Controlling Drinking Water Chromium-6 and Other Emerging Constituents

Western Coalition of Arid States (WESTCAS)
Fall Conference – Tucson, AZ

Presented by: Steve Bigley
Coachella Valley Water District
October 29, 2015

Emerging Drinking Water Constituents

Federal Update

Unregulated Contaminant Monitoring Rule (UCMR3)

- 30 contaminants VOCs, metals, fire retardants, hormones or DBPs
  - List 1: 21 VOCs, metals, fire retardants, DBPs
  - List 2: 7 hormones
  - List 3: 2 microbials
- Complete testing by 12/31/15
- Top Hits (PWS's with results >reference concentration)
  - 1,2,3-TCP (1.3%)
  - Vanadium (3.3%)
  - Strontium (5.6%)
  - 1,4-Dioxane (6.7%)
  - Chlorate (36%)
  - Chromium-6 (88%)[1]

[1] – No federal reference concentration exists for Chromium-6; used California Public Health Goal (0.02 ppb) instead.

Regulatory Determination 3 (RD3)

- Contaminant Candidate List 3 (116 contaminants)
- Preliminary determination (5 contaminants)
- Chlorate and nitrosamines – assessment ongoing
- EPA plans to issue final determination in December 2015

Constituent	Preliminary Determination
1,3-Dinitrobenzene	No regulation
Dimethoate	No regulation
Terbufos	No regulation
Terbufos sulfone	No regulation
Strontium	Regulate

Strontium

- Another natural element in groundwater
- Also in Colorado River
- Replaces calcium during bone development
- Health reference level = 1,500 ppb
- Treatment:
  - High-pH precipitation (lime softening)
  - Ion exchange (Strong Acid Cationic Resin)
  - Membrane (NF or RO)
- EPA regulatory timeline
  - Dec 2015: final determination to regulate
  - Jan 2018: draft regulation
  - June 2019: final regulation

Cyanobacterial Toxins

- Blooms in surface water
- Impacts plant operations
- Taste/odor problems
- Toxin (targets organs)
- EPA Health Advisories
- Long viability in sludge (higher toxin release)
- Supernatant return can pose increased risk

Constituent	10-Day Health Advisory	
	Bottle-fed Infants and Pre-school Children	School-age Children and Adults
Microcystins	0.3 ug/L	1.6 ug/L
Cylindro-spermopsin	0.7 ug/L	3 ug/L

Lead and Copper Rule - Long-Term Revision (LCR LTR)

NDWAC Report (Aug 2015)

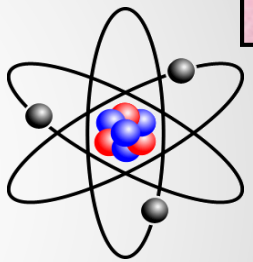
- Lead Service Line replacement & public education
- Stronger Corrosion Control Treatment (CCT)
- Allow consumer requested tap samples
- Tailor Water Quality Parameters for CCT plans
- Household "action levels" trigger follow-up
- Separate requirements where copper is problematic

“Emerged” Drinking Water Regulation

Chromium-6 (Only in California)

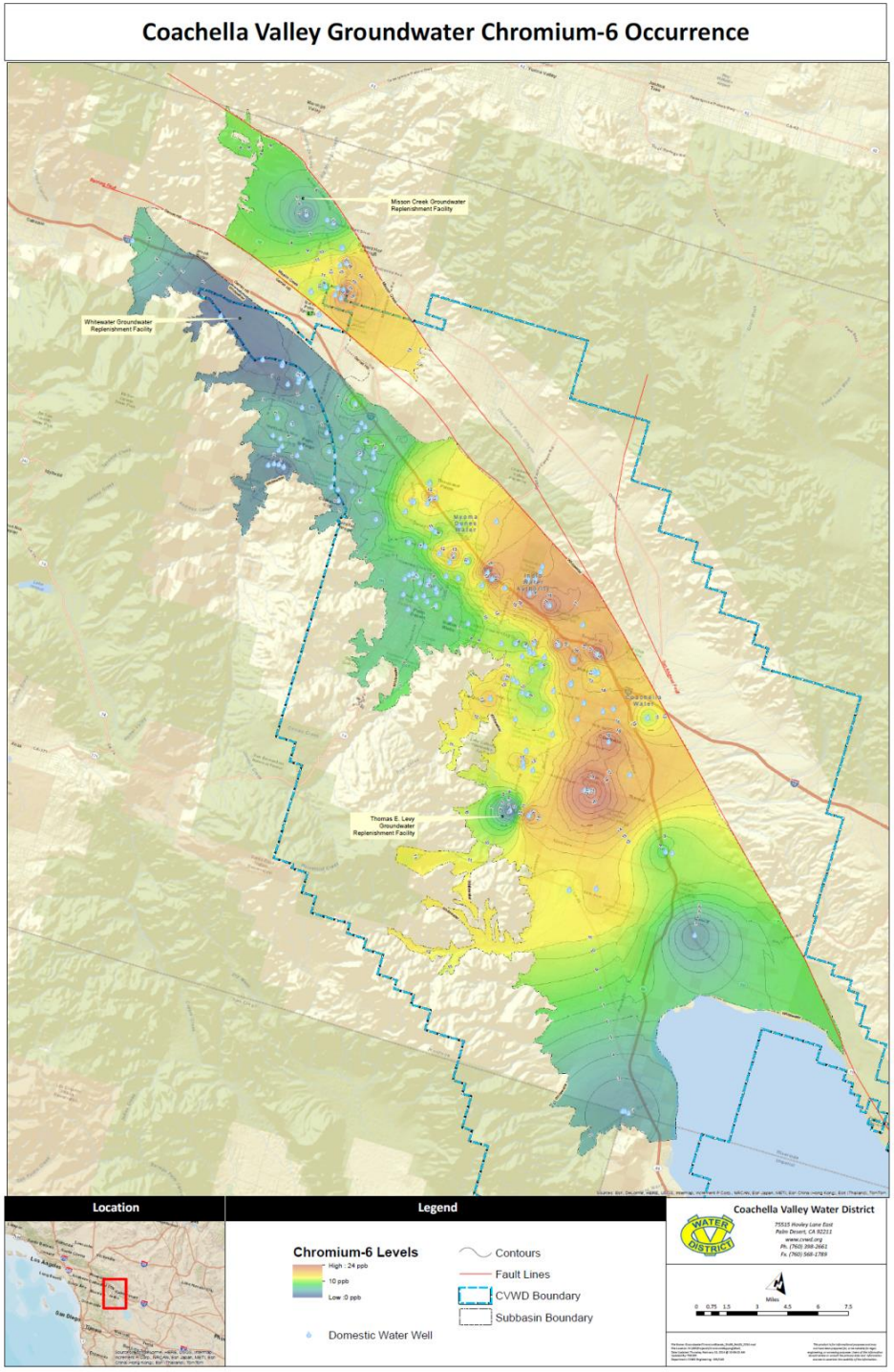
Chromium (Cr) Background

- Chromic oxide – 9th most abundant compound in earth's crust
- Chromium-3 (Cr3) or chromium-6 (Cr6) in water
  - Mostly Cr6 in groundwater
  - Need Cr3 to produce insulin
- Cr6 Sources in Water
  - Erosion of natural sediments
  - Isolated industrial sources
- Cr6 Health Concerns
  - Carcinogen when inhaled at work
  - Listed as possible carcinogen when ingested (rodent studies)

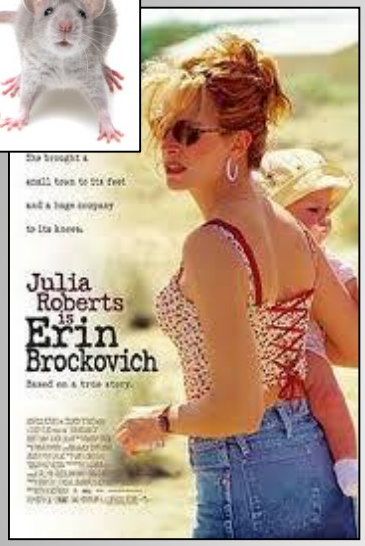


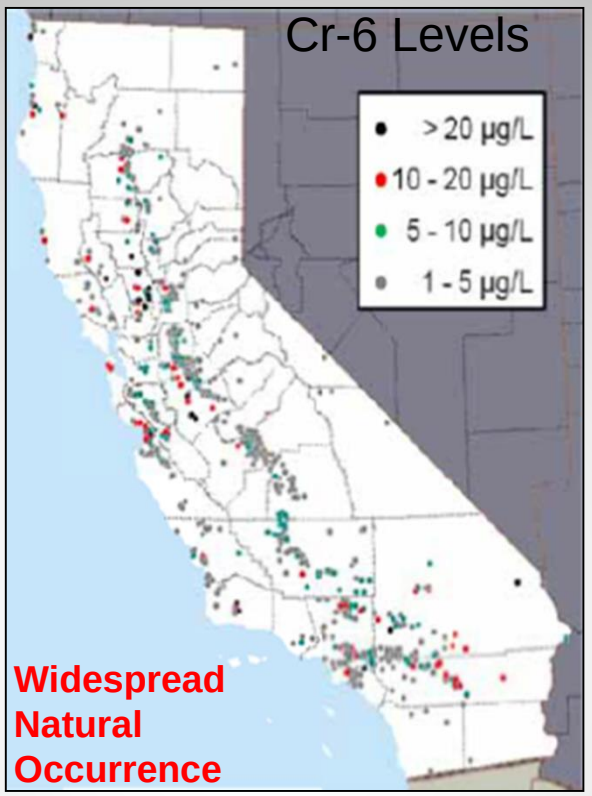
Coachella Valley Cr6 Occurrence

- Natural in groundwater
  - Ultra-mafic sediments
- Levels from <1 to 22 parts per billion (ppb)
- Above 10 ppb in about 100 domestic wells valley-wide
- 30 of CVWD's 100 wells (150 square mile service area)
- Cr6 below reportable levels in Colorado River water used for aquifer replenishment



California's Path to Regulate Cr6





April 15, 2014
Court Order Cr6
MCL is set at
0.010 mg/L
(10 ppb)

NRDC
THE EARTH'S BEST DEFENSE

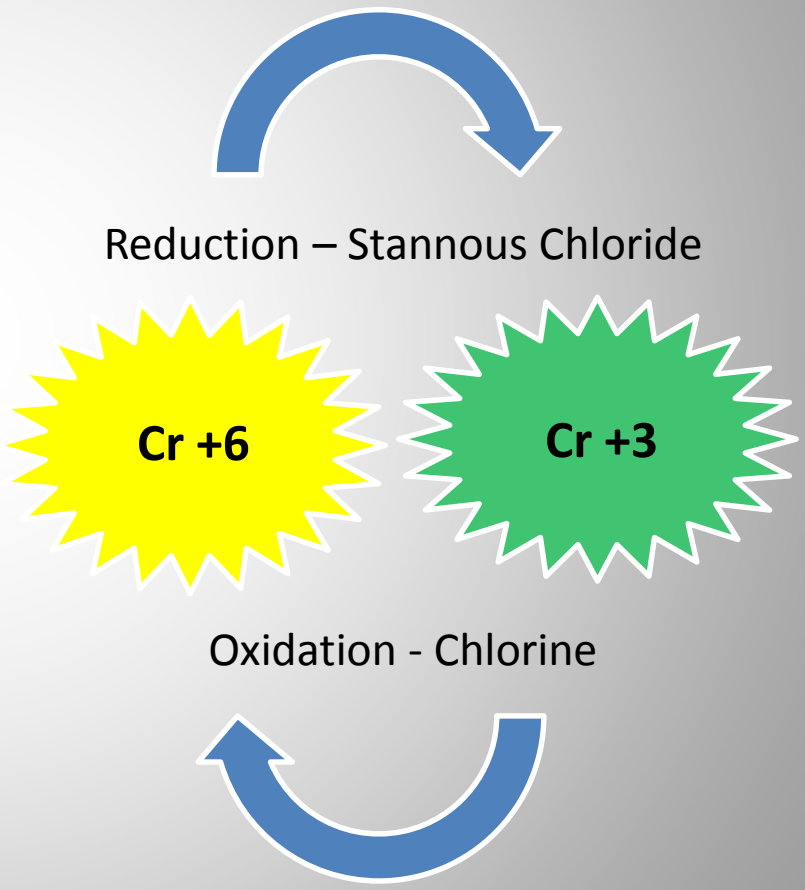
V.

CALIFORNIA REPUBLIC

Early "Cr6 Treatment" Work

Cr6 Reduction

- Proved reduction of Cr6 to Cr3 was possible
- More cost effective than removing Cr
- Critical limiting factor
  - Drinking water is chlorinated to meet bacteria standards
  - Chlorine oxidizes Cr3 to Cr6
  - Can provide residual Cl_2 or reduced Cr, not both



CHROMIUM REMOVAL

BEST AVAILABLE TECHNOLOGIES (BAT)

Weak-Base Anion Exchange (WBA)

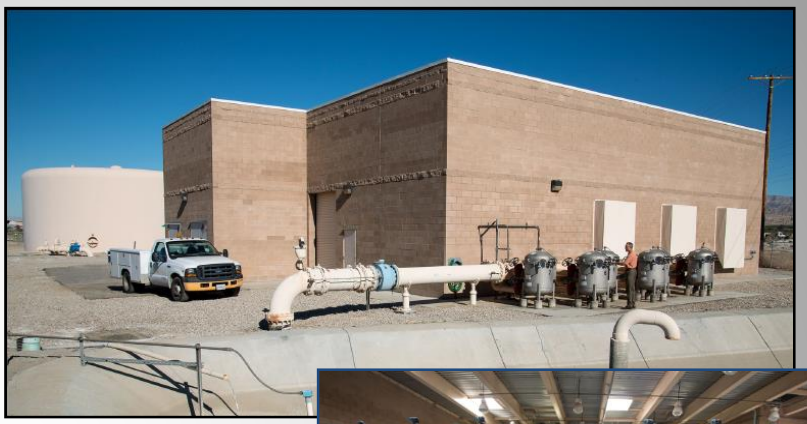
Strong-Base Anion Exchange with Residuals Treatment (SBA)

Reduction Coagulation Filtration (RCF or RCMF)

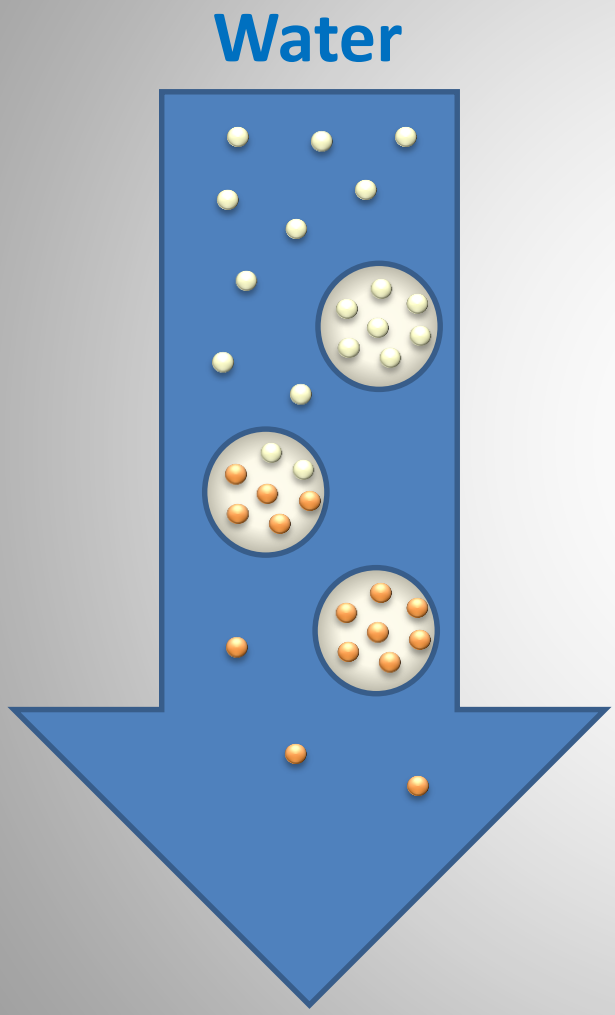
Reverse Osmosis (RO)

CVWD's Cr6 Treatment Work

- 2001 – Cr6 added to pilot Arsenic removal tests
- 2006 – Two Ion Exchange treatment plants begin removing Arsenic and Cr6 ($13 million)
- 2011 – Collaborative Water Research Foundation Cr6 pilot study (IX & RCF)
- 2012 – CVWD absorption media pilot test for Cr6
- 2013 – Second Cr6 Water Research Foundation study (RCMF & Brine)
- 2013 – Begin Source Study (draft MCL)
- 2014 – Multiple ion-exchange and brine pilot test programs (Hazen)
- 2015 – Follow-up pilot tests to finalize Facilities Basis of Design



Cr6 Removal By Ion Exchange



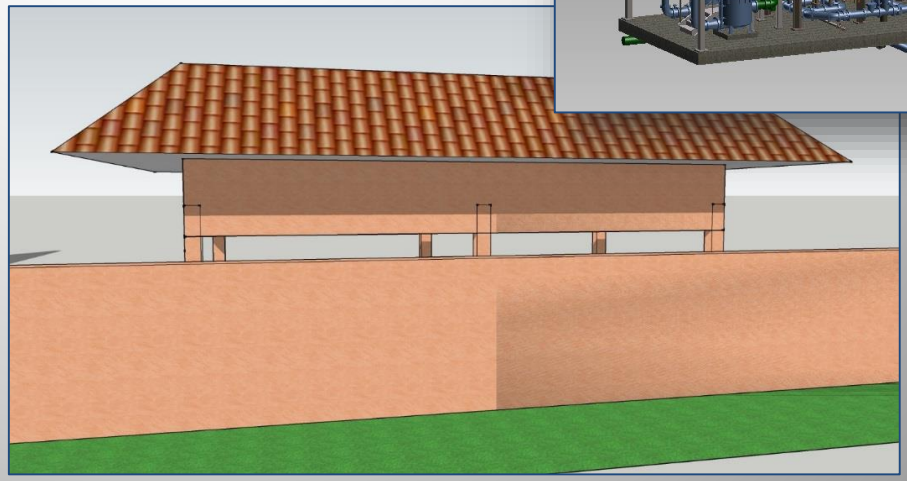
Ion Exchange

Ions of Cr6 attach to specially coated resin beads

- Cr6 in water
- Chloride on resin
- Resin bead

SBA Treatment Facilities

- Planned for 23 impacted wells
- Uses compact SBA design for small well sites
- No pipelines required
- No well-site regeneration or brine management
- Depends on 40 acre Central Resin Regeneration Facility (CRRF)

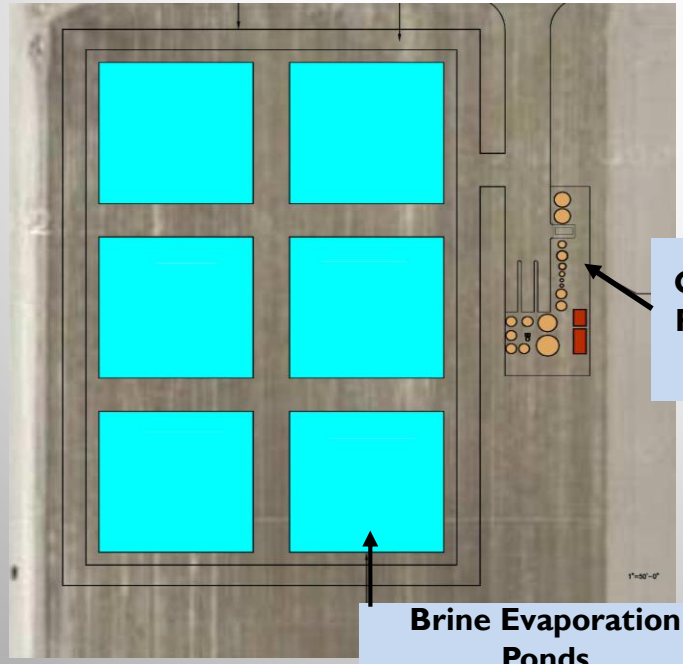


Typical Well SBA System Layout

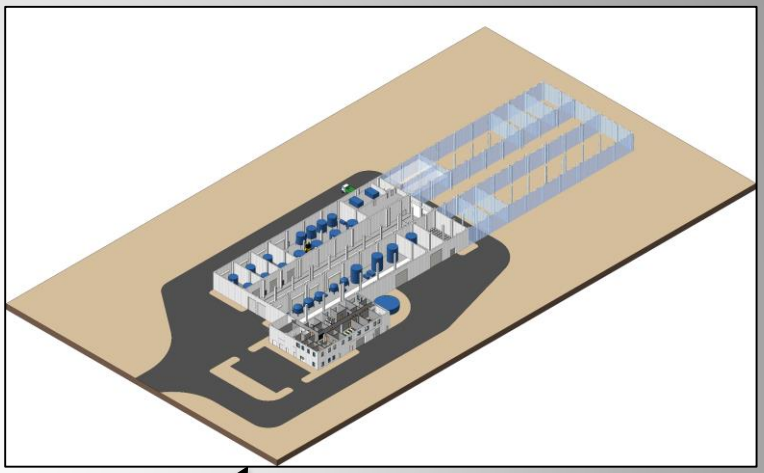
Central Resin Regeneration Facility (CRRF)

Existing Wastewater Reclamation Facility

CRRF Site Location



Brine Evaporation Ponds



Central Resin Regeneration Facility

SBA Resin Transfer/Regeneration Summary

Tanker to Well (0.5 hr)

Transfer from Vessel (2 hrs)

Tanker to CRRF (0.5 hr)

Resin Regen (4 hrs)

Return to Well (0.5 hr)

Transfer to Vessel (2 hrs)

Return Tanker to CRRF (0.5 hr)

Total Time = 10 hours

Waste Management Process

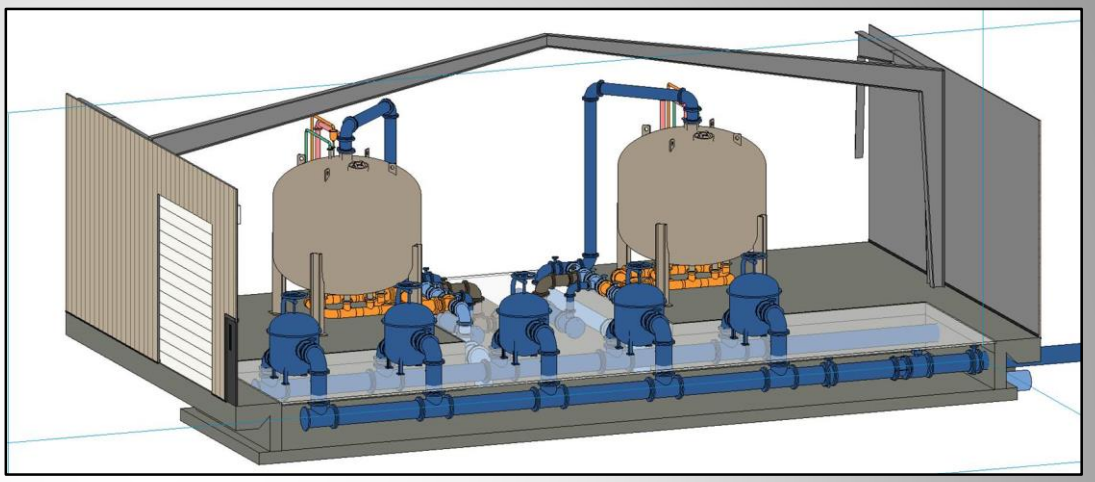
- Most costly, complex and unreliable element of compliance
- Waste minimization is key
- Not just chromium
- Not within Division of Drinking Water's Authority
- Important to have redundancy and control
- Advanced treatment technologies may help

Chemical Coagulation

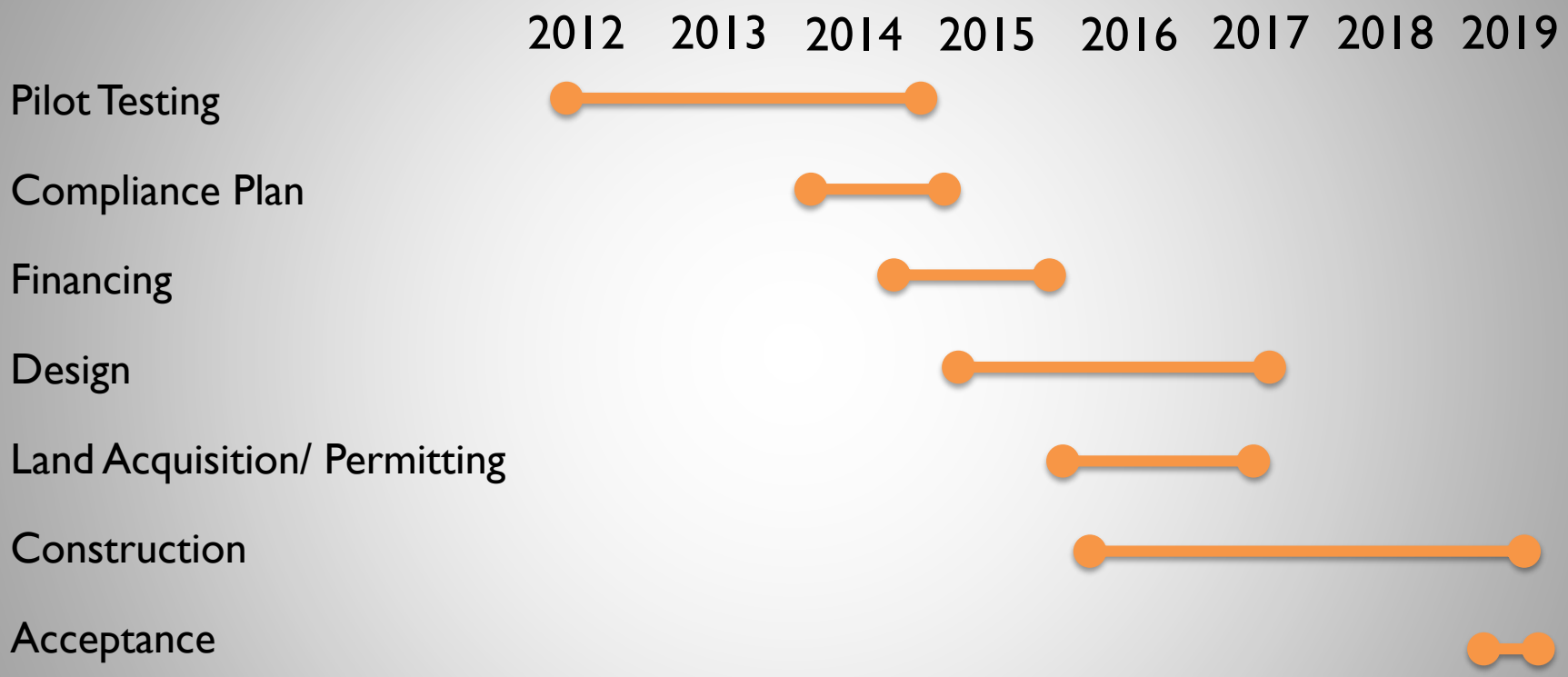
Electrocoagulation

WBA Treatment Facilities

- Planned for 6 impacted wells
- Two WBA facilities each treating multiple wells
- Land required for large plants
- 10 miles of pipelines



BAT Installation Timeline



Regulation Timeline

- Effective July 1, 2014
- Initial compliance monitoring on or before January 1, 2015
  - Compliance based on annual average level of quarterly samples
- State failed to provide a compliance period consistent with Federal Safe Drinking Water Act requirements

Compliance Challenge

- Maintain compliance with drinking water laws
  - Years to build CVWD's most costly project ever
- Non-compliance increases ratepayer impact
- Already using accelerated effort to install BAT
- Initiated two unlikely options to avoid violation:
  - Obtain urgent California legislation
  - Find an additional control measure

Legislation

- 2014 Appropriations Trailer Bill – developed from discussions with Governor's staff
  - RIP - August 2014
- SB 385 (Hueso)
  - ACWA Sponsored; significant stakeholder input
  - Supported unanimously by legislators
  - **Signed by Governor Brown 9/4/15**
    - Provides California water agencies path to maintain compliance while installing BAT by earliest feasible date
    - Sunsets January 1, 2020

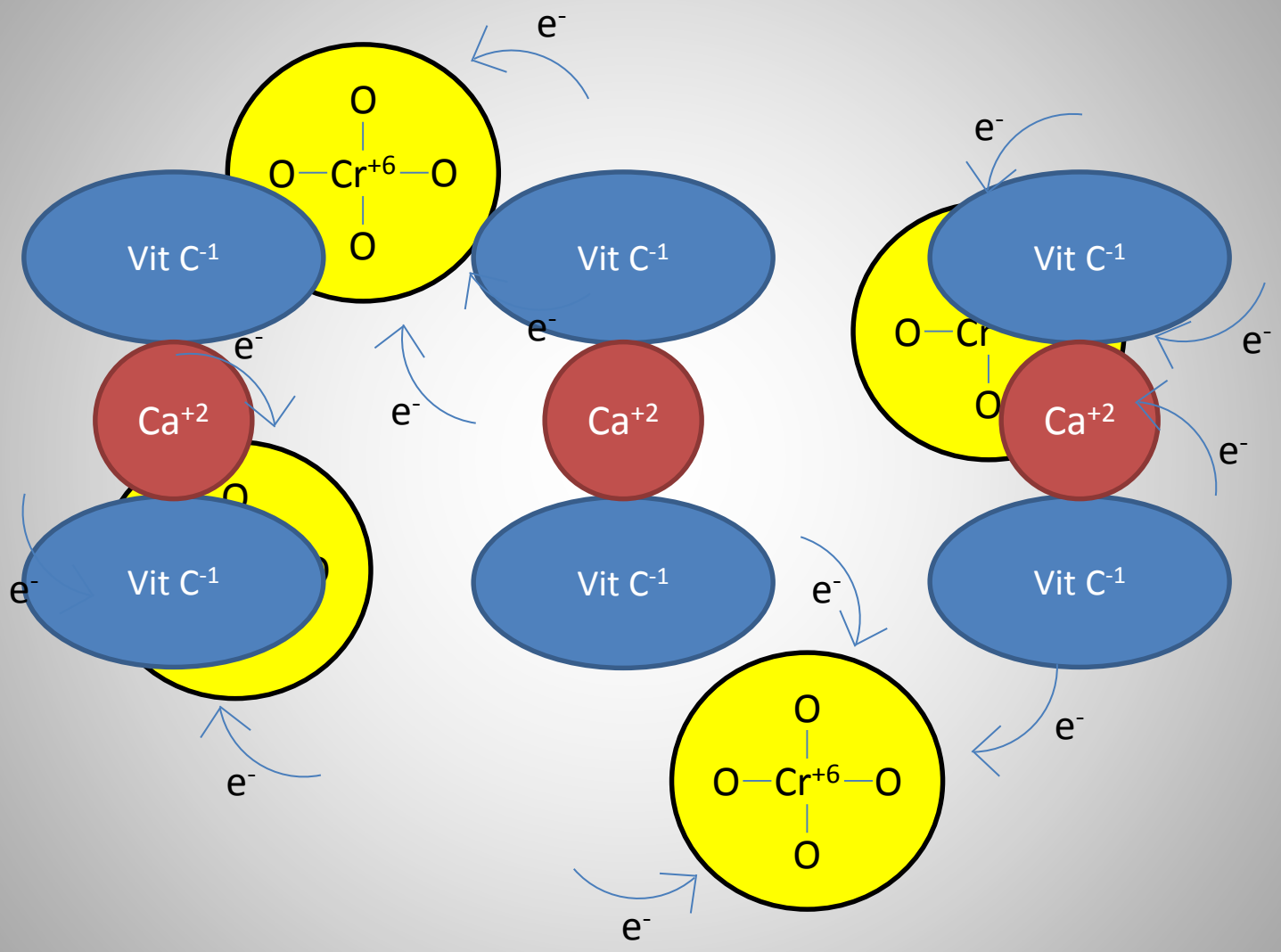
Additional Control Measure

- Must achieve "no unreasonable risk"
- Install Point Of Use Treatment – too costly and not quick enough
  - Exceeds BAT cost
- Provide bottled water – quick but too costly
  - $1.60 gallon delivered
  - $0.84/person/day = $92 million/year
- What about Cr6 reduction at the tap?

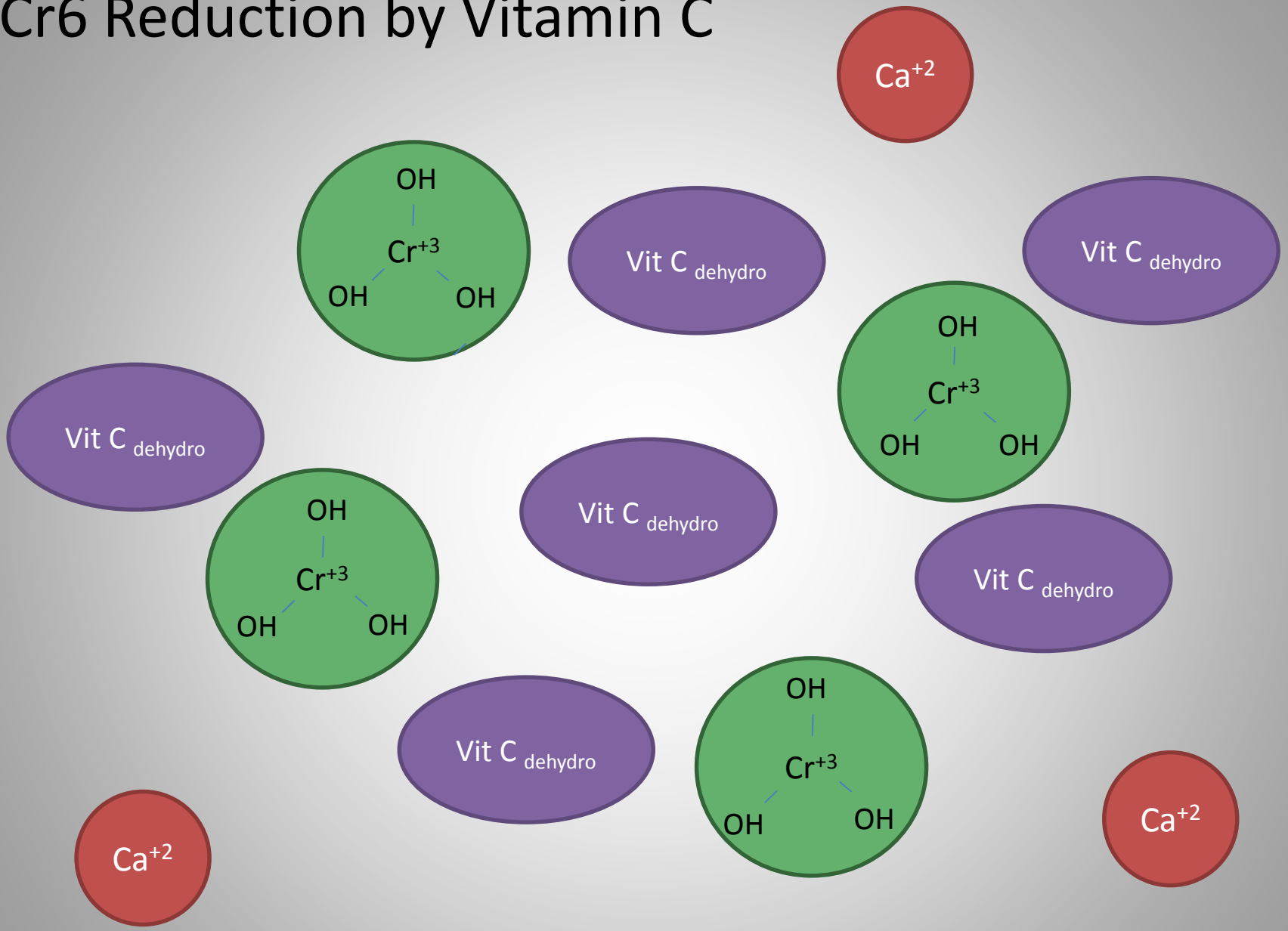
Ascorbic Acid (Vitamin C)

- Antioxidant (strong reducing agent)
  - Excellent electron donor
  - Used to de-chlorinate water
  - Observed to reduce Cr6 (Xu et al., 2004)
- Ingestion is Essential
  - Added to infant formula
  - RDA = 60 milligrams (mg)/day (prevents scurvy)
  - 500 to 1,000 mg/day doses are common
- Easy to dispense, quick to implement

Cr6 Reduction by Vitamin C

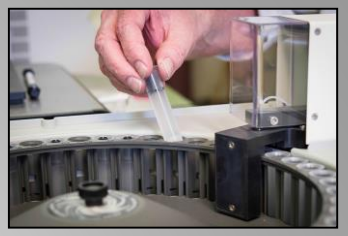


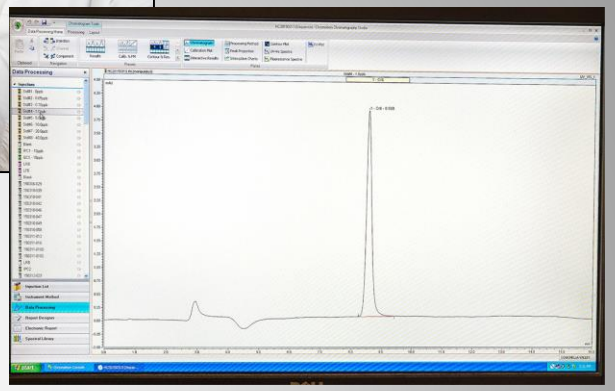
Cr6 Reduction by Vitamin C

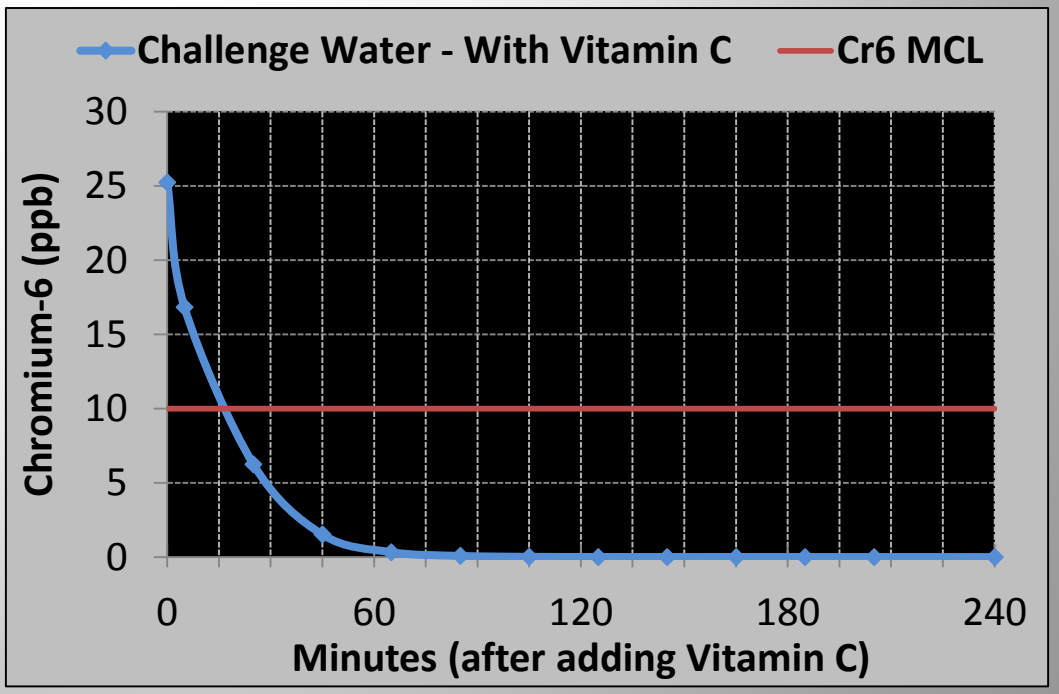


Demonstration Results

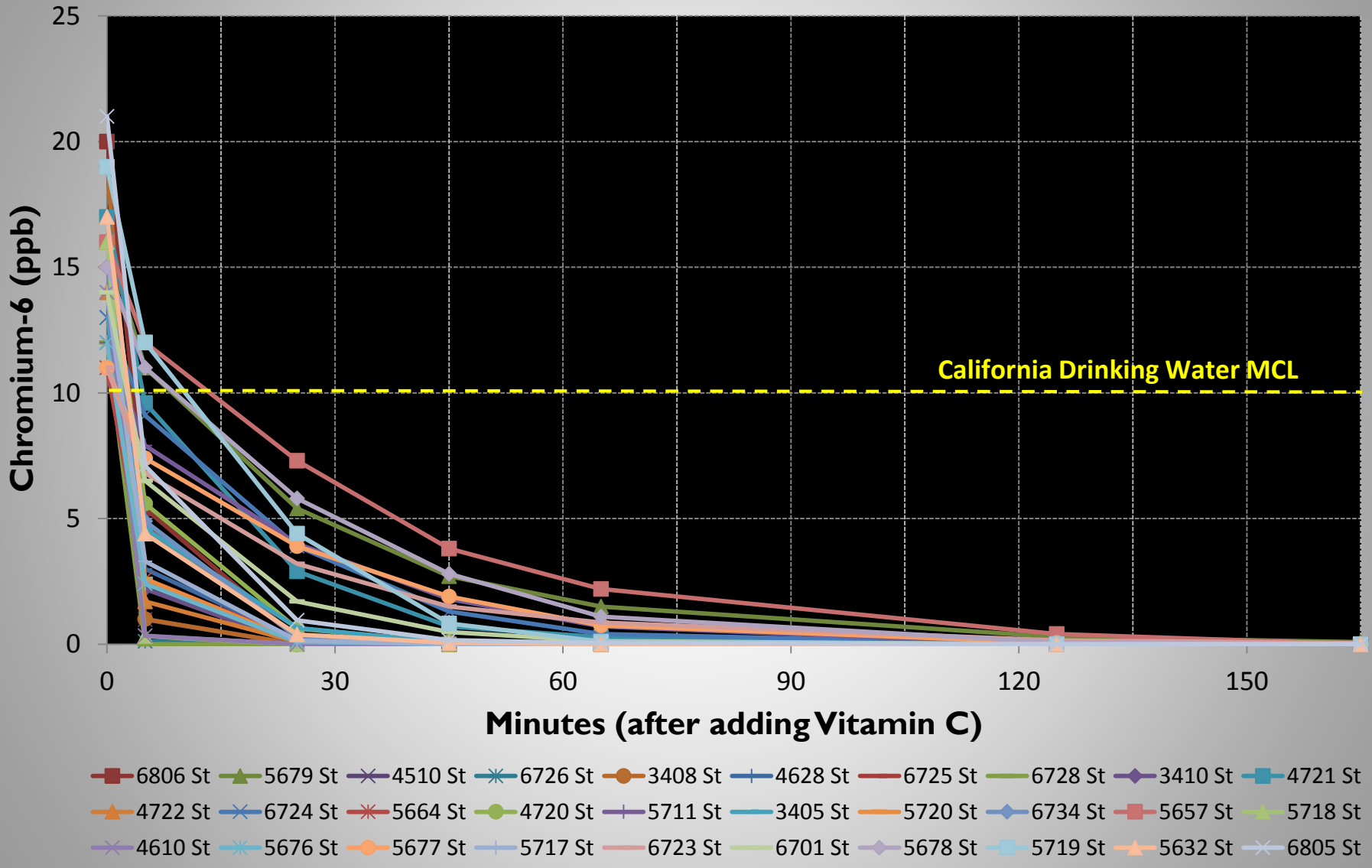
- Challenge water
  - Elevated Cr6, pH & salinity
  - Spiked Cr6
  - Spiked Chlorine
- Vitamin C dose
  - Calcium vs sodium buffer
  - Multiple doses
  - Higher dose = faster reaction
  - Lower dose = lower cost
  - "Pinch" per gallon provides good balance
    - 220 mg Vitamin C
    - 30 mg Calcium







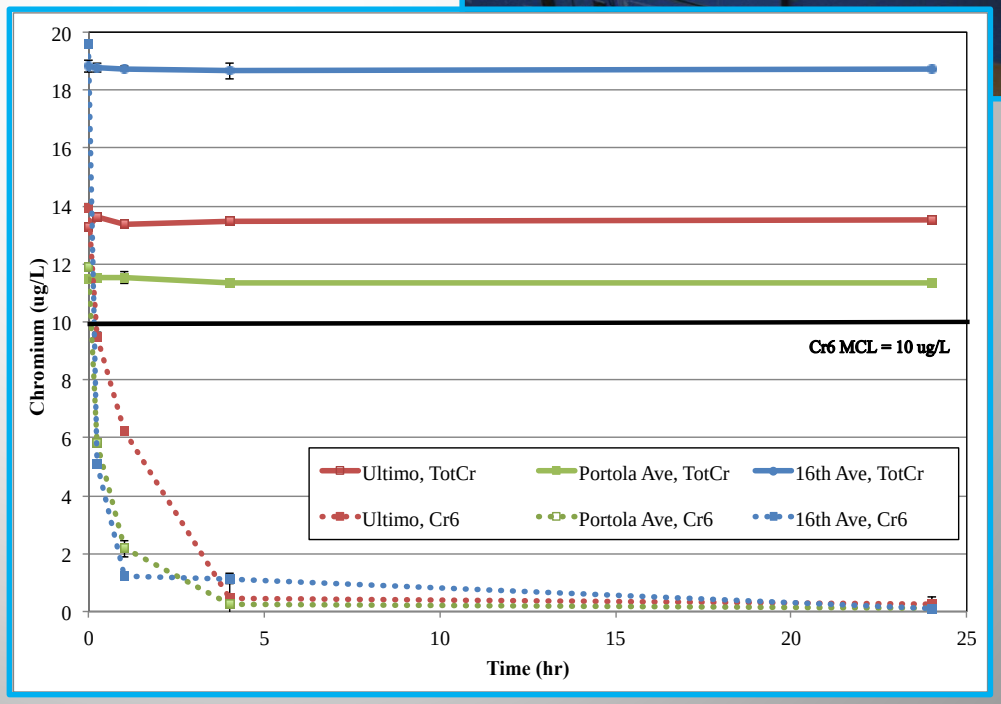
Cr6 Reduction in Impacted Wells



Utah State University - Process Verification

Performed by Dr. Laurie McNeill and Nate Rogers

- Used CVWD treatment kit
- Water tested from 3 representative wells
- Duplicate testing by CA certified lab
- Results:
  - Cr6 levels below 10 ppb within 15 minutes of Vitamin C addition
  - Cr6 levels dropped below 0.3 ppb within 24 hours
  - Total Cr remained stable (Cr6 reduced to Cr3)
  - No re-oxidation of Cr6 observed



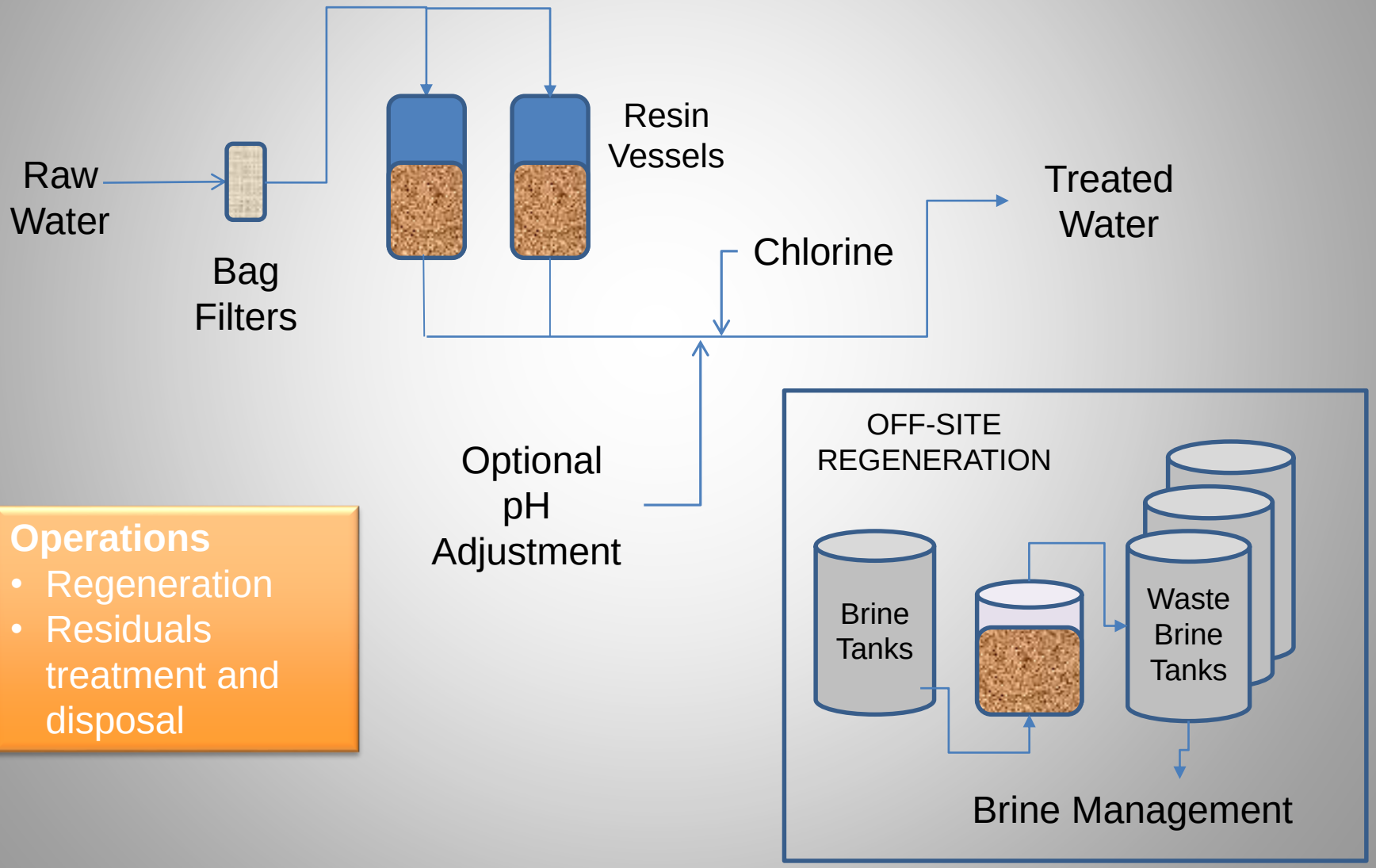
Questions?

Steve Bigley
Director of Environmental Services
Coachella Valley Water District
760-398-2661, ext. 2286
sbigley@cvwd.org

Carcinogenic VOC's

- 2011 EPA decision to group cVOC's
  - May co-occur
  - Same treatment
  - Same analytical method
- 16 cVOC's
  - **8 Regulated** – benzene; carbon tetrachloride; 1,2-dichloroethane; 1,2-dichloropropane; dichloromethane; tetrachloroethylene; trichloroethylene and vinyl chloride
  - 8 Unregulated - aniline; benzyl chloride; 1,3-butadiene; 1,1-dichloroethane; nitrobenzene; oxirane methyl; 1,2,3-trichloropropane and urethane
- EPA expected to release "regulatory process" in late 2014

Strong Base Anion Exchange (SBA)

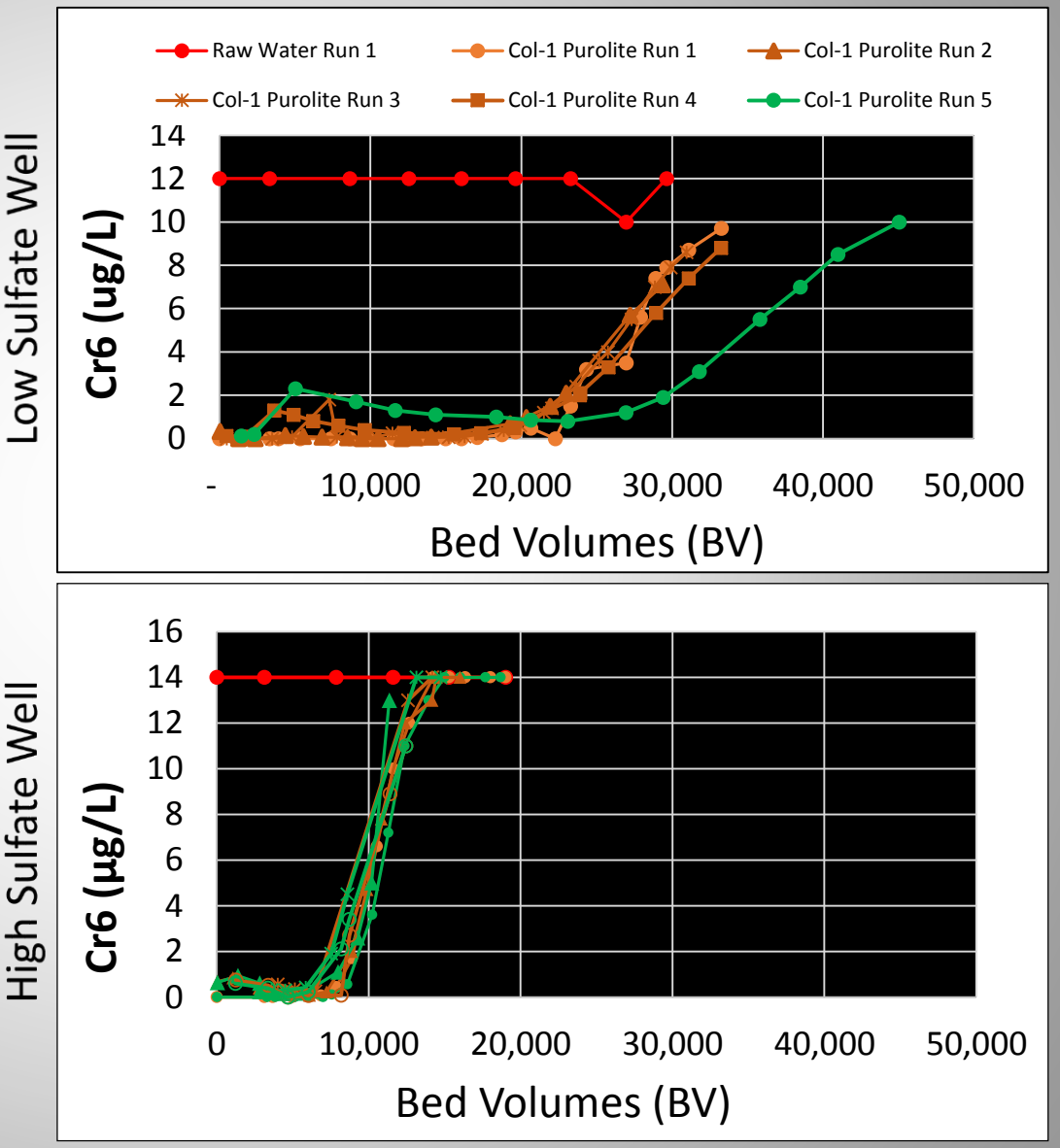


Operations

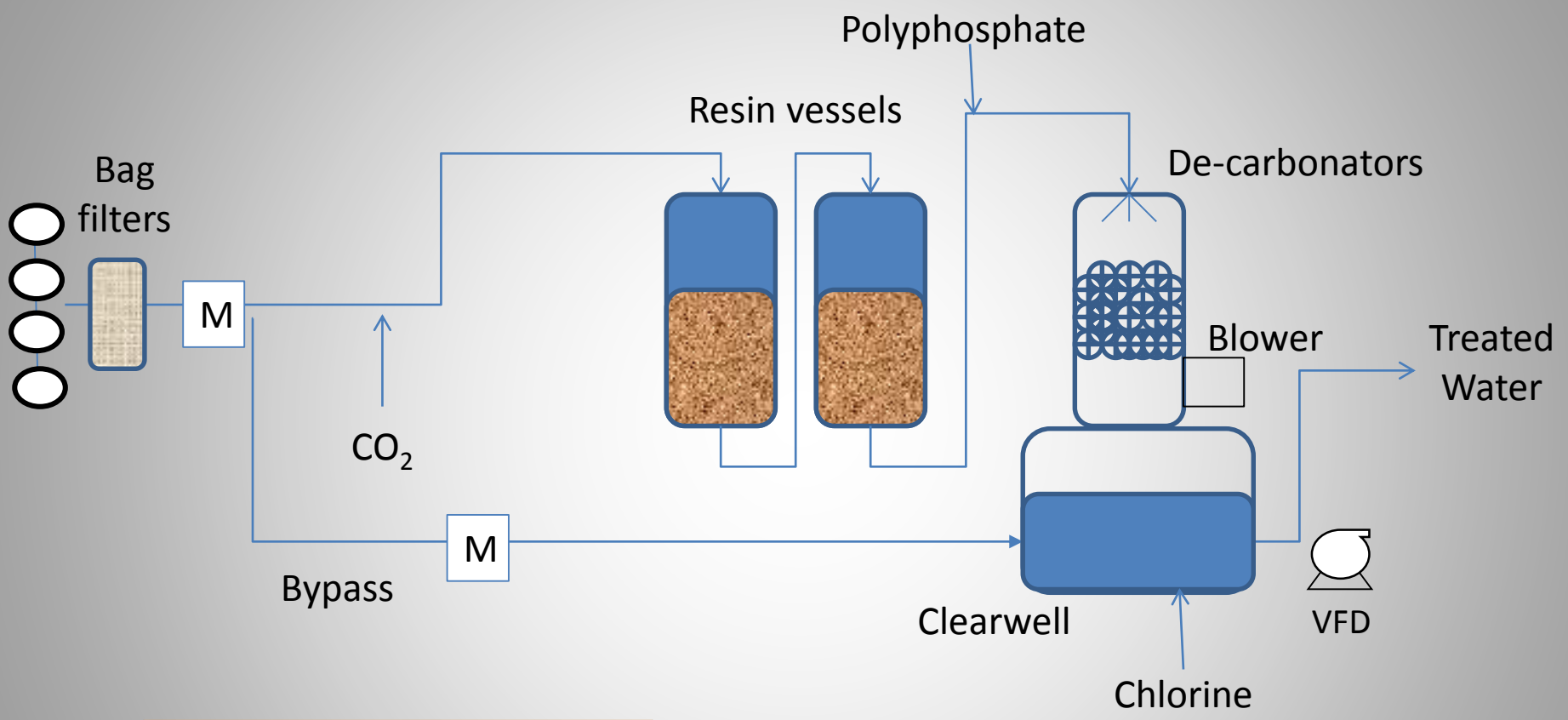
- Regeneration
- Residuals treatment and disposal

SBA Pilot Tests

- No pH adjustment needed
- Elevated sulfate limits bed volumes (run times)
- Longer than expected run times when sulfate levels are low
- Good recovery following regeneration with both fresh and recycled brine (Run 5)



Weak Base Anion Exchange (WBA) Process



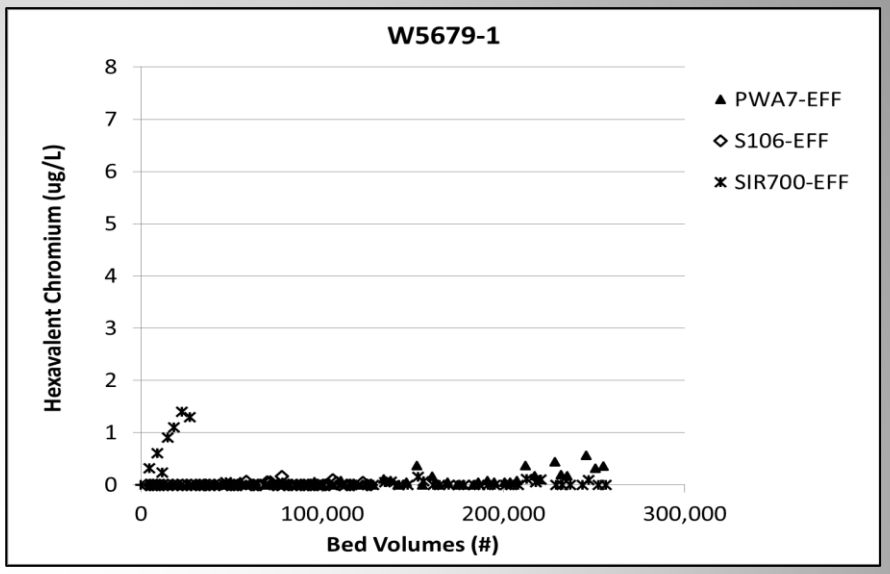
Operations

- Bag filter replacement
- Carbon dioxide refills
- Resin replacement

WBA Pilot Tests

- pH control is essential (pH 6 target)
- Achieved very high bed volumes
- Estimate 1-2 year runtime between change-outs
- Less impacted by sulfate levels
- Spent resin is hazardous waste and considered radioactive material (naturally occurring uranium)

Low Sulfate Well



High Sulfate Well