Review of the Proposed Plan for the Record of Decision Amendment, Operable Units Two and Three, Lemon Lane Landfill Superfund Site, Bloomington, Indiana.

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Page 4: **Site Characteristics**

Borings and wells have a very low probability of intersecting conduits and there is no mention of this. Also, using borings and wells implicitly assumes that a site is a porous medium. This clearly not the case in carbonates and/or karst, so the data collected from these devices must be treated skeptically until tested using methods that do not make porous medium assumptions.

Page 5. **Site Geology**

Worthington et al.,(2001) show that it is likely that > 99% of the flow is in conduits in karst terranes in Paleozoic rocks. Even in any type of carbonate probably > 94% of the flow is in conduits. Rather than say flow is in karst features the word conduit should be used. If a spring exists then there must be a conduit that the water is discharging from. Conduits are continuous from sinkholes (swallow holes or swallets) and springs.

The term “solution cavities” is used and implies an isolated opening not connected to a conduit. So, if there is solution (or dissolution) it implies that the aquifer is exposed to atmospheric water - which would have initial very high aggressiveness. The question would be how would this water enter a piece of solid rock and initiate the dissolution process if “cavities” formed? The cavity concept possibly comes from the fact that sinuous conduits are sometimes intersected when drilling wells. The term ‘solution cavity” is misleading and should not be used.

Page 5. **Site Hydrogeology**

The word majority in terms of low flow and storm water drainage would be much more useful if quantitative tracing had been done and the actual fraction estimated. The difference between the low and high discharge is > 150 times but still suggests that most of the flow from the basin discharges through ICG Spring.

Figure 2.

The location of Rinker Spring appears to be inaccurate.

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Connection between ICS and Quarry springs area. It appears from the text that this was simply a visual tracer test. I doubt this to be the case - so describe what was done in more detail. It would have been much more useful if a quantitative tracer test had been done to see if there were significant losses to underflow springs.

The interpretation of the tracing to Quarry A and Quarry B springs from the swallets needs to be rewritten. It is obvious that there is a lack of knowledge and understanding about the vertical hierarchical nature of flow in carbonates. There are also some logic problems with what is stated about the hydraulic connections in the proposed plan.

For example - it cannot be stated that there is no direct connection between ICS and the Quarry B spring because the flows that affect both springs are related by overflow components and the conditions that would allow flow from Lemon Lane Landfill to both springs were not observed and not that they cannot happen. The fact that the Quarry B spring has a reported higher baseflow and comparable PCB data to Quarry A spring suggests that they are related to the same pathways. One is probably discharging more of an overflow component from the baseflow pathway. Another problem is that accurate data on the elevations of the lips of these springs is unknown, but it is clear that they should not be and are not at the same elevations. The fact that Rinker Spring discharges more PCB load is explained by the fact that it is another overflow and the fact that PCB concentrations are often correlated to TSS concentrations and the TSS concentrations should be higher in overflow components because that water may be moving faster especially in storms.

Another possiblity could be a problem in the tracing data. Rhodamine types dyes were used and they could easily be subject to deaminoalkylation (Käss,1998). This means that one tracer dye can easily look like another. The transformed rhodamine signal may not have been recognized at monitoring locations. This would have been particularly difficult if not almost impossible if the tracing technique used involved charcoal and elutant methods.

Page 10. (karst conduit investigation)

(The geophysical work done in attempting to identify the location of conduits.)

There are several methods that can be used and most are claimed to have marvelous merits. However, there seems to be a lack of understanding that the resolution needed must be at some level and even when this is optimal there may still be noise or uncertainty.

It is clear to me that the best initial method in any karst terrane would the Natural Potential method using a base station and a roving electrode. This method allows the resolution of data to be adjusted “on the fly.” Following collection of such data other techniques can be used. In my experience the collection of NP or other geophysical data is typically not followed up by enough drilling. Often only a few test holes are drilled and if

these do not result in some obvious feature being seen the NP method is deemed to not work rather than the fact that the drilled hole may have missed the feature possibly by a few centimeters without that being known. What is also problematic is that the geophysicist who did the work is often not consulted sufficiently when the first few holes are drilled to discuss what was observed and where maybe additional holes can be tried. There is a very low probability of drilling to intersect a conduit even if its general location is known. Unfortunately even if conduits can be drilled into the nature of the subsurface often with many interconnected bedding planes down the bore hole above the conduit make sampling for tracers or contaminants subject to complex hydraulic connections that may not result in data that are easy to interpret (Smart, 1999).

In addition when tracers are recovered in such conduit wells recovery curves are multimodal and it is very challenging to try and estimate what percentage of the tracer was recovered there. There are also effects that are a result of pumping the well in order to sample the water for the tracers. The same complications can apply to contaminants (Smart, 1999).

There are a few examples of collection of geophysical (NP) data followed by drilling and constructing wells with construction of a potentiometric map that shows troughs (and by association conduits) where tracers and contaminants are present.

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Explanation for Figure 10.

Somebody please explain “SURFACE WATER SPRING”

A spring is the discharge of ground water - which maybe connected to surface water, but is not surface water. So the term “surface water spring” is an oxymoron. It should just be called - spring. Unless there is some chicanery with regards to what type of water the spring is discharging!

References Cited

Käss, W., 1998, Tracing Technique in Geohydrology, Balkema, Rotterdam, p. 34.

Smart, C.C., 1999, Subsidiary conduit systems: a hiatus in aquifer monitoring and modeling, in Palmer, A.N., Palmer, M.V., and Sasowski, I.D., (eds) *Karst Modeling*, Karst Waters Institute Special Publication No. 5, p. 146 -157.

Worthington, S.R.H., Davies, G. J., and Ford, D. C., 1999, Quantification of matrix, fracture and channel contributions to storage and flow in a Paleozoic Carbonate aquifer. Chapter in: Approaches to Understanding Groundwater Flow at Contaminant Transport in Carbonate Aquifers, Balkema, Rotterdam, p. 113 - 128.