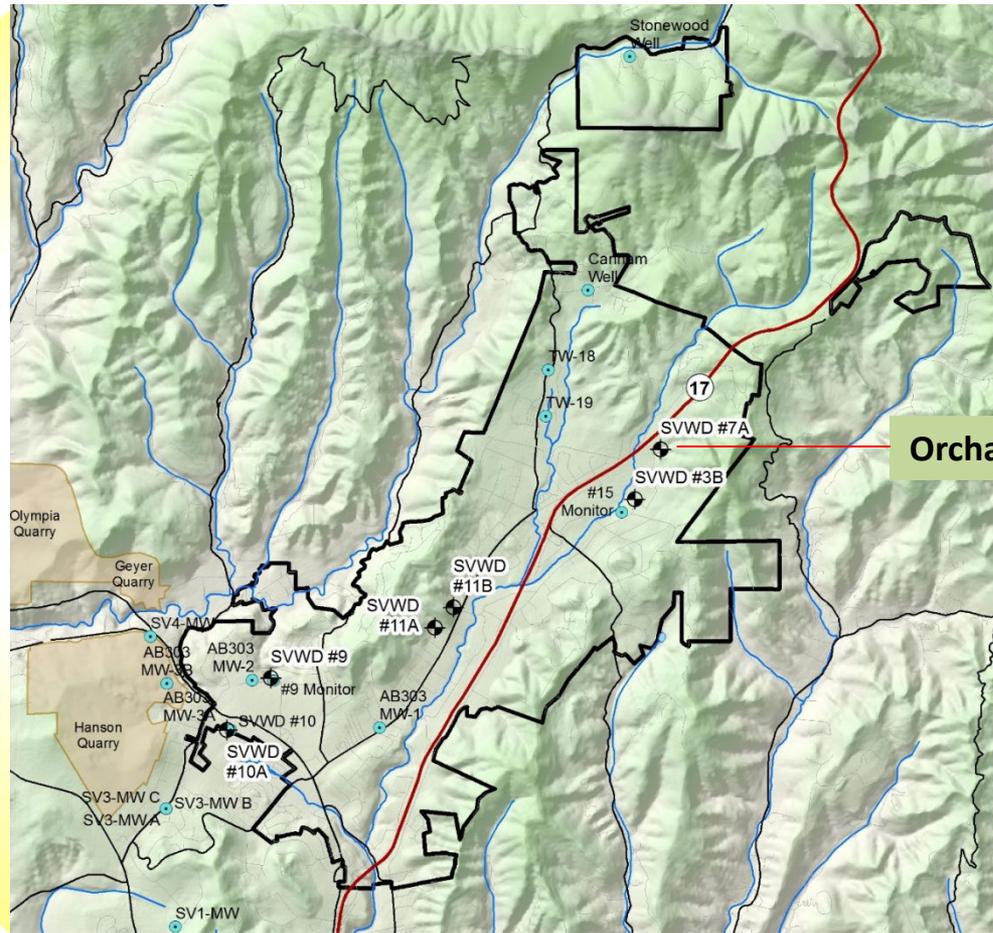


Implementation of Taste & Odor Improvements at Scotts Valley

Milt Larsen, PE
Don Ervin, PE

Scotts Valley Water District



Orchard Run WTP

Scotts Valley Water Supply

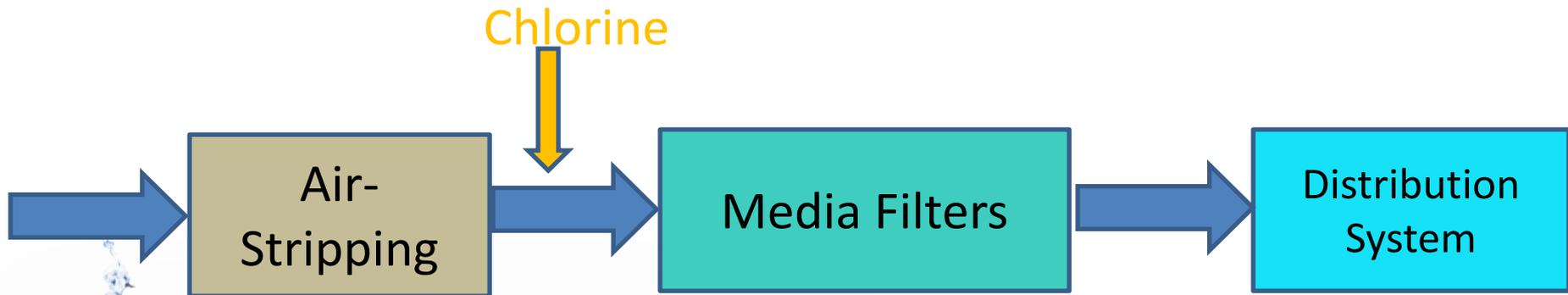
- 💧 Lompico Aquifer: Wells 3B & 7A (Orchard Run), Well 10A & D, Wells 11A & 11B (El Pueblo)
- 💧 Santa Margarita Aquifer: Well 9
- 💧 Butano Aquifer: Orchard Run
- 💧 Water Quality Characteristics
 - Relatively high TDS & Hardness
 - Elevated Fe & Mn
 - Hydrogen Sulfide
 - Ammonia
 - Arsenic (Well 11 A & 11B)
 - MTBE, VOCs
- 💧 “Scotts Valley has been notorious for its taste, a little too much flavor”

Historical Issues

- Many of the residents use point of use devices and bottled water
- Water Screening Investigation
 - Quarterly sampling
 - 30 residences, storage reservoirs, distribution system, & WTP finished water
 - ✓ Chlorine residuals generally 0.4 to 0.7 mg/L
 - ✓ Threshold Odor Numbers (TON)
 - SMCL: TON 3
 - Average TON: 4 to 6
 - Maximum TON: 8 to 17
 - Orchard Run WTP: Poorest water quality

SVWD Water Treatment

- Groundwater treatment at Orchard Run and Well 10 WTPs
- Air-stripping partially removes H_2S
- Chlorine & DO oxidizes Fe, Mn, Sulfides
- Mn-oxide coated anthracite/silica sand media filters for removal of Fe and Mn



Orchard Run WTP



- Built 1993
- 800 gpm capacity
- Tight site
- Periodic odor complaints
- High end residential development going in on adjacent property
- No sewer
- Discharge pressure 160 to 175 psi



Orchard Run WTP



Orchard Run WTP

- 💧 Poor aesthetic water quality
- 💧 Sulfurous and ammonia odors
- 💧 Corrosion due to sulfides
- 💧 Inconsistent chlorine residual in treated water (NH_3 & sulfides)
- 💧 Incomplete removal of sulfides
- 💧 Decant and backwash solids tank corrosion
- 💧 Scaling leading to pump seal failure
- 💧 Scaling of packing & filter media



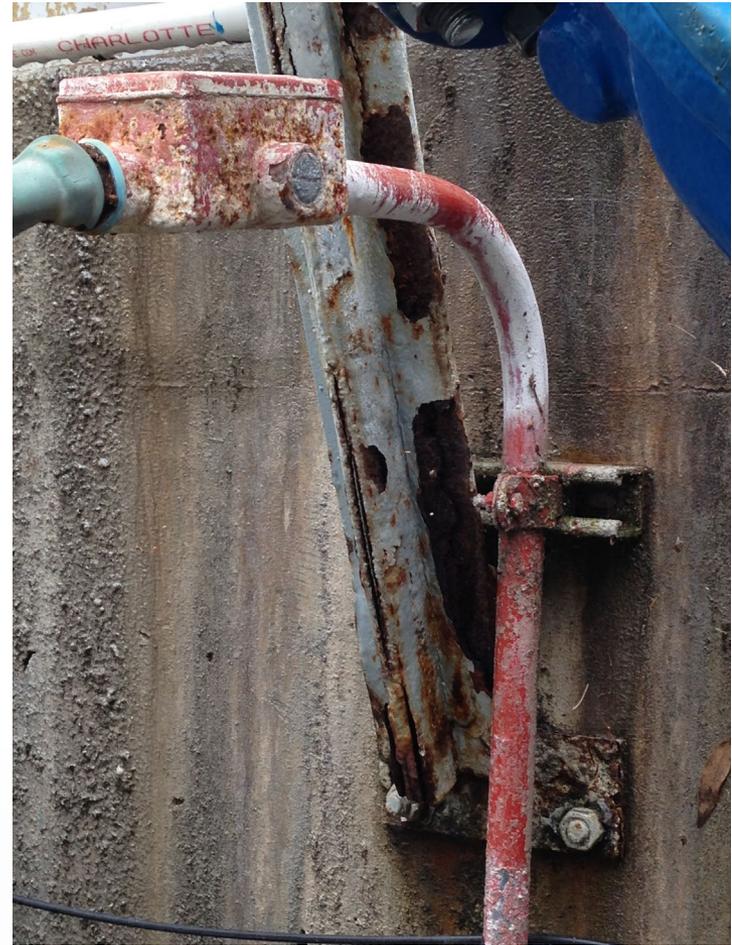
Inadequate Foul Air Odor Scrubber



- 💧 30% ammonia solution
- 💧 Packed bed scrubber
- 💧 \$25K± annual aqua ammonia cost
- 💧 \$25K± for waste ammonia disposal
- 💧 Staff complaints
 - Handling safety
 - Odors
- 💧 Neighbor odor complaints

Hydrogen Sulfide Emissions

- 💧 Damage to adjacent redwood trees
- 💧 Corrosion
- 💧 Odor complaints from neighbors



Pilot Testing Aesthetic Water Quality Improvements

Orchard Run WTP

- Monitor H₂S (water and air stripper foul air)
- Evaluated ozone
- Evaluated pyrolusite vs existing oxide-coated sand/anthracite
- Evaluated catalytic GAC

Sulfide Monitoring

Raw Water

- Hach HS-C (measures H₂S but not HS⁻)
- 1.67 mg/L H₂S during piloting

Air Stripper Exhaust

- 24" FRP duct prior to air scrubber
- Anemometer for air velocity measurement
 - ✓ 3,000 CFM
- OdaLog gas monitor (0 to 1,000 ppm H₂S)
 - ✓ 1 minute time intervals
 - ✓ 8 ppm H₂S average
 - ✓ 29 ppm H₂S peak

Ammonia Scrubber Exhaust

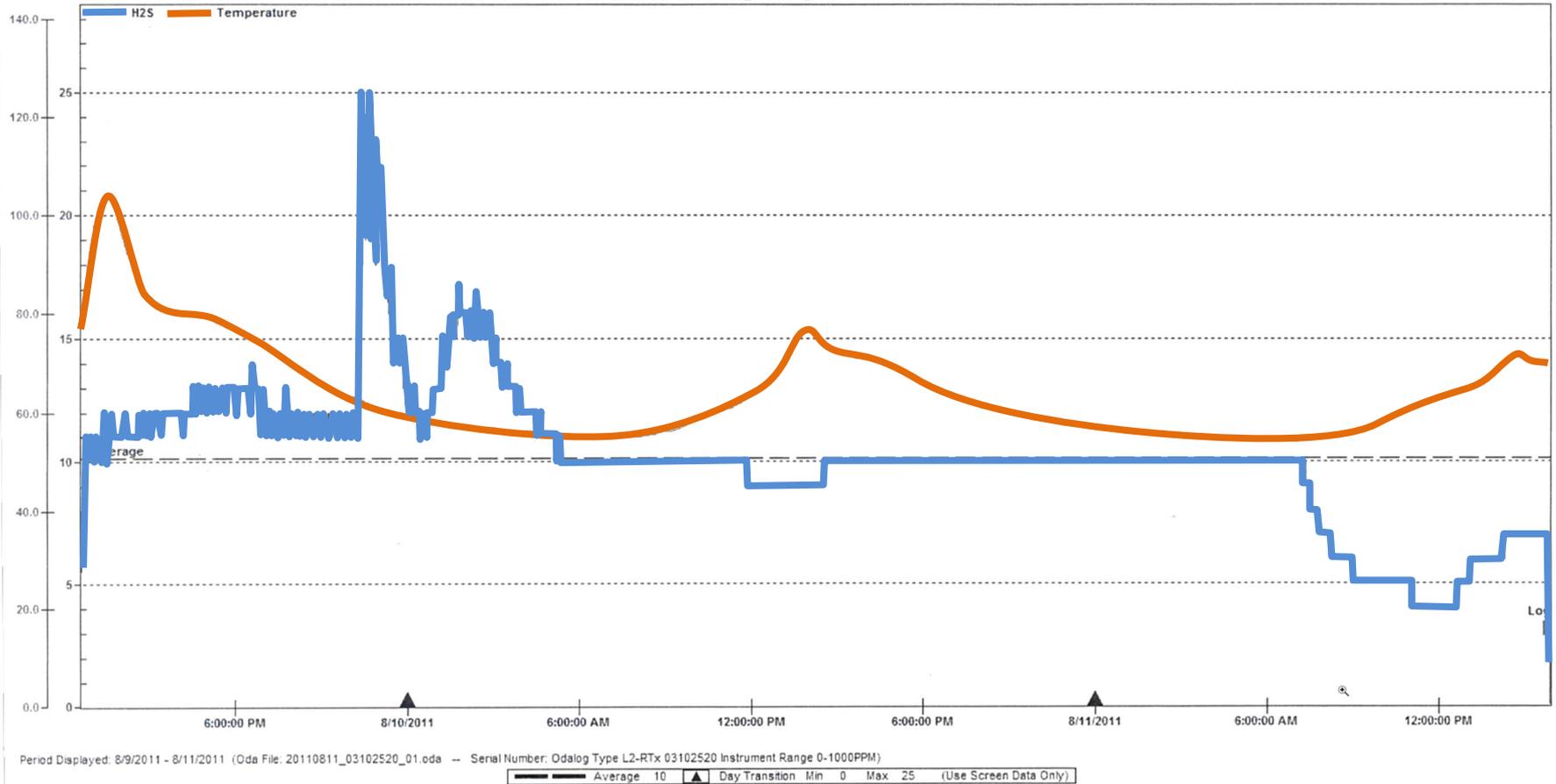
- OdaLog gas monitor (0 to 50 ppm H₂S)
 - ✓ <5 ppm H₂S average
 - ✓ 5 ppm H₂S peak



H₂S in Air Stripper Discharge

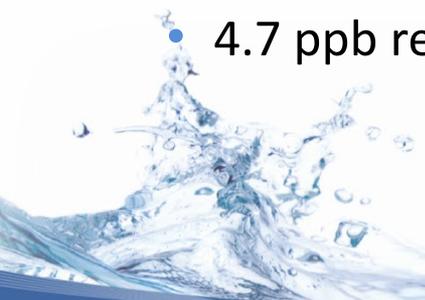
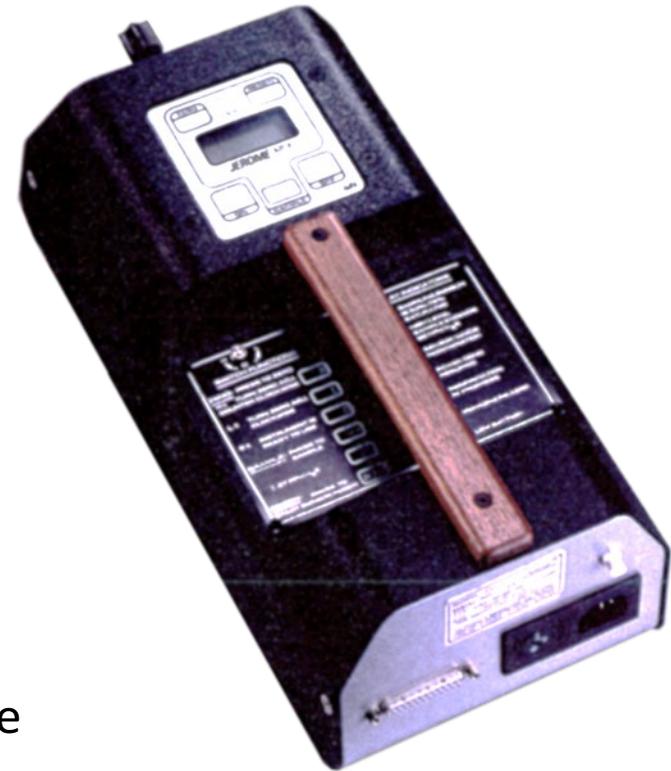
Detection Instruments Capital Unit

20110811_03102520_01: Session 1



Sulfide Monitoring

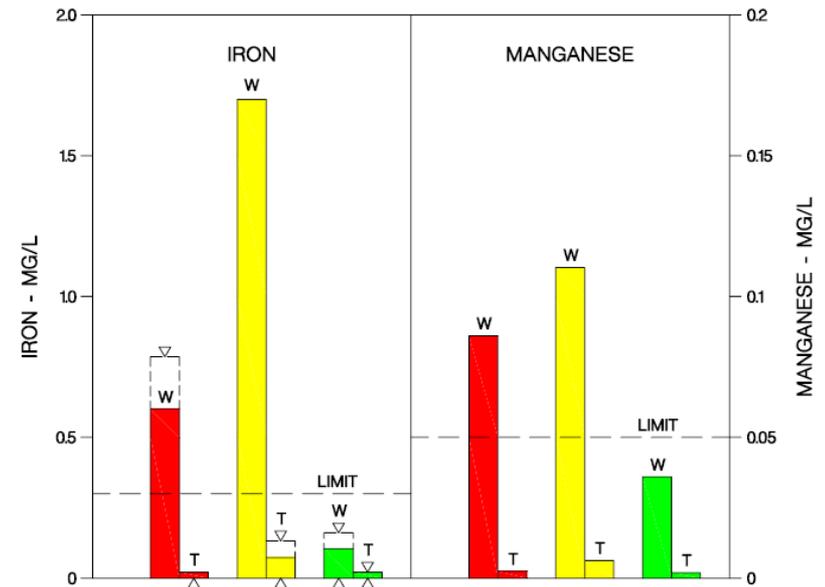
- 💧 **Atmospheric H₂S**
 - Measured at property line
 - Jerome Model 631A gold leaf unit
 - Can measure 1 to 500 ppb
 - 12 ppb peak observed
- 💧 **Air Quality Management District**
 - 25 ppb average for 30 minutes
 - Frequently reported nuisance conditions
- 💧 **Threshold Odor**
 - 0.025 to 0.25 µg/L in clean water
 - 0.47 ppb odor threshold – 50% detect presence
 - 4.7 ppb recognition threshold



Oxidation/Filtration has been effective at SVWD for iron and manganese

Filter media

- Anthracite and silica sand
- Filter media develops a manganese oxide coating
- Low loading rates
 - ✓ 3 to 5 gpm/SF

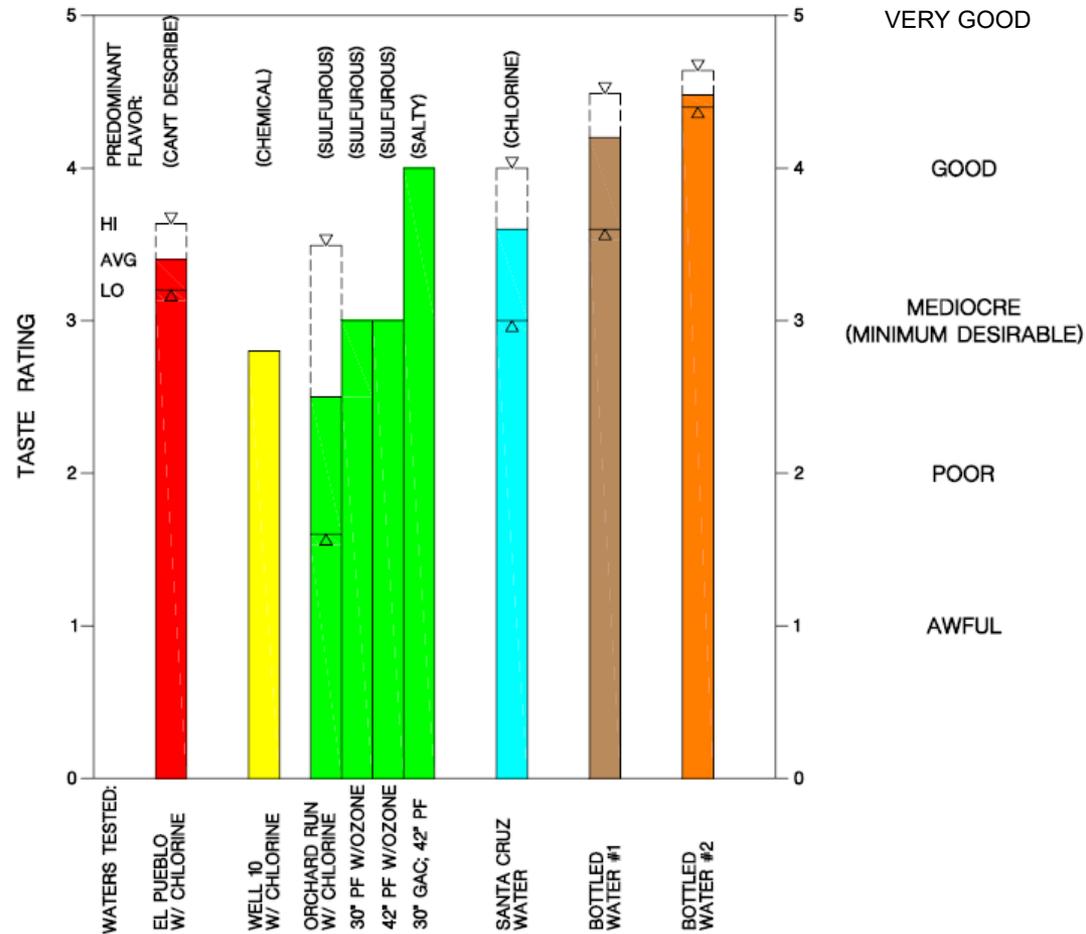


LEGEND:

LO	AVG	HI	
			EL PUEBLO WTP
			WELL 10 WTP
			ORCHARD RUN WTP
	W		WELL WATER
	T		TREATED WATER

Sulfide and chemical tastes have been issues for Orchard Run and Well 10 WTP

- 💧 Simplified flavor profile analysis
- 💧 Panel of SVWD staff & customers met twice a week
- 💧 Pilot treated water at ambient temperature
- 💧 Rated 1 to 5
 - 3 – Mediocre (minimum acceptable)



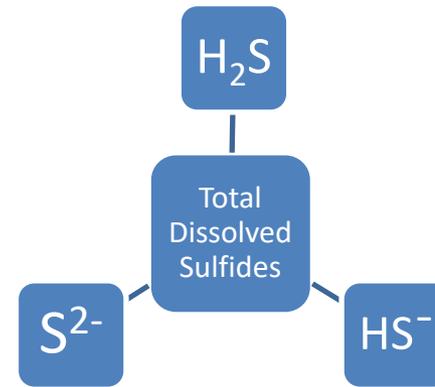
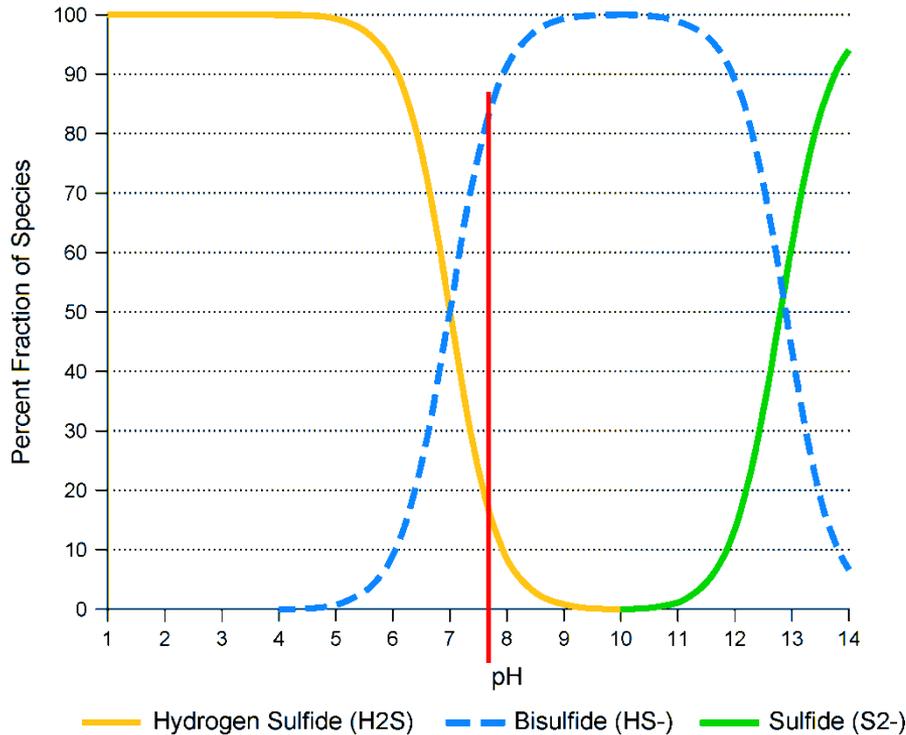
Hydrogen Sulfide Concentration Design Criteria

Location	Compound	Units	Measured		Design	
			Average	Peak	Average	Peak
Well 3B	H ₂ S	mg/L	3.6	5.0	4	5
Well 7A	H ₂ S	mg/L	4.2	5.0	5	5
Aerated Water	Sulfide	mg/L	0.2	0.6	0.25	1
Filtered Water (GAC Contactors)	Sulfide	mg/L	ND	ND	0.1	0.1
Air Stream (Odor Scrubber)	H ₂ S	ppm	8	29	10	50

💧 Raw water

- Pilot Study = 1.67 mg/L average
- Recent = 3.6 and 4.2 mg/L average
- Concentrations at startup much higher

Total Dissolved Sulfides



- 💧 All forms contribute to undesirable taste
- 💧 H₂S can be stripped
- 💧 HS⁻ can be oxidized, but yields Sulfur, polysulfides, sulfites, thiosulfates, sulfate end products

Total Dissolved Sulfides

💧 Field testing

- SVWD measured only H₂S
- Pilot testing measured total dissolved sulfides

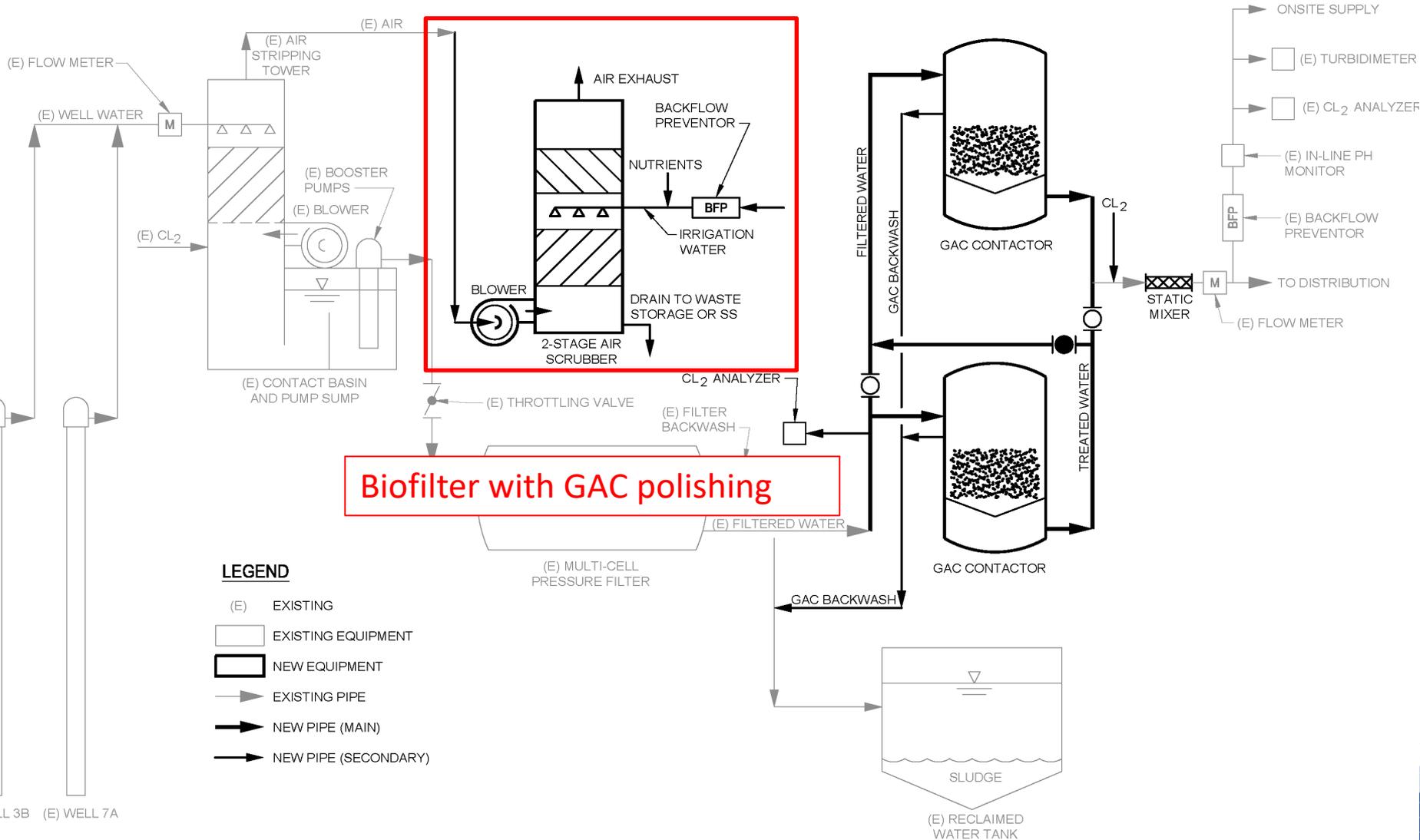
💧 Polysulfides

- Contribute to taste & odor
- No Standard Method for analysis

💧 GAC Adsorber Design Criteria

- Empty Bed Contact Time (EBCT) (Pilot Study = 5 mins)
- Dissolved Oxygen
- Head Loss

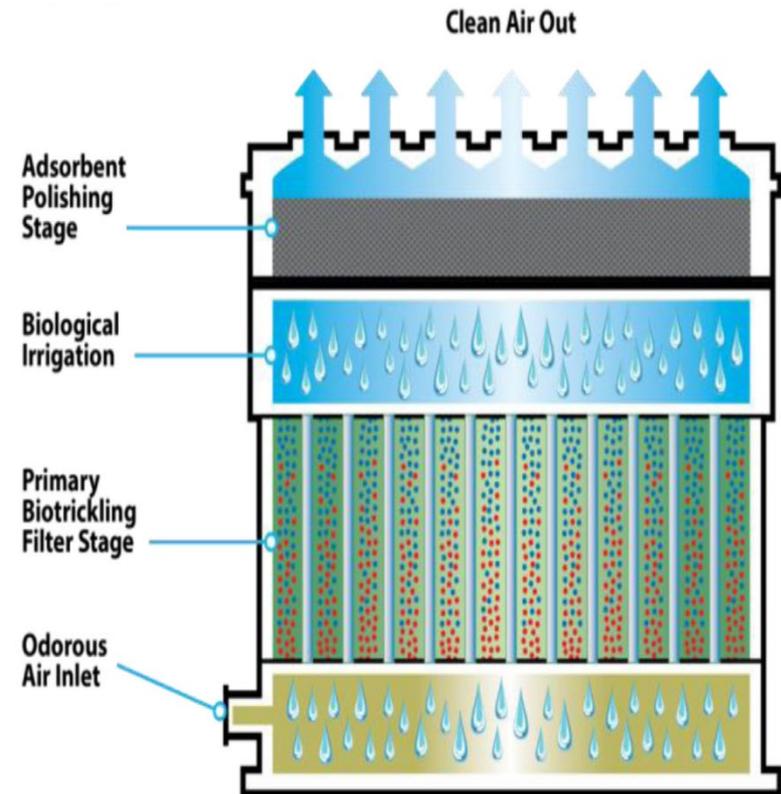
Air Quality Improvements



(E) WELL 3B (E) WELL 7A

Foul Air Scrubber

- 2 stage scrubber
 - Biological oxidation with GAC polishing
- Design parameters
 - Air flow rate = 3,000 cfm
 - Air head loss = 2.2 inches WC
 - H₂S = 10 ppm average, 50 ppm peak
- Irrigation water
 - 1,267 gals/day (20 sec/10 minutes)
- Drainage pH 2.0 to 2.5



Foul Air Scrubber

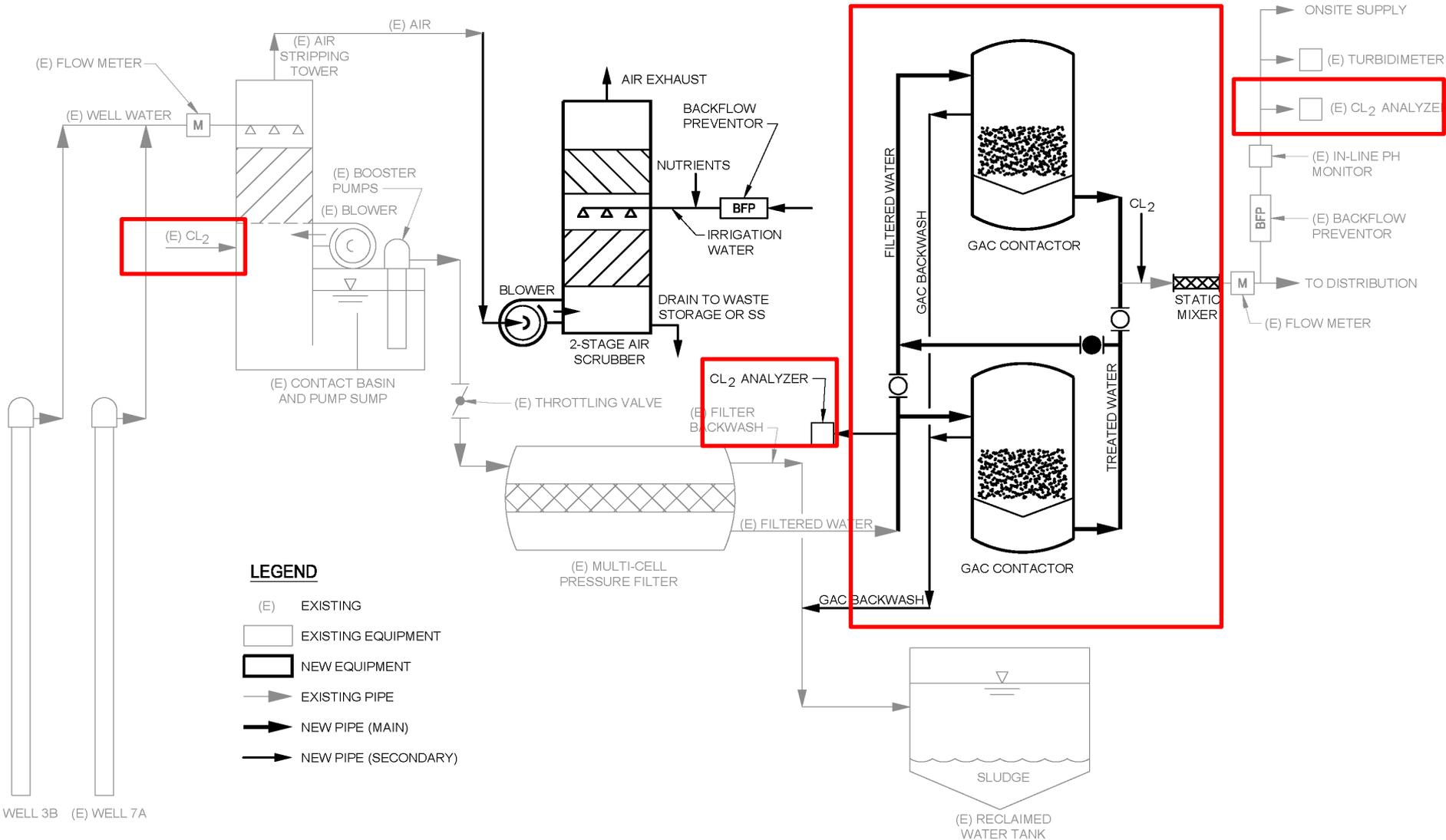


Scrubber Discharge Neutralization

- Scrubber drainage pH 2.0 to 2.5
- Did not meet sewer discharge limits
- pH neutralization pellets followed by dilution



Water Quality Improvements



Recommended GAC Contactor Media

Catalytic GAC

- Initially adsorbs H_2S and other sulfides
- Then oxidizes H_2S to S and polysulfides
 - ✓ Minimum DO required
 - 2x stoichiometric requirement to convert S & polysulfides to sulfate
 - 4 mg/L



GAC Contactors

💧 20,000 lbs GAC per vessel

💧 EBCT

- 800 GPM = 11 mins
- 420 GPM = 20 mins

💧 Two 10 ft diameter contactors

💧 200 psi working pressure

💧 Operating configuration

- Lead-lag operation under normal production
- Parallel operation under high-demand production

Flow Rate (gpm)	Parallel Operation Head Loss (psi)	Series Operation Head Loss (psi)
400	1.7	6.9
600	3.0	12.6
800	4.8	19.7
900	5.2	-

GAC Adsorbers



American Water Works Association
Pacific Northwest Section

Kennedy/Jenks Consultants

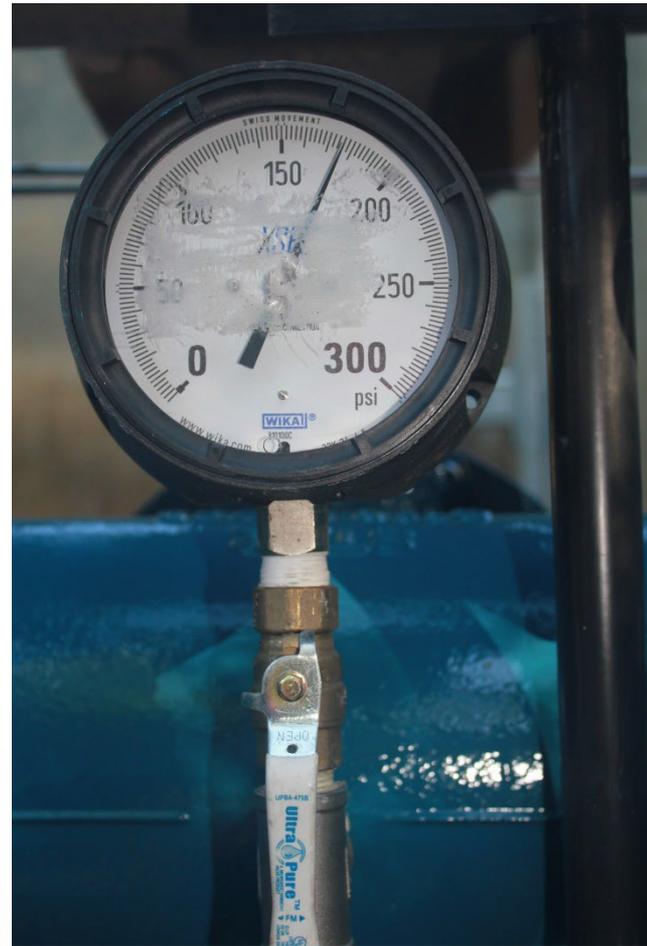
Design & Construction Issues

- Well 7 casing failed just prior to design
- Space availability
 - Demolished plate & frame press to make room for GAC
 - Demolished corroded backwash tank, waste solids tank & existing odor scrubber



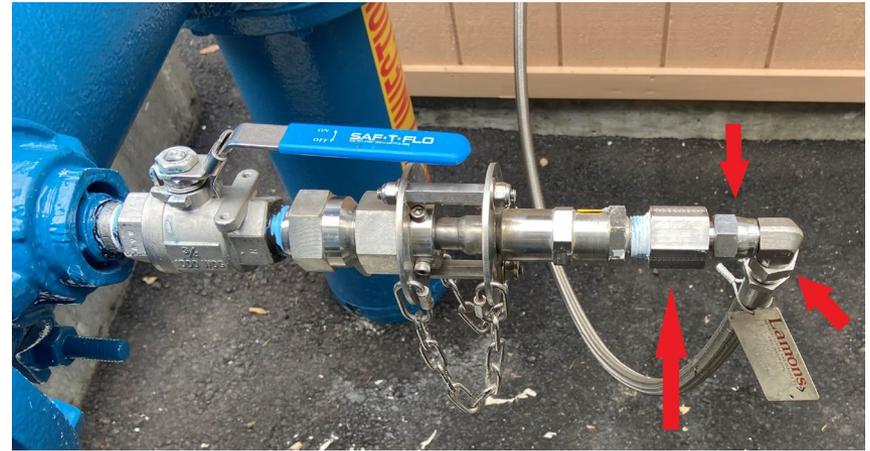
Post GAC Chlorination

- Post chlorination required
- GAC eliminates chlorine residual
- Contractor & District concerned about injecting hypochlorite at pressures > 160 psi



Post GAC Chlorination

- 💧 Titanium or Hastelloy C wetted parts
- 💧 Contractor installed 316 SS on hypochlorite piping
- 💧 Corrosion leak before they could install the correct material



Arsenic (As) Leaching

- As naturally occurs in GAC (coal & coconut shell)
- Flush-to-waste ≈ 20 bed volumes prior to start up typical
- Future sewer connection capacity 50 gpm
- Used 24 hr soak & drain
- 8.5 & 9.1 $\mu\text{g/L}$ As after 4 cycles
- Startup delay-ORP dropped
- As 13 & 14 $\mu\text{g/L}$
- Repeated soak & drain
- As 3.8 $\mu\text{g/L}$

