From: Dougherty, Brian
Sent: Friday, May 29, 2020 8:48 AM
To: Dougherty, Brian <Brian.Dougherty@dep.state.fl.us>
Subject: Limitations on use of the BaP ASCTL

Good morning All,

As previously discussed, the Division no longer supports the use of the 1.0 mg/kg BaP ASCTL for default residential scenarios (i.e., unrestricted use). A further discussion of this follows.

The soil cleanup target levels (SCTLs) used in the cleanup of contaminated sites are promulgated in Chapter 62-777, Florida Administrative Code (F.A.C.). These SCTLs are calculated in accordance with the equations, parameters, and parameter values identified in that chapter. However, provisions are also included in the chapter to calculate alternative SCTLs using the procedures in the rule and adjusting parameter values as appropriate. Parameter values can be adjusted for a variety of reasons including updates to overall exposure factors, site-specific selection or identification of exposure factors, and updates to the underlying physical and chemical parameters such as reference doses or toxicity.

In keeping with the provisions that allow calculation of an alternative cleanup target level, the Division of Waste Management (DWM) calculated alternative direct exposure soil cleanup target levels (ASCTL) for Benzo(a)Pyrene (BaP) equivalents based upon an update to the toxicity value for BaP. This ASCTL calculation followed the process and equations set out in Chapter 62-777, F.A.C., and referenced in Rule 62-780.650, F.A.C., and resulted in values of 1.0 milligrams/kilogram (mg/kg) for the residential scenario and 3.1 mg/kg for the commercial/industrial exposure scenario. (Note: In accordance with Chapter 62-777, F.A.C., the carcinogenic polynuclear aromatic hydrocarbons (PAHs) are weighted and summed to determine Benzo(a)Pyrene equivalents. Correspondingly, all references here to Benzo(a)Pyrene or BaP are references to Benzo(a)Pyrene equivalents.)

Based upon a recent re-evaluation of that ASCTL calculation, it has been determined that the 1.0 mg/kg BaP ASCTL is not sufficiently protective of children in a residential setting and that the Chapter 62-777, F.A.C., SCTL of 0.1 mg/kg should be used as the residential direct exposure SCTL for BaP. The reasons for this determination are as follows:

Benzo(a)pyrene belongs to a group of carcinogens known to have disproportionate effects during development and therefore have a greater potential for risk to children than to adults. To account for this disproportionate risk, the U.S. Environmental Protection Agency developed Age Dependent Adjustment Factors (ADAFs) to apply when developing exposure limits, such as cleanup target levels, in situations where children may be present. The purpose of the ADAFs is to provide greater weight to childhood exposure when calculating limits based on lifetime exposure.

The ADAFs were not used in the initial calculation of the BaP ASCTL because they are not an explicit part of the promulgated alternative CTL process in Rule 62-780.650, F.A.C., and require a modification to the process used to calculate the CTLs in Chapter 62-777, F.A.C. Because the ADAFs were not used, this ASCTL may not be sufficiently protective when children may be present. The ADAFs can be incorporated into a calculation of the BaP ASCTL using accepted practices and doing so would lead to a reduction from the current ASCTL of 1.0 mg/kg to 0.1 – 0.4 mg/kg (the variability is due to exactly how the ADAF is incorporated).

The attached letter from the University of Florida, Center for Environment and Human Toxicology (UF) outlines three possible approaches for incorporating the ADAFs into the BaP ASCTL calculation.

Because these three different approaches have not been publicly vetted and because the resulting differences are arguably small, DWM recommends that the Chapter 62-777, F.A.C., default residential direct exposure soil cleanup target level be used for closure of site where children may be present. In other words, the current default soil cleanup target level of 0.1 mg/kg should be used for evaluating closure without controls for BaP in soil. The other routine exceptions, such as background or best achievable detection limit, still apply.

The ASCTL of 3.1 mg/kg for BaP for the commercial/industrial scenario is still considered protective as this scenario is not one where children are expected to be present.

Also note it may be possible to calculate an ASCTL for leachability to groundwater for BaP using the updated toxicity value. However, the individual carcinogenic PAHs have individual groundwater CTLs so the leachability CTLs must be calculated for each such PAH.

Going forward, please bear in mind the "grandfathering" provisions in 62-780.150(5), F.A.C. and the required conditions for implementing those provisions.

I'll be happy to help with any questions or follow up.
Brian

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July 25, 2018

Leah J. Smith
District and Business Support Program
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2600 Blair Stone Road
Tallahassee, FL 32399-2400

Re: Evaluation of the age-dependent adjustment factors in relation to Chapter 62-777, F.A.C.

Dear Ms. Smith:

At your request, we have evaluated the United States Environmental Protection Agency's (USEPA's) age-dependent adjustment factors (ADAFs) in relation to Chapter 62-777, F.A.C. As you know, these factors are intended to take into account the increased susceptibility of children to carcinogenicity from mutagenic carcinogens. Groundwater cleanup target levels (GCTLs) in Chapter 62-777, F.A.C. are based upon drinking water consumption of groundwater in adults only. As such, ADAFs are not relevant to the derivation of default GCTLs in the current rule. This evaluation is focused on incorporation of ADAFs into the development of soil cleanup target levels (SCTLs), where according to Chapter 62-777, F.A.C., exposure by a child is assumed to be part of a residential land use scenario for carcinogens.

Incorporation of the age-dependent adjustment factors into the soil equation promulgated in Chapter 62-777, F.A.C. is not straightforward. The Florida Department of Environmental Protection (FDEP) uses a different method for averaging body weight and soil ingestion over a residential exposure period than the USEPA. The explanation for this difference is provided on pages 22-23 of the *Technical Report: Development of Cleanup Target Levels (CTLs) for Chapter 62-777, F.A.C.* (FDEP, 2005). Although more technically correct, the FDEP methodology does not allow for the simple insertion of ADAFs. This is because the ADAFs adjust a toxicity value for a specific age range and its effect on the final criterion is based on the exposure parameters for the same age range. The FDEP averaging method does not allow for the application of an ADAF to age-specific exposure parameters. Instead, the ADAF would be averaged over the entire residential period. Therefore, the use of the ADAFs in the Chapter 62-777, F.A.C. soil equation will not produce an equivalent decrease in the criteria for mutagenic chemicals as the USEPA equation. Three different methodologies for incorporating ADAFs into Chapter 62-777, F.A.C. are shown below:

1. The most scientifically defensible method for calculating soil criteria for mutagenic chemicals is to use the USEPA regional screening level (RSL) soil equations for mutagens

(Figure 1). Default values for the equation are listed in Figure 1 and Table 1. This method applies the toxicity value modified by the ADAF separately based on the ADAF's age range and whether the age range has adult or child exposure parameters: 1) two years as a child with an ADAF of 10, 2) four years as a child with an ADAF of 3, 3) ten years as an adult with an ADAF of 3, and 4) ten years as an adult with an ADAF of 1. Advantages: This method applies ADAF values as intended by USEPA guidance. It would provide cancer estimates for residential exposure consistent with those developed by the USEPA. Disadvantages: As explained in the technical report for Chapter 62-777, F.A.C. cited above, the method for calculating soil exposure used by the USEPA (i.e., the average rate of soil ingestion per body weight over the exposure interval of interest) is different from the way that dose per body weight is calculated in developing most cancer slope factors. Ideally, the method for dose calculation for exposure and to establish the dose-response [cancer] relationship should be the same. FDEP currently uses an age-averaging approach to estimate soil exposure that matches the approach used in cancer slope factor development. This alignment of dose calculation methods would be lost using the USEPA RSL soil equation for mutagens. Also, to avoid inconsistencies in the way that cancer risks are calculated for soil exposures, the USEPA equation for non-mutagenic carcinogens would also need to be adopted.

2. The second method is a modification of the current Chapter 62-777, F.A.C. equation. This would allow for the incorporation of the ADAFs in to the Chapter 62-777, F.A.C. soil equation for each age group while maintaining the FDEP method of body weight averaging. The proposed modified equation is presented in Figure 2. Default values for the equation are listed in Table 2. Advantages: This approach uses the equation currently in Chapter 62-777, F.A.C., with the addition of a term incorporating ADAFs for mutagenic carcinogens. It preserves, to some extent, the body weight and soil ingestion averaging approach currently used by FDEP; however, it is modified to average over age intervals consistent with the ADAFs. Disadvantages: This equation will produce results somewhat different from the USEPA equations, even using the same exposure parameters. There are two important caveats to the equation and inputs presented for this option: 1) The FDEP excludes children ages 0 through 1 year old from the assessment. For the USEPA, exposure is assumed to begin at birth. Because, 0 through 1 year old is one of the most sensitive time periods for exposure to a mutagen, exclusion of this age group underestimates risk to children. 2) The FDEP uses an inhalation cancer slope factor instead of an inhalation unit risk value to calculate cancer risk from inhalation exposure. Since inhaled dose is no longer believed to be a function of body weight, the current Chapter 62-777, F.A.C. equation is outdated and does not calculate inhalation dose correctly. Both of these issues could be easily addressed through a change in the equation and exposure assumptions.

3. The third method is to retain the soil equation in Chapter 62-777, F.A.C. and add a modifier for mutagens. The soil criteria would be divided by the multiplier to account for the ADAF. The modifier based on the average ADAF over 26 years of residential exposure is 2.4 [(10×1 year) + (3×14 years) + (1×11 years)/26 years]. This estimation assumes an exposure period from ages 1-27 years. The modifier for ages 0-26 years would be 2.8. Advantages: The principal advantage is simplicity in implementation. It also fully preserves the age averaging of body weight and soil ingestion currently in Chapter 62-777, F.A.C. Disadvantages: While preserving a technically more correct means of age averaging exposure, it is arguably a technically incorrect application of ADAFs. The rationale for separately age-averaging body weight and exposure in the current method does not apply to ADAFs. As a result, a modifier of 2.4 (or 2.8) underestimates the effect

of the ADAF on soil criteria with chemicals showing up to a 4.5-fold decrease in criteria when the ADAFs are applied using the USEPA methodology.

Using benzo(a)pyrene (BaP) as an example chemical, we calculated SCTLs using each of the three proposed methodologies. Chemical-specific assumptions for BaP are listed in Table 3. Use of the USEPA RSL soil equations for mutagens (method 1) results in a residential BaP SCTL of 0.1 mg/kg. The modified Chapter 62-777, F.A.C. equation (method 2) would result in a residential BaP SCTL of 0.2 mg/kg. Using a modifier of 2.4 (method 3), would result in a residential BaP SCTL of 0.4 mg/kg. These values are based on rounding to one significant figure. For BaP, the three methodologies produce a four-fold difference in residential SCTLs.

Please let us know if you have any questions regarding this evaluation.

Sincerely,

Leah D. Stuchal, Ph.D.

Stephen M. Roberts, Ph.D.

References:

CEHT (2005) *Final Technical Report: Development of Cleanup Target Levels (CTLs) for Chapter 62-777, F.A.C.* Center for Environmental & Human Toxicology, University of Florida, Gainesville, FL.

USEPA (2014) *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER Directive 9200.1-200*. United States Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C.

Figure 1 – USEPA mutagenic equations for residential soil:

Ingestion:

$$SL_{res\text{-}soil\text{-}mu\text{-}ing}\left(\frac{mg}{kg}\right) = \frac{TR \times AT_{res}\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right)}{CSF_o\left(\frac{mg}{kg\text{-}day}\right)^{-1} \times RBA \times IFSM_{res\text{-}adj}\left(\frac{166{,}833\ mg}{kg}\right) \times \left(\frac{10^{-6} kg}{mg}\right)}$$

where:

$$IFSM_{res\text{-}adj}\left(\frac{166{,}833\ mg}{kg}\right) = \left(\begin{array}{l} \frac{EF_{0\text{-}2}\left(\frac{350\ days}{year}\right) \times ED_{0\text{-}2}\left(2\ years\right) \times IRS_{0\text{-}2}\left(\frac{200\ mg}{day}\right) \times 10}{BW_{0\text{-}2}\left(15\ kg\right)} + \\ \frac{EF_{2\text{-}6}\left(\frac{350\ days}{year}\right) \times ED_{2\text{-}6}\left(4\ years\right) \times IRS_{2\text{-}6}\left(\frac{200\ mg}{day}\right) \times 3}{BW_{2\text{-}6}\left(15\ kg\right)} + \\ \frac{EF_{6\text{-}16}\left(\frac{350\ days}{year}\right) \times ED_{6\text{-}16}\left(10\ years\right) \times IRS_{6\text{-}16}\left(\frac{100\ mg}{day}\right) \times 3}{BW_{6\text{-}16}\left(80\ kg\right)} + \\ \frac{EF_{16\text{-}26}\left(\frac{350\ days}{year}\right) \times ED_{16\text{-}26}\left(10\ years\right) \times IRS_{16\text{-}26}\left(\frac{100\ mg}{day}\right) \times 1}{BW_{16\text{-}26}\left(80\ kg\right)} \end{array}\right)$$

Dermal exposure:

$$SL_{res\text{-}soil\text{-}mu\text{-}der}\left(\frac{mg}{kg}\right) = \frac{TR \times AT_{res}\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right)}{\left(\frac{CSF_o\left(\frac{mg}{kg\text{-}day}\right)^{-1}}{GIABS}\right) \times DFSM_{res\text{-}adj}\left(\frac{428{,}260\ mg}{kg}\right) \times ABS_d \times \left(\frac{10^{-6} kg}{mg}\right)}$$

where:

$$DFSM_{res\text{-}adj}\left(\frac{428{,}260\ mg}{kg}\right) = \left(\begin{array}{l} \frac{EF_{0\text{-}2}\left(\frac{350\ days}{year}\right) \times ED_{0\text{-}2}\left(2\ years\right) \times AF_{0\text{-}2}\left(\frac{0.2\ mg}{cm^2}\right) \times SA_{0\text{-}2}\left(\frac{2373\ cm^2}{day}\right) \times 10}{BW_{0\text{-}2}\left(15\ kg\right)} + \\ \frac{EF_{2\text{-}6}\left(\frac{350\ days}{year}\right) \times ED_{2\text{-}6}\left(4\ years\right) \times AF_{2\text{-}6}\left(\frac{0.2\ mg}{cm^2}\right) \times SA_{2\text{-}6}\left(\frac{2373\ cm^2}{day}\right) \times 3}{BW_{2\text{-}6}\left(15\ kg\right)} + \\ \frac{EF_{6\text{-}16}\left(\frac{350\ days}{year}\right) \times ED_{6\text{-}16}\left(10\ years\right) \times AF_{6\text{-}16}\left(\frac{0.07\ mg}{cm^2}\right) \times SA_{6\text{-}16}\left(\frac{6032\ cm^2}{day}\right) \times 3}{BW_{6\text{-}16}\left(80\ kg\right)} + \\ \frac{EF_{16\text{-}26}\left(\frac{350\ days}{year}\right) \times ED_{16\text{-}26}\left(10\ years\right) \times AF_{16\text{-}26}\left(\frac{0.07\ mg}{cm^2}\right) \times SA_{16\text{-}26}\left(\frac{6032\ cm^2}{day}\right) \times 1}{BW_{16\text{-}26}\left(80\ kg\right)} \end{array}\right)$$

Inhalation:

$$SL_{res\text{-}soil\text{-}mu\text{-}inh}\left(mg/kg\right) = \frac{TR \times AT_{res}\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right)}{IUR\left(\frac{\mu g}{m^3}\right)^{-1} \times \left(\frac{1}{VF_s\left(\frac{m^3}{kg}\right)} + \frac{1}{PEF_w\left(\frac{m^3}{kg}\right)}\right) \times \left(\frac{1000\ \mu g}{mg}\right) \times \left(\begin{array}{l} \left(ET_{0\text{-}2}\left(\frac{24\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times EF_{0\text{-}2}\left(\frac{350\ days}{year}\right) \times ED_{0\text{-}2}\left(2\ years\right) \times 10\right) + \\ \left(ET_{2\text{-}6}\left(\frac{24\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times EF_{2\text{-}6}\left(\frac{350\ days}{year}\right) \times ED_{2\text{-}6}\left(4\ years\right) \times 3\right) + \\ \left(ET_{6\text{-}16}\left(\frac{24\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times EF_{6\text{-}16}\left(\frac{350\ days}{year}\right) \times ED_{6\text{-}16}\left(10\ years\right) \times 3\right) + \\ \left(ET_{16\text{-}26}\left(\frac{24\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times EF_{16\text{-}26}\left(\frac{350\ days}{year}\right) \times ED_{16\text{-}26}\left(10\ years\right) \times 1\right) \end{array}\right)}$$

Calculation of the ASCTL:

$$SL_{res\text{-}soil\text{-}mu\text{-}tot}\left(mg/kg\right) = \frac{1}{\frac{1}{SL_{res\text{-}soil\text{-}mu\text{-}ing}} + \frac{1}{SL_{res\text{-}soil\text{-}mu\text{-}der}} + \frac{1}{SL_{res\text{-}soil\text{-}mu\text{-}inh}}}$$

Figure 2 – Modification of the Chapter 62-777, F.A.C. soil equation for the incorporation of ADAFs

Ingestion (oral):

$$SL_{ing}\ (mg/kg) = \frac{TR \times AT}{RBA \times FC \times CSF_o \times EF \times OFSM \times 10^{-6}(kg/mg)}$$

$$OFSM\ (mg/kg) = \frac{ED_{1-2} \times IR_{o_{1-2}} \times 10}{BW_{1-2}} + \frac{ED_{2-16} \times IR_{o_{2-16}} \times 3}{BW_{2-16}} + \frac{ED_{16-27} \times IR_{o_{16-27}}}{BW_{16-27}}$$

Dermal:

$$SL_{derm}\ (mg/kg) = \frac{TR \times AT}{FC \times CSF_d \times EF \times DFSM \times DA \times 10^{-6}(kg/mg)}$$

$$DFSM\ (mg/kg) = \frac{ED_{1-2} \times AF_{1-2} \times SA_{1-2} \times 10}{BW_{1-2}} + \frac{ED_{2-16} \times AF_{2-16} \times SA_{2-16} \times 3}{BW_{2-16}} + \frac{ED_{16-27} \times AF_{16-27} \times SA_{16-27}}{BW_{16-27}}$$

Inhalation:

$$SL_{inh}\ (mg/kg) = \frac{TR \times AT}{FC \times CSF_i \times EF \times IFSM \times \left(\frac{1}{VF} + \frac{1}{PEF}\right)}$$

$$IFSM\ (mg/kg) = \frac{ED_{1-2} \times IR_{i_{1-2}} \times 10}{BW_{1-2}} + \frac{ED_{2-16} \times IR_{i_{2-16}} \times 3}{BW_{2-16}} + \frac{ED_{16-27} \times IR_{i_{16-27}}}{BW_{16-27}}$$

Calculation of the ASCTL:

$$SCTL\ (mg/kg) = \frac{1}{\frac{1}{SL_{ing}} + \frac{1}{SL_{derm}} + \frac{1}{SL_{inh}}}$$

Table 1 - Default values for the calculation of a mutagenic ASCTL using the USEPA equation

Symbol	Definition (units)	Default
DA	Dermal absorption (unitless) organics	0.1
	Dermal absorption (unitless) inorganics	0.001
PEF	Particulate emission factor (m^3/kg)	1.24×10^{9}
TR	Target risk (unitless)	1×10^{-6}
RBA	Relative bioavailability	1
GIABS	Gastrointestinal absorption	1
CSF_o	Oral cancer slope factor (per mg/kg-d)	Chemical-specific
CSF_d	Dermal cancer slope factor (per mg/kg-d)	Chemical-specific
CSF_i	Inhalation cancer slope factor (per mg/kg-d)	Chemical-specific
VF	Volatilization factor (m^3/kg)	Chemical-specific

Table 2 – Default values for the calculation of a mutagenic ASCTL using a modified Chapter 62-777, F.A.C. SCTL equation

Symbol	Definition (units)	Receptor	Default	Source
BW	Body weight (kg)	1-2	11.4	EFH, 2011 Table ES-1
		2-16	36.6	
		16-27	76.2	
IR_o	Ingestion rate, oral (mg/day)	1-2	200	USEPA, 2014
		2-16	129	
		16-27	100	
EF	Exposure frequency (days/yr)		350	USEPA, 2014
ED	Exposure duration (years)	1-2	1	Calculated
		2-16	14	
		16-27	11	
SA	Surface area exposed (cm^2/day)	1-2	2345	Calculated*
		2-16	4171	
		16-27	6203	
AT	Averaging time (days) (carcinogens)		25550	USEPA, 2014
AF	Adherence factor (mg/cm^2)	1-2	0.2	USEPA, 2014
		2-16	0.1	
		16-27	0.07	
IR_i	Inhalation rate (m^3/day)	1-2	8.1	Chapter 62-777, F.A.C.
		2-16	11.7	
		16-27	13.1	
DA	Dermal absorption (unitless)	organics	0.1	USEPA RSL defaults
		inorganics	0.001	
PEF	Particulate emission factor (m^3/kg)		1.24×10^9	Chapter 62-777, F.A.C.
TR	Target risk (unitless)		1×10^{-6}	Chapter 62-777, F.A.C.
RBA	Relative bioavailability		1	Chapter 62-777, F.A.C.
FC	Fraction from contaminated source		1	Chapter 62-777, F.A.C.
CSF_o	Oral cancer slope factor (per mg/kg-d)		Chemical-specific	
CSF_d	Dermal cancer slope factor (per mg/kg-d)		Chemical-specific	
CSF_i	Inhalation cancer slope factor (per mg/kg-d)		Chemical-specific	
VF	Volatilization factor (m^3/kg)		Chemical-specific	

RSL – regional screening level, * - Calculated based on the body weights in the EFH, 2011. The Burmaster (1998) equation was used to convert body weight to surface area. The surface area was multiplied by the percent surface area exposed by body part (Table A-5) as listed in the Chapter 62-777, F.A.C. technical report (CEHT, 2005).

Table 3 – Benzo(a)pyrene chemical-specific parameters

Symbol	Definition	Value
DA	Dermal absorption (unitless)	0.13
CSF_o	Oral cancer slope factor (per mg/kg-d)	1.0E+00
CSF_d	Dermal cancer slope factor (per mg/kg-d)	1.0E+00
CSF_i	Inhalation cancer slope factor (per mg/kg-d)	2.4E+00
VF	Volatilization factor (m^3/kg)	2.988E+07

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August 1, 2017

Gladys Liehr, PhD
District and Business Support Program
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Re: Review of benzo(a)pyrene ASCTLs in letters dated February 10 and May 11, 2017

Dear Dr. Liehr:

At your request, we have reviewed the benzo(a)pyrene (BaP) toxic equivalents (TEQs) alternative soil cleanup target levels (ASCTLs) calculated in a letter addressed to you dated February 10, 2017 and in the draft update to the Chapter 62-777, Florida Administrative Code (F.A.C.) table submitted May 11, 2017. This letter explains how different BaP ASCTLs were derived in the two letters. Additionally, it evaluates the effect of incorporating the age dependent adjustment factor (ADAF) in the BaP TEQ calculation as recommended by the U.S. Environmental Protection Agency (USEPA).

The February 10, 2017 letter contained a derivation of a residential ASCTL for BaP TEQs of 1.5 mg/kg and a commercial/industrial ASCTL of 6.4 mg/kg. The derivation of these values included use of updated toxicity values and exposure assumptions. The updated toxicity values were taken from the USEPA's Integrated Risk Information System (IRIS) and include a BaP oral cancer slope factor of 1E+00 per mg/kg-d and an inhalation unit risk of 6E-04 per mg/m^3 (USEPA, 2017). Updated exposure assumptions were taken from OSWER Directive 9200.1-120 (2014). Assumptions not included in the OSWER Directive were taken from Chapter 62-777, F.A.C. The equation used to calculate the February 10, 2017 ASCTLs was taken from Figure 4 of Chapter 62-777, F.A.C. However, the dermal pathway was inadvertently excluded from the calculation. Therefore, these ASCTLs do not include dermal exposure. Exclusion of the dermal pathway is not consistent with Chapter 62-777, F.A.C. or Chapter 62-780, F.A.C., with regard to the derivation of alternative cleanup target levels. Although the USEPA currently excludes dermal exposure for the indoor worker scenario, this is not appropriate for an outdoor worker or a resident.

The draft Chapter 62-777, F.A.C. Table 2 update dated May 11, 2017 includes a residential SCTL for BaP TEQs of 1 mg/kg and a commercial/industrial SCTL of 3.1 mg/kg. The assumptions and toxicity values utilized in the calculation of these SCTLs were identical to those used in the ASCTLs for BaP TEQs in the letter dated February 10, 2017 (Figure 1 and Table 1). However, this calculation included the dermal pathway. Additionally, between the February 10, 2017 letter and the May 11, 2017 letter, the dermal absorption for BaP was updated from the default value of 0.1 to the chemical-specific value of 0.13 listed in the USEPA regional screening level (RSL) tables (https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-june-

2017). The inclusion of the dermal pathway and update to the dermal absorption results in the difference in BaP TEQ criteria between these two letters. The SCTLs for BaP TEQs listed in the draft Table 2 update (1 mg/kg residential and 3.1 mg/kg commercial/industrial) reflect the most current assumptions and toxicity values and should be used in place of the February 10, 2017 ASCTLs. The February 10, 2017 ASCTLs can no longer be supported by current parameter values or as meeting Florida's regulatory requirements for the default exposure scenarios.

An additional issue to consider is the inclusion of age-dependent adjustment factors (ADAFs) for mutagenic carcinogens, which include BaP and other carcinogenic polycyclic aromatic hydrocarbons (PAHs). Current toxicity estimates based on an average daily exposure do not include the potential for higher cancer risk during early lifestages (i.e., infancy through mid-teens). ADAFs were developed by the USEPA in 2005 to address such childhood exposures. ADAFs are factors that take into account the greater susceptibility of children to mutagenic carcinogens by adjusting the toxicity value for early lifestages. The USEPA analyzed repeated dose studies for early postnatal, juvenile, and adults on 67 different carcinogenic chemicals (or mixtures). They concluded that early lifestage exposure to carcinogenic chemicals with a mutagenic mode of action leads to increased tumor incidence compared with adult exposures of similar duration and dose (USEPA, 2005). Early lifestage susceptibility is not only seen in animal studies. Evidence of increased susceptibility in childhood to carcinogens is also apparent in clinical and epidemiological cases (e.g., diethylstilbestrol, radioactive iodine, immunosuppressive drugs) (WDOE, 2010).

The ten-fold adjustment that is applied to toxicity values for 0-2 year olds represents the weighted geometric mean tumor incidence ratio between juvenile and adult exposures in repeated dosing studies (USEPA, 2005). The three-fold toxicity adjustment for ages 2 through <16 years old represents a midpoint between the toxicity adjustment for adults (1) and juveniles (10) on a logarithmic scale. Consideration of early lifestage susceptibility in risk assessment is supported by the Science Advisory Board (USEPA, 2011) and the National Research Council (NRC, 2008). Currently 46% of 40 states surveyed utilize the ADAF (University of Florida survey presented to the Contaminated Media Forum). This number increases to 65% for states that have updated their soil equations in the last 7 years. ADAFs are not currently included in Chapter 62-777, F.A.C. equations. If the ADAF is not used to account for the increased susceptibility of early lifestages to mutagens, risks to children may be underestimated. The inclusion of ADAFs would lower the BaP SCTL for residents. Although the exact amount the SCTL would be lowered is determined by the equation used, current Chapter 62-777, F.A.C. equations would result in lowering the mutagenic SCTLs by a factor of 2.4. However, it would not affect SCTLs for scenarios that do not include children (e.g., commercial/industrial worker, construction worker, adult residential community).

Please let us know if you have any questions regarding this review.

Sincerely,

Leah D. Stuchal, Ph.D.

Stephen M. Roberts, Ph.D.

References:

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Figure 1 – Equation used in the development of commercial/industrial soil cleanup target levels for benzo(a)pyrene

$$SCTL = \frac{TR \times BW \times AT}{EF \times ED \times FC \times \left[(CSF_o \times IR_o \times RBA \times 10^{-6}\, kg/mg) + (CSF_d \times SA \times AF \times DA \times 10^{-6}\, kg/mg) + \left(CSF_i \times IR_i \times \left(\frac{1}{VF} + \frac{1}{PEF} \right) \right) \right]}$$

Table 1 - Default values for the calculation of the benzo(a)pyrene ASCTL

Symbol	Definition (units)	Receptor	Default
AF	Adherence factor (mg/cm^2)	resident	0.1
		worker	0.12
AT	Averaging time (days) (carcinogens)	resident	25550
		worker	25550
BW	Body weight (kg)	resident	65
		worker	80
CSF_o	Oral cancer slope factor (per mg/kg-d)		1E+00
CSF_d	Dermal cancer slope factor (per mg/kg-d)		1E+00
CSF_i	Inhalation cancer slope factor (per mg/kg-d)		2.4E+00
DA	Dermal absorption (unitless) (organics)		0.13
EF	Exposure frequency (days/yr)	resident	350
		worker	250
ED	Exposure duration (years)	resident	26
		worker	25
FC	Fraction from contaminated source		1
IR_i	Inhalation rate (m^3/day)	resident	12.2
		worker	20
IR_o	Ingestion rate, oral (mg/day)	resident	120
PEF	Particulate emission factor (m^3/kg)	worker	50
RBA	Relative bioavailability		1
SA	Surface area exposed (cm^2/day)	resident	5188
		worker	3527
TR	Target risk (unitless)		1×10^{-6}
VF	Volatilization factor (m^3/kg)	resident	2.988E+07
		worker	2.929E+07