APPENDIX L

Air Screening Level Calculations

TABLE L-1
RESIDENTIAL METHOD B CARCINOGENIC RISK SLs FOR PCE
VAPOR INTRUSION ASSESSMENT
BOEING AUBURN

Given:

IUR_{PCE}(µg/m^3)	=	0.00000026	***Inhalation unit risk (IUR) from EPA IRIS Database last updated 2/10/12***
CPF (kg-day/mg)	=	0.00091	***CPF calculated from IUR. CPF multiplied by standard adult average body weight and conversion factor of 1000, over standard adult breathing rate***
H_{cc} @ 13° Celsius (C)	=	0.393	***Henry's Law Constant (H_{cc}) from EPA On-line Tools for Site Assessment***

Constants from MTCA Equation 750-2, for Carcinogens with reduced RISK per WAC 173-340-750 (4)(b)(ii)(B)

RISK	=	1.E-06	Acceptable cancer risk level
ABW (kg)	=	70	Average body weight over exposure duration
AT (yr)	=	75	Averaging time
UCF (µg/mg)	=	1000	Unit conversion factor
CPF	=		Carcinogenic potency factor per WAC 173-340-708(8) (kg-day/mg)
BR (m^3/day)	=	20	Breathing/inhalation rate
ABS (unitless)	=	1	Inhalation absorption fraction
ED (yr)	=	30	Exposure duration
EF (unitless)	=	1	Exposure frequency

Find: (a) Indoor Air Screening Level (SL_{IA}), (b) Soil Gas Screening Level (SL_{SG}),and (c) Shallow GW Screening Level (SL_{GW})

Equations:

(1) SL_{IA} (µg/m^3) = $\frac{\text{RISK X ABW X AT X UCF}}{\text{CPF X BR X ABS X ED X EF}}$ ***MTCA Equation 750-2***

(2) SL_{SG} (µg/m^3) = SL_{IA} /VAF

Eqn 2. Generic soil gas VI SLs from Ecology's Draft Vapor Intrusion Guidance Document
The sub-slab soil gas screening level is based on a Vapor Attenuation Factor (VAF) of 0.03, per EPA's updated database (EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings; EPA 530-R-10-002. March 16, 2012) and communications with Ecology.

(3) SL_{GW} (µg/L) = $\frac{SL_{IA}}{\text{VAF x UCF x } H_{cc}}$

Eqn 1. Generic groundwater VI SLs from Ecology's Draft Vapor Intrusion Guidance Document
VAF = 0.001 (unitless; default)
UCF = 1000 L/m^3
H_{cc} = Chemical- and temperature-dependent value. H_{cc} values are based on an average Washington shallow groundwater temperature of 13 °C, consistent with Ecology's draft vapor intrusion guidance document.

Solve:

(a) SL_{IA} (µg/m^3) =	**9.6**
(b) SL_{SG} (µg/m^3) =	**320**
(c) SL_{GW} (µg/L) =	**24**

TABLE L-2
RESIDENTIAL METHOD B NON-CARCINOGENIC RISK SLs FOR PCE
VAPOR INTRUSION ASSESSMENT
BOEING AUBURN

Given:

RfC_{PCE}(mg/m^3)	=	0.04	***RfC from EPA IRIS database updated 2/10/2012 based on studies of occupationally-exposed adults; childhood exposure studies inadequate***
RfD_{PCE}(mg/kg-day)	=	0.011428571	***RfC_{PCE} multiplied by standard adult BR of 20m^3/day over standard adult average body weight of 70 kg.***
H_{cc} @ 13° Celsius (C)	=	0.393	***Henry's Law Constant (H_{cc}) from EPA On-line Tools for Site Assessment***

Constants from MTCA Equation 750-1, for Non-carcinogens per WAC 173-340-750 (4)(b)(ii)(A)

ABW (kg)	=	16	Average body weight over exposure duration
UCF (µg/mg)	=	1000	Unit conversion factor
HQ (unitless)	=	1	Hazard Quotient
AT (yr)	=	6	Averaging time
BR (m^3/day)	=	10	Breathing/inhalation rate
ABS (unitless)	=	1	Inhalation absorption fraction
ED (yr)	=	6	Exposure duration
EF (unitless)	=	1	Exposure frequency

Find: (a) Indoor Air Screening Level (SL_{IA}), (b) Soil Gas Screening Level (SL_{SG}), and (c) Shallow GW Screening Level (SL_{GW})

Equations:

(1) SL_{IA} (µg/m^3) = $\frac{RfD \times ABW \times UCF \times HQ \times AT}{BR \times ABS \times ED \times EF}$ ***MTCA Equation 750-1***

(2) SL_{SG} (µg/m^3) = SL_{IA} /VAF

Eqn 2. Generic soil gas VI SLs from Ecology's Draft Vapor Intrusion Guidance Document
The sub-slab soil gas screening level is based on a Vapor Attenuation Factor (VAF) of 0.03, per EPA's updated database (EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings; EPA 530-R-10-002. March 16, 2012) and communications with Ecology.

(3) SL_{GW} (µg/L) = $\frac{SL_{IA}}{VAF \times UCF \times H_{cc}}$

Eqn 1. Generic groundwater VI SLs from Ecology's Draft Vapor Intrusion Guidance Document
VAF = 0.001 (unitless; default)
UCF = 1000 L/m^3
H_{cc} = Chemical- and temperature-dependent value. H_{cc} values are based on an average Washington shallow groundwater temperature of 13 °C, consistent with Ecology's draft vapor intrusion guidance document.

Solve:

(a) SL_{IA} (µg/m^3) =	**18**
(b) SL_{SG} (µg/m^3) =	**610**
(c) SL_{GW} (µg/L) =	**47**

TABLE L-3
INDUSTRIAL METHOD C CARCINOGENIC RISK SLs FOR PCE
VAPOR INTRUSION ASSESSMENT
BOEING AUBURN

Given:

CPF_{PCE} (kg-day/mg)	=	0.00091	***CPF calculated for Revised Method B SL for PCE***
H_{cc} @ 13° Celsius (C)	=	0.393	***Henry's Law Constant (H_{cc}) from EPA On-line Tools for Site Assessment***

Constants from MTCA Equation 750-2, for Carcinogens with reduced RISK per WAC 173-340-750 (4)(b)(ii)(B)

RISK	=	1.E-05	Acceptable cancer risk level
ABW (kg)	=	70	Average body weight over exposure duration
AT (yr)	=	75	Averaging time
UCF (µg/mg)	=	1000	Unit conversion factor
CPF	=		Carcinogenic potency factor per WAC 173-340-708(8) (kg-day/mg)
BR (m^3/day)	=	20	Breathing/inhalation rate
ABS (unitless)	=	1	Inhalation absorption fraction
ED (yr)	=	30	Exposure duration
EF (unitless)	=	1	Exposure frequency

Find: (a) Indoor Air Screening Level (SL_{IA}), (b) Soil Gas Screening Level (SL_{SG}),and (c) Shallow GW Screening Level (SL_{GW})

Equations:

(1) SL_{IA} (µg/m^3) = $\frac{\text{RISK X ABW X AT X UCF}}{\text{CPF X BR X ABS X ED X EF}}$ ***MTCA Equation 750-2***

(2) SL_{SG} (µg/m^3) = SL_{IA} /VAF

Eqn 2. Generic soil gas VI SLs from Ecology's Draft Vapor Intrusion Guidance Document
The sub-slab soil gas screening level is based on a Vapor Attenuation Factor (VAF) of 0.03, per EPA's updated database (EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings; EPA 530-R-10-002. March 16, 2012) and communications with Ecology.

(3) SL_{GW} (µg/L) = $\frac{SL_{IA}}{VAF \times UCF \times H_{cc}}$

Eqn 1. Generic groundwater VI SLs from Ecology's Draft Vapor Intrusion Guidance Document
VAF = 0.001 (unitless; default)
UCF = 1000 L/m^3
H_{cc} = Chemical- and temperature-dependent value. H_{cc} values are based on an average Washington shallow groundwater temperature of 13 °C, consistent with Ecology's draft vapor intrusion guidance document.

Solve:

(a)	SL_{IA} (µg/m^3) =	**96**
(b)	SL_{SG} (µg/m^3) =	**3200**
(c)	SL_{GW} (µg/L) =	**240**

TABLE L-4
INDUSTRIAL METHOD C NON-CARCINOGENIC RISK SLs FOR PCE
VAPOR INTRUSION ASSESSMENT
BOEING AUBURN

Given:

RfC_{PCE}(mg/m^3)	=	0.04	***RfC from EPA IRIS database updated 2/10/2012***
RfD_{PCE}(mg/kg-day)	=	0.011428571	***RfC for PCE multiplied by standard adult BR of 20m^3/day over standard adult average body weight of 70 kg.***
H_{cc} @ 13° Celsius (C)	=	0.393	***Henry's Law Constant (H_{cc}) from EPA On-line Tools for Site Assessment***

Constants from MTCA Equation 750-1, for Non-carcinogens per WAC 173-340-750 (4)(b)(ii)(A)

ABW (kg)	=	70	Average body weight over exposure duration
UCF (µg/mg)	=	1000	Unit conversion factor
HQ (unitless)	=	1	Hazard Quotient
AT (yr)	=	30	Averaging time
BR (m^3/day)	=	20	Breathing/inhalation rate
ABS (unitless)	=	1	Inhalation absorption fraction
ED (yr)	=	30	Exposure duration
EF (unitless)	=	1	Exposure frequency

Find: (a) Indoor Air Screening Level (SL_{IA}), (b) Soil Gas Screening Level (SL_{SG}), and (c) Shallow GW Screening Level (SL_{GW})

Equations:

(1) SL_{IA} (µg/m^3)= $\frac{RfD \times ABW \times UCF \times HQ \times AT}{BR \times ABS \times ED \times EF}$ ***MTCA Equation 750-1***

(2) SL_{SG} (µg/m^3) = SL_{IA} /VAF ***Eqn 2. Generic soil gas VI SLs from Ecology's Draft Vapor Intrusion Guidance Document***

The sub-slab soil gas screening level is based on a Vapor Attenuation Factor (VAF) of 0.03, per EPA's updated database (EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings; EPA 530-R-10-002. March 16, 2012) and communications with Ecology.

(3) SL_{GW} (µg/L) = $\frac{SL_{IA}}{VAF \times UCF \times H_{cc}}$ ***Eqn 1. Generic groundwater VI SLs from Ecology's Draft Vapor Intrusion Guidance Document***

VAF = 0.001 (unitless; default)

UCF = 1000 L/m^3

H_{cc} = Chemical- and temperature-dependent value. H_{cc} values are based on an average Washington shallow groundwater temperature of 13 °C, consistent with Ecology's draft vapor intrusion guidance document.

Solve:

(a)	SL_{IA} (µg/m^3)=	**40**
(b)	SL_{SG} (µg/m^3) =	**1300**
(c)	SL_{GW} (µg/L) =	**100**

TABLE L-5
COMMERCIAL MODIFIED METHOD B CARCINOGENIC RISK SLs FOR PCE
VAPOR INTRUSION ASSESSMENT
BOEING AUBURN

Given:

CPF (kg-day/mg)	=	0.00091	***CPF calculated for Res. Method B SL for PCE*** https://fortress.wa.gov/ecy/clarc/FocusSheets/TCE%20PCE%20Oct%202004%20Final.pdf
H_{cc} @ 13° Celsius (C)	=	0.393	***Henry's Law Constant (H_{cc}) from EPA On-line Tools for Site Assessment***

Constants from MTCA Equation 750-2, for Carcinogens

RISK	=	1.E-06	Acceptable cancer risk level
ABW (kg)	=	70	Average body weight over exposure duration
AT (yr)	=	75	Averaging time
UCF (ug/mg)	=	1000	Unit conversion factor
CPF	=		Carcinogenic potency factor per WAC 173-340-708(8) (kg-day/mg)
BR (m^3/day)	=	20	Breathing/inhalation rate
ABS (unitless)	=	1	Inhalation absorption fraction
ED (yr)	=	30	Exposure duration
EF (unitless)	=	0.33	Exposure frequency

Find: (a) Indoor Air Screening Level (SL_{IA}), (b) Soil Gas Screening Level (SL_{SG}), and (c) Shallow GW Screening Level (SL_{GW})

Equations:

(1) SL_{IA} ($\mu g/m^3$) = $\frac{RISK \times ABW \times AT \times UCF}{CPF \times BR \times ABS \times ED \times EF}$ ***MTCA Equation 750-2***

(3) SL_{SG} ($\mu g/m^3$) = SL_{IA} / VAF

Eqn 2. Generic soil gas VI SLs from Ecology's Draft Vapor Intrusion Guidance Document
The sub-slab soil gas SL is based on a Vapor Attenuation Factor (VAF) of 0.03, per EPA's updated database (EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings; EPA 530-R-10-002. March 16, 2012) and communications with Ecology.

(4) SL_{GW} ($\mu g/L$) = $\frac{SL_{IA}}{VAF \times UCF \times H_{cc}}$

Eqn 1. Generic groundwater VI SLs from Ecology's Draft Vapor Intrusion Guidance Document
VAF = 0.001 (unitless; default)
UCF = 1000 L/m^3
H_{cc} = Chemical- and temperature-dependent value. H_{cc} values are based on an average Washington shallow groundwater temperature of 13 °C, consistent with Ecology's draft vapor intrusion guidance document.

Solve:

(a) SL_{IA} ($\mu g/m^3$) =	**29**
(b) SL_{SG} ($\mu g/m^3$) =	**960**
(c) SL_{GW} ($\mu g/L$) =	**73**

TABLE L-6
COMMERCIAL MODIFIED METHOD B NON-CARCINOGENIC RISK SLs FOR PCE
VAPOR INTRUSION ASSESSMENT
BOEING AUBURN

Given:

$RfC_{PCE}(mg/m^3)$	=	0.04	***RfC from EPA IRIS database updated 2/10/2012 based on studies of occupationally-exposed adults; childhood exposure studies inadequate***
RfD_{PCE}(mg/kg-day)	=	0.011428571	***RfC_{PCE} multiplied by standard adult BR of 20m^3/day over standard adult average body weight of 70 kg.***
H_{cc} @ 13° Celsius (C)	=	0.393	***Henry's Law Constant (H_{cc}) from EPA On-line Tools for Site Assessment***

Constants from MTCA Equation 750-1, for Non-carcinogens per WAC 173-340-750 (4)(b)(ii)(A)

ABW (kg)	=	70	Average body weight over exposure duration
UCF (µg/mg)	=	1000	Unit conversion factor
HQ (unitless)	=	1	Hazard Quotient
AT (yr)	=	30	Averaging time
BR (m^3/day)	=	20	Breathing/inhalation rate
ABS (unitless)	=	1	Inhalation absorption fraction
ED (yr)	=	30	Exposure duration
EF (unitless)	=	0.33	Exposure frequency

Find: (a) Indoor Air Screening Level (SL_{IA}), (b) Soil Gas Screening Level (SL_{SG}), and (c) Shallow GW Screening Level (SL_{GW})

Equations:

(1) SL_{IA} ($\mu g/m^3$) = $\frac{RfD \times ABW \times UCF \times HQ \times AT}{BR \times ABS \times ED \times EF}$ ***MTCA Equation 750-1***

(2) SL_{SG} ($\mu g/m^3$) = SL_{IA} /VAF

Eqn 2. Generic soil gas VI SLs from Ecology's Draft Vapor Intrusion Guidance Document
The sub-slab soil gas screening level is based on a Vapor Attenuation Factor (VAF) of 0.03, per EPA's updated database (EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings; EPA 530-R-10-002. March 16, 2012) and communications with Ecology.

(3) SL_{GW} (µg/L) = $\frac{SL_{IA}}{VAF \times UCF \times H_{cc}}$

Eqn 1. Generic groundwater VI SLs from Ecology's Draft Vapor Intrusion Guidance Document
VAF = 0.001 (unitless; default)
UCF = 1000 L/m^3
H_{cc} = Chemical- and temperature-dependent value. H_{cc} values are based on an average Washington shallow groundwater temperature of 13 °C, consistent with Ecology's draft vapor intrusion guidance document.

Solve:

(a) SL_{IA} ($\mu g/m^3$) =	**120**
(b) SL_{SG} ($\mu g/m^3$) =	**4000**
(c) SL_{GW} (µg/L) =	**305**

TABLE L-7
RESIDENTIAL METHOD B CARCINOGENIC RISK SLs FOR TCE
VAPOR INTRUSION ASSESSMENT
BOEING AUBURN

Kidney Cancer	$CPF_{TCE,i}$(kg-day/mg)		=	0.0035	Converted	cancer potency factor for inhalation (CPF_i) from current EPA IUR.
Early-Life Exp. Age Adj. Assumptions:		<2yrs	2 to <6yrs	6 to <16yrs	16 to 30yrs	
(age dependent adjustment factor) ADAFs		10	3	3	1	Factors for Kidney Cancer per EPA IRIS database summary.
(exposure duration) ED		2	4	10	14	Factors for Kidney Cancer per EPA IRIS database summary.
(breathing rate) BR		10	10	20	20	Factors for Kidney Cancer per EPA IRIS database summary.
(body weight) BW		16	16	70	70	Factors for Kidney Cancer per EPA IRIS database summary.
Non-Hodgkin's Lymphoma (NHL)	$CPF_{TCE,i}$(kg-day/mg)		=	0.007	Converted CPF_i from current EPA IUR.	
Liver Cancer	$CPF_{TCE,i}$(kg-day/mg)		=	0.0035	Converted CPF_i from current EPA IUR.	

H_{cc} @ 13° Celsius (C)	=	0.238	***Henry's Law Constant (H_{cc}) from EPA On-line Tools for Site Assessment***

Constants from MTCA Equation 750-2, for Carcinogens with reduced RISK per WAC 173-340-750 (4)(b)(ii)(B)

RISK	=	1.E-06	Acceptable cancer risk level
ABW (kg)	=	70	Average body weight over exposure duration
AT (yr)	=	75	Averaging time
UCF (µg/mg)	=	1000	Unit conversion factor
CPF	=		Carcinogenic potency factor per WAC 173-340-708(8) (kg-day/mg)
BR (m^3/day)	=	20	Breathing/inhalation rate
ABS (unitless)	=	1	Inhalation absorption fraction
ED (yr)	=	30	Exposure duration
EF (unitless)	=	1	Exposure frequency

(a) ELE for Kidney Cancer, (b) Kidney SLi, (c) Lymphoma SLi, (d) Liver SLi, (e) Indoor Air Screening Level SL_{IA}, (f) Soil Gas Screening Level (SL_{SG}), and (g) Shallow GW Screening Level (SL_{GW})

(1) Early Life Exposure (ELE) Adjustment Factor (µg-yr/kg-day) =

$$\frac{\text{<2yrs}}{\frac{(ADAF*ED*BR)}{BW}} + \frac{\text{2 to <6yrs}}{\frac{(ADAF*ED*BR)}{BW}} + \frac{\text{6 to <16yrs}}{\frac{(ADAF*ED*BR)}{BW}} + \frac{\text{16 to 30 yrs}}{\frac{(ADAF*ED*BR)}{BW}}$$

(2) Final Kidney Cancer CPF_i = (kg-day/mg)

$$[CPF_i \times (2yrs/30yrs) \times ADAF_1] + [CPF_i \times (14yrs/30yrs) \times ADAF_2] + [CPF_i \times (14yrs/30yrs) \times ADAF_3]$$

(3) Kidney Cancer SL_i = (µg/m3)

$$\frac{RISK \times AT \times UCF}{CPFi \times ELE \times ABS \times EF}$$

(4) SL_{IA} (µg/m^3) for Lymphoma Cancer and Liver Cancer=

$$\frac{RISK \times ABW \times AT \times UCF}{CPF \times BR \times ABS \times ED \times EF}$$

MTCA Equation 750-2

(5) SL_{SG} (µg/m^3) = SL_{IA} /VAF

Eqn 2. Generic soil gas VI SLs from Ecology's Draft Vapor Intrusion Guidance Document

The sub-slab soil gas screening level is based on a Vapor Attenuation Factor (VAF) of 0.03, per EPA's updated database (EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings; EPA 530-R-10-002. March 16, 2012) and communications with Ecology.

(6) SL_{GW} (µg/L) =

$$\frac{SL_{IA}}{VAF \times UCF \times H_{cc}}$$

Eqn 1. Generic groundwater VI SLs from Ecology's Draft Vapor Intrusion Guidance Document

VAF = 0.001 (unitless; default)

UCF = 1000 L/m^3

H_{cc} = Chemical- and temperature-dependent value. H_{cc} values are based on an average Washington shallow groundwater temperature of 13 °C, consistent with Ecology's draft vapor intrusion guidance document.

(a) ELE for Kidney Cancer = (µg-yr/kg-day)	**32.6**	
(b) Kidney SL_i (µg/m3) =	**0.658**	
(c) Lymphoma SL_i (µg/m3) =	**1.25**	
(d) Liver SL_i (µg/m3) =	**2.50**	
(e) SL_{IA} (µg/m^3)=	**0.37**	
(f) SL_{SG} (µg/m^3) =	**12**	
(g) SL_{GW} (µg/L) =	**1.6**	ECY gets 1.6

TABLE L-8
RESIDENTIAL METHOD B NON-CARCINOGENIC RISK SLs FOR TCE
VAPOR INTRUSION ASSESSMENT
BOEING AUBURN

Given:

RfC_{TCE}(mg/m^3)	=	0.002	***Principal candidate reference concentration for chronic inhalation exposure, continuous exposure scenario; from EPA IRIS database, updated 9/28/11.***
RfD_{TCE}(mg/kg-day)	=	0.000571	***RfCTCE multiplied by standard adult BR of 20m^3/day over standard adult average body weight of 70 kg.***
H_{cc} @ 13° Celsius (C)	=	0.238	***Henry's Law Constant (H_{cc}) from EPA On-line Tools for Site Assessment***

Constants from MTCA Equation 750-1, for Non-carcinogens per WAC 173-340-750 (4)(b)(ii)(A)

ABW (kg)	=	16	Average body weight over exposure duration
UCF (µg/mg)	=	1000	Unit conversion factor
HQ (unitless)	=	1	Hazard Quotient
AT (yr)	=	6	Averaging time
BR (m^3/day)	=	10	Breathing/inhalation rate
ABS (unitless)	=	1	Inhalation absorption fraction
ED (yr)	=	6	Exposure duration
EF (unitless)	=	1	Exposure frequency

Find: (a) Indoor Air Screening Level (SL_{IA}), (b) Soil Gas Screening Level (SL_{SG}), and (c) Shallow GW Screening Level (SL_{GW})

Equations:

(1) SL_{IA} (µg/m^3) = $\frac{RfD \times ABW \times UCF \times HQ \times AT}{BR \times ABS \times ED \times EF}$ ***MTCA Equation 750-1***

(2) SL_{SG} (µg/m^3) = SL_{IA} /VAF

Eqn 2. Generic soil gas VI SLs from Ecology's Draft Vapor Intrusion Guidance Document
The sub-slab soil gas screening level is based on a Vapor Attenuation Factor (VAF) of 0.03, per EPA's updated database (EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings; EPA 530-R-10-002. March 16, 2012) and communications with Ecology.

(3) SL_{GW} (µg/L) = $\frac{SL_{IA}}{VAF \times UCF \times H_{cc}}$

Eqn 1. Generic groundwater VI SLs from Ecology's Draft Vapor Intrusion Guidance Document
VAF = 0.001 (unitless; default)
UCF = 1000 L/m^3
H_{cc} = Chemical- and temperature-dependent value. H_{cc} values are based on an average Washington shallow groundwater temperature of 13 °C, consistent with Ecology's draft vapor intrusion guidance document.

Solve:

(a)	SL_{IA} (µg/m^3) =	**0.91**
(b)	SL_{SG} (µg/m^3) =	**30**
(c)	SL_{GW} (µg/L) =	**3.8**

TABLE L-9
INDUSTRIAL METHOD C CARCINOGENIC RISK SLs FOR TCE
VAPOR INTRUSION ASSESSMENT
BOEING AUBURN

Given:

$IUR_{TCE}(m^3/\mu g)$	=	0.000004	***Approximate inhalation unit risk from EPA IRIS database for kidney cancer, Non-Hodgkin's Lymphoma (NHL), and liver cancer for adult scenario; IRIS has 4.1E-6.***
CPF (kg-day/mg)	=	0.014	***CPF calculated from IUR. CPF multiplied by standard adult average body weight and conversion factor of 1000, over standard adult breathing rate***
H_{cc} @ 13° Celsius (C)	=	0.238	***Henry's Law Constant (H_{cc}) from EPA On-line Tools for Site Assessment***

Constants from MTCA Equation 750-2, for Carcinogens with reduced RISK per WAC 173-340-750 (4)(b)(ii)(B)

RISK	=	1.E-05	Acceptable cancer risk level
ABW (kg)	=	70	Average body weight over exposure duration
AT (yr)	=	75	Averaging time
UCF (µg/mg)	=	1000	Unit conversion factor
CPF	=		Carcinogenic potency factor per WAC 173-340-708(8) (kg-day/mg)
BR (m^3/day)	=	20	Breathing/inhalation rate
ABS (unitless)	=	1	Inhalation absorption fraction
ED (yr)	=	30	Exposure duration
EF (unitless)	=	1	Exposure frequency

Find: (a) Indoor Air Screening Level (SL_{IA}), (b) Soil Gas Screening Level (SL_{SG}), and (c) Shallow GW Screening Level (SL_{GW})

Equations:

(1) SL_{IA} ($\mu g/m^3$) = $\frac{RISK \times ABW \times AT \times UCF}{CPF \times BR \times ABS \times ED \times EF}$ ***MTCA Equation 750-2***

(2) SL_{SG} ($\mu g/m^3$) = SL_{IA} / VAF

Eqn 2. Generic soil gas VI SLs from Ecology's Draft Vapor Intrusion Guidance Document
The sub-slab soil gas screening level is based on a Vapor Attenuation Factor (VAF) of 0.03, per EPA's updated database (EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings; EPA 530-R-10-002. March 16, 2012) and communications with Ecology.

(3) SL_{GW} (µg/L) = $\frac{SL_{IA}}{VAF \times UCF \times H_{cc}}$

Eqn 1. Generic groundwater VI SLs from Ecology's Draft Vapor Intrusion Guidance Document
VAF = 0.001 (unitless; default)
UCF = 1000 L/m^3
H_{cc} = Chemical- and temperature-dependent value. H_{cc} values are based on an average Washington shallow groundwater temperature of 13 °C, consistent with Ecology's draft vapor intrusion guidance document.

Solve:

(a)	SL_{IA} ($\mu g/m^3$)=	**6.3**
(b)	SL_{SG} ($\mu g/m^3$) =	**210**
(c)	SL_{GW} (µg/L) =	**26**

TABLE L-10
INDUSTRIAL METHOD C NON-CARCINOGENIC RISK SLs FOR TCE
VAPOR INTRUSION ASSESSMENT
BOEING AUBURN

Given:

$RfC_{TCE}(mg/m^3)$	=	0.002	***Principal candidate reference concentration for chronic inhalation exposure, continuous exposure scenario; from EPA IRIS database, updated 9/28/11.***
RfD_{TCE}(mg/kg-day)	=	0.000571429	***RfC_{TCE} multiplied by standard adult BR of 20m^3/day over standard adult average body weight of 70 kg.***
H_{cc} @ 13° Celsius (C)	=	0.238	***Henry's Law Constant (H_{cc}) from EPA On-line Tools for Site Assessment***

Constants from MTCA Equation 750-1, for Non-carcinogens per WAC 173-340-750 (4)(b)(ii)(A)

ABW (kg)	=	70	Average body weight over exposure duration
UCF (µg/mg)	=	1000	Unit conversion factor
HQ (unitless)	=	1	Hazard Quotient
AT (yr)	=	30	Averaging time
BR (m^3/day)	=	20	Breathing/inhalation rate
ABS (unitless)	=	1	Inhalation absorption fraction
ED (yr)	=	30	Exposure duration
EF (unitless)	=	1	Exposure frequency

Find: (a) Indoor Air Screening Level Level (SL_{IA}), (b) Soil Gas Screening Level (SL_{SG}), and (c) Shallow GW Screening Level (SL_{GW})

Equations:

(1) SL_{IA} (µg/m^3) = $\frac{RfD \times ABW \times UCF \times HQ \times AT}{BR \times ABS \times ED \times EF}$ ***MTCA Equation 750-1***

(2) SL_{SG} (µg/m^3) = SL_{IA} /VAF ***Eqn 2. Generic soil gas VI SLs from Ecology's Draft Vapor Intrusion Guidance Document***

The sub-slab soil gas screening level is based on a Vapor Attenuation Factor (VAF) of 0.03, per EPA's updated database (EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings; EPA 530-R-10-002. March 16, 2012) and communications with Ecology.

(3) SL_{GW} (µg/L) = $\frac{SL_{IA}}{VAF \times UCF \times H_{cc}}$ ***Eqn 1. Generic groundwater VI SLs from Ecology's Draft Vapor Intrusion Guidance Document***

VAF = 0.001 (unitless; default)
UCF = 1000 L/m^3
H_{cc} = Chemical- and temperature-dependent value. H_{cc} values are based on an average Washington shallow groundwater temperature of 13 °C, consistent with Ecology's draft vapor intrusion guidance document.

Solve:

(a)	SL_{IA} (µg/m^3) =	**2.0**
(b)	SL_{SG} (µg/m^3) =	**67**
(c)	SL_{GW} (µg/L) =	**8.4**

TABLE L-11
COMMERCIAL MODIFIED METHOD B CARCINOGENIC RISK SLs FOR TCE
VAPOR INTRUSION ASSESSMENT
BOEING AUBURN

Given:

Kidney Cancer	$CPF_{TCE,i}$(kg-day/mg)	=	0.0035	Converted CPF_i from current EPA IUR.
Non-Hodgkin's Lymphoma (NHL	$CPF_{TCE,i}$(kg-day/mg)	=	0.007	Converted CPF_i from current EPA IUR.
Liver Cancer	$CPF_{TCE,i}$(kg-day/mg)	=	0.0035	Converted CPF_i from current EPA IUR.

H_{cc} @ 13° Celsius (C) = 0.238 ***Henry's Law Constant (H_{cc}) from EPA On-line Tools for Site Assessment***

Constants from MTCA Equation 750-2, for Carcinogens with reduced RISK per WAC 173-340-750 (4)(b)(ii)(B)

RISK	=	1.E-06	Acceptable cancer risk level
ABW (kg)	=	70	Average body weight over exposure duration
AT (yr)	=	75	Averaging time
UCF (µg/mg)	=	1000	Unit conversion factor
CPF	=		Carcinogenic potency factor per WAC 173-340-708(8) (kg-day/mg)
BR (m^3/day)	=	20	Breathing/inhalation rate
ABS (unitless)	=	1	Inhalation absorption fraction
ED (yr)	=	30	Exposure duration
EF (unitless)	=	0.33	Exposure frequency

Find: (a) Total CPFi, (b) Indoor Air Screening Level (SL_{IA}), (c) Soil Gas Screening Level (SL_{SG}), and (d) Shallow GW Screening Level (SL_{GW})

Equations:

(1) Total CPF_i (for 3 cancers) = (kg-day/mg) Final Kidney Cancer CPF_i + NHL CPF_i + Liver Cancer CPF_i

(2) SL_{IA} (µg/m^3) = $\frac{\text{RISK x ABW x AT x UCF}}{\text{CPF x BR x ABS x ED x EF}}$ ***MTCA Equation 750-2***

(3) SL_{SG} (µg/m^3) = SL_{IA} /VAF ***Eqn 2. Generic soil gas VI SLs from Ecology's Draft Vapor Intrusion Guidance Document***
The sub-slab soil gas screening level is based on a Vapor Attenuation Factor (VAF) of 0.03, per EPA's updated database (EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings; EPA 530-R-10-002. March 16, 2012) and communications with Ecology.

(4) SL_{GW} (µg/L) = $\frac{SL_{IA}}{VAF \times UCF \times H_{cc}}$ ***Eqn 1. Generic groundwater VI SLs from Ecology's Draft Vapor Intrusion Guidance Document***
VAF = 0.001 (unitless; default)
UCF = 1000 L/m^3
H_{cc} = Chemical- and temperature-dependent value. H_{cc} values are based on an average Washington shallow groundwater temperature of 13 °C, consistent with Ecology's draft vapor intrusion guidance document.

Solve:

(a) Total CPF_i (kg-day/mg) =	**0.014**
(b) SL_{IA} (µg/m3) =	**1.9**
(c) SL_{SG} (µg/m3) =	**63**
(d) SL_{GW} (µg/L) =	**7.9**

TABLE L-12
COMMERCIAL MODIFIED METHOD B NON-CARCINOGENIC RISK SLs FOR TCE
VAPOR INTRUSION ASSESSMENT
BOEING AUBURN

Given:

RfC_{TCE}(mg/m^3)	=	0.002	***Principal candidate reference concentration for chronic inhalation exposure, continuous exposure scenario; from EPA IRIS database, updated 9/28/11.***
RfD_{TCE}(mg/kg-day)	=	0.000571	***RfCTCE multiplied by standard adult BR of 20m^3 /day over standard adult average body weight of 70 kg.***
H_{cc} @ 13° Celsius (C)	=	0.238	***Henry's Law Constant (H_{cc}) from EPA On-line Tools for Site Assessment***

Constants from MTCA Equation 750-1, for Non-carcinogens per WAC 173-340-750 (4)(b)(ii)(A)

ABW (kg)	=	70	Average body weight over exposure duration
UCF (µg/mg)	=	1000	Unit conversion factor
HQ (unitless)	=	1	Hazard Quotient
AT (yr)	=	30	Averaging time
BR (m^3/day)	=	20	Breathing/inhalation rate
ABS (unitless)	=	1	Inhalation absorption fraction
ED (yr)	=	30	Exposure duration
EF (unitless)	=	0.33	Exposure frequency

Find: (a) Indoor Air Screening Level (SL_{IA}), (b) Soil Gas Screening Level (SL_{SG}), and (c) Shallow GW Screening Level (SL_{GW})

Equations:

(1) SL_{IA} (µg/m^3) = $\frac{RfD \times ABW \times UCF \times HQ \times AT}{BR \times ABS \times ED \times EF}$ ***MTCA Equation 750-1***

(2) SL_{SG} (µg/m^3) = SL_{IA} /VAF ***Eqn 2. Generic soil gas VI SLs from Ecology's Draft Vapor Intrusion Guidance Document***

The sub-slab soil gas screening level is based on a Vapor Attenuation Factor (VAF) of 0.03, per EPA's updated database (EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings; EPA 530-R-10-002. March 16, 2012) and communications with Ecology.

(3) SL_{GW} (µg/L) = $\frac{SL_{IA}}{VAF \times UCF \times H_{cc}}$ ***Eqn 1. Generic groundwater VI SLs from Ecology's Draft Vapor Intrusion Guidance Document***

VAF = 0.001 (unitless; default)

UCF = 1000 L/m^3

H_{cc} = Chemical- and temperature-dependent value. H_{cc} values are based on an average Washington shallow groundwater temperature of 13 °C, consistent with Ecology's draft vapor intrusion guidance document.

Solve:

(a)	SL_{IA} (µg/m^3) =	**6**
(b)	SL_{SG} (µg/m^3) =	**200**
(c)	SL_{GW} (µg/L) =	**25**

TABLE L-13
RESIDENTIAL METHOD B CARCINOGENIC RISK SLs FOR VC
VAPOR INTRUSION ASSESSMENT
BOEING AUBURN

Given:

$IUR_{VC}(\mu g/m^3)$	=	0.0000088	***Inhalation unit risk for early childhood exposure from EPA IRIS database***
CPF (kg-day/mg)	=	0.0308	***CPF calculated from IUR. CPF multiplied by standard adult average body weight and conversion factor of 1000, over standard adult breathing rate***

H_{cc} @ 13° Celsius (C)	=	0.816	***Henry's Law Constant (H_{cc}) from EPA On-line Tools for Site Assessment***

Constants from MTCA Equation 750-2, for Carcinogens with reduced RISK per WAC 173-340-750 (4)(b)(ii)(B)

RISK	=	1.E-06	Acceptable cancer risk level
ABW (kg)	=	70	Average body weight over exposure duration
AT (yr)	=	75	Averaging time
UCF (µg/mg)	=	1000	Unit conversion factor
CPF	=		Carcinogenic potency factor per WAC 173-340-708(8) (kg-day/mg)
BR (m^3/day)	=	20	Breathing/inhalation rate
ABS (unitless)	=	1	Inhalation absorption fraction
ED (yr)	=	30	Exposure duration
EF (unitless)	=	1	Exposure frequency

Find: (a) Indoor Air Screening Level (SL_{IA}), (b) Soil Gas Screening Level (SL_{SG}),and (c) Shallow GW Screening Level (SL_{GW})

Equations:

(1) SL_{IA} ($\mu g/m^3$)= $\frac{RISK \times ABW \times AT \times UCF}{CPF \times BR \times ABS \times ED \times EF}$ ***MTCA Equation 750-2***

(2) SL_{SG} ($\mu g/m^3$)= SL_{IA} /VAF ***Eqn 2. Generic soil gas VI SLs from Ecology's Draft Vapor Intrusion Guidance Document***

The sub-slab soil gas screening level is based on a Vapor Attenuation Factor (VAF) of 0.03, per EPA's updated database (EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings; EPA 530-R-10-002. March 16, 2012) and communications with Ecology.

(3) SL_{GW} (µg/L) = $\frac{SL_{IA}}{VAF \times UCF \times H_{cc}}$ ***Eqn 1. Generic groundwater VI SLs from Ecology's Draft Vapor Intrusion Guidance Document***

VAF = 0.001 (unitless; default)

UCF = 1000 L/m^3

H_{cc} = Chemical- and temperature-dependent value. H_{cc} values are based on an average Washington shallow groundwater temperature of 13 °C, consistent with Ecology's draft vapor intrusion guidance document.

Solve:

(a)	SL_{IA} ($\mu g/m^3$)=	**0.28**
(b)	SL_{SG} ($\mu g/m^3$)=	**9.5**
(c)	SL_{GW} (µg/L) =	**0.35**

TABLE L-14
RESIDENTIAL METHOD B NON-CARCINOGENIC RISK SLs FOR VC
VAPOR INTRUSION ASSESSMENT
BOEING AUBURN

Given:

RfC_{VC}(mg/m^3)	=	0.1	***RfC from EPA IRIS database updated 8/7/2000***
RfD_{VC}(mg/kg-day)	=	0.029	***RfC_{VC} multiplied by standard adult BR of 20m^3/day over standard adult average body weight of 70 kg.***
H_{cc} @ 13° Celsius (C)	=	0.816	***Henry's Law Constant (H_{cc}) from EPA On-line Tools for Site Assessment***

Constants from MTCA Equation 750-1, for Non-carcinogens per WAC 173-340-750 (4)(b)(ii)(A)

ABW (kg)	=	16	Average body weight over exposure duration
UCF (µg/mg)	=	1000	Unit conversion factor
HQ (unitless)	=	1	Hazard Quotient
AT (yr)	=	6	Averaging time
BR (m^3/day)	=	10	Breathing/inhalation rate
ABS (unitless)	=	1	Inhalation absorption fraction
ED (yr)	=	6	Exposure duration
EF (unitless)	=	1	Exposure frequency

Find: (a) Indoor Air Screening Level (SL_{IA}), (b) Soil Gas Screening Level (SL_{SG}), and (c) Shallow GW Screening Level (SL_{GW})

Equations:

(1) SL_{IA} (µg/m^3) = $\frac{RfD \times ABW \times UCF \times HQ \times AT}{BR \times ABS \times ED \times EF}$ ***MTCA Equation 750-1***

(2) SL_{SG} (µg/m^3) = SL_{IA} /VAF ***Eqn 2. Generic soil gas VI SLs from Ecology's Draft Vapor Intrusion Guidance Document***

The sub-slab soil gas screening level is based on a Vapor Attenuation Factor (VAF) of 0.03, per EPA's updated database (EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings; EPA 530-R-10-002. March 16, 2012) and communications with Ecology.

(3) SL_{GW} (µg/L) = $\frac{SL_{IA}}{VAF \times UCF \times H_{cc}}$ ***Eqn 1. Generic groundwater VI SLs from Ecology's Draft Vapor Intrusion Guidance Document***

VAF = 0.001 (unitless; default)
UCF = 1000 L/m^3
H_{cc} = Chemical- and temperature-dependent value. H_{cc} values are based on an average Washington shallow groundwater temperature of 13 °C, consistent with Ecology's draft vapor intrusion guidance document.

Solve:

(a) SL_{IA} (µg/m^3) =	**46**
(b) SL_{SG} (µg/m^3) =	**1500**
(c) SL_{GW} (µg/L) =	**56**

TABLE L-15
INDUSTRIAL METHOD C CARCINOGENIC RISK SLs FOR VC
VAPOR INTRUSION ASSESSMENT
BOEING AUBURN

Given:

$IUR_{VC}(\mu g/m^3)$	=	0.0000088	***Inhalation unit risk from EPA IRIS database***
CPF (kg-day/mg)	=	0.0308	***CPF calculated from IUR. CPF multiplied by standard adult average body weight and conversion factor of 1000, over standard adult breathing rate***
H_{cc} @ 13° Celsius (C)	=	0.816	***Henry's Law Constant (H_{cc}) from EPA On-line Tools for Site Assessment***

Constants from MTCA Equation 750-2, for Carcinogens with reduced RISK per WAC 173-340-750 (4)(b)(ii)(B)

RISK	=	1.E-05	Acceptable cancer risk level
ABW (kg)	=	70	Average body weight over exposure duration
AT (yr)	=	75	Averaging time
UCF (µg/mg)	=	1000	Unit conversion factor
CPF	=		Carcinogenic potency factor per WAC 173-340-708(8) (kg-day/mg)
BR (m^3/day)	=	20	Breathing/inhalation rate
ABS (unitless)	=	1	Inhalation absorption fraction
ED (yr)	=	30	Exposure duration
EF (unitless)	=	1	Exposure frequency

Find: (a) Indoor Air Screening Level (SL_{IA}), (b) Soil Gas Screening Level (SL_{SG}), and (c) Shallow GW Screening Level (SL_{GW})

Equations:

(1) $SL_{IA}\ (\mu g/m^3) = \frac{RISK \times ABW \times AT \times UCF}{CPF \times BR \times ABS \times ED \times EF}$ ***MTCA Equation 750-2***

(2) $SL_{SG}\ (\mu g/m^3) = SL_{IA} / VAF$ ***Eqn 2. Generic soil gas VI SLs from Ecology's Draft Vapor Intrusion Guidance Document***

The sub-slab soil gas screening level is based on a Vapor Attenuation Factor (VAF) of 0.03, per EPA's updated database (EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings; EPA 530-R-10-002. March 16, 2012) and communications with Ecology.

(3) $SL_{GW}\ (\mu g/L) = \frac{SL_{IA}}{VAF \times UCF \times H_{cc}}$ ***Eqn 1. Generic groundwater VI SLs from Ecology's Draft Vapor Intrusion Guidance Document***

VAF = 0.001 (unitless; default)

UCF = 1000 L/m^3

H_{cc} = Chemical- and temperature-dependent value. H_{cc} values are based on an average Washington shallow groundwater temperature of 13 °C, consistent with Ecology's draft vapor intrusion guidance document.

Solve:

(a)	$SL_{IA}\ (\mu g/m^3)$ =	**2.8**
(b)	$SL_{SG}\ (\mu g/m^3)$ =	**95**
(c)	$SL_{GW}\ (\mu g/L)$ =	**3.5**

TABLE L-16
INDUSTRIAL METHOD C NON-CARCINOGENIC RISK SLs FOR VC
VAPOR INTRUSION ASSESSMENT
BOEING AUBURN

Given:

RfC_{VC}(mg/m^3)	=	0.1	***RfC from EPA IRIS database updated 8/7/2000***
RfD_{VC}(mg/kg-day)	=	0.029	***RfC_{VC} multiplied by standard adult BR of 20m^3/day over standard adult average body weight of 70 kg.***
H_{cc} @ 13° Celsius (C)	=	0.816	***Henry's Law Constant (H_{cc}) from EPA On-line Tools for Site Assessment***

Constants from MTCA Equation 750-1, for Non-carcinogens per WAC 173-340-750 (4)(b)(ii)(A)

ABW (kg)	=	70	Average body weight over exposure duration
UCF (µg/mg)	=	1000	Unit conversion factor
HQ (unitless)	=	1	Hazard Quotient
AT (yr)	=	30	Averaging time
BR (m^3/day)	=	20	Breathing/inhalation rate
ABS (unitless)	=	1	Inhalation absorption fraction
ED (yr)	=	30	Exposure duration
EF (unitless)	=	1	Exposure frequency

Find: (a) Indoor Air Screening Level (SL_{IA}), (b) Soil Gas Screening Level (SL_{SG}), and (c) Shallow GW Screening Level (SL_{GW})

Equations:

(1) SL_{IA} (µg/m^3) = $\frac{RfD \times ABW \times UCF \times HQ \times AT}{BR \times ABS \times ED \times EF}$ ***MTCA Equation 750-1***

(2) SL_{SG} (µg/m^3) = SL_{IA} /VAF

Eqn 2. Generic soil gas VI SLs from Ecology's Draft Vapor Intrusion Guidance Document
The sub-slab soil gas screening level is based on a Vapor Attenuation Factor (VAF) of 0.03, per EPA's updated database (EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings; EPA 530-R-10-002. March 16, 2012) and communications with Ecology.

(3) SL_{GW} (µg/L) = $\frac{SL_{IA}}{VAF \times UCF \times H_{cc}}$

Eqn 1. Generic groundwater VI SLs from Ecology's Draft Vapor Intrusion Guidance Document
VAF = 0.001 (unitless; default)
UCF = 1000 L/m^3
H_{cc} = Chemical- and temperature-dependent value. H_{cc} values are based on an average Washington shallow groundwater temperature of 13 °C, consistent with Ecology's draft vapor intrusion guidance document.

Solve:

(a)	SL_{IA} (µg/m^3) =	**100**
(b)	SL_{SG} (µg/m^3) =	**3300**
(c)	SL_{GW} (µg/L) =	**120**

TABLE L-17
COMMERCIAL MODIFIED METHOD B CARCINOGENIC RISK SLs FOR VC
VAPOR INTRUSION ASSESSMENT
BOEING AUBURN

Given:

IUR_{VC}(µg/m^3)	=	0.0000088	***Inhalation unit risk for child exposure from EPA IRIS database; adult exposure not applicable since could be pregnant employees***
CPF (kg-day/mg)	=	0.0308	***CPF calculated from IUR. CPF multiplied by standard adult average body weight and conversion factor of 1000, over standard adult breathing rate***
H_{cc} @ 13° Celsius (C)	=	0.816	***Henry's Law Constant (H_{cc}) from EPA On-line Tools for Site Assessment***

Constants from MTCA Equation 750-2, for Carcinogens with reduced RISK per WAC 173-340-750 (4)(b)(ii)(B)

RISK	=	1.E-06	Acceptable cancer risk level
ABW (kg)	=	70	Average body weight over exposure duration
AT (yr)	=	75	Averaging time
UCF (µg/mg)	=	1000	Unit conversion factor
CPF	=		Carcinogenic potency factor per WAC 173-340-708(8) (kg-day/mg)
BR (m^3/day)	=	20	Breathing/inhalation rate
ABS (unitless)	=	1	Inhalation absorption fraction
ED (yr)	=	30	Exposure duration
EF (unitless)	=	0.33	Exposure frequency

Find: (a) Indoor Air Screening Level (SL_{IA}), (b) Soil Gas Screening Level (SL_{SG}),and (c) Shallow GW Screening Level (SL_{GW})

Equations:

(1) SL_{IA} (µg/m^3) = $\frac{\text{RISK X ABW X AT X UCF}}{\text{CPF X BR X ABS X ED X EF}}$ ***MTCA Equation 750-2***

(2) SL_{SG} (µg/m^3) = SL_{IA} /VAF

Eqn 2. Generic soil gas VI SLs from Ecology's Draft Vapor Intrusion Guidance Document
The sub-slab soil gas screening level is based on a Vapor Attenuation Factor (VAF) of 0.03, per EPA's updated database (EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings; EPA 530-R-10-002. March 16, 2012) and communications with Ecology.

(3) SL_{GW} (µg/L) = $\frac{SL_{IA}}{VAF \times UCF \times H_{cc}}$

Eqn 1. Generic groundwater VI SLs from Ecology's Draft Vapor Intrusion Guidance Document
VAF = 0.001 (unitless; default)
UCF = 1000 L/m^3
H_{cc} = Chemical- and temperature-dependent value. H_{cc} values are based on an average Washington shallow groundwater temperature of 13 °C, consistent with Ecology's draft vapor intrusion guidance document.

Solve:

(b) SL_{IA} (µg/m^3) =	**0.85**
(c) SL_{SG} (µg/m^3) =	**28.4**
(d) SL_{GW} (µg/L) =	**1.0**

TABLE L-18
COMMERCIAL MODIFIED METHOD B NON-CARCINOGENIC RISK SLs FOR VC
VAPOR INTRUSION ASSESSMENT
BOEING AUBURN

Given:

RfC_{VC} (mg/m^3)	=	0.1	***RfC from EPA IRIS database updated 8/7/2000***
RfD_{VC} (mg/kg-day)	=	0.029	***RfC_{VC} multiplied by standard adult BR of 20m^3/day over standard adult average body weight of 70 kg.***
H_{cc} @ 13° Celsius (C)	=	0.816	***Henry's Law Constant (H_{cc}) from EPA On-line Tools for Site Assessment***

Constants from MTCA Equation 750-1, for Non-carcinogens per WAC 173-340-750 (4)(b)(ii)(A)

ABW (kg)	=	70	Average body weight over exposure duration
UCF (µg/mg)	=	1000	Unit conversion factor
HQ (unitless)	=	1	Hazard Quotient
AT (yr)	=	30	Averaging time
BR (m^3/day)	=	20	Breathing/inhalation rate
ABS (unitless)	=	1	Inhalation absorption fraction
ED (yr)	=	30	Exposure duration
EF (unitless)	=	0.33	Exposure frequency

Find: (a) Indoor Air Screening Level (SL_{IA}), (b) Soil Gas Screening Level (SL_{SG}), and (c) Shallow GW Screening Level (SL_{GW})

Equations:

(1) SL_{IA} (µg/m^3) = $\frac{RfD \times ABW \times UCF \times HQ \times AT}{BR \times ABS \times ED \times EF}$ ***MTCA Equation 750-1***

(2) SL_{SG} (µg/m^3) = SL_{IA} /VAF

Eqn 2. Generic soil gas VI SLs from Ecology's Draft Vapor Intrusion Guidance Document

The sub-slab soil gas screening level is based on a Vapor Attenuation Factor (VAF) of 0.03, per EPA's updated database (EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings; EPA 530-R-10-002. March 16, 2012) and communications with Ecology.

(3) SL_{GW} (µg/L) = $\frac{SL_{IA}}{VAF \times UCF \times H_{cc}}$

Eqn 1. Generic groundwater VI SLs from Ecology's Draft Vapor Intrusion Guidance Document

VAF = 0.001 (unitless; default)

UCF = 1000 L/m^3

H_{cc} = Chemical- and temperature-dependent value. H_{cc} values are based on an average Washington shallow groundwater temperature of 13 °C, consistent with Ecology's draft vapor intrusion guidance document.

Solve:

(a) SL_{IA} (µg/m^3) =	**300**
(b) SL_{SG} (µg/m^3) =	**10000**
(c) SL_{GW} (µg/L) =	**370**