Nut Island Odor Control: How Lasers and Data Analytics Kept Bids in the Ballpark, and Treated Air Flowing

Introduction

- **The Nut Island Headworks**
    - Built as part of the Boston Harbor Cleanup project, facility put online in1998
    - One of 4 large remote headworks that sends flow to MWRA's Deer Island Water Treatment Facility
    - 400 MGD capacity
    - Removes screenings and grit, then sends flow via a shaft below Boston Harbor to Deer Island Treatment Facility
    - Flow through the facility is by gravity, with shaft hydraulic grade controlled by a pump station at Deer Island
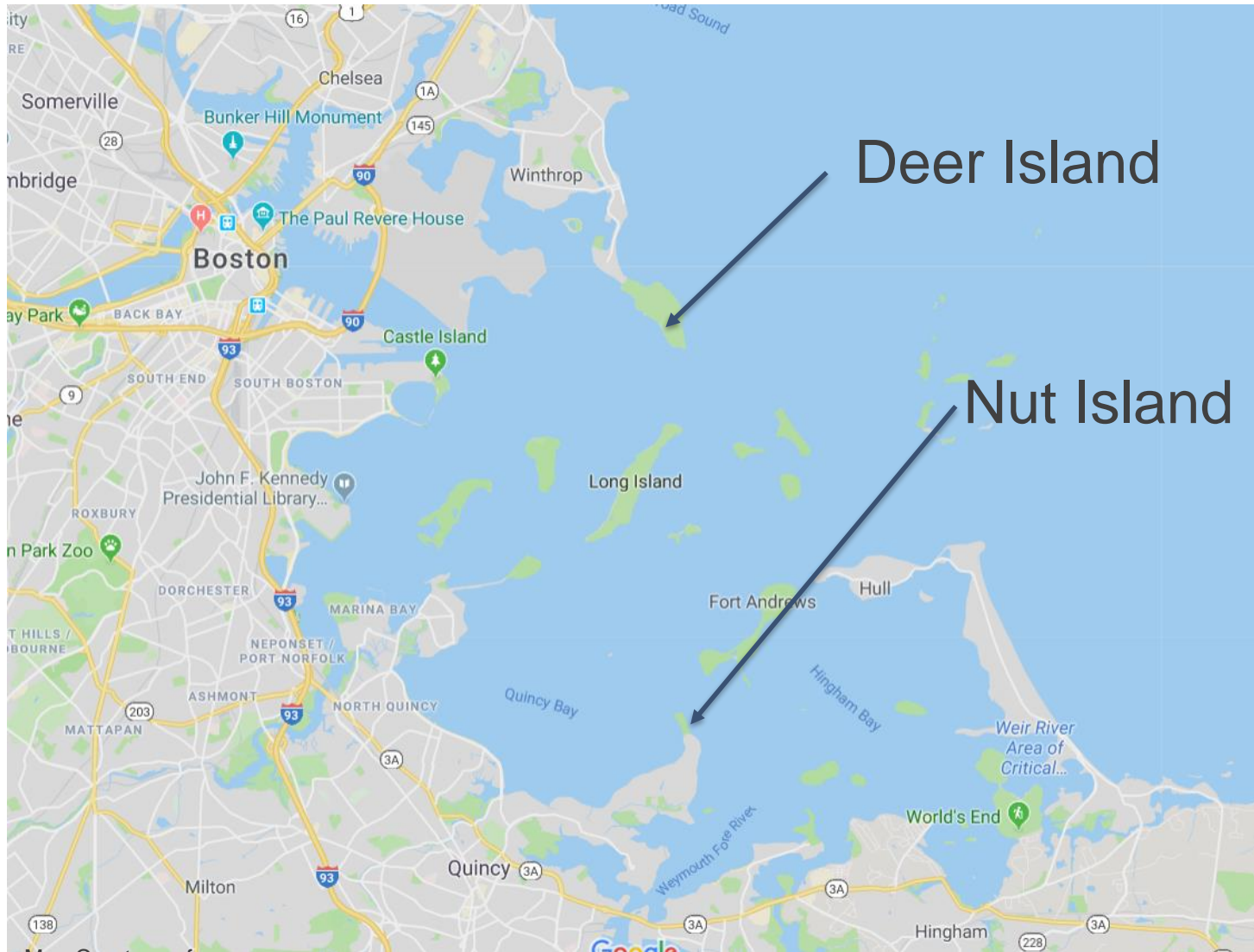
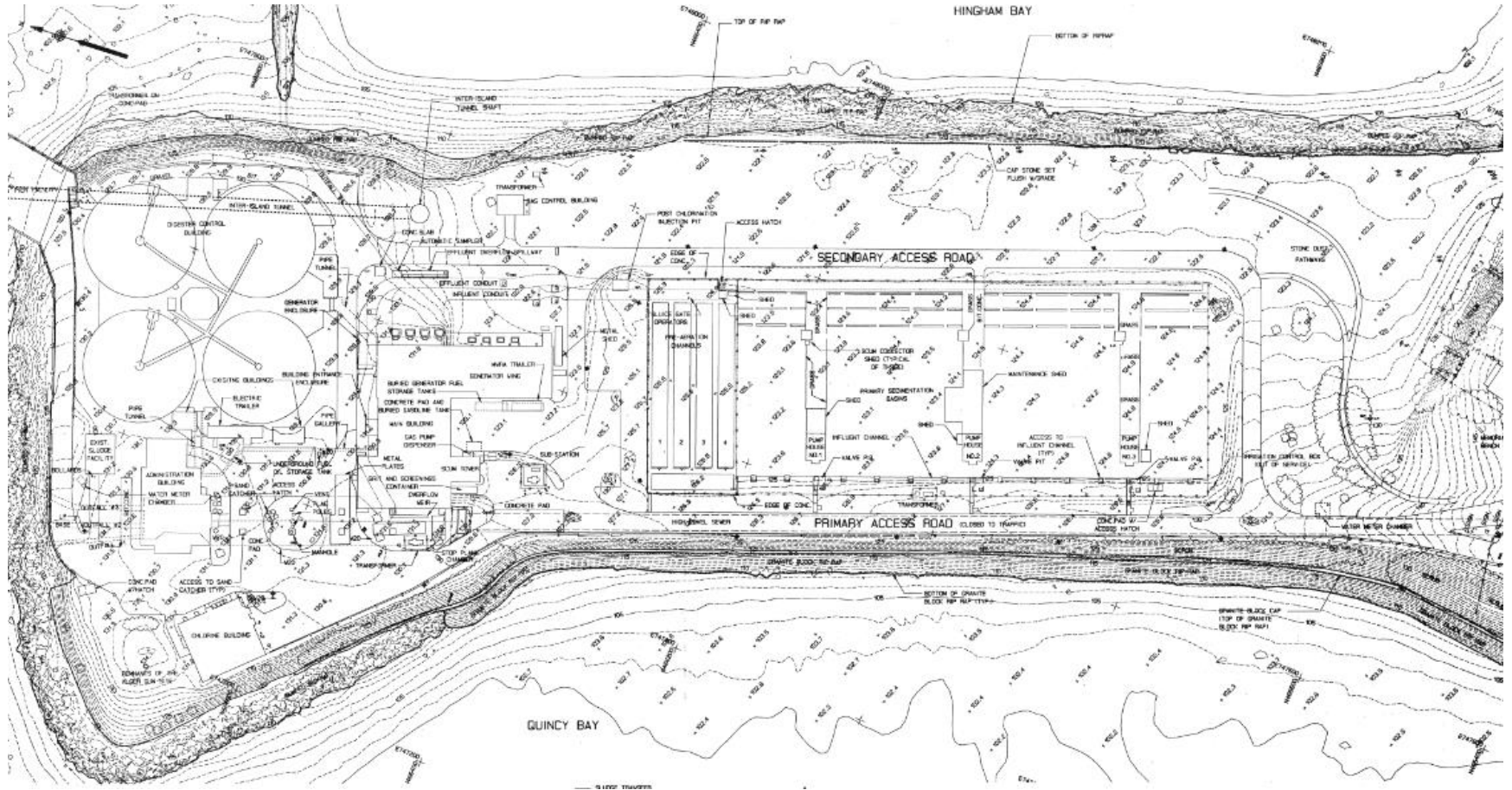# Nut Island Service Area
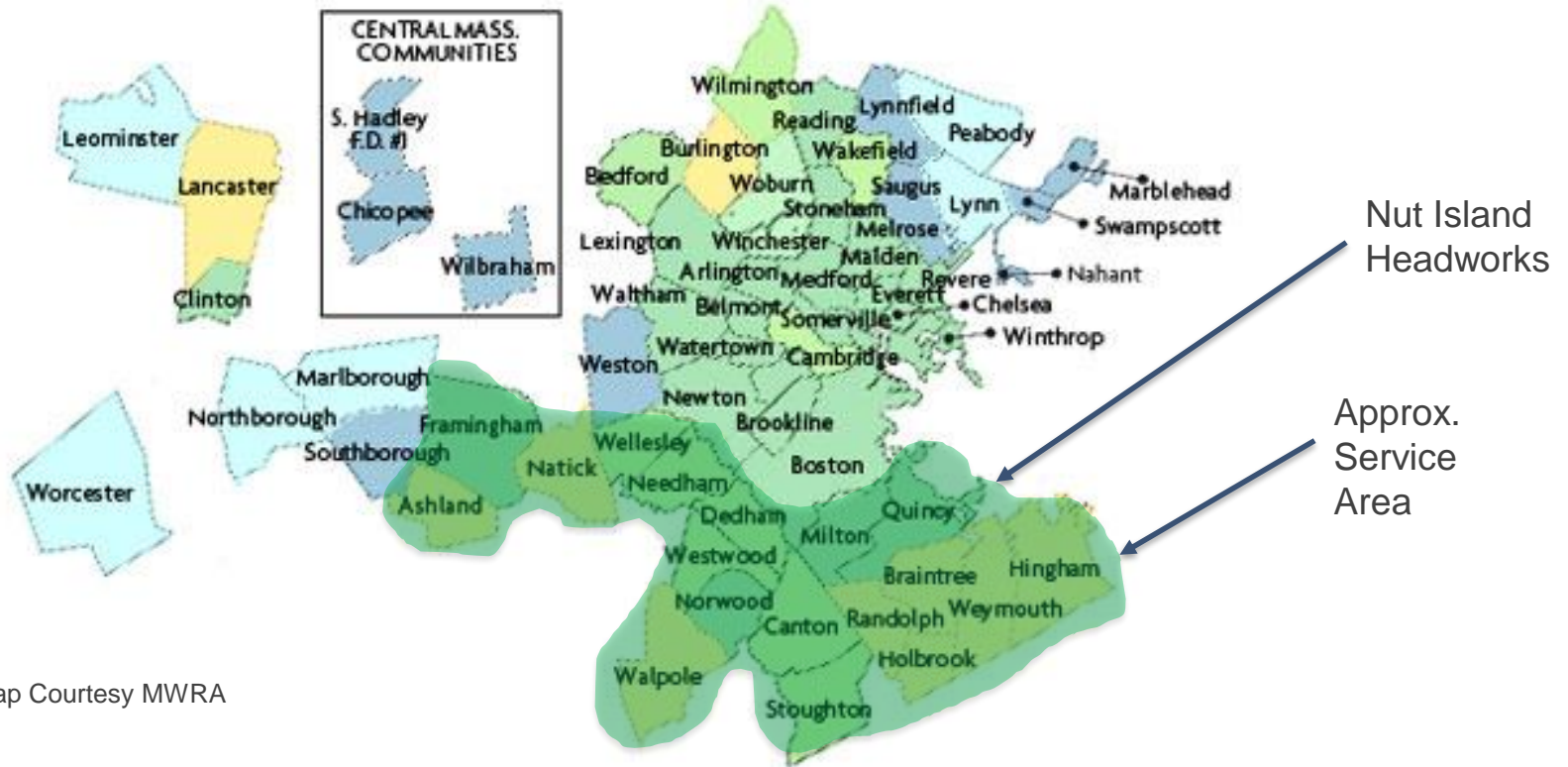
Map Courtesy MWRA

NI and Deer Island

Map Courtesy of
Google Maps

Hazen

Original Nut Island Treatment Facility

Current Facility

The new facility includes a public park that is a gem of the Hough's Neck community
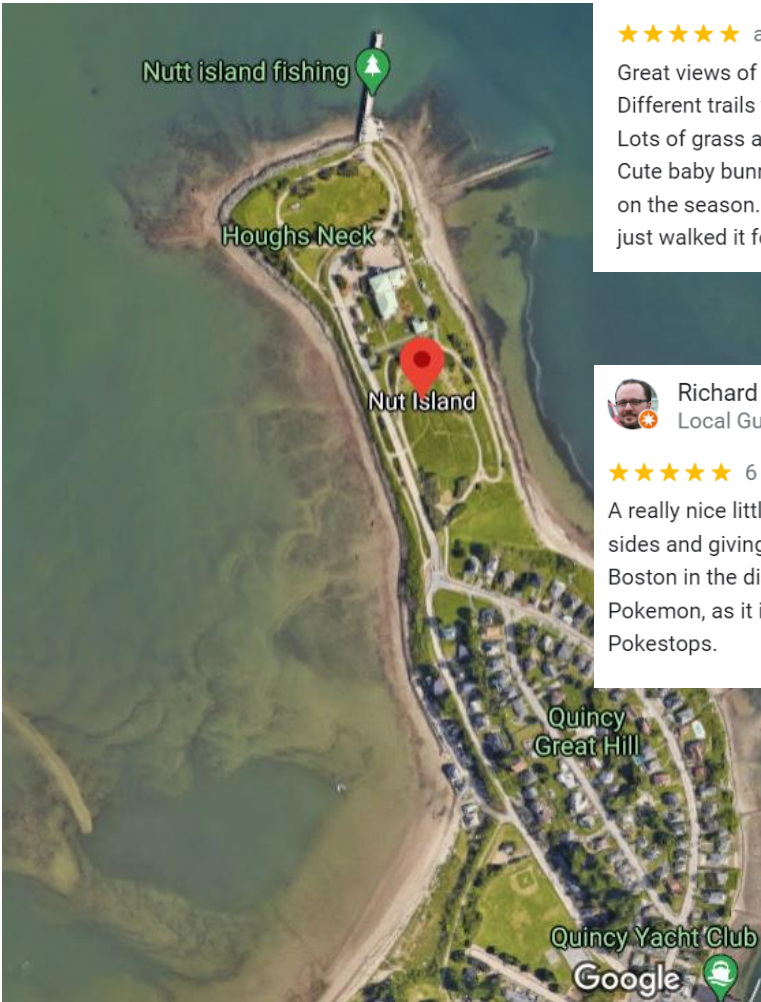
Current Facility

Image and Reviews Courtesy: Google Maps

MWRA Nut Island

Vanessa
Local Guide · 246 reviews

★★★★★ a year ago

Great views of the ocean & Boston. Ocean breeze. Different trails to walk. Beach area. Great fishing spot. Lots of grass area and benches for picnic or kids play. Cute baby bunnies pop out from time to time depending on the season. Lived in this area my whole life, and we just walked it for our first time.

Richard Sanders
Local Guide · 48 reviews

★★★★★ 6 years ago

A really nice little park, surrounded by the ocean on 3 sides and giving a beautiful sunset view overlooking Boston in the distance. Also a nice place to catch Pokemon, as it is a regular nest spawn area and has 8 Pokestops.

Laura Cunningham
Local Guide · 85 reviews

★★★☆☆ 2 years ago

It is beautiful with lovely views. A few benches and a walking path around the whole place. The only downside is the sewage plant on site can get smelly especially on warm days.

MWRA Nut Island

4.7 ★★★★⯪ (159)

Park

Derek Butler
Local Guide · 16 reviews

★★★★★ 3 years ago

Great place to fish or walk the dog/baby. Beautifully landscaped with paved paths and incredible views of the city skyline as well as both sunrise and sunset. Large fishing pier with the ferry going by. There is even a small sandy beach if you can find it.

Hazen

Odor Control System

- **Original Odor Control system included wet scrubbers and carbon adsorbers that could be operated in series**
- **Reduction of industrial contributors to the southeast sewershed resulted in reduced levels of H2S and other odor causing constituents**
- **MWRA never operated the system in series**
- **Operated carbon adsorbers in cool weather months when H2S levels were relatively low**
- **Operated wet scrubbers in warm weather months with H2S levels were relatively high**
- **The entire odor control facility is underground**

Odor Control System Evaluation

- **Hazen was hired in 2015 to complete an evaluation and recommendations for upgrades to the odor control and HVAC systems at the facility.**

- **In late January of 2016, about halfway through our evaluation contract, there was a large fire in the Odor Control facility at Nut Island**

MWRA NUT ISLAND HEADWORKS

ODOR CONTROL, HVAC AND ENERGY MANAGEMENT SYSTEM

FINAL EVALUATION REPORT

DECEMBER 2016

Prepared for:

Massachusetts Water Resources Authority
2 Griffin Way
Chelsea, Massachusetts 02150

Prepared by:

Hazen

Hazen and Sawyer P.C.
24 Federal Street, 5th Floor
Boston, MA 02110

Scope of Design

- The design scope included rehabilitation of the wet scrubbers, including new chemical storage and pumping systems.

- MWRA requested additional carbon capacity, and better access to the carbon adsorbers to change out spent carbon.

- MWRA requested the ability to bypass the initial wet scrubber phase of odor control

- All of this in the existing facility footprint, 40 feet below a buried roof

Design and Construction: Fitting it in the Space

- **Wet Scrubber Bypass**

  - Two common bypasses around the wet scrubbers
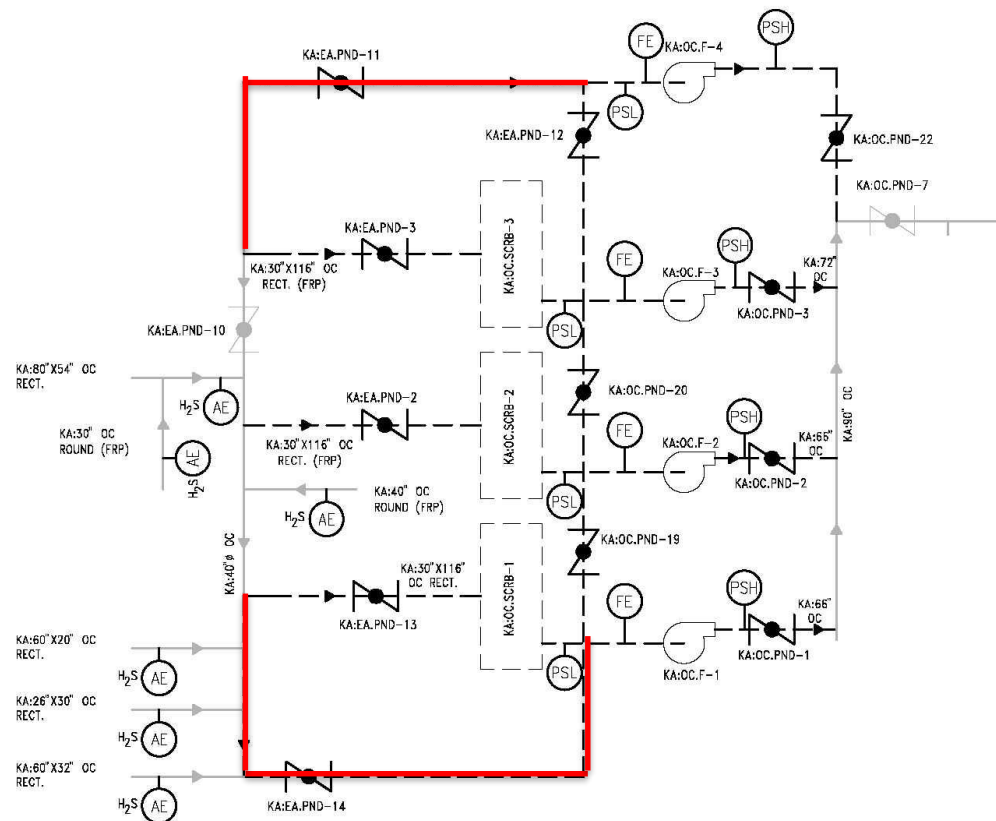
Design and Construction: Fitting it in the Space

- **Carbon Adsorber Vessels**

  - 10 Dual bed vertical vessels to provide additional carbon capacity in the same footprint
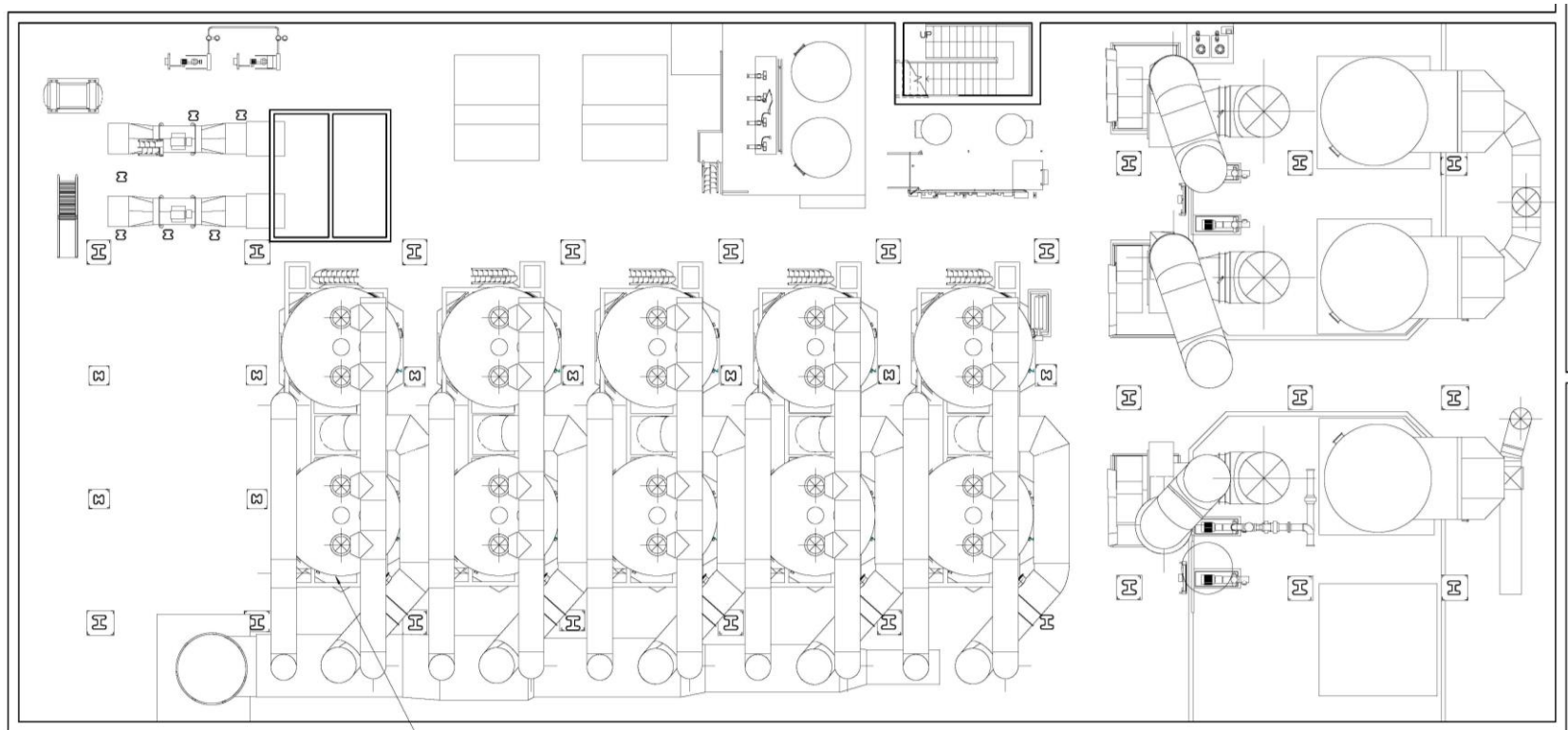
14"Ø DUEL BED CARBON ADSORBER VESSEL (TYP. OF 10)

1   10 VERTICAL VESSELS DESIGN OPTION
1/8" = 1'-0"

Hazen

Design and Construction: 3D and 4D Design

- **3D laser scanning of the existing facility was critical to ensuring that additional capacity, ductwork, dampers and other systems could fit within the existing building.**
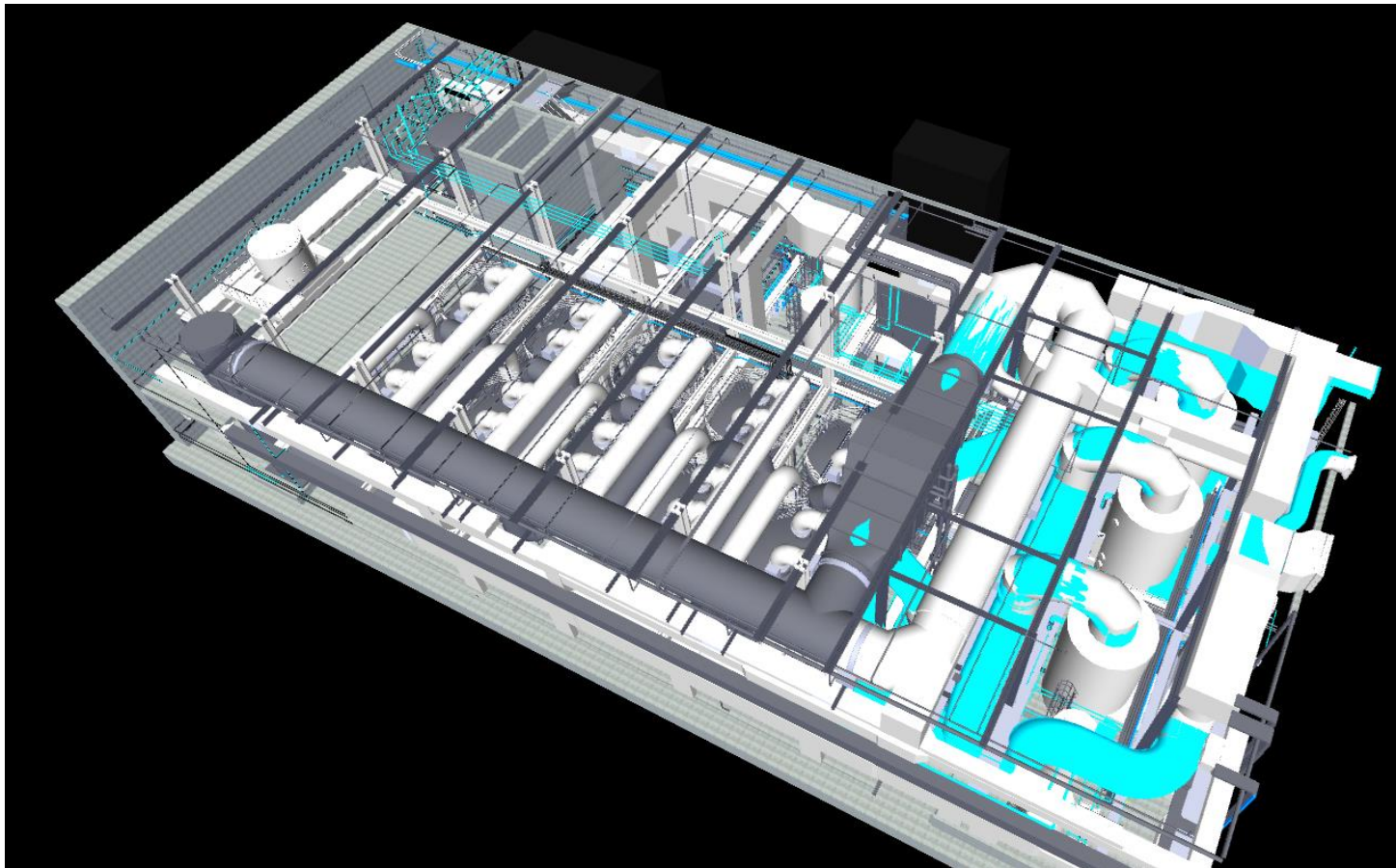
Design and Construction: 3D and 4D Design

- **3-D Visualization**
  - Proposed Structural Modifications
    - New Odor Control Room Access Hatches
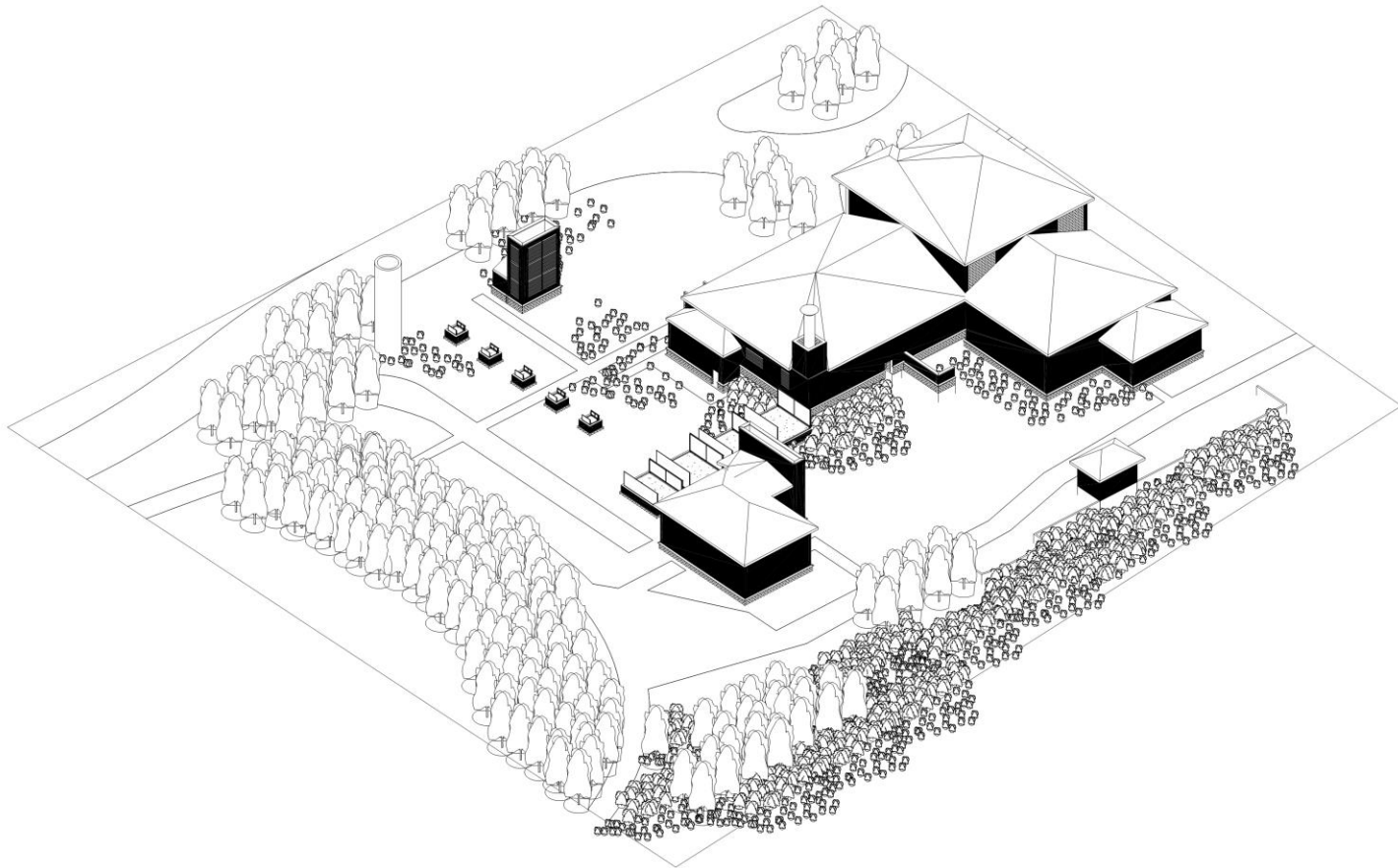
Design and Construction: 3D and 4D Design

- 3-D visualization allowed Hazen and MWRA to get buy in from local community groups prior to final design

4-D Design for Staging and MOPO

- **Maintaining odor control throughout construction without requiring the construction of a large, intrusive temporary system was a critical project goal**

- **Providing detailed staging plans allowed us to means test contract constraints, and provide direction to bidding contractors**

- **The contract noted "suggested staging" and allowed the contractor to be creative if they chose to do so**

4-D Design for Staging and MOPO

- **Odor Control**
  - Phasing of work was critical to maintaining odor control during construction
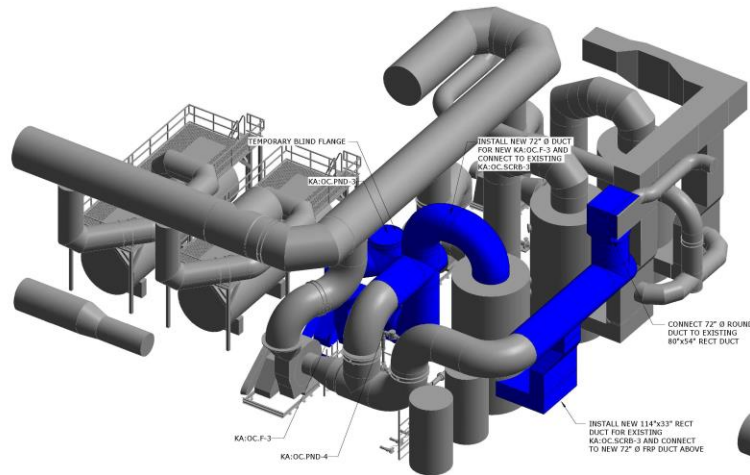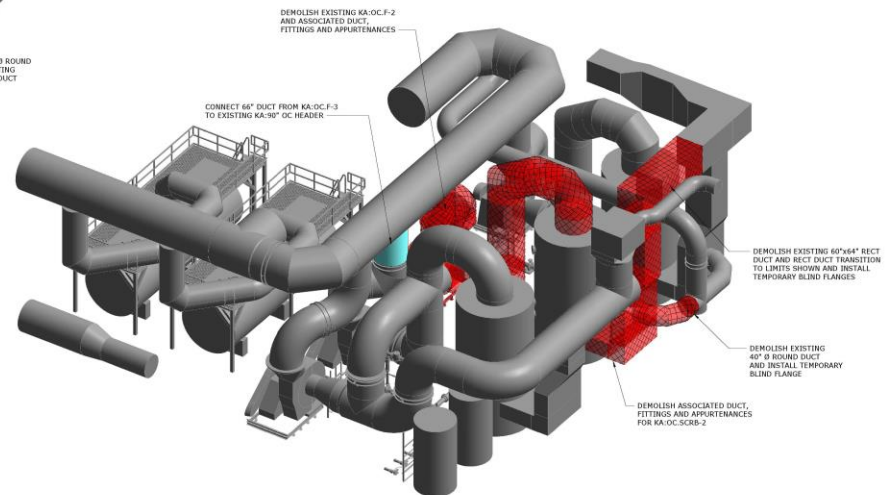
4-D Design for Staging and MOPO
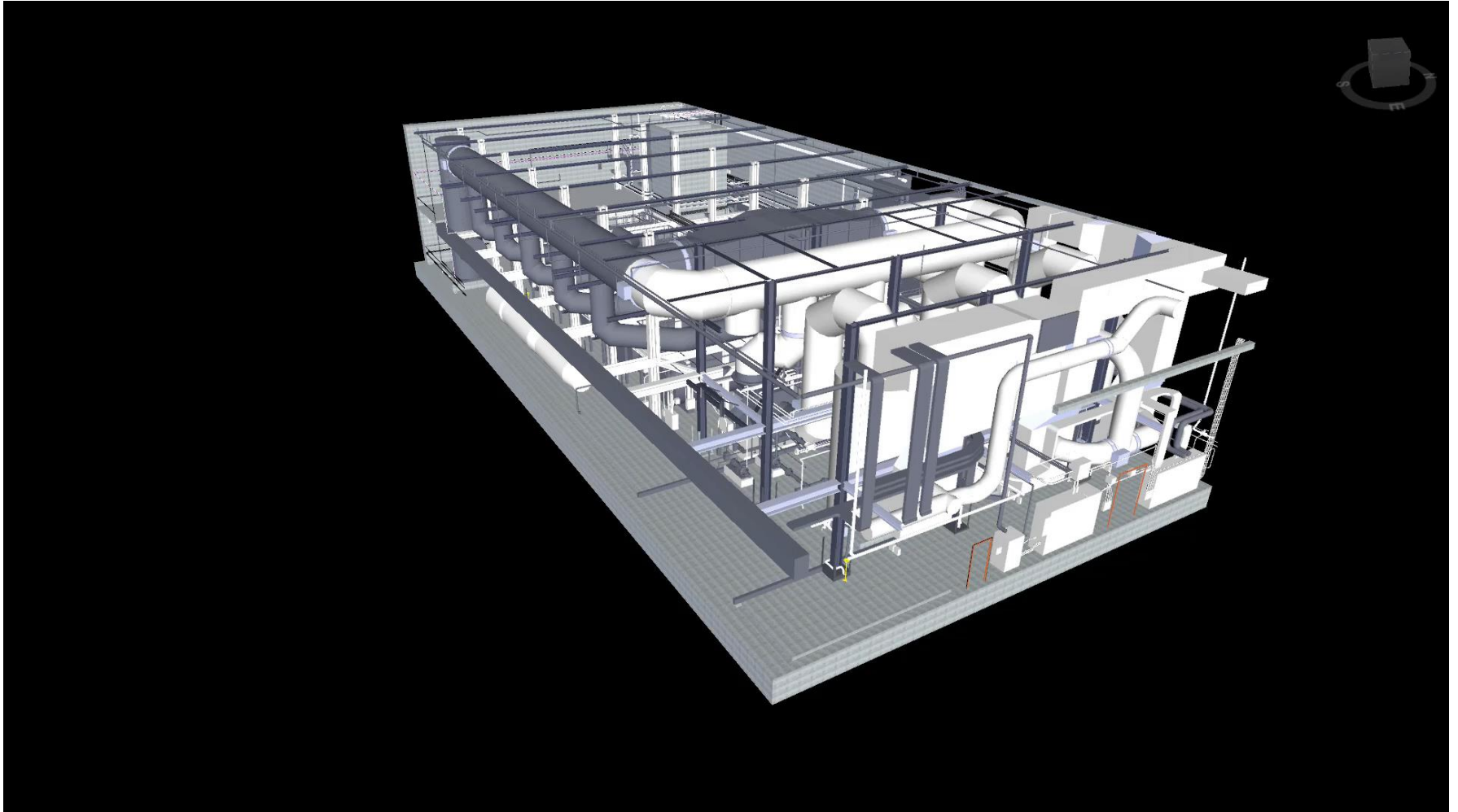
4-D Design for Staging and MOPO

- **Benefits of Detailed Staging Plans**
  - Requires designers to means test project constraints
  - Provides contract documents that result in consistent bids
    - Contract value over $55 million, bids within <0.5%
  - Documents provide suggested staging, allow contractor to modify the work provided they meet contract constraints
  - 3D design has limited construction change orders (under 3% for all odor control and HVAC work)

Wet Scrubber Startup Testing Data! – The Dark Times – Manual Analysis

Data! – The Dark Times – Manual Analysis

Data! – The Dark Times – Manual Analysis

	O	P	Q
	1232.421021	3432.015381	3415.771973
	1232.390991	3430.992188	3414.712891
	1232.361084	3429.96875	3413.654053
	1232.331055	3428.945313	3412.594971
	1232.301025	3427.922119	3411.536133
	1232.270996	3426.898682	3410.477051
	1232.2323	3425.875244	3409.418213
	1232.191528	3424.852051	3408.359131
	1232.150635	3423.828613	3407.300293
	1232.109863	3422.805176	3406.241455
	1232.06897	3421.781982	3405.182373
	1232.028198	3420.758545	3404.123535
	1231.987427	3419.735107	3403.064453
	1231.946533	3418.711914	3402.005615
	1231.905762	3417.688477	3400.946533
	1231.864868	3416.665039	3399.887695
	1231.824097	3415.641846	3398.828613
	1231.783203	3414.618408	3397.769775
	1231.742432	3413.594971	3396.710938
	1231.701538	3412.571777	3395.651855
	1231.660767	3411.54834	3394.593018
	1231.619873	3411.018555	3393.533936
	1231.579102	3409.76123	3392.475098
	1231.538208	3416.631348	3391.416016
	1231.497437	3406.463623	3390.357178
	1231.456543	3421.244141	3389.298096
	1231.415771	3405.882568	3388.239258
	1231.374878	3404.704834	3387.18042
Max		3688.644775	3671.107666
Min		3404.704834	3387.18042
Use		283.9399414	283.9272461
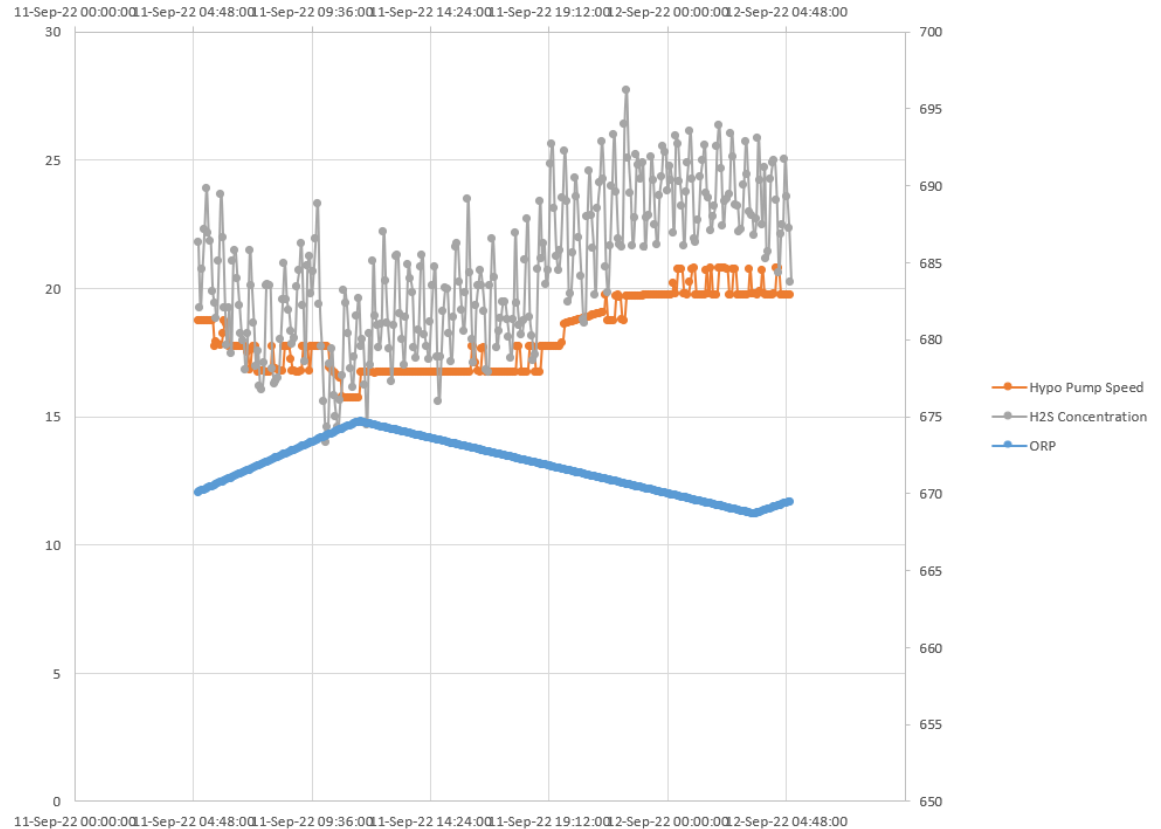
Data!

How do we see long term operational trends, AND short term operational upsets?

- Long term trends demonstrate that the treatment process is behaving how we would expect.
- Short term data shows us where upsets occur, and how the system reacted.

How do we determine if systems are reacting to process upsets, or mechanical/system upsets?

- The treated process flow is highly variable, and diurnal.
- Issues with specific equipment result in specific issues with the process.

How do we verify that the system is working how we want it to?

- Without the ability to evaluate long and short term data we cannot determine how the system is reacting to variable inputs.
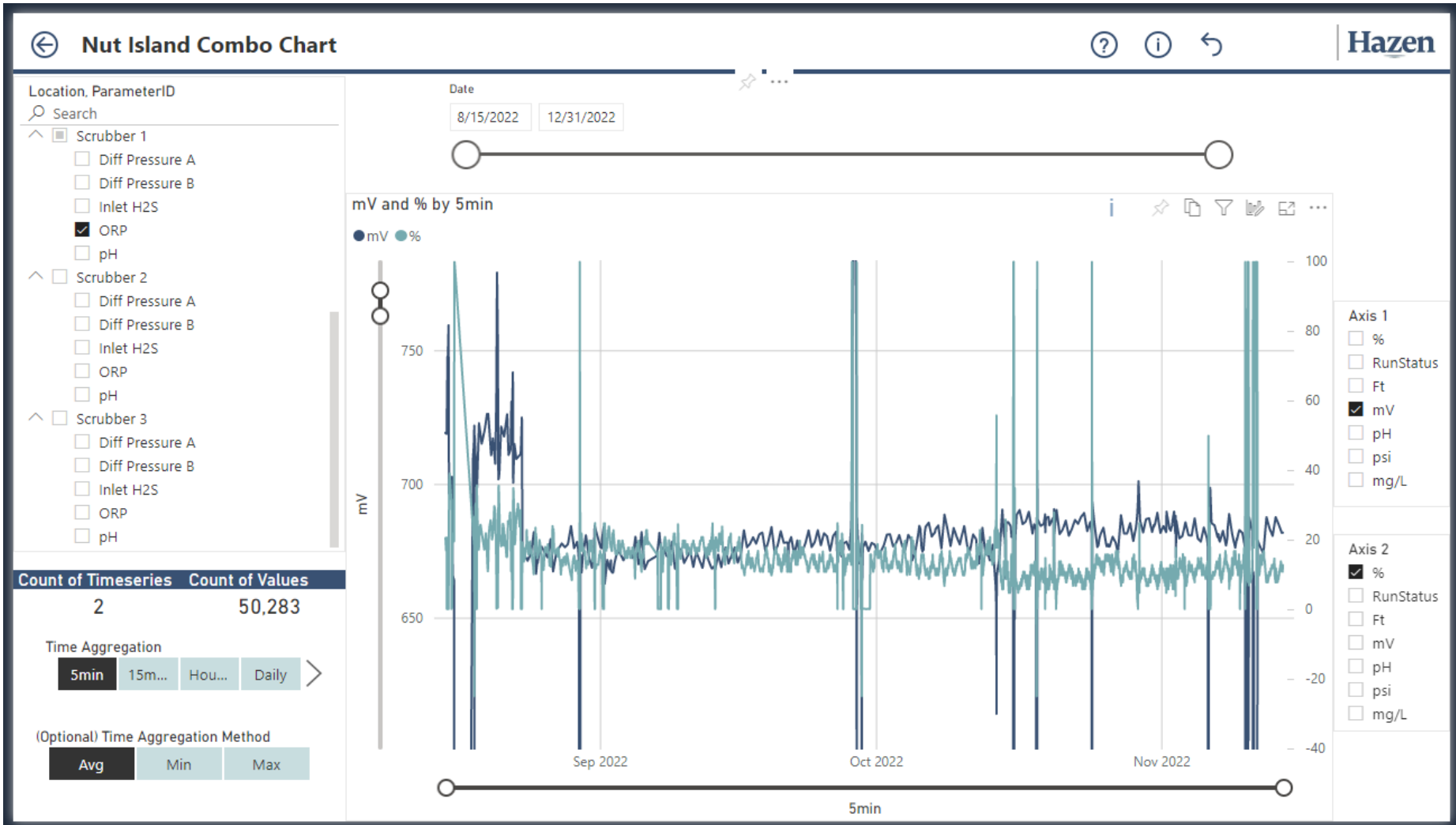
Data! – Enter Power BI!

Nut Island Headworks
Odor Control Dashboard
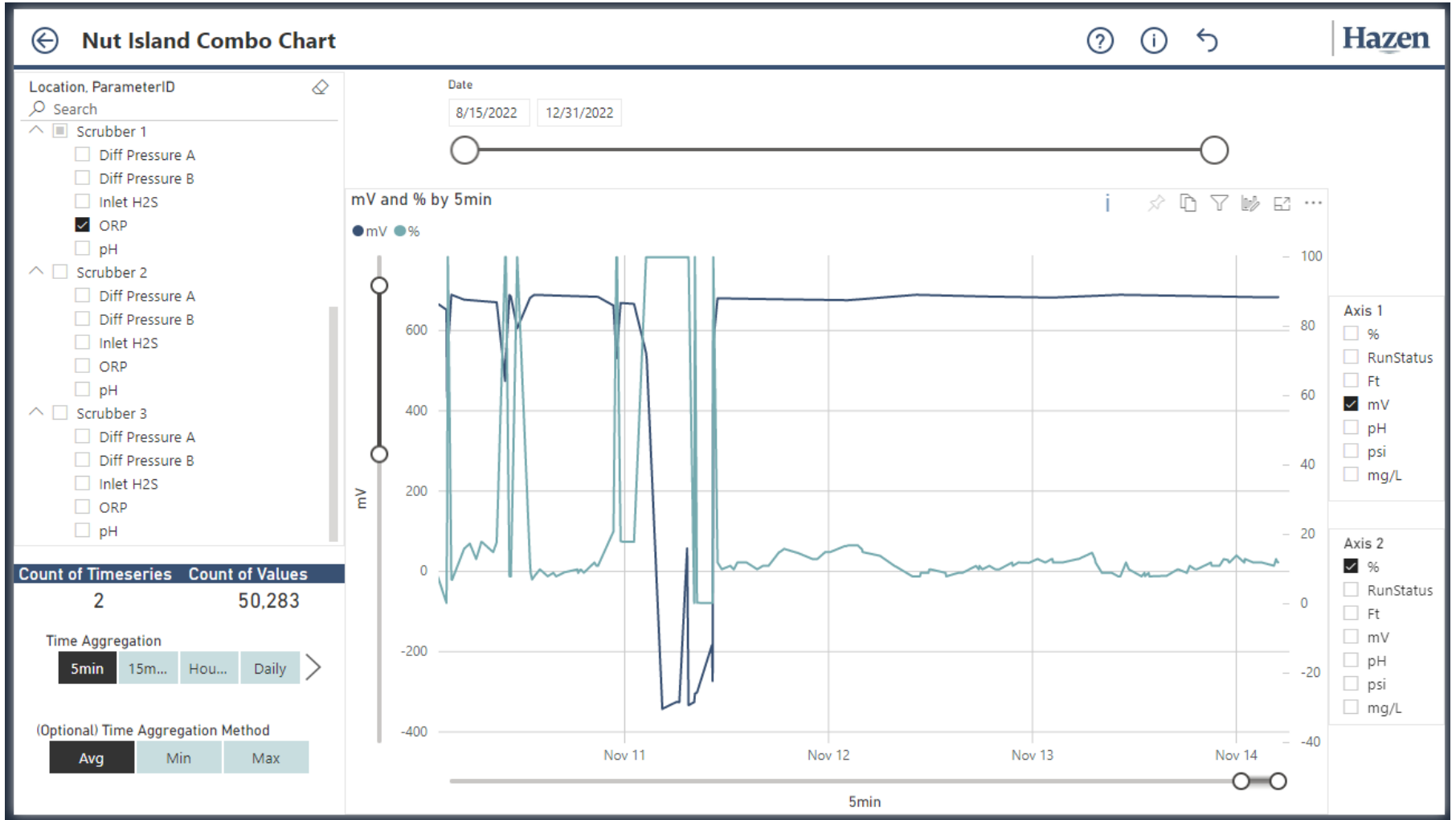
Multiple Parameters

Single Parameters

Inventory

2 tag (layout 1)

2 tag (layout 2)

2 tag (layout 3)

Last refreshed at 11/21/2022 12:36:51 …

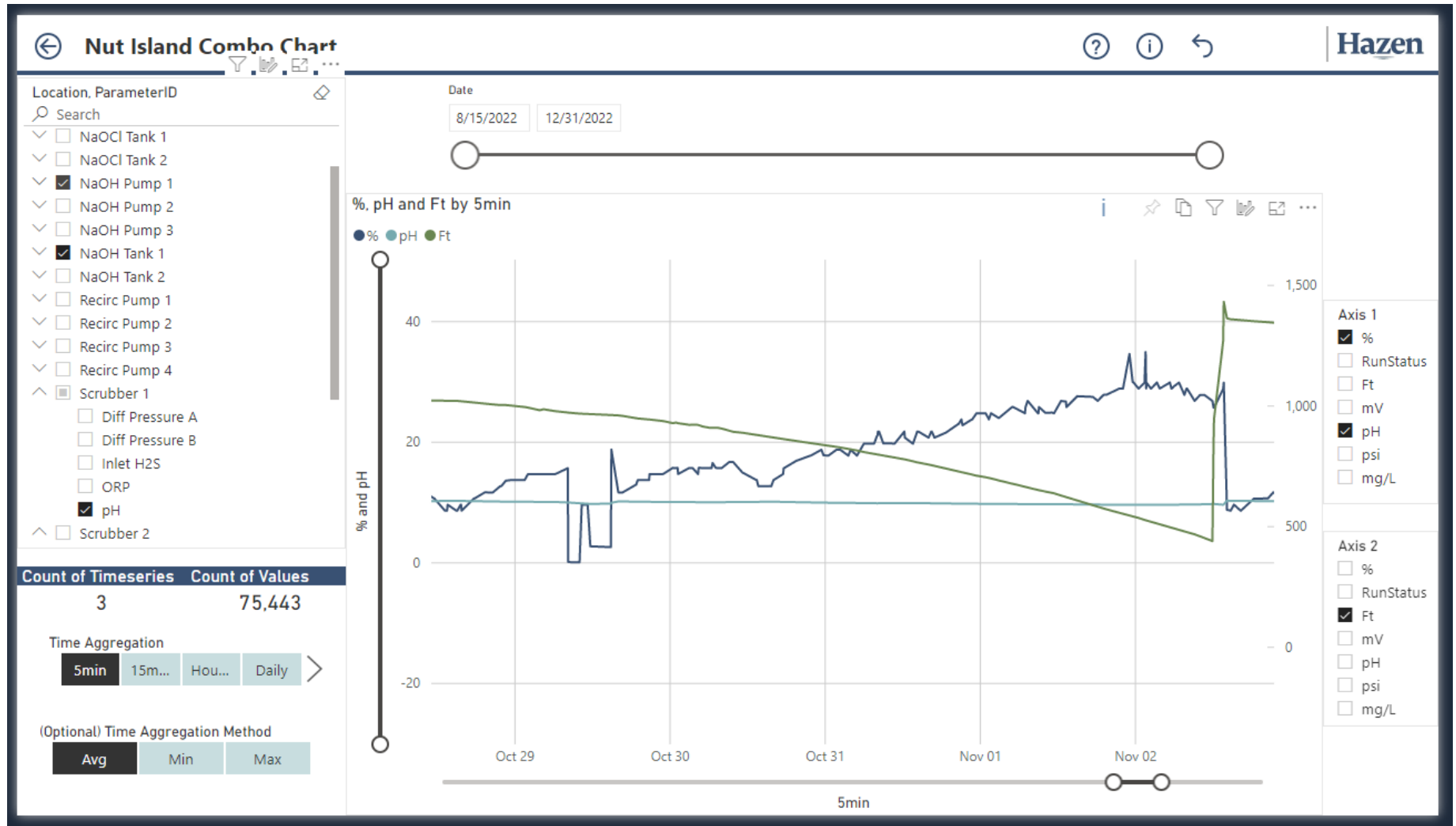# Data! – Enter Power BI!

Data! – Enter Power BI!

Data! – Enter Power BI!

Data! – Enter Power BI!
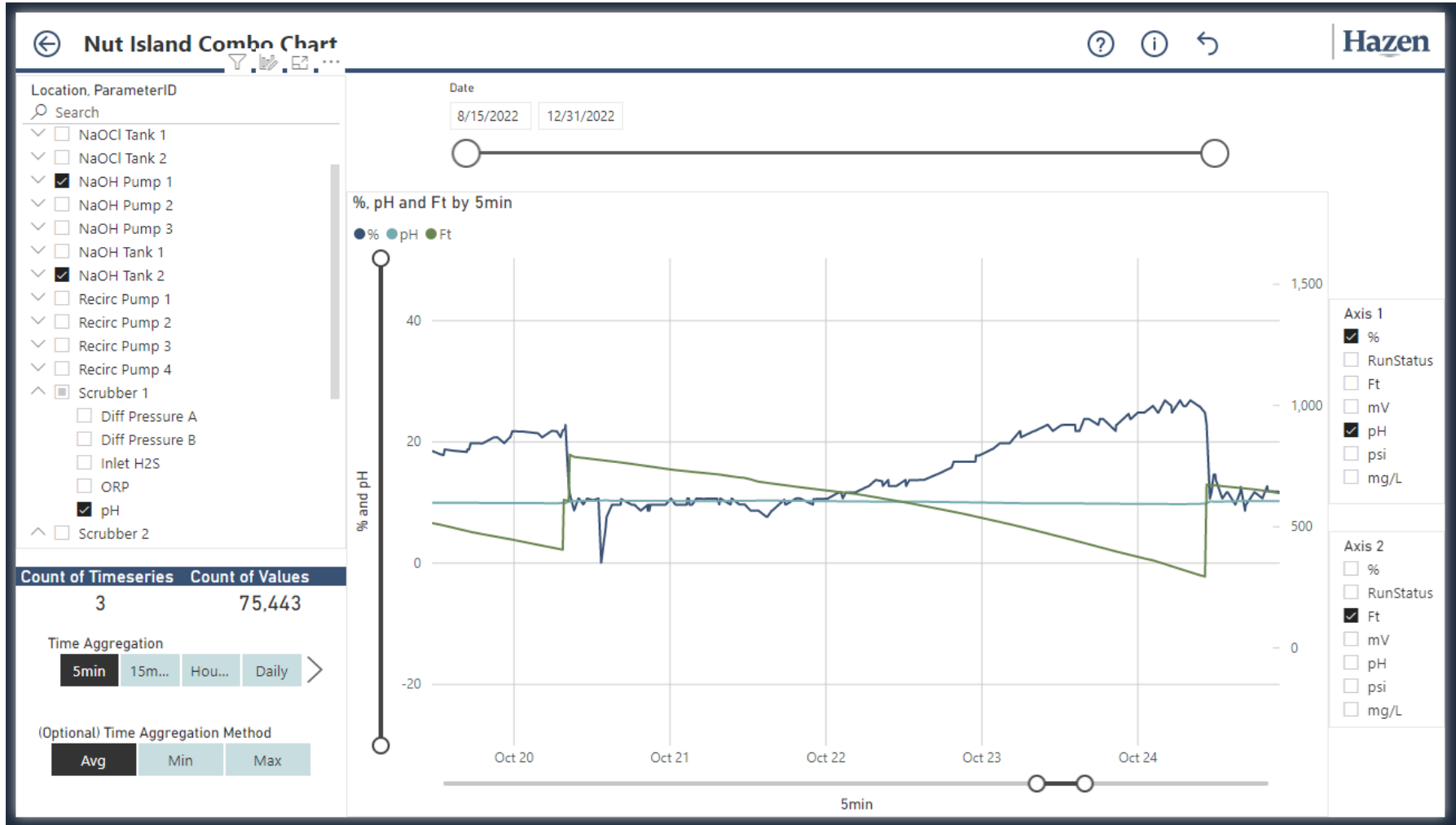
What did we learn?

Data is great, as long as we can analyze and use it effectively.

Static data is not very helpful – Scalable data shows us long term trends and short term process reactions.

Utilizing BI dashboards for multi parameter data analysis is extremely effective.

With a little more finesse, these dashboards can be automated and update real time based on historian data.

What's Next?

- **Using data to program dynamic control strategies**
  - Modify chemical dosing pump operating ranges based on seasonal variables
  - Predict chemical usage rates to facilitate chemical ordering
  - Controls that select the odor control treatment technology based on process variables
    - Wet Scrubbing during high H2S periods
    - Carbon Adsorbers during low H2S periods
  - Controls that monitor and predict carbon usage and replacement frequency

- **Using data and machine learning to provide dynamic process feedback**
  - Alarms when the process isn't necessarily out of expected range, but is not behaving like it normally does
    - Ex: pumps are at higher speed than expected for the level of H2S incoming

Thank you!

- **Questions???**

- **Nicholas Ellis, PE**

- **Hazen and Sawyer**

- **nellis@hazenandsawyer.com**