BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)
	)
STANDARDS FOR THE DISPOSAL OF	) R 20-19
COAL COMBUSTION RESIDUALS IN	) (Rulemaking – Land)
SURFACE IMPOUNDMENTS: PROPOSED	)
NEW 35 ILL. ADM. CODE 845	)
	)
	)

NOTICE OF ELECTRONIC FILING

To: Attached Service List

PLEASE TAKE NOTICE that on September 24, 2020, I electronically filed with the Clerk of the Illinois Pollution Control Board ("Board") the **PREFILED ANSWERS OF IAN MAGRUDER AND SCOTT PAYNE** and **ATTACHMENTS**, copies of which are served on you along with this notice.

Dated: September 24, 2020

Respectfully Submitted,

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PREFILED ANSWERS OF IAN MAGRUDER AND SCOTT PAYNE

Questions from the Illinois Pollution Control Board

12. The figures listed in your prefiled testimony goes from Figure 1 to Figure 3. Please clarify if Figure 2 is missing or the numbering is due to a typographical oversight.

Response: The numbering is due to a typographical oversight.

13. On pages 32 and 36, you recommend that the Board require IEPA to develop model review guidance or a model review checklist specific to modeling Illinois CCR facilities to ensure the appropriate development and use of groundwater contaminant transport ("GCT") models.

a. Please comment on whether you are aware of other Board regulations such as the nonhazardous landfill rules under 35 Ill. Adm. Code 811 that allow the regulated entities the flexibility to use GCT models of their choice as long as the regulatory criteria are met. See 35 Ill. Adm. Code 811.317(c).

Response: Yes, we are familiar with 35 Ill. Adm. Code 811. We agree that regulated entities should have the flexibility to use GCT models of their choice as long as the regulatory criteria are met.

b. If so, comment on whether it would be preferable to specify GCT model performance criteria in the rules rather than require the Agency to develop Illinois-specific guidance document? In this regard, clarify whether the proposed amendments to Sections 845.220 and 845.620 sufficiently address the regulatory criteria for GCT modeling.

Response: We do not recommend specifying model performance, i.e. residual error or calibration summary statistic requirements, in the rule.

Our opinion is the essential elements required for GCT modeling should be put in the rule now. Illinois-specific modeling guidance can be provided at a later date. Our opinion is that compared to providing regulatory criteria for GCT modeling

in the rule alone, an Illinois-specific guidance document could provide the public with both more clarity and more detail. The level of detail provided in a guidance document is much higher than what would be appropriate to put in rule. Additional detail and clarity provided by a guidance document would help the coal power industry to more efficiently prepare models which are adequate for IEPA to evaluate closure and corrective action regulatory criteria. Our proposed amendments to Sections 845.220 and 845.620 are intended to address what we believe should be the minimum requirements for GCT modeling.

Both Georgia Department of Natural Resources Environmental Protection Division and North Carolina Department of Environment and Natural Resources provide a modeling guidance document to provide detail on their policy. The Georgia guidance is Attachment 15 to our Joint Testimony. The North Carolina guidance is Attachment 1 to this document.

c. Also, please submit a typical model review checklist that addresses the types of information that must be included in a modeling report submitted for the Agency's review.

Response: See Attachment 2. We are not proposing that this exact checklist be used by IEPA as it may contain details that are not relevant to modeling of CCR facilities. We recommend IEPA develop their own state guidance for modeling but the agency could consider developing a checklist if the agency deems a checklist satisfactory or useful as an interim substitute for a guidance document.

This particular checklist was developed by the Australian Government National Water Commission and we are providing it as an example because we know of no U.S. checklist. The checklist is intended to outline industry best practices, assist model review, but is not regulation or law. We recommend that Illinois develop a guidance document such as discussed under question 13 b. A checklist is another option if resources or time are limited for developing a guidance document.

Questions from Illinois EPA

1. On page 6 of your testimony, you state that the HELP model is not meant to be applied when groundwater is in contact with the bottom of the CCR unit.

    a. What model would you use instead of HELP where groundwater is in contact with the bottom of the surface impoundment? Is there another model available? How would you model this?

    Response: There are a number of models available to perform this. The National Research Council provides a review of models applicable to predicting percolation through waste containment covers. (National Research Council. 2007. *Assessment of the Performance of Engineered Waste Containment Barriers*.

Washington, DC: The National Academies Press.) The NRC Report is provided as Attachment 3. Section 5.2.3 of the NRC Report evaluates model suitability for modeling waste containment cover system performance and percolation rates. The NRC assessment indicates that unsaturated flow models that are based on Richards's equation are superior in accuracy to HELP. Richards's equation solves unsaturated flow such as percolation through the unsaturated portion of a CCR impoundment. All of the models in Table 5.4 of the 2007 NRC Report with the exception of HELP employ Richard's equation.

HELP may be sufficient if it is combined with a model that can accurately predict the effects of groundwater contact with CCR in the waste unit. The Pre-Filed Testimony of Andrew Bittner, P.E. for the current IPCB case shows one possible way to use HELP in combination with MODFLOW for modeling groundwater contact with a CCR impoundment. Mr. Bittner uses HELP to model percolation through the CCR cap/cover system only and uses a constant-concentration boundary in MODFLOW-MT3DMS to model groundwater leaching of CCR.

If we were to model this, we would use one of the models from Table 5.4 of NRC (2007) to model percolation through the cap/cover system and use a saturated groundwater flow model with a constant-concentration boundary to model advective groundwater flow and leaching of CCR in contact with groundwater. This technique would also agree with the recommendations for using HELP to model an impoundment in contact with groundwater made to us by USEPA's Center for Environmental Solutions and Emergency Response, the organization that maintains the HELP model (*see* Attachment 28 to Joint Testimony of Scott M. Payne and Ian Magruder (Aug. 27, 2020)).

b. Isn't it true that you can change the designation of the layer at the bottom of the model in a HELP model from a vertical drainage layer?

Response: Assuming you mean "vertical percolation layer," this is correct. For instance, in the hydrostatic modeling reports prepared for the closure plans for three sites in Illinois that we reviewed (Hennepin Power Station in Putnam County, Meredosia Power Station in Morgan County, and Wood River Power Station in Madison County), they use a barrier soil liner as the bottom layer in the HELP models used to simulate unlined impoundments. A barrier soil liner also assumes a free draining condition. Changing the vertical percolation layer in the HELP model by itself does not allow for accurately modeling ash in contact with groundwater. Both a vertical percolation layer and a barrier soil liner can be used to simulate vertical percolation from the bottom of the waste unit. However, when used for modeling percolation rates from the bottom of the waste unit, as was done in the Hennepin, Meredosia, and Wood River hydrostatic reports, the model assumes a free draining condition exists at the bottom of the landfill at all times. The free draining condition assumption is violated if groundwater contacts the waste unit at all. That is why those models do not conceptually match the environment of the CCR impoundment.

When used to simulate CCR impoundments, the vertical leachate percolation modeled using HELP is commonly used as the input for the flux boundary used to simulate the impoundment in the groundwater flow model for the site. If HELP is used to simulate vertical percolation, it should be used to model the portion of the CCR impoundment where free draining conditions exist (Attachment 28 to Joint Testimony of Scott M. Payne and Ian Magruder (Aug. 27, 2020)). Free draining conditions can generally be assumed at the cover system/cap. Free draining conditions do not exist at the bottom of an impoundment that is in contact with groundwater.

2. Regarding page 9 of your testimony, are there exceptions to your statement that all groundwater elevation data available at a site should be used as calibration data?

   Response: Yes, there are exceptions.

   a. If so, what? Are there ever times where you would not include all available site-specific data for groundwater elevation data for calibration?

      Response: Data may be questionable and not meet quality control criteria. It is also possible that a small number of groundwater elevation data from outside of the period of quarterly or more frequent data collected during site characterization would not be used because modeling a time period with limited data would not improve model calibration or performance.

      Our point is all groundwater elevation data should be included in the hydrogeologic characterization reports and evaluated for use as a calibration target. Our opinion is that having all water elevation data provided in the site characterization will help to evaluate the frequency and magnitude of groundwater contact with CCR and will help with development of the site conceptual model. If data are questionable it should be flagged as such. If data are not used for model calibration its exclusion should be explained in the modeling report. Our proposed amendment to Sections 845.220 (c)(2)(C) and 845.220 (d)(3)(C) is worded “Pre-defined calibration targets which *consider* the entirety of available Hydrogeologic Site Characterization data required in 845.620” (emphasis added). We use the word “consider” so that available data are evaluated for use as calibration targets, but data may be excluded from calibration if there is a valid reason to do so.

   b. Do you look at the age or construction of the well?

      Response: Yes. It is reasonable to consider the age and construction of a well in determining if data from the well meets data quality objectives and is appropriate to use as a calibration target.

3. Have you experienced issues with the accuracy of groundwater elevation data that may be available for a particular site, such as:

a. Long periods of missing groundwater elevation data?

Response: Yes.

b. Wells that have been abandoned?

Response: Yes.

c. Wells that have been added?

Response: Yes.

d. Wells with inaccurate location data, or missing well log data?

Response: Yes.

4. On Page 13 of your testimony, you state that CCR should be sampled by installing piezometers in saturated impoundments.

a. Are there practical or technical complexities associated with installing piezometers within a surface impoundment?

Response: Yes, there may be.

b. If so, please describe.

Response: Accessing the impoundment with boring or direct-push equipment may be impossible if the CCR near the surface is not dry enough. Our expectation is that if the equipment necessary to complete closure construction can access the impoundment then it is likely that boring or direct-push equipment can access the site. Our opinion is that actual porewater measurements will provide the most accurate data on current leachate concentrations and this data should be taken if possible.

We indicate in our Joint Testimony Comment e. that leachate testing of CCR using appropriate leaching test methods should be allowed as an alternative to direct sampling using piezometers. (Joint Testimony of Scott M. Payne and Ian Magruder, p. 13 (Aug. 27, 2020) [hereinafter "Joint Testimony"]). Our proposed amendment to Section 845.620(b)(13) which states "Statistically supportable data for CCR leachate concentration measured from porewater in each CCR impoundment" could be edited to clarify that leachate testing of representative CCR samples from the impoundment can be used to determine leachate concentration. (*Id.*).

What is not acceptable in our opinion is basing a GCT model contaminant source concentration on a guess, or on published values from a completely unrelated coal ash site, when other methods of site specific testing are possible.

5. On page 16, you testify that not using attenuation is not as conservative for the outcome of the model.

    a. When you say conservative, do you mean the results using attenuation will be higher concentrations?

    Response: Results using attenuation will have potentially higher concentrations at later times, depending on other aspects of the modeled setting. If the contaminant is attenuated and is modeled as such, the model with attenuation could predict that water quality standards are not achieved in within a certain time frame, while a model without attenuation could show standards being met during that time frame.

    b. If not, but results show cleanup may take longer, is not using attenuation conservative in a different way as it results in higher concentrations?

    Response: We do not agree. If the contaminant is attenuated it should be modeled as such. The goal of GCT modeling should be to have an accurate depiction of actual contaminant transport. If attenuation was arbitrarily left out of the model, other model parameters may be adjusted during calibration to values which are not representative of the actual site conditions, because the modeler is attempting to match the higher modeled concentration to site sampling data. This could lead to a cascading loss of model accuracy because attenuation was not included.

6. You suggest that daily water levels should be required in at least one well upgradient, down-gradient and within the impoundment.

    a. Is this common? Have you required this at all sites you have worked on?

    Response: Our recommendation does not include daily water level data within the impoundment. We propose that Section 845.620(b)(17)(A) include the language: "Water table depth recorded at least daily in one monitoring well upgradient and one downgradient of the CCR impoundment." (Joint Testimony, p. 40). We recommend this because upgradient and downgradient wells typically exist to comply with 40 CFR § 257.91(c)(1). Upgradient and downgradient wells also typically exist because they are needed to determine groundwater flow direction at the impoundment and those data are needed for an accurate site hydrogeologic characterization.

    Daily water levels at one upgradient and one downgradient well will allow evaluation of hydraulic connection between the CCR in the impoundment and

groundwater and thereby aid in developing the site conceptual model and understanding of contaminant release. Instrumenting the existing wells with automatic digital pressure transducers will allow the site characterization to gain significantly better understanding of site conditions.

Daily water level data are common. We employ digital pressure transducers in many of our groundwater monitoring projects and it is an industry standard practice when frequent water level data are needed for site characterization. We have not used this at all sites we have worked on, however.

b. Does MODFLOW allow for daily fluctuations in river elevations in input? If so, how would that be done? SFP

Response: Yes, MODFLOW does allow for daily fluctuations in river elevation input if the model stress periods are set up as such. However, daily stress periods are not common. It is common for boundary conditions such as river elevations to be averaged or interpolated over the course of a stress period, which may be several days, weeks, or longer depending on the modeling objective. The modeling objective at a CCR facility should be to simulate those processes which affect CCR leaching to groundwater. Where river elevations affect CCR leaching, the model stress periods should be set up to simulate such.

c. You have stated that models need to be calibrated to all groundwater data available.

   i) Is it possible to calibrate to daily groundwater elevation data available in a transient model over weeks? Months? Years? Decades?

   Response: We do not propose that models need to be calibrated to all groundwater data. Our proposed amendment to Sections 845.220 (c)(2)(C) and 845.220 (d)(3)(C) is worded "Pre-defined calibration targets which *consider* the entirety of available Hydrogeologic Site Characterization data required in 845.620" (Joint Testimony, pp. 35, 37) (emphasis added). We use the word "consider" so that available data are evaluated for use as calibration targets, but data may be excluded from calibration if there is a valid reason to do so. See our response to Question #2 for further response regarding when we believe it may be appropriate to exclude groundwater data from model calibration. To this end, the modeler has a responsibility to describe why selected data are used for calibration and other data are excluded. The modeling report must support why the dataset used represents the groundwater system and the observed variation in, for example, groundwater flow direction.

   Yes, it is possible to calibrate to daily groundwater elevation data in a transient model over weeks, months, years, or decades.

ii) How do you input and include daily water levels into a MODFLOW model, for calibrating to the groundwater elevation of a well? Have you done this?

Response: The calibration data may need to be averaged or interpolated for the model stress periods. Data can be digitally averaged and translated to the model stress periods using a spreadsheet. Yes, we have done this; it is a reasonable exercise.

7. You suggest that Part 845 should require site specific data to be used when modeling groundwater.

a. How would you handle the model boundary or other data for the model that is potentially located off-site?

Response: Assuming the question is asking how we would handle data for points located off-site, we would look for off-site data such as well logs with water levels, or monitoring data from various agencies or academia. We would attempt to gain access to wells for monitoring. While a private property owner may not allow access to install a monitoring well, road easements owned by local municipality or county often provide a substitute location to install monitoring wells. The entity responsible for the model must attempt all reasonable alternatives vs. simply suggesting that no data are needed.

We may use a known physical entity for the model boundary such as a river, lake, or aquifer boundary (e.g. no-flow boundary). If those types of off-site data are not available, as a last resort we may use topography and an understanding of typical depth to groundwater to designate a constant head boundary. The point of our testimony is that boundary conditions which significantly affect model predictions should not be assigned with no supporting information.

b. Are there limitations on obtaining site specific data if, for instance, boundary conditions are two miles off-site?

Response: Yes, there are potential limitations.

c. How would you obtain the data?

Response: See response to 7.a.

i) How would you obtain the data for the model if you don’t have access to the neighboring property?

Response: See response to 7.a.

ii) Would you potentially be limited to publicly available data?

Response: Yes, potentially.

8. You recommend a number of additions to the hydrogeologic site characterization requirements in Section 845.620.

a. To what extent are the hydraulic characteristics on each geologic layer, each soil and each fill layer needed?

Response: The 100-foot depth, which is stated in the Agency's draft rule language at Section 845.620(b)(13) "Vertical and horizontal extent of the geologic layers to a minimum depth of 100 feet below land surface, including lithology and stratigraphy" and (15) "Chemical and physical properties of the geologic layers to a minimum depth of 100 feet below land surface," is likely a sufficient extent for evaluating the hydraulic characteristics of geologic layers, soil, or fill which significantly affect groundwater flow or contaminant transport.

We agree with that language and have retained it in our proposal. In addition to the term "geologic layers", we include soil and fill because geologic layers can be interpreted to mean only native geology. Soil and fill may also host groundwater and affect groundwater flow and thereby contaminant transport.

i) Will contaminants from an impoundment flow through the soil layers at the site?

Response: Possibly. Some people may also interpret soil to mean unconsolidated sediments. Groundwater commonly flows through unconsolidated sediments and impoundments are commonly constructed on top of unconsolidated sediments.

ii) Is there professional judgment involved to identify where this data is necessary?

Response: Yes, professional judgment should be used. The rule should also provide minimum requirements for hydrogeologic site characterization such as the 100-foot deep level that the draft rule language includes for describing the chemical and physical properties of geologic layers.

b. To what extent is the modeled or measured CCR impoundment percolation rates needed to properly close each CCR surface impoundment?

Response: Modeled or measured CCR impoundment percolation rates are needed to calibrate the GCT model to existing conditions and for accurate model predictions of closure or corrective action alternatives. If the site has an

exceedance of groundwater quality standards, then having accurately modeled or measured CCR impoundment percolation rates are very important to understanding if a closure or corrective action option will achieve water quality standards and how long it will take.

i) Is there professional judgment involved which can be utilized to identify when this data is necessary?

Response: Yes, professional judgment should be used.

c. To what extent is the measurement of CCR separation from groundwater, including daily groundwater elevation measurements and evaluation of separation due to seasonal variation needed to properly close a CCR surface impoundment?

Response: Understanding the frequency and magnitude of groundwater contact with CCR is critical to the ability to evaluate appropriate closure options. Site characterization should characterize CCR separation from groundwater and having daily groundwater elevation measurements will greatly improve this characterization. Quarterly groundwater elevation measurements often completely miss the river flooding events which lead to groundwater inundating the impoundment or reversal of groundwater flow; this is discussed further in our testimony and examples are given there. Monthly water level measurements can also miss these events. We have reviewed examples in Illinois where routine, quarterly water elevation monitoring was not performed because the wells were apparently inaccessible because they were under floodwater. This indicates that utilities may be less likely to monitor water elevation during the flood events which are so important for site characterization. Instrumenting wells with digital pressure transducers will provide a much more consistent and detailed dataset.

There are a number of considerations for how daily water elevation data will assist in evaluating the appropriate closure options for site. All three of the sites we reviewed in Illinois experience regular river flooding events that cause groundwater flow to reverse direction and/or to contact CCR in impoundments. It is essential to understand the effects of these events because they have important implications for closure and corrective action needs, such as but not limited to the following:

1. Choosing appropriate locations for background monitoring wells and therefore characterizing the source of contamination.

2. Evaluating potential impacts to offsite wells and water supplies.

3. Evaluating if capping an impoundment will rectify water quality impairment.

4. Adequate calibration of groundwater models should be informed by a complete understanding of transient groundwater flow and contaminant transport.

ii) Is there professional judgment involved which can be utilized to identify when this data is necessary?

Response: The water elevation data should be collected, and then professional judgment can be used to determine how the data affect closure decisions. It is necessary to have the data in the first place to make these decisions.

Questions from MWG

1. Identify prior projects you have worked on for any federal or state environmental agency regarding the development of rules or regulations of general applicability that applied to coal combustion residuals ("CCR") as that term is defined Section 3.142 of the Illinois Environmental Protection Act ("Act").

Response by Dr. Payne: I have worked on the development of federal environmental policy and guidance for the Navy. Under Executive Order 12580, the President in 1987 gave the military, including the Navy, lead agency authority under CERCLA. As the lead agency, the Navy was directly responsible for meeting water quality and soil cleanup standards on military bases and adjoining impacted land. The order takes EPA CERCLA authority and transfers it to the Navy. The Navy is in the position of lead authority to characterize, cleanup, and make decisions related to hazardous contaminants released on military bases. I worked closely with former EPA staffers that wrote the National Oil and Hazardous Substances Pollution Contingency Plan ("NCP"). Other expert staff, the former EPA staffers, and I worked under two $250,000,000 Navy CLEAN contracts which involved work at dozens of military sites. Our job was to help the Navy meet the goals of CERCLA as lead agency. At the time, I was employed by PRC Environmental Management, Inc. ("EMI") (now Tetra Tech) and served as a program manager. Our work included not only cleaning up contaminated military bases, but also helping the Navy assume a lead agency authority through development of policy and guidance that meet the requirements of the NCP and CERCLA. My involvement also led me to write Records of Decisions ("ROD") for military bases, removal actions memoranda (decision document for removal actions), linking RCRA CAMUs to cleanup on bases, presenting and demonstrating cleanup actions, etc. Eventually the experience led me to write my book *Accelerating Cleanup at Toxic Waste Sites*.[1] The military bases were typically mixed waste sites with metals, petroleum, organic compounds, and just about every type of contamination imaginable that impacted large swaths of land and water. Generally speaking, these sites were more complex and toxic than CCR sites. The experience provided me with an understanding for developing rules, regulations, policy, and guidance at toxic waste sites. Some of the contaminants in groundwater and soil I worked

[1] Payne, SM. 1997. Strategies for Accelerating Cleanup at Toxic Waste Sites. Fast-Tracking Environmental Actions and Decision Making, CRC Press.

on at military bases, such as arsenic, are common to CCR. Additionally, CERCLA has been applied to CCR releases and as such has general applicability to coal combustion residuals.

2. Identify any prior projects which you have worked on for an industrial facility in the past 10 years that involved CCR as that term is defined in the Act and describe the work conducted. Of those projects, identify any in Illinois.

   Response:

   - Colstrip Steam Electric Station Units 1 & 2 Stage I and II Evaporation Ponds: Review Remedy Evaluation Reports and Groundwater Modeling Reports, provide technical comments and model review, develop and cost alternative remedy alternatives.

   - Colstrip Steam Electric Station Plant Site: Review Remedy Evaluation Reports and Groundwater Modeling Reports, develop and cost alternative remedy alternatives.

   - Colstrip Steam Electric Station Units 3 & 4 Effluent Holding Pond (EHP): Review Remedy Evaluation Reports and Groundwater Modeling Reports, provide technical comments and model review, develop and cost alternative remedy alternatives.

   - Michigan City Generating Station: Review Closure Plan and RCRA Facility Investigation Report, provide technical comments.

   We have significant additional experience relevant to groundwater modeling and contaminant transport modeling performed for industrial clients and facilities. These are not CCR facilities although there is significant overlap in the contaminants present and modeling techniques required.

   - East Helena Smelter Arsenic Transport Model: Dr. Payne developed a groundwater flow and solute transport model for a lead smelter Superfund site, located in East Helena, Montana. Dr. Payne was responsible for simulating groundwater flow conditions and surface water interaction over a 6-square mile area, predicting arsenic concentration and transport over a 500-year period. As part of remedial design, Dr. Payne conducted additional computer modeling that included simulating drawdown from proposed recovery wells installed at the plant site and resultant arsenic recovery.

   - Burlington Northern Paradise RCRA site model review: For a private client, Dr. Payne reviewed a MODFLOW groundwater flow and a BIO1D solute transport model for the BN Paradise site. A groundwater control zone was proposed for the site, and Dr. Payne reviewed the proposal for completeness and technical merit on how it would affect adjacent properties.

- Superfund Technical Assistance model review: Dr. Payne and Mr. Magruder provide technical oversight of cleanup plans under an EPA grant for wood treatment chemicals at the Montana Pole Superfund Site and mining contaminants at the Silver Bow Creek Butte Area Superfund Site which is the largest Superfund complex in the U.S. They review groundwater and solute transport models, groundwater contamination, and Superfund remediation plans, and meet with EPA and responsible parties to encourage improved ways to cleanup groundwater.

- Technical review of mine expansion EIS and drawdown modeling: Working on behalf of an agricultural producer, Dr. Payne reviewed an EIS and supporting groundwater modeling report. The producer was experiencing reduced water flow from springs on their property used for stock water. Dr. Payne reviewed the hydrogeologic data in the EIS and groundwater modeling results used to predict groundwater flow impacts from increased mine dewatering pumping rates. In his review he found that the model was inappropriate for evaluating impacts to the producer's springs due to issues with model set up and assumptions made by the EIS team.

- Hardrock mine drawdown modeling: Metal mining often involves pumping and treating large quantities of groundwater to allow mining below ground. Working for several mining companies, Mr. Magruder provided transient MODFLOW simulations to evaluate mine dewatering requirements and to predict water table decline. The results were used to plan for replacement of private well water supplies. He managed field data collection for these projects to provide high quality data for the models, including water level measurement in wells, aquifer testing, geologic mapping, and streamflow measurement of groundwater interaction.

- Mine discharge modeling: Mr. Magruder has provided groundwater modeling services for several mining clients to evaluate discharge disposal alternatives for treated mine water. He used MODFLOW models to assess the aquifer capacity to accept discharge water and to transport and dilute elevated nitrates in the water resulting from blasting activities. He prepared soil and plant water balance models to evaluate land application evapotranspiration capacity of discharge water.

3. Identify the scope of any work you have been requested to perform on behalf of the clients you are representing here today, including any work related to any coal-fired generating stations.

   Response:

   - Michigan City Generating Station: Review Closure Plan and RCRA Facility Investigation Report, provide technical comments for Indiana Department of Environmental Management.

- IPCB Rulemaking: Standards for the Disposal of Coal Combustion Residuals in Surface Impoundments: Proposed New 35 Ill. Admin. Code 845. Review existing Closure Plan documentation including hydrogeologic site characterization, CCR impoundment leachate percolation and hydrostatic models, groundwater modeling, and IEPA response to comments at the Hennepin Power Station, Meredosia Power Station, and Wood River Power Station. Provide technical comments, review draft rule, develop testimony and recommended rule language.

4. On p. 32 of your testimony, you state that natural resource agencies and geologic surveys and researchers at nearby colleges and universities often have the most accurate site-specific data. Are you suggesting that consultants do not use that data?

   Response: We are not suggesting that at all. We are suggesting that the expertise of natural resource agencies, geologic surveys, and researchers can best be incorporated into the closure and corrective action modeling process through a robust public involvement process. We are suggesting that modeling documentation should sufficiently describe the model development and application process such that members of the public can understand the data that was used, why it was used, and the modeling result. We are suggesting that the public should have direct access, via the documents being posted on the internet, to the entire record of the modeling documentation.

5. Assuming you are suggesting that consultants do not use that data, what is your basis to state that consultants working at CCR surface impoundments do not use natural resource agencies data and geologic surveys?

   Response: We are not suggesting that consultants do not use that data.

6. On p. 32 of your testimony, you state that "Consultants who work for coal plant owner/operators may be from out-of-state and lack this site-specific knowledge." Please confirm that you are located in Montana.

   Response: We are located in Montana.

Questions from CWLP

1. How many samples of water within different horizontal and vertical locations of a CCR impoundment do you believe would be adequate for development of model assumptions?

   Response: A minimum of eight independent samples should be taken to provide an adequate characterization of CCR porewater concentration to be consistent with the groundwater monitoring requirements in Section 845.650(b). Samples should be taken from locations near the bottom of the impoundment to be representative of leachate that is percolating downwards.

2. Are you requiring "at least" daily groundwater elevation measurements upgradient and downgradient at every site in order to develop a site characterization? How long must this type of monitoring be implemented for before a characterization can begin?

   Response: The daily groundwater elevation measurements should begin with the Hydrogeologic Site Characterization required for permits pursuant to Sections 845.220 and 845.230 or groundwater monitoring required pursuant to Section 845.610. The Hydrogeologic Site Characterization should be submitted on any timeline required for permits pursuant to Sections 845.220 and 845.230 or groundwater monitoring required pursuant to Section 845.610. The daily groundwater level measurements at one monitoring well upgradient and one downgradient of the CCR impoundment should continue for the life of the Groundwater Monitoring Program.

3. What is the difference in your proposed Section 845.220(c)(2)(B) between "estimates informed by site characterization data" which are allowed and "assumptions" which are not allowed?

   Response: Simply put "assumptions" are not directly supported by data. For example, at locations near the site, boundaries can be designated based upon data in the Hydrogeologic Site Characterization. We understand that data may be limited for off-site locations. The modeling report should document the data that are available for designating boundaries located off-site and how data are integrated into the modeling process. It is unacceptable for boundary conditions to be designated with no supporting information in the model report. For additional discussion relevant to what are appropriate modeling assumptions that is not specific to our proposed language at 845.220(c)(2)(B), refer to answer to Dynegy 8(c).

4. Is the intent of Section 845.220(c)(2)(C) to make sure calibration targets are defined before modelling and not during modelling? If not, explain the intent of this Section. If so, explain how this will be documented or enforced.

   Response: Yes, establishing calibration targets ahead of time is the intent of this section. Calibration targets can be defined before modeling. The intent is also to ensure that calibration targets be logically connected to the Hydrogeologic Site Characterization data and include head and flux targets.

   The modeling report should document calibration targets, the source of the calibration targets, and calibration performance including whether these targets were met, and the adjustments that had to be made to complete the modeling. We do not anticipate this will require enforcement; it will be a self-implementing requirement. This is not a new concept and is used in other regulatory settings, such as Superfund. It is an industry best practice that the CCR modeler should be following. We encourage IEPA to develop guidance to supplement the rules as a way to help modelers less familiar with industry best practices come up to speed before submitting reports for review.

5. Explain the difference between "calculated" leachate flux and "modeled" leachate flux in proposed Section 845.220(c)(2)(F). Is this different than "statistically supportable data for CCR leachate concentration measured from porewater" in proposed Section 845.620(b)(13)?

   Response: The leachate flux, which is the flow rate of the leachate produced in an impoundment, can be based upon manual calculations, if appropriate methods exist for a site, or derived using a modeling application as was done using HELP at the three sites in Illinois we reviewed. Leachate flux is different than "statistically supportable data for CCR leachate concentration measured from porewater" in proposed Section 845.620(b)(13) because leachate flux is a flow, not a concentration. The statistically supportable data for CCR leachate concentration is used to provide data for modeling source concentration.

6. In the proposed rule changes included in your testimony, you recommend the Board require certain sites to perform a "model forecast uncertainty analysis". When would it be determined which sites must perform this analysis? Who would determine? How long will the analysis take?

   Response: This would be determined during the modeling effort performed for Corrective Action Construction permits or Closure Construction permits. The CCR facility owner/operator has the opportunity to identify if contaminants derived from CCR at the facility present a potential risk to human health and drinking water supplies based on existing water quality sampling or the site conceptual model they develop. IEPA would have discretion to approve of that analysis or provide their own. The analysis would rely upon existing information including water quality sampling and the site conceptual model developed for the Section 845.620 Hydrogeologic Site Characterization. Therefore, new information is not required and the analysis should not require significant extra time. Model forecast uncertainty analysis is one part of the industry best practices which we recommend be integrated into the proposed rules.[2] (Joint Testimony, p. 30).

7. Is the list of modeling documentation provided in your new subsection 845.220(c)(2)(H) an exhaustive list of precisely the modeling documentation that must be provided or is this a list of examples of the type of information that should be provided?

   Response: The list of modeling documentation provided in our new Subsection 845.220(c)(2)(H) are specific requirements for documentation in the modeling report, which are in addition to the requirements specified in Sections A through G, I, and J of this section. It is not a list of examples of the type of information provided. We expect that all of the modeling requirements in Sections 845.220(c)(2)(A) through (J) to be documented in the modeling report. This is not an exhaustive list of what should be

[2] *See, e.g.*, Anderson, M.P., Woessner, W.W., and Hunt, R.J., 2015, Forecasting and Uncertainty Analysis, chap. 10 *of* Applied Groundwater Modeling. 2nd ed. Elsevier Press (textbook, not provided as attachment).

covered in a modeling report, but it does provide specific requirements that are essential to document.

Questions from Dynegy

1. Did IEPA review each of the hydrogeologic characterization reports and groundwater models you discussed in the "Problem Statement" of your testimony?

   Response: It is our understanding that IEPA reviewed these reports, but we do not have personal knowledge of the depth of IEPA review.

2. Did IEPA approve the CCR surface impoundment closures associated with the hydrogeologic characterization reports and groundwater models you discussed in the "Problem Statement" of your testimony?

   Response: Yes, that is our understanding.

3. Were the groundwater models submitted to the Agency for Hennepin East Ash Pond No. 2, Meredosia, and Wood River sufficient for IEPA to properly evaluate the proposed closures of the CCR surface impoundments?

   Response: We are unaware if the modeling files are available for our review. We also do not know if IEPA made their decision based on the modeling files (i.e. the model) or based on the modeling documentation. The modeling reports prepared in support of those models indicate serious deficiencies in the modeling approach and calibration. The model reports should describe the model such that a reviewer can determine how the site was modeled without needing to use the modeling files.

4. Is the groundwater modeling required by proposed Part 845, as currently drafted, sufficient to evaluate how long it will take each proposed closure to achieve the groundwater protection standards?

   Response: No. Our review of the modeling documentation prepared for Hennepin, Meredosia, and Wood River indicates it is not sufficient for regulations to only require that modeling be done. The modeling reports prepared in support of those models indicate serious deficiencies in the modeling approach and calibration when regulatory requirements for modeling are not specific. We recommend that minimum modeling requirements be specified in the rule.

5. Is the groundwater modeling required by proposed Part 845, as currently drafted, sufficient to evaluate whether a groundwater corrective action will achieve compliance with the proposed groundwater protection standards?

   Response: No. See our response to Question #2.

6. Does IEPA have experience reviewing groundwater models?

   Response: Yes. We do not question IEPA's experience reviewing models.

7. Is it common for groundwater models to be revised in response to comments from regulatory agencies, such as IEPA?

   Response: Yes. But the process of IEPA model review will be more efficient if models meet basic standards to begin with. IEPA has limited resources to review models. It should not be IEPA's job to dictate basic modeling practices and industry standards in their review comments. Models and modeling reports should come in the door with a basic level of adequacy that is missing from the models prepared for the three sites we reviewed.

   Additionally, without regulatory criteria which requires modeling to be performed appropriately, IEPA has limited authority to force owner/operators to improve model accuracy. In the May 2, 2019 IEPA comments regarding the Hennepin model, Comment #12 indicates that IEPA requested that the model should be better calibrated, meeting a calibration performance of 10% or less standard deviation to the data mean. (Letter from IEPA, Comments on Hennepin Closure/Post-Closure Plan (May 2, 2019), Attachment 4). In their July 22, 2019 response Dynegy states, "Additional calibration beyond river elevation inputs would be required to whittle down the calibration statistics from 13.2% to 10% to meet the recommended criteria." (Letter from Dynegy, Response to IEPA Comments, p. 7 (July 22, 2019) [hereinafter "Dynegy Response"], Excerpt provided as Attachment 5). In the response, Dynegy provides information explaining that they see the model as adequate, but refuses to attempt further model refinement and calibration. We discuss in our response to Question 20 that we interpret the data presented in Dynegy's response to indicate that the model could not meet the 10% calibration target because the model did not incorporate the effects of river stage on groundwater elevation. IEPA was apparently unable to get Dynegy to include variable river stage in the model even though the site characterization data clearly shows that river stage can reverse groundwater flow.

8. Is it possible to construct a groundwater model without making any assumptions?

   Response: No, it is not.

   a. Have you ever constructed a groundwater model that contained no assumptions?

      Response: No, we have not.

   b. Have you ever reviewed a groundwater model used for a site cleanup, remediation, or closure that contained no assumptions?

      Response: No, we have not.

c. If a groundwater model contains assumptions, how should one determine which assumptions are acceptable and which are not?

Response: Modeling assumptions that reasonably fit the data and site conceptual model are acceptable. Modeling assumptions that are made in place of actual data collection or hydrogeologic characterization are not acceptable.

d. Does IEPA have sufficient experience to make such a determination?

Response: Yes, we believe they do.

9. Is a groundwater model ever 100% accurate?

Response: No, 100% accuracy is unlikely. We are not proposing that models should be 100% accurate. We are proposing they should be accurate in regards to the site characterization data and site conceptual model. In addition, the models must include the basic elements that we identify in our recommended rule language. The proposed rules need to be clear and precise on what must be included in future modeling efforts so that models sufficiently simulate the temporal and spatial variation of groundwater flow and contaminant transport at CCR sites.

10. Will a comparison of post-closure sampling data with pre-closure modeling predictions provide useful information regarding the accuracy of a groundwater model?

Response: Yes. But it is not proof that the model is accurate.

11. According to page 11 of Mr. Rehn's pre-filed testimony, Attachment 21 to his testimony was presented by Mr. Rick Cobb of the Illinois Environmental Protection Agency, right?

Response: Correct.

12. Do you have any reason to question the validity of the information contained in Attachment 21 of Mr. Rehn's pre-filed testimony?

Response: No. However, we have not reviewed the underlying data discussed in Mr. Rehn's presentation and cannot say whether we would have questions about it if we performed a comprehensive review of data for those sites.

13. According to slide 2 of Attachment 21 of Mr. Rehen's [sic] pre-filed testimony, an impoundment at the Havana power station was closed in 1993, correct?

Response: Correct

14. According to slide 2 of Attachment 21 of Mr. Rehen's [sic] pre-filed testimony (Havana), the blue line is the modeled boron concentration after closure, and the green line is the observed concentration after closure, correct?

    Response: The blue line is the "predicted" boron concentration after closure, which we assume is the model-predicted concentration. The green line is the observed concentration before and after closure.

    a. Do you understand observed concentration to refer to actual groundwater sampling data?

       Response: Yes, this is the standard meaning.

    b. Do you agree that the sampling concentrations observed after closure were consistent with or lower than the concentrations predicted by the model?

       Response: No. The predicted and observed concentrations are not consistent with each other and observed concentrations are not consistently lower than predicted. The post-closure observed concentrations in Well A were typically less than predicted until 2003 after which they appear to be greater than predicted concentrations. Boron concentrations in Well A appear to have stabilized while the predicted concentration appears to have a decreasing trend. Observed concentrations in Well B are lower than the predicted concentration in all observations; but again, they are not consistent with predicted values because they are typically less than half of the predicted concentration.

       This model was sufficient to evaluate how long it would take the proposed closure to achieve the groundwater standard for boron, right?

       Response: We cannot conclude that without additional information. The slide only presents predicted and observed boron concentrations for two wells and numerous other wells are shown to be near and downgradient of the impoundment. We discuss in our testimony that groundwater flow and elevation at Illinois CCR facilities can be highly variable. Flow directions can reverse and CCR located near the water table can be inundated when groundwater is elevated. We are not familiar with the site-specific details at Havana. We do not have enough information to determine if the location and timing of the samples taken at these two wells are sufficient to determine if the Part 620 boron groundwater quality standard has been achieved throughout the site. Additionally, at these two wells the boron standard was met in the samples taken prior to closure indicating the groundwater may not have been severely impacted at the location of these two wells to begin with.

       For the two wells (Well A and Well B) presented in the slide we can conclude that the observed concentrations were lower than the Part 620 boron groundwater

quality standard prior to closure and continue to be after closure with the exception of a short term spike in 1994. We would need additional information to determine whether the post-closure boron exceedance in 1994 was related to change in groundwater flow or elevation. The site characterization information that is needed to evaluate whether groundwater elevation or flow variability caused the 1994 exceedance includes the daily water level data that we recommend to be required in the rule language we propose in our testimony at Section 845.620(b)(17)(A). With daily water level data, it would be possible to determine if periodic contact between groundwater and CCR occurs at the site. Secondary contamination in the unsaturated zone above the water table may also be released during increases in groundwater elevation, even without direct groundwater contact with the impoundment. More detailed site characterization data including daily water level data near the impoundment is needed to determine whether the post closure water quality samples were taken at appropriate times to capture any impacts from changes in groundwater elevation and flow. Without that data, we do not know if more events like the exceedance in 1994 are likely to have occurred but were missed due to sample timing.

It is also possible that a model was not needed to evaluate how long it would take the proposed closure to achieve the boron groundwater standard because the standard was met in all of the sampled observations at these two wells prior to closure. We would need to review the complete data for the site to answer whether the model was sufficient to evaluate how long it would take the proposed closure to achieve the groundwater standard for boron. Further, the model predictions appear to be a poor fit for the observed data indicating that model accuracy may be deficient and the model predictions may not be accurate.

c. This model was sufficient to evaluate whether the groundwater corrective action would achieve compliance with the groundwater standard for boron, right?

Response: We have no information on the corrective action at this site. However, if corrective action was performed we would reach the same conclusion as in c. above.

15. According to slide 3 of Attachment 21 of Mr. Rehen's [sic] pre-filed testimony the impoundment at the Venice Power Station was closed in place with a geosynthetic cap, correct?

Response: Correct.

a. According to IEPA the groundwater was intermittently intersecting with the CCR in the impoundment at Venice, right?

Response: Correct.

b. What do you understand the phrase "intermittent intersecting groundwater" as used in the slide to mean?

Response: The water table periodically rises causing groundwater to have contact with the impoundment and the CCR within the impoundment if it is unlined or poorly lined.

c. According to this slide, the yellow line represents the modeled concentration of boron and the blue line represents the observed concentration of boron, correct?

Response: Correct.

d. Do you agree that the sampling concentrations post closure were consistent with or lower than the modeled concentration?

Response: No. The predicted and observed concentrations are not consistent with each other and post closure observed concentrations are not consistently lower than predicted concentrations in wells MW-A and MW-C.

e. This model was sufficient to evaluate how long it would take the proposed closure to achieve the groundwater standard for boron, right?

Response: We cannot conclude that without additional information. For the three wells presented in the slide, well MW-A does meet the Part 620 boron groundwater quality standard in what appears to be the last year of data in 2017. Well MW-B met the boron standard with one exception prior to closure; post closure it has met the standard in every sample shown. Sampled concentration at Well MW-C has decreased and appears to have stabilized near but slightly above the boron standard.

The modeled concentrations are not a good fit for the observed data suggesting that the fact that the closure has come close to meeting water quality standards is not a reflection of the accuracy of the model.

f. This model was sufficient to evaluate whether the groundwater corrective action would achieve compliance with the groundwater standard for boron, right?

Response: We have no information on the corrective action at this site. However, if corrective action was performed we would reach the same conclusion as in e. above.

16. When performing your critique of the groundwater models in the "Problem Statement" of your testimony, did you review any post-closure groundwater sampling data to evaluate whether the models accurately predicted groundwater concentrations?

Response: We did not review post-closure groundwater sampling at the three sites for which we reviewed the closure plan models. We agree there is value in that exercise. As shown in the Havana and Venice examples discussed in question #14 and 15, the post closure sampling may show that model-predicted concentration is not consistent with post-closure sampled concentration. This would indicate the need to review whether improvements can be made to model accuracy and closure/corrective action.

17. For Hennepin East you only reviewed the 2017 groundwater model, right?

Response: See response to #18.

18. Are you aware that additional modeling for Hennepin East was performed in 2018, 2019, and 2020?

Response: We are aware of modeling performed as described in the official closure plan documents cited below:

1. Appendix C Hydrostatic Modeling Report Hennepin East Ash Pond No. 2 Hennepin, Illinois. Prepared by Natural Resource Technology for Dynegy Midwest Generation, LLC. December 20, 2017.

2. Appendix D Groundwater Model Report Hennepin East Ash Pond No. 2 Hennepin, Illinois. Prepared by Natural Resource Technology for Dynegy Midwest Generation, LLC. December 20, 2017.

3. July 22, 2019 Letter from Brian Hennings and Nicole Pagano of O'Brien & Gere Engineers, Inc. (OBG) to Phil Morris, Vistra Energy, Re: Response to EPA Comments- Closure and Post-Closure Care Plan for the Hennepin East Ash Pond No. 2, and Closure Plan Addendum Hennepin East Ash Pond No. 2 which includes closure of Ash Pond No. 4.

Appendix C and D appear to be the 2017 modeling reports. We reviewed the Appendix C and D modeling reports, not the actual model or modeling files. The July 22, 2019 Response to IEPA describes a 2 foot change to the modeled static river stage, which was performed to test and attempt to discredit the need to model transient river stage. However, the model end product remained the same. We reviewed the description of the additional modeling described in the letter, not the actual model or modeling files.

19. Did you consider whether any of the concerns raised in your pre-filed testimony were addressed in the October 25, 2018 Closure Plan Addendum for Hennepin East?

Response: Yes. The addendum indicates there was no additional modeling done in preparation of the addendum by stating: "Therefore, revision to the model is not needed because capping of Ash Pond No. 4 will not significantly alter the timeframe to reach standards, and will improve groundwater quality related to Ash Pond No. 4." (Dynegy

Midwest Energy, LLC, Closure Plan Addendum (Oct. 25, 2018), Excerpt provided as Attachment 6).

20. Did you consider whether any of the concerns raised in your pre-filed testimony were addressed in the July 22, 2019 Response to IEPA Comments for Hennepin East?

Response: Yes. The July 22, 2019 Response to IEPA states under Comment #12, "the current model calibration continues to be appropriate for predictive modeling." (Dynegy Response, p. 5). The end result of the analysis presented by O'Brien & Gere Engineers, Inc. (OBG) in the letter is that no changes were made to the model.

We find the analysis presented in the letter to show that the model is deficient. Additionally, no changes were made to the model to evaluate the impacts of groundwater rewetting of CCR on contaminant concentrations. We expand upon this conclusion in the following examples.

OBG states under Comment #9, "The occasional saturation of ash during flood events will not have significant effect on the predicted concentration of boron; which also applies to reductions in lithium and molybdenum concentrations with strong correlations to boron." (Dynegy Response, p. 2). This effect on predicted (modeled) concentrations should be demonstrated using a model, not assumed.

In Comment #12, IEPA asks for better calibration. OBG responds that it is not a requirement: "The 10% criteria referenced in this comment is an indicator of how well modeled and observed values correlate within the model domain; however, it is not a requirement that a model meet this statistical benchmark to adequately simulate flow and transport." (Dynegy Response, p. 5). This indicates the limitation of IEPA's ability to require better calibration and better model accuracy and shows the importance of having minimum modeling standards in rule.

In comment #12, OBG states, "The predicted heads were all lower than their corresponding observed medians at each well, indicating the model generally under-predicts median head values." (Dynegy Response, p. 5). This shows a problem with attempting to calibrate a model with a static river stage and which is not designed to simulate regular flooding and the resulting rise in groundwater elevation. The problem is the model does not simulate the transient groundwater elevation and flow, while the calibration data (actual site water level measurements) include those effects. The outcome is the model is calibrated to what OBG refers to as "long-term (median) flow conditions" which neither represents the more common baseflow towards the river or the periodic flow reversal and groundwater rise during flooding.

OBG's response goes on to state, "The calibration residuals clustered below the 1 to 1 line of the Observed vs. Computed Target Values graph and the cluster of residuals on the Observed vs Residuals graph (Figure 4B) is consistent with the generally under-

predicted heads." (Dynegy Response, p. 6). This shows the modeled groundwater elevation is biased low because it does not consider variable river stage.

Our professional judgment is that if the same level of effort was put into modeling variable river stage and any effects of CCR rewetting on water quality as was put into defending the use of a static river stage, the resulting model would be better calibrated and more accurate.

Our recommended proposed rules are intended to ensure the initial submittal for CCR modeling reports are complete and provide sufficient detail to meet industry standards and best practices. Our goal is to limit the need for IEPA to reject or severely criticize CCR modeling reports because they are not well supported or documented. The objective of our proposed amendments is to reduce waste of agency resources and limit the amount of time needed for IEPA to review and request corrections of modeling deficiencies. We believe one goal of the rulemaking should be to provide clarity such that GCT models are developed with adequate data and best modeling practices to begin with.

We base our proposed rule amendments and our recommendation that IEPA develop modeling guidance after review of three CCR modeling submittals to IEPA. These modeling submittals clearly demonstrate that detailed rules and guidance are needed to ensure professionals undertaking CCR modeling meet industry standards. Our objective is to provide regulatory clarity such that models and documentation need only minor corrections. Without this type of rulemaking and guidance, it is possible that industry may continue to submit subpar modeling efforts.

21. Did you consider whether any of the concerns raised in your pre-filed testimony were addressed in the January 15, 2020 River Flood Evaluation Report for Hennepin East?

    Response: No. We have not reviewed this report.

22. Did you consider the cost implications of having to collect the additional data you are advocating for in your pre-filed testimony?

    Response: We are not lawyers, but we understand that costs are not to be considered in developing regulations specific to RCRA. We base our recommendations on best practices for hydrogeologic site characterization and modeling.

    Our proposed requirement of the hydrogeologic site characterization to include site specific contaminant attenuation and dispersion properties for each geologic unit should be able to be accomplished using existing information on lithology and contaminant travel times available from lithologic logs and water quality monitoring performed for other requirements of the rule. Developing site specific contaminant attenuation and dispersion properties for each geologic unit should be considered a standard modeling practice for GCT modeling.

Our proposal to require actual CCR porewater sampling or leachate testing of CCR from the site is justified considering the importance of that data in developing accurate models and accurate predictions of closure and corrective action performance, including whether water quality standards are achieved.

Monitoring wells are already required to be installed to assess background water quality and wells are also required upgradient and downgradient of surface impoundments. We do not believe that the additional work to aquifer test these wells or to instrument some of these wells with digital pressure transducers will be excessive. The majority of the cost is already incurred in constructing the wells and performing the site monitoring visits as is required by other portions of the rule.

23. Did you consider the cost implications of performing groundwater modeling consistent with the positions taken in your pre-filed testimony?

Response: In our professional careers, we have seen many instances where modeling performed for site characterization and groundwater remediation meets the standards we are proposing so we know it is both possible and economically feasible. We also do not believe that cost should be the primary determinant in whether modeling performed for closure and corrective action planning is done accurately and according to standard modeling practices.

Submission of subpar or underfunded site characterization or modeling to IEPA for review wastes agency resources and the time needed to correct them and has the potential to hide important site characteristics that impact water quality. This is not a new concept. Other regulatory arenas, such as Superfund, require high quality, properly developed, well supported, and documented modeling deliverables. Cost is not a deterrent to the requirement for groundwater modeling to meet basic standards under these regulatory programs and nor should cost a deterrent be under CCR rules.

24. Did you perform any analyses to determine whether the additional data and modeling inputs you are advocating for are necessary to evaluate how long it will take each proposed closure alternative to achieve the groundwater protection standards?

Response: No, we did not. We believe the modeling performed for the three sites we reviewed (Hennepin, Meredosia, and Wood River) speaks for itself. The models are poorly calibrated as demonstrated in the comparison between modeled and observed water levels and concentrations. It is clear that the poor calibration is partly a result of the models not sufficiently reflecting actual site conditions or an accurate site conceptual model. We believe the additional data and modeling inputs we are advocating for are necessary to develop both accurate site conceptual models and GCT models which are based on the site-specific information needed to accurately simulate contaminant transport at a site.

25. Did you perform any analyses to determine whether the additional data and modeling inputs you are advocating for are necessary to evaluate whether a groundwater corrective action will achieve compliance with the groundwater protection standards?

    Response: No, we did not. See our response to Question #24.

26. Did you perform any analyses to determine whether the additional data or modeling inputs you advocate for would have changed the predictive ability of the models you critiqued in your "Problem Statement"?

    Response: No, we did not. We believe that effort should have been part of the original modeling performed and documented for the site. That could have demonstrated the relative effects on water quality of various contaminant release and transport mechanisms that the GCT modeling ignored, such as the periodic rewetting of CCR or groundwater flow reversal.

27. Did you perform any analyses to determine whether the additional data or modeling inputs you advocate for would have changed the ability of the models you critiqued in your "Problem Statement" to predict how long it will take to achieve the groundwater standards after closure has been implemented?

    Response: No. See our response to Question #26. We consider the predictive ability of the models and the model ability to accurately predict how long it will take to achieve the groundwater standards to be intertwined.

    a. If yes, please provide a comparison of your results to the original models.

       Response: NA

28. Did you perform any analyses to determine whether the additional data or modeling inputs you advocate for would have changed the ability of the models you critiqued in your "Problem Statement" to predict whether a closure will achieve the groundwater standards?

    Response: No. See our response to Question #26. We consider the predictive ability of the models and the model ability to accurately predict whether a closure will achieve the groundwater standards to be intertwined.

    a. If yes, please provide a comparison of your results to the original models.

       Response: NA

29. Are model properties and boundaries usually adjusted during model calibration?

    Response: Yes, within reasonable limits based on site hydrogeologic characterization data.

30. Do the constituent concentrations in CCR in a surface impoundment deplete over time?

    Response: In general, this is likely the case in the long-term; but shorter term fluctuations in constituent concentrations are likely to occur due to climate, flooding, groundwater contact with CCR, etc.

31. Does the source concentration in a CCR surface impoundment deplete over time when CCR is in intermittent, reoccurring, or constant contact with groundwater?

    Response: See our response to Question 30.

32. Do you agree that groundwater sampled today was impacted by CCR constituents that leached from an impoundment sometime in the past?

    Response: Yes.

33. Using the present day leachate concentration in a groundwater model could potentially underestimate the impact of higher initial concentrations that have declined as the leachate concentrations of the CCR was depleted over time, right?

    Response: Yes, if that present day leachate concentration was assumed to be representative of past concentrations, when past concentrations were actually higher.

    By the same token, climate change over the course of decades could impact the amount and concentration of contaminants in leachate. Or a 100-year flood event inundates a site changing leachate generation because all past scenarios assumed no inundation. The point is each site is unique and temporal variation requires modeling to be well supported and documented. Following the rule changes we propose would require actual site data to be collected for CCR leachate contaminant concentration instead of making simplified assumptions for all sites that all leachate concentrations decrease over time regardless of changes to the local climate and hydrologic system.

34. Using a constant constituent concentration from a CCR source in a groundwater model could potentially overestimate the future impact to groundwater, right?

    Response: Yes. We are not suggesting that models must be required to use constant constituent concentration from a CCR source. There may be additional data that indicates that leachate concentrations have not been consistent over time. Having measurements of present day leachate concentrations does allow source concentrations for one period in the model to be constrained based on real data, and eliminates the need to base modeled source concentrations completely on model calibration as was done in the models for the three sites we reviewed. Determining source concentration based entirely on model calibration will increase the likelihood of compounding error in the model because calibration is also affected by the accuracy of the other parameters in the model. Having present day source concentration data is much better than no data at all.

35. On page 19 of your testimony, you refer to CCR in some situations as a “perpetual source” for leachate constituents such as boron.

    a. Is a “perpetual source” one that supplies leachate constituents to groundwater at a constant concentration for an unlimited amount of time?

       Response: We use perpetual to mean continuing for an indefinite length of time. We acknowledge that CCR may be depleted of constituents on the scale of millennia. The time scale for depletion of CCR constituents therefore may be orders of magnitude beyond the time period of modeling typically done for cleanup and post-closure care. Also, if the closure or corrective action plan for a site is to allow the CCR to be depleted of contaminants over millennia and use groundwater monitoring to show that the pollution is contained and there are no human or environmental exposures, then the closure or corrective action plans should evaluate whether that meets regulatory criteria. The other point to be made here is if industry believes that a source of contaminant will not last long, perhaps only a few decades, then industry is free to run a geochemical model based on site characterization and trend data to demonstrate the source will be short lived.

    b. Have you performed an analysis demonstrating that CCR could contain a sufficient mass of leachate constituents to behave as a perpetual source?

       Response: No, we have not personally done this.

ATTACHMENTS

1. Aquifer Protection Section, NCDENR Division of Water Quality, *Groundwater Modeling Policy* (May 31, 2017).
2. Appendix A – Model Review Checklist.
3. National Research Council 2007. *Assessment of the Performance of Engineered Waste Containment Barrier*s. Washington, DC: The National Academies Press. https://doi.org/10.17226/11930.
4. Letter from IEPA, Comments on Hennepin Closure/Post-Closure Plan (May 2, 2019).
5. Letter from Dynegy, Response to IEPA Comments (July 22, 2019) (Excerpt).
6. Dynegy Midwest Energy, LLC, Closure Plan Addendum (Oct. 25, 2018) (Excerpt).

CERTIFICATE OF SERVICE

The undersigned, Faith E. Bugel, an attorney, certifies that I have served by email the Clerk and by email the individuals with email addresses named on the Service List provided on the Board's website, available at https://pcb.illinois.gov/Cases/GetCaseDetailsById?caseId=16858, a true and correct copies of the **PREFILED ANSWERS OF IAN MAGRUDER AND SCOTT PAYNE** and **ATTACHMENTS** before 5 p.m. Central Time on September 24, 2020. The number of pages in the email transmission is 258 pages.

Respectfully Submitted,

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