Long Point Water Treatment Plant Process Evaluation and Design Upgrades for Performance Enhancement; Dover, DE

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PA-AWWA's 68th Annual Conference

May 12, 2016

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Long Point Water Treatment Plant

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Presentation Outline – *The 'Story' of a WTP Design Upgrade*

- Background
- Initial Task – WTP Capacity improvement - Ozone
- Original Evaluation and Approach
- Evaluation Findings
- Alternatives to Process Train and Recommendations
- Design Upgrades

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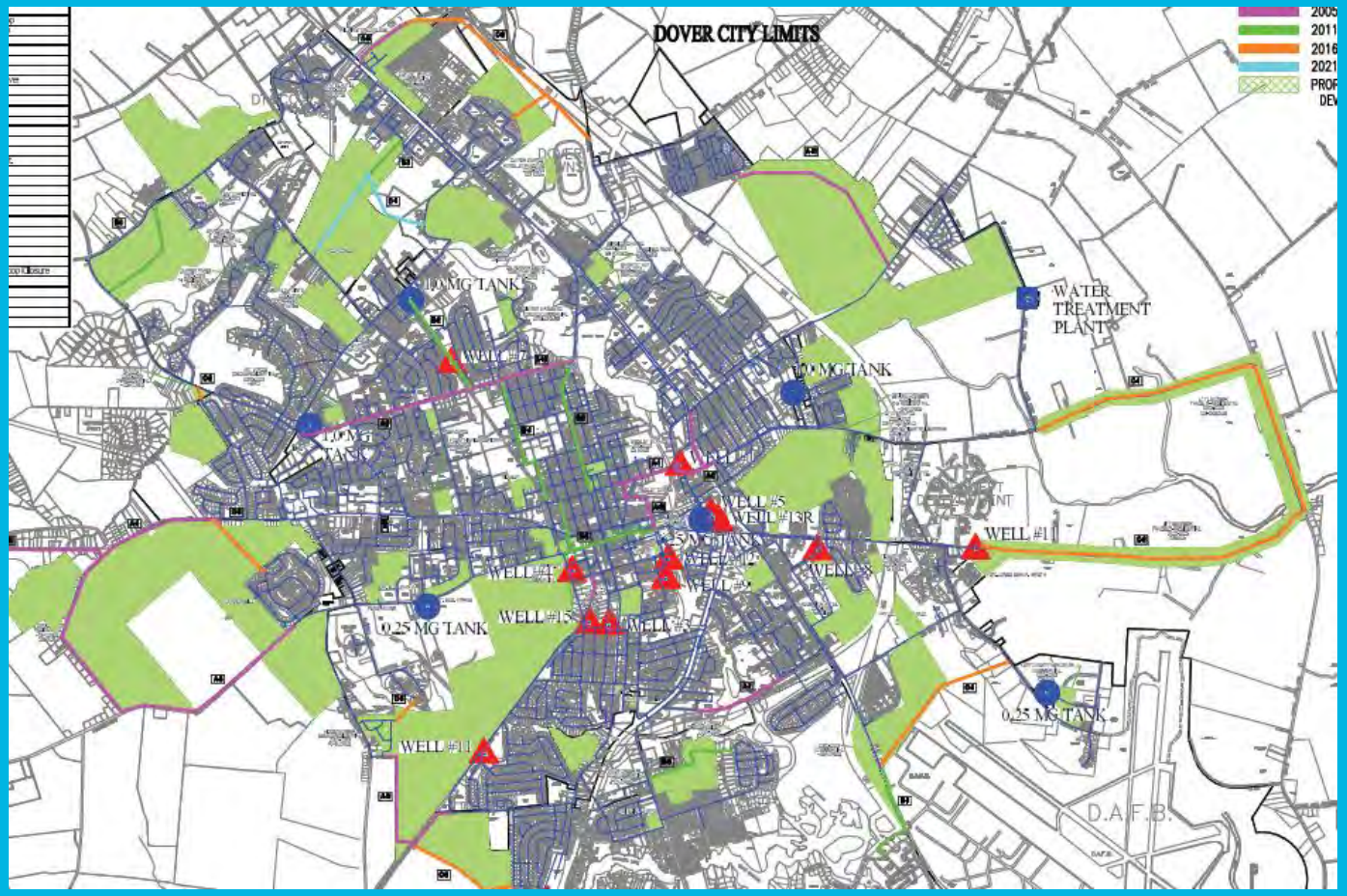
Dover Water System - Snapshot

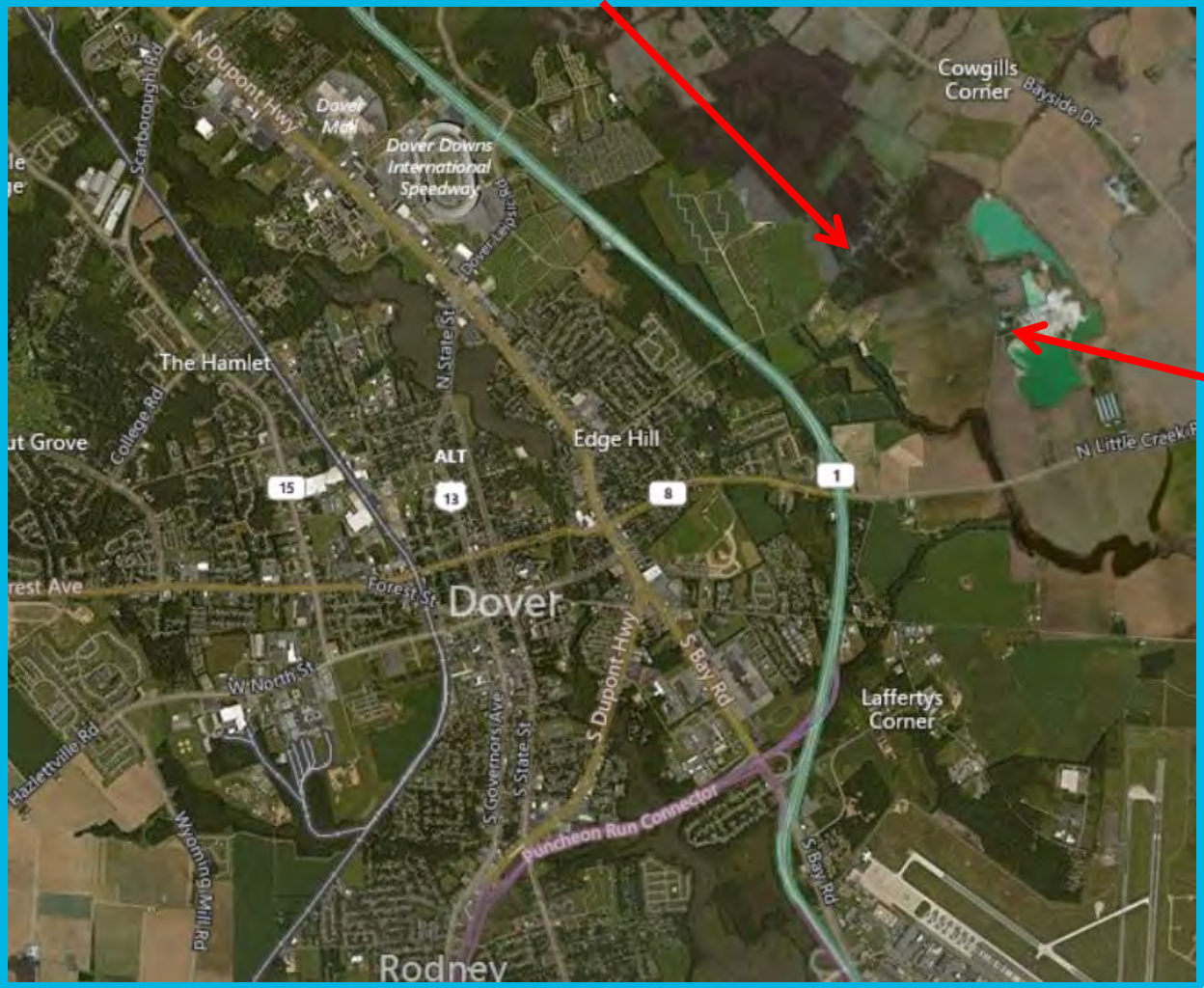
- Demand: ADD ~ 5.11 MGD, MDD ~ 9.28 MGD
- Water Supply: 14 'deep' groundwater wells

- Long Point WTP by surficial Columbia Aquifer



Future Water Needs – Dual Turbine Energy Plant

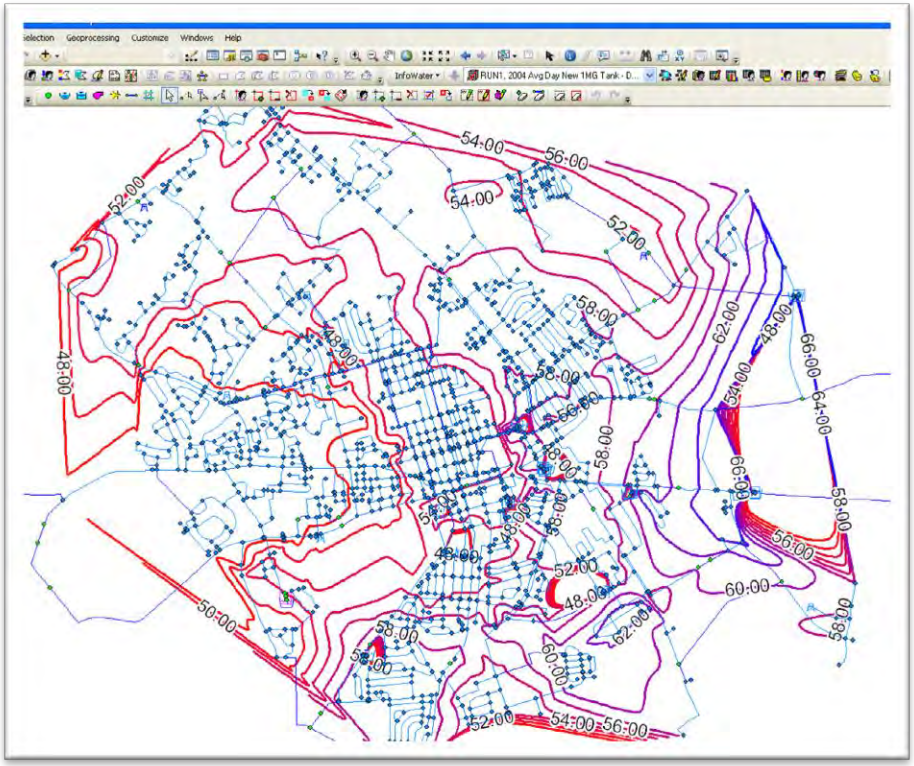
- Phase1: 1600 gpm (2.304 MGD)
- Phase 2: 3200 gpm (4.608 MGD)



Long Point WTP

Garrison Oak Technical Park - Energy Plant

- Construction progressing
- InfoWater water modeling



Minimum Pressures – ADD plus *Phase 2 (3200 gpm)* over 168 hours.
Initial HGL 158.0 ft.

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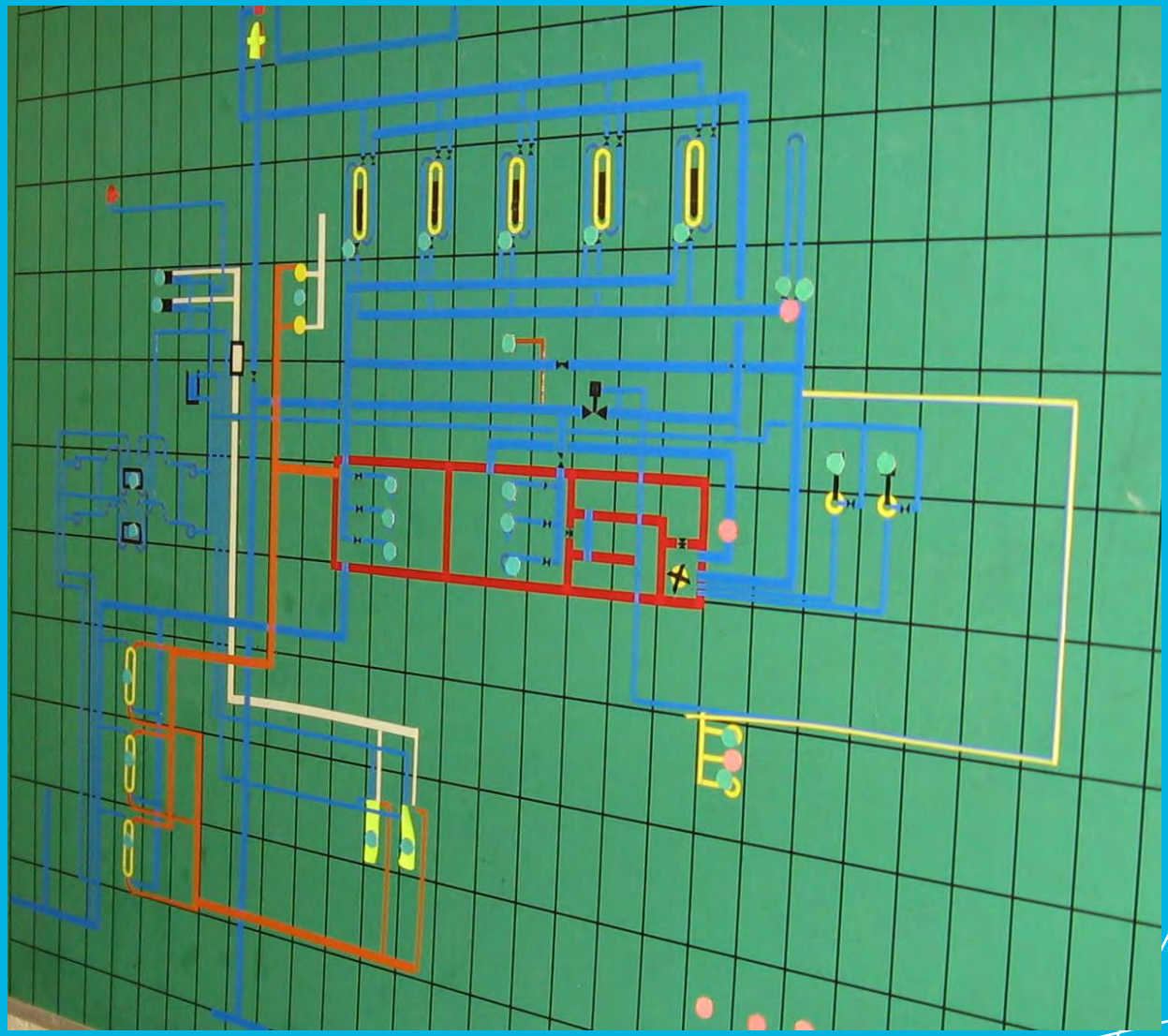
Long Point WTP

- Put into operation in the early 1990's
- Six Supply Wells in unconfined Columbia Aquifer
- Original design rated capacity 5.0 MGD
- Ozone disinfection, pH adjustment, granular activated carbon, secondary sodium hypochlorite disinfection

Long Point WTP – Process Flow Diagram



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Long Point WTP

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Long Point WTP

GAC Units

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GAC Units

High Service Pumps

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Lime Silo

Storm Water Drainage Lagoon

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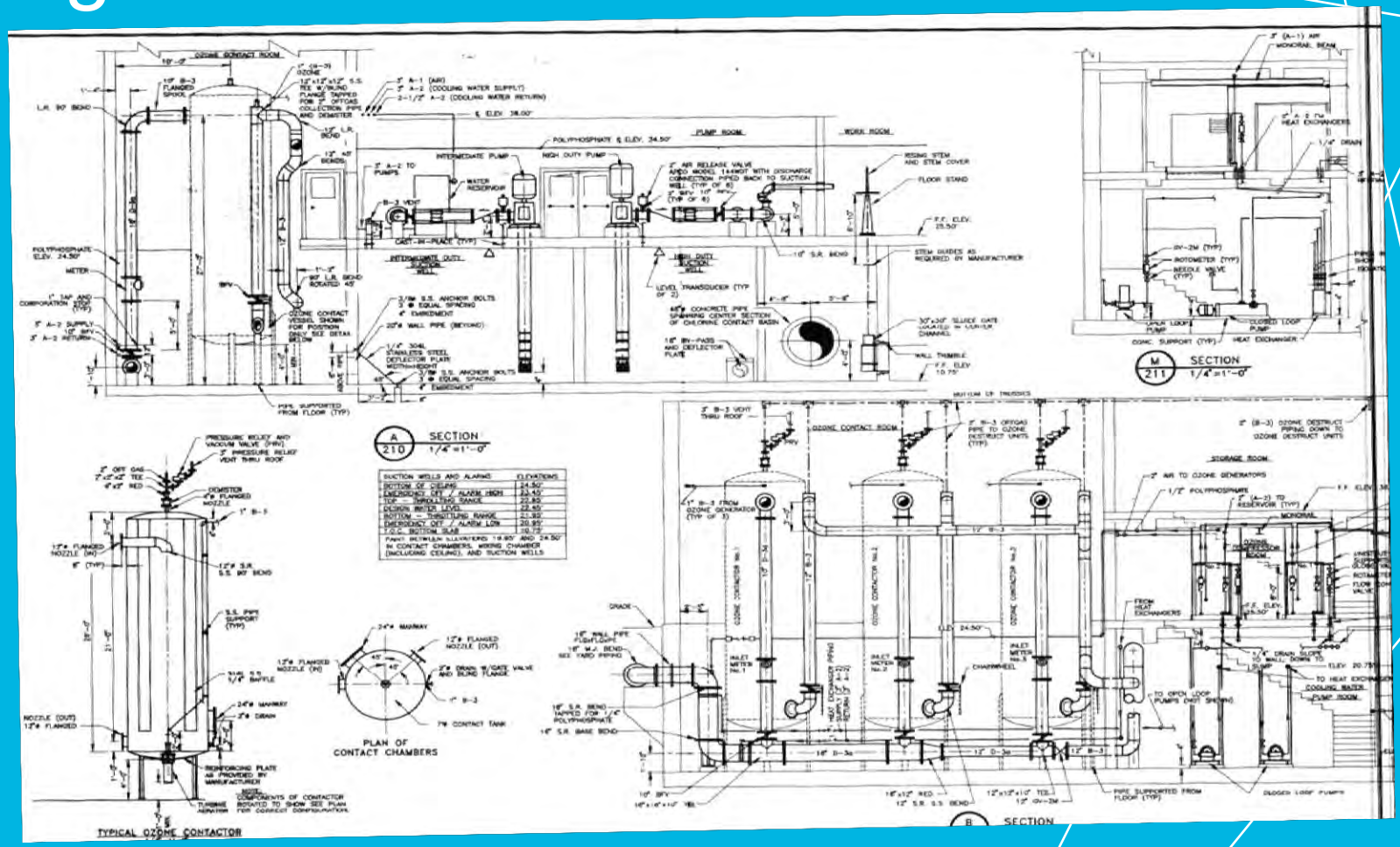
Long Point WTP



Ozone Contactors

Intermediate Wet Well

Clearwell

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Original Evaluation Approach – WTP limited in production to less than original capacity

- Operations Performance
- Treatment Effectiveness
- Chemical Requirements
- Energy Expenditure

Ozone Contactors

Pressing Concern: The contactors cannot provide the necessary contact time when more than 5 wells are operational. Excess ozone carried out to ozone destructors.

Ozone generation is expensive with considerable ancillary equipment requirements: *high pressure air blowers to feed air to the ozone generators, heat exchange equipment with pumps, and ozone destruction equipment to assure that no excess ozone is discharged to the environment.*

Research into necessity of use.

Evaluate existing treatment methods.

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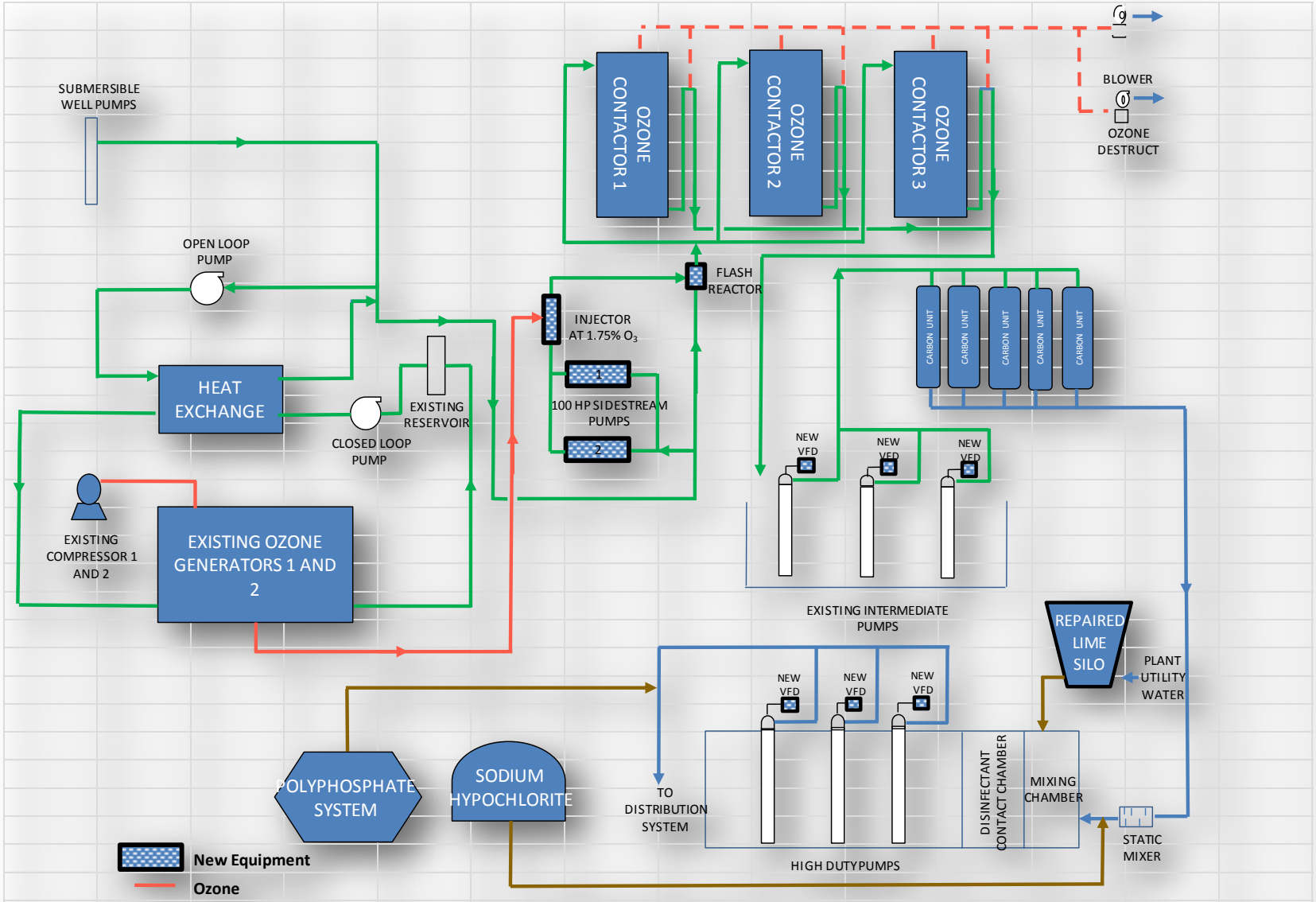
Ozone – Alterative 1 (of four)

Alternative 1 relies on the continued use of the ozonation equipment but with a new injection system that would allow the existing contactors to operate efficiently. The injection system is known as a flash reactor. It takes a sidestream of raw water and pumps it through an injector nozzle (a venturi) where ozone is added. The water rejoins the raw water flow in the pipeline before the contactors. The point at which it rejoins the raw water is known as a pipeline flash reactor.

Ozone – Alterative 1 (of four)



Alternative 1 - Existing O3 Generator and Sidestream Injector

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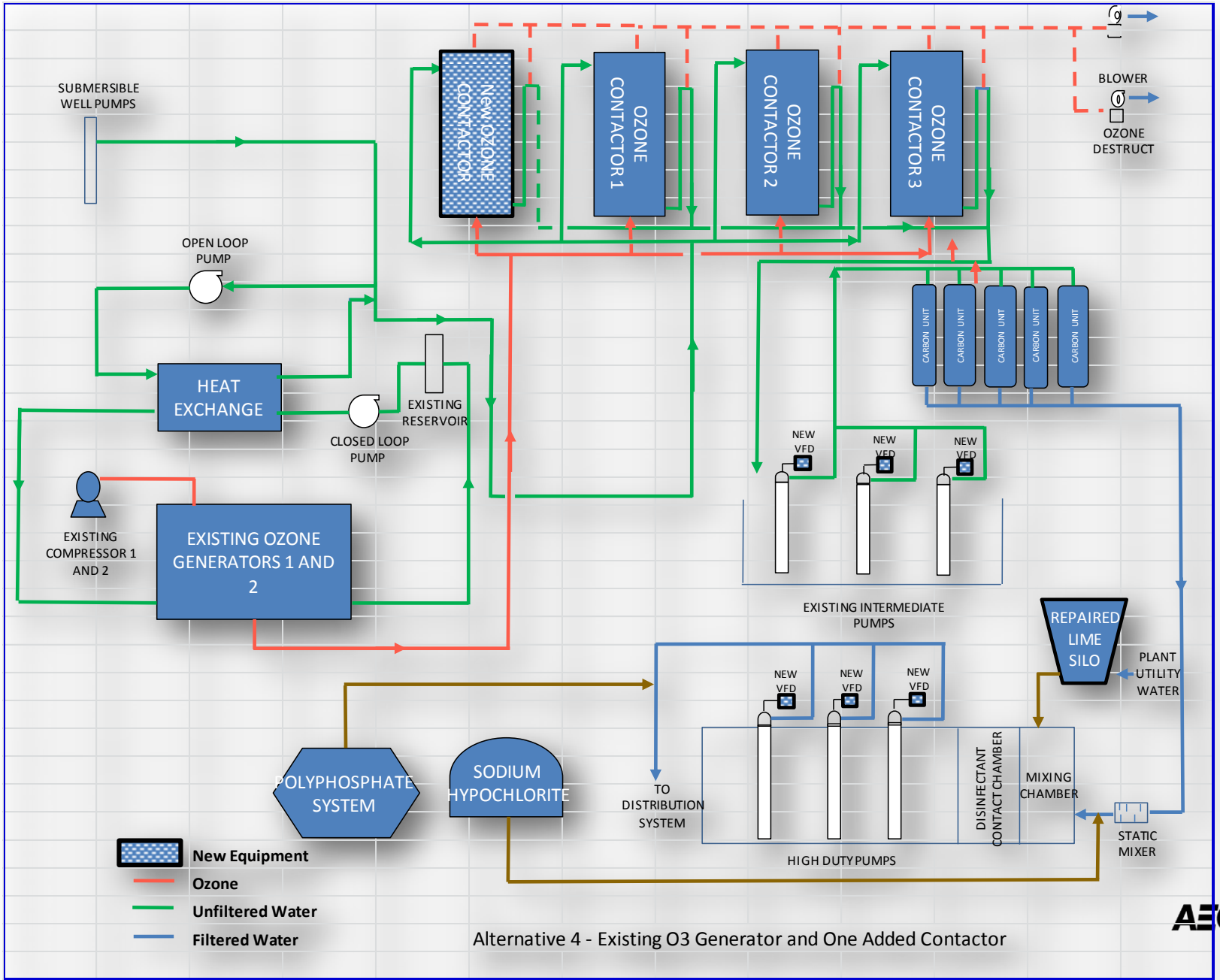
Ozone – Alterative 4 (of four) – Additional O_3 Contactor



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Water Quality Evaluation

		Dover Data	AECOM Water Quality Analysis - January 2015							
Long Point WTP - Dover, DE		mg/L		mg/L	mg/L	mg/L	mg/L - $CaCO_3$	mg/L - $CaCO_3$	mg/L	mg/L
	Source	Fe	pH	Fe	Mn	Nitrate	Alkalinity	Hardness	TDS	Na^+
Well	1A		5.2	1.92	0.0543	2.4	4.0	87	221	32.6
Well	2		5.2	1.64	0.209	0.47	7.7	43.6	143	23.7
Well	4B		5.3	0.0334	0.0206	9.7	4.1	85.4	165	11.7
Well	5		5.7	0.0334	0.0738	3.8	13.2	65.6	122	10.3
Well	6A		5.5	0.0975	0.178	1.2	3.5	84.0	158	9.43
Well	8A		5.7	1.85	0.041	6.4	8.4	75.4	165	18.0
Wells	Wells Average		5.43	0.93	0.0961	4.00	6.82	73.50	162.33	17.62
WTP	Raw Water Influent Confluence	0.75	5.7	0.484	0.106	3.7	7.5	71.8	153	17.8
WTP	Post Ozone Treatment	0.65	5.3	0.465	0.0986	3.7	5.3	71.9	147	17.3
WTP	WTP Effluent	0.25								

		Division of Public Health Sanitary Survey Water Quality Analysis - November 2012								
Long Point WTP - Dover, DE			mg/L	mg/L	mg/L	mg/L - $CaCO_3$	mg/L - $CaCO_3$	mg/L	mg/L	mg/
	Source	pH	Fe	Mn	Nitrate	Alkalinity	Hardness	TDS	Na^+	Cl
Well	1A	5.02	2.34	-	2.7	8	34.5	198	28.5	51.9
Well	2A	4.86	1.09	-	1.0	8	15.9	174	26.3	31.9
Well	4B	5.74	0.0334	-	7.8	4	15.9	142	12.2	22.0
Well	5A	5.23	0.0334	-	3.9	12	26.4	172	10.3	18.3
Well	6A	5.20	0.11	-	1.4	6	36.8	154	9.5	16.1
Well	8A	5.12	2.14	-	6.1	10	25.1	174	17.4	30.1
Wells	Wells Average	5.20	0.96	-	3.82	8.00	25.77	169.00	17.37	28.4

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Residuals Generation

Number	Parameter		
x	# of Wells On-Line		
2083.3	Well Flowrate (gpm)		
3.000	WTP Influent Flowrate (MGD)		
0.484	Weighted Average Raw Water Iron Concentration (mg/L)		
0.106	Weighted Average Raw Water Manganese Concentration (mg/L)		
0.926	mg/L $Fe(OH)_3(s)$ Residual		lb/hr
23.2	Residual Mass Flow (lb/d - $Fe(OH)_3(s)$)		0.97
0.280	mg/L $MnO_2(s)$ Residual		lb/hr
6.99	Residual Mass Flow (lb/d - $MnO_2(s)$)		0.29
		lb/d	30.168
1.206	mg/L Precipitates (s)	lb/yr	11018.83
		lb/MG	10.0560

Chemistry - Stoichiometry (at Equilibrium)

	E° (V)
$O_2(g) + 4H^+ + 4e^- \rightarrow 2H_2O$	-1.06
$4(Fe^{2+} + 3H_2O \rightarrow Fe(OH)_3(s) + 3H^+ + e^-)$	1.23
$4\,Fe^{2+} + 10H_2O + O_2(g) \rightarrow 4\,Fe(OH)_3(s) + 8H^+$	0.17

$Fe(OH)_3$ (Atomic Weight)		Fe (Atomic Weight)	
106,869	mg/mol	55,847	mg/mol

	E° (V)
$Mn^{2+} + 2H_2O \rightarrow MnO_2(s) + 4H^+ + 2e^-$	-1.21
$MnO_4^- + 4H^+ + 3e^- \rightarrow MnO_2(s) + 2H_2O$	1.68
$3Mn^{2+} + 2MnO_4^- + 2H_2O \rightarrow 5MnO_2(s) + 4H^+$	0.47

MnO_2 (Atomic Weight)		Mn (Atomic Weight)	
86,937	mg/mol	54,938	mg/mol

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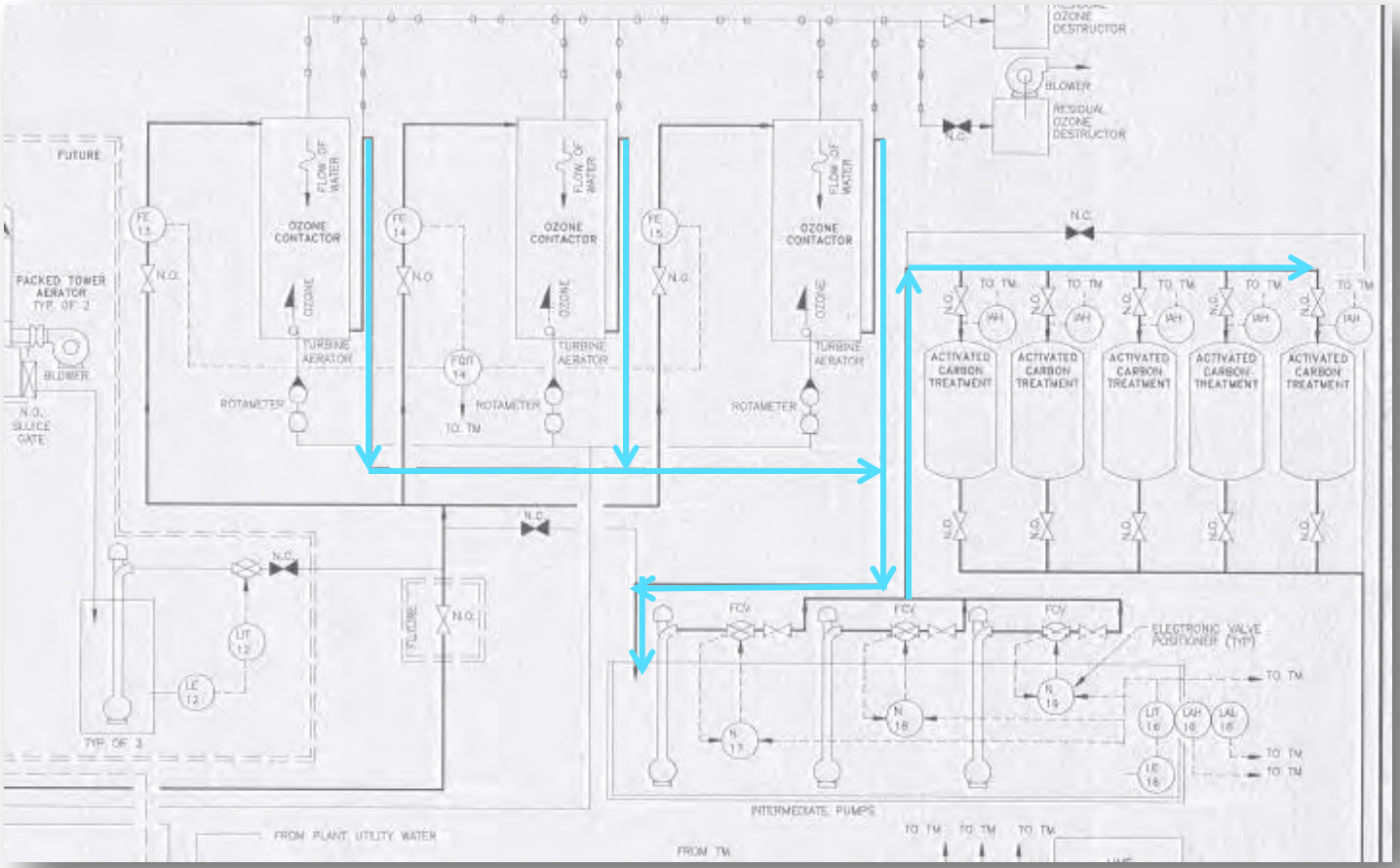
Analysis of Existing Treatment Methods

Current process treatment method not appropriate as treatment for iron and manganese removal is required.



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Analysis and Alternatives for Overall Process Train

Major Treatment Upgrades/Components

- Oxidation followed by Pressure Filtration
  Horizontal or Vertical Configuration
- pH Adjustment -> Upgrade Lime Silo and lime delivery to treatment
- Centrifuge/Sand Drying Beds/Sanitary Sewer for Residuals disposal
- Pumping Configuration - Intermediate Booster Pumps or improve well pump capacity and add VFDs

Pressure Filters

- Horizontal Configuration at Design Water Production Capacity is more cost effective
- For filter media only oxidant required will be chlorine (NaOCl)
- pH adjustment will be required pre-filtration.

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Horizontal Pressure Filters

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Horizontal Pressure Filters

Communication and work the with The State of Delaware's Division of Public Health's Office of Engineering (Office of Drinking Water) to have approval for a hydraulic loading rate of greater than 7.0 gpm/ft^2

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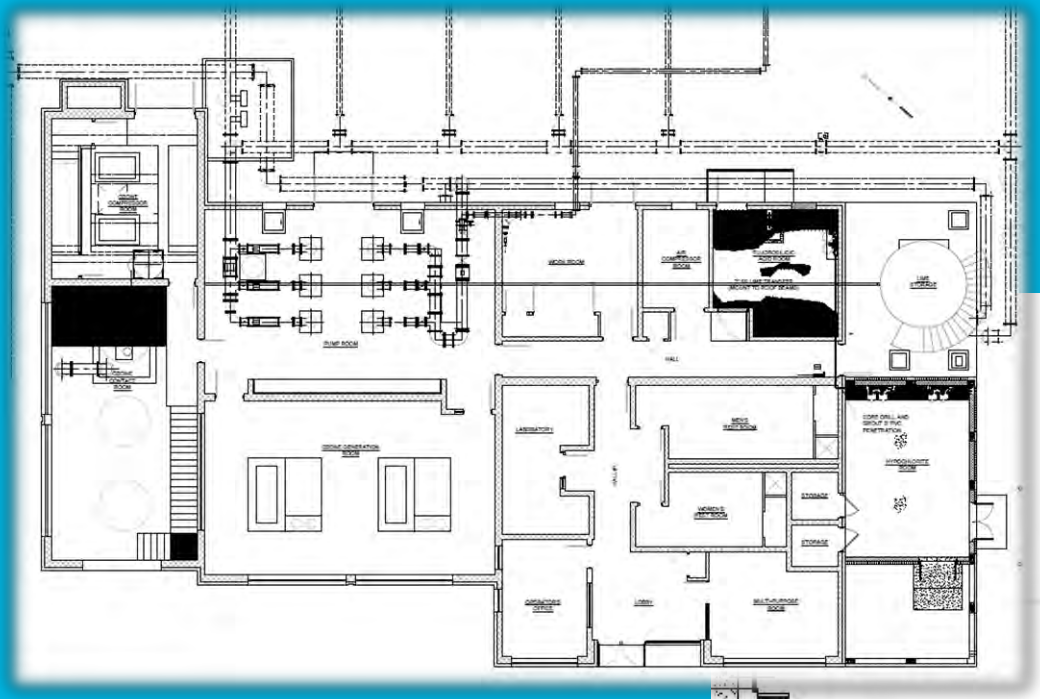
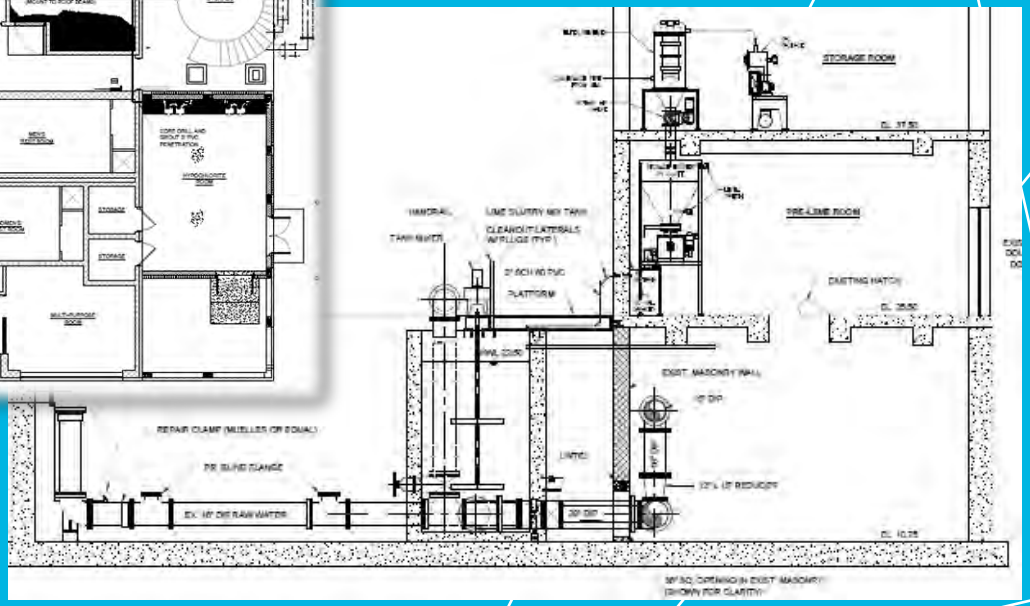
pH Adjustment

- Investigation included NaOH, CaO, air stripping and combinations of all.
- Lime Silo location is immediately adjacent to clearwell. pH adjustment occurs prior to entry into clearwell. This location is on the opposite side of water treatment facility from where the raw water enters into WTP
- Pneumatic lime delivery system to a day tank adjacent in rapid mix tank.

pH Adjustment – Silo System Rehab. Pneumatically convey lime to the headworks of the WTP into a day hopper dispensing into a mix tank,





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Residuals Disposal

Sand drying beds will work very effectively and will operationally be much cheaper.

All process water will be able to be recycled to headworks - Zero Discharge.

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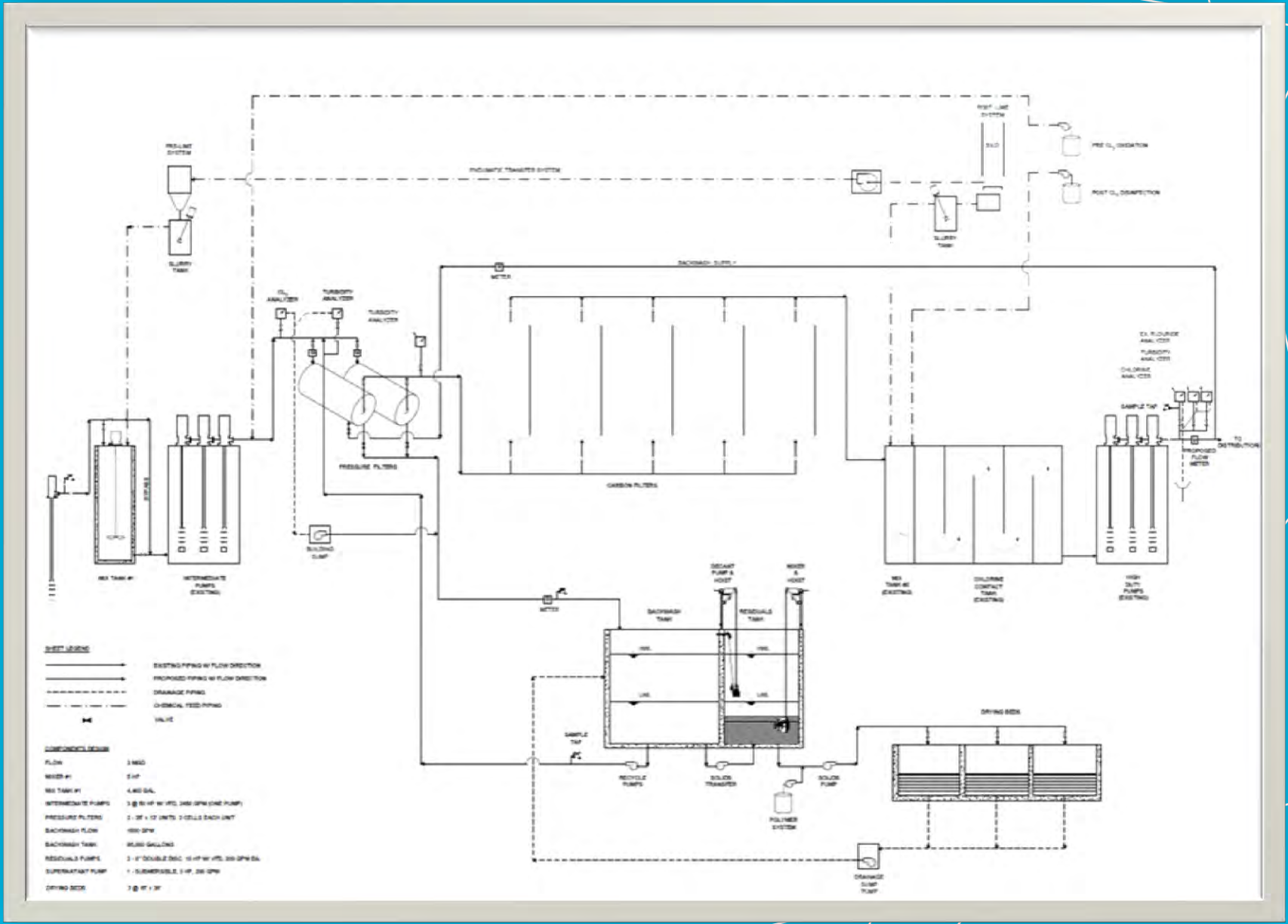
Process Flow Diagram for Upgrades – Design on-going



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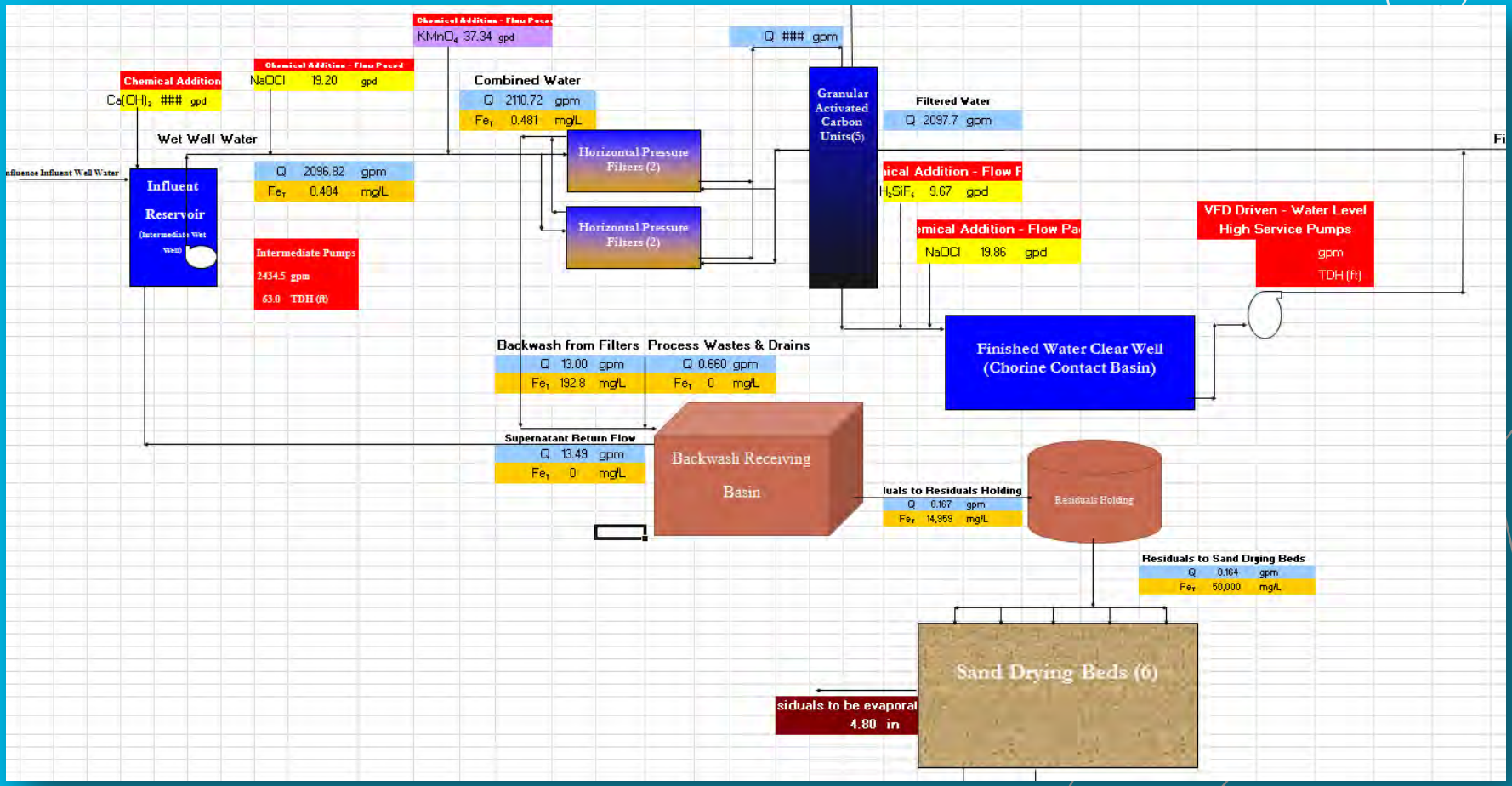

Thank You !

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Questions?

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