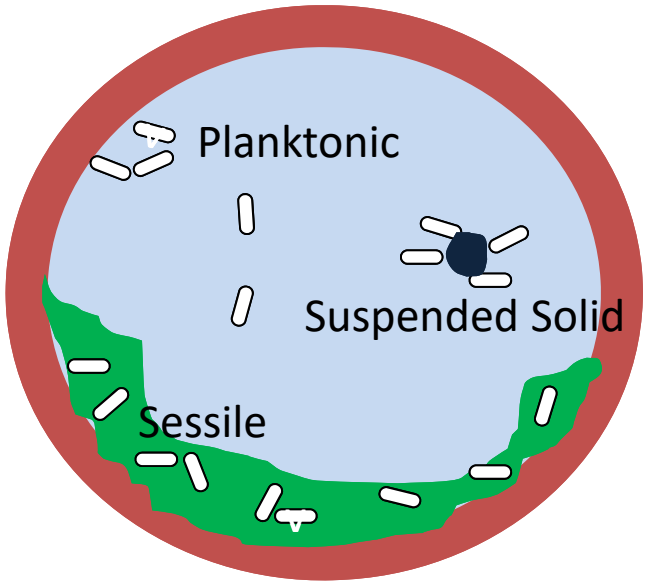
HYDROZONIX

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

# Problem Statement: Solids Accumulation/Bacteria in a Oilfield Gathering System




- Bacteria
- Solid / Particle
- Slime/Film

# Problem Statement: Solids Accumulation/Bacteria in a Oilfield Gathering System

Paraffin

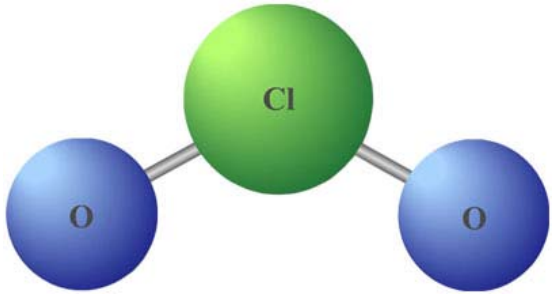
# Chlorine Dioxide Program was initiated, but unsuccessful

- No fault of $ClO_2$
- Solids were misidentified
- Paraffin Control products tested
- Paraffin control resolved the problem

Paraffin

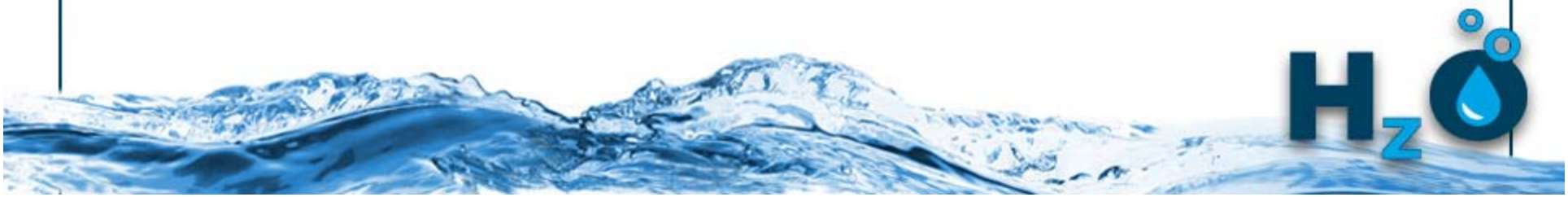
# Bacterial Control Program

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

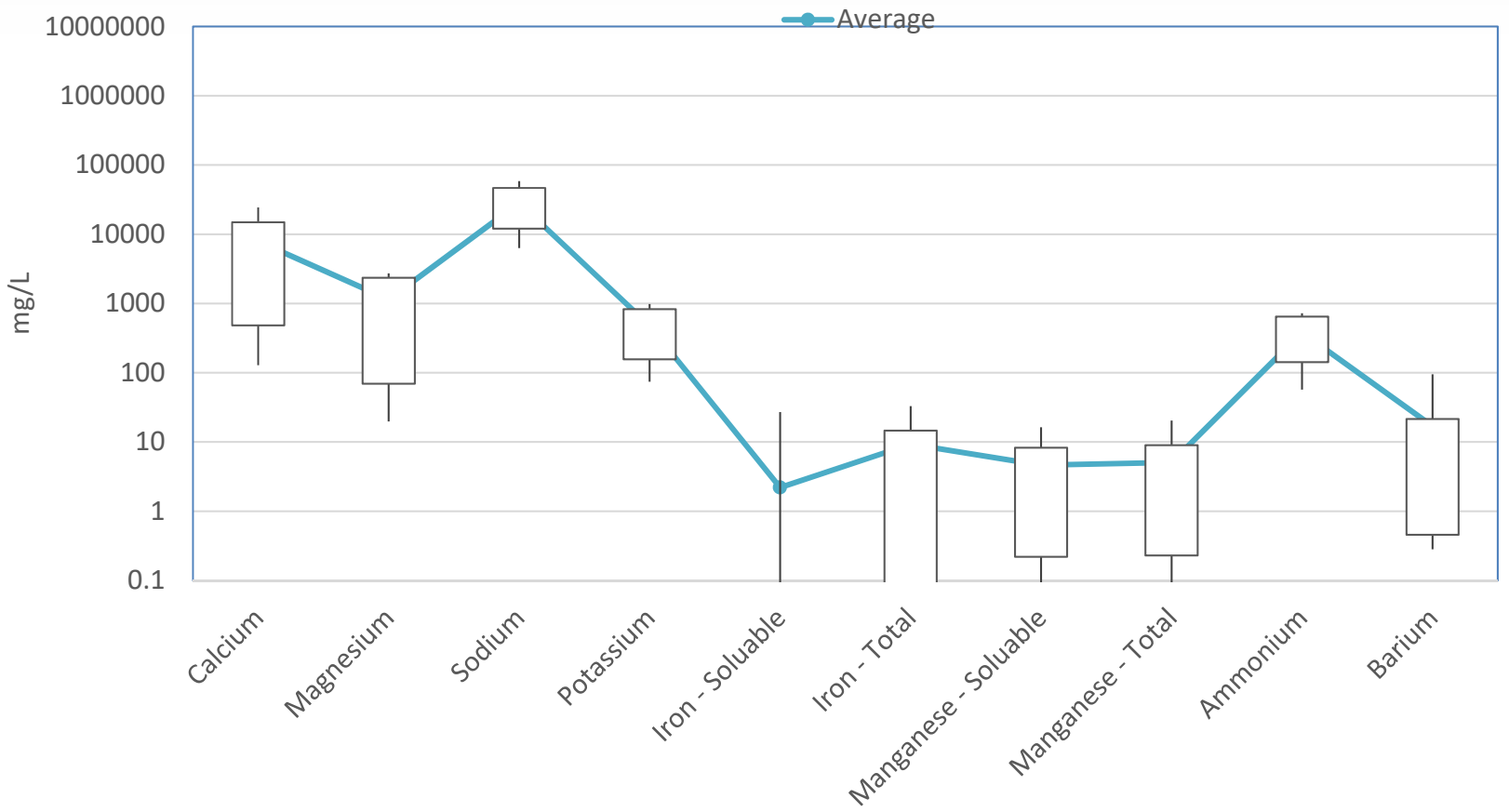


# Bacteria Control Program

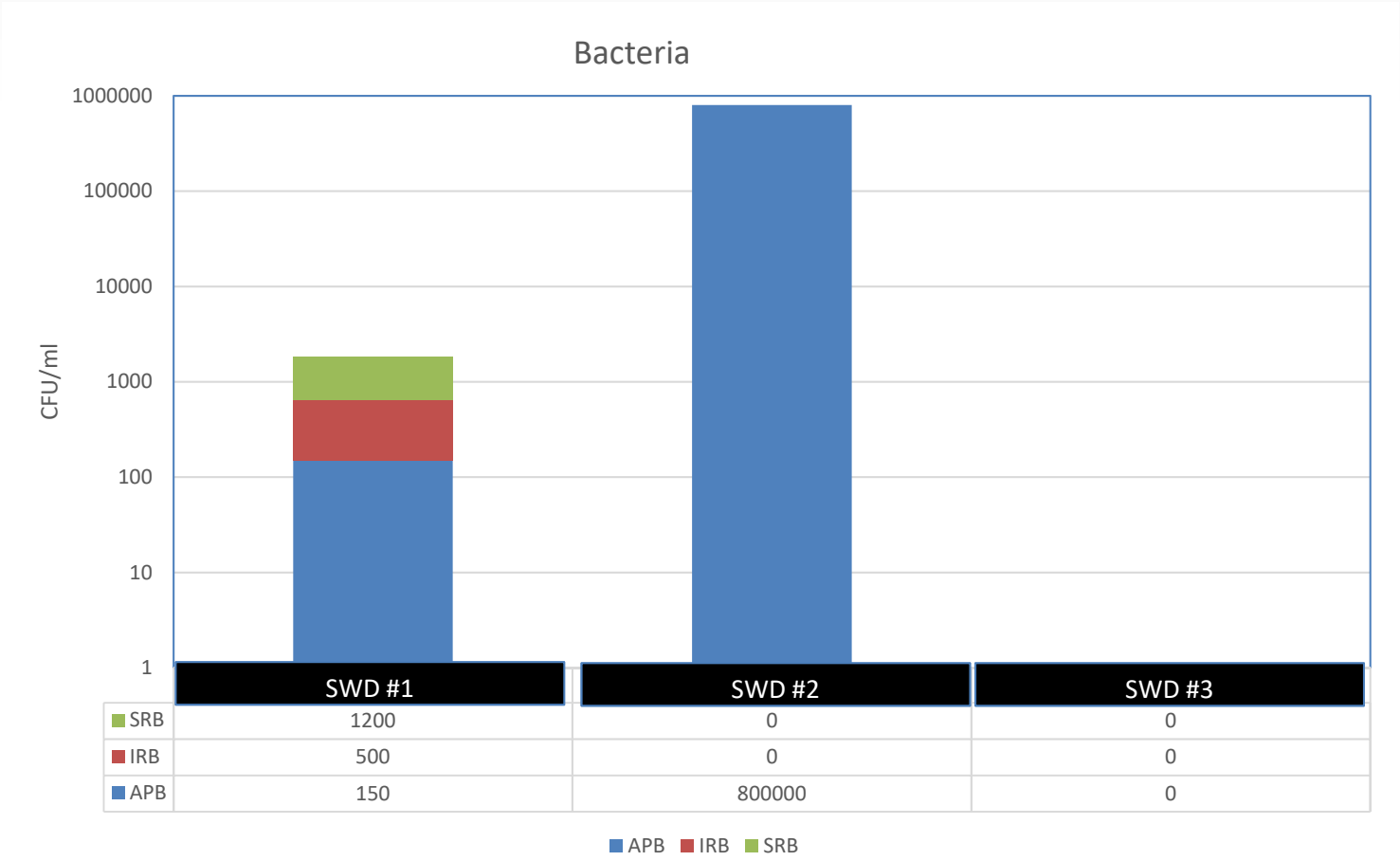
| Parameter | Unit | Min | Max | Average |
|---|---|---|---|---|
| Temperature | °C | 29.1 | 43.9 | 36.4 |
| Dissolved oxygen | mg/L | 0.3 | 5.9 | 1.8 |
| pH | s.u. | 5.8 | 7.7 | 6.7 |
| Sulfide | mg/L | 0.0 | 186.0 | 21.3 |
| Couctivity | mS/m | 3657.4 | 39800.1 | 20501.6 |
| Total Dissolved Solids | 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 |



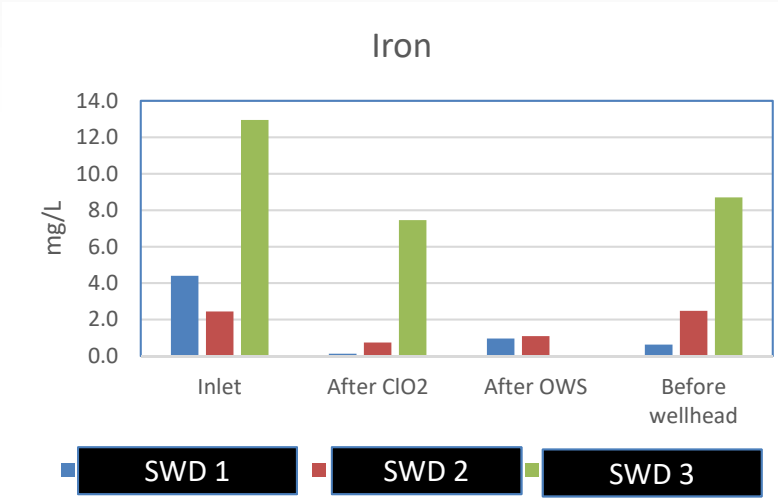
# Water Quality at Tank Batteries and SWDs

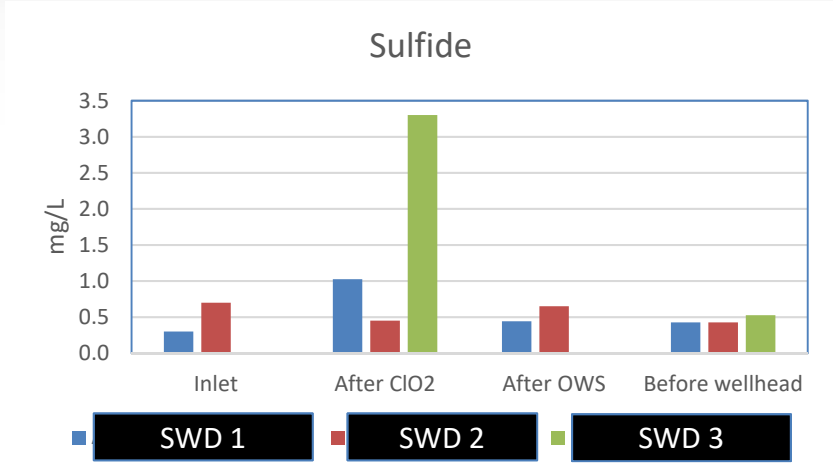


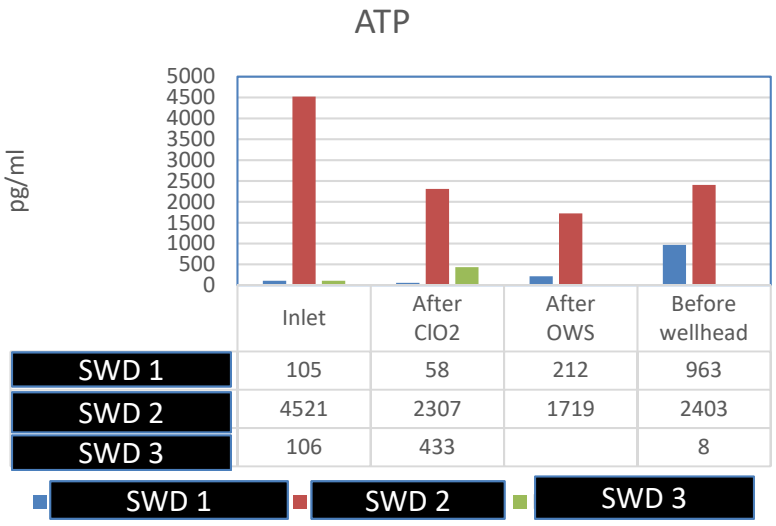
# Bacteria at the SWDs



# Water Qualities at Different Locations of the SWDs



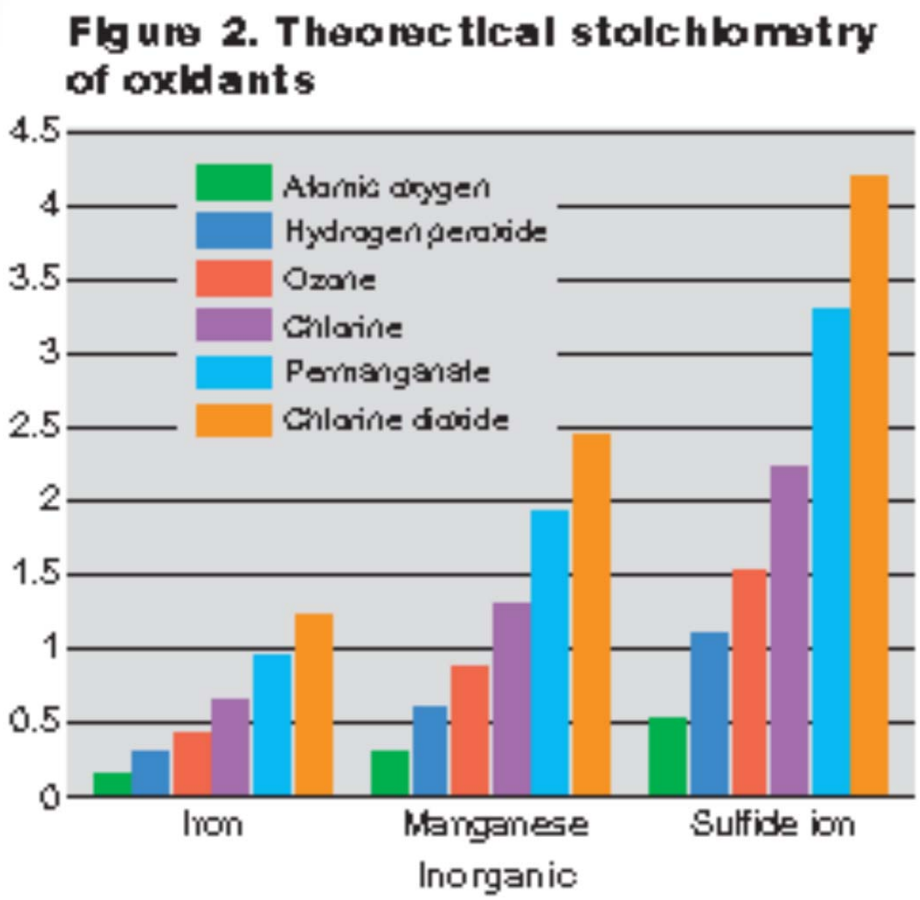

| | Inlet | After ClO2 | After OWS | Before wellhead |
|---|---|---|---|---|
| SWD 1 | 105 | 58 | 212 | 963 |
| SWD 2 | 4521 | 2307 | 1719 | 2403 |
| SWD 3 | 106 | 433 | | 8 |

- **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*

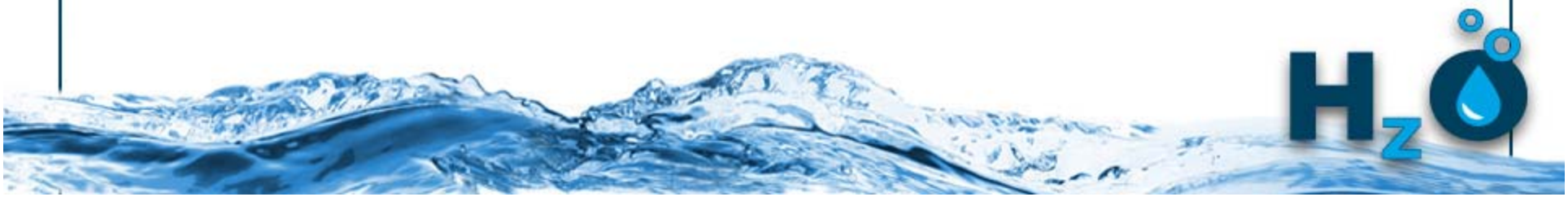
- Ozone is significantly more effective on Iron and Sulfides than Chlorine Dioxide
- Manganese, Iron and Sulfides require much more Chlorine Dioxide for effective treatment
- This can lead to reduced bacterial disinfection if too little Chlorine Dioxide or Bleach is used
- Chlorine Dioxide concentrations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



Introducing

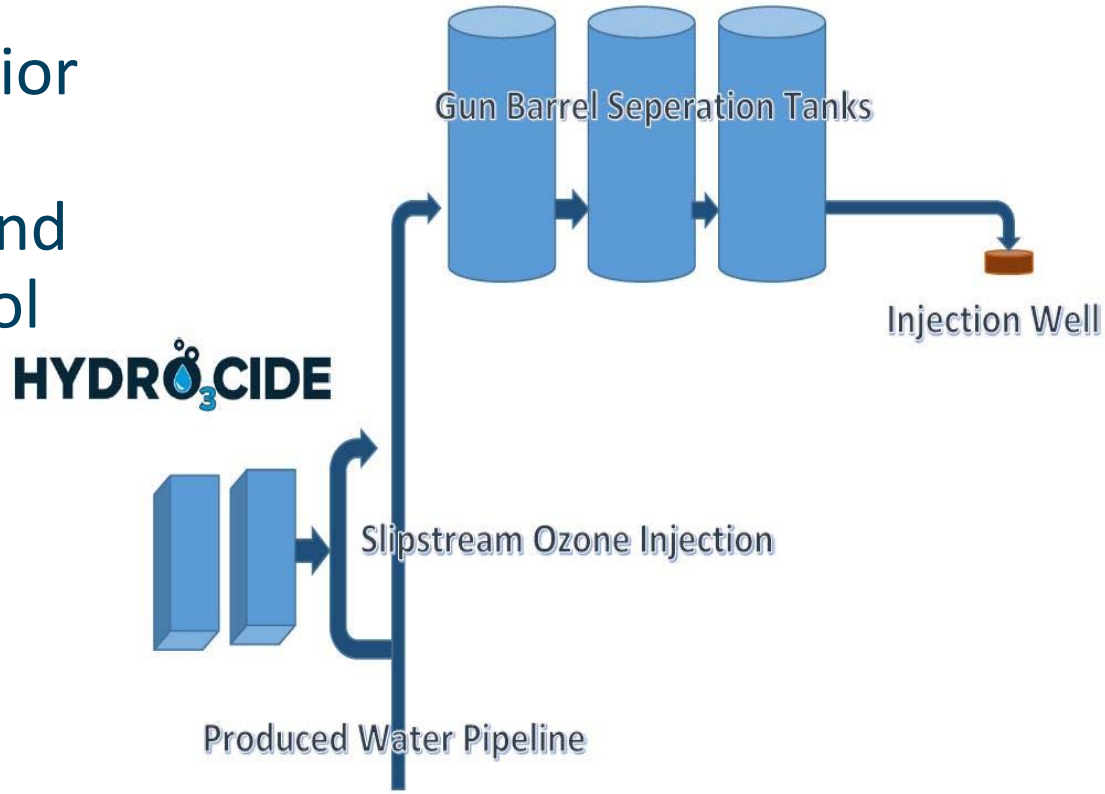
# HYDRO$_3$CIDE

An unmanned, fully automated ozone treatment system



HYDRO$_3$CIDE

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




$H_2O$

# HYDRO$_3$CIDE

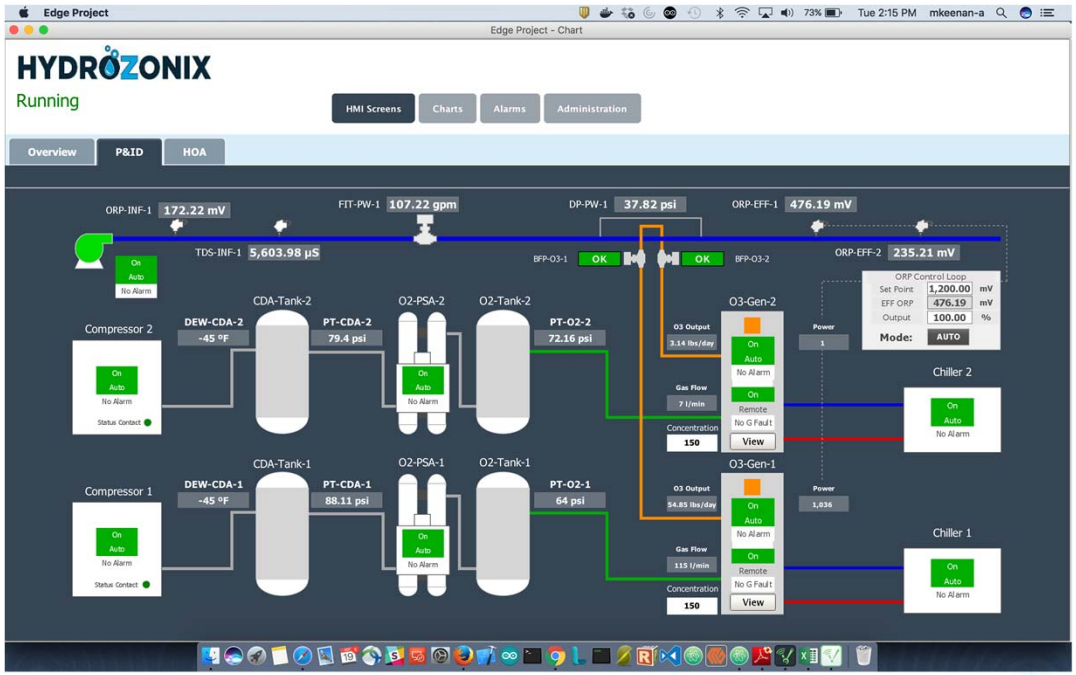

Fully Automated

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

# HYDRO$_3$CIDE


Fully Automated

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



# HYDRO$_3$CIDE

Engineered for your application

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

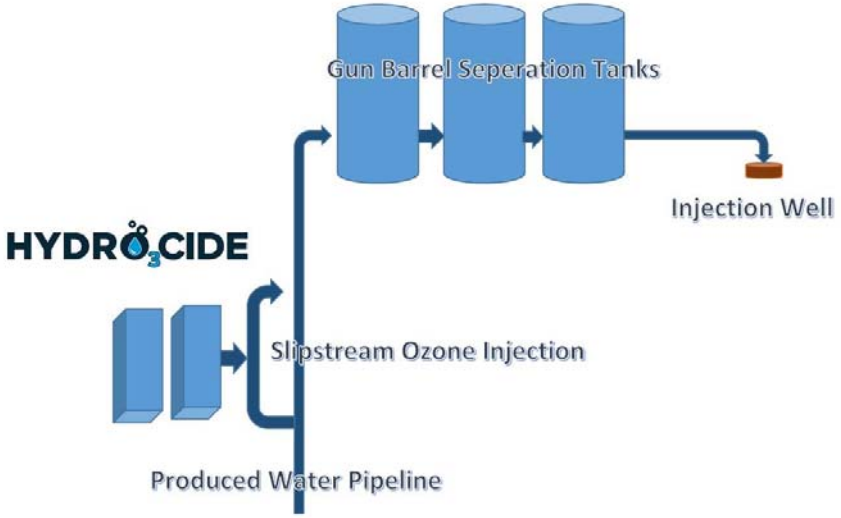



HZO

HYDRO$_3$CIDE

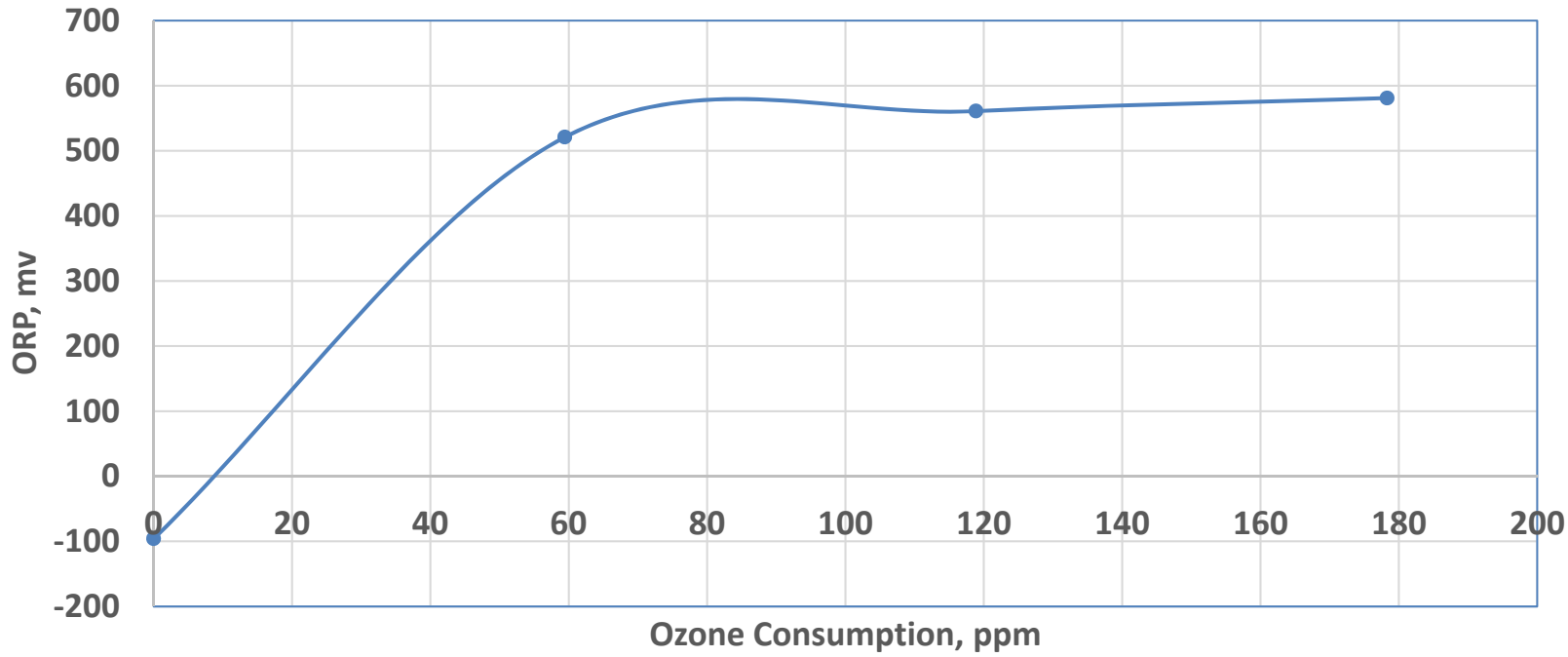
Improved Oil/Water Separation ?

- Initial Tests show improvement
- Induced Gas Flotation Effect


$H_2O$

# Produced Water Treatment – Ozonation Study SWD 1



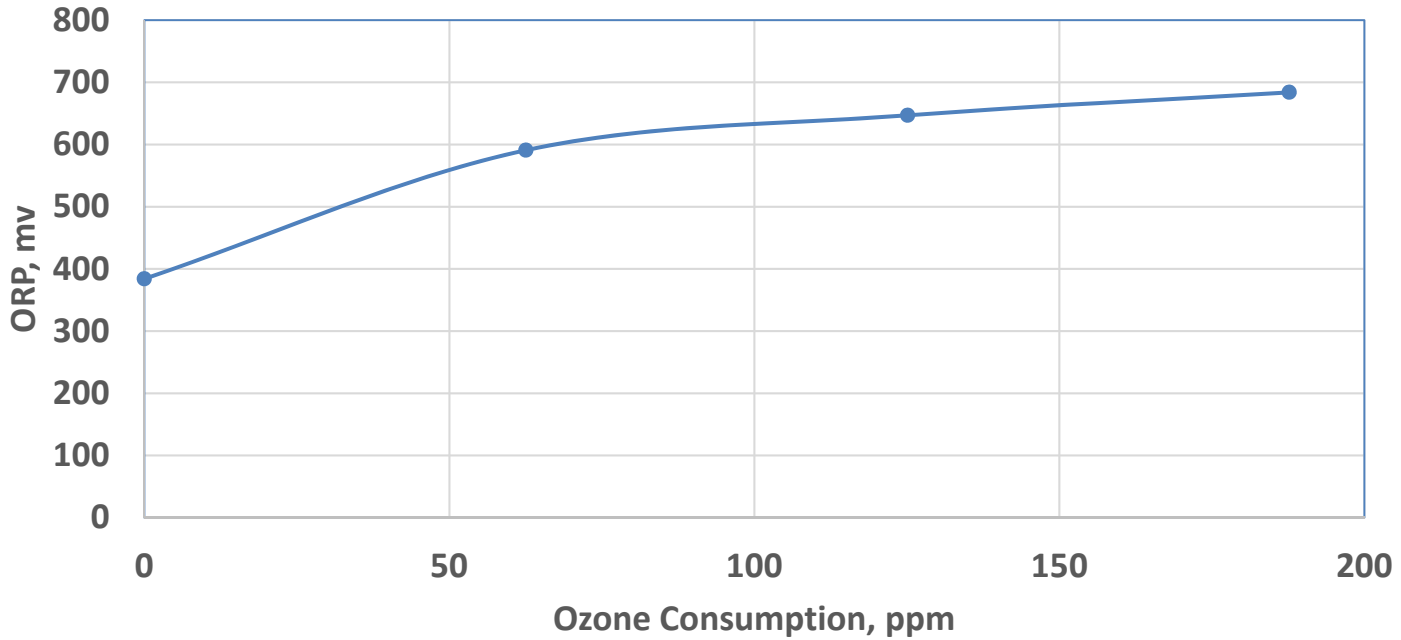

- **The water was treated with ozone continuously.**
- **The Oxidation Reduction Potential (ORP) of the water was monitored periodically.**

# 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



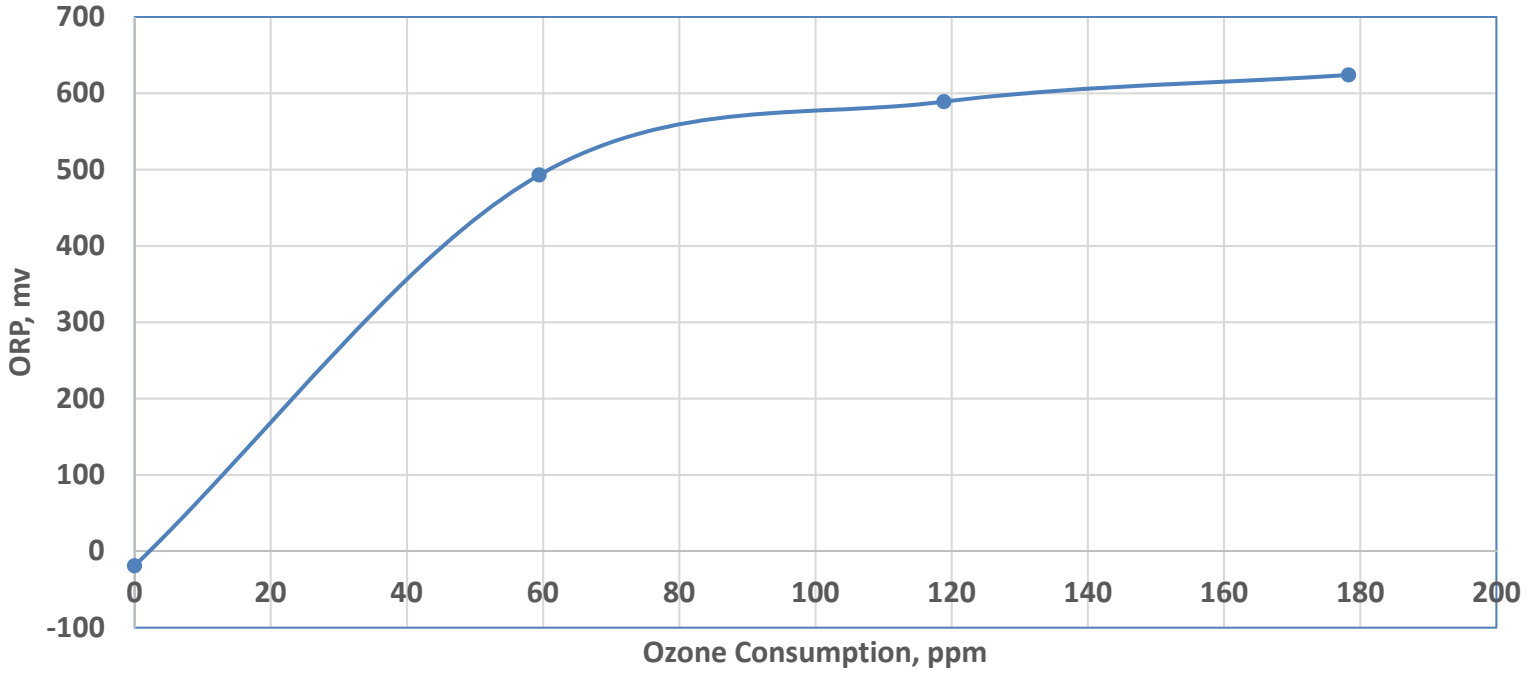

- **The water was treated with ozone continuously.**
- **The Oxidation Reduction Potential (ORP) of the water was monitored periodically.**

# 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.

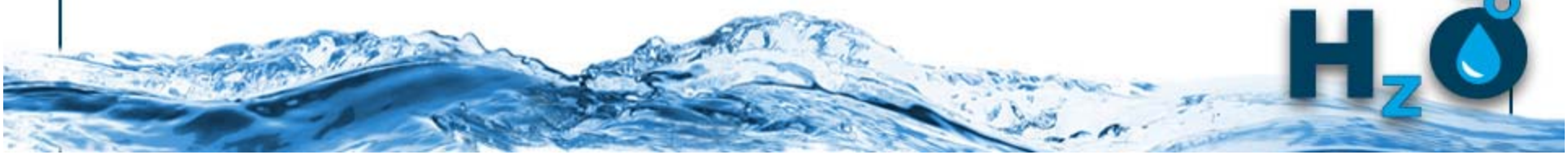
HYDRO$_3$CIDE

## 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* |

| 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* |

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




www.hydrozonix.com