April 27, 2018 2:45 PM
PNWS-AWWA
Section Conference
Room 317

CITY OF SUMNER: CENTRAL WELL DEVELOPMENT

Case Study for Manganese and Polysulfide Removal

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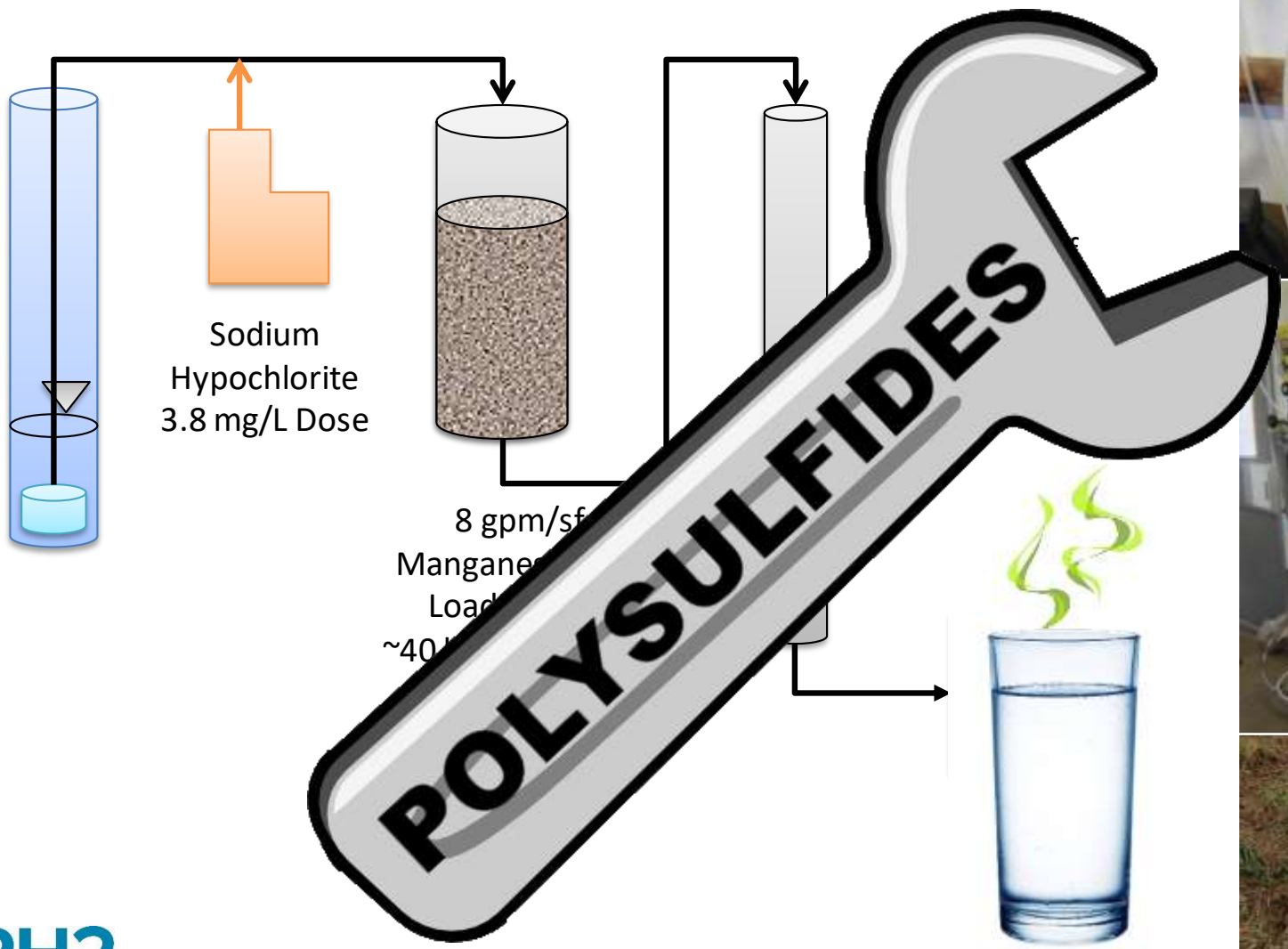
AGENDA

1. Background and Overview
2. Manganese Treatment
3. Polysulfide Treatment
4. Engineering Considerations
5. Summary

1. BACKGROUND AND OVERVIEW

- City Goals:
  - Develop Central Well
  - Improve Operational Flexibility
  - Meet Projected Water Demands
- Water Quantity:
  - 1,050 gpm now (2,100 gpm future)
- Water Quality:
  - Manganese (0.12 ppm)
  - Ammonia (0.2 ppm)
  - Hydrogen Sulfide odor

2. MANGANESE TREATMENT



CHLORINATION OF HYDROGEN SULFIDE

- Typical Chlorination of Hydrogen Sulfide

$$H_2S + Cl_2 \rightarrow 2HCl + S^0$$

  - 2.1 mg/L chlorine for each mg/L H_2S to produce elemental sulfur

$$H_2S + 4Cl_2 + 4H_2O \rightarrow 8HCl + H_2SO_4$$

  - 8.5 mg/L chlorine for each mg/L H_2S to produce sulfuric acid

- Polysulfides can also form as elemental sulfur combines with residual sulfide

$$H_2S + Cl_2 \rightarrow 2HCl + S^0$$

$$nS + H_2S \leftrightarrow H_2S_n$$

3. POLYSULFIDE TREATMENT

- Chemical Feed
  - Sodium meta-bisulfite, sodium bisulfite or sulfur dioxide
  - Initial reaction create sulfite ion which then dissolves polysulfide compounds into thiosulfate

$$Na_2S_2O_5 + H_2O \leftrightarrow 2Na^+ + 2HSO_3^-$$

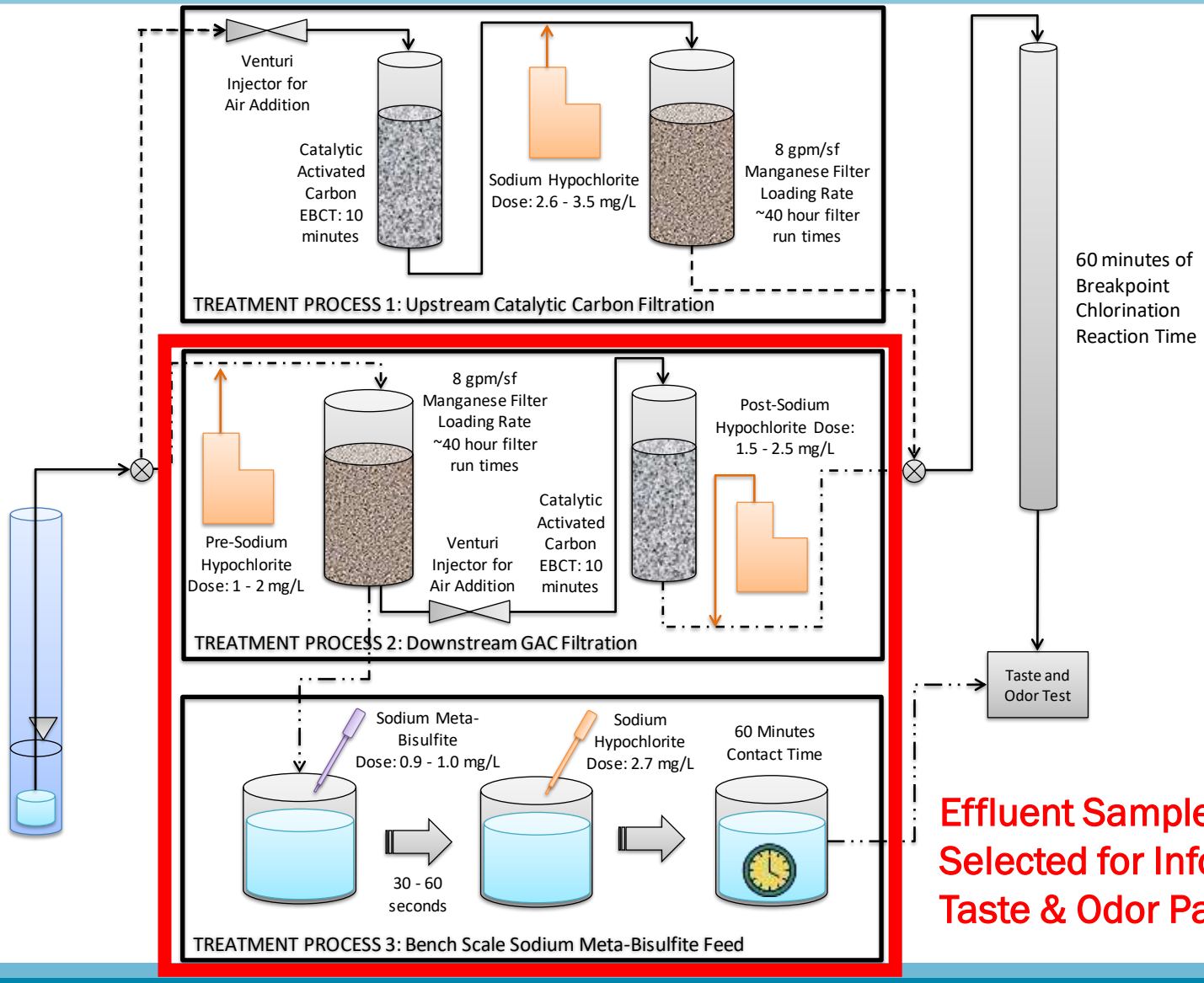
$$HSO_3^- \leftrightarrow H^+ + SO_3^{2-}$$

$$SO_3^{2-} + S \rightarrow S_2O_3^{2-}$$

$$SO_3^{2-} + H_2S_n \rightarrow S_2O_3^{2-} + H_2S_{n-1}$$

- Catalytic Granulated Activated Carbon Adsorption
  - Adsorbs sulfite compounds
  - Required elevated dissolved oxygen upstream (aeration)

TASTE AND ODOR PILOT STUDY

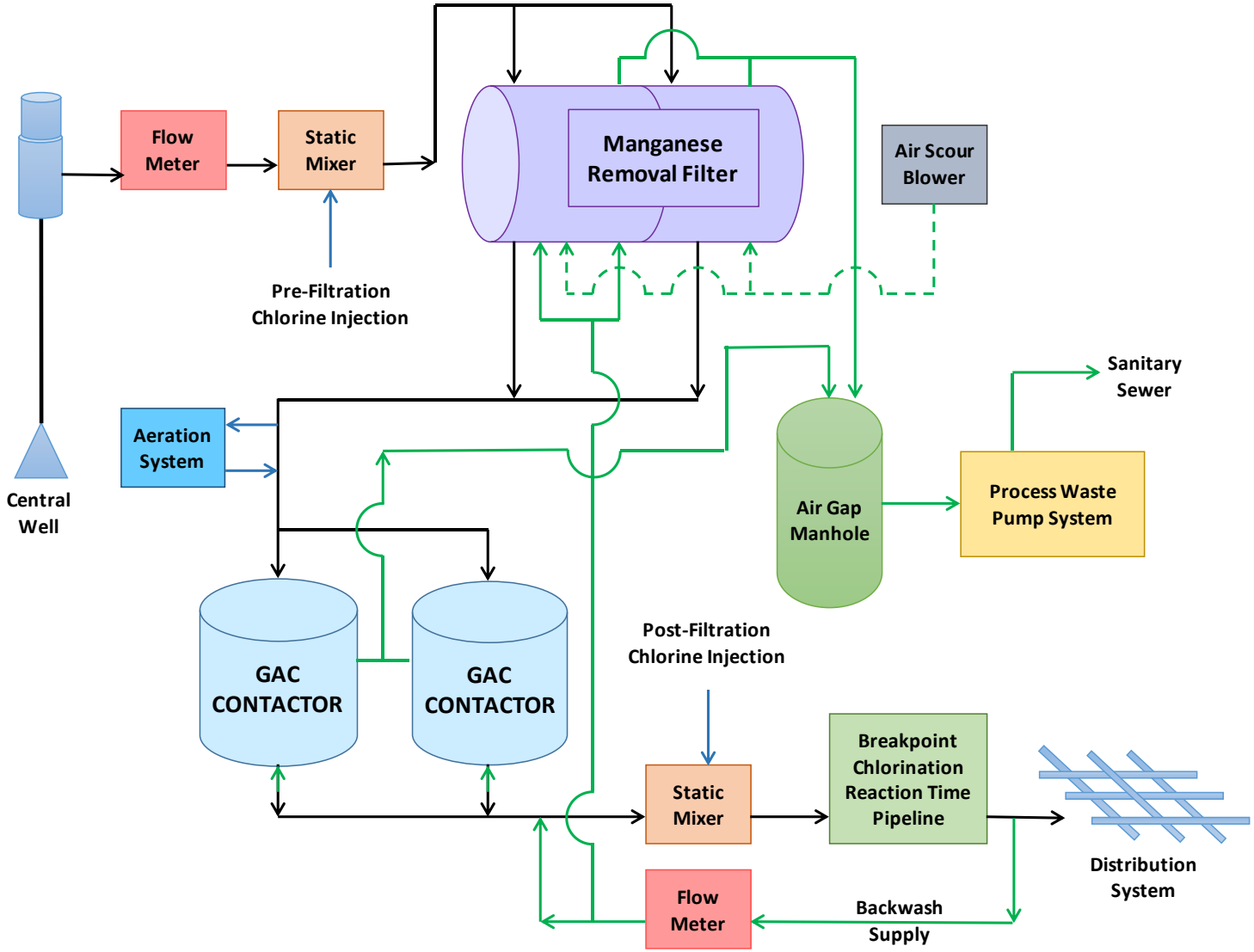


Effluent Samples Selected for Informal Taste & Odor Panel

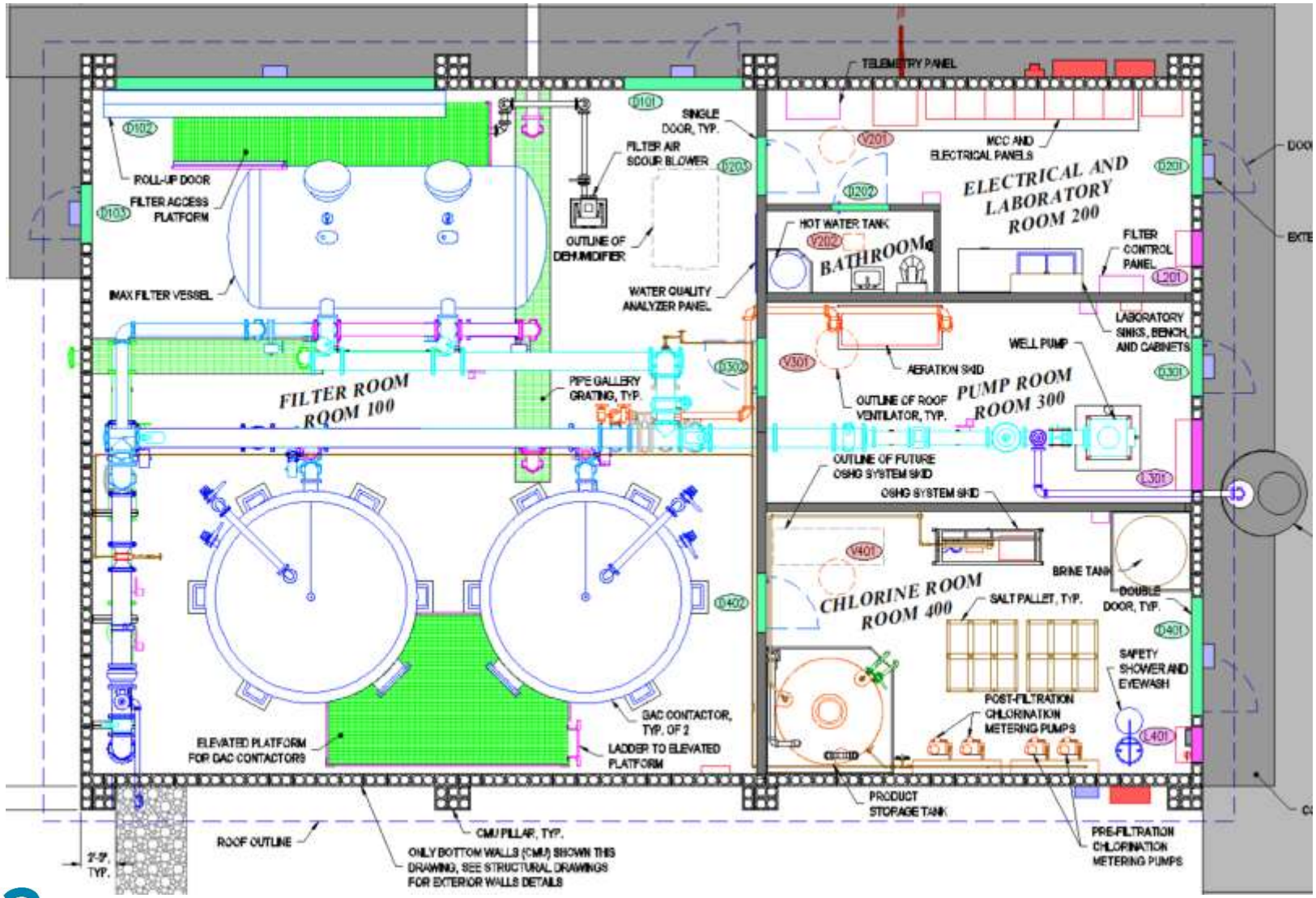
INFORMAL TASTE AND ODOR PANEL

- Sample Comparison
  - Pilot Process 2 Effluent (Catalytic GAC)
  - Pilot Process 3 Effluent (Meta-Bisulfite)
  - City Hall tap
  - Bottled water
  - Neighboring residential tap
- Treatment Process 2 (Manganese → GAC) most accepted ratings except bottled water
- Catalytic GAC was selected for design
  - Higher capital and O&M costs
  - Produced the most acceptable water

4. ENGINEERING CONSIDERATIONS



FACILITY LAYOUT



WELL HEAD

- Vertical Turbine Pump
  - 1,050 gpm
  - Variable Frequency Drive
  - Expandable to 2,100 gpm thru bowl and electrical modifications

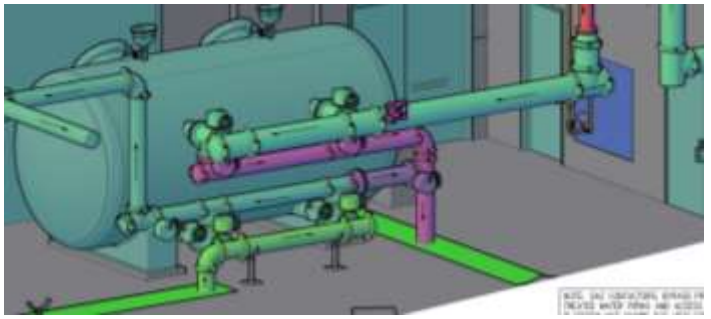
DISINFECTION SYSTEM

- 48-pound per day OSEC On-site Sodium Hypochlorite Generation System
- ProMinent Metering Pumps

DISINFECTION SYSTEM 2

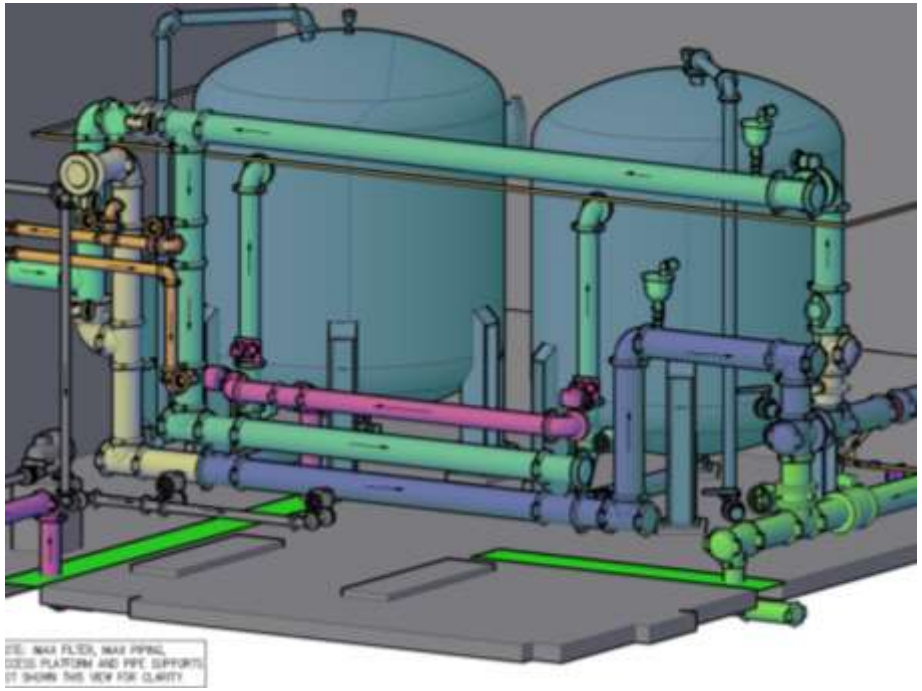
- Pre-Filtration Injection (0.15 ppm)
  - Minimize Cl_2 Residual in IMAX Filter Effluent
- Post-Filtration Injection (1.7 ppm)
- 60-minute Breakpoint Chlorination Reaction Time Pipeline
  (700 feet of 48” Diameter Pipe)

MANGANESE FILTRATION



- Tonka Water (2 cells; 8-foot diameter x 18-foot long HPF)
  - IMAX Media (Proprietary Pyrolusite & Silica Sand Blend)
  - 8 gpm/square foot loading rate → 0.006 – 0.012 ppm Mn effluent
  - 40 hour filter runtimes expected
  - Simultaneous air & water backwash, no media restratification required

CATALYTIC GAC CONTACTOR

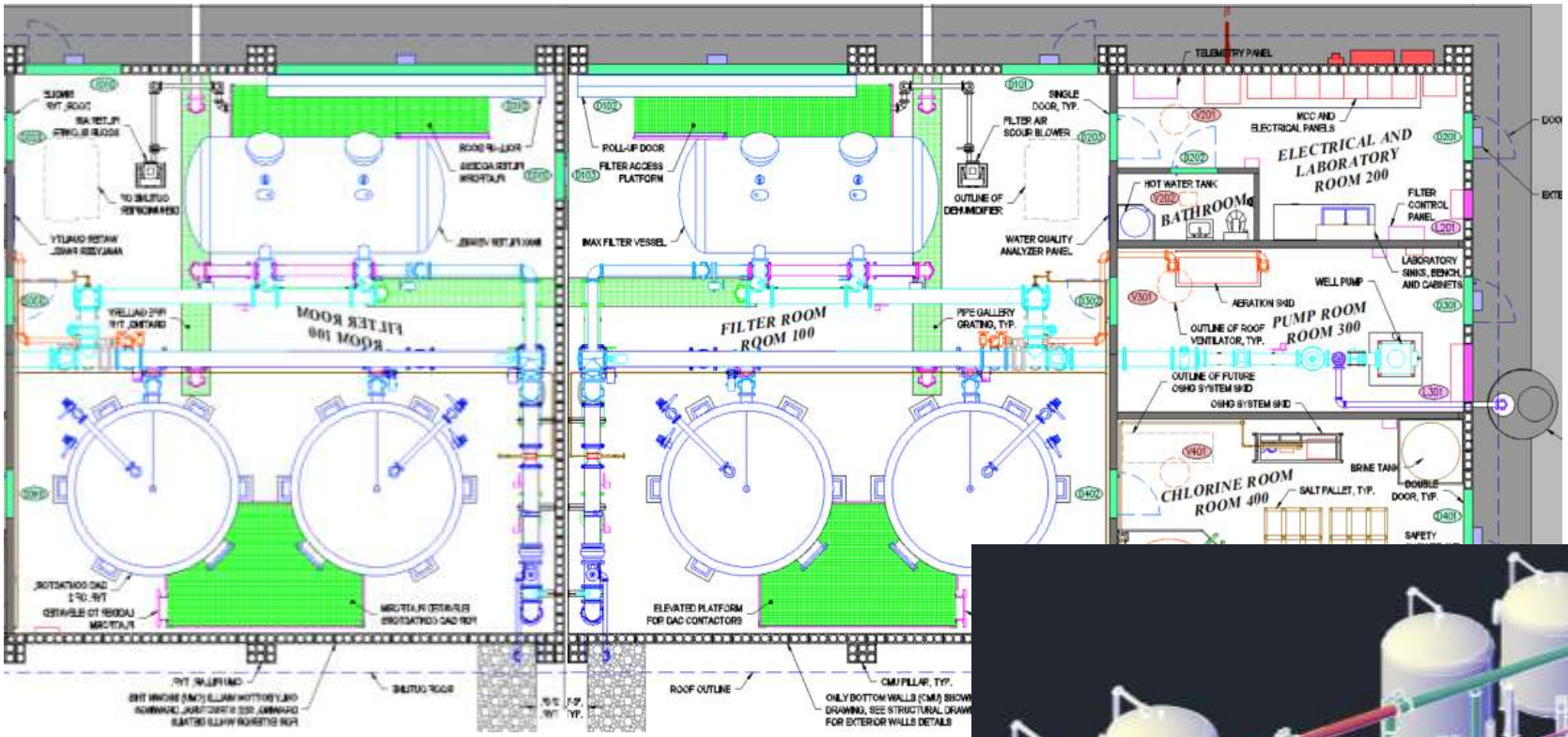


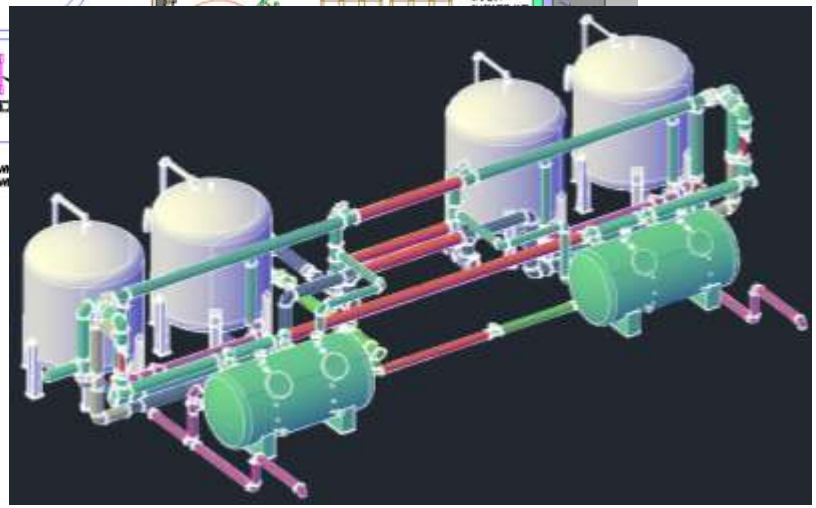
- Loprest Catalytic GAC Contactors (2 vessels, 12-feet diameter, 10-feet sideshell, 78 inches media depth)
  - Jacobi AquaSorb CX-MCA
    catalytic granular coconut shell based activated carbon media
  - 4.6 gpm/square foot loading rate; 10 minute EBCT
  - Pre-Aeration for hydrogen sulfide removal (Mazzei)

PROCESS WASTE SYSTEM

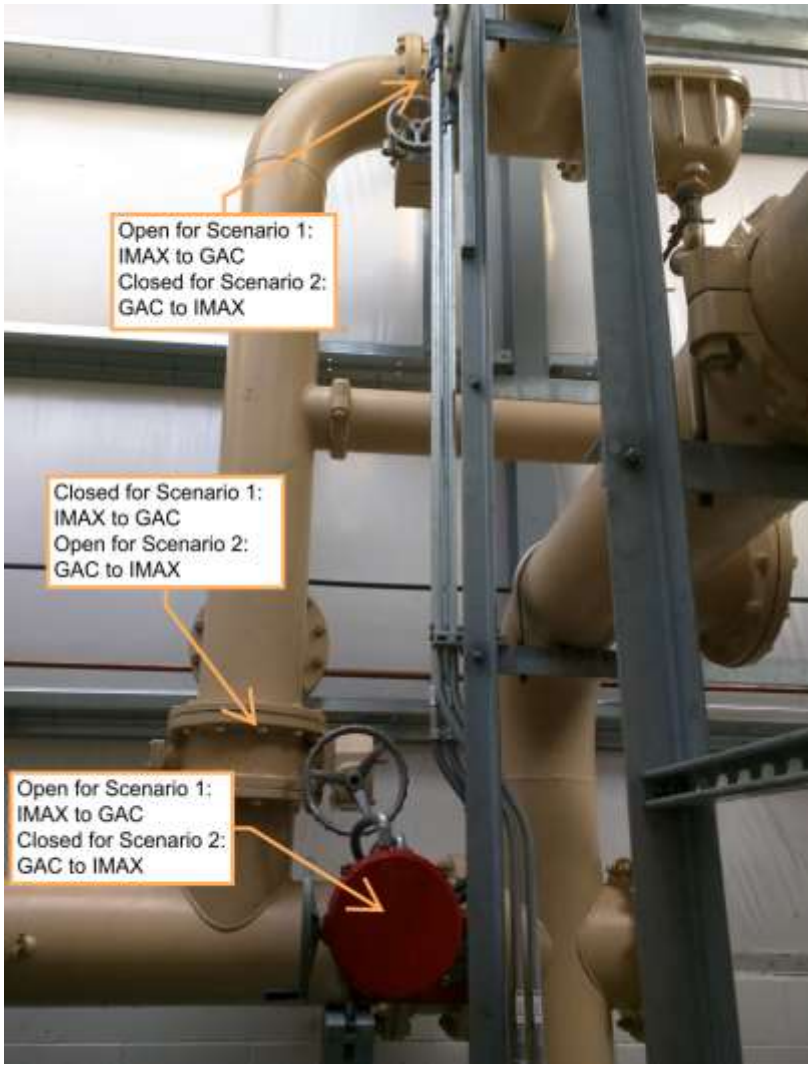
- Minimal waste via IMAX
- Air-gap Manhole
- Lift Station
  - Submersible Pumps w/ VFD
    - Single Pump: 680 gpm
    - Both Pumps: 900 gpm

DESIGN FLEXIBILITY: FUTURE EXPANSION



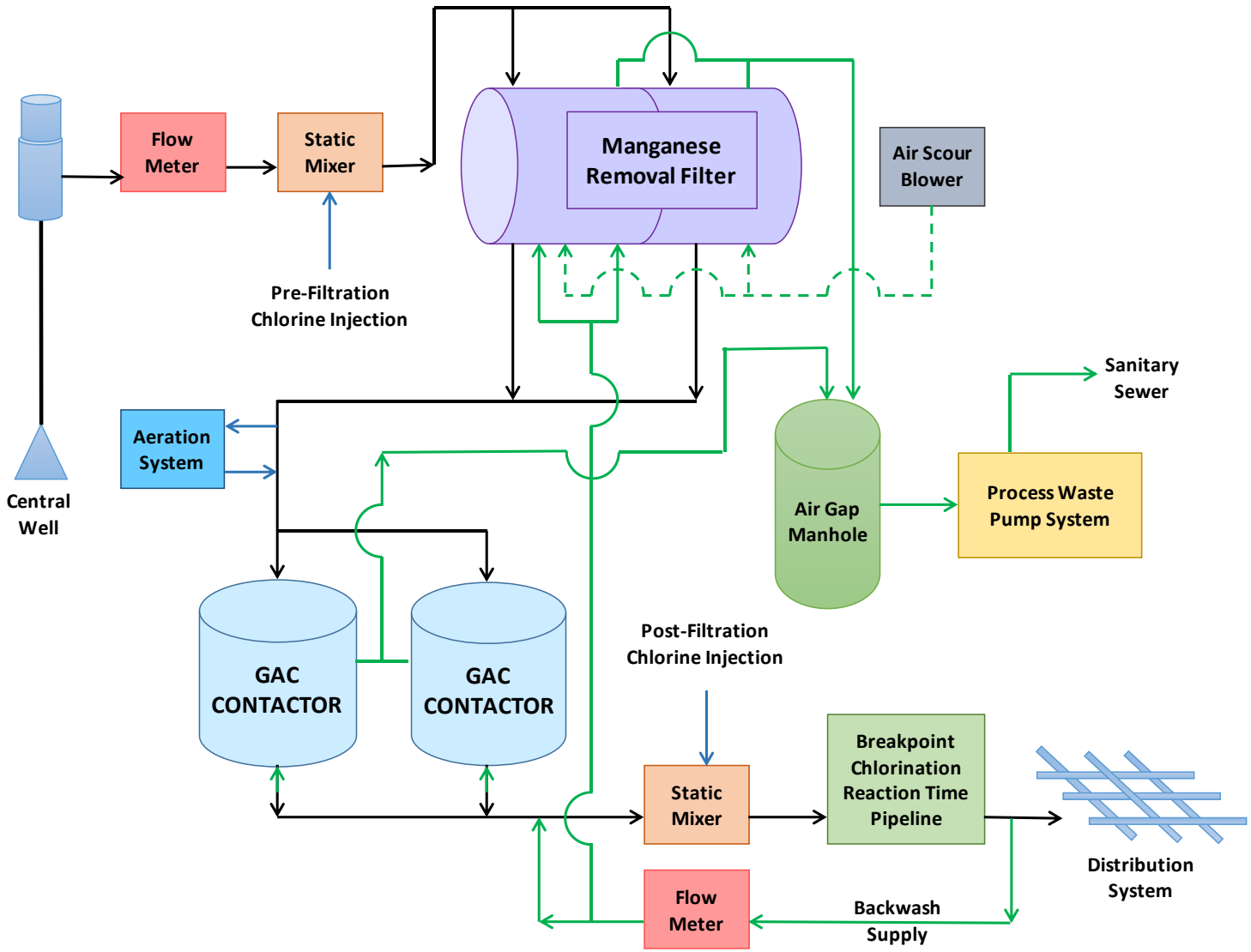


DESIGN FLEXIBILITY: FILTER SWAP

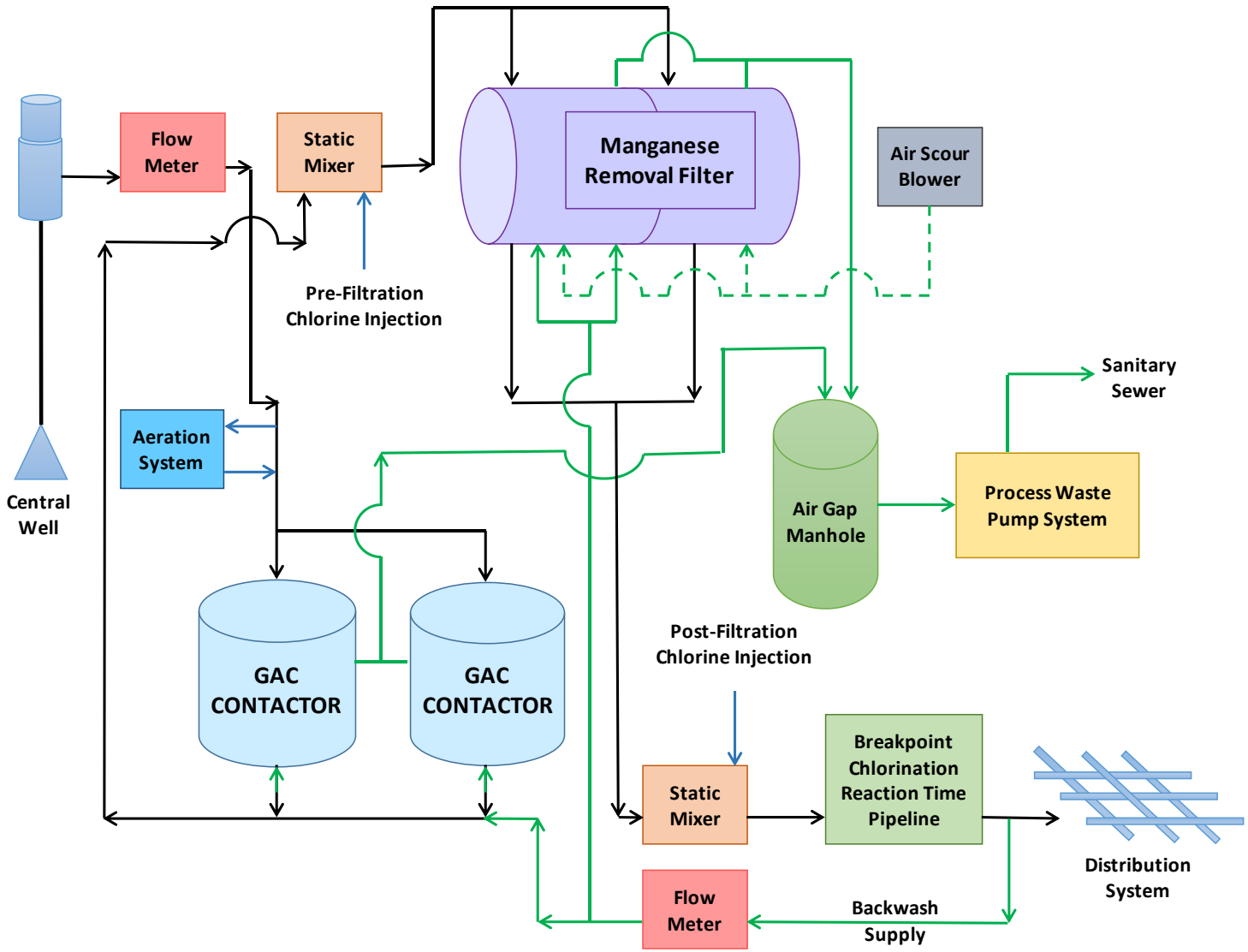


- Strategic Piping and Valves Provide Process Flexibility

NORMAL TREATMENT PROCESS



FILTER SWAPPED TREATMENT PROCESS



5. SUMMARY

- City of Sumner: Central Well Development
  - Polysulfides Threw a Wrench into Manganese Treatment
  - What worked:
    - Initial pre-chlorination dose
    - Manganese removal
      - detectable chlorine trace in effluent to keep media charged
    - Catalytic GAC Contactor (upstream aeration)
    - Post-chlorinate and 60 minute breakpoint reaction time
- Current [Limited] Plant Operations

QUESTIONS?

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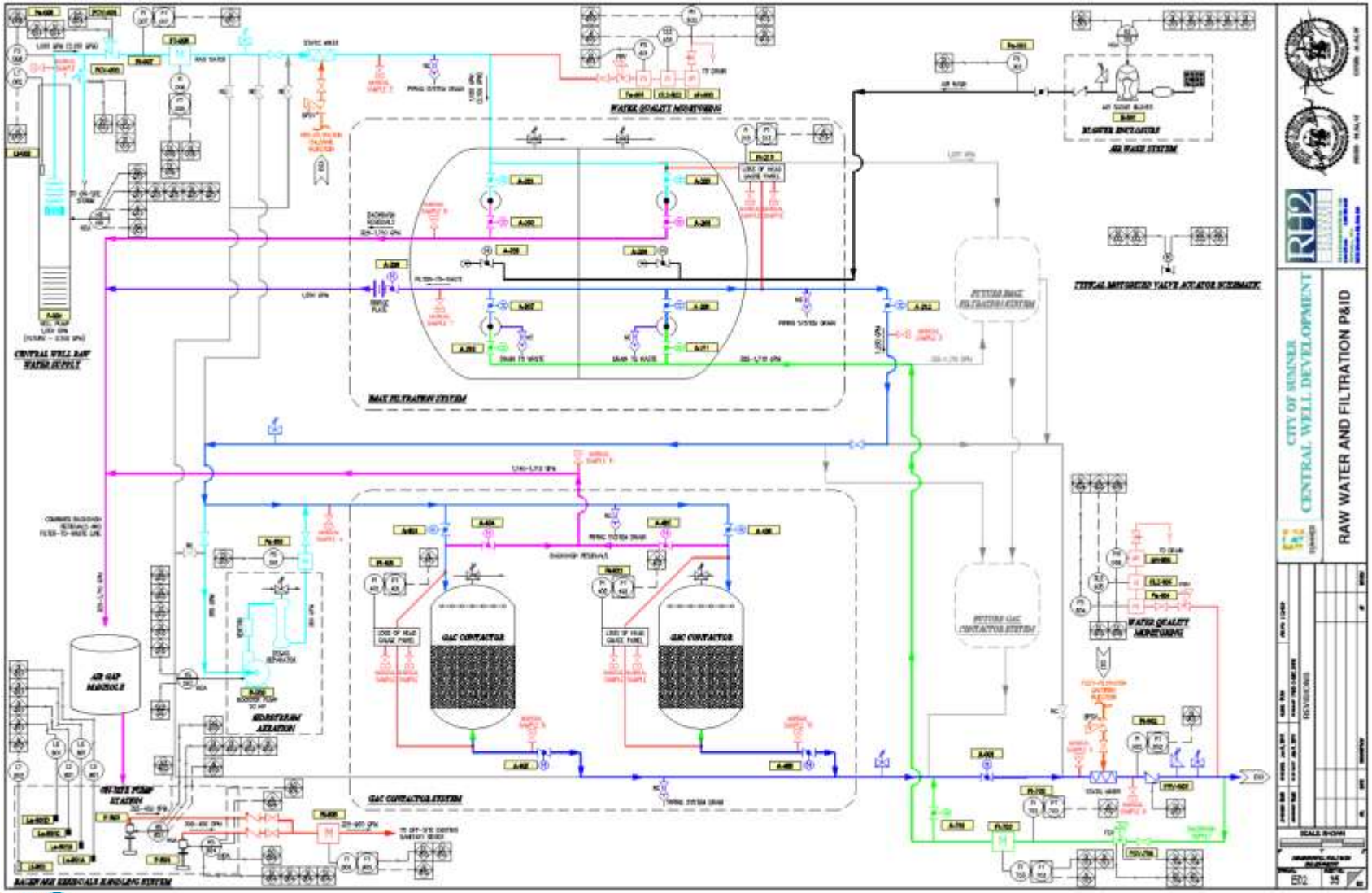
PHOTOS

PHOTOS

PHOTOS

DESIGN P&ID


CITY OF SUMNER
CENTRAL WELL DEVELOPMENT
RAW WATER AND FILTRATION P&ID
GAC CONTACTOR
GAC CONTACTOR
GAC CONTACTOR SYSTEM