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In the Matter of:	)	
	)	
SIERRA CLUB, ENVIRONMENTAL	)	
LAW AND POLICY CENTER,	)	
PRAIRIE RIVERS NETWORK, and	)	
CITIZENS AGAINST RUINING THE	)	
ENVIRONMENT	)	
Complainants,	)	PCB 2013-015
v.	)	(Enforcement – Water)
MIDWEST GENERATION, LLC,	)	
Respondent.	)	
	)	
	)	
	)	
	)	

Rebuttal Report to
Expert Report of John Seymour, P.E.

James R. Kunkel, Ph.D., P.E.

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INTRODUCTION,

This expert rebuttal report provides my responses to expert opinions of John Seymour, P.E. related to my Expert Report on Ground-water Contamination (Kunkel, 2015a) and my Expert Report on Remedy for Ground-water Contamination (Kunkel 2015b) for Midwest Generation, LLC's (MWG's) Joliet #29, Powerton, Waukegan, and Will County coal-fired power plants.

My rebuttal responses will emphasize, but not necessarily be limited to, the following:

- Much of Seymour's expert report (Seymour, 2015) is unsound and incorrectly interprets the available data and information;
- The indicator pollutants I use for ground-water contamination from coal ash are consistent with USEPA, EPRI and IEPA documents;
- The concentrations of the indicator pollutants in ground water at the four plant sites are much higher than background. This shows that the ground water at the four sites is likely contaminated by a coal ash source. I utilized the same background data for the indicator pollutants as IEPA utilized in their coal ash assessment, except at Powerton where background data at MW-16 (the only true background well at the four plant sites) agrees with the IEPA background for sand and gravel aquifers;
- At Joliet #29, Powerton and Will County sites, no other potential sources of indicator pollutants, except coal ash, are present up-gradient. At Waukegan, ground-water from the Greiss-Phleger Tannery site is not reaching the monitoring well network. Even if boron from the tannery site were reaching the monitoring network, the concentrations of boron in the tannery ELUC wells (up-gradient) are much lower than in monitoring wells located within the old ash storage area just west of the ash ponds. Therefore, I conclude that none of the boron is coming from the tannery;
- The ground-water concentrations are temporally and spatially consistent at each of the four plant sites;
- Ground-water contamination at all four plant sites has generally remained the same, at high concentrations for the monitoring period between Dec. 2010 through present, which confirms my opinion that the actions taken by MWG will not solve the ground-water contamination issues at the four sites;
- MWG's actions will not significantly reduce or eliminate ground-water contamination from coal ash at the four sites; and
- My proposed remedy (Kunkel, 2015b) is economically reasonable compared to other source-term removal remedies or ground-water remediation.

CONTAMINATION IN THE MONITORING WELLS AT THE FOUR SITES IS COMING FROM COAL ASH

I chose the correct indicator pollutants, which are those accepted by other experts and regulators (Kosson and others, 2009; EPRI, 2012; IEPA, 2013; USEPA, 2015). These indicator pollutants, comprised of boron (B), manganese (Mn) and sulfate (SO_4), are known to be the result of leaching of coal ash. As I indicated in my contamination report (Kunkel, 2015a), it is highly unlikely that the presence of these indicator pollutants together in the high concentrations found in the ground water at the four sites is the result of naturally occurring hydrogeologic formations or industrial processes other than coal-fired power plants. USEPA (2015) proposes using the following indicator constituents of ground-water contamination: B, chloride (Cl), conductivity, fluoride (F), pH, SO_4, sulfide (S^{2-}), and total dissolved solids. EPA makes special note of B and SO_4: "The high mobility of boron and sulfate explains the prevalence of these constituents in damage cases that are associated with groundwater impacts." (USEPA, 2015, p. 21456). In its technical support document for coal combustion waste impoundments in Illinois, IEPA (2013) states that "Boron, sulfate, and manganese are the same contaminants that have been found in recent hydrogeologic assessments of groundwater in multiple confirmed sample results collected from down-gradient dedicated monitoring wells adjacent to surface impoundment units containing

CCW at power generating facilities in Illinois. These contaminants were found to be attributable to these surface impoundment units".

I chose the correct background concentrations. IEPA (2013), in its technical support document for coal combustion waste impoundments in Illinois, utilized certain ground-water background concentrations for sand and gravel aquifers and bedrock aquifers to assess if contamination was present. I utilized these same background concentrations for my indicator pollutants at the Joliet #29, Waukegan and Will County sites because there are no up-gradient, background wells at these sites. The monitoring wells at these sites are immediately adjacent to the coal ash ponds and cannot be considered to be either up-gradient or background, because they are impacted by the coal ash ponds. At Powerton, MW-16 is likely up-gradient and has background ground-water concentrations of the indicator pollutants which closely match IEPA's background concentrations for sand and gravel aquifers. In my contamination report, the concentrations of indicator pollutants in MW-16 were utilized as up-gradient, background ground-water concentrations at Powerton.

The indicator contaminants are present in ground water in concentrations much higher than background. There is no evidence that there are up-gradient, off-site sources for the indicator pollutants at the four sites. Seymour (2015, numerous pages) opines that the post-2013 continuing ground-water contamination at the four sites is being caused by up-gradient, off-site sources. My ground-water contamination report (Kunkel, 2015a) describes the historical land uses up-gradient and off-site at each of MWG plant areas. At Joliet, the historical land use north and east of the property was mostly undeveloped land with the Des Plaines River on the south border of the property. There is no evidence of sources of B, Mn or SO_4 that could migrate on-site from adjacent properties. At Joliet #29, B concentrations are up to 21.7 times higher than the background B concentration of 0.12 mg/L. Mn concentrations are up to 22.2 times higher than the background Mn concentration of 0.072 mg/L. SO_4 concentrations are up to 7.4 times higher than the background SO_4 concentration of 54 mg/L. I conclude from this that there is past and continuing ground-water contamination by the indicator pollutants of B, Mn and SO_4 at the Joliet #29 site and this contamination is from on-site sources.

At Powerton, the historical and current land use comprises the Illinois River to the north, industrial and residential properties to the east, agricultural land to the south, and Lake Powerton (Powerton Fish and Wildlife Area) to the west. There is no indication that these land uses could be sources for B, Mn, and SO_4 at the site. This is confirmed by Well MW-16, which is considered to be an up-gradient, background well. At Powerton, B concentrations are up to 21.5 times higher than the background B concentration of 0.20 mg/L. Mn concentrations are up to 4,330 times higher than the background Mn concentration of 0.003 mg/L. SO_4 concentrations are up to 32.6 times higher than the background SO_4 concentration of 43 mg/L at MW-16. I conclude from this that there is past and continuing ground-water contamination by the indicator pollutants of B, Mn and SO_4 at the Powerton site and this contamination is from on-site sources.

At Waukegan, the historical land use of interest was the Greiss-Phleger Tannery, which MWG alleges is the up-gradient source of B at the coal ash pond monitoring wells. This is highly unlikely for three reasons: (1) the ground-water flow away (down-gradient) from the tannery site is not toward the coal ash ponds or the monitoring wells, (2) the concentrations of B in the MW-10 through MW-14 (MW-13 is inactive) ELUC monitoring wells are the direct result of these wells having their screens completed in coal ash, and (3) the B concentrations in MW-10 through MW-14 are much less than those in the MW-5, MW-6, MW-7, MW-8, MW-9 and MW-15.

For example, Figure 1 shows recent MWG ground-water B concentration data for monitoring wells MW-5 through MW-15. Wells MW-10 through -14 (MW-13 is inactive) are ELUC wells which are up-gradient from the old coal ash storage area, and wells MW-5 through -9 and MW-15 are downgradient from the old coal ash storage area. Interpretation of the B concentrations on Figure 1 clearly show that the up-gradient wells (dashed lines) have B concentrations much lower than the down-gradient wells (solid lines). ENSR (1998d) boreholes

located near wells MW-10 through MW-14 (MW-13 is inactive) show that there is ash present in the soil which can account for the B and Mn concentrations at these monitoring wells, which were not part of the ash pond ground-water monitoring network.

At Waukegan, B concentrations in MW-1 through MW-9 are up to 408 times higher than the background B concentration of 0.12 mg/L. Mn concentrations are up to 13.8 times higher than the background Mn concentration of 0.072 mg/L. SO_4 concentrations are up to 22.2 times higher than the background SO_4 concentration of 54 mg/L. I conclude from this that there is past and continuing ground-water contamination by the indicator pollutants of B, Mn and SO_4 at the Waukegan site and this contamination is from on-site sources.

At Will County, the historical and current land uses consist of undeveloped land to the north, the Chicago Sanitary and Ship (CSS) Canal to the east, a quarry to the south, and the Des Plaines River to the west. There is no indication that these land uses could be sources for B, Mn and SO_4 in ground water at the site. At Will County, B concentrations are up to 22.1 times higher than the background B concentration of 0.12 mg/L. Mn concentrations are up to 34.5 times higher than the background Mn concentration of 0.072 mg/L. SO_4 concentrations are up to 45.3 times higher than the background SO_4 concentration of 54 mg/L. I conclude from this that there is past and continuing ground-water contamination by the indicator pollutants of B, Mn and SO_4 at the Will County site and this contamination is from on-site sources.

My rebuttal responses above to Seymour's allegations regarding the ground-water contamination at the four MWG plant sites include several important facts which show Seymour is incorrect in his allegations or has misinterpreted the ground-water quality data and other information which universally has been agreed to by MWG and IEPA since before the site characterization in late 2010.

The Leachate Test that Seymour Utilized is not Representative of Field Conditions in the Coal Ash Ponds

Seymour (2015, p. 40) claims that *"Recent Groundwater Concentrations are Not the Result of Ash Stored in Lined Ponds"*, but rather ground-water contamination is from up-gradient, off-site sources entering each site. Seymour (2015, p. 51) concludes that *"Bottom Ash Indicator Constituents from Leachate Do Not Match the Groundwater Chemistry"*. Seymour bases these conclusions on the neutral leaching procedure from the American Society for Testing and Materials (ASTM) given in its D3987 test. This test, as established by IEPA in *415 Illinois Compiled Statutes 5/3.135* to determine if coal ash may be classified for beneficial use, is not appropriate or valid for establishing long-term leaching of coal ash (ASTM, 2012), which is occurring at the four plant sites. In its most recent publication of the neutral leaching test, ASTM (2012), in part, states the following in the Significance and Use section of the ASTM D3987-12 procedure:

- "4.1 This practice is intended as a rapid means for obtaining an extract of solid waste. The extract may be used to estimate the release of constituents of the solid waste under the laboratory conditions described in this procedure".
- "4.2 This practice is not intended to provide an extract that is representative of the actual leachate produced from a solid waste in the field or to produce extracts to be used as the sole basis of engineering design".
- "4.3 This practice is not intended to simulate site-specific leaching conditions. It has not been demonstrated to simulate actual disposal site leaching conditions".

Hattaway and others (2013) have proposed guidelines for a suite of test methods for coal ash which are more representative of field conditions. This suite of tests is known as the Leaching Environmental Assessment Framework (LEAF) and is designed to replace the single-point pH tests such as the Toxicity Characteristic Leaching Procedure (TCLP), Synthetic Precipitation Leaching Procedure (SPLP) and ASTM D3987, which

typically utilize large liquid to solids (by weight) ratios which are not representative of field conditions. An appropriate LEAF test for the ash pond solids is EPA 1313 (Hattaway and others, 2013). LEAF tests were utilized by the USEPA (Kosson and others, 2009) in their coal ash characterization report. I relied on Kosson and others (2009) for my opinions in my ground-water contamination report (Kunkel, 2015a).

The two main reasons that the ASTM D3987 test does not accurately measure field leaching of coal ash is that (1) the liquid to solids ratio within the ponds and in the ground water is much lower than the 20 (liquid) to 1 (solids) ratio of the laboratory test, and (2) the pH of the laboratory test (pH = 7) is not representative of either the coal ash in the ponds or outside the ponds.

I conclude from the above that the use of ASTM D3987 by Seymour and other MWG consultants is incorrect and gives concentrations in the resulting test extracts which are much lower than would be expected from field conditions.

Seymour's Matching Analysis of Coal Ash Leachate is Flawed

Seymour's matching analyses is flawed for two reasons. Firstly, detection monitoring does not work on the assumption that you must match each ground-water constituent; instead the principle is that any one of the indicator pollutants can suggest the presence of coal ash leachate (EPRI, 2012). Secondly, a pollutant is not absent just because it is present at a concentration less than the detection limit. The detection limits used in the ASTM D3987-85 test procedure were sometimes 200 times higher than the quarterly ground-water detection limits. The constituents that were not detected in the ASTM test were, in fact, shown to be detected in the MWG 2014 quarterly ground water as well as in actual coal ash pond leachate for subbituminous/lignite impoundment leachate values (Seymour, 2015, Table 5-2). Seymour should have utilized those pond leachate data found in his Table 5-2 for his matching analyses.

Not only was Seymour's approach to matching flawed, but it was misapplied. If he had applied his approach correctly, he would have found a near-100 percent match to all the MWG 2014 quarterly ground-water sampling data. For example, I reanalyzed the "matching" of the ASTM D3987-85 test procedure results obtained by Seymour (Table 5-1) to the 2014 MWG quarterly ground-water sampling data at the Waukegan plant site. Seymour (2015, Table 5-5) indicated that there was a match of between 74 and 84 percent of the time between the ASTM D3987-85 test procedure results and the Waukegan ground-water results for wells MW-1 through MW-7 for the 2014 quarterly data. I have reanalyzed the match because the detection limits used in the ASTM D3987-85 test procedure were sometimes 200 times higher than the quarterly ground-water detection limits. I also utilized the EPRI (Seymour, 2015, Table 5-2) subbituminous/lignite impoundment leachate values and detection limits for comparison to the MWG 2014 quarterly ground-water values to determine if there was a match to ground-water concentrations if the ASTM D3987-85 test procedure results in Seymour's (2015) Table 5-1 showed a non-detect.

The attached Table 1 is my reanalysis of the Waukegan 2014 quarterly ground-water data to Seymour's list of indicator constituents which are found in impoundment coal ash leachate. My interpretation is that there is a nearly perfect match of the Waukegan 2014 quarterly ground-water data to indicator constituents of coal ash leachate presented by Seymour (2015) in his Tables 5-1 and 5-2. This match varies from a 95 percent match to the impoundment leachate indicator constituents for wells MW-2, MW-5, MW-6 and MW-7, to a 100 percent match for wells MW-1, MW-3 and MW-4.

Analyses of my Table 1 shows that the ASTM D3987-85 test procedure results (Seymour, 2015, Table 5-1) and the EPRI impoundment leachate results (Seymour, 2015, Table 5-2) showed consistency for all the leachate indictor constituents except for iron. Therefore, my method of matching using MWG's 2014 quarterly ground-

water data and Seymour's (2015) Tables 5-1 and 5-2 provide near perfect matches to the observed ground-water contamination at Waukegan.

Additionally, if only my three indicator pollutants (B, Mn and SO_4) are analyzed, there is a 100 percent match to Seymour's leachate indicator constituents. Therefore, I further conclude that Seymour's use of the results from the ASTM D3987 to determine if the leachate "matches" the chemistry of the ground water underlying the ponds is incorrect and a gross misuse of the ASTM D3987 procedure and that there were leachate data available from his Table 5-2 which should have been utilized for these matches.

The Leachate Test that Seymour Utilized is not Representative of Field Conditions in Coal Ash Deposits Outside the Ash Ponds

Seymour (2015, p. 45) claims that *"Historical Ash in Fill Materials Outside of the Ponds is Not Adversely Impacting Groundwater",* but rather ground-water contamination is from up-gradient, off-site sources entering each site. Seymour (2015, p. 52) concludes that *"There is No Evidence That Historical Coal Ash Outside of the Ash Ponds is a Source of Groundwater Impacts".* Leaching of coal ash deposits outside the ash ponds at the four plant sites involves two possible scenarios: (1) leaching of coal ash by percolating rainfall and snowmelt, and (2) leaching of coal ash by the rising and falling of seasonal ground-water levels.

Leachate from this intermittent wetting and drying of coal ash will be significantly different than the extractant resulting from the ASTM D3987 procedure. Therefore, the ASTM D3987 procedure utilized by Seymour and other MWG consultants to characterize the coal ash outside the ponds is not applicable. In fact, the chemical process going on beneath the ponds, which leaked in the past and may continue to leak now, is one of pore-water equilibrating with the ash and or soil/ash mixtures in the ground water. This means that there are much lower liquid-to-solids ratios in the coal ash within the ponds and in the coal ash/soil outside the ponds. Additionally, a variable pH depending on the expected initial liquid pH, i.e. rain water, higher pH ground water, or other leaching solutions also is different than the neutral pH of 7 utilized in the ASTM D3987 test procedure.

Values of pH in the environment vary with both space and time. Rainfall pH (typically acidic; pH <7) is very different from ground-water pH (typically basic; pH >7) as well as coal ash leachate pH (typically basic). All rainfall ranges in pH from about 5.6 to 6.0 (nationwide) due to dissolution of CO_2 which forms carbonic acid (Skilling, 2002). In and near Chicago, June and August rainfall is most acidic with a pH of about 4.65. At other times during the year pH varies from about 4.79 to 5.68. Thus, using a neutral pH of 7.0 for the ASTM D3987 leach test will underestimate the concentrations of inorganics in leachate produced by the test procedure. Additionally, the ASTM D3987 procedure's Significance and Use item 4.1 through 4.3 above indicate that the test is not representative of field conditions (ASTM, 2012).

Time series data of ground-water quality collected at the four sites since late 2010 also shows that the existing ground water at all four sites is typically greater than pH 7 and often is greater than pH 8. As with lower (acidic) pH values, higher, more basic pH can facilitate greater leaching than neutral pH. This indicates that the use of the ASTM D3987 procedure to assess leachate concentrations from coal ash is invalid. As indicated above, the processes occurring both at the ground surface and beneath the ground surface relative to coal ash leaching are not single-point pH related but rather chemical equilibration of the liquid phase with the solid coal ash phase to produce the site-specific concentrations of contaminants presented in MWG's quarterly reports. An appropriate LEAF test for the coal ash within and outside the ash ponds is EPA 1313 (Hattaway and others, 2013), the same test procedure utilized by Kosson and others (2009) to characterize coal ash leachate. I relied on Kosson and others (2009) for my opinions in my ground-water contamination report (Kunkel, 2015a).

Seymour is Incorrect that there is no Evidence of Spatial and Temporal Consistency in Ground-Water Impacts

Seymour (2015, pp. 15, 18, 21 and 23) claims that there is no "... evidence that there is spatial or temporal consistency in groundwater impacts, [and] it is my opinion that there is no plume ..." at the four MWG plant sites. This is incorrect. A contaminant plume can exist without spatial or temporal consistency but in this case there is both spatial and temporal consistency as well as a contaminant plume at each of the four plant sites. The monitoring networks at each plant site show consistently high ground-water contamination by the indicator pollutants since monitoring began. Nearly all the monitoring wells are downgradient from the coal ash ponds and other coal ash deposits.

What variability there is in the ground-water concentrations is consistent with continued contamination from coal ash. Continued leaching of coal ash outside the ponds by rising and falling ground-water levels will contribute to the observed ground-water contamination at each of the plant sites. Seasonal variations in ground-water contamination from the indicator pollutants would be expected at each site due to these rising and falling ground-water levels. There is both spatial and temporal consistency in accordance with seasonal variability.

MWG'S ACTIONS ARE NOT APPROPRIATE TO SIGNIFICANTLY REDUCE OR ELIMINATE GROUND-WATER CONTAMINATION FROM COAL ASH AT THE FOUR SITES

My rebuttal responses to MWG's past actions at the four power plant sites include the following:

- The Compliance Commitment Agreement (CCA) remedies for each of the four sites will not reduce existing or future ground-water contamination from coal ash deposits and leaky liners;
- Liner construction did not follow normally acceptable engineering standards;
- Dredging of coal ash from the ponds will continue to be a potential source of liner tears and leaks;
- GMZ's and ELUC's do not address the continuing ground-water contamination at the four sites; and
- Monitoring is not addressing the reduction or elimination of ground-water contamination.

The CCA remedies for each of the four sites will not reduce existing or future ground-water contamination from coal ash deposits and leaky liners. The CCAs (IEPA, 2012a, b, c and d) set forth various supposedly remedial actions by MWG to eliminate ground-water contamination at the four sites. Ground water at the four sites is contaminated with constituents including Sb, As, B, Cl, Fe, Mn, NO_3, Hg, SO_4 and Se. Additionally, ground-water at the sites is affected by high pH and TDS immediately up-gradient and down-gradient from the ash ponds. The CCA remedies will not, in my opinion, reduce the ground-water contamination at any of the four sites because:

(1) Continued ground-water monitoring will not eliminate the ash pond liner leaks nor leaching of contaminants from past coal ash placement outside the existing ash ponds;
(2) None of the coal ash pond liners meet the engineering standards given by the USEPA (2015) coal ash rule;
(3) There is no provision in the CCA for cessation of use and removal of coal ash from the three ash ponds;
(4) There is no provision in the CCA for clean-up and removal of fill/construction coal ash placed outside the ash ponds nor for coal ash disposed of on land surface;
(5) Since MWG is continuing to use the same ash dredging techniques as in the past, relining the ash ponds will not reduce liner damage and subsequent liner leakage; and
(6) Hydrostatic uplift of plastic liners can occur at high ground-water levels.

Without removal of the coal ash sources at the four plant sites, ground-water contamination will continue unabated into the future. Creation of a Groundwater Management Zone (GMZ) or an Environmental Land Use Control (ELUC) area and installation of additional ground-water monitoring wells will not prevent the existing coal

ash sources from continuing to cause ground-water contamination into the future. Only partial or total removal of the coal ash sources can reduce ground-water contamination at the four power plant sites.

Liner construction during lining or relining of the coal ash ponds at the four sites did not follow normally acceptable engineering standards. Seymour (2015, p. 54) says that *"Ash Ponds are not Leaking and Construction Quality is Consistent with the Ash Pond Lining Quality Management Standards for Long-Term Use"*. Seymour (2015, p. 54. Footnote 158) claims that "... Schroeder (1994) [...] does not consider the frequency of leaks when certain construction quality assurance protocols are followed". This is untrue. Schroeder and others (1994) relate the frequency of liner construction defects to the degree of contact the plastic liner makes with the underlying subbase as summarized in Kunkel (2015a). They define this contact as either poor, fair, good or excellent. No matter how good the construction quality assurance is, there is a small likelihood that the degree of contact will be excellent, which can be achieved only in the laboratory or in small field lysimeters. Good contact is defined by Schroeder and others (1994) as good field installation with well-prepared, smooth soil surface and geomembrane wrinkle control to insure good contact between geomembrane and adjacent soil that limits the drainage rate through a liner defect.

Schroeder and others (1994) also discusses a liner placement quality known as "geotextile separating geomembrane liner and drainage limiting soil" which assumes liner leakage spreading, with the rate of leakage determined by the in-plane transmissivity of the geotextile separating the geomembrane and the adjacent soil or Poz-o-Pac layer that would have otherwise limited the drainage (Schroeder and others, 1994). In the case of the four MWG plant sites, the subbase is either unspecified prepared subgrade or Poz-o-Pac (Seymour, 2015, pp. 28–35). It is well documented by MWG that when some of the ponds were relined, the Poz-o-Pac was partially removed and geotextile placed between the Poz-o-Pac and/or soil subbase and the HDPE liner (Bates Nos. 9584, 9642, , 28418-28586, 49477-49478). The surface of the remaining Poz-o-Pac could not have been smooth enough to ensure a "good" contact with the HDPE liner. This conclusion is strongly supported by Bates Nos. 66-69, which mention that the MWG Poz-o-Pac liners are in "poor" condition. This type of construction is not standard engineering practice.

My opinion is that the existing ponds at the four plant sites do not meet the engineering standards set by the USEPA (2015) coal ash rule for lined ponds. That rule states (p. 21474) that, for existing coal ash surface impoundments, "... the owner or operator of an existing CCR surface impoundment must document whether or not such unit was constructed with any one of the following: (i) A liner consisting of a minimum of two feet of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} cm/sec; (ii) A composite liner that meets the requirements of §257.70(b); or (iii) An alternative composite liner that meets the requirements of §257.70(c). (2) The hydraulic conductivity of the compacted soil must be determined using recognized and generally accepted methods".

§257.70(b) of the rule states:

> "... A *composite liner* must consist of two components; the upper component consisting of, at a minimum, a 30-mil geomembrane liner (GM), and the lower component consisting of at least a two foot layer of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} centimeters per second (cm/sec). GM components consisting of high density polyethylene (HDPE) must be at least 60-mil thick. The GM or upper liner component must be installed in direct and uniform contact with the compacted soil or lower liner component. The composite liner must be: (1) Constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients (including static head and external hydrogeologic forces), physical contact with the CCR or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation; (2) Constructed of materials that provide appropriate shear resistance of the upper and lower component interface to

prevent sliding of the upper component including on slopes; (3) Placed upon a foundation or base capable of providing support to the liner and resistance to pressure gradients above and below the liner to prevent failure of the liner due to settlement, compression, or uplift; and (4) Installed to cover all surrounding earth likely to be in contact with the CCR or leachate".

§257.70(c) of the rule states:

> "If the owner or operator elects to install an alternative composite liner, all of the following requirements must be met: (1) An *alternative composite liner* must consist of two components; the upper component consisting of, at a minimum, a 30-mil GM, and a lower component, that is not a geomembrane, with a liquid flow rate no greater than the liquid flow rate of two feet of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} cm/sec. GM components consisting of high density polyethylene (HDPE) must be at least 60-mil thick. If the lower component of the alternative liner is compacted soil, the GM must be installed in direct and uniform contact with the compacted soil. (2) The owner or operator must obtain certification from a qualified professional engineer that the liquid flow rate through the lower component of the alternative composite liner is no greater than the liquid flow rate through two feet of compacted soil with a hydraulic conductivity of 1×10^{-7} cm/sec. The hydraulic conductivity for the two feet of compacted soil used in the comparison shall be no greater than 1×10^{-7} cm/sec. The hydraulic conductivity of any alternative to the two feet of compacted soil must be determined using recognized and generally accepted methods. The liquid flow rate comparison must be made using Equation 1 of this section, which is derived from Darcy's Law for gravity flow through porous media.
>
> (Eq. 1) $$\frac{Q}{A} = q = k\left(\frac{h}{t} + 1\right)$$
>
> Where, Q = flow rate (cubic centimeters/second);
> A = surface area of the liner (squared centimeters);
> q = flow rate per unit area (cubic centimeters/second/squared centimeter);
> k = hydraulic conductivity of the liner (centimeters/second);
> h = hydraulic head above the liner (centimeters); and
> t = thickness of the liner (centimeters).
>
> (3) The alternative composite liner must meet the requirements specified in paragraphs (b)(1) through (4) of this section".

There is no evidence in the record that MWG's coal ash ponds meet the above definitions of a lined pond in the USEPA (2015) coal ash rule.

Seymour (2015, p. 55) says that *"O&M of the Ash Ponds are Not Expected to Cause Leaks and O&M are Conducted in Accordance with Consistent Operating Procedures".* Dredging of coal ash from the ponds will continue to be a potential source of liner tears and leaks. Excavators can damage plastic liners if less than 2-ft of soil overlies the plastic. Seymour's use of static load bearing calculations of equipment is not acceptable to assess the potential for liner damage from equipment because movement of the equipment, especially turning the equipment or suddenly braking the equipment, is a dynamic load which can cause stresses which will tear the liner. Even with 2 ft of protective soil over the liner, turns and sudden braking by trucks, excavators, and even pickups is discouraged (Narejo and Corcoran, 1996, Bates Nos. 49293-49361). MWG has photographs

and other documentation showing construction equipment on the pond liners covered only with the 1-ft sand "cushion" layer (Bates Nos. 49495, 49504). This is not acceptable engineering practice for liner construction.

GMZ's and ELUC's do not address the continuing ground-water contamination at the four sites. The GMZ's and ELUC's may not be large enough to ensure that they are effective in eliminating ground-water exposure pathways at the four sites. During establishment of the GMZ's/ELUC's, no consideration was given to the extent of other coal ash deposits at each site. GMZ's and ELUC's generally have not and will not lead to reductions in ground-water contamination at the four plant sites because they do not provide partial or total removal of the coal ash source terms which lead to ground-water contamination. At Will County, retirement of the Ponds 1-N and 1-S did not remove all of the coal ash and water and thus coal ash leachate has continued to enter the ground water.

Monitoring is not addressing the reduction or elimination of ground-water contamination. There were and are pathways for contamination from the ponds to enter the ground water prior to and after ash pond lining. The evidence does not show that site characterization, ground-water analytics, and implementation of administrative controls have eliminated exposure pathways nor ground-water impacts at any of the four sites. Kunkel (2015a) on Figures 5 through 7, 13 through 15, 22 through 25, and 29 through 31 shows the time series of the indicator pollutants at the four plant sites since monitoring began at the end of 2010. These figures show the following:

(1) At Joliet #29, the indicator pollutant concentrations in ground-water have increased in four monitoring wells and stayed essentially the same in seven monitoring wells.
(2) At Powerton, the indicator pollutant concentrations in ground-water have increased in six monitoring wells and stayed essentially the same in 10 monitoring wells.
(3) At Waukegan, the indicator pollutant concentrations in ground-water have increased in five monitoring wells and essentially stayed the same in 10 monitoring wells.
(4) At Will County, the indicator pollutant concentrations in ground water have increased in seven monitoring wells and essentially stayed the same in three monitoring wells.

The monitoring data do not show that contamination has been significantly reduced, let alone eliminated, after lining the ponds. My opinion is that ground-water monitoring does not show mitigation of ground-water contamination or exposure pathways.

Temporary or seasonal water table elevations at or above the pond liners (not necessarily the pond bottoms) are causes for concern due to the potential for hydrostatic uplift, reduction of the load-bearing capacity of the underlying soils, and ground-water inflows through cracks in the old Poz-o-Pac liners. Additionally, temporary or seasonal water table elevations at or above the pond liners are not permitted under the USEPA (2015) coal ash rule. Under the rule, the liners must be 5 ft above the highest ground-water elevation of the uppermost aquifer (§257.60 of the rule). Thus, except for possibly the Joliet #29 site, none of the MWG coal ash ponds can attain this 5-ft distance under their present locations.

It is untrue that hydrostatic uplift is a potential issue only for soil liners and not geomembrane liners. I have personal experience at the Colstrip Montana Steam Electric Station where ground-water hydrostatic uplift on a plastic liner caused the liner to fail. A rock underdrain was installed to reduce the ground-water hydrostatic uplift pressures. Also see §257.70(b) of the USEPA (2015) coal ash rule.

Seymour's evaluation of hydrostatic uplift assumed that the Poz-o-Pac liners were impermeable and added weight to offset the hydrostatic uplift. We have documentation at the Will County site that the Poz-o-Pac is cracked and allows ground-water to percolate upward into at least one ash pond (Bates Nos. 28850, 28862). We know that, as of 2006, all of the Poz-o-Pac liners dated from the late 1970s and were in poor condition (Bates

66-69). It is therefore reasonable to expect that other Poz-o-Pac liners are cracked, especially those ponds where part of the Poz-o-Pac was removed to maintain ash storage capacity when they were relined. If the ground-water rises above the bottom of the ponds only temporarily, there could still be hydrostatic uplift and the potential for liner failure.

Seymour (2015, p. 37) states that liner leak testing was done either prior to or after placement of the 1-ft sand "cushion" layer. Evidence (Bates Nos. 49495, 49504) shows that trucks drove on this 1-ft sand cushion layer to place the 6-in crushed limestone warning layer. This is not good engineering practice because the turning trucks, dozer spreading of the crushed limestone, and sudden braking or reversals of equipment could cause liner tears. No additional liner leak testing was done after placement of the 6-in crushed limestone warning layer in the ponds.

After dredging of the ash ponds using heavy equipment, there is no visual method to check for liner leaks caused by the dredging equipment. MWG has documented liner tears during dredging (for example, Bates No. 44621), but it is highly likely that some liner tears have gone unnoticed because of coal ash and the warning layer covering these liner failures.

ECONOMIC REASONABLENESS OF THE PROPOSED REMEDY

My remedy report (Kunkel, 2015b) has the only economically reasonable remedy to reduce the source terms for the indicator pollutants at the four plant sites. This remedy removes the coal ash ponds and selected ash storage areas outside the ash ponds. MWG's remedies of establishing GMZ's, ELUC's and ground-water monitoring does nothing to reduce the source terms. Lining of the coal ash ponds at the four plant sites also has not significantly reduced the indicator pollutant ground-water contamination at the four sites.

I conclude that removal of at least some of the coal ash source terms at the four plant sites is the most cost-effective method to reduce continuing ground water contamination. Other ground-water "clean-up" methods such as pump-and-treat or natural attenuation will be effective only if all, or a portion of, the source terms are removed. Additionally, pump-and-treat for B and SO_4 involves elaborate and expensive treatment processes such as membrane technologies and also would involve treatment of large volumes of water because all four plant sites are adjacent to water bodies. I conclude that source removal is more cost-effective than pump-and-treat, because it is more effective in reducing ground-water contamination and less costly. Source removal also is more cost-effective than natural attenuation even though natural attenuation is less costly.

MWG's remedial approach does not address all of the ground-water contamination source terms at the four sites. Seymour misinterprets the Kunkel (2015b) remedy report, which does not recommend removal of all the coal ash at the four plant sites, but rather removal of only the ash ponds and ash immediately adjacent to the ash ponds, the former fly ash disposal area at Waukegan, and, for Joliet #29, additional removal of the northeast ash landfill.

Seymour (2015, p. 63) objects to Kunkel's *"Costs of Soil Disposal at a Permitted Landfill."* Seymour states "It is my opinion that the Kunkel Remedy Report significantly underestimates the cost of proposed cleanup to remove all ash ponds and all CCRs in fill at the plants". He continues that Kunkel's proposed remedy (1) "… fails to incorporate the costs of disposal at a permitted landfill …"; (2) "… does not account for significant and costly disruption at the generating plants …"; (3) "… results in significant impacts to the surrounding communities, including dust, noise, and traffic …"; and (4) "… fails to consider the impact of vehicle carbon dioxide emissions …".

I utilized a cost range of $29.27 (low unit cost) to $42.95 (high unit cost) per ton for estimating the cost to remove the existing coal ash ponds and coal ash-impacted soils at each site, to haul the material removed to an existing landfill and to backfill the excavated areas for the proposed remedy. The unit soil tonnages and costs for the proposed remedy are based on a total impacted area of 196 acres for all four sites rather than the 1,064 acres assumed by Seymour (2015, p. 64). The remedy includes only ash pond removal and ash fill very near the ponds at the four sites, except at Waukegan where the costs include removal of the former fly ash disposal area, and at Joliet #29 where the costs include the removal of ash from the old NE Ash Landfill (Kunkel, 2015b, Table 6). Thus, all of Seymour's objections and his estimated costs and impacts are unwarranted because the remedy at any one of the four sites is most likely no different than a moderate construction project.

CONCLUSIONS

I have shown in this rebuttal report that:

(1) Much of Seymour's expert report (Seymour, 2015) is unsound and incorrectly interprets the available data and information;
(2) The indicator pollutants I use for ground-water contamination from coal ash are consistent with USEPA, EPRI and IEPA documents;
(3) The concentrations of the indicator pollutants in ground water at the four plant sites are much higher than background;
(4) I utilized the same background data for the indicator pollutants as IEPA utilized in their coal ash assessment, except at Powerton where background data at MW-16 (the only true background well at the four plant sites) agrees with the IEPA background for sand and gravel aquifers;
(5) At Joliet #29, Powerton and Will County sites, no other potential sources of indicator pollutants, except coal ash, are present up-gradient;
(6) At Waukegan, ground-water from the Greiss-Phleger Tannery site is not reaching the monitoring well network and, therefore, I conclude that none of the boron is coming from the tannery;
(7) The ground-water concentrations are temporally and spatially consistent at each of the four plant sites;
(8) Ground-water contamination at all four plant sites has generally remained the same, at high concentrations for the monitoring period between Dec. 2010 through present;
(9) MWG's actions will not significantly reduce or eliminate ground-water contamination from coal ash at the four sites; and
(10) My proposed remedy (Kunkel, 2015b) is economically reasonable compared to other source-term removal remedies or ground-water remediation.

Yours truly,

JmR Kunkel

JAMES R. KUNKEL, Ph.D., P.E.

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ATTACHMENTS

Figure 1	Boron Concentrations in Ground Water at Wells MW-5 through -12 and MW-14 and -15 at Waukegan Site
Table 1	Summary of Constituents Detected in Ground Water at the Waukegan Site Compared to Detection in Bottom Ash Based on the ASTM D3987-85 Test Procedure and Impoundment Ash Leachate Samples

Figure 1 Boron Concentrations in Ground Water at Wells MW-5 through -12 and MW-14 and MW-15 at Waukegan Site

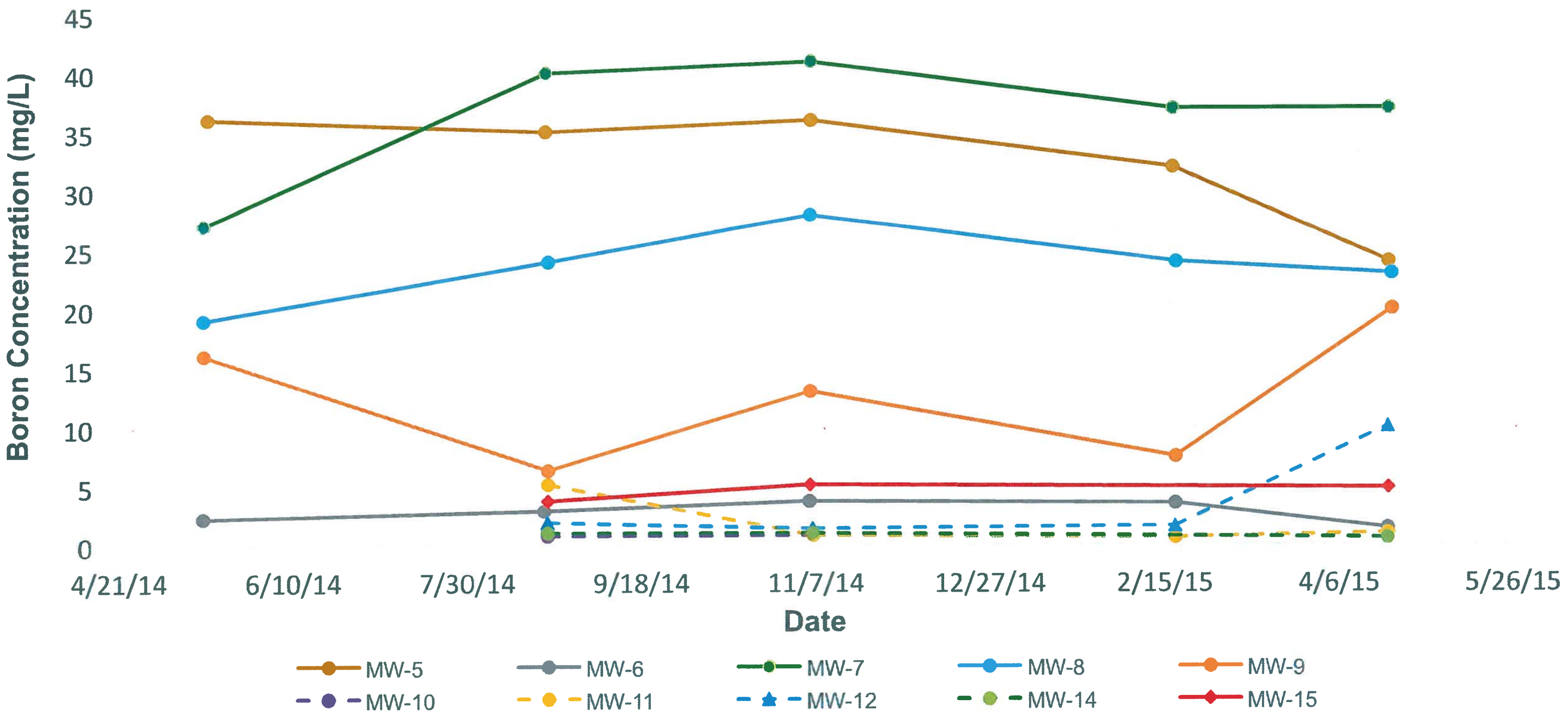

Table 1 Summary of Constituents Detected in Ground Water at the Waukegan Site Compared to Detection in Bottom Ash Based on the ASTM D3987-85 Test Procedure and Impoundment Ash Leachate Samples

Constituent	Detection Limit in Ground Water (1) (mg/L)	Detection Limit in ASTM D3987-85 Test(2) (mg/L)	Constituents Detected in Ground-water During 2014 Quarterly Sampling(1)						
			MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7
Antimony	0.003	0.006	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Arsenic	0.001	0.05	X (3)	X	X	X	X	X	X
Barium	0.0025	0.5	X	X	X	X	X	X	X
Beryllium	0.001	0.004	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Boron	0.5	0.1	X	X	X	X	X	X	X
Cadmium	0.0005	0.005	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Chromium	0.005	0.025	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Cobalt	0.001	0.025	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Copper	0.002	0.025	X	🟩	🟩	🟩	🟩	X	🟩
Iron	0.1	0.1	🟩	🟦 X	🟩	🟩	🟦 X	🟦 X	🟦 X
Lead	0.0005	0.0075	🟩	🟩	X	🟩	🟩	🟩	🟩
Manganese	0.0025	0.025	X	X	X	X	X	X	X
Mercury	0.0002	0.002	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Nickel	0.002	0.025	🟩	🟩	🟩	🟩	X	🟩	🟩
Selenium	0.0025	0.05	X	X	X	X	🟩	X	🟩
Silver	0.0005	0.025	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Sulfate	50	0.002	X	X	X	X	X	X	X
Thallium	0.002	0.002	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Zinc	0.02	0.1	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Number of Observed Constituents that are NOT Consistent with Indicators of Leachate from Ash Currently Stored in the Ash Ponds (4)			0	1	0	0	1	1	1
Percent of Observed Constituents that are NOT Consistent with Indicators of Leachate from Ash Currently Stored in the Ash Ponds			0	5	0	0	5	5	5
Percent of Observed Constituents that ARE Consistent with Indicators of Leachate from Ash Currently Stored in the Ash Ponds			100	95	100	100	95	95	95

(1) From MWG quarterly ground-water monitoring reports.

(2) From Table 5-1 of Seymour (2015).

(3) X means the constituent was detected in ground water at the Waukegan site and also observed in impoundment leachate (Seymour, 2015, Table 5-2) (CONSISTENT).

🟦 (4) means an ash leachate indicator constituent as defined by Seymour (2015, Table 1) was NOT detected by the ASTM D3987-85 test procedure in Waukegan ash pond bottom ash at the detection limit used in the MWG quarterly ground-water monitoring reports (INCONSISTENT).

🟩 (5) means the ash leachate indicator constituent as defined by Seymour (2015, Table 1) was NOT detected in the Waukegan site ground water or the ASTM D3987-85 test procedure in the Waukegan bottom ash (CONSISTENT).