BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	**)**	
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	)	
STANDARDS FOR THE DISPOSAL OF	**)**	**R20-19**
COAL COMBUSTION RESIDUALS	**)**	**(Rulemaking – Land)**
IN SURFACE IMPOUNDMENTS:	**)**	
PROPOSED NEW 35 ILL. ADM. CODE 845	**)**	

NOTICE OF FILING

To: ALL PARTIES ON THE ATTACHED SERVICE LIST

PLEASE TAKE NOTICE that I have today electronically filed with the Office of the Clerk of the Illinois Pollution Control Board the attached **Prefiled Responses of David Hagen**, copies of which are herewith served upon you.

/s/ Ryan C. Granholm
Ryan C. Granholm

Dated: September 24, 2020

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NOW COME Dynegy Midwest Generation, LLC, Electric Energy, Inc., Illinois Power Generating Company, Illinois Power Resources Generating, LLC, and Kincaid Generation, LLC, (collectively, "Dynegy"), by their attorneys, Schiff Hardin LLP, pursuant to the Hearing Officer's July 14, 2020 Order and submit the below responses.

Prefiled Responses of David Hagen

Illinois Pollution Control Board:

23. On page 31, you state that it is inappropriate to require corrective measures and post closure care to be completed within the proposed 30-year period because the timeframes to remedy groundwater may take a longer period of time. Please comment on whether the proposed 30-years post closure care period should be required as a minimum time period rather than a set period of time to complete post closure care.

RESPONSE: The proposed post-closure period set forth in Section 845.780 is a minimum time period. I read proposed Section 845.780(c) to require the post-closure care period to be the later of either (1) achieving the groundwater protection standards; or (2) 30 years. This is supported by IEPA's statement on page 35 of the Statement of Reasons that the 30-year period is a minimum period, which may be longer if the groundwater protection standards have not been achieved.

I am not suggesting that the proposed post-closure care period be revised. Instead, my testimony was intended to respond to any suggestion that groundwater corrective action

must be completed within a set period of time, which as discussed on pages 31 and 32 of my testimony, is inappropriate because many groundwater remedies will likely require decades to meet the GWPS (as indicated in my analysis).

Illinois Environmental Protection Agency:

1. On page 3 of your testimony you state that closure is not simply a matter of closure in place or closure by removal. Do Sections 845.670 and 845.710 require owners and operators of CCR surface impoundments to assess multiple factors based on site specific data as part of the corrective action plan and closure alternatives analysis, respectively?

RESPONSE: Yes, and as discussed on pages 3 through 10 of my testimony, the evaluation process that incudes multiple factors based on site specific data as described in Sections 845.670 and 845.710 is appropriate for closure and remedy selection. The evaluation process in Sections 845.670 and 845.710 is common to other environmental laws and rules including RCRA and CERCLA and is intended to allow remedy evaluators to select an appropriate remedy while considering the multiple evaluation factors of long- and short-term effectiveness and protectiveness, the effectiveness of the remedy/closure in controlling future releases, the ease or difficulty of implementation, and community concerns.

2. On page 3 of your testimony and the subsequent example models, you explain that the example models you provide demonstrate "…compliance is achieved when the maximum groundwater concentration upgradient of the river falls below the Illinois GWPS."

a. Under Part 845 and Part 257, isn't the point of compliance for a CCR surface impoundment the down gradient waste boundary?

RESPONSE: The performance standard for groundwater remedies in both Part 845 and Part 257 is compliance with the GWPS at all points within the plume of contamination beyond the waste boundary. As can be seen in multiple locations in my testimony (for

example on page 15), the GWPS in many instances may be met sooner at the waste boundary than points down gradient of the surface impoundment including at the modeled river, which would likely occur late in the remedy performance period. I am not proposing that the point of compliance be altered.

b. Do Sections 845.660 or 845.670 prohibit the evaluation of monitored natural attenuation within the context of the required evaluation?

RESPONSE: **I do not read Section 856.660 or 845.670 as precluding the use of MNA as a remedy component. As indicated from my testimony on pages 10 through 15, MNA is a potentially viable remedy technology that should be evaluated, when appropriate, using the criteria specified in Sections 845.660 and 845.670.**

3. On page 28 of your testimony you provide example conditions that might allow an owner or operator to reduce groundwater monitoring from quarterly to semi-annually. If those conditions and allowance for reduction in sampling frequency is incorporated into Part 845, would it be your expectation that those demonstrations would be subject to Agency review and approval?

RESPONSE: **Yes, I would expect that the Agency would review and approve such demonstrations as part of the Rule.**

4. On Page 29 of your testimony you state: "The Unified Guidance notes that "as the number of tests increases, the false positive rate associated with the testing network as whole (i.e., across all well-constituent pairs) can be surprisingly high.""

a. Does monitoring for more constituents make it more likely that a false positive will be detected for any single constituent?

RESPONSE: **The more constituents for which comparisons to GWPS (tests) are made, the more likely a false positive will be encountered collectively. Assuming the constituent sample collection and analysis methods are independent, the analysis of an additional constituent does not change the false positive rate for any single constituent. However, looking at more constituents does increase the number of tests (each constituent,**

in each sample, from each well compared to the GWPS constitutes a test) which in turn increases the accumulative chance of encountering a false positive.

b. Does each constituent have to comply with its own GWPS?

RESPONSE: **Yes, each constituent would have to comply with its own GWPS.**

5. On page 30 of your testimony you discuss a real-world situation in which Boron concentrations increased at a monitoring point after closure occurred.

a. Could the increase in Boron concentration be caused by a rebalancing of hydrogeologic conditions as they changed after cover placement?

RESPONSE: **It is possible, and also could have occurred for many other reasons, including that it was simply within the range of results for the statistical population for this monitoring well.**

b. Could those changes have been predicted by groundwater modeling?

RESPONSE: **It is possible although, based on my experience, unlikely. A model would not likely have the sensitivity to predict such a small change in the two sampling events as identified in my testimony.**

c. Do you believe a groundwater model that predicted such an increase would be a valid justification for an alternative source demonstration?

RESPONSE: **Yes. That said, alternate source demonstrations are often times weight of evidence determinations and do not rely solely on one justification such as a modeling result. The use of groundwater models can be part of ASD determinations.**

d. If the Agency concurs with an alternative source demonstration, does Part 845 require corrective action?

RESPONSE: **An owner or operator should not be in the position to conduct an ASD if statistical evaluation of data do not indicate an exceedance of a GWPS. That said, if an ASD is demonstrated then Part 845 would not require corrective action.**

6. On page 34 of your testimony you state that proposed Part 845 does not allow enough time to complete a closure construction permit application. Based on your testimony and the testimony of other Dynegy witnesses, Dynegy appears to have a good understanding of the closure priorities required by Part 845, as proposed.

a. Since Section 22.59 of the Act requires that the Board adopt rules by March 30, 2021, is Dynegy doing work now so that when a final rule is available, less time will be needed to prepare permit applications?

RESPONSE: I am not aware of the status of Dynegy's work progress related to the Rule.

b. If Dynegy is currently taking steps to ensure future compliance, please describe.

RESPONSE: I am not aware of the status of Dynegy's work progress related to the Rule.

CWLP:

1. On page 21 of your testimony, you make the conclusion that "Removal will not always result in achieving the groundwater protection standards earlier." Explain the reasoning behind your opinion.

RESPONSE: The removal process can be lengthy, particularly when large volumes of CCR are involved in the removal. For example, I conducted a Corrective Measures Assessment that included evaluating a removal action. There was no space at the facility to build an on-site landfill and the CCR was not suitable for beneficial use; therefore off-site disposal was the only viable option for disposal. As part of the assessment, we estimated the rate at which CCR could be removed on a daily basis, which included an evaluation of equipment needs and availability, suitability of roadways and the daily limits and capacity limitations of nearby landfills as some of the evaluation factors. The study concluded that the maximum daily haul rate was approximately 5,000 tons. The total amount of CCR in

the impoundment was estimated to be 21.6 million tons, which placed the removal duration in the 30-year range. By comparison, other closure options including closure in place by capping required far less time to implement and our analysis indicated that GWPS could be met prior to the 30-year timeframe for removal.

2. On page 21 of your testimony you refer to "daily disposal limits set by off-site landfill permits" as an example of factors that can delay the timeline of a closure by removal project. Explain what a "daily disposal limit" is and how it could delay a project?

RESPONSE: Solid waste landfills operate under permits with the states in which they are located. These permits include requirements for the maximum amount of solid waste the facility can receive in a given day. These are commonly known as daily disposal limits. The daily disposal limits will vary from facility to facility primarily based on the size of the facility. Based on my experience, the daily limits will vary between 100's of tons per day to 1000's of tons per day.

ELPC, Prairie Rivers Network, and Sierra Club:

Groundwater extraction wells

1. In your "cases" for sites 1, 2, and 3, you reference groundwater extraction wells. Please explain how a groundwater extraction well works.

RESPONSE: A groundwater extraction well works by means of a mechanical pump which extracts groundwater from a well.

2. Do groundwater extraction wells need to be operated? Please explain your answer and provide examples.

RESPONSE: Yes and they will need to operate until GWPS are met. Also if groundwater extraction wells are a remedy or remedy component, the owner/operator will need to post financial assurance for the expected cost of the extraction wells to make sure

they are operated and maintained. In addition, the operation of groundwater extraction wells would be considered as part of the evaluation criteria in 845.670, the process by which remedies are evaluated and would likely be a requirement in any construction/operating permit.

3. If so, and the groundwater extraction wells are not operated as needed, how may that affect the functionality of the groundwater extraction wells?

RESPONSE: **It depends on the definition of "as needed" and "functionality of." Groundwater extraction wells should be operated in a manner that minimizes wear on the equipment to maintain system performance. The operation of groundwater extraction wells would be considered as part of the evaluation criteria in 845.670, the process by which remedies are evaluated.**

4. Do groundwater extraction wells need to be maintained? Please explain your answer and provide examples.

RESPONSE: **Yes. Two common maintenance activities are replacing mechanical pumps and cleaning well screens. The maintenance of groundwater extraction wells would be considered as part of the evaluation criteria in 845.670, the process by which remedies are evaluated and if this was the selected remedy I expect the construction/operating permit would require the wells be maintained.**

5. If so, if that maintenance is not provided, how may that affect the functionality of the groundwater extraction wells?

RESPONSE: **I would expect declining extraction efficiency over time.**

6. Do groundwater extraction wells need to be inspected? Please explain your answer.

RESPONSE: **Yes. Numerous options are available including down well cameras and optical televiewers to evaluate wells for their integrity. If this were the selected remedy I expect the construction/operating permit would require the wells be maintained.**

7. If so, if such inspections do not take place or take place too infrequently, how may that affect the functionality of the groundwater extraction wells?

<u>RESPONSE:</u> It depends. Inspections do not increase functionality/performance of wells, they only inform as to the performance level of a groundwater extraction well.

8. Do groundwater extraction wells involve any parts that at times need replacement? Please explain your answer and provide examples.

<u>RESPONSE:</u> Yes, at times and that is part of the evaluation criteria in 845.670, the process by which remedies are evaluated.

9. If so, and those parts are not replaced when necessary, how may that affect the functionality of the groundwater extraction well?

<u>RESPONSE:</u> I would expect declining extraction efficiency over time.

10. Must entire groundwater extraction wells sometimes be replaced? Please explain your answer.

<u>RESPONSE:</u> Yes, at times and that is part of the evaluation criteria in 845.670, the process by which remedies are evaluated.

11. Can changes in environmental conditions – including but not limited to increased severity and frequency of storms or floods; increased drought; changes in groundwater elevation, groundwater flow direction, or groundwater flow rate; or increased fractures in the subsurface – affect the functionality of groundwater extraction wells? Please explain your answer.

<u>RESPONSE:</u> Yes. Most of these things may cause changes in local hydrogeology, which in turn could affect well performance. The part of the question regarding "increased fractures in the subsurface" cannot be answered in a meaningful way without knowing the origin of the fractures. These affects are part of the evaluation process found in 845.670, the process by which remedies are evaluated.

12. Do contaminant plumes at times move in multiple directions?

<u>RESPONSE:</u> Yes depending on site specific conditions which are determined as part of hydrogeologic investigations as specified in Part 845. These affects are part of the evaluation process found in 845.670, the process by which remedies are evaluated.

13. Do contaminant plumes at times migrate in unanticipated directions?

<u>RESPONSE:</u> Yes they can, depending on site specific conditions. These affects are part of the evaluation process found in 845.670, the process by which remedies are evaluated.

14. Do contaminant plumes at times migrate at unanticipated speeds?

<u>RESPONSE:</u> Yes they can, depending on site specific conditions. These considerations are part of the evaluation process found in 845.670, the process by which remedies are evaluated.

15. Do groundwater extraction wells sometimes need to be added in order to capture contaminant plumes that migrated in a different direction or speed than anticipated?

<u>RESPONSE:</u> Yes they can and I expect they would be part of the ongoing evaluation of remedy effectiveness requirements of Part 845.

16. Would it be prudent to set up a system of groundwater extraction wells that does not anticipate the need for future operation, maintenance, inspection and/or replacement of those wells? Please explain your answer.

<u>RESPONSE:</u> No, and because of prudence, the operations and maintenance of groundwater extraction well systems are an integral part of such systems and their performance and would likely be part of any construction/operating permit.

17. Please identify the typical annual operating, maintenance, inspection and replacement costs associated with groundwater extraction wells.

<u>RESPONSE:</u> It depends on multiple site-specific factors and therefore cannot be framed or estimated as typical.

<u>Selection of remedy criteria</u>

18. On page 3 of your testimony, you describe the criteria to be met for a groundwater corrective action remedy as "inclusive of: protect health and the environment; attain the GWPS; control sources; remove contamination released from the CCR impoundment; and comply with waste management standards."

a. With regard to controlling sources, the criteria for selection of remedy set out at proposed Part 845.670 states: "Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of constituents in Section 845.600 of this Part into the environment." 845.670(d)(3). Did you take into account the full proposed standard in conducting your analyses for sites 1, 2 and 3?

RESPONSE: Part 845.670(d)(3) requires that the selected remedy must meet this criterion and does not require that remedies under consideration be compared to one another under this section of the rule. The comparison of potential remedies is undertaken as part of 845.670(e), which I did not undertake as part of my opinion.

b. With regard to removing contamination, the criteria for selection of remedy set out at proposed Part 845.670 states: "Remove from the environment as much of the contaminated material that was released from the CCR surface impoundment as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems." 845.670(d)(4). Did you take into account the full proposed standard in conducting your analyses for sites 1, 2, and 3?

RESPONSE: Part 845.670(d)(3) requires that the selected remedy must meet this criterion and does not require that remedies under consideration be compared to one another under this section of the rule. The comparison of potential remedies is undertaken as part of 845.670(e), which I did not undertake as part of my opinion.

19. Did you make a determination in your analysis of which "case," for each site, reduces or eliminates, to the maximum extent feasible, further releases of constituents into the environment?

a. If so, which "case" did you find reduces or eliminates, to the maximum extent feasible, further releases of contaminants into the environment? Please explain how you came to that conclusion.

RESPONSE: Part 845.670(d)(3) requires that the selected remedy must meet this criterion and does not require that remedies under consideration be compared to one

another under this section of the rule. The comparison of potential remedies is undertaken as part of 845.670(e), which I did not undertake as part of my opinion.

b. If not, how would you go about determining which method reduces or eliminates, to the maximum extent feasible, further releases of constituents into the environment?

RESPONSE: Part 845.670(d)(3) requires that the selected remedy must meet this criterion and does not require that remedies under consideration be compared to one another under this section of the rule. The comparison of potential remedies is undertaken as part of 845.670(e), which I did not undertake as part of my opinion.

20. Did you make a determination in your analysis of which "case," for each site, removes from the environment as much of the contaminated material that was released from the CCR surface impoundment as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems?

a. If so, which "case" did you find removes from the environment as much of the contaminated material that was released from the CCR surface impoundment as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems?

RESPONSE: Part 845.670(d)(3) requires that the selected remedy must meet this criterion and does not require that remedies under consideration be compared to one another under this section of the rule. The comparison of potential remedies is undertaken as part of 845.670(e), which I did not undertake as part of my opinion.

b. If not, how would you go about determining which case removes from the environment as much of the contaminated material that was released from the CCR surface impoundment as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems?

RESPONSE: Part 845.670(d)(3) requires that the selected remedy must meet this criterion and does not require that remedies under consideration be compared to another under this section of the rule. The comparison of potential remedies is undertaken as part of 845.670(e), which I did not undertake as part of my opinion.

21. Were the simulations discussed on pages 3-9 and Appendix B of your testimony run in steady state?

RESPONSE: The flow simulation performed using MODFLOW was a steady-state result. The subsequent fate and transport simulations performed using MT3D-USGS were not.

22. Why did the simulations you discuss on pages 3-9 and Appendix B of your testimony use 10 mg/L boron to saturate the CCR material? Please explain the basis for that 10 mg/L concentration.

RESPONSE: 10 mg/L is a representative value for boron measured in CCR pore water. A 2020 analysis of 1,651 water samples compiled by EPRI found a median concentration of 8.1 mg/L for pore water in CCR impoundments. To avoid false precision, the concentration is rounded to the nearest power of 10, which is well within the range of statistical significance for this data set (25th percentile concentration = 4 mg/L; 75th percentile concentration = 25 mg/L). (source: EPRI, 2020. Chemical Constituents in Coal Combustion Products: Boron. Report no. 3002018777.)

23. If a concentration higher than 10 mg/L boron were used to saturate the CCR, would that affect the outcome of the simulations?

RESPONSE: The solutions all demonstrate that different remedies will eventually comply with the GWPS. Increasing the concentration will extend the timeline for each remedy, but proportional to the remedy simulations I conducted. Accordingly, the outcome of the evaluation of remedies and closure options using the evaluation criteria provided in 845.670(e) and 845.871(b)(1)(E) would be the same regardless of the porewater concentration used.

24. Why did you use simulations that "saturate" the impoundment with boron, rather than other methods of establishing contaminant mass within an impoundment?

RESPONSE: **This method creates an equilibrium condition while the impoundment is in active operation. An alternative would be to assume that the entire mass CCR with its complement of boron is already present in the impoundment the very day it starts to operate, which is not realistic.**

25. What was the total mass of boron in the simulated impoundment at the end of "operation" for Site 1?

RESPONSE: **The total mass of boron is not relevant; the mass available for transport (leachable mass) is relevant. 132,000 kg (132 Tons metric) of leachable mass.**

26. What was the total mass of boron in the simulated impoundment at the end of "operation" for Site 2?

RESPONSE: **The total mass of boron is not relevant; the mass available for transport (leachable mass) is relevant. 206,000 kg (206 Tons metric) of leachable mass.**

27. What was the total mass of boron in the simulated impoundment at the end of "operation" for Site 3?

RESPONSE: **The total mass of boron is not relevant; the mass available for transport (leachable mass) is relevant .184,000 kg (184 Tons metric) of leachable mass.**

28. Have you measured, estimated, or reviewed estimations of the total mass of boron in real CCR surface impoundments that have characteristics the same or similar to modeled "sites" 1, 2, and 3? If so, please state how much total boron mass you found or estimated to be in those impoundments.

RESPONSE: **The total mass of boron is not relevant; the mass available for transport (leachable mass) is relevant.**

29. Did the simulations you completed for "sites" 1, 2, and 3 include evaluations of concentrations of any CCR constituents other than boron?

RESPONSE: **No.**

a. If not, why not?

<u>RESPONSE:</u> Boron is found in most CCR and exhibits similar behavior in most groundwater regardless of geochemical conditions and does not readily sorb to natural solids. Because of this boron is often the most mobile constituent observed at many CCR sites.

b. Why did you choose to model boron rather than other constituents known to leach from CCR?

<u>RESPONSE:</u> Most other leachable constituents have very different mobility in different geochemical conditions, and many are less common in CCR. Therefore, boron is an end member case with many direct comparisons possible, whereas other constituents would need to be compared on a limited case by case basis.

30. On page 4 of your testimony, the "present concentration in alluvial aquifer" diagram for Site 1 shows a concentration of about 4 mg/L for boron. Please provide the basis for that concentration.

<u>RESPONSE:</u> That is the concentration predicted by the model: this is the groundwater plume that would form from the CCR impoundment operating as described with 10 mg/L of boron in porewater. 4 mg/L is the groundwater concentration after that pore water has migrated into and mixed with groundwater.

31. What are the differences between the site 1 "impoundment" you simulated and impoundments where boron concentrations far higher than 4 mg/L have been detected in groundwater monitoring wells?

<u>RESPONSE:</u> The models simulate a groundwater plume generated from CCR pore water with a concentration of 10 mg/L. The concentration of 10 mg/L is a median value from a collection of 1,651 analyses (see question 22). "Much higher" groundwater concentrations have certainly been identified, but in the context of these models would be statistical outliers. The intention of this modeling work was to model typical, rather than, extreme cases.

32. Please provide the basis for the thickness of the "vertical layers" modeled for "sites" 1, 2, and 3.

<u>RESPONSE:</u> The layers are representative of the geology with 100 to 150 feet of alluvial sediments. This is also conservative, as, all else equal, thinner alluvium would result in smaller, more rapidly attenuating groundwater plumes which in turn would be easier to contain and remediate. The bedrock layer thickness is unimportant as it is considered to be impermeable for these simulations.

33. Had you assumed different thicknesses of the "vertical layers" of the simulations, described in Appendix B, could that change the outcome of your simulations?

<u>RESPONSE:</u> Varying the layer thickness would not change the outcome of compliance to the GWPS. Varying layer thicknesses would change the timeline for each remedy, but proportional to the remedy simulations I conducted. Accordingly, the outcome of the evaluation of remedies and closure options using the evaluation criteria provided in 845.670(e) and 845.871(b)(1)(E) would be the same regardless of the layer thickness used.

34. In Appendix B, you state that "all model results shown in the report are concentrations from Layer 4."

a. Why did you select layer 4 for the model results?

<u>RESPONSE:</u> Because that is the deepest permeable layer of the Site 2 model, hence necessary to compare the three sites side by side. Layer 3, layer 4, and (with the exception of Site 2) layer 5 all have similar concentrations.

b. In your simulations, do other layers also have concentrations of boron in the groundwater? If so, how do they compare with the concentrations in layer 4?

<u>RESPONSE:</u> Yes. They are all very similar except for layer 1 and 2 which contain some dry cells.

35. Appendix B of your testimony shows that you assumed a recharge rate of 2 inches/year for site 1 and 14 inches/year for sites 2 and 3. Why did you assume those recharge rates in the simulations?

<u>RESPONSE:</u> In Illinois, 14 inches/year is a reasonable recharge value for well drained sandy soils with low runoff potential, such as hypothesized for sites 2 and 3. Recharge can be much lower in low lying floodplain areas with standing water and less transmissive soil; hence 2 inches/year at site 1. However, actual recharge will vary considerably with site conditions, particularly how developed the site is with pavement and other impervious materials. This study was not intended to make a quantitative evaluation of recharge.

36. Had you assumed different recharge rates, could that change the outcome of your simulations?

<u>RESPONSE:</u> Varying the recharge rates would not change the outcome of compliance to the GWPS. Varying recharge would change the timeline for each remedy, but proportional to the remedy simulations I conducted. Accordingly, the outcome of the evaluation of remedies and closure options using the evaluation criteria provided in 845.670(e) and 845.871(b)(1)(E) would be the same regardless of the recharge rates used.

37. Appendix B of your testimony shows that you assumed a vertical conductivity rate of 10 ft/day for site 1, 50 ft/day for site 2, and 20 ft/day for site 3. Why did you assume those vertical conductivity rates in the simulations?

<u>RESPONSE:</u> These are typical values for medium to coarse alluvial sediments.

38. Had you assumed different vertical conductivity rates, could that change the outcome of your simulations?

<u>RESPONSE:</u> Varying the vertical conductivity rates would not change the outcome of compliance to the GWPS. Varying vertical conductivity rates would change the timeline for each remedy, but proportional to the remedy simulations I conducted. Accordingly, the outcome of the evaluation of remedies and closure options using the evaluation criteria provided in 845.670(e) and 845.871(b)(1)(E) would be the same regardless of the vertical conductivity rates used.

39. Appendix B of your testimony shows that you assumed a horizontal conductivity rate of 1 ft/day for site 1, 5 ft/day for site 2, and 2 ft/day for site 3. Why did you assume those horizontal conductivity rates in the simulations?

RESPONSE: These are typical values for medium to coarse alluvial sediments.

40. Had you assumed different horizontal conductivity rates, could that change the outcome of your simulations?

RESPONSE: Varying the horizontal conductivity rates would not change the outcome of compliance to the GWPS. Varying horizontal conductivity rates would change the timeline for each remedy, but proportional to the remedy simulations I conducted. Accordingly, the outcome of the evaluation of remedies and closure options using the evaluation criteria provided in 845.670(e) and 845.871(b)(1)(E) would be the same regardless of the horizontal conductivity rates used.

41. Appendix B of your testimony shows that you assumed a pond operating recharge rate of 60 inches/year for site 1, 175 inches per year for site 2, and 100 inches/year for site 3. Why did you assume those pond operating recharge rates in your simulations?

RESPONSE: These were the recharge rates necessary to maintain standing water in each pond. This represents the time during operation when CCR material is actively being sluiced into the pond; inspection of any active pond will reveal the presence of such standing water.

42. Had you assumed different pond operating recharge rates, could that change the outcome of your simulations?

RESPONSE: Varying the pond operating recharge rates would not change the outcome of compliance to the GWPS. Varying pond operating recharge rates would change the timeline for each remedy, but proportional to the remedy simulations I conducted. Accordingly, the outcome of the evaluation of remedies and closure options using the evaluation criteria provided in 845.670(e) and 845.871(b)(1)(E) would be the same regardless of the pond operating recharge rates used.

43. Appendix B of your testimony shows that you assumed a 30 inches/year pond out of service recharge rate for all three "sites." Why did you assume that pond out of service recharge rate in your simulations?

<u>RESPONSE:</u> It is assumed that the inactive pond is a depression that captures most rainwater. Annual precipitation in Illinois is 36-48 inches per year; 30 inches/year is a conservative value assuming minimal loss to evapotranspiration.

44. Had you assumed different pond out of service recharge rates, could that change the outcome of your simulation?

<u>RESPONSE:</u> Varying the pond out of service recharge rates would not change the outcome of compliance to the GWPS. Varying pond out of service recharge rates would change the timeline for each remedy, but proportional to the remedy simulations I conducted. Accordingly, the outcome of the evaluation of remedies and closure options using the evaluation criteria provided in 845.670(e) and 845.871(b)(1)(E) would be the same regardless of the pond out of service recharge rates used.

45. Appendix B of your testimony shows that you assumed a 460 feet above sea level river stage for site 1, a 440 feet above sea level river stage for site 2, and a 415 feet above sea level river stage for site 3. Why did you assume those river stages in your simulations?

<u>RESPONSE:</u> The actual numerical value of the river stage has no significance; the meaningful quantity is the difference between the river stage, water table, and CCR impoundment. The models were constructed on an arbitrary base elevation of 400 feet to put them in a familiar context for individuals used to working in northern Illinois.

46. Had you assumed different river stages, could that change the outcome of your simulations?

<u>RESPONSE:</u> Varying the river stages would not change the outcome of compliance to the GWPS. Varying the river stages would change the timeline for each remedy, but proportional to the remedy simulations I conducted. Accordingly, the outcome of the

evaluation of remedies and closure options using the evaluation criteria provided in 845.670(e) and 845.871(b)(1)(E) would be the same regardless of the river stages used.

47. Appendix B of your testimony shows that you assumed a constant head of 480 feet above sea level for site 1, 475 feet above sea level for site 2, and 435 feet above sea level for site 3. Why did you assume those constant head elevations in your simulations?

RESPONSE: Please note, the quantities referenced in this question are the constant head boundary conditions applied at the up-gradient edge of the model domain. The actual numerical value of this constant head has no significance; the meaningful quantity is the elevation of this constant head above the river and the CCR impoundment. This value was varied to create scenarios with CCR below the water table (sites 1 and 2) or above the water table (site 3). The models were constructed on an arbitrary base elevation of 400 feet to put them in a familiar context for individuals used to working in northern Illinois.

48. Had you assumed different constant head elevations, could that change the outcome of your simulations?

RESPONSE: Varying the constant head elevations would not change the outcome of compliance to the GWPS. Varying constant head elevations would change the timeline for each remedy, but proportional to the remedy simulations I conducted. Accordingly, the outcome of the evaluation of remedies and closure options using the evaluation criteria provided in 845.670(e) and 845.871(b)(1)(E) would be the same regardless of the constant head elevations used.

49. Appendix B of your testimony shows that you assumed a 1.0 L/Kg Kd for boron in CCR and a .1 L/Kg Kd for boron in the aquifer. Why did you assume those Kds in the simulations?

RESPONSE: 0.1 L/kg is a typical literature value for boron in natural aquifers. CCR material was approximated as 1 L/kg; one order of magnitude stronger sorption than observed in natural aquifers, but likely a conservative overestimate as there is not a strong sorption mechanism for the glassy fused particles comprising the CCR matrix.

50. Have you measured the Kd of boron in any impoundments in Illinois? If so, please provide the results of those measurements.

RESPONSE: **No, I have not.**

51. Had you assumed different Kds for boron in CCR or in the aquifer, could that change the outcome of the simulations?

RESPONSE: **Varying the Kds would not change the outcome of compliance to the GWPS. Varying Kds would change the timeline for each remedy, but proportional to the remedy simulations I conducted. Accordingly, the outcome of the evaluation of remedies and closure options using the evaluation criteria provided in 845.670(e) and 845.871(b)(1)(E) would be the same regardless of the Kds used.**

52. Appendix B of your testimony shows that you assumed an aquifer porosity of 0.35 for "sites" 1, 2, and 3. Why did you assume that aquifer porosity rate in your simulations?

RESPONSE: **"Porosity rate" is not a meaningful hydrogeological term. Porosity refers to a volume ratio which is a static quantity, not a rate.**

53. Had you assumed a different aquifer porosity, could that change the outcome of the simulations?

RESPONSE: **Varying the porosity would not change the outcome of compliance to the GWPS. Varying porosity would change the timeline for each remedy, but proportional to the remedy simulations I conducted. Accordingly, the outcome of the evaluation of remedies and closure options using the evaluation criteria provided in 845.670(e) and 845.871(b)(1)(E) would be the same regardless of the porosity used.**

54. Appendix B of your testimony shows that you assumed an aquifer bulk density of 1700 kg.m^3. Why did you assume that aquifer porosity rate in your simulations?

RESPONSE: **See answer to question 52: "aquifer porosity rate" is not a meaningful term in hydrogeology, nor does it agree with the subject of the previous sentence (bulk density).**

55. Had you assumed a different aquifer bulk density, could that change the outcome of the simulations?

RESPONSE: **Varying the bulk density would not change the outcome of compliance to the GWPS. Varying bulk density would change the timeline for each remedy, but proportional to the remedy simulations I conducted. Accordingly, the outcome of the evaluation of remedies and closure options using the evaluation criteria provided in 845.670(e) and 845.871(b)(1)(E) would be the same regardless of the bulk density used.**

56. Appendix B of your testimony shows that you assumed a riverbed conductance rate of 1.0e6 ft^2/day in your simulations. Why did you assume that riverbed conductance rate?

RESPONSE: **It is a value sufficiently large so that the riverbed does not create a significant barrier to groundwater flow. It is necessary to select a value, but it does not have much affect on steady state models results.**

57. Had you assumed a different riverbed conductance rate, could that change the outcome of the simulations?

RESPONSE: **Varying the riverbed conductance rate would not change the outcome of compliance to the GWPS. Varying riverbed conductance rates would change the timeline for each remedy, but proportional to the remedy simulations I conducted. Accordingly, the outcome of the evaluation of remedies and closure options using the evaluation criteria provided in 845.670(e) and 845.871(b)(1)(E) would be the same regardless of the riverbed conductance rates used.**

58. What distance between the impoundment and the river is assumed for each "site" in your simulations?

RESPONSE: **For Site 1: 2,500 feet. For Sites 2 and 3: 1,000 feet.**

59. Have you measured the distance between CCR surface impoundments and surface water bodies in Illinois? If so, please provide those distances.

<u>RESPONSE:</u> Yes, as follows (measured to rivers consistent with the models in my testimony):

Hennepin West:	**100 feet**
Hennepin East:	**200 feet**
Havana South:	**900 feet**
Hudsonville:	**50 feet**
Venice:	**350 feet**
Baldwin:	**1,600 feet**
Coffeen:	**900 feet**
Kincaid:	**100 feet**
Newton:	**350 feet**

I note that, in general, the less the distance of the impoundment is from a river as the groundwater discharge point, the shorter the timeframe to reach GWPS for implemented remedies.

60. Are you aware of CCR surface impoundments in Illinois that are located more than 500 feet from the nearest surface water body? If so, please identify them.

<u>RESPONSE:</u> See above.

61. For "case 1" for site 2, on page 7 of your testimony, you state that "boron mass is removed through natural groundwater flow to the river and no active source controls are put into place." Under this scenario, following capping, nothing is done to impede the flow of boron through groundwater into the river, correct?

<u>RESPONSE:</u> Correct

a. What is the source of the "boron mass" referenced in the above statement?

<u>RESPONSE:</u> The CCR material, and whatever boron is simulated to be already in the aquifer.

b. Are there methods or technologies that can reduce or eliminate the mass of boron that flows through groundwater into the river? If so, please describe.

<u>RESPONSE:</u> Yes. There are several technologies as mentioned in my testimony on pages 9 and 10 that can be used to reduce or eliminate boron in the groundwater including groundwater extraction, engineered barriers, in-situ treatment and MNA.

62. For "case 2" for site 2, you state on page 7 of your testimony that "the remaining boron mass is removed by natural groundwater flow to the river." What is the source of the "remaining boron mass?"

<u>RESPONSE:</u> The remnant boron mass in the groundwater.

a. Under this scenario, following removal, is anything done to impede the flow of boron through groundwater into the river?

<u>RESPONSE:</u> No, although that is not an uncommon approach to groundwater remediation for sites that do not pose a risk to human health and the environment. Numerous examples of such approaches can be found in RCRA and CERCLA.

b. Are there methods or technologies that can reduce or eliminate the mass of boron that flows through groundwater into the river? If so, please describe.

<u>RESPONSE:</u> Yes. There are several technologies as mentioned in my testimony on pages 9 and 10 that can be used to reduce or eliminate boron in the groundwater including groundwater extraction, engineered barriers, in-situ treatment and MNA. As stated in my opinion any of these technologies may be considered for groundwater remediation based on site-specific conditions and would require the analysis described in 845.670 and on page 9 of my testimony. This includes a determination that the remedy protects human health and the environment and that it meets the GWPS as well as Part 845.670(e), which includes the evaluation factors for comparison purposes. I did not conduct such an analysis for my testimony.

63. For "case 1" for site 3, you state on page 8 of your testimony that "boron mass is removed through natural groundwater flow to the river and no active source controls are put into place." Under this scenario, following capping, nothing is done to impede the flow of boron through groundwater into the river, correct?

<u>RESPONSE:</u> Correct, although that is not an uncommon approach to groundwater remediation for sites that do not pose a risk to human health and the environment. Numerous examples of such approaches can be found in RCRA and CERCLA.

a. What is the source of the "boron mass" referenced in the above statement?

<u>RESPONSE:</u> The CCR material, and whatever boron is already in the aquifer.

b. Are there methods or technologies that can reduce or eliminate the mass of boron that flows through groundwater into the river? If so, please describe.

<u>RESPONSE:</u> Yes. There are several technologies as mentioned in my testimony on pages 9 and 10 that can be used to reduce or eliminate boron in the groundwater including groundwater extraction, engineered barriers, in-situ treatment and MNA. As stated in my opinion any of these technologies may be considered for groundwater remediation based on site-specific conditions and would require the analysis described in 845.670 and on page 9 of my testimony. This includes a determination that the remedy protects human health and the environment and that it meets the GWPS as well as Part 845.670(e), which includes the evaluation factors for comparison purposes. I did not conduct such an analysis for my testimony.

64. For "case 2" for site 3, you state on page 9 of your testimony that "the remaining boron mass is removed by natural groundwater flow to the river." What is the source of the "remaining boron mass?"

a. Under this scenario, following removal, is anything done to impede the flow of boron through groundwater into the river?

<u>RESPONSE:</u> No, although that is not an uncommon approach to groundwater remediation for sites that do not pose a risk to human health and the environment. Numerous examples of such approaches can be found in RCRA and CERCLA.

b. Are there methods or technologies that can reduce or eliminate the mass of boron that flows through groundwater into the river? If so, please describe.

RESPONSE: Yes. There are several technologies as mentioned in my testimony on pages 9 and 10 that can be used to reduce or eliminate boron in the groundwater including groundwater extraction, engineered barriers, in-situ treatment and MNA. As stated in my opinion any of these technologies may be considered for groundwater remediation based on site-specific conditions and would require the analysis described in 845.670 and on page 9 of my testimony. This includes a determination that the remedy protects human health and the environment and that it meets the GWPS as well as Part 845.670(e), which includes the evaluation factors for comparison purposes. I did not conduct such an analysis for my testimony.

Groundwater pumping and treatment

65. On pp. 9-10 of your testimony, you reference several "remedy classes," including "Hydraulic Control (groundwater pumping and treatment); Engineered Barriers (slurry walls, sheet-pile walls, etc.); In-situ Treatment (using amendments such as emulsified vegetable oil to create a reducing condition); and MNA." Please describe groundwater pumping and treatment.

RESPONSE: Groundwater pumping and treating is extraction of groundwater from pumping or extraction wells.

66. Do groundwater pumping and treatment systems need to be operated? Please explain your answer.

RESPONSE: Yes and they will need to operate until GWPS are met. Also if groundwater extraction wells are a remedy or remedy component, the owner/operator will need to post financial assurance for the expected cost of the extraction wells to make sure they are operated and maintained. In addition, the operation of groundwater extraction wells would be considered as part of the evaluation criteria in 845.670, the process by which remedies are evaluated, and would likely be a requirement in any construction/operating permit.

67. If so, and the groundwater pumping and treatment systems are not operated as needed, how may that affect the functionality of the groundwater pumping and treatment system?

RESPONSE: **It depends on the definition of "as needed" and "functionality of." Groundwater extraction wells should be operated in a manner that minimizes wear on the equipment to maintain system performance. The operation of groundwater extraction wells would be considered as part of the evaluation criteria in 845.670, the process by which remedies are evaluated.**

68. Do groundwater pumping and treatment systems need to be maintained? Please explain your answer and provide examples.

RESPONSE: **Yes. Two common maintenance activities are replacing mechanical pumps and cleaning well screens. The maintenance of groundwater extraction wells would be considered as part of the evaluation criteria in 845.670, the process by which remedies are evaluated and if this was the selected remedy I expect the construction/operating permit would require the wells be maintained.**

69. If so, if that maintenance is not provided, how may that affect the functionality of the groundwater pumping and treatment system?

RESPONSE: **I would expect declining extraction efficiency over time.**

70. Do groundwater pumping and treatment systems need to be inspected? Please explain your answer.

RESPONSE: **Yes. Numerous options are available including down well cameras and optical televiewers to evaluate wells for their integrity. If this were the selected remedy, I expect the construction/operating permit would require the wells be maintained.**

71. If so, if such inspections do not take place or take place too infrequently, how may that affect the functionality of the groundwater pumping and treatment system?

RESPONSE: **It depends. Inspections do not increase functionality/performance of wells, they only inform as to the performance level of a groundwater extraction well.**

72. Do groundwater pumping and treatment systems include any parts that at times need replacement? Please explain your answer and provide examples.

<u>RESPONSE:</u> Yes, at times and that is part of the evaluation criteria in 845.670, the process by which remedies are evaluated.

73. If so, and those parts are not replaced when necessary, how may that affect the functionality of the groundwater pumping and treatment system?

<u>RESPONSE:</u> I would expect declining extraction efficiency over time.

74. Can changes in environmental conditions – including but not limited to increased severity and frequency of storms or floods; increased drought; changes in groundwater elevation, groundwater flow direction, or groundwater flow rate; or increased fractures in the subsurface – affect the functionality of groundwater pumping and treatment systems? Please explain your answer.

<u>RESPONSE:</u> Yes. Most of these things may cause changes in local hydrogeology, which in turn could affect well performance. The part of the question regarding "increased fractures in the subsurface" cannot be answered in a meaningful way without knowing the origin of the fractures. These affects are part of the evaluation process found in 845.670, the process by which remedies are evaluated.

75. Would it be prudent to set up a groundwater pumping and treatment system that does not anticipate the need for future operation, maintenance, inspection and/or parts replacement? Please explain your answer.

<u>RESPONSE:</u> No, and because of prudence, the operations and maintenance of groundwater extraction well systems are an integral part of such systems and their performance and would likely be part of any construction/operating permit.

76. Please identify the typical annual operating, maintenance, inspection and replacement costs associated with groundwater pumping and treatment systems.

<u>RESPONSE:</u> It depends on multiple site-specific factors and therefore cannot be framed or estimated as typical.

77. On page 14 of your testimony, you note that pumping and treatment "often requires higher levels of long-term management, increases the potential for exposures and has reliability

concerns." You also note that pumping and treatment involves "added components required for remedy construction…."

a. Please explain how pumping and treatment "increases the potential for exposures."

RESPONSE: Operators of pumping and treatment systems can come in contact with contaminated water and may have to handle water treatment chemicals, which may increase exposures as compared to other remedy alternatives.

b. What "reliability concerns" are you referring to in this statement?

RESPONSE: Many of the factors described above as I have indicated. Mechanical systems require operations and maintenance that can have less reliability than other remedies. Reliability is one of the evaluation factors provided in 845.670(e), the process by which remedies are selected.

c. What "added components" are required for pumping and treating?

RESPONSE: Added components are mechanical and installed appurtenances of pumping systems in comparison to other potential remedy options.

Slurry walls

78. Please describe what a slurry wall is and what it does.

RESPONSE: A slurry wall is a constructed low-permeability vertical barrier generally composed of bentonite or polymers and concrete. The intent of a slurry wall is to impede groundwater flow through the wall.

79. Do slurry walls need to be operated? Please explain your answer.

RESPONSE: No. Once they are constructed no operations are needed.

80. If so, and the slurry wall is not operated as needed, how may that affect the functionality of the slurry wall?

RESPONSE: See above.

81. Do slurry walls need to be maintained? Please explain your answer and provide examples.

<u>RESPONSE:</u> No. Once they are constructed no maintenance is needed.

82. If so, if that maintenance is not provided, how may that affect the functionality of the slurry wall?

<u>RESPONSE:</u> See above.

83. Do slurry walls need to be inspected? Please explain your answer.

<u>RESPONSE:</u> No. Inspections of slurry walls are generally not possible.

84. If so, if such inspections do not take place or take place too infrequently, how may that affect the functionality of the slurry wall?

<u>RESPONSE:</u> See above.

85. Do slurry walls include any parts that at times need replacement? Please explain your answer and provide examples.

<u>RESPONSE:</u> No.

86. If so, and those parts are not replaced when necessary, how may that affect the functionality of the slurry wall?

<u>RESPONSE:</u> See above.

87. Can changes in environmental conditions – including but not limited to increased severity and frequency of storms or floods; increased drought; changes in groundwater elevation, groundwater flow direction, or groundwater flow rate; or increased fractures in the subsurface – affect the functionality of slurry walls? Please explain your answer.

<u>RESPONSE:</u> The functionality of the slurry should not change with changing environmental conditions.

88. Would it be prudent to put in place a slurry wall without anticipating the need for future operation, maintenance, inspection and/or parts replacement? Please explain your answer.

<u>RESPONSE:</u> See above.

89. Please identify the typical annual operating, maintenance, inspection and replacement costs associated with slurry walls.

RESPONSE: **See above. As for replacement of a slurry wall, a typical cost cannot be determined because the cost would be site specific.**

Sheet-pile walls

90. Please describe what a sheet pile wall is and what it does.

RESPONSE: **A sheet pile wall is a series of connected (and sometime sealed) steel sheets that are installed into the ground by driving/pounding the sheets using specialized pile driving equipment. It can be used for a variety of purposes, including groundwater flow, berm stability, and flood control.**

91. Do sheet pile walls need to be operated? Please explain your answer.

RESPONSE: **No, once they are installed no operations are required.**

92. If so, and the sheet pile wall is not operated as needed, how may that affect the functionality of the groundwater pumping and treatment system?

RESPONSE: **See above.**

93. Do sheet pile walls need to be maintained? Please explain your answer and provide examples.

RESPONSE: **It depends on site conditions. It is not uncommon to maintain sheet pile walls with cathodic protection to minimize or corrosion.**

94. If so, if that maintenance is not provided, how may that affect the functionality of the sheet pile wall?

RESPONSE: **The sheet pile may corrode as stated above. The need for and type of cathodic protection is identified during sheet pile design.**

95. Do sheet pile walls need to be inspected? Please explain your answer.

RESPONSE: **Often sheet piles are below grade (ground) features that cannot be inspected.**

96. If so, if such inspections do not take place or take place too infrequently, how may that affect the functionality of the sheet pile wall?

<u>RESPONSE:</u> See above.

97. Do sheet pile walls include any parts that at times need replacement? Please explain your answer and provide examples.

<u>RESPONSE:</u> No.

98. If so, and those parts are not replaced when necessary, how may that affect the functionality of the sheet pile wall?

<u>RESPONSE:</u> See above.

99. Can changes in environmental conditions – including but not limited to increased severity and frequency of storms or floods; increased drought; changes in groundwater elevation, groundwater flow direction, or groundwater flow rate; or increased fractures in the subsurface – affect the functionality of sheet pile walls? Please explain your answer.

<u>RESPONSE:</u> The functionality of the sheet pile wall should not change with changing environmental conditions.

100. Would it be prudent to put in place a sheet pile wall without anticipating the need for future operation, maintenance, inspection and/or parts replacement? Please explain your answer.

<u>RESPONSE:</u> No, and because of prudence, the maintenance of sheet pile walls are an integral part of such systems and their performance and would likely be part of any construction/operating permit.

101. Please identify the typical annual operating, maintenance, inspection and replacement costs associated with sheet pile walls.

<u>RESPONSE:</u> See above. As for replacement, a typical cost cannot be determined because the cost would be site specific.

<u>In-situ treatment</u>

102. Please describe what in-situ treatment is and what it does.

<u>RESPONSE:</u> In situ treatment consists of treatment processes that destroy or immobilize contaminants without extracting contaminants from the subsurface.

103. Do in-situ treatment systems need to be operated? Please explain your answer.

<u>RESPONSE:</u> In situ treatment consists of a wide spectrum of technologies that require various degrees of system operation. For example, groundwater amendments and permeable reactive barriers may require minimal, if any, operation once installed.

104. If so, and the in-situ treatment systems are not operated as needed, how may that affect the functionality of the in-situ treatment system?

<u>RESPONSE:</u> It depends on the definition of "as needed" and "functionality of" and the nature of the system. To the extent the system requires operation, it should be operated in a manner to maintain system performance. The operation of in situ treatment may be considered as part of the evaluation criteria in 845.670, the process by which remedies are evaluated.

105. Do in-situ treatment systems need to be maintained? Please explain your answer and provide examples.

<u>RESPONSE:</u> It depends on the nature of the system. For mechanical systems with dedicated wells, common maintenance activities are replacing mechanical pumps and cleaning well screens. If a groundwater amendment or permeable reactive barrier is used, minimal, if any, maintenance is likely needed. The maintenance of an in situ treatment system would be considered as part of the evaluation criteria in 845.670, the process by which remedies are evaluated and if this was the selected remedy I expect the construction/operating permit would require the system performance be maintained.

106. If so, if that maintenance is not provided, how may that affect the functionality of the in-situ treatment system?

<u>RESPONSE:</u> For systems requiring maintenance, I would expect declining treatment efficiency over time.

107. Do in-situ treatment systems need to be inspected? Please explain your answer.

<u>RESPONSE:</u> It depends. Some in-situ treatment systems have above-ground instrumentation components, as well as using wells and pumps; these components will

require periodic inspection. Some in-situ treatment uses a passive treatment system that does not have instrumentation for operation for inspection (e.g., permeable reactive barrier).

108. If so, if such inspections do not take place or take place too infrequently, how may that affect the functionality of the in-situ treatment system?

<u>RESPONSE:</u> It depends. Inspections do not increase functionality/system performance, they only inform as to the performance level of the system.

109. Do in-situ treatment systems include any parts that at times need replacement? Please explain your answer and provide examples.

<u>RESPONSE:</u> It depends. Passive in-situ treatment systems like permeable reactive barriers may not have any part that needs replacement. Some systems may contain parts that are also used by a groundwater extraction system; in such cases, part replacement is likely at times and that is part of the evaluation criteria in 845.670, the process by which remedies are evaluated.

110. If so, and those parts are not replaced when necessary, how may that affect the functionality of the in-situ treatment system?

<u>RESPONSE:</u> I would expect declining performance over time.

111. Can changes in environmental conditions – including but not limited to increased severity and frequency of storms or floods; increased drought; changes in groundwater elevation, groundwater flow direction, or groundwater flow rate; or increased fractures in the subsurface – affect the functionality of in-situ treatment systems? Please explain your answer.

<u>RESPONSE:</u> Yes. Many of these conditions may cause changes in local hydrogeology, which in turn could affect system performance. The part of the question regarding "increased fractures in the subsurface" cannot be answered in a meaningful way without knowing the origin of the fractures. These factors are part of the evaluation process found in 845.670, the process by which remedies are evaluated.

112. Would it be prudent to set up an in-situ treatment system that does not anticipate the need for future operation, maintenance, inspection and/or parts replacement? Please explain your answer.

<u>RESPONSE:</u> No, and because of prudence, the operations and maintenance of in-situ treatment systems are an integral part of such systems and their performance and would likely be part of any construction/operating permit.

113. Please identify the typical annual operating, maintenance, inspection and replacement costs associated with in-situ treatment systems.

<u>RESPONSE:</u> It depends on multiple site-specific factors, as well as in-situ technologies involved, and therefore cannot be framed or estimated as typical.

<u>MNA</u>

114. On page 10 of your testimony, you cite US EPA 1999 for the proposition that "Where conditions are favorable, natural attenuation processes may reduce contaminant mass or concentrations at sufficiently rapid rates to be integrated into a site's soil or groundwater remedy." Are conditions favorable for natural attenuation where the contaminant plume is expanding vertically or horizontally?

<u>RESPONSE:</u> It depends. The two relevant factors related to decisions regarding MNA are protection of human health and the environment (845.670(d)(1)) and compliance with the GWPS (845.670(d)(2)). Accordingly, if a remedy is implemented (CIP for example) and groundwater contamination expands vertically or horizontally yet meets these two criteria, then MNA including physical processes was part of successful remedy. If MNA cannot meet these two criteria as a remedy component, the remedy could not be selected. Further, in many cases, after appropriate source management actions are implemented to curtail contaminant discharge to groundwater, the plume may expand temporarily and then become stabilized. In this case, since the plume expansion is temporal and since no receptor will be exposed to unacceptable risks, the conditions are favorable for natural attenuation.

115. Are conditions favorable for natural attenuation where monitoring reveals the presence of CCR contaminants that are not being attenuated?

<u>RESPONSE:</u> It depends. Natural attenuation may be more a effective remedy to some constituents as compared to others. Also some natural attenuation processes such as

dispersion, diffusion and dilution should apply to all constituents. The two relevant factors related to decisions regarding MNA are protection of human health and the environment (845.670(d)(1)) and compliance with the GWPS (845.670(d)(2)). Accordingly, if a remedy is implemented (CIP for example) and groundwater contamination meets these two criteria, then MNA including physical processes is part of a successful remedy. If MNA cannot meet these two criteria as a remedy component, the remedy could not be selected. Further, in many cases, after appropriate source management actions are implemented to curtail contaminant discharge to groundwater, the plume may expand temporarily and then become stabilized. In this case, since the plume expansion is temporal and since no receptor will be exposed to unacceptable risks, the conditions are favorable for natural attenuation.

116. Are conditions favorable for natural attenuation where there is an increasing concentration, over time, in downgradient groundwater monitoring wells?

<u>RESPONSE:</u> It depends. MNA is a weight (multiple lines) of evidence demonstration and concentration trend analysis is one tool to help make this demonstration. The two relevant factors related to decisions regarding MNA are protection of human health and the environment (845.670(d)(1)) and compliance with the GWPS (845.670(d)(2)). Accordingly, if a remedy is implemented (CIP for example) and groundwater contamination increases in concentration, over time, in downgradient monitoring wells yet meets these two criteria, then MNA including physical processes is successful. If MNA cannot meet these two criteria as a remedy component, the remedy could not be selected. Further, in many cases, after appropriate source management actions are implemented to curtail contaminant discharge to groundwater, the plume may increase in concentration and then become stabilized. In this case, since the concentration trend is temporal and since no receptor will be exposed to unacceptable risks, the conditions are favorable for natural attenuation.

117. Is natural attenuation appropriate if the vertical and horizontal extent of the plume has not been defined?

<u>RESPONSE:</u> It depends. First, the determination of the plume extent is required in 845.650(d)(1) and therefore should be completed as part of Part 845 process. Second it is possible to conduct preliminary MNA evaluations as data are collected for purposes of nature and extent of contamination and remedy selection.

118. Is natural attenuation appropriate if the extent of the plume cannot be defined?

<u>RESPONSE:</u> It depends. First, the determination of the plume extent is required in 845.650(d)(1) and therefore should be completed as part of Part 845 process. Second it is possible to conduct preliminary MNA evaluations as data are collected for purposes of nature and extent of contamination and remedy selection even if the full plume is not defined.

119. Is natural attenuation appropriate if the capacity of the aquifer to attenuate contaminants within the plume is unknown?

<u>RESPONSE:</u> Based on USEPA (2015) MNA guidance for inorganics, a tiered analysis approach for developing multiple lines of evidence is recommended to determine whether natural attenuation is appropriate for a site. One line of evidence is to understand the capacity of the aquifer for natural attenuation. If attenuation capacity of the aquifer is and if the plume is also expanding and may cause an unacceptable condition for receptors, natural attenuation is not indicated and will not satisfy 845.670(d)(1). If the attenuation capacity of an aquifer is unknown but the plume is stable, MNA may serve as an interim measure for plume management to facilitate additional data gathering to determine aquifer capacity. Ref: USEPA, 2015. Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites. Directive 9283.1-36. August.

120. Is natural attenuation appropriate if there is insufficient space between the contaminant source and groundwater discharges areas to allow a monitoring system to be established, including sentry wells located ahead of the leading edge of the plume?

<u>RESPONSE:</u> It depends. Monitoring is not the only way to demonstrate the feasibility of natural attenuation. In some cases, site-specific biogeochemical conditions are highly favorable for contaminant immobilization/degradation, which may serve as a primary line of evidence to support natural attenuation.

121. Is natural attenuation appropriate for sites that have anything other than a low potential for contaminant migration?

<u>RESPONSE:</u> It depends. The two relevant factors related to decisions regarding MNA are protection of human health and the environment (845.670(d)(1)) and compliance with the GWPS (845.670(d)(2)). Accordingly, if a remedy is implemented (CIP for example) and groundwater contamination increases in concentration, over time, in downgradient monitoring wells yet meets these two criteria, then MNA including physical processes is successful. If MNA cannot meet these two criteria as a remedy component, the remedy could not be selected. This is inclusive for sites other than low potential for contaminant migration.

122. Is natural attenuation appropriate where cross media transfer of contaminants from groundwater to surface water is occurring?

<u>RESPONSE:</u> Attenuation that occurs when groundwater flows into surface water is specifically cited as being a mechanism to derive Alternate Concentration Limits (ACLs) for GWPS under RCRA. OSWER Directive 9481.00-6C, EPA/530-SW-87-017

123. Is natural attenuation appropriate where there are current receptors of the contaminant plume, including surface waters, wetlands, or water supply wells?

<u>RESPONSE:</u> It depends and can be applied if human health and the environment is protected as required under 845.670(d)(1).

124. Is natural attenuation appropriate if there is insufficient distance between the contaminant source and potential receptors to allow contaminant concentrations to be reduced to safe levels prior to reaching those receptors?

RESPONSE: It depends. As long as human health and the environment is protected as required under 845.670(d)(1), then natural attenuation may be appropriate. If not, then natural attenuation would not be appropriate.

125. Is natural attenuation appropriate if it does not prevent the migration or expansion of the contaminant plume?

RESPONSE: It depends. The two relevant factors related to decisions regarding MNA are protection of human health and the environment (845.670(d)(1)) and compliance with the GWPS (845.670(d)(2)). Accordingly, if a remedy is implemented (CIP for example) and the plume expands or migrates and, yet meets these two criteria, then MNA including physical processes is successful. If MNA cannot meet these two criteria as a remedy component, the remedy could not be selected. Further, in many cases, after appropriate source management actions are implemented to curtail contaminant discharge to groundwater, the plume may migrate or expand and then become stabilized. In this case, since the expansion is temporal, the conditions may be favorable for natural attenuation.

126. Is natural attenuation appropriate if it cannot achieve the remediation objectives within a reasonable timeframe as compared to other alternatives?

RESPONSE: Reasonable timeframe is a subjective term and varies based on site-specific conditions.

127. Is natural attenuation appropriate if conditions allow contaminants that have adsorbed to solids to be remobilized in groundwater?

RESPONSE: Sorption does not immobilize contaminants, it simply slows contaminant migration. Accordingly, desorption does not remobilize contaminants.

128. Arsenic can be remobilized in groundwater under certain conditions, correct?

RESPONSE: Yes and arsenic can also remain immobilized under certain conditions.

129. Which other CCR constituents that are subject to sorption can be remobilized in groundwater?

<u>RESPONSE:</u> Sorption does not immobilize contaminants, it simply slows contaminant migration. Accordingly, desorption does not remobilize contaminants.

130. Do dispersion or dilution change the mass of contamination?

<u>RESPONSE:</u> No, although the other MNA processes related to metals also does not change the mass of contamination. The state in which the mass exists could change.

131. Boron and sulfate are highly mobile constituents, correct?

<u>RESPONSE:</u> Yes.

132. Does that mobility, or other characteristics of boron or sulfate, limit whether MNA should be used for CCR contaminant plumes containing boron or sulfate?

<u>RESPONSE:</u> MNA processes are constituent specific. With respect to boron and sulfate, physical MNA processes including dispersion, dilution and diffusion are often applicable. Under certain circumstances, sulfate can also be biotransformed.

133. According to US EPA, should natural attenuation be the sole, default, or presumed remedy for a contaminated site?

<u>RESPONSE:</u> No, as indicated in my testimony on page 10 where I state "Since the beginning of EPA's MNA initiative, it has been emphasized that MNA is not a "presumptive" or "default" remedy – it is an option that should be evaluated with other applicable remedies. EPA has never viewed MNA to be a "no action," "walk-away," or "do-nothing" approach, but rather considered it to be an alternative means of achieving remediation objectives" (U.S. EPA 1999, ITRC 2010, U.S. EPA 2015). In the case of Part 845, I expect MNA could be coupled with closure, which is part of the groundwater remedy.

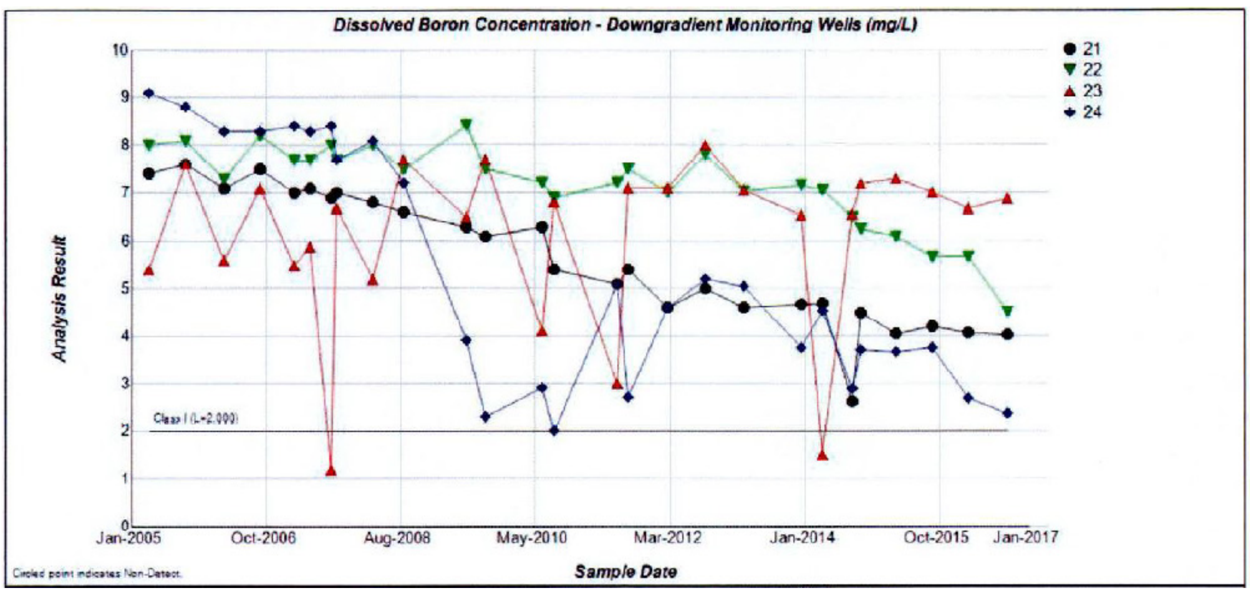
<u>CCR and water:</u>

134. The graphs on page 17 of your testimony showing monitoring wells at the Hennepin West Ponds 1 and 3 appear to include monitoring only through 2013. Why did you only include monitoring results up through 2013?

<u>RESPONSE:</u> The graphs were derived from Figure 2-12 in Closures Alternatives Evaluation Report dated July 24, 2014. Data in the Figure 2-12 spanned from 1994 through 2013, as is shown in the graphs on page 17 of my testimony. We used these graphs because it included chemical data prior to West Ash Pond being taken out of service in 1996.

135. Have you reviewed more recent groundwater monitoring data from those impoundments? If so, please describe whether GWPS for boron has been consistently achieved at any of those wells.

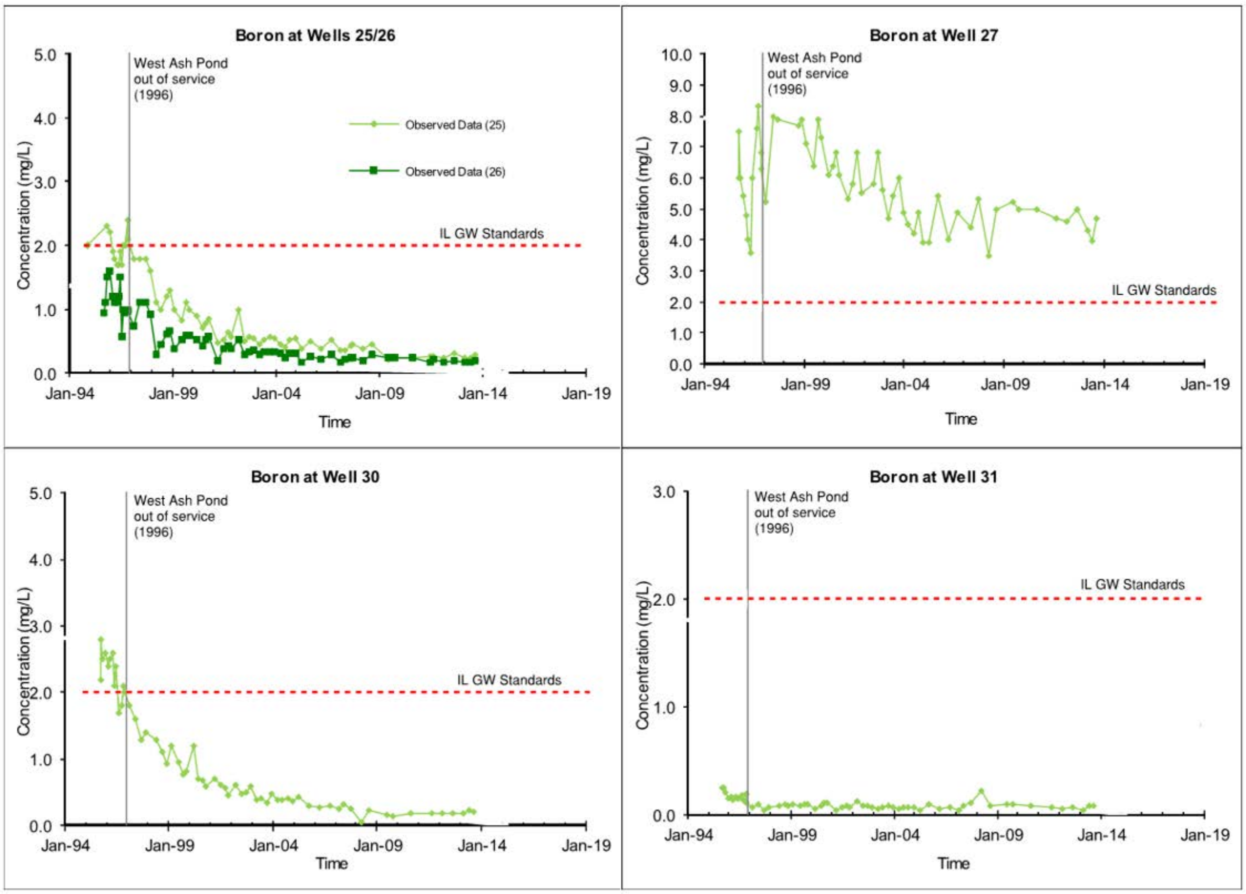
<u>RESPONSE:</u> As part of answering these questions, we found additional groundwater data in an appendix of one of the reports that we did not review and that was inadvertently omitted from my testimony. We include the graphic below that provides data through 2016, which continues to show boron trends consistent with and in support of my original testimony.



From Appendix C1 of the Hennepin West Closure Plan

136. Are there other monitoring wells that may be impacted by Hennepin West Ponds 1 and 3? If so, please identify them and explain why you did not include data from those wells in your testimony.

<u>RESPONSE:</u> Other monitoring wells do not appear to have been impacted above the GWPS by Hennepin West Ponds 1 and 3. Wells 25, 26, 30 and 31 have achieved GWPS and were therefore not included in my testimony. We were uncertain as to whether well 27 is impacted by other site appurtenances so it was not included in my testimony; however, the well demonstrates a declining trend for boron consistent with and in support of my testimony.



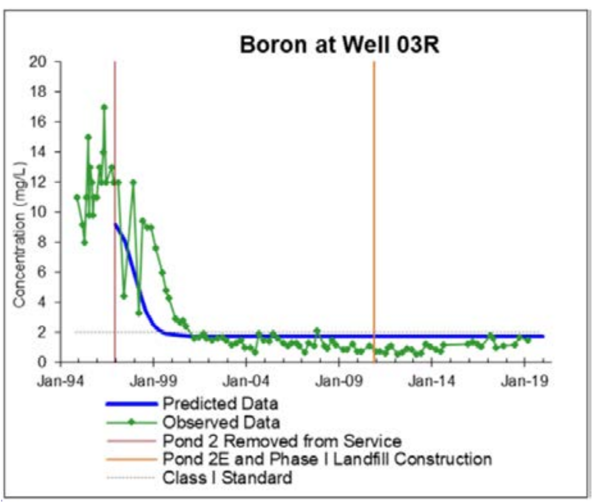
137. The graphs on page 19 of your testimony showing monitoring wells from the Hennepin ash ponds 2 and 4 appear to show data only through 2014 for some wells and 2016 for other wells. Why did you only include monitoring results up to 2014 for wells 3R and 5R and only through 2016 for wells 10, 12, 13, and 15?

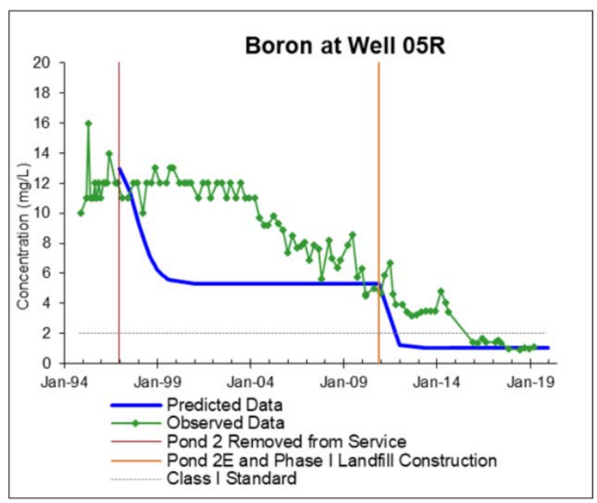
<u>RESPONSE:</u> The graphs were derived from Figure 4 in the Closure Plan Addendum for Hennepin East Ash Pond 2 dated 25 October 2018. Data in Figure 4 spanned from 1994

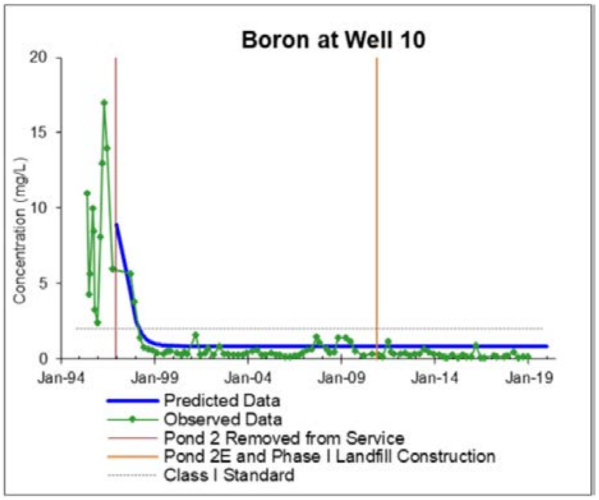
through 2013, as is shown in the graphs on page 19. As part of answering these questions, we found additional groundwater data in an attachment to response to IEPA comments that we did not review and that was inadvertently omitted from my testimony.

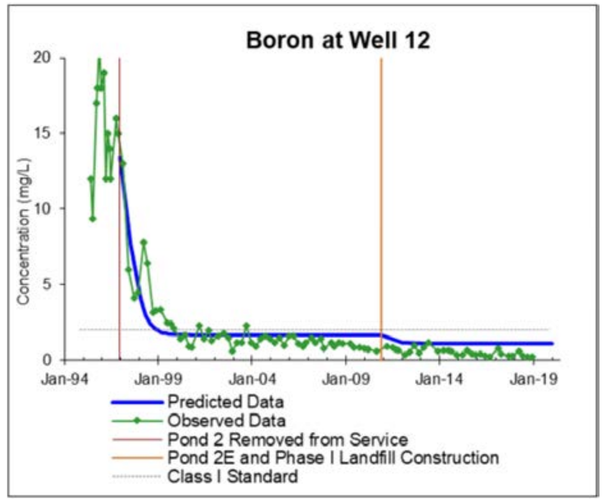
138. Have you reviewed more recent groundwater monitoring data from those impoundments? If so, please state whether GWPS for boron has been consistently achieved at all monitoring wells.

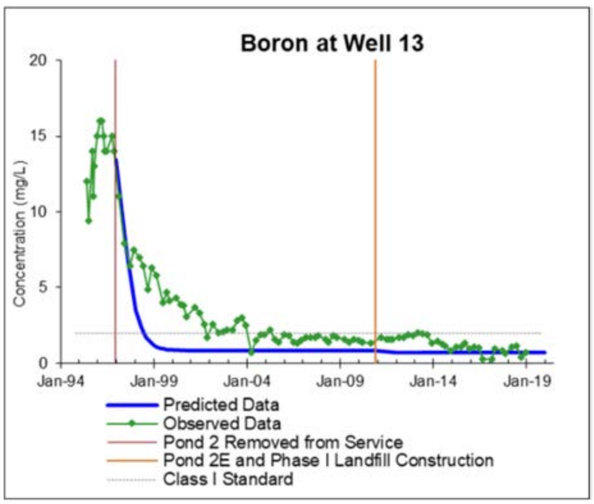
<u>RESPONSE:</u> Yes, as part of answering these questions, we found additional groundwater data in in an attachment to response to IEPA comments that we did not review and that was inadvertently omitted from my testimony. We include the graphic below that provides the most recent data in our possession, which continues to show boron trends consistent with and in support of my original testimony.











See graphs derived from Figures No. 1A-1F, Response to IEPA Comments – Closure Care Plan for the Hennepin East Ash Pond No. 2 and Closure Plan Addendum Hennepin East Ash Pont No. 2, dated July 22, 2019.

139. Are there other monitoring wells that may be impacted by Hennepin West Ponds 2 and 4? If so, please identify them and explain why you did not include data from those wells in your testimony.

<u>RESPONSE:</u> We evaluated downgradient wells for impacts from Hennepin West Ponds. Downgradient wells are Wells 03R, 05R, 05DR, 06R, 10, 11, 12, 13, 15, 18S, 18D, 19S, 19D, 40S, 45S, 46, 47, 48. Data included in my testimony were from Wells 03R, 05R, 10, 12,

13, and 15. Data from Wells 05DR, 6R, 11, 18S, 18D, 19S, 19D, 40S, 45S, 46, 47, and 48 were not included because:

- **Wells 05DR, 18S, 18D, 19S, 19D, 40S, 45S, 46, 47, and 48 – Sampling data for these wells began in 2009 or later. We wanted to evaluate data from wells with a long history of sampling data (prior to Pond 2 being taken out of service).**

- **Well 6R – This well did not appear to be impacted by the ponds and had achieved GWPS in 1998.**

- **Well 11 – Sampling at Well 11 stopped in 2006.**

140. On page 20 of your testimony you discuss CCR surface impoundments "located on high permeability alluvium." Even if the percentage of groundwater flowing through the CCR is small, will the high permeability and relatively high gradient of groundwater flow result in a rapidly moving plume of CCR-contaminated groundwater downgradient of the CCR surface impoundment, once groundwater moves through the ash into the high permeability alluvium? Please provide the basis for your answer.

RESPONSE: The term "rapidly" is not defined. Compared to groundwater system where gradients are lower and/or the permeability is lower, the higher gradient with higher permeability groundwater would result in higher groundwater flow velocities. These statements are predicated on flow through porous media.

141. Even if the "contribution of CCR constituents" is "small," does that prevent that contribution from exceeding groundwater protection standards for CCR constituents?

RESPONSE: It depends on many factors including site specific conditions.

142. Is it your opinion that industrial wastes should be left buried in highly productive aquifers if the waste has a lower permeability than the surrounding geology?

RESPONSE: No. Remedy decisions are based on site specific conditions and extensive data.

143. On page 20 of your testimony, you state that "Flooding/rising and receding groundwater associated with flood events does not create an unacceptable risk and may not contribute to exceedences [sic] of GWPS's." What do you mean by "unacceptable risk"?

<u>RESPONSE:</u> The term unacceptable risk in this context is more appropriately described in relationship to the GWPS, which is the following portion of that sentence. Accordingly, reference to unacceptable risk in my testimony should be indexed to the GWPS.

144. Can flooding/rising and receding groundwater contribute to exceedances of the groundwater protection standards?

<u>RESPONSE:</u> It depends on site specific conditions.

145. For closure by removal, is it correct that before the excavation of the CCR commences, standing water is removed from the impoundment and active dewatering of the CCR impoundment begins? If not, please explain your answer.

<u>RESPONSE:</u> It depends. Removal of CCR can take place in the wet using dredging techniques. The decision on removal means and methods would be based on site specific conditions.

146. Have you considered the effect that dewatering the CCR has on the ability of redox-sensitive constituents to migrate from the impoundment?

<u>RESPONSE:</u> Not for my testimony.

147. Have you reviewed groundwater monitoring data for redox-sensitive constituents at sites where removal is underway or has been completed? If so, please describe.

<u>RESPONSE:</u> Not for my testimony.

148. On page 24 of your testimony you discuss Ash Pond D at the Hutsonville site and mention a groundwater collection system along the south boundary. Please briefly describe that "groundwater collection system" and state whether it includes any of the remedy types discussed earlier in your testimony (groundwater pumping and treatment, engineered barriers, in-situ treatment, or MNA).

<u>RESPONSE:</u> The groundwater collection system (Collection Trench) runs from the southwest corner of Ash Pond A to the southeast corner of Ash Pond D. The Trench extends to bedrock (except at the extreme east end) and is designed to intercept groundwater that migrates to the south from the Ash Pond D area.

The Collection Trench consists of a perforated HDPE pipe encased in coarse aggregate and wrapped in non-woven geotextile that run the full length of the Trench. The

bottom slope of the Trench will be constructed to direct collected groundwater to four separate sumps; a pair in the east portion of the Trench adjacent to Ash Pond D and a part in the west portion of the Trench adjacent to Ash Pond A.

The groundwater collection trench is designed to continuously withdraw groundwater to control the gradient and flow direction of potentially impacted groundwater associated with Ash Pond D. Groundwater collected in the trench flows by gravity to one of the four collection sumps, each equipped with a 50 gallon per minute (gpm) pump system. Capture of groundwater within the Trench occurs as soon as pumping begins, as the flow to the pumps induce a groundwater flow gradient toward the Trench from all sides, intercepting groundwater contaminants that migrate across the south property line. The pumps activate or shut down based on the water level in the sump. Water from each sump is pumped to a central catch basin located adjacent to the existing Ash Pong D outlet structure along the mid-east side of the pond. It then discharges to the Wabash River in accordance with the Stations NPDES permit.

Source: Closure of Ash Pond D Hutsonville Power Station Closure Plan prepared for Ameren Energy Generating Company Crawford County, Illinois by Hanson Engineering, dated 26 July 2011. [In H&A folder: "Revised Closure Plan – Ash Pond D (4.3.12)"]

149. Also on page 24 of your testimony concerning Hutsonville Ash Pond D, you state that "antimony, arsenic, boron, chromium, cobalt, lead, mercury, and thallium had exceedances over proposed GWPS's," and that "only boron consistently exceeded the proposed standard." Do any of the other constituents you mention sometimes exceed the proposed GWPS for that pollutant in wells that may be affected by leachate from Ash Pond D?

RESPONSE: Antimony, arsenic, cobalt, lead, mercury, and thallium exceedances in downgradient wells were one-time exceedances (detected above GWPS at only one sampling event in a well; all other sampling events at the well had concentrations either

below GWPS or were non-detected). Chromium was detected below GWPS in the downgradient wells for all sampling events. Boron had exceedances at several sampling events in wells MW11R and MW6 as provided in my testimony. At MW6, boron exceeded GWPS 37% of the time (7 out of 19 sampling events) and at MW11R, boron exceeded GWPS 65% of the time (15 out of 23 sampling events). As noted on page 25 of my testimony, boron continues to trend downward over time at MW116 and MW6, towards the GWPS compliance.

150. In your testimony on page 25 you show data from two monitoring wells for Hutsonville Pond D. Are there additional monitoring wells that may be impacted by leachate from Hutsonville Pond D? If so, please identify them and explain why you did not include data from those wells in your testimony.

RESPONSE: **Downgradient wells had exceedances of antimony, arsenic, boron, cobalt, lead, mercury, and thallium. With the exception of boron, the other COCs were one-time exceedances.**

Boron had one-time exceedances in four wells and exceedances at several sampling events in three downgradient wells (MW11R, MW6, and MW8). Data for those of these wells (MW11R and MW6) are shown on page 25. MW8 had boron concentrations above GWPS standards; however, it is not clear the impacts to MW8 are from Ash Pond D. Boron impacts to MW8 could be attributed to Former Bottom Ash Pond, Former Coal Storage Yard, or Former Ash Pond C. Boron concentrations detected at wells MW11R and MW6 are less likely impacted by other units and more likely attributed to Ash Pond D.

151. On page 27 of your testimony, concerning ash ponds at the Venice plant, you state that “antimony, arsenic, boron, chromium, cobalt, and lead had exceedances over the proposed GWPS’s,” and that “only boron consistently exceeded the proposed standard.” Do any of the other constituents you mention sometimes exceed the proposed GWPS for that pollutant in wells that may be affected by leachate from those ash ponds?

<u>RESPONSE:</u> Antimony and chromium detected in downgradient wells were one-time exceedances in wells (detected above GWPS at only one sampling event in a well; all other sampling events at the well had concentrations either below GWPS or were non-detected). Cobalt exceedances were observed in one well (MW-02) for three sampling events (out of a total of 27 events). Lead exceedances were observed in six wells and of the six wells, MW-06 had four sampling events out of 57 events with lead exceedances (the maximum lead exceedances in a well).

As noted in Closure Plan for the Venice Power Plant Ash Ponds 2 & 3, Section 2.4, "the Venice ponds are not a significant source of arsenic to groundwater". Arsenic concentrations in field leachate samples taken from the ash ponds were lower than the maximum concentrations observed in groundwater and arsenic concentrations higher than the Class I standard were observed in a background sampling location. Arsenic exceedances in wells may not be attributed to Ponds 2 and 3.

Of the constituents with exceedances, boron exceeded GWPS in all downgradient wells and at certain wells, exceedances were detected during multiple sampling events. At MW-02, boron exceeded GWPS 61% of the time (35 out of 57 sampling events) and at MW-05, boron exceeded GWPS 86% of the time (57 out of 66 sampling events)Additionally, as stated in Appendix C of the Closure Plan, boron was identified as the primary indicator constituent for coal ash leachate impacts to groundwater at the site.

152. On page 27 of your testimony, you show data from two monitoring wells for Venice ash ponds. Are there additional monitoring wells that may be impacted by leachate from those ash ponds? If so, please identify them and explain why you did not include data from those wells in your testimony.

<u>RESPONSE:</u> As explained in the response to question 151, boron is the only constituent that exceeded the proposed GWPS in down gradient wells and is the primary

indicator constituent for coal ash leachate impacts to groundwater at the site. Plots of boron concentrations from wells MW-02 and MW-05 are shown because these are the downgradient wells that have an extensive sampling history dating prior to the impoundments being taken out of service and that indicate the boron impacts at these wells are likely attributable to the ash ponds, as described below.

In evaluating downgradient wells with boron exceedances, four wells (MW-02, MW-03, MW-05, MW-06) had analytical data prior to, and post, cap construction. Wells with no data prior to cap construction were not included. Data for MW-02 and MW-05 is shown in the plots on page 27. MW-03 had only one sampling event exceeding boron standards (out of 46 sampling events), and therefore the plot was not included. MW-06 was not included because the well appeared to be an intermediate well (not a downgradient well) in many contour maps included in Annual Reports from 2012 to 2018.

153. On page 28 of your testimony, you state that "[t]he concept of 'unimpacted background' may be valid for site-wide evaluations…." Why is that so?

<u>RESPONSE:</u> Site-wide evaluations (such as RCRA Corrective Actions) are intended to evaluate the impact of contaminants across an entire site/facility. Accordingly, site background groundwater quality is relevant to the goals of a site-wide program. Under Part 845, an owner operator is responsible for response actions directly related to a regulated unit (surface impoundment). Without knowledge of background to the unit, the owner/operator may be trying to remediate something other than the unit, a proposition that would be destined for failure and outside the requirements of the proposed rule.

154. Does quarterly monitoring provide more opportunity to understand seasonal variation in Illinois than semi-annual monitoring? If your answer is no, please explain.

<u>RESPONSE:</u> Part 845 provides ample opportunity to understand seasonality including during the hydrogeologic site characterization and as part of groundwater

sampling (Part 845.640). As noted in my testimony, the Agency should be authorized to reduce the frequency to semi-annual when appropriate. .

155. Is the evaluation of concentrations of CCR constituents in groundwater hindered by more frequent measurements of groundwater levels in site monitoring wells?

<u>RESPONSE:</u> No and the frequency of such monitoring should be based on site-specific conditions. The Agency should be authorized to reduce the frequency to semi-annual when appropriate.

156. Does measurement of groundwater levels in monitoring wells inform understanding of the fate and transport of CCR constituents in groundwater? If your answer is no, please explain.

<u>RESPONSE:</u> Yes and the frequency of such water level monitoring should be based on site-specific conditions (page 29 of my testimony). The Agency should be authorized to reduce the frequency to semi-annual when appropriate.

157. On page 29 of your testimony, you state that "the more comparisons conducted the more it 'increases the accumulative risk of making a false positive mistake.'" Is the converse also true – that is, the fewer comparisons conducted the less the accumulative risk of false positives?

<u>RESPONSE:</u> The rate of false positive mistakes would not significantly change but the accumulative risk of a false a positive mistake would decrease with fewer comparisons.

158. What is the design lifespan of a soil layer?

<u>RESPONSE:</u> It depends. The lifespan of soil layer (cover) is dependent on design considerations such as slopes and material used for cover as well as degree and type of vegetation and maintenance of the cover system over time.

159. Does a soil layer require ongoing maintenance and inspection to remain effective?

<u>RESPONSE:</u> It depends on what the soil layer is intended to do. Generally speaking inspection of a soil layer during post closure care to confirm that vegetative cover exists, vegetation type, and identification of signs of erosion are common to confirm the

effectiveness of a cover soil layer during that period. Maintenance during post closure care of identified conditions is also common. The maintenance of a soil layer would be considered as part of the evaluation criteria in 845.670, the process by which remedies are evaluated, and would likely be a requirement in any construction/operating permit.

160. If soil layers are not maintained or inspected, how can that affect the soil liner?

<u>RESPONSE:</u> Cover soil layers serve the purpose of providing protection for the underlying soil liner. If the cover soil layers are not inspected or maintained during the post closure care period, they may not serve their purpose of protecting the soil liner. I expect the construction or operating permits issued under Part 845 to require inspections and maintenance during the post closure care period.

161. Do the Hydrologic Evaluation of Landfill Performance (HELP) model evaluations discussed on pages 33 and 34 of your testimony assume that the soil liners remain intact?

<u>RESPONSE:</u> Per "The Hydrologic Evaluation of Landfill Performance (HELP) Model; User's Guide for Version 3 [EPA/600/R-94/168a]" dated September 1994, "the HELP model assumes Darcian flow by gravity influences through homogeneous soil and waste layers. It does not consider explicitly preferential flow through channels such as cracks, root holes, or animal burrows but allows for vertical drainage through the evaporative zone at moisture contents below field capacity."

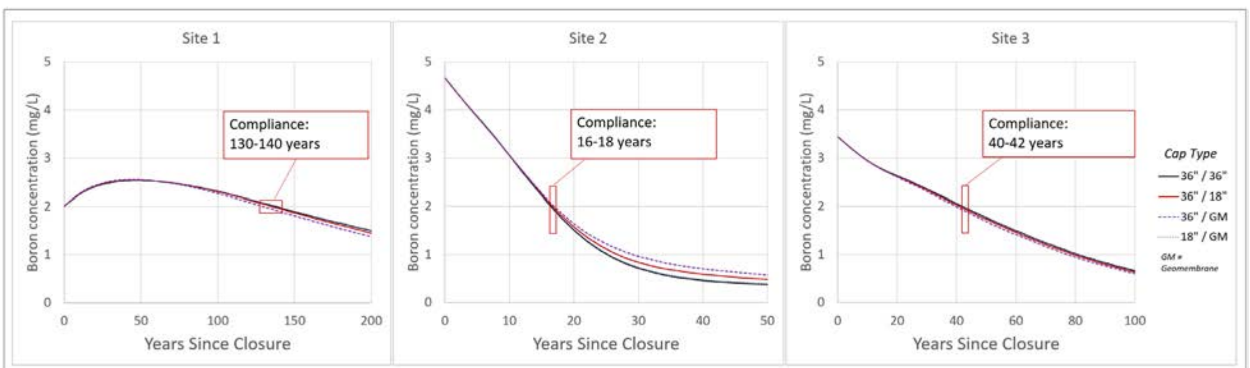
162. Why did the HELP model evaluations discussed on page 34 assume a 1% slope?

<u>RESPONSE:</u> A nominal 1% slope was selected as a conservative flatslope. Although flatter slopes could be considered based on the type of drainage systems and materials used, 1% is generally a reasonable minimal slope used to support adequate surface drainage. By using this flatter slope, it simulates a situation which has less runoff thereby creating more infiltration.

163. Was any HELP modeling of the cap conducted based on slopes up to a 5% grade, as allowed by proposed Part 845.750 under certain conditions?

<u>RESPONSE:</u> No. As mentioned previously, a 1% slope is a more conservative analysis. In the HELP model, the slope is only used to support the determination of the runoff curve number. The HELP model can be used to compute a runoff curve number by using the slope, slope length, soil texture, and vegetation type. This calculation estimates the amount of runoff removed from the system, and a flatter slope with comparable soils would produce less runoff and more infiltration.

As shown below in model simulations based on the Sites described in my testimony, using a 1% slope in the HELP model for the cap and cover configurations proposed by Mr. Bonaparte with their correspondent infiltration values have little effect on the time to reach the GWPS for boron relative the cap and cover configurations proposed by IEPA in Section 845.750.



The variation in infiltration rates between these cap and cover designs has no more than a 10% effect on the time required to reach compliance. Given the granularity of the model, and the fact that the different cap designs may have some variation in construction time, these are not significant differences.

164. Does the slope grade affect the volume of precipitation that filters through the cover system? If so, please explain.

<u>**RESPONSE:**</u> **As previously discussed, in the HELP model a steeper slope would generally increase runoff and reduce infiltration.**

165. Did the HELP model evaluation of different protective soil layer thicknesses take into account varying weather conditions (i.e., winter versus spring or summer)?

<u>**RESPONSE:**</u> **The HELP model is not a tool to evaluate individual storm events or weather conditions and has been used to evaluate infiltration for more than 35 years – it is the industry standard. The HELP model uses weather data to evaluate evapotranspiration, precipitation, temperature, and solar radiation data. This evaluation allows the user to either select default precipitation data by city (in Illinois, the cities already in the system are Chicago and East St. Louis), or the user can provide synthetic climate data. The climate data are derived from NOAA documentation. The model uses precipitation, surface snow, snowmelt, wind, temperature, and solar radiation data to generate the overall climate data used for the duration of the model run. The model can be simulated between 1 to 100 years.**

166. On page 34 of your testimony, you state that the models assumed "a material below the geomembrane exhibiting a permeability matching or greater than that of the cover soil . . . . If the permeability of the material below the geomembrane was lower than the cover soil, the expected percolation would be less than the results provided in this table." Were any HELP model runs completed that included an assumption that the material below the geomembrane had a permeability lower than the cover soil? If so, please discuss the results.

<u>**RESPONSE:**</u> **The modeled scenarios where the materials underlying the geomembrane are a higher permeability than the cover soils above the geomembrane produce higher infiltration rates as provided in the testimony as compared to underlying soils with a lower permeability than the cover soils. For an identical model run of Scenario GM-1 as presented, when a lower permeability soil underlying the geomembrane is used instead, the reduction in infiltration improves from 85.2% to 91.9%.**

CERTIFICATE OF SERVICE

I, the undersigned, certify that on this 24th day of September, 2020, I have electronically served the attached **Prefiled Responses of David Hagen**, upon all parties on the attached service list. I further certify that my email address is rgranholm@schiffhardin.com; the number of pages in the email transmission is 58; and the email transmission took place today before 5:00 p.m.

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