UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF INDIANA
SOUTH BEND DIVISION

AMOS HOSTETLER, et al.,	)	
	)	
Plaintiffs,	)	
	)	
v.	)	Case No. 3:15-cv-226 JD
	)	
JOHNSON CONTROLS, INC., et al.,	)	
	)	
Defendants.	)	

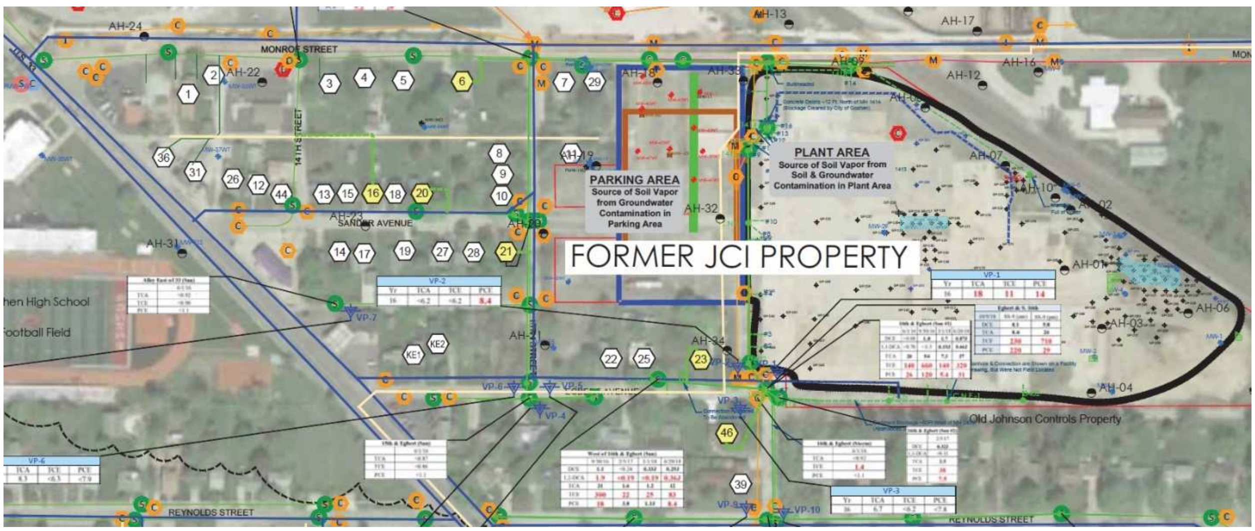
OPINION AND ORDER

Five plaintiffs assert claims against Johnson Controls, asserting that their homes have been impacted by contamination from a former Johnson Controls facility. As relevant here, they assert that the contamination has caused TCE and PCE vapors to enter the indoor air of their homes. They claim that vapors in the soils at the site have migrated to their homes through the soil and through sewer lines. They also allege that contaminated groundwater below their homes produced vapors that migrated upwards to their homes. The Plaintiffs retained an expert, Dr. Vasiliki Keramida, to calculate the concentrations of vapors that would have resulted inside their homes through these various routes.

Johnson Controls moves to exclude those opinions under Rule 702, offering a litany of criticisms of Dr. Keramida's analysis. Some of its arguments reflect disagreements with her inputs or conclusions, which are not grounds for excluding expert testimony. Others, however, go to whether she reliably applied her methodologies to the facts of this case. As to those issues, the Court agrees with Johnson Controls' arguments, so it grants the motion in part.

A. Dr. Keramida's Analysis

Dr. Keramida employed a somewhat complex methodology to estimate the amount of vapors that would have reached each plaintiff's home. She analyzed four different sources that could have contributed to the indoor air contamination: (1) vapors in the soil below the former plant at the site (in the central and eastern portion of the site); (2) vapors in the soil below the former parking area at the site (in the western portion of the site); (3) vapors from the groundwater below the Plaintiffs' homes; and (4) vapors from sewer lines. In the figure below, the thick black line outlines the "plant area," the thick blue and red lines to its left outline the "parking area" for TCE and PCE, respectively. The yellow-shaded hexagons reflect the Plaintiffs' properties, and the thin colored lines reflect utility lines.



Vapors from the first three sources—the plant area, the parking area, and the neighborhood groundwater—would have entered the homes (if at all) through the homes' sub-slabs. For each of those three sources, Dr. Keramida calculated the amount of vapors that would have traveled from those sources to each home's sub-slab. She then added those concentrations together to produce the total sub-slab vapor concentrations for each home. She then multiplied that by a ratio of the indoor air and sub-slab vapor concentrations (the sub-slab to indoor air attenuation factor) to determine the levels of vapors that the sub-slab vapors would have produced in each home.

Dr. Keramida then calculated the concentration of vapors that would have entered from sewer lines. To do so, she used the vapor levels that had been detected in sewer lines near each home. She then multiplied that amount by an attenuation factor that she calculated to reflect the ratio between sewer vapors and indoor air vapors. Finally, she added those amounts to the vapor levels that would have entered through the sub-slab, producing the total vapor concentration in each home, for each year of occupancy. She performed this same analysis for TCE and PCE, but omitted the neighborhood groundwater as a source area for her PCE calculation, as PCE has not been detected in the groundwater below the neighborhood.

Further complicating this analysis, Dr. Keramida used a different process for each source area to determine the vapor levels those areas would have produced. For the plant area, Dr. Keramida began her analysis with soil samples reflecting the concentration of contaminants in the soil. From the soil samples, she calculated the vapor concentrations that the soil contamination would have produced. She then averaged those concentrations, multiplied the average concentration by the total volume of the site, and multiplied that by the "soil air filled porosity" (reflecting the amount of air in the soil), to produce the total mass of vapor contamination in this entire source area.

From there, she calculated how many of those vapors would have traveled laterally through the soil and reached each home through the process of diffusion—movement from areas of higher concentration to lower concentration. For that step, she used the "Crank Equation 3.5," a mathematical equation used to calculate what concentration will result a given distance away, after a certain amount of time, if a certain mass is released from a certain point:

$$C = \frac{M}{8(\pi Dt)^{\frac{3}{2}}} \exp(-\frac{r^2}{4Dt})$$

Assumption:
a. Point instantaneous source
b. Infinite volume

Where	C =	Soil vapor concentration at distance r from the source and time t from release of the source
	M =	Mass of contaminant released at source
	D =	Effective diffusivity
	t =	Time from release of the source
	r =	Distance from the source (distance of each Home)

This equation assumes that a single mass is released from a single point, and that it diffuses into an infinite volume. As the input for distance, Dr. Keramida used the distance between each home and a point on the western edge of this source area—the closest point to the Plaintiffs' homes within the plant area. The output of that equation produced an estimated vapor concentration in the sub-slab of each home for each year.

Dr. Keramida used a similar approach for the parking area, except that she used groundwater samples instead of soil samples to calculate the total mass of contamination in that area. From the groundwater samples, Dr. Keramida used an equation to determine the amount of vapors that the groundwater contamination would have produced. She then averaged those concentrations and, like for the plant area, multiplied that average by the total volume of the area and by the soil air filled porosity, to arrive at a total mass of contaminants in this area. Dr. Keramida then applied the Crank Equation using that mass as an input, to determine how much vapor would have traveled by lateral diffusion from this area to each home. For the distance input, she used the distance between each home and a point at the western edge of this area. The result represented the estimated vapor levels at each home's sub-slab attributable to the vapors in this area.

Dr. Keramida used a different method for the next source—the vapors produced by contamination in the shallow groundwater below each home. (Dr. Keramida did not use this step for PCE, which has not been detected in the neighborhood groundwater.) Dr. Keramida first used groundwater samples from near each home to estimate the amount of groundwater contamination below each home. She then used an equation—the Johnson and Ettinger model—to determine the levels of vapors that would volatize from the groundwater and migrate vertically to reach the sub-slabs. This model can be used to evaluate the amount of vapors that will volatize from groundwater, the diffusion through the soil to the sub-slab, and the transport across the building slab and the vapors' mixing with indoor air. Its inputs include parameters relating to the groundwater and soil properties, chemical properties, and building properties. Dr. Keramida applied this model to calculate the concentration of vapors at the sub-slab.

Having calculated the concentrations of sub-slab vapors that each of these three sources would have produced, Dr. Keramida then estimated the levels of contamination those sub-slab vapors would have produced in the indoor air. To do so, she multiplied the sum of those three sources by two different attenuation factors. She first used a site-specific attenuation factor, which she calculated by averaging the ratios of indoor air to sub-slab vapor concentrations from samples taken in the neighborhood. Multiplying the attenuation factor by the sub-slab concentration thus predicts the indoor air concentration. The site-specific attenuation factor Dr. Keramida calculated was 0.003, meaning that if vapors were present in the sub-slab at 100 $\mu g/m^3$, then 0.3 $\mu g/m^3$ would be expected in the indoor air. Dr. Keramida also used the EPA's default sub-slab to indoor air attenuation factor, which represents an upper-bound level and is ten times higher than the site-specific level, or 0.03. This step produced two alternative vapor levels in each home attributable to vapor intrusion from the sub-slab.

Finally, Dr. Keramida calculated the amount of vapors that would be present in the indoor air from the sewer gas. She calculated an attenuation factor by comparing the levels of PCE in sewer samples and in indoor air samples of nearby homes. She also inspected each of the homes to determine if they were susceptible to vapor intrusion from the sewer lines. She then multiplied the attenuation factor by the average concentration of sewer gas samples taken in sewer lines near each home, producing an estimate of the vapor levels that would have resulted in each home from sewer gas contamination. She then added that amount to the amount of indoor air vapors produced by sub-slab vapors, to produce her estimate for the total indoor air concentrations that would have resulted in each home.

B. Standard of Review

Rule 702 governs the admission of testimony by expert witnesses. Under that rule, a witness "who is qualified as an expert by knowledge, skill, experience, training, or education" may offer an opinion if the following criteria are met:

> (a) the expert's scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue;
>
> (b) the testimony is based on sufficient facts or data;
>
> (c) the testimony is the product of reliable principles and methods; and
>
> (d) the expert has reliably applied the principles and methods to the facts of the case.

Fed. R. Evid. 702.

A court has a gatekeeping role to ensure that expert testimony meets these criteria. *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579 (1993); *C.W. ex rel. Wood v. Textron, Inc.*, 807 F.3d 827, 834–35 (7th Cir. 2015). The proponent of the expert testimony bears the burden of demonstrating that the testimony meets each of those elements. *Varlen Corp. v. Liberty Mut. Ins. Co.*, 924 F.3d 456, 459 (7th Cir. 2019). However, a court does not assess "'the ultimate correctness of the expert's conclusions.'" *Textron*, 807 F.3d at 834 (quoting *Schultz v. Akzo Nobel Paints, LLC*, 721 F.3d 426, 431 (7th Cir. 2013)). Rather, a court must focus "solely on principles and methodology, not on the conclusions they generate." *Schultz*, 721 F.3d at 432 (quoting *Daubert*, 509 U.S. at 595). "So long as the principles and methodology reflect reliable scientific practice, 'vigorous cross-examination, presentation of contrary evidence, and careful instruction on the burden of proof are the traditional and appropriate means of attacking shaky but admissible evidence.'" *Id.* (quoting *Daubert*, 509 U.S. at 596).

C. Analysis

Johnson Controls moves to exclude Dr. Keramida's opinions, asserting numerous criticisms of her calculations. Johnson Controls argues that Dr. Keramida's calculated vapor levels are out of step with observed conditions (exceeding sampling results by over 1,000 times in some instances), that she failed to fit her calculations to the facts of the case, and that she failed to properly apply her methodologies to the inputs she selected, among other arguments. The Plaintiffs disagree in each respect. More fundamentally, however, they also argue that these arguments only reflect disagreements with Dr. Keramida's inputs and conclusions or competing opinions between experts, which are not grounds for excluding an opinion under Rule 702.

The crux of this dispute is how to characterize Johnson Controls' objections: as criticisms of Dr. Keramida's inputs and conclusions, or arguments about whether she reliably applied her methodology to the facts of the case. On the one hand, an expert must not only use a reliable methodology, she must also "reliably appl[y] the principles and methods to the facts of the case." Fed. R. Evid. 702(d). On the other hand, Rule 702 authorizes courts to assess "the validity of the methodology employed by an expert, not the quality of the data used in applying the methodology or the conclusions produced." *Manpower, Inc. v. Ins. Co. of Penn.*, 732 F.3d 796, 806 (7th Cir. 2013); *see also Stollings v. Ryobi Techs., Inc.*, 725 F.3d 753, 765 (7th Cir. 2013)

("Rule 702's requirement that the district judge determine that the expert used reliable methods does not ordinarily extend to the reliability of the conclusions those methods produce—that is, whether the conclusions are unimpeachable."). "The soundness of the factual underpinnings of the expert's analysis and the correctness of the expert's conclusions based on that analysis are factual matters to be determined by the trier of fact, or, where appropriate, on summary judgment." *Smith v. Ford Motor Co.*, 215 F.3d 713, 718 (7th Cir. 2000).

As the Seventh Circuit has recognized, "this is not always an easy line to draw." *Manpower*, 732 F.3d at 806. Whether a methodology produces accurate results will often depend on the inputs an expert chooses to apply. However, "the selection of data inputs to employ in a model is a question separate from the reliability of the methodology reflected in the model itself." *Id.* at 807. Thus, as the Seventh Circuit has summarized this point, "arguments about how the selection of data inputs affect the merits of the conclusions produced by an accepted methodology should normally be left to the jury." *Id.* at 808; *see also Stollings*, 725 F.3d at 766–67.

Some of Johnson Controls arguments plainly fall on the "inputs" or "conclusions" side of that line. Others, however, take issue with whether she has reliably applied her calculations to the facts of this case. In particular, the Court finds that Dr. Keramida has not shown that she reliably applied her equation for diffusion from the plant and parking areas—which calculates diffusion based on the release of a single mass from a single point—to the circumstances of this case, such that it offers a relevant and reliable method of estimating the diffusion of vapors spread throughout a multi-acre site. The Court also concludes that Dr. Keramida's upper-bound calculation of vapors through the sub-slab is unreliable because she failed to run her calculation with the input she chose for that scenario. Johnson Controls' criticisms of Dr. Keramida's sewer vapor calculations only address her inputs and conclusions, though, which are not grounds for exclusion.

Before addressing Johnson Controls' specific criticisms, the Court addresses its threshold argument that Dr. Keramida simply assumed that vapors are in fact traveling through all of the theoretically possible mechanisms of vapor transport. That's not quite right. Dr. Keramida considered various potential contributors to the vapor intrusion, but she did not just assume that they were all occurring—the whole point of her calculations was to determine whether and in what amount those sources would have contributed to vapor intrusion. For each source area, she used sampling data to calculate the levels of contamination in that area. She then used equations to estimate the extent to which that contamination would have reached each home. She also calculated site-specific attenuation factors, which would have reflected the extent to which vapors were migrating through the slabs or the sewer connections, at least on average. She also inspected each of the homes to examine whether they were susceptible to vapor intrusion. [DE 393-2 p. 4–12, 23–25]. Johnson Controls can take issue with whether that analysis was reliable and whether the conclusions were sound, which the Court turns to next, but Dr. Keramida did not simply assume that vapor intrusion was occurring from each source.

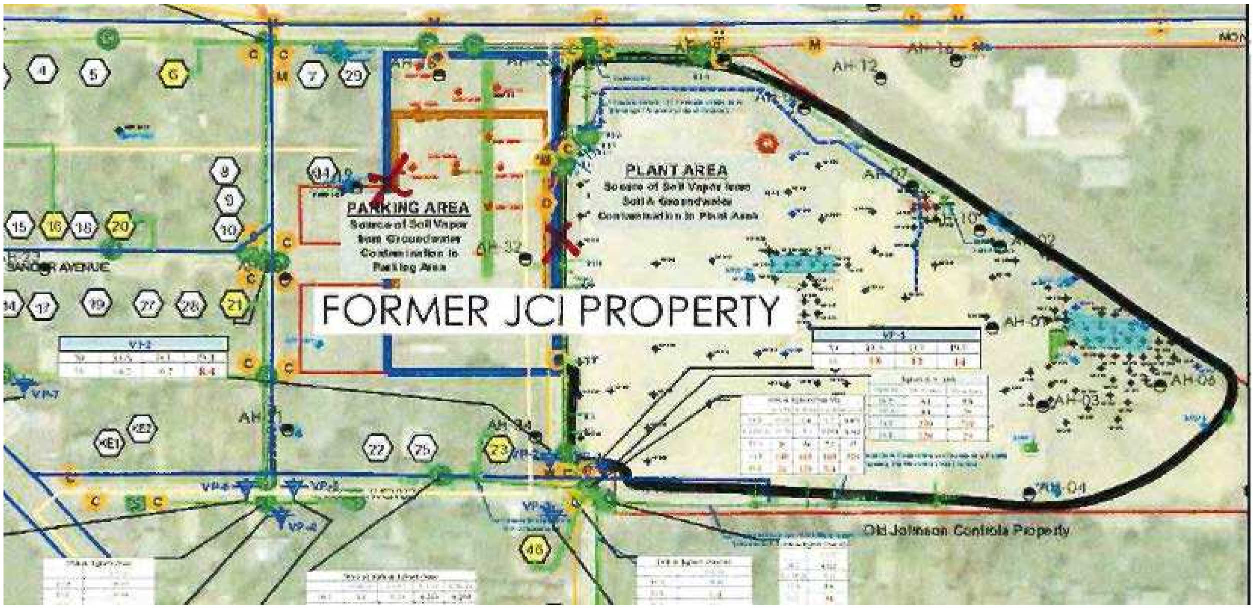
1. Plant and Parking Area Calculations

The Court begins with Dr. Keramida's calculations of the vapors from the plant area and parking area. For these source areas, Dr. Keramida used the "Crank Equation 3.5" to estimate the amount of lateral diffusion from these areas to the Plaintiffs' sub-slabs. Johnson Controls takes issue with her application of that equation in multiple respects. Some of those criticisms plainly take issue with her inputs, though. It argues, for example, that the input Dr. Keramida used for the soil moisture was too low, and that the average depth to the water table is less than she assumed. Those challenges to the inputs or factual underpinnings of her opinions are matters for the jury to decide. *See Smith*, 215 F.3d at 718.

Other of Johnson Controls' argument are more substantial, though. Most notably, Johnson Controls argues that Dr. Keramida misapplied the Crank Equation by using a starting point untethered to the facts of this case and not grounded in the equation. The Crank Equation assumes that a single mass is released from a single point. The plant area is not a single point, though, but a multi-acre site.[1] To apply this equation, then, Dr. Keramida needed to decide how to adapt the equation to the fact of this case. That included deciding which point at the site to use in order to make distance measurements for each home. In doing so, she "assumed that the point source is located at the middle of the *western edge* of" each area. [DE 393-2 p. 89 (emphasis added)]. In other words, she used a point at the border of the plant area closest to the Plaintiffs' homes.

In the figure below, the point sources Dr. Keramida used for each area are marked in pen with red x's. The red x near the middle of the figure represents the point source for the entire "plant area" to its right (shown by the thick black outline), and the red x to the left represents the point source for the "parking area":

[1] Dr. Keramida used the same approach for the parking area, and the analysis is the same for that area, but the Court refers to the plant area for simplicity.



[DE 398-14].

Thus constructed, the equation calculates the diffusion that would result if the entire mass of contaminants throughout the plant area was collected and then released from that single point closest to the Plaintiffs' homes. Johnson Controls argues that this equation is not a reliable way of calculating diffusion under the facts of this case, since vapors were actually spread across the site, and the areas of highest concentration were near the central and eastern portions of the site, far from the points on which Dr. Keramida based her equation. Johnson Controls argues that Dr. Keramida artificially increased her projected vapor concentrations by orders of magnitude by modeling the release from this point.

One way to characterize Johnson Controls' argument might be as a criticism of Dr. Keramida's inputs—the distance input into the equation. The Court believes, however, that this is better characterized as an issue of whether Dr. Keramida reliably applied a reliable methodology to the facts of this case. The Seventh Circuit has held that disputes over the appropriate inputs to use in a reliable methodology are not generally subject to scrutiny under Rule 702. In those cases, though, the inputs in question have generally been factual issues that the juries could have found to be correct, or discrepancies that juries could find did not affect the applicability of the expert's opinion. In *Stollings*, 725 F.3d 753, for example, one of the inputs into the expert's analysis was the effectiveness rate of a safety measure. The expert was not asked to opine on that issue; the plaintiffs instead relied on another witness who testified that the safety measure would work the "vast majority" of the time. *Id.* at 764. Based on that testimony, the expert assumed an effectiveness rate of 90 percent. Though the court characterized that input as "undoubtedly a rough estimate," it held that the accuracy of this input did not go to the reliability of the expert's analysis based on that input, particularly since the expert's opinion would have been the same even if the rate was much lower. *Id.* at 766–67.

Likewise, in *Manpower*, 732 F.3d 796, a damages expert's calculation depended in part on the growth rate the expert used for the plaintiff's revenues. The expert calculated the growth rate based on a short window of time reflecting the plaintiff's most recent performance. The expert did so based on testimony that the company's performance had improved beginning in that period, making that period representative of its likely future performance. *Id.* at 801–02. Though the district court found that such a short window could not reliably reflect the company's growth rate, the Seventh Circuit characterized that as a challenge to the factual underpinnings of the expert's analysis and the quality of its data inputs, which should not have factored into a Rule 702 ruling. *Id.* at 807.

In both those cases, there was evidence from which the jury could have found the inputs or factual underpinnings to be accurate, whether through the expert's testimony or through other evidence. Because resolving those disputes is the jury's job, a court cannot make its own factual finding on those issues and exclude expert testimony as a result. A court's inquiry is instead whether the expert's opinion would be relevant and reliable if the jury resolved those disputes in the proponent's favor.

By contrast, when an expert's opinion is simply not grounded in the facts of the case, the opinion will be excluded as unreliable and irrelevant. *Owens v. Auxilium Pharms., Inc.*, 895 F.3d 971, 973 (7th Cir. 2018); *see also Hartman v. EBSCO Indus., Inc.*, 758 F.3d 810, 819 (7th Cir. 2014) (stating that expert testimony must "fit the issue to which the expert is testifying and be tied to the facts of the case"). In *Owens*, for example, a medical expert opined that the plaintiff was injured by a drug he had been prescribed because the drug was capable of causing the plaintiff's injury when used as directed. The court excluded that testimony, however, as it was undisputed that the plaintiff had not used the drug as directed. Even though the manner in which the plaintiff used the drug might be described as a factual underpinning, the court explained that the opinion's exclusion was appropriate: "Of course, some questions regarding an expert's use of faulty assumptions or data should be left to a jury. But whether an expert's approach lines up with the basic facts of the case goes to the relevance and admissibility of the testimony itself. Gatekeeping of this sort is properly left to the court." 758 F.3d at 973. Likewise, when experts do not offer a reliable method for moving from the factual underpinnings to their conclusions, the opinions will not satisfy Rule 702's reliability elements. *See Gopalratnam v. Hewlett-Packard Co.*, 877 F.3d 771, 784 (7th Cir. 2017) ("[The expert's] reliability fails when it comes to the method by which he derived conclusions *from* these underlying events."); *Bielskis v. Louisville Ladder, Inc.*, 663 F.3d 887, 896 (7th Cir. 2011) (holding that the district court properly determined "whether it was appropriate for the expert to rely on the test that he administered and upon the sources of information which he employed"); Fed. R. Evid. 702(d).

Those latter circumstances better describe the issues here. There is no factual dispute over where the Plaintiffs' homes are located in relation to the site. The question is whether Dr. Keramida has offered a reliable basis for bridging the gap between the existence of soil vapors at that site and the amount of vapors that would result below those homes' slabs. To do so, she decided to use the "Crank Equation 3.5." That equation calculates the extent of diffusion at a particular distance if a single mass is released from a single point and then diffuses into an infinite volume. There is no dispute that the equation reliably calculates diffusion under those circumstances. The site here, however, is not a single point but a multi-acre property, and the contamination is not concentrated in a single mass but is dispersed throughout the property in varying amounts. Dr. Keramida thus has to show that she reliably adapted and applied the equation to the conditions of this site such that its result is probative of the vapor levels at each plaintiff's home.

The Plaintiffs have not shown that she did so. Again, the equation calculates diffusion based on the release of a single mass at a single point (not to be confused with mass contained within an area or volume). For the mass input, Dr. Keramida calculated the total mass of vapors spread all across each multi-acre area at the site. For the release points, she selected points on the western border of each area. Thus, the equation Dr. Keramida ran calculated the diffusion that would result if every molecule of contamination throughout the area was moved to the point closest to the Plaintiffs' homes and then released. (Johnson Controls likens this to the Big Bang or to dropping a bomb on that point.) Neither the Plaintiffs nor Dr. Keramida have shown how calculating the diffusion that would occur under those plainly counterfactual circumstances offers a reliable basis for calculating the diffusion that would occur here, particularly given that the vast majority of soil contamination is concentrated toward the center and eastern portions of the site. Thus constructed, the equation does not fit the facts of this case or offer a reliable basis for calculating diffusion of the contaminants at the site to the Plaintiffs' homes.

The Plaintiffs argue that calculating diffusion from that point is appropriate to account for the effect of the concrete slab on the ground level, which Dr. Keramida testified creates a "box" that contains the vapors within the soil throughout the site. Their argument and Dr. Keramida's testimony, however, suggest that Dr. Keramida misunderstood and misapplied this equation. There are other Crank equations that do measure the diffusion of a mass that is distributed within an area or a volume. [DE 393-15 p. 166–69]. J. Crank, *The Mathematics of Diffusion* p. 29 (2d 1975). The equation Dr. Keramida relied on was not one of those, however, and her explanations fail to show how her method reliably applies her calculation (based on a single mass being released at a single point source) to the facts of this case.

Dr. Keramida testified, for example, that the concrete cover is important because it would cause vapors to pool in the soil throughout the site instead of diffusing into the air:

> But because of the cover, the vapors are collecting underneath. . . . So underneath that cover then, . . . it's like having a box, and all the vapors are going into that box; and they commingle. So it is very appropriate to consider what is leaving the box as a uniform average of what has gone into the box.

[DE 393-3 p. 26]. The equation Dr. Keramida applied, however, does not use a "uniform average" of contamination across the plant area, but the total of all the mass throughout that area. Likewise, Dr. Keramida's calculation does not reflect vapors commingling throughout the multi-acre site—the "box." Instead, it calculates the effect of if every molecule of contamination throughout the whole site was moved to the edge of the area closest to the Plaintiffs' homes and then released. Even under the "box" theory, vapors are not focused at a single point, as the equation assumes, but are spread over multiple acres. Though some vapors would have exited the "box" at the point Dr. Keramida used on the western edge, vapors would have equally exited hundreds of yards away on the eastern edge, as well as along the northern and southern edges. Her calculation, though, measures the effect of if the entire mass was released from a single point closest to the Plaintiffs' homes.[2]

Dr. Keramida testified along those same lines that contaminants were "released through the area" and that "they cover pretty much the entire site." [DE 393-3 p. 20]. There is a fundamental disconnect between that explanation—that contaminants were spread through the whole site—and the calculation she actually ran—based on the entirety of the contamination being released from a single point at the edge of the site. This explanation might make sense if the equation was based on diffusion from a volume containing a distributed mass[3] [DE 393-15 p. 165–69], but the equation she chose instead uses a single, one-dimensional point source. Dr. Keramida's reference to the concrete slab falls short of explaining why calculating the effect of releasing the entire mass at the edge closest to the Plaintiffs' homes reliably reflects the diffusion that would result from the presence of contaminants spread throughout the site.

In response to criticism by Johnson Controls' expert that Dr. Keramida should have used the center of mass at the site as the starting point for her equation, the Plaintiffs argue that Dr. Dawson cited no authority for that opinion except for the Crank textbook, which is simply a textbook of mathematical equations and says nothing about environmental sites. But it is the Plaintiffs, as the proponents of this testimony, who have the burden of showing that Dr. Keramida reliably applied a reliable methodology to the facts of this case. In that respect, their argument that the Crank textbook is just a mathematical discourse that doesn't describe

[2] Calculating the effect of releasing higher levels of vapors at shorter distances from the Plaintiffs' homes naturally increases the resulting projections—by many orders of magnitude in some instances, as noted below.
[3] Dr. Keramida's testimony that she used the point where "the vapors are exiting [the] source area" suggests she applied her calculation as if it was such an equation.

environmental sites cuts the opposite direction. The Crank Equation may reliably calculate the diffusion of a single mass instantaneously released from a single point into an infinite volume. But Dr. Keramida has the burden of showing that she has reliably applied that equation to the very different conditions of this multi-acre environmental site, such that her calculation is relevant to this case. The Plaintiffs cannot meet that burden simply by criticizing the opposing expert, and their own argument falls short in making an affirmative case for why Dr. Keramida's method is appropriate. *See Zenith Elecs. Corp. v. WH-TV Broadcasting Corp.*, 395 F.3d 416, 419 (7th Cir. 2005) ("An expert must offer good reason to think that his approach produces an accurate estimate using professional methods, and this estimate must be testable.").

The Plaintiffs also argue in response that the equation includes other conservative assumptions. The equation assumes, for example, a single instantaneous release instead of a continuous release, which could produce higher values. It also assumes that the diffusion occurs into an infinite volume in all directions, even though the concrete slab may have inhibited vertical diffusion.[4] The problem, however, is that Dr. Keramida offered no analysis as to how much effect those assumptions would have on the equation's results or why that makes it appropriate to model the release as if every bit of contamination was released from the edge of the area. Dr. Keramida performed no calculations of how much vertical diffusion would have occurred but for the slab or how the absence of diffusion in that direction would impact lateral diffusion. She did nothing, in other words, to test the effect of these assumptions so that she could reliably apply the calculations to the different circumstances of this case. A bare assertion

[4] The Plaintiffs argue that Dr. Keramida used another conservative assumption by accounting for the removal of contaminated soils in 1999. But even though Dr. Keramida testified that that remediation *removed* TCE mass from the site, [DE 393-3 p. 33], her calculation reflected an *increase* in total TCE mass. [DE 393-2 p. 78 (calculating an increase from 407 to 409 billion µg in mass beginning in 2000)].

that the slab inhibits vertical diffusion does not suffice to explain why the manner in which Dr. Keramida accounted for that effect is reliable. *Zenith*, 395 F.3d 419 (stating that an expert cannot invoke "'my expertise' rather than analytic strategies"). Nor have the Plaintiffs cited any literature or studies indicating that the Crank Equation can reliably calculate diffusion from an environmental site if applied in this manner. *Daubert*, 509 U.S. 579, 593 (1993) (noting that whether a theory has been tested or has been subjected to peer review and publication may bear on the reliability of expert testimony).

Moreover, unlike in *Stollings*, where the input in question had no effect on the expert's opinion, the location of the mass's release has a profound effect on Dr. Keramida's calculation. Even a 100-meter change in distance could change the vapor calculations by multiple orders of magnitude. [DE 393-3 p. 48 (Table A-3), p. 79 (Table A-4), p. 89 (Table A-7); *see also* DE 393-9 p. 57 (figure 17)]. That's the difference between vapor levels in the tens of thousands versus almost none at all.[5] Given the extreme variation caused by that parameter, the Plaintiffs would need to offer some basis for concluding that the point source Dr. Keramida used is appropriate in order for her calculation to be relevant and reliable when applied to this case, but the Court cannot find that they have done so.

At bottom, Dr. Keramida's use of the Crank Equation offers little more than speculation wrapped in a fancy equation. That some of its inputs were founded on site data does not mean that she reliably applied the methodology to the facts of this case in a way that makes the calculation probative of the amount of vapors that would migrate from the source areas to any

[5] For example, Dr. Keramida calculates the sub-slab vapors from the plant area for 1996 at 1109 Sander Ave to be 3.93 $\mu g/m^3$, while her calculation for 1213 Egbert, just over 100 meters closer to the point source, was 39,045.65 $\mu g/m^3$—a difference of four orders of magnitude. [DE 393-2 p. 48].

home's sub-slab. Of course, an equation's parameters need not be perfectly aligned to the facts of a case to be admissible; a calculation might still be relevant and reliable even if it carries a degree of imprecision. The Court finds, however, that there is simply too great a gap between the equation Dr. Keramida relied on and the actual conditions, and too little explanation and support for whether she reliably adapted it to these facts, to find that the calculation is sufficiently relevant and reliable under the circumstances of this case.

For those reasons, the Court excludes Dr. Keramida's opinions as to the contributions of TCE and PCE from the plant and parking areas. Having excluded the opinions on that basis, the Court need not also resolve whether Dr. Keramida's use of a simple average instead of a weighted average was a reliable method for calculating the total mass in the plant area, when the samples were not taken at equal or random intervals across the site but were focused most heavily in the areas of greatest contamination.[6]

2. Upper-Bound TCE Calculations

Johnson Controls next takes issue with Dr. Keramida's upper-bound calculation for TCE. Recall that Dr. Keramida used two different attenuation factors to estimate the extent to which the sub-slab vapors would impact the indoor air: a site-specific attenuation factor (0.003) and the

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[6] The Court notes, however, that the Plaintiffs' arguments on that topic reflect misunderstandings of both sides' experts' opinions in this respect, and also mistake concentrations for mass. For example, the Plaintiffs assert that the total TCE mass in a given area is the sum of all samples taken in that area. [DE 398 p. 17]. But the samples reflected only concentrations (µg/kg)—ratios—not mass (µg). To convert concentrations to mass, the concentrations have to be multiplied by the mass or volume of the medium containing the contaminant in order to determine the mass of the contaminant. Thus, *both sides'* experts first averaged the concentrations before multiplying them by the volume to calculate mass. [*See* DE 393-2 p. 78 (multiplying the *average* concentration (µg/m^3) by the volume (m^3) to calculate mass (µg))]. Dr. Dawson just did so within smaller areas instead of across one large area. The Plaintiffs likewise assert that Dr. Dawson calculated the TCE mass in a particular cell as 71,993 µg/kg. As reflected by the unit, though, that is a concentration, not a mass. [DE 398-10 p. 6]. To calculate the mass within that cell, Dr. Dawson multiplied that average concentration by the volume of air in that cell. [DE 393-9 p. 53].

EPA's default upper-bound attenuation factor (0.03). She multiplied those attenuation factors by her predicted sub-slab vapor levels, to estimate the indoor air vapor levels. Johnson Controls argues that Dr. Keramida failed to recognize, however, that the sub-slab to indoor air attenuation factor is also an input in the Johnson and Ettinger model, which she used to estimate the sub-slab vapors produced by TCE in the groundwater below each home. Because Dr. Keramida did not run the Johnson and Ettinger model using her upper-bound attenuation factor, Johnson Controls argues that Dr. Keramida failed to reliably apply her methodology to the inputs she chose. The Court agrees.

The sub-slab to indoor air attenuation factor is a comparison between the concentrations of vapors below the slab and in indoor air. To slightly oversimplify, this attenuation factor reflects in part how easily the vapors travel through the slab into the indoor air. A higher attenuation factor means that more vapors are traveling through the slab into the indoor air, resulting in higher concentrations of vapors in indoor air. [DE 393-11 p. 4]. This also means, however, that because more vapors travel through the slab, fewer vapors pool below the slab. *See id.* p. 8. Thus, using the Johnson and Ettinger model, a higher attenuation factor results in lower levels of vapors in the sub-slab, *id.*; more vapors are traveling through the slab instead of pooling below the slab.

Dr. Keramida's calculation assumed a low sub-slab to indoor air attenuation factor (0.003) when using the Johnson and Ettinger model to calculate the concentration of vapors below the slab. This low attenuation factor resulted in higher levels of sub-slab vapors. To make her upper-bound calculations of TCE in indoor air, however, Dr. Keramida used an attenuation factor ten times higher (0.03). With that higher attenuation factor, more of the sub-slab vapors enter indoor air but fewer vapors pool below the slab, so the Johnson and Ettinger model produces a lower amount of vapors at the sub-slab (as explained here by Dr. Ettinger, co-author of the model [DE 393-11 p. 7–10]). Yet, Dr. Keramida did not re-run her calculation at the previous step to calculate the level of vapors that would result below the slab using that attenuation factor. Surprisingly, Dr. Keramida failed to recognize that her assumption at this step was also an input at the previous step and would change (substantially reduce) the levels of vapors in the sub-slab. She thus did not re-run the Johnson and Ettinger model with this new attenuation factor, but instead used the higher sub-slab vapor levels that would be produced by a lower attenuation factor.

In other words, Dr. Keramida's upper-bound calculation rests on two contradictory assumptions: that a low attenuation factor is causing vapors to pool below the building slabs in greater amounts, and that a high attenuation factor is causing more of those vapors to enter the indoor air from below the slabs. The problem is not, as the Plaintiffs attempt to characterize the argument, whether she should have used a particular attenuation factor. Rather, the problem is that, having chosen a given attenuation factor for her upper-bound calculation, Dr. Keramida did not reliably apply her own calculations using that input. [DE 401 p. 11 ("[T]he issue is that, having chosen that input, Keramida was obligated to correctly apply it within the J&E model. She did not.")]. If the sub-slab-to-indoor-air attenuation factor she used for the upper-bound calculation is correct, then she did not reliably apply her methodology at the previous step to estimate the amount of vapors that would be present below the buildings. This disconnect is fatal to the reliability of her opinion on the upper-bound levels of TCE in indoor air. *See Stollings*, 725 F.3d at 766 (stating that an expert's testimony must be "based on a *correct application* of a reliable methodology" (emphasis added)).

The Court thus excludes Dr. Keramida's upper-bound opinion as to TCE from the neighborhood groundwater. This does not affect the groundwater calculations Dr. Keramida used based on an attenuation factor of 0.003, though, since that is the same input she used for the Johnson and Ettinger model. Though Johnson Controls disagrees with Dr. Keramida's opinions on that issue, it does not offer any specific objections to her methodology for her lower-bound calculations. Dr. Keramida can thus offer her calculations as to the TCE vapor levels that would result from the neighborhood groundwater based on that attenuation factor.

3. Sewer Vapor Calculations

Last, Johnson Controls moves to exclude Dr. Keramida's opinions as to vapor intrusion from the sewer lines. As to these issues, the Court finds that Johnson Controls' arguments go only to Dr. Keramida's inputs, selection of data, and conclusions, rather than the reliability of her methods, so the Court denies the motion in this respect. To calculate the amount of vapor intrusion through the sewers, Dr. Keramida began with sampling data reflecting the levels of TCE and PCE vapors in sewer lines near the homes. To determine what effect those sewer vapors had on indoor air, she calculated an attenuation factor by comparing sewer samples and nearby indoor air samples. She used samples from eight different homes and averaged the ratios together to produce a site-specific attenuation factor. Dr. Keramida explained that she used PCE samples for that step because PCE was detected in almost all of the samples while TCE was not, so using PCE allowed for more comparisons.[7] Then, for each home, Dr. Keramida took an average of the sewer vapors detected in nearby sewer lines and assumed that those levels

[7] Johnson Controls argues in a footnote that Dr. Keramida double-counted the indoor air vapors by assuming for the purposes of this attenuation factor that all of the vapors came from the sewers, while assuming for her sub-slab attenuation factor that all vapors came from the sub-slab. The Court has excluded Dr. Keramida's opinions as to PCE entering from the sub-slab, though, and Johnson Controls argues that no PCE was entering the indoor air through the sub-slab.

represented an average over time. Finally, she multiplied those levels by the attenuation factor she calculated, producing her estimate for the vapor levels in each home attributable to the sewers.

Johnson Controls takes issue with Dr. Keramida's calculation of the attenuation factor. It first disagrees with her decision to calculate the attenuation factor based on the PCE samples instead of TCE (which would have produced a much lower attenuation factor). This is a disagreement with an expert's selection of data, though, which is not grounds for exclusion. *Manpower*, 732 F.3d at 809 ("That the reasoning behind that choice [of data to use] could be challenged as incomplete or faulty does not make it any less grounded in real data."). Johnson Controls does not dispute that comparing sewer vapor samples to indoor air samples is an appropriate way of determining an attenuation factor.[8] Dr. Keramida did so here, using samples of PCE. Her use of those samples instead of TCE samples may be grounds for cross-examination or for offering contrary evidence, but does not undermine the reliability of her method.

Johnson Controls also objects that Dr. Keramida applied the same PCE-based attenuation factor to her projections for both TCE and PCE in indoor air. Yet it argues at the same time that the attenuation rates for TCE and PCE should be the same. Thus, her use of a site-specific attenuation rate to calculate TCE vapors is not unreliable just because it was derived from PCE samples. Johnson Controls can argue at trial that the TCE levels from the same sampling results would produce a much lower attenuation factor, and that the PCE in indoor air might have been due to other sources. But those would be matters of weight, they do not affect whether Dr. Keramida applied a reliable methodology.

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[8] Johnson Controls asserts that Dr. Keramida did not consider building ventilation, but the attenuation factor inherently accounts for building ventilation.

Johnson Controls also argues that the attenuation factor Dr. Keramida calculated is "exceedingly improbable." That's a challenge to her conclusion at this step, though, which is likewise misplaced in a Rule 702 analysis. Johnson Controls further argues that some of the inputs Dr. Keramida used had implausibly high ratios of indoor-air to sewer-gas levels, given the ventilation rates of indoor air and the dilution that would occur when sewer gases mix with indoor air. As already explained, though, that is a challenge to Dr. Keramida's selection of data to rely on. Johnson Controls is free to argue that the attenuation factor Dr. Keramida calculated is implausible and based on faulty data. It can also disagree with her explanations for whether her results are consistent with literature and whether she has plausibly explained away the difference between the PCE and TCE levels. But Dr. Keramida applied an appropriate methodology in calculating the attenuation factor, which suffices for Rule 702. The Court thus denies the motion to exclude Dr. Keramida's projections as to the vapor levels from sewer gases.

D. Conclusion

The Court grants in part and denies in part Johnson Controls' motion to exclude Dr. Keramida's opinions. [DE 393]. The Court excludes Dr. Keramida's calculations as to vapors from the plant and parking areas, and her upper-bound calculation as to TCE from the neighborhood groundwater. The Court otherwise denies the motion, however, so Dr. Keramida may present her calculations as modified to reflect the vapor concentrations from the neighborhood groundwater (with the site-specific attenuation factor) and the sewer pipes.

SO ORDERED.

ENTERED: October 8, 2020

/s/ JON E. DEGUILIO
Chief Judge
United States District Court