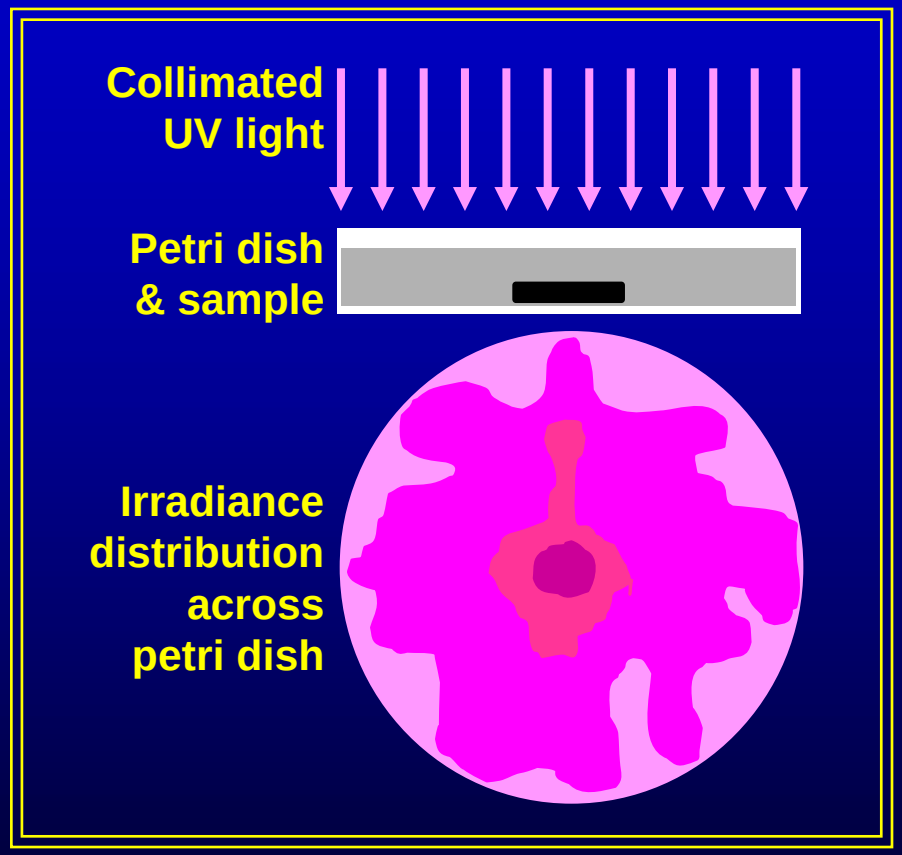


Demonstration-scale UV research

(3 million gallons per day)

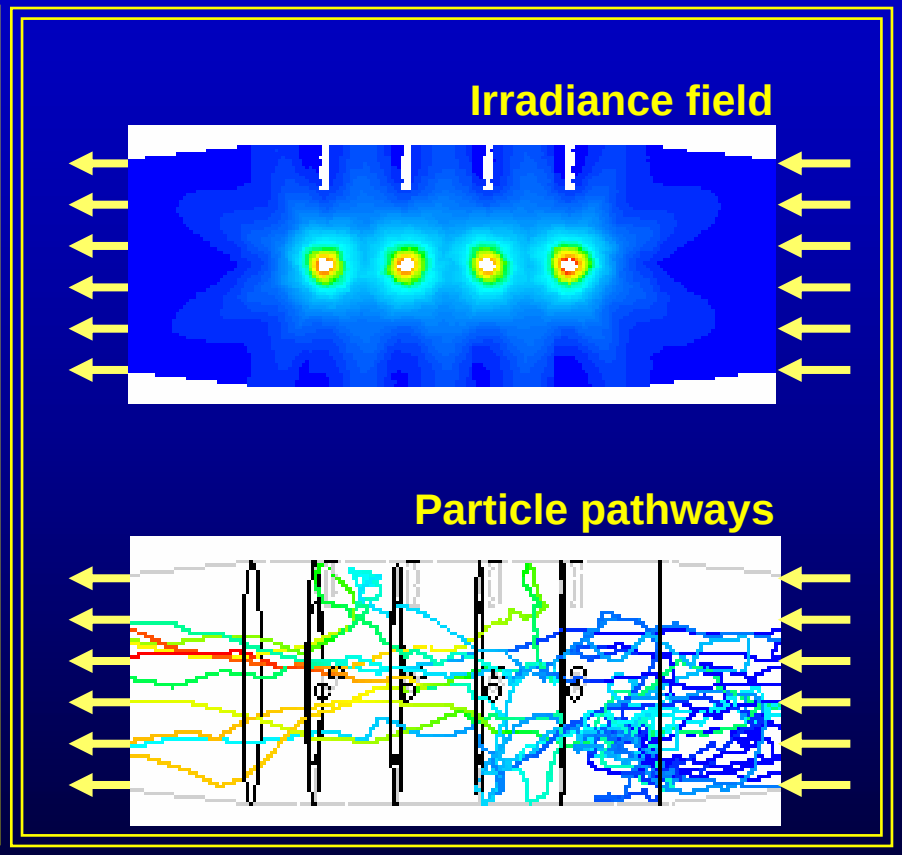
Scale-Up of UV Disinfection

- **Bench-Scale**



- ✓ Irradiance/area (mW/cm^2)
- ✓ Time applied "t" (s)
- ✓ Dose = mW*s/cm^2 = mJ/cm^2

- **Full-Scale**



- ✓ Irradiance field (equivalent "I")
- ✓ Hydrodynamics (effects "t")
- ✓ "Equivalent" dose (mJ/cm^2)

Scale-Up of UV Treatment

UV reactor at Metropolitan

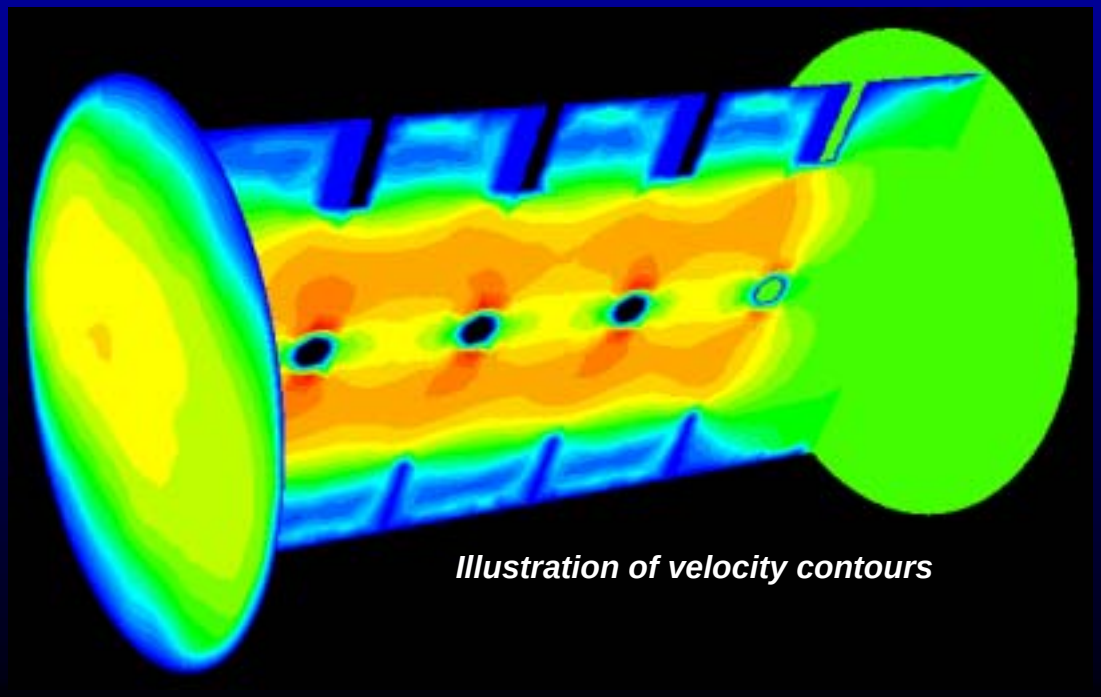
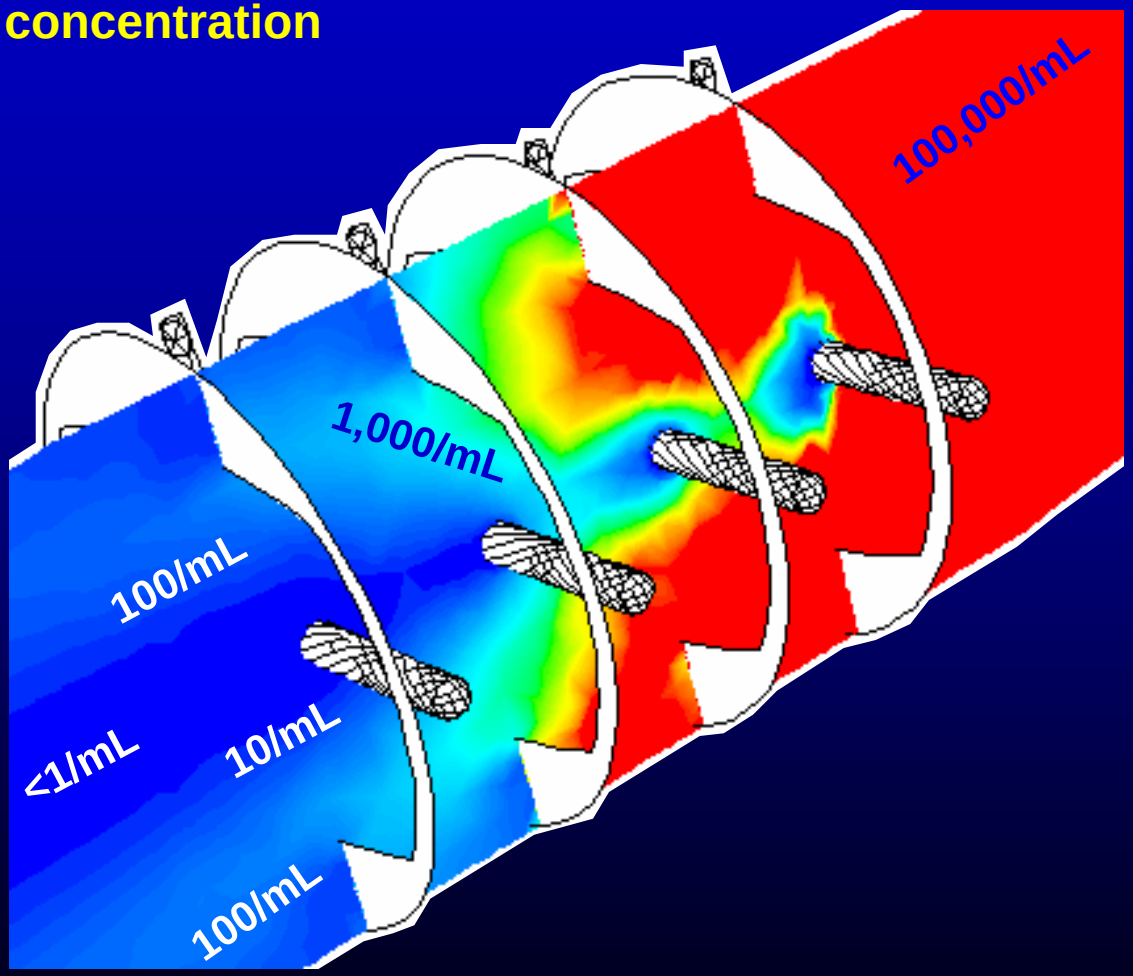


Illustration of velocity contours

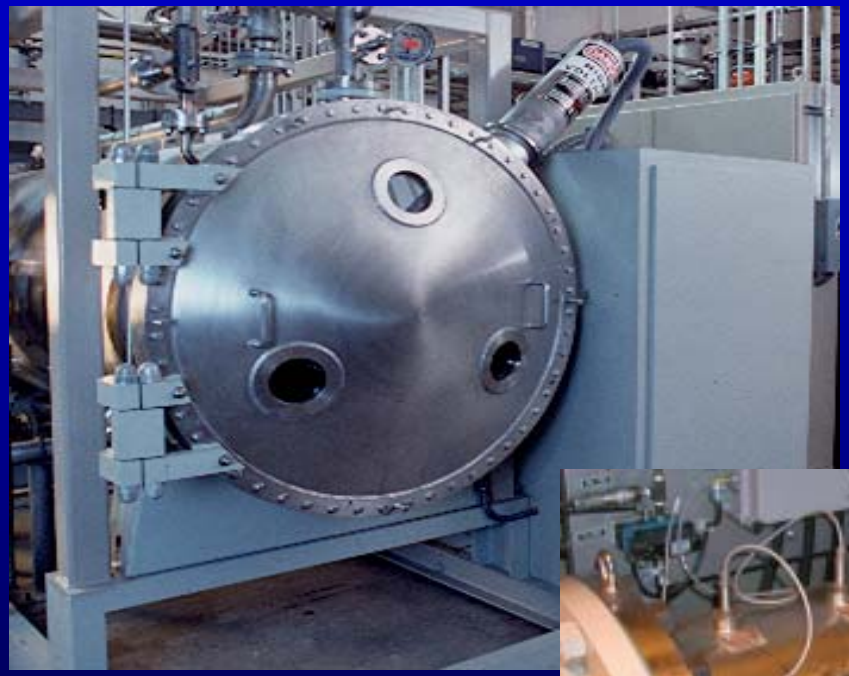
Large-Scale UV Issues

Modeled effect on microorganism concentration



- UV dose
- Water quality
  - Absorbance
  - Turbidity
- Hydraulics
  - Flow changes
  - Headloss
- Reactor size

Integrating UV Light to Achieve Multiple Water Quality Objectives



Ozone

UV

Chlorine dioxide

Project Objectives

- Integrated UV treatment may minimize chemical/microbial risk while allowing for increased variation in Delta water quality
- Integrated process must achieve multiple treatment objectives
  - Particle removal
  - Disinfection
  - DBP minimization
  - Oxidation of micropollutants
- Sequential combination of UV light with ozone, chlorine, and chlorine dioxide

Integrating UV Light to Achieve Multiple Water Quality Objectives

California Bay-Delta Authority

State Project Water → **Conventional treatment with UV light** → **Multiple treatment objectives**

- ✓ TOC
- ✓ Bromide

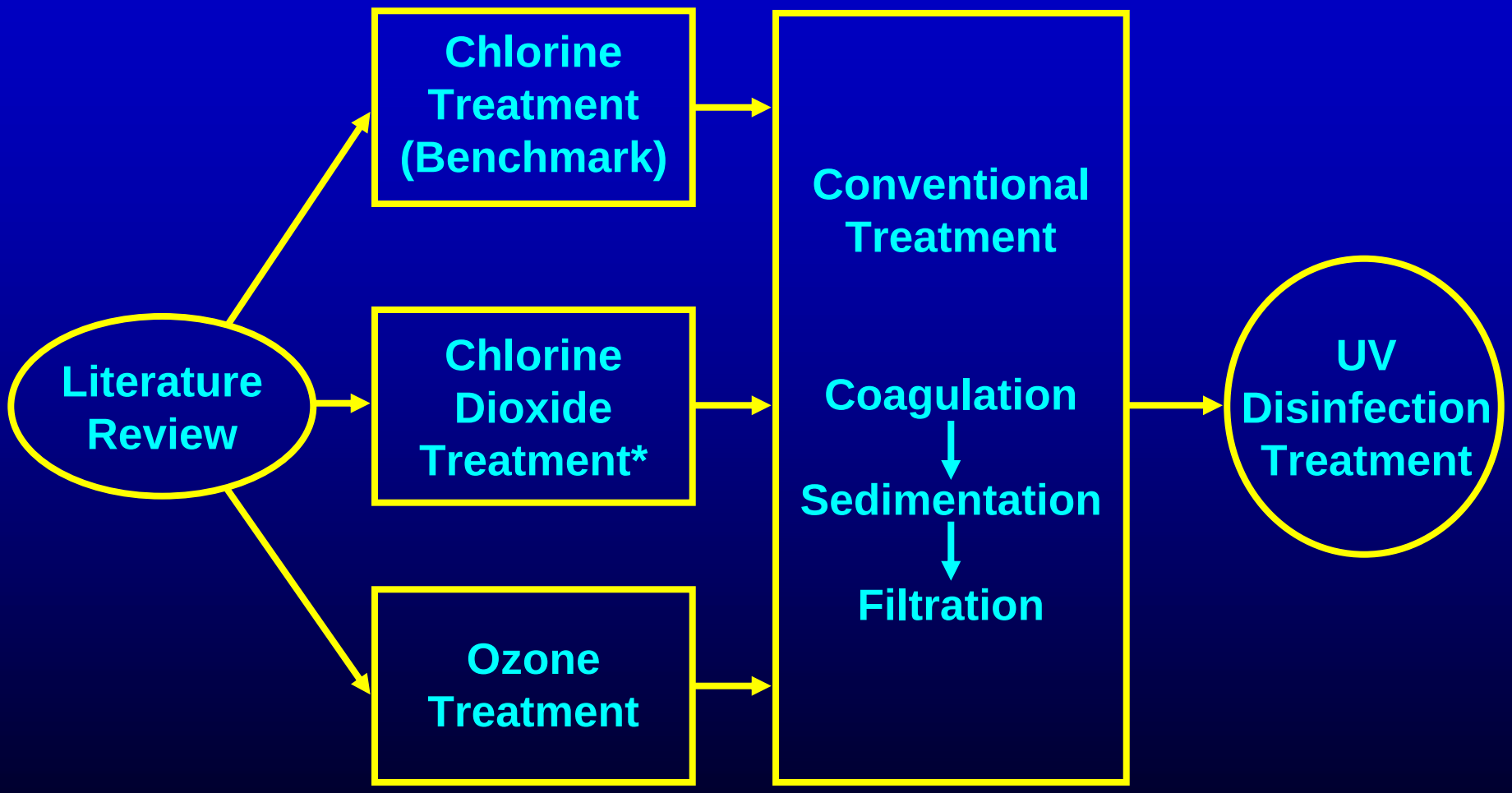
- ✓ Ozone, chlorine, chlorine dioxide
- ✓ Floc., sed., filtration
- ✓ Bench-scale
- ✓ Demonstration-scale

- ✓ Disinfection
- ✓ Miminize DBPs
- ✓ Remove particles
- ✓ Oxidize micropollutants

Research Approach

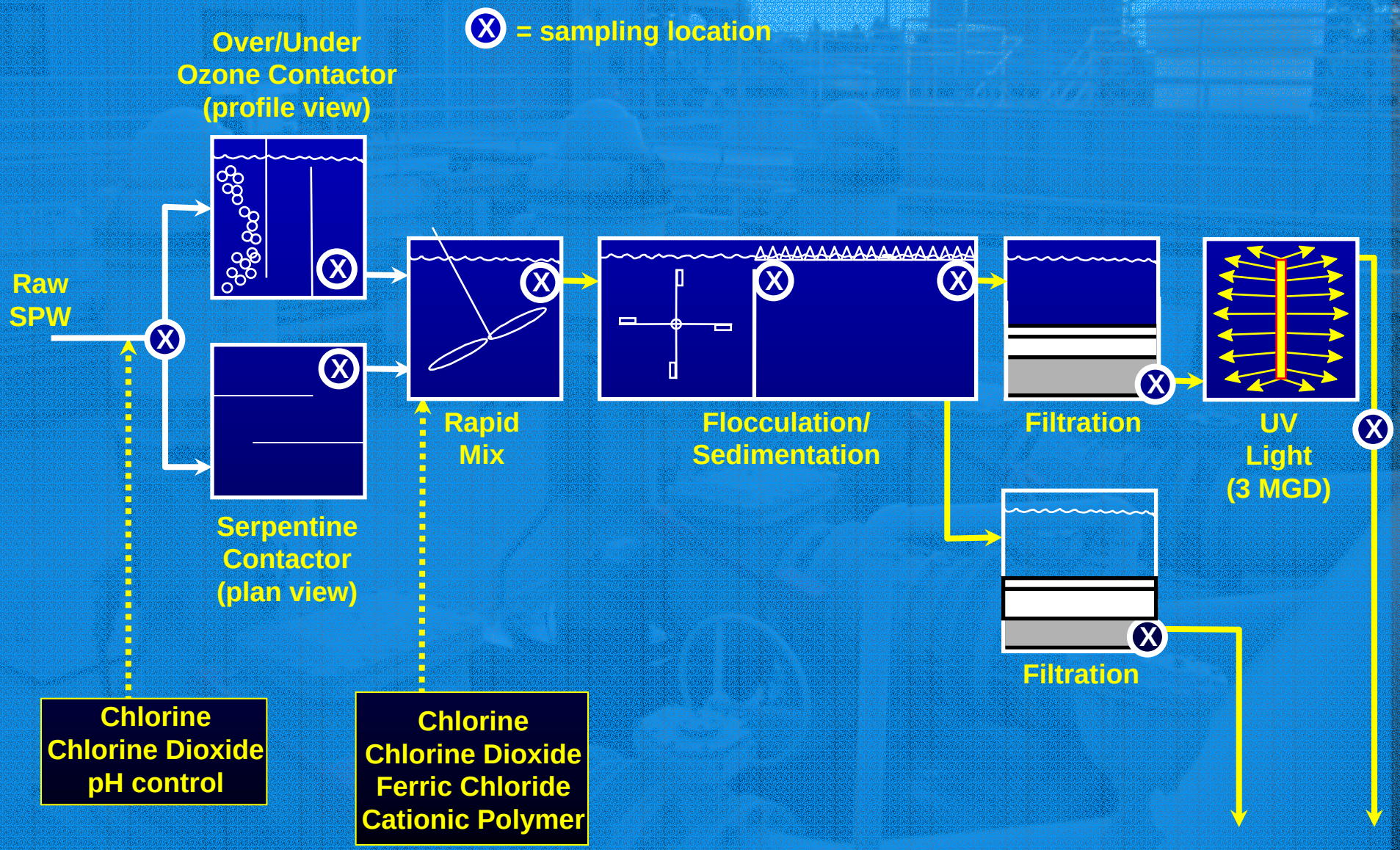
- Review literature
  - Affirm testing protocol and project goals
- Optimize oxidation
  - Control bromate, *Crypto.*, & micropollutants
- Integrate coagulation
  - Reduce DBPs, oxidant demand, and NOM
- Improve filtration
  - Minimize BOM and particle (pathogen) passage
- Integrate UV light
  - Inactivate *Crypto*. while reducing oxidant use

Project Approach



* Minimal bench-scale chlorine dioxide demand tests will precede demo work

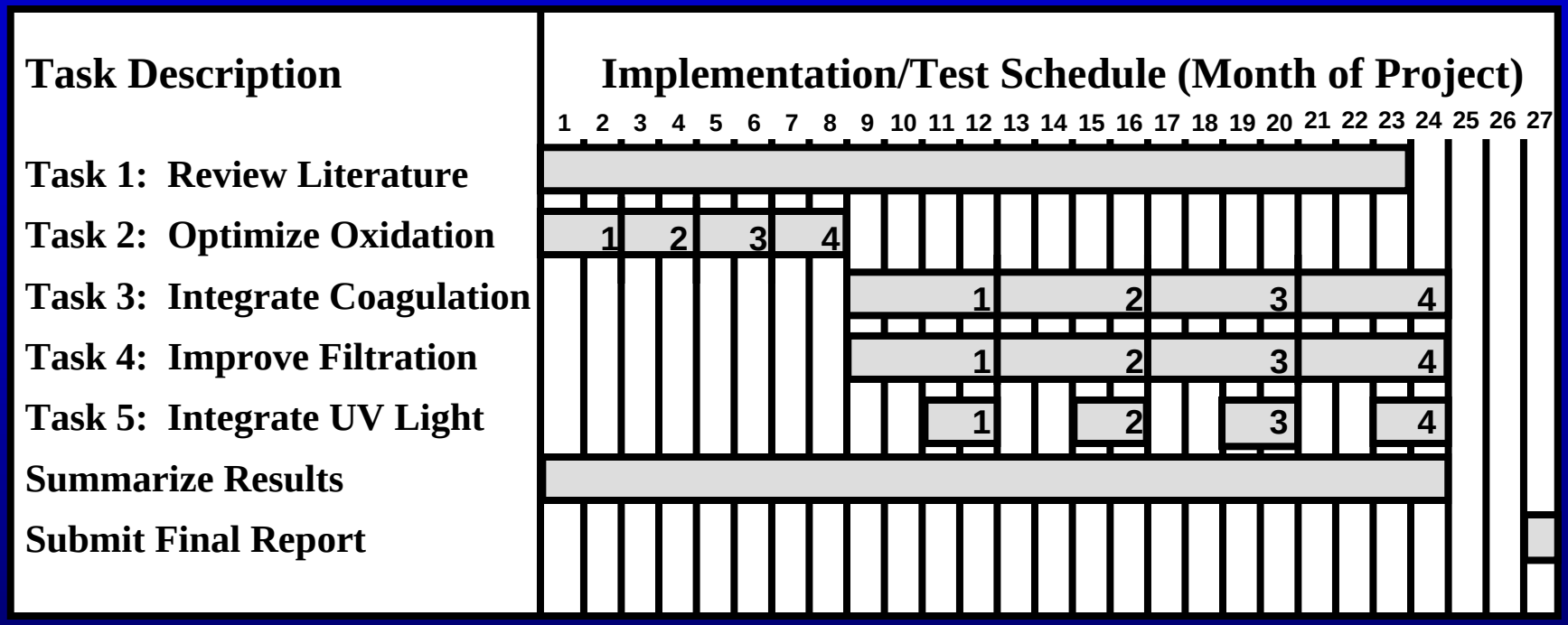
Demonstration-Scale Testing



Summary

- Technologies assessed under multiple water quality objectives
- Variations in SPW quality may be mitigated by integrated treatment
- UV likely not “silver bullet,” but helpful tool

Project Schedule



Status:

- **Finalizing project plan (July)**
- **Begin bench-scale ClO_2 work (July)**
- **Demonstration-scale ClO_2 retrofit and startup is complete**
- **Begin full-scale testing (September)**