Technical Support Document for the Second Tier Analysis
Greater Wenatchee Regional Landfill
Landfill Expansion Project
Wenatchee, Washington
May 15, 2008

1. EXECUTIVE SUMMARY

Proposed hydrogen sulfide and vinyl chloride emissions from the proposed expansion of the Greater Wenatchee Regional Landfill (GWRL) exceed a regulatory trigger level called an Acceptable Source Impact Level (ASIL). The project was therefore required to undergo a Second Tier analysis per Chapter 173-460 Washington Administrative Code (WAC).

On the basis of the Second Tier analysis described here and the modeled hydrogen sulfide and vinyl chloride concentrations, the Washington State Department of Ecology's Headquarters Office (Ecology HQ) has determined the health risks are within the acceptable range. Therefore, Ecology HQ may approve the proposed new source of Toxic Air Pollutants (TAP) under Chapter 173-460 WAC.

This document describes the technical analysis performed by Ecology HQ.

2. THE PROCESS

2.1 The Regulatory Process

The requirements for performing toxics air permitting is established in Chapter 173-460 WAC. These rules require a review of any increase in toxic emissions for all new or modified stationary sources in the State of Washington.

2.1.1 The Three Tiers of Toxic Air Permitting

The objectives of Toxics Air Permitting are to establish the systematic control of new sources emitting toxic air pollutants in order to prevent air pollution, reduce emissions to the extent reasonably possible, and maintain such levels of air quality as will protect human health and safety.

There are three levels of review when processing a new or modified emissions unit emitting TAPs: (1) Tier One (toxic screening), (2) Tier Two (health impacts assessment), and (3) Tier Three (risk management decision).

All projects are required to undergo a toxic screening (Tier One analysis) as required by WAC 173-460-040. There are two ways to perform a Tier One analysis. If proposed emissions are below the Small Quantity Emission Rate (SQER) tables, no further analysis is required. If emissions are greater than the SQER table or no value exists in the SQER table, those emissions must be modeled and the resultant ambient concentration compared against the appropriate ASIL. If the ambient concentration is below the ASIL then no further analysis is required.

A Tier Two analysis, promulgated in WAC 173-460-090, is a site-specific health impacts assessment. The objective of a Tier Two analysis is to quantify the increase in lifetime cancer risk for persons exposed to the increased concentration of any Class A TAP and to quantify the increased health hazard from any Class B TAP in ambient air that would result from the proposed project. Once quantified, the cancer risk is compared to the maximum risk allowed by a Tier Two analysis, which is one in one hundred thousand, and the concentration of any Class B

TAP that would result from the proposed project is compared to a Risk Based Concentration (RBC).

If the emissions of a Class A toxic pollutant result in a cancer risk of greater than one in one hundred thousand then an applicant may request Ecology HQ perform a Tier Three analysis. A Tier Three analysis is basically a risk management decision in which the Director of Ecology makes a decision that the risk of the project is acceptable based on determination that emissions will be maximally reduced through available preventive measures, assessment of environmental benefit, disclosure of risk at a public hearing and related factors associated with the facility and the surrounding community.

Since Class B TAPs are not confirmed carcinogens, there is no Tier Three analysis performed. Rather, all risks are evaluated in the Tier Two analysis.

2.1.2 Processing Requirements

Ecology HQ shall evaluate a source's Second Tier analysis only if:

- The authority (or in this case Ecology's Central Regional Office (CRO)) has advised Ecology HQ that other conditions for processing the Notice of Construction (NOC) have been met,
- Emission controls contained in the conditional Notice of Construction represent at least Best Available Control Technology for Toxics (T-BACT), and
- Ambient concentrations exceed acceptable source impact levels after using more refined emission quantification and air dispersion modeling techniques.

CRO submitted the three items listed above to Ecology HQ on October 5, 2007.

2.2 T-BACT Verification

T-BACT is required for any new or modified emission unit that has an increase in emissions of toxic air pollutants. See Section 3.5.3 for details on T-BACT for this project.

2.2.1 Ambient Concentration of Toxic Air Pollutants

Ecology HQ reviewed the application and verified the emission estimates. Emissions of hydrogen sulfide and vinyl chloride exceed the ASILs and a Second Tier analysis must be performed.

3. THE PROJECT

3.1 Permitting History

- On April 2, 1999, CRO issued Air Operating Permit (AOP) No. DE 99AOP-C122. It underwent several revisions during its 5-year term, expiring on April 2, 2004.

- On March 8, 2004, CRO issued renewal AOP No. 04AQ-C007. It was revised on April 13, 2006, and March 7, 2008, and will expire on April 2, 2009, or upon issuance of a subsequent revision.

- Trench 1 and the northeast half of the North Berm were capped during the summer 2000, resulting in issuance of the first Notice of Construction (air quality permit) to this source. Closure of these cells was permitted under NOC Order No. 00AQCR-1000, issued April 21, 2000.

- On January 29, 2003, NOC Order No. 00AQCR-1000 First Revision was issued. The revised Order mandated installation and use of an active landfill gas collection system and a single enclosed flare.

- On April 13, 2006, NOC Order No. 00AQCR-1000 Second Revision was issued. The revised Order allowed installation of additional landfill gas flaring capacity, provided that all flaring capacity is achieved through the use of enclosed flares meeting Best Available Control Technology.

- On March 7, 2008, NOC Order No. 00AQCR-1000 Third Revision was issued. The revised Order allowed for an increase in the flare's sulfur dioxide emission rate.

3.2 The Proposed Project

GWRL has proposed to expand their existing municipal solid waste landfill to accommodate future regional demands for landfill capacity. The existing landfill does not have sufficient capacity to meet the projected future regional needs for environmentally safe and cost effective solid waste disposal. The proposal is to increase the landfill's disposal capacity by approximately 34,278,000 cubic yards (92.5 acres).

Landfill gas is currently collected with an active collection system. The collection system is estimated to collect 90 percent of the landfill gas generated. The collection system is routed to a single enclosed flare, capable of flaring up to 2000 standard cubic feet per minute. The flare is required to destroy at least 99 percent of the Toxic Air Pollutants routed through it.

In addition, GWRL intends to make several other changes that will not affect the emissions of hydrogen sulfide or vinyl chloride. Those changes are:

- Relocation of the Wenatchee Red Apple Fliers' facility.
- Development of landfill accessory facilities such as scales, scale house, maintenance facility, new entrance, and new site roads.
- Development of integrated solid waste handling improvements, including a material recovery facility.
- Use of a portable rock, concrete, and asphalt crusher and soil screening unit.
- Potential future relocation of solid waste collection company and administrative services.

3.3 NOC Processing Timelines

CRO received the application on February 1, 2006. Additional information was received from the applicant on May 12, 2006; May 15, 2006; July 25, 2006; October 5, 2006, and August 2, 2007. CRO shared a preliminary draft Notice of Construction permit with the applicant on September 7, 2007. On September 24, 2007, the applicant advised CRO to "hold-off" on issuing the draft for public comment, as they revised their proposal. Subsequently, additional application information was received from the applicant on November 16, 2007; November 21, 2007, and December 26, 2007. CRO provided a new draft of the NOC to Ecology HQ on January 4, 2008. CRO received additional information on March 7, 2008.

3.4 Site Description

The landfill is located at 191 S. Webb Avenue, Douglas County near Wenatchee, Washington.

3.5 Emissions

GWRL has estimated its emissions from the project and they are compared to the SQER tables below:

Pollutant	Class A or B Pollutant	Landfill Expansion		SQER		Emissions Above SQER Yes or No
		Lb/hr	Lb/yr	Lb/hr	Lb/yr	
1,1,1, Trichloroethane	B	0.0059	51.8	5.0	43,748	No
1,1,2,2-Tetrachloroethane	B	0.017	149.5	0.2	1,750	No
1,1-Dichloroethane	B	0.0011	9.5	5.0	43,748	No
1,1-Dichloroethene	B	0.0019	16.6	1.2	10,500	No
1,2-Dichloroethane	A	0.0017	14.6	-	10	Yes
Isopropyl alcohol	B	0.0080	70	5.0	43,748	No
1,2-Dichloropropane	A	0.0019	16.5	-	500	No
Acetone	B	0.039	343.2	5.0	43,748	No
Acrylonitrile	A	0.00073	6.4	-	10	No
Benzene	A	0.0038	33	-	20	Yes
Butane	B	0.049	426.9	5.0	43,748	No
Carbon disulfide	B	0.0041	35.7	2.0	17,500	No
Carbon tetrachloride	A	0.000057	0.5	-	20	No
Carbonyl sulfide	B	0.0000211	0.0185	-	-	Yes
Chlorobenzene	B	0.00036	3.24	2.6	22,750	No
Chlorodifluoromethane	B	0.0104	90.9	5.0	43,748	No
Ethyl chloride	B	0.0040	35.2	5.0	43,748	No
Chloroform	A	0.00033	2.9	-	10	No
Chloromethane	B	0.000101	0.89	5.0	43,748	No
Dichlorobenzene	B	0.000029	0.26	5.0	43,748	No
Dichlorodifluoromethane	B	0.17	1,529.2	5.0	43,748	No
Dichlorofluoromethane	B	0.025	216.4	2.6	22,750	No
Dichloromethane	A	0.0023	20.5	-	50	No
Ethyl mercaptan	B	0.013	115.6	0.02	175	No
Ethyl benzene	B	0.019	168.6	5.0	43,748	No
Ethylene dibromide	A	0.000017	0.15	-	0.5	No
Formaldehyde	A	0.0078	68.3	-	20	Yes
Hexane	B	0.205	1,792.9	2.6	22,750	No
Hydrogen sulfide	B	0.942	8202	0.02	175	Yes
Mercury	B	$9.7\text{x}10^{-8}$	0.0009	-	50	No
Methyl ethyl ketone	B	0.072	633.9	5.0	43,748	No
Methyl isobutyl ketone	B	0.0037	32.7	5.0	43,748	No
Methyl mercaptan	B	0.011	97.3	0.02	175	No
Napthalene	B	0.00063	0.56	2.6	22,750	No
Polyaromatic hydrocarbon	A	$9.16\text{x}10^{-6}$	0.080	-	-	Yes
Pentane	B	0.022	192.6	5.0	43,748	No
Perchloroethylene	A	0.0062	54.2	-	500	No
Toluene	B	0.083	726.4	5.0	43,748	No
Trichloroethylene	A	0.0028	24.2	-	50	No
Vinyl chloride	A	0.0072	62.8	-	20	Yes
Xylenes	B	0.055	483.8	5.0	43,748	No
Styrene	B	0.0014	12.2	5.0	43,748	No
Trimethyl benzene	B	0.0066	58.2	5.0	43,748	No
1,2-Dichloroethene	B	0.00070	6.1	-	50	No
1,2 dichloro- 1,1,2,2 tetrafluoroethane	B	0.0012	10.9	5.0	43,748	No

Emissions of 1,2-dichloroethane, benzene, carbonyl sulfide, formaldehyde, hydrogen sulfide, polyaromatic hydrocarbon, and vinyl chloride exceed the values listed in SQER tables. The applicant then modeled these TAPs and compared them to their respective ASILs as shown in Section 3.5.1.1.

3.5.1 Point of Compliance

Assessment of potential health risks from the project were based on the maximum modeled concentration of 1,2-dichloroethane, benzene, carbonyl sulfide, formaldehyde, hydrogen sulfide, polyaromatic hydrocarbon, and vinyl chloride at an assumed point of public exposure (nearest point of ambient air) the property fence line. The maximum concentration was modeled at the property fence line and the distance from the fence line to the nearest residence is 406 feet (124 meters).

3.5.1.1 Emissions Concentrations

Below are the modeling results of the pollutants that exceeded the SQER's compared to the ASILs.

Pollutant	Class A or Class B TAP?	Highest Concentration (Fence line) (µg/m^3)	ASIL (µg/m^3)	Emissions Above ASIL Yes or No
1,2-Dichloroethane	A	0.005	0.0380000 (annual avg.)	No
Benzene	A	0.011	0.12 (annual avg.)	No
Carbonyl sulfide	B	N/A	---[1]	No
Formaldehyde	A	0.0007	0.0770000 (annual avg.)	No
Hydrogen sulfide	B	1.79	0.9 (24-hr avg.)	Yes
Polyaromatic hydrocarbon	A	1.1×10^{-6}	0.00048 (annual avg.)	No
Vinyl chloride	A	0.023	0.0120000 (annual avg.)	Yes

3.5.2 Pollutants Subject to Second Tier Analysis

Emissions of 1,2-dichloroethane, benzene, formaldehyde, and polyaromatic hydrocarbon are below the ASIL after being modeled and carbonyl sulfide has no listed ASIL therefore only hydrogen sulfide and vinyl chloride are subject to review under this Second Tier analysis.

3.5.2.1 Background Emissions

Information on existing ambient air quality TAP concentrations of vinyl chloride and hydrogen sulfide near the GWRL has been researched and obtained from readily available sources, and are discussed as follows:

There are five other documented sources of vinyl chloride in Chelan and Douglas Counties, Washington. These sources include four other landfills and one demolition waste facility. The reported emissions for these five sources range from 3.97 to 74.6 pounds per year (based on data for 1999—the most recent information available). However, as the closest source is approximately 10 miles from the GWRL, the ambient air concentration is estimated to be below 0.0001 µg/m^3 for the receptors situated near the GWRL, due to air dispersion characteristics.

[1] There is no ASIL for carbonyl sulfide. This TAP is not analyzed further.

Facility Name	Emissions (lbs/yr)	Address	Approximate Distance from GWRL
Box Canyon Inert Demolition Waste Facility	74.6	4801 Contractors Drive, E. Wenatchee, WA 98802	10 miles to the northwest
Cashmere Landfill	17.9	101 Woodring St, Cashmere, WA 98815	17 miles to the northwest
Manson Landfill	4.93	Manson, Chelan Co., WA	31 miles to the north
Dryden Landfill	3.97	9073 Highway 2, Dryden, WA	22 miles to the northwest
Pine Canyon Landfill	6.49	Near Jameson Lake, Douglas County, WA	30 miles to the northeast

There were no emissions data readily available for hydrogen sulfide. As the ambient air quality TAP concentrations for vinyl chloride are expected to be toxicologically insignificant (due to the large distance from the other sources to the GWRL), they have not been added to the modeled TAP concentrations at the fence line of the proposed expansion of the GWRL, or to the modeled TAP concentrations at the nearby residences.

3.5.3 T-BACT

T-BACT is contained in the existing flare NOC Order No. 00AQCR-1000 Second Revision, and consists of (1) an active landfill gas collection system, with 90 percent collection efficiency, and (2) landfill gas control by an enclosed flare with 99 percent destruction of TAPs. Many of the conditions in the proposed decision are BACT/T-BACT for a particular activity.

3.5.4 Air Dispersion Modeling

The applicant used EPA's Industrial Source Complex (ISC3) model with meteorological data processed from the Pangborn Memorial Airport in Wenatchee to evaluate emissions from this project. Five years of meteorological data were from 2000 through 2004. Typical meteorological conditions at the landfill include the prevailing wind direction to the southeast and an annual average wind speed of 7.8 miles per hour.

Ecology HQ no longer accepts projects using ISC3 as of December 2006. However, because this project was originally submitted to CRO prior to December 2006, we are willing to allow this project to continue using ISC3 (a functionally equivalent model) for this one last project.

4. GENERIC HEALTH IMPACTS ASSESSMENT PROCESS

A health impacts assessment was prepared by the applicant and it was reviewed and approved by Ecology HQ. Ecology HQ has put together a project team consisting of an engineer, a toxicologist, and a modeler.

Below are descriptions of the content of each part of the Health Impacts Assessment.

4.1 Hazard Identification

Hazard identification involves gathering and evaluating toxicity data on the types of health injury or disease that may be produced by a chemical and on the conditions of exposure under which injury or disease is produced. It may also involve characterization of the behavior of a chemical within the body and the interactions it undergoes with organs, cells, or even parts of cells. This information may be of value in determining whether the forms of toxicity known to be produced by a chemical agent in one population group or in experimental settings are also likely to be produced in human population groups of interest. Note: Risk is not assessed at this stage; hazard identification is conducted to determine whether and to what degree it is scientifically correct to infer that toxic effects observed in one setting will occur in other settings.

4.1.1 Identification of Potentially Exposed Populations

This step involves describing the nature and size of the various populations exposed to a chemical agent in the vicinity of the proposed project.

4.1.2 Discussion of TAP Concentrations

This step involves the identification of the toxicological profiles of all toxic air pollutants that exceed the ASIL. It includes a discussion of the toxicological effects of hazardous substances, chemicals, and compounds. Each profile includes an examination, summary, and interpretation of available toxicological and epidemiological data evaluations on the hazardous substance.

4.1.3 Exposure Assessment

This step includes characterization of exposure pathways, and total daily intake based on the magnitude and duration of exposure to toxic air pollutants that exceed the ASIL from these pathways. The evaluation could include past exposures, current exposures, or exposures expected in the future.

4.1.4 Risk/Hazard Assessment

This step involves the integration of data analyses from each step of the risk assessment to determine the likelihood that the human population of interest will experience any of the various forms of toxicity associated with a chemical under its known or anticipated conditions of exposure.

4.1.5 Uncertainty

In almost all risk assessments undertaken in support of regulatory decisions, especially concerning chronic hazards, risk assessors are required to go beyond available data and make inferences about risks expected for conditions of exposure under which direct evidence of risk cannot now be collected. When scientific uncertainty is encountered in a risk assessment, the integration of any assumptions is required to fill information gaps. The following are examples of components that constitute gaps in the scientific basis for assessing human cancer risk:

- How relevant is the data to humans?
- How relevant to humans are results from animal studies using a different route of exposure?
- How relevant are results from studies using an exposure regimen (in terms of frequency and duration) that differs from the human situation?
- Which species/strains of animals are most appropriate for dose response assessment in humans?
- How should risk estimates be developed?
- Using most sensitive species/strain/sex?
- Combining incidents of benign and malignant tumors?
- Using pooled tumor incidence (tumor bearing animals)?
- Can results of an animal study that does not extend over a lifetime be extrapolated to lifetime?
- How does the dose-response relation relate to the unobservable dose-response relation in the dose region of concern for the human population under study?
- How should low-dose risk be modeled?
- Do agents operate by threshold or non-threshold mechanisms?

5. HEALTH IMPACTS ASSESSMENT

5.1 Introduction

The Second Tier analysis described below was conducted according to the requirements promulgated in Chapter 173-460 WAC. It addressed the public health risk associated with exposure to hydrogen sulfide and vinyl chloride emissions from landfill operations in the health impacts assessment prepared by the consultant (SCS Engineers) for the Greater Wenatchee Regional Landfill.

5.2 Hazard Identification

The properties of hydrogen sulfide and vinyl chloride are identified in the table below:

	Hydrogen sulfide	Vinyl chloride
CAS #	7783-06-4	75-01-4
Characteristics	Colorless gas with a strong odor of rotten eggs	Colorless gas that liquefies in a freezing mixture
Molecular Weight	34	62.5
Boiling Point	-76^{0}F	7^{0}F
Solubility	N/A	Slightly soluble

5.2.1 Acute (Short-term) Effects

5.2.1.1 Hydrogen Sulfide

Some epidemiologic studies have reported compromised cognitive and sensory performance, and physiological effects, such as nausea and headache, among individuals exposed to low concentrations of hydrogen sulfide.

5.2.1.2 Vinyl Chloride

Acute (short-term) exposure to high levels of vinyl chloride in air has resulted in central nervous system effects. The exposure has the potential to manifest itself as:

- Acute exposure of humans to high levels via inhalation has resulted in effects on the Central Nervous System (CNS), such as dizziness, drowsiness, headaches, and giddiness.
- Slight irritation to the eyes and respiratory tract in humans.
- Acute exposure to extremely high levels has caused loss of consciousness, lung, and kidney irritation, and inhibition of blood clotting in humans and cardiac arrhythmias in animals.

5.2.2 Chronic (Long-term) Effects

5.2.2.1 Hydrogen Sulfide

Epidemiological information for specific chronic effects in humans include significant impairments of reaction time, balance, color discrimination, memory and other cognitive abilities, as well as effects on mood (Kilburn & Warshaw, 1995).[2]

5.2.2.2 Vinyl Chloride

Cancer is a major concern from exposure to vinyl chloride via inhalation, as vinyl chloride exposure has been shown to increase the risk of a rare form of liver cancer in humans. EPA has classified vinyl chloride as a Class A, human carcinogen.[3] In addition to the following effects:

- Chronic (long-term) exposure to vinyl chloride through inhalation and oral exposure in humans has resulted in liver damage.

- A small percentage of individuals occupationally exposed to high levels of vinyl chloride in air have developed a set of symptoms termed "vinyl chloride disease," which is characterized by Raynaud's phenomenon (fingers blanch and numbness and discomfort are experienced upon exposure to the cold), changes in the bones at the end of the fingers, joint and muscle pain, and scleroderma-like skin changes (thickening of the skin, decreased elasticity, and slight edema).

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[2] Kilburn KH, Warshaw RH. (1995) Hydrogen sulfide and reduced-sulfur gases adversely affect neurophysiological functions. Toxicol Ind Health.; 11(2):185-97.

[3] http://www.epa.gov/ttn/atw/hlthef/vinylchl.html

- Central nervous system effects (including dizziness, drowsiness, fatigue, headache, visual and/or hearing disturbances, memory loss, and sleep disturbances) as well as peripheral nervous system symptoms (peripheral neuropathy, tingling, numbness, weakness, and pain in fingers) have also been reported in workers exposed to vinyl chloride.

- Animal studies have reported effects on the liver, kidney, and CNS from chronic exposure to vinyl chloride.

- EPA has established a Reference Concentration (RfC) of 0.1 milligrams per cubic meter, and a Reference Dose (RfD) of 0.003 milligrams per kilogram per day for vinyl chloride.

5.2.3 Reproductive/Developmental Effects

5.2.3.1 Hydrogen Sulfide

Although a single generation reproductive study (Dorman et al., 2000) noted testicular alterations that were observed only in the high dose group, the alterations were not significantly different from the controls and had no apparent effects on reproductive performance. No other indicators of reproductive toxicity were observed in this study. No significant histopathology of reproductive organs was noted in a longer duration (subchronic) study. These results can be considered to lessen the concern for lack of a multi-generational reproductive study.[4]

5.2.3.2 Vinyl Chloride

The following information was identified with respect to vinyl chloride emissions:

- Several case reports suggest that male sexual performance may be affected by vinyl chloride. However, these studies are limited by lack of quantitative exposure information and possible co-occurring exposure to other chemicals.

- Several epidemiological studies have reported an association between vinyl chloride exposure in pregnant women and an increased incidence of birth defects, while other studies have not reported similar findings.

- Epidemiological studies have suggested an association between men occupationally exposed to vinyl chloride and miscarriages in their wives' pregnancies although other studies have not supported these findings.

- Testicular damage and decreased male fertility have been reported in rats exposed to low levels for up to 12 months.

- Animal studies have reported decreased fetal weight and birth defects at levels that are also toxic to maternal animals in the offspring of rats exposed to vinyl chloride through inhalation.

[4] http://www.epa.gov/IRIS/subst/0061.htm

5.2.4 Cancer Risk

5.2.4.1 Hydrogen Sulfide

Hydrogen sulfide has not been shown to cause cancer in humans, and its possible ability to cause cancer in animals has not been studied thoroughly. The Department of Health and Human Services, the International Agency for Research on Cancer (IARC), and the EPA have not classified hydrogen sulfide for carcinogenicity.[5]

5.2.4.2 Vinyl Chloride

EPA has classified vinyl chloride as a Group A, a human carcinogen. Some of the effects include:

- Inhaled vinyl chloride has been shown to increase the risk of a rare form of liver cancer (angiosarcoma of the liver) in humans.

- Animal studies have shown that vinyl chloride, via inhalation, increases the incidence of angiosarcoma of the liver and cancer of the liver.

- Several rat studies show a pronounced early-life susceptibility to the carcinogenic effect of vinyl chloride (i.e., early exposures are associated with higher liver cancer incidence than similar or much longer exposures that occur after maturity).

- EPA uses mathematical models, based on animal studies, to estimate the probability of a person developing cancer from breathing air containing a specified concentration of a chemical. EPA has calculated an inhalation unit risk estimate of 8.8×10^{-6} $(\mu g/m^3)^{-1}$ for lifetime exposure to vinyl chloride. Please see IRIS for current information.

- EPA has calculated an oral cancer slope factor of 1.5 $(mg/kg/d)^{-1}$ for lifetime exposure to vinyl chloride.

5.2.5 Terrestrial Fate

5.2.5.1 Hydrogen Sulfide

Hydrogen sulfide does not appear to create a risk from terrestrial deposition. A literature search did not produce any information on terrestrial fate.

5.2.5.2 Vinyl Chloride

If vinyl chloride is released to soil, it will be subject to rapid volatilization based on a reported vapor pressure of 2660 mm Hg at 25 degrees C; half-lives of 0.2 and 0.5 days were reported for volatilization from soil incorporated into 1 and 10 cm of oil, respectively. Any vinyl chloride, which does not evaporate, will be expected to be highly mobile in soil. It may be subject to biodegradation under anaerobic conditions such as exists in flooded soil and groundwater;

[5] http://www.atsdr.cdc.gov/tfacts114.pdf

however, limited existing data indicate that vinyl chloride is resistant to biodegradation in aerobic systems and therefore, it may not be subject to biodegradation in natural waters. It will not be expected to hydrolyze in soils under normal environmental conditions.[6]

5.3 Aquatic Fate

5.3.1 Hydrogen Sulfide

Hydrogen sulfide does not appear to create a risk from aquatic fallout. A literature search did not produce any information on aquatic fate.

5.3.2 Vinyl Chloride

If vinyl chloride is released to water, it will not be expected to hydrolyze, to bioconcentrate in aquatic organisms or to adsorb to sediments. It will be subject to rapid volatilization with an estimated half-life of 0.805 hr for evaporation from a river 1 m deep with a current of 3 m/sec and a wind velocity of 3 m/sec(1,SRC). In waters, containing photo sensitizers such as humic acid, photodegradation will occur rapidly. Limited existing data indicate that vinyl chloride is resistant to biodegradation in aerobic systems and therefore, it may not be subject to biodegradation in natural waters.

5.4 Atmospheric Fate

5.4.1 Hydrogen Sulfide

Atmospheric hydrogen sulfide is affected by ambient temperature and other atmospheric variables including humidity, sunshine, and presence of other pollutants. The decreased temperatures and decreased levels of hydroxide in northern regions (e.g. Alberta, Canada) in winter increase the residence time of hydrogen sulfide in air. Once released into the atmosphere, hydrogen sulfide will behave like many other gaseous pollutants and be dispersed and eventually removed.

Residence times in the atmosphere range from about one day to more than 40 days, depending upon season, latitude, and atmospheric conditions.[7]

5.4.2 Vinyl Chloride

If vinyl chloride is released in the atmosphere, it can be expected to exist mainly in the vapor-phase in the ambient atmosphere based on a reported vapor pressure of 2660 mm Hg at 25 degrees C. Gas phase vinyl chloride is expected to degrade rapidly in air by reaction with photochemically produced hydroxyl radicals with an estimated half-life of 1.5 days. Products of reaction in the atmosphere include chloroacetaldehyde, hydrochloric acid, chloroethylene epoxide, formaldehyde, formyl chloride, formic acid, and carbon monoxide. In the presence of

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[6] http://www.speclab.com/compound/c75014.htm
[7] http://www.gasdetection.com/TECH/h2s.html

nitrogen oxides, (e.g. photochemical smog situations), the half-life would be reduced to a few hours.[8]

5.5 Identification of Exposed Populations

The table below shows the distances to the sensitive receptors, businesses, and residences.

#	Name	Address	Facility Type	Distance in Feet	Distance in Meters
Nearest Sensitive Receptors					
1	Rock Island School	5645 Rock Island Rd. Rock Island	School (K-5)	7,350	2,240
2	Grand School	1430 1st St. SE East Wenatchee	School (K-5)	19,391	5,910
3	Kenroy School	601 N. Jonathan Ave. East Wenatchee	School (K-5)	20, 952	6,386
4	Sterling Middle School	East Wenatchee	School (6-7)	21,975	6,698
5	Life's Little Pleasures	516 N. Lyle Ave. East Wenatchee	Assisted Living Facility	17,645	5,378
6	Lover & Wishes Adult Family Home	325 N. Kansas Ave. East Wenatchee	Retirement Community	19,253	5,868
7	Quality Care Homes	208 S. Houston Ave. East Wenatchee	Retirement Community	21,644	6,597
8	Highline Care Center	609 Highline Dr. East Wenatchee	Retirement Community/hospital	22,388	6,824
9	Epic Wenatchee Early Childhood Developmental Program Apple Valley Site	1901 Rock Island Rd. East Wenatchee	Day Care	18,198	5,547
10	Teddy Bear Child Care Pre-School	1301 3rd St. SE East Wenatchee	Day Care	20,104	6.128
11	Sandra K Root Daycare	3064 Riviera Blvd. Malaga	Day Care	16,041	4,889
Nearest Business Address					
I	Jen Tel Pest Management Inc	4084 Airport Way East Wenatchee	Pest Manager	4,859	1,481
II	Century Aviation	3908 Airport Way East Wenatchee	Plane Restoration	5,140	1,567
III	Wings of Wenatchee	3724 Airport Way East Wenatchee	Flight school	5,569	1,687
IV	Martin & Webber Plumbing	1010 Webb Pl. S. East Wenatchee	Plumber	3,046	928

8 http://www.speclab.com/compound/c75014.htm

Nearest Residential Addresses				
Address		Facility Type	Distance in Feet	Distance in Meters
A	488 S. Webb Ave, East Wenatchee	Residence	406	124
B	4920 4th St. SE, East Wenatchee	Residence	430	131
C	5361 & 5371 4th St. SE, East Wenatchee	Residence	430	131
D	5451 4th St. SE, East Wenatchee	Residence	524	160
E	275 Witte Ave, East Wenatchee	Residence	562	171
F	310 Woodridge Ave. East Wenatchee	Residence	1,137	347
G	277 S. Ward Ave, East Wenatchee	Residence	1,106	337
H	11 S Ward, East Wenatchee	Residence	1,008	307

5.6 Discussion of TAP Concentrations

The concentrations of hydrogen sulfide and vinyl chloride at the closest point of ambient air, the highest concentration, and the highest concentration at an existing residential receptor are:

Pollutant	Class A or B TAP	Closest Point of Ambient Air (fence line) (μg/m^3)	Highest Concentration (fence line) (μg/m^3)	Highest Concentration (Residence E) (171 m) (μg/m^3)	ASIL (μg/m^3)
Hydrogen Sulfide	B	Same as highest concentration	1.79 24-hr avg.	1.79 24-hr avg.	0.9 24-hr avg.
Vinyl Chloride	A	Same as highest concentration	0.022 Annual Average	0.0044 Annual Average	0.0120000 Annual Average

5.7 Background

Background ambient levels of hydrogen sulfide in urban areas range from 1.56×10^{-4} to 4.68×10^{-4} μg/m^3, while in undeveloped areas concentrations can be as low as 2.82×10^{-5} to 9.92×10^{-5} μg/m^3 (ATSDR 2004 converted at 20^0 C).[9]

The 1999 National Air Toxics Assessment NATA (EPA, 2005) states the HAPEM5 modeled background vinyl chloride concentration in each of Douglas County's census tracts was 2.1682×10^{-2} μg/m^3.

5.7.1 Exposure Assessment (daily intake and risk)

5.7.1.1 Hydrogen Sulfide

Due to the high vapor pressure of hydrogen sulfide, all the landfill's emissions are likely to remain in the air, thus all resulting exposure is likely to be by inhalation alone.

[9] Agency for Toxic Substances and Disease Registry (ATSDR). 2004. Toxicological profile for hydrogen sulfide (*Draft for Public Comment*). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Chapter 2, p.1.

5.7.1.2 Vinyl Chloride

No significant transfer of vinyl chloride from air to ground water is expected; therefore, nearly all exposure resulting from landfill emissions is expected to be by inhalation.

6. RISK/HAZARD ASSESSMENT

6.1 Hydrogen Sulfide

Under some meteorological conditions, hydrogen sulfide emissions may not disperse enough to prevent people from sometimes experiencing strong unpleasant odors and potential health effects at times at the residences nearest the landfill. The unpleasant odors are expected to be generated at the landfill. These health effects can include the smell a rotten egg odor, nausea, and headaches but are transient and reversible once exposure to hydrogen sulfide ends. . In addition at concentrations exceeding 50 ppm (70,000 µg/m³), olfactory fatigue prevents detection of hydrogen sulfide odor.[10] The table below identifies the modeled maximum 1-hr and 24-hr concentrations at residences D, E, and F.

	Residence D	Residence E	Residence F
Maximum 1-hr Concentration (µg/m³)	31.4	40.4	37.1
Maximum 24-hr Concentration (µg/m³)	< 1.79	< 1.79	< 1.79

The RBC levels used in Second Tier analysis are based on existing data. An RBC is the airborne chemical concentration at or below which significant health effects are not expected to occur. Ecology HQ evaluated these data and developed the following exposure limits:

RBC (µg/m³)	Hours	Basis
42[11]	1	1-hr Reference exposure level for hydrogen sulfide
2[12]	24	24-hr Reference concentration for hydrogen sulfide

6.1.1 Hazard Quotient

A hazard quotient (HQ) is the ratio of the potential exposure to a substance compared to the exposure level that is considered to be "safe." If the hazard quotient is less than one, then the risk is considered acceptable. In the case of hydrogen sulfide, if the hazard quotient is only slightly less than one or greater than one, then adverse health effects are possible.[13] The more the hazard quotient increases above one, the more likely it is that adverse health effects will occur by some undefined amount (due in part to how the risk-based concentration is derived).

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[10] http://www.oehha.org/air/acute_rels/pdf/7783064A.pdf
[11] http://www.oehha.org/air/acute_rels/allAcRELs.html
[12] http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showQuickView&substance_nmbr=0061
[13] Based on OEHHA. *Determination of Acute Reference Exposure Levels for Airborne Toxicants. Hydrogen Sulfide Acute Toxicity Summary*. March 1999.
http://www.oehha.ca.gov/air/acute_rels/pdf/7783064a.pdf

In the case of hydrogen sulfide, mild health effects are still possible even though the hazard quotient may be one or slightly less than one.[14]

Averaging Time Exposure Duration	Closest Point of Ambient Air (fence line) (μg/m^3)	Highest Concentration (fence line m) (μg/m^3)	Residence (171 m) (μg/m^3)
24-Hr Concentration (μg/m^3)	1.79	1.79	1.79
24-Hr Reference Concentration (μg/m^3)	2	2	2
24-Hr HQ	0.90	0.90	0.90
1-Hr Concentration (μg/m^3)	42.0	42.0	40.4
1-Hr Reference exposure level (μg/m^3)	42.0	42.0	42.0
1-Hr HQ	1	1	0.96

The Health Impacts Assessment does not list the exact concentrations of hydrogen sulfide at residences A, B, C, G, and H. Based upon the gradient maps in the application, the concentrations at those residences are lower than the maximum of 1.79 μg/m^3 and 42 μg/m^3 listed for 24-hr and 1-hr average concentrations, respectively. The risk is, therefore, assumed acceptable.

It is important to note the application indicates maximum hydrogen sulfide emissions will occur in the year 2049. At that time, when extreme meteorological conditions occur, hydrogen sulfide exposure at residences D, E and F will be at levels that cause at least 36 percent of people to be annoyed by the rotten egg odor, nausea, and headaches. Some people may also experience impairments in reaction time, color discrimination, and mood.[15] These effects are short-term and reversible when exposure is stopped.

6.2 Vinyl Chloride

The formula for determining additional cancer risk is as follows: Risk = C_{Air} x URF

Where C_{Air} is Concentration in air at the receptor (μg/m^3).
And, URF is Unit Risk Factor for vinyl chloride (8.8 x10^{-6} (μg/m^3)). This factor comes from the EPA's Technology Transfer Network.[16]

[14] http://www.oehha.ca.gov/air/acute_rels/pdf/7783064A.pdf
[15] 36% of the general human population if exposed at residence D; 42% at residence E; and 41% at residence F (Estimates based on Collins J, Lewis D. *Hydrogen sulfide: Evaluation of current California air quality standards with respect to protection of children*. Prepared for California Air Resources Board, California Office of Environmental Health Hazard Assessment. Sept. 1, 2000 http://www.oehha.ca.gov/air/pdf/oehhah2s.pdf).
[16] http://www.epa.gov/ttn/atw/hlthef/vinylchl.html#ref1

Location	Distance (meters)	C_{Air} (µg/m^3)	URF[17] (µg/m^3)	Risk (µg/m^3)
Point of closest ambient air	Fence Line	0.023	8.8 x10^{-6}	1.94 x 10^{-7}
Point of maximum concentration	Fence Line	0.023	8.8 x10^{-6}	1.94 x 10^{-7}
Point of closest residential receptor	124	0.0044	8.8 x10^{-6}	3.87 x 10^{-8}

For residences D, E, and F, additional cancer risk associated with exposure to vinyl chloride from the landfill will be less than 0.0128-µg/m^3 (the lifetime average exposure level associated with a 1-in-1 million additional cancer risk). For off-site locations, additional cancer risk will be less than 0.128-µg/m3 (the lifetime average exposure level associated with a 1-in-100,000 additional cancer risk).

6.3 Uncertainty Characterization

The data about effects to humans and animals from exposure to hydrogen sulfide is extensive. With that information and the modeled concentrations given to Ecology HQ by the applicant, Ecology HQ has determined that mild health effects are possible and even likely. These health effects are short-term and reversible when exposure is stopped. Ecology HQ considers this risk to be acceptable.

Vinyl chloride is a known human carcinogen. Its toxicity has been characterized by several large occupational epidemiology studies and by numerous animal studies. Therefore, Ecology HQ has determined that vinyl chloride will not harm people exposed at the levels proposed by this project.

Not all of the receptor locations in the neighborhood of the landfill, as identified by SCS, were adequately characterized in terms of modeled concentrations. Characterization of the emissions was scaled off of the submitted modeled contour maps. Therefore, this health risk assessment has been performed using the best information available. The concentrations at all receptor locations will be less that the highest concentration analyzed, which will be experienced at the fence line, and which Ecology HQ has determined are acceptable.

6.4 Length of Exposure

People off-site who approach the landfill's fence line from downwind may occasionally smell a rotten egg odor and experience short-term nausea and headaches from landfill hydrogen sulfide emissions. Some people may also experience impairments in reaction time, color discrimination, and mood. With the possibility increasing each year through 2049, people at residences E, F, and G may occasionally experience these same effects related to hydrogen sulfide exposure. Exposure to vinyl chloride from the landfill is not likely to cause harm to anyone.

[17] Background is 0.451-µg/m^3. Using this background the risk from background alone is 5.9x10^{-6}.

7. CONCLUSION

Hydrogen Sulfide: The highest concentrations and thus the highest likelihood of experiencing effects, is anticipated to occur in 2049. People who approach the landfill's fence line from downwind may occasionally smell a rotten egg odor and experience short-term nausea and headaches from landfill hydrogen sulfide emissions. Some people may also experience impairments in reaction time, color discrimination, and mood. These effects are short-term and reversible by reducing or terminating exposure.

Vinyl Chloride: Exposure to vinyl chloride from the landfill is not likely to cause harm to anyone. The risk of exposure to vinyl chloride is less than one in ten million.

Therefore, this project will not have a significant adverse impact on air quality. The risks from inhalation exposure to hydrogen sulfide and vinyl chloride are within acceptable levels. The Washington State Department of Ecology finds that the applicant, the Greater Wenatchee Regional Landfill, has satisfied all requirements for Second Tier analysis.

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8. LIST OF ABBREVIATIONS

AERMOD	Air dispersion model
AOP	Air Operating Permit as described in Chapter-173-401 WAC
ASIL	Acceptable Source Impact Level
BACT	Best Available Control Technology
C	Celsius
Cair	Concentration in air
CAS	Chemical Abstracts Service
CNS	Central Nervous system
cm	Centimeters
CRO	Washington State Department of Ecology, Central Regional Office
Ecology HQ	Washington State Department of Ecology, Headquarters Office
EPA	United States Environmental Protection Agency
GWRL	Greater Wenatchee Regional Landfill
Hg	Mercury
hr	Hour
HQ	Hazard Quotient
IARC	International Agency for Research on Cancer
IRIS	Integrated Risk Information System
ISC3	Industrial Source Complex 3
m/sec	Meters per Second
mg/kg/d	Milligrams per kilograms per day
mm/Hg	Millimeters of mercury
NATA	National Air Toxics Assessment
ppm	Parts per million
RBC	Risk Based Concentration
RfC	Reference Concentration
RfD	Reference Dose
SQER	Small Quaintly Emission Rate
NOC	Notice of Construction
TAP	Toxic Air Pollutants
T-BACT	Best Available Control Technology for Toxics
ug/m3	Micrograms per Cubic Meter
URF	Unit Risk Factor
WAC	Washington Administrative Code