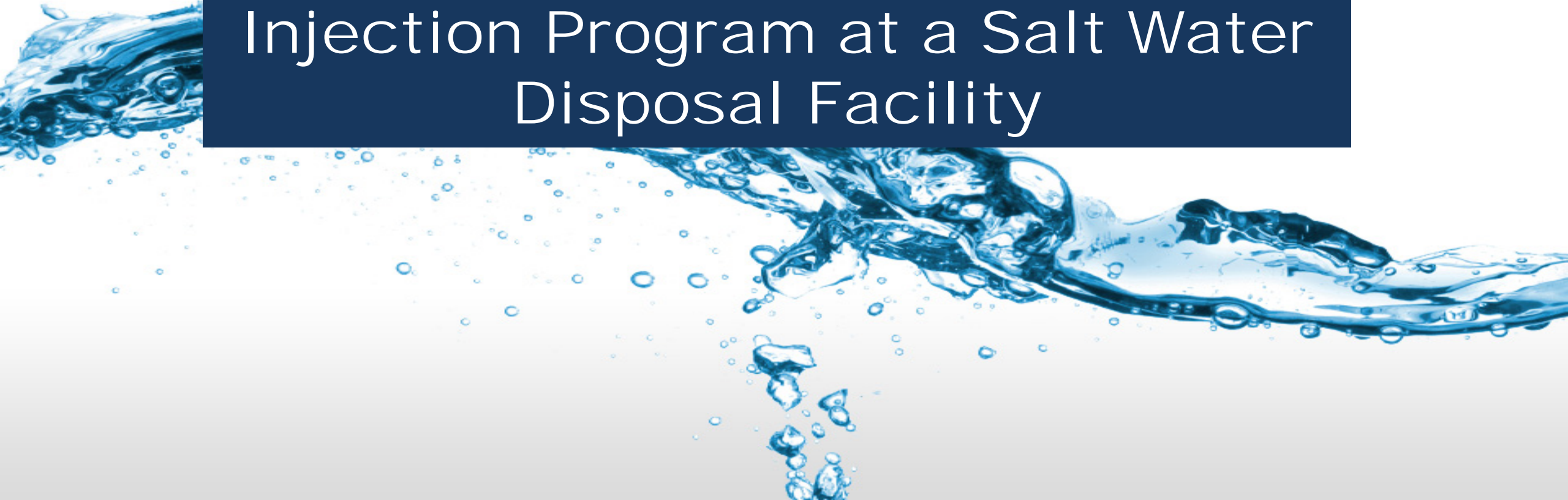
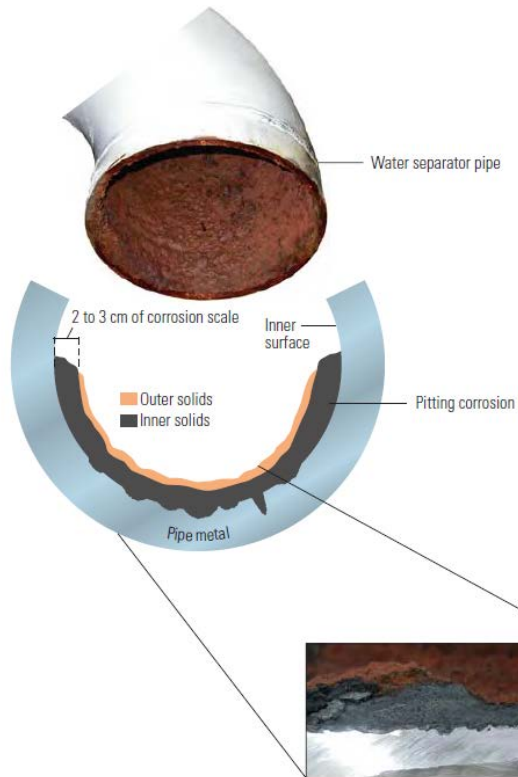


HYDRÖZONIX

An Unmanned Approach for the
Optimization of a Chemical
Injection Program at a Salt Water
Disposal Facility



Problem Statement: Bacteria Control in a Oilfield Gathering System

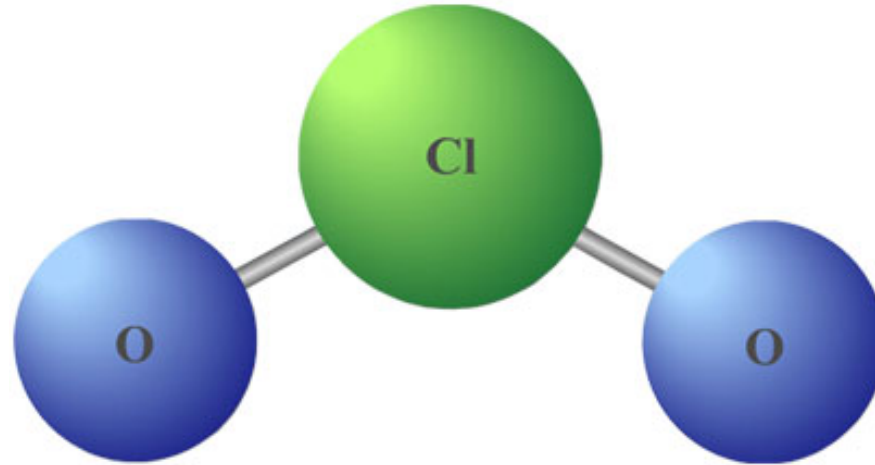


- Microbial Induced Corrosion
- Biofilms
- Hydrogen Sulfide



Bacterial Control Program

- Continuous injection of ClO₂
- Constant Dose rate
- Good to Poor water quality
- \$0.10/BBL

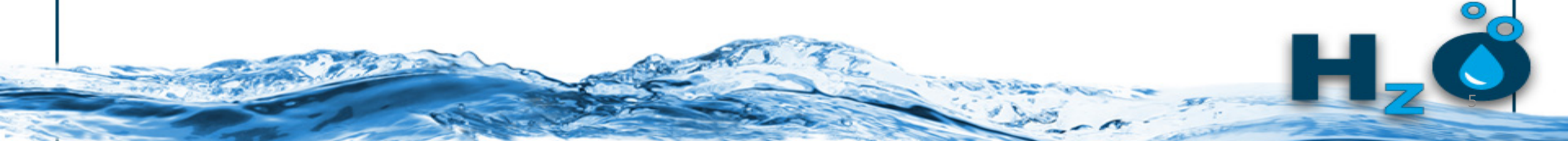
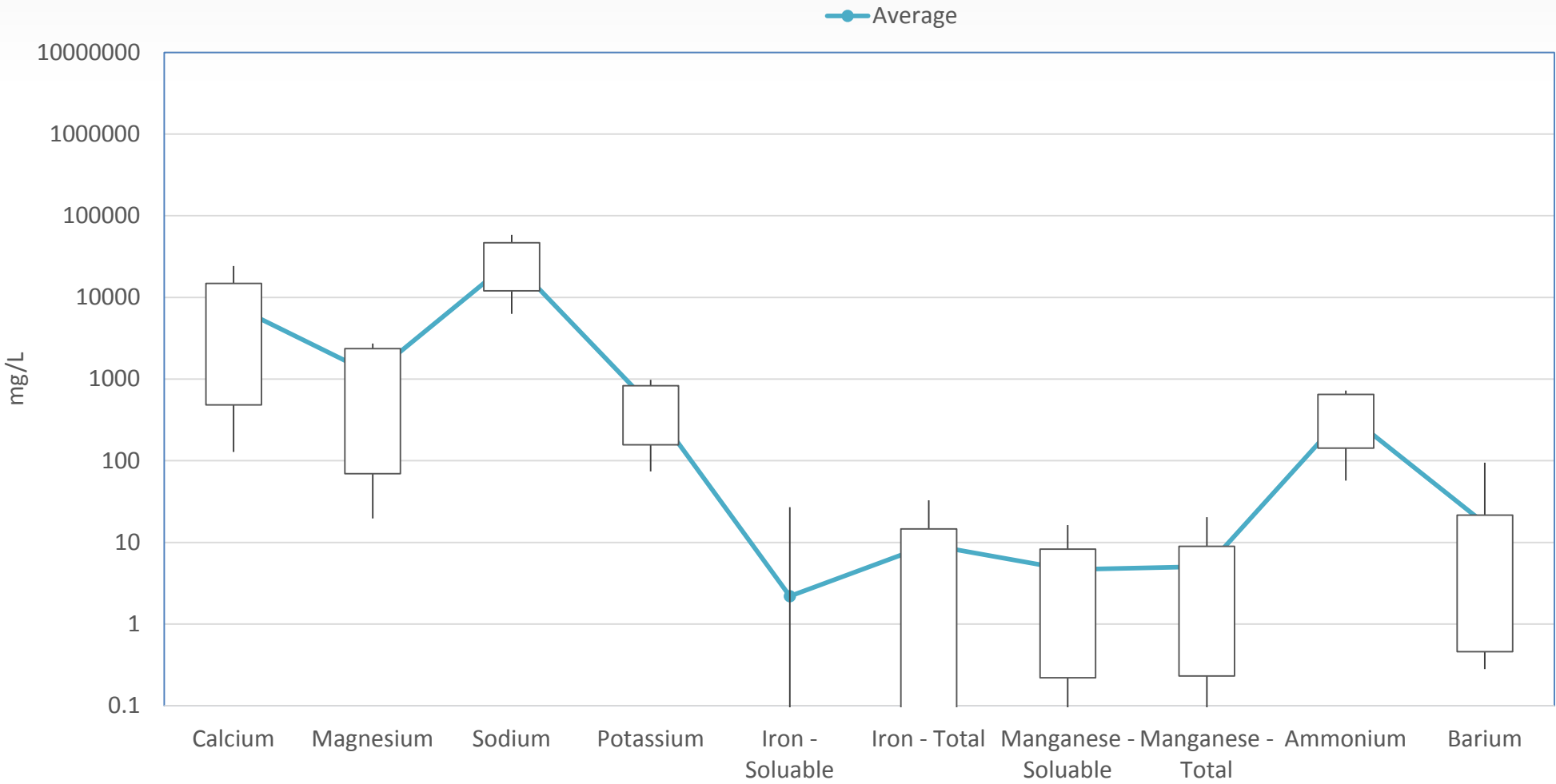


Bacteria Control Program

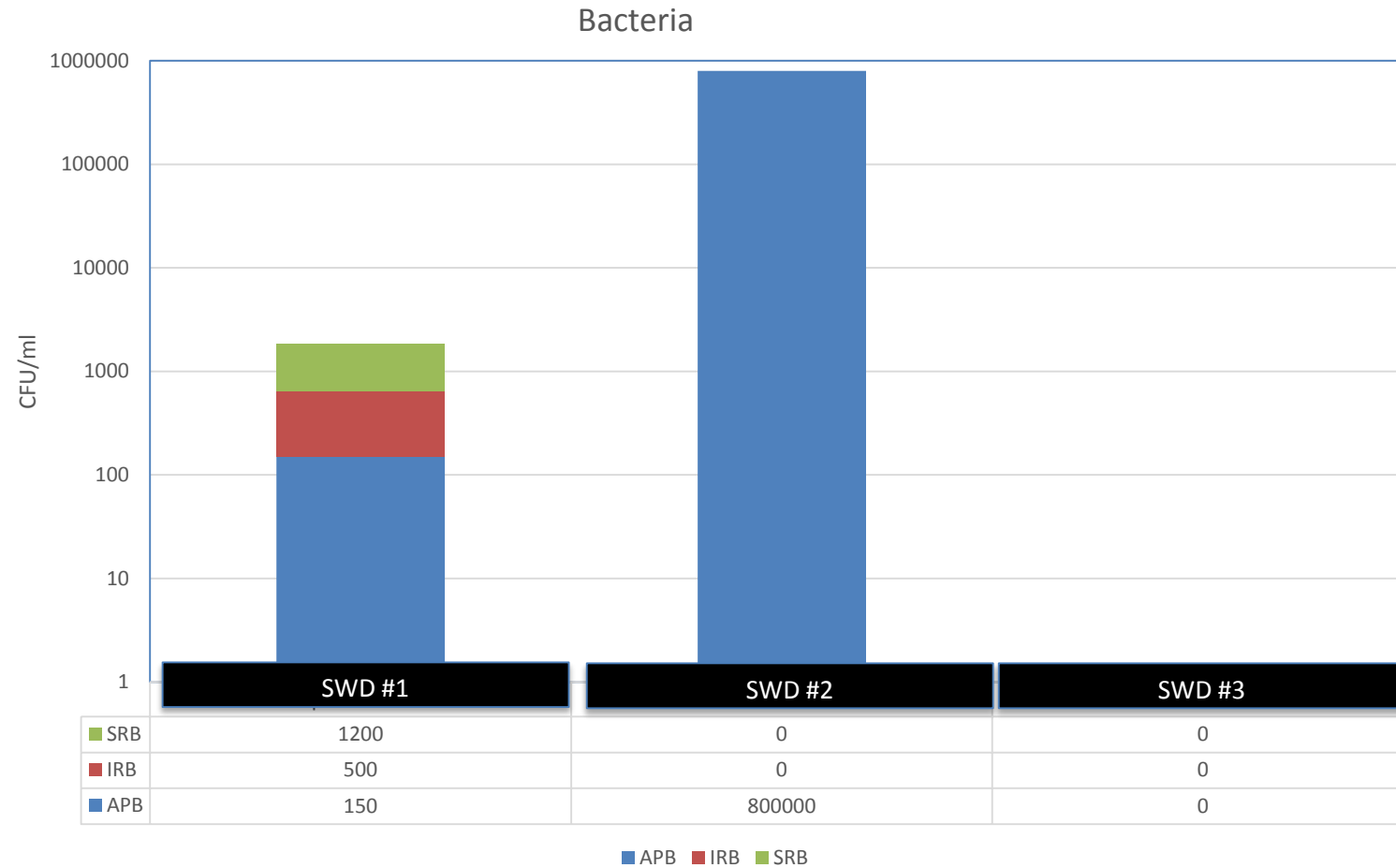
Parameter	Unit	Min	Max	Average
Temperature	°C	29.1	43.9	36.4
Dissolved oxygen	mg/L	0.3	5.9	1.8
pH	s.u.	5.8	7.7	6.7
Sulfide	mg/L	0.0	186.0	21.3
Couctivity	mS/m	3657.4	39800.1	20501.6
Total Dissolved Solids	mg/L	19500	571000	158908
Alkalinity	mg-CaCO3/L	0	1480	488
Total Suspeed Solids	mg/L	4.9	774	179
Turbidity	NTU	0	748	82
Specific Gravity	[-]	1.0102	1.1940	1.0747
ATP	pg/ml	0.1	67946.7	5279.0



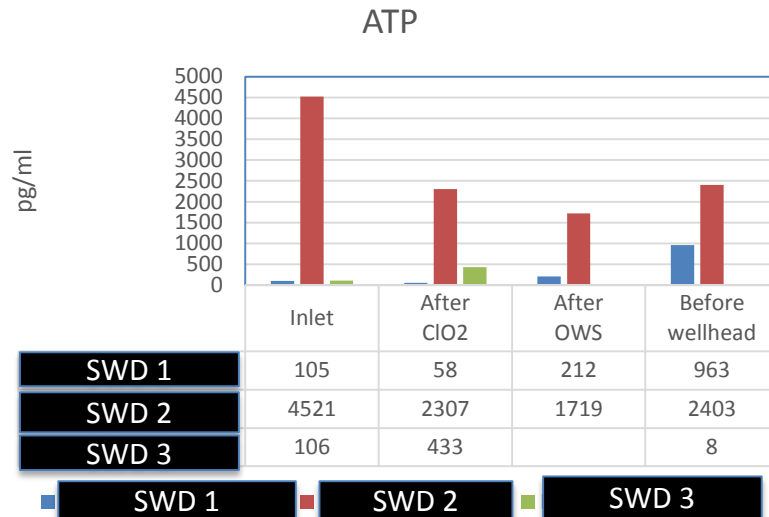
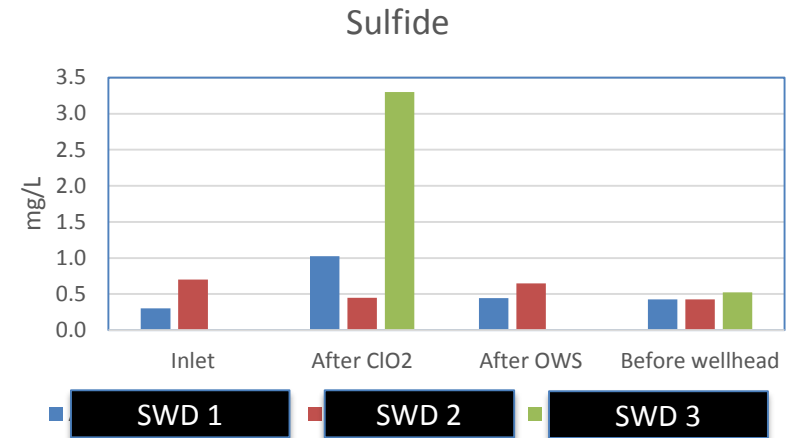
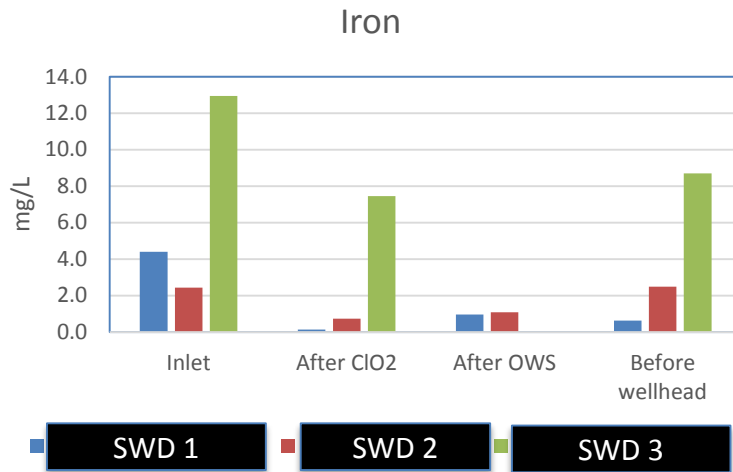
Water Quality at Tank Batteries and SWDs



Bacteria at the SWDs



Water Qualities at Different Locations of the SWDs



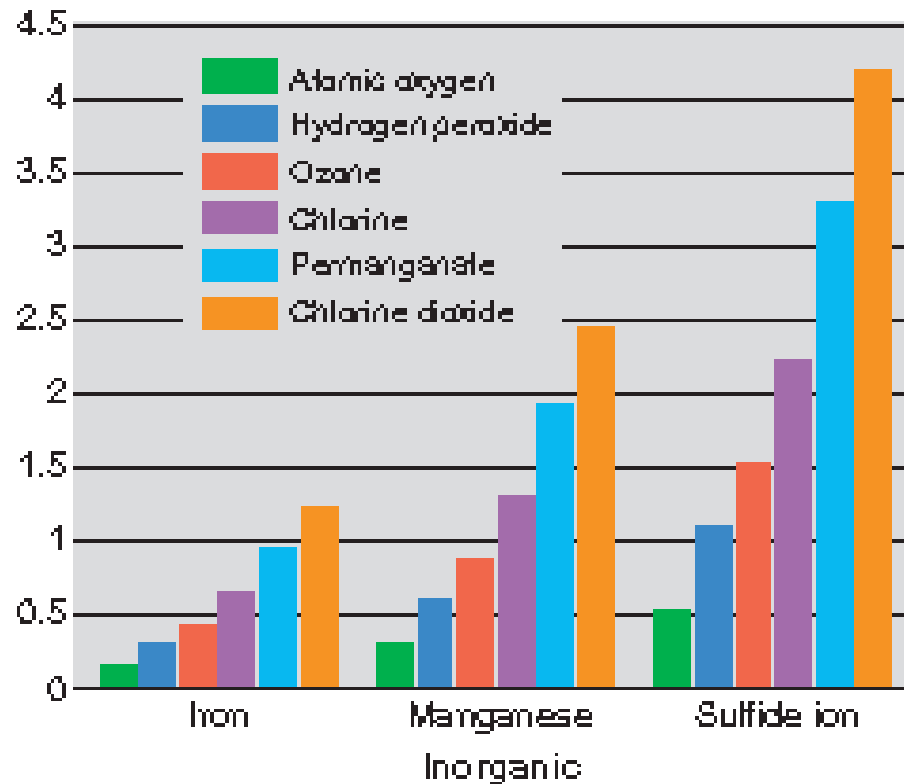
- Samples were taken at the Inlet, right after the ClO₂ injection, after the Oil/Water Separators and right before the injection well
- Iron level fluctuates as the water flows through the facility. The level at SWD 2 is higher than at SWDs 1&3
- Sulfide level is low at all three SWDs, while it fluctuates throughout the facility
- The ATP level at SWD 1 & 3 is relatively low, while it is high throughout the whole facility of SWD 2.

Iron and Sulfide Oxidation

Ozone vs. Chlorine Dioxide

- Ozone is significantly more effective on Iron and Sulfides than Chlorine Dioxide
- Manganese, Iron and Sulfides require much more Chlorine Dioxide for effective treatment
- This can lead to reduced bacterial disinfection if too little Chlorine Dioxide or Bleach is used
- Chlorine Dioxide concentrations need to be increased significantly when iron and sulfides are present

Figure 2. Theoretical stoichiometry of oxidants



Introducing

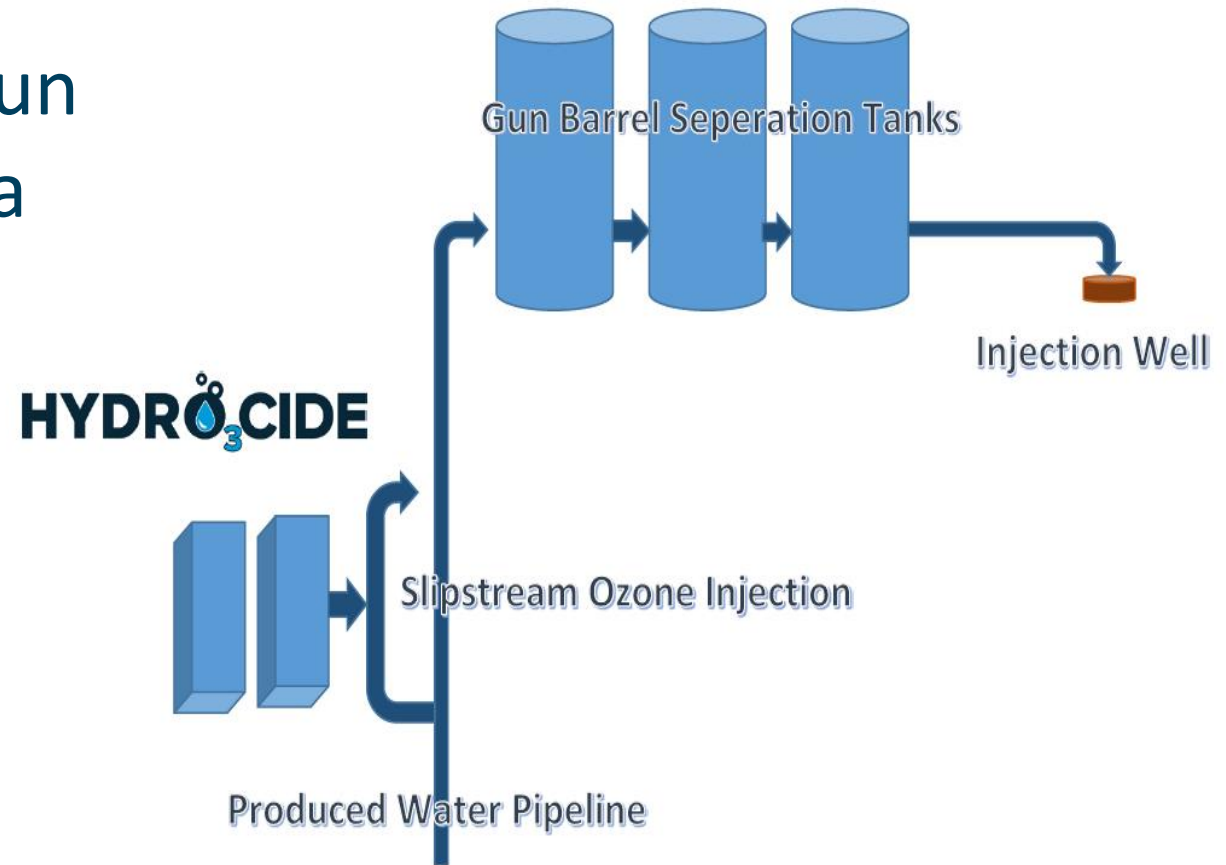
HYDRÖ₃CIDE

An unmanned, fully automated ozone
treatment system



HYDR₃O₃CIDE

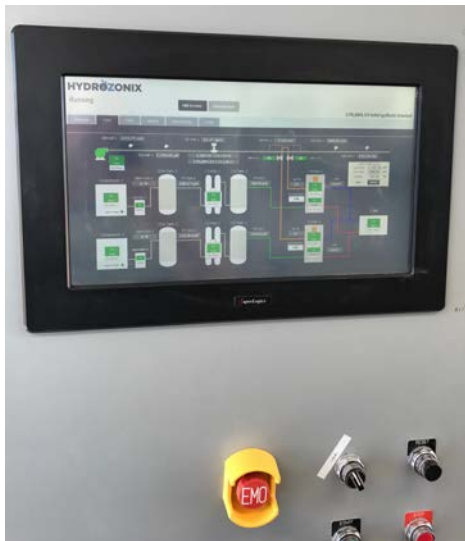
Typically placed prior to gun barrel
barrels to prevent bacteria
and provide iron control



HYDR₃O₃CIDE

Fully Automated

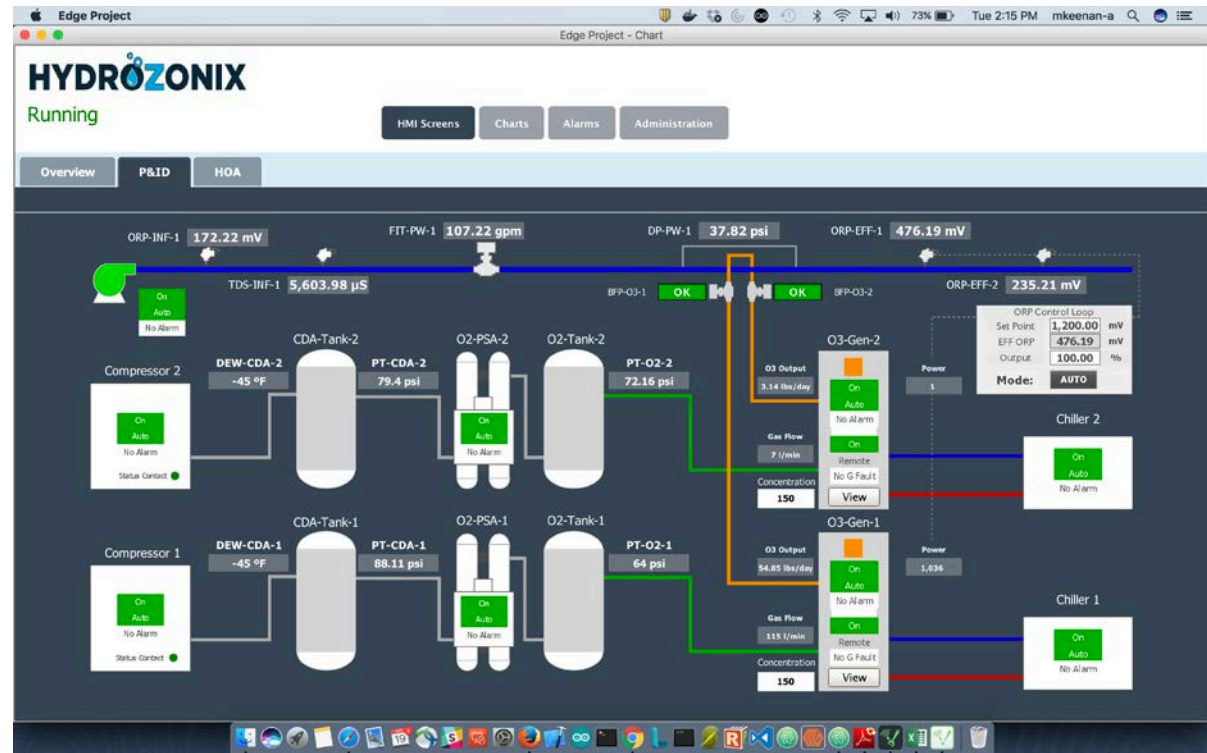
- Can be monitored and operated remotely, even from a cell phone
- System adjusts disinfection/oxidation automatically when water quality changes



HYDRÖ₃CIDE

Fully Automated

- Can be monitored and operated remotely, even from a cell phone
- System adjusts disinfection/oxidation automatically when water quality changes



HYDRÖ₃CIDE

Engineered for your application

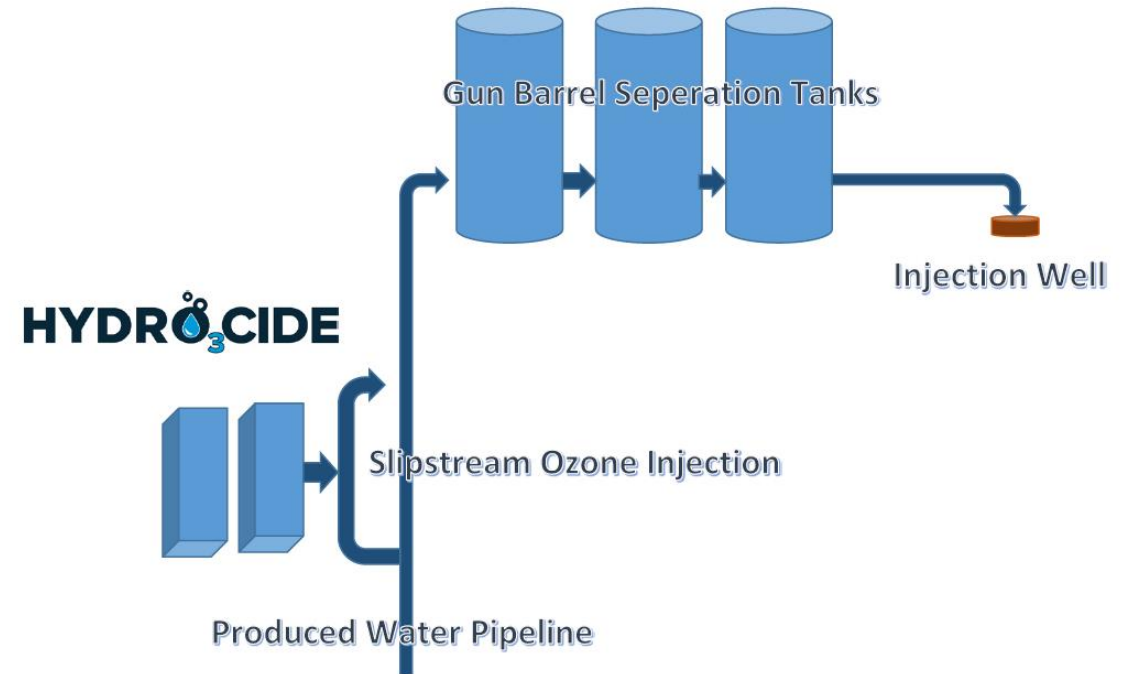
- 5K,10K,15K and 30K BPD



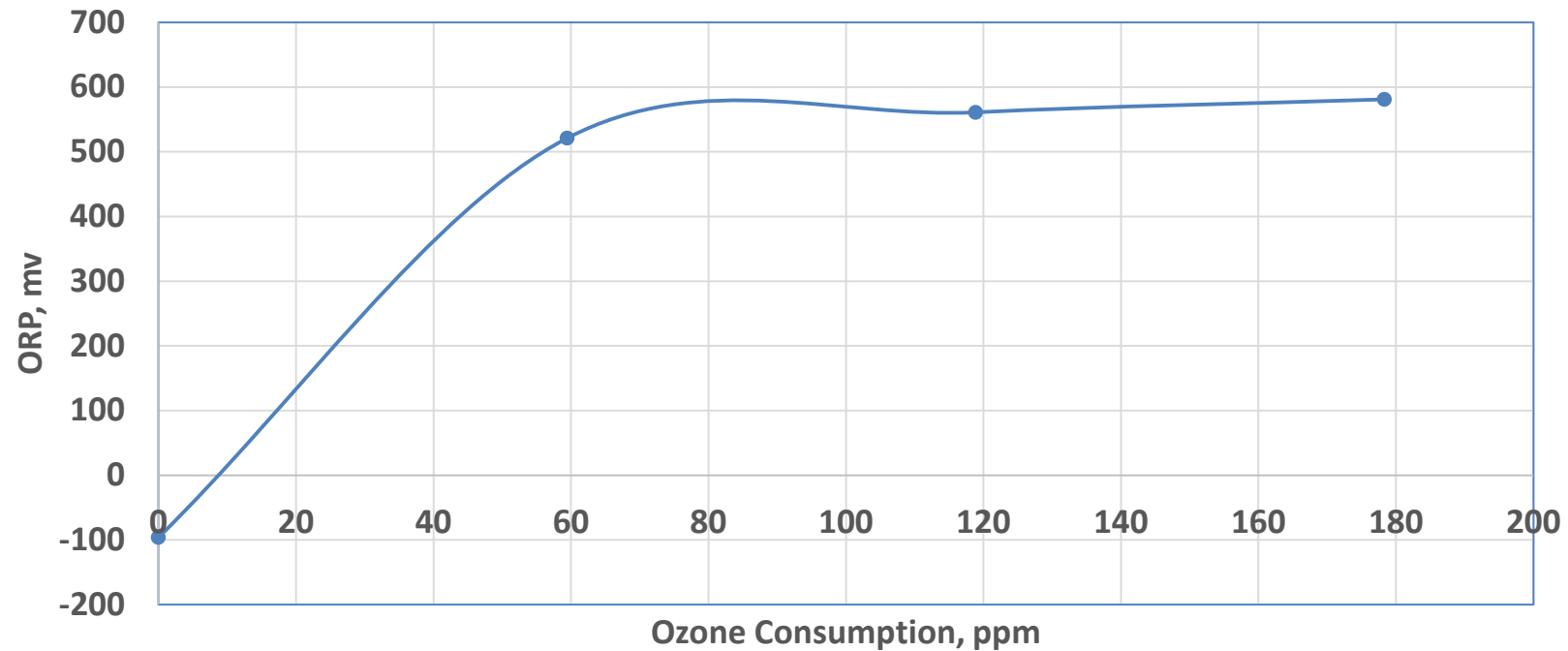
HYDRÖ₃CIDE

Improved Oil/Water Separation ?

- Initial Tests show improvement
- Induced Gas Flotation Effect



Produced Water Treatment – Ozonation Study SWD 1



- The water was treated with ozone continuously.
- The Oxidation Reduction Potential (ORP) of the water was monitored periodically.

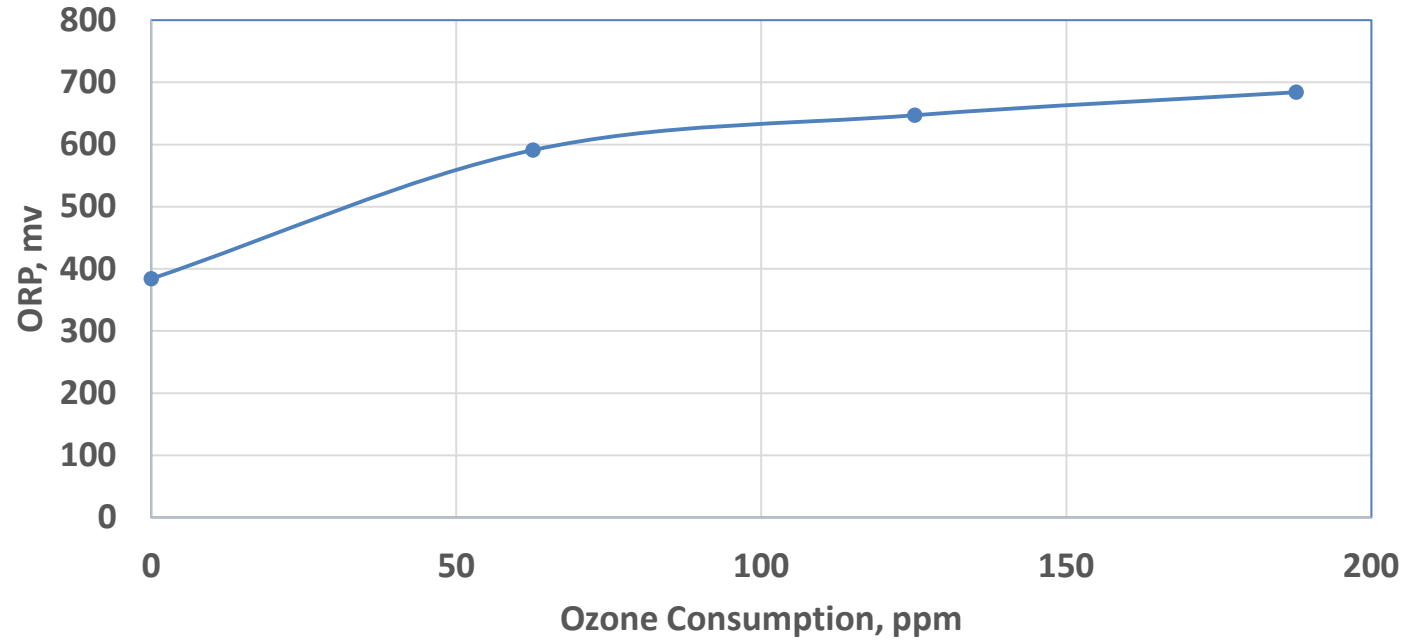
Produced Water Treatment – Changes in Water Quality

SWD 1

	ATP, pg/ml	Sulfide, mg/L	Total Iron, mg/L	Ferrous Iron, mg/L	Turbidity, FAU	TSS, mg/L	TPH, mg/L
Untreated	9710.8	0.4	6.3	0.4	112.0	115.0	126.0
Oxidized	12.0		3.4	0.1	100.0	115.5	-
Filtered, 5µm	9.6	0.1	3.4	0.1	62.0	52.5	8.4
Filtered, 1µm					0.0	1.0	

- After the oxidation and filtration, there is a significant reduction of bacteria (ATP).
- The sulfide and iron levels for the untreated water were not high to begin with. Reductions of those levels were also achieved through oxidation and filtration.
- The significant reduction of TPH could be due to the improved oil / water separation, as the oil flowed to the top layer after oxidation, it was captured in the treated water sample.

Produced Water Treatment – Ozonation Study SWD 2



- The water was treated with ozone continuously.
- The Oxidation Reduction Potential (ORP) of the water was monitored periodically.

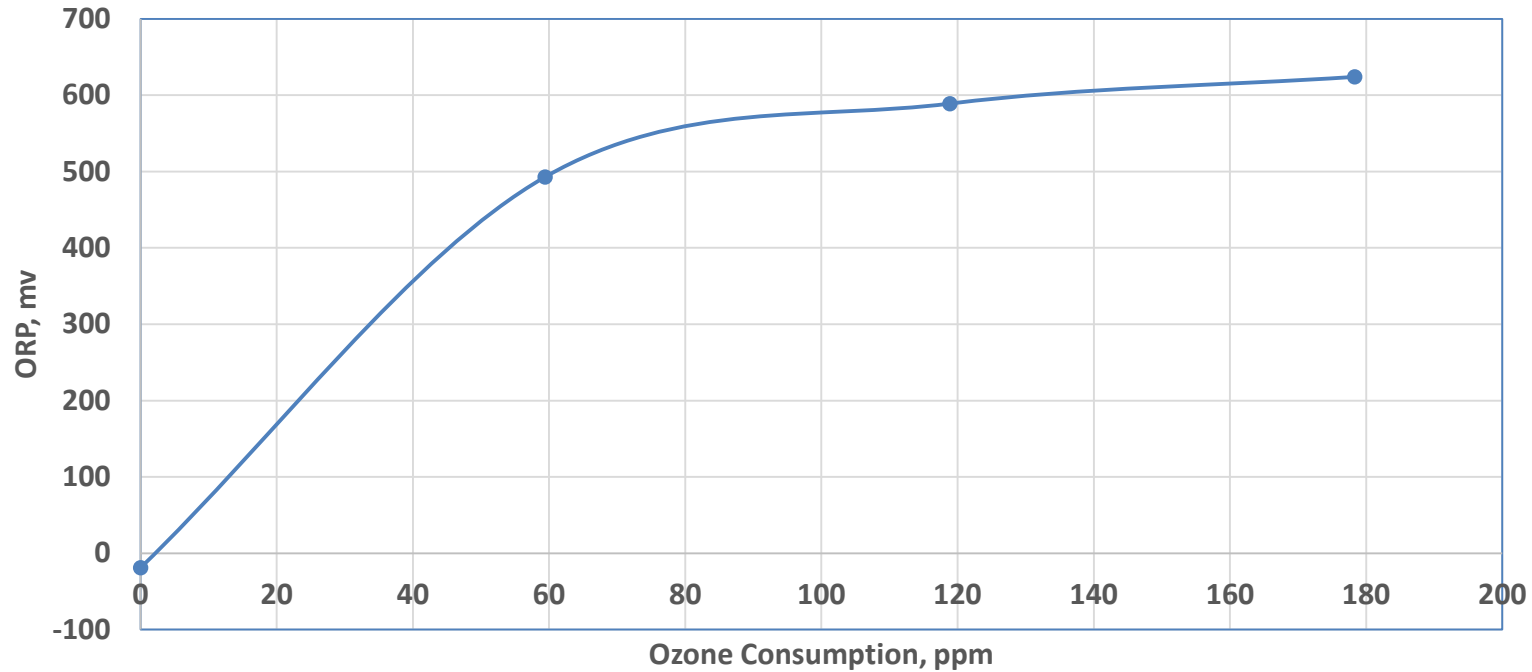
Produced Water Treatment – Changes in Water Quality

SWD 2

	ATP, pg/ml	Sulfide, mg/L	Total Iron, mg/L	Ferrous Iron, mg/L	Turbidity, FAU	TSS, mg/L	TPH, mg/L
Untreated	7647.3	0.3	7.2	0.5	157.0	157.5	86.0
Oxidized	26.0		6.1	0.0	148.0	150.5	-
Filtered, 5µm	11.7	0.2	5.5	0.4	34.5	31.5	6.3
Filtered, 1µm					5.0	3.0	

- After the oxidation and filtration, there is a significant reduction of bacteria (ATP).
- The sulfide and iron levels for the untreated water were not high to begin with. Reductions of those levels were also achieved through oxidation and filtration.
- The significant reduction of TPH could be due to the improved oil / water separation, as the oil flowed to the top layer after oxidation, it was captured in the treated water sample.

Produced Water Treatment – Ozonation Study SWD 3



- The water was treated with ozone continuously.
- The Oxidation Reduction Potential (ORP) of the water was monitored periodically.

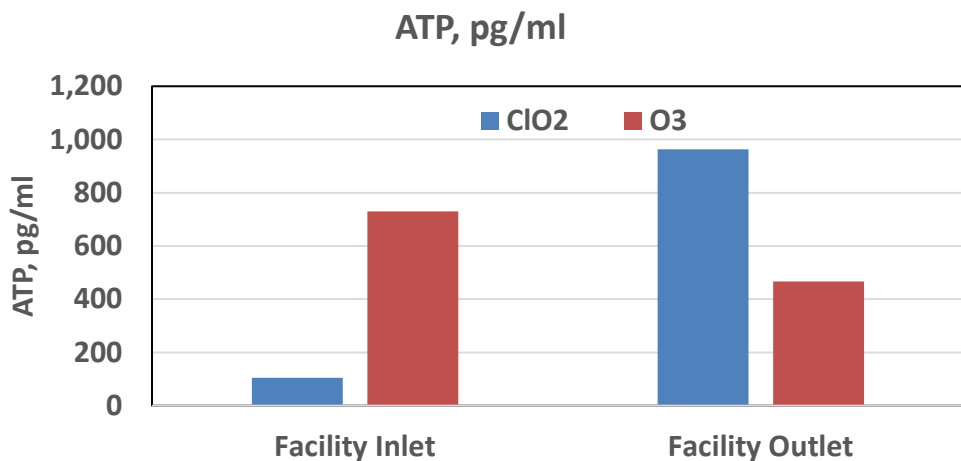
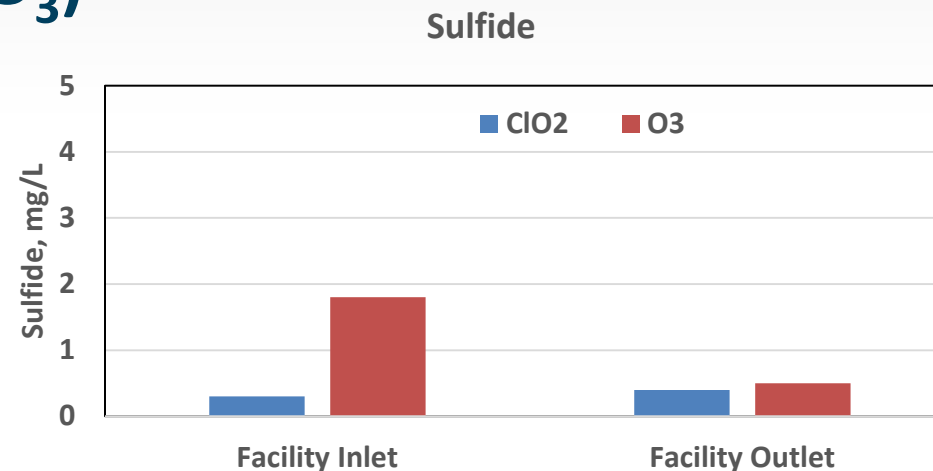
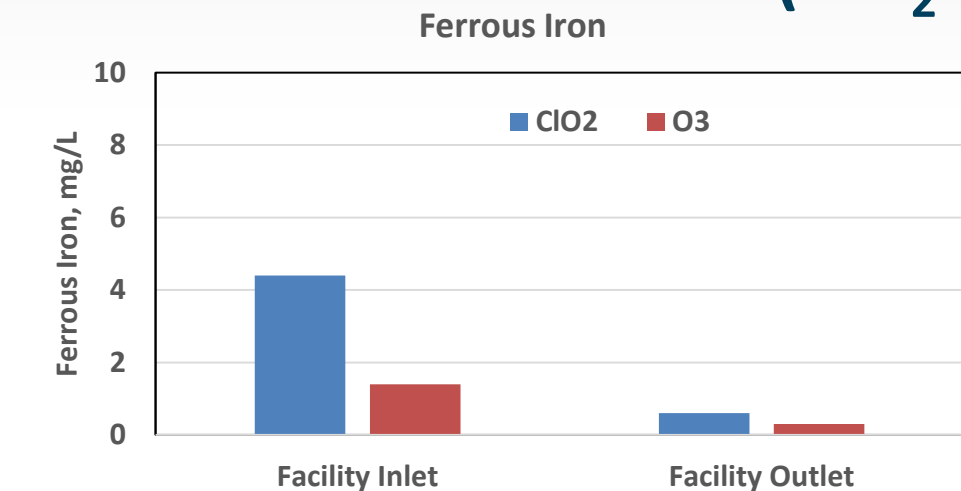
Produced Water Treatment – Changes in Water Quality

SWD 3

	ATP, pg/ml	Sulfide, mg/L	Total Iron, mg/L	Ferrous Iron, mg/L	Turbidity, FAU	TSS, mg/L	TPH, mg/L
Untreated	15089.6	0.9	1.9	0.7	373.5	408.5	196.0
Oxidized	14.0		1.6	0.3	203.5	118.0	-
Filtered, 5µm	1.9	0.0	0.7	0.3	4.5	0.0	0
Filtered, 1µm					3.0	0.0	

- After the oxidation and filtration, there is a significant reduction of bacteria (ATP).
- The sulfide and iron levels for the untreated water were not high to begin with. Reductions of those levels were also achieved through oxidation and filtration.
- The significant reduction of TPH could be due to the improved oil / water separation, as the oil flowed to the top layer after oxidation, it was captured in the treated water sample.

Water Qualities at Different Locations of the SWDs (ClO₂ vs O₃)



- Samples were taken at the Inlet and outlet of the SWD facility
- Both ClO₂ and O₃ treatments showed reduction on ferrous iron level.
- Sulfide level at the facility inlet during ClO₂ treatment was low, O₃ treatment showed reduction on sulfide level.
- There was an increase of ATP level as the water flowed through the facility during ClO₂, while reduction of ATP level was achieved when O₃ was used. O₃ treatment was able to prevent the bacteria level from increasing as the water flowed through the SWD facility.

HYDRO₃CIDE



Lease and Purchase Options

HYDRO ₃ CIDE	Lease	Purchase
30,000 BPD	\$33,000/month	\$650,000
O&M	\$15,000/month	\$15,000/month
\$/bbl	\$0.053/bbl	\$0.023/bbl*

1. * based on 10 year straight line depreciation
2. Utilities < \$0.01/bbl
3. Unmanned, fully automated

HYDRO ₃ CIDE	Lease	Purchase
15,000 BPD	\$26,000/month	\$500,000
O&M	\$12,000/month	\$12,000/month
\$/bbl	\$0.084/bbl	\$0.038/bbl*





www.hydrozonix.com