DMS CSI: A Multi-pronged Investigation for Comprehensive Odor Control

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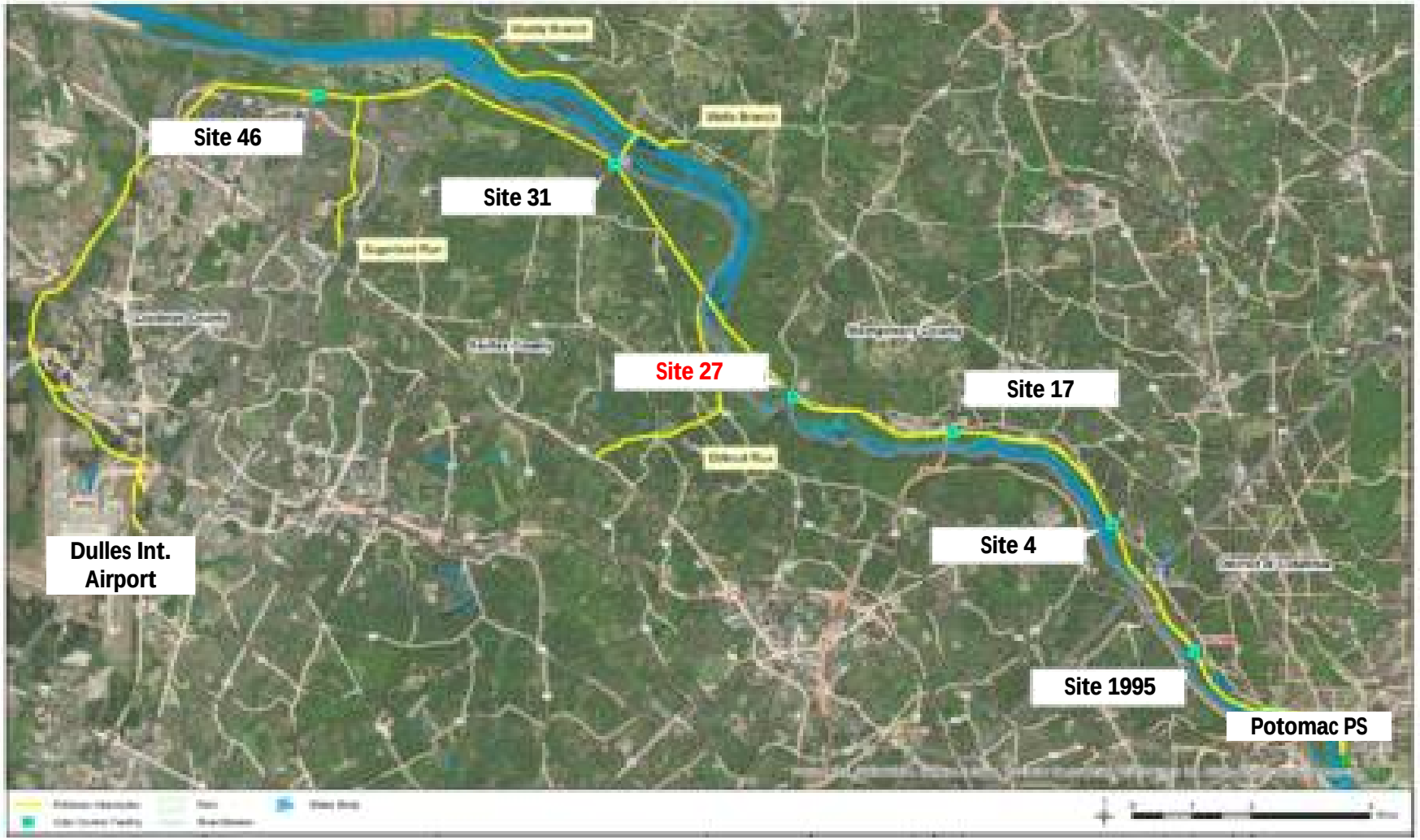
Odors and Air Pollutants 2016

DC Water's Potomac Interceptor

- 50 miles in length, ~50 MGD ADF
- Runs through VA, MD, and DC
- 6 radial, single bed odor control facilities (OCFs)
- Adsorption Treatment
- 8,000 to 12,250 scfm

DC Water's Potomac Interceptor



Site 27 Background

- Across the street from established restaurant, popular outdoor seating (established in 1860!)
- Seating areas at similar elevation as exhaust
- Also located on National Park Service (NPS) property
- Visitors frequent the adjoining C&O Canal National Historic Park, walking the trails and utilizing the waterways for canoeing and kayaking

Site 27 Background

- Soon after startup nuisance odor complaints filed from restaurant
- Responsive to community concerns, DC Water initiated an investigation
- Influent and exhaust air samples collected
- H_2S and most other compounds were being removed, but the carbon was not very effective at removing dimethyl sulfide

Dimethyl Sulfide (DMS)

- Odor similar to decaying cabbage or rotting vegetables
- The average person can detect DMS in the single digit parts per billion concentrations (or less)
- Lab data showed that the DMS in the system's exhaust far exceeded odor threshold concentrations (orders of magnitude)

Initial Investigation

Wastewater Sampling:

- Specific point source upstream of Site 27?
- Results showed a consistent low level of DMS along PI

Counteractant:

- Herbal extract substances which envelope odor molecules
- Four variations of oils: citrus; cinnamon; blend of citrus and cinnamon; and blend of citrus, cinnamon, pine, and clove
- Odor complaints logged within 1-2 days of operation, due to “unnatural” scents

Initial Investigation

Modeling/Stack Modification:

- **Discharge Through a Single Stack** – Sending exhaust through one stack instead of two would increase exhaust velocity/dispersion
- **Increasing the Stack Height** – Raising stack could improve atmospheric dispersion/dilution potential
- **Reducing the Stack Diameter** – Decreasing existing stack diameter would increase exhaust velocity and provide greater vertical momentum
- **Dispersion modeling**

Initial Investigation

Initial Pilot Testing (3 weeks):

- Coconut, coal-based carbons in catalytic, virgin forms, potassium permanganate zeolite media
- Pilot unit exhaust analyzed for sulfur compounds and odor parameters (strength, intensity, character, hedonic tone and persistence) evaluated by separate odor panel
- Carbon bed with potassium permanganate-impregnated zeolite guard bed performed the best
- Capacity of permanganate media not fully tested, life uncertain
- Radial configuration of the bed made installing a polishing layer unfeasible without extensive modifications

Alternative Media

- Historical grab samples collected from 2013 through 2015 (inlet):
  - **H_2S**: ND to 540 ppbV
  - **MM**: ND to 150 ppbV
  - **DMS**: 18 to 51 ppbV
  - **DMDS**: 14 to 32 ppbV
  - **CS**: 8.3 to 15 ppbV
  - **CDS**: 5.1 to 13 ppbV

Alternative Media

- "Compromise" custom media
- 730 ft^3 of pre-mixed blend
- 75% permanganate-impregnated zeolite/25% virgin anthracite carbon
- Blend avoided extensive modifications to the single bed of the vessel
- Low levels of odorous inlet compounds

Alternative Media

- Performance monitored by collecting periodic samples
- Silonite® canisters and ASTM D5504 analysis
- t = 0 months: NDs
- t = 1 month: 7.2 ppbV carbonyl sulfide and 8.2 ppbV carbon disulfide
- t = 3 months: 17 ppbV DMS, 3 ppbV carbon disulfide, and 10 ppbV DMDS

System Evaluation

- Influent air flow: ~25% higher than design criteria
- No media bypassing
- No damage to the bed screen
- Mist eliminator condition
- No moisture damage to the permanganate media
- Media condition: dark grey coating

Media Coating

Dark Grey on the outside

Purple on the inside

Media Testing

- Strange influent compound clogging pore spaces?
- Coating analyzed using Particle-induced X-ray Emission (PIXE) Chemical Analysis method
- Results indicated mysterious coating was nothing more than elemental sulfur
- This makes sense considering we're oxidizing odorous sulfur compounds! But still, the media should have lasted longer…

Media Testing

- Further assessed coating and remaining media life
- Coated samples sent to independent lab to compare pore volumes between new and used zeolite
- Results indicated virgin material had a pore volume of 1.3 cubic centimeters/100 grams of media
- The coated media only had 0.1 cubic centimeters/100 grams – the pore spaces were almost completely filled!

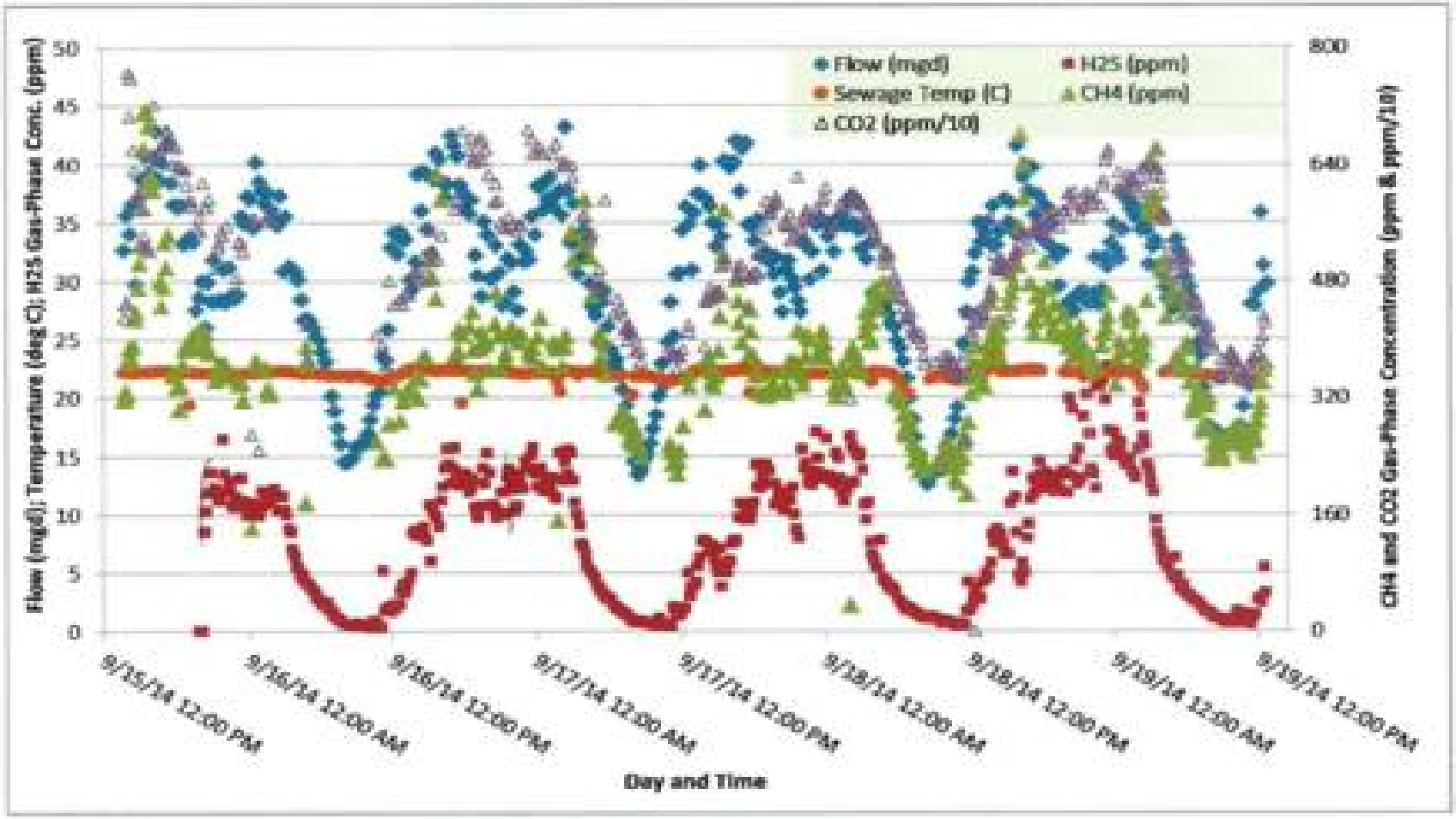
Missing Piece of the Puzzle?

- DC Water was conducting a WERF study on collection system greenhouse gas emissions
- Obtained data continuously collected in summer time
- Data showed highest generation of odors in the PI seemed to be occurring in late night hours
- Also matched SCADA exhaust data for H_2S

Missing Piece of the Puzzle?

- Historical grab samples collected during a.m. and p.m. provided sulfide loading less than what the system sees – especially in the summer months
- H_2S loading is actually many times greater than what was previously understood
- This (coupled with the higher-than-design air flow) likely caused the coating of the media at Site 27
- Blended media approach may continue to be a problem because permanganate media oxidizes H_2S as well as the DMS/DMDS it was meant to be treating

Continuous Data



Vessel Retrofit

- Reconfiguring the radial vessel for multiple media beds had been entertained, but was deemed unfeasible
- But providing an initial bed to remove H_2S, coupled with a polishing layer of specialized media to remove the remaining organosulfur compounds would greatly enhance performance and media life

Vessel Retrofit

System manufacturer proposed a cost-effective plan:

- Modular intermediate screen pieces
- Bell and spigot type joints w/ epoxy
- Custom base support ring
- Access hatch and lid modifications

Site 27 retrofit completed in April 2016 (performance enhanced)

Specialized Media Pilot Test

- In addition to the vessel retrofit, identifying most effective, cost-efficient polishing media was desired
- Six specialized media were pilot tested (bench scale):
  - 6% potassium permanganate-impregnated zeolite
  - 6% sodium permanganate-impregnated activated alumina
  - 12% sodium permanganate-impregnated activated alumina
  - Potassium iodide-impregnated carbon pellet
  - 12% permanganate-impregnated carbon pellet
  - A new proprietary “ferritic” alumina media designed to specifically target DMS/DMDS

Specialized Media Pilot Test

- Two-stage configuration
- Multiple sample ports
- Foul air first passed through a single bed of high-H_2S capacity carbon
- Followed by the columns of polishing media
- Ran test for 3 months

Summary and Conclusions

A whole array of tactics have been utilized to investigate and manage pesky nuisance odors like DMS for nearby sensitive receptors at Site 27:

- Wastewater sampling
- Media pilot testing
- Air dispersion modeling
- Exhaust stack modifications
- Counteractant system
- Alternative media types
- Detailed system evaluations
- Data collection and analysis
- System design modifications
- And even more pilot testing

Summary and Conclusions

- After H_2S is removed, other odorous compounds
- Dual media layers has greatly enhanced performance
- Permanganate-impregnated media for polishing
- Odor control requires problem solving and can be similar to detective work
- Often multiple tools and approaches can and should be used to meet the increasingly difficult task of being a good (and odorless) neighbor

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Questions?

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