SOMERVILLE COMBINED SEWER OVERFLOW (CSO) ODOR CONTROL REPORT

SOMERVILLE, MA

**PROJECT NUMBER:
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A Report Prepared for:

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Kleinfelder Project No: 25003516.001A

TABLE OF CONTENTS

Section **Page**

TABLES

FIGURES

SOMERVILLE COMBINED SEWER OVERFLOW (CSO) ODOR CONTROL REPORT

SOMERVILLE, MA

1 EXECUTIVE SUMMARY

In recent years, residents and watershed advocacy organizations have raised concerns about odor control at the SOM-001A combined sewer overflow (CSO) outfall operated by the City of Somerville (City). In response, MassDEP incorporated odor control measures into the August 2024 Water Quality Standards Variance for CSO Discharges to the Alewife Brook/Upper Mystic River Basin (Variance). The variance requires that the City assess odor control at SOM-001A, recommend the most appropriate solution through a report due June 1, 2025, and implement this solution.

The City is committed to mitigating odors throughout the system including at CSO regulators and outfalls. As such, the City has evaluated the following odor control measures for CSOs in the following report: physical system modifications, system repair, mechanical cleaning, venting, catch basin hoods, sealed manholes, backflow controls, flap valves, air filtration systems, chemical addition, and bioaugmentation. Each technology is evaluated based on installation cost, operation and maintenance requirements, and likely effectiveness. Regulatory and permitting requirements were evaluated as well.

The most feasible solution to odor control has been identified as a combination of the following:

- Additional odor control monitoring for up to a 6-month period (June to November 2025).
- Piloting the implementation of several improvements to seal SOM-001A and prevent odors from escaping including,
    - Installation of a PVC curtain barrier at the SOM-001A outlet.
    - Installation of a CB hood in one CB connected to the SOM-001A structure.
    - Installation of manhole insert lids in two manholes associated with SOM-001A.

2 PROJECT BACKGROUND

2.1 LEGAL REQUIREMENTS AND MOTIVATION

On August 30, 2024, MassDEP issued an updated Water Quality Variance to the City of Somerville, which was later approved by the EPA. The Variance requires the City to take steps to reduce CSO events and mitigate their impacts. MassDEP reached out to water advocacy groups for input on the Variance. Advocacy groups raised concerns about the odor associated with the outfalls. As a result, the variance requires that the City compile this report which evaluates odors emanating from the collection system in the vicinity of CSO structures and identifies potential best management practices (BMPs) for reducing odors near CSO structures. The variance also requires that the City implement the most feasible BMPs identified by the evaluation.

2.2 REPORT CONTENTS

Chapter 3: Odor Control – This chapter explains the process by which sewer systems generate odors. It details sewer characteristics that improve or worsen odor generation. It ends with a description of common odor control measures used in sewer systems.

Chapter 4: Existing Conditions – This chapter describes the design and condition of Somerville's SOM001A outfall. It also includes a description of odor control measures already in place throughout the system.

Chapter 5: Regulations and Permits: This section details existing regulations and permits that apply to the Somerville sewer system. It also describes the permits and permitting processes that may be required for the implementation of odor control measures.

Chapter 6: Evaluation of Options – This chapter evaluates the feasibility of implementing each odor control measure detailed in Chapter 3 at the SOM001A site. Odor control measures are evaluated based on their expected impact, implementation timelines, cost, regulatory and permitting requirements, and operations and maintenance needs.

Chapter 7: Findings and Recommendations – This section recommends the most feasible odor control BMPs.

3 ODOR CONTROL

Wastewater systems naturally generate sewer gas through the processes of decomposition. Sewer gas contains of a mix of toxic and nontoxic gases including hydrogen sulfide (H_2S), carbon dioxide, ammonia, and methane among others. Sewer gases often have a noxious, rotten egg-like odor due to the presence of hydrogen sulfide. As a result, the escape of sewer gases from the wastewater system can lead to odor issues in the surrounding environment. **Table 1** shown below details various ranges of Hydrogen Sulfide concentrations and their potential physiological effects at the top of the range shown.

Table 1. Physiological Effects of Hydrogen Sulfide Exposure at Various Concentrations

Objective	Hydrogen Sulfide (ppm)	Exposure	Reference	Physiological Effect at Highest Value within Range[1]
Minimum Noticeable Concentration by Humans	0.1 to 1.5	Human Exposure	OSHA	Odor Threshold
Minimum Noticeable Concentration by Humans	0.1 to 3	Human Exposure	EPA[1]	Odor Threshold
Corrosion Control	2 to 5	Sewer Headspace	WERF[2]	Offensive Odor
Corrosion Control	3 to 5	Sewer Headspace	EPA[3]	Offensive Odor
Worker Safety	10	Human Exposure (10 minute)	NIOSH	Headache Nausea Throat and Eye Irritation
Worker Safety	10	Human Exposure (8-hour)	OSHA (construction work)	Headache Nausea Throat and Eye Irritation
Worker Safety	50	Human Exposure (10-minute)	OSHA	Headache Nausea Throat and Eye Irritation Eye Injury

Table References:

1. U.S. EPA, "Odor and Corrosion Control in Sanitary Sewerage Systems and Treatment Plants," U.S. EPA, Washington D.C., 1985.
2. Water Environment Research Foundation (04-CTS-1), Minimization of Odors and Corrosion in Collection Systems, Alexandria, VA: Water Environment Federation/IWA Publishing, 2007.

3. U.S. Environmental Protection Agency: Office of Enforcement and Compliance, “Detection, Control, and Correction of Hydrogen Sulfide Corrosion in Existing Wastewater Systems,” U.S. Environmental Protection Agency, Washington D.C., 1992.

Odor issues are the result of three processes: hydrogen sulfide generation, release of hydrogen sulfide from the wastewater into the air, and escape of air from the wastewater system. Management of each of these three processes reduces odor issues. Hydrogen sulfide is the byproduct of anaerobic decomposition. Thus, the removal organic matter and the mitigation of anaerobic environments reduces the likelihood of hydrogen sulfide generation. Both turbulence reduction and air filtration reduce concentrations of hydrogen sulfide in the air space of the sewer. Sealing openings and keeping odors out of open structures reduces the escape of odorous air from the system.

Outfalls themselves may not be the only source of odor at CSO locations. CSO outfalls are typically in wetland areas that naturally produce similar odors. Like sewer systems, wetlands contain decomposing organic matter which often give off unpleasant odors, especially in warmer weather. While sewer gas may contribute to the odor, it is likely not the sole source of the odor. CSO regulators are typically within roadways or directly adjacent to the public right of way (ROW). In urban environments, trash dumpsters from large residential and commercial buildings may be found in close proximity to the ROW, whereas public trash cans/receptacles are typically found where there is heavy or frequent pedestrian traffic. Both points of human trash collection can contribute to odors in the environments where CSO regulators exist. To address odors impacting the public, the following series of BMPs and/or sewer system improvements may be employed.

3.1 PHYSICAL MODIFICATIONS

Physical modifications are odor control options that physically alter the combined sewer system infrastructure to reduce hydrogen sulfide generation and/or limit the ability of hydrogen sulfide to be released into the surrounding environment. Examples of physical modifications include altering pipe slope to maintain scouring velocity, removing hydraulic jumps, and installing structures to prevent odor escape from the system. Maintaining scouring velocity prevents hydrogen sulfide generation by limiting the build-up of organic material. Sediment build-up most often occurs at low elevation points in the system or in flat stretches of pipe. Designing or modifying pipe slopes to eliminate such sections may reduce hydrogen sulfide generation within the system.

Physical modifications that mitigate turbulence in the system reduce hydrogen sulfide release from wastewater into the air. In locations of high turbulence hydrogen sulfide can be stripped from the sewer flow into the air. Thus, reducing areas of turbulence by avoiding sharp bends, drop manholes, and hydraulic jumps prevents hydrogen sulfide from entering the vapor phase.

Less expensive physical modifications may be installed to prevent hydrogen sulfide and other odorous gasses from escaping the system. Barriers to the air flow may be implemented by baffle-like structures or curtain barriers. When water levels rise to the bottom of the baffle or curtain, a water-lock seal is created. This stops odorous air from migrating through the system. Similarly, curtain barriers can be installed over openings to mitigate the odorous air flow.

The costs of physical modifications to address odor control issues range greatly. Modifications such as altering pipe slopes or redesigning siphons typically require road excavation. They are often highly disruptive and expensive as stand-alone projects. Cost varies greatly based on several factors including pipe diameter, pipe material, project location, and number of sewer laterals. As such, it is preferable to incorporate them into the design phase of projects as opposed to completing them as stand alone projects. Alternatively, solutions such as baffles or curtain barriers cost as little as $100.

3.2 MECHANICAL CLEANING

Mechanical cleaning removes deposited organic matter which can lead to the production of hydrogen sulfide. Cleaning may occur throughout the system, or at locations where sediment is known to accumulate. In addition, regular cleaning of the system can prevent debris buildup and blockages and maintain the hydraulic capacity of the system which could lead to less CSO events.

Cleaning of the system is performed utilizing a high-velocity water jetting system, commonly referred to as a “jetter.” These systems are mounted on a truck, utilize a hose reel, a nozzle, and water (from a source such as a hydrant) to deliver high-pressure water into the system. Typically, when this is performed by a contractor, cleaning is divided into the levels of light, medium, or heavy cleaning. The number of passes that the hose takes through a pipe to remove sewer material and debris deposits determines the type of cleaning. Light cleaning may be only one or two passes, while heavy cleaning could be greater than six to eight passes. This varies depending on the sewer cleaning contractor and the equipment used.

Cleaning the system at more frequent intervals could help mitigate the formation of deposits that generate hydrogen sulfide gas. In addition, regular cleaning of the system can prevent debris buildup and blockages and maintain the hydraulic capacity of the system. Costs for light cleaning for smaller diameter pipes (6”-18” diameter) may range from $0.30-$4.00 per linear foot, while heavy cleaning may range from $2.00-$10.00 per linear foot. Costs for light cleaning bigger diameter pipes (greater than 18” diameter) may range from $1.00-$5.00 per linear foot, while heavy cleaning may range from $10.00-$20.00 per linear foot.

3.3 SYSTEM REPAIR

The repair of cracks and leaks within the sewer structures or pipes that are at or above grade can reduce odorous air and sewage from escaping the system. Frequent inspection of the sewer system and repair of identified cracks is an important maintenance practice to reduce odors in the system. The cost of repairs is low relative to the cost of physical modifications. The cost of cured-in-place pipelining (CIPP) a pipe may range from $50 - $350 per linear foot depending on pipe diameter and quantity of pipe being lined. For around 8-in to 12-in pipe diameter the costs are typically around $50 - $100.

3.4 VENTING

Venting systems are installed in sewer structures to release built up sewer gasses from locations where they are likely to accumulate. Vents can either release sewer gasses directly to the atmosphere, or they can include carbon filters that remove odorous gasses. If the vented structure is located in a highly trafficked location, the vent may be extended to above head height to reduce odor impacts. Vents are frequently used at low elevation structures in the sewer system where sewer gasses build or at locations such as drop manholes where high turbulence increase the stripping of sewer gasses into the air. Venting is not actively removing air from the system, the venting still requires positive pressurization to move air. An schematic of a vent pipe installed within a sewer manhole is shown in **Figure 1.** This figure is solely shown for representative purposes.

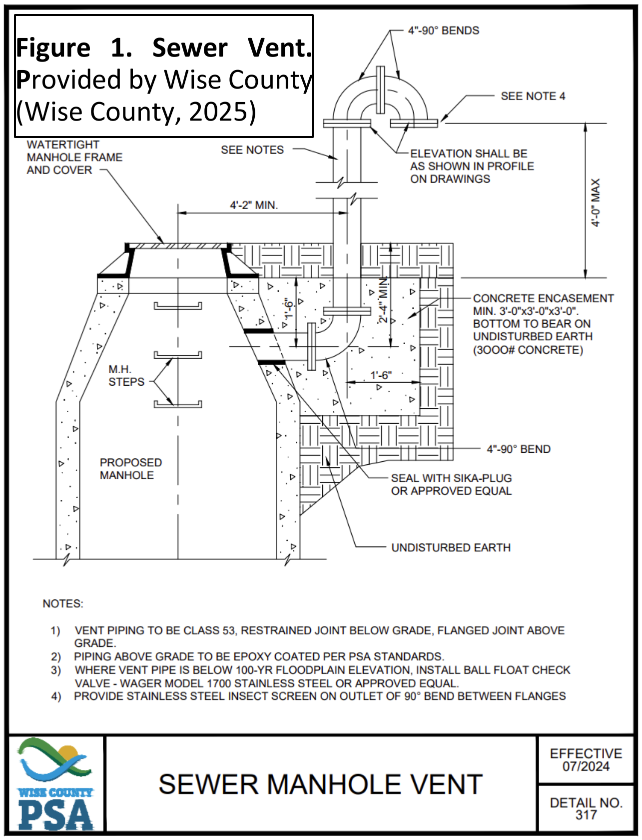

Figure 1. Sewer Vent. Provided by Wise County (Wise County, 2025)

A vent pipe could be installed along the existing collection system at a location adjacent to the CSO outfall, or at low points at upstream locations to introduce more fresh air into the collection system. The deeper structures in the system are assumed to accumulate more hydrogen sulfide gas. A vent, either with or without a carbon filter, could then be installed several feet up above pedestrian head height. This approach would require drilling into the existing CSO structure towards the ceiling to install the new vent pipe that will come up through and above the surrounding grade. This would require grouting of any voids or cracks in the manhole after construction. Another approach could be excavating a segment of existing sewer pipe in the system to be replaced with a wye connection which allows for there to be a branch off the main line. This would require more extensive excavation.

The inclusion of a carbon filter in the vent pipe installed in the system may prevent odors from emanating from the pipe near the surrounding area. However, the carbon within these filters would need to be changed out at a regular interval which may vary from every few months to years. The cost of the vented pipe depends on the location and method of installation and could range from $5,000 to $20,000.

3.5 HOODS

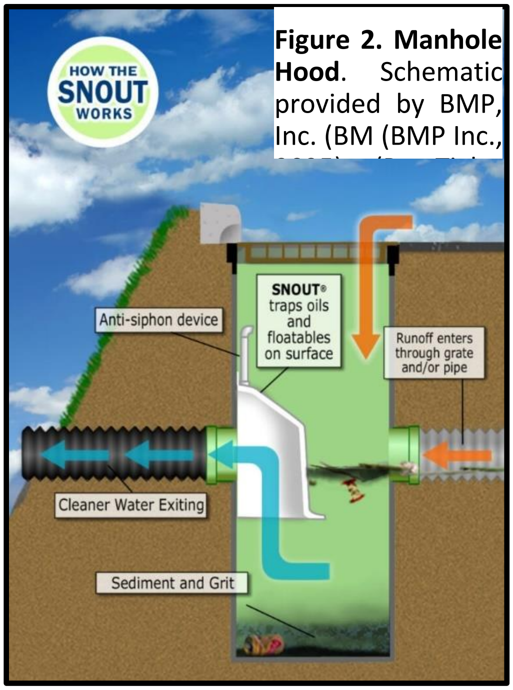

Figure 2. Manhole Hood. Schematic provided by BMP, Inc. (BM (BMP Inc.,

Hoods are primarily used for floatables control. However, they have a secondary benefit of preventing odor migration by forming a water-lock seal when the system is surcharged. Placing hoods on the outlets of upstream manholes may reduce hydrogen sulfide migration to downstream areas of odor concern. In addition, manhole hoods can be installed within catch basins that are within areas of concern for residents to further mitigate odors. An example of a manhole hood schematic is shown in **Figure 2**.

Hoods can be installed within existing manholes and catch basins, so disruption to the surrounding community would be minimal. Installing a snout in an existing manhole or catch basin is estimated to cost approximately $1,000 - $3,000.

3.6 SEALED MANHOLES

Airtight manhole frame and covers could stop sewer gasses from escaping to the atmosphere. The implementation of airtight manhole frame and covers at the manholes adjacent to the CSO may help mitigate odor observed by pedestrians walking on the path adjacent to the outfall. However, the implementation of sealed manhole frame and covers will not help if odor is emitting from the outfall itself. Airtight manhole frame and covers typically have closed pick holes, gaskets, and are bolted. One important consideration is that not all watertight manhole frame and covers are also airtight. An example of an airtight manhole frame and cover is shown in **Figure 3**.

Figure 3. Sealed Mahole Frame and Cover. Provided by Pamtight (Pamtight, 2025)

This solution can be used to reduce odor impacts from particular manholes, but it does not reduce the generation of odorous gasses nor eliminate them from the system. Implementation of this solution must consider if the gasses will be re-routed to a new location that may cause disruption with residents at other locations. In addition, hydraulics and pressurization scenarios should be evaluated in further analyses prior to implementing this alternative.

The replacement of the existing manhole frame and covers with airtight manhole covers will require excavation (approximately 4-ft by 4-ft) around the existing manhole frame and cover. The approximate cost of the replacement of the existing frame and cover with an airtight manhole frame and cover is approximately $4,000 - $5,000 each.

Manhole inserts have several different names such as "Inflow Protectors" or "Infiltration/Inflow (I/I) Inserts." These are installed underneath the existing cover within a manhole and held in place between the frame and the cover. These plastic inserts prevent rainwater from entering the sewer system through any gaps in the manhole. The cost for a typical manhole insert is approximately $100 - $200. In addition, the inserts could include a passive filtration system as detailed further in **Section 3.8.1.**

Another option is applying sealant on the cover of existing manholes. The sealant could be applied to any existing defects in the manhole frame and cover, over the pick holes for the manhole pick, and to the gap between the frame and cover itself. With this approach, the sealant would have to be chipped off and re-applied if the manhole were to be opened. This approach would require no excavation. The approximate cost of applying a sealant to existing manhole frame and covers is approximately $100 each.

Figure 4. Backflow Control Valves. Provided by RedValve (RedValve, 2025).

3.7 BACKFLOW CONTROLS

Backflow prevention devices, such as duck-bill check valves, can be installed at outfalls to stop odors from escaping at CSO locations. Check valves only open to the level of fluid flow, preventing air from flowing through the pipe, as shown in **Figure 4**. This prevents the escape of sewer gas during dry periods, mitigating odor control issues. During overflow events, when check valves open, they allow minimal air to escape. This mitigates odor control issues during wet weather conditions.

Check valves can be fitted into most pipes and are relatively easy to install. Check valves are available in a wide range of pipe sizes from 3" to 72". They are typically installed in circular pipes but can be manufactured to have elliptical or arched shapes. Check valves are well suited for CSOs on land owned by others, as they require no work to be performed outside of the pipe, reducing permitting issues. Installation typically consists of sliding the check valve into a pipe, securing the clamp on either the upstream or downstream end, and bolting either the upstream or downstream end in place. If check valves larger than 24” are to be installed through an access manhole, the manhole cone and chimney may need to be deconstructed to install the valve.

Headloss requirements and sewage composition must be evaluated prior to check valve installation. Check valves introduce additional headlosses into the system. Prior to installation, headloss curves must be compared to the sewer system’s hydraulics to ensure installation will not cause up stream back-ups and overflows. Check valves are less well suited for locations with high quantities of floatables, as this can lead to clogging of the valve.

Check valve cost depends on outfall geometry and diameter. **Table 2** shows the cost of circular check valves for a range of pipe diameters. Outfalls with alternative geometries can expect higher costs.

Table 2. Check Valve Costs (2025)

Diameter	Cost
6-inch	$610
18-inch	$3,715
36-inch	$12,920
48-inch	$29,185

3.8 FILTRATION SYSTEMS

The escape of sewer gas from the sewer system can be controlled using air filtration. Air treatment may consist of chemical scrubbers, biofilters, or dry media filters. Air treatment processes may be passive, relying on natural air flow, or active, requiring air blowers.

3.8.1 Passive Filtration

Passive filters are systems where air is pushed out of the system and through a filter media to remove odorous chemicals, relying on the passive airflow and existing pressure in the system to do so. These systems do not require a power source. Passive filters can be installed in any location where air flows out of the system. They may be installed within the sewer system in vent pipes or as manhole inserts. They may also be installed as external tanks and connected to the sewer system with a pipe. Examples of these types of passive filtration systems are shown in **Figure 5**. The airflow path through the filter media must be the path of least resistance for passive filtration to be effective.

Numerous filter medias are available for air filtration of hydrogen sulfide and other sewer gasses. Common media types include carbon media and biological media. Carbon media removes odorous chemicals through adsorption. Biological media removes odorous chemicals through biological processes which consume hydrogen sulfide and convert it into odorless compounds including carbon dioxide and

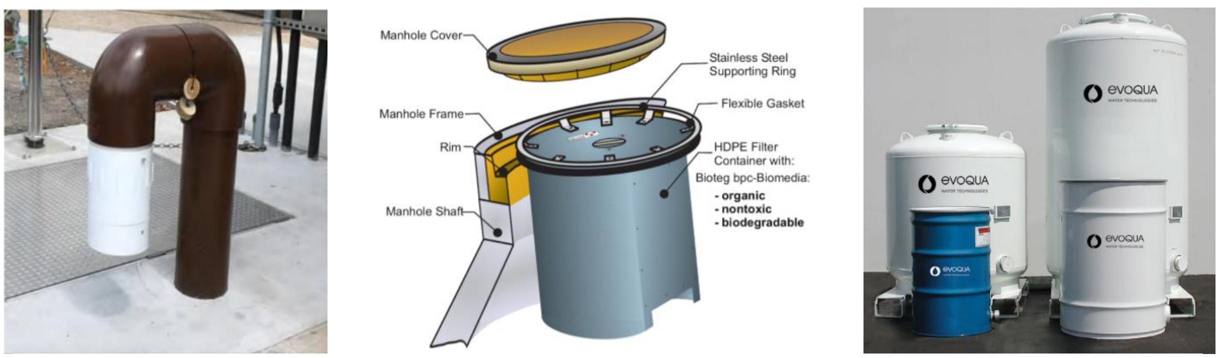

Figure 5. Passive Filtration Systems. *Left* - Example carbon media vent filter as provided by PEACEMAKER (Syneco Systems, 2025). *Middle* – Example biomedia manhole odor filter as provided by Bioteg (Bioteg, 2025). *Right* – External filtration system (Evoqua, 2025).

water.

The chemical make-up of sewer gas and the sewer gas flow rate must be considered when choosing an appropriate filter media and size of the filter. Some types of biological media require constant hydrogen sulfide concentrations to perform at their full capacity. Media service life ranges from months to years. The exact service life will depend on the media type, air flow rate, hydrogen sulfide concentration, and filter size.

The cost of air filtration varies based on the application chosen. Manhole inserts typically range from $300-$1,500 depending on the media type. Filters within vent pipes can cost as little as $75. Simple external air filtration systems can cost between $5,000 to $7,500. Operations and maintenance of all filters includes the replacement of the filter media. Carbon filter media is not typically considered hazardous and can be easily disposed of after media change outs. Some biological medias can be composted.

3.8.2 Active

Figure 6. Active Filtration System Provided by Evoqua. (Evoqua, 2025)

Active media filters are similar to passive filters but contain air blowers that force air through the filtration media. Active filtration is used when air is stagnant or does not flow strongly enough to pass through a filter. Active filtration systems have higher installation and maintenance costs compared to passive filtration.

Active filtration systems are typically installed at the surface near sewer structures, such as manholes or pump stations. They contain air blowers that pull air from the sewer structure through filter vessels. Active air filtration requires an electrical connection. An example active filtration system is shown in **Figure 6.**

Operation and maintenance of active air filtration systems are similar to passive systems as they also require media replacement. However, active systems will also require maintenance of air blowers and motors.

3.9 CHEMICAL ADDITION

Chemicals may be added to the system to reduce odors. The addition of a chemical addition system requires construction of a location to store chemicals as well as an injection system for introducing the chemicals into the sewer system. The quantity and type of chemical used requires an analysis of the existing system and hydrogen sulfide concentrations within the system. Chemical addition systems are not typically cost effective for isolated locations.

3.10 BIOAUGMENTATION

By introducing microorganisms at select locations in the collection system odors can be mitigated by the reduction of sulfate-reducing-bacteria (SRB) in the system. The SRB cause the hydrogen sulfide as a byproduct by their metabolism in anaerobic environments. Therefore, the reduction of the SRB in the system will cause the reduction of hydrogen sulfide. By adding a specific type of microorganism that will enhance the degradation of the SRB, the overall production of hydrogen sulfide will be mitigated as well. This can be done through the addition of non-SRB microbes to out-compete SRB for food sources.

Some factors to consider with the implementation of bioaugmentation include the flow velocity in the pipe, the current levels of SRB in the system, and the distance from the elevated hydrogen sulfide levels (Cray et al., 2022). The non-SRB microorganisms need to be introduced in the system at a location with low flows, to ensure the bacteria are not washed out. The dosage for microorganisms should be measured based on the current levels of SRB in the system to ensure an effective response. The dosing may need to occur at a regular frequency. There are several considerations surrounding the complexity of bioaugmentation within collection systems.

3.11 ODOR CONTORL BMP SUMMARY TABLE

Table 3. BMP Summary Table

BMP	Description	Pros	Cons	Cost Range
Physical Modifications	Changing the slope of pipes as required to mitigate turbulence, or the installation of baffles.	-Preventing turbulence helps control the creation of H_2S. -Long-term fix.	-Will require excavation. -Cost.	As low as $100 (baffles) to $100,000 (changing pitch of pipes)
Mechanical Cleaning	Additional cleaning of the sewer pipes to remove debris.	-Prevent blockages in the system. -Controls a source of H_2S formation.	-Requires consistent upkeep.	$0.3 to $20/LF (dependent on type of cleaning and pipe diameter)
System Repair	Lining the sewer pipes to seal cracks.	-Overall beneficial for the sewer system by increasing longevity.	-Potential road closures.	$50 - $100/LF (dependent on pipe diameter)
Vent – No Filter	Vents installed in structures or in areas of high turbulence to allow for the release of H_2S gas.	-Relies on passive air filtration, no mechanical parts.	-Impacts to surrounding area, requires excavation.	$5,000 - $20,000
Vent – with Filter (Passive Air Filtration)	Vents with filters installed in structures or in areas of high turbulence to allow for the release of H_2S gas.	-Relies on passive air filtration, no mechanical parts.	-Impacts to surrounding area, requires excavation. -Requires upkeep.	$7,500 - $30,000
Hoods	Installation of hoods within catch basins to prevent odors from escaping.	-Low disruption to surrounding area.	-Lower impact on odor mitigation.	As low as $600
Manhole I/I Inserts	Plastic insert underneath the manhole cover that mitigates odors escaping.	-Low disruption to surrounding area.	-Lower impact on odor mitigation.	As low as $100
Manhole I/I Inserts with Filter (Passive Air Filtration)	Plastic insert underneath the manhole cover that mitigates odors escaping.	-Filters remove the odors from the air. -Low disruption to surrounding area.	-Lower impact on odor mitigation. -Requires upkeep.	As low as $700
Sealing Exterior of Manholes with Sealant	Applying a sealant to any gaps in the manhole frame and cover.	-Low disruption to surrounding area.	-Will require resealing after accessing the manhole.	As low as $100 plus crew time
Airtight Frame and Covers	Excavation and replacement of current manhole frame and covers with airtight bolt-down manhole frame and covers.	-Creates an air-tight seal around manholes. -Still can be opened and closed with the use of a wrench for the bolts.	-Requires further studies on hydraulic impact. -Requires excavation.	Roughly $5,000
Backflow Controls	Check valves installed in pipe to prevent odor from escaping.	-Creates a seal to prevent odor from traveling to outfall.	-High impact to surrounding areas during installation.	$610 - $29,185
Active Filtration Systems	Utilizing air blowers to force air through a filter.	-Will lower levels of H_2S rather than just containing the odor.	-Requires initial evaluation to determine sizing and location. -Disruption to surrounding area.	Variable depending on the design (e.g. $50,000 - $150,000)
Chemical Addition	Introducing chemicals into the system to lower H_2S levels.	-Will lower levels of H_2S rather than just containing the odor.	-Requires initial evaluation to determine chemical addition. -Requires consistent upkeep.	Variable depending on the design (e.g. >$100,000 with yearly costs)
Bioaugmentation	Introducing microorganisms that cause the reduction of SRB in the system.	-Will lower levels of H_2S rather than just containing the odor.	-Requires initial evaluation to determine microorganisms to introduce. -Requires consistent upkeep.	Variable depending on the design (e.g. >$100,000 with yearly costs)

4 EXISTING CONDITIONS

4.1 STRUCTURE DESIGN

The outfall structure is approximately rectangular with a width of 96.75 inches, height of 41 inches, and length of 75 feet. During dry weather, flow exits the structure through a vertical drop into the MWRA interceptor below conveying primarily wastewater to the MWRA interceptor. Downstream of the MWRA interceptor connection, the structure widens to a width of 167.75 and slopes upward. The structure ends at a rectangular weir at an elevation of 41.1 ft. During wet weather events, when flow levels exceed the capacity of the MWRA interceptor, combined flows surpass the weir and overflow into the Alewife Brook. Design sketches are shown in **Figure 7.**

The outfall opening is rectangular with dimensions of 167.75 inches by 18 inches. The outfall site is shown in **Figure 8**. A baffle is located immediately upstream of the weir to prevent the release of floatables. A manhole is located immediately downstream of the weir for access. Two catch basins convey runoff into the CSO structure and are located just north of the outfall on Alewife Brook Parkway.

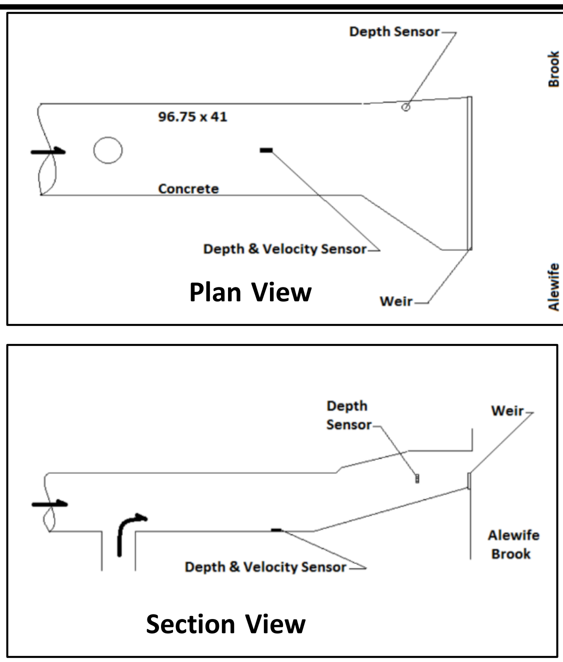

Figure 7. SOM-001A Sketch

Figure 8. SOM-001A Site

4.2 OVERFLOWS

The frequency and volume of overflow events at SOM001A are closely monitored, as required by the City's NPDES permit. Monitoring results for 2024 and 2023 are shown in Tables 4 and 5. Between 2018 and 2024, SOM001A averaged 9 overflows per year and an overflow volume of 8.18 MG.

Table 4. 2023 Overflows

MUNICIPALITIES AFFECTED	START DATE AND TIME	END DATE AND TIME	DURATION	VOLUME (MG)	EVENT RAINFALL (IN)
Arlington, Cambridge, Medford, Somerville	12/18/2023 12:20 PM	12/18/2023 12:45 PM	30 min	0.227	2.20
Arlington, Cambridge, Medford, Somerville	12/11/2023 03:00 AM	12/11/2023 03:20 AM	20 min	0.096	2.24
Arlington, Cambridge, Medford, Somerville	09/18/2023 08:30 PM	09/18/2023 09:00 PM	30 min	0.243	0.70
Arlington, Cambridge, Medford, Somerville	09/13/2023 1:35 pm	09/13/2023 01:45 PM	10 min	0.035	0.26
Arlington, Cambridge, Medford, Somerville	09/09/2023 04:20 PM	09/09/2023 04:25 PM	5 min	0.032	0.58
Arlington, Cambridge, Medford, Somerville	08/08/2023 10:45 AM	08/08/2023 12:05 PM	80 min	3.41	2.17
Arlington, Cambridge, Medford, Somerville	07/29/2023 06:15 PM	07/29/2023 08:35 PM	30 min	0.122	2.13
Arlington, Cambridge, Medford, Somerville	07/21/2023 09:20 PM	07/21/2023 09:50 PM	30 min	0.933	0.98
Arlington, Cambridge, Medford, Somerville	07/10/2023 02:15 PM	07/10/2023 02:55 PM	40 min	0.37	0.77
Arlington, Cambridge, Medford, Somerville	07/03/2023 01:45 AM	07/03/2023 02:15 AM	30 min	0.374	1.75
Arlington, Cambridge, Medford, Somerville	06/10/2023 02:25 PM	06/10/2023 02:50 PM	25 min	0.216	0.87
Arlington, Cambridge, Medford, Somerville	05/20/2023 11:25 PM	05/21/2023 12:55 AM	55 min	0.96	1.29
NUMBER OF DISCHARGES				**12**	
TOTAL VOLUME (MG)				**7.018**	

Table 5. 2024 Overflows

MUNICIPALITIES AFFECTED	START DATE AND TIME	END DATE AND TIME	DURATION	VOLUME (MG)	EVENT RAINFALL (IN)
Arlington, Cambridge, Medford, Somerville	7/31/2024 11:50:00 AM	7/31/2024 12:05:00 PM	15 min	0.104	0.61
Arlington, Cambridge, Medford, Somerville	6/27/2024 12:15:00 AM	6/27/2024 12:20:00 AM	5 min	0.026	0.45
Arlington, Cambridge, Medford, Somerville	6/20/2024 9:40:00 PM	6/20/2024 9:45:00 PM	5 min	0.026	0.54
Arlington, Cambridge, Medford, Somerville	6/14/2024 1:35:00 PM	6/14/2024 2:05:00 PM	30 min	0.396	0.79
Arlington, Cambridge, Medford, Somerville	05/30/2024 09:25 AM	05/30/2024 10:05 AM	40 min	0.29	1.73
Arlington, Cambridge, Medford, Somerville	01/10/2024 03:45 AM	01/10/2024 05:35 AM	1 hr 50 min	2.984	2.73
NUMBER OF DISCHARGES				**6**	
TOTAL VOLUME (MG)				**3.826**	

4.3 ODOR CONTROL INVESTIGATIONS

The City performed CCTV inspections approximately 1,000 ft upstream of the outfall on September 20, 2024. **Figure 9** shows a representative image of the results. Pipe sections downstream of the CCTV location do not include connections to sanitary sewers. The CCTV footage was taken during dry weather conditions. Inspected pipes in the videos are less than 5% full. No mist is visible in the CCTV footage, indicating low levels of hydrogen sulfide generation. This suggests that the sewer contents consist primarily of storm runoff and not sanitary sewage.

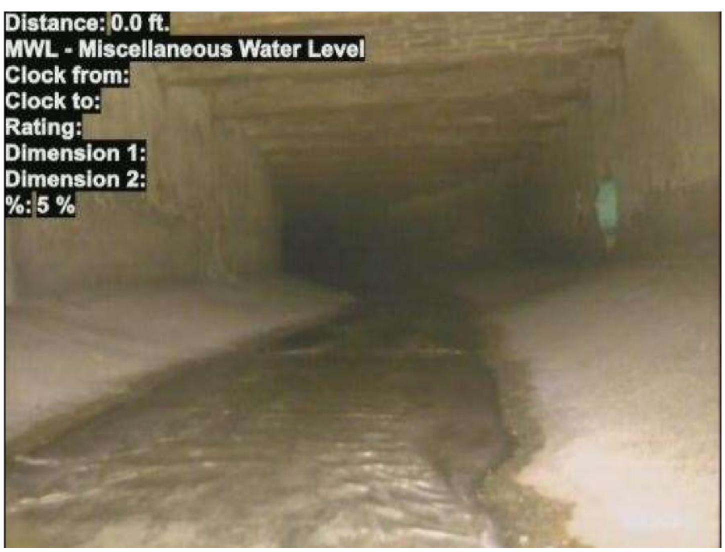

Figure 9. Representative CCTV Results

Residents have reported odor issues at the SOM001A outfall during both dry and wet weather events. In response, the City installed a hydrogen sulfide monitor on site from 03/07/2025 to 04/04/2025, see **Figure 10**. The monitor detected no hydrogen sulfide at levels above 1 part per million (ppm), which was the minimum detection limit of the odor logger.

There are a number of explanations for the low hydrogen sulfide readings. First, odors in the vicinity of SOM-001A may originate outside of the structure. The nearby Alewife Brook, for example, may naturally generate odors as a result of sediment decomposing in the brook's bed. Second, cool weather during the monitoring period may have inhibited decomposition and therefore reduced odor. Additionally, odors may be linked to CSO events and none occurred during the monitoring period. CSO events fill the structure with water and force out a large quantity of air. It is possible that odor issues are primarily a result of these large outflows of air. Third, the sewer gas found in the sewer may have unusually low hydrogen sulfide concentrations and the odor may be the result of different gasses. This is supported by the fact that when opening the manhole located downstream of the weir, the odor monitor installation team was able to detect sewer odors with the human nose, although no hydrogen sulfide was detected.

Figure 10. Odor Logger at SOM-001A

Analysis of the structure design, inspection logs, field investigations, and hydrogen sulfide monitoring results suggest air expulsion during wet weather events are a primary cause of odor issues. However, this explanation does not account for summer odor complaints from residents during dry periods. It is possible that odors experienced during dry-weather periods are worsened by the nearby CSO structure but primarily caused by another source. One likely source is the MWRA Alewife Brook Conduit that is connected to the SOM-001A structure. This pipe carries storm and sanitary sewage from a much larger catchment area, lengthening the resident time of sewage in the pipe, and increasing the likelihood that decomposition is occurring. A second likely source is the nearby Alewife Brook.

No odor control measures are currently in place at the outfall.

5 REGULATORY AND PERMITING CONSIDERATIONS

The Somerville sewer system is subject to existing permits that regulate CSO events and stormwater discharges. In addition to existing permits, construction permits may need to be obtained depending on the odor control measures installed.

5.1 EXISTING PERMITS

5.1.1 WATER QUALITY STANDARD VARIANCE

In line with the Clean Water Act, Massachusetts has published the Massachusetts Surface Water Quality Standards. These standards are set forth in 314 CMR 400. The standard categorizes all water bodies into "classes" based on their intended use. Each class of water bodies must meet certain water quality metrics to ensure that it is able to support its intended use. MassDEP regulates the types and volumes of discharges into each water body to make sure that required water quality standards are met.

In instances where it is infeasible to meet discharge requirements, MassDEP provides a Water Quality Standard Variance. The City of Somerville received a Water Quality Standard Variance for CSO discharges into the Alewife Brook and Upper Mystic, since it is technically infeasible to eliminate CSO overflows in these locations at this time. As discussed in Section 2, the variance is the basis for this report.

As part of the Variance, the City must mitigate the effects of CSO outfalls and work to minimize CSO discharge volume and frequency. It requires that the City research and report out on possible odor control measures to mitigate odor issues at SOM-001A. It also requires that the city implement the most feasible odor control approach identified. The City will continue to meet the requirements set forth in the variance as they implement the recommendations contained herein.

5.1.2 NPDES

The National Pollutant Discharge Elimination System is a national program that regulates point-source pollutant discharges to waters of the United States. NPDES permits establish both acceptable pollutant levels in a discharge and establish specific technologies that must be used to limit a pollutant. The permits also set forth monitoring and reporting requirements for discharges. In Massachusetts, the NPDES program is administered by the Environmental Protection Agency (EPA).

In 2012, the EPA issued a NPDES permit to the City of Somerville for their CSOs. The permit contains no requirements with the primary purpose of addressing odor control. However, there are requirements that may reduce order generation as a secondary benefit. The permit sets specific CSO volume and frequency limits, and reduced CSO overflow volume in the Alewife will reduce odors at the outfall. The permit also mandates that the City continue to implement the Nine Minimum Control measures and lists specific activities that must be undertaken to meet these measures. As part of the City's program to address the nine minimum control measures, the City conducts catch basin cleaning to keep all catch basins less than 50% full. This reduces the quantity of organic matter in the sewer system, reducing the likelihood of hydrogen sulfide generation. Furthermore, the NPDES permit requires monthly inspection of the CSO structure. With such frequent inspection, the City can ensure organics do not build up within the structure and reduce the risk of hydrogen sulfide generation within it. Finally, the NPDES permit orders that the City remain in compliance with Water Quality Standards Variances issued by MassDEP which mandates that odor control measures be identified and implemented.

5.2 LAND OWNERSHIP

SOM-001A is located within the City of Cambridge, on DCR land, as shown in **Figure 11**. This poses a number of land ownership and permitting issues. The sewer pipes entering the outfall are located under the Alewife Brook Parkway, a DCR right of way; but the twin pipes directly upstream traverse across City of Cambridge property. Work in this location must be coordinated with the City of Cambridge and DCR (as needed).

SOM-001A is located on land managed by the Department of Conservation and Recreation (DCR). As such, a DCR construction permit must be obtained for any work on the land surrounding the outfall. Permitting requirements for DCR construction permits are set forth in 302 CMR 11.08. Permit applications must include an access permit application form, complete engineering plans, documentation of any other permits required for the work, traffic management plans, and any other information requested by DCR on the project.

Permits are obtained through the DCR online portal. In addition to the online application process, a plotted plan set must be mailed to DCR. (Commonwealth of Massachusetts, 2025) The permit application fee is $50. Additional fees are charged based on the project type and scope of the project work. There is no defined permit timeline in the DCR construction permit regulations.

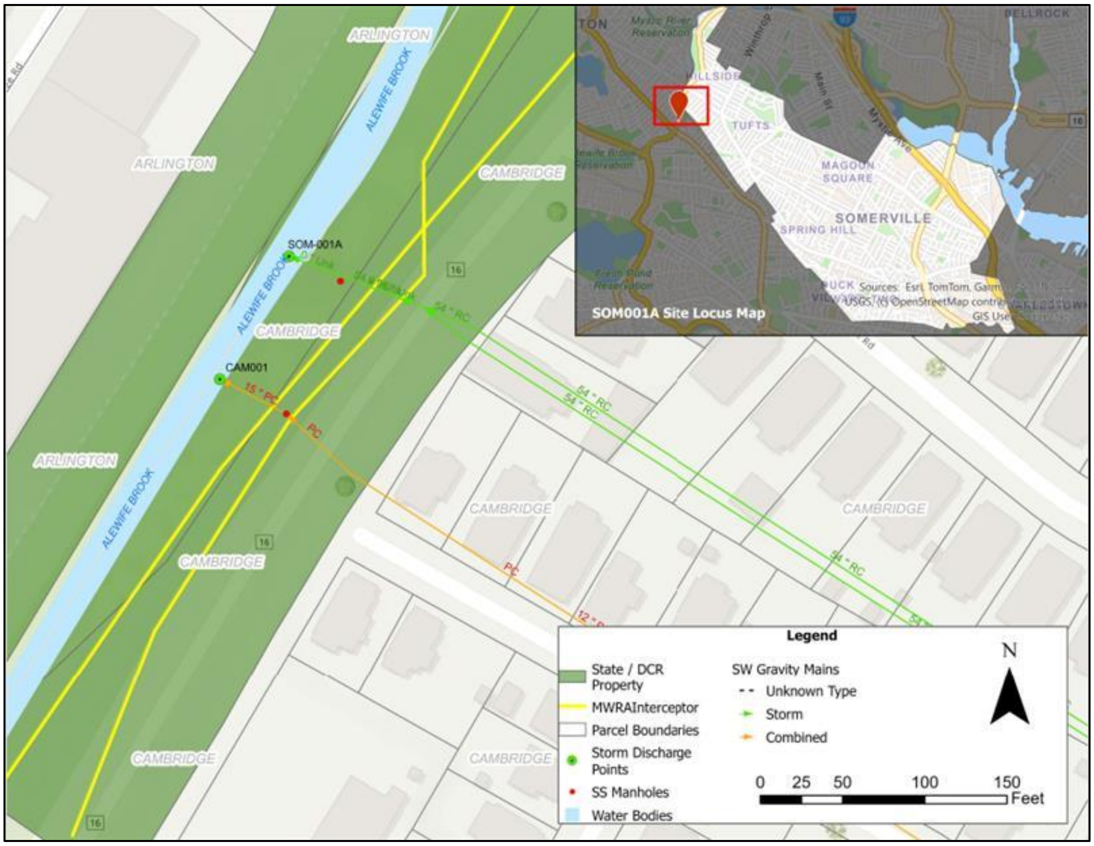

Figure 11. Land Ownership

6 SOM001A ODOR CONTROL EVALUATION

6.1 PHYSICAL MODIFICATIONS

Physical modifications to achieve scouring velocities are not applicable for the SOM-001A location. Inspection reports and CCTV footage indicate minimal build-up of organic materials in the CSO structure and in the pipe. Similarly, modifications to reduce turbulence are unlikely to improve odor control as CCTV footage indicates smooth flow through the system.

Physical modifications to restrict odor escape at the structure are feasible solutions for the SOM-001A outfall. A PVC curtain is a preferable choice to a rigid baffle as it will adjust to changing water levels in the structure. A flexible curtain is also unlikely to affect the hydraulics of the structure.

6.2 SYSTEM REPAIR

Repairs to the SOM-001A structure are not likely to assist with odor control, as recent inspection reports show no major cracking within the structure. The City inspects SOM-001A monthly. If cracks are identified during these inspections, it is recommended that they are repaired. However, since no cracks currently exist, it is unlikely that odors are seeping out of the structure at this time.

6.3 MECHANICAL CLEANING

The City already conducts regular cleaning of the collection system. However, the frequency of cleaning could be increased to mitigate buildup of debris that could cause odor. Existing CCTV data collected throughout the City can be reviewed to identify areas that have a tendency to build up debris and adjust the cleaning frequency to target these pipes. This recommended modification would be relatively easy to implement, there are many pipe cleaning contractors that could perform this work. The stakeholders located in the impacted areas would need to be notified prior to cleaning the pipes, and an analysis of the type of cleaning (light, medium, heavy) and the total linear footage of pipe would need to be analyzed to determine an appropriate schedule based on budget.

6.4 VENTING

The combined collection system is not sealed to the external atmosphere, the catch basins within the system expose the collection system already allow air to escape. Therefore, the installation of a vent pipe would not force air out of the system. However, a vent pipe could be installed in the area around where pedestrians are walking near the CSO outfall. A vent pipe installed upstream of the CSO outfall may allow more air into the system and further dilute the odor at the outfall itself. The vent would need to be routed around the road.

6.5 HOODS

Due to the configuration of the pipes leading to the CSO outfall, hoods would need to be installed on several upstream inlets to mitigate odor. This would include installing hoods on both upstream manholes and catch basins. However, this is only useful if other locations that air can escape are addressed, and hoods are not feasible to be installed at the outfall itself. This would provide the additional benefit of reducing floatables.

6.6 SEALED MANHOLES

A sealed manhole lid may be useful for the access manhole located in the Alewife Brook Parkway. A sealed manhole lid would only be useful in conjunction with other measures to reduce or treat odors escaping from the outfall itself. Otherwise, the sewer gases will exit the structure through the CSO outfall. A sealed manhole lid would not be useful at the access manhole downstream of the weir, since this manhole accesses a location open to the environment.

6.7 BACKFLOW CONTROLS

Backflow controls may be installed either at the outfall itself or in upstream laterals to prevent odors from reaching the outfall structure. Both options present challenges. Firstly, modifications are likely to reduce the size of the outfall opening. Secondly, check valves themselves introduce headloss into the system. Alteration of outfall geometry and addition of headloss will change the hydraulics of the structure and may cause backups in the system.

Backflow controls installed in pipes entering the CSO structure may cause upstream odor issues or lead to sewer blockages. Three pipes enter the CSO structure; two pipes sewer mains and one catch basin lateral connected to two nearby catch basins. If backflow control valves were installed on the sewer mains entering the CSO, they would trap odors in the upstream pipe. These sewer pipes run through residential areas east of the structure, where odor accumulation is likely to be more disruptive than at the outfall area. If backflow prevention were installed in the catch basin lateral, it would likely suffer from blockages due to the combination of debris entering the catch basin and the small diameter of the pipe. Furthermore, available pressure head in the catch basin laterals is no more than a few feet and may not be great enough to open the valve.

6.8 FILTRATION SYSTEMS

Both passive and active filtration systems may be feasible solutions for odor control. The most applicable passive filtration solutions are manhole inserts. An access manhole is in the center of the structure within Alewife Brook Parkway. Manhole inserts at this manhole will filter the air that seeps out of it and may reduce odor control issues. However, this solution will only be effective if air escaping from the outfall and connected catch basins is also managed.

Installation of passive filtration through external filters or vent pipes is unlikely to address odor control issues since there is no evidence of consistent, passive air flow through the CSO.

Active air filtration could successfully remove odors from the air within the CSO structure. The downsides to active air filtration are installation costs, maintenance requirements, and site concerns. Active air filtration is the most expensive odor control solution evaluated for this project. Maintenance requirements are also higher than other proposed solutions. They consist of media replacement and upkeep of air blowers and motors. Site concerns at SOM-001A include finding a location for active air filtration and permitting requirements. The outfall is located along a pedestrian path next to a major roadway with limited open space. In addition, the Department of Conservation and Recreation (DCR) owns the land surrounding the outfall and extensive permitting will be required to obtain permission to build on the land.

6.9 CHEMICAL ADDITION

Due to the high costs, complexity of implementation, and potential impacts on the receiving water body, chemical addition is not an optimal solution for the SOM-001A site. Chemical addition is unlikely to be a cost-effective method of odor control for many reasons. First, an in-depth analysis would be required to identify the proper chemicals and dosing. Secondly, implementation would require a significant amount of space for chemical storage. Finally, maintenance costs including staff training and time would be significant. The impact of chemicals reaching the Alewife Brook during overflow events must also be considered. While chemical selection and dosing may mitigate impacts to the Alewife Brook ecosystem, chemicals that alter sewer chemistry to inhibit decomposition or remove natural sulfides are still likely to have some effects. Due to all of these factors, chemical addition is not recommended at this site.

6.10 BIOAUGMENTATION

There are several elements that would go into initiating a bioaugmentation program within the collection system, such as the selection of an effective dosing site, ongoing coordination with an appropriate contractor, and the levels and frequency of dosing based on severity of hydrogen sulfide. In addition, it is unknown how the addition of microorganisms could impact the Alewife Brook during CSO events. Due to the complexity of introducing microbes to the collection system and the potential impacts to the receiving waters during CSO events, this method is not recommended for this area.

7 FINDINGS AND RECOMMENDATIONS

In summary, Kleinfelder suggests gathering additional odor data at the SOM001A CSO structure and outfall as a primary recommendation. Odor monitoring efforts should also be coordinated with Cambridge and the MWRA to better understand system-wide odor concerns. As a secondary recommendation, low-cost alternatives are recommended to help prevent odors from escaping out of SOM-001A and into the environment while additional odor data is being collected. After more data is available more robust tertiary odor control measures may be warranted. This ensures that the areas that are the highest priority are remedied first, and that the recommended fix is appropriate to address the level of odor observed at the location.

7.1 PRIMARY RECOMMENDATIONS

7.1.1 Additional Observation and Monitoring

Odor issues are highly seasonal and, as a result, long term odor data is required to identify locations with persistent, intense odor issues. Due to the timing of this report, the City was unable to gather long-term odor data. In addition, the report is due prior to the dry summer months when odors are strongest and most frequent. To determine locations most in need of odor control measures and to determine which measures are best suited for these locations, the City requires additional data, especially from summer months. To address this challenge, the City plans to implement additional odor monitoring at SOM-001A for up to 6 months (from June 2025 through November 2025). Recent monitoring activities consisted of installing a hydrogen sulfide odor logger outside of the structure for multiple weeks, including several wet weather events. At the time the meter was installed, readings were also taken inside of the structure. No hydrogen sulfide above 1 part per million was ever detected. To increase the probability that hydrogen sulfide levels are measurable, future monitoring activities will take place during dry-weather periods when odors are most common. Additionally, the meter will be mounted inside of the CSO regulator. While this means that hydrogen sulfide readings will not be indicative of the levels detectable outside of the structure, it will provide better data for determining the likelihood that odors in this area are emanating from the CSO or are unrelated. Additional monitoring will be coordinated with the MWRA, as this structure is connected to an MWRA interceptor.

Additionally, since CSO regulators are inspected monthly, the City will incorporate qualitative odor observations into monthly inspections. This will provide consistent, long-term data for each CSO for minimal cost. Recorded data should include the severity of the odor (N/A, mild, strong, severe) prior to opening the regulator structure and after opening the regulator structure. Odor should also be observed at the outfall of each CSO. Odor observations can be completed as a sniff test. No additional equipment will be required.

7.2 SECONDARY RECOMMENDATIONS

7.2.1 Prevent Air Escape at Outfall

There are five locations from which gas may escape the SOM-001A structure: the outfall, the two nearby catch basins, and the two access manholes within the structure. The recommended odor control program addresses gas escape from each of these locations.

A PVC curtain is recommended to prevent air from escaping from the outfall of the CSO structure. A PVC curtain should not introduce headlosses into the system and will allow water to flow freely out of the structure. This has a distinct advantage over backflow control valves or rigid baffle structures. PVC curtains should be periodically inspected as part of the regulator inspections. The need for cleaning should be determined following the inspection but should be no less than twice a year. This should be done using a high-pressure spray of distilled water.

A catch basin hood is proposed at the nearby catch basin in the south-bound lane, as this is the only catch basin connected to the CSO structure without an existing hood. Also, I/I manhole inserts are recommended in all access manholes. Inserts are recommended over sealing the manhole because the manhole requires frequent opening for catch basin inspections and sealing the manhole may lead to pressurization issues. Any air entering the structure and unable to escape through the outfall, catch basins, or manhole covers.

All construction improvements will require coordination with the DCR. The City may be required to obtain an access permit for work around the outfall that extends beyond the existing access easement.

Maintenance requirements of the proposed system include inspection of the PVC curtain for debris build up and regular inspection of the catch basin and manholes. Inspection of the PVC curtain can occur at the same time as CSO regulator inspections, which happen monthly in accordance with the City's NPDES permit. Catch basin inspections occur regularly as detailed in the City's SWMP. No change to the catch basin inspection schedule is necessary. Installation costs are estimated in Table 6.

Table 6. Outfall Improvement Estimated Costs

Item	Cost
Engineering	$ 20,000
Police Details	$ 1,800
Permitting Fees	$ 50
Construction Costs	
PVC Curtain	*$ 1,000*
MH Inserts	*$ 2,000*
Catch Basin Hood	*$ 3,000*
Labor	*$ 5,000*
Total	**$ 32,850**

7.3 TERTIARY RECOMMENDATIONS

7.3.1 Airtight Manhole Frame and Covers or Manhole I/I Inserts with Passive Media Filtration

If the implementation of the secondary recommendations does not mitigate any odor concerns to acceptable levels, there are further actions that could be implemented by the City. The installation of typical I/I manhole inserts were recommended as a secondary recommendation. Installing airtight manhole frames and covers would prevent any air escaping to the atmosphere. However, this would require additional studies to examine the pressure and hydraulic impacts this would have on both the air and the water within the system. In addition, this would require the excavation and removal of the existing manhole frame and cover the repaving around the newly installed airtight manhole frame and cover. Due to these factors, it may not be as feasible to replace all surrounding upstream manhole frame and covers with airtight manhole frame and covers.

A more enhanced measure than the typical manhole I/I inserts is the I/I manhole inserts with passive media filtration as described in **Section 3.8.1**. These include the media filter which consume hydrogen sulfide and convert it into odorless compounds including carbon dioxide and water. These are more advanced than the typical manhole I/I inserts since they mitigate odor, rather than just preventing the air from escaping. The media lifespan of the filters is typically up to 7 years.

7.3.2 Additional Mechanical Cleaning

In conjunction with reducing odor escape from the system, Kleinfelder recommends that the City reduce odor generation directly upstream of the regulator by increasing the cleaning frequency of these pipes. The City should consider cleaning the regulator structure and the pipes directly upstream of the structure (if there are material deposits present), up to twice a year. The cost associated with each additional cleaning is approximately $5,000 to $7,500 for the cost of the cleaning and CCTV inspection crew plus the cost of access permitting.

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