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Leah J. Smith
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Florida Department of Environmental Protection
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Re: Evaluation of the development of alternative groundwater cleanup target levels for commercial/industrial use

Dear Ms. Smith:

At your request, we have evaluated the development of alternative groundwater cleanup target levels (AGCTLs) for commercial/industrial use. Non-potable, non-irrigation commercial/industrial uses of groundwater may encompass an unlimited number of scenarios. Some common exposure scenarios include use as process water, for dust control, and for vehicle washing. Exposure to groundwater during commercial/industrial use would likely include all three routes of exposure (ingestion, dermal contact, and inhalation of volatiles and semi-volatiles). This whitepaper proposes exposure parameters for commercial/industrial groundwater that are protective under most use scenarios. However, the actual assessment of the risk from groundwater use should be site-specific. Even with the use of site-specific variables, estimates for exposure variables may not be available and the estimation of risk at the site may not have a quantitative solution. Use of a commercial/industrial AGCTL would likely require a restriction that limited the possible on-site usage of groundwater.

The first step to the assessment should be the problem formulation step. In this step, the exposure variables should be defined. The scope of the problem is identified to determine which processes or variables should be examined in more detail. Several site-specific variables will need to be considered for the determination of human health risk from exposure during use including the type of use, the contaminants involved, the extent of exposure, exposure time, and the temperature of the water. Several exposure variables that may be used in the derivation of commercial/industrial AGCTLs are discussed below. Chemical-specific variables determine which exposure pathways are of most concern. Dermal permeability and the volatility of a chemical indicate whether the dermal and inhalation pathways, respectively, could significantly contribute to risk from exposure. A chemical with high dermal permeability would be of concern for dermal exposure. Estimates of the extent of dermal contact and exposure time are important for these chemicals. For highly dermally absorbed chemicals it is critical to utilize accurate site-specific exposure data or choose high-end estimates so that risk from dermal exposure will not

be underestimated. Chemicals with a high volatility (high Henry's Law Constant) are of concern for inhalation exposure, especially in enclosed areas. Inhalation exposure will be the most challenging to estimate. In addition to volatility, exposure will depend upon the temperature of the water being used (volatility increases with increasing temperatures) and whether the water usage can produce mist and/or droplets containing the chemicals of concern.

Body Weight

The body weight used to estimate exposure to commercial/industrial groundwater is the body weight of a worker. The United States Environmental Protection Agency (US EPA) recommends a default worker body weight of 80 kg (US EPA, 2014). This represents the weighted mean body weight for adults 21-78 years old (US EPA, 2011).

Exposure Duration and Frequency

In the absence of site-specific data, default estimates should be used for exposure duration and frequency. The default commercial/industrial exposure duration is 25 years (Chapter 62-777, F.A.C.; USEPA, 2014). The default commercial/industrial exposure frequency is 250 d/y (Chapter 62-777, F.A.C.). If exposure to commercial/industrial groundwater is intermittent, then a site-specific exposure frequency should be used. Exposure frequency should represent the actual number of days exposed and should not be adjusted based on exposure time.

Surface Area

Surface area exposed to commercial/industrial groundwater is site-specific. The surface area estimate would include all parts of the body in contact with groundwater. Clothing would not protect the skin from exposure to commercial/industrial groundwater. However, personal protective equipment (PPE) would prevent dermal contact and the skin areas covered with PPE could be excluded from the exposure estimate. Possible exposure ranges from no dermal contact to full body dermal contact. For the average worker, this is equivalent to 0 to 6,032 cm^2 (US EPA, 2014). In the absence of site-specific data, we recommend a worker surface area of 3,527 cm^2. This represents the weighted average of mean values for the head, hands, and forearms for adult (a minimum of 21 years old) males and females (US EPA, 2014).

Exposure Time

Exposure time is site-specific and depends on the groundwater use. Three of the most likely uses of commercial/industrial groundwater include use as process water, for dust control, and for vehicle washing. We could not find any data regarding expected exposure time estimates for these uses. Each exposure time would vary depending on site-specific conditions. For example, an exposure time estimate for vehicle washing would depend on the size of the vehicle and the number of vehicles involved. Therefore, the range of exposure time estimates for a typical

workday includes 0-8 hours. If site-specific information is not available, we recommend using an exposure time of eight hours per day.

Incidental Ingestion

The Exposure Factors Handbook (US EPA, 2019) includes a study by Sinclair et al. (2016) regarding the incidental ingestion of water during vehicle washing. Twenty-six participants (ages 18 to 25 years old) used a high-pressure spray device in a simulated car wash activity for 10 minutes. The 95th percentile volume of water ingested was 1.93 mL. This is equivalent to 12 mL per hour (rounded to two significant figures). Although the data are limited, we recommend using 12 mL/h as the incidental ingestion rate for commercial/industrial groundwater. This estimate should be updated as more data on incidental ingestion under commercial/industrial scenarios are available.

Inhalation Rate

The Florida Department of Environmental Protection (FDEP) default inhalation rate for commercial/industrial workers is 20 m^3/d (Chapter 62-777, F.A.C.), which is equivalent to 2.5 m^3/hour. This estimate is based on inhalation rates in the 1997 Exposure Factors Handbook. The 2019 update to the Exposure Factors Handbook includes recommendations for inhalation rates based on updated estimates from the US EPA (US EPA, 2009). These inhalation rates are categorized based on age and work intensity. We calculated a weighted 95th percentile inhalation rate for workers ages 18-71 from the 2019 update to the Exposure Factors Handbook (USEPA, 2019, Table 6-2). The calculated inhalation estimates for moderate intensity activities (18 m^3/d or 2.3 m^3/hour) are similar to the previous FDEP default value. We also calculated inhalation rates for work at high intensity (36 m^3/d or 4.4 m^3/hour). We recommend using the updated inhalation rates for the worker based on the time the worker is exposed to commercial/industrial groundwater and the intensity of the work being performed.

Dermal permeability

The dermal permeability coefficient determines the amount of chemical that will be dermally absorbed. As dermal permeability increases, the absorbed dose of the chemical will also increase. Although dermal permeability can be affected by skin-specific factors (e.g., hydration, damage), it is usually dependent upon the lipophilicity of a chemical. Dermal permeability coefficients and formulas for their use to calculate dermal doses from water contact are available from the Risk Assessment Guidance for Superfund (RAGS) Part E (US EPA, 2004). Dermal permeability coefficients not listed in this document may be estimated using US EPA's Estimation Program Interface Suite (EPI Suite).

Chemical concentration in air

Chemicals in groundwater can volatilize to the air and become an inhalation risk. For a given chemical in groundwater, its concentration in air will be highly dependent upon circumstances of water use and is difficult to generalize. Chemical concentration in air is dependent on the volatility of the chemical and the temperature of the water, as well as wind velocity if outdoors and ventilation rates if indoors. Inhaled concentration is also dependent on the use of the water. If the water is aerosolized (such as when misting), the chemical does not need to volatilize to be inhaled. Chemical solubilized in tiny droplets may be inhaled and absorbed directly into the lungs. Uncertainty regarding air concentrations expected to result from commercial/industrial groundwater use can be reduced if site-specific air monitoring data are available, or are available for similar use of contaminated water at other facilities.

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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US EPA (2009) Metabolically-derived human ventilation rates: A revised approach based upon oxygen consumption rates. Office of Research and Development, Washington, DC; EPA/600/R-06/129F.

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