PNWS AWWA, Boise, Idaho. May 6, 2011

Validation Testing of the Portland Water Bureau's K143 UV System for the Bull Run Supply

Harold Wright[1], Bryant Bench[1], Timothy Phelan[2], Bryan Townshend[2], Dave Peters[3], Chad Talbot[3], and Ronnie Bemus[4]

1. Carollo Engineers, 2. Black and Veatch,
3. Portland Water Bureau, 4. ITT-WEDECO

Portland's Bull Run Supply Meets SWTR Filter Avoidance Criteria

Portland’s Bull Run Supply’s Protected Watershed

2006 LT2ESWTR Requires Crypto Inactivation With Unfiltered Systems

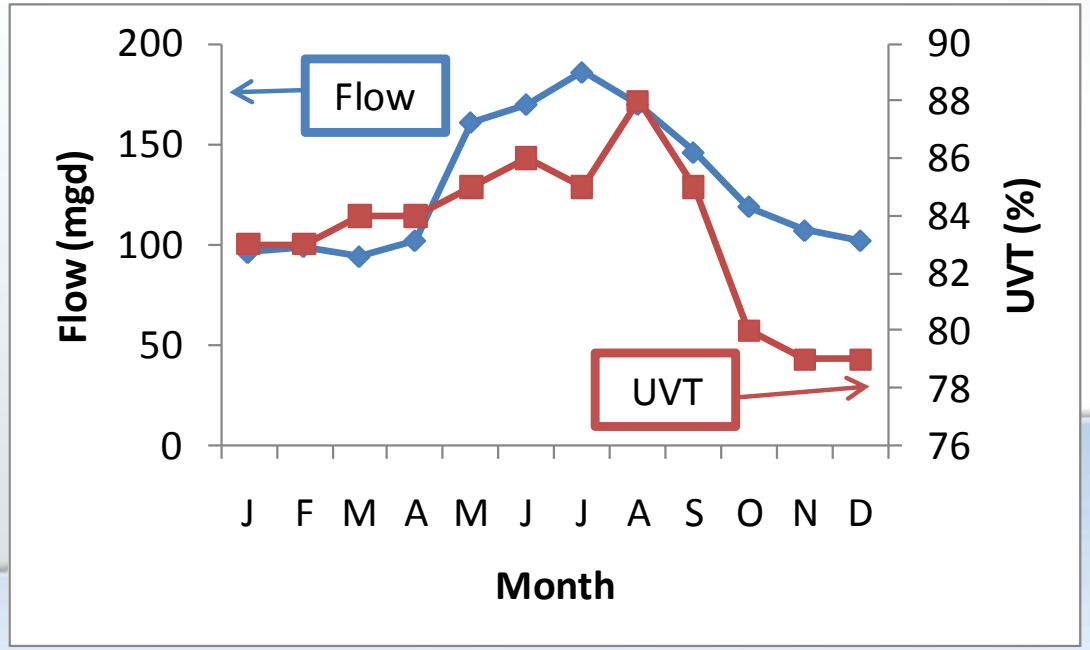
Source Water *Cryptosporidium* Concentration	Treatment Required for Unfiltered System
< 0.000 075/L	Variance may be granted
< 0.01/L	2.0 log
> 0.01/L	3.0 log

Portland's LT2 Compliance Strategy

- Two compliance options being pursued
  - Obtain Variance to the LT2
    - Based on 8 years of sampling showing zero Crypto oocysts
  - Implement UV Disinfection
    - Best Available Technology for Crypto Inactivation
    - Implement if variance not obtained

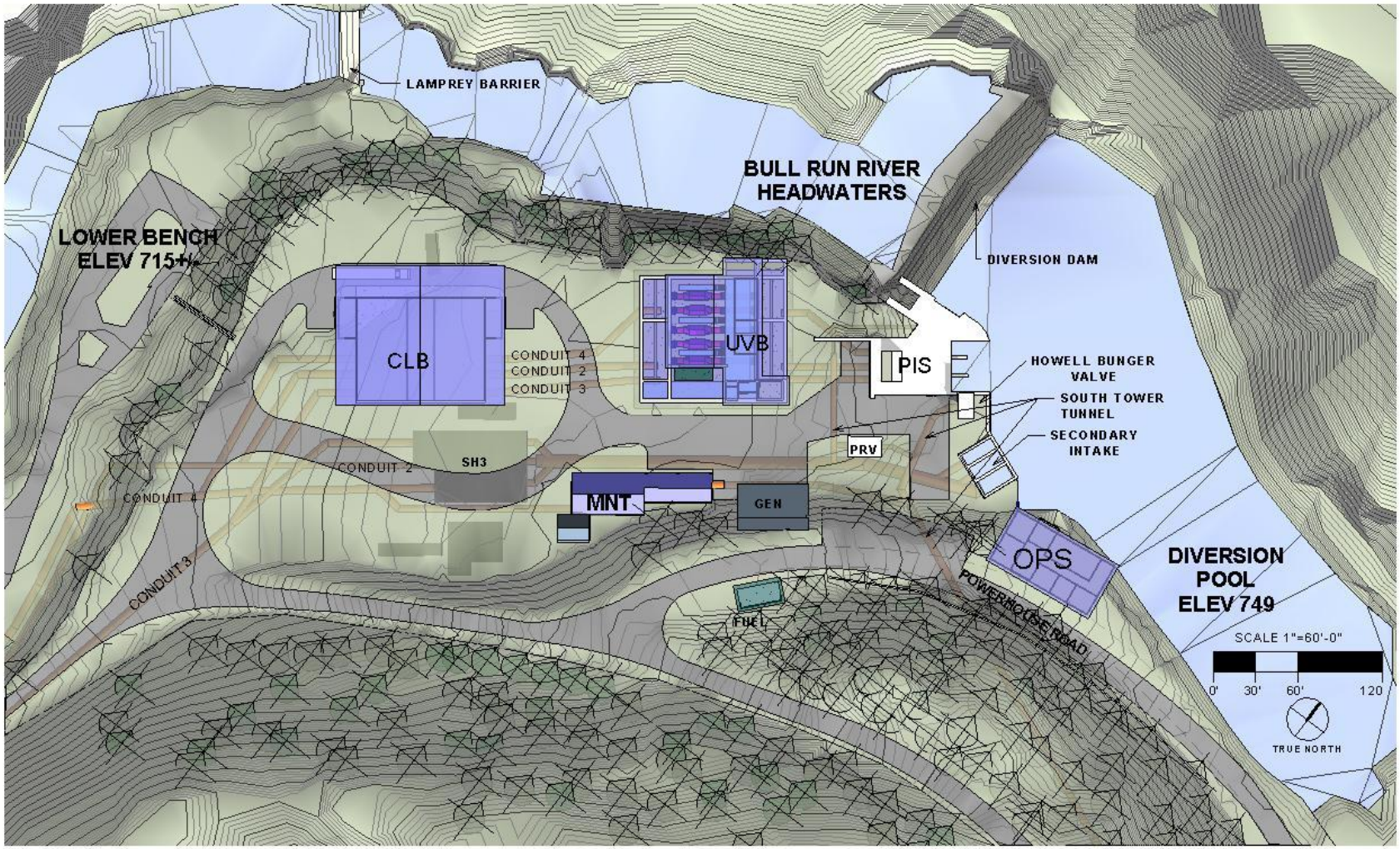
UV System Design Criteria

- Up to 3 log Cryptosporidium inactivation with 20% safety factor
  - Option to operate for 2 or 3 log credit
- Design flow and UVT accounts for seasonal impacts

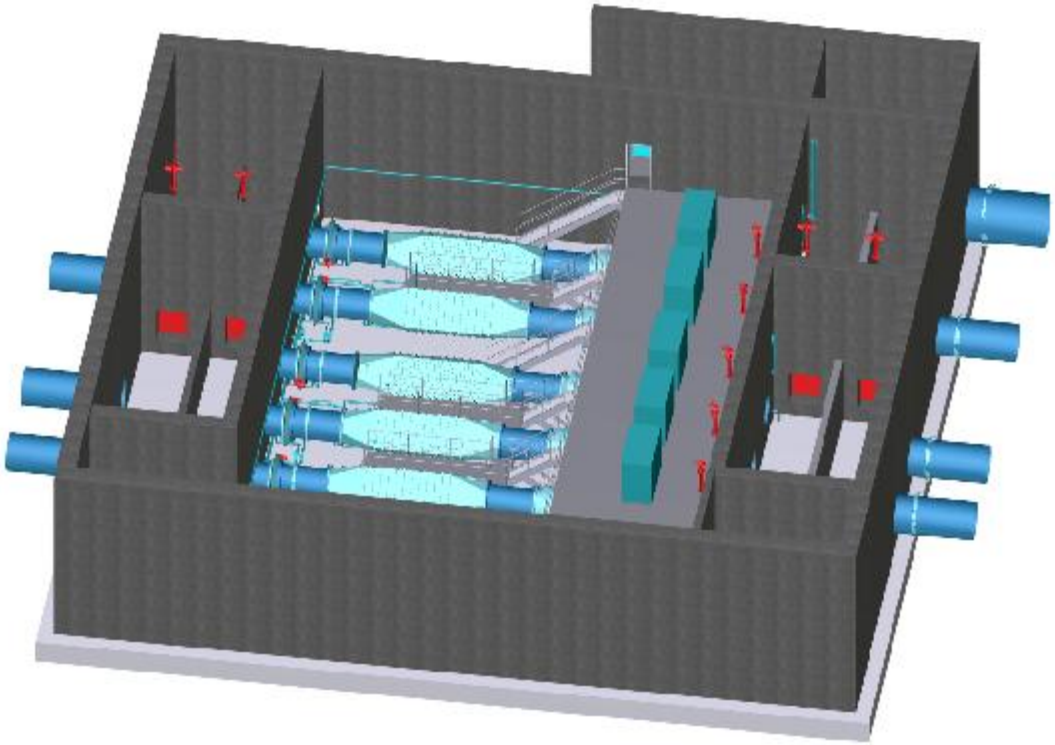


Portland Selected ITT-WEDECO K143 Reactors

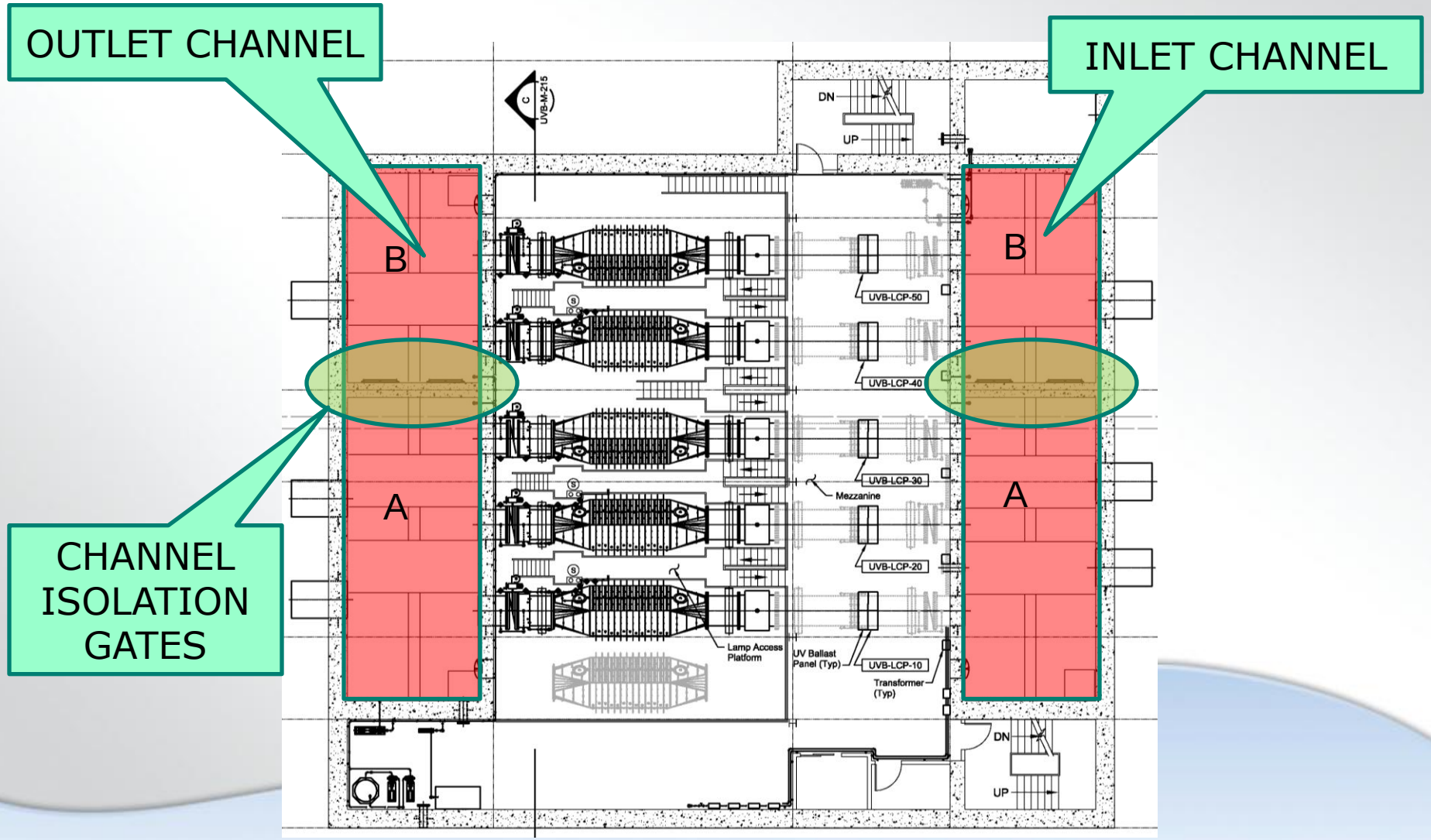
UV Disinfection Located at the Bull Run Headworks



UV Building Layout Uses 5 Reactors

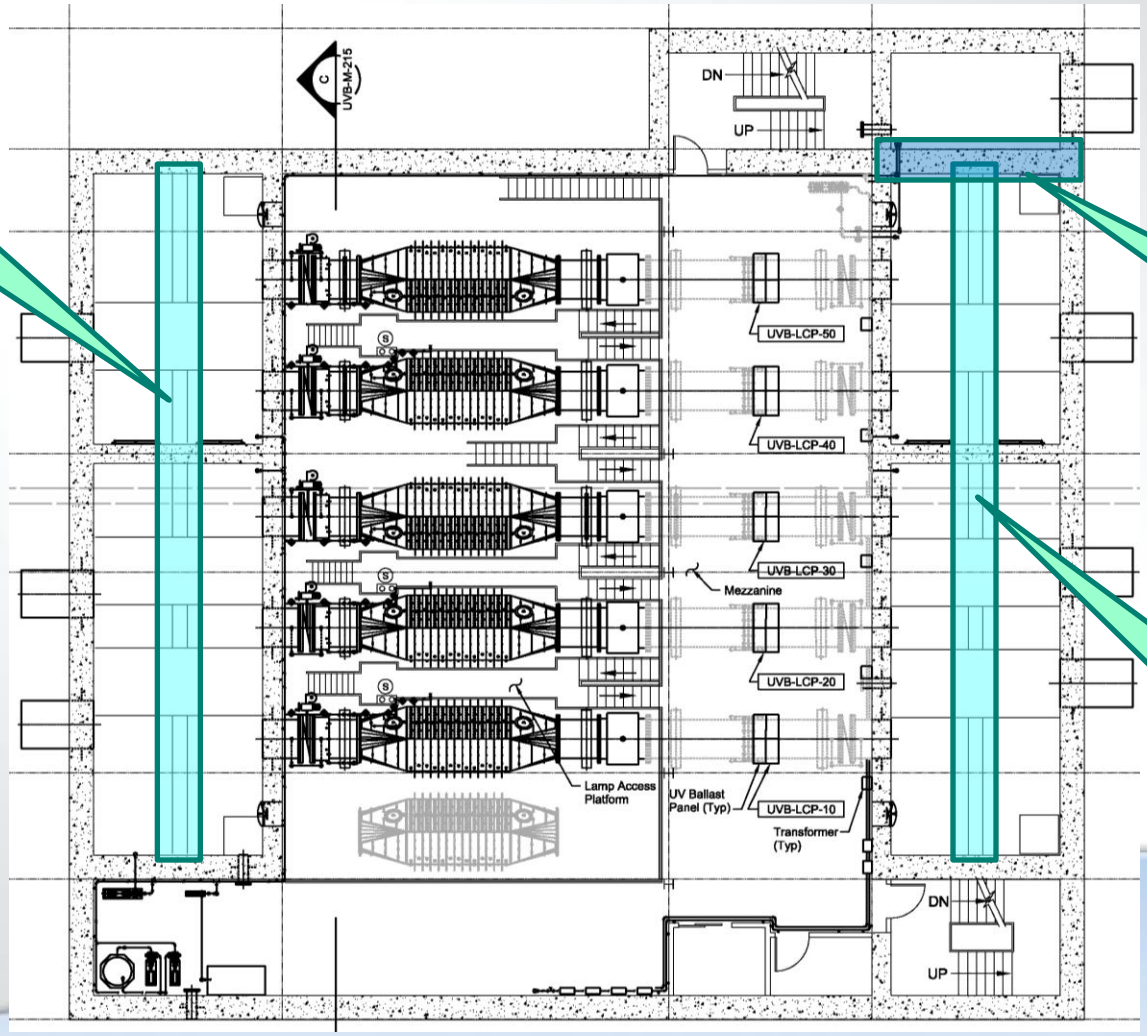


Inlet and Outlet Channels Feed Water to UV Reactors



Baffle Walls Provide Flow Distribution

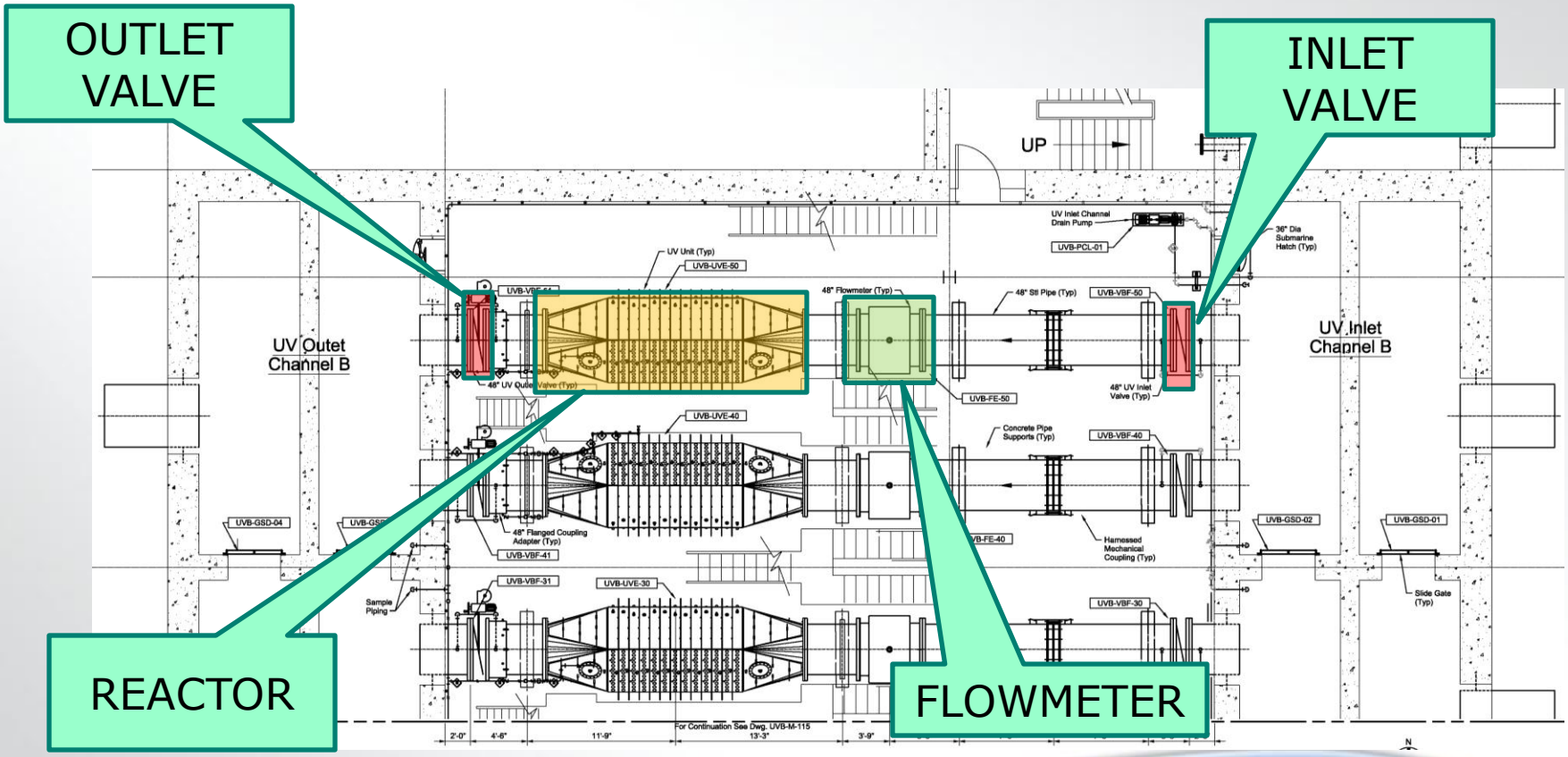
OUTLET BAFFLE WALL



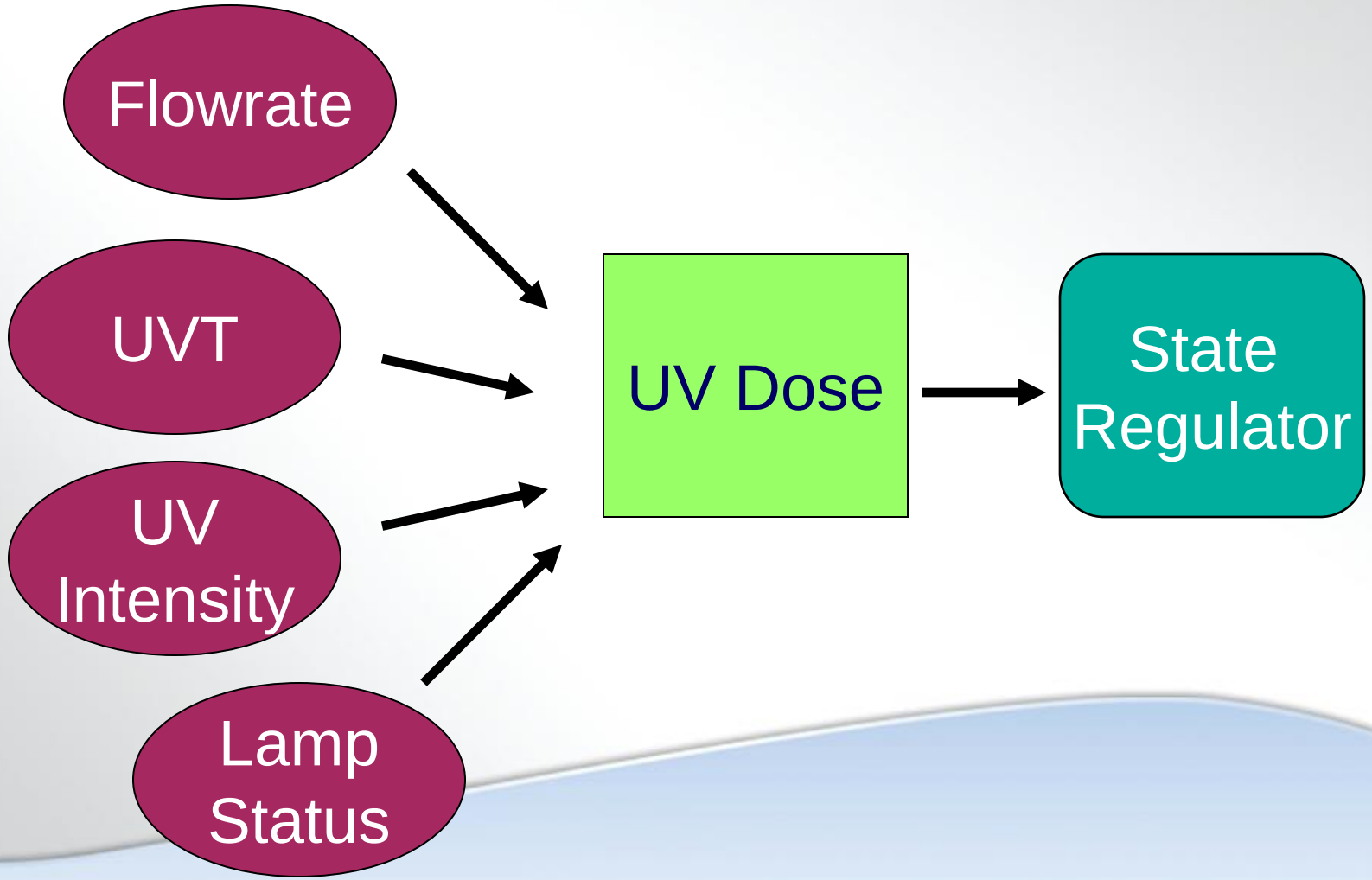
OVERFLOW WEIR

INLET BAFFLE WALL

Reactor Trains Include Isolation Valves and Magmeters



On-line Dose Monitoring is the Basis for Public Health Protection



Calculated Dose Algorithms Account for Important Factors

$$UV\ Dose = 10^{A} \times UVA^{B} \times \left(S/S_0 \right)^{C} \times Q^{D} \times Banks^{E}$$

UV Absorbance

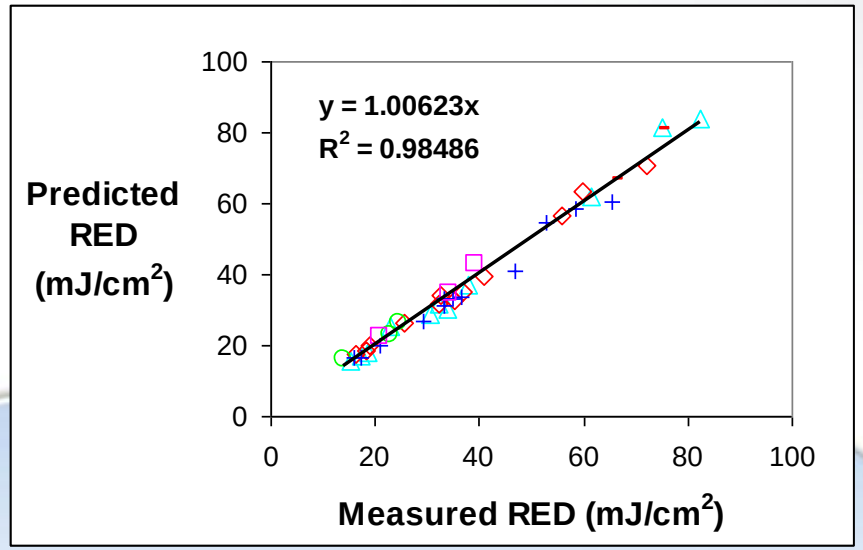
UV Lamp Output

Flowrate

Bank of Lamps

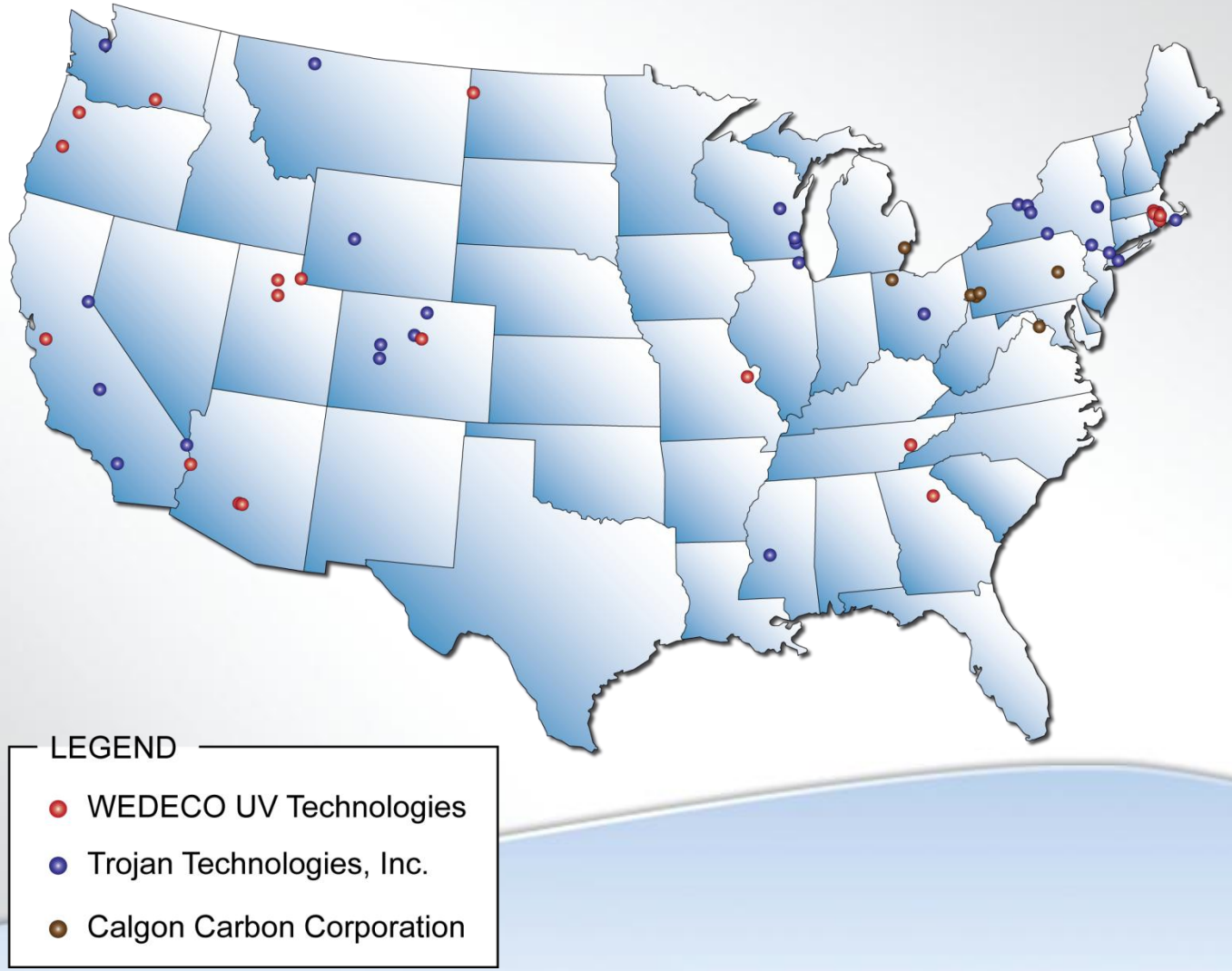
A, B, C, D, and E – constants defined by UV validation

UV Validation Testing Proves Dose Monitoring Algorithm

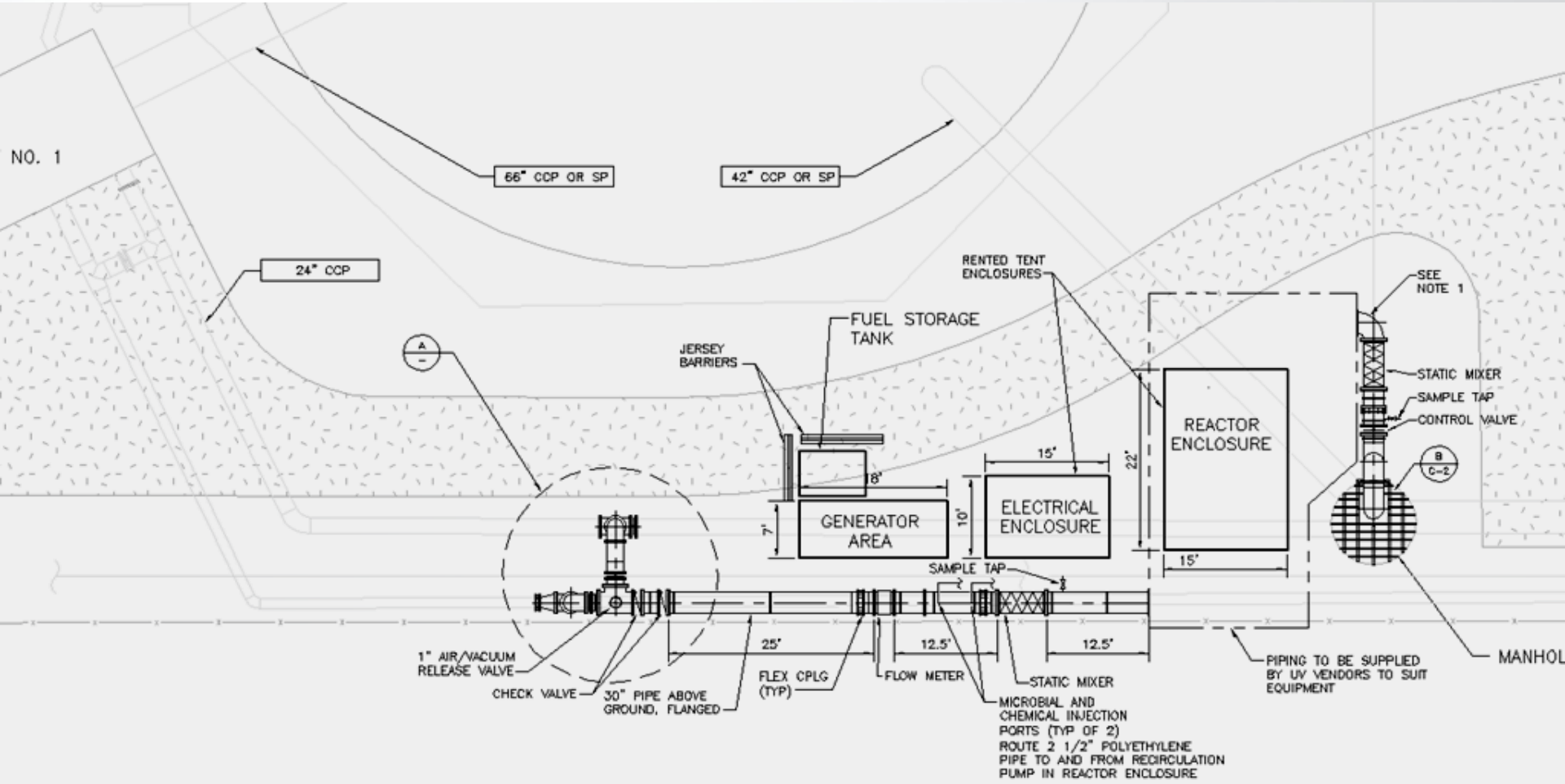


UV Validation Testing at the Portland UV Test Facility

Portland UV Facility Globally Impacts UV Implementation



Facility Located at Groundwater Pump Station



90 mgd Well Field Provides On-Demand High Quality Water

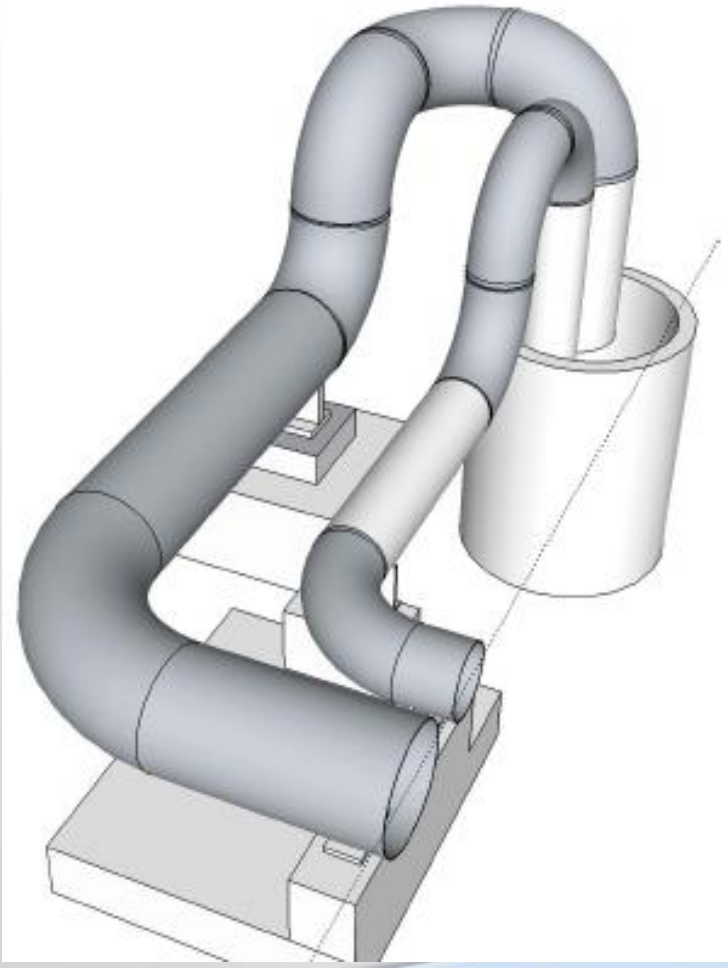
- 98% plus UVT, no chlorine, no coagulants

Injection System Controls UVT and Adds Challenge Microbe

- 120 gpm loop
- MS2, T1, T7 phage
- LSA or SuperHume
- Static mixer

Effluent Discharged Under Existing NPDES

Test Facility Upgraded 2011 to Provide 60 mgd Flows



UV Reactor Installed April 2011

Test Plan Includes 74 test Conditions

Test Microbes	MS2, T1 and T7 phage
Flowrates	6 – 60 mgd
UVT	70 to 98 %
Rows	2 to 13 rows
Power Levels	50 to 100%
Log Kill	1 to 4.7 log Kill
RED	2 to 103 mJ/cm^2

Multiple Microbes Provides More Efficient UV Disinfection

Target Pathogen	Crypto	
Required Log Inactivation	3	
Required UV Dose	12 mJ/cm^2	
Validation Microbe	MS2	T1
RED Bias at 90% UVT	1.73	1.15
Uncertainty	4 mJ/cm^2	1 mJ/cm^2
Validation Factor	2.00	1.23
Operating Dose	25 mJ/cm^2	15 mJ/cm^2

Anticipated Optimized UV Dose Algorithm

$$UV\ Dose = 10^{A} \times UVA^{B} \times \left(\frac{S/S_0}{Q \times D_L} \right)^{C+D\times UVA+E\times UVA^2} \times Rows^{F+G\times UVA+H\times UVA^2}$$

UVA

Flow

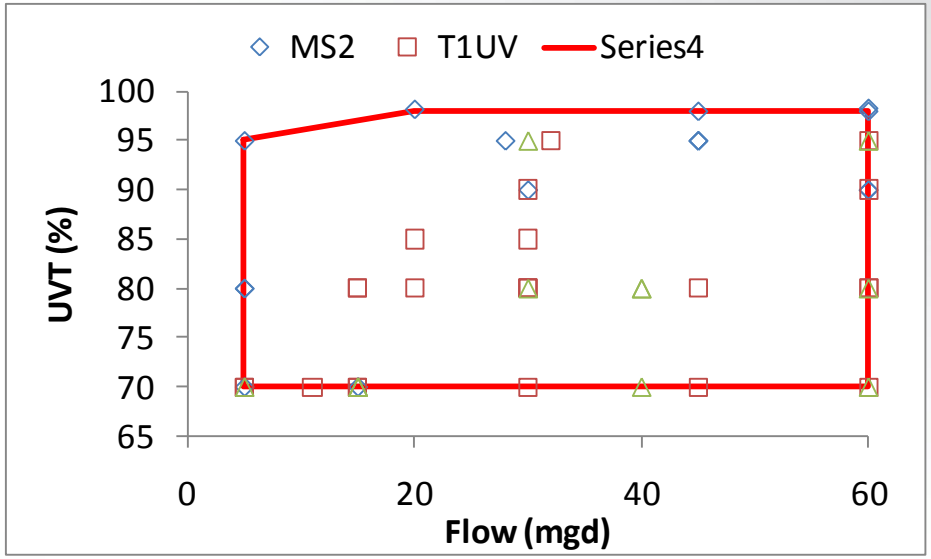
Lamp Output

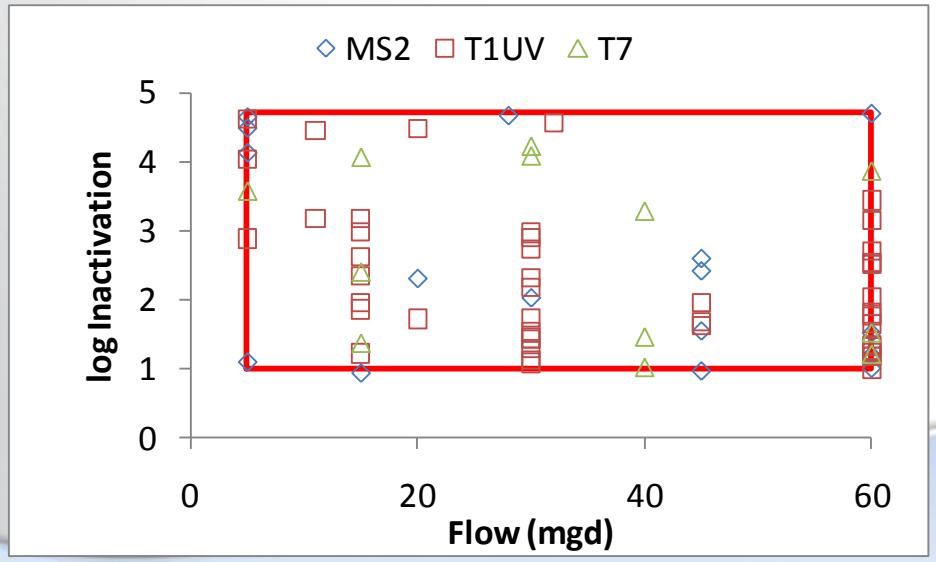
Microbe UV Sensitivity

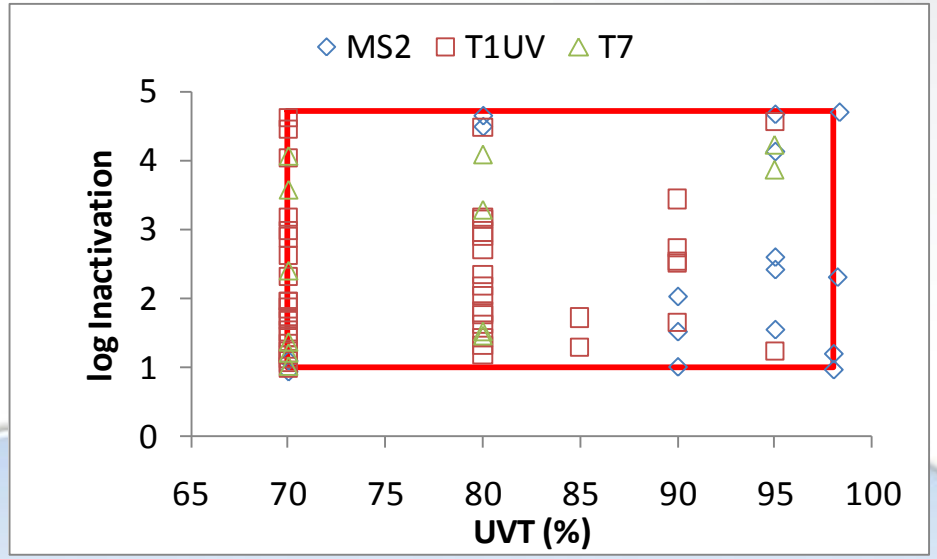
Rows

A through H– constants defined by UV validation

Anticipated Validated Range







UV Provides Portland a Viable Alternate for LT2 Compliance

- UV system will be located at Bull Run Headworks
- Five ITT/WEDECO K143 reactors will provide up to 3 log Crypto credit at flows up to 186 mgd and UVTs down to 79%
- UV reactor shall be validated using MS2, T1UV and T7 phage at flows up to 60 mgd at the Portland Test Facility
- UV dose algorithm will be optimized based on T1UV

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