State of Oregon Department of Environmental Quality

2018 Cleaner Air Oregon Fiscal Impact Statement

Background

DEQ held a public comment period on an earlier draft of the Cleaner Air Oregon rules between October 2017 and January 2018. In March 2018, the Oregon Legislature passed SB 1541, which provided fee authorization and set certain program requirements. The agencies updated the proposed rules as a result of the earlier public comments and SB 1541. This fiscal impact statement describes the fiscal and economic impacts of the current draft of the Cleaner Air Oregon proposed rules, and references input received during two fiscal impact review advisory committee processes and the 2017 and 2018 public comment periods.

SB 1541 set benchmarks for excess lifetime cancer risk and noncancer risk, defined as Risk Action Levels in the Cleaner Air Oregon proposed rules, in statute at levels higher than what DEQ and OHA originally proposed. Based on those higher risk levels, there would be potentially less fiscal impact on regulated businesses and potentially greater costs related to public health since not as much risk reduction would be realized. In addition, the SB 1541 requirement that a source complying with federal NESHAPs would presumptively meet TBACT requirements would be expected to further limit Cleaner Air Oregon fiscal impacts at many facilities. As stated below, DEQ used best available information to estimate potential fiscal impacts, but specifically quantifying fiscal impacts was not possible because of the lack of detailed facility-specific data and risk analyses, which have not been completed, and data on health effects in specific populations near specific facilities which is not available.

DEQ determined and most advisory committee members believed that Cleaner Air Oregon could cause a significant fiscal impact for small businesses. As is the case for businesses generally, the extent of the small business fiscal impact is unknown and cannot be accurately quantified because it depends on future analysis of source emissions and risk, and any required emission controls. In addition to the fiscal mitigation measures initially proposed in Cleaner Air Oregon, DEQ has proposed additional significant small business fiscal impact mitigation measures to lower cost, streamline procedural requirements, and provide flexibility for both small and large businesses.

Methodology for this analysis

The following analysis describes fiscal impacts to business, government and the public. For regulated businesses, the analysis focuses on the fiscal impacts associated with performing risk assessments at different levels, reducing risk, and paying fees for Cleaner Air Oregon permitting. For government, the analysis describes potential impacts on government-owned

facilities and fiscal impacts to the agencies administering the new regulations. For the public, the analysis describes potential benefits to the service and consulting sector and, using example pollutants and associated illnesses, potential general fiscal benefits from decreasing health risks. All estimates in this analysis are bounded by important caveats and limitations.

DEQ used EPA Air Pollution Control Technology Fact Sheets to estimate ranges of costs for pollution control equipment that facilities may need to install if required to control toxic air contaminant emissions under CAO. DEQ contacted several pollution control equipment suppliers but they were not able to provide more detailed cost estimates without site-specific data (i.e., toxic air contaminant emitted, exhaust airflow and temperature, and space availability). Throughout the rulemaking process, DEQ also requested specific information on fiscal impacts from regulated sources who have cost information relevant to the proposed rules. During the two fiscal impact review processes and public comment periods, DEQ received a limited amount of information from committee members and commenters on costs of purchasing, installing and operating specific pollution control equipment. DEQ incorporated those estimates in the fiscal impact statement.

In November 2016 DEQ sent a request to permitted facilities that may be subject to Cleaner Air Oregon rules to report on their toxic air contaminant emissions. Facilities have submitted emissions data and DEQ worked with facilities to check the quality of their information. While this level of emissions inventory is sufficient to begin the prioritization and call-in process, the more detailed data and analysis necessary to calculate a facility's risk is not available yet. Each affected facility will need to go through the proposed risk screening and assessment process to gain accurate knowledge about risk posed and regulatory requirements. Some businesses will not be called in to demonstrate compliance and will experience little fiscal impact, some will "screen out" at more simple assessment levels and will experience relatively low fiscal impact, while others will be required to implement more complex and costly steps to assess and reduce risk from their toxic air contaminant emissions. Without a facility proceeding through the full steps of risk screening and assessment, it is not possible to predict with accuracy how much a particular business would have to spend to comply with risk reduction requirements, or how much benefit from reduction of associated toxic air contaminant risk could occur for people living nearby.

Because of the high level of uncertainty about precisely who will be affected and how, this fiscal analysis estimates potential ranges of impacts for business, government and the public, rather than developing speculative scenarios for hypothetical facilities or for each of the approximately 2,700 facilities that could be affected by Cleaner Air Oregon rules. Generating scenarios for each potentially affected facility would have required additional research and modeling work for which resources were not available.

Who would experience fiscal and economic impacts?

The proposed rules would have fiscal and economic impacts on businesses, state and federal agencies, units of local governments and the public. Fiscal impacts can be positive or negative to those affected. As examples, reducing health costs to the public

would be a positive impact, and increasing costs of regulatory compliance for businesses would be a negative impact.

Owners and operators of facilities that currently require an air quality permit would incur costs of program permit fees, described above, and be required to analyze whether emissions from their operations are below Risk Action Levels set under the Cleaner Air Oregon rules. This includes public entities who manage facilities or operations requiring an air quality permit. Cost estimates for these analyses are included in Table 7 below, Cost to Facilities for Emissions Analysis and Risk Assessment. Some facilities with emissions resulting in health risks above Risk Action Levels would incur additional costs to participate in community engagement and/or to reduce emissions.

People who are exposed to toxic air contaminants at sufficient concentrations and durations have an increased chance of getting cancer or experiencing other serious health effects. These health effects can include damage to the immune system, as well as neurological, reproductive (e.g., reduced fertility), developmental (e.g., birth defects), respiratory and other health problems. In addition to exposure from breathing toxic air contaminants, some toxic air contaminants, such as mercury, can deposit onto soils or surface waters, where they are taken up by plants or ingested by animals and are eventually magnified up through the food chain to human consumption. The proposed rules may result in reduced toxic air contaminant emissions and less exposure to toxic air contaminants for people who live and work in proximity to facilities that emit toxic air contaminants. Less exposure to toxic air contaminants will result in fewer premature deaths and illnesses allowing Oregonians to experience longer lives, better quality of life, lower medical expenses, fewer work and school absences, and better worker productivity.

Table 7
Cost to Facilities for Emissions Analysis and Risk Assessment

Task	Simple	Complex
Emissions inventory	$0*-$5,000	$60,000
Level 1 Assessment – Lookup Table Calculation Using Stack Heights and Exposure Location Distance	$100	$5,000
Level 2 Assessment – Screening modeling	$5,000	$35,000
Level 3 Assessment – Refined modeling	$5,000	$100,000
Level 4 Assessment – Health Risk Assessment	$5,000	$500,000

*DEQ is calculating the emissions inventories for all of the approximately 2,200 sources that have Basic and General Air Contaminant Discharge Permits.

Reporting

All currently permitted sources report to DEQ annually, so their reporting requirements for Cleaner Air Oregon will be in addition to existing reporting requirements. Some facilities that aren't required to have air permits under current regulations may still be required to report, and in that case annual reporting would be new. Some facilities already report emissions of

Hazardous Air Pollutants (187 pollutants out of approximately 600 toxic air contaminants) annually. Under the proposed regulations, all permitted facilities that emit toxic air contaminants must submit an emissions inventory to DEQ every three years. Facilities that have permit requirements to limit toxic air contaminant emissions must report compliance annually or semi-annually.

Since facilities with current air permits were already required to submit an initial toxic air contaminant emissions inventory, future updates of their emissions inventory should involve lower costs. DEQ anticipates that the additional reporting requirements for Cleaner Air Oregon would cost facilities approximately $120 to $1,200 per year.

Source testing

Source testing is currently not required as a part of Cleaner Air Oregon, but some facilities may choose to do source testing to more accurately estimate emissions. Source testing may be required to determine compliance with Cleaner Air Oregon permit conditions but DEQ anticipates that will not be the case for very many sources. Cost for source testing depends on the toxic air contaminant to be tested, the length of the test, and other factors. Source testing for some toxic air contaminants, such as hexavalent chromium, is relatively complex and therefore expensive. Source test costs range from $7,500 for a single toxic air contaminant that is easy to test to $35,000 for multiple toxic air contaminants that are more difficult to test. Businesses already required to perform periodic compliance source testing could limit some of these additional costs if toxic air contaminant and criteria pollutant tests could be aligned.

Monitoring

The proposed Cleaner Air Oregon regulations allow facilities to conduct ambient air monitoring and to use that data to supplement their risk assessments if they choose. DEQ expects that the cost of monitoring would vary based on equipment and analysis needed for different pollutants to be monitored and the number of monitors needed. Depending on the topography, meteorology, land use and exposure locations, a facility may need to run multiple monitor locations to accurately characterize concentrations resulting from its emissions.

DEQ estimates that the lower end cost for a year of monitoring including equipment, deployment and pollutant analysis could be $50,000 per monitoring location. Assuming a site would require four monitor locations, this total lower end cost could be $200,000. DEQ estimates that the higher end cost for more complex equipment, analysis or multiple pollutants could be $200,000 per monitor. If a facility needed four such locations, the total upper end cost could be $800,000. DEQ deleted an earlier proposal allowing it to require that a facility undertake monitoring and it is now a voluntary action that a facility may employ.

Community engagement

SB 1541 requires that DEQ (rather than facilities, as proposed in an earlier draft of the rules), provide community engagement. This decreases direct community engagement costs for facilities, but fees assessed to facilities support this activity performed by DEQ and OHA staff. If

the risk from a facility is greater than the Community Engagement Risk Action Level, the agencies will provide Community Engagement and other outreach activities near that facility. As part of community engagement, DEQ will notify the community within the area of impact when a permit addendum application is submitted, and may hold one or more public meetings to describe the risks, and solicit input on ways to reduce the risks. If DEQ and OHA hold a required public meeting, facilities would be required to attend and to pay a fee to DEQ.

Statement of cost of compliance

State agencies

The majority of state agencies and local governments should be minimally or not directly impacted by the proposed rules because the rules predominantly regulate process emission sources that are not government owned. However, state agencies and local government facilities that emit toxic air contaminants may be required to reduce toxic air contaminant emissions if the predicted risk exceeds Risk Action Levels. If owners or operators choose to install pollution control equipment, Table 8 below shows what the range of estimated costs could be for both government-owned and business facilities. As of August 31, 2017, state agencies own 23 permitted facilities, federal agencies own 5 permitted facilities, and local governments own 62 permitted facilities. Currently there are no tribally owned permitted facilities. Cleaner Air Oregon base and activity fees would affect these permit holders directly. Changes to fees could affect these agencies indirectly if businesses change the price of goods and services to offset any increased costs from paying a permit fee. Local government may also be consulted in land use issues related to commercial facilities emitting toxic air contaminants.

DEQ and OHA will see an increase in workload as a result of the proposed rules. Implementation of program requirements will require additional resources. DEQ has completed a workload analysis to estimate the cost of different levels of risk assessment and the additional resources needed. DEQ will permit facilities subject to Cleaner Air Oregon with the aid of OHA staff in areas of health risk assessment, community engagement, and risk communication. DEQ and OHA workloads would initially increase as staff become familiar with the proposed rules and a new program and could level off after the first years of implementation.

Having the Cleaner Air Oregon toxic air contaminant program in place may also reduce DEQ and OHA's workload in some instances, by reducing the need for the agencies to respond on a facility by facility basis to public concerns about toxic air contaminant emissions and health effects that are not currently covered by a regulatory structure.

Table 8 Pollution Control Equipment for Toxic Air Contaminant Emissions						
Control Device Type	**Types of Pollutants it can reduce**	**Examples of facilities where this could be used**	**Initial costs[1, 2]**		**Annual Operating Costs**	
			low	**high**	**low**	**high**
Fabric filter (baghouse)	Particulate matter (PM), hazardous air pollutant (HAP) PM	Asphalt batch plants, concrete batch kilns, steel mills, foundries, fertilizer plants, and other industrial processes. Colored art glass manufacturers.	$360,000 - $18,500,000		$180,000 - $6,200,000	
Electrostatic precipitator (ESP)	PM, HAP PM	Power plants, steel and paper mills, smelters, cement plants, oil refineries	$320,000 - $10,000,000		$100,000 - $7,600,000	
Enclosure	Fugitive PM or volatile organic compounds (VOCs)	Any process or operation where emissions capture is required, i.e., printing, coating, laminating	$14,000 - $420,000		$400 - $10,000	
HEPA filter	Chrome emissions	chrome plating	$13,000 - $240,000		Application specific	
Wet scrubber (packed towers, spray chambers, Venturi scrubbers)	Gases, vapors, sulfur oxides, corrosive acidic or basic gas streams, solid particles, liquid droplets	Asphalt and concrete batch plants; coal-burning power plants; facilities that emit sulfur oxides, hydrogen sulfide, hydrogen chloride, ammonia, and other	$25,000 - $750,000		$19,000 - $830,000	

[1] Costs are from examples in the EPA Air Pollution Control Cost Manual, Report No. 452/B-02-001, EPA Air Pollution Control Technology Fact Sheets, and information provided by permitted facilities and regulatory agencies.
[2] Costs are estimated based on best available information, but may be higher or lower than shown, depending on facility-specific conditions and business decisions.

		gases that can be absorbed into water and neutralized with the appropriate reagent.		
Wet scrubber with mercury controls (carbon injection or flue gas desulfurization)	Gases, vapors, sulfur oxides, corrosive acidic or basic gas streams, solid particles, liquid droplets, mercury	Coal-fired power generation	Low end cost not available High end cost $516,803,000	Not available
Semi-dry scrubber with carbon injection mercury controls	Gases, vapors, sulfur oxides, corrosive acidic or basic gas streams, solid particles, liquid droplets, mercury	Coal-fired power generation	Ranges not available, estimated cost: $470,803,000	Ranges not available, estimated cost: $74,807,000
Flue gas desulfurization with limestone injection	mercury	Coal-fired power generation	$75,000,000-$247,000,000	$3,500,000
Activated carbon injection	mercury	Coal-fired power generation	$960,000-$5,000,000	$1,800,000
Thermal oxidizer	VOCs, gases, fumes, hazardous organics, odors, PM	Landfills, crematories, inks from graphic arts production and printing, can and coil plants, hazardous waste disposal. semiconductor manufacturing	$17,000 - $6,200,000	$3,500 - $5,200,000

Regenerative thermal oxidizer	VOCs	Paint booths, printing, paper mills, municipal waste treatment facilities	$940,000 - $7,700,000	$110,000 - $550,000
Catalytic reactor	VOCs, gases	Landfills, oil refineries, printing or paint shops	$21,000 - $6,200,000	$3,900 - $1,700,000
Carbon adsorber	Vapor-phase VOCs, hazardous air pollutants (HAPs)	Soil remediation facilities, oil refineries, steel mills, printers, wastewater treatment plants	$360,000 - $2,500,000	Not available
Biofilter	VOCs, odors, hydrogen sulfide (H_2S), mercaptans (organic sulfides)	Wastewater treatment plants, wood products facilities, industrial processes	$360,0000 - $3,600,000	Not available
Fume suppressants	Chromic acid mist, chromium, cadmium and other plating metals	Chromic acid anodizing and chrome plating operations	Up to $122,000	Not available

As an alternative to or in addition to the controls above, facilities may be able to use pollution prevention to meet CAO risk reduction requirements. In EPA's and DEQ's hierarchy of pollution management strategies (acceptable ways to reduce pollution), pollution prevention, also known as source reduction, is preferred over the addition of pollution controls and treatment whenever feasible (see Pollution Prevention Act of 1990, https://www.epa.gov/p2/pollution-prevention-act-1990)[3] Pollution prevention has been implemented successfully for cleaning

[3] Pollution prevention is generally preferred because it results in less pollution to control, treat, or dispose of. Pollution controls can generate wastes or contaminated equipment that require end-of-life management. Reducing pollution at the source means fewer hazards posed to the public and the environment. In addition, pollution controls can fail and toxic substances can be used in unintended ways. Reducing the use of those toxic substances at the source avoids those potential risks.

operations (e.g., metal parts), coating and painting (e.g., marine anti-fouling, wood preservation), lubricants and process fluids (e.g., loss lubrication, mold release agents), and dry cleaning of clothes. In evaluating the costs of pollution prevention, DEQ considers not only the cost of replacing one production method with another, but also capital costs, energy differences, labor costs, waste disposal and quality control considerations. In many instances involving both large and small businesses, DEQ has found that pollution prevention can decrease costs for a facility owner, rather than increase them. Short-term investments in pollution prevention measures can result in savings that may pay for the initial investments over time.

Local governments

As noted above, local governments own or operate 62 facilities currently requiring an air quality permit. Minimally, those local government agencies would be impacted by the proposed fee structure for Cleaner Air Oregon which includes an annual base fee assessed on all current air quality permit holders. In addition, local governments who operate facilities that are called in to Cleaner Air Oregon would be required to assess the risk that the facility's emissions pose and in some cases may be required to reduce that risk.

Local government representatives, such as city or county health or planning staff and elected officials may also be impacted by the need to participate in public meetings, including time to research and understand potential toxic air contaminant health concerns and risk assessment and permitting issues, and time spent preparing communications and attending meetings. DEQ is not able to quantify the time and fiscal impact on public process participants, but recognizes that time spent may impact local government budgets for travel or other expenses.

Large businesses

DEQ anticipates the proposed rules, when fully implemented, could have fiscal and economic impacts on approximately 1,360 existing large businesses holding air quality permits and an unknown number of new large businesses and businesses that do not have air permits. If the cancer or noncancer risk from a facility exceeds the Risk Action Levels, the facility would be required to take action to reduce toxic air contaminant emissions or show that TLAER or TBACT is already being achieved. The proposed rules would allow facilities flexibility in choosing a method to reduce emissions through the application of pollution prevention or pollution control equipment. If owners or operators choose to install pollution control equipment, Table 8 above shows what the range of estimated costs could be. Small businesses may also incur these costs if required to install pollution control equipment.

As required by SB 1541, the draft proposed rules allow that existing facilities (major sources of hazardous air pollutants that emit 10 tons/year of one hazardous air pollutant or 25 tons/year of combined hazardous air pollutants) complying with federal toxic air contaminant standards known as National Emission Standards for Hazardous Air Pollutants (NESHAPs) will under certain conditions be presumed to meet TBACT requirements. Although specific numbers will not be known until sources proceed through the screening and analysis process, this requirement will likely decrease fiscal and economic impacts for many sources of toxic air contaminants. Many facilities already complying with a NESHAP would not need to reduce their risk unless they exceed a risk level of 200 in a million excess cancer risk or an HI of 10.

This is higher than the originally proposed levels of 25 in a million and an HI of 1, and is expected to result in a lower fiscal impact than the October 2017 proposed rules.

Included in public comments DEQ received was a cost benefit analysis performed by Maul Foster Alongi (MFA) on behalf of Oregonians for Fair Air Regulations (OFAR), a business interest group. The MFA analysis submitted by OFAR during the first public comment period concluded that CAO would cost facilities between $44 million and $8.4 billion over the first 20 years of the program. An updated analysis submitted during the second public comment period concluded that CAO would cost facilities between $44 million and $34 billion over the first 20 years of the program.

DEQ reviewed MFA's analysis, but the information submitted with the public comment was not sufficient to fully reconstruct it. However, DEQ can comment on the assumptions that were listed.

The MFA analysis was designed to "bracket" potential CAO compliance costs between a low and high scenario, with a medium scenario in between. The low scenario is based on an assumption that all facilities will screen out of CAO requirements with a Level 1 risk assessment, which does appear to represent a lower bound to what CAO compliance costs could be for facilities. DEQ analyzed the medium and high scenarios proposed by MFA and believes that they include several factors that tend to significantly overestimate the total costs.

MFA assumed that all facilities with air permits will be called in to CAO during the first 20 years of the program, which would overestimate costs because DEQ will likely not call in facilities that screen out as de minimis based on emissions inventory data.

MFA also appeared to assume that all facilities that are above the TBACT level after a Level 3 risk assessment will proceed to Level 4, though DEQ anticipates that few facilities will have the unusual exposure scenarios under which it would benefit them to perform a Level 4 risk assessment.

MFA also assumed that all facilities that proceed to Level 4 will ultimately install pollution controls. This is likely an overestimate because many facilities above the TBACT level may qualify as having presumptive TBACT, based on the new rule provisions brought in from SB 1541. Also, the increase in the RALs between the first and second public comment periods should reduce the number of facilities that will be required to install pollution controls, but did not reduce MFA's estimate of that parameter.

MFA's estimate of the cost of installing and operating pollution controls for CAO is also likely to be an overestimate, particularly for their most recent submittal, because they used an average of installation and operation costs from a list of pollution controls that included controls that would be necessary only for a coal-fired power plant, which are very high cost. That is likely to be an overestimate because Oregon's only coal-fired power plant is mandated by rule to close in 2020, and Oregon statutes phasing out coal-fired power mean that new coal-fired power plants in Oregon (with attendant high pollution control costs) are unlikely.

Finally, MFA acknowledged that their analysis, "does not reflect any specific Oregon facility, and the information available to MFA is insufficient to allow estimation of whether any specific facility will incur increased costs or the value of those costs." DEQ has therefore

concluded that the MFA medium- and high-cost scenarios both likely significantly overstate the fiscal impacts on businesses.

The ultimate compliance costs of the program would depend on many factors, including facility risk assessments and TBACT analyses that are not yet complete. DEQ has concluded that the overall cost to business over a 20 year period is likely at least $44 million, and will likely be higher than that. But any determination of how much higher would be purely speculative. That said, DEQ has provided, in Tables 7 and 8 above, the ranges of costs that individual facilities will encounter when they are "called in" and are required to demonstrate compliance with the CAO rules.

Small businesses

Similar to the requirements for large businesses, the proposed rules would require that the facility owner or operator of a small business demonstrate that the risk posed by the facility's air emissions would not exceed the proposed Risk Action Levels. This compliance demonstration can be accomplished using any of the levels of risk assessment, 1 through 4.

In addition to the fiscal and economic impact described in the large business section above, the proposed rules could have the following impacts on small business:

Estimated number of small businesses and types of businesses and industries with small businesses subject to proposed rule

The proposed rules could affect approximately 1,090 small businesses. These businesses include asphalt plants, auto body shops, chromium electroplaters, ethylene oxide sterilizers, grain elevators, lumber mills, metal fabricators, metal foundries, and surface coaters. If any of these businesses are called in to Cleaner Air Oregon and receive CAO permit conditions, they would have additional compliance requirements in addition to existing permit requirements. In addition there may be an unknown number of additional facilities that are currently not required to get permits under the existing air quality permitting program but may be required to submit emissions inventories, perform risk assessment and pay fees because of the Cleaner Air Oregon rules. Facilities that are not required to get air permits under existing rules could not be required to reduce risk under Cleaner Air Oregon.

Many of the small businesses subject to the Cleaner Air Oregon rules would only be required to submit triennial reports of toxic air contaminant emissions. Some small businesses may be required to reduce toxic air contaminant emissions through either permit limits, pollution prevention or pollution control equipment if cancer risk, chronic noncancer risk or acute noncancer risk is above Risk Action Levels.

Projected reporting, recordkeeping and other administrative activities, including costs of professional services, required for small businesses to comply with the proposed rule

Small businesses that must meet Cleaner Air Oregon permit requirements would have increased recordkeeping and reporting requirements. Administrative activities, including costs of professional services, required for small businesses to comply with the proposed rule may increase in a range from $100 to $500,000 above current costs if the small business is required

to perform computer modeling or a health risk assessment if cancer risk, chronic noncancer risk or acute noncancer risk is above Risk Action Levels.

Projected equipment, supplies, labor and increased administration required for small businesses to comply with the proposed rule

Depending on the size and nature of a small business's operation, pollution control costs could be much less than, or in some cases the same as, the cost ranges for different types of control equipment found in Table 8, above. Summarizing from Table 8, if a small business's cancer risk, chronic noncancer risk or acute noncancer risk were above Risk Action Levels, the proposed rules could result in additional costs ranging from approximately $13,000 to $18,500,000 for initial equipment including purchase and labor, and ranging from approximately $400 to $7,600,000 in annual operating costs[4]. The same decrease in costs that apply to large businesses resulting from higher risk action levels required in SB 1541 will apply to smaller businesses. Smaller businesses are even more likely to screen out of more costly Cleaner Air Oregon requirements at risk levels of 50 in a million and an HI of 5.

Because of existing regulatory coverage and generally low risk estimates for gas stations and dry cleaners, DEQ proposes not to require these facilities to perform risk assessments. If DEQ determines that risk may need to be reduced from these types of facilities, DEQ would change the existing rules that would apply to all gas stations and dry cleaners. These facilities would need to pay small fees to be tracked and evaluated by DEQ, but generally would not bear the costs of risk analysis or emission reductions.

Mitigation measures for small businesses

DEQ determined and most fiscal advisory committee members indicated that Cleaner Air Oregon could cause a significant fiscal impact for small businesses. As is the case for businesses in general, the extent of the small business fiscal impact is unknown and cannot be accurately quantified because it depends on future analysis of source emissions and risk, and any required emission controls. As a result of public comment and discussion with the fiscal advisory committee in two meetings, DEQ has developed a final proposal of small business fiscal impact mitigation measures in Cleaner Air Oregon to lower cost, streamline procedural requirements, and provide flexibility for small business. DEQ lacks specific information to provide estimates of cost decreased from these measures. Mitigation measures include:

- Cleaner Air Oregon base fees are a percentage of existing permit base fees. Many smaller facilities are on General or Basic Air Contaminant Discharge Permits, which have lower base fees and whose CAO base fees would also be low. This is consistent with fiscal advisory committee small business mitigation recommendations on providing lower fees for small businesses.

- Smaller sources on General and Basic Air Contaminant Discharge Permits (approximately 2,200 sources, including gas stations and dry cleaners) would not be required to prepare and submit an emissions inventory, as was required for all other permitted sources. These

[4] Costs in Table 8 for a wet scrubber with mercury controls, semi-dry scrubber with carbon injection mercury controls, and flue gas desulfurization with limestone injection are most often used at coal-fired power plants, which are unlikely to meet small business criteria.

businesses would not be required to perform Level 1 risk assessment either. DEQ would do both the emissions inventory and the Level 1 risk assessment for these sources. Only sources on General and Basic Air Contaminant Discharge Permits that calculate emissions using material balance methods (less than 75 sources) would be required to prepare and submit their own emissions inventories. This is consistent with fiscal advisory committee small business mitigation recommendations on providing technical assistance.

- Given the lower potential for higher risk emissions, smaller businesses are likely to be called in later in program implementation, after the higher risk facilities, delaying regulatory costs for some smaller businesses. These businesses would be able to use screening tools to determine whether they could undertake emission reductions or process changes to avoid more costly assessment measures like modeling or monitoring.

- Fiscal impacts to businesses, including small businesses, generally decreased between the 2017 and 2018 draft regulations because risk action levels became less stringent or allowed more risk as required by SB 1541.

- The SB 1541 requirement that sources, including small businesses, complying with federal NESHAPs would presumptively meet TBACT requirements would be expected to further limit Cleaner Air Oregon fiscal impacts for many sources.

- Sources that are de minimis or exempt would not need to take action to obtain a permit or reduce risk under Cleaner Air Oregon. DEQ has proposed an increase to the Source Permit Level for existing facility cancer risk, which will raise the de minimis risk level for facilities. This should further mitigate impacts on small businesses, by lessening the burdens associated with permitting for facilities that pose low risk.

- The proposed change to the significant TEU level would reduce the burden on businesses that exceed the TBACT or TLAER levels, by ensuring that they don't have to conduct TBACT/TLAER analyses or install TBACT/TLAER on TEUs that only pose a very small part of their total risk.

- Businesses, including small businesses, can apply to delay or postpone risk reduction based on financial hardship.

- Air monitoring, which can be very expensive, would be optional for all sources including small businesses. No source would be required to undertake air monitoring.

- The program would include a technical assistance staff person to help sources explore and analyze emission reduction options if they are required. DEQ anticipates that technical assistance to small businesses will be prioritized, consistent with fiscal advisory committee small business mitigation recommendations on providing technical assistance.

How DEQ involved small businesses in developing this proposed rule

DEQ notified small businesses during rule development by email, announcements on the DEQ website, advisory committee meetings, and through Twitter and Facebook. Small business representatives were on the Rules Advisory Committee during rule development. At the onset of the first public comment period, DEQ notified small businesses by email, and notices in the Secretary of State Bulletin.

Impacts on the public

The proposed Cleaner Air Oregon rules are intended to assess and decrease risk above Risk Action Levels for people living near industrial and commercial facilities that emit toxic air contaminants. Risk analyses will be based on many factors, including the best available science regarding toxicity of regulated toxic air contaminants, as proposed in the Risk-Based Concentrations. Cleaner Air Oregon toxic air contaminant reductions that decrease cancer risk, chronic noncancer risk or acute noncancer risk could create positive economic benefits and improvements in public health and welfare statewide. The rules could also have negative economic effects on the public. In analyzing potential positive and negative effects on the public of the proposed Cleaner Air Oregon rules, DEQ has consulted with OHA staff and relied upon information provided by them.

Positive impacts on the public

The proposed Cleaner Air Oregon rules have the potential to meaningfully impact public health in the state by reducing toxic air contaminant emissions. The toxic air contaminants that would be regulated by Cleaner Air Oregon rules are known to increase risk of a wide range of health outcomes including cardiovascular and respiratory illness, lung disease, cancers, birth defects, premature births, developmental disorders, central nervous system damage, intellectual disability, and premature death.

Based on a preliminary analysis of a subset of emissions inventory data using proposed screening tools and Risk Action Levels, DEQ and OHA have determined that a number of toxic air contaminants are most likely emitted at concentrations whose risk exceeds the proposed Risk Action Levels. Information from EPA's National Air Toxics Assessment supports this initial analysis. The impact of toxic air contaminants on health depends on people's exposure. DEQ and OHA do not currently have enough information about how many people are exposed to specific concentrations of industrial and commercial toxic air contaminant emissions or about the relative actual contribution of toxic air contaminants to disease to know how reducing emissions will translate to improved public health in quantitative terms. As Cleaner Air Oregon regulations are implemented, the emissions inventory and the permitting process will improve DEQ and OHA's understanding of Oregonians' toxic air contaminant exposures. This is especially true for public health risk from toxic air contaminants in neighborhoods close to industrial facilities, where risk may never have been specifically or accurately assessed.

National and local air toxics models and other states' estimates show that an array of emissions sources contribute significantly to public health risk. These include non-industrial emissions

from vehicle engines, wood burning and atmospheric formation of toxic air contaminants, as well as industrial emissions. However this information cannot be used to estimate risk for people living nearby industrial facilities because the data are on too large a geographic scale, do not factor in where people are actually exposed, do not include all facilities, do not assess the number of pollutants proposed for Cleaner Air Oregon, and do not include risk from acute exposures. At the geographic level of neighborhoods that could be impacted by industrial toxic air contaminant emissions, the relative proportions of sources causing toxic air contaminant risk can be very different from those on a larger spatial scale, for example at the census tract, county or state level. In other air quality programs, DEQ continues to work on the larger scale exposure risks from ubiquitous non industrial sources. Cleaner Air Oregon will give the state a regulatory tool to address localized health risks from toxic air contaminants, and industrial emissions reductions will also contribute to area-wide reductions in air toxics.

In this analysis it is not possible to predict the total reduced medical costs that would result from the proposed rules for the reasons noted above. However, it is possible to describe the range of health outcomes associated with toxic air contaminants currently emitted in Oregon and to describe the economic burden of medical treatment for a subset of those health effects. This section also points to national analyses that estimate the fraction of certain diseases that are due to environmental exposures.

Health effects caused by toxic air contaminants commonly emitted by facilities in Oregon

DEQ and OHA summarized the health effects associated with 15 of the toxic air contaminants to be regulated under Cleaner Air Oregon. This information is summarized in Table 9 below. This summary illustrates the range of health effects that may be caused by this small subset of 15 toxic air contaminants. Many more of the toxic air contaminants to be regulated under Cleaner Air Oregon are associated with these and other health effects.

Table 9

Examples of health effects associated with a subset of 15 toxic air contaminants

Type of Toxicity	Toxic air contaminants associated with these health outcomes
Respiratory Effects Includes asthma and asthma symptoms (difficulty breathing, shortness of breath, coughing, wheezing, chest pain), reduced lung function, respiratory irritation, and other respiratory conditions	formaldehyde*, cobalt*, hexavalent chromium*, cadmium*, chlorine*, acrolein*, hydrogen fluoride*, naphthalene*, PAHs, manganese, arsenic
Cancer includes lung, respiratory, leukemia, lymphoma, liver, kidney and gastrointestinal cancers	arsenic*, hexavalent chromium*, cadmium*, formaldehyde*, PAHs*, benzene*, trichloroethylene*, lead*, dioxins*, naphthalene*

Heart Disease includes hypertension, arrhythmia, heart attack	arsenic, PAHs, lead, acrolein, hydrogen fluoride
Kidney Function includes reduced kidney function, kidney stones	cadmium*, lead, trichloroethylene, hydrogen fluoride
Liver Disease includes reduced liver function, fatty liver disease	dioxin*, trichloroethylene, hydrogen fluoride
Neurological Effects includes effects on motor function, balance, vision, hearing, cognition, memory, anxiety, focus or behavior following exposure as an adult or during brain development	lead*, arsenic*, manganese*, cadmium, PAHs, benzene, trichloroethylene, formaldehyde, cobalt
Fetal Development includes low birth weight, pre-term birth, miscarriage, and birth defects following exposure to mothers during pregnancy	arsenic*, PAHs*, trichloroethylene*, formaldehyde, cadmium, benzene, trichloroethylene, lead, dioxins
Impaired Fertility includes damage to male or female reproductive organs, reduced sperm counts, altered sex hormones, and infertility	manganese, PAHs, hexavalent chromium, dioxins, trichloroethylene
Blood Regulation includes impaired bone marrow function, anemia	benzene*, lead, naphthalene, cobalt
Immune Function includes allergic responses, reduced immune function	trichloroethylene*, benzene*, dioxins, PAHs

*For these chemicals, the associated health effect serves as the basis for Risk Action Levels proposed in Cleaner Air Oregon. Inclusion of all other chemicals is based on studies referenced in EPA, ATSDR, or OEHHA documents. The magnitude of and certainty around these associations varies.[5]

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[5] EPA Integrated Risk Information System. https://www.epa.gov/iris

ATSDR Toxic Substances Portal. https://www.atsdr.cdc.gov/toxprofiles/index.asp

California Office of Environmental Health Hazard Assessment. Air Toxics Hot Spots Program Technical Support Document for the Derivation of Noncancer Reference Exposure Levels. Dec, 2008 https://oehha.ca.gov/air/crnr/notice-adoption-air-toxics-hot-spots-program-technical-support-document-derivationadoption-air-toxics-hot-spots-program-technical-support-document-derivation

Information needed to quantify economic impact of health improvements

Oregon currently lacks the data necessary to quantify total potential health cost savings from Cleaner Air Oregon because of the lack of information about how many people are exposed to specific concentrations of industrial and commercial toxic air contaminant emissions and the relative actual contribution of toxic air contaminants to disease. Just as a lack of information about individual facility risk assessment and emission reduction outcomes prevents DEQ and OHA from quantifying specific fiscal impacts to businesses, a lack of health information also prevents DEQ from quantifying specific positive fiscal impacts from potential Cleaner Air Oregon emission reductions. The health impact of reducing emissions depends on the specific chemicals that are being reduced, the health risks those chemicals influence, the relationship between exposure and health, and the extent to which emissions are reduced. Defining the economic impact of improved health further requires knowledge of the portion of cases that are related to toxic air contaminant exposures, prevalence of health outcomes in the state, and the cost of medical treatment for each case.

Included with the compliance cost analysis submitted by Oregonians for Fair Air Regulations was an analysis of the health benefits of CAO. The submittal during the first public comment period, prepared for OFAR by Maul Foster Alongi, attempted to quantify an upper bound for potential health benefits of CAO, using information about asthma, cancer and cardiovascular disease and assumptions about the proportion of those diseases caused by pollution from emissions sources that would be subject to CAO. DEQ and OHA reviewed and considered the methods and conclusions of their analysis. The agencies concluded that there was not sufficient evidence to support several of the fundamental assumptions of MFA's calculations. More information can be found in the response to the public comment category "Fiscal impacts – Sufficiency of fiscal impact statement". The updated MFA analysis submitted during the second public comment period did not attempt to quantify the potential health benefits.

As described above, DEQ and OHA believe that multiple data gaps would need to be filled in order to accurately quantify potential health benefits of CAO at this time. However, we have presented information about what is known, including known data gaps, in the sections below.

Table 10 summarizes data limitations for the different types of information that would be necessary to assess health effects.

Table 10 Availability of Data Needed to Quantify Economic Impact of Health Improvements	
Information Type	Current availability of data
Health risks associated with each chemical	Some chemicals are well characterized, while toxicity data is missing or incomplete for others. There is some information about toxicity for all chemicals with proposed RBCs. The amount of information and level of certainty around the association with health effects varies.
Relationship between exposure and health	Even when health effects are identified, it can be difficult to quantify the amount of risk expected at a specific level of exposure; This relationship is well characterized for some chemicals and not available for others. While there is evidence that multiple chemicals may interact to affect health, there is little information to quantify these effects. This makes it difficult to evaluate the cumulative health impact of reducing exposure to multiple toxic air contaminants.
Level of current exposure	Information from existing DEQ air permits and EPA's National Air Toxics Assessment provide some information on potential exposures, but these do not cover all sources of industrial toxic air contaminants. The emissions inventory will help provide a clearer picture of current potential exposures once it is complete. As CAO is implemented and facilities perform risk assessments in the course of the new permitting process, we will have a more accurate picture of emissions.
Percent of each health outcome that is attributable to toxic air contaminants	This is determined based on what we know about the relationship between exposure and effect, the extent to which exposure to each chemical occurs, and the extent to which other factors are known to contribute to health risk. Previous analyses of the environmental contribution to disease have weighed these factors to identify the percent of each health outcome that is due to an environmental exposure. This is referred to as the "environmentally attributable fraction". Typically, this is presented as a range rather than a specific percentage to demonstrate the extent of uncertainty around each estimate. Existing estimates for “environmentally attributable fractions” of specific diseases have been designed for smog-producing chemicals and are generally not directly applicable to the set of chemicals covered in Cleaner Air Oregon

Prevalence of each health outcome in Oregon	OHA tracks incidence of several health outcomes that may be impacted by toxic air contaminants, including cancer, adverse birth outcomes, asthma, and heart disease. Baseline data is not as readily available for conditions related to brain development, neurological outcomes, infertility, allergy, immunity, and other health outcomes that may be impacted by toxic air contaminants but are not conditions health care providers must report under current public health rules.
Economic burden of each case of illness	Economic costs can be measured in different ways. Some estimates focus on direct medical costs of disease. Others account for indirect costs such as missed days of work and school. For some health outcomes metrics of different types have been established by the CDC or in published literature, while for other health outcomes data on economic burden is less easily accessible. In addition, social costs of illness such as social isolation, time spent by unpaid caretakers, and emotional burden of premature death are important to consider but difficult to quantify.
Predicted reduction in exposure	This will depend on which facilities are included in the first tier of implementation and which toxic air contaminants they emit. Without complete information on current emissions, it is difficult to know how much emissions of each air toxic will be reduced in order to bring facilities into compliance

Costs of chronic diseases in Oregon

Toxic air contaminants included in Cleaner Air Oregon are associated with increased risk of four of the top five leading causes of death in Oregon (heart disease, stroke, respiratory disease, and cancer).[6] DEQ and OHA don't know what portion of these may be attributable to industrial and commercial toxic air contaminants, but data clearly show that chronic diseases have a substantial social and economic impact in Oregon. OHA uses Center for Disease Control and Prevention data to estimate the cost of certain chronic diseases in Oregon. If even a small fraction of these chronic health outcomes is attributable to toxic air contaminants, reducing emissions could prevent substantial health costs in addition to human suffering. The total estimated costs of chronic diseases tracked in Oregon are summarized in Table 11.

[6] OHA. 2016. Leading Causes of Death http://public.health.oregon.gov/ProviderPartnerResources/PublicHealthAccreditation/Documents/indicators/leadingcausesofdeath.pdf)

Table 11

Total Estimated Cost of Chronic Diseases that are Tracked in Oregon

Health Outcome	Description	Average Annual Cost of Each Case	Estimated Annual Medical Costs in Oregon[A]	Examples of toxic air contaminants that may contribute to health risk
Asthma	Estimates include adults and children	$2,740	$411 million	formaldehyde, cobalt, hexavalent chromium, cadmium, PAHs, manganese, arsenic
Cancer	Estimates are based on adult cancer treatment only	$11,410	$1.9 billion	arsenic, hexavalent chromium, cadmium, formaldehyde, PAHs, benzene, trichloroethylene, lead, dioxins, naphthalene
Cardiovascular disease	Estimates are for adults only and include hypertension, stroke, coronary heart disease, congestive heart failure, and other heart disease	$2,220-$16,760 (disease-specific)	$3.6 billion[B]	arsenic, PAHs, lead, acrolein, hydrogen fluoride

[A] Calculated using the CDC Chronic Disease Cost Calculator [7] based on 2008 prevalence and cost statistics and 2010 census data. Estimates are limited to medical expenditures and do not include indirect costs such as missed days of work and school.
[B] This cost estimate integrates costs of all cardiovascular disease without double counting costs of treatments for comorbid cardiovascular conditions.

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[7] OHA, 2010. Estimated medical treatment costs of chronic diseases, Oregon 2010. http://www.oregon.gov/oha/PH/DISEASESCONDITIONS/CHRONICDISEASE/DATAREPORTS/Documents/datatables/CDCC_2010.pdf

Oregon Health Authority also tracks cases of pre-term birth, low birth weight, miscarriage, and some birth defects. There are no existing estimates of the direct medical costs associated with these adverse birth outcomes in Oregon, but there is potential for substantial economic and social impact. The total incidence of selected adverse birth outcomes in Oregon are summarized in Table 12. While several toxic air contaminants are associated with increased risk for these adverse birth outcomes, the portion of cases attributable to exposure to toxic air contaminants is unknown.

Table 12

Adverse Birth Outcomes in Oregon

Health outcome	Total number of pregnancies impacted by each health outcome in OR 2009-2013[A]	Potential Economic and Social Costs	Examples of toxic air contaminants that may contribute to health risk
Low birth weight[B]	14,239	Costs depend on degree of prematurity/weight but can include direct medical costs associated with neonatal ICU treatment, increased risk of neonatal infections, increased risk of developmental disabilities, predisposition to disease later in life, parental stress, and costs of parents' missed days of work.	arsenic, PAHs, formaldehyde, cadmium, benzene, trichloroethylene
Pre-term birth[C]	17,442	Costs depend on degree of prematurity/weight but can include direct medical costs associated with neonatal ICU treatment, increased risk of neonatal infections, increased risk of developmental disabilities, predisposition to disease later in life, parental stress, and costs of parents' missed days of work.	lead, formaldehyde
Miscarriage[D]	978	Costs include direct medical costs, genetic testing/placental virus testing to determine the cause, parents' missed days of work, and emotional trauma to parents.	PAHs, lead, formaldehyde, arsenic, dioxins, trichloroethylene

Birth anomalies[E]	2,831	Costs are highly variable depending on the type and severity of the anomaly, but may include neonatal surgery, follow-up surgeries and medical costs throughout childhood and into adulthood, long-term disability, parents' missed days of work, and stress to families	dioxins, arsenic, trichloroethylene, benzene

[A] There were 228,115 total live births in Oregon 2009-2013.

[B] <2500 grams birth weight. Source: Vital records

[C] <36 weeks' gestation at birth. Source: Vital records

[D] Fetal deaths at or after 20 weeks of gestation. Any spontaneous pregnancy losses earlier in gestation are not recorded. Source: Oregon Vital Records http://www.oregon.gov/oha/PH/BIRTHDEATHCERTIFICATES/VITALSTATISTICS/Pages/index.aspx

[E] Birth anomaly numbers are limited to cases of 12 "core" birth anomalies that have been tracked historically in the Oregon Birth Anomalies Surveillance System (anencephalus, cleft lip alone, cleft palate, gastroschisis, hypoplastic left heart syndrome, hypospadias, limb deficiencies, spina bifida, tetralogy of fallot, transposition of the great arteries, and trisomy 21). Oregon has recently started tracking a broader set of birth anomalies but data are not yet available. National Birth Defects Prevention Network, 2016 https://www.nbdpn.org/docs/bdra23587-sup-0001-suppinfo01_2016DEC16.pdf

Estimates of the portion of health effects caused by pollution

Several analyses have estimated the portion of a given disease that is attributable to environmental exposures. Because there is often uncertainty around the complex ways that genes, nutrition, social factors, behavior, and chemical exposures interact to influence health, the environmentally attributable fraction is often presented as a range rather than a specific number.

These estimates of the environmentally attributable fraction are not specific to the set of toxic air contaminants included in Cleaner Air Oregon. Therefore, these numbers cannot be directly applied to estimate the contribution of toxic air contaminants to health risks in Oregon. Rather, they provide an indication of the potential magnitude of the contribution of pollution to disease. The most comprehensive assessment of the contribution of pollution to disease is a 2002 study drawing on 1997 data (dollar figures are 1997 dollars). The findings are summarized below.

- Asthma. Researchers estimate that 10-30% of asthma is attributable to outdoor air pollution (including both industrial and non-industrial sources). The yearly fraction of asthma cases that could be attributed to environmental factors cost the US between $0.7 and $2.3 billion. These cost estimates account for direct medical costs and lost productivity due to asthma-related premature deaths.[8]

[8] Landrigan PJ, Schechter CB, Lipton JM, Fahs MC, Schwartz J. Environmental pollutants and disease in American children: estimates of morbidity, mortality, and costs for lead poisoning, asthma, cancer, and developmental disabilities. Environ Health Perspect. 2002 Jul;110(7):721-8

- Cancer. Researchers estimate that between 2-10% of childhood cancer is attributable to environmental factors, accounting for nationwide costs ranging from $132-663 million a year. These cost estimates account for direct medical costs, costs associated with secondary cancers, lost productivity associated with treatments and premature death.[5]
- Neurodevelopmental disorders. Researchers estimate that 5-20% of neurodevelopmental disorders such as ADHD, autism, and mental retardation may be attributable to environmental factors (excluding lead which was considered separately), costing the US between $4.6-18.4 billion a year. Cost estimates in this study were based on direct costs of medical care, long-term care, and lost productivity.[5] Another study estimated that developmental delays caused by exposure to polycyclic aromatic hydrocarbons in New York City alone cost $13.7 million.[9]
- Lead Poisoning. Researchers estimated that the total cost of childhood lead poisoning in the US was 43.4 billion yearly. All cases of lead poisoning are attributed to lead exposure, but the relative contribution of different sources of exposure to lead is not well established.

Living near industrial and commercial sites is associated with increased risk of illness

Several national studies, most published in the past five years, have found that living near industrial and commercial sites increases risk for several health conditions that are common in Oregon. The specific health impacts that are observed depend on the kinds of chemicals industries are using. Taken together, these studies suggest that reducing industrial and commercial exposure to toxic air contaminants could improve health.

- Mortality. A national study found that counties with higher rates of toxic air and water emissions also had increased rates of adjusted mortality.[10]
- Cardiovascular disease. A national study found that counties with higher emissions of carcinogens, metals, or hazardous air pollutants saw significantly higher rates of mortality from cardiovascular disease.[11]
- Autism. A national study found that children living close to industrial and commercial facilities releasing arsenic, lead or mercury into the air are significantly more likely to be diagnosed with autism spectrum disorder.[12]

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[9] Weiland K, Neidell M, Rauh V, Perera F. Cost of developmental delay from prenatal exposure to airborne polycyclic aromatic hydrocarbons. J Health Care Poor Underserved. 2011 Feb;22(1):320-9. doi: 10.1353/hpu.2011.0012

[10] Hendryx M, Fedorko E. The relationship between toxics release inventory discharges and mortality rates in rural and urban areas of the United States. J Rural Health. 2011 Winter;27(4):358-66. doi: 10.1111/j.1748-0361.2011.00367.x

[11] Hendryx M, Luo J, Chen BC. Total and cardiovascular mortality rates in relation to discharges from Toxics Release Inventory sites in the United States. Environ Res. 2014 Aug;133:36-41. doi: 10.1016/j.envres.2014.05.010.

[12] Dickerson AS, Rahbar MH, Han I, Bakian AV, Bilder DA, Harrington RA, Pettygrove S, Durkin M, Kirby RS, Wingate MS, Tian LH, Zahorodny WM, Pearson DA, Moyé LA 3rd, Baio J. Autism spectrum disorder prevalence and proximity to industrial facilities releasing arsenic, lead or mercury. Sci Total Environ. 2015 Dec 1;536:245- 51. doi: 10.1016/j.scitotenv.2015.07.024.

- Asthma. A nationwide evaluation of National Air Toxics Assessment data performed by CDC scientists found a correlation between modeled acrolein exposure and prevalence of asthma attacks in census tracts across the US.[13]
- Cancer. A national study found that living close to industrial and commercial facilities releasing chemicals known to cause cancer is associated with significantly higher rates of cancer hospitalizations. The authors estimated that in 2009, excess cancer risk associated with these industrial and commercial exposures cost an estimated $902.8 million in treatment costs.[14]

Improved air quality can improve public health

There are several examples of clear public health improvements observed in response to improvements in air quality:

- In Southern California, air pollution control efforts were accompanied by meaningful improvements in children's respiratory health. As air quality improved, the percent of children with decreased lung function was cut in half,[15] and children with asthma were 30% less likely to experience symptoms of bronchitis.[16]
- The temporary closure of a steel mill in Utah Valley was linked to temporary improvements in birth outcomes and respiratory health. One study found that rates of premature birth were significantly lower among women who were pregnant while the mill was closed than among women who were pregnant before or after the closure.[17] Another study found that children's hospital admissions for pneumonia, bronchitis and asthma were two to three times higher when the mill was opened than when it was closed.[18]
- Federal regulations on leaded gasoline resulted in a dramatic decrease in blood lead levels in children across the country.[19] The Center for Disease Control and Prevention has concluded that there is no safe level of lead exposure due to its impacts on brain

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[13] deCastro BR. Acrolein and asthma attack prevalence in a representative sample of the United States adult population 2000-2009. PLoS One. 2014 May 9;9(5):e96926. doi: 10.1371/journal.pone.0096926. eCollection 2014.

[14] Hendryx M, Luo J. Cancer hospitalizations in rural-urban areas in relation to carcinogenic discharges from Toxics Release Inventory facilities. Int J Environ Health Res. 2013;23(2):155-69. doi: 10.1080/09603123.2012.708919

[15] Gauderman WJ, Urman R, Avol E, Berhane K, McConnell R, Rappaport E, Chang R, Lurmann F, Gilliland F. Association of improved air quality with lung development in children. N Engl J Med. 2015 Mar 5;372(10):905-13. doi: 10.1056/NEJMoa1414123

[16] Berhane K, Chang CC, McConnell R, Gauderman WJ, Avol E, Rapapport E, Urman R, Lurmann F, Gilliland F. Association of Changes in Air Quality With Bronchitic Symptoms in Children in California, 1993-2012. JAMA. 2016 Apr 12;315(14):1491-501. doi: 10.1001/jama.2016.3444.

[17] Parker JD, Mendola P, Woodruff TJ. Preterm birth after the Utah Valley Steel Mill closure: a natural experiment. Epidemiology. 2008 Nov;19(6):820-3. doi: 10.1097/EDE.0b013e3181883d5d.

[18] Pope CA 3rd.Respiratory disease associated with community air pollution and a steel mill, Utah Valley. Am J Public Health. 1989 May;79(5):623-8.

[19] EPA, History of Reducing Air Pollution from Transportation in the United States https://www.epa.gov/air-pollution-transportation/accomplishments-and-success-air-pollution-transportation

development. Because lead exposure comes from many sources, scientists were not sure of the extent to which lead from paint and gasoline were responsible for high blood lead levels in children until they were able to observe the effect of these regulations.

Other considerations

In attempting to estimate the economic and health burden of toxic air contaminant emissions in Oregon, there are several additional points worth considering:

- A portion of the health costs of toxic air contaminant emissions are currently externalized. People who are not employed by a facility, but who live, go to school, or work near a facility emitting pollutants above proposed Risk Action Levels may bear the health burden of pollution exposure without experiencing the economic benefit a facility may have from exceeding Risk Action Levels.
- Many of the broader social costs of disease are particularly difficult to quantify. For example, indirect costs of asthma hospitalization include missed days of work and school; indirect costs of neurodevelopmental delays include lost lifetime earning potential, social isolation, and caregiver time; indirect costs of fetal heart malformation often include increased risk of secondary health effects.
- Risk-based toxic air contaminant permitting regulations could also significantly improve the health of workers, resulting in lower health care costs and more productive workers. Workplace exposure standards are typically not entirely health-based.

Negative impacts on the public

The proposed rules could have negative economic effects on the public if facilities providing jobs and contributing to local economies were to curtail production or close in response to regulatory requirements. DEQ and OHA recognize that employment plays a key role in public health, and that negative economic impacts through job loss could occur despite proposed provisions to allow business flexibility and decrease the chances of business closures or employee layoffs in direct response to regulations.

Some of the same provisions that mitigate impacts on small businesses can potentially mitigate public impacts from lower employment. Under the draft rules, facilities above Risk Action Levels may wait for effective control technologies to develop if none are available at the time of permitting, unless their risk is above the Risk Reduction Level. Facilities demonstrating a lack of financial ability to install the needed controls at the time required could postpone installation of controls to reduce risk. The proposed tiered implementation will delay potential impacts to many facilities. However, business decisions are influenced by many factors, and DEQ therefore lacks information to predict specific potential impacts to employment that would adversely affect the public.

The proposed rules could affect the public indirectly if businesses alter the price of goods and services in response to increased base or activity permit fees or the cost to comply with Cleaner Air Oregon rules. DEQ expects any such price increases to be small, but lacks available information to estimate potential increases accurately.

Citizens may also be impacted by the need to participate in public meetings, including time to research and understand potential toxic air contaminant health concerns and risk assessment and permitting issues, and time spent preparing communications and attending meetings. DEQ is not able to quantify the time and fiscal impact on public process participants, but recognizes that time spent may impact members of the public and require time away from work, childcare, travel or other expenses.

Impacts on the environmental services sector

The direct cost of complying with regulations can result in increased employment in the environmental services sector. For example, an environmental regulation could mean more jobs for those engaged in environmental consulting and pollution abatement. Further, it is possible that regulations may produce more labor-intensive production processes. Studies of national air quality regulations have shown positive effects on overall economic health. The Clean Air Act's public health safeguards encourage technology investments that can have positive economic effects on the public.

General impacts to businesses from environmental regulations

Although in the short term new environmental regulations can have some positive and negative impacts on employment in different sectors, studies indicate that those impacts are limited and that the overall effect of environmental regulations on reported job shift events are extremely minor compared to other factors, such as overall economic growth, business cycles, and changes in technology.[20]

A peer-reviewed study by economists at Resources for the Future, a nonpartisan Washington, D.C. think tank, examined the impact of environmental compliance costs on employment in four regulated industries (pulp and paper, refining, iron and steel, and plastics). They concluded that increased environmental spending generally does not cause a significant change in employment. [21] Another peer-reviewed study published in the Journal of Public Economics found no evidence that stringent local air quality regulation substantially reduced employment in the Los Angeles basin over a 13-year period of "sharply increased" regulation.

[20] http://econweb.ucsd.edu/~elib/berman_bui2001

[21] https://www.epa.gov/clean-air-act-overview/clean-air-act-and-economy#_edn10

Fiscal Advisory Committee

DEQ appointed a fiscal advisory committee for help with the development of the Cleaner Air Oregon toxic air contaminant permitting program and review of this fiscal impact statement, which describes the fiscal and economic impacts of the May 2018 second draft of the Cleaner Air Oregon proposed rules. DEQ convened the fiscal advisory committee on May 9, 2018 to ask for the committee's input and recommendations on fiscal impact issues stated in ORS 183.333:

- Whether the proposed rules would have a fiscal impact,
- The extent of the impact, and
- Whether the proposed rules would have a significant adverse impact on small businesses; if so, then how DEQ can comply with ORS 183.540 to reduce that impact.

DEQ sought comments and discussion on the entire fiscal impact analysis, not just the changes made since the first fiscal impact analysis was reviewed in August 2017. However, much of the May 9, 2018 discussion focused on changes, since most members had familiarity with and a previous opportunity to comment on the first fiscal analysis. Advisory committee members had the opportunity to submit additional written comments on the draft fiscal statement until May 30, 2018.

Would the draft rule have a fiscal impact?

The committee reviewed the draft fiscal and economic impact statement and no committee members objected to DEQ's finding that there would be a fiscal impact to businesses. One member stated that there would be significant costs to large businesses and businesses of any size.

What would the extent of the impact be?

Pollution Control Costs

Some committee members noted that DEQ had improved the detail in the pollution control equipment cost table but indicated that costs to business could be larger than the ranges included in the draft fiscal impact statement.

One member recommended inclusion of costs that DEQ estimated between 2006 and 2009 for mercury and regional haze control at Oregon's one coal-fired power plant in Boardman, Oregon. A description of pollution control equipment costs for wet and semi dry scrubbers with mercury controls for that facility is now included in Table 8. However, the Boardman coal-fired power plant is mandated by rule to close in 2020, and Oregon statutes phasing out coal-fired power mean that new coal-fired power plants in Oregon (with attendant high pollution control costs) are unlikely.

Fees

Committee members discussed proposed Cleaner Air Oregon base and activity fees. Fees would be a significant part of the cost of the program from an industry perspective.

Members asked whether, if a facility submitted TBACT determinations for multiple identical units, DEQ would charge multiple TBACT determination activity fees. In response, DEQ has added language to the proposed rules to allow one TBACT/TLAER activity fee to be charged if there were

multiple similar emission units with the same pollution control device. The draft rules also state that if one emission unit required two different pollution control devices because it emitted different types of toxic air contaminants, then two TBACT/TLAER fees could be charged.

Members also asked whether DEQ had analyzed the differences between fees proposed for the first public comment period and those in the currently proposed rules. DEQ has added and removed several fees. Table 13 below illustrates the currently proposed fees, compared to those proposed during the first public comment period, for several hypothetical facility scenarios. The committee was also interested in what percentages of program costs are covered by base vs. activity fees. DEQ has added this information to the fee analysis section of the public notice.

Members discussed the then-proposed source test review fee of $5,900, asking if it would be the same for Title V facilities and smaller facilities, and whether it would be a one-time charge for one test or multiple charges for multiple tests. In written comments, one member requested that if a source is conducting multiple source tests that it only be charged one fee. Some felt that this fee level would be a very large burden for a small facility. DEQ explained that in the current permitting program there is no source test fee and there is a backlog of source tests to review for the 1.5 FTE assigned to this task. To ensure adequate resources for source test review in Cleaner Air Oregon, DEQ has proposed a separate fee.

To mitigate impacts to both large and small businesses, DEQ proposes to create separate tiers for the source test fee, for complex ($6,000) reviews of multiple emission units and toxic air contaminants, moderate ($4,200) reviews for a single emission unit with multiple toxic air contaminant test methods, and simple ($1,400) source tests for single emission units with a single toxic air contaminant test method. Smaller facilities may have less complex source testing, and if so, this change would reduce the economic burden from this fee.

A member also stated that it would be clearer to call this fee a stack test fee rather than a source test fee. DEQ has opted to maintain the language “source test fee” because while many facilities would be source testing emission stacks, some would be source testing other emission points within their processes.

Members asked about the potential extent of community engagement, especially in areas with fewer public participants where costs could be lower. Some stated that the community engagement fee should be lower because it should only cover the cost of notifying people of a meeting and holding the meeting. Others commented that the $10,800 community engagement fee is appropriate for all levels of permit, as it will serve as an incentive for pollution reduction. In setting public meeting fees DEQ sought to arrive at an average amount estimated to run public meetings. Some will likely require more resources and others will likely require less. Another member commented that the proposed 1.5 kilometer distance for public notification is unnecessarily large and a less costly process would be to limit notification to areas impacted by a facility’s emissions. DEQ has declined to make this change in regulations because source modeling generally shows that 1.5 km is the distance from facilities at which the concentrations fall off sharply. In addition, community notification on a scale smaller than 1.5 kilometers may be ineffective to engage members of the community who may be impacted and interested.

Table 13 Cleaner Air Oregon Specific Activity Fee Examples							
Example	**Call-In Fee**	**Risk Assess-ment Fee**	**Risk Reduction or Ambient Monitoring Fee**	**TBACT Fee**	**Community Engagement Fee**	**Incomplete Application or Postponement of Risk Reduction Fee**	**Total**
Examples for Facilities Applying for CAO Toxic Air Contaminant Permit Addendums							
An existing facility with a General ACDP permit performs a Level 2 Risk Assessment using AERSCREEN and can screen out below Risk Action Levels as de minimis	$500	$2,000	NA	NA	NA	NA	$2,250
An existing facility with a Title V permit performs a Level 3 Risk Assessment using AERMOD and can screen out below Source Permit Levels as de minimis	$10,000	$8,800	NA	NA	NA	NA	$18,800
An existing facility with a Title V permit performs a Level 3 Risk Assessment using AERMOD, is above de minimis and is permitted to stay below the TBACT Level	$10,000	$19,900	NA	NA	$8,000	NA	$37,900
An existing facility with a Standard ACDP permit performs a Level 4 Risk Assessment and applies for a Risk Reduction Plan that requires 1 TBACT determination, but submits an incomplete application and DEQ must modify application	$10,000	$25,800	$6,700	$3,000	$8,000	$2,500	$56,000
An existing facility with a Title V permit performs a Level 4 Risk Assessment and has TBACT on 3 TEUs but requests postponement of risk reduction on 1 TEU	$10,000	$34,600	NA	$12,000	$8,000	$4,400	$69,000

An existing facility with a Standard ACDP permit requests ambient monitoring plan option at Level 4	$10,000	$25,800	$25,900	NA	$8,000	NA	$69,700
Examples for Facilities with Existing CAO Toxic Air Contaminant Permit Addendums							
An existing facility with a Simple ACDP requests approval of one new de minimis TEU. Potential risk stays below Risk Action Level. Already has Toxic Air Contaminant Permit Addendum (no modeling required).	NA	$500	NA	NA	NA	NA	$500
An existing facility with a Standard ACDP requests approval of two new TEUs that require a permit modification but potential risk stays below Risk Action Level. Already has Toxic Air Contaminant Permit Addendum (no modeling required).	NA	$8,000	NA	NA	NA	NA	$8,000

Would the draft rules have a significant adverse impact on small businesses, and if so, what are recommendations for potential mitigation?

After discussing potential economic impacts to small businesses and the process of reviewing DEQ's fiscal impact statement, the facilitator polled the committee to determine how many members thought that Cleaner Air Oregon could cause a significant adverse economic impact on small businesses. Out of the 17 members and 2 co-chairs present, eleven indicated that the draft rules could cause a significant impact on small business, seven abstained, and one did not indicate a significant impact. Several members commented on the difficulty of answering fiscal impact questions.

The committee proceeded to discuss the types of economic impacts and potential mitigation measures. One member stated in their written comments that economic mitigation measures and off ramps should not be available to small businesses posing significant health risk. Others noted that innovative ideas for mitigation of small business impacts could help more facilities move past the need for the financial hardship or postponement of risk reduction process. DEQ noted the challenges of determining economic impacts because levels of risk and response actions are not yet known.

DEQ summarized proposed rule options for the mitigation of economic impact on small businesses. At the time of the August 2018 fiscal committee meeting these included:

- Higher risk action levels that would cause more facilities to screen out or have less stringent requirements to reduce emissions
- Tiered implementation of the program which would delay regulatory costs for most smaller businesses
- Additional time for compliance with risk levels through extensions and postponement proposals
- DEQ doing level 1 risk assessments for sources on General and Basic Air Contaminant Discharge Permits
- Process to allow postponement of risk reduction requirements based on financial hardship
- DEQ and OHA staff positions for technical assistance

A member commented that since there is no indication that fees can be waived or reduced for small businesses, there would be a logical assumption that fees would impact smaller businesses more greatly than they would impact larger businesses. Several members agreed that there could be a significant economic impact on small businesses operating on low profit margins. Another member said that the state is now proposing to require that people who put toxics in the environment assume some of the externalized costs for those actions.

A member with experience managing a colored art glass manufacturer noted that compliance with the colored art glass rules caused very significant impacts on those small businesses. They wanted to do everything right and it almost put them out of business. The cost of engineering and consultants was less than what it took to operate the pollution control equipment. Capital cost recovery will take over ten years with an aggressive payback schedule for the loan necessary to buy and install the

equipment. Normally the business would budget between 5 and 8 percent for maintenance of equipment, but for pollution control equipment, that should be increased to 20 to 22 percent annually of the cost of the original equipment.

The committee-generated options for small business mitigation followed by DEQ evaluation were as follows:

- Lower base fees for small business.
    - Cleaner Air Oregon base fees are a percentage of existing permit base fees. Smaller facilities with few emissions units are on General or Basic Air Contaminant Discharge Permits, with lower base fees so their CAO base fee would also be low.
- Include options for fee payment flexibility or installment payments.
    - DEQ has determined that there is existing authority and guidance available for sources who want to request a fee installment payment plan.
- Allowing small businesses of equal risk with large businesses to come later in the call in schedule.
    - General permittees are highly unlikely to pose significant health risk from emissions of air toxics, and if they do, DEQ would propose changes to the overall general permits, rather than to each source to mitigate risk. However, DEQ has declined to categorically delay call in for other permitted small businesses that could pose significant health risk because this would prevent DEQ from achieving the intended public health protection purpose of these rules.

- Stage fees for small businesses to come at the most convenient times, earlier in the fiscal year is better (avoid the last fiscal quarter, line up with tax year.)
    - DEQ plans to further consider implementation of this recommendation, which would not require any changes to Cleaner Air Oregon rules.

- Develop a mitigation program to directly assist small businesses. Set up small business assistance centers at universities. They could form a consortium and small businesses could pay a reduced fee and have their situation evaluated by students and professors.
    - In addition to providing a full position to provide technical assistance, DEQ plans to explore options for considering and involving universities and forming a consortium to assist small businesses with technical analysis and emission reduction actions.

- DEQ could help coordinate engineering and risk assessment support. Similar industries may be able to reuse each other's work. This would reduce time and cost for subsequent sources. Similar types of businesses will use similar types of designs. There could be leveraging of expertise and information by process components or source categories. To handle concerns about proprietary information and competition use non-disclosure agreements.
    - Similar to the recommendation on involving universities, DEQ plans to further explore this option to facilitate coordination and sharing of engineering and risk assessment information. This work would be led by the Cleaner Air Oregon technical assistance position.

- Look into how loan programs or consolidation of loan opportunities could work for small businesses in Cleaner Air Oregon.
    - Through technical assistance and other resources, DEQ plans to further explore this recommendation for development of loan programs to small businesses impacted by Cleaner Air Oregon.

- Use a model like the small business association to coordinate financing and funding. This could get some facilities off of the inability to pay list.
    - Through technical assistance and other resources, DEQ plans to further explore this recommendation for coordination of financing and funding for small businesses impacted by Cleaner Air Oregon.

- Call in businesses at least 6 months in advance so they can work on their budgets and chart out their resources to get ready.
    - DEQ will consider providing all businesses as much time as possible to respond to Cleaner Air Oregon requirements.

- Consider mitigation measures for new small businesses that will have the more stringent CAO new business risk action levels.
    - New small businesses will have the opportunity to design processes that meet the more stringent new source risk action levels, and DEQ plans to provide technical assistance to these sources. However, DEQ has declined to categorically exempt small businesses from new source risk action levels because this would prevent DEQ from achieving the intended public health protection purpose of these rules.

Impacts on the Public

A member commented that proposed Cleaner Air Oregon regulations would have a positive economic impact on the public, providing more information, more certainty of conditions that could affect health, and a better assurance of health. It is important to measure health outcomes to make a real assessment of health impacts. Another member commented that the section on negative impacts on public health including potential effects on jobs appeared defensive because the description of impacts was followed directly by a description of factors that would mitigate economic impacts on business. A member asked whether employment is the only indicator of public health and DEQ clarified that it was not, the fiscal analysis contains a section discussing the potential relationships between reducing toxic air contaminants and disease. DEQ also noted that uncertainty exists in both impacts to businesses and impacts on the public.

Advisory committee members' comments are further summarized in written meeting minutes, and an audio recording of the meeting when they discussed the program's fiscal impact is also available upon request.

Housing cost

To comply with ORS 183.534, DEQ determined the proposed rules may have an effect on the development cost of a 6,000-square-foot parcel and construction of a 1,200- square-foot

detached, single-family dwelling on that parcel. The costs of additional permits, pollution control or process equipment, and compliance could be passed through by businesses providing products and services for such development and construction. The possible impact of these proposed changes appears to be minimal. DEQ cannot quantify the impact at this time because the available information does not indicate whether the costs would be passed on to consumers and any such estimate would be speculative.

Documents relied on for fiscal and economic impact

Document title	Document location
Air Contaminant Discharge Permits – OAR 340-216-8010 Table 1	https://secure.sos.state.or.us/oard/view.action?ruleNumber=340-216-8010
Air & Waste Management Association Fact Sheet: Air Pollution Emission Control Devices for Stationary Sources, April 2007	http://events.awma.org/files_original/ControlDevicesFactSheet07.pdf
EPA Air Pollution Control Cost Manual, Report No. 452/B-02-001, December 1995, Section 5, Chapter 1, SO_2 and Acid Gas Controls	http://www.epa.gov/ttn/catc/dir1/cost_toc.pdf
EPA Air Pollution Control Cost Manual, Report No. 452/B-02-001, January 2002, Section 6, Chapter 1, Baghouses and Filters	http://www.epa.gov/ttn/catc/dir1/cost_toc.pdf
EPA Air Pollution Control Cost Manual, Report No. 452/B-02-001, September 1999, Section 6, Chapter 3, Electrostatic Precipitators	https://www3.epa.gov/ttn/ecas/docs/cs6ch3.pdf
EPA Health and Environmental Effects of Hazardous Air Pollutants	https://www.epa.gov/haps/health-and-environmental-effects-hazardous-air-pollutants
EPA Technical Bulletin Choosing an Adsorption System for VOC: Carbon, Zeolite, or Polymers? May 1999	https://www3.epa.gov/ttncatc1/cica/files/fadsorb.pdf
EPA Pollution Control Technology Fact Sheet Spray-Chamber/Spray-Tower Wet Scrubber, EPA-452/F-03-016	https://www3.epa.gov/ttncatc1/cica/files/fsprytwr.pdf
EPA Air Pollution Control Technology Fact Sheet Catalytic Incinerator, EPA-452/F-03- 018	https://www3.epa.gov/ttncatc1/cica/files/fcataly.pdf
EPA Air Pollution Control Technology Fact Sheet Regenerative Incinerator, EPA- 452/F-03-021	https://www3.epa.gov/ttncatc1/cica/files/fregen.pdf
EPA Air Pollution Control Technology Fact Sheet Thermal Incinerator, EPA-452/F-03- 022	https://www3.epa.gov/ttncatc1/cica/files/fthermal.pdf
EPA Air Pollution Control Technology Fact Sheet, Paper/Nonwoven Filter – High Efficiency Particle Air (HEPA) Filter, EPA-452/F-03-023	https://www3.epa.gov/ttncatc1/cica/files/ff-hepa.pdf
EPA Pollution Control Technology Fact Sheet Fabric Filter – Mechanical Shaker Cleaned Type, EPA-452/F-03-024	https://www3.epa.gov/ttncatc1/cica/files/ff-shaker.pdf
EPA Air Pollution Control Technology Fact Sheet Dry Electrostatic Precipitator (ESP) – Wire-Plate Type, EPA-452/F-03-028	https://www3.epa.gov/ttncatc1/cica/files/fdespwpl.pdf

EPA Air Pollution Control Technology Fact Sheet Permanent Total Enclosures (PTEs), EPA-452/F-03-033	https://www3.epa.gov/ttncatc1/cica/files/fpte.pdf
EPA The Clean Air Act and the Economy	https://www.epa.gov/clean-air-act-overview/clean-air-act-and-economy#economy
Analytical Components of the Benefits and Costs of the Clean Air Act 1990-2020, the Second Prospective Study	https://www.epa.gov/clean-air-act-overview/analytical-components-benefits-and-costs-clean-air-act-1990-2020-second
Air Toxics Case Study – Health Benefits of Benzene Reduction in Houston, 1990-2020	https://www.epa.gov/sites/production/files/2015-07/documents/812caaa_benzene_houston_final_report_july_2009.pdf
EPA AP-42, Chapter 12.20 Electroplating 07/1996	https://www3.epa.gov/ttnchie1/ap42/ch12/final/c12s20.pdf
EPA Integrated Risk Information System	https://www.epa.gov/iris
ATSDR Toxics Substances Portal	https://www.atsdr.cdc.gov/toxprofiles/index.asp
California Office of Environmental Health Hazard Assessment. Air Toxics Hot Spots Program Technical Support Document for the Derivation of Noncancer Reference Exposure Levels. Dec, 2008	https://oehha.ca.gov/air/crnr/notice-adoption-air-toxics-hot-spots-program-technical-support-document-derivation
OHA. 2016. Leading Causes of Death	http://public.health.oregon.gov/ProviderPartnerResources/PublicHealthAccreditation/Documents/indicators/leadingcausesofdeath.pdf
OHA, 2010. Estimated medical treatment costs of chronic diseases, Oregon 2010.	http://www.oregon.gov/oha/PH/DISEASESCONDITIONS/CHRONICDISEASE/DATAREPORTS/Documents/datatables/CDCC_2010.pdf
Oregon Vital Records	http://www.oregon.gov/oha/PH/BIRTHDEATHCERTIFICATES/VITALSTATISTICS/Pages/index.aspx
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Hendryx M, Fedorko E. The relationship between toxics release inventory discharges and mortality rates in rural and urban areas of the United States	J Rural Health. 2011 Winter;27(4):358-66. doi: 10.1111/j.1748-0361.2011.00367.x
Hendryx M, Luo J, Chen BC. Total and cardiovascular mortality rates in relation to	Environ Res. 2014 Aug;133:36-41. doi: 10.1016/j.envres.2014.05.010.

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Berman E, T.M. Bui L, Environmental regulation and labor demand: evidence from the South Coast Air Basin	http://econweb.ucsd.edu/~elib/berman_bui2001
The Clean Air Act and the Economy	https://www.epa.gov/clean-air-act-overview/clean-air-act-and-economy

Alternative formats

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