Appendix D

Updated *Air Quality and Odor Technical Memos*

King County

Technical Memorandum

To:	Phil Coughlan	Date:	January 3, 2022
From:	M. Kirk Dunbar Karam Singh, PE	Project:	King County Cedar Hills Regional Landfill - 2020 SDP and EIS

Subject: Cedar Hills Regional Landfill Air Toxics Impacts - Update

This memorandum has been prepared to document the air toxics impacts associated with the alternatives evaluated in the Cedar Hills Regional Landfill (CHRLF) 2020 Site Development Plan (SDP) and Facilities Relocation Final EIS, and has been organized into these sections:

- Introduction: provides general overview of the methodology adopted for the impacts analysis;
- Emission Estimation Methodology: details the calculation methods used to quantify facility air toxics;
- Air Toxics Evaluation: presents details of the air toxics evaluation, including various parameters and emission calculation refinements used to demonstrate modeled compliance and a discussion about the impact of diesel engine emissions, particulate (DEEP); and
- Conclusions: summarizes the results of the air toxics impact evaluation.

Introduction

The Cedar Hills Regional Landfill (CHRLF) has two potential sources of toxic air pollutants (TAP): landfill gas and leachate. Specifically, the TAP associated with the landfill are released in the form of fugitive (uncollected) landfill gas and emissions from the aeration of the leachate lagoons. The Puget Sound Clean Air Agency (PSCAA) and Washington State Department of Ecology (Ecology) have rules that require the review of TAP from new or modified sources of toxic air pollutants. One aspect of this review is a demonstration that the impacts of any increase in TAP are less than Ecology's Acceptable Source Impact Levels (ASIL) for each TAP.

Air dispersion modeling was used to estimate the impact of increases in the TAP emissions resulting from implementation of various Action Alternatives contained in the Final Environmental Impact Statement (EIS) (including the possible option under Action Alternative 3 to relocate support facilities from CHRLF to a site adjacent to the Renton Recycling and Transfer Station). These TAP impacts have been evaluated to determine any exceedance of the ASIL at or beyond the facility property line.

Emissions Estimation Methodology

This analysis focused on the fugitive landfill gas and leachate compounds that are classified as TAP by Ecology in the Washington Administrative Code (WAC) 173-460-150 (effective as of December 23, 2019). In addition, diesel engine emissions, particulate (DEEP), a TAP that is not a constituent of the landfill gas or leachate, was evaluated.

Landfill Gas

The quantity and components of landfill gas are a function of the quantity, type and age of the waste disposed in the landfill, and the moisture and temperature of the waste in the landfill at a given time. In general, landfill gas is about 50 percent methane and 50 percent carbon dioxide and water vapor, by volume. Landfill gas also contains small amounts of nitrogen, oxygen, hydrogen, non-methane organic compounds (NMOC), and trace amounts of inorganic compounds, some of which have strong, pungent odors. The NMOC include some TAP, which can cause adverse health effects.

For the landfill gas TAP emission calculations, Action Alternative 3 was considered since this alternative represents the largest quantity of additional waste disposed in the landfill. The landfill gas TAP emissions were calculated based on the following input parameters:

- Design Capacity – Filling for the increase in capacity under Action Alternative 3 will begin sometime in 2028 and filling will continue through 2046.
- Methane Generation Rate – 0.057/year. The current calculation methodology of Title 40 Code of Federal Regulations (CFR) Part 98 (Greenhouse Gas Reporting Rule) for landfills specifies the use of this value for landfills with precipitation greater than 40 inches per year (see https://ccdsupport.com/confluence/download/attachments/63996073/Equation%20HH-1%20Calculation%20Spreadsheet.xls?version=2&modificationDate=1490103941000&api=v2, Table HH-1). The annual average precipitation in the CHRLF area (Maple Valley, WA) is above 50 inches based on historical data review.
- Annual Waste Acceptance Rates (short tons per year):
  2028 – 946,609
  2029 – 964,652
  2030 – 981,050
  2031 – 997,728
  2032 – 1,014,691
  2033 – 1,031,940
  2034 – 1,049,483
  2035 – 1,067,324
  2036 – 1,085,469

2037 – 1,103,922
2038 – 1,122,688
2039 – 1,141,774
2040 – 1,161,184
2041 – 1,180,924
2042 – 1,201,000
2043 – 1,221,417
2044 – 1,242,181
2045 – 1,263,298
2046 – 1,284,774

- Potential Methane Generation Capacity – 100 m^3/Mg (AP-42 Inventory Conventional default).
- NMOC Concentration – 4,000 ppm as hexane.
- TAP Concentrations:
  - TAP Contained in the Generated Landfill Gas:
    - Flare Inlet Test Results (obtained from the most recent (January – February 2021) compliance testing performed on the CHRLF flares):
      - For each landfill gas TAP with one or more analytical results above the detection limit, the maximum three run concentration from all detected analytical values.
      - For each landfill gas TAP with all analytical results below the detection limit, one half of the maximum three run non-detect concentration.
    - Default concentrations listed in AP-42 for TAP that were not included in the flare inlet test results that are listed in Fifth Edition AP-42, Table 2.4-1 for landfills with waste in place on or after 1992 (DRAFT, October 2008, the most recently published update).
  - Sulfur Dioxide and Hydrogen Chloride Emissions Generated by Combustion Devices – Maximum three run average flare outlet concentration for each TAP obtained from the most recent (January – February 2021) compliance testing performed on the CHRLF flares.
  - Carbon Monoxide Emissions Generated by CHRLF and BEW Flares – Maximum three run average flare outlet concentration obtained from the most recent (January – February 2021) compliance testing performed on the CHRLF flares.
  - Carbon Monoxide Emissions Generated by BEW Engines – Maximum three run average engine outlet concentration obtained from the most recent (November 2020) compliance testing performed on the BEW engines.
- Landfill Gas Collection Efficiency – 75 percent (AP-42, typical landfill gas collection efficiency).

- TAP Destruction Efficiency:
    - Flares – 97.7% (AP-42, typical)
    - Engines – 97.2% (AP-42, typical)
    - Elemental Mercury – 0% (mercury simply passes through the flare or engine).

The applicable parameters listed above were input to the LandGEM (current version 3.03, June 2, 2020) spreadsheet to calculate the maximum landfill gas generation rate (which is projected to occur in 2047) associated Action Alternative 3. The resulting maximum landfill gas generation rate was used in combination with the concentration, collection and destruction parameters listed above to estimate both fugitive (i.e., uncollected emissions) and flare/engine emissions of each TAP associated with Action Alternative 3.

Leachate Pond Emissions

CHRLF conducts routine sampling of the leachate that is collected and sent to the leachate ponds (influent), as well as the aerated leachate that is pumped to the King County Wastewater Treatment conveyance system (effluent) for treatment and disposal. Leachate samples are analyzed to determine the concentrations of several compounds, a number of which are TAP. The sampling results were reviewed and TAP were identified for further evaluation.

The Action Alternative 3 will yield maximum amounts of additional leachate. The associated increase in leachate TAP emissions (through volatilization from aeration of the leachate ponds) were calculated using estimated peak daily leachate production (for increased leachate quantities) and historic leachate analytical data, as follows:

- For each leachate TAP with one or more analytical results above the detection limit (except ammonia, as discussed below), the maximum leachate pond influent concentration value from all detected analytical values was used to calculate emissions assuming that the concentration of the TAP was not diluted during high rain events and that 100% of the TAP in the leachate is released to the atmosphere. This is a conservative approach to calculating emissions because some portion of a given TAP will remain in the leachate pond effluent.
- For each leachate TAP with all analytical results below the detection limit, one half of the typical reported detection limit for the leachate influent from the most recent two years of data was used to calculate emissions. The methodology conservatively assumes that the concentration of the TAP was not diluted during high rain events and that 100% of the TAP in the leachate is released to the atmosphere.
- The increase in maximum daily leachate flow rate (69,941 gallons) was estimated by multiplying the maximum historic daily leachate production value (3,329,900 gallons, occurring on February 13, 2017) by the percent increase in total landfill size anticipated under Action Alternative 3.

Leachate Ammonia Refined Calculation
Based on a Water Science and Technology study of the fate of ammonia in wastewater ponds (available at https://pubmed.ncbi.nlm.nih.gov/22828301/), approximately 2% of the total ammonia is expected to be released to the air as ammonia from the storage pond. Review of the leachate analytical results indicates that the concentration of ammonia contained in both influent and effluent of the leachate pond is correlated to the leachate flows. The projected peak daily flow rate (3,399,841 gal) was used to calculate the amount of ammonia in the influent. This value, in combination with the increase in peak daily flow and 2% ammonia loss to the air factor, was used to calculate the increase in ammonia emissions from the leachate ponds used in the TAP evaluation.

TAP Evaluation against De Minimis, SQER and ASIL Thresholds

The increases in the landfill gas TAP emissions and the leachate pond emissions were summed to determine the facility-wide increase in TAP emissions associated with Action Alternative 3. These facility wide-increases in TAP emissions were compared to the TAP evaluation criteria contained in the Washington Administrative Code (WAC) 173-460-150 (current version effective December 23, 2019).

De Minimis and SQER Thresholds

As discussed above, the increase in the TAP emissions associated with the implementation of Action Alternative 3 consists of the sum of the fugitive landfill gas emissions, the collected landfill gas that is not destroyed in a flare or engine, and the leachate emissions. The sum of these emissions for each TAP was compared to the applicable WAC 173-460-150 de minimis and small quantity emission rate (SQER) thresholds as summarized in Tables 1 through 3 below. Each TAP with emissions that exceeded both their respective de minimis and SQER thresholds was modeled for comparison to their ASIL, as discussed in subsequent tables.

Table 1. TAP with 1-Hour Averaging Period

TAP	CAS #	Action Alternative 3 Emissions Increase (lb/hr)				173-460 Thresholds			
		Fugitive (not collected)	Combustion Device Exhaust *	Leachate Pond	Facility Total	De Minimis	*De Minimis Exceeded?*	SQER	*SQER Exceeded?*
Isopropyl Alcohol (2-Propanol)	67-63-0	5.45E-02	4.58E-03		5.91E-02	3.0E-01	***NO***		
Carbon Monoxide	630-08-0		4.50E+00		4.50E+00	1.1E+00	***YES***	4.3E+01	***NO***
Sulfur Dioxide	7446-09-5		2.33E+01		2.33E+01	4.6E-01	***YES***	1.2E+00	***YES***

* The collected landfill gas can be combusted in the CHRLF flares, BEW engines and/or BEW flare. The listed value reflects all of the TAP being emitted by the device with the highest emissions.

Table 2. TAP with 24-Hour Averaging Period

TAP	CAS #	Action Alternative 3 Emissions Increase (lb/hr) Fugitive (not collected)	Combustion Device Exhaust *	Leachate Pond	(lb/24-hr) Facility Total	173-460 Thresholds (lb/24-hr) De Minimis	*De Minimis Exceeded?*	SQER	*SQER Exceeded?*
1,1,1-Trichloroethane	71-55-6	1.24E-03	1.04E-04	6.81E-05	3.39E-02	1.9E+01	NO		
1,1-Dichloroethene	75-35-4	9.08E-04	7.63E-05	4.11E-05	2.46E-02	7.4E-01	NO		
1,2,3-Trichloropropane	96-18-4	5.48E-03	4.60E-04	1.22E-05	1.43E-01	1.1E-03	YES	2.2E-02	***YES***
1,2,3-Trimethylbenzene	526-73-8	1.55E-02	1.30E-03		4.04E-01	2.2E-01	YES	4.4E+00	***NO***
1,2,4-Trimethylbenzene	95-63-6	3.95E-02	3.32E-03		1.03E+00	2.2E-01	YES	4.4E+00	***NO***
1,3,5-Trimethylbenzene	108-67-8	1.70E-02	1.43E-03		4.43E-01	2.2E-01	YES	4.4E+00	***NO***
2-Butanone (MEK)	78-93-3	4.15E-01	3.49E-02	7.22E-01	2.81E+01	1.9E+01	YES	3.7E+02	***NO***
2-Hexanone	591-78-6	3.68E-03	3.09E-04	3.50E-03	1.80E-01	1.1E-01	YES	2.2E+00	***NO***
4-Methyl-2-Pentanone	108-10-1	2.19E-02	1.84E-03	6.08E-03	7.16E-01	1.1E+01	NO		
Acetonitrile	75-05-8	3.88E-03	3.26E-04	5.57E-03	2.35E-01	2.2E-01	YES	4.4E+00	***NO***
Acrolein	107-02-8			3.04E-04	7.29E-03	1.3E-03	YES	2.6E-02	***NO***
Ammonia	7664-41-7			4.86E-02	1.17E+00	1.9E+00	NO		
Bromomethane (Methyl Bromide)	74-83-9	8.79E-03	7.39E-04	8.51E-04	2.49E-01	1.9E-02	YES	3.7E-01	***NO***
Carbon Disulfide	75-15-0	6.12E-03	5.14E-04	5.83E-04	1.73E-01	3.0E+00	NO		
Carbonyl Sulfide	463-58-1	5.45E-03	4.58E-04		1.42E-01	3.7E-02	YES	7.4E-01	***NO***
Chlorobenzene	108-90-7	1.04E-03	8.72E-05	6.08E-04	4.16E-02	3.7E+00	NO		
Chlorodifluoromethane (CFC 22)	75-45-6	7.85E-03	6.59E-04		2.04E-01	1.9E+02	NO		
Chloroethane	75-00-3	2.41E-03	2.02E-04	7.78E-04	8.13E-02	1.1E+02	NO		
Chloromethane	74-87-3	4.66E-03	3.91E-04	9.00E-04	1.43E-01	3.3E-01	NO		
Cumene	98-82-8	1.79E-02	1.50E-03		4.65E-01	1.5E+00	NO		
Cyclohexane	110-82-7	6.72E-02	5.64E-03		1.75E+00	2.2E+01	NO		
Dimethyl Mercury	627-44-1	2.35E-07	7.06E-07		2.26E-05	5.2E-04	NO		
Hexane	110-54-3	5.56E-02	4.67E-03		1.45E+00	2.6E+00	NO		
Hydrogen Chloride	7647-01-0		8.32E-01		2.00E+01	3.3E-02	YES	6.7E-01	***YES***
Hydrogen Sulfide	7883-06-4	6.13E-04	1.78E-01		4.30E+00	7.4E-03	YES	1.5E-01	***YES***
Mercury (total)	7439-97-6	5.55E-06	1.67E-05	3.33E-06	6.13E-04	1.1E-04	YES	2.2E-03	***NO***
Methyl Methacrylate	80-62-6			3.18E-04	7.64E-03	2.6E+00	NO		
Propene (Propylene)	115-07-1	5.02E-02	4.22E-03		1.31E+00	1.1E+01	NO		
Styrene	100-42-5	1.21E-02	1.02E-03	9.00E-05	3.17E-01	3.2E+00	NO		
Tetrahydrofuran	109-99-9	6.69E-02	5.62E-03		1.74E+00	7.4E+00	NO		
Toluene	108-88-3	5.39E-01	4.53E-02	5.18E-03	1.42E+01	1.9E+01	NO		
trans-1,2-Dichloroethene	156-60-5	3.62E-03	3.04E-04	6.56E-04	1.10E-01	3.0E+00	NO		
Vinyl Acetate	108-05-4	3.21E-03	2.70E-04	1.22E-05	8.39E-02	7.4E-01	NO		
Xylene (mixture)	1330-20-7	4.87E-01	4.09E-02	1.23E-03	1.27E+01	8.2E-01	YES	1.6E+01	***NO***

* The collected landfill gas can be combusted in the CHRLF flares, BEW engines and/or BEW flare. The listed value reflects all of the TAP being emitted by the device with the highest emissions.

Table 3. TAP with Annual Averaging Period

		Action Alternative 3 Emissions Increase				173-460 Thresholds (lb/yr)			
		(lb/hr)			(lb/yr)				
TAP	CAS #	Fugitive (not collected)	Combustion Device Exhaust *	Leachate Pond [3]	Facility Total	De Minimis	*De Minimis Exceeded?*	SQER	*SQER Exceeded?*
1,1,1,2-Tetrachloroethane	630-20-6	6.35E-03	5.33E-04	3.04E-05	6.05E+01	1.1E+00	YES	2.2E+01	***YES***
1,1,2,2-Tetrachloroethane	79-34-5	1.57E-03	1.32E-04	1.22E-05	1.50E+01	1.4E-01	YES	2.8E+00	***YES***
1,1,2-Trichloroethane (vinyl trichloride)	79-00-5	1.24E-03	1.04E-04	1.22E-05	1.19E+01	5.1E-01	YES	1.0E+01	***YES***
1,1-Dichloroethane	75-34-3	3.61E-03	3.03E-04	6.56E-04	4.00E+01	5.1E+00	YES	1.0E+02	***NO***
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8	8.79E-03	7.39E-04	3.04E-04	8.62E+01	2.6E-03	YES	5.2E-02	***YES***
1,2-Dibromoethane	106-93-4	1.76E-03	1.48E-04	1.22E-05	1.68E+01	1.4E-02	YES	2.7E-01	***YES***
1,2-Dichloroethane	107-06-2	1.24E-02	1.04E-03	4.96E-04	1.22E+02	3.1E-01	YES	6.2E+00	***YES***
1,2-Dichloropropane	78-87-5	2.74E-03	2.30E-04	1.22E-05	2.61E+01	8.1E-01	YES	1.6E+01	***YES***
1,3-Butadiene	106-99-0	9.86E-04	8.28E-05		9.36E+00	2.7E-01	YES	5.4E+00	***YES***
1,3-Dichloropropene (trans-1,3-Dichloropropene)	542-75-6	1.04E-03	8.72E-05		9.86E+00	2.0E+00	YES	4.1E+01	***NO***
1,4-Dichlorobenzene	106-46-7	6.81E-03	5.72E-04	5.59E-04	6.95E+01	7.4E-01	YES	1.5E+01	***YES***
1,4-Dioxane	123-91-1	3.29E-03	2.76E-04		3.12E+01	1.6E+00	YES	3.2E+01	***NO***
Acetaldehyde	75-07-0	1.17E-04	9.85E-06		1.11E+00	3.0E+00	NO		
Acrylonitrile	107-13-1	1.98E-30	1.66E-04	4.98E-05	1.92E+01	2.8E-02	YES	5.6E-01	***YES***
Aldrin	309-00-2			3.04E-07	2.66E-03	1.7E-03	YES	3.3E-02	***NO***
Allyl Chloride (3-Chloropropene)	107-05-1	2.87E-03	2.41E-04	6.81E-04	3.32E+01	1.4E+00	YES	2.7E+01	***YES***
alpha-Hexachlorocyclohexane	319-84-6			3.04E-07	2.66E-03	1.1E-02	NO		
Benzene	71-43-2	5.02E-02	4.21E-03	6.08E-04	4.82E+02	1.0E+00	YES	2.1E+01	***YES***
Benzyl chloride (alpha-Chlorotoluene)	100-44-7	1.18E-03	9.92E-05		1.12E+01	1.7E-01	YES	3.3E+00	***YES***
beta-Hexachlorocyclohexane	319-85-7			8.51E-06	7.45E-02	1.9E-02	YES	3.8E-01	***NO***
Bromodichloromethane	75-27-4	1.53E-03	1.28E-04	3.04E-05	1.48E+01	2.2E-01	YES	4.4E+00	***YES***
Bromoform	75-25-2	2.37E-03	1.99E-04	6.08E-05	2.30E+01	7.4E+00	YES	1.5E+02	***NO***
Carbon Tetrachloride	56-23-5	1.43E-03	1.20E-04	3.04E-05	1.38E+01	1.4E+00	YES	2.7E+01	***NO***
Chlordane	57-74-9			3.04E-07	2.66E-03	8.1E-02	NO		
Chloroform	67-66-3	1.11E-03	9.34E-05	6.08E-04	1.59E+01	3.5E-01	YES	7.1E+00	***YES***
Chloroprene	126-99-8	3.29E-03	2.76E-04	1.22E-05	3.13E+01	1.6E-02	YES	3.3E-01	***YES***
DDD (dichlorodiphenyldichloroethane) [4,4'-DDD]	72-54-8			3.04E-07	2.66E-03	1.2E-01	NO		
DDE (dichlorodiphenyldichloroethylene) [4,4'-DDE]	72-55-9			3.04E-07	2.66E-03	8.4E-02	NO		
DDT(dichlorodiphenyltrichloroethane) [4,4'-DDT]	50-29-3			3.04E-07	2.66E-03	8.4E-02	NO		
Dichloromethane (Methylene Chloride)	75-09-2	2.34E-02	1.96E-03	3.23E-03	2.50E+02	4.9E+02	NO		
Dieldrin	60-57-1			3.04E-07	2.66E-03	1.8E-03	YES	3.5E-02	***NO***
Ethylbenzene	100-41-4	1.99E-01	1.67E-02	9.12E-04	1.90E+03	3.2E+00	YES	6.5E+01	***YES***
Formaldehyde	50-00-0	1.26E-03	1.06E-04		1.20E+01	1.4E+00	YES	2.7E+01	***NO***
gamma-Hexachlorocyclohexane (lindane)	58-89-9			9.02E-06	7.90E-02	2.6E-02	YES	5.2E-01	***NO***
Heptachlor	76-44-8			3.04E-07	2.66E-03	6.2E-03	NO		
Heptachlor Epoxide	1024-57-3			6.90E-07	6.05E-03	3.1E-03	YES	6.2E-02	***NO***
Hexachlorobutadiene	87-68-3	9.81E-03	8.24E-04		9.31E+01	3.7E-01	YES	7.4E+00	***YES***
Hexachloroethane	67-72-1	8.79E-03	7.39E-04		8.35E+01	7.4E-01	YES	1.5E+01	***YES***
Methyl tert-butyl ether	1634-04-4	3.29E-03	2.76E-04		3.12E+01	3.1E+01	YES	6.2E+02	***NO***
Naphthalene	91-20-3	4.84E-03	4.07E-04		4.60E+01	2.4E-01	YES	4.8E+00	***YES***

TAP	CAS #	Action Alternative 3 Emissions Increase (lb/hr) Fugitive (not collected)	Combustion Device Exhaust *	Leachate Pond 3	(lb/yr) Facility Total	173-460 Thresholds (lb/yr) De Minimis	*De Minimis Exceeded?*	SQER	*SQER Exceeded?*
Tetrachloroethene	127-18-4	1.87E-02	1.57E-03	5.11E-04	1.82E+02	1.3E+00	YES	2.7E+01	***YES***
Toxaphene	8001-35-2			3.04E-05	2.66E-01	2.4E-02	YES	4.8E-01	***NO***
Trichloroethene	79-01-6	3.40E-02	2.86E-03	5.59E-04	3.28E+02	1.7E+00	YES	3.4E+01	***YES***
Vinyl Chloride	75-01-4	1.10E-02	9.21E-04	6.03E-04	1.09E+02	9.2E-01	YES	1.8E+01	***YES***

* The collected landfill gas can be combusted in the CHRLF flares, BEW engines and/or BEW flare. The listed value reflects all of the TAP being emitted by the device with the highest emissions.

ASIL Dispersion Modeling

Model Selection, Options, and Assumptions

The current version of the EPA-approved AERMOD dispersion model (version 21112) was used to estimate pollutant concentrations. The model utilized the regulatory default options recommended in the current version of EPA's "Guideline on Air Quality Models" (40 CFR 51, Appendix W, effective February 16, 2017) and the following methodology:

- Rural dispersion coefficients were used because the land use zoning of the three kilometer (about 1.9 mile) radius around the facility is greater than 50 percent rural (i.e., non-urban) based on the Auer land-use classifications.
- Locations of all buildings and emission sources were determined using a combination of facility design information and Google Earth.
- A building downwash analysis using the current BPIPPRIME (version 04274) was conducted and incorporated into the modeling analysis to account for potential plume downwash due to facility structures.
- The source and receptor coordinates used in this analysis are based on the NAD83 Universal Transverse Mercator (UTM) Zone 10 coordinate system.

AERMOD is capable of producing concentration predictions for various averaging times. Separate model runs were set up and executed for the 1-hour, 24-hour, and annual averaging periods. The resulting modeled impacts were compared to Ecology's current ASIL in WAC 173-460-150.

Meteorological Data

The meteorological data used for this analysis consisted of the most recent currently available five years, 2016-2020, of surface (including 1-minute data) and upper air meteorological data. The meteorological data stations were chosen because they were the closest to the project location and best represented site characteristics.

The surface data was downloaded from the National Centers for Environmental Information's (NCEI) Integrated Surface Hourly Database (ISD) archived data database for the Renton airport station (Station No. 727934-94248). The surface data are in ISHD format and are reported in Local Standard Time (LST). The location and elevation were extracted from the ISHD file (47.493N, 122.21W, 9 m). The upper air meteorological data were obtained for the Quillayute State Airport station from the National Oceanic and Atmospheric Administration's (NOAA) Earth System Research Laboratory (ESRL) Radiosonde Database (Station No. 94240-72797). The upper air data were in FSL format and have an 8-hour time adjustment applied to correct the data from Coordinated Universal Time (UTC) to Pacific Time. The location was extracted from the FSL file (47.95N, 124.55W). Lastly, monthly 1-minute Automated Surface Observing Systems (ASOS) wind data were obtained from the National Climactic Data Center (NCDC) for the Renton surface station.

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- Surface station location (47.493N, 122.214W, NAD83)
- Default seasons of Winter (12, 1, 2), Spring (3, 4, 5), Summer (6, 7, 8), and Autumn (9, 10, 11).
- No continuous snow cover
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This meteorological data was processed using the current AERMET (version 21112) and AERMINUTE (version 15272) software using a 0.5 m/s threshold wind speed to address missing and calm conditions. The profile base elevation of 9 meters was used, which is the same elevation as the surface meteorological data weather station.

Onsite Data Comparison

Surface wind speed and direction data are collected from a meteorological observation tower located at the landfill. Measurements are recorded in five-minute intervals indicating wind speed and direction over that time step (Figure 1). A gap in available data of roughly six months was found between July 2017 and February 2018, and therefore those observations are not included in this presentation of data. When compared with airport observations from Renton Municipal Airport (KRNT), the predominate wind flow from the southeast matches over the 2016-2020 analysis period. Winds at KRNT are shown after processing by AERMET, as described above (Figure 2).

One key difference between the datasets is the alignment of the secondary wind pattern. In the onsite observations, a secondary wind pattern with northeasterly flow appears (less than 15% of observations), whereas the secondary wind pattern from Renton was from the northwest (roughly 20% of observations). The terrain features between the two sites, including the landfill elevation itself, are likely the contributing factor between this secondary wind shift. Overall, the maximum and average wind speeds between the two sites are consistent. Therefore, Renton is a suitable analog for meteorology at the facility for use within AERMOD.

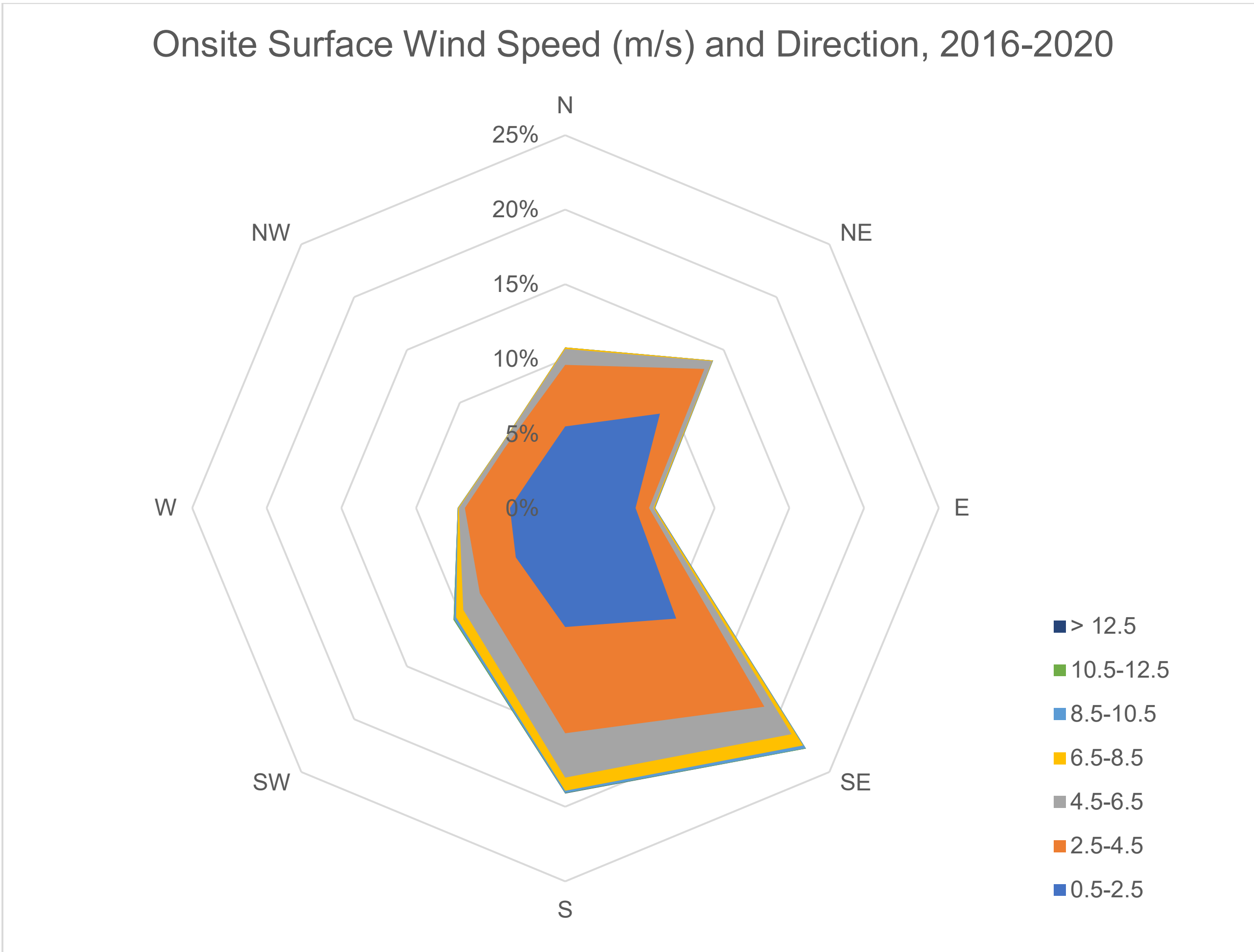

Figure 1. Onsite Surface Wind Speed (m/s) and Direction, 2016-2020

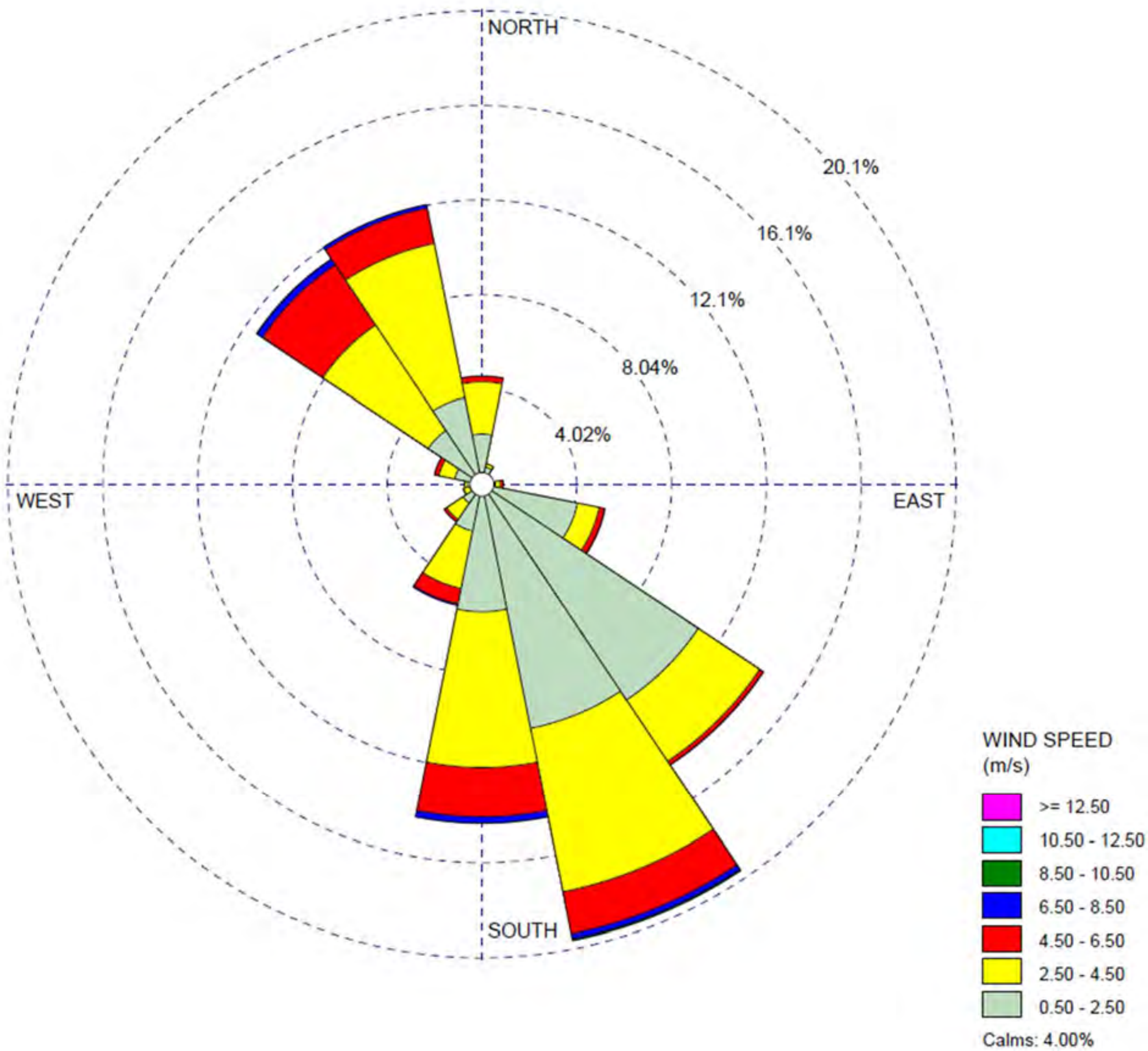

Figure 2. Surface Weather Observations from Renton Municipal Airport, 2016-2020

Receptors

Model receptors were placed at 50-meter intervals along the landfill's property boundary. From the property boundaries, a network of rectangular receptor grids of decreasing densities was placed: 100-meter spacing out to 2 kilometers (about 1.2 miles); then 250-meter spacing out to 5 kilometers (about 3.1 miles); and finally, 500-meter spacing out to 8 kilometers (about 5 miles). Receptor elevation information was generated using the current AERMAP processor (18081) and 1/3 arc second National Elevation Dataset (NED) data obtained for the area (from https://landfire.gov/) covered by the receptor grids.

Sources

As discussed previously, all sources that could emit TAP generated by implementation of Action Alternative 3 were modeled. This includes both the fugitive (i.e., uncollected) and the non-destructed portion of the collected landfill gas that passes through the flares, as well as the aerated leachate ponds. To be conservative, 100% of the collected landfill gas was modeled as being simultaneously routed to each of these on-site control devices: CHRLF flare, Bio Energy Washington (BEW) flare, and BEW reciprocating engine. Although such simultaneous routing is not physically possible (as landfill gas quantity is limited), this conservative approach was adopted to reflect the fact that there are no permit limitations on how much gas can be routed to each control device.

Fugitive TAP emissions were modeled as an AREAPOLY source (with a surface area of 1,473,348 m^2), covering the area of the existing landfill plus a small additional area that is part of Action Alternative 3. This source was modeled with a base elevation of 788 ft, which is the minimum height of the Action Alternative 3 design final surface, and a release height of zero feet (i.e., surface level emissions).

CHRLF operates two leachate ponds located adjacent to one another. The two ponds were modeled as adjacent AREA sources, named “LPWEST” and “LPEAST” in the AERMOD input files, each assumed to emit 50% of the total leachate-generated TAP emissions. Each leachate pond was modeled with a base elevation of 512 ft, which is the normal lagoon operating surface level. The release height of each pond was modeled as 1 meter to reflect the difference between the normal surface elevation the height of the berm surrounding the ponds. The methodology contained in the AERMOD user guide and the 1 meter difference between the normal surface elevation and the berm elevation were used to calculate the initial vertical sigma-z value.

The CHRLF flare, BEW flare, and BEW engine (named “CHFLARE”, BEWFLARE”, and “BEWENG”, respectively, in the AERMOD input files) were each modeled as a POINT source. The base elevation of each was determined using AERMAP. The TAP emission rates for each correspond to the “Combustion Device Exhaust” values in the TAP evaluation spreadsheet. The other parameters for the CHRLF flare were obtained from test reports, while those parameters for the BEW engine and flare were obtained for BEW’s NOC application.

ASIL MODELING ANALYSIS RESULTS

The emission rates modeled for each source, along with the maximum concentrations predicted by AERMOD, for each TAP at or beyond the property boundaries are shown in Table 4 for the averaging period that corresponds to the applicable ASIL. As shown, the majority of TAP have modeled impacts that are below the ASIL.

Table 4. Modeling Results for TAPs and ASIL Comparison

			Action Alternative 3 Emissions Increase (g/s)									
			Fugitive Landfill Gas Emissions	Combustion Device Exhaust			Leachate Pond Emissions					
				CHRLF Flare	BEW Flare	BEW Engine						
		Model	AERMOD ID						Modeled Facility Impact	173-460 ASIL		
TAP	CAS #	ID	EXPAND	CHFLARE	BEWENG	BEWFLARE	LPWEST	LPEAST	($\mu g/m^3$)	Period	($\mu g/m^3$)	*Exceeded?*
Sulfur dioxide	7783-06-4	A		2.93E+00	2.93E+00	2.93E+00			1.51E+02	1 Hour	6.6E+0	***NO***
1,2,3-Trichloropropane	96-18-4	B	6.90E-04	4.76E-05	5.80E-05	4.76E-05	7.66E-07	7.66E-07	1.17E-02	24 Hour	3.0E-01	***NO***
Hydrogen Chloride	7647-01-0	C		1.05E-01	1.05E-01	1.05E-01			1.20E+00	24 Hour	9.0E+0	***NO***
Hydrogen Sulfide	7783-06-4	D	7.72E-05	1.85E-02	2.25E-02	1.85E-02			2.13E-01	24 Hour	2.0E+0	***NO***
1,1,1,2-Tetrachloroethane	630-20-6	E	7.99E-04	5.52E-05	6.72E-05	5.52E-05	1.91E-06	1.91E-06	2.47E-03	Annual	1.4E-01	***NO***
1,1,2,2-Tetrachloroethane	79-34-5	F	1.98E-04	1.37E-05	1.66E-05	1.37E-05	7.66E-07	7.66E-07	6.10E-04	Annual	1.7E-02	***NO***
1,1,2-Trichloroethane (vinyl trichloride)	79-00-5	G	1.56E-04	1.08E-05	1.31E-05	1.08E-05	7.66E-07	7.66E-07	4.80E-04	Annual	6.3E-02	***NO***
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8	H	1.11E-03	7.64E-05	9.31E-05	7.64E-05	1.91E-05	1.91E-05	3.44E-03	Annual	3.2E-04	***YES***
1,2-Dibromoethane	106-93-4	I	2.22E-04	1.53E-05	1.86E-05	1.53E-05	7.66E-07	7.66E-07	6.90E-04	Annual	1.7E-03	***NO***
1,2-Dichloroethane	107-06-2	J	1.56E-03	1.08E-04	1.31E-04	1.08E-04	3.12E-05	3.12E-05	4.86E-03	Annual	3.8E-02	***NO***
1,2-Dichloropropane	78-87-5	K	3.46E-04	2.38E-05	2.90E-05	2.38E-05	7.66E-07	7.66E-07	1.07E-03	Annual	1.0E-01	***NO***
1,3-Butadiene	106-99-0	L	1.24E-04	8.57E-06	1.04E-05	8.57E-06			3.80E-04	Annual	3.3E-02	***NO***
1,4-Dichlorobenzene	106-46-7	M	8.58E-04	5.92E-05	7.21E-05	5.92E-05	3.52E-05	3.52E-05	2.69E-03	Annual	9.1E-02	***NO***
Acrylonitrile	107-13-1	N	2.49E-04	1.72E-05	2.09E-05	1.72E-05	3.14E-06	3.14E-06	7.70E-04	Annual	3.4E-03	***NO***
Allyl chloride (3-Chloropropene)	107-05-1	O	3.61E-04	2.49E-05	3.04E-05	2.49E-05	4.29E-05	4.29E-05	2.87E-03	Annual	1.7E-01	***NO***
Benzene	71-43-2	P	6.32E-03	4.36E-04	5.31E-04	4.36E-04	3.83E-05	3.83E-05	1.96E-02	Annual	1.3E-01	***NO***
Benzyl chloride (alpha-Chlorotoluene)	100-44-7	Q	1.49E-04	1.03E-05	1.25E-05	1.03E-05			4.60E-04	Annual	2.0E-02	***NO***
Bromodichloromethane	75-27-4	R	1.92E-04	1.33E-05	1.62E-05	1.33E-05	1.91E-06	1.91E-06	6.00E-04	Annual	2.7E-02	***NO***
Chloroform	67-66-3	S	1.40E-04	9.66E-06	1.18E-05	9.66E-06	3.83E-05	3.83E-05	2.50E-03	Annual	4.3E-02	***NO***
Chloroprene	126-99-8	T	4.14E-04	2.86E-05	3.48E-05	2.86E-05	7.66E-07	7.66E-07	1.28E-03	Annual	2.0E-03	***NO***
Ethylbenzene	100-41-4	U	2.51E-02	1.73E-03	2.11E-03	1.73E-03	5.74E-05	5.74E-05	7.74E-02	Annual	4.0E-01	***NO***
Hexachlorobutadiene	87-68-3	V	1.24E-03	8.52E-05	1.04E-04	8.52E-05			3.81E-03	Annual	4.5E-02	***NO***
Hexachloroethane	67-72-1	W	1.11E-03	7.64E-05	9.31E-05	7.64E-05			3.42E-03	Annual	9.1E-02	***NO***
Naphthalene	91-20-3	X	6.10E-04	4.21E-05	5.13E-05	4.21E-05			1.88E-03	Annual	2.9E-02	***NO***
Tetrachloroethene	127-18-4	Y	2.36E-03	1.63E-04	1.98E-04	1.63E-04	3.22E-05	3.22E-05	7.32E-03	Annual	1.6E-01	***NO***
Trichloroethene	79-01-6	Z	4.29E-03	2.96E-04	3.60E-04	2.96E-04	3.52E-05	3.52E-05	1.33E-02	Annual	2.1E-01	***NO***
Vinyl Chloride	75-01-4	AA	1.38E-03	9.53E-05	1.16E-04	9.53E-05	3.80E-05	3.80E-05	4.31E-03	Annual	1.1E-01	***NO***

The modeling results summarized in Table 4 indicate that all compounds, with the exception of 1,2-Dibromo-3-chloropropane (DBCP) are predicted to have an impact below their respective ASIL. Review of the information used to estimate emissions of DBCP indicates that each analytical result was below the detection limit used (in the raw landfill gas, the flare outlet, and the leachate). As such, the compound may or may not be present at measurable levels.

To address comments to the Draft EIS, a comprehensive health risk assessment is being conducted. The methodology and results of this analysis as they pertain to health risks are presented in a separate document.

DIESEL ENGINE EXHAUST, PARTICULATE (DEEP)

Another TAP associated with landfill operations is DEEP, which is emitted by the diesel-powered KCSWD waste transfer trucks, commercial direct haul trucks, and landfill equipment such as dozers and compactors.

CHRLF

DEEP emissions for both the No Action Alternative and Action Alternative 3 were developed using EPA's MOVES model and the following parameters and assumptions:

- Fleet mix: National default
- Truck type: Combination short haul trucks
- Road Speeds:
    - Cedar Grove Road – 40 mph
    - 228th Avenue SE – 30 mph
    - CHRLF Roads – 15 mph
- No Action Year of Analysis– 2028
- Action Alternative 3 Year of Analysis – 2046
- Brake wear and tire wear emissions not included
- Road type: Rural
- Values were calculated for January and July (winter and summer) and the average of the two months was used in the analysis

Tables 7 through 9 show the calculated DEEP emissions per 100 feet of road traveled. As shown in the tables, DEEP emissions (and associated air quality impacts) will decrease under the Action Alternative 3 scenario. This reduction will occur because equipment in the existing truck fleet will be replaced with newer, lower emitting equipment each year into the future. The same trend is expected for the other diesel-powered equipment operated at the landfill. Based on these results, implementation of Action Alternative 3 will not cause an increase in DEEP emissions; therefore, no further analysis is required.

Relocation of Support Facilities to Renton Facility

The potential relocation of landfill support facilities to a site adjacent to the Renton Recycling and Transfer Station (RRTS) will impact the flow and levels of traffic flow at both CHRLF and RRTS. At CHRLF, the potential relocation will not impact overall waste delivery truck traffic levels or traffic flow. The area surrounding RRTS will experience an increased level of empty waste delivery trucks traveling on public roads.

Dispersion modeling of road sources of emissions are typically performed by assigning the emissions associated with 100 ft of road to a volume source. Using this approach, an anticipated 149 trucks per day associated with this option, the DEEP emission factor for Table 7 and 260 days per year of operation, the estimated DEEP emissions are 4.5E-02 lb/yr for each volume source. This value is less than Ecology's SQER of 5.4E-01 lb/yr for DEEP. Therefore, no further analysis is required.

Table 7. DEEP Emissions Comparison for Truck Operations on Cedar Grove Road.

Scenario	Vehicle [1]	Trips Per Day [2]	DEEP Emission Factor (g/mile) [3]	Distance Traveled (100' VMT)	DEEP Emissions (lb/day per 100')
No Action	KCSWD Trucks	324	0.045	0.019	0.0007
	Commercial Haul	30			
Action Alternative 3	KCSWD Trucks	430	0.028	0.019	0.0006
	Commercial Haul	42			

1 The KCSWD truck numbers include waste transfer trucks and soil import and export trucks.
2 Obtained from April 16, 2020 Transpo Group memorandum, corresponding to the maximum traffic levels associated with each scenario.

Table 8. DEEP Emissions Comparison for Truck Operations on 228th Ave SE.

Scenario	Vehicle [1]	Trips Per Day [2]	DEEP Emission Factor (g/mile) [3]	Distance Traveled (100' VMT)	DEEP Emissions (lb/day per 100')
No Action	KCSWD Trucks	324	0.063	0.019	0.0009
	Commercial Haul	30			
Action Alternative 3	KCSWD Trucks	430	0.040	0.019	0.0008
	Commercial Haul	42			

1 The KCSWD truck numbers include waste transfer trucks and soil import and export trucks.
2 Obtained from April 16, 2020 Transpo Group memorandum, corresponding to the maximum traffic levels associated with each scenario.

Table 9. DEEP Emissions Comparison for Truck Operations on CHRLF Site.

Scenario	Vehicle [1]	Trips Per Day [2]	DEEP Emission Factor (g/mile) [3]	Distance Traveled (100' VMT)	DEEP Emissions (lb/day per 100')
No Action	KCSWD Trucks	324	0.082	0.019	0.0012
	Commercial Haul	30			
Action Alternative 3	KCSWD Trucks	430	0.050	0.019	0.0010
	Commercial Haul	42			

1 The KCSWD truck numbers include waste transfer trucks and soil import and export trucks.
2 Obtained from April 16, 2020 Transpo Group memorandum, corresponding to the maximum traffic levels associated with each scenario.

Conclusions

Based on the analysis described in this memo, implementation of any of the Action Alternatives proposed in the CHRLF 2020 Site Development Plan is not expected to cause any TAP (with the possible exception of DPCP for which all analytical results are below detection limits used), including DEEP at both CHRLF and RRTS, to exceed the ASIL at or beyond the facility's property line.

Technical Memorandum

To:	Phil Coughlan	Date:	January 3, 2022
From:	M. Kirk Dunbar Karam Singh, PE	Project:	King County Cedar Hills Regional Landfill 2020 SDP and EIS, 2021 Update
Subject:	Fugitive Dust Air Quality Impacts		

This memorandum has been prepared to document the fugitive dust impacts associated with the Cedar Hills Regional Landfill (CHRLF) 2020 Site Development Plan (SDP), and has been organized into these sections:

- Introduction: this section provides general overview of the methodology adopted for the impacts analysis;
- Emission Estimation Methodology: this section details the calculation methods used to quantify facility fugitive dust emissions;
- Fugitive Dust Evaluation: this section dives into details of the fugitive dust evaluation, including various parameters used to demonstrate modeled compliance; and
- Conclusions: this section summarizes the results of the fugitive dust impact evaluation.

Introduction

HDR reviewed various alternatives identified in the Draft EIS and identified Action Alternative 3 and five days per week operation for the fugitive dust air quality analysis since this alternative represents the largest quantity of additional waste disposed in the landfill and associated additional vehicular movement. The memo describes the potential impacts on the surrounding community from worst case fugitive dust scenarios under the Action Alternative 3 with five days per week operation (including the possible option under Action Alternative 3 to relocate support facilities from CHRLF to a site adjacent to the Renton Recycling and Transfer Station (RRTS) in comparison to the impacts associated with the No Action Alternative with seven days per week operation. The Alternatives are described in detail in the Draft EIS.

A number of operations associated with the CHRLF generate fugitive dust. The ambient air impacts of this fugitive dust were determined using U.S. Environmental Protection Agency (EPA) calculation methods and approved air dispersion models and modeling guidelines.

Emissions Estimation Methodology

Truck and Other Traffic on Public Roads

In August 2021, staff from Transpo Group provided an updated technical memorandum (see Transportation Discipline Report – Appendix L to the Final EIS) that estimated traffic volumes on public roads near CHRLF for both the No Action, Action Alternatives 1 through 3, seven days per week operation, five days per week operation and the RRTS relocation option). This information was used to model particulate matter emissions.

Emission factors for PM_{10} and $PM_{2.5}$ were developed using the methodology from EPA's Fifth Edition AP-42, Section 13.2.1. PM_{10} is defined as particulate matter (both solid particles and liquid droplets) that have an aerodynamic diameter of less than 10 micrometers, and $PM_{2.5}$ is defined as particulate matter with an aerodynamic diameter of less than 2.5 micrometers. The range of particles with diameters larger than 2.5 micrometers and smaller than 10 micrometers are commonly referred to as "inhalable coarse particles". $PM_{2.5}$ is commonly referred to as "fine particles."

The traffic volumes in the Transportation Discipline Report were used to determine the paved road silt loading value used for each segment of public roadways:

- Cedar Grove Road SE between SR 169 and 228th Ave SE; and
- 228th Ave SE between Cedar Grove Road SE and the CHRLF entrance gate.

The emission factors were used in combination with the Transportation Discipline Report traffic estimates to calculate particulate matter emissions for these paved public roads. The traffic on public road emission calculations were based on trucks operating 15 hours per day. The traffic on public roads emission calculations are presented in Attachment 1.

Landfill Fugitive Dust Sources

The modeling included fugitive dust generated by haul-truck traffic on public roads leading to the landfill, on-site truck traffic on paved and unpaved roads, and daily cover operations (including dozers and scrapers). The emission calculations for these operations are presented in Attachment 2.

For paved roads the primary difference between the calculation methodologies for truck traffic on-site versus truck traffic on public roads is the silt loading that was applied. A silt loading value of 0.2, which corresponds to the baseline silt loading value for public roads with an average daily traffic (ADT) of 500-5000 published in AP-42, was used for the public roads truck traffic emission calculations. A silt loading value of 1.1 g/m^2, which corresponds to the lowest value of the range of landfill road silt loadings published in AP-42, was used for the on-site truck traffic emission calculations. This value was used because King County routinely sweeps the facility's paved roads.

Fugitive Dust Evaluation

ASIL Dispersion Modeling

Model Selection, Options, and Assumptions

The current version of the EPA-approved AERMOD dispersion model (version 21112) was used to estimate pollutant concentrations. The model was run with the regulatory default options as recommended in the current version of EPA's "Guideline on Air Quality Models" (40 CFR 51, Appendix W, January 17, 2017) and the following methodology:

- Rural dispersion coefficients were used because the land use within the area circumscribed by an approximately 2 mile radius around the facility is greater than 50 percent rural (i.e., non-urban) based on the Auer land-use classifications.

- Locations of the roads and other fugitive dust emission sources were determined using a combination of facility design information and Google Earth.
- The source and receptor coordinates used in this analysis are based on the NAD83 Universal Transverse Mercator (UTM) Zone 10 coordinate system.

The truck traffic (both on-site and public roads) data was inputted to AERMOD as volume sources that were placed along the roads. The other on-site sources of fugitive dust (dozers and compactors operating at the active face) were inputted to the model as area sources, located in the general location in which they occur.

The volume source parameters were determined using EPA guidance for haul roads (EPA Memorandum dated March 2, 2012). The guidance specifies that plume height is calculated by multiplying the average vehicle height by 1.7 to account for vehicle induced turbulence. Using an average heavy-duty vehicle height of 4 meters, the plume height would be 6.8 meters. The plume height value is used to calculate the following volume source parameters:

- Initial Vertical Dimension, S_{zinit}: Plume height is divided by 2.15 (= 3.16 meter); and
- Source Release Height, Relhgt: Plume height is divided by 2 (= 3.4 meter).

The width of the plume was determined as the width of each road segment plus 6 meters. This value was then divided by 2.15 to calculate the Initial Horizontal Dimension (S_{yinit}) for each road segment.

Receptor Locations

Receptors were placed along the CHRLF's property line and at nearby residences. The highest modeled concentration (in the form of the standard) at any receptor for a given averaging period was added to background concentrations to estimate facility impacts for comparison to the applicable ambient air quality standards.

Meteorological Data

The meteorological data used for this analysis consisted of the most recent currently available five years, 2016-2020, of surface (including 1-minute data) and upper air meteorological data. The meteorological data stations were chosen because they were the closest to the project location and best represented site characteristics.

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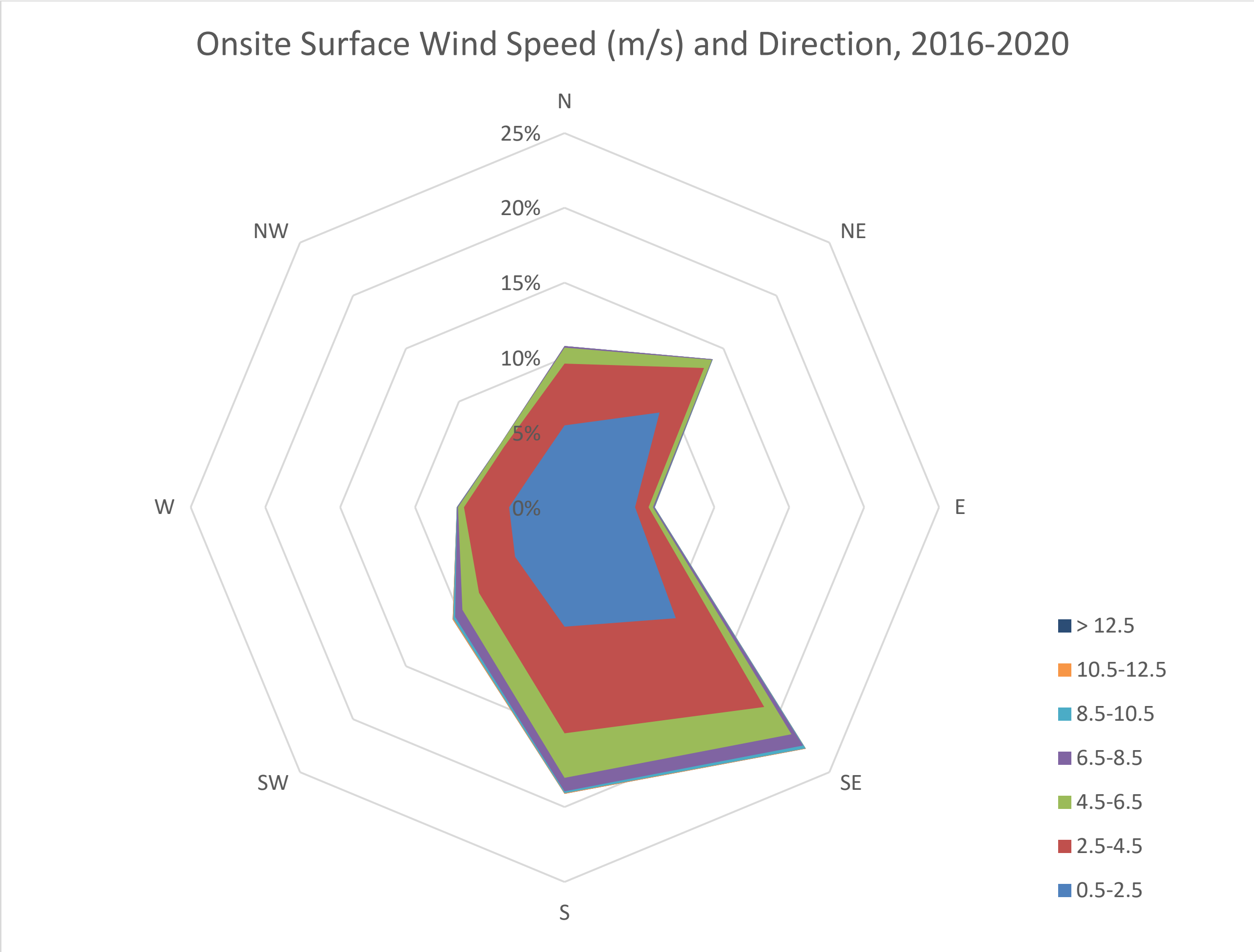


Figure 1. Onsite Surface Wind Speed (m/s) and Direction, 2016-2020

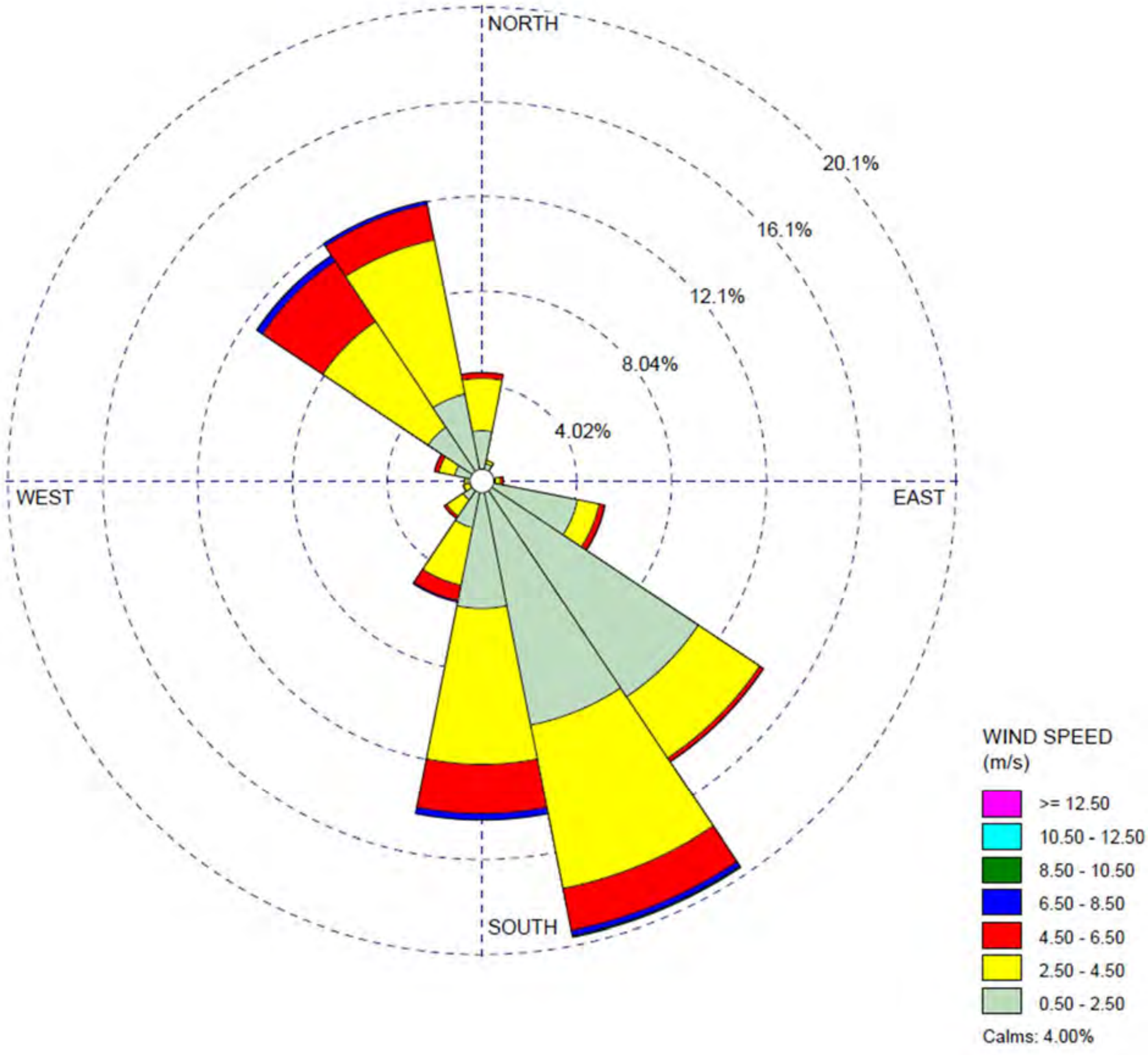


Figure 2. Surface Weather Observations from Renton Municipal Airport, 2016-2020

Key Assumptions

Several other assumptions and parameters were included in the dispersion modeling, including the following:

- The fugitive dust modeling was based on traffic and landfill sources operating between the hours of 5:00 AM and 9:00 PM.
- Although the five days per week operation traffic volumes were used to calculate emissions, the fugitive dust modeling was performed for the facility operating at those rates 7 days per week, 365 days per year. This conservative approach ensures that no potentially adverse meteorological condition is omitted from the analysis because it occurred on a weekend day.

- There are a number of other sources of fugitive dust at the facility such as wind erosion from exposed surfaces, miscellaneous vehicular traffic, etc. As with the analyses performed for past EIS evaluations, these sources were not included in the present inventory because they are expected to be of less magnitude than the major sources discussed above. On occasion, wind erosion may be a larger source, typically during high wind events, when the action of the wind on exposed surfaces is more pronounced. However, peak modeled particulate concentrations typically occur during low wind events, when atmospheric dilution is poorest and wind erosion emissions are minimal. Thus, even though high wind events cause more movement of particulate matter, they are not the peak periods of concern for purposes of modeling facility impacts.
- Local traffic on the public roads during the time period of 9:00 PM to 5:00 AM was not included in the model. Any impacts from this type of activity are included in the background concentration added to the model results to estimate total ambient air impacts.
- A background concentration of 38 μg/m^3 for PM_{10} was calculated based on monitoring data obtained from EPA's AIRSDATA, corresponding to the most recent three calendar years of available data (2018-2020) for a monitor located at 4103 Beacon Hill S in Seattle, Washington. The use of a monitor located in an urban area of King County is expected to yield conservatively high background concentration values for PM_{10}. The 24-hour background PM_{10} is the fourth highest concentration that was measured over the three years.
- Background concentrations of $PM_{2.5}$ were obtained from EPA (https://www.epa.gov/air-trends/air-quality-design-values), corresponding to the most recent design value (2019) for a monitor located at 4103 Beacon Hill S in Seattle, Washington that was determined to be representative of normal maximum ambient concentrations. The design value for 2020 was deemed to be non-representative because of an exceptional event occurring in September 2020. This event consisted of a massive smoke plume from regional wildfires that persisted in the Seattle area from September 11 through September 17 (Washington Smoke Information: September 2020 (wasmoke.blogspot.com)). Use of the design value for 2019 is considered conservatively high because the value includes the impacts measured in 2017 and 2018, both of which had significant wildfire smoke events, although at much lower levels than those occurring in 2020. Again, the use of a monitor located in an urban area of King County is expected to yield conservatively high background concentration values for $PM_{2.5}$. The background concentrations for this monitor site from 2019 were 26 μg/m^3 for the 24-hour averaging period and 6.3 μg/m^3 for the annual averaging period.

Results

No Action Alternative

The maximum 24-hour PM_{10} concentration modeled for the No Action Alternative was 12 μg/m^3. Summing the CHRLF modeled value and the background concentration results in a predicted No Action Alternative maximum 24-hour PM_{10} concentration of 50 μg/m^3. This concentration is below the 24-hour PM_{10} ambient air quality standard of 150 μg/m^3.

The maximum 24-hour and annual $PM_{2.5}$ concentrations modeled for the No Action Alternative were 2 μg/m^3 and 0.7 μg/m^3, respectively. Summing the CHRLF modeled values and the background concentrations results in predicted No Action Alternative maximum 24-hour $PM_{2.5}$ concentration of 28 μg/m^3 and maximum predicted annual $PM_{2.5}$ concentration of 7.0 μg/m^3. These concentrations are below the 24-hour and annual $PM_{2.5}$ ambient air quality standards of 35 μg/m^3 and 12.0 μg/m^3, respectively.

Action Alternative 3

The maximum 24-hour PM_{10} concentration modeled for the action alternatives was 18 μg/m^3, under Action Alternative 3. Summing the CHRLF modeled value and the background concentration results in a predicted action alternative maximum 24-hour PM_{10} concentration of 56 μg/m^3. This concentration is below the 24-hour PM_{10} ambient air quality standard of 150 μg/m^3.

The maximum 24-hour and annual $PM_{2.5}$ concentrations modeled for the action alternatives were 3.1 μg/m^3, and 1.1 μg/m^3, respectively, under Action Alternative 3. Summing the CHRLF modeled values and the background concentrations results in predicted action alternatives maximum 24-hour $PM_{2.5}$ impact of 29 μg/m^3 and maximum annual $PM_{2.5}$ impact of 7.4 μg/m^3. These concentrations are below the 24-hour and annual $PM_{2.5}$ ambient air quality standards of 35 μg/m^3 and 12.0 μg/m^3, respectively.

Relocation of Support Facilities

Each Alternative has three options related to relocation of the main landfill support facilities. The options for relocation of the support facility include:

- Option 1 (CHRLF South) – Relocate and build main landfill support facilities in the south including, but not limited to the scale/scalehouse, truck wash, heavy equipment maintenance facility (cat shack), some tractor and trailer parking, office space and laboratory space.
- Option 2 (CHRLF North) - Relocate and build landfill support facilities in the north including, but not limited to the truck maintenance building, some tractor and truck parking, office space and laboratory space. The remaining landfill support facilities, including, but not limited to the scale/scalehouse, truck wash, cat shack and some tractor and trailer parking would be relocated and built as described in Option 1 above.
- Option 3 – (Renton Site) – Relocate and build main landfill support facilities at an off-site location at 3005 NE 4th Street in Renton, beside the Renton Recycling and Transfer Station including, but not limited to a portion of the vehicle maintenance shop (for repairing tractors, trailers, operations vehicles, and passenger vehicles), employee offices, and parking for employees, tractors, trailers, and operations vehicles. Relocate and build some landfill support facilities in the north or south (except the scale/scalehouse; truck wash; cat shack; and some tractor and trailer parking, all of which would only be relocated in the south).

Option 1 (CHRLF South)

The potential relocation of landfill support facilities in the south will impact the flow and levels of traffic flow at the CHRLF. However, this relocation is not expected to cause an exceedance of the PM_{10} or $PM_{2.5}$ air quality standards.

The potential relocation will not impact overall waste transfer truck and staff traffic levels. The relocation will result in a small change in overall vehicle flow patterns, but these minimal changes are expected to minimally change the fugitive dust impacts in the area surrounding the CHRLF.

Option 2 (CHRLF South)

The potential relocation of landfill support facilities in the north will impact the flow and levels of traffic flow at the CHRLF. However, this relocation is not expected to cause an exceedance of the PM_{10} or $PM_{2.5}$ air quality standards.

The potential relocation will not impact overall waste transfer truck and staff traffic levels. The relocation will result in a small change in overall waste transfer truck flow patterns. The relocation will result in a significant change in the staff vehicle flow pattern and in transfer trucks going to the truck maintenance building, but these are changes to miscellaneous vehicle traffic that are not explicitly included in the modeling because of their anticipated small impacted. Therefore, these changes are expected to minimally change the fugitive dust impacts in the area surrounding the CHRLF.

Relocation of Support Facilities to Renton Facility

The potential relocation of landfill support facilities to a site adjacent to the Renton Recycling and Transfer Station (RRTS) will impact the flow and levels of traffic flow at both the CHRLF and the RRTS. However, this relocation is not expected to cause an exceedance of the PM_{10} or $PM_{2.5}$ air quality standards.

At CHRLF the potential relocation will not impact overall waste transfer truck traffic levels or traffic flow. The relocation will result in fewer staff coming to CHRLF, who instead will drive to the RRTS. This reduction in car traffic will result in lower fugitive dust impacts in the area surrounding the CHRLF.

The area surrounding the RRTS will experience increased levels of both empty waste transfer trucks and staff vehicles. However, all of the vehicles will travel on paved roads and will have impacts less than those described above for the CHRLF (Action Alternative 3 in particular). Based on the options comparison, relocation of support facilities to the RRTS is not anticipated to adversely impact the air quality surrounding the facility.

Conclusions

The No Action Alternative for the CHRLF operations, including traffic on public roads, currently meets all applicable particulate matter ambient air quality standards. This memo analyzed worst case scenario for fugitive dust emissions associated with the Action Alternative 3 with five days per week operation. The results of this analysis demonstrate that the CHRLF, including traffic on public roads, will continue to meet all applicable particulate matter ambient air quality standards under each of the three action alternatives and the option that includes relocation of support facilities to a site adjacent to the RRTS.

Based on the analysis described in this memo, no significant unavoidable adverse impacts to air quality will occur as a result of fugitive dust from implementation of any of the action alternatives proposed in the Draft EIS.

ATTACHMENT 1

Public Road Fugitive Dust Emission Calculations

CHRLF - 2020 SDP EIS
Estimation of Fugitive Dust Emissions from Public Paved Roads
CHRLF-Related Traffic
SR-169 to CHRLF Scalehouse Area
No Action Alternative

Vehicle	Average Surface Silt Loading (g/m^2)[2]	Vehicle Weight (tons)	Trips Per Day[3]	Fleet Average Vehicle Weight (tons)	Distance Traveled (100' VMT)	Fugitive $PM_{2.5}$ Emission Factor (lb/VMT)[4]	Fugitive $PM_{2.5}$ Emission Rate (lb/day per 100')	Fugitive $PM_{2.5}$ Emission Rate Based on Daily Hours of Operation (g/s per 100')[5]	Fugitive PM_{10} Emission Factor (lb/VMT)[4]	Fugitive PM_{10} Emission Factor (lb/day per 100')	Fugitive PM_{10} Emission Rate Based on Daily Hours of Operation (g/s per 100')[5]
KCSWD Trucks[1]	0.20	27	324	12	0.019	0.00158	0.028	0.00044	0.0065	0.114	0.00180
Commercial Haul		27	30								
Other Vehicle		3	582								

Daily Hours of Operation 16

Constant	$PM_{2.5}$	PM_{10}
k (lb/VMT)	0.00054	0.0022

[1] Includes waste transfer trucks and soil import and export trucks.
[2] Silt loading value taken from Fifth Edition AP-42, Table 13.2.1-2 (1/11), corresponding to a road in ADT Category 500-5,000.
[3] Obtained from the Transportation Discipline Report - Appendix L to the Draft EIS, corresponding to the maximum (2028) No Action Alternative traffic levels.
[4] Calculated using equation (1) from Fifth Edition AP-42, Section 13.2.1 (1/11)
[5] Multiplied by two to reflect round trip travel.

CHRLF - 2020 SDP EIS
Estimation of Fugitive Dust Emissions from Public Access Paved Roads
CHRLF-Related Traffic
SR-169 to CHRLF Scalehouse Area
Action Alternative 3
5-Day Operations (Worst Case)

Vehicle	Average Surface Silt Loading (g/m^2)[2]	Vehicle Weight (tons)	Trips Per Day[3]	Fleet Average Vehicle Weight (tons)	Distance Traveled (100' VMT)	Fugitive $PM_{2.5}$ Emission Factor (lb/VMT)[4]	Fugitive $PM_{2.5}$ Emission Rate (lb/day per 100')	Fugitive $PM_{2.5}$ Emission Rate Based on Daily Hours of Operation (g/s per 100')[5]	Fugitive PM_{10} Emission Factor (lb/VMT)[4]	Fugitive PM_{10} Emission Factor (lb/day per 100')	Fugitive PM_{10} Emission Rate Based on Daily Hours of Operation (g/s per 100')[5]
KCSWD Trucks[1]	0.20	27	526	15	0.019	0.00195	0.043	0.00067	0.0080	0.174	0.00274
Commercial Haul		27	42								
Other Vehicle		3	586								

Daily Hours of Operation 16

Constant	$PM_{2.5}$	PM_{10}
k (lb/VMT)	0.00054	0.0022

[1] Includes waste transfer trucks and soil import and export trucks.
[2] Silt loading value taken from Fifth Edition AP-42, Table 13.2.1-2 (1/11), corresponding to a road in ADT Category 500-5,000.
[3] Obtained from the Transportation Discipline Report - Appendix L to the Draft EIS, corresponding to the maximum (2046) Alternative 3 Build traffic levels.
[4] Calculated using equation (1) from Fifth Edition AP-42, Section 13.2.1 (1/11)
[5] Multiplied by two to reflect round trip travel.

ATTACHMENT 2

Landfill Operations Fugitive Dust Emission Calculations

CHRLF - 2020 SDP EIS
Estimation of Fugitive Dust Emissions from On-Site Paved Roads
From CHRLF Scalehouse Area to Unpaved Road
No Action Alternative

Vehicle	Average Surface Silt Loading (g/m^2)[2]	Vehicle Weight (tons)	Trips Per Day[3]	Fleet Average Vehicle Weight (tons)	Distance Traveled (100' VMT)	Fugitive $PM_{2.5}$ Emission Factor (lb/VMT)[4]	Fugitive $PM_{2.5}$ Emission Rate (lb/day per 100')	Fugitive $PM_{2.5}$ Emission Rate Based on Daily Hours of Operation (g/s per 100')[5]	Fugitive PM_{10} Emission Factor (lb/VMT)[4]	Fugitive PM_{10} Emission Factor (lb/day per 100')	Fugitive PM_{10} Emission Rate Based on Daily Hours of Operation (g/s per 100')[5]
KCSWD Trucks[1]	1.1	27	324	27	0.019	0.01698	0.114	0.00179	0.0692	0.464	0.00731
Commercial Haul		27	30								

Daily Hours of Operation	16	
Constant	$PM_{2.5}$	PM_{10}
k (lb/VMT)	0.00054	0.0022

[1] Includes waste transfer trucks and soil import and export trucks.

[2] Silt loading value taken from Fifth Edition AP-42, Table 13.2.1-2 (1/11). King County regularly sweeps the paved roads, so the lowest value of the range of landfill road silt loadings was used.

[3] Obtained from the Transportation Discipline Report - Appendix L to the Draft EIS, corresponding to the maximum (2028) No Action Alternative traffic levels.

[4] Calculated using equation (1) from Fifth Edition AP-42, Section 13.2.1 (1/11)

[5] Multiplied by two to reflect round trip travel.

CHRLF - 2020 SDP EIS
Estimation of Fugitive Dust Emissions from On-Site Unpaved Roads
No Action Alternative

$$E = k\ (s/12)^a (W/3)^b$$

$$E_{ext} = E\ [(365 - P)/365]$$

Eqs. 1a and 2, AP-42 13.2.2

Haul Trucks Section

k_{PM10}	1.5	lb/VMT
$k_{PM2.5}$	0.15	lb/VMT
Control Efficiency	75	% [1]
s	6.4	% silt
W	27	tons
a	0.9	
b	0.45	
P	180	
Average Speed	10	mph
E_{ext}	0.38	lb PM_{10}/VMT [2]
E_{ext}	0.038	lb $PM_{2.5}$/VMT [2]

Trips per Day	354	
Volume Source Spacing	0.019	miles
Daily Hours of Operation	16	hours
Emissions	2.558688	lbs PM_{10}/day per 100'
	0.04030	g PM_{10}/s [3]
	0.26	lbs $PM_{2.5}$/day per 100'
	0.00403	g $PM_{2.5}$/s [3]

[1] King County routinely waters the unpaved roads. The control efficiency was obtained from Fifth Edition AP-42, Figure 13.2.2-2 (11/06).
[2] Based on the AP-42 unpaved roads background documentation, the emission factors were corrected by multiplying by 2/3 (i.e., the ratio of the average vehicle speed to 15 mph).
[2] Multiplied by two to reflect round trip travel.

CHRLF - 2020 SDP EIS
Estimation of Fugitive Dust Emissions from On-Site Paved Roads
From CHRLF Scalehouse Area to Unpaved Road
Action Alternative 3
5-Day Operations (Worst Case)

Vehicle	Average Surface Silt Loading (g/m^2)[2]	Vehicle Weight (tons)	Trips Per Day[3]	Fleet Average Vehicle Weight (tons)	Distance Traveled (100' VMT)	Fugitive $PM_{2.5}$ Emission Factor (lb/VMT)[4]	Fugitive $PM_{2.5}$ Emission Rate (lb/day per 100')	Fugitive $PM_{2.5}$ Emission Rate Based on Daily Hours of Operation (g/s per 100')[5]	Fugitive PM_{10} Emission Factor (lb/VMT)[4]	Fugitive PM_{10} Emission Factor (lb/day per 100')	Fugitive PM_{10} Emission Rate Based on Daily Hours of Operation (g/s per 100')[5]
KCSWD Trucks[1]	1.1	27	526	27	0.019	0.01698	0.183	0.00288	0.0692	0.744	0.01172
Commercial Haul		27	42								

Daily Hours of Operation	16	
Constant	$PM_{2.5}$	PM_{10}
k (lb/VMT)	0.00054	0.0022

[1] Includes waste transfer trucks and soil import and export trucks.
[2] Silt loading value taken from Fifth Edition AP-42, Table 13.2.1-2 (1/11). King County regularly sweeps the paved roads, so the lowest value of the range of landfill road silt loadings was used.
[3] Obtained from the Transportation Discipline Report - Appendix L to the Draft EIS, corresponding to the maximum (2046) Alternative 3 Build traffic levels.
[4] Calculated using equation (1) from Fifth Edition AP-42, Section 13.2.1 (1/11)
[5] Multiplied by two to reflect round trip travel.

CHRLF - 2020 SDP EIS
Estimation of Fugitive Dust Emissions from On-Site Unpaved Roads
Action Alternative 3
5-Day Operations (Worst Case)

$$E = k\,(s/12)^a (W/3)^b$$

$$E_{ext} = E\,[(365 - P)/365]$$

Eqs. 1a and 2, AP-42 13.2.2

Haul Trucks Section

k_{PM10}	1.5	lb/VMT
$k_{PM2.5}$	0.15	lb/VMT
Control Efficiency	75	% [1]
s	6.4	% silt
W	27	tons
a	0.9	
b	0.45	
P	180	
Average Speed	10	mph
E_{ext}	0.38	lb PM_{10}/VMT [2]
E_{ext}	0.038	lb $PM_{2.5}$/VMT [2]

Trips per Day	568	
Volume Source Spacing	0.019	miles
Daily Hours of Operation	16	hours
Emissions	4.105465	lbs PM_{10}/day per 100'
	0.06466	g PM_{10}/s [3]
	0.41	lbs $PM_{2.5}$/day per 100'
	0.00647	g $PM_{2.5}$/s [3]

[1] King County routinely waters the unpaved roads. The control efficiency was obtained from Fifth Edition AP-42, Figure 13.2.2-2 (11/06).
[2] Based on the AP-42 unpaved roads background documentation, the emission factors were corrected by multiplying by 2/3 (i.e., the ratio of the average vehicle speed to 15 mph).
[2] Multiplied by two to reflect round trip travel.

CHRLF - 2020 SDP EIS
Estimation of Fugitive Dust Emissions from Compactor and Bulldozer Area Sources
No Action Alternative and Action Alternative 3
5-Day Operations (Worst Case)

PM_{10} [1]

$E = [1.0(s)^{1.5} / (M)^{1.4}] \times (\%PM_{10})$

M	16.8	% moisture [2]
s	6.9	% silt
PM_{10} Scaling Factor	0.75	dimensionless
Emissions (E)	0.26	lb/hr
	0.033	g/s

$PM_{2.5}$ [3]

$E = [5.7(s)^{1.2} / (M)^{1.3}] \times (\%PM_{2.5})$

M	16.8	% moisture [2]
s	6.9	% silt
$PM_{2.5}$ Scaling Factor	0.105	dimensionless
Emissions (E)	0.16	lb/hr
	0.020	g/s

[1] Fifth Edition AP-42 Table 11.9-1 (10/98), Bulldozer, Overburden, PM_{15} emission factor scaled to PM_{10}.
[2] Based on the CHRLF being a wet area, the top of the bulldozer overburden moisture content range was used.
[3] Fifth Edition AP-42 Table 11.9-1 (10/98), Bulldozer, Overburden, TSP emission factor scaled to $PM_{2.5}$.

Compactor

Working Area	979	m^2
PM_{10}	3.4E-05	$g/s\text{-}m^2$
$PM_{2.5}$	2.0E-05	$g/s\text{-}m^2$

Bulldozer

Working Area	5463	m^2
PM_{10}	6.0E-06	$g/s\text{-}m^2$
$PM_{2.5}$	3.6E-06	$g/s\text{-}m^2$

Technical Memorandum

To:	Phil Coughlan	Date:	January 3, 2022
From:	Ed Liebsch Karam Singh, PE	Project:	King County Cedar Hills Regional Landfill 2020 SDP and EIS, 2021 Update
Subject:	Cedar Hills Regional Landfill Odor Dispersion Modeling		

Introduction

This technical memorandum describes the methodology and results of an odor dispersion analysis for the Cedar Hills Regional Landfill in King County, Washington. The odor analysis was applied to both existing (summer 2021) conditions, and to predicted future operating conditions where the odor emissions from the working face for municipal solid waste (MSW) landfilling are moved to various locations on the property.

Methodology

The odor dispersion analysis utilized the EPA's latest AERMOD dispersion model (version 21112) for both estimation of odor emission rates, and the prediction of odor levels in the neighborhoods near the landfill, as explained in the sections below.

For purposes of this dispersion analysis, it was determined, based on observations at the landfill and process knowledge, that the primary odor sources are:

1) the working face MSW is being actively disposed and covered, and
2) the two leachate ponds located near the southwest corner of the landfill.

Other potential odor sources include the exhaust of BEW engines combusting the landfill gas for energy, the flares that burn excess gas not diverted to BEW or used by the BEW engines, or odorous gases that are not gathered by the landfill gas collection system and are emitted as fugitive gas. The combustion sources are not expected to cause noticeable odors offsite, because the vast majority of H_2S and various volatile organic compounds will be destroyed by the combustion processes. Any odor from fugitive gas is expected to be very small, based on spot measurements near the ground in capped areas of the landfill, which indicated very low H_2S levels.

Therefore, the leachate ponds and the MSW working face are the subject of this odor analysis. It should be noted that a large composting facility just south of the landfill is likely also a significant source of odor. However, no attempt is made here to quantify the odor emission rates from the compost facility, or to include such emissions in the odor dispersion modeling.

Emission Rates

The estimation of odor emission rates is a challenging exercise, especially for landfill odor sources, as the odorous compounds emitted are varied and complex. The most common approach to odor analysis is to use field or laboratory instruments to analyze odor samples in terms of their intensity, measured in terms of dilutions-to-threshold (D/T). The D/T value is a unitless metric that quantifies how many volumes of clean, filtered air must be added to a sample until the diluted mixture reaches a threshold where the odor sample cannot be distinguished from odorless air. The odor samples quantified for this analysis were collected and analyzed by Intertox, using a portable field odor measurement device known as the Nasal Ranger. The Nasal Ranger allows the observer to draw in ambient air samples into the nose, diluting them at various multiples, until the observer can just detect the odorous air. The observer starts with high dilution and gradually works toward a lower number of dilutions, until they can just detect the odor (i.e., until they have determined the number of dilutions required to reach the observer's odor threshold).

The Nasal Ranger odor sampling done by Intertox in late June (22nd and 23rd) and early July (7th and 8th) 2021 included samples at each of 14 sites on and near the landfill site. The intensity of the odor in these samples provided levels in the range of non-detect up 30 D/T. Attachments 1 and 2, respectively, provide a map showing the locations of all the sampling sites, and a listing of all the sampling results obtained. The maximum detected level of 30 D/T occurred for four of the samples, with time and meteorological conditions as listed in Table 1. The meteorological conditions listed in Table 1 are based on data collected by Intertox using a portable wind instrument deployed during the odor measurements using the Nasal Ranger.

Table 1. Meteorological Conditions and Sampled Odor Concentrations for Emission Rate Estimates

Site #	Sample Date	Sample Time	Odor Description	Odor Conc.	Wind Speed	Wind Direction
				D/T	*(m/s)*	*(deg.)*
S11	6/22/2021	7:47:00 AM	Offensive: landfill leachate; Medicinal: astringent, ammonia	30	1.03	106
S11	6/23/2021	7:19:00 AM	Offensive: Landfill leachate, sewer, rancid; Chemical: solvent	30	1.25	121
S13	7/7/2021	7:16:00 AM	Offensive: garbage, decay, putrid, rancid; Chemical: solvent, gas	30	2.55	176
S12	7/7/2021	7:38:00 AM	Offensive: manure, garbage; Earthy: musky, soil	30	2.58	162

Wind directions for the two 30 D/T samples collected near the leachate ponds (site S11) and for the one 30 D/T sample collected at site S13 were such that odors should have come primarily from the leachate ponds for the S11 samples, and the landfill working face for MSW disposal, for the S13 sample. The wind direction for the S12 sample was such that the odors would have come from the easternmost edge of the compost piles at the Cedar Grove Composting facility located south of the CHRLF, and the odor description is consistent with composting odors. Thus, that 30 D/T sample will not be useful for landfill odor emission rate calculation. The relative locations of these sampling sites and potential odor sources are shown in Figure 1, with the leachate ponds clearly visible in the SW corner of that image. Near the bottom left corner of this image, one can see a portion of the Cedar Grove Composting facility.

The current version of the EPA-approved AERMOD dispersion model (version 21112) was used in this analysis. The model utilized the regulatory default options recommended in the current version of EPA's "Guideline on Air Quality Models" (40 CFR 51, Appendix W, effective February 16, 2017) and the following methodology:

- Rural dispersion coefficients were used because the land use zoning of the approximately 2 mile radius around the facility is greater than 50 percent rural (i.e., non-urban) based on the Auer land-use classifications.
- Locations of emission sources were determined using a combination of field sampling notes, facility design information, and Google Earth.
- The source and receptor coordinates used in this analysis are based on the NAD83 Universal Transverse Mercator (UTM) Zone 10 coordinate system.

AERMOD is capable of producing concentration predictions for various averaging times.

AERMOD was used to back-calculate the odor emission rates for the leachate ponds or the landfill working face that would generate a 30 D/T concentration at the respective sampling sites, based on the wind speeds and directions during odor sampling as summarized in Table 1. Other meteorological input parameters for the back-calculation AERMOD run, such as stability, roughness length, cloud cover, etc., were based on data for the same days of the year, day of the month, and hour of day as the sampling events, except that these other data were taken from the year of preprocessed 2020 meteorological data. Those data were reviewed to confirm that the stability parameter (Monin-Obukhov length) and other meteorological parameters were representative of conditions during the hours sampled as defined in Table 1.

The sampling events used in this back-calculation procedure were for various periods within 8 hours (from 7 AM to 8 AM) of each day sampled. The wind speed and wind direction as measured for the sampled hours were then substituted into the 2020 preprocessed meteorological data files (surface and upper-air/profile files) for AERMOD for the same hours sampled. See discussion of the meteorological data sources and processing presented below.

The AERMOD model was executed for the limited range of days spanning the sampling period, and hourly concentrations for the receptors (sites) of interest for that entire period were output using the POSTFILE option. The emission rates for the area sources (leachate ponds and landfill working face) were input to AERMOD using a unitized (1.0 odor units/second/square meter) emission rate. The observed odor concentrations (30 D/T or 30 OU) for the episodes of interest were then divided by the AERMOD predicted concentrations in odor units (OU), to estimate the odor emission rate (OU/sec/m^2) of each area source for the episodes of interest. These estimates are shown in Table 2. Because independent odor emission estimates were made for two separate hours of observations for the leachate ponds, the higher of these two estimated emission rates was used for the predictive modeling with AERMOD.

The 1-hour overall maximum odor concentrations were multiplied by a factor of 3 to convert the 1-hour average AERMOD estimates to a peak instantaneous concentration. The peak to average (P/A) concentration ratio generally ranges from 1 to 5 for an emission source and receptor located at the same level above ground (approximately the case here), based on data provided in Meteorology and Atomic Energy (D. H. Slade, Editor, 1968). Therefore, the mid-range factor of 3 for P/A ratio is used in this analysis.

The leachate ponds and the MSW working face sources were input to AERMOD as rectangular area sources (ponds) and a polygon area source (MSW working face), based on the area sources sizes and locations shown in Figure 1.

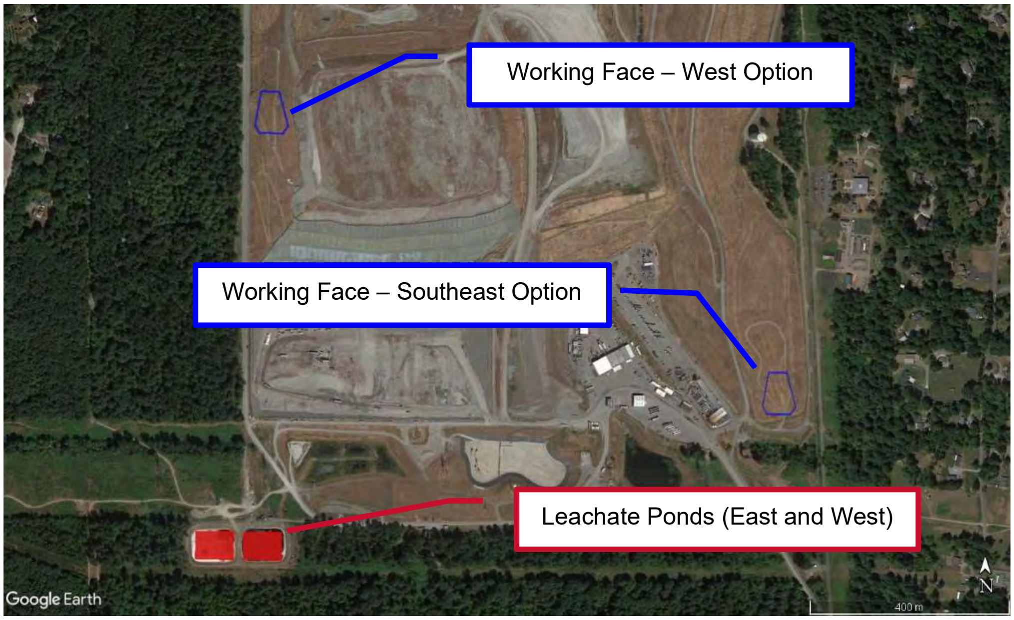
Table 2. AERMOD Unitized Results and Back-Calculated Odor Emission Rates

Site #	Sample Date	Sample Time	Sampled Odor Conc.	1-Hour AERMOD Conc. @ 1.0 OU/Sec/m^2	Short-Term Peak Conc. (peak/mean factor = 3)	Estimated Odor Emission Rate
			D/T	*OU*	*OU*	*(OU/sec/m2)*
S11	6/22/2021	7:47:00 AM	30	2.60	7.79	3.85
S11	6/23/2021	7:19:00 AM	30	1.05	3.16	9.51
S13	7/7/2021	7:16:00 AM	30	0.056	0.17	177.68

For the AERMOD odor dispersion analysis of existing (2021) conditions, the same source locations shown in Figure 1 were used in the analysis. For the potential “worst-case” future dispersion analysis of odor impacts, the working face was input as the same size, shape, and intensity of emission rate, but was placed at each of the two locations shown in Figure 2. These locations were selected to provide worst-case off-site impact estimates, based on the closest proximity of the working face to existing residential locations, and the predominant wind directions. For the future case modeling, the leachate odor emission rates were increased from present estimates by 2.1%, which is the estimated increase in leachate flow for the future landfill, based on a projected increase in landfill area.

Figure 1. Odor Sampling Locations in Relation to On-Site and Off-Site Odor Sources

Figure 2. Future Working Face Modeled Locations



Meteorological Data

The meteorological data used for the AERMOD dispersion analysis consisted of the most recent currently available five years, 2016-2020, of surface (including 1-minute data) and upper air meteorological data. The meteorological data stations were chosen because they were the closest to the project location and best represented site characteristics.

The surface data was downloaded from the National Centers for Environmental Information's (NCEI) Integrated Surface Hourly Database (ISD) archived data database for the Renton airport station (Station No. 727934-94248). The surface data are in ISHD format and are reported in Local Standard Time (LST). The location and elevation were extracted from the ISHD file (47.493N, 122.21W, 9 m). The upper air meteorological data were obtained for the Quillayute State Airport station from the National Oceanic and Atmospheric Administration's (NOAA) Earth System Research Laboratory (ESRL) Radiosonde Database (Station No. 94240-72797). The upper air data were in FSL format and have an 8-hour time adjustment applied to correct the data from Coordinated Universal Time (UTC) to Pacific Time. The location was extracted from the FSL file (47.95N, 124.55W). Lastly, monthly 1-minute Automated Surface Observing Systems (ASOS) wind data were obtained from the National Climatic Data Center (NCDC) for the Renton surface station.

The current version of AERSURFACE (version 20060) was executed using 12 equal sized compass sectors for each month of the year. The input surface land cover data file was from the National Land Cover Database (NLCD) for the state of Washington. Moisture was determined separately for each year based on Seattle area 30-year climate data. The 30-year data were sorted from dry to wet and each of the years being processed was compared to the data set based on the yearly precipitation. If the year being processed fell within the lowest 9 years it was classified as dry, if the year fell in the middle 12 years it was classified as average, and if the year fell in the top 9 it was classified as wet. The years determined to be wet were 2016, and 2017; years 2018 and 2020 were average; and only 2019 was classified as dry. The climatological precipitation data set was from the Western Regional Climate Center for the Seattle Tacoma International Airport. Other AERSURFACE inputs were:

- Surface station location (47.493N, 122.214W, NAD83)
- Default seasons of Winter (12, 1, 2), Spring (3, 4, 5), Summer (6, 7, 8), and Autumn (9, 10, 11).
- No continuous snow cover
- At an airport
- Not arid

This meteorological data was processed using the current AERMET (version 21112) and AERMINUTE (version 15272) software using a 0.5 m/s threshold wind speed to address missing and calm conditions. The profile base elevation of 9 meters was used, which is the same elevation as the surface meteorological data weather station.

Onsite Data Comparison

Surface wind speed and direction data are collected from a meteorological observation tower located at the landfill. Measurements are recorded in five-minute intervals indicating wind speed and direction over that time step (Figure 3). A gap in available data of roughly six months was found between July 2017 and February 2018, and therefore those observations are not included in this presentation of data. When compared with airport observations from Renton Municipal Airport (KRNT), the predominant wind flow from the southeast matches over the 2016-2020 analysis period. Winds at KRNT are shown after processing by AERMET, as described above (Figure 4).

One key difference between the datasets is the alignment of the secondary wind pattern. In the onsite observations, a secondary wind pattern with northeasterly flow appears (less than 15% of observations), whereas the secondary wind pattern from Renton was from the northwest (roughly 20% of observations). The terrain features between the two sites, including the landfill elevation itself, are likely the contributing factor between this secondary wind shift. Overall, the maximum and average wind speeds between the two sites are consistent. Therefore, Renton is a suitable analog for meteorology at the facility for use within AERMOD.

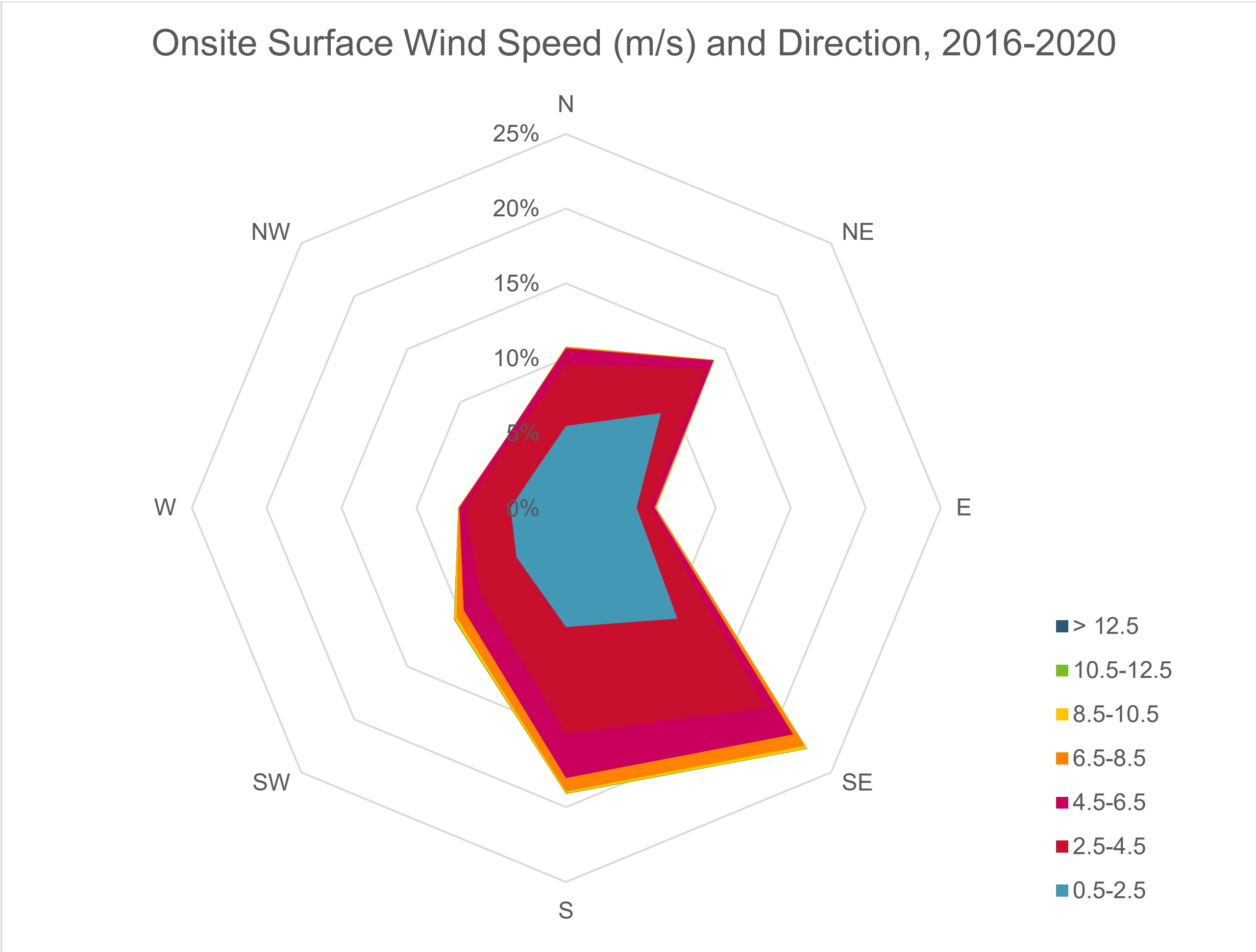


Figure 3. Onsite Surface Wind Speed (m/s) and Direction, 2016-2020

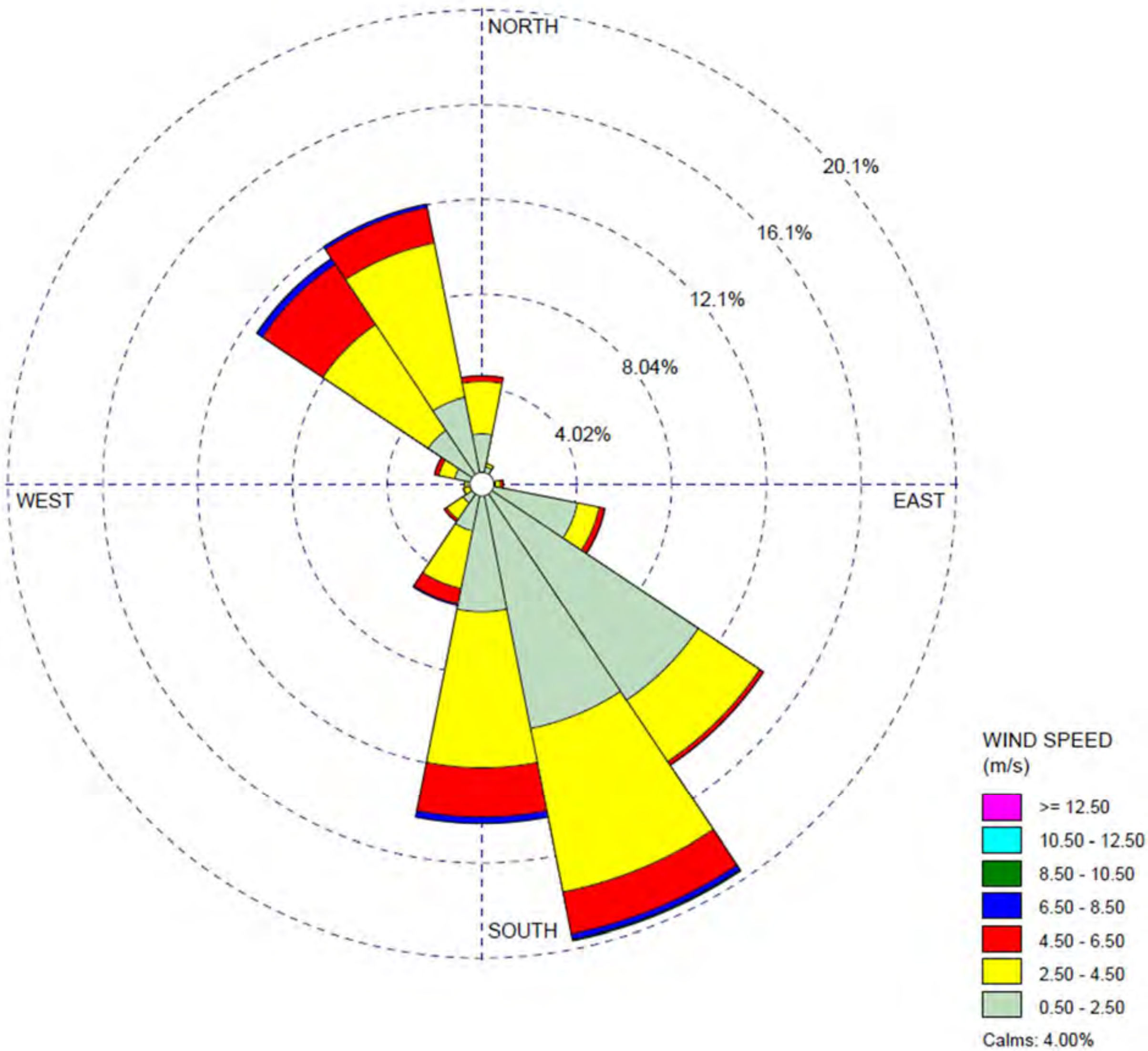


Figure 4. Surface Weather Observations from Renton Municipal Airport, 2016-2020

Receptors

To estimate future odor impacts associated with Action Alternative 3, receptors were placed at 100-meter intervals across the landfill property and out to at least 2,000 meters in all directions from the boundary of the landfill area. This grid encompasses the nearest potential residential neighbors in all directions and is sufficient to show the patterns of predicted odor impacts and how those impacts fall off with distance from the emission sources.

Discussion of Odor Modeling Results

Based on AERMOD runs using the full 5-year period of meteorological data, contour plots were prepared for the existing (2021) case, and for the two separate future cases (MSW disposal on west-central and southeastern portions of landfill site).

For each of the three cases modeled, odor contour plots are provided for both an overall maximum peak odor concentration and a 99th percentile odor concentration, a concentration that is predicted to not be exceeded 99% of the time. The existing (2021) scenario maximum and 99th percentile plots are provided as Figures 5 and 6, respectively. The west-central MSW disposal scenario plots are provided for maximum and 99th percentile impacts as Figures 7 and 8, respectively. The southeast MSW disposal scenario plots are provided for maximum and 99th percentile impacts as Figures 9 and 10, respectively.

While the plots for each case (existing, MSW west-central working face, MSW southeastern working face) provide both the highest modeled short-term impact over 5 years of meteorology, and the 99th percentile over 5 years of meteorology, this discussion focuses mainly on the 99th percentile plots. The 99th percentile plots represent odor concentration predictions that can be expected with some significant frequency, as opposed to a one-time extreme event.

The 99th percentile modeled odor plots for each case show similar patterns of concentrations, as would be expected based on the unique wind direction and other meteorological conditions applicable to this part of Washington. The slight differences in the shapes and locations of the various odor contour levels are due to the changes in location of the MSW working face, in combination with odor concentrations from the leachate ponds.

A common axiom regarding odor levels is that odor concentrations above 100 OU will generally trigger complaints from people experiencing such odors, while a level of 20 OU will sometimes generate complaints. The results show that for the existing conditions scenario, the 99th percentile 100 OU (D/T) contour reaches just into the neighborhood on the west side of the landfill property, and also extends onto the composting facility property south of the landfill.

For the future scenario with the MSW working face on the west-central portion of the landfill, the 99th percentile 100 OU contour encompasses much of the nearby neighborhood west of the landfill, but stays inside the property on the east side, and extends just onto the composting facility site to the south.

For the future scenario with the MSW working face on the southeastern portion of the landfill, the 99th percentile 100 OU contour encompasses the nearest residential areas adjacent to the east and southeast sides of the landfill property but stays just short of the nearest neighborhood on the west side of the landfill.

Figure 5. Peak Odor Concentration – Current Working Face

Figure 6. 99th Percentile Odor Concentration – Current Working Face

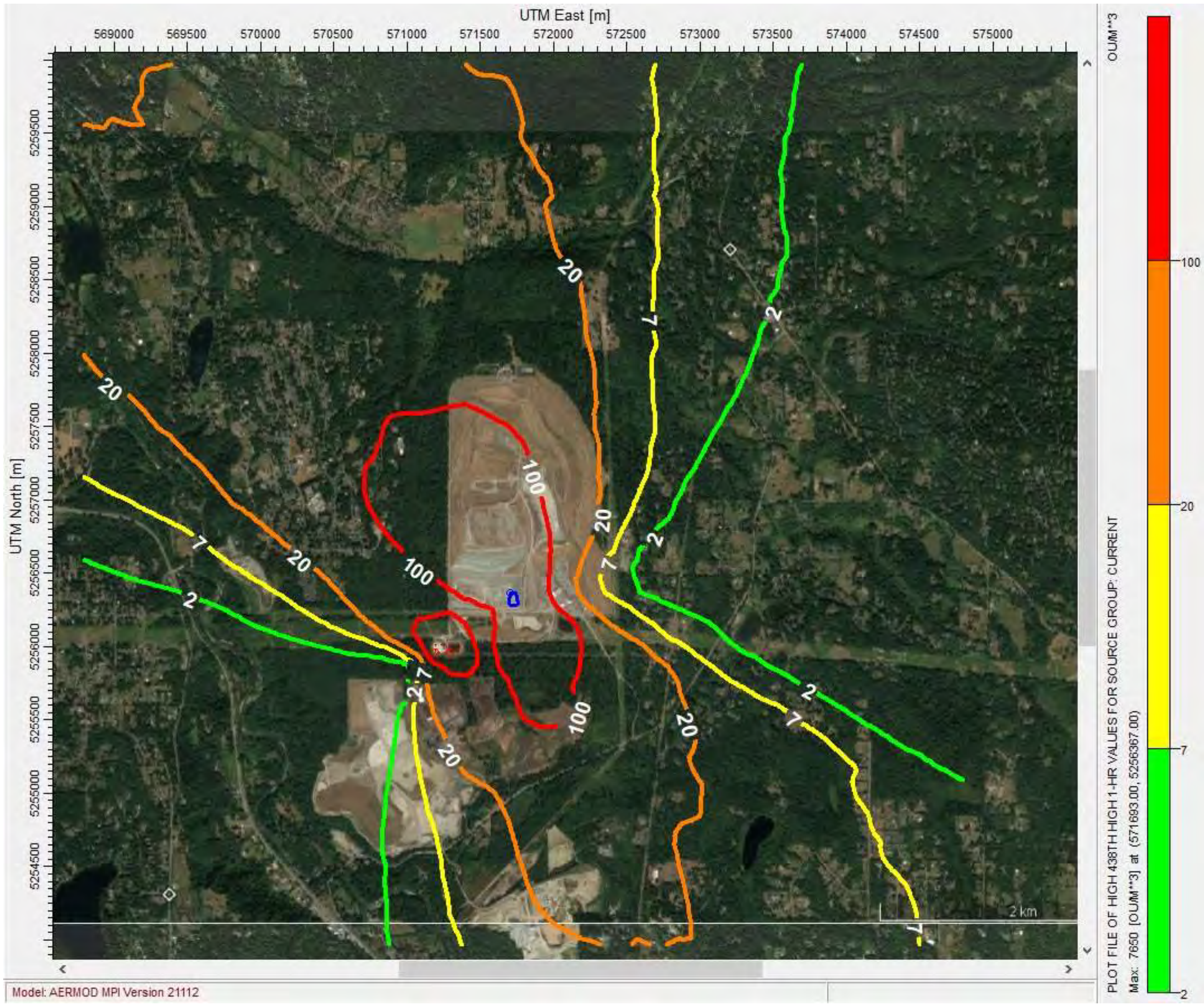


Figure7. Peak Odor Concentration - West Working Face Option

Figure8. 99th Percentile Odor Concentration - West Working Face Option

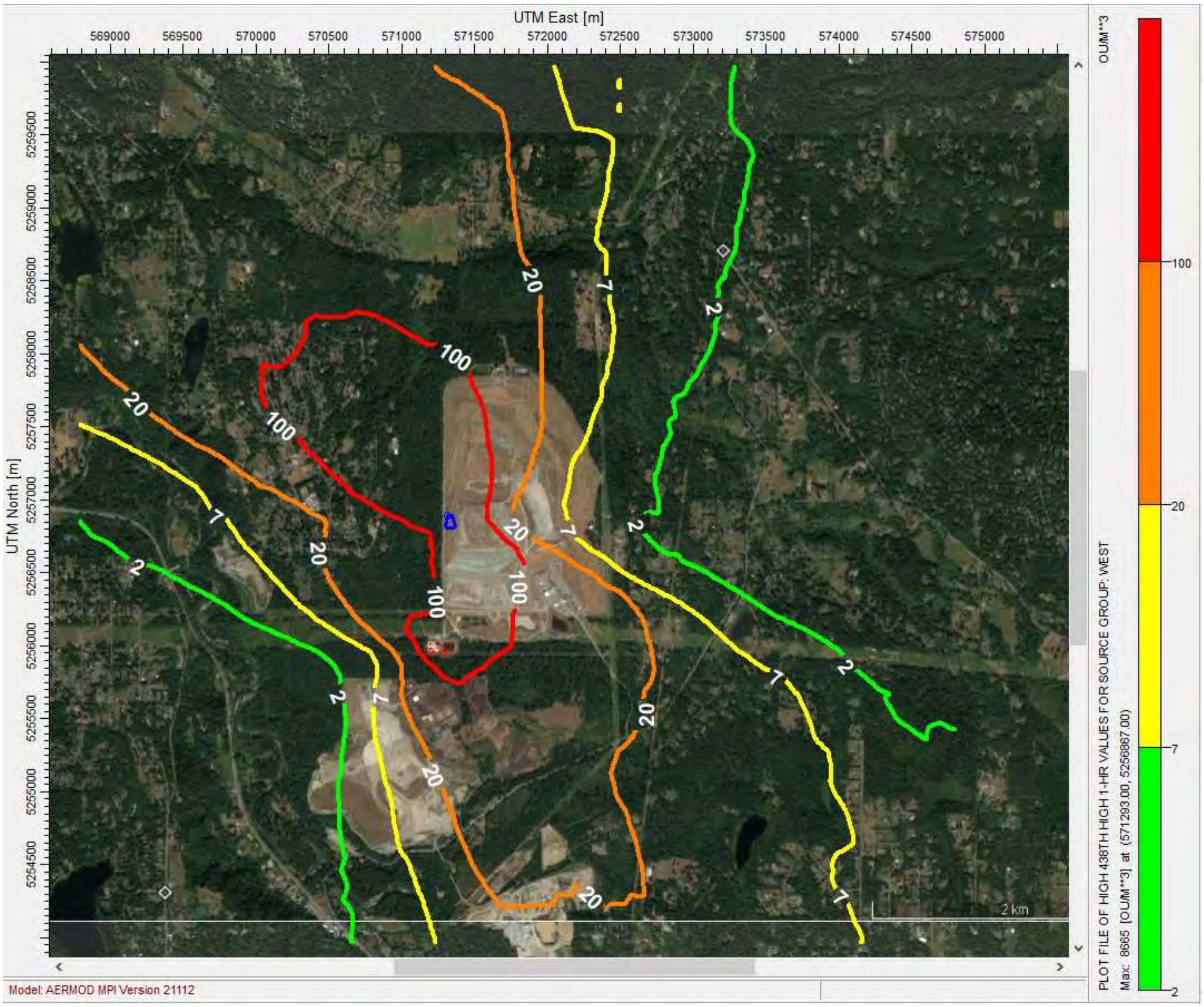
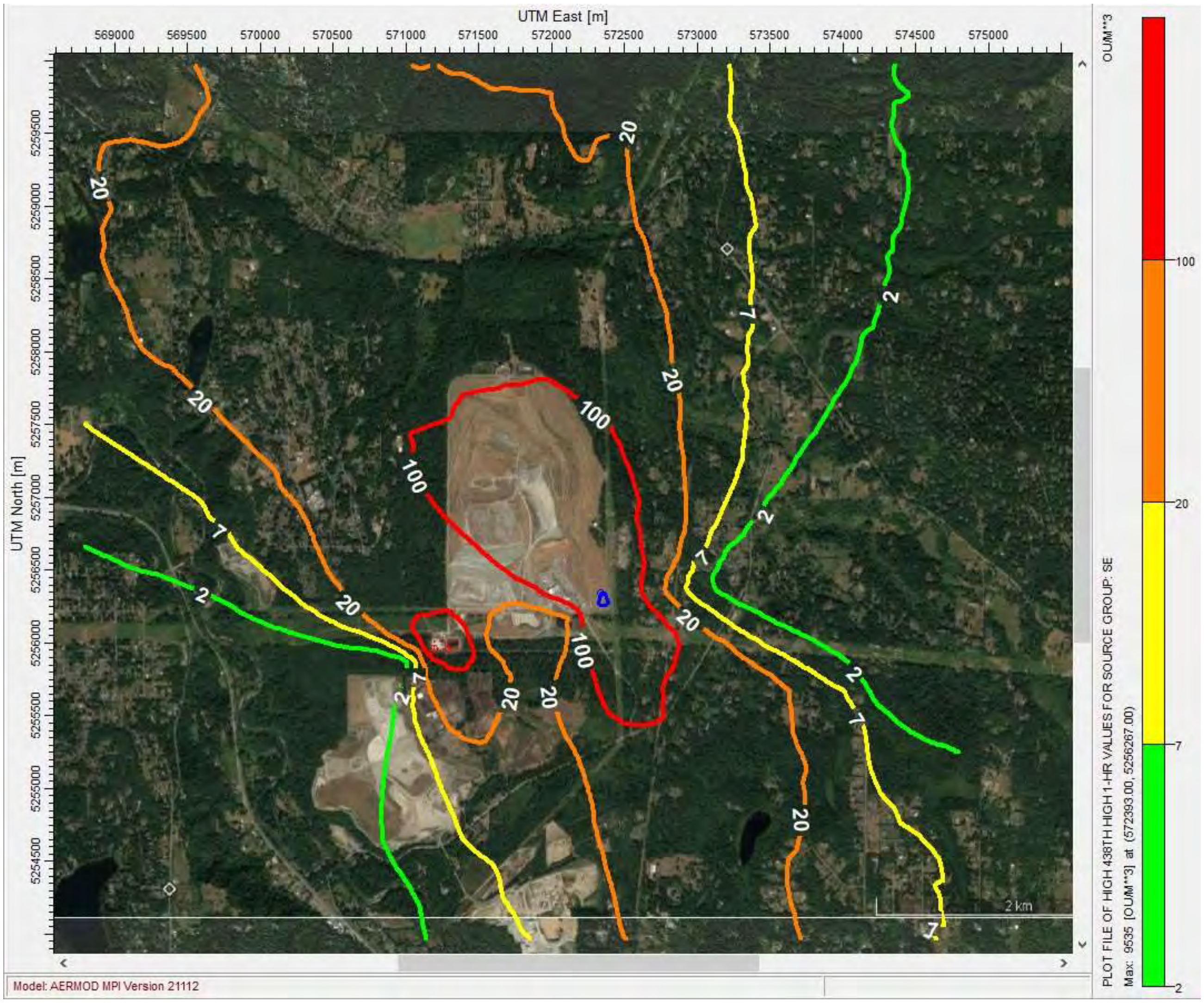


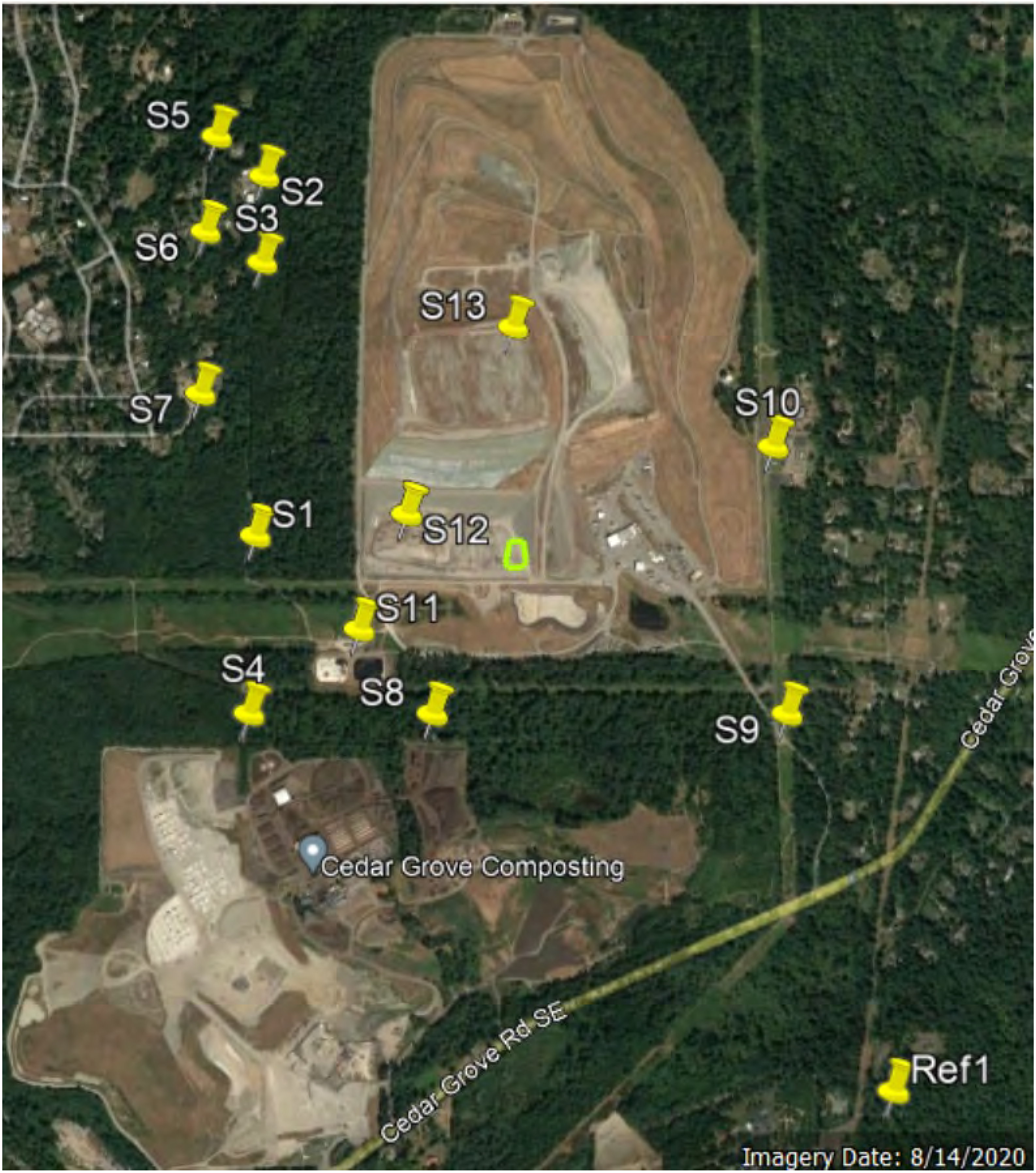
Figure 9. Peak Odor Concentration - Southeast Working Face Option

Figure 10. 99th Percentile Odor Concentration - Southeast Working Face Option



ATTACHMENT 1

Map of Odor Sampling Sites


S5
S2
S3
S6
S13
S7
S10
S1
S12
S11
S4
S8
S9
Cedar Grove Composting
Cedar Grove Rd SE
Cedar Grove
Ref1
Imagery Date: 8/14/2020

ATTACHMENT 2

Field Notes and Results of Odor Sampling

Site #	Location Coordinates		Sample Date	Sample Time	Odor Desciption	Odor Concentration	Temperature*	Relative Humidity*	Barometric Pressure*	Wind Speed*	Heat Index*	Dew Point*	Crosswind*	Headwind*	Compass Magnetic Direction*	Compass True Direction*	*Average Sampling height**	***Weather Conditions***
Day 1	*Latitude*	*Longitude*				*D/T*	*°C*	*%*	*mb*	*km/h*	*°C*	*°C*	*km/h*	*km/h*	*Deg*	*Deg*	*m ASML*	
S13	47 27' 41" N	122 2' 56" W	6/22/2021	6:15:00 AM	Chemical: Gaseous; Offensive: Maure, putrid, garbage	7	17.3	73.6	1012.3	6.4	16.7	12.6	1.4	-6.2	175	176	225	Sunny, clear, breezy
S12	47 27' 24" N	122 3' 10" W	6/22/2021	7:29:00 AM	Offensive: Manure, garbage	7	18.7	69.2	1013.5	4.3	18.0	12.9	1.3	-3.9	172	172	167	Sunny, clear, breezy
S11	47 27' 13" N	122 3' 15" W	6/22/2021	7:47:00 AM	Offensive: Landfill leachate; Medicinal: astringent, ammonia	30	20.5	63.4	1013.0	3.7	20.2	13.3	3.3	-1.1	106	106	159	Sunny, clear, breezy
S8	47 27' 6" N	122 3' 6" W	6/22/2021	8:19:00 AM	Offensive: manure; Earthy: woody	15	19.2	64.9	1012.5	2.5	18.5	12.5	0.7	-2.2	172	173	149	Sunny, clear, breezy
S4	47 27' 6" N	122 3' 30" W	6/22/2021	8:38:00 AM	Offensive: manure; Earthy: woody	2	20.3	65.9	1012.0	3.6	20.0	13.7	2.4	-2.6	225	226	160	Sunny, clear, breezy
S1	47 27' 22" N	122 3' 30" W	6/22/2021	8:56:00 AM	Offensive: manure; Earthy: woody	2	19.8	65.7	1011.6	1.6	19.4	13.2	0.6	-1.0	220	220	165	Sunny, clear, breezy
S3	47 27' 47" N	122 3' 30" W	6/22/2021	9:16:00 AM	ND	<2	18.9	68.2	1011.0	0.0	18.2	12.9	0.0	0.0	100	101	191	Sunny, clear, breezy
S2	47 27' 55" N	122 3' 30" W	6/22/2021	9:35:00 AM	Offensive: manure; Earthy: woody	2	19.3	67.2	1012.0	0.9	18.7	13.1	0.9	0.2	173	174	199	Sunny, clear, breezy
S9	47 27' 6" N	122 2' 19" W	6/22/2021	10:08:00 AM	Earthy: Grassy; Floral: herbal; Chemical: Car exhaust	2	23.7	55.9	1013.3	2.2	23.5	14.3	1.9	0.1	69	70	158	Sunny, clear, breezy
S10	47 27' 30" N	122 2' 21" W	6/22/2021	10:32:00 AM	Floral: Herbal; Earthy: Grassy	2	22.3	60.3	1010.6	5.1	22.2	14.2	2.5	-3.1	213	214	175	Sunny, clear, breezy
Ref1	47 26' 33" N	122 2' 5" W	6/22/2021	11:09:00 AM	ND	<2	22.7	56.6	1013.5	0.4	22.4	13.6	0.3	0.2	163	164	156	Sunny, clear, breezy
S7	47 27' 35" N	122 3' 38" W	6/22/2021	12:25:00 PM	ND	<2	22.8	60.2	1013.0	3.3	22.7	14.7	1.8	-2.3	191	191	169	Sunny, clear, breezy
S6	47 27' 50" N	122 3' 38" W	6/22/2021	12:42:00 PM	ND	<2	24.0	55.6	1011.4	2.0	23.7	14.6	1.7	-0.1	276	277	173	Sunny, clear, breezy
S5	47 27' 59" N	122 3' 37" W	6/22/2021	12:57:00 PM	ND	<2	24.2	55.2	1011.0	2.4	23.8	14.6	0.6	-2.3	199	199	183	Sunny, clear, breezy
Day 2																		
S13	47 27' 41" N	122 2' 56" W	6/23/2021	6:38:00 AM	Offensive: Rancid, garbage; Chemcial: Solvent; Medicinal: Ammonia	4	13.1	84.0	1013.2	7.1	13.1	10.5	4.5	-5.5	219	219	225	Overcast, cool, low clouds, occasional breeze
S12	47 27' 24" N	122 3' 10" W	6/23/2021	7:02:00 AM	Offensive: Rancid, putrid, garbage	4	13.8	83.6	1013.8	4.5	13.7	11.0	2.3	-3.8	211	212	167	Overcast, cool, low clouds, occasional breeze
S11	47 27' 13" N	122 3' 15" W	6/23/2021	7:19:00 AM	Offensive: Landfill leachate, sewer, rancid; Chemical: solvent	30	14.0	81.4	1013.9	4.5	13.8	10.9	3.1	-3.0	187	187	159	Overcast, cool, low clouds, occasional breeze
S8	47 27' 6" N	122 3' 6" W	6/23/2021	8:07:00 AM	Earthy: Musty, grassy; Offensive: Manure	2	15.5	75.5	1015.2	1.1	15.0	11.1	1.0	0.5	297	298	149	Overcast, cool, low clouds, occasional breeze
S4	47 27' 6" N	122 3' 30" W	6/23/2021	8:25:00 AM	Floral: Herbal; Earthy: Grassy, musky, petrichore	2	14.8	79.8	1014.8	0.8	14.6	11.4	0.5	-0.5	262	263	160	Overcast, cool, low clouds, occasional breeze
S1	47 27' 22" N	122 3' 30" W	6/23/2021	8:39:00 AM	ND	<2	15.1	79.0	1013.9	0.0	14.8	11.5	0.0	0.0	292	293	165	Overcast, cool, low clouds, occasional breeze
S3	47 27' 47" N	122 3' 30" W	6/23/2021	8:59:00 AM	Earthy: grassy, musky	<2	14.8	80.6	1014.3	0.0	14.6	11.5	0.0	0.0	56	57	191	Overcast, cool, low clouds, occasional breeze
S2	47 27' 55" N	122 3' 30" W	6/23/2021	9:13:00 AM	Earthy: grassy; Offensive: Manure	2	15.2	79.8	1014.4	0.0	14.9	11.7	0.0	0.0	185	185	199	Overcast, cool, low clouds, occasional breeze
S9	47 27' 6" N	122 2' 19" W	6/23/2021	9:42:00 AM	Earthy: Musky, petrichore; Chemical: Car exhaust	<2	16.3	76.2	1014.3	0.0	15.9	12.1	0.0	0.0	334	335	158	Overcast, cool, low clouds, occasional breeze
S10	47 27' 30" N	122 2' 21" W	6/23/2021	9:56:00 AM	Offensive: Garbage; Earthy: Grassy	2	15.3	80.0	1013.9	6.7	15.0	11.8	1.3	-6.5	186	187	175	Overcast, cool, low clouds, occasional breeze
Ref1	47 26' 33" N	122 2' 5" W	6/23/2021	10:32:00 AM	ND	<2	16.0	77.4	1015.9	0.5	15.6	12.0	0.1	0.5	345	345	156	Overcast, cool, low clouds, occasional breeze
S6	47 27' 50" N	122 3' 38" W	6/23/2021	11:15:00 AM	Offensive: Garbage, putrid, manure	4	16.4	74.9	1015.2	1.3	15.9	11.9	0.3	-1.3	175	175	173	Overcast, cool, low clouds, occasional breeze
S5	47 27' 59" N	122 3' 37" W	6/23/2021	11:33:00 AM	Floral: Herbal; earthy: Grassy; Offensive: Manure	<2	16.7	75.0	1016.3	2.7	16.2	12.2	1.1	-2.5	201	201	183	Overcast, cool, low clouds, occasional breeze
S7	47 27' 35" N	122 3' 38" W	6/23/2021	11:50:00 AM	Offensive: Manure; earthy: Grassy, musky	2	17.8	70.4	1012.5	0.6	17.1	12.3	0.6	-0.1	89	89	169	Overcast, cool, low clouds, occasional breeze
Day 3																		
S13	47 27' 41" N	122 2' 56" W	7/7/2021	7:16:00 AM	Offensive: garbage, decay, putrid, rancid; Chemical: solvent, gas	30	13.9	88.1	1017.2	9.2	14.0	11.9	2.3	-8.7	165	166	225	Overcast, cool, low clouds, occasional breeze
S12	47 27' 24" N	122 3' 10" W	7/7/2021	7:38:00 AM	Offensive: Manure, garbage; Earthy: Musky, soil	30	14.2	86.6	1020.5	9.3	14.3	12.0	2.9	-8.7	161	162	167	Overcast, cool, low clouds, occasional breeze
S11	47 27' 13" N	122 3' 15" W	7/7/2021	7:54:00 AM	Offensive: Landfill leachate, garbage, manure; Chemical: Solvent; Medicinial: Ammonia	15	14.6	85.6	1017.6	2.6	14.5	12.2	1.7	-1.9	196	196	159	Overcast, cool, low clouds, occasional breeze
S8	47 27' 6" N	122 3' 6" W	7/7/2021	8:21:00 AM	Offensive: Manure; earthy: Grassy, musky, woody	4	15.0	83.6	1017.8	0.9	15.0	12.2	0.2	-0.8	157	158	149	Overcast, cool, low clouds, occasional breeze
S9	47 27' 6" N	122 2' 19" W	7/7/2021	8:38:00 AM	ND	<2	15.3	83.5	1018.1	3.5	15.2	12.5	0.4	-2.9	226	227	158	Overcast, cool, low clouds, occasional breeze
S10	47 27' 30" N	122 2' 21" W	7/7/2021	8:53:00 AM	Earthy: Grassy, woody, musty; Floral: Herbal; Chemical: Car exhaust	2	15.7	83.1	1017.8	0.0	15.7	12.9	0.0	0.0	195	195	175	Overcast, cool, low clouds, occasional breeze
S2	47 27' 55" N	122 3' 30" W	7/7/2021	9:18:00 AM	Earthy: Grassy, woody; Floral: herbal; Ofeensive: Garbage, manure	2	15.6	82.0	1018.7	0.0	15.5	12.6	0.0	0.0	77	78	199	Overcast, cool, low clouds, occasional breeze
S3	47 27' 47" N	122 3' 30" W	7/7/2021	9:30:00 AM	Earthy: Woody, musty; offensive: garbage, manure	4	15.6	82.0	1017.8	0.0	15.5	12.6	0.0	0.0	182	182	191	Overcast, cool, low clouds, occasional breeze
S1	47 27' 22" N	122 3' 30" W	7/7/2021	9:44:00 AM	Offensive: Manure, garbage	15	14.3	86.9	1014.5	7.4	14.3	12.1	1.8	-7.1	169	169	165	Overcast, cool, low clouds, occasional breeze
S4	47 27' 6" N	122 3' 30" W	7/7/2021	9:59:00 AM	offensive: Manure; earthy: soil, woody	7	14.9	84.8	1017.3	0.7	14.8	12.3	0.2	-0.7	216	216	160	Overcast, cool, low clouds, occasional breeze
Ref1	47 26' 33" N	122 2' 5" W	7/7/2021	10:52:00 AM	ND	<2	17.7	77.0	1019.3	0.0	17.3	13.6	0.0	0.0	263	264	156	Overcast, cool, low clouds, occasional breeze
S7	47 27' 35" N	122 3' 38" W	7/7/2021	11:36:00 AM	Offensive: manure, garbage; earthy: woody, grassy	2	17.6	75.9	1014.5	1.8	17.2	13.3	0.7	-1.7	168	169	169	Overcast, cool, low clouds, occasional breeze
S6	47 27' 50" N	122 3' 38" W	7/7/2021	11:52:00 AM	offensive: garbage, manure; earthy: soil, woody, grassy	2	17.0	77.0	1016.3	1.0	16.7	13.0	0.1	-1.0	243	243	173	Overcast, cool, low clouds, occasional breeze
S5	47 27' 59" N	122 3' 37" W	7/7/2021	11:59:00 AM	offensive: Manure; earthy: soil, woody, grassy	4	17.2	77.0	1018.2	1.7	16.8	13.1	0.5	-1.6	154	155	183	Overcast, cool, low clouds, occasional breeze
Day 4																		
S6	47 27' 50" N	122 3' 38" W	7/8/2021	5:08:00 AM	ND	<2	15.1	73.3	995.9	0.4	14.5	10.3	0.0	-0.4	179	179	173	Sunny, clear, occasional breeze
S5	47 27' 59" N	122 3' 37" W	7/8/2021	5:30:00 AM	ND	<2	13.9	77.5	995.8	0.0	13.5	10.0	0.0	0.0	108	108	183	Sunny, clear, occasional breeze
S7	47 27' 35" N	122 3' 38" W	7/8/2021	5:43:00 AM	Offensive: Manure, garbage; Earthy: Musky	2	12.4	84.6	997.1	0.9	12.3	9.8	0.5	-0.8	198	198	169	Sunny, clear, occasional breeze
Ref1	47 26' 33" N	122 2' 5" W	7/8/2021	6:18:00 AM	ND	<2	14.7	78.2	1000.3	0.0	14.4	10.9	0.0	0.0	15	16	156	Sunny, clear, occasional breeze
S13	47 27' 41" N	122 2' 56" W	7/8/2021	6:55:00 AM	Chemical: slightly gaseous	2	13.1	82.9	989.8	1.9	13.0	10.3	1.4	0.7	146	146	225	Sunny, clear, occasional breeze
S12	47 27' 24" N	122 3' 10" W	7/8/2021	7:16:00 AM	Offensive: garbage, rancid, putrid	7	13.5	79.0	997.8	1.4	13.2	9.9	1.1	0.9	216	217	167	Sunny, clear, occasional breeze
S11	47 27' 13" N	122 3' 15" W	7/8/2021	7:28:00 AM	Offensive: landfill leachate; chemical: solvent, astringent	4	13.9	78.9	998.6	0.0	13.5	10.3	0.0	0.0	319	319	159	Sunny, clear, occasional breeze
S4	47 27' 6" N	122 3' 30" W	7/8/2021	7:49:00 AM	ND	<2	14.6	79.5	998.2	0.0	14.3	11.1	0.0	0.0	289	289	160	Sunny, clear, occasional breeze
S8	47 27' 6" N	122 3' 6" W	7/8/2021	8:01:00 AM	Offensive: Manure; Earthy: soil, musty, fresh compost	7	14.1	78.0	999.7	0.0	13.8	10.3	0.0	0.0	260	260	149	Sunny, clear, occasional breeze
S9	47 27' 6" N	122 2' 19" W	7/8/2021	8:16:00 AM	Offesnive: Manure; Earthy: Grassy, woody, fresh compost	2	14.0	78.1	999.3	0.5	13.7	10.2	0.2	0.5	238	238	158	Sunny, clear, occasional breeze
S10	47 27' 30" N	122 2' 21" W	7/8/2021	8:27:00 AM	Offesnive: Manure, garbage	2	14.2	82.0	995.3	1.0	14.0	11.1	0.9	0.4	69	69	175	Sunny, clear, occasional breeze
S2	47 27' 55" N	122 3' 30" W	7/8/2021	8:59:00 AM	Offensive: fecal (horse)/manure; Earthy: woody, musty, grassy	2	14.1	81.0	993.7	1.1	13.9	10.9	0.8	-0.7	125	126	199	Sunny, clear, occasional breeze
S3	47 27' 47" N	122 3' 30" W	7/8/2021	9:12:00 AM	ND	<2	14.7	78.2	995.0	0.0	14.4	10.9	0.0	0.0	93	94	191	Sunny, clear, occasional breeze
S1	47 27' 22" N	122 3' 30" W	7/8/2021	9:26:00 AM	ND	<2	14.6	78.8	996.0	0.0	14.4	11.0	0.0	0.0	158	159	165	Sunny, clear, occasional breeze

***Data averaged across approximately 10-15 min at each sampling location.**