Health Consultation

Summary of Air Quality Issues and Identification of Information Needed to Address Community Health Concerns –

PORT TOWNSEND PAPER CORPORATION

JEFFERSON COUNTY, WASHINGTON

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared By:

Washington State Department of Health
Under a Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Foreword

The Washington State Department of Health (DOH) has prepared this health consultation in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for health issues related to hazardous waste. This health consultation was prepared in accordance with methodologies and guidelines developed by ATSDR.

The purpose of this health consultation is to identify and prevent harmful human health effects resulting from exposure to hazardous substances in the environment. Health consultations focus on specific health issues so that DOH can respond to requests from concerned residents or agencies for health information on hazardous substances. DOH evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health. The findings in this report are relevant to conditions at the site during the time of this health consultation, and should not necessarily be relied upon if site conditions or land use changes in the future.

For additional information or questions regarding DOH or the contents of this health consultation, please call the health advisor who prepared this document:

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For persons with disabilities this document is available on request in other formats. To submit a request, please call 1-800-525-0127 (voice) or 1-800-833-6388 (TTY/TDD).

For more information about ATSDR, contact the ATSDR Information Center at 1-888-422-8737 or visit the agency's Web site: www.atsdr.cdc.gov/.

Glossary

Air emissions inventory	An air emissions inventory is a listing of the amount of air pollution emitted by various sources. Every year, Ecology and the local air quality agencies inventory large businesses. Every three years, Ecology inventories many additional sources such as motor vehicles, woodstoves, outdoor burning, agricultural sources, and natural sources.
Acute	Occurring over a short time [compare with **chronic**].
Agency for Toxic Substances and Disease Registry (ATSDR)	The principal federal public health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.
Carcinogen	Any substance that causes cancer.
Chronic	Occurring over a long time (more than 1 year) [compare with **acute**].
Comparison value	Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.
Contaminant	A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.
Dose **(for chemicals that are not radioactive)**	The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.
Emissions inventory	An emissions inventory provides a detailed description of the quantity of pollutants along with their emissions characteristics (how and where contaminants are being emitted.
Exposure	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [**acute exposure**], of intermediate duration, or long-term [**chronic exposure**].

Hazardous air pollutants (HAPs)	HAPs are those pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects. Examples of toxic air pollutants include benzene, which is found in gasoline; perchlorethlyene, which is emitted from some dry cleaning facilities; and methylene chloride, which is used as a solvent and paint stripper by a number of industries.
Inhalation	The act of breathing. A hazardous substance can enter the body this way [see **route of exposure**].
Media	Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.
Organic	Compounds composed of carbon, including materials such as solvents, oils, and pesticides that are not easily dissolved in water.
Pollutants	Air pollution describes a collection of airborne pollutants that contribute to our air quality. The term "pollutants" recognizes that these substances are undesirable because of their impact on human health, the environment and the economy.
Parts per billion (ppb)/Parts per million (ppm)	Units commonly used to express low concentrations of contaminants. For example, 1 ounce of trichloroethylene (TCE) in 1 million ounces of water is 1 ppm. 1 ounce of TCE in 1 billion ounces of water is 1 ppb. If one drop of TCE is mixed in a competition size swimming pool, the water will contain about 1 ppb of TCE.
Route of exposure	The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].
Toxics Release Inventory (TRI)	Toxics Release Inventory (TRI) - TRI is the common name for Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA). Each year, facilities that meet certain thresholds must report their releases and other waste management activities for listed toxic chemicals. That is, facilities must report the quantities of toxic chemicals recycled, collected and combusted for energy recovery, treated for destruction, or disposed of. A separate report must be filed for each chemical that exceeds the reporting threshold. EPA compiles the reported information into a publicly available database known as the Toxics Release Inventory.

Purpose

The Washington State Department of Health (DOH) prepared this health consultation at the request of citizens of Port Townsend and Jefferson County. Local residents expressed concern over the potential health impacts of both past and current air emissions from the Port Townsend Paper Corporation (PTP) mill. The purpose of this health consultation is to summarize health concerns regarding air pollution generated from the PTP mill and respond to the community's requests for an investigation of the following issues:

- Epidemiological analysis of the incidence of cancer cases and detailed geographic tracking of cancer cases in Jefferson County.
- Tracking of hospital visits for asthma, respiratory issues, and/or cardiac problems with comparison to wind direction and speed at the time of visit to the emergency room to see if there is a correlation to mill plume or other sources of air pollution.
- Tracking of self-reported health impacts from the mill.

DOH reviewed available information and attempted to find answers for these questions, unfortunately, they are complex and not easy to address. The cause-and-effect relationship between the given exposure and the observed health effect needs to be established to estimate the public health impact at any given level of exposure to a specific chemical. DOH found no record of specific health evaluation studies done in the Port Townsend area by either Jefferson County Public Health or the Washington State Department of Health Office of Epidemiology. Such a study would require a sufficiently large population exposed in sufficient concentrations to the contaminants being investigated. The health endpoints must also be different from other causes (e.g., diesel emissions, wood stoves, fireplaces, outdoor burning, etc). Correlations between mill emissions and symptoms of the odorous compounds such as headache, sleep disturbance, nausea, vomiting, and worsening of respiratory symptoms and asthma would need to be confirmed. Many other exposures and conditions can bring about these classes of symptoms. Studies would need distinctions between exposed and unexposed populations of sufficient size to be able to attribute effects to these gases.

All the information necessary to conduct a health study, as described above, is not available to assess the possible health effects associated with air emissions from PTP mill. Instead, DOH focused on available information and studies on health effects of mill emissions released by kraft paper and pulp mills in general. DOH also reviewed available epidemiological data in order to assess whether Port Townsend residents experience a higher rate of certain health conditions than those reported for Washington State residents overall. In addition, this health consultation included a discussion of data gaps that need to be filled in order to assess the health impacts of mill related pollutants on the community.

DOH prepares health consultations under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

Background and Statement of Issues

Site Description and History

Port Townsend is situated at the extreme northeastern end of the Olympic Peninsula in Jefferson County, Washington. The elevation is 131 feet. The 2000 census indicated a population of 8,334. The Port Townsend Paper (PTP) mill is just south of Port Townsend. It is an active facility located along the southeast shore of Port Townsend Bay on the northeastern corner of the Olympic Peninsula in Port Townsend, Jefferson County, Washington (Figures 1 and 2). The Port Townsend site began operation in 1927, employs approximately 325 full-time employees, and manufactures unbleached kraft pulp paper and lineboard for sale both domestically and internationally.[1] The process produces approximately 941 tons of pulp per day. This corresponds approximately to 2/3 of unbleached kraft pulp and 1/3rd of recycled pulp from corrugated cardboard.

Kraft is the German word for "strength," which is an important characteristic for paper making. The kraft chemical pulping process includes a recycling process where most of the chemicals used to produce pulp and paper are captured, recovered, and reused again and again. At the same time, byproducts from the pulping process are used as a fuel source to generate steam and electricity. The site contains both a pulp mill and a paper mill. The product of the pulp milling process is pulp fiber and water slurry which, through the use of mechanical and chemical treatment at the paper mill, is turned into various paper products such as boxes, paper bags, paper towels, and paper sheets.

Industry description and practices

The main steps in pulp and paper manufacturing are raw material preparation, such as wood debarking and chip making; pulp manufacturing; pulp bleaching; paper manufacturing; and fiber recycling. PTP mill uses a chemical pulp process without bleaching to make printing papers for applications in which low brightness is acceptable. The pulp mill uses wood chips and sawdust as raw material and adds them separately to digesters. The digesters chemically break down the lignin holding the cellulose fibers together in the wood. The chip digesters use steam and a sodium hydroxide and sodium sulfide solution (liquor) to break down the wood fibers into a brown wood pulp. The pulp is washed, screened, and the liquor is removed and recycled.

Air permit

PTP mill is required to have a Title V Air Operating Permit because it emits or has the potential to emit, one hundred tons per year or more of one or more air pollutants (WAC 173-401-300(1)).[2] Sulfur dioxide and hydrogen sulfide are monitored periodically, but because the volumes are thought to be low, they are not monitored frequently. Toxics emissions are not monitored. According to Ecology and PTP mill, chlorine, chloroform, and chlorine dioxide are not currently being released at the mill.[3,4] Consequently, chlorine, chloroform, and chlorine dioxide are not monitored.

Local air monitoring

In Port Townsend, monitoring for air pollution occurs at Blue Heron Middle School, 3339 San Juan Avenue in Jefferson County. This monitor only collects information on particulate matter (PM2.5).[5] Additionally, it may not be sited in a place that is relevant (i.e., does not consistently capture emissions from PTP mill). Indeed, this monitoring station was sited to represent air quality conditions representing the overall air shed. It was never intended to capture emissions directly from the mill.

Potential air pollution sources at PTP mill

There are many potential emission sources at the pulp mill including combustion units, chemical manufacturing operations, and effluent treatment processes. According to EPA's Toxics Release Inventory (TRI), industries in the Port Townsend industrial area release toxic substances into the air. Estimates of the annual air emissions of many chemicals can be found at http://www.epa.gov/triexplorer/. TRI data provide DOH staff with a general overview of the potential chemicals in an area. However, the TRI regulations only require facilities in certain industries to disclose releases for specific hazardous chemicals. The regulations do not require that all facilities report and do not address all chemicals. In addition, information in the TRI database does not represent measured concentrations; rather, it represents industry-reported estimates of emissions. The accuracy of these estimates of emissions is not known. Furthermore, while TRI data typically capture large stationary sources of emission releases, smaller stationary sources are not captured. These smaller stationary sources could include offices and residences, gasoline stations, and dry cleaners. Additionally, TRI data do not capture mobile sources, like automobiles, trucks, buses, and motorcycles. These mobile sources may be a significant source of outdoor air pollution, including such chemicals as acetaldehyde, propionaldehyde, and formaldehyde. TRI data shows self-reported estimates of pollutants emitted from PTP in the past. Tables 1 and 2 show TRI emissions (tons per year) from 2002, 2005 and 2006. Additional limitations of the data collected in the TRI inventory include the following:[6]

- TRI requires the reporting of chemical releases only when a facility manufactures, processes, or otherwise uses an amount greater than the TRI reporting threshold (e.g., more than 0.1 grams/year of dioxin and dioxin-like compounds, more than 100 pounds/year of polycyclic aromatic hydrocarbons (PAHs)).

- Per TRI guidance, release reports may be based on estimates, not measurements. As a result, facilities may overstate releases because they can be penalized for under-reporting releases.[6]

- Certain chemicals (PAHs, dioxin and dioxin-like compounds, metal compounds) are reported as a class, not as individual chemical compounds. Because the individual compounds in the class have widely varying toxic effects, the potential toxicity of chemical releases can be inaccurately estimated.

Table 1. Annual Air Emissions and Toxics Release Inventory for 2002-2006 from PTP Corporation, Port Townsend, Washington.[7,8]

Stack source	Description of fuel or material processed	Pollutant	Units (Tons per year)		
			2002*	2005	2006
Recovery Furnace	Pulp -unbleached kraft	Formaldehyde	1	1	1
		PM	71	150	144
		PM_{10}	53	113	107
		$PM_{2.5}$	48	101	97
		SO_2	298	196	195
		NO_x	185	193	185
		CO	1124	1166	1122
		VOC (reported as THC)	35	36	35
Smelt Tank	Pulp – unbleached kraft	Phenol	0.1	0.1	0.1
		PM	40	43	29
		PM_{10}	30	34	21
		$PM_{2.5}$	27	30	19
		SO_2	3	3	3
		NO_x	5	5	5
		CO	0	0	0
		Ammonia (NH_3)	23	26	2
Lime Kiln	Pulp – unbleached kraft	PM	38	20	26
		PM_{10}	38	19	26
		$PM_{2.5}$	37	19	25
		SO_2	1	2	1
		NO_2	62	64	62
		CO	10	11	10
		VOC (reported as THC)	1	1	1
		NH_3	13	14	13
#10 Power Boiler	Wood/Bark & Reprocessed Fuel Oil	Lead	0.01	0.03	0.03
		Manganese	0.7	0.03	0.03
		Mercury	0.0001	0.0002	0.0002
		Hydrochloric acid aerosol (HCl)	7	60	57
		PM	116	110	102
		PM_{10}	113	107	99
		$PM_{2.5}$	113	107	99
		SO_2	167	140	14
		NO_x	250	273	239
		CO	531	592	515
		VOC	12	17	15
Package Boiler	Specification Reprocessed Fuel Oil	PM	18	25	33
		PM_{10}	15	21	28
		$PM_{2.5}$	10	14	18
		SO_2	76	69	74
		NO_x	48	46	60
		CO	8	8	10
		VOC (reported as VOC)	0	0	1
Kraft pulping	Washer vents, pulp & paper dryers	Methanol	31	29	29
		VOC (reported as THC)	14	15	14
Pulp & paper, wood products, fugitive emissions	Material handling & storage (excluding mobile sources)	PM	4	13	6
		PM_{10}	1	5	2
		$PM_{2.5}$	0	1	1

VOC = volatile organic compounds; PM = particulate matter; $PM_{2.5}$ = particle matter size equal or less than 2.5 micrometers (µm); PM_{10} = particle matter size equal or less than 10µm; SO_2 = sulfur dioxide; NO_x = nitric oxide; CO = carbon monoxide; THC = Total hydrocarbon.
* Emission year 2002 represents emissions and stack data: This data set gives emissions of criteria pollutants and some air toxics by emission point (emission unit) basis - and includes stack data; criteria pollutants are from Washington Department of Ecology (WDOE) data, broken down by stack. The portion of the air toxic data presented here is from the Toxic Release Inventory (TRI). The TRI pollutants are reported in accordance with the federal law, on a plant wide basis. The TRI pollutants were assigned to emission points based on engineering judgments.[9]

Table 2. Summary of PTP TRI and annual air emissions, TRI 2002/2005.

Pollutant	**Annual emissions, Tons/year**	
	2002	**2005**
Acetaldehyde	32	44
Ammonia	36	41
Benzo(g,h,i)perylene	0.001	NA
Cresol (mixed isomers)	NA	9
Dioxin & dioxin-like compounds*	0.4 g	0.4 g
Formaldehyde	5	8
Hydrochloric acid aerosols	137	11
Lead compounds	0.04	0.04
Manganese compounds	0.7	0.05
Mercury compounds	0.0005	0.0005
Methanol	57	56
Naphthalene	NA	7
Phenol	3	3
Polycyclic aromatic compounds	0.03	0.03
Propionaldehyde	NA	11
PM_{10}	268	333
$PM_{2.5}$	240	282
SO_2	545	410
NO_x	550	582
VOC	63	72
CO	1,680	1,788
Total reduced sulfur (TRS)	18	15

Source: Port Townsend Paper Emissions Inventory & Toxic Release Inventory (TRI), year 2002 & 2005.[10]
NA – Pollutant was not reported because mass emissions were zero or below federal reporting thresholds.
VOC = volatile organic compounds; PM = particulate matter; $PM_{2.5}$ = particle matter size equal or less than 2.5 micrometers (µm); PM_{10} = particle matter size equal or less than 10µm; SO_2 = sulfur dioxide; NO_x = nitric oxide; CO = carbon monoxide.
* Dioxin & dioxin-like compounds are in grams (g) per year.

Based on annual air emissions reported in 2005 (Table 2), total chemical releases at PTP mill were about 3,657 tons per year. PTP mill's emissions consist of 51% carbon monoxide (CO), 17% nitrogen dioxide (NO_2), 12% sulfur dioxide (SO_2), 10% particulate matter PM_{10}, 8% $PM_{2.5}$, and 2% volatile organic carbons (VOCs).

Use of Reprocessed Fuel Oil (RFO)

The package boiler is run on reprocessed fuel oil (RFO). In 2006, the total pulp mill burned an estimated 14,000,000 gallons of RFO (the package boiler itself used 3.8 million gallons).[11,12] RFO is essentially used oil blended with other fuels to achieve the desired specifications. Some effort is made to remove contaminants from RFO. RFO is less expensive than alternate fuels such as #2 fuel oil or diesel, and it has properties most similar to #4 fuel oil. It is used in all of the power boilers, recovery furnace, and lime kiln. Burning RFO emits less sulfur into the atmosphere than burning #6 fuel oil, but RFO creates significantly more ash. RFO combustion generates an ash content of 0.54% weight compared to 0.05 – 0.10 for #6 fuel oil. Ash is a source of PTP particulate emissions that come from PTP.[13]

Notices of violation at PTP mill

Notices of violation have occurred periodically since 1999 at PTP mill. Most of the violations were for opacity (measurement of PM emissions) exceedances, but included TRS and nitrogen oxides (NOx) exceedances. For instance, in 1999 most exceedances were related to opacity, while in 2000, most exceedances were related to opacity, TRS and NOx. In 2001 and 2002, most exceedances were attributed to opacity, NOx, TRS and PM. Violation of opacity limits have decreased since 2004 until 2007. No data exist to evaluate opacity violations before 2004 and 2008. Violations of NOx standards were more frequent in 2005 and decreased in 2006 and 2007.[14]

Community health concerns

DOH has received numerous health complaints since May 2007, from the Port Townsend AirWatchers and local citizens. DOH received community complaints by regular mail, electronic mail and summaries from the Port Townsend Paper Corporation. DOH received a list of 285 complaints recorded by the mill from 1/19/2004 to 7/10/2007, ten written letters and ten electronic mail messages. Overall, the community complaints include smells of rotten egg and/or "pungent acid" odors that irritate eyes, throat, and nose and causes headaches. Some residents have reported that these odors trigger asthma-like reactions and vomiting. The following summarizes community health complaints made by citizens of Port Townsend to the mill related to air emissions from March 2004 to July 2007:[15]

- Chronic throat and lung irritation
- Persistent "respiratory and cardiac" problems in a previously healthy 43-year old female
- Strong smells "pungent acid"
- High noise level
- Headaches and/or nausea and/or eye irritation and/or respiratory irritation
- Development of "chronic respiratory problems" that disappear when people leave town
- Development of "extreme chemical sensitivity" and severely heightened seasonal allergies

Some members of the community complain that smoke emissions from the mill are higher in the middle of the night, and on weekends. Residents perceive higher odor levels at night.[a] People living in close proximity to the pulp mill often complain of breathing discomfort, with some people expressing concern about possible adverse health effects following exposure. Residents reported experiencing headaches, coughing, nausea, allergies, mucous irritation in eyes and respiratory tract concurrent with odors. Odors are typically a rotten egg and pungent acid smell that may be associated with hydrogen sulfide (H_2S) and sulfur dioxide (SO_2) respectively (these chemicals are described in detail below). Over ten residents also reported that they have left their homes in order to avoid the ill effects associated with the odors.

Air pollution and health effects

Air pollution is associated with a variety of health effects including respiratory tract irritation, asthma, heart and lung diseases, decreased immunity, and increased risk of cancer. The very young and very old are particularly sensitive to air pollution. Most healthy people recover from the effects of air pollution when air quality improves. However, people with existing lung and heart diseases (such as asthma or chronic obstructive pulmonary disease) are at risk of dying from either short-term or long-term exposure to air pollution.

The air we breathe contains a mixture of gases and particles, and breathing this mixture affects us 24 hours a day, indoors and outside. Humans are exposed to air pollution outdoors and indoors, including during transit in vehicles. Indoor air pollution comprises a mixture of contaminants penetrating from outdoors and those generated indoors. Because most of the health effects attributable to air pollutants can also be attributable to a wide variety of other risk factors, the impact of air pollution on human health is further complicated by human exposure to a mixture of substances at various concentrations present in the air. The mixture is different inside and outside, and may affect people in different ways.

There are many different factors that contribute to air pollution. Depending on the length of time you are exposed, your health status, your genetics, and the concentration of pollutants, air pollution can have a negative effect on your respiratory system (lungs and airways) and on your cardiovascular system (heart function and blood circulation) by:

- Making it harder to breathe
- Irritating the respiratory system

[a] Ecology has determined that the mill does not release more reduced sulfur gases during the night. Reduced sulfur gas emissions remains steady, day and night. The natural behavior of air in relation to day and night warming and cooling of water can explain why more odorous gases are released from water bodies at night. Winds tend to be calmer at night, and there is little or no mixing of the air. As the surface of the water cools at night, mixing occurs as the cooler water sinks, and more dissolved gases are released. In the daytime there is good mixing of air as the land heats up, and this leads to ventilation that disperses and dilutes gases. Because of topography, odorous, heavier than air gases can also be trapped so that their concentrations increase under an inversion layer and the smell will be more intense.[16]

- Affecting Chronic Obstructive Pulmonary Diseases such as chronic bronchitis emphysema and in some cases asthma
- Causing heart attack, heart failure and other manifestations of heart disease because of narrowing (constriction) of blood vessels, altering heart rate and rhythm and affecting blood clotting

Adverse health effects associated with air pollution increase as air pollution worsens. Studies have shown that even modest increases in air pollution can cause small but measurable increases in emergency room visits, hospitals admissions and death. Some health effects, such as an increase in asthma attacks, have been observed in conjunction with episodes of high pollution concentration lasting one or two days. Such effects are considered acute, because they are associated with short-term exposures to a pollutant. In fact, it has been shown that even small increases in air pollution levels for a short period of time can exacerbate illness among sensitive or at-risk people.[17,18,19]

There are many substances emitted from kraft mills that can have an effect on the respiratory tract, and little is known about the health effects of living in close proximity to pulp and paper mills and low-level exposure to malodorous sulfur compounds. A review of the scientific literature indicated there is a possible association between a paper mill's location and wheezing symptoms among adolescents. The results of a study conducted in North Carolina suggests that the community-based exposure to pulp and paper mill emissions may have a greater impact on smokers and individuals exposed to cigarette smoke in the home than on non-smokers without such household exposure.[20] In 1995, DOH conducted a health study (Phase I) in Port Angeles to determine the amount of respiratory disease among elementary school children in response to community health concerns regarding air pollution. This study reported levels of cough and bronchitis among school children in Port Angeles as high as those in other areas of the U.S. with relatively high levels of air pollution. The reported levels of other respiratory conditions (wheeze, asthma, etc.) in Port Angeles were not high compared to those in other areas of the U.S.[21] A second phase (Phase II) of the study in Port Angeles was conducted in order to determine whether children who reported asthma, wheeze, or chronic cough in the Phase I study had more respiratory symptoms on days with relatively high levels of ambient air pollution compared to days with relatively low levels of air pollution. The results of this study showed that respiratory symptoms in children increased as levels of air pollution (i.e., SO_2) increased. However, there were several limitations of this study which made the results uncertain including changes in symptom reporting over time and difficulties in accurately characterizing individual exposures using air pollution data collected from monitoring stations.[22]

An air pollution study conducted in 1996, assessed exposure to very low levels of ambient-air malodorous sulfur compounds and their effects on eye irritation, respiratory-tract symptoms, and central nervous system symptoms in adults. This study concluded that residents living in close proximity to a pulp mill had a higher risk of developing respiratory infections, headache and cough.[23]

No data currently exist for the Port Townsend area that specifically can be used to assess the direct relationship between health effects in the community and PTP mill air emissions. Even if

there were reports from the community about these types of health effects such as headache, nausea, or respiratory irritation, asthma, and cancer, it would be difficult to establish the extent the mill's emissions contribute to these effects. There may be other air contaminant exposures (e.g., motor vehicle exhaust including diesel emissions,[b] chemicals released by wood stoves[c], fireplaces, outdoor burning, and wildfires)[d], and reasons why people experience these symptoms. Thus, the relationship of health effects to PTP emissions remains undetermined.

Discussion

Community members in Port Townsend and surrounding neighborhoods have raised health concerns regarding potential exposures to chemical compounds emitted into the air from the PTP mill. The residents have contacted state and local agencies. The discussion that follows will address sources of pollution, key pollutants, possible exposures, health data relevant to air pollution concerns, and data gaps.

Sources of pollution at PTP mill

TRI data indicate that emissions from the mill occur from these predominant sources (Tables 1 and 2).

- Recovery furnace
- Smelt Tank
- Lime Kiln
- Hog Fuel and package boiler
- Treatment system
- Water treatment ponds

The TRI data for the PTP mill includes plant-wide emissions to air, land and water. However, the list of chemicals in TRI is not comprehensive and does not report emissions of many air toxics below certain threshold quantities, nor does it attribute emissions to specific sources at the mill.

Key pollutants at PTP mill

Air pollution is not completely characterized. PTP Corporation only monitors emissions specified in their Air Operating Permit.[2] Toxics emissions are not monitored. The TRI emissions inventory only includes a partial list of chemicals emitted from the mill. Key pollutants from the mill that could possibly cause odors or health effects are nitrogen dioxide, sulfur containing

[b] Chemicals in vehicle emissions can irritate the eyes, nose and throat; cause wheezing, coughing and breathing difficulties; worsen existing heart and lung problems; increase the risk of heart attacks; and lead to premature death.

[c] Health effects of wood-smoke exposure include an increased risk of lower respiratory tract illness such as coughing, wheezing, shortness of breath, and chest tightness. For people with asthma, wood smoke is associated with an exacerbation (or flaring up) of asthma. Other health effects include a decrease in lung function or decreased breathing ability resulting in increased emergency room visits.

[d] Wood stoves, fireplaces, on-road diesel, and on-road gasoline have been identified as sources of air pollution in Port Townsend area.[24]

chemicals (i.e., sulfur dioxide, and total reduced sulfur compounds), and particulate matter. As mentioned above, local residents typically report rotten egg and pungent acid smells that may be associated with H_2S and SO_2 respectively. Some people believe that the odors signal something harmful to their health, and that the odors reduce their quality of life and sense of well-being.

Without knowing more about the specific emissions from PTP mill and the resulting ambient air concentrations, it is difficult to identify which chemical substances might contribute to adverse health effects. The presence of odors in the air does not necessarily suggest that adverse health effects will occur among exposed populations. To estimate, identify and quantify the public health impact at any given level of exposure of a specific pollutant is a challenging task and typically requires the use of large sample sizes and sophisticated statistical methods. The following discussion summarizes health related information for each of the primary air pollutant categories associated with Kraft paper mill production methods.

Nitrogen Dioxide (NO_2)

NO_2 is a gas produced as a by-product of nitrogen oxide incineration at sufficiently high temperatures. NO_2 is a product of the combustion of fuels in boilers. NO_2 contributes to two major pollution problems: smog and acid rain. NO_2 combines with volatile organic compounds and sunlight in the lower atmosphere to form ozone, a key component of smog. In moist air, nitrogen oxides can also form nitric acid, which is precipitated as a component of acid rain. NO_2 is harmful to the lungs, irritates bronchial and respiratory systems, and increases symptoms in asthmatic patients.

Sulfur containing chemicals

Sulfur Dioxide (SO_2)

SO_2 is a colorless gas or liquid that has a pungent odor. SO_2 is emitted when sulfur containing fuel (i.e., burning of fossil fuels (coal, oil) is combusted for uses during kraft pulp production). SO_2 increases symptoms in asthmatic patients and irritates the respiratory system.

Total reduced sulfur (TRS)

Total reduced sulfur compounds cause the distinct odor typically associated with kraft pulp mills. These mills can release a range of odorous sulfur compounds that include hydrogen sulfide (H_2S), methyl mercaptan (CH_3SH), dimethyl sulfide (CH_3SCH_3), and dimethyl disulfide (CH_3SSCH_3).

The sulfur in these malodorous substances can be measured or monitored in ambient air as a group. When measured in this manner they are referred as “total reduced sulfur” (TRS) compounds, also known as “non-condensable” gases. According to the Environmental Protection Agency (EPA) Sector Notebook for the pulp and paper industry, “humans can detect some TRS compounds in the air as a ‘rotten egg’ odor at as little as one part per billion”[25] Mercaptan has a skunky odor (it is about ten times less toxic than H_2S) while H_2S smells like rotten eggs at low concentrations. The combined odor of the TRS gases may not be distinctly the odor of rotten

eggs or skunk, but a different complex odor. Residents from Port Townsend report that this odor irritates the eyes and the respiratory tract, can awaken people from sleep, and causes a sensation of "not being able to breathe."

Generally H_2S, methyl mercaptan, dimethyl sulfide and dimethyl disulfide account for 95% of TRS in air, with other sulfur compounds generally present in small amounts. Environmental exposures to malodorous emissions are usually to a mixture of sulfur-containing gases. The exact concentration of hydrogen sulfide in these types of mixtures cannot be determined. In estimating exposure, there is also uncertainty about the dose and duration of exposure. Based on limited information presented in toxicological studies, rodents appear to be less sensitive to hydrogen sulfide than humans. Since the respiratory tract is the major target organ of hydrogen sulfide toxicity, humans with asthma, the elderly and young children with compromised respiratory function represent sensitive subpopulations.[26,27]

Hydrogen sulfide

Hydrogen sulfide can be found in sewage treatment facilities, fish aquaculture and in areas where livestock or manure is handled.[27] Hydrogen sulfide is also present in emissions from industrial paper plants that use the kraft process (i.e., it is a by-product of kraft pulp and paper manufacturing). Of all reduced sulfur gases, hydrogen sulfide is the most toxic, followed by methyl mercaptan (about one-tenth as toxic) and the methyl sulfides (much less toxic).

Effects resulting from short term, relatively high exposures are well documented and are of great concern for occupational safety and health. Hydrogen sulfide is a respiratory tract irritant and exposures greater than 20 ppm can cause irritation of the mucous membranes. Respiratory irritation may decrease the ability of people to fight off infection. Generally pulmonary function tests changes are not seen in healthy people exposed to 5-10 ppm. However, asthmatics have shown changes in pulmonary function following exposure to 2 ppm for 30 minutes.[28] Eye irritation is another sensitive effect. A normal healthy adult male exposed to concentrations in the range of 30 ppm and higher could exhibit olfactory sense paralysis—so he could no longer smell the gas.[29,27] At very high exposures—greater than 500 ppm during brief periods, or greater than 50 ppm during several hours—the exposed person could lose consciousness and stop breathing. H_2S in ambient air could, at times, pose a health risk to area residents, especially for persons with pre-existing respiratory conditions. In some people, levels found in the air (i.e., at low levels, perhaps at less than 1,000 ppb) could lead to headaches, eye irritation, nausea, and can sometimes make asthma symptoms worse or more frequent. In general, symptoms are unlikely to occur if the odor is not present. (See Appendix A, Table 1 for a detailed description of effects of hydrogen sulfide at increasing concentrations).

The emissions that most people are likely to notice (reduced sulfur gases) are not known to be causes of cancer, and other known emissions such as the aldehydes, are not known to be associated with the top five common cancers in Jefferson County (i.e., prostate, bladder, breast (female) lung, and melanoma of the skin).[30]

Asthma is not a condition that results from hydrogen sulfide exposure.[31,27] Asthma can be a relatively non-specific indicator for exposure to irritant gases, of which TRS are one class. Acute

exposures to such gases could be tracked if monitoring in the community were done over a period of time sufficient to encompass a fair number of odor episodes, and if tracking of asthma-related indicators (emergency room (ER) visits, hospitalizations, physician visits or medication use) was conducted over the same time period. However, the reported effects are not necessarily related to TRS gases, or may result from exposure to these or other as yet unidentified components of mill emissions.

Particulate Matter (PM)

Epidemiological studies indicate that small particles or PM air pollution is associated with increases in mortality, especially in people older than 65 years old who have existing cardiopulmonary diseases and in children.[32,33,34,35,36,37,38,39,40] It is also associated with health problems including aggravation of asthma, especially in children, and other chronic lung diseases, impacts on lung function, and increased susceptibility to infectious illnesses.[41,42,43,44,45,46,47,48,49,50,51,52,53,54,55] Most studies on PM conclude that there is little information about the relative effects of PM constituents with less than 2.5 µm in diameter (i.e., it is not clear what constituents of particles contribute to their toxicity). Despite the wealth of data supporting associations between health outcomes and PM exposures, there are many gaps in our knowledge. One concern is whether the particle concentration measured at an outdoor monitoring site is, in fact, related to the exposure of people in the community. Another concern is also the lack of knowledge on the synergistic interaction of various pollutants or the effects of multiple exposures.

Particulate matter air pollution includes several types of particles with different chemical compositions. Particulate matter with a diameter of less than 10 micrometers (µm), PM_{10} has been the criteria pollutant of greatest current interest with respect to lung cancer because particles of size 10µm or less can be inhaled into the lung and generally originates from combustion processes and may carry carcinogenic substances, such as polycyclic aromatic hydrocarbons, on their surfaces. Smaller sized particulate matter with less than 2.5µm in diameter ($PM_{2.5}$) has the potential to penetrate deeply into the lung's small airways and alveoli. $PM_{2.5}$ comes from combustion sources, while larger particles between $PM_{2.5}$ and equal or greater than 10 µm and up to 30-40 µm in diameter include wind-blown dust as well as bacteria, pollen, and mold spores. Particles emitted from a combustion source generally consist of a central carbon core upon which other pollutants can be attached, such a polycyclic aromatic hydrocarbons (PAHs) or metals, depending on the source.

Other potential contaminants released at pulp mills

PTP Corporation has never been a bleaching mill, so it never used chlorine as a bleaching agent. There is no historical reason to associate dioxin with the mill's liquid effluent. Chlorinated organic compounds such as dioxin, however, may form as a by-product of combustion if chlorine is present in hogged fuel.[16]

In addition to pollutants identified in the TRI, PTP mill may also emit numerous other compounds in smaller quantities (e.g., dioxins, mixtures of dioxin-like compounds (DLCs), chlorinated forms of dibenzofurans and certain polychlorinated biphenyls (PCBs), VOCs

(volatile organic compounds), and metals). Emissions from fuel oil combustion depend on the grade and composition of the fuel, the type and size of the boiler, the firing and loading practices used, and the level of equipment maintenance. Because the combustion characteristics of distillate and residual oils are different, their combustion can produce significantly different emissions.[56] An emissions inventory is not available at this time to assess potential human health risks related to air emissions from the mill. The mill process releases these chemicals through:

- Air emissions, i.e., from burning of lignin/black liquor to generate energy
- Water emissions through effluent disposal
- Sludge - incinerated or landfilled
- Contaminants in products

Dioxins and DLCs are released into the environment from several sources, including combustion, metal processing, and chemical manufacturing and processing. They are ubiquitous in the environment. The most toxic of these compounds is TCDD (2,3,7,8-tetrachlorodibenzo-p-dioxin), often simply called dioxin. PCBs, dioxins and furans have been found in fly ash from the burning of sludge from bleached kraft pulp mills [57] raising concerns that some quantities may be emitted to the atmosphere. Because of its exceptional potency TCDD is the most studied dioxin or furan, therefore, the IARC (International Agency for Research on Cancer) has classified TCDD as a known human carcinogen (Group 1) and NTP (National Toxicology Program) as a known human carcinogen.[58,59] Other polychlorinated dibenzo-*p*-dioxins and dibenzofurans have not been studied sufficiently for IARC to determine their carcinogenicity. Information about environmental levels and health effects is available http://www.atsdr.cdc.gov/toxprofiles. The U.S. EPA provides updated exposure and health assessments online at http://www.epa.gov/ncea/pdfs/dioxin.

Review of Jefferson County health data

DOH reviewed the literature and compiled available data. DOH used age-adjusted hospitalization, cancer incidence and death rates for Jefferson County and compared these to the Washington State total. The use of age-adjusted rates[e] is necessary due to differences in population demographics between Jefferson County and Washington State overall. Also, the population of Jefferson County is relatively small and so rates vary from year to year relative to Washington State rates. Differences in rates may be assessed by comparing 95% confidence intervals (CIs)[f].[60]

Limited information exists on health data relevant to air pollution concerns for residents of Jefferson County. In general, air pollution can increase the risk of developing asthma attacks through several different mechanisms including: 1) a direct irritant effect on sensitive airways; 2) a toxic effect on the respiratory epithelium; 3) generating bronchial hyper reactivity, both allergen-specific and nonspecific; or 4) modifying the immune response by increasing susceptibility to an immunological trigger.[61] Exposure to other allergens, airborne pollen, irritant gases, cold air, physical and emotional stress, and exercise have been shown also to initiate asthma attacks.[62,63,64]

Health statistics reviews (HSRs)

DOH used HSR to determine whether higher rates of a specific disease occurred at Jefferson County. To achieve this objective, DOH compared disease occurrence in the community of concern, in this case Jefferson County and compared these to Washington State rates. For example, hospitalization rates in Jefferson County were compared to those in Washington State. To obtain these data, DOH compared age-adjusted rates in Jefferson County to age-adjusted rates for Washington State. Appendix C describes in more detail the advantages and limitations of HSR.

[e] Age-adjustment is a method of developing rates that eliminate the impact of different age structures in two populations. Age-adjustment also allows us to compare rates in the same population over a period of time during which the population may have aged. Age-adjusted rates are computed by multiplying the rate for a specific age group in a given population by the proportion of people in the same age group in a standard population and then adding across age groups.

[f] In statistics a confidence interval (CI) is an interval estimate of a population parameter. Instead of estimating the parameter by a single value, an interval of likely estimates is given. How likely the estimates are, is determined by the confidence coefficient. The more likely it is for the interval to contain the parameter, the wider the interval will be.

Based on published reports and the health concerns raised by residents, disease conditions that might be associated with mill air emissions in general are respiratory diseases (i.e., diseases of the lung such as, asthma[g], and chronic obstructive pulmonary disease (COPD))[h], ischemic heart diseases[i] and some forms of cancers.

Asthma

One of the diseases that might be associated with air pollution is asthma. The telephone-based Behavioral Risk Factor Surveillance System (BRFSS)[j] reported that Jefferson County in 2003-2005, the age-adjusted county level prevalence for current asthma was 8.8%, 95% confidence interval (CI) (6.5 – 12%). The overall asthma prevalence rate in Washington for 2003 to 2005 was 9.1% (8.8 – 9.3%).[65,66] The Jefferson County rate is similar to the Washington State rate.

The rates of hospitalization for asthma have been declining in Washington and Jefferson County over the past decade.[67] In the period 1997-1999, the state asthma age-adjusted hospitalization rate was 91.3 per 100,000.[67] The Jefferson County rate was similar to the Washington State rate (Table 3).[65]

[g] Asthma is a chronic inflammatory disorder of the airways characterized by variable airflow obstruction and airway hyper-responsiveness. Prominent clinical manifestations include wheezing and shortness of breath.

[h] Chronic obstructive pulmonary disease (COPD) is a term referring to two lung diseases, chronic bronchitis and emphysema, that are characterized by obstruction to airflow that interferes with normal breathing. Both of these conditions frequently co-exist, hence physicians prefer the term COPD. It does not include other obstructive diseases such as asthma. COPD is most often caused by smoking, but also cause by exposure to second-hand smoke and in some instances by exposure to other toxic substances.

[i] Ischemic heart disease: A condition in which there is an inadequate blood supply to the heart due to blockage of the blood vessels to the area.

[j] The purpose of the BRFSS is to provide indicators of health risk behavior, preventive practices, attitudes, health care use and access, and prevalence of selected diseases in Washington. BRFSS is the largest telephone survey of health in the world sponsored by the Centers for Disease Control and Prevention (CDC), BRFSS utilizes random-digit-dialing to survey adults ages 18 and over, and is used to track health risks among the American people.

Table 3. Age-adjusted asthma hospitalization rates per 100,000 for all ages combined from 2003 to 2005 in Washington.[65]

PLACE	RATE	LB	UB
State Total	**80.6**	**79.3**	**81.9**
Adams	109.3	83.5	141.3
Asotin	38.4	24.2	58.4
Benton	85.0	76.7	94.0
Chelan	78.3	66.8	91.3
Clallam	118.6	103.4	135.6
Clark	46.3	42.3	50.5
Cowlitz	109.7	98.0	122.5
Douglas	74.4	58.9	93.2
Ferry	61.8	29.6	117.2
Franklin	88.5	74.5	104.8
Grant	88.2	76.8	100.9
Grays Harbor	92.2	79.6	106.4
Island	31.8	24.8	40.2
Jefferson	**85.2**	**63.3**	**113.4**
King	83.7	81.2	86.3
Kitsap	79.9	73.3	86.9
Kittitas	41.9	29.6	58.0
Klickitat	90.7	67.5	120.1
Lewis	85.8	73.9	99.3
Lincoln	99.0	66.9	144.0
Mason	69.0	55.9	84.4
Okanogan	51.6	39.2	67.0
Pacific	76.0	54.7	104.4
Pend Oreille	98.0	65.7	143.0
Pierce	91.3	87.4	95.5
Skagit	54.2	46.6	62.7
Skamania	87.6	51.2	141.9
Snohomish	60.3	56.8	63.9
Spokane	104.9	99.4	110.7
Stevens	120.4	99.8	144.5
Thurston	80.7	73.8	88.1
Wahkiakum	166.7	91.7	287.3
Walla Walla	75.2	62.2	90.3
Whatcom	98.4	89.8	107.6
Whitman	51.5	38.0	68.5
Yakima	108.0	100.3	116.2

Counties with fewer than 10 hospitalizations not reported.
Asthma Hospital Rates per 100,000, 2003-2005 combined, by age, by county
11-27-2007, VistaPHw 7.2.0.0, Calculator Version 6.0.2.1 Web. LB = lower bound, and UB = upper bound
LB and UB correspond to 95% confidence intervals.

From 2000 through 2005, while the age-adjusted asthma hospitalization rates in Jefferson County appear to be higher than for the state overall, in fact, the rates are not different than the Washington State rates (Table 4). Due to the small numbers of cases in Jefferson County, asthma rates vary between years and have wide confidence intervals. Asthma is a complex illness that varies in extent and severity among individuals. Some studies on short-term exposure to gaseous pollution on asthma hospitalization in children showed that carbon monoxide, sulfur dioxide, coarse particulate matter ($PM_{10-2.5}$) and nitrogen dioxide were positively associated with asthma admissions in both sexes.[68,69,55]

Table 4. Age-adjusted hospitalization rates per 100,000 for asthma, Jefferson County vs. Washington State, 2000-2005.

State Total				Jefferson County			Jefferson different than WA*
Year	Rate	LB	UB	Rate	LB	UB	
2000	91.7	89.3	94.3	126.0	82.6	187.8	No
2001	88.7	86.3	91.2	104.3	62.8	165.7	No
2002	93.4	91.0	95.9	92.0	53.7	150.1	No
2003	81.4	79.1	83.7	88.7	52.8	143.9	No
2004	75.9	73.7	78.1	92.8	56.3	148.4	No
2005	84.1	81.8	86.4	70.6	37.1	124.8	No
2000-2005	84.6	83.6	85.7	89.6	71.7	111.2	No

Data Sources:
Hospitalization Discharge Data: Washington State Department of Health, Office of Hospital and Patient Data Systems. 1990-2005 Population Estimates: Population Estimates for Public Health Assessment, Washington State Department of Health. Vista Partnership, and Krupski Consulting. November 2006.
LB = lower bound, and UB = upper bound, LB and UB correspond to 95% confidence intervals.
International classification of disease (ICD) ICD -9 codes: 493
**Jefferson County rates are not significantly[k] different than Washington state rates.*

Table 5. Childhood (0-14 years old) hospitalization rates per 100,000 for asthma, Jefferson County vs. Washington State, 2000-2005.

State Total				Jefferson County			Jefferson different than WA*
Year	Rate	LB	UB	Rate	LB	UB	
2000-2005	157.0	154.2	159.9	152.6	105.8	213.3	No

LB = lower bound, and UB = upper bound, LB and UB correspond to 95% confidence intervals.
** The significance for individual years in Jefferson County can't be tested because the number of hospitalizations is too small to perform a statistical test.*

[k] Significantly different means that the number of asthma cases in a place or time is greater than would be expected due to normal fluctuations alone. Researchers use statistics to help them decide if a disease rate is really unusual. For asthma concerns, researchers commonly agree that an excess of asthma cases is "statistically significant" when it is so different from average that you would expect it only 5 out of 100 times by chance alone. "Statistical significance" only means that the number of cases that has occurred is unusual. It does not explain why the number of cases is elevated. Furthermore, it does not rule out chance as a cause.

Table 6. Adult (15-99 years old) hospitalization rates per 100,000 for asthma, Jefferson County vs. Washington State, 2000-2005.

State Total				Jefferson County			Jefferson different than WA*
Year	Rate	LB	UB	Rate	LB	UB	
2000	64.5	62.2	66.9	91.4	55.1	142.5	No
2001	67.5	65.1	69.8	76.1	43.6	123.4	No
2002	70.2	67.8	72.6	75.7	43.4	122.8	No
2003	67.6	65.3	69.9	79.6	46.4	127.3	No
2004	58.9	56.8	61.1	101.7	63.8	153.9	No
2005	64.3	62.1	66.6	58.4	31.1	99.5	No
2000-2005	65.4	64.5	66.4	80.3	65.6	97.4	No

Data sources:
Hospitalization Discharge Data: Washington State Department of Health, Office of Hospital and Patient Data Systems. 1990-2005 Population estimates: Population Estimates for Public Health Assessment, Washington State Department of Health. Vista Partnership and Krupski Consulting. November 2006.
LB = lower bound, and UB = upper bound, LB and UB correspond to 95% confidence intervals.
ICD-9 codes: 493
** The statistical test did not show significant differences between Jefferson County and the state, even though there is little overlap the statistical test did not reveal a statistical significance. When one CI is contained entirely within other, or when one confidence interval includes the other estimate rate, this implies that the two rates are not significantly different.*

The observed childhood (0-14 years old) asthma hospitalization rate is not significantly different for Jefferson County compared to Washington State (Table 5). A statistical test cannot be performed for individual years because the number of hospitalizations is too small. The observed adult (15- 99 years old) hospitalization rates for asthma were not significantly different for Jefferson County compared to Washington state rates (Table 6).

Other health conditions that might be associated with air pollution in Port Townsend are ischemic heart diseases and chronic lower respiratory diseases. Tables 7 and 8 present hospitalization rates for these conditions, comparing Jefferson County with the overall Washington State hospitalization rates.

The observed hospitalization rate for Jefferson County compared to Washington State for ischemic heart disease was higher in 2000, 2001 and 2002, but not different than the Washington State rate in 2003, 2004, and 2005 (Table 7). The combined hospitalization rate (2000-2005) for ischemic heart disease was higher in Jefferson County compared to Washington State total.

The observed hospitalization rates for chronic lower respiratory disease was higher only in 2003 in Jefferson County compared to Washington State total (Table 8). The combined hospitalization rates (2000-2005) were not significantly different in Jefferson County compared to Washington State total. Due to the small numbers of cases in Jefferson County, rates vary between years and have wide confidence intervals, which indicate that rates are quite variable.

Table 7. Age-adjusted hospitalization rates per 100,000 for ischemic heart disease, Jefferson County vs. Washington State, 2000-2005.

State Total				Jefferson County			Jefferson different than WA
Year	Rate	LB	UB	Rate	LB	UB	
2000	488.4	482.6	494.3	631.3	553.5	722.7	Yes, higher
2001	463.2	457.6	468.9	618.8	543.5	707.5	Yes, higher
2002	441.4	435.9	446.8	592.8	515.8	683.7	Yes, higher
2003	418.6	413.4	423.9	377.7	319.2	450.3	No
2004	407.7	402.6	412.9	446.8	383.3	524.1	No
2005	383.6	378.7	388.5	343.2	288.3	412.0	No
2000-2005	432.3	430.1	434.4	499.7	471.3	530.2	Yes, higher

Age adjusted to 2000 US population.
Data Sources for the Ischemic Heart Disease and Respiratory disease figures:
Hospitalization Discharge Data: Washington State Department of Health, Office of Hospital and Patient Data Systems.
1990-2005 Population Estimates: Population Estimates for Public Health Assessment, Washington State Department of Health, Vista Partnership, and Krupski Consulting. November 2006.
LB = lower bound, UP = upper bound, LB and UB correspond to 95% confidence intervals.
ICD-9 codes: 410-414, 429.2

Table 8. Age-adjusted hospitalization rates per 100,000 for chronic lower respiratory disease, Jefferson County vs. Washington State, 2000-2005.

State Total				Jefferson County			Jefferson different than WA
Year	Rate	LB	UB	Rate	LB	UB	
2000	760.6	753.3	767.9	794.3	689.1	915.1	No
2001	756.0	748.8	763.2	729.5	628.8	845.7	No
2002	762.9	755.7	770.1	728.6	631.3	841.1	No
2003	754.8	747.7	761.9	904.8	795.3	1029.6	Yes, higher
2004	684.9	678.2	691.6	780.4	681.0	895.0	No
2005	798.9	791.8	806.1	769.6	668.5	886.2	No
2000-2005	752.9	750.0	755.8	783.7	741.1	828.7	No*

Age adjusted to 2000 US population.
Data Sources for the Ischemic Heart Disease and Respiratory disease figures:
Hospitalization Discharge Data: Washington State Department of Health, Office of Hospital and Patient Data Systems.
1990-2005 Population Estimates: Population Estimates for Public Health Assessment, Washington State Department of Health, Vista Partnership, and Krupski Consulting. November 2006.
LB = lower bound, UP = upper bound, LB and UB correspond to 95% confidence intervals.
ICD-9 codes: 460-519
** The statistical test did not show significant differences between Jefferson County and the state. When one CI is contained entirely within other, or when one confidence interval includes the other estimate rate, this implies that the two rates are not significantly different.*

Death and hospitalization rates have similar trends. The age-adjusted annual death rates in Jefferson County show that death rates for chronic lower respiratory disease and major

cardiovascular diseases are not significantly different compared to Washington State rates (Tables 9 and 10).

Table 9. Age-adjusted chronic lower respiratory disease death rate per 100,000 in Jefferson County vs. Washington State, 2000-2005.

State Total				Jefferson County			Jefferson different than WA*
YEAR	RATE	LB	UB	RATE	LB	UB	
2000	49.3	47.4	51.2	43.5	25.7	77.5	No
2001	48.2	46.3	50.0	32.5	17.7	64.2	No
2002	48.6	46.7	50.4	33.6	18.3	65.8	No
2003	46.4	44.6	48.2	25.6	12.8	56.4	No
2004	43.6	41.9	45.4	51.1	31.2	87.3	No
2005	45.1	43.4	46.9	42.7	25.6	76.0	No
2000-2005	46.8	46.1	47.5	38.3	31.0	47.9	No

Source: Center for Health Statistics Death Data.[70]
Rate per 100,000 age-adjusted to U.S. 2000 population. Does not include deaths where age is unknown.
LB and UB correspond to 95% confidence intervals.
ICD-10 codes: J40-J47; ICD-9 codes: 490-494, 496
Comparability ratio: 1.0411, standard error (SE): 0.00095
** There were no significant differences for Jefferson County compared to Washington State rates.*
For each individual year and for 2000 – 2005 combined years, the confidence interval for Jefferson County either completely contained the state confidence interval or at least contained the point estimate for the state. This implies that there were no significant differences between Jefferson County and the state.

Table 10. Age-adjusted cardiovascular death rate per 100,000 in Jefferson County vs. Washington State, 2000-2005.

State Total				Jefferson County			Jefferson different than WA*
Year	Rate	LB	UB	Rate	LB	UB	
2000	299.1	294.5	303.8	245.1	198.5	305.4	No
2001	290.3	285.9	294.9	314.6	260.9	382.0	No
2002	281.6	277.3	286.0	253.0	206.3	313.3	No
2003	272.6	268.4	276.9	261.5	214.0	322.8	No
2004	251.3	247.2	255.3	201.4	160.7	256.0	No
2005	244.9	241.0	248.9	237.4	193.6	294.8	No
2000-2005	272.5	270.7	274.2	252.1	232.5	273.8	No

Source: Center for Health Statistics Death Data.[70]
Rate per 100,000 age-adjusted to U.S. 2000 population. Does not include deaths where age is unknown.
LB = lower bound, UP = upper bound, LB and UB correspond to 95% confidence intervals.
ICD-10 codes: I00-I78, ICD-9 codes: 390-434, 436-448
Comparability ratio: 0.9963, SE: 0.00021
For each individual year and for 2000 – 2005 combined years, the confidence interval for Jefferson County either completely contained the state confidence interval or at least contained the point estimate for the state. This implies that there were no significant differences between Jefferson County and the state.

Cancer incidence data

Heart and lung illnesses and diseases are common in Washington, and there are many factors that can increase the chances of contracting them such as smoking and genetic predisposition. The role of air pollution as the underlying cause remains unclear but it is the subject of considerable research. However, it is clear that air pollution, infections and allergies can exacerbate these conditions. An early diagnosis can lead to appropriate treatment and ensure a normal or close to normal quality of life. In many cases however, there is no cure and those affected may die prematurely.

The Washington State Cancer Registry (WSCR) has collected information on all Washington residents diagnosed with cancer since 1992.[71] Information includes the type of cancer, age and ZIP code of the person's residence at diagnosis. Data sharing agreements with Oregon and Idaho assure that we obtain information on Washington residents who have cancer even if they are not diagnosed and treated in Washington.

Lung and bronchus cancer[l] rates for Jefferson County and Washington State are presented below (Table 11). The age adjusted incident rates for lung and bronchial cancer are not significantly different in Jefferson County compared to the state overall. Rates vary considerably between years due to the small number of cases. The overall observed pattern of lung and bronchial cancer does not indicate Jefferson County has a significantly elevated occurrence of lung and bronchial cancer over the years compared to Washington.

Table 11. Age-adjusted incident rates per 100,000 for lung and bronchial cancer, Jefferson County vs. Washington Sate, 2000-2005.

State Total				**Jefferson County**			**Jefferson different than WA***
Year	Rate	LB	UB	Rate	LB	UB	
2000	71.3	69.1	73.6	55.7	34.6	92.7	No
2001	72.0	69.8	74.3	71.4	48.1	110.0	No
2002	68.9	66.8	71.1	70.9	46.9	110.6	No
2003	69.8	67.6	72.0	87.9	62.4	128.4	No
2004	67.3	65.3	69.5	54.6	34.9	90.4	No
2005	67.0	65.0	69.1	74.0	50.4	112.8	No
2000-2005	69.3	68.4	70.2	69.0	59.1	81.1	No

RATE = Cancer cases per 100,000, age-adjusted to year 2000 US population.
Data Sources for the cancer rates: Cancer Registry: Washington State Cancer Registry, Washington State Department of Health, November 2006.

[l] **Lung Cancer -** is the most common cause of death due to cancer in women and men. Cigarette smoke contains various carcinogens and is responsible for most cases of this often fatal disease. The symptoms of lung cancer begin silently and then progress to chronic cough, wheezing and chest pain. Air pollution has been linked somewhat weakly to lung cancer.

1990-2005 Population Estimates: Population Estimates for Public Health Assessment, Washington State Department of Health, Vista Partnership, and Krupski Consulting. November 2006.
LB = lower bound, UB = upper bound, LB and UB correspond to 95% confidence intervals.
ICD-O: C34.0-34.9, excluding histologies 9140, 9590-9989, SiteCode Codes: 14
For each individual year and for 2000 – 2005 combined years, the Jefferson County confidence interval completely contains the state confidence interval, implying that the rates are not significantly different.

Child health considerations

ATSDR and DOH recognize infants and children are susceptible to environmental hazards from multiple sources and in a variety of settings that can occur at levels much lower than those causing other types of toxicity. Infants and children are also more vulnerable to exposures than adults. The following factors contribute to this vulnerability at this site:

- Children can be at increased risk because they are more sensitive to air pollution
- Not only do children have less developed respiratory systems, but because of their relative size, children also breathe more rapidly and inhale more air per kilogram of body weight compared to adults
- Children also tend to be more exposed to ambient air pollution because they spend more time outdoors being physically active
- Fetal and child exposure to many chemicals can cause permanent damage during critical growth stages

These unique vulnerabilities of infants and children demand special attention in communities with contamination of their water, food, soil or air.

Conclusions

Port Townsend residents have long reported odor and health illnesses from the mill's air emissions. The following is a summary of DOH findings.

A review of available health statistics in Jefferson County revealed that:

- Age-adjusted asthma hospitalization rates are not significantly different in Jefferson County compared to Washington State overall between 2000 and 2005.
- Childhood (0-14 years old) asthma hospitalization rates are not significantly different in Jefferson County compared to Washington State overall between 2000 and 2005.

- Adult (15-99 years old) asthma hospitalization rates are not significantly different in Jefferson County compared to Washington State overall.[m]

- Age-adjusted hospitalization rates for ischemic heart disease are higher in 2000, 2001 and 2002 in Jefferson County compared to Washington State overall. The hospitalization rate was higher for the combined period 2000 to 2005 in Jefferson County compared to Washington State overall.

- The age-adjusted hospitalization rates for chronic lower respiratory disease in Jefferson County were only significantly higher in 2003 compared to Washington State overall.

- Age-adjusted death rates for chronic lower respiratory and major cardiovascular diseases for individual and combined years are not significantly different for Jefferson County compared to Washington State overall.

- Age-adjusted incidence rates for lung and bronchial cancer are not significantly different in Jefferson County compared to Washington State overall.

At this time, it is not possible to directly associate any of the observed disease conditions at Port Townsend to chemical substances that may be emitted to the air from the mill. Even in the presence of certain chemicals, not all individuals would be expected to develop a disease, and for those who did, pinpointing the sole cause to emissions from the mill would be very challenging. This is because several other factors can contribute to respiratory diseases, ischemic heart diseases, and cancer. In order to identify specific cause(s), information on all possible exposure factors, and a follow-up of healthy individuals for a long period of time would be required.

Since levels of all air pollutants in the community of Port Townsend are unknown, exposure cannot be fully assessed. DOH cannot conclude whether air emissions from PTP mill could harm people's health because the information we need to make a firm conclusion is not available. DOH cannot currently evaluate the degree of past, current, or future exposure to PTP site-related contaminants. (Appendix B lists a more detailed description about general steps for evaluating exposure pathways that can be applied at PTP mill). In communities where hazardous chemicals exist, DOH's goal is to ensure that the community has the best information possible to safeguard its health. In order to reach a conclusion, DOH needs air monitoring data for levels of chemicals emitted by the mill which could impact neighborhoods surrounding the plant.

[m] *The statistical test did not show significant differences between Jefferson County and the state, even though there is little overlap the statistical test did not reveal a statistical significance. When one CI is contained entirely within other, or when one confidence interval includes the other estimate rate, this implies that the two rates are not significantly different.*

Data gaps

DOH has identified the following data gaps:

a) Emissions inventory data – e.g., information about all the possible chemicals being released from the mill to outdoor air
b) Dispersion modeling (See Appendix B, for more detail to better understand the exposed populations)
c) Meteorological data
   In order to help determine if the odors experienced by individuals are coming from PTP or if there are certain meteorological conditions under which odors seem to be more prevalent, DOH needs meteorological data. Data must be collected during these events. Useful information would include temperature, wind speed, wind direction, relative humidity, and barometric pressure etc.
d) Limitations of looking at county-wide data when the exposed population may only be a small subset of the population.

Recommendations

1. In addition to the criteria pollutants and precursors[n] (e.g., carbon monoxide, particulate matter, nitrogen oxides, sulfur dioxide, and lead) and the non-condensable gases coming from the pulping process (e.g., TRS compounds), DOH has identified the following chemicals of concern (COCs) as the most significant hazardous air pollutants (HAPs) emitted from the pulping process and combustion sources:
   - Metals (e.g., cadmium, beryllium, arsenic, chromium (total), manganese compounds and all forms of mercury)
   - Various organic compounds (e.g., methanol, propionaldehyde, acetaldehyde, and formaldehyde)
   - Hydrochloric acid (HCl)

   However, there may be other COCs released by the mill which can cause health impacts. In order to begin assessing exposure to air pollutants, DOH recommends Ecology, as the regulatory enforcement authority, require an expanded emissions inventory[o].

   The information obtained from the emissions inventory should be used with appropriate emission factors (e.g., EPA's AP-42 emission factors[p], and/or emission factors listed in

[n] A precursor of a criteria pollutant is a compound that reacts in the air to produce that pollutant (e.g., the precursors of ozone are VOCs, and nitrogen oxides).

[o] An emissions inventory provides a detailed description of the quantity of pollutants along with their emissions characteristics (how and where they are being emitted).

[p] An EPA42 is an emission factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e. g., kilograms of particulate emitted per megagram of coal burned). Such factors facilitate estimation of emissions from various sources of air pollution. In most cases, these factors are simply averages of all available data

the EPA's National Emission Inventories (NEI) clearinghouse for inventories and emission factors, web page (http://www.epa.gov/ttn/chief/), and/or emission factors listed in the Environmental Resource Handbook for Pulp and Paper Mills from the National Council for Air and Stream Improvement (NCASI), web page (http://www.ncasi.org)) from the PTP mill to determine what, how and where they are being emitted. If PTP mill is unable to estimate emission rates based on existing data, Ecology should require the mill to do source test of stacks, ponds, and identify other emission sources. In conjunction with recommendations 2 - 4, this information will be used to estimate community exposures at various locations downwind of the PTP mill.

2. Obtain meteorological data near the source:
    - Useful information includes temperature, wind speed, wind direction, relative humidity, and barometric pressures etc.
    - These data in conjunction with emissions data will be useful to model air emissions

3. Ecology should ensure that air dispersion modeling or risk modeling is conducted in order to estimate levels of contaminants in ambient air at locations in the community. This will help us to determine the community's short- and long-term exposures to contaminants from the mill.

4. Continue to track odor complaints from community members specifically identifying the date, time, and nature of the complaint. Useful information would include:
    - Address where the odor was detected
    - Time when odor was first detected
    - Duration of odor
    - Description of the odor, perhaps taken from a list of possible descriptors
    - Intensity of the odor, rated on a 1-2-3 scale rather than a 0-to-5 scale, without fractions
    - Any additional information the citizen wishes to share

5. Communicate the results of this health consultation and health messages to the community through fact sheets and public health meetings.

Public Health Action Plan

DOH understands that the uncertainty surrounding air quality issues and their health is stressful to community members. DOH will work closely with PTP mill and Ecology to assure air emissions data is collected and conduct air modeling in the community in order to gather the information needed to assess community exposures to emissions from PTP mill. Once this information is at hand, one could look at "hot spots' and determine the best locations to establish air monitoring, if possible.

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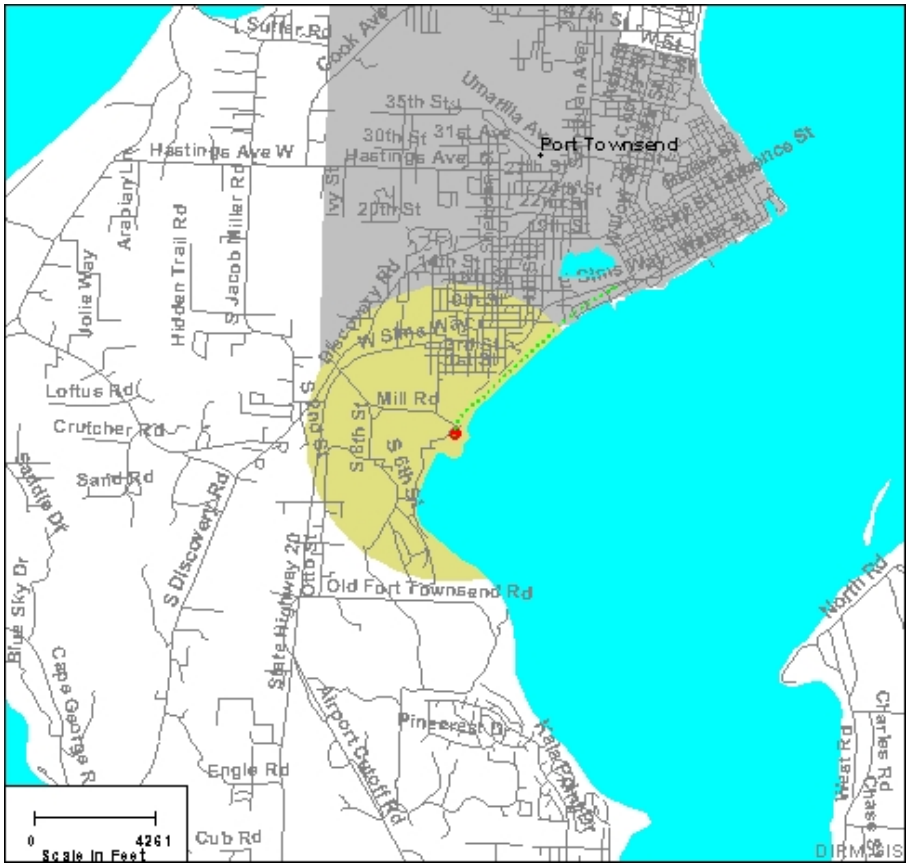
of acceptable quality, and are generally assumed to be representative of long-term averages for all facilities in the source category (i.e., a population average).

The adverse health effects caused by industrial air pollution have been the subject of international health research for many decades. The association between air pollution and human illness has been well established. People who are most sensitive to air pollution are those with heart and lung disease (including asthma), stroke, diabetes, infants and children, and older adults, (those 65 and older), or people with a current respiratory infection. While we are gathering the information we need, if you are among those sensitive to air pollution or are concerned about your health, limit outdoor activity during poor air quality days. If this is not possible, reduce the amount and intensity of activity or exercise and take frequent breaks.

Establishing a cause and effect relationship between specific industrial pollution sources and patterns of illness in a community requires expensive, large scale studies that are oftentimes inconclusive. Human disease is the result of many risk factors – behavioral, genetic, and environmental – with effects cumulative over an individual's entire life span. If the goal is improvement of air quality, the highest priority should be given to accurately characterizing the type and range of contaminants released by mill emissions, determining whether they exceed legally permitted levels, and measuring the concentrations of pollutants that community members are being exposed to. This information can be used to guide individual health recommendations and, if indicated, prompt regulatory action or changes in industrial practice (i.e. reduced emissions during adverse weather conditions).

DOH will be available to comment on work plans that are generated in the future at this site. DOH will also explore the need to conduct further studies. Residents can get general information on air quality from the Olympic Regional Clean Air Agency at 2940 B Limited Lane NW Olympia, Washington 98502, 360-586-1044 or 1-800-422-5623. Email: info@orcaa.org or http://www.orcaa.org/

Figure 1. Port Townsend Paper Mill, Jefferson County, Washington



Jefferson County

Demographic Statistics Within One Mile of the Site*

Total Population	1229
White	1127
Black	7
American Indian, Eskimo, Aleut	26
Asian or Pacific Islander	18
Other Race	19
Hispanic Origin	44
Children Aged 6 and Younger	105
Adults Aged 65 and Older	251
Females Aged 15 - 44	228
Total Aged over 18	956
Total Aged under 18	273
Total Housing Units	653

* Calculated using the area proportion technique. Source: 2000 U.S. CENSUS

Figure 2. Demographic Statistics within One Mile of the Site* - Port Townsend Paper Corporation, Jefferson County

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Appendix A

Table 1. Literature review on the effects of hydrogen sulfide at increasing concentrations

H_2S concentration	**Reported effects**
0.02 – 0.05 ppb	This is the concentration of H_2S measured in undeveloped area[72].
0.5 ppb	The odor of 0.5 ppb H_2S can be detected by 2% of the population.[73,74]
0.7 ppb	This is the Chronic Reference Concentration (RfC) for H_2S For the United States Environmental Protection Agency (USEPA). It is an estimate (with uncertainty Spanning perhaps and order of magnitude) of a daily inhalation exposure of the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.
H_2S concentration	**Reported effects**
2 ppb	The odor of 2 ppb H_2S can be detected by 14% of the population, and 2% of the population is annoyed by the odor.[73,74]
4 ppb	The odor of 4 ppb H_2S can be detected by 30% of the population and 5% of the population is annoyed by the odor.[73,74]
5 ppb	The World Health Organization (WHO) recommends that H_2S concentrations not exceed 5 ppb (7 µg /m^3) for ½-hour.[23,75]
7 to 27 ppb annual average with peaks up to 500 ppb	Exposure to ambient air containing H_2S at these levels resulted in elevated self-reported health symptoms (especially those related to the central nervous system) for 9 of 12 symptom categories.[76]
8 ppb	The odor of 8 ppb H_2S can be detected by 50% of the population, and 11% of the population is annoyed by the odor[73,74]
10 ppb	The odor of 10 ppb H_2S can be detected by 56% of the population and 17% of population is annoyed by the odor.[73,74]
10 ppb average (100 ppb peak)	Exposure to air containing 10 ppb H_2S on average resulted in neurophysiological abnormalities in reaction time, color discrimination, and mood in humans.[77,78,79]
10 ppb daily average	At an average daily exposure to this level of H_2S, there were increased reports of eye and nasal symptoms and cough for the previous year.[75]

30 ppb	This is the intermediate inhalation minimum risk level (MRL) for ATSDR.[27]
30 ppb (CAAQS)	The odor of 30 ppb H_2S can be detected by 83% of the population, and 40% of the population is annoyed by the odor. In addition, 30 ppb or 42 µg /m3 H_2S averaged over 1 hour and not to be equaled or exceeded is the California Ambient Air Quality Standard (CAAQS).[74]
H_2S concentration	**Reported effects**
40 ppb	This concentration constitutes the mean annoyance threshold, i.e., odor annoyance for 50% of the population (annoyance occurs by 5 times the detection threshold; 5 times 8 ppb = 40 ppb).[74]
70 ppb	This is the acute inhalation minimum risk level (MRL) for the Agency for Toxic Substances and Disease Registry (ATSDR). This MRL is an estimate of the daily exposure that is likely to be without appreciable risk of adverse non-cancer health effects for acute (1-14 days) exposure.[72,27]
≥ 30 ppb	TRS or H_2S levels may be associated with exacerbations of asthma or other respiratory diseases among the residents of Dakota City and South Sioux City when they are exposed to high ambient level (30-min rolling average ≥ 30 ppb).[80,81]
≥ 90 ppb	Air data for 1999 indicated that Dakota city residents, in Nebraska were repeatedly exposed, both indoors and outdoors, to moderate levels of H_2S. Individual and population exposures to air contaminants depend upon many factors including time spent outdoors and indoors, permeability of housing structures, and mobility within a community.[82]
≥ 90 ppb	Repeated and long-term exposure to moderate-to-low-level H_2S was not associated with poorer performance on neurobehavioral tests.[78]
2 ppm	Headache and increased airway resistance were found in an asthmatic subset.[28]
2.5 to 5 ppm	Coughing and throat irritation (after 15 minutes) were found for this level of H_2S.[74,83]

Appendix B

General steps for evaluating exposures that can be applied at PTP mill

To evaluate whether the public will be exposed to concentrations of chemicals that could cause adverse health effects, chemical concentrations in the emissions are compared to health comparison values (CVs). When exposure to contaminated media occurs, the exposure pathway is regarded as "complete." To determine whether completed pathways pose a potential health hazard, DOH compares contaminant concentrations to health-based comparison values. Comparison values are calculated from scientific literature available on exposure and health effects. These values, which are derived for each of the different media, reflect the estimated contaminant concentration for a given chemical that is *not* likely to cause adverse health effects, given a standard daily ingestion rate and standard body weight. If contaminant concentrations are greater than comparison values, DOH further analyzes exposure variables (for example, duration and frequency) and the toxicology of the contaminant.

The following questions need to be answered in order to determine exposure pathways for residents of Port Townsend exposed to air pollutants and to conduct a prospective health risk assessment for air emissions from the facility:

- What is in the emissions? And/or what chemicals and at what concentrations are they in the air when odor events are reported?
- Where are people exposed?
- How much are people exposed?
- How much is in the air and what is the personal exposure pattern?
- What is the direction of the wind?

What is in the emissions?

An adequate emissions inventory, dispersion analysis and meteorological data can help identify “hot spots” and determine the best locations to establish air monitoring, if possible.

1) What chemicals, at what concentrations, are detected in the air during odor events? Are the concentrations above background, or control, levels?

2) Are chemicals detectable in the air during odor events? Is there a temporal (time) trend to the detection of these chemicals?

3) What airborne particulates, and at what concentrations, are in the air?

4) Is it plausible that the Port Townsend citizen’s complaints of health effects are associated with detected chemicals and concentrations?

5) When an odor event occurs, do meteorological data indicate that the PTP mill is upwind of the odor detection?

Where are people exposed?

Modeling is used to predict the average concentration of a pollutant at different distances and directions from the source in the air for a specific time. Air dispersion models are mathematical equations that predict (simulate or model) the movement of chemicals in the air; this movement is called dispersion since the chemicals disperse after they are released into the air. The mathematical equations are entered into a computer program for ease of use. Data needed for these air dispersion models include weather data, the amount of pollutants released to the air over time, site topography, and site geometry. Predicted concentrations are generally calculated for one hour or 24 hours and are called the predicted one hour average or the 24 hour average ground level concentrations. The modeled hourly results can be used to calculate 24-hour or annual averages or maximums. Dispersion modeling works by matching patterns of emissions from a specific source with the variability of winds (meteorology data) that occur over a year in the general area.

Overall air models can.[84]

- Be used to estimate a substance's concentration over different time frames, such as a given day or an entire year.
- Be used to estimate the level of multiple substances in the air as a result of emissions from a single source or multiple sources.
- Estimate a substance's concentration at a wide range of locations.
- Be used to estimate levels of air pollution in residential areas.
- Offer insights into where contaminants deposit in greatest quantities.
- Identify areas where air sampling should take place.

Models usually require inputs that describe the source of contamination and local weather conditions. Model outputs are estimates of air pollution levels and the amount of air contaminants that might land on the ground. Though many models are quite advanced, none are perfect. Therefore, outputs from models should be viewed as estimates of actual conditions.

Certain meteorological patterns may exacerbate conditions that result in health complaints. Air current monitoring is extremely complex in coastal Washington, especially along the Straits of Juan de Fuca, where the interaction of sea, mountains, water currents, and atmospheric changes complicate most software modeling efforts. Therefore, certain meteorological conditions which odors seem to be more prevalent need to be considered.

How much are people exposed?

The extent people are exposed to background pollutants and mill emissions is determined by two major factors; how much is in the air and the behavior of the person.

How much is in the air?

Concentrations of pollutants in the air from point industrial sources are not constant; the concentration varies according to the direction and strength of the wind, time of day, how far away the location is from the emission source etc. Sometimes the pollutant concentration may be

high for a short time but not present at other times and will be between these extremes for varying periods. Most of the time the concentration will not be zero, but nonetheless will be very low.

Personal exposure pattern

Most people spent 90 – 95% of the time indoors. Whether or not a person is affected by a pollutant in air from an industrial source requires them to be present at the location at the same time the high concentration occurs. Although people may move around, they can still receive different levels of exposure while they are indoors or outdoors. Although the chances of being present during an episode may be low if the receptor is a residence, the chances are high if the modeled receptor is a workplace.

Appendix C

What is a Health Statistics Review?

A HSR uses existing health data from data sources like health registries database to determine whether health outcomes in a particular community are occurring at higher, lower, or about the same level compared to statewide or national levels after taking into account the age, race, and sex of individuals in the community. A HSR does not tell us why elevations or deficits in health outcomes exist and can not prove whether there is a cause and effect relationship between exposure to chemicals and health outcomes. While a health statistics review can take risk factors commonly found on health records into account, a health statistics review may not be able to take into account certain individual risk factors for health outcomes such as medical history, genetics and occupational exposures which may explain the elevations or deficits. Rather a HSR can generate hypotheses and may indicate whether a more rigorous study should be considered.

Why was a HSR conducted?

A HSR was conducted because of concerns about possible exposures to chemicals emitted from PTP mill. It is unknown what is in the emissions, and/or what chemicals and at what concentrations are in the air when odor events are reported. Because of possible health concerns, the Washington State Department of Health conducted this health statistics review. HSR are conducted to respond to community concerns; provide specific information on the health status of a community; and examine outcomes associated with exposures to chemicals. State health departments may provide annual summaries on the rates of asthma, cancer, diabetes and other diseases to provide communities with the health status in a particular area. In developing HSR, DOH only uses previously collected data, such as cancer, hospitalization rates, and other registry data as well as birth certificates, death records and other vital statistics. Data in registries are reported by physicians and hospitals to health agencies.

Strengths and limitations of HSRs

DOH acknowledges that each data source contains strengths and limitations. For example, only physical birth defects seen at delivery are reported by physicians. Malformations or internal health conditions are not captured on birth certificates. To conduct an HSR analysis, DOH examines the ratio between the observed number of cases in the area of concern and the expected number of cases based on county or state data. Particularly for cancer, the analysis accounts for age and gender. None of DOH analyses accounted for differences in race.

HSR results provide data on the number of persons in an area who have or died from a specific disease. The findings also determine whether more cases are present in the area than would be expected in comparison to the county or state. HSRs have both strengths and limitations. One the one hand, HSRs respond to community concerns about disease occurrence in the area; specify particular geographic locations and disease outcomes to examine; and use established methods to conduct analyses. On the other hand, HSRs rely on available data; cannot determine the cause of disease; do not identify other risk factors that may be associated with the disease; provide no

information on length of residence or occupational exposures; and generate unstable estimates due to a small number of cases.

Other limitations of HSRs?

As mentioned before, HSRs can not establish a cause and effect relationship between an exposure and a health outcome for a variety of reasons. While this review was conducted for Jefferson County with unknown documented exposures, current exposure and historical data was not available. Therefore, we can not be sure that all residents who were diagnosed with cancer lived in the area for a substantial duration and were exposed to mill emissions prior to the occurrence of their health outcome. Likewise, HSR does not capture long-time residents who were potentially exposed to chemicals and moved away prior to a cancer diagnosis. Also, the small population size of Jefferson County limited the ability to detect meaningful elevations or deficits in disease rates, hospitalization rates, and certain types of cancer.

Will DOH conduct additional HSRs?

DOH will not conduct additional HSRs until complex exposure (i.e., exposure pathways to air emissions) and risk characterization (i.e., how individuals or populations are affected, or what is the extra risk to health, cancer versus non-cancer health effects) is resolved.

Certification

The Washington State Department of Health prepared this Evaluation of Air Exposure at Port Townsend in Washington, Washington Public Health consultation under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodologies and procedures existing at the time the health consultation were initiated. Editorial review was completed by the Cooperative Agreement partner.

Technical Project Officer, CAPEB, SPAB, DHAC

The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this health consultation and concurs with its findings.

Team Lead, CAPEB, SPAB, DHAC, ATSDR

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