Reducing H2S and Odors with Superoxygenated Wastewater

NEWEA 2018 – Session 28

Tim Haskell – York Sewer District

Richard Russell – Walker Wellington

Chris Milligan - BlueInGreen

York Sewer District

- Original sewers late 1800's early 1900's
  - York Village Corporation
  - York Beach Corporation
  - York Harbor Corporation
- 1947 M&E Study of Sewer System for York Water District
- York Sewer District Established in 1951

SEASONAL TOURIST & POPULATION CHANGES

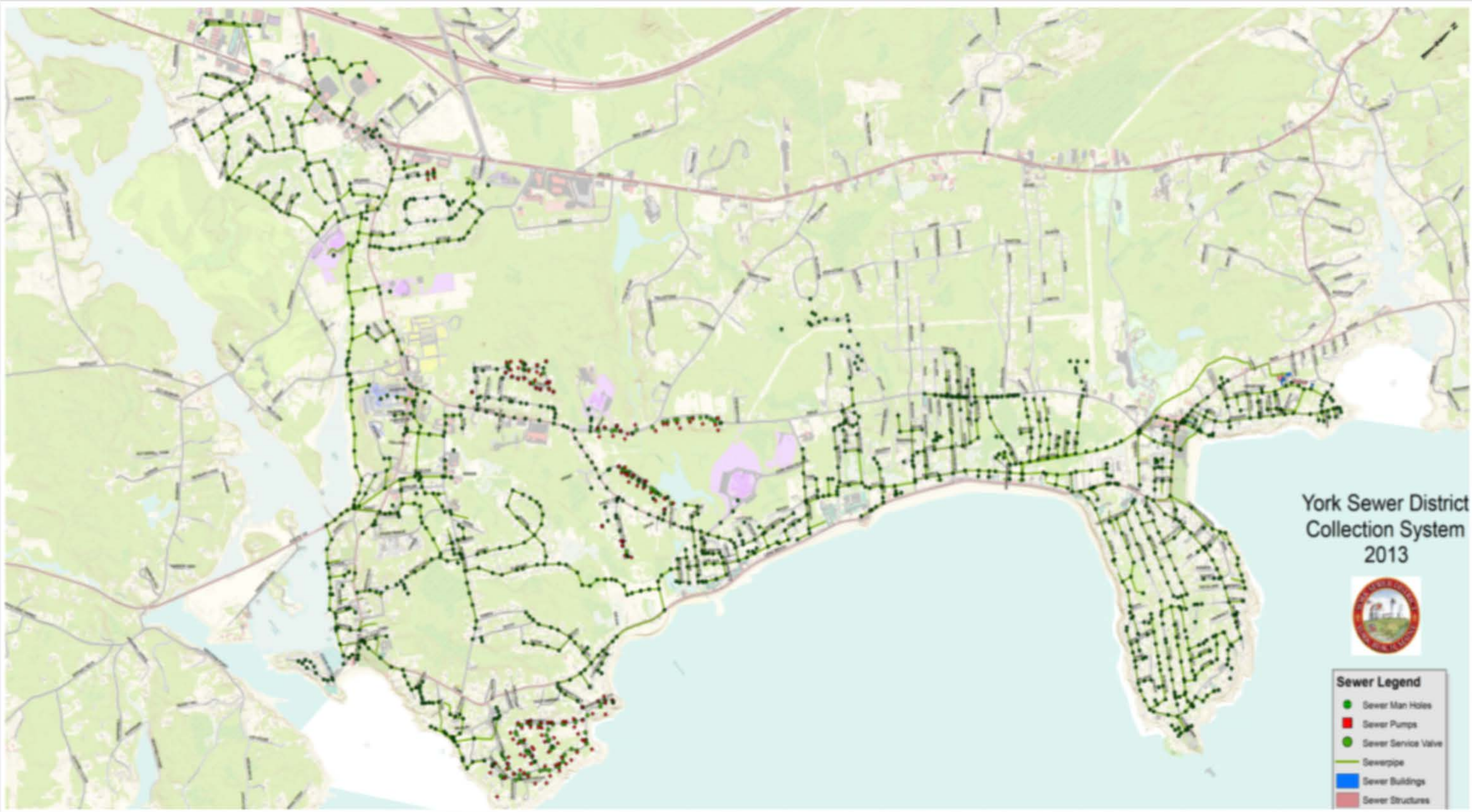
SHORT SANDS BEACH

Welcome to Short Sands Beach

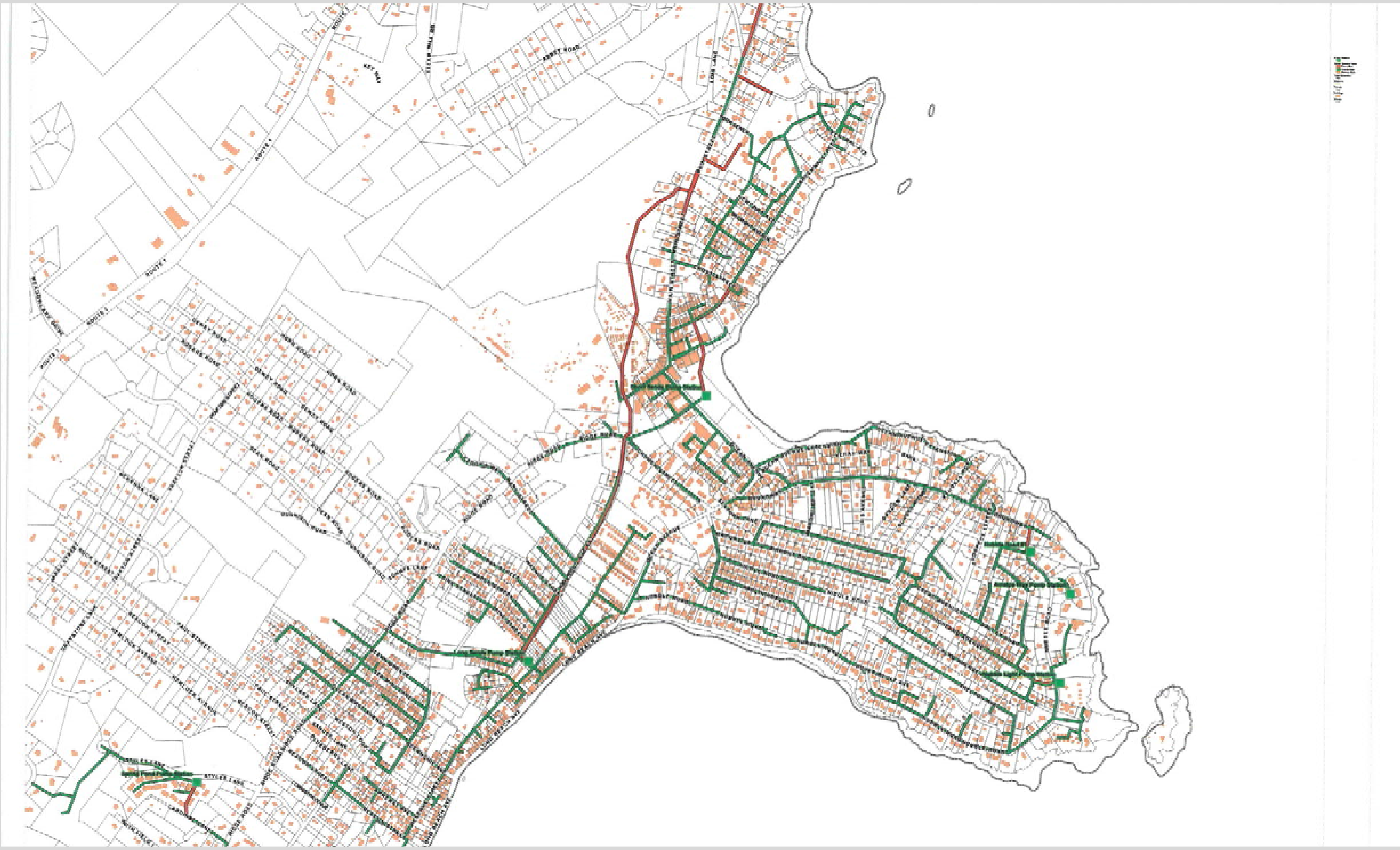
Not so Welcome to Short Sands Beach

York Sewer District

- Year round population - 12,656 (2012 Census)
  - Snowbirds, 30-40% still seasonal
- Summer weekends - 50,000-75,000
- Over 90 % residential flows
- 4,420 sewer accounts
- 119 Mostly Seasonal Restaurants
- 1,800 motel/hotel rooms
- Campground, B&B’s, Day Trippers


York Sewer District
Collection System
2013
Sewer Legend
Sewer Man Holes
Sewer Pumps
Sewer Service Valve
Sewerpipe
Sewer Buildings
Sewer Structures

Long Beach Forcemain



The Origin of The Problem

Long Beach Pump Station

Solutions to H2S Odor and Degradation Problem?

Phased Approach

Cap and Contain

Headworks Building

Hydrogen Sulfide Degradation

Epoxy Coating Applied

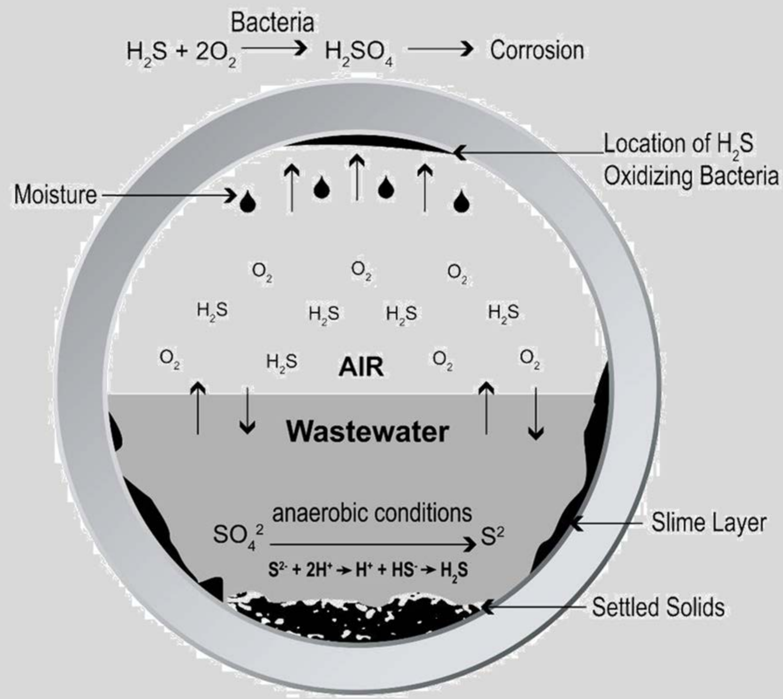
Solutions to H2S Odor and Degradation Problem?

Eliminate H2S

Background

Defining the Problem

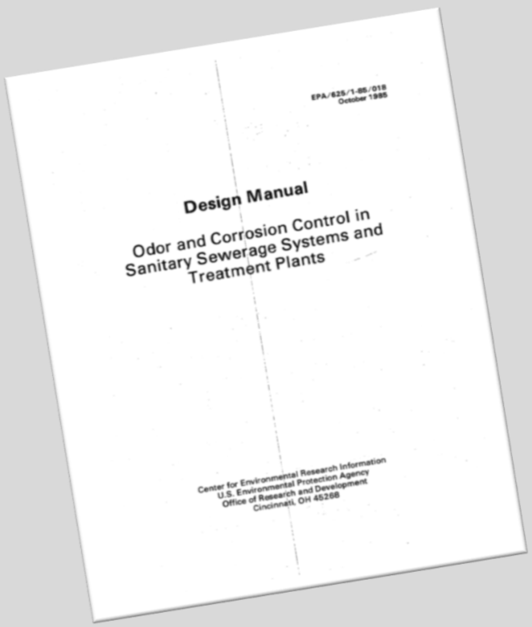
- Hydrogen sulfide, H_2S
  - toxic substance that acts as a respiratory depressant
  - probably the most difficult compound plaguing wastewater collection systems today
- The formation of hydrogen sulfide raises two primary concerns
  - nuisance complaints from odor emissions
  - corrosion to steel and concrete pipe & structures



Background

Defining the Problem

- Millions of dollars are spent annually to address odor issues and correct long-term corrosion damage to structures within collection systems.

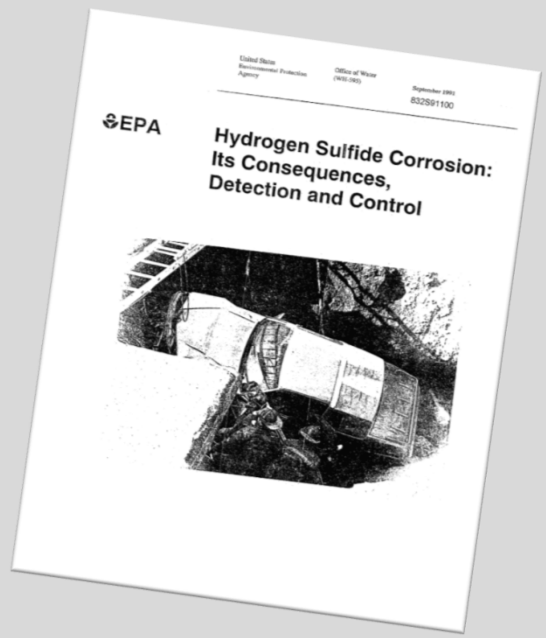


EPA/625/1-85/018
October 1985

Design Manual

Odor and Corrosion Control in Sanitary Sewerage Systems and Treatment Plants

Center for Environmental Research Information
U.S. Environmental Protection Agency
Office of Research and Development
Cincinnati, OH 45268



United States
Environmental Protection
Agency

Office of Water
(WH-595)

September 1991
832S91100

EPA

Hydrogen Sulfide Corrosion: Its Consequences, Detection and Control

Design Considerations

Designing Oxygen Injection Equipment for Odor and Corrosion Control

- There are two key questions that must be considered when designing an oxygen injection system for odor and corrosion control

  - How much oxygen is needed? Quantity.
  - Where should it be injected? Location.

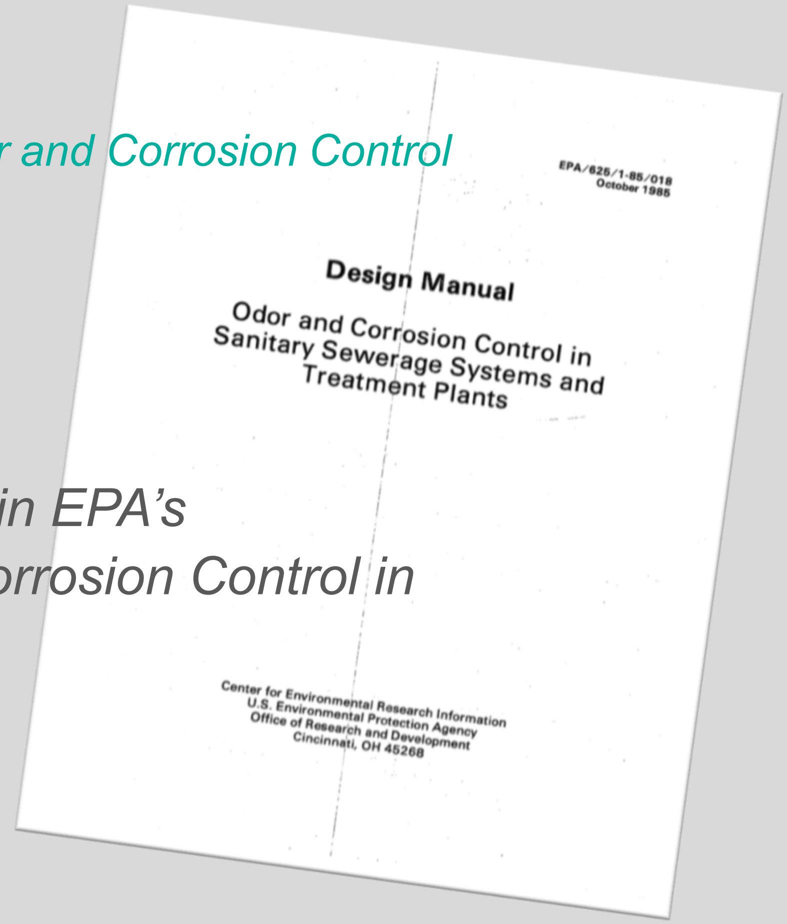
Design Considerations

Sizing Oxygen Injection Equipment for Odor and Corrosion Control

- Estimating Oxygen Quantity

  - Total O2 = $O2_{OUR} + O2_{S2}$

  - *Based on methods outlined in EPA's Design Manual: Odor and Corrosion Control in Sanitary Sewerage*



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Design Considerations

Sizing Oxygen Injection Equipment for Odor and Corrosion Control

Oxygen Uptake Rate (OUR)

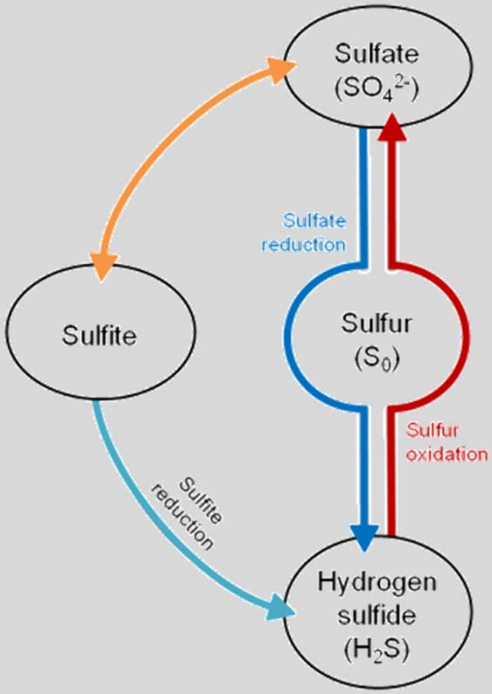
- Measure of microbiology oxygen consumption within the wastewater.
- Must be satisfied to maintain aerobic conditions within the pipeline.
- Varies with temperature and wastewater quality (COD/BOD).
- Ranges from 5 to 15-mg/L/hr for most municipal wastewaters
  - 10-mg/L/hr is typical for design, if information not available

Design Considerations

Sizing Oxygen Injection Equipment for Odor and Corrosion Control

Sulfide Oxidation (S2)

- In most cases, sulfides have already formed upstream of oxygen injection.
  - Dissolved free sulfides (H2S, HS− and S2−)
- Oxidization of existing sulfides is needed to prevent possible odor or corrosion concerns.
- S2 varies with temperature and wastewater quality, specifically pH.
- Theoretically, O2:S2 ratio is 2 : 1



Design Considerations

Locating Oxygen Injection Equipment for Odor and Corrosion Control

- Location is Dependent on Goals
  - Odor Control
    - can be located more closely to problem area
  - Corrosion Control
    - ideally entire pipeline is free of H_2S
    - can be strategically located

- Requires in-depth knowledge of collection system, diurnal flows, pump operations, etc.
  - field evaluation studies recommended

- Oxidation Reduction Potential (ORP)
  - Good indicator of biological activity and electron availability
  - ORP levels greater than -150mV (negative) generally correspond to minimal activity of sulfate-reducing bacteria, effectively preventing the formation of H_2S.

Long Beach Forcemain

Sizing Oxygen Injection Equipment for Odor and Corrosion Control

Basis for Design	
Given	
Oxygen Demand	lbs/day
Minimum Flow	600 gpm
Average Flow	1000 gpm
Maximum Flow	3200 gpm
Pumping Frequency	Continuous
Location of Injection	Pump Station
Forcemain Length	6,382 ft
Forcemain Diameter	16 in
Forcemain Pressure	14 psi
Maximum Temperature of Wastewater	19ºC
Assumptions, To Be Confirmed	
Influent Sulfide Concentration	1.0 mg/L
pH	6-8

Long Beach Forcemain

Sizing Oxygen Injection Equipment for Odor and Corrosion Control

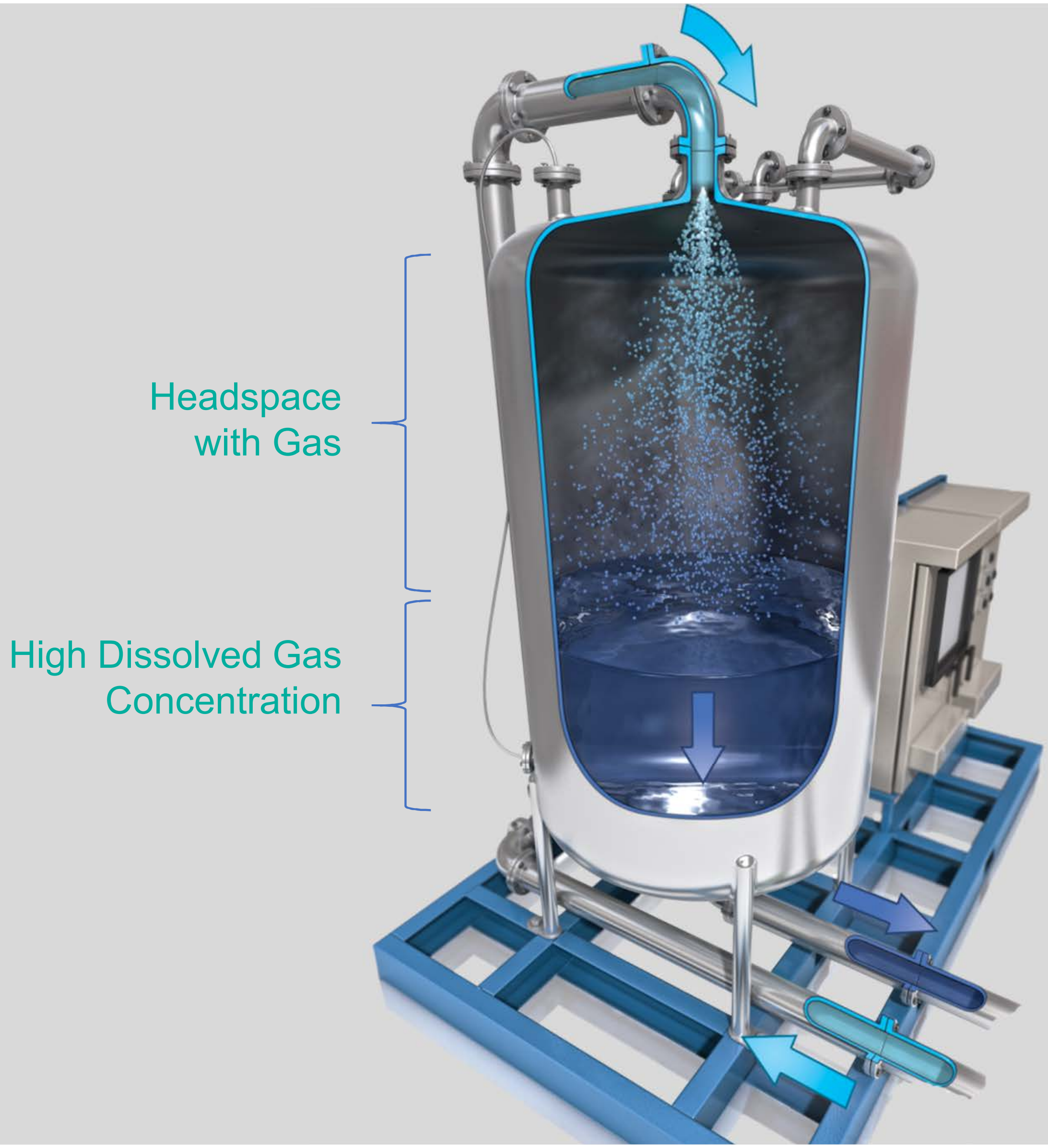
- Oxygen Uptake Rate (OUR)
  - $O2_{OUR}$ (lb/d) = OUR (mg/L/hr) * HRT (hrs) * Q (mgd) * 8.34
  - $O2_{OUR}$ (lb/d) = 10 (mg/L/hr) * 2.0 (hrs) * 1.4 (mgd) * 8.34
  - $O2_{OUR}$ (lb/d) = 230

- Sulfide Oxidation (S2)
  - $O2_{S2}$ (lb/d) = S2 (mg/L) * O2:S2 * Q (mgd) * 8.34
  - $O2_{S2}$ (lb/d) = 1 (mg/L) * 2 * 1.4 (mgd) * 8.34
  - $O2_{S2}$ (lb/d) = 25

- Total O2 = $O2_{OUR}$ + $O2_{S2}$
  - Total O2 (lb/d) = 25 + 230
  - Total O2 (lb/d) = 255

Needed DO concentration is ~22-mg/L

BlueInGreen
solutions for water quality

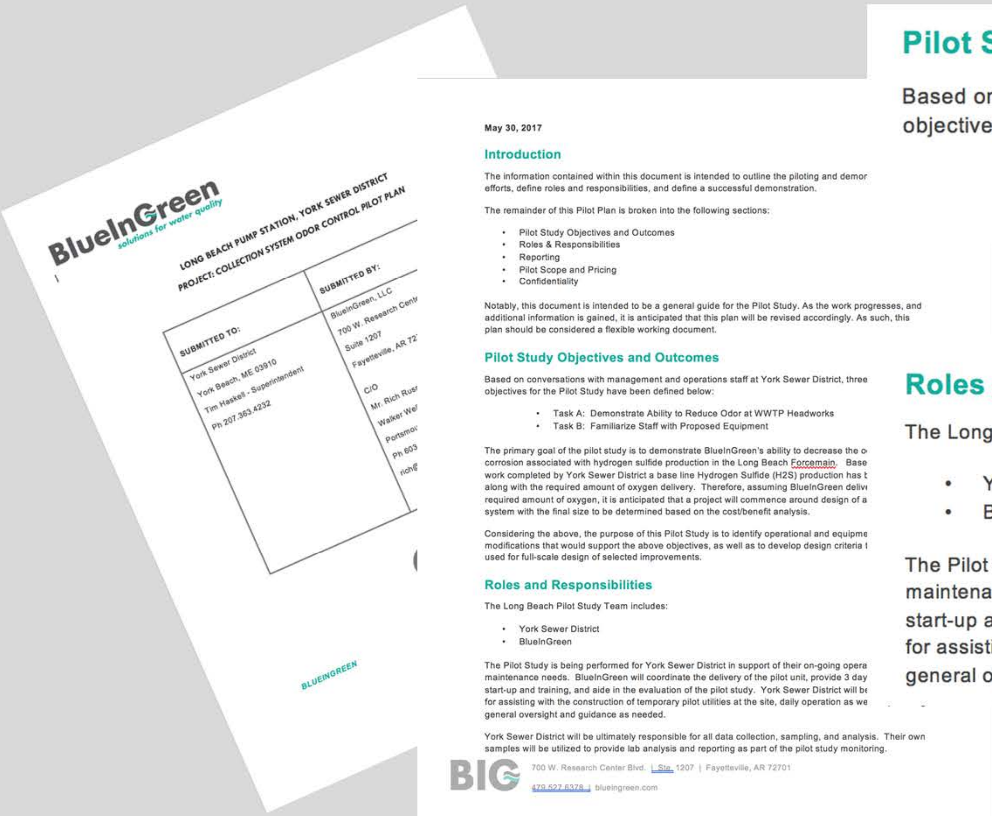


- Patented Side Stream Gas Dissolution Method
- Water Serves as a Barrier to Limit Undissolved Gas from Escaping
- Achieves Very High O_2-O_3-CO_2 Concentrations
- Allows for a Much Smaller Carrier Stream
- Results in <u>Less Cost</u> for the Same Level of Treatment

BlueInGreen
solutions for water quality

Long Beach Forcemain - Pilot Plan

Planning for Success



May 30, 2017

Introduction

The information contained within this document is intended to outline the piloting and demor efforts, define roles and responsibilities, and define a successful demonstration.

The remainder of this Pilot Plan is broken into the following sections:

- Pilot Study Objectives and Outcomes
- Roles & Responsibilities
- Reporting
- Pilot Scope and Pricing
- Confidentiality

Notably, this document is intended to be a general guide for the Pilot Study. As the work progresses, and additional information is gained, it is anticipated that this plan will be revised accordingly. As such, this plan should be considered a flexible working document.

Pilot Study Objectives and Outcomes

Based on conversations with management and operations staff at York Sewer District, three objectives for the Pilot Study have been defined below:

- Task A: Demonstrate Ability to Reduce Odor at WWTP Headworks
- Task B: Familiarize Staff with Proposed Equipment

Roles and Responsibilities

The Long Beach Pilot Study Team includes:

- York Sewer District
- BlueInGreen

York Sewer District will be ultimately responsible for all data collection, sampling, and analysis. Their own samples will be utilized to provide lab analysis and reporting as part of the pilot study monitoring.

700 W. Research Center Blvd. | Ste. 1207 | Fayetteville, AR 72701

Pilot Study Objectives and Outcomes

Based on conversations with management and operations staff at York Sewer District, three primary objectives for the Pilot Study have been defined below:

- Task A: Demonstrate Ability to Reduce Odor at WWTP Headworks
- Task B: Familiarize Staff with Proposed Equipment

Roles and Responsibilities

The Long Beach Pilot Study Team includes:

- York Sewer District
- BlueInGreen

The Pilot Study is being performed for York Sewer District in support of their on-going operations and maintenance needs. BlueInGreen will coordinate the delivery of the pilot unit, provide 3 days on-site for start-up and training, and aide in the evaluation of the pilot study. York Sewer District will be responsible for assisting with the construction of temporary pilot utilities at the site, daily operation as well as providing general oversight and guidance as needed.

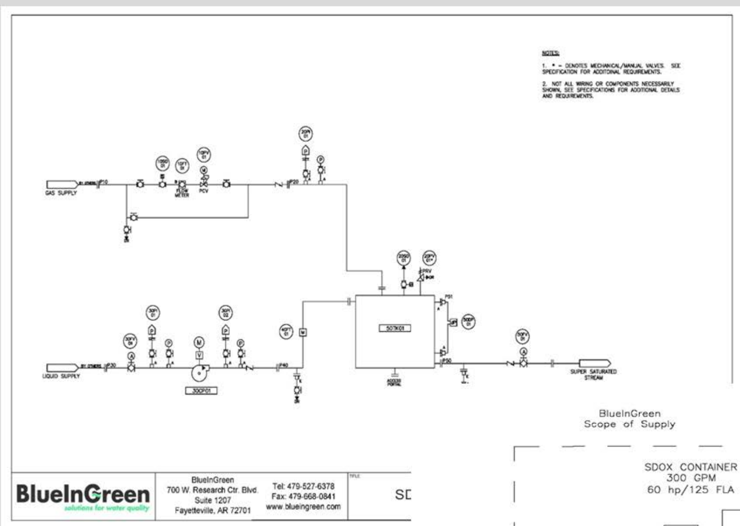
Long Beach Forcemain - Pilot Plan

Planning for Success

Task	BlueInGreen	York Sewer District
Management and Administration	Responsible for communicating with team, review of test plan	Schedule personnel, provide timely input and review
Prepare Pilot Study Plan	Provide details on system design, operation as needed for Study Plan	Provide timely input and review. Obtain baseline H_2S and DO.
Pre-Pilot Study Preparation	Assemble, check, and deliver Pilot Unit	Assist in installation and provide temporary staging and utility provisions
Startup	Provide technicians for startup, and provide input	Provide operators for oversight and training
Pilot Study Execution	Provide operational assistance and data collection support. Review data and input to enhance effectiveness and troubleshooting	Provide timely input and review, data collection and monitoring. Provide staff for daily operation needs.
Data Analysis	Review operational and water quality data and perform analysis	Provide timely input and review
Reporting	Review regular data summaries, participate in conference calls, prepare Pilot Report	Participate in conference calls

Long Beach Forcemain - Pilot Plan

Planning for Success



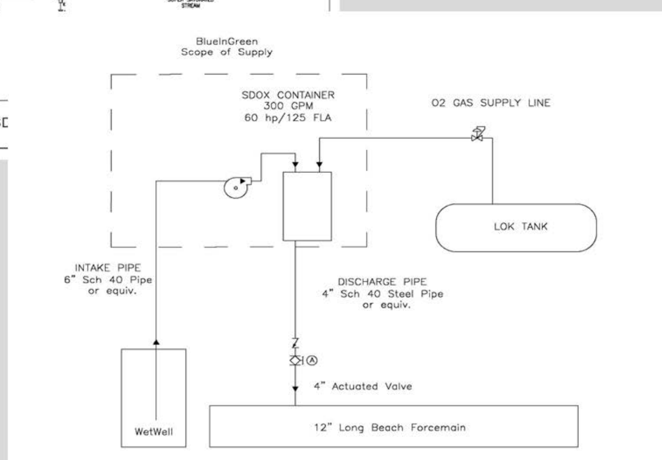


Figure 1. Pilot Unit Layout

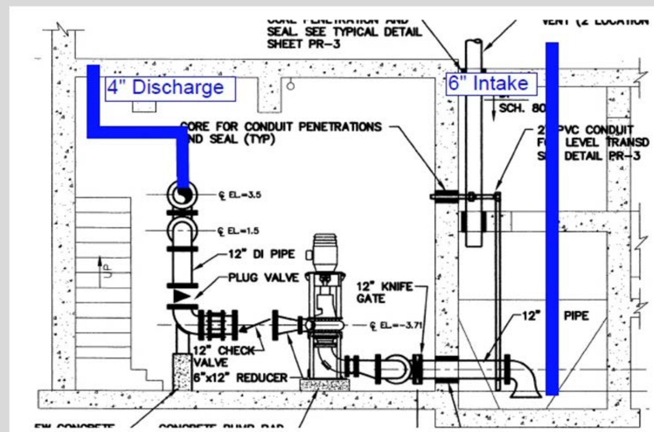
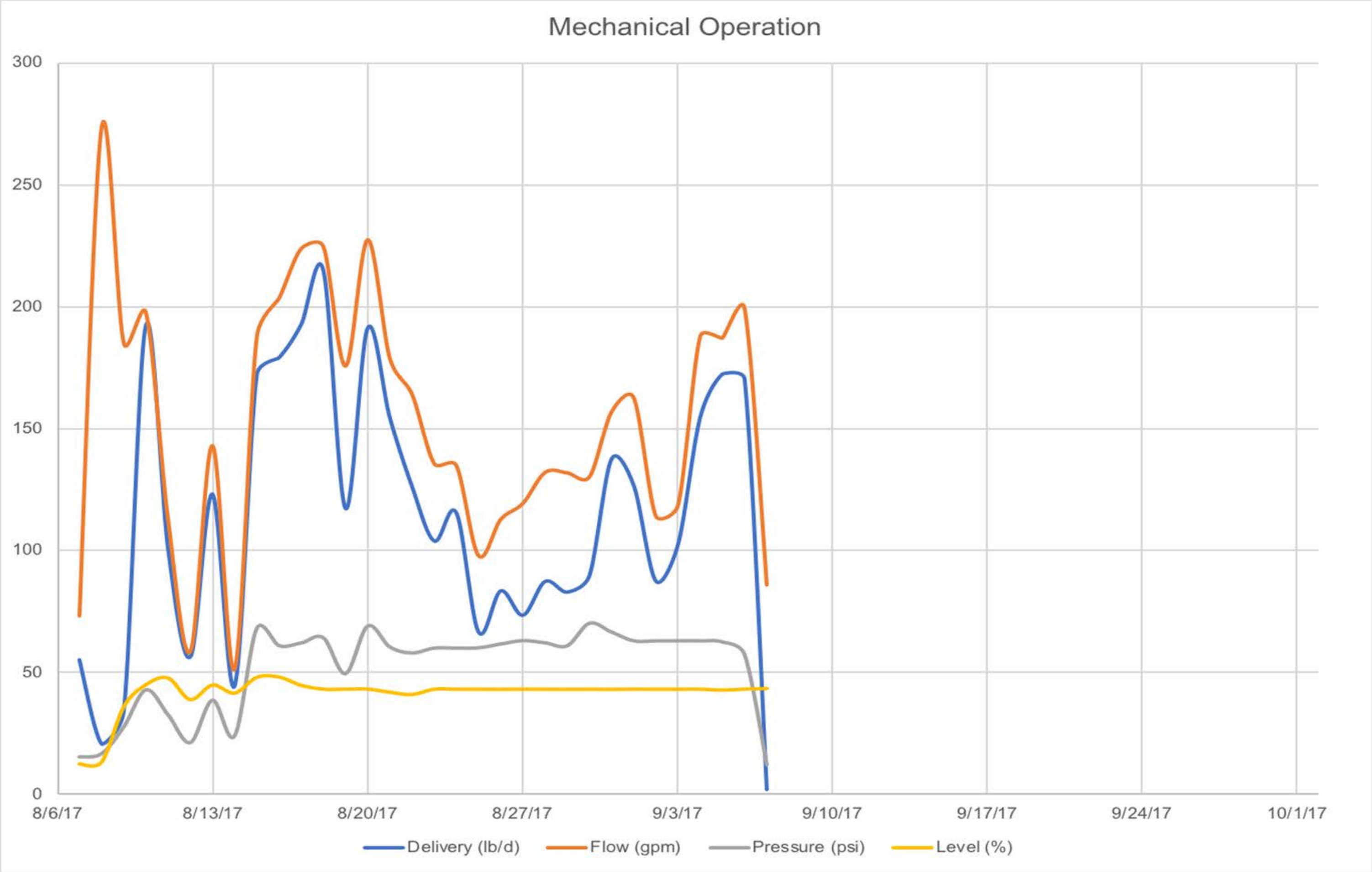


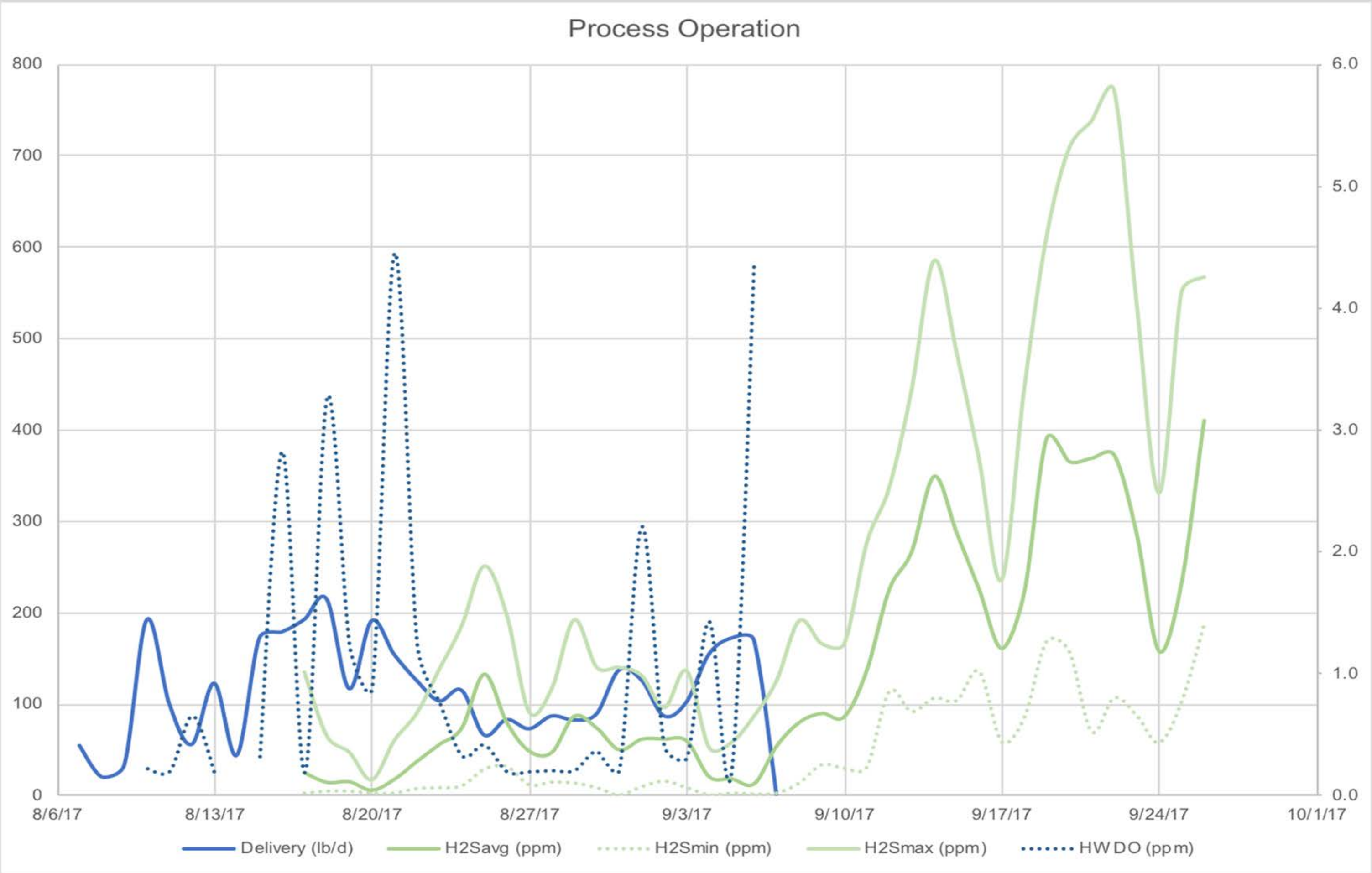
Figure 4. SDOX Wetwell Pilot Setup

Pilot Results

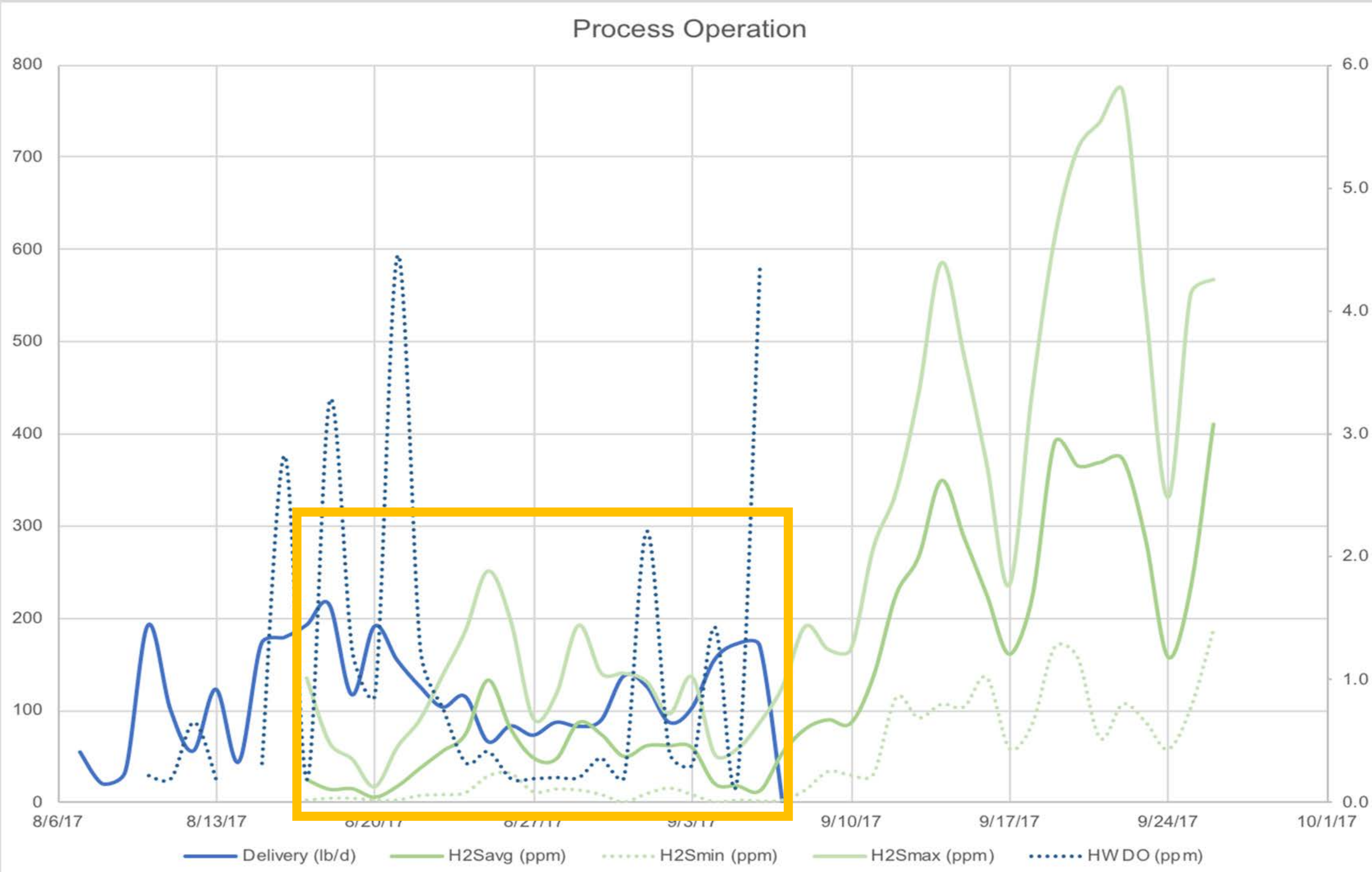
Pilot Results



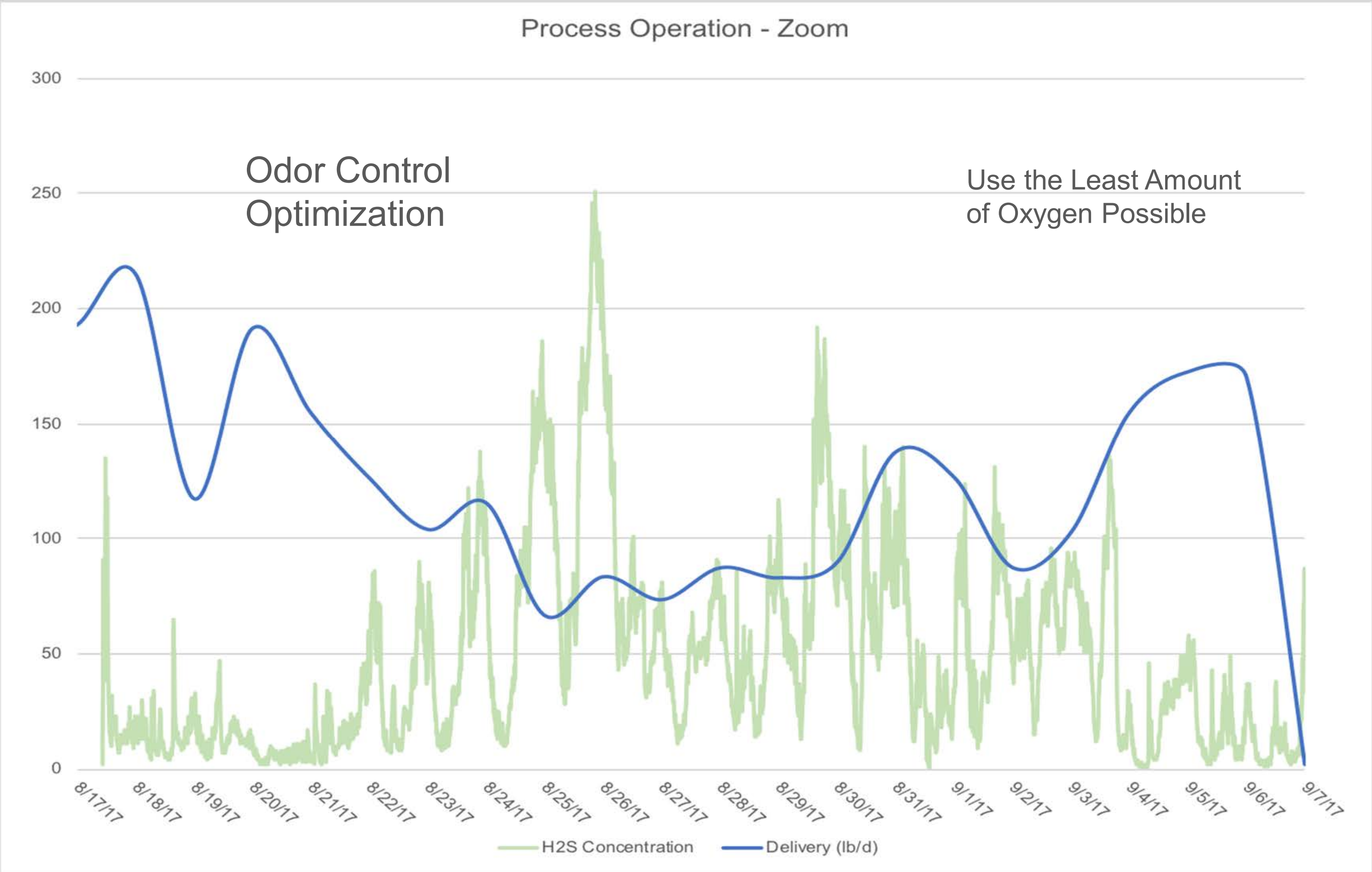
Pilot Results



Pilot Results



Pilot Results



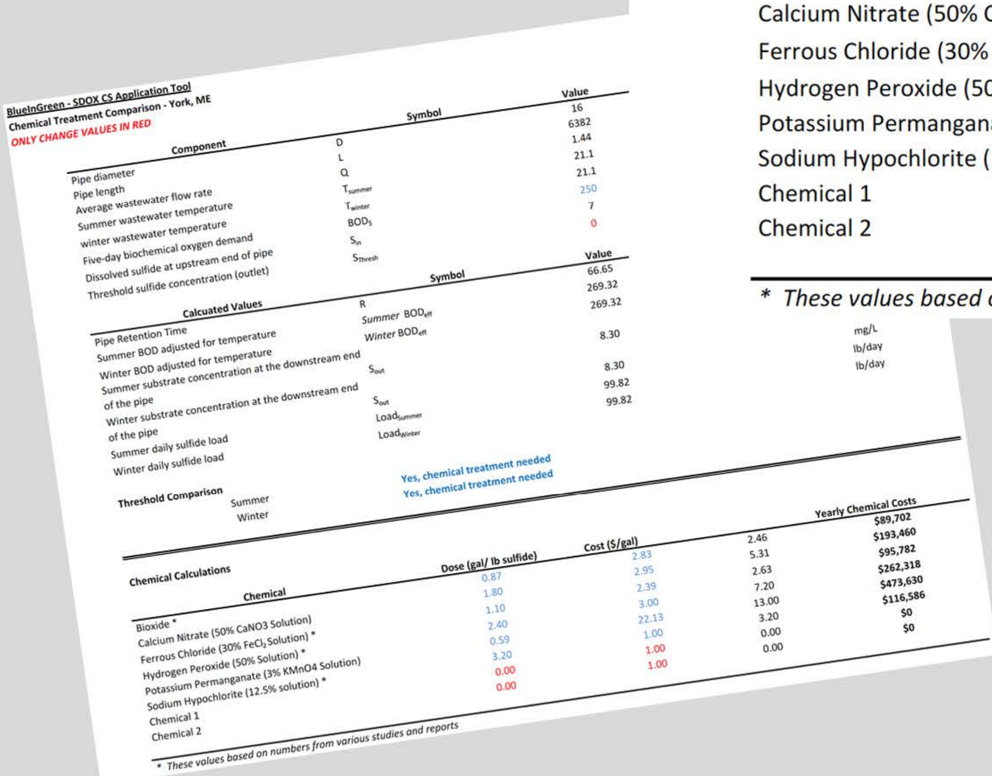
Pilot Results

- Demonstrated ability to ‘control’ H2S levels with oxygen addition via BlueInGreen technology.

- Confirmed estimated oxygen requirements for H2S control at > 200-lb/d.
  - Depending on goals, oxygen dose can be varied to meet process, treatment, or financial constraints.

- Operations and maintenance staff became familiar with equipment and control methodologies.

Financial Impacts



BlueInGreen - SDOX CS Application Tool
Chemical Treatment Comparison - York, ME
ONLY CHANGE VALUES IN RED

Component	Symbol	Value
Pipe diameter	D	16
Pipe length	L	6382
Average wastewater flow rate	Q	1.44
Summer wastewater temperature	T_{summer}	21.1
winter wastewater temperature	T_{winter}	21.1
Five-day biochemical oxygen demand	BOD_5	250
Dissolved sulfide at upstream end of pipe	S_{in}	7
Threshold sulfide concentration (outlet)	S_{Thresh}	0

Calcuated Values	Symbol	Value	
Pipe Retention Time	R	66.65	
Summer BOD adjusted for temperature	Summer BOD_{eff}	269.32	
Winter BOD adjusted for temperature	Winter BOD_{eff}	269.32	
Summer substrate concentration at the downstream end of the pipe	S_{out}	8.30	mg/L
Winter substrate concentration at the downstream end of the pipe	S_{out}	8.30	lb/day
Summer daily sulfide load	$Load_{summer}$	99.82	lb/day
Winter daily sulfide load	$Load_{winter}$	99.82	

Threshold Comparison	
Summer	Yes, chemical treatment needed
Winter	Yes, chemical treatment needed

Chemical Calculations

Chemical	Dose (gal/ lb sulfide)	Cost ($/gal)		Yearly Chemical Costs
Bioxide *	0.87	2.83	2.46	$89,702
Calcium Nitrate (50% CaNO3 Solution)	1.80	2.95	5.31	$193,460
Ferrous Chloride (30% $FeCl_3$ Solution) *	1.10	2.39	2.63	$95,782
Hydrogen Peroxide (50% Solution) *	2.40	3.00	7.20	$262,318
Potassium Permanganate (3% KMnO4 Solution)	0.59	22.13	13.00	$473,630
Sodium Hypochlorite (12.5% solution) *	3.20	1.00	3.20	$116,586
Chemical 1	0.00	1.00	0.00	$0
Chemical 2	0.00	1.00	0.00	$0

* *These values based on numbers from various studies and reports*

Chemical	Yearly Chemical Costs
Bioxide *	**$89,702**
Calcium Nitrate (50% CaNO3 Solution)	**$193,460**
Ferrous Chloride (30% $FeCl_2$ Solution) *	**$95,782**
Hydrogen Peroxide (50% Solution) *	**$262,318**
Potassium Permanganate (3% KMnO4 Solution)	**$473,630**
Sodium Hypochlorite (12.5% solution) *	**$116,586**
Chemical 1	**$0**
Chemical 2	**$0**

* *These values based on numbers from various studies and reports*

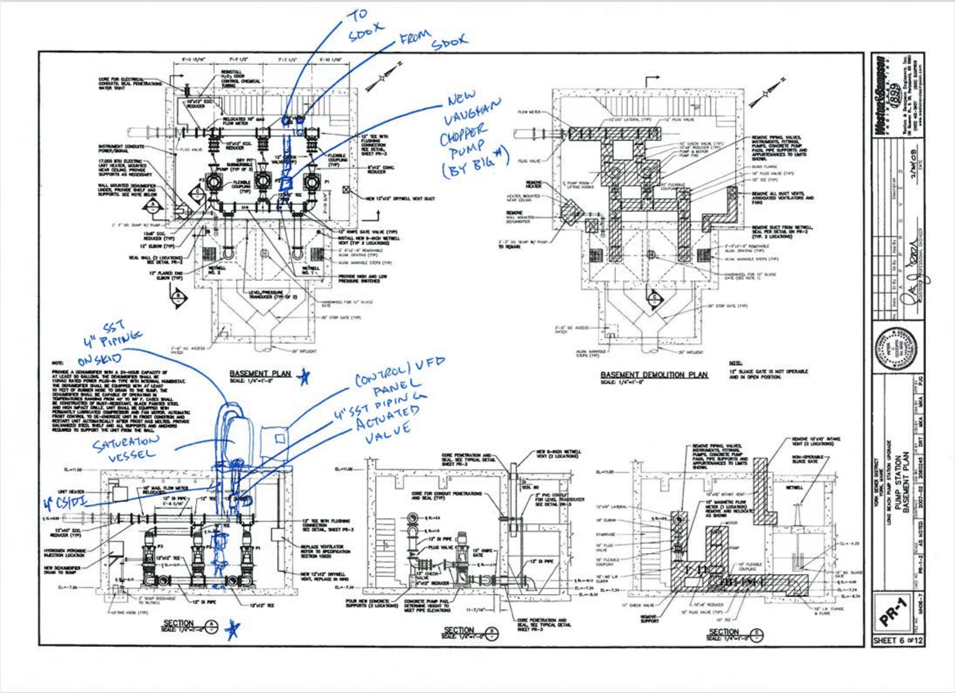
- Operating costs - including electricity, oxygen, operations, and maintenance – are estimated at less than $30,000/yr.
  - Significantly less than competing chemical solutions

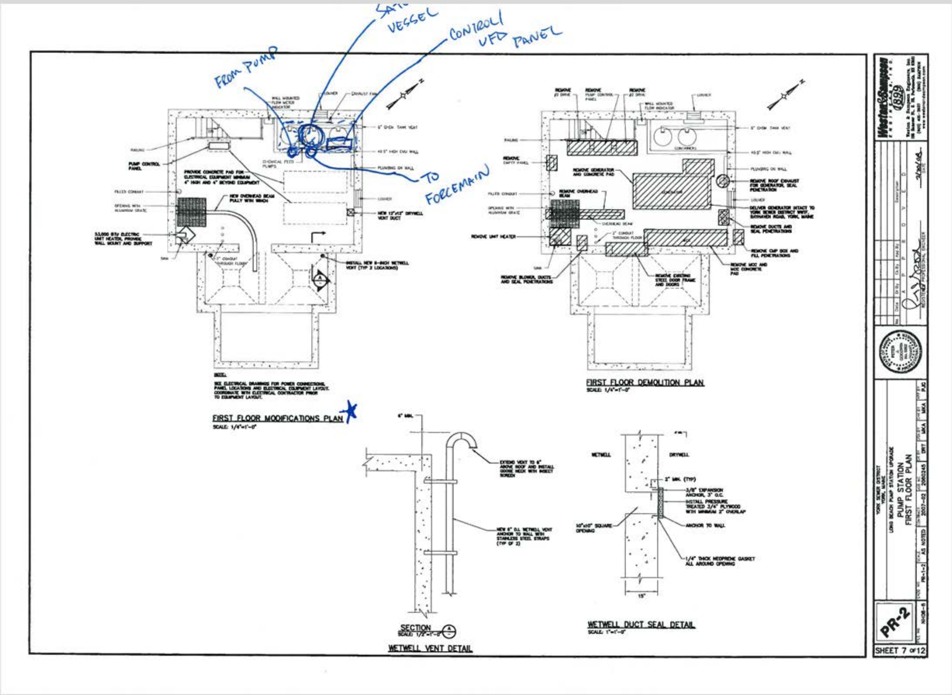
Conclusion

Consider the Benefits

- Odor and Corrosion are effectively controlled through oxygen injection.
    - Treat the problem, not the symptom.
    - Lower annual cost than iron salts and chlorine, with no by-products.
    - Reduced soluble BOD loadings at WWTP due to aerobic processes.

Final Design in Progress





Questions?

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