

A Regulatory Analysis of Part 17 – Odors

Full Benefit-Cost Analysis

Rhode Island Department of Environmental Management

Office of Air Resources

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Executive Summary

This benefit-cost analysis (BCA) has been prepared by the Rhode Island Department of Environmental Management's (RIDEM) Office of Air Resources (OAR) pursuant to and in accordance with R.I. Gen. Laws § 42-35-2.9. An in-depth look at the benefits and costs that could be monetized were analyzed in this report.

Benefits included were Quality of Life factor – Willingness to pay for Odor Abatement (monetized) and Economic Value of Outdoor Activity (not monetized).

- Quality of Life – WTP for Odor Abatement Low-end: \$1,431,425.25 (2025\$)
- Quality of Life – WTP for Odor Abatement Mid-range: \$2,290,280.30 (2025\$)
- Quality of Life – WTP for Odor Abatement High-end: \$3,435,420.61 (2025\$)

Costs included are Implementation of an Odor Control Plan, Staff Training, and Installation of odor Control Equipment (2025\$).

- Odor Control Plan In-House: \$1,452.00
- Odor Control Plan Out-of-House: \$8,869.86
- Staff Training: \$7,078.50
- Oxidizing Agents: \$2,640.00 - \$7,173.00
- Biofilter Installation: \$325,357.50 - \$1,188,887.50
- Biofilter O&M: \$80,850.00 - \$565,565.00
- Regenerative Thermal Oxidizer Installation: \$2,328,817.00
- Regenerative Thermal Oxidizer O&M: \$1,346,183.00

In summary, based off the costs and benefits calculated in this analysis, the following final net present values at 3%, 5% and 7% are shown below. The data associated with these calculations are further explained in this analysis.

Scenario	NPV at 3% Discount Rate	NPV at 5% Discount Rate	NPV at 7% Discount Rate
Low-End Enforcement	\$ 5,249,823.47	\$ 5,006,065.69	\$ 4,779,980.96
Mid-Range Enforcement	\$ 6,207,339.87	\$ 5,878,417.25	\$ 5,573,342.34
High-End Enforcement	\$ (1,567,508.48)	\$ (1,722,893.07)	\$ (1,867,011.90)

Based upon the results of this analysis, the OAR has determined that the proposed changes would not have a significant effect on business within Rhode Island.

Introduction and Background

The RIDEM is authorized to promulgate and implement these regulatory amendments pursuant to its enabling authority under R.I. Gen. Laws § 42-17-1.2(19) and Chapter 23-23 of the Rhode Island General Laws. These provisions provide the RIDEM with the statutory authority to adopt rules necessary to protect public health and the environment. The intended outcome of the proposed regulation is to reduce nuisance odor impacts and establish a consistent and enforceable standard for odor management across applicable facilities.

The need for this rule arises from the limitation in the current odor management requirements and ambiguity in existing odor standards, which has resulted in challenges for both regulated entities and the RIDEM in achieving consistent compliance and enforcement outcomes. The proposed amendments are designed to address these issues by improving clarity, strengthening procedural consistency, and modernizing odor management requirements based on available evidence and best practices. In doing so, the rule advances the principles of Executive Order 15-07 by promoting regulatory clarity, ensuring a least-burdensome approach consistent with achieving statutory objectives, and relying on sound evidence to support regulatory decision-making.

The purpose of Part 17 is to prohibit the release of air contaminants which may create odors beyond a facility's property line. As currently written, a violation of the regulation occurs when a RIDEM inspector determines that an objectionable odor is present beyond a facilities property line. Objectionable odors are often very difficult and subjective to determine, and as a result, the regulation was difficult to understand and enforce. The determination of what is objectional can vary from person to person. In an effort to correct this, odors are now clearly defined in the rule. An odor constitutes a nuisance if one or more representatives of the Department (RIDEM) determine that an odor exists with such intensity, characteristics, frequency, and duration that it is, or can reasonably be expected to interfere with the enjoyment of life or property. Odors can cause a significant impact to the enjoyment of life and property to an individual and the public. Regulations such as the proposed update to Part 17 are a crucial tool to protecting the public and environment in Rhode Island.

It should be noted that the RIDEM does not have the power to inspect private residential properties in accordance with RI General Law, Title 23 Health and Safety, Chapter 23 Air Pollution.

23-23-5 Powers and duties of the director

In addition to the other powers and duties granted in this chapter, the director shall have and may exercise the following powers and duties:

(7) To enter at all reasonable times in or upon any private or public property, except private residences, and to detain and inspect any motor vehicle for the purpose of inspecting or investigating any condition which the director shall believe to be either an air pollution source or in violation of any of the rules or regulations or orders promulgated under this chapter;

Categories of Proposed Regulatory Changes

Prior to evaluating specific regulatory alternatives, this BCA summarizes the principal categories of revisions proposed in the draft regulation. The purpose of this section is to provide context regarding the nature, intent, and anticipated implementation implications of the proposed amendments. The proposed revisions are intended to reduce nuisance odor impacts and establish a consistent and enforceable standard for odor management across applicable facilities.

The categories below group the related amendments by subject matter and summarize the rationale for each category of change. References to the corresponding sections of the proposed rule are provided for context.

Table of Proposed Regulatory Changes

Category of Change	Summary of Revision	Purpose of Revision	Relevant Rule Sections
Definition of “Odor”	Revision of the definition of odor to include more specific descriptions and identifying terms	Improve clarity, consistency, and enforceability of the regulation	17.4.
Odor Determinations	Revision of procedures and standards for odor determinations including using revised odor defining descriptions and adding a time based approach	Establish a clearer and more consistent implementation and enforcement procedures	17.7. A and B
Regulatory Scope/Applicability	Clarify applicability through revisions and adding Standard Industrial Classification (SIC) codes	Clarify which entities and activities are subject to the regulation	17.4. A. 5. 17.6.1. A.
Odor Control Plan (OCP) Requirements and Controls	Adding OCP requirements including: facility information, information on odors generated by facility, odor mitigation procedures and practices (administrative and/or engineering controls)	Promote consistent and proactive odor management practices and improve odor mitigation and compliance flexibility	17.8.

There are some overlap with State agencies outside of the RIDEM, however DEM has determined that these proposed changes are not duplicative of current requirements.

Within the Office of Air Resources, there is no specific regulation that points to Part 17 Odors in a current regulation, however sources that are subject to Part 9 Air Pollution Control Permits are generally also applicable to the requirements of Part 17 Odors.

Analysis

The RIDEM reviewed various odor control measures and techniques that are seen across industries and relevant to the facilities represented in the State of Rhode Island. This analysis portion will discuss in depth the identified benefits and costs found as a result of the proposed regulation updates.

Benefits include Willingness-To-Pay for odor mitigation which will improve quality of life for those located near or around industrial sites that can produce odors. This benefit was quantified as summarized below:

	% of Household WTP	Total (2025\$)
Low – End	5%	\$1,431,425.25
Mid – Range	8%	\$2,290,280.40
High - End	12%	\$3,435,420.61

It was also qualitatively discussed that a benefit to odor control would provide a societal benefit of economic value of outdoor activity.

The DEM identified multiple odor control scenarios that would be possible if found in violation of the proposed updated regulation and needing to implement an Odor Control Plan. The DEM put the values in like terms through dollar value for potential implementation costs, which are explained later in this analysis. The costs were identified for low, medium and high range enforcement scenarios.

Scenario	NPV at 3% Discount Rate	NPV at 5% Discount Rate	NPV at 7% Discount Rate
Low-End Enforcement	\$ 5,249,823.47	\$ 5,006,065.69	\$ 4,779,980.96
Mid-Range Enforcement	\$ 6,207,339.87	\$ 5,878,417.25	\$ 5,573,342.34
High-End Enforcement	\$ (1,567,508.48)	\$ (1,722,893.07)	\$ (1,867,011.90)

In summarization, the RIDEM would most likely see a Low-end enforcement scenario due to current enforcement trends and industries within Rhode Island. This includes 5 enforcement cases (1 per year for 5 years), with most sites using an OCP with Administrative controls only (4 sources) totaling in a cost of \$63,793.44, and one source using an OCP and Oxidizers for a cost of \$23,121.36.

Low-End Enforcement Scenario		
Analytical Year	Item	Cost Per Facility (incl. Transfers) * Number of Facilities
0	OCP + Admin Controls	\$ 63,793.44
0	OCP + Oxidizing Agents	\$ 23,121.36
0	OCP + Biofilter	\$ -
0	OCP + RTO	\$ -
Annually in AY 1 through 4	OCP + Admin Controls	\$ 28,314.00
Annually in AY 1 through 4	OCP + Oxidizing Agents	\$ 14,251.50
Annually in AY 1 through 4	OCP + Biofilter	\$ -
Annually in AY 1 through 4	OCP + RTO	\$ -
Calendar Year	Analytical Year	Costs
2026	0	\$ 86,914.80
2027	1	\$ 42,565.50
2028	2	\$ 42,565.50
2029	3	\$ 42,565.50
2030	4	\$ 42,565.50

Assumptions

A project lifetime of 5 years was chosen to represent costs over a 5-year timeline for a facility if found out of compliance with the regulation and would require an Odor Control Plan to be implemented. The

timeframe was determined to reasonably capture both initial and implementation cost and recurring operational, administrative, and maintenance costs associated with compliance activities.

A discount rate of 5% was chosen to be consistent with discount rates used by the United State Environmental Protection Agency in their economic analysis for environmental regulation proposals and updates. To evaluate the sensitivity analysis to changes in discount assumptions, additional sensitivity analyses were conducted using discount rates of 3% and 7%.

Certain anticipated benefits of the proposed amendments were not monetized due to data limitations and qualitative nature of some impacts. These non-monetized benefits may include reductions in odor-related nuisance conditions, improved responsiveness to odor complaints, greater regulatory clarity and improved consistency in odor management practices and compliance expectations.

Analysis of Impacts – Benefits

Economic Value of Quality of Life – Willingness to Pay Calculation

Willingness to Pay (WTP) is used in this analysis to estimate the economic value of quality-of-life impacts associated with odor exposure, consistent with established environmental economics literature that applies stated-preference method to value non-market goods. Under this approach, WTP reflects the maximum amount households are willing to pay to avoid or reduce odor-related disamenities, thereby providing a monetized estimate of welfare impacts that are otherwise difficult to quantify directly.

This approach is supported by prior literature applying contingent valuation methods to environmental and public health contexts, including odor-related impacts. For example, studies has found that odor nuisance can significantly affect perceived quality of life, even when odors are not associated with toxicological harm, due to their subjective and psychological effects on individuals and communities (Magdalena).

“The term “quality of life” used in the article is based on the definition of the World Health Organization (WHO). WHO defines Quality of Life in general as an individual's perception of their position in life within the context of the culture and value systems in which they live, and in relation to their goals, expectations, standards and concerns.... In most cases, the harmful effects of odours are not related to their toxic effects on the body but result from their subjective reception and evaluation, which have an adverse effect on the human psyche in the long run.” (Magdalena).

Consistent with the WHO's definition of quality of life, these impacts are understood as changes in individuals' perceptions of their well-being within their environmental and social context.

Economic literature further supports the use of WTP methods to value non-market environmental improvements. As noted in prior analyses of environmental projects, WTP has been widely applied to estimate societal benefits where market prices do not exist, despite recognized limitations related to survey design and stated preference bias (Adrila et al.; Uttam) When applied prudently, WTP provides a

structured means of translating changes in environmental quality into monetary terms for use in benefit-cost analysis.

A study conducted by economists in 1998, A Review of the Use of Contingent Valuation Methods in Project Analysis at the Inter-American Development Bank, looked at multiple environmental projects and the willingness to pay estimates involved in said projects. Willingness to pay is the maximum price a customer is willing to pay for a product or service (Harvard). Economists have used the willingness to pay method to determine societal benefit estimates for environmental projects/issues. Using this method in research allows for a dollar value to be assigned to factors that previously may not have been quantifiable. While there are limitations with this method, as it usually relies on surveys from consumers, it is a valid method to collect data.

“Though WTP (Willingness to Pay) is supposed to be debatable issue in terms of its validity, a prudent use of WTP (Willingness to Pay) for yielding benefit of non-tradable goods provides a single precise and accurate elicitation of changed utility value. With the review of papers since 1990 to till the data, mostly the environmental issues and few health economics papers seems employed the WTP (Willingness to Pay) method for benefit and utility elicitation” (Uttam)

A purpose of the Inter-American Development Bank analysis was to determine a willingness to pay (WTP) in money terms for posited change in environmental conditions. Specifically, this study looked at sewer/wastewater facilities and the willingness to pay (WTP) to improved environmental factors associated, including odors. (Ardila et al).

Country- Project	<u>Method</u>	<u>AEQ Target</u> (1996 US\$/household/month)	<u>Mean WTP</u>
BA-0036	CV	Beaches-swimmable water	\$1.04
BR-0072	CV	River pollution control-no specifics	\$7.85
BR-0072	CV	Beaches-swimmable water	\$7.74
BR-0073	CV	Beaches-swimmable water	\$5.40
BR-0073	CV	Beaches-swimmable water	\$7.28
CO-0082	CV	Odor elimination	\$3.24
CO-0208	CV (direct)	Odor elimination	\$3.28
CO-0208	CV (direct)	Odor elimination & aesthetics	\$7.14
CO-0208	CV (direct)	Swimmable water	\$11.34
CO-0227	CV	Swimmable water	\$3.72
EC-0161	Hedonic	Property "affected" by pollution	\$4.20
ME-0056	CV	Clean River-no specifics	\$6.30
NI-0027	CV	Odor elimination & aesthetics	\$4.00
PR-0064	CV	Improvement in Water Quality	\$13.38
UR-0023	CV	Beaches-swimmable water	\$0.74
<i>Average:</i>			\$5.78
<i>Standard Deviation</i>			\$3.50
<i>Median</i>			\$5.40

Note: WTP expressed in constant 1996 US\$ by application of the US BLS Implicit Price Deflator.
CV means referendum question format unless otherwise noted.

As seen in the above table, using the contingent valuation method, 3 projects dealing with odor elimination concluded a Mean Willingness to Pay (WTP) per household, per month of \$3.24, \$3.28 and \$4.00. The average of these values $(3.24+3.28+4)/3 = \$3.50$ in 1996\$. Using the CPI Inflation calculator, that is valued at \$7.20 per household, per month in 2025\$. This value will be used in the benefits calculation. These studies conducted looked at major cities or towns within a specific state/province and did not account for the entire state/province.

The RIDEM has a lot of assumptions in this determination. The study was based off of Latin American countries and specifically sewage treatment facilities. For the purpose of this analysis the values found were converted to US \$ and adjusted to current day inflation rates. The study looked at higher density state/provinces near sewage treatment facilities. The RIDEM is also making a liberal assumption in using this study to calculate the value of willingness to pay for odor abatement for sewage treatment because it can be considered the most highly offensive odor. It does not account for all the different types of odors that can be offensive to people, but this is the best available data to calculate WTP for the proposed regulation update. There are limits in what a person or household may consider an odor and if it affects them as much as their neighbor.

Using the U.S. Census data, the OAR estimated that about five (5) to twelve (12) percent of the 332,049 households in Providence County and Kent County – a proxy for population density in the State’s industrialized area most likely to be impacted by nuisance odor – would have the willingness to pay for odor mitigation. (See Appendix A for calculation spreadsheet).

Societal Willingness to Pay for Odor Mitigation

	% of Household WTP	Total (2025\$)
Low – End	5%	\$1,431,425.25
Mid – Range	8%	\$2,290,280.40
High - End	12%	\$3,435,420.61

The resulting benefit estimate are presented as low (5%), base (8%), and high (12%) scenarios to reflect uncertainty in both (1) proportion of households experiencing meaningful odor-related disamenity and (2) the appropriate transfer of WTP values from broader environmental valuation literature to odor-specific impacts in Rhode Island. This approach is intended to provide a transparent and conservative bounding of potential quality-of-life benefits associated with the proposed regulatory changes.

For the low-end valuation, 5% of households was chosen for the percent of RI households located within the Providence and Kent county that may be willing to pay to implement odor mitigation. This is a good value, as not all persons are affected the same from odors, and not all households in a specific area near industry may be affected by an odor. The RIDEM received odor complaints for specific areas such as in Providence and Kent County that are nearby businesses and are affected by odors extending facilities property lines. These complaints come in from multiple different households within an area and sometimes may account for around 5% of the immediate neighborhood surrounding a subject business that may be emitting an odor. 5% is assumed to be a good low-end value for this analysis.

A mid-range percent of households within Providence and Kent County of 8% was chosen to account for more households who could potentially be within a business operation area and be affected by odors

extending beyond property lines of said business. This was chosen for a reasonable but still low value of households that would be WTP for odor mitigation efforts.

A high-end value of 12% was used to estimate the highest amount of households in the Providence or Kent County that may be willing to pay for odor mitigation. Not all household are affected by odors and may be sensitive to certain odor types (sewage vs coffee roasters vs plastics manufacturing). 12% was chosen as the highest percent that could be WTP, within reason.

The most reasonable approach to this analysis is to take the low-end valuation of % of households (5%) in Providence and Kent county that may be willing to pay to implement odor mitigation. Providence and Kent county are good representations of areas that have higher population density, proximity to industrial areas, and is the reasonable approach for this analysis. The valuation of \$1,431,425.25 (2025\$) will be used as the benefits calculated for this analysis. This is the best available data for this analysis. (See Appendix A for calculation spreadsheet).

Economic Value of Outdoor Activity

This analysis did not monetize the value of increased outdoor activity as it is too broad a topic to cover in this analysis. It is important to discuss as a benefit to the implementation of the updated odor regulation as it is an important factor. Places that may be affected by odors from facilities in a given area may not participate in outdoor activity as frequently in areas not affected by odors. The proposed update in regulation would allow the RIDEM to further investigate and enforce the odor requirements, which will lead to a reduction in odors in a given area around a facility. With odors reduced due to the proposed updated regulation, it will allow more people to participate in outdoor activity.

A study published in 2017, Handbook of Environmental Psychology and Quality of Life Research, author Maria Lima took a look at Living in Industrial Areas: Social Impacts, Adaptation and Mitigation further. Using the principal proposed by Moser, “people–environment congruity refers to the interrelation between the individual and his or her (especially residential) environment, considering the match between individual life satisfaction and objective standards of living” (Moser), research was conducted on the effects of quality of life and its proximity to industrialized areas.

“Research has consistently shown that people are annoyed by the level of noise and air quality, which are often inevitable effects of industrial activity. Environmental annoyance is generally defined as “a feeling of dissatisfaction associated with any agent or condition that is believed to affect individuals in an adverse way” and has often been associated with increased feelings of stress. Specifically, annoyance with noise has usually been identified as a source of low psychological and physical well-being in more general terms while annoyance with air quality has also been associated with harmful effects on psychological health” (Lima).

According to this study, high levels of stress in an individual can lead to a lower quality of life.

A study conducted in 2020 in Vancouver, Canada, explored the utility of crowd-sourced odor report data in improving understanding of spatiotemporal patterns of odor experiences and their impacts.

“Users report long-term avoidance of odorous areas (1% of the reported actions), such as 'moved away' or going 'to a distant part of the city to go for a walk'—significant life changes to avoid odors.

Similar observations of the desire to relocate due to the impacts of malodor have been reported elsewhere as well” ([Sahil](#)).

It can be assumed that when there are odors present, a person will be less likely to leave their house, or travel farther to enjoy outdoor activities. RIDEM operates an odor complaint line which collects complaints from members of the public on odors throughout the state. The data included in these complaints outline the date, time, severity of odor, and dialogue (comments). Many of the complaints received to the RIDEM include that odors are so significant that person submitting the complaint had to close their windows and screen doors to avoid odors outside. RIDEM has received complaints that include citizens not wanting to go outside of their homes due to severity of odors outside.

According to the US Bureau of Economic Analysis, Outdoor activity in Rhode Island accounted for \$1.7 billion of the total US Outdoor Recreation Value of \$563 Billion in 2022 (United States Bureau of Economic Analysis). Outdoor activities as follows – boating/fishing, RVing, Motorcycling/ATVing, Climbing/hiking/tent camping, recreational flying, snow activities, hunting/shooting/trapping, equestrian and bicycling.

Areas highly impacted by odors and air contaminants may be prevented from leaving their homes to participate in these activities. According to Lima, “In some situations, environmental changes can introduce modifications in the structure (e.g., new highways) or the ambiance (e.g., smells) of the locality, so that they reduce the use of public spaces and socialization practices” (Lima). The proposed update to the regulation may lead to an increase in these activities, therefore adding more value to the RI economy.

Analysis of Impacts – Costs

Implementation of Odor Control Plan – In House

Facilities that have been deemed by the RIDEM to cause an odor in violation of the regulation will be required to submit an Odor Control Plan to the DEM. Developing a program, as is developing any new procedure or program into standard operating procedures a business has, have a cost associated with it. The business must take the time to research and develop a program that will address the odors present at a facility and how to reduce these odors.

When a business has an environmental person on staff, whether that be an EHS Specialist, Facility Maintenance Manager, or a Maintenance Technician, the Odor Control Plan may be drafted and created on site. This would require some time and effort from the specific staff person, so opportunity cost needs to be calculated.

Using salary values identified in this analysis, the following calculations were conducted for the creation and implementation of an Odor Control Plan In-House.

Position	Salary (2025\$)	Calculation	Total (2025\$)
Environmental Health and Safety Specialist (EHS)	\$75,512.00 a year Or \$36.30 per hour	\$36.30 x 40 hours =	\$1,452.00

Facility Maintenance Manager	\$74,947.00 a year Or \$36.03 per hour	36.03 x 40 hours =	\$1,441.20
Maintenance Technician	\$23.67 per hour	23.67 x 40 hours =	\$946.80

40 Hours was chosen as a timeframe it would take a staff member to draft and implement an Odor Control Plan at a facility. It can be assumed that businesses that have direct environmental program people on staff can more easily implement and adapt to the requirements of an odor control plan, as the person has an environmental background already and it would be a standard addition to regular job tasks. The requirements are similar to other environmental program regulations and requirements and would only be small differences in day-to-day business operations. The highest value of \$1,452.00 for an EHS Specialist to create and implement an Odor Control Plan will be used in the analysis, as this is the most likely scenario and is consistent with what RIDEM sees currently. (See Appendix A).

Implementation of Odor Control Plan - Out of House

The facilities that have been deemed by the RIDEM to cause an odor in violation of the regulation will be required to submit an Odor Control Plan to the RIDEM. Developing a program, as is developing any new procedure or program into standard operating procedures a business has, have a cost associated with it. The business must take the time to research and develop a program that will address the odors present at a facility.

If a business does not have a staff person capable of creating the plan, an outside environmental consultant may be hired to do the work. The costs of hiring a consultant to complete the work may vary, but an estimate of costs was analyzed for this report.

For this analysis, a project timeline of 49 hours was chosen. A typical project will include multiple staff members to work on and review. A project engineer, senior engineer, supervisor, and administration/office personnel will usually be part of the team working on an environmental project. The breakdown of jobs and pay as outlined here.

Title	Pay 2016 \$	Pay 2025 \$	Hours	Total \$ (2025 \$)
Project Engineer	123.72	168.36	40	6,734.40
Senior Engineer	150.12	204.29	1	204.29
Principal Engineer	194.59	264.80	7	1,853.60
Admin	57.00	77.57	1	77.57
			49	\$8,869.86

Data for costs per job was compared to many environmental consulting companies but based off SCRA values in 2016 (CSRA pg. 12-13). All values were put into the US Bureau of Labor Statistics CPI Inflation Calculator to reflect 2025\$.

The main engineer on the project, the project engineer, will take up most of the time contracted for creating the odor control plan. This includes visiting the facility (if required) to identify odor-emitting activities and the emissions, drafting up the plan with administrative controls and engineering controls,

monitoring plan and other requirements as outlined in the proposed updated regulation. Forty (40) hours was determined to be the average time it would take to research, identify, draft and finalize the odor control plan for a facility.

A principal engineer (manager or supervisor) will do a complete review of the project and sign off on the project for finalization. A total of seven (7) hours of time was chosen as the review process time.

A senior engineer and administrative assistant were both given a one (1) hour timeframe of work on a project. A senior engineer may originally assign the work to the project engineer, or to confirm completion before handing to the principal engineer for review. An administrative assistant may be requested to print and mail the plan to the facility, process contracts, or process pay.

The total cost to the facility to hire a consulting firm to create an odor control plan would be a one-time initial cost of \$8,869.86. (See Appendix A).

Staff Training, Administrative Control Requirements– Opportunity Cost

For a facility required to implement an Odor Control Plan, and only doing administrative controls there may be an adjustment period of staff training, and becoming familiar with any new tasks associated with the Odor Control Plan. These tasks may be new to employees of an affected facility and will take time to learn and incorporate into daily operations. The following job titles and salaries would be the workers assigned with taking on any environmental related administrative tasks, as this is normally part of the position already.

Position	Salary (2025\$)	Source
Environmental Health and Safety Specialist (EHS)	\$75,512.00 a year Or \$36.30 per hour	ZipRecruiter
Facility Maintenance Manager	\$74,947.00 a year Or \$36.03 per hour	ZipRecruiter
Maintenance Technician	\$23.67 per hour	Indeed

With these above salaries, a calculation of opportunity cost can be done. According to Investopedia, Opportunity Cost *represents the potential benefits that a business, an investor, or an individual consumer misses out on when choosing one alternative over another.* For the purpose of this analysis, the business approach will be used. A business that has had to implement an odor control plan, will have to assign work to an employee in addition to their regular scheduled tasks. This can result in additional hours being added to a worker's schedule, or reduction in productivity on other tasks while in an adjustment period for newly assigned requirements. This analysis will assign 1 hour a day to a worker's schedule, using the above salaries. In most cases, one worker will be assigned the work on a regular schedule and can include various types of workers. The most common workers who may work on environmental related tasks are either EHS Specialists, Facility Maintenance Managers, or Maintenance Technicians. For this calculation, a time period of a regular work week, Monday – Friday, 40 hours a week will be used, and for a total of 6-months. 6-months was chosen as a time period in which a business will adjust to new tasks

and roles, and the opportunity costs will be negligible. After six-months, staff will be adjusted to the new tasks and will have learned to complete their new tasks alongside their regular schedule, without loss in productivity. This is an opportunity cost because the business could have these workers do their regular assigned tasks for the operation and profit of the business, versus work on the odor control plan requirements. Therefore, the following opportunity costs calculations are made,

Position	Calculation	Total (2025\$)
EHS Specialist	\$36.30/hr. x 5 hours a week x 26 weeks	\$4,719.00
Facility Maintenance Manager	\$36.03/hr. x 5 hours a week x 26 weeks	\$4,683.90
Maintenance Technician	\$23.67/hr. x 5 hours a week x 26 weeks	\$3,077.10

This calculation has many assumptions and limitations. This is assuming that an onsite EHS person or someone responsible for environmental compliance, would have enough knowledge and experience to understand the requirements of the odor control plan, along with the skills to adhere to the plan on a day-to-day basis. This also assumes that an EHS person or someone responsible for environmental compliance would be at an average salary rate based off available data at the time of this analysis. If a worker is more experienced or a company pays higher than average rates, that can increase the total costs. It also assumes that 6-months would be enough time to incorporate any extra tasks required by the odor control plan.

Due to these assumptions and limitations, the following sensitivity analysis is conducted.

For a 1-year period:

Position	Calculation	Total (2025\$)
EHS Specialist	\$36.30/hr. x 5 hours a week x 52 weeks =	\$9438.00
Facility Maintenance Manager	\$36.03/hr. x 5 hours a week x 52 weeks =	\$9367.80
Maintenance Technician	\$23.67/hr. x 5 hours a week x 52 weeks =	\$6154.20

For a longer work day/more time a week (2 hours per work day) on a 6-month time period:

Position	Calculation	Total (2025\$)
EHS Specialist	\$36.30/hr. x 10 hours a week x 26 weeks =	\$9438.00
Facility Maintenance Manager	\$36.03/hr. x 10 hours a week x 26 weeks =	\$9367.80
Maintenance Technician	\$23.67/hr. x 10 hours a week x 26 weeks =	\$6154.20

For a higher salary on a 6-month period (adding \$5 for simplification calculations):

Position	Calculation	Total (2025\$)
EHS Specialist	\$41.30/hr. x 5 hours a week x 26 weeks =	\$5369.00
Facility Maintenance Manager	\$41.03/hr. x 5 hours a week x 26 weeks =	\$5333.90
Maintenance Technician	\$28.67/hr. x 5 hours a week x 26 weeks =	\$3727.10

For a newly hired full time employee:

Position	Salary (2025\$)	Source
Environmental Health and Safety Specialist (EHS)	\$75,512.00 a year Or \$36.30 per hour	ZipRecruiter
Facility Maintenance Manager	\$74,947.00 a year Or \$36.03 per hour	ZipRecruiter
Maintenance Technician	\$49,233.60 a year Or \$23.67 per hour	Indeed

For the purpose of this analysis, the average value of \$7,078.50 for an EHS Specialist working for 5-10 hours a week for 6-months will be used in the calculation, as this is the most likely scenario the RIDEM would see. The average value of 5 hours a week for 6-months and 10 hours a week for 6-months was used to reasonably represent the opportunity cost that a facility may see in this scenario. The RIDEM meets with and works with many regulated facilities that are subject to Part 17 Odors and see most often an EHS Specialist handling the environmental work. It is the higher valued position cost-wise for the likely scenario of additional work added to a staff member already hired by the company. (See Appendix A for calculation spreadsheet).

Installation of Odor Control Equipment (Engineering controls)

A facility may need to install odor control equipment (engineering controls) if the administrative controls implemented do not result in elimination of detectable odors off property lines. The cost of types of odor control equipment can range from facility to facility, depending on the type of odor and its severity. Not all facilities subject to the regulation will be required to install engineering controls. Facilities that have been required to submit an Odor Control Plan, and administrative controls are not sufficient to mitigate the odors, may need to install engineering controls to address the odors. It can be assumed that facilities would take the lowest cost option that fits their operation best.

Based on an EPA study conducted on odor controls in September 2000, the following chart was included (EPA (2)):

TABLE 2 RELATIVE COSTS OF ODOR CONTROL TECHNOLOGIES

System	Overall	Capital	Operation/ Maintenance	Electrical or fuel	Supplies/ Chemicals	Effectiveness
Biofilter	Moderate	Moderate- but land area needed	Moderate	Low	Water needed	High >95% in compost
Activated Sludge Basins	Low, if existing system	Low, if existing system	Low, if existing system, may corrode blowers	Low, if existing system and biosolids processing facility is close	Low	High 90-95% for H ₂ S and Ammonia
Wet Chemical Scrubbers	High	High-up to 50% of total plant costs	High - much high speed equipment + instrumentat'n	High - must move water at high pressure	High - chemical costs and water demand	High <80%-99% handles alkaline stab and all plant odors
Regenerative Thermal Oxidizers	High	Moderate	High- due to high temp equipment	High - tremendous heat demand	High - oil or gas	Good for organic odorants from incinerators, and heat dryers
Oxidizing Agents	Varies- moderate to high	Low	Low- just mat'l handling issues	Low - small pumps required	High - potassium permanaganate can be expensive	Varies from one plant to another
Counteractant & Neutralizing Agents	Moderate	Low- moderate	Varies from one plant to another	Low	High - usually patented compounds	Varies, but may help at end use site.

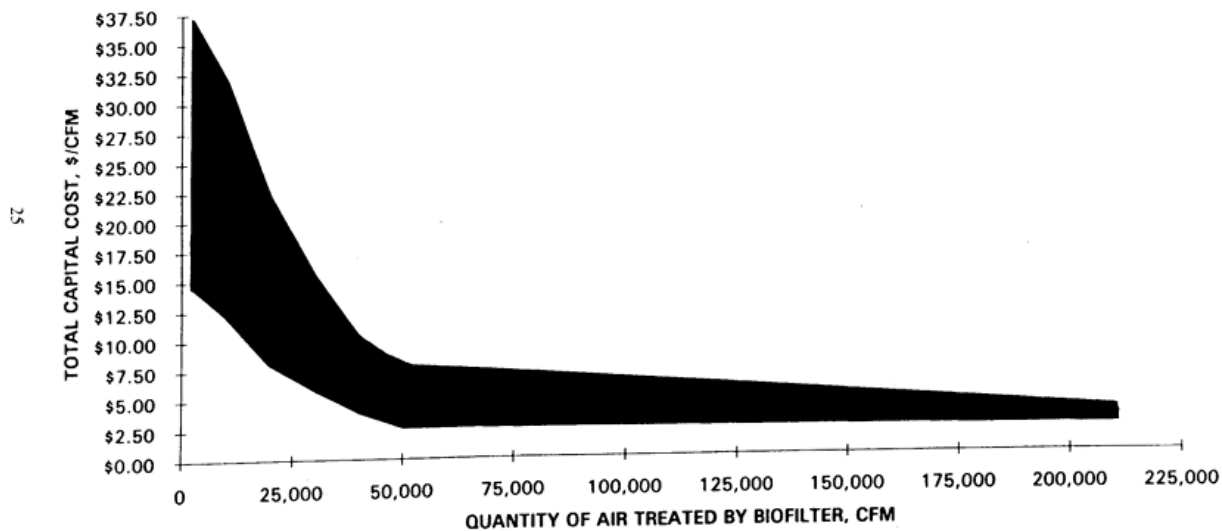
Source: Hentz et al, Haines et al, Giggey, Ostojic and O'Brien, Pisarczyk and Rossi, Ponte, Bowker, Vaith et al, Williams, Wu.

The RIDEM does not expect a Wet Chemical Scrubber to be used for odor control in the state. It is highly unlikely for this technology to be installed as a result of an odor violation with the proposed updates to the regulation. This analysis does cover the costs of installing and operating a Regenerative Thermal Oxidizer, but the RIDEM also does not expect this type of odor control equipment to be installed and used at a facility as a result of an odor violation. It is included in this analysis as the highest valued type of equipment that could be used for odor control.

Biofilter

A study conducted by E&A Environmental Consultants of North Carolina, Biofilter Economics and Performance, included the following table (Boyette):

FIGURE 1 BIOFILTER CAPITAL COST PER CFM OF AIR TREATED



Based upon the scfm that flows through a biofilter will determine the price. There are many factors that will determine the flow rate through a biofilter, and it is dependent on facility operations. Some of the capital costs studied include, Pre-treatment of emissions, concentration and biodegradability of compounds, quantity of air being treated, removal efficiency requirements, ductwork, available space, degree of automatic desired, degree of flexibility, and design factors. The operating costs identified are electricity, media replacement, periodic inspection and testing, equipment maintenance and side stream treatment, if applicable. All of these specifics were studied and determined in the above-mentioned graph. It should be noted that although this report was conducted many years ago, the technology of biofilters has remained the same. For this analysis, the costs identified have just been adjusted to 2025\$. Although this technology has only improved and become more efficient and widely used, the RIDEM has assumed the technology cost has not decreased due to efficiency and that the rate of price increase was the same as the rate of inflation.

The report summarized, for small biofilters treating less than 15,000 cubic feet per minute (“CFM”), capital costs range from \$10 to \$38 per CFM of air treated, adjusted to 2025\$ is \$20.99 – \$79.75. For biofilters treating 100,000 CFM or more capital costs range from \$2.50 to \$5.00, adjusted to 2025\$ is \$5.25 to \$10.49 per CFM treated.

The study also concluded that Operation and Maintenance costs range from \$2-\$14 per CFM a year, adjusted in 2025\$ is \$4.20 - \$29.38 per CFM. Annual costs are identified as electricity to run the blower, and periodic media replacement. The RIDEM chose to include a calculation that would account for a higher end biofilter treating 100,000 CFM. Included are calculations that account from 95% of the biofilters installed treating 15,000 CFM and 5% of biofilters installed treating 100,000 CFM.

Calculations identified below.

Scenario	Calculation	Total (2025\$)
----------	-------------	----------------

Installation Costs Low end	$=(0.95 \times \$20.99 \times 15,000 \text{ CFM treated}) + (0.05 \times 5.25 \times 100,000 \text{ CFM treated})$	\$325,357.50
Installation Costs High end	$=(0.95 \times \$79.75 \times 15,000 \text{ CFM treated}) + (0.05 \times 10.49 \times 100,000 \text{ CFM treated})$	\$1,188,887.50
Annual Costs Low end	$=4.2 \times ((0.95 \times 15,000 \text{ CFM treated}) + (0.05 \times 100,000 \text{ CFM treated}))$	\$80,850.00
Annual Costs High end	$=29.38 \times ((0.95 \times 15,000 \text{ CFM treated}) + (0.05 \times 100,000 \text{ CFM treated}))$	\$565,565.00

This calculation has a few assumptions and limitations. This analysis assumes a 15,000 CFM biofilter would be the average the DEM would see for the purpose of odor control. This technology can treat various levels of CFM, from 0 to 225,000 CFM. It is all dependent on the nature of the business and operations of what needs to be treated.

For the purpose of this analysis, the values/calculations associated with 15,000 CFM of air treated was used, as this is the most likely scenario the RIDEM would see. Facilities that may be subject to needing to install odor control equipment would see 15,000 CFM being a likely amount needing to be treated before release to the atmosphere. A business may have a limitation in space to install equipment, so will take actions to reduce the amount of actual air needing to be treated through other means. The values chosen for the calculation are as identified above, low-end \$325,357.50, high-end \$1,188,887.50, low end O&M \$80,850.00 and high-end O&M \$565,565.00. (See Appendix A for calculation spreadsheet). 15,000 CFM is the most likely scenario the RIDEM will see for installation of a biofilter at a facility.

Regenerative Thermal Oxidizer (RTO)

The USEPA released a cost estimate study on thermal and catalytic oxidizers as part of their studies on Cost Reports and Guidance for Air Pollution Regulations, which provides an in-depth study of the various control equipment and their capital costs, operating costs, etc. A spreadsheet is creating using the formulas identified by the EPA and can be used to calculate costs for these types of equipment. For example, a Regenerative Thermal Oxidizer (RTO) treating 20,000 standard cubic feet (“SCF”) will have the following costs. (EPA (4)).

General data inputted:

Desired dollar-year	2025			
CEPCI* for 2025	811.5808	Enter the CEPCI value for 2025	390.6	1999 CEPCI
Annual Interest Rate (i)	7.25	Percent		
Electricity (Cost _{elect})	0.11098	\$/kWh		
Natural Gas Fuel Cost (Cost _{fuel})	0.0433	\$/scf		
Operator Labor Rate	\$31.59	per hour		
Maintenance Labor rate	\$36.33	per hour		
Contingency Factor (CF)	10.0	Percent		

Values adjusted to 2025 numbers.

Current federal interest rate 7.25% (Bank, 2025).

Current Rhode Island electricity rate for industrial/commercial sources is 11.098 cents/kwh. (RIPUC)

Current Rhode Island natural gas rate for industrial/commercial large sources is 0.0433 \$/scf (RI Energy)

Current Operator Labor Rates/Maintenance Labor Rates: \$31.59 and \$36.33 (Bureau of Labor Statistics)

Data calculated from EPA Spreadsheet:

Direct Costs			
Total Purchased equipment costs (in 2025 dollars)			
Incinerator + auxiliary equipment ^a (A) =			
Equipment Costs (EC) for a Fixed Bed/Monolith Catalytic Oxidizer			in 2025 dollars
Instrumentation ^b =	0.10 × A =		\$113,554
Sales taxes =	0.03 × A =		\$34,066
Freight =	0.05 × A =		\$56,777
Total Purchased equipment costs (B) =			\$1,339,941 in 2025 dollars
<u>Footnotes</u>			
a - Auxiliary equipment includes equipment (e.g., duct work) normally not included with unit furnished by incinerator vendor.			
b - Includes the instrumentation and controls furnished by the incinerator vendor.			
Direct Installation Costs (in 2025 dollars)			
Foundations and Supports =	0.08 × B =		\$107,195
Handlong and Errection =	0.14 × B =		\$187,592
Electrical =	0.04 × B =		\$53,598
Piping =	0.02 × B =		\$26,799
Insulation for Ductwork =	0.01 × B =		\$13,399
Painting =	0.01 × B =		\$13,399
Site Preparation (SP) =			\$0
Buildings (Bldg) =			\$0
Total Direct Installaton Costs =			\$401,982
Total Direct Costs (DC) =	Total Purchase Equipment Costs (B) + Total Direct Installation Costs =		\$1,741,923 in 2025 dollars
Total Indirect Installation Costs (in 2025 dollars)			
Engineering =	0.10 × B =		\$133,994
Construction and field expenses =	0.05 × B =		\$66,997
Contractor fees =	0.10 × B =		\$133,994
Start-up =	0.02 × B =		\$26,799
Performance test =	0.01 × B =		\$13,399
Total Indirect Costs (IC) =			\$375,183
Contineny Cost (C) =	CF(IC+DC)=		\$211,711
Total Capital Investment =	DC + IC +C =		\$2,328,817 in 2025 dollars

This data calculated in the EPA spreadsheet is the best available cost data for an RTO (Regenerative Thermal Oxidizer) available to the RIDEM for this analysis. The total installation cost will be \$2,328,817.00 in 2025\$. (See Appendix B for EPA calculation spreadsheet tool.)

Direct Annual Costs		
Catalyst Replacement Cost	$= 1.08 \times CC \times Vol_{cat} \times FWF$ Where CC is the \$/ft³ cost for the replacement catalyst; Vol_{cat} is the volume of catalyst required based on the waste gas flow rate (Q_{in}) and the catalyst space velocity (Φ); and FWF is the future worth factor.	\$0
Annual Electricity Cost	= Fan Power Consumption × Operating Hours/year × Electricity Price =	\$91,129
Annual Fuel Costs for Natural Gas	= Cost _{fuel} × Fuel Usage Rate × 60 min/hr × Operating hours/year	\$842,314
Operating Labor	Operator = 0.5hours/shift × Labor Rate × (Operating hours/8 hours/shift)	\$17,296
	Supervisor = 15% of Operator	\$2,594
Maintenance Costs	Labor = 0.5 hours/shift × Labor Rate × (Operating Hours/8 hours/shift)	\$19,891
	Materials = 100% of maintenance labor	\$19,891
Direct Annual Costs (DC) =		\$993,115 in 2025 dollars
Indirect Annual Costs		
Overhead	= 60% of sum of operating, supervisor, maintenance labor and maintenance materials	\$35,803
Administrative Charges	= 2% of TCI	\$46,576
Property Taxes	= 1% of TCI	\$23,288
Insurance	= 1% of TCI	\$23,288
Capital Recovery	= CRF[TCI-1.08(cat. Cost)]	\$224,113
Indirect Annual Costs (IC) =		\$353,069 in 2025 dollars
Total Annual Cost =		DC + IC = \$1,346,183 in 2025 dollars

This data calculation from the EPA spreadsheet is the best available cost data for an RTO available to the RIDEM for this analysis. The total annual cost will be \$1,346,183.00 in 2025\$.

Oxidizing Agents

Oxidizing Agents such as activated carbon are used to absorb organic compounds from liquids to gases and is effectiveness in odor control. A facility may be able to add carbon or other media to their processes to react and control odors. Costs as follows,

Oxidizer Type	Cost (2025\$)	Year Total, one per month (2025\$)	Year Total, 3 per month (2025\$)	Source
Catalytic Activated Carbon	\$245.00 for 40 lb.	\$2,940.00	\$8,820.00	Industrial Odor Control
Coconut-Shell-Based Activated Carbon Pellets	\$220.00 for 55 lb.	\$2,640.00	\$7,920.00	Industrial Odor Control
Bituminous Activated Carbon	\$290 for 55 lb.	\$3,480.00	\$10,440.00	Aquatic Solutions
Activated Carbon Charcoal	\$440.50 for 55 lb.	\$5286.00	\$15,858.00	CQ Concepts Inc.

There are some limitations with this calculation. All businesses are unique in their operations, and RIDEM is assuming an average facility would only use one 40-55 lb. bag of the oxidizing agent per month. This may not be an accurate representation of all possible usages for facilities that would be subject to this

regulation. It is possible a facility could use less or more. That is why the year total, 3 used in a month was calculated for each oxidizer type identified above.

The final calculations as identified in the Appendix A, would be an annual cost of \$2,640.00 for one site (Coconut-shell based activated carbon pellets) or averaged for all identified costs (1 to 3 bags used, each type of oxidizer) of \$7,173.00. (See Appendix A for calculation spreadsheet.)

Costs Summarized

These are some of the many types of engineering controls that are used to treat odors. A facilities decision and use will range depending on the operations and types of odors. Due to the range of types of facilities and their operations within Rhode Island, it is difficult to pinpoint the exact amount of engineering controls needed as each facilities needs differ. Not all facilities will be required to install an air pollution control device such as the above mentioned

For the total costs analyzed in this report, a summary as follows for a simple case to the worst-case scenario for facilities that have has odors identified by the RIDEM to be out of compliance with the regulation.

Severity of Case	Types of Compliance Methods	2025 \$
Low	Has EH&S person on payroll who can create Odor Control Plan	\$1,452.00
Low	Facility does not have a EH&S person on payroll who can create an Odor Control Plan, has to hired outside consultant and opportunity cost of new changes	\$8,869.86 + \$7,078.50 = \$15,948.36
Medium	Odor Control Plan (in house) and Facility has to install minimal engineering controls for odors – Oxidizing Agents	\$1,452.00 + \$2,640.00 = \$4,092.00
Medium	Odor Control Plan (not in house), Opportunity Cost and Facility has to install minimal engineering controls for odors – Oxidizing Agents	\$8,869.86 + \$7,078.50 + \$2,640.00 = \$ 18,588.36
High	Odor Control Plan (in house), and installation of high engineering controls - Biofilter	\$325,357.50 low end \$1,188,887.50 high end
High	Odor Control Plan (not in house), Opportunity Cost, and installation of high engineering controls – RTO	\$8,869.86 + \$7,078.50 + \$2,328,817.00 = \$2,344,765.36

In most cases, as seen in the RIDEM, the amount of odor complaints that come into the RIDEM are minimal and may not result in a violation. A facility that has been found to have an odor complaint, or odors are found during an inspection, it can be attributed to open windows or doors at the facility. A

RIDEM representative will order the facility to close all windows and doors leading to outside, which will result in the decrease or elimination of odors present off-site. This is, in most cases, the likely outcome of a facilities response to an odor violation. There are some cases where there are weather factors that are causing the odors to travel off property lines such as high winds or storm occurrences. These are not necessarily a facilities fault, and the RIDEM takes into account odors present during high winds vs. normal wind patterns when determining a violation in the odor regulation. In most cases, facilities have an environmental or EH&S person on site, who is capable of producing an Odor Control Plan if asked by the RIDEM to produce one. These two scenarios listed in the Low severity category in the table above, are the two most likely to occur with this proposed regulation update. The RIDEM also provides help to regulated entities who are subject to the Air Pollution Control Regulations, and offer advice, suggestions, and review of plans to assist any facilities that have found themselves in violation of the odor regulation.

In the unlikely event that after a violation is found, and the Odor Control Plan at the facility does not address the issues of odors, a facility may be required to install air pollution control device specifically aimed to reduce odors. This is considered an unlikely event because if a facility has high enough odor violations to need to install equipment, it would be subject to the Air Permits regulation already in place at the RIDEM Office of Air Resources (OAR). As presented in this analysis, some odors can be linked to HAPs or VOCs, and therefore will already require air pollution control equipment to control the emissions, thus already having this equipment to control odors. In this scenario, odors may be present due to a malfunction of air pollution control equipment. In the case that a facility does not have any equipment installed and is not exceeding the Air Permit minimum quantities that would require a permit, a facility may have to install engineering controls to treat odors. The equipment outlined in the analysis range, as seen in the medium to high severity categories in the table above.

of Facilities

The RIDEM OAR has determined that this Part is generally applicable to all permitted and non-permitted facilities in the State of Rhode Island that fall into the following SIC classifications.

Standard Industrial Classification (SIC) Manual, 1987

- a. Manufacturing (**20-39**);
- b. Transportation, communications, electric, gas and sanitary service (**40-49**);
- c. Personal services (**72**);
- d. Automotive repair, services and parking (**75**);
- e. Miscellaneous repair services (**76**); or
- f. Health services (**80**)

The RIDEM OAR utilizes a database for facilities and their operations. Using the data that is available to the RIDEM, the following sectors and sites were further identified as possible sites that would be subject to the proposed updated regulation. This data set does not include facilities that the RIDEM may not be aware of yet or new businesses starting operations after this analysis was conducted. A 5% increase in the total sites will be added to account for new source being added to the universe of facilities that could be subject to the odor regulation.

Types of facilities, including, but not limited to, that are subject to odor regulations are as follows:

- Manufacturing (All types – Chemical, Products, Plastics, Wood products, Jewelry, Metals, etc.): **176**
- Textiles: **20**
- Asphalt & Cement: **12**
- Rendering/Meat Packing/Slaughterhouses: **1**
- Automotive Repair, Paint, Maintenance, etc.: **265**
- Landfill: **1**
- Waste Treatment & Collection: **4**
- Sewage: **23**
- Stone Mining/Quarrying: **5**
- Hospitals/Medical: **19**
- Drycleaners/Laundry Services: **38**
- Crematories/Pet Crematories: **7**
- Boat Building/Ship Building: **28**
- Coffee/Tea Manufacturing: **6**
- Commercial Bakeries: **2**
- Printing: **13**
- Electroplating, Plating, Polishing, etc.: **24**
- Electric Power Generation/Distribution Services & Natural Gas Distribution: **27**
- Foundries, Metal Working, Smelting: **20**
- Machine Shop: **3**
- Materials Recovery: **3**
- Millwork: **4**
- Waste Treatment: **2**
- Petroleum Storage/Fuel Dealers: **8**
- Wood Preservation: **2**

Total DEM Database Sources: **709**

5% increase: ~ 35 sources = **744** Sources potentially affected by proposed regulation update. This value was inputted into the spreadsheet for total number of sources.

Each type of business is different and could comply with the requirements of the regulation in a variety of ways, depending on the nature of their odors.

Calculation Assumptions and Parameters

Parameter/Assumption	Value (2025 USD)
Societal WTP for odor mitigation (LOW-END)	\$ 1,431,425.25
Societal WTP for odor mitigation (MID-RANGE)	\$ 2,290,280.40
Societal WTP for odor mitigation (HIGH-END)	\$ 3,435,420.61
Close Doors, No OCP	\$ -
OCP Preparation: In-House (Transfer)	\$ 1,452.00
OCP Preparation: Out-of-House (Transfer)	\$ 8,869.86

OCP Staff Training (Transfer)	\$ 7,078.50
Oxidizing Agent (Catalytic Activated Carbon) Annual Cost	\$ 2,640.00
Averaged Estimate: Oxidizing Agent Annual Cost	\$ 7,173.00
Low-End Biofilter Capital + Installation Cost	\$ 325,357.50
High-End Biofilter Capital + Installation Cost	\$ 1,188,887.50
Low-End Biofilter O&M	\$ 80,850.00
High-End Biofilter O&M	\$ 565,565.00
Regenerative Thermal Oxidizer Capital + Installation Cost	\$ 2,328,817.00
Regenerative Thermal Oxidizer Total Annual Cost	\$ 1,346,183.00

The above data is a combination of the costs and benefits discussed in this analysis. (See Appendix A for calculation spreadsheet and inputs).

Expected Enforcement of the Regulation to Regulated Facilities & NPV Calculations

As a result of the proposed regulation update, facilities may be found out of compliance with the requirements of the regulation and be required to submit and implement an Odor Control Plan. The RIDEM has conducted the following totals of inspections in the Office of Compliance & Inspection (in charge of responding to citizen air complaints):

- 2018 – 210
- 2019 – 249
- 2020 – 136
- 2021 – 105
- 2022 – 46
- 2023 – 144
- 2024 – 132
- 2025 – 124

Total Inspection: 1146

The RIDEM has seen enforcement of two (2) odor cases in the past 7 years that have resulted in the creation and implementation of an odor control plan. This rate of enforcement for odor violations has been consistent in the RIDEM for longer than the identified 7 year timeframe. Therefore, the identified expected enforcement rates in the analysis of 5 (low -end), 15 (mid-range) and 25 (high-end) are very reasonable for the RIDEM to see based off of current data and trends.

The net present value (NPV) for the values below are calculated by discounting all estimated costs and benefits over the analysis period to present-value terms using a real discount rate of 5% at the base case. This rate is consistent with commonly applied federal guidance for regulatory analysis. To account for uncertainty in the selection of the discount rate, sensitivity analysis is also conducted using a discount rate of 3% and 7%.

Benefit and cost estimates are developed as bounded ranges (low, medium, high cases) to reflect uncertainty in key inputs and assumptions. The calculations below combined all the previous benefits and costs identified in this analysis.

Low-end Enforcement Scenario

The RIDEM has been regulating facilities for odors for many years and have in some extreme cases required facilities to implement an OCP (Odor Control Plan) if necessary to address the odor issues. Therefore, on a low-end scenario, the RIDEM assumes to expect to have one (1) facility per year over five (5) years found in violation of this regulation and require an OCP. This valuation of one (1) source per year is based off of previous RIDEM enforcement data and the RIDEM expected enforcement with the implementation of the proposed regulation. A calculation was run off the different options identified in this analysis with the assumption as follows:

Expected Total Enforcements Over 5 Calendar Years (LOW-END)	5
Expected % Resulting in Close Doors, no OCP	0%
Expected % Resulting in OCP, Administrative Controls Only	80%
Expected % Resulting in OCP + Oxidizing Agent	20%
Expected % Resulting in OCP + Biofilter	0%
Expected % Resulting in OCP + RTO	0%
# Facilities That Close Doors, no OCP	0
# Facilities That Have OCP Only	4
# Facilities That Have OCP + Oxidizing Agent	1
# Facilities That Have OCP + Biofilter	0
# Facilities That Have OCP + RTO	0

The RIDEM assumes many of the facilities can implement the zero cost option of closing doors to address odors present. The RIDEM utilizes this solution now for sources that are found to have odors extend beyond property lines. The RIDEM would expect to only have a source or two (2) be required to create an OCP and have to use oxidizing agents to treat odors.

Costs over five (5) years identified below:

Low-End Enforcement Scenario				
Analytical Year	Item	Cost Per Facility (incl. Transfers) * Number of Facilities	Benefits: Odor Mitigation WTP	Benefits: Transfers
0	OCP + Admin Controls	\$ 63,793.44	\$ -	\$ 34,122.00
0	OCP + Oxidizing Agents	\$ 23,121.36	\$ -	\$ 8,530.50
0	OCP + Biofilter	\$ -	\$ -	\$ -
0	OCP + RTO	\$ -	\$ -	\$ -
Annually in AY 1 through 4	OCP + Admin Controls	\$ 28,314.00	1431425.2525944 annually (do not multi- count)	\$ 28,314.00
Annually in AY 1 through 4	OCP + Oxidizing Agents	\$ 14,251.50		\$ 7,078.50
Annually in AY 1 through 4	OCP + Biofilter	\$ -		\$ -
Annually in AY 1 through 4	OCP + RTO	\$ -		\$ -

Calendar Year	Analytical Year	Costs	PV Costs (r = 3%)	Benefits	PV Benefits (r = 3%)	Present Value (r = 3%)	Net Value (Undiscounted)
2026	0	\$ 86,914.80	\$ 86,914.80	\$ 42,652.50	\$ 42,652.50	\$ (44,262.30)	\$ (44,262.30)
2027	1	\$ 42,565.50	\$ 41,325.73	\$ 1,466,817.75	\$ 1,424,094.91	\$ 1,382,769.18	\$ 1,424,252.25
2028	2	\$ 42,565.50	\$ 40,122.07	\$ 1,466,817.75	\$ 1,382,616.41	\$ 1,342,494.35	\$ 1,424,252.25
2029	3	\$ 42,565.50	\$ 38,953.46	\$ 1,466,817.75	\$ 1,342,346.03	\$ 1,303,392.57	\$ 1,424,252.25
2030	4	\$ 42,565.50	\$ 37,818.90	\$ 1,466,817.75	\$ 1,303,248.57	\$ 1,265,429.68	\$ 1,424,252.25
						Net Present Value:	\$ 5,249,823.47
						NPV (r = 3%):	\$ 5,249,823.47
						NPV (r = 5%):	\$ 5,006,065.69
						NPV (r = 7%):	\$ 4,779,980.96

(See Appendix A for formulas and inputs of calculations)

It should be noted that the low-end enforcement scenario at one (1) site of five (5) years would be the most likely scenario the RIDEM would see. This is backed by the current odor enforcement data the RIDEM has showing two (2) odor enforcements in seven (7) years.

Mid-range Enforcement Scenario

For a mid-range scenario, the RIDEM assumes to expect three (3) sources per year for five (5) years to be found in violation of the regulation and required to create an OCP. This valuation of three (3) sources per year is based off an increase in the ability to enforce this regulation with the proposed changes. A calculation was run off of different options identified in this analysis with the assumptions as follows:

Expected Total Enforcements Over 5 Calendar Years (MID-RANGE)	15
Expected % Resulting in Close Doors, no OCP	0%
Expected % Resulting in OCP, Administrative Controls Only	67%
Expected % Resulting in OCP + Oxidizing Agent	27%
Expected % Resulting in OCP + Biofilter	7%
Expected % Resulting in OCP + RTO	0%
# Facilities That Close Doors, no OCP	0
# Facilities That Have OCP Only	10.05
# Facilities That Have OCP + Oxidizing Agent	4.05
# Facilities That Have OCP + Biofilter	1.05
# Facilities That Have OCP + RTO	0

The RIDEM in this scenario assumes facilities may have to install a biofilter to address the odors when found in violation. The analysis for a mid-range scenario assumes that more facilities will need to use mid-range costs options to comply with the requirements of the regulation, and to have to create an OCP.

Costs over five (5) years identified below:

Mid-Range Enforcement Scenario				
Analytical Year	Item	Cost Per Facility (incl. Transfers) * Number of Facilities	Benefits: Odor Mitigation WTP	Benefits: Transfers
0	OCP + Admin Controls	\$ 160,281.02	\$ -	\$ 85,731.53
0	OCP + Oxidizing Agents	\$ 93,641.51	\$ -	\$ 34,548.53
0	OCP + Biofilter	\$ 811,724.40	\$ -	\$ 8,957.03
0	OCP + RTO	\$ -	\$ -	\$ -
Annually in AY 1 through 4	OCP + Admin Controls	\$ 71,138.93	2290280.40415104 annually (do not multi- count)	\$ 71,138.93
Annually in AY 1 through 4	OCP + Oxidizing Agents	\$ 57,718.58		\$ 28,667.93
Annually in AY 1 through 4	OCP + Biofilter	\$ 346,800.30		\$ 7,432.43
Annually in AY 1 through 4	OCP + RTO	\$ -		\$ -

Calendar Year	Analytical Year	Costs	PV Costs (r = 3%)	Benefits	PV Benefits (r = 3%)	Present Value (r = 3%)	Net Value (Undiscounted)
2026	0	\$ 1,065,646.93	\$ 1,065,646.93	\$ 129,237.08	\$ 129,237.08	\$ (936,409.85)	\$ (936,409.85)
2027	1	\$ 475,657.80	\$ 461,803.69	\$ 2,397,519.68	\$ 2,327,689.01	\$ 1,865,885.32	\$ 1,921,861.88
2028	2	\$ 475,657.80	\$ 448,353.10	\$ 2,397,519.68	\$ 2,259,892.24	\$ 1,811,539.15	\$ 1,921,861.88
2029	3	\$ 475,657.80	\$ 435,294.27	\$ 2,397,519.68	\$ 2,194,070.14	\$ 1,758,775.87	\$ 1,921,861.88
2030	4	\$ 475,657.80	\$ 422,615.79	\$ 2,397,519.68	\$ 2,130,165.18	\$ 1,707,549.39	\$ 1,921,861.88
						Net Present Value:	\$ 6,207,339.87
						NPV (r = 3%):	\$ 6,207,339.87
						NPV (r = 5%):	\$ 5,878,417.25
						NPV (r = 7%):	\$ 5,573,342.34

High-end Enforcement Scenario

For a high-end scenario, the RIDEM assumes around five (5) facilities per year for five (5) years to be found in violation of the regulation. The valuation of five (5) sources per year is based off of RIDEMs high level ability to enforce the regulation. A calculation was run off the different options identified in this analysis with the assumption as follows:

Expected Total Enforcements Over 5 Calendar Years (HIGH-END)	25
Expected % Resulting in Close Doors, no OCP	0%
Expected % Resulting in OCP, Administrative Controls Only	60%
Expected % Resulting in OCP + Oxidizing Agent	28%
Expected % Resulting in OCP + Biofilter	8%
Expected % Resulting in OCP + RTO	4%
# Facilities That Close Doors, no OCP	0
# Facilities That Have OCP Only	15
# Facilities That Have OCP + Oxidizing Agent	7
# Facilities That Have OCP + Biofilter	2
# Facilities That Have OCP + RTO	1

Costs over five (5) years identified below:

[illegible]

Summary of Calculations

Overall, the regulation is assessed relative to the principle of the least-burdensome implementation consistent with achieving the intended regulatory objectives, with consideration of alternative compliance pathways and administrative efficiency. (See Appendix A for formulas and inputs of calculations).

Alternatives

Alternative 1

The RIDEM considered a having a frequency of odors detected on a single (1) day within a thirty (30) day period, versus the current proposal of three (3) days in any thirty (30) day period. The RIDEM felt that this was too strict on businesses, and that a single day of odors could be due to extraneous factors unavoidable by the business, or entirely not related to the subject business. Having three days of odor

detection is more reasonable to ensure the subject business is the actual cause of the odors, and not a one-off case. This would result in increased number of violations found, and more facilities required to create and implement an odor control plan. This would present higher costs to businesses throughout RI, as it would be easier to be found in violation under this stricter threshold of one (1) day. In comparison to the calculations found within this analysis, the following are the calculations if there was an increase in violations found and more facilities required to implement an odor control plan and install engineering controls. Specifically low-end 10 sources in violation, mid-range 25 sources in violation and high-end 50 sources in violation. Calculation and follows:

Expected Total Enforcements Over 5 Calendar Years (LOW-END)	10
Expected % Resulting in Close Doors, no OCP	0%
Expected % Resulting in OCP, Administrative Controls Only	80%
Expected % Resulting in OCP + Oxidizing Agent	20%
Expected % Resulting in OCP + Biofilter	0%
Expected % Resulting in OCP + RTO	0%
# Facilities That Close Doors, no OCP	0
# Facilities That Have OCP Only	8
# Facilities That Have OCP + Oxidizing Agent	2
# Facilities That Have OCP + Biofilter	0
# Facilities That Have OCP + RTO	0
Expected Total Enforcements Over 5 Calendar Years (MID-RANGE)	25
Expected % Resulting in Close Doors, no OCP	0%
Expected % Resulting in OCP, Administrative Controls Only	67%
Expected % Resulting in OCP + Oxidizing Agent	27%
Expected % Resulting in OCP + Biofilter	7%
Expected % Resulting in OCP + RTO	0%
# Facilities That Close Doors, no OCP	0
# Facilities That Have OCP Only	16.75
# Facilities That Have OCP + Oxidizing Agent	6.75
# Facilities That Have OCP + Biofilter	1.75
# Facilities That Have OCP + RTO	0
Expected Total Enforcements Over 5 Calendar Years (HIGH-END)	50
Expected % Resulting in Close Doors, no OCP	0%
Expected % Resulting in OCP, Administrative Controls Only	60%
Expected % Resulting in OCP + Oxidizing Agent	28%
Expected % Resulting in OCP + Biofilter	8%
Expected % Resulting in OCP + RTO	4%
# Facilities That Close Doors, no OCP	0
# Facilities That Have OCP Only	30
# Facilities That Have OCP + Oxidizing Agent	14
# Facilities That Have OCP + Biofilter	4
# Facilities That Have OCP + RTO	2

Low-End Enforcement Scenario		
Analytical Year	Item	Cost Per Facility (incl. Transfers) * Number of Facilities
0	OCP + Admin Controls	\$ 127,586.88
0	OCP + Oxidizing Agents	\$ 46,242.72
0	OCP + Biofilter	\$ -
0	OCP + RTO	\$ -
Annually in AY 1 through 4	OCP + Admin Controls	\$ 56,628.00
Annually in AY 1 through 4	OCP + Oxidizing Agents	\$ 28,503.00
Annually in AY 1 through 4	OCP + Biofilter	\$ -
Annually in AY 1 through 4	OCP + RTO	\$ -

Calendar Year	Analytical Year	Costs
2026	0	\$ 173,829.60
2027	1	\$ 85,131.00
2028	2	\$ 85,131.00
2029	3	\$ 85,131.00
2030	4	\$ 85,131.00

Mid-Range Enforcement Scenario		
Analytical Year	Item	Cost Per Facility (incl. Transfers) * Number of Facilities
0	OCP + Admin Controls	\$ 267,135.03
0	OCP + Oxidizing Agents	\$ 156,069.18
0	OCP + Biofilter	\$ 1,352,874.01
0	OCP + RTO	\$ -
Annually in AY 1 through 4	OCP + Admin Controls	\$ 118,564.88
Annually in AY 1 through 4	OCP + Oxidizing Agents	\$ 96,197.63
Annually in AY 1 through 4	OCP + Biofilter	\$ 578,000.50
Annually in AY 1 through 4	OCP + RTO	\$ -

Calendar Year	Analytical Year	Costs
2026	0	\$ 1,776,078.22
2027	1	\$ 792,763.00
2028	2	\$ 792,763.00
2029	3	\$ 792,763.00
2030	4	\$ 792,763.00

High-End Enforcement Scenario		
Analytical Year	Item	Cost Per Facility (incl. Transfers) * Number of Facilities
0	OCP + Admin Controls	\$ 478,450.80
0	OCP + Oxidizing Agents	\$ 323,699.04
0	OCP + Biofilter	\$ 4,819,343.44
0	OCP + RTO	\$ 4,689,530.72
Annually in AY 1 through 4	OCP + Admin Controls	\$ 212,355.00
Annually in AY 1 through 4	OCP + Oxidizing Agents	\$ 199,521.00
Annually in AY 1 through 4	OCP + Biofilter	\$ 2,290,574.00
Annually in AY 1 through 4	OCP + RTO	\$ 2,706,523.00

Calendar Year	Analytical Year	Costs
2026	0	\$ 10,311,024.00
2027	1	\$ 5,408,973.00
2028	2	\$ 5,408,973.00
2029	3	\$ 5,408,973.00
2030	4	\$ 5,408,973.00

As shown in the cost charts above, the alternative considered of a single (1) day of odor violation that would result in a facility having to create and implement an odor control plant would be significantly higher cost to businesses. (Compared to the cost calculations found within this report, See Appendix C for alternative calculation spreadsheet).

Alternative 2

The RIDEM considered requiring the Odor Control Plan to be submitted after ninety (90) days versus the proposed sixty (60) days. Ninety days was determined to be an unreasonable timeframe to accurately get a company into compliance with the regulation due to the seasonality of businesses within Rhode Island. Some businesses may only operate during warmer months throughout the year, and ninety days may occur during the off season, which will not provide an accurate odor control plan implementation. Sixty days allows for a quicker turn around to implement an odor control plan and get a company into compliance. Costs would be same as outlined in this alternative approach, but RIDEM did not feel that facilities would be more likely to get into compliance with this timeframe.

Alternative 3

The RIDEM considered an alternative approach under which Odor Control Plans would rely solely on administrative controls. This alternative was not advanced because administrative controls alone may not be sufficient to address odor issues in all scenarios. Costs and benefits associated with this alternative are summarized below. (See Appendix A for calculation spreadsheet and inputs).

Scenario	Costs	Benefit
Has EH&S person on payroll who can create Odor Control Plan	\$1,452.00	\$1,466,817.75
Facility does not have a EH&S person on payroll who can create an Odor Control Plan, has to hired outside consultant and opportunity cost of new changes	\$8,869.86 + \$7,078.50 = \$15,948.36	\$956,973.49

Alternative 4

The RIDEM considered multiple broad approaches for odor sampling and assessment including those similar to Connecticut, Title 22a Environmental Protection, Sec. 22a-174-23 Control of Odors (Connecticut). For example. Connecticut included a concentration table in their Odor regulation outlining different levels of concentration of compounds that would classify a nuisance odor.

These alternatives were evaluated based upon technical feasibility, implementation complexity, costs, enforceability, and consistency of approach. They were not considered because some odors can be

detected by humans at concentrations below monitoring equipment detection limits. For instance, a person could smell compounds, like hydrogen sulfide, at a concentration level lower than the level of detection of the air monitoring equipment that would be used, therefore setting a standard for specific compounds would not be appropriate. Setting a standard level of concentration of compounds would required subject businesses to purchase monitors to detect compounds or hire outside testing companies to conduct monitoring. In cases of compounds such as hydrogen sulfide (H₂S), the human nose can detect concentration levels at a lower level than a monitor can. It would not be reasonable to require a business to use a monitor to detect a specific level of H₂S if a monitor cannot go low enough to detect it reasonably.

Sensor	Cost 2025\$	
Aeroqual Ranger w/ data subscription - portable	\$4,765.00	Aeroqual
Aeroqual AQS1 Monitor w/ data subscription - stationary	\$21,800.00	Aeroqual
H ₂ s Data Logger	\$1,499.00	Forensics Detectors

Above are examples of monitors that would be an unnecessary cost to business to meet the threshold concentration if it was included in the proposed updated regulation. The RIDEM did not feel it would result in increased compliance, so it was not chosen as the final option in the regulation.

Alternative 5

The RIDEM considered the use of alternative industrial classification systems to identify applicable major group as outlined in the 2022 North American Industry Classification System (NAICS) vs. the chosen 1987 Standard Industrial Classification (SIC) Manual. Although the SIC Manual has largely been superseded by the NAICS, most recently updated in 2022, use of the NAICS codes in this context would not be realistic, as there are potentially 1200+ NAICS codes, vs. the 34 SIC codes identified in the regulation. Use of SIC codes is also consistent throughout the Clean Air Act and used by USEPA.

The proposed approach was selected because the changes are intended to clarify and expand the types of sources that may be subject to the regulation, while maintaining consistency with the definitions and frameworks already established in part 9. In doing so, the amendments rely on the 1987 SIC Manual because it aligns with the existing regulatory structure and intended scope of the rule. Alternative classification systems were not advanced because the use of the SIC Manual provides an administrable method for identifying source categories intended to fall within the regulation. In addition, SIC codes continue to be utilized today in certain regulatory and administrative contexts, supporting their continued use here for consistency and implementation purposes.

Alternative 6

The RIDEM considered broader and narrower applicability approaches, including the inclusion of certain industries, major groups, or facility types from the regulation. This includes including mining of metals, oil and gas field exploration services, coal mining, etc. (SIC Code 10-17), but ultimately, these industries are not found in Rhode Island.

These alternatives were evaluated based on the potential for odor-generating activities, implementation burden, enforceability, and consistency with the objective of the regulation. These approaches were not advanced because they were not consistent with the industries outlined in Part 9 or not found within RI.

The alternatives within this section were all considered but ultimately the proposed updated version of the regulation is what the RIDEM is proposing to implement.

Recommendation

Pursuant to R.I. Gen. Law § 42-35-2.9(b)(3), the agency has determined that the benefits of the proposed regulation amendments justify the associated costs and that the proposed rule achieves the statutory and regulatory objective in a more cost-effective manner than any known reasonable alternatives. In particular, the proposed amendments are intended to improve consistency in the identification and mitigation of nuisance odors and reduce the impacts on nearby residents and communities.

The agency has determined that the proposed amendments do not unnecessarily overlap with or duplicate existing state or federal regulations. Any overlap identified is necessary to ensure consistency and effective administration of the regulatory program. The anticipated benefits of reducing nuisance odors, improving the quality of life, and the public's ability to enjoy outdoor recreation and other outdoor activities found near facilities justify the compliance and administrative costs associated with the proposed amendments.

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