Model Report

Source Type

Gas station P/V valves were modeled as point sources for breathing losses and loading emissions and fueling and spillage and hose permeation losses were modeled as volume sources, following CARB's Gasoline Service Station Industrywide Risk Assessment Technical Guidance from February 2022. Table 14 and 15 below from the CARB technical report show the key parameters utilized, with the exception that the fueling, spillage and hose permeation release height were all assumed to be 1.25 m, and P/V vent exhaust temperature was modeled at 290 K for both loading and breathing losses for modeling simplicity.

P/V valves as point sources (can use Table 14 from CARB Gasoline Service Station 2022 Technical Guidance)

Table 14. Point Sources Parameters

Parameter	Loading	Breathing
Unit Rate Emission Factor (g/s)	1	1
Release Height (m)	3.66	3.66
Temperature (K)	291	289
Stack Diameter (m)	0.0508	0.0508
Exit Velocity (m/s)	0.001	0.001

Volume sources for fueling, spillage, hose permeation emissions 4 meters x13 meters long x 13 meters wide

Table 15. Volume Sources Parameters

Parameter	Fueling	Spillage	Hose Permeation
Height (m)	4	4	4
Width (m)	13	13	13
Length (m)	13	13	13
Sigma y[1] (dimensionless)	3.02	3.02	3.02
Sigma z[2] (dimensionless)	1.86	1.86	1.86
Release Height (m)	1.5	1	1.5

1. Sigma y is defined as the initial lateral dimension (length/4.3).
2. Sigma z is defined as the initial vertical dimension (height/2.15).

Receptors

The receptor grid utilized followed WA Department of Ecology's September 2010 (Revised August 2015) Guidance Document on First, Second, and Third Tier Review of Air Toxics guidelines which utilized a 12.5 meter spacing from 0-150 meter radius from the source, and then 25 meter spacing from 150-400 meter

radius from the source. PSCAA opted to maintain 25 meter spacing for the 400-500 meter range radius as well for consistency.

PSCAA modeled out to a 500 meter radius based on analyses completed in the CARB 2022 Technical Guidance which indicated that within 200 meters the zones of impact for a given station disaggregate from a group of stations, in the modeled scenarios completed by CARB. Given that cancer risk from gas stations decreases as the receptor moves further from the source, including a grid out 500 meters from the center of the station or stations is anticipated to model worst case concentrations.

Terrain

The reference point of the model was set with a location near Angle Lake and utilized available DEM dataset encompassing the area.

Meteorological Data

Seattle Tacoma International Airport meteorological data from 2017-2021 was utilized and was processed with AERMET 23132. For annual concentrations for a single gas station, the year 2020 yielded the worst-case highest concentration and year 2020 was utilized for meteorological data across the model cases for a single station. For annual concentrations for four combined stations, the year 2019 yielded the worst-case highest concentration and year 2019 was utilized for meteorological data across model cases for a 4 station configuration.

Cases

PSCAA modeled two different gas station configurations: (1) Single Station and (2) 4-Station Intersection. Within each configuration, PSCAA modeled four equipment specifications for Stage 2 vapor recovery: (A) EVR without vapor processor (B) EVR (C) Enhanced Conventional and (D) Conventional. For each equipment configuration, gas station throughput was varied: (i) 200,000 gal/yr, (ii) 840,000 gal/yr, (iii) 1,200,000 gal/yr, (iv) 3,600,000 gal/yr and (v) 6,000,000 gal/yr.

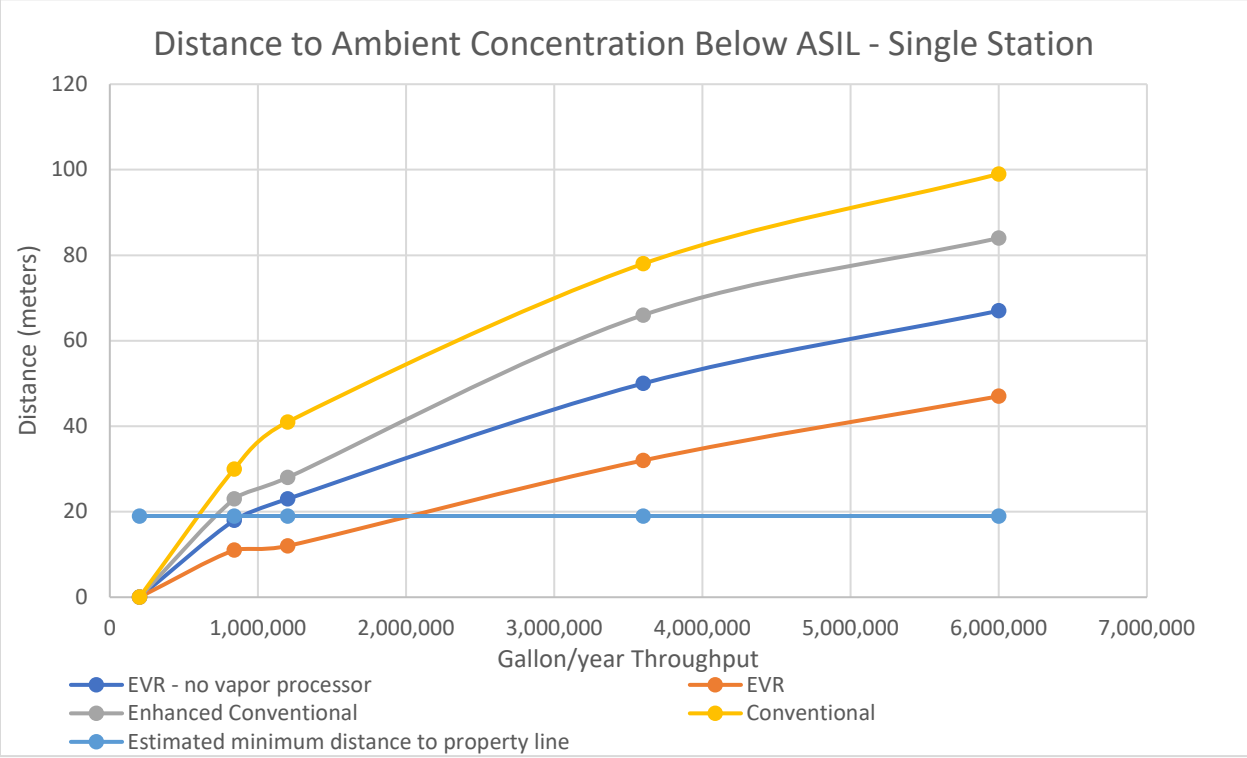
Single Station

A single station was also modeled with ~35 meters between the canopy (volume source) and the P/V valve at the facility.

Case	# Stations	Gal/yr-station	Equipment	PT Emission g/s	Volume Emission g/s	Max ug/m3
1.A.i	1	200,000	EVR w/out vapor processor	2.09E-06	1.97E-05	0.06301
1.A.ii	1	840,000	EVR w/out vapor processor	8.77E-06	8.27E-05	0.26453
1.A.iii	1	1,200,000	EVR w/out vapor processor	1.25E-05	1.18E-04	0.37744
1.A.iv	1	3,600,000	EVR w/out vapor processor	3.76E-05	3.55E-04	1.13552
1.A.v	1	6,000,000	EVR w/out vapor processor	6.27E-05	5.91E-04	1.89042
1.B.i	1	200,000	EVR	1.50E-06	9.79E-06	0.03142
1.B.ii	1	840,000	EVR	6.31E-06	4.11E-05	0.13189
1.B.iii	1	1,200,000	EVR	9.01E-06	5.87E-05	0.18837
1.B.iv	1	3,600,000	EVR	2.70E-05	1.76E-04	0.5648
1.B.v	1	6,000,000	EVR	4.50E-05	2.94E-04	0.94345

1.C.i	1	200,000	Enhanced Conventional	7.85E-06	1.94E-05	0.06333
1.C.ii	1	840,000	Enhanced Conventional	3.30E-05	8.16E-05	0.26637
1.C.iii	1	1,200,000	Enhanced Conventional	4.71E-05	1.17E-04	0.38187
1.C.iv	1	3,600,000	Enhanced Conventional	1.41E-04	3.50E-04	1.14238
1.C.v	1	6,000,000	Enhanced Conventional	2.36E-04	5.83E-04	1.90313
1.D.i	1	200,000	Conventional	7.85E-06	3.63E-05	0.11709
1.D.ii	1	840,000	Conventional	3.30E-05	1.53E-04	0.49309
1.D.iii	1	1,200,000	Conventional	4.71E-05	2.18E-04	0.70258
1.D.iv	1	3,600,000	Conventional	1.41E-04	6.54E-04	2.10768
1.D.v	1	6,000,000	Conventional	2.36E-04	1.09E-03	3.51303

The furthest distance from a single canopy of a station until modeled concentration at or below Acceptable Source Impact Level (ASIL) concentration for benzene was measured from contour plots and the distances are plotted below.

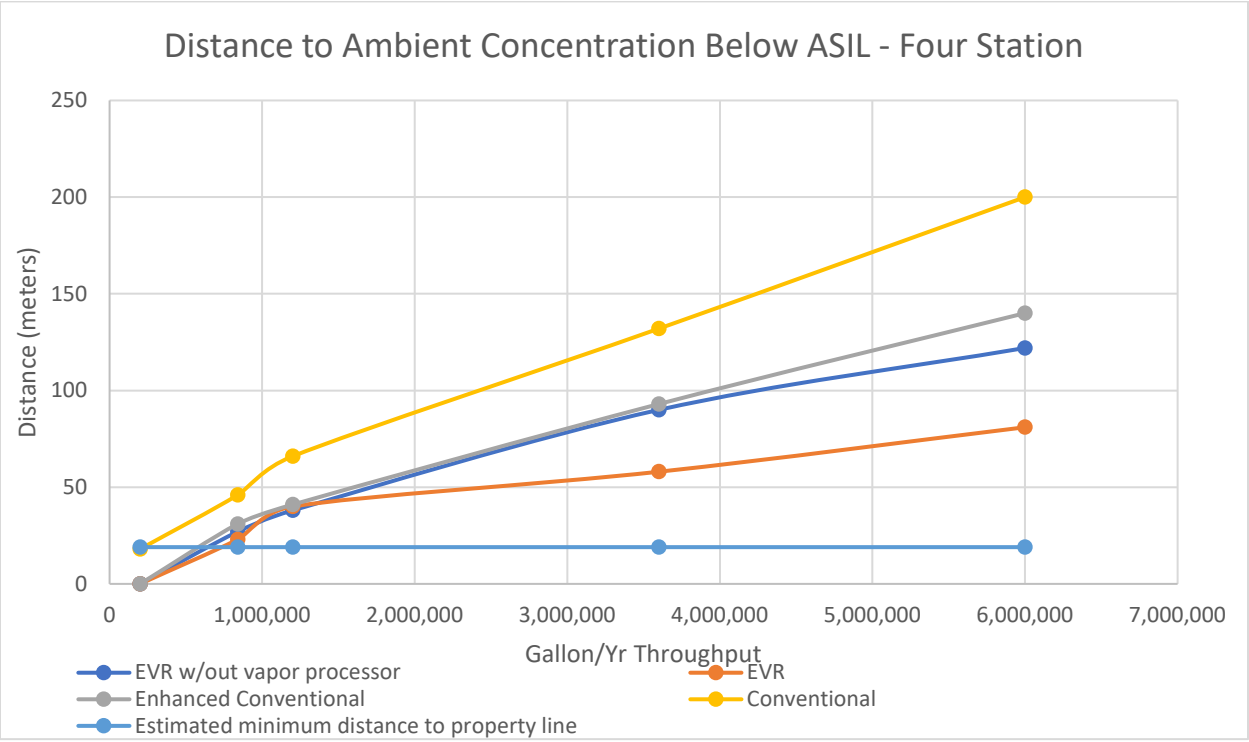


Four Station Intersection

Four stations were modeled with 40 meter distance between each canopy and with 50 meter distance between each P/V valve. P/V valves are often located closer to the edges of gas station property, and this configuration attempted to reflect the potential of closer proximity of P/V valves to surrounding receptors. Receptors were not placed between the four stations as this space is typically occupied by roads of an intersection.

Case	# Stations	Gal/yr-station	Equipment	PT Emission g/s	Volume Emission g/s	Max ug/m3
2.A.i	4	200,000	EVR w/out vapor processor	2.09E-06	1.97E-05	0.10312
2.A.ii	4	840,000	EVR w/out vapor processor	8.77E-06	8.27E-05	0.4329
2.A.iii	4	1,200,000	EVR w/out vapor processor	1.25E-05	1.18E-04	0.61766
2.A.iv	4	3,600,000	EVR w/out vapor processor	3.76E-05	3.55E-04	1.8582
2.A.v	4	6,000,000	EVR w/out vapor processor	6.27E-05	5.91E-04	3.09368
2.B.i	4	200,000	EVR	1.50E-06	9.79E-06	0.05203
2.B.ii	4	840,000	EVR	6.31E-06	4.11E-05	0.21843
2.B.iii	4	1,200,000	EVR	9.01E-06	5.87E-05	0.31197
2.B.iv	4	3,600,000	EVR	2.70E-05	1.76E-04	0.93535
2.B.v	4	6,000,000	EVR	4.50E-05	2.94E-04	1.56229
2.C.i	4	200,000	Enhanced Conventional	7.85E-06	1.94E-05	0.11132
2.C.ii	4	840,000	Enhanced Conventional	3.30E-05	8.16E-05	0.46822
2.C.iii	4	1,200,000	Enhanced Conventional	4.71E-05	1.17E-04	0.67098
2.C.iv	4	3,600,000	Enhanced Conventional	1.41E-04	3.50E-04	2.00738
2.C.v	4	6,000,000	Enhanced Conventional	2.36E-04	5.83E-04	3.34564
2.D.i	4	200,000	Conventional	7.85E-06	3.63E-05	0.11709
2.D.ii	4	840,000	Conventional	3.30E-05	1.53E-04	0.49309
2.D.iii	4	1,200,000	Conventional	4.71E-05	2.18E-04	0.70258
2.D.iv	4	3,600,000	Conventional	1.41E-04	6.54E-04	2.10768
2.D.v	4	6,000,000	Conventional	2.36E-04	1.09E-03	3.51303

The furthest distance from a single canopy of a station until modeled concentration at or below Acceptable Source Impact Level (ASIL) concentration for benzene was measured from contour plots and the distances are plotted below.

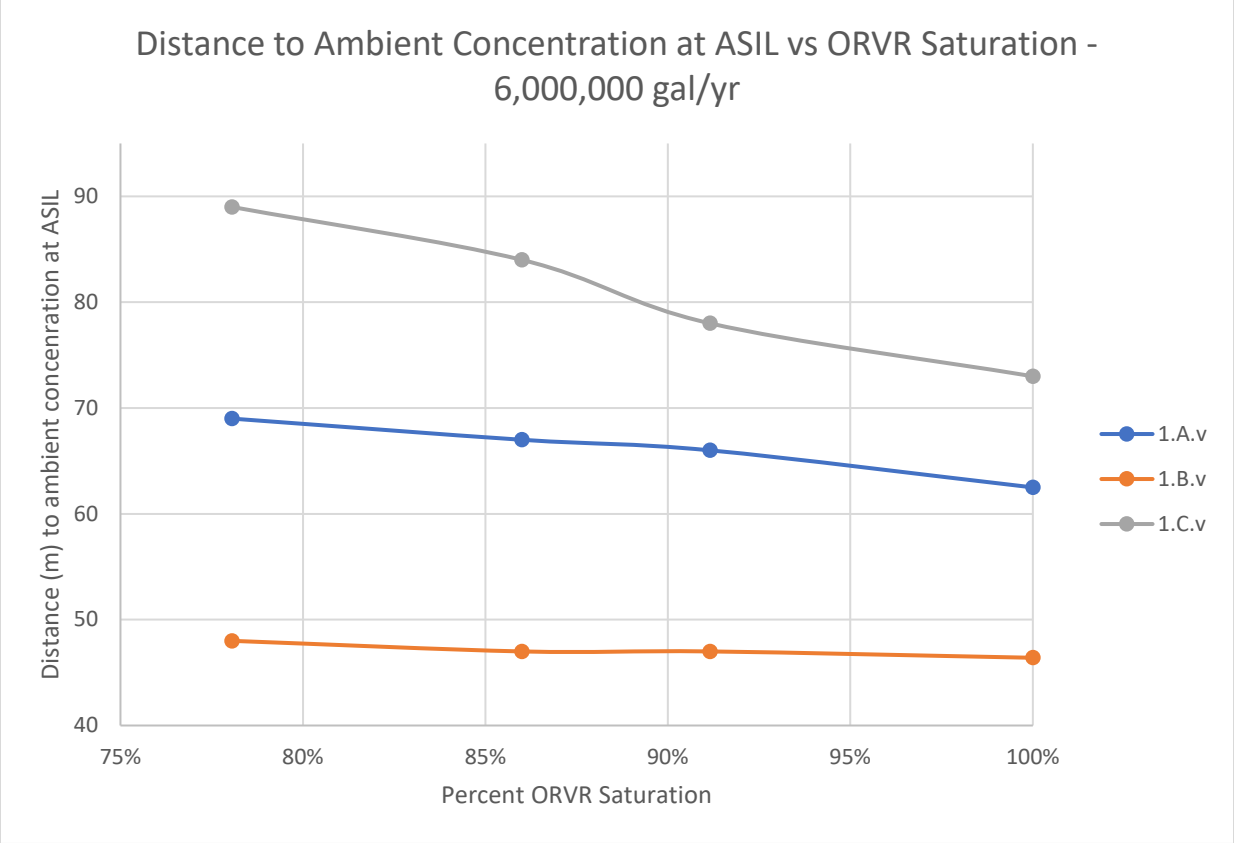


ORVR Saturuation Sensitivity Analysis:

The following model runs were selected for further review to assess the impact of ORVR saturation on ambient concentration of benzene. The value from the zip code with lowest observed ORVR saturation, the value from the zip code with highest observed ORVR saturation, and an assumed theoroetical maximum of 100% ORVR saturation were plotted modeled. For each ORVR saturaion case, the measured distance at which ambient concentrations were equal to the acceptable souce impact level (ASIL) for benzene are plotted against the ORVR saturation from the concentration plots results of the sensitivty analysis. The model results utilizing the 4 county average ORVR saturation of 86% is also included.

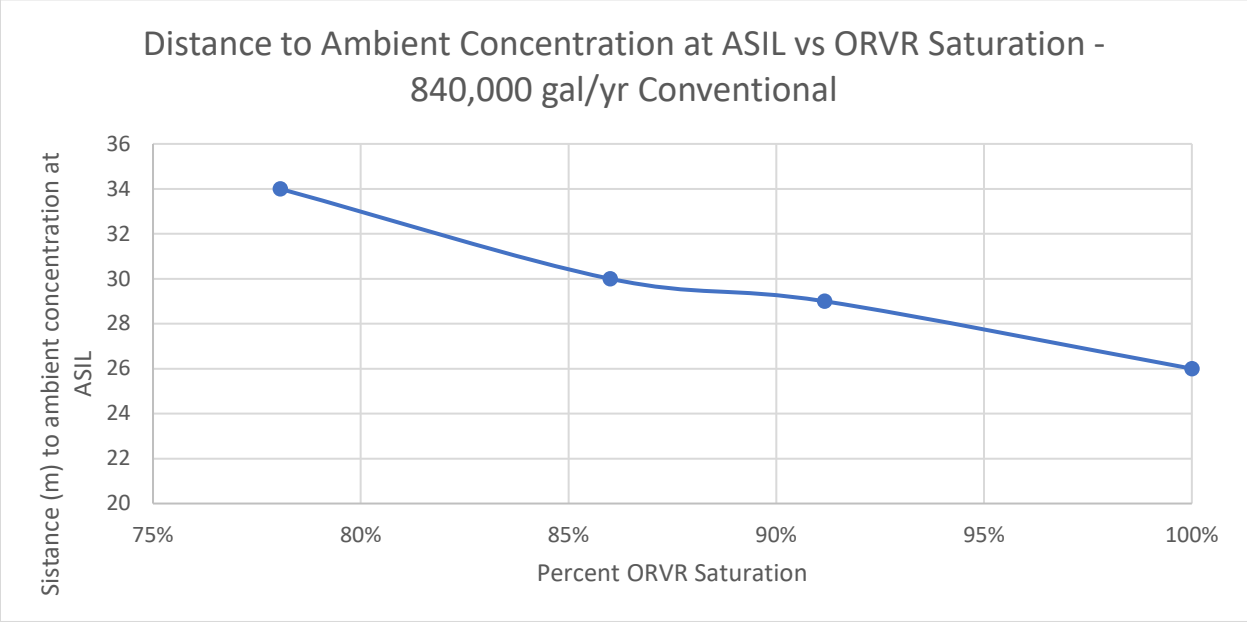
1.A.v	**1 Station EVR except for vapor processor at 6,000,000 gallon/yr**			
Subcase	ORVR Saturation	PT Emissions (g/s)	Volume Emissions (g/s)	Max ug/m3
1.A.v.1	78%	6.27E-05	6.38E-04	2.03966
1.A.v	86%	6.27E-05	5.91E-04	1.89042
1.A.v.2	91%	6.27E-05	5.60E-04	1.79198
1.A.v.3	100%	6.27E-05	5.08E-04	1.62686
1.B.v	**1 Station EVR at 6,000,000 gallon/yr**			
Subcase	ORVR Saturation	PT Emissions (g/s)	Volume Emissions (g/s)	Max ug/m3
1.B.v.1	78%	4.50E-05	3.02E-04	0.96885
1.B.v	86%	4.50E-05	2.94E-04	0.94345
1.B.v.2	91%	4.50E-05	2.88E-04	0.9244
1.B.v.3	100%	4.50E-05	2.79E-04	0.89582
1.C.v	**1 Station Enhanced Conventional at 6,000,000 gallon/yr**			
Subcase	ORVR Saturation	PT Emissions (g/s)	Volume Emissions (g/s)	Max ug/m3
1.C.v.1	78%	2.36E-04	7.55E-04	2.44929
1.C.v	86%	2.36E-04	5.83E-04	1.90313

1.C.v.2	91%	2.36E-04	4.71E-04	1.54749
1.C.v.3	100%	2.36E-04	2.79E-04	0.93782



For conventional nozzles, the throughput of 840,000 gallon/yr was modeled for ORVR sensitivity following the same procedure discussed above.

1.D.ii	**1 Station Conventional at 840,000 gallon/yr**			
Subcase	ORVR Saturation	PT Emissions (g/s)	Volume Emissions (g/s)	Max ug/m3
1.D.ii.1	78%	3.30E-05	1.76E-04	0.56612
1.D.ii	86%	3.30E-05	1.53E-04	0.49309
1.D.ii.2	91%	3.30E-05	1.38E-04	0.44546
1.D.ii.3	100%	3.30E-05	1.12E-04	0.3629



Model Limitations and Variations

The model runs are unable to capture all configurations of gasoline dispensing facilities in PSCAA jurisidction. Distances between canopies and P/V valves and distances to receptors will be unique to stations, as well as terrain and meterological data impacting dispersion. Review of sample stations in PSCAA jurisdiction situated with residence or businesses nearby were used to inform the estimated nearest receptor distance of 19 meters from any canopy. The number of closely located stations and throughput of those stations will vary based on location; 4 stations (one on each intersection) would be the highest antcipated number of clustered stations, however many such station clusters are situated on larger roadways with fewer very close receptors.

Findings

The equipment configuration and throughput combinations resulting in modeled benzene emissions at or below the ASIL at 19 meters from the station canopy is used to inform recommended controls at different throughput stations.

For a single station with conventional equipment, linearly interpolating between the modeled cases 1.D.i and 1.D.ii, a throughput of up to about 600,000 gallons yields benzene at the ASIL about 19 meters from the station. Following the interpolation, PSCAA ran model 1.D.vi at 600,000 gallons throughput and identified ASIL levels about 25 meters from the nearest canopy, so the model was rerun with run 1.D.vii at 500,000 gallons per year and identified ASIL levels about 23 meters from the nearest canopy, and 1.D.viii identified ASIL levels at about 19 meters from the nearest canopy. The single station ORVR sensitivity analysis with 840,000 gallon throughput indicated that the distance to reach ASIL could be affected ±8 meters due to differences in the ORVR saturation of the vehicles utilizing the station. 4 conventional station each with throughput of 200,000 gallons per year modeled combined impacts reaching the ASIL at around 19 meters from the nearest canopy to a receptor.

For a single station with enhanced conventional equipment, linearly interpolating between the modeled cases 1.C.i and 1.C.ii, a throughput of up to about 728,000 gallons yields benzene at the ASIL about 19 meters from the station. The single station ORVR sensitity analysis with much larger throughput of 6,000,000 indicated that distance to reach the ASIL could be affected ±16 meters due to differences in ORVR saturation of the vehicles utilzing the station. Combined impacts for 4 stations each with enhanced conventional nozzles and throughput of about 592,000 gallons per year each was the throughput that met the ASIL within 19 meters of nearest receptor.

For a single station with EVR without vapor processor, linearly interpolating between the modeled cases 1.A.ii and 1.A.iii, a throughput of up to about 912,000 gallons yields benzene at the ASIL about 19 meters from the station. The single station ORVR sensitivity analysis with much larger throughput 6,000,000 gallons per year indicated that distance to reach the ASIL could be affected ±6.5 meters due to differences in ORVR saturation of the vehicles utilizing the station. Combined impacts for 4 stations each with EVR without vapor processor and throughput of about 650,000 gallons per year each was the throughput that met the ASIL within 19 meters of nearest receptor.

For a single station with EVR and vapor processor, linearly interpolating between the modeled cases 1.B.iii and 1.B.iv, a throughput of up to about 2,000,000 gallons per year yields benzene at the ASIL about 19 meters from the station. The single station ORVR sensitivity analysis with 6,000,000 gallons per year indicated that the distance to reach the ASIL could be affected ±1.6 meters due to the differences in ORVR saturation of the vehicles utilizing the station. Combined impacts for 4 stations each with EVR and vapor processor and throughput of about 728,000 gallons per year each was the throughput that met the ASIL within 19 meters of nearest receptor.

Recommendations

Two alternatives for tiered equipment requirements are proposed, Option 1 is more stringent and more informed by the risk of clustered smaller throughput stations and Option 2 is less stringent and follows more closely with regulatory requirements that would apply were an individual gas station to be permitted in a Notice of Construction (minor new source review) process.

Option 1:

Equipment	Annua Gasoline Throughput (gal/yr)
Conventional	0-200,000
Enhanced Conventional	200,000 – 500,000
EVR no Vapor Processor	500,000 – 650,000
EVR	650,000 – 6,000,000+

Option 2:

Equipment	Annua Gasoline Throughput (gal/yr)
Conventional	0-500,000
Enhanced Conventional	500,000 – 700,000
EVR no Vapor Processor	700,000 – 1,000,000
EVR	1,000,000 – 6,000,000+