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MSD Odor Control Master Plan

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Memo

Subject: Technical Memorandum #6B – Morris Forman Collection System Air and Liquid Sampling Phase Results Analysis

1. Introduction

1.1 Odor Control Master Plan Background

In response to receiving a Notice of Violation (NOV) in November 2019 for failure to control odors from the Morris Forman Water Quality Treatment Center (WQTC, Plant) and its collection system, MSD entered into an agreed order with the Louisville Metro Air Pollution Control District (APCD) to develop and implement a phased District-wide Odor Control Master Plan. MSD has contracted AECOM to provide MSD with professional engineering services for the development of Phase I of the Odor Control Master Plan (Odor Control Master Plan), which is focused on the Morris Forman Service Area. MSD also contracted with a public relations firm to increase public engagement and communications during development and implementation of the phased Odor Control Master Plan.

The Morris Forman combined sewer collection system (Morris Forman Collection System) serves approximately 134 square miles across Jefferson County, Kentucky. Wastewater from the Morris Forman Service Area is collected and conveyed through numerous gravity trunk sewers, force mains, and pump stations. Several communities in the Morris Forman Service Area have experienced odors leading to a significant amount of complaints, specifically during the summer of 2019. Primary affected residents were in the Chickasaw, California, and Park DuValle neighborhoods. These complaints led to the development of a dedicated Odor Control Master Plan for the Morris Forman Service Area.

1.2 Purpose

This Report is intended to document Sampling Program efforts to date for the Morris Forman combined sewer collection system (Morris Forman Collection System) including gravity trunk sewers, force mains, manholes and catch basins in the tributary area. The main objectives of this Report are to:

1. Summarize and analyze the liquid and vapor sampling in critical areas of the collection system
2. Incorporate findings from this TM#6B into TM#7 (Current Odor Control Technologies Performance Evaluation), TM#8 (New Odor Control Technologies Performance Evaluation), and TM#9 (Odor Control Conceptual Design)

1.3 Previous Documentation and Implementation Schedule

In accordance with the agreed order, MSD has submitted several documents to APCD to demonstrate ongoing odor control efforts. Table 1 shows MSD's completed and ongoing efforts towards the APCD agreed order.

Table 1 – Phase I Master Plan Implementation Schedule

Title		Due Date	Status
TM#1	Morris Forman WQTC Background Document Review	Q1 2021	Completed
TM#2	Collection System Background Document Review	Q2 2021	Completed
TM#3	Pump Stations Background Document Review	Q2 2021	Completed
TM#4	WQTC, Pump Stations and Combined Sewer System Planned Process Modifications	Q1 2021	Completed
TM#5	Current WQTC, Pumping Stations and Combined Sewer System Odor Impact Evaluation	Q2 2021	Completed
TM#6A, TM#6B, TM #6C	Morris Forman WQTC (TM#6A), Collection System (TM #6B), and Pump Stations (TM #6C) Sampling Phase Results Analysis	Q4 2022	Completed
TM#7A TM#7B TM#7C	Morris Forman WQTC Current Odor Technologies Performance Evaluation Collection System Current Odor Technologies Performance Evaluation Pump Stations Current Odor Technologies Performance Evaluation	Q4 2022	Completed
TM#8	**New Odor Control Technologies Recommendation**	**Q4 2022**	**Ongoing**
TM#9	**Odor Control Conceptual Design**	**Q4 2022**	**Ongoing**
Odor Control Master Plan Phase I Final Report		**Q4 2022**	**Ongoing***

**- The Final Odor Control Master Plan Phase I Final Report will be a comprehensive document which includes information about the Morris Forman Collection System, WQTC, and selected pump stations.*

2. Morris Forman Collection System Sampling

2.1 Sampling Locations

Initially, the Morris Forman Collection System Sampling Program included thirteen (13) sampling locations (Liquid and Vapor Sampling Program TM, AECOM, April 2021). Sampling locations were selected based on odor complaints which showed relatively high odor impacts – specifically within the Chickasaw, Shawnee, California, and Park DuValle neighborhoods. These locations were further evaluated in fall of 2021 and narrowed down to eight (8) locations for inclusion in the first phase of the Morris Forman Collection System Sampling Program. The second phase included 4 additional sites that were sampled in May of 2022, for a total of 12 sampling locations. The Morris Forman Collection System sampling program consisted of (2) phases:

- Phase 1 – Vapor and Liquid Sampling at Eight (8) Locations: October 12-14, 2021
- Phase 2 – Vapor and Liquid Sampling at Four (4) Locations: May 2022

Sampling parameters included in the Morris Forman Collection System Sampling Program are listed in Table 2 (vapor parameters) and Table 3 (liquid parameters). A summary of the sampling program locations and characteristics is shown in Table 4 and an overview map of the sampling locations is shown in Figure 1. Liquid sampling and vapor sampling was contracted to a third-party contractor, and liquid and vapor samples were quantified by third-party laboratories.

Note that the catch basin sampling locations (2, 8, and 14) did not include H_2S monitoring. Refer to Table for detailed sampling results from the Morris Forman Collection System Sampling Program.

Table 2 – Sampling Program Parameters – Vapor

Sampling Parameter		Description	Standard/ Guideline
1	Odor	10-liter Tedlar bag grab samples collected and shipped to sensory consultant to measure odor detectability as Detection-to-Threshold (D/T)	ASTM E679-91/ E544-99
2	Reduced Sulfur Compounds (RSC)	3-liter Tedlar bag grab samples collected and shipped to laboratory for analytical analysis	ASTM 5504-12
3	Volatile Organic Compounds (VOCs)	3-liter Tedlar bag grab samples collected in pre-calibrated canisters and shipped to laboratory for analytical analysis	EPA TO-15
4	Ammonia	Air samples pulled from odor and RSC grab sample bags and tested on-site using GASTEC detector tubes and pump model GV-100S	EPA CTM 027 (Vapor); APHA 4500-NH3 (Liquid)
5	Amines	Sorbent tubes used to collect air samples and shipped to laboratory for analytical analysis	OSHA Method 40
6	Aldehydes	Sorbent tubes used to collect air samples and shipped to laboratory analytical analysis	EPA TO-11A
7	Instantaneous Hydrogen Sulfide (H2S)	H_2S analyzers used to measure and instantaneous H2S concentration using Arizona Instruments Jerome 631X	-

Table 3 – Sampling Program Parameters – Liquid

	Sampling Parameter	Description	Standard/ Guideline
1	pH	pH meters used to measure pH within (2) hours of sampling	APHA 4500-H
2	Dissolved Oxygen (DO)	Azide modification to the Winkler Titration Method	APHA 4500-O
3	Dissolved Sulfides	Samples collected directly from manhole/catch basin and shipped to laboratory for analytical analysis	APHA 4500-S2
4	Sulfates	Samples collected directly from manhole/catch basin and shipped to laboratory for analytical analysis	APHA 4110B
5	Ammonia	Ammonia-selective electrode method used to analyze liquid samples within 24 hours	APHA 4500-NH3
6	5-day Biological Oxygen Demand (BOD5)	Difference in DO before and after incubation of liquid samples for five days	APHA 5210B
7	Volatile Organic Compounds (VOCs)	GC/MS instrumentation used to analyze VOCs in liquid samples	EPA 624/625
8	Total Suspended Solids (TSS)	-	APHA 2540-D

Table 4 – Collection System Sampling Overview

Sample ID	Location Description	Adjacent Neighborhood(s)	Sampling Type	Date(s) of Sampling
1	Northwestern Interceptor	Shawnee	Vapor & Liquid	10/12/21- 10/14/2021
2	Northwestern Interceptor	Shawnee	Vapor	10/12/21- 10/14/2021
3	Northwestern Interceptor	Shawnee	Vapor & Liquid	5/11/2022
4	Western Outfall	Chickasaw	Vapor & Liquid	10/12/21- 10/14/2021
5	Western Outfall	Chickasaw	Vapor & Liquid	5/11/2022
6	Ohio River Interceptor	Chickasaw	Vapor	10/12/21- 10/14/2021
7	Southern Outfall	Park DuValle/ Chickasaw	Vapor & Liquid	10/12/21- 10/14/2021
8	Southern Outfall	Park DuValle/ Chickasaw	Vapor	10/12/21- 10/14/2021
11	Western Outfall	California	Vapor & Liquid	5/11/2022
12	Western Outfall	California	Vapor & Liquid	10/12/21- 10/14/2021
13	Western Outfall	California	Vapor & Liquid	5/11/2022
14	Southern Outfall	Park DuValle	Vapor	10/12/21- 10/14/2021

Notes:

Samples 9 and 10 correspond to WWTF and the Southwestern Pump Station, respectively, and can be found in TM #6A and TM #6C.

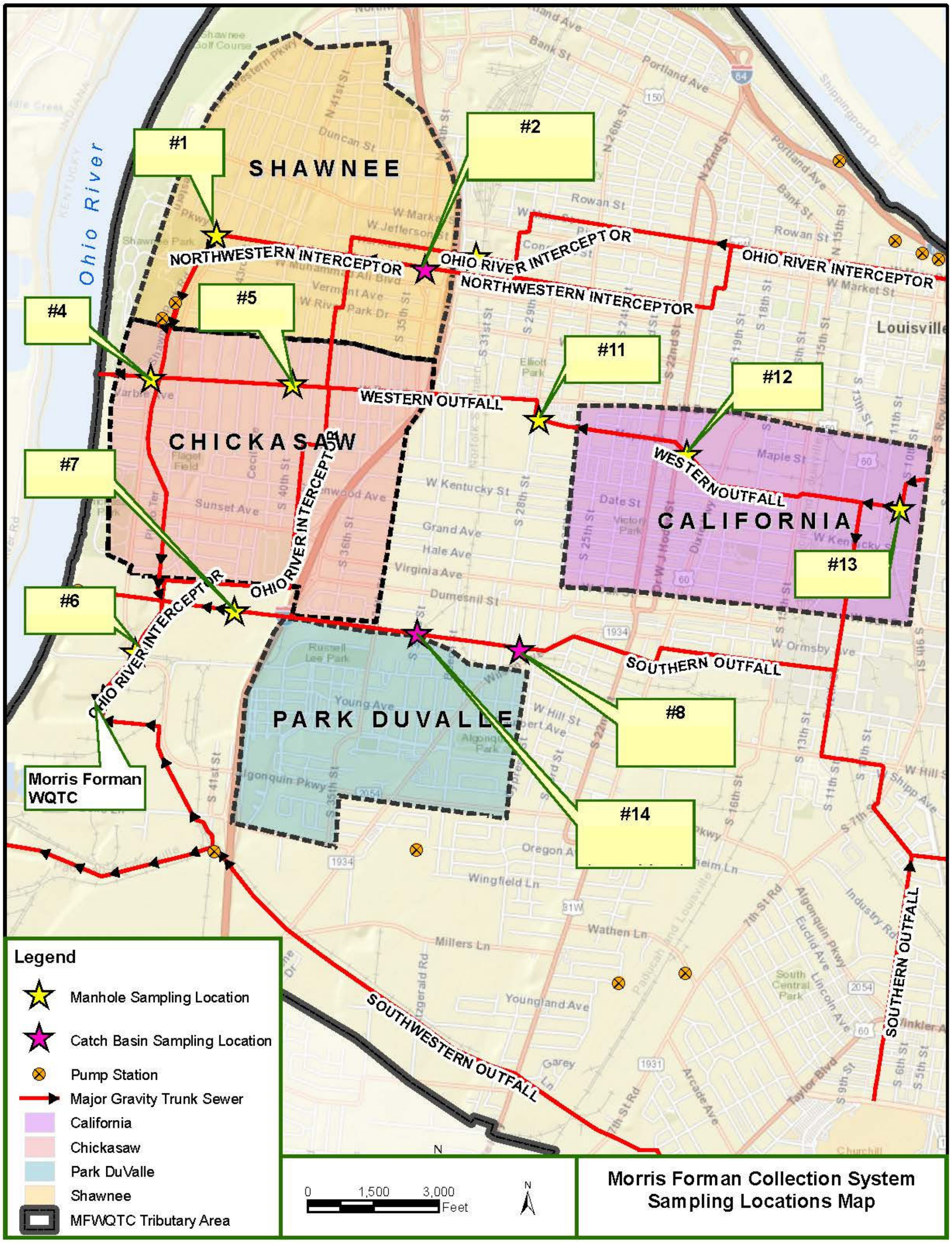

Figure 1 – Collection System Sampling Locations Map

Table 5 was developed to summarize the results from the Fall 2021 and Spring/Summer 2022 collection system sampling events. Results are presented as either low or high values. If the sampling location showed both non-detect (ND) and detectable values, the values were averaged by replacing the ND value with the minimum reporting limit. Red text indicates instances where sampling results are high.

A value was labeled as low or high for each analyte based on various regulatory standards and guidelines. For analytes without required exposure limits, available guidelines and mean air odor detection thresholds were utilized to assign a target limit and are noted for each analyte.

Table 5 – Collection System Sampling Results Evaluation

		Sampling Parameter	Sampling Location 1	2	3	4	5	6	7	8	11	12	13	14
Liquid Sampling		pH	4.6	-	7.79	6.8	7.13	6.3	7.1	-	4.22	NL	7.66	-
		Sulfide	ND	-	ND	Low	Low	ND	ND	-	ND	NL	ND	-
		BOD 5	High	-	Low	High	Low	High	Low	-	High	NL	ND	-
		Dissolved Oxygen	Low	-	Low	Low	Low	ND	ND	-	Low	NL	Low	-
		Sulfate	Low	-	Low	Low	Low	Low	Low	-	Low	NL	Low	-
		TSS	Low	-	Low	High	Low	Low	Low	-	Low	NL	Low	-
		Ammonia	Low	-	Low	Low	Low	Low	Low	-	Low	NL	ND	-
		Acetone	ND	-	Low	ND	ND	Low	ND	-	ND	NL	ND	-
		Toluene	ND	-	ND	Low	ND	ND	ND	-	ND	NL	ND	-
Vapor Sampling		Odor (Average)	High	High	High	High	High	High	High	High	High	High	High	High
	Reduced Sulfur Compounds	H2S	Low	ND	Low	SL	Low	Low	Low	Low	Low	Low	Low	SL
		Carbonyl Sulfide	ND	ND	Low	SL	ND	ND	Low	ND	Low	Low	ND	SL
		Methyl Mercaptan	ND	ND	Low	SL	Low	Low	Low	ND	Low	Low	ND	SL
		Ethyl Mercaptan	-	-	Low	-	Low	-	-	-	Low	-	ND	-
		Dimethyl Sulfide	ND	ND	Low	SL	Low	Low	Low	ND	Low	Low	ND	SL
		Carbon Disulfide	-	-	Low	-	ND	-	-	-	ND	-	ND	-
		Dimethyl Disulfide	-	-	ND	-	ND	-	-	-	Low	-	ND	-
	Aldehydes	Formaldehyde	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	ND
		Acetaldehyde	ND	ND	ND	Low	Low	ND	ND	ND	Low	Low	ND	ND
		Acetone	ND	ND	Low	Low	Low	ND	ND	ND	Low	ND	ND	ND
		Butyraldehyde	ND	ND	High	Low	ND	Low	ND	ND	High	ND	ND	ND
		Valeraldehyde	ND	Low	ND	Low	ND	Low	Low	ND	ND	Low	ND	ND
		Hexanal	Low	Low	ND	Low	ND	Low	Low	Low	ND	Low	ND	ND
	Pressure	Max Pressure	0.135	-	1.205	0.041	0.373	0.122	0.037	-	0.019	-	0.321	-
		8-Day Average Pressure	0.0026	-	0.0196	-0.0017	0.0027	0.0019	-0.0001	-	0.0043	-	-0.003	-

***Red text indicates sampling location exceeded analyte target limit at the odor source.**

***Target Limit Resources:**

1. Air Pollution Control District (APCD) Ambient Air Quality Standards, Regulation 3.01 Section 7
2. American Industrial Hygiene Association (AIHA), 1989
3. Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits, Annotated Table Z-1
4. Louisville MSD Wastewater/ Stormwater Discharge Regulations
5. American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value
6. Approaches to Total VOC Guidelines, Alberta Environment-Based on Effects Screening Level (ESL)
7. National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit
8. United States Department of Energy (DOE) Protective Action Criteria for Chemicals (PACs) PAC-1

Notes:

H_2S= Hydrogen Sulfide
BOD= Biological Oxygen Demand
TSS= Total Suspended Solids

ND= Non-Detect – Compound was analyzed for, but not detected above the method detection limit
- = Substance was not sampled for or has not been analyzed by the appropriate laboratory
SL= Sample Loss – Air sample was damaged during shipment to laboratory
NL=No Liquid – no liquid was present at sample location.

The following compounds were tested for but not detected in the liquid at any location in the distribution system:
1,1,1,2-Tetrachloroethane, 1,1,1-Trichloroethane, 1,1,2,2-Tetrachloroethane, 1,1,2-Trichloroethane, 1,1-Dichloroethane, 1,1-Dichloroethene, 1,2-Dichloroethane, 1,2-Dichloropropane, 2-Butanone, 2-Hexanone, 4-Methyl-2-pentanone, Acrolein, Acrylonitrile, Benzene, Bromodichloromethane, Bromoform, Bromomethane, Carbon Disulfide, Carbon tetrachloride, Chlorobenzene, Chloroethane, Chloroform, Chloromethane, cis-1,2-Dichloroethene, cis-1,3-Dichloropropene, Dibromochloromethane,, Ethylbenzene m,p-Xylene, Methylene chloride, Methyl-t-Butyl Ether, o-Xylene, Styrene, Tetrachloroethene, trans-1,2-Dichloroethene, trans-1,3-Dichloropropene, Trichloroethene, Trichlorofluoromethane, Vinyl Acetate, Vinyl chloride, 1,1-Dichloropropene, 1,2,3-Trichlorobenzene, 1,2,3-Trichloropropane, 1,2,4-Trichlorobenzene, 1,2,4-Trimethylbenzene, 1,2-Dibromo-3-chloropropane, 1,2-Dibromoethane, 1,2-Dichlorobenzene, 1,3,5-Trimethylbenzene, 1,3-Dichlorobenzene, 1,4-Dichlorobenzene, 2,2-Dichloropropane, 2-Chloroethyl vinyl ether, 2-Chlorotoluene, 4-Chlorotoluene, Bromobenzene, Bromochloromethane, Dibromomethane, Dichlorodifluoromethane, Hexachlorobutadiene, Iodomethane, Isopropylbenzene, Naphthalene, n-Butylbenzene, n-Propylbenzene, p-Isopropyltoluene, sec-Butylbenzene, tert-Butylbenzene, Total 1,2-Dichloroethene, and Total Xylenes (1,2-Dichloroethane-d4, 4-Bromofluorobenzene, Dibromofluoromethane, and Toluene-d8)

The following compounds were tested for but not detected in the vapor at any location in the distribution system:
Isopropyl Mercaptan, tert-Butyl Mercaptan, n-Propyl Mercaptan, Ethyl Methyl Sulfide, Thiophene, Isobutyl Mercaptan, Diethyl Sulfide, n-Butyl Mercaptan, 3-Methylthiophene, 110-01-0 Tetrahydrothiophene, 2,5-Dimethylthiophene, 2-Ethylthiophene, Diethyl Disulfide, Propene, Dichlorodifluoromethane (CFC 12), Chloromethane, 1,2-Dichloro-1,1,2,2-tetrafluoroethane (CFC 114), Vinyl Chloride, 1,3-Butadiene, Bromomethane, Chloroethane, Acrolein, Trichlorofluoromethane (CFC 11), Acrylonitrile, 1,1-Dichloroethene, 3-Chloro-1-propene (Allyl Chloride), Trichlorotrifluoroethane (CFC 113), trans-1,2-Dichloroethene, 1,1-Dichloroethane, Methyl tert-Butyl Ether, Vinyl Acetate, cis-1,2-Dichloroethene, Ethyl Acetate, Tetrahydrofuran (THF), 1,2-Dichloroethane, 1,1,1-Trichloroethane, Benzene, Carbon Tetrachloride, Cyclohexane, 1,2-Dichloropropane, Trichloroethene, 1,4-Dioxane, Methyl Methacrylate, n-Heptane, cis-1,3-Dichloropropene, Methyl-2-pentanone, trans-1,3-Dichloropropene, 1,1,2-Trichloroethane, Hexanone, Dibromochloromethane, 1,2-Dibromoethane, n-Butyl Acetate, n-Octane, Chlorobenzene, Ethylbenzene, m,p-Xylenes, Bromoform, Styrene, o-Xylene, n-Nonane, 1,1,2,2-Tetrachloroethane, Cumene, n-Propylbenzene, 4-Ethyltoluene, 1,3,5-Trimethylbenzene, Benzyl Chloride, 1,3-Dichlorobenzene, 1,4-Dichlorobenzene, 1,2-Dichlorobenzene, 1,2-Dibromo-3-chloropropane, 1,2,4-Trichlorobenzene, Naphthalene, Hexachlorobutadiene, Acrolein, Propionaldehyde, Crotonaldehyde, Benzaldehyde, Isovaleraldehyde, o-Tolualdehyde, m,p-Tolualdehyde, 2,5-Dimethylbenzaldehyde, Diethylamine, Dimethylamine, Ethylamine, and Methylamine.

An extensive list of VOC compounds were tested for as part of the sampling program, but the results were well below the target limits; therefore, the results were excluded from this table for clarity.

3. Conclusions

The air sampling results indicated the exceedance of analyte target limits at several locations. The pressure monitoring results indicate that most of the manholes operate at positive pressure compared with the atmospheric pressure which causes the release of pipe headspace air into the surrounding environment. It is important to notice that high odor levels have been measured at several locations.

Table 6 and Table 7 summarize the vapor and liquid sampling results evaluation, respectively, for each of the sampling locations. They were developed to aid the odor control master plan in the selection of odor control improvements and mitigation of current odor impacts within the treatment facilities.

The sampling locations are presented in order of highest to lowest estimated vapor odor impacts. The odor detection values obtained from the sampling efforts will be incorporated into the air dispersion model to assess community odor impacts at critical receptors.

The liquid sampling results indicate that it's more likely that there is production of odorous compounds at high BOD. The results show this as the lower pH readings (H_2S more likely to be present) coincides with the high BOD measurements. Sample ID #11 has high BOD. The pH is the lowest at the high BOD reading, but dissolved oxygen is not low compared to other readings. The conditions are favorable for odor generation.

Table 6 – Collection System Vapor Sampling Results Summary

Sampling Location	Location Description	Potential Odor Receptors	Target Limit Exceedance(s)	Odor Control Priority
6	Ohio River Interceptor	Chickasaw residents, Adjacent properties near Plant	Odor, Pressure	High
4	Western Outfall	Chickasaw residents	Odor, Pressure	High
12	Western Outfall	Chickasaw residents	Odor	Moderate
5	Western Outfall	Chickasaw residents	Odor, Pressure	Moderate
11	Western Outfall	California residents	Odor, Butyraldehyde	Moderate
7	Southern Outfall	Park DuValle residents	Odor	Moderate
1	Northwestern Interceptor	Shawnee residents	Odor, Pressure	Low
3	Northwestern Interceptor	Shawnee residents	Odor, Butyraldehyde, Pressure	Low
8	Southern Outfall	Park DuValle residents	Odor	N/A
14	Southern Outfall	Park DuValle residents	Odor	N/A

2	Northwestern Interceptor	Shawnee residents	Odor	N/A
13	Western Outfall	California residents	Odor	N/A

Table 7 – Collection System Liquid Sampling Results Summary

Sampling Location	Location Description	Potential Odor Receptors	Target Limit Exceedance(s)	Odor Control Priority
4	Western Outfall	Chickasaw residents	BOD and TSS	High
11	Western Outfall	California residents	BOD	Moderate
1	Northwestern Interceptor	Shawnee residents	BOD	Low
5	Western Outfall	Chickasaw residents		Low
6	Ohio River Interceptor	Chickasaw residents, Adjacent properties near Plant	BOD	Low
2	Northwestern Interceptor	Shawnee residents	-	N/A
3	Northwestern Interceptor	Shawnee residents	-	N/A
7	Southern Outfall	Park DuValle residents	-	N/A
8	Southern Outfall	Park DuValle residents	-	N/A
12	Western Outfall	Chickasaw residents	-	N/A
13	Western Outfall	California residents	-	N/A
14	Southern Outfall	Park DuValle residents	-	N/A

4. Recommendations

The findings from the 2021 and 2022 sampling events in the Morris Forman collection system indicate that odor control improvements should be considered for some of the collection system especially for those operating at the positive pressure.   TM#8 - New Odor Control Technologies Performance Evaluation, and TM#9 - Odor Control Conceptual Design will focus on the design approach for interceptor sewers in controlling reducing the odors in these sewers.