MWMC Eugene-Springfield WPCF Facility Plan—Odor Control Enhancement Alternatives

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Executive Summary

The existing odor control facility has a peak capacity of 18,000 cubic feet per minute (ft^3/minute). Odor control requirements for projected conditions are 41,000 ft^3/minute. To accommodate the projected odor control requirements, three alternatives for replacement of the existing system have been evaluated. The first alternative is to replace the existing odor control system with a conventional open-space organic media filter. The second alternative is to construct a conventional open-space soil media filter. The third alternative involves installing a biotrickling tower or bioscrubber. The capital cost comparison and non-monetary comparison are summarized in Table 1.

TABLE 1
Summary of Odor Control Alternatives Comparison
MWMC Facility Plan, Eugene-Springfield

Alternative	Capital Cost (millions of dollars)	Non-Monetary Rating[a]
1 – Conventional Open-Space Organic Media Biofilter	$3.75	17
2 – Conventional Open-Space Soil Media Biofilter	$4.14	21
3 – Bioscrubbers (Biotrickling Tower)	$4.55	24

Notes:
[a] Non-monetary score is out of a possible maximum score of 30 points.

For the purpose of comparing alternatives it was assumed that 40,000 cfm of capacity would be constructed. Capital costs associated with the organic media filter are approximately $3,750,000. Soil media filter capital costs are estimated to be $4,140,000. The capital costs for the bioscrubber alternative are approximately $4,550,000. A non-monetary evaluation of the three alternatives indicates that the bioscrubber is more favorable than either media filter option. It is recommended the bioscrubber facility be carried forward in the predesign effort.

While both the soil media organic biofilter and the bioscrubber technologies were similarly ranked, the bioscrubber was selected as the recommended option because the exhaust air from this system is subject to greater atmospheric dispersion. A conceptual design for a bioscrubber system is presented using five parallel treatment trains each with a capacity of 9,250 standard cubic feet per minute (scfm).

Introduction

This technical memorandum has been prepared as part of the Metropolitan Wastewater Management Commission (MWMC) Eugene-Springfield Water Pollution Control Facility (E-S WPCF) Facility Plan Update and Pre-Design (Project No. 80010) and consists of an evaluation of alternatives for enhancing and providing additional odor control capacity at the E-S WPCF. The existing odor control facility has a peak capacity of 18,000 ft^3/minute at peak conditions. Consequently, a new odor control facility must be constructed to accommodate the additional 23,000 ft^3/minute required for the projected peak.

A three-tiered approach was taken for addressing enhancements to odor control, as follows:

1. Selection of an appropriate odor control technology.
2. Identification of design criteria pertinent to the selected technology.
3. Conceptual design and footprint of an odor control system using the selected odor control technology.

Existing Facilities

The existing odor control system consists of a three-cell, organic media biofilter with a design capacity of 15,000 ft^3/minute and a connected capacity of 18,000 ft^3/minute. It is assumed that the new odor control system will have a capacity equivalent to the capacity of the existing system. Table 2 provides a list of existing odor control equipment at E-S WPCF.

TABLE 2
E-S WPCF Odor Control Facility Unit Processes and Equipment
MWMC Facility Plan, Eugene-Springfield

Equipment	Type	Quantity	Capacity (each/total firm[a]/total[b])
Biofilter	3-cell, organic media	1	15,000 ft^3/minute /15,000 ft^3/minute /18,000 ft^3/minute

Notes:
[A] Total firm capacity is with largest unit out –of service.
[B] Total capacity is with all units in service.

Selection of Design Criteria

This section represents the design criteria used to size the odor control system(s). In general, the total volume of treated air will be kept to a minimum while still providing sufficient odor control. This will limit the size of the treatment facility required and increase the inlet concentration to the odor control system. The odor control system flow rates will be determined based on differing criteria. The criteria and the basis for each odor source are summarized in Table 3.

TABLE 3
Exhaust Flow Rate Criteria
MWMC Facility Plan, Eugene-Springfield

Odor Source	Exhaust Rate Criteria	Basis
New Headworks Channels	20 ACH	Corrosion Control
Truck Loadout Bays	12 ACH	Corrosion Control/Work Environment
Primary Clarifier Floc Wells	12 ACH	Corrosion Control
Primary Clarifier Effluent Launders	12 ACH	Corrosion Control
Gravity Thickeners	12 ACH	Corrosion Control
Existing Odor Control	NA	Accommodate Existing Capacity

ACH = Air changes per hour

It has been assumed that the existing odor control system shall be replaced with identical capacity within the new system. Representative sizes for new facilities requiring odor control have been selected and the resulting flow rates calculated using the applicable criteria. The resulting exhaust flow rates for all area and the assumed facility sizes are summarized in Table 4.

TABLE 4
Exhaust Flow Rates by Area
MWMC Facility Plan, Eugene-Springfield

Odor Source	Unit Size Assumptions	Total Flow Rate
Headworks Channels	4 Channels, 5' Wide and 75' Long, with 4' Average Headspace.	2000 ft^3/minute
Truck Loadout Bay	50' Long, 20' Wide, and 20' High.	4000 ft^3/minute
Primary Clarifier Floc Wells	4 Units,35' Diameter with 2' Average Headspace.	800 ft^3/minute
Primary Clarifier Effluent Launders	4 Units, 135' Outer Diameter and 130' Inner Diameter with 3' Average Headspace.	7600 ft^3/minute
Gravity Thickener	2 Units, 50' Diameter with 12' Average Headspace	5100 ft^3/minute
Equipment Enclosures	Various	2500 ft^3/minute

TABLE 4
Exhaust Flow Rates by Area
MWMC Facility Plan, Eugene-Springfield

Odor Source	Unit Size Assumptions	Total Flow Rate
Existing Odor Control	Existing Connected Load	18000 ft^3/minute
Total Flow Rate		41,000 ft^3/minute

ft^3/minute = Cubic feet per minute

The odor control system will be designed to achieve the specified removal efficiency based on hydrogen sulfide concentration, which is used as the surrogate for total odor. The design removal efficiencies, based on inlet hydrogen sulfide concentration, are summarized in Table 5.

TABLE 5
Design Removal Efficiencies
MWMC Facility Plan, Eugene-Springfield

Inlet H_2S Concentration (ppm)	Minimum H_2S Removal Efficiency (%)
>10	99.0
<10	95.0

ppm = parts per million by volume

The bioscrubber system used for this analysis is factory constructed and transportable to the site as opposed to one requiring extensive field fabrication. The system is a modular design and can be installed in units of equal capacity as more odor control is added to the total system. The modules would operate in a parallel arrangement. The parameters to be used in the conceptual design of the bioscrubbers are summarized in Table 6.

TABLE 6
Bioscrubber Sizing Parameters
MWMC Facility Plan, Eugene-Springfield

Parameter	Value
Bioscrubber Vessel Maximum Diameter	14 Feet
Minimum Gas Residence Time	12 Seconds
Maximum Gas Loading Rate	60 ft^3/minute / ft^2
Minimum Media Depth	12 Feet
Media Type	Porous Volcanic Rock
Media Size	0.75 to 1.5 In.
Media Pressure Drop	0.3 In. W.C./ft

TABLE 6
Bioscrubber Sizing Parameters
MWMC Facility Plan, Eugene-Springfield

Parameter	Value
Minimum Inlet Temperature	50 Degrees Fahrenheit
Maximum Inlet Temperature	100 Degrees Fahrenheit
Scrubbant Recirculation Rate	0.0236 gpm/ft^3/minute
Basin pH setpoint	2.0
Makeup Water Source	Secondary Effluent
Inlet Hydrogen Sulfide Concentration	5 ppm

Notes:
ft^3/minute = cubic feet per minute
gpm = gallons per minute

Preliminary Screening of Alternatives

A preliminary screening of available odor control technologies produced the following ideas:

- Conventional Open-Space Organic Media Biofilter
- Conventional Open-Space Soil Media Biofilter
- Bioscrubbers (Biotrickling Tower)

The candidate processes were given scores of 1 to 5 based on various performance, operations and maintenance (O&M), and implementation criteria. The ideas receiving the highest combined scores were given more consideration for inclusion in alternatives to be evaluated for expansion of pretreatment capacity. For comparing alternatives, it was assumed that the selected alternative would replace the existing system.

Odor Control Alternatives

Alternative 1—Conventional Open-Space Organic Media Biofilter

In an organic media biofilter, wet compost or wood chips are used as a medium to grow sulfur-reducing bacteria. Treated air migrates out of the filter bed and into the atmosphere. The bacteria also use other odor-producing compounds as a food source, including ammonia and various organic reduced sulfur compounds.

This system consists of an above or partially below grade configuration with retaining wall or soil berm filled with an organic media, such as a mulch or composted yard debris. The media allows the cultivation of a fixed film growth that consumes the odors that pass through it. The odorous air is evenly distributed throughout the biofilter by distribution piping located near the bottom within a layer of river rock. Below the rock is a sloped membrane for capturing the moisture. Above the river rock is a layer of media, approximately 5 feet thick. Keeping the media moist is critical for proper operation of the biofilter. This is accomplished by supplying a spray nozzle in the ductwork upstream of the biofilter and by providing an irrigation spray system on top of the biofilter. Moisture sensors are provided for controlling the irrigation system. The footprint is large because of the following requirements: loading rate of 4 to 6 cfm per square foot (ft^2), and contact time of 60 seconds through the organic media.

Alternative 2—Conventional Open-Space Soil Media Filter

In a soil biofilter, a proprietary sandy loam material is used as a medium to grow sulfur-reducing bacteria. Treated air migrates out of the filter bed and into the atmosphere. The bacteria also use other odor-producing compounds as a food source, including ammonia and various organic reduced sulfur compounds.

This system consists of an above or partially below grade configuration with retaining wall or soil berm filled with an inorganic media such as selected native soil. The media allows the cultivation of a fixed film growth that consumes the odors that pass through it. The odorous air is evenly distributed throughout the biofilter by distribution piping located near the bottom within a layer of river rock. Below the rock is a sloped membrane for capturing the moisture. Above the river rock is a layer of media, approximately 5 feet thick. A layer of washed rock is applied over the top of the soil media for aesthetics and weed control. Keeping the media moist is critical for proper operation of the biofilter. This is accomplished by providing a spray nozzle in the ductwork upstream of the biofilter and by supplying an irrigation spray system on top of the biofilter. Moisture sensors are provided for controlling the irrigation system. The footprint is large because of a required loading rate of 2 to 3 cfm/ft^2 to allow a contact time of 60 to 90 seconds through the soil media.

Alternative 3—Bioscrubbers (Biotrickling Tower)

In a biotrickling tower, odorous air is blown into the bottom of the tower and flows up through the media material. Treated air migrates out of the filter bed and into the atmosphere. The media may be a synthetic material or an inorganic material such as lava rock. The media allows the cultivation of a fixed film growth that consumes the odors that pass through it. The bacteria also use other odor compounds as a food source including ammonia and various organic reduced sulfur compounds. Recirculation pumps provide a continuous stream of water that keeps the media wet, provides nutrients, and carries away waste products. A source of water, preferably non-chlorinated secondary plant effluent, is needed for the unit. If potable water is used, a supplemental nutrient feed system is required. The recirculated water is continually blown down to a drain to control pH and remove waste products. Drain water will be low in pH and should be routed to a flow stream where it can be diluted.

Design bed velocities for biotrickling towers are 50 feet per minute (fpm) maximum. The design head loss through the media is generally about 0.3-inch per foot of bed depth. A scrubbant recirculation pump is required to keep the media moist, add necessary nutrients, and maintain pH. The footprint for the bioscrubber is smaller than for the conventional filters because of the tower configuration.

Alternatives Analysis

Analysis of the alternatives is based on a non-monetary and monetary comparison.

Non-Monetary Comparison

The purpose of a non-monetary comparison between the three alternatives is to evaluate issues other than cost that may influence the selection of one alternative over the others. Issues include constructibility, O&M, performance, siting, etc. Table 7 summarizes the preliminary results of the non-monetary comparison.

TABLE 7
E-S WPCF Odor Control Alternatives Non-Monetary Comparison
MWMC Facility Plan, Eugene-Springfield

Issue	Alternative 1 – Conventional Open-Space Organic Media Filter	Alternative 2 – Conventional Open-Space Soil Media Filter	Alternative 3 – Bioscrubbers (Biotrickling Tower)
Siting	1	1	5
Constructibility	4	4	5
Odor Control Performance	5	5	5
Effect on Performance of Downstream Equipment	3	3	3
Operational Flexibility	3	3	3
Maintenance	1	5	3
Totals (30 points maximum)	17	21	24

Scoring
1 = Negative/Difficult
5 = Beneficial

Capital Cost Estimates

Order-of-magnitude capital cost estimates were developed for the three alternatives. An order-of-magnitude cost estimate is an approximate estimate made without detailed engineering data. Examples of such estimates are an estimate from cost capacity curves, an estimate using scale-up factors, and an approximate ratio estimate. The cost estimates were developed for conducting relative comparisons between the alternatives and are based on very limited design information.

The cost estimate for each odor control alternative reflects the proposed alternative, as described in previous sections, and is based on current permit conditions. In general, costs were estimated based on cost per ft^3/minute treated. A 3 percent markup for mobilization/demobilization is included in the capital costs. Contingency costs are factored into the total capital costs as well. For both alternatives, a 25 percent factor was included for a construction contingency and an additional 25 percent for the engineering, legal, and administration allowance.

Once a particular alternative is selected, further project definition and predesign work will be required to better define the scope and prepare a more complete cost estimate of the selected alternative. The capital cost comparisons are provided in Table 8.

TABLE 8
E-S WPCF Odor Control Alternatives Capital Cost Estimates
MWMC Facility Plan, Eugene-Springfield

Alternative	Capital Cost
Alternative 1 – Conventional Open-Space Organic Media Filter	$3,750,000
Alternative 2 – Conventional Open-Space Soil Media Filter	$4,140,000
Alternative 3 – Bioscrubbers (Biotrickling Tower)	$4,550,000

Conclusions and Recommendations

Based on technical, economical, and environmental considerations, it is recommended that E-S WPCF use bioscrubbers for odor control. Bioscrubber and biofilter technologies produced a nearly equivalent result in the evaluation. Factors such as higher atmospheric dispersion may make bioscrubber technology more favorable in some specific circumstances and will be incorporated into the overall odor control design. Because of higher initial capital costs, the bioscrubber technology usually becomes most favorable when handling low volumes of air streams with a high to very high odor concentration.

At ultimate build-out, the bioscrubber odor control system will have a total treatment capacity of 46,250 ft^3/minute. It consists of five parallel treatment modules each with a maximum capacity of 9,250 ft^3/minute. The facility will have a rectangular footprint of approximately 30 feet by 100 feet. The properties of the concept system are summarized in Table 9.

TABLE 9
Bioscrubber Sizing Parameters
MWMC Facility Plan, Eugene-Springfield

Parameter	Value
Odor Control System Total Flow Rate	41,000 ft^3/minute
Maximum Flow per Bioscrubber Module	9,250 ft^3/minute
Number of Bioscrubber Vessels / Exhaust Fans	5
Bioscrubber / Exhaust Fan Flow Rate per Module	8,200 ft^3/minute
Estimated Exhaust Fan Static Pressure	7 In. W.C.
Estimated Fan Brake Horsepower per Module	14 hp
Estimated Fan Motor Size per Module	15 hp
Estimated Scrubbant Recirculation Rate per Module	215 gpm

TABLE 9
Bioscrubber Sizing Parameters
MWMC Facility Plan, Eugene-Springfield

Parameter	Value
Estimated Pump Head per Module	100 ft
Estimated Pump Brake Horsepower per Module	7 hp
Estimated Pump Motor Size per Module	7 ½ hp
Total Installed Horsepower	112.5 hp
Maximum Estimated System Power Demand	85 kW
Total Secondary Effluent Consumption	2.5 gpm

Notes:
ft^3/minute = cubic feet per minute
gpm = gallons per minute
hp = horsepower
kW = kilowatt