



BAAQMD
Health Risk Assessment
Modeling Protocol

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BAAQMD HRA Modeling Protocol

1. Introduction

This document is intended to be used as a guide for conducting Health Risk Assessments (HRAs) required by BAAQMD regulations and programs using the AERMOD dispersion model and the Hotspots Analysis and Reporting Program Version 2 (HARP2). The procedures in this document shall be followed both by Air District staff and by those who submit HRAs to the Air District for review. The applicability of this protocol includes, but is not limited to the following programs:

- BAAQMD Regulation 2, Rule 5 “New Source Review of Toxic Air Contaminants”
- BAAQMD Regulation 11, Rule 18 “Reduction of Risk from Air Toxic Emissions at Existing Facilities”
- California AB 2588 Air Toxics “Hot Spots” Program

Users of this document should have some experience with AERMOD and HARP2. This Modeling Protocol documents and standardizes established BAAQMD HRA Modeling procedures and expectations. It is not intended to serve as a training guide for running AERMOD or conducting HRAs.

2. Toxic Emissions Inventory

2.1 Pollutants: Toxic Air Contaminants (TACs)

The purpose of HRA is to evaluate the potential health risks to humans from exposure to toxic air contaminants (TACs). A TAC is defined as an air pollutant that may cause or contribute to an increase in mortality or in serious illness or that may pose a present or potential hazard to human health. For the purposes of BAAQMD programs, TACs consist of the substances listed in Regulation 2, Rule 5, Table 2-5-1 “Toxic Air Contaminant Trigger Levels”. Acute and Chronic trigger levels included in Table 2-5-1 are used only as an initial screening tool for certain applications, but they should not be considered once the requirement for HRA has been established. The emissions of any compound included in Table 2-5-1, no matter how small, must be included in the HRA when conducting an HRA for BAAQMD programs.

2.2 Determination of Emissions

For each pollutant and process whose emissions are required to be quantified in the HRA, the annual average emissions (pounds/year) and the maximum one-hour emissions (pounds/hour) are required. Annual average emissions are used for evaluating chronic exposures (i.e., chronic noncancer health impacts or cancer risk assessment). Maximum one-hour emissions are used for evaluating acute noncancer health impacts.

For the purposes of assessing project health risks for new source review (NSR) permit applications and BAAQMD Regulation 2, Rule 5, the project emissions inventory shall include all equipment in the current and related permit applications as defined by “project” in Regulation 2-5-216. Emissions inventories for all sources and abatement devices in the project shall be based on the potential to emit TACs, whether limited by equipment capacity or permit conditions, as described in Regulation 2-5-601.

For the purposes of assessing facility wide health risks pursuant to BAAQMD Regulation 11, Rule 18 or the California Air Toxics “Hot Spots” Program, health risks shall be determined based on the most recent Air District approved emission inventory for the facility. This facility emissions inventory shall include all routine and predictable releases of toxic air contaminants,¹ and it shall represent actual emission releases rather than a maximum potential to emit. The facility emissions inventory shall be prepared in accordance with BAAQMD’s Petroleum Refinery Emissions Inventory Guidelines, BAAQMD’s Toxic Air Contaminant Emission Factor Guidelines and BAAQMD’s 1-Hour Emission Inventory Guidelines. The above guidelines reference and generally conform with Air Resources Board’s (ARB’s) Emission Inventory Criteria and Guidelines Report (EICG Report, <https://www.arb.ca.gov/ab2588/final/reg.pdf>).

The BAAQMD maintains a chronic emissions inventory for each facility that is typically updated on an annual basis. This inventory is produced based on source-specific throughput data reported by the facility and emission factors and control efficiencies that are maintained in an Air District database. Prior to conducting a facility wide health risk assessment, the facility shall evaluate the accuracy and completeness of this annual TAC inventory and shall provide: any missing data including a maximum 1-hour emission inventory, all information requested by the Air District to support the inventory data, and any input data needed to complete a health risk assessment. The Air District will review any inventory changes requested by the facility and will identify any additional inventory updates needed due to new or improved emission factor data or emission calculation techniques. The Air District will identify a final approved facility emission inventory that will be used for the HRA.

¹ For engines powering emergency standby generators or fire pumps, any emissions resulting from qualifying emergency operation time may be excluded from the facility’s TAC inventories. Emissions resulting from routine readiness testing, maintenance, or emissions testing shall be included in the facility’s TAC inventories.

3. Air Dispersion Modeling

3.1 AERMOD Air Dispersion Modeling System

AERMOD is currently USEPA's preferred near-field dispersion modeling system (40 CFR Part 51, Appendix W Guideline on Air Quality Models) and is required for all HRA modeling performed by or for the BAAQMD. The AERMOD dispersion model incorporates two input data processors that are regulatory components of the AERMOD modeling system: AERMET, a meteorological data preprocessor that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, and AERMAP, a terrain data preprocessor that incorporates complex terrain using USGS Digital Elevation Data. Other non-regulatory components of this system include: AERSCREEN, a screening version of AERMOD; AERSURFACE, a surface characteristics preprocessor, and BPIP PRIM, a multi-building dimensions program incorporating the GEP technical procedures for PRIME applications. Modelers should make a reasonable effort to ensure that the latest version of each part of the AERMOD Modeling System is used when performing HRA modeling. The version numbers of each component of the AERMOD Modeling System used in the HRA shall be identified in the HRA report.

3.2 Control Options

AERMOD contains several regulatory options, which are set by default, as well as non-regulatory options. The Air District requires that the regulatory options be used. The use of any non-regulatory default options must be justified with a discussion in the HRA report and approved by the Air District.

3.3 AER Urban Option

The AER Urban option in the AERMOD model allows the user to incorporate the effects of increased surface heating from an urban area on pollutant dispersion under stable atmospheric conditions. To account for the dispersive nature of the "convective-like" boundary layer that forms during nighttime conditions due to the urban heat island effect, AERMOD enhances the turbulence for urban nighttime conditions over that which is expected in the adjacent rural, stable boundary layer, and it also defines an urban boundary layer height to account for limited mixing that may occur under these conditions. The magnitude of the urban heat island effect is driven by the urban-rural temperature difference that develops at night. AERMOD currently uses the population of the urban area as a surrogate to define the magnitude of this differential heating effect. AER Urban requires the population of the Urban area and provides an optional user defined roughness length (default = 1.0).

Selecting Population Data: For relatively isolated urban areas, the user may use published census data corresponding to the Metropolitan Statistical Area (MSA) for that location. For urban areas adjacent to or near other urban areas, or part of urban corridors, the user should attempt to identify that part of the urban area that will contribute to the urban heat island plume affecting the source(s). If this approach results in the identification of clearly defined MSAs, then census data may be used as above to determine the appropriate population for input to AERMOD. Use of population based on the Consolidated

MSA (CMSA) for applications within urban corridors is not recommended, since this may tend to overstate the urban heat island effect. (Ref. *AERMOD Implementation Guide, April 17, 2018*)

Optional Urban Roughness Length: The URBANOPT keyword on the CO pathway in AERMOD (EPA, 2018b) includes an optional parameter to specify the urban surface roughness length. The urban surface roughness parameter is used to define a reference height for purposes of adjusting dispersion for surface and low-level releases to account for the enhanced turbulence associated with the nighttime urban heat island. This optional urban roughness length is not used to adjust for differences in roughness length between the meteorological measurement site, used in processing the meteorological data, and the urban application site. The default value of 1 meter for urban surface roughness length, assumed if the parameter is omitted, is considered appropriate for most applications. Any application of AERMOD that utilizes a value other than 1 meter for the urban roughness length should be considered as a non-regulatory default application and would require appropriate documentation and justification as an alternative model, subject to Section 3.2 of the *Guideline on Air Quality Models* (EPA, 2017). The use of a value other than 1 meter for the urban surface roughness length will be explicitly treated as a non-DEFAULT option in the next update to the AERMOD model. (Ref. *AERMOD Implementation Guide, Section 5.3, April 17, 2018*)

All BAAQMD HRAs using the Urban option should use a roughness length of 1 meter.

3.4 Urban / Rural Determination

For any dispersion modeling exercise, the Urban or Rural determination of a source is critical in determining the boundary layer characteristics that affect the model's prediction of downwind concentrations. The selection of rural or urban dispersion coefficients in a specific application should follow one of the procedures suggested by Irwin (Ref. 74: 40 CFR 51, Appendix W Guideline on Air Quality Models) to determine whether the character of an area is primarily urban or rural (of the two methods, the land use procedure* is considered more definitive.).

***Note on Using Land Use Procedure Near Bodies of Water:**

Section 7.2.1.1 of the Guideline on Air Quality Models (EPA, 2017) provides the basis for determining the urban/rural status of a source. For most applications the Land Use Procedure described in Section 7.2.1.1(b)(i) is sufficient for determining the urban/rural status. However, there may be sources located within an urban area, but located close enough to a body of water or to other non-urban land use categories to result in a predominately rural land use classification within 3 kilometers of the source following that procedure. Users are therefore cautioned against applying the Land Use Procedure on a source-by-source basis but should also consider the potential for urban heat island influences across the full modeling domain. Furthermore, Section 7.2.1.1(e) of Appendix W recommends modeling all sources within an urban complex using the urban option even if some sources may be defined as rural based on the procedures

outlined in Section 7.2.1.1(b). Such an approach is consistent with the fact that the urban heat island is not a localized effect but is more regional in character.

Land Use Procedure: (1) Classify the land use within the total area, (A), circumscribed by a 3 km radius circle about the source using the meteorological land use typing scheme proposed by Auer (Ref. 75. Appendix W Guideline on Air Quality Models); (2) if land use types I1, I2, C1, R2, and R3 account for 50 percent or more of A, use urban dispersion coefficients; otherwise, use appropriate rural dispersion coefficients.

Auer Urban Categories:

Type	Use and Structures	Vegetation
I1: Heavy Industrial	Major chemical, steel, and fabrication industries; generally 3-5 story buildings, flat roofs	Grass and tree growth extremely rare; <5% vegetation
I2: Light-moderate Industrial	Rail yards, truck depots, warehouses, industrial parks, minor fabrications; generally 1-3 story buildings, flat roofs	Very limited grass and trees; <5% vegetation
C1: Commercial	Office and apartment buildings, hotels; >10 story heights, flat roofs	Limited grass and trees; <15% vegetation
R2: Compact Residential	Single, some multiple, family dwelling with close spacing; generally <2 story, pitched roof structures; garages (via alley), no driveways	Limited lawn sizes and shade trees; <30% vegetation
R3: Compact Residential	Old multi-family dwellings with close (<2 m) lateral separation; generally 2 story, flat roof structures; garages (via alley) and ashpits, no driveways	Limited lawn sizes, old established shade trees; <35% vegetation

Auer Rural Categories:

Type	Use and Structures	Vegetation
R1: Common Residential	Single family dwelling with normal easements; generally one story, pitched roof structures; frequent driveways	Abundant grass lawns and light-moderately wooded; >70% vegetation
R4: Estate Residential	Expansive family dwelling on multi-acre tracts	Abundant grass lawns and lightly wooded; >80% vegetation
A1: Metropolitan Natural	Major municipal, state, or federal parks, golf courses, cemeteries, campuses; occasional single story structures	Nearly total grass and lightly wooded; >95% vegetation
A2: Agricultural Rural	Agricultural Rural	Local crops (e.g., corn, soybean); >95% vegetation
A3: Undeveloped	Uncultivated; wasteland	Mostly wild grasses and weeds, lightly wooded; >90% vegetation
A4: Undeveloped Rural	Undeveloped rural	Heavily wooded; >95% vegetation
A5: Water Surfaces	Rivers, lakes	

AERSURFACE Land Use Procedure: BAAQMD has developed a procedure using the AERSURFACE tool that may be helpful in making the Urban / Rural land use determination. See APPENDIX A.

Population Density Procedure: (1) Compute the average population density, (P) per square kilometer with A as defined above; (2) If P is greater than 750 people per square kilometer, use urban dispersion coefficients; otherwise use appropriate rural dispersion coefficients. Population density should be used with caution and generally not be applied to highly industrialized areas where the population density may be low and, thus, a rural classification would be indicated. However, the area is likely to be sufficiently built-up so that the urban land use criteria would be satisfied. Therefore, in this case, the classification should be “urban” and urban dispersion parameters should be used. For applications of AERMOD in urban areas, under either the Land Use Procedure or the Population Density Procedure, the user needs to estimate the population of the urban area affecting the modeling domain because the urban influence in AERMOD is scaled based on a user-specified population.

3.5 UTM Coordinates, Base Maps, Fencelines

Use UTM Coordinates in NAD83 or WGS84 format to reference all parts of the model. Use Base Maps (e.g. geo referenced aerial photography) in AERMOD to establish the modeled area. Include Fenceline boundaries to identify the property or properties owned by the facility that will be excluded from the HRA.

3.6 Stationary Source Parameters

The modeler should document the origin of and basis for all emission release parameters used in the model in the modeling section of the HRA report. In addition, the modeler should explain why an emission release was modeled as a point, area, or volume source, if the emission release type is not obvious. Documentation allows anyone reviewing the HRA to better understand what the model was intending to portray and helps reviewers identify any errors that may be present. Examples of emission releases that require good documentation include: Point Sources with variable operating parameters, Volume Sources where the AERMOD source inputs (SYINIT, SZINIT) alone may not fully describe the emissions source, and Area Sources where both a Release Height and Initial Vertical Dimension are used.

3.7 Mobile Source Considerations

For some HRAs, it may be necessary to assess the risk from mobile sources. These will generally be sources that are part of a facility’s normal ongoing operations such as locomotive engine emissions from on-site rail travel, hoteling emissions from ships while docked at a facility, emissions from portable engines (50 bhp or higher) that are owned by the facility or remain at the facility for more than 12 months, and emissions from portable engines (50 bhp or higher, owned by contractors or other parties) that are operated at the facility for periods of 72 hours or more per event. Examples of how these mobile source types may be modeled are as follows:

Locomotives: A typical case for rail travel within a facility generally involves a short distance of low speed locomotive operation followed by a period of idling while a product is loaded or unloaded from the rail cars. The moving locomotive should be modeled as a line source (a series of either area or volume sources) that follows the tracks inside the facility boundaries. The area where the locomotive stops can be modeled as a point source.

Ships: Similar to rail travel, ships generally follow a channel or regular course into the wharf area at a facility, dock, and run auxiliary engines to provide power while hoteling. Hoteling at the wharf may last several hours to days for each cargo ship and typically accounts for most of the risk from shipping operations. In some cases, accounting for just the hoteling emissions may be adequate to assess the facility risk from the shipping operation. In other cases, especially when there are nearby receptors, it may also be appropriate to account for ship maneuvering near the wharf and harbor craft such as tugs. As with locomotives, ships should be modeled as line sources while moving and point sources while stopped (hoteling).

Portable Diesel Engines: Portable diesel engines create a challenge for HRA modeling because they do not stay in one place and usually cannot be modeled as a single point source as a stationary diesel engine would be. As an alternative, multiple point source locations could be used if the engines have distinct operating locations; or they could be modeled singly or as a group over a broader area as an area source. Height and orientation of the release point are other important considerations when determining release type and parameters for groups of portable engines.

3.8 Mobile Source Modeling Inputs

Mobile source modeling inputs will vary based on the individual source characteristics and the source type chosen to represent the mobile source in the model. Since idling locomotives and hoteling ships will be treated as **point sources**, the actual or estimated stack parameters will be used. However, for moving combustion equipment modeled as **line sources** or **area sources**, there is no consideration given for the plume rise that is driven by momentum and buoyancy from the heated exhaust unless it is built into the source parameters by the modeler.

What drives a plume is its heat flux, defined as the amount of heat being discharged through the stack per unit time. Unless the stack is rain capped or releases horizontally, the initial plume rise will be momentum driven due to the upward velocity created by expanding gases exiting the stack. As momentum slows, buoyancy will then take over as the heated plume rises through the cooler surrounding atmosphere. As the plume rises and cools, it encounters a temperature becoming closer to its own and progressively loses buoyancy. At some level, it will have lost all buoyancy and will begin to spread horizontally or sink.

To account (somewhat) for a rising plume, the modeled release height should be increased above the actual release height to account for the initial plume rise. In addition, the "Szinit" parameter required for volume sources to specify an **initial vertical dimension**

to the plume may also be used for area sources as an optional parameter. This parameter, which is used to add an initial depth to the area source, is often used with sources that have mechanically generated emissions where turbulent mixing occurs at or near the source. The parameter may also be useful in adding a depth component to an area source as it relates to the mixing of moving exhaust plumes from mobile sources within the defined area source.

If the source parameters for a representative mobile source IC engine are known or can be estimated, these values can be used in EPA's SCREEN3 model to estimate the plume rise (for release height) and sigma z components (for Szinit parameter) to be used in the area source. It is recommended that an AERMOD test case be designed to evaluate the ground level impacts of an area source consisting of mobile sources versus equivalent stationary point source impacts. It is expected that the area source impacts will fall within a range of plus 25% to plus 100% of the point source impacts, due to the uncertainty of equipment locations. Modeled mobile area source impacts should never be less than the equivalent stationary point source impacts.

Note: If stacks are rain capped or release horizontally, the area source release height should be adjusted accordingly. If using SCREEN3 plume height for the determination, the stack velocity should be adjusted to 0.001 m/s.

3.9 Building Impacts

Buildings and other structures near a relatively short stack can have a substantial effect on plume transport and dispersion, and on the resulting ground-level concentrations. Building downwash for point sources that are within the area of influence of a building must be considered when running AERMOD. A building is considered sufficiently close to a stack to cause wake effects when the distance between the stack and the nearest part of the building is less than or equal to five times the lesser of the building height or the projected width of the building (PBW), as described in the following equation:

$D \leq 5L$, where:

D = shortest distance from the exhaust stack to the building

L = lesser of the building height and projected building width (PBW)

PBW = maximum cross-sectional length of the building; for rectangular buildings,
 $PBW = (\text{length}^2 + \text{width}^2)^{0.5}$

The PBW is the maximum length of a building that could affect air flow around and over the structure. Include all buildings that may cause downwash for any point source in the model. AERMOD requires the user to input the UTM coordinates for all building corners and the height of each building. For buildings with more than one height or roofline, the UTM coordinates and height are required for each building tier. Use AERMAP (see Section 3.12) to add baseline elevations for building corners or enter appropriate baseline elevations for new constructions involving terrain changes.

3.10 Receptors - Overview

There are many types of receptor options available in AERMOD including Cartesian Grids, Polar Grids, and Fenceline Grids; also, Discrete Receptors, which may be individually placed to evaluate a particular point of interest. Receptors must be appropriately configured to capture the point of maximum impact (PMI), the maximally exposed individual resident (MEIR), the maximally exposed individual worker (MEIW), and any sensitive receptors to be included in the analysis. As a rule of thumb, a Cartesian Grid should be designed for receptor spacing no larger than 25 meters out to 200 meters from the property boundary. Between 200 and 500 meters from the boundary, the spacing should be no larger than 50 meters. Between 500 and 2000 meters from the boundary, the receptor spacing should be no larger than 100 meters. If there are significant impacts near the edge of the grid, the grid must be extended farther. Fenceline receptor spacing should not exceed 20 meters.

There are however, situations where this general rule does not apply. For example, Power Plants or similar tall, hot, high flow point sources often have the highest impacts at locations that are far from the source. In situations like this, it may be helpful to start with a much coarser and larger grid to identify the potential impact zones, then target receptor gridding to capture maximum impacts. Conversely, for facilities with emissions only from short stacks or vents and a close property line a tighter receptor spacing may be required. Another example is spatial averaging in HARP2, which requires 5-meter receptor spacing.

Polar Grids are useful for identifying the distance from the source that maximum impacts occur. Polar Grids are particularly helpful when modeling portable equipment, so that minimum safe distances from receptors can be established for the equipment.

In all cases the goal is to identify the exposure to TACs that people could receive from air pollution sources. Since the most common pathway for this exposure is inhalation, it is recommended that a Flagpole Height of 1.5 meters be used for all receptors to approximate an average human breathing zone. The flagpole height may be adjusted as necessary for specific cases such as sensitive receptors.

3.11 Receptor Types

The types of receptors most commonly used for HRA modeling are as follows:

Residential Receptors: Receptors for onsite or offsite locations within the modeling domain where people live or spend the majority of their day. This may include indoor and outdoor areas. Generally, an appropriately spaced Cartesian grid covering areas identified as residential by recent aerial photography is adequate to determine the MEIR for a project. However, if the Cartesian grid receptors show the potential for a significant risk, it may require additional residential receptors to be placed. It is also useful to use multiple receptors, at various heights and locations for large multi-story residential buildings to capture impacts at different levels or areas of the building (assuming it has opening windows, deck doors, etc.) or to model roof air intakes for sealed buildings. Discrete receptors with flagpole heights should be used for this situation.

Worker Receptors: Receptors for each offsite location within the modeling domain where people work. This may include indoor and outdoor areas. Generally, an appropriately spaced Cartesian grid covering areas identified as work places by recent aerial photography is adequate to determine the MEIW for a project. As with the residential case, more receptors should be added as necessary to refine the MEIW.

Acute Receptors: Receptors for each offsite location within the modeling domain where an individual person or group of people may be exposed to toxic air contaminants for durations as short as 1 hour. An acute receptor location could be almost any off property location that is accessible to humans. However, discretion should be used as to the likelihood of exposure in certain cases, e.g. roadways, bodies of water, steep terrain, etc. The potential for even intermittent public exposure is the determining factor when designating acute receptor locations.

Sensitive Receptors: Receptors for each offsite location within the modeling domain where people with particular sensitivity to TACs are temporarily or permanently located. Sensitive receptors may include, but are not limited to the following categories:

- Schools
- Daycare Facilities
- Hospitals
- Care Facilities for Seniors or Disabled Persons

Depending on the requirements of HRA performed, Sensitive Receptors may or may not be used. For example, Students at K-12 Schools become Sensitive Receptors only when a project emitting TACs is proposed for a location within 1,000 feet of the school. For Rule 11-18 or Air Toxics “Hot Spots” HRAs, all of these categories would become Sensitive Receptors and have special requirements.

On-site Receptors: In some situations, receptors inside the facility boundary will need to be evaluated. Examples of these situations include the following:

- Residential receptors for each onsite building in which people sleep (e.g., dormitories at colleges and housing on military bases).
- Residential receptors for each onsite residential building if it is not owned by or monetarily tied (lease agreement, etc.) to the facility being evaluated.
- Sensitive receptors for each onsite school, daycare, hospital or adult/elderly care facility where people sleep or spend the majority of their day.
- Worker receptors for each onsite area where a person works if they are not employed by or monetarily tied to the facility being evaluated (e.g. employees of restaurants located at airports, etc.).

Census Receptors: Census receptors are required for calculating the cancer burden and population exposure for some HRAs, such as those performed for AB2588 Air Toxics “Hot

Spots". Census receptors are required to be included over the entire 1.0 per million cancer risk isopleth and the hazard index of 0.5 for the chronic noncancer risk isopleth.

3.12 AERMAP – Adding Terrain Data

All sources, buildings and receptors are required to have a base elevation, which is affected by the terrain of the site. Terrain elevations can have a large impact on the air dispersion modeling results. Therefore, it is important to consider the relative differences between the elevations of emissions sources and the receptors impacted by those sources. AERMAP is the terrain preprocessor used by AERMOD to add actual elevation values to all sources, receptors, buildings, and other objects included in the model. In addition, AERMAP provides elevations to terrain features (hill heights) that may be important in the dispersion calculations.

BAAQMD maintains a set of one third arc second (10 meter) resolution National Elevation Dataset (NED) files in .tif format that meet most of the modeling needs in the Bay Area. However, in some cases where the modeling domain may extend beyond the boundaries of the BAAQMD, NED data from the USGS can be downloaded through the landfire.gov website. It is critical that the elevation data be in UTM NAD83 or WGS84 format or that it is converted to NAD83 or WGS84.

Modeling Domain, 10% Slope Rule Guidance: Section 2.1.2 of the AERMAP User's Guide (EPA, 2018c) states that the DEM array and domain boundary must include all terrain features that exceed a 10% elevation slope from any given receptor. The 10% slope rule may lead to excessively large domains in areas with considerable terrain features (e.g., fjords, successive mountain ranges, etc.). In these situations, the reviewing authority may make a case-by-case determination regarding the domain size needed for AERMAP to determine the critical dividing streamline height for each receptor. (*Ref. AERMOD Implementation Guide Section 4.2, April 17, 2018*)

Due to the presence of significant terrain features in the Bay Area, the domain size based on the 10% rule can be quite significant, to the point where it may take days to process all of the terrain data for a large project. BAAQMD has found that for most projects a domain 2 to 3 times the size of the modeled receptor area is sufficient. However, the general policy is to attempt to process terrain based on the 10% rule first. Another option would be to reduce receptors by processing terrain for a coarse grid using the 10% rule, then again for a smaller refined grid targeting specific areas.

3.13 AERMET – Choosing Meteorological Data

BAAQMD currently maintains AERMOD ready meteorological data sets for 35 sites in the Bay Area. There are (11) Primary Meteorological Sites at Airports, (14) Onsite Meteorological Sites at Major Facilities, and (10) Onsite Meteorological Sites maintained by BAAQMD. See Below.

Primary Meteorological Sites

File Name	Site Name	UTM (East) (meters)	UTM (North) (meters)	Base El. (meters)
KCCR	Concord-Buchanan Field	583,186	4,205,316	5.5
KDVO	Gross Field	539,024	4,221,638	1.0
KWHD	Hayward Air Terminal	577,700	4,168,482	13.1
KLVK	Livermore Municipal Airport	604,495	4,172,427	119.8
KNUQ	Moffet Federal Airfield	584,163	4,140,329	11.9
KAPC	Napa County Airport	563,001	4,229,077	4.3
KOAK	Oakland International Airport	567604	4,174,784	1.8
KSFO	San Francisco International Airport	555,987	4,163,804	2.4
KSJC	San Jose International Airport	595,250	4,135,286	15.5
KSTS	Sonoma County Airport	516,476	4,261,713	34.7
KSUU	Travis Air Force Base	595,964	4,237,499	18.9
Onsite Meteorological Sites (Major Facilities)				
CHEVRON	Chevron Refinery	585,265	4,199,547	1.5
CP_CARBON	Conoco Philips Carbon	544,029	4,174,288	24.1
CP_CUMMINGS	Conoco Philips Cummings	607,194	4,171,841	225.2
CP_HILLCREST	Conoco Philips Hillcrest	553,263	4,180,642	22.9
CP_RODEO	Conoco Philips Rodeo	563,139	4,236,960	10.7
GE_REFINERY	Golden Eagle Refinery	566,119	4,152,498	3.0
SHELL_EAST	Shell East	624,325	4,105,311	5.0
SHELL_WEST	Shell West	520,806	4,252,148	1.0
VALERO_ADMIN	Valero Administration Building	546,045	4,220,545	54.9
VALERO_WAREHOUSE	Valero Warehouse	580,905	4,231,416	15.2
CC_POWER	Contra Costa Power	566,808	4,217,464	3.0
DOW	Dow Chemical	585,265	4,199,547	3.0
PITTSBURG	Pittsburg PG&E	544,029	4,174,288	0.0
OAKLAND_STP	Oakland Sewage Treatment Plant	607,194	4,171,841	1.0
Onsite Meteorological Sites (BAAQMD)				
CONCORD	Concord	585,265	4,199,547	23.6
FT_FUNSTON	Fort Funston	544,029	4,174,288	57.0
LIVERMORE	Livermore Rincon	607,194	4,171,841	137.2
NAPA_COLLEGE	Napa College	563,139	4,236,960	1.8
SAN_CARLOS	San Carlos	566,119	4,152,498	1.0
SAN_MARTIN	San Martin	624,325	4,105,311	85.3
SANTA_ROSA	Santa Rosa	520,806	4,252,148	29.3
SONOMA_BAYLANDS	Sonoma Baylds	546,045	4,220,545	0.1
SUISUN_STP	Suisun STP	580,905	4,231,416	5.3
VALLEJO	Vallejo	566,808	4,217,464	6.0
NAPA_COLLEGE	Napa College	563,139	4,236,960	1.8
NUMMI*	Former NUMMI Plant (Tesla)	593,516	4,151,089	9.1

* The NUMMI meteorological tower has been removed. There is however a reprocessed 4-year AERMET set available for use for projects in the Fremont area. This data has been reviewed by Air District staff and determined to be acceptable for projects not subject to 40 CFR Part 51 Appendix W, Guideline on Air Quality Models.

Guidance for Selecting a Representative Meteorological Site: Selecting a representative meteorological set for AERMOD modeling should be on a case-by-case basis, due to the uneven coverage of meteorological towers and the complex terrain in the San Francisco Bay Area. Tools such as a blob map are useful, but narrowly represent

winds near the meteorological site or within the terrain-defined basin the tower resides. Uncertainty in model applications outside of these blobs cannot be readily estimated. However, experiments can be designed to estimate the upper and lower bounds of uncertainty. The points given below should be considered when determining a representative meteorological dataset.

1. Wind roses and terrain elevation should be evaluated together when selecting a meteorological set for AERMOD.
 - a. Investigate the wind rose at meteorological sites in surrounding areas of the source site and determine if the wind speeds and directions will be similar at the source site. Do this for each meteorological site that may be considered representative.
 - b. Look for similarities and differences in terrain elevation between the source and meteorological sites. Be aware of any significant terrain barriers between the two sites.
2. When there are significant differences between the project site and the closest meteorological tower in terms of terrain elevation and land use, it is recommended that AERMOD be run with meteorological inputs from multiple nearby sites. The resulting concentration estimates should be compared against each other and also be used to determine the upper and lower bounds of uncertainty. This information could help with the risk analysis and in deciding to use a screening approach. Consider the following in deciding if multiple meteorological data sets need to be applied.
 - a. A meteorological site may be in close proximity to the source site, but a terrain barrier between the two locations can make the closest meteorological station a poor choice.
 - b. There will be situations where there are no close proximity meteorological towers to the source site. In that case, AERMOD should be tested with farther meteorological sites that may have similar terrain orientation and/or land use types.
 - c. Unless the source site has its own meteorological tower, it is unlikely that land use will be a close match between the two locations. In that case, item 3 below should be followed.
3. If land use is considerably different between the source site and meteorological site, assess if this difference will be significant to the model results. Meteorological site land use characteristics (surface roughness, albedo, and Bowen ratio) are used for estimating unmeasured meteorological parameters such as mixing height and the vertical temperature gradient, due to surface heat flux, and mechanical mixing, due to surface roughness. Keep in mind the following when evaluating land use.
 - a. Mixing height and the vertical temperature gradient will not significantly change within 10-20 miles of the meteorological site. An important exception to this

- assumption is if there is a significant terrain barrier between the source and meteorological sites.
- b. Mechanical mixing can be significantly different if there are large differences in nearby upwind land use and terrain roughness. If the land use is different, but the roughness is similar in scale, such as water versus open or grassy flat terrain, mechanical mixing will not be significantly different.
4. No changes will occur in the upper air data from one meteorological site to the next. The Oakland sounding data are used for all the meteorological sites in the entire Bay Area. This means there will be no differences in any upper air parameters from source to source.
 5. The current blob map can still be used for those processed sites that have blobs. However, the blob maps are unavailable for meteorological sites recently added to the AERMOD site list. The creation of blob maps is a time-consuming process with limited applicability in selecting representative meteorological data. Therefore, there is no current plan to create additional blobs for newly added sites.

3.14 Modeling Non-Continuously Operating Sources

Chronic Risk Scenarios: Air dispersion modeling for chronic risk scenarios is typically run using the unit emission rate of 1.0 gram/second (g/s) for 24 hours a day, 365 days a year (i.e. 8760 hours/year). However, when source emissions are not continuous and are variable on a consistent basis, such as regular facility operating hours, it may be useful to adjust the emissions rates based on the hours of the day that the source normally operates. This can better align the source emissions to the meteorological conditions that are typical for certain times of the day.

In HARP2, risk assessment for chronic exposures is based on continuous source operation at 1.0 g/s; equivalent to 31,536 kg/year (i.e. 1 g/s x 3600 seconds/hour x 8760 hours/year). Therefore, if using variable emissions, the annual unit emissions for each source must still add up to 31,536 kg/year. This means that for every hour that is not included due to non-operation, the operating hours must be adjusted accordingly to ensure that the annual unit emission rate still equals 31,536 kg. For example, the HROFDY (Hour of Day) option in AERMOD allows the user to select the emission rate factor for certain hours of the day. The total emission rate factor (n) for the entire day is equal to 24 for the Hour of Day option. Therefore, for a source operating 12 hours a day (from 6AM to 6PM), 365 days a year, the user should input a factor of 2 for each hour that the source operates; $n = 2 \times 12 = 24$.

Maximum Hourly Risk Scenarios: When emissions vary by hour and are adjusted as described above, a second dispersion modeling run is required for the maximum hourly emissions (i.e., for the acute non-cancer risk). Specifically, the user must enter a value of 1 for the times during which the source is emitting and a value of 0 for the times during which the source is not emitting. For the acute HI, the modeled unit hourly emission rate must never exceed 1.0 or the acute HI will be overestimated.

It is important to note that the hours of the day displayed in AERMOD correspond to the hour *ending* at the time displayed. Therefore, hour 7 corresponds to the hour from 6AM to 7AM, and hour 18 corresponds to the hour from 5PM to 6PM.

4. Health Risk Assessment (HRA)

The HRA must be consistent with the methodology presented in BAAQMD Air Toxics NSR Program Health Risk Assessment Guidelines (or BAAQMD HRA Guidelines), which generally conform with the *OEHHA Air Toxics Hot Spots Program Risk Assessment Guidelines: The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments* (Office of Environmental Health Hazard Assessment, “OEHHA” 2015) for sites other than gasoline dispensing facilities (GDF). The Air District is currently using an alternative methodology for GDFs that is a hybrid of the 2003 OEHHA Guidelines and the 2015 Health Effects Values. This GDF HRA methodology is explained in detail in the BAAQMD HRA Guidelines.

4.1 HARP2 Requirement – Regulation 11, Rule 18 HRAs

To provide consistent verifiable results and a common data output format, BAAQMD is requiring that the California Air Resources Board Hotspots Analysis and Reporting Program Version 2 (HARP 2) be used for all HRAs conducted for the purposes of Regulation 11, Rule 18 “Reduction of Risk from Air Toxic Emissions at Existing Facilities”. The most recent version of the HARP2 Air Dispersion Modeling and Risk Tool (ADMRT) shall be used to perform the risk calculations for Regulation 11-18 HRAs using the functions available under the “Import/Calc GLCs” and “Risk Analysis” tabs. AERMOD air dispersion modeling may be conducted within the ADMRT or imported from another AERMOD program using the “Period” and “1-Hour” output PLOTFILES for each source in .PLT format.

4.2 HARP2 – BAAQMD Health Values Table

Since BAAQMD publishes health effects values in Table 2-5-1 of Regulation 2, Rule 5 “New Source Review of Toxic Air Contaminants” these “health values” become a requirement of the regulation that can only be changed through the rule development process and with the approval of the Air District’s Board of Directors. Therefore, when OEHHA makes a change to a health value, there will be a delay until Table 2-5-1 is updated through a rule change. Because of this, BAAQMD uses a separate health values table in HARP2. To access the table from the ADMRT, select “File” (upper left-hand corner), “Settings”, then check the box for “Use Bay Area AQMD approved health table”.

4.3 HARP2 – ADMRT Risk Analysis Settings

The optional settings in the ADMRT “Risk Analysis” tab that are recommended by BAAQMD are discussed in this section. Some settings vary by the risk scenario chosen.

4.3.1 “Intake Rate Percentile” is an option on the “Select Risk Scenario” screen that allows the user to select exposure options for Cancer and Chronic (non-cancer) risk scenarios. For cancer risk, BAAQMD recommends the following Intake Rate Percentile settings:

- Residential Cancer Risk (Individual or Population-Wide): Risk Management Policy (RMP) Method; Version (1) “RMP – Inhalation Only” or Version (2) “RMP Derived”
- Worker Cancer Risk – Residential and Worker Chronic HI: OEHHA Derived Method

Risk Management Policy: The policy uses the 95th percentile daily breathing rate (DBR) for the most sensitive age groups (i.e., last trimester to birth and ages 0 to 2 years old) and uses the 80th percentile DBR for all other age groups (i.e., greater than age 2). The 95/80 DBR policy follows the model for the OEHHA derived approach to risk assessment which uses the high-end point estimate of exposure for the two driving exposure pathways and the average point-estimates for the remaining exposure pathways (OEHHA, 2015). The 95/80 DBR policy follows this same concept by not using only high-end assumptions. The 95/80 DBR policy uses the high-end DBRs for the most sensitive age groups and uses the 80th percentile DBRs for the remaining age groups. Both methods are intended to reduce conservatism by not using only high-end assumptions, yet remaining health protective. There are two RMP options in HARP2:

- RMP – Inhalation Only is intended for Inhalation Only pathway pollutants, the breathing rate is the 95th percentile for age groups less than 2 years old and the 80th percentile for age groups that are greater than or equal to 2 years old.
- RMP Derived is intended for Multi-pathway pollutants, the breathing rate is the 95th percentile for age groups less than 2 years old and the 80th percentile for age groups that are greater than or equal to 2 years old only if inhalation is one of the driven pathways, otherwise, the inhalation pathway uses the 65th percentile breathing rate.

Note: RMP Derived is equivalent to RMP - Inhalation Only; whenever inhalation is a driven pathway, so its use does not need to be limited to situations where multi-pathway pollutants are present.

OEHHA Derived Method: In cancer risk assessments, the derived method uses the high-end point estimate (i.e., 95th percentile) for the *two* driving (dominant) exposure pathways (e.g., soil and breast milk) and the mean (65th percentile) point estimate for the remaining pathways. In non-cancer chronic assessments, the inhalation pathway is always considered a driving pathway, the next two risk driving pathways will use the 95th percentile, and the remaining pathways will use the mean intake rate.

4.3.2 “Pathways to Evaluate”

There are many exposure pathways by which humans may be exposed to airborne chemicals. Therefore, the module provides four types of pathway assessments to choose from:

1. **Inhalation Only** will account for inhaled toxics and no other pathways of exposure.
2. **Mandatory Minimum Pathways** will activate the four minimum exposure pathways required by OEHHA to conduct a health risk assessment for residents, when multi-pathway pollutants are involved. These include inhalation, soil, dermal, and mother’s milk.
3. **Worker Pathways** are used for potential exposure at the workplace during working hours. Worker pathways are inhalation, soil, and dermal.
4. **User Defined** allows you to choose your pathways, but always includes **Inhalation**.

Mandatory Exposure Pathways

For all multi-pathway substances, the exposure pathways that must be evaluated at every residential and worker site (in addition to inhalation) are soil ingestion and dermal exposure. If polycyclic aromatic hydrocarbons (PAHs) and creosotes, lead, dioxins, furans, or polychlorinated biphenyls (PCBs) are emitted, then the breast-milk consumption pathway is also evaluated.

The other exposure pathways (e.g., ingestion of homegrown produce or fish) are site specific. If the resident can be exposed through an impacted exposure pathway, then it should be included in the health risk assessment. Consult with the reviewing authority to determine which pathways must be considered.

The table below identifies the residential receptor exposure pathways that are mandatory and those that are dependent on the available routes of exposure. It also identifies the three exposure pathways that are relevant for a worker receptor. While residents can be exposed though several exposure pathways, worker receptors are only evaluated for inhalation, soil ingestion, and dermal exposure using point estimates.

Mandatory and Site/Route Dependent Exposure Pathways ¹	
Mandatory Exposure Pathways	Site/Route Dependent Exposure Pathways
<ul style="list-style-type: none"> • Inhalation^W • Soil Ingestion^W • Dermal Exposure to Contaminated Soil^W • Breast Milk Consumption* 	<ul style="list-style-type: none"> • Homegrown Produce Ingestion • Angler-Caught Fish Ingestion • Drinking Water Ingestion • Home-Raised Animal Product Ingestion (Dairy (Cow’s) Milk, Meat (Beef, Pork, Chicken) and Egg)

(1) OEHHA Guidance Manual, Table 8.6 Mandatory and Site-Route Dependent Exposure Pathways.

(w) Identifies the appropriate exposure pathways that should be evaluated for a worker. These pathways are inhalation, dermal exposure, and the soil ingestion pathway.

(*) If PAHs (including creosotes), lead, dioxins, furans, or PCBs are emitted, then the breast-milk consumption pathway becomes mandatory.

4.3.3 “Pathways to Evaluate” - Deposition Rate

A deposition rate must be chosen when determining potential multi-pathway health impacts. Use the conservative deposition rate of 0.05 m/s for the risk assessment if any multi-pathway pollutant (MPP) sources are uncontrolled. The deposition rate of 0.02 m/s may be used if all MPP sources have verifiable particulate matter control devices. Any uncontrolled MPP sources must only emit particulate matter that is less than 2.5 microns (e.g., internal combustion engines powered by compressed natural gas) in order to use the deposition rate of 0.02 m/s. If a deposition rate of 0.02 m/s is used for an uncontrolled device, a justification for its use should be part of the HRA report.

4.3.4 “Pathways to Evaluate” – Fraction of Time at Home

Under the Inhalation tab (Inh) there are 2 options under the “Fraction of time at home” heading:

1. Apply fraction of time at residence to age bins less than 16 years
2. Apply fraction of time at residence to age bins greater or equal to 16 years

If you are conducting an assessment for a residential receptor, the **Fraction of time at home** (FAH) is used to adjust exposure duration. This is based on the assumption that exposure to a toxic air contaminant is not occurring away from home. By age group, apply the fraction of time at residence if you wish to assume that the individual spends only part of his or her day at home. It is BAAQMD’s policy that only option 2 (age bins greater or equal to 16 years) be selected for Tier 1 assessments. This means that the residential exposure assumption will be 73% for age bins 16 years and older; and 100% for age bins less than 16 years. However, under the BAAQMD HRA Guidelines Section 2.3.1, the FAH for age bins less than 16 years can be refined using Tier 2 options if there are no schools within one in a million or greater cancer risk isopleths. This option allows a reduction of assumed exposure and is less conservative than the Tier 1 option.

4.3.5 “Pathways to Evaluate” – Worker Adjustment Factor (WAF)

When modeling a non-continuously emitting source (e.g., operating for eight hours per day and five days per week), the modeled long-term average concentrations are based on 24 hours a day and seven days per week for the period of the meteorological data set, even if the emitting source is modeled using a non-continuous emissions schedule. This does not affect residential exposure because it is assumed that residents will be exposed to pollutant concentrations from all source emissions on an annual average basis. However, worker exposure to a non-continuous source may be much greater than that which is predicted by the standard exposure assumption values. For example, a worker whose schedule directly coincides with the source may be exposed to 100% of the annual source emissions (instead of 23% if the same emissions occurred evenly over an entire year) because the worker is always present when the source operates.

To address this discrepancy, a worker adjustment factor (WAF) is applied in HARP2 to align actual worker exposure to annual source operation. This WAF is for worker cancer risk only. The WAF does not apply to the worker chronic or acute non-cancer risk, or to the residential risk. Enter the WAF under the Inhalation tab (Inh). Select “Use adjustment factors”, then enter the calculated value.

The worker adjustment factor for cancer risk is calculated as follows:

$$\mathbf{WAF}_{\text{cancer}} = \frac{\mathbf{H}_{\text{resident}}}{\mathbf{H}_{\text{source}}} \times \frac{\mathbf{D}_{\text{resident}}}{\mathbf{D}_{\text{source}}} \times \mathbf{DF}$$

Where: $\mathbf{WAF}_{\text{cancer}}$ = the worker adjustment factor for cancer risk

$\mathbf{H}_{\text{resident}}$ = the number of hours per day on which the long-term residential concentration is based = 24 hours

$\mathbf{H}_{\text{source}}$ = the number of hours per day that the source operates

$\mathbf{D}_{\text{resident}}$ = the number of days per week on which the long-term residential concentration is based = 7 days

$\mathbf{D}_{\text{source}}$ = the number of days per week that the source operates

\mathbf{DF} = the discount factor (default value is 1)

To refine the discount factor for situations where the worker is not present at all times that the source is operating, use the equation below:

$$\mathbf{DF} = \frac{\mathbf{H}_{\text{coin}}}{\mathbf{H}_{\text{worker}}} \times \frac{\mathbf{D}_{\text{coin}}}{\mathbf{D}_{\text{worker}}}$$

Where: \mathbf{DF} = the discount factor

\mathbf{H}_{coin} = the number of hours per day that the offsite worker's schedule and the source's emissions schedule coincide

$\mathbf{H}_{\text{worker}}$ = the number of hours that the offsite worker works per day

\mathbf{D}_{coin} = the number of days per week that the offsite worker's schedule and the source's emissions schedule coincide

$\mathbf{D}_{\text{worker}}$ = the number of days that the offsite worker works per week

WAF Example:

For the simplest case where the source and the offsite worker have the same schedules (8 hrs/day, 5 days/week, 50 weeks/year; i.e. no discount factor), the worker adjustment factor will be:

$$\begin{aligned}
 \text{WAF}_{\text{cancer}} &= \frac{H_{\text{resident}}}{H_{\text{source}}} \times \frac{D_{\text{resident}}}{D_{\text{source}}} \times \text{DF} \\
 &= \frac{24 \text{ hours}}{8 \text{ hours}} \times \frac{7 \text{ days}}{5 \text{ days}} \times 1.0 = 4.20
 \end{aligned}$$

This example emphasizes the importance of the WAF for non-continuous source operation. If this exposure adjustment was not included, the worker cancer risk would have been underestimated by 420%.

Adjusting Worker Exposure for Individual Sources in Multi-Source Assessments: When assessing a project in HARP2 that includes both continuous and non-continuous sources, the WAF adjustment under the Inhalation tab is not appropriate because it will apply the adjustment to all sources and significantly overestimate the risk from the continuously operating sources. One way of handling this situation without additional dispersion modeling is to create a separate emissions inventory for Worker exposures and apply the appropriate WAF as a multiplier to the annual emission rate for each non-continuously operating source. Then recalculate ground level concentrations (GLCs) and run the Worker Cancer Risk scenario. CAUTION! Prior to running the Worker Chronic HI scenario, the annual GLCs for all sources must be at the original non-adjusted values because the WAF does not apply to the Chronic HI.

4.3.6 Spatial Averaging

Spatial averaging is a refinement to a risk assessment. It is performed after the initial HRA if the results show a significant cancer or chronic non-cancer risk. Spatial averaging cannot be used for 8-hour or acute non-cancer risk. It averages the air concentration over a small area, instead of a single point. A person, when home, will not spend all their time at one location within their residence; instead, residents spend time throughout their living areas. Likewise, some workers, such as agriculture field workers, may spend time in various locations throughout their work day.

Use a domain size of 20 meters by 20 meters with a grid spacing resolution of equal to or less than five meters for a residential or sensitive receptor. This domain represents an area that is approximately the size of a small urban lot. If part of the domain is out of the receptor's property boundary (e.g., domain covers part of two parcels), the grid points outside of the receptor's property must be omitted. If the risk with the omitted grid points shows a significant risk, then the grid may be repositioned so that the full 20-meter by 20-meter domain is only on the receptor's property. Although a domain size of 20 meters by 20 meters is generally appropriate for residential and sensitive receptors, there may be cases where that size is considerably larger than the receptor's actual living area. If the Air District finds that the modeled domain size is not representative of the area where the

receptor spends time, the Air District may require a smaller domain size or not allow spatial averaging.

4.4 HARP2 – ADMRT Risk Contributions

To make the HRA a more useful tool, it is necessary to identify the individual sources and pollutants that contribute the most to the overall facility risk. The ADMRT provides a convenient means of making this analysis under the “Risk Analysis”, “Press Calculate” tab. Once the highest receptor has been identified, a second run can be performed for that receptor that will include the risk contributions from each source included in the HRA as follows:

1. Under “Press Calculate”, select “Output risk by source (batch process) and “Output risk for a single receptor”.
2. Enter the receptor index number for the highest receptor.
3. Use a filename prefix that identifies the run (e.g. for Residential Cancer Risk Contribution, “ResCaCont” could be used).
4. Press “Calculate” and the ADMRT will individually calculate risk for each source at the designated receptor.
5. Go to the “hra” folder created by the ADMRT and find the files for each included source.
6. Copy and paste the results for each source into a separate spreadsheet to evaluate the risk contributions for each source to the total risk. This can be done for both source contributions and pollutant contributions.

The combined spreadsheet can be customized to fit the user’s needs. Examples of a cancer risk source contribution analysis and a cancer, chronic HI, Acute HI pollutant contribution analysis is included in Appendix B.

5. Health Risk Assessment Report

The HRA report is a summary of the methodology, assumptions, and findings of the HRA model. It should be presented in such a way as to provide all relevant information to the user in a consistent format and with sufficient detail to document the process and the decisions that lead to the findings. The detail included in the HRA Report will vary depending on the type of HRA and intended audience, but should include the following elements:

1. **Executive Summary**
2. **Purpose**
3. **Background**
4. **Source List - Emissions Inventory**
5. **Dispersion Modeling**
6. **HARP2 Risk Assessment**

7. Detailed Summary of Results

8. Conclusions

9. Appendices

5.1 Executive Summary

The Executive Summary should provide an overview of all relevant information included in the HRA including, but not limited to, the following:

- Facility information, including the name, address, and BAAQMD plant number.
- The purpose of this HRA: why it is required, applicable regulations, and how else it may be used.
- Describe the location of the facility and surrounding community. Identify sensitive receptors.
- A brief description of the plant operations, including what is produced or handled on site, and the potential for emissions of toxic air contaminants.
- Discussion of dispersion model, meteorological data, and model assumptions.
- The cancer, non-cancer chronic, and 1-hour acute risk values at the highest receptor for each category.
- A statement of compliance or non-compliance with regulatory requirements.
- A list of the sources and pollutants driving the risk for each risk category.
- Any notes or supporting information related to the HRA.

5.2 Purpose

This section shall explain the reason why the HRA is being conducted and shall describe the applicable regulations. Describe any applicable screening levels that may have been used to trigger the HRA. Provide citations for regulatory limits that the project or facility will be subject to. Describe any additional uses for this HRA.

5.3 Background

This section shall provide background information about the location of the project or facility including a description of the community and sensitive receptors. For Rule 11-18 HRAs, include background health risks in the community, if known. Also, provide general information about the facility or project. Describe materials used or produced and the general types of emissions and toxins that may be present.

5.4 Source List – Air District Approved Emissions Inventory

In this section each source included in the evaluation and its associated annual and maximum 1-hour emissions should be listed; preferably in tabular form. This allows the reader a clear and concise reference to what was evaluated in the HRA. Discuss any relevant information about alternate operating schedules, variable emission rates, etc. as they pertain to the HRA.

5.5 Dispersion Modeling

This section should discuss all relevant facts about the model itself and the options and inputs selected. Of particular importance is a discussion of the decision process for the selection of: (1) Meteorological Data and (2) the Rural / Urban land use designation, since these two items are likely to have the most impact on the overall results. Also important to discuss if applicable are: (3) decisions related to source types and locations, including release type for Point Sources (i.e. Default, Raincap, Horizontal) and the variable inputs used for Volume and Area Sources; (4) receptor placement and the any use of Flagpole heights; (5) selected Modeling Domain and justification for cases where the 10% Slope Rule is not used; (6) any use of Scalar Values or other factors that modify the output results from the Dispersion Model; and (7) any Non-Default options selected and the reason for each.

In addition to discussions of modeling decisions, the following specific information about the model and model inputs should be included:

- Version numbers for AERMOD and AERMET
- Coordinate system used (e.g. UTM NAD83)
- Name, location, and included years of meteorological data; also, whether the data includes the (u*) adjustment for surface friction
- Source of terrain data and horizontal resolution (e.g. National Elevation Dataset (NED), 1/3 arc second (10 meter) resolution)

5.6 HARP2 Risk Assessment

BAAQMD requires that the California Air Resources Board Hotspots Analysis and Reporting Program Version 2 (HARP 2) be used for all HRAs conducted for the purposes of Regulation 11, Rule 18 “Reduction of Risk from Air Toxic Emissions at Existing Facilities”. Therefore, this section is devoted to a discussion of the factors that went into determining risk values (Cancer, Chronic HI, Acute HI) for the HRA project. The following elements of the HARP2 Risk Assessment should be included in the HRA Report:

Standard Summary of Exposure Assumptions: Include the following statement:

“Health risk estimates were calculated in accordance with the BAAQMD’s Air Toxics NSR Program HRA Guidelines, dated December 2016. Estimates of residential risk assume potential exposure to annual average TAC concentrations occur 350 days per year, for 30 years. In addition, residential risk estimates assume a 95th percentile breathing rate for age groups younger than two years old, and 80th percentile breathing rate for age groups that are older than or equal to two years of age. Risk estimates for offsite workers assume potential exposure occurs 8 hours per day, 250 days per year, for 25 years. For offsite workers, the 95th percentile 8-hour breathing rate based on moderate activity was assumed. Residential cancer risk estimates include age sensitivity factors (ASFs) and fraction of time at home (FAH) adjustments. The ASFs are age-specific weighting factors used in calculating cancer risks from exposures of infants, children and adolescents, to reflect their anticipated special sensitivity to

carcinogens. Since worker exposure assumptions are based on a continuously operating source, a Worker Adjustment Factor (WAF) is added in cases where source operation is not continuous to account for higher than estimated coincident exposure to source emissions.”

Risk Scenario Settings: For each risk scenario calculated by HARP2 an output file is created and saved in the “hra” folder for the project. This file lists the settings used in the scenario and should be included in the HRA Report for each risk scenario.

Risk Contribution Analysis: Determining the emissions sources and pollutants that drive a facility’s toxic air contaminant risk to the public is vital to the risk reduction process. All BAAQMD HRAs should include this determination. HARP2 allows the user to make these determinations as discussed in Section 4.4. The risk contribution analysis procedures should be discussed in this section.

Note: HRAs conducted in accordance with Regulation 11, Rule 18 “Reduction of Risk from Air Toxic Emissions at Existing Facilities” must identify all sources that trigger TBARCT (cancer risk of 1 in a million or more, or chronic HI of 0.2 or more, or acute HI of 0.2 or more).

5.7 Detailed Summary of Results

The summary of results is a detailed report of the findings of the HRA and includes the maximum risk values at each receptor type (e.g. MEIR, MEIW, PMI, or Sensitive Receptors) included in each type of health risk assessment and the sources and pollutants that contribute to this risk for each category.

For Rule 2-5 toxic new source review HRAs, present project health risks for each receptor type and source risks for each source in the project.

For Rule 11-18 facility-wide HRAs, the facility-wide HRA results shall be presented for stationary sources alone and for stationary source plus cargo carriers, ship hoteling, portable and temporary sources (if these additional emission sources are present). HRA results for stationary sources alone will be compared to Rule 11-18 risk action levels. For the more comprehensive HRA that also includes mobile and portable sources, explain the additional impacts on health risk and affected receptors. Also, identify each significant risk source and analyze the contributing pollutants. Identify any pollutants that are causing a source to have a significant health risk due to the inclusion of emissions data based on source test detection limits rather than measured values. Such sources will not be subject to TBARCT for that pollutant.

These results should be clearly stated and identify receptors and contributing sources by name and location in UTM coordinates. Tabular form is the preferred method of presenting these results. In addition, all findings should be supported by graphical depictions of receptor and source locations and include risk isopleths.

5.8 Conclusions

Identify the applicable regulatory limits and compare the HRA results from Section 5.7 to the applicable health risk limits or risk action levels. Describe all conclusions drawn from this comparison.

For Rule 2-5 toxic new source review HRAs, determine if the project will comply with health risk limits. Identify all sources that trigger TBACT. If the project does not comply with a health risk limit or a source triggers TBACT, the modeler may also include potential risk reduction strategies that may have been identified. For example:

- An increase of stack height or removal of rain cap
- Establishing a “safe” operating distance for mobile sources
- Amount of pollutant reduction required to achieve an acceptable risk level
- A change of operating schedule to reduce offsite worker exposure
- A refinement of source emissions that may have been overestimated

For Rule 11-18 HRAs, the HRA results shall be presented in context to background health risks for the Bay Area and for the community (if known). HRA results for the facility due to stationary sources alone shall be compared to Rule 11-18 risk action levels to determine if a risk reduction plan is required.

If a risk reduction plan is required, describe the sources, operations, and pollutants that are driving the health risk. Identify any potential risk reduction measures that have been planned or identified.

Based on the analysis of the sources with significant health risks, the modeler will identify all sources that are subject to TBARCT.

HRA results for stationary source plus cargo carriers, ship hoteling, portable and temporary sources (if these additional emission sources are present) shall also be discussed. These results are for informational purposes only and do not have an associated regulatory requirement.

5.7 Appendices

Appendices are used to include supporting documentation for the HRA. Examples of documents that should go in an Appendix are:

- AERMOD modeling files
- Wind rose for meteorological data
- AERSURFACE output files
- HARP2 output files
- Correspondence related to the HRA

APPENDIX A

AERSURFACE Land Use Procedure

AERSURFACE uses land cover data from the U.S. Geological Survey (USGS), National Land Cover Database (NLCD). The Air District has adopted NLCD_2016 as the best comprehensive land cover data currently available. This data is used to determine the types of land cover present at and around a user-specified location. AERSURFACE matches the NLCD_2016 land cover categories to the surface characteristics of the land cover in the study area and assigns land cover counts for each category. NLCD_2016 has 4 categories of land cover data related to developed land as described below.

NLCD_2016 Developed:

21: Developed, Open Space - areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.

22: Developed, Low Intensity - areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover. These areas most commonly include single-family housing units.

23: Developed, Medium Intensity - areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units.

24: Developed, High Intensity -highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover.

In comparison, the Auer Urban Categories are described as follows:

I1: Heavy Industrial - Major chemical, steel, and fabrication industries; generally 3-5 story buildings, flat roofs. Grass and tree growth extremely rare; <5% vegetation

I2: Light-moderate Industrial - Rail yards, truck depots, warehouses, industrial parks, minor fabrications; generally, 1-3 story buildings, flat roofs. Very limited grass and trees; <5% vegetation

C1: Commercial - Office and apartment buildings, hotels; >10 story heights, flat roofs. Limited grass and trees; <15% vegetation

R2: Compact Residential - Single, some multiple, family dwelling with close spacing; generally, <2 story, pitched roof structures; garages (via alley), no driveways. Limited lawn sizes and shade trees; <30% vegetation

R3: Compact Residential - Old multi-family dwellings with close (<2 m) lateral separation; generally, 2 story, flat roof structures; garages (via alley) and ashpits, no driveways. Limited lawn sizes, old established shade trees; <35% vegetation

Based on this comparison, the Air District considers NLCD_2016 categories 23 (Developed Medium Intensity) and 24 (Developed High Intensity) to be Urban for the purpose of determining AERMOD dispersion algorithms. The example below shows Land Cover Counts from an AERSURFACE run modified to estimate the percentage of land cover that falls into an “Urban” category as suggested by the Auer land use procedure:

UTM Easting (meters): 571152.0
 UTM Northing (meters): 4175385.0
 UTM Zone: 10
 Datum: NAD83
 Study Radius for surface roughness (km): 3.0

NLCD

2016:	Land	Cover Counts: Surface Roughness	
	0	Missing, Out-of-Bounds, or Unde:	0
	11	Open Water:	2691
	12	Perennial Ice/Snow:	0
	21	Developed, Open Space:	1544
	22	Developed, Low Intensity:	3403
	23	Developed, Medium Intensity:	11922
	24	Developed, High Intensity:	9909
	31	Barren Land (Rock/Sand/Clay):	111
	32	Unconsolidated Shore:	0
	41	Deciduous Forest:	0
	42	Evergreen Forest:	0
	43	Mixed Forest:	0
	51	Dwarf Scrub:	0
	52	Shrub/Scrub:	0
	71	Grasslands/Herbaceous:	720
	72	Sedge/Herbaceous:	0
	73	Lichens:	0
	74	Moss:	0
	81	Pasture/Hay:	0
	82	Cultivated Crops:	793
	90	Woody Wetlands:	6
	91	Palustrine Forested Wetland:	0
	92	Palustrine Scrub/Shrub Wetland:	0
	93	Estuarine Forested Wetland:	0
	94	Estuarine Scrub/Shrub Wetland:	0
	95	Emergent Herbaceous Wetland:	313
	96	Palustrine Emergent Wetland (Pe:	0
	97	Estuarine Emergent Wetland:	0
	98	Palustrine Aquatic Bed:	0
	99	Estuarine Aquatic Bed:	0
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		Total:	31412
		Urban % =	69.50%

APPENDIX B Example HARP2 Risk Contribution Output

Cancer Risk By Source

Project Cancer Risk (Res): 4.40E-06															
*HARP - HRA Calc v17023 7/16/2018 4:15:15 PM - Cancer Risk - Input File: C:\HRSA - New\WP#4173\A#028172\RECOSF-7-12REV\hra\S20.ResCaContHRAInput.hra															
REC	GRP	NETID	X	Y	CONC	POLID	POLABBR	RISK_SUM	SCENARICDETAILS	INH_RISK	SOIL_RISK	DERMAL	MMILK_RI		
1054	S20			552970	4173770	0.091318	75070	Acetaldehy	6.18E-07	30YrCance	97.20%	6.18E-07	0.00E+00	0.00E+00	0.00E+00
1054	S20			552970	4173770	0.006849	67630	Isopropyl A	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S20			552970	4173770	1.171911	67561	Methanol	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S20			552970	4173770	9.13E-05	91203	Naphthaler	7.41E-09	30YrCance	1.17%	7.41E-09	0.00E+00	0.00E+00	0.00E+00
1054	S20			552970	4173770	0.001522	115071	Propylene	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S20			552970	4173770	0.000244	107051	AllylChlor	3.46E-09	30YrCance	0.54%	3.46E-09	0.00E+00	0.00E+00	0.00E+00
1054	S20			552970	4173770	0.000289	75150	CS2	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S20			552970	4173770	0.01248	108054	Vinyl Aceta	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S20			552970	4173770	0.042615	78933	MEK	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S20			552970	4173770	0.001979	108883	Toluene	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S20			552970	4173770	0.001172	100414	Ethyl Benz	6.90E-09	30YrCance	1.09%	6.90E-09	0.00E+00	0.00E+00	0.00E+00
1054	S20			552970	4173770	0.000563	1330207	Xylenes	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S20			552970	4173770	0.002892	100425	Styrene	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S20			552970	4173770	0.000654	95476	o-Xylene	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S20			552970	4173770	0.044137	7664417	NH3	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
									6.36E-07	14.45%	100.00%				
*HARP - HRA Calc v17023 7/16/2018 4:15:19 PM - Cancer Risk - Input File: C:\HRSA - New\WP#4173\A#028172\RECOSF-7-12REV\hra\S21.ResCaContHRAInput.hra															
REC	GRP	NETID	X	Y	CONC	POLID	POLABBR	RISK_SUM	SCENARICDETAILS	INH_RISK	SOIL_RISK	DERMAL	MMILK_RI		
1054	S21			552970	4173770	0.521471	75070	Acetaldehy	3.53E-06	30YrCance	97.07%	3.53E-06	0.00E+00	0.00E+00	0.00E+00
1054	S21			552970	4173770	0.040973	67630	Isopropyl A	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S21			552970	4173770	6.952947	67561	Methanol	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S21			552970	4173770	0.000546	91203	Naphthaler	4.44E-08	30YrCance	1.22%	4.44E-08	0.00E+00	0.00E+00	0.00E+00
1054	S21			552970	4173770	0.009436	115071	Propylene	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S21			552970	4173770	0.00149	107051	AllylChlor	2.12E-08	30YrCance	0.58%	2.12E-08	0.00E+00	0.00E+00	0.00E+00
1054	S21			552970	4173770	0.001738	75150	CS2	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S21			552970	4173770	0.074496	108054	Vinyl Aceta	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S21			552970	4173770	0.24832	78933	MEK	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S21			552970	4173770	0.011919	108883	Toluene	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S21			552970	4173770	0.006953	100414	Ethyl Benz	4.09E-08	30YrCance	1.13%	4.09E-08	0.00E+00	0.00E+00	0.00E+00
1054	S21			552970	4173770	0.003352	1330207	Xylenes	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S21			552970	4173770	0.017382	100425	Styrene	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S21			552970	4173770	0.003849	95476	o-Xylene	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S21			552970	4173770	0.260736	7664417	NH3	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
									3.63E-06	82.64%	100.00%				
*HARP - HRA Calc v17023 7/16/2018 4:15:23 PM - Cancer Risk - Input File: C:\HRSA - New\WP#4173\A#028172\RECOSF-7-12REV\hra\S24.ResCaContHRAInput.hra															
REC	GRP	NETID	X	Y	CONC	POLID	POLABBR	RISK_SUM	SCENARICDETAILS	INH_RISK	SOIL_RISK	DERMAL	MMILK_RI		
1054	S24			552970	4173770	0.018336	75070	Acetaldehy	1.24E-07	30YrCance	97.18%	1.24E-07	0.00E+00	0.00E+00	0.00E+00
1054	S24			552970	4173770	0.001383	67630	Isopropyl A	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S24			552970	4173770	0.234454	67561	Methanol	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S24			552970	4173770	1.83E-05	91203	Naphthaler	1.49E-09	30YrCance	1.17%	1.49E-09	0.00E+00	0.00E+00	0.00E+00
1054	S24			552970	4173770	0.000331	115071	Propylene	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S24			552970	4173770	5.11E-05	107051	AllylChlor	7.26E-10	30YrCance	0.57%	7.26E-10	0.00E+00	0.00E+00	0.00E+00
1054	S24			552970	4173770	5.71E-05	75150	CS2	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S24			552970	4173770	0.002495	108054	Vinyl Aceta	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S24			552970	4173770	0.008416	78933	MEK	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S24			552970	4173770	0.000391	108883	Toluene	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S24			552970	4173770	0.000234	100414	Ethyl Benz	1.38E-09	30YrCance	1.08%	1.38E-09	0.00E+00	0.00E+00	0.00E+00
1054	S24			552970	4173770	0.000111	1330207	Xylenes	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S24			552970	4173770	0.000571	100425	Styrene	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S24			552970	4173770	0.000129	95476	o-Xylene	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1054	S24			552970	4173770	0.009017	7664417	NH3	0.00E+00	30YrCance	0.00%	0.00E+00	0.00E+00	0.00E+00	0.00E+00
									1.28E-07	2.90%	100.00%				

Risk By Pollutant

Residential Cancer Risk:

Table with 17 columns: REC, GRP, NETID, X, Y, CONC, POLID, POLABBREV, RISK_SUM, SCENARIC, DETAILS, INH_RISK, SOIL_RISK, DERMAL_F, FMILK_RIS, WATER_RI, FISH_RISK. Rows include pollutants like Acetaldehyde, Isopropyl Alcohol, Methanol, Naphthalene, Propylene, AllylChlor, CS2, Vinyl Acetate, MEK, Toluene, Ethyl Benzene, Xylenes, Styrene, o-Xylene, and NH3.

Residential Chronic HI:

Table with 17 columns: REC, GRP, NETID, X, Y, CONC, POLID, POLABBREV, SCENARIC, CV, CNS, IMMUN, KIDNEY, GILV, REPRO/DE, RESP, DETAILS. Rows include pollutants like Acetaldehyde, Isopropyl Alcohol, Methanol, Naphthalene, Propylene, AllylChlor, CS2, Vinyl Acetate, MEK, Toluene, Ethyl Benzene, Xylenes, Styrene, o-Xylene, and NH3.

Acute HI:

Table with 17 columns: REC, GRP, NETID, X, Y, CONC, POLID, POLABBREV, SCENARIC, CV, CNS, IMMUN, KIDNEY, GILV, REPRO/DE, RESP, DETAILS. Rows include pollutants like Acetaldehyde, Isopropyl Alcohol, Methanol, Naphthalene, Propylene, AllylChlor, CS2, Vinyl Acetate, MEK, Toluene, Ethyl Benzene, Xylenes, o-Xylene, and NH3.